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STAFF REPORT

RENEWABLE POWER IN CALIFORNIA: STATUS AND ISSUES

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ABSTRACT

Developing renewable energy in California will create thousands of jobs, build the businesses of the twenty-first century, increase energy independence, and protect public health. California's Renewable Portfolio Standard requires utilities to increase the amount of renewable generation sold to customers to an average of 20 percent per year from January 1, 2011 to December 31, 2013; 25 percent by December 31, 2016, and 33 percent by December 31, 2020. In addition, Governor Brown's Clean Energy Jobs Plan identifies a goal of installing 20,000 megawatts of renewable generating capacity, including 12,000 megawatts of localized electricity generation and 8,000 megawatts of utility-scale generation, by 2020. This draft report outlines progress toward each of these goals and discusses the issues the state must address to develop clean, renewable electricity generation and the transmission infrastructure needed to bring that electricity to customers as the first step toward creating a strategic plan to increase renewable generation and transmission infrastructure development in California.

Keywords: American Recovery and Reinvestment Act, biomass, California Independent System Operator, California Public Utilities Commission, cogeneration, competitive renewable energy zones, Desert Renewable Energy Conservation Plan, digester gas, distributed generation, energy storage, environmental impacts, environmental justice, feed-in tariff, financing, geothermal, greenhouse gas emissions, renewable integration, interconnection, land use planning, landfill gas, levelized cost, local government, natural gas, permitting, Public Interest Energy Research Program, Public Utilities Regulatory Policies Act, Renewable Energy Action Team, Renewable Energy Transmission Initiative, renewable net short, Renewable Portfolio Standard, small hydroelectric, smart grid, solar photovoltaic, solar thermal, transmission, wind, workforce development.

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EXECUTIVE SUMMARY

Governor Brown's Clean Energy Jobs Plan emphasized the importance of investing in renewable energy as a central element of rebuilding California's economy. Investments in renewable energy create local jobs both in clean tech industries and support industries like construction. Renewable generation facilities also provide economic benefits in the form of increased property and sales taxes. In addition to its contribution to the state's economy, renewable energy also improves California's energy independence by using local energy sources and fuels rather than imported natural gas which is susceptible to supply shortages and price spikes. Increasing the amount of renewable resources in California's electricity portfolio also benefits the environment by reducing fossil-fuel generation that has negative impacts on air and water quality. Renewable resources are also essential to achieving the state's greenhouse gas emission reduction goals and reducing climate change impacts from the electricity sector.

Governor Brown directed the Energy Commission to prepare a plan to "expedite permitting of the highest priority [renewable] generation and transmission projects" to support investments in renewable energy that will create new jobs and businesses, increase energy independence, and protect public health. As the first step in developing a strategic plan for renewable development in California, Energy Commission staff developed the draft *Renewable Power in California: Status and Issues.* This draft plan describes the status of renewable development in the state and identifies challenges that will affect the state's ability to meet its renewable goals. The intent of this document is to develop consensus among stakeholders on the major challenges facing renewable development in California as the basis for development of a more comprehensive strategic plan that establishes a vision, goals, and suggested strategies.

Status of Renewable Development in California

For more than a century, California has used renewable energy – energy from natural resources like sunlight, wind, rain, and the earth's heat – to help meet its electricity needs. Renewable energy represented a relatively small portion of California's electricity mix until the late 1970s when Congress enacted the Public Utility Regulatory Policies Act (PURPA). A key element of PURPA was diversifying and strengthening domestic electricity production by encouraging the development of cogeneration (combined heat and power) and renewable energy facilities. Under Governor Brown's first administration, California established policies to implement this act that resulted in nearly 10,000 megawatts of new cogeneration and renewable generating capacity by the early 1990s. However, declining fossil fuel prices in the 1990s led to a drop in renewable development as PURPA contracts expired and renewable projects were not able to compete with new natural gas turbines.

In response, in 2002 the California Legislature established the Renewable Portfolio Standard (RPS) to diversify the electricity system and reduce growing dependence on natural gas by increasing the amount of renewable electricity in the state's power mix to 20 percent by 2017. In 2006, this target date was accelerated to 2010, and in 2011 the RPS was revised to require that renewable electricity should equal an average of 20 percent of the total electricity sold to retail customers in California during the compliance period ending December 31, 2013, 25 percent by December 31, 2016, and 33 percent by December 31, 2020. To support the RPS targets, Governor Brown's Clean Energy Jobs Plan calls for adding 20,000 megawatts of new renewable capacity by 2020, including 8,000 megawatts of large-scale wind, solar, and geothermal as well as 12,000 megawatts of localized generation close to consumer loads and transmission and distribution lines.

California appears to be on track to achieve the 20 percent by 2013 Renewable Portfolio Standard target, with nearly 16 percent of statewide retail sales coming from renewable generation facilities in 2010. The California Public Utilities Commission reports that more than 2,000 megawatts of new renewable capacity has begun commercial operation since the RPS was established in 2002. Publicly owned utilities have added another 290 MW of renewables since the RPS program began. As of 2010, California had more than 9,000 megawatts of renewable generating capacity, with nearly 6,000 megawatts from utility-scale renewables, 2,292 from wholesale distributed generation facilities, and nearly 1,000 megawatts from customer-side distributed generation systems.

Table ES-1: In-State Renewable Capacity and Generation (2010)

Renewable Resource	Utility-scale Capacity (MW)	Wholesale Distributed Generation Capacity (MW)	Distributed Generation Capacity (MW)	Total Capacity (MW)	Total Generation (GWh)
Biomass	598	454	25	1,077	5,745
Geothermal	2,470	130	0	2,600	12,740
Small Hydro	308	1,072	0	1,380	4,441
Solar	387	16	953	1,356	908
Wind[C]	2,191	620	8	2,819	6,172
Total	**5,954**	**2,292**	**986**	**9,232**	**30,005**

Source: California Energy Commission

California has also made progress toward achieving the Governor's 12,000 megawatt renewable distributed generation goal, with 3,278 megawatts of distributed generation capacity installed as of June 2011. If existing state programs to support distributed generation are fully successful, the state could add 5,400 megawatts of additional capacity in the next five to eight years, leaving a gap of approximately 3,500 megawatts that may require additional programs or incentives. However, given declining trends in solar photovoltaic costs, it may make sense to focus on developing the low hanging fruit and reforming permitting and interconnection processes in the early years to take advantage of cost reductions and improved regulatory structures in later years.

Energy Commission staff have developed regional targets to break down the 12,000 megawatts distributed generation goal into its component parts as a starting point to help meet the goal and measure progress over time. These regional targets are "soft targets" that serve as a starting point for discussions on a local level, and may be reevaluated annually by the Energy Commission.

Table ES-2: Proposed Regional DG Targets by 2020

Region	Behind the Meter (all technologies)	Wholesale	Undefined (mix of behind the meter and wholesale)	Total
Central Coast	280	90	0	370
Central Valley	830	1590	0	2,420
East Bay	420	30	0	450
Imperial	50	90	0	140
Inland Empire	480	430	0	910
Los Angeles, *city and county	970	860	2170	4,000
North Bay	220	0	0	220
North Valley	120	50	0	170
Sacramento Region	410	170	220	800
San Diego	500	50	630	1,180
SF Peninsula	480	10	310	800
Sierras	30	40	0	70
Orange	420	10	40	470
Total	**5,210**	**3,420**	**3,370**	**12,000**

Source: California Energy Commission

As mentioned above, the Governor's Clean Energy Jobs Plan also sets a target for developing 8,000 megawatts of utility-scale renewable generating capacity by 2020. In 2010, more than 9,000 megawatts of new renewable capacity was permitted. Of that amount, about 8,000 megawatts were associated with new California Independent System Operator transmission lines and upgrades (Table ES-3). If these new lines and upgrades are permitted, built, and operating before 2020, they could allow more than 16,000 megawatts of additional generation to flow to load centers at any point in time. Only half of the capacity to fill these lines was permitted last year, meaning another 8,000 megawatts of capacity could be sited in the Competitive Renewable Energy Zones associated with these lines in the future. This is consistent with Governor Brown's goal of 8,000 megawatts of new capacity sited and built by 2020. Some of these zones are located in California's Mojave and Colorado Desert regions. The Energy Commission continues to support a fully integrated transmission and generation planning process, which includes the land use assumptions and natural resource planning information being developed in the state/federal Desert Renewable Energy Conservation Plan process.

Table ES-3: Preliminary Regional Targets for 8,000 Megawatts of New Renewable Capacity by 2020

Identified Transmission Line (s)	CREZ Served	Total Additional Capacity with New/Upgraded Lines (MW)[A]	Project Capacity Permitted in 2010 Associated with the New/Upgrades (MW)[B]	Additional Project Capacity for 8,000 MW of New Large-Scale Renewables (MW)
Sunrise Powerlink	Imperial North and South, San Diego South	1,700	760	940
Tehachapi and Barren Ridge Renewable Transmission Projects	Tehachapi, Fairmont	5,500	2,810	2,690
Colorado River, West of Devers, and Path 42 Upgrade	Riverside East, Palm Springs, Imperial Valley	4,700	1,825	2,875
Eldorado-Ivanpah, Pisgah-Lugo, and Coolwater-Jasper-Lugo	Mountain Pass, Pisgah, Kramer	2,450[C]	1,470	980
Borden-Gregg	Westlands	800	145	655
South of Contra Costa	Solano	535	155	380
Carrizo-Midway	Carrizo South, Santa Barbara	900	800	100
TOTAL				8,620

[A] California Energy Commission data.
[B] Renewable Energy Action Team database. Only projects associated with the transmission projects specified were included.
[C] The total deliverability potential with these lines could be as high as 3800 MW. However, the Eldorado-Ivanpah and the Pisgah-Lugo lines upgrade the same corridor and the capacity associated with the new lines may not be additive. The 2,450 MW includes the deliverability linked to the Pisgah-Lugo and the Coolwater-Jasper-Lugo lines.

Source: California Energy Commission

Looking forward, California has significant potential for additional renewable development to meet the 33 percent RPS target, with an estimated 18 million megawatts of renewable technical potential (the amount of generating capacity theoretically possible given resource availability, geographical restrictions, and technical limitations like energy conversion efficiencies). Achieving even a fraction of this potential, however, will depend on the ability of project developers to secure financing, permits, transmission, interconnection, and power purchase contracts.

Table ES-4: California's Renewable Energy Potential

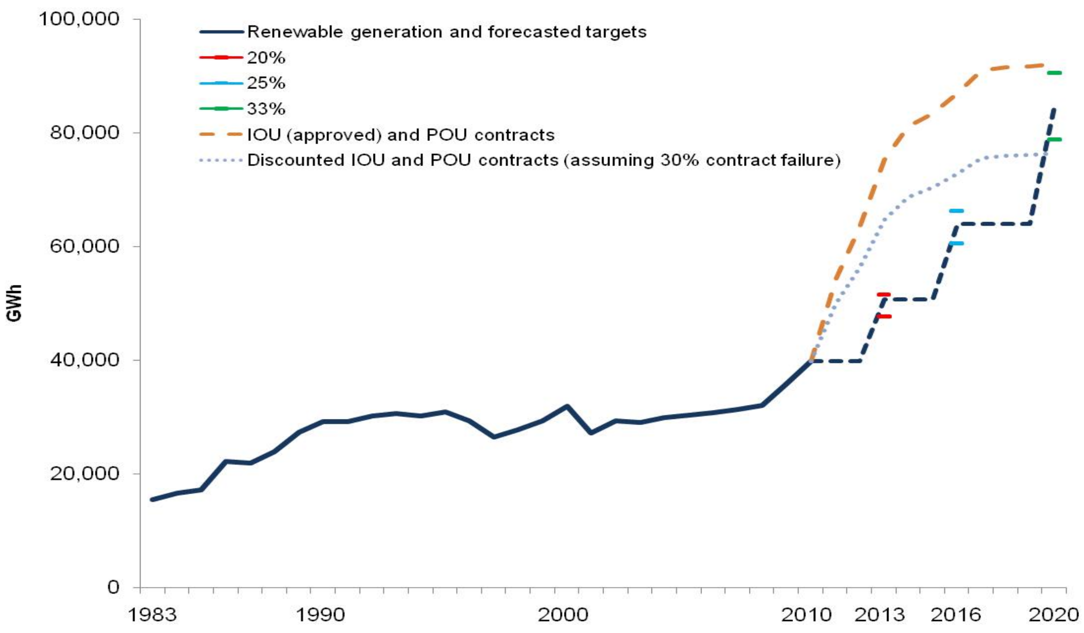
Technology	Technical Potential (MW)
Biomass	3,820
Geothermal	4,825
Small Hydro	2,158
Solar	
Concentrating Solar Power	1,061,362
PV	17,000,000
Wave and Tidal	32,763
Wind	
On-shore	34,000
Off-shore	75,400
TOTAL TECHNICAL POTENTIAL	**18,214,328**

Source: California Energy Commission.

Although an estimate of renewable market potential is beyond the scope of this report, recent trends indicate an increasing market interest in renewable development. The 2009 RPS solicitation by the California Public Utilities Commission drew bids from developers offering to supply enough renewable generation to meet half of the investor-owned utilities' total electrical load in 2020, and utilities currently have signed contracts for between 9,305 and 10,505 megawatts of new renewable capacity. In 2010, state and local entities issued permits for 9,435 megawatts of renewable capacity, and renewable projects totaling nearly 26,000 megawatts of capacity are currently being tracked in various permitting processes. As mentioned above, the California Independent System Operator's Interconnection Queue includes approximately 57,000 megawatts of renewable capacity, and there are 450 active interconnection requests for distributed generation systems in the Wholesale Distribution Access Tariff queue totaling approximately 5,200 megawatts.

The ability of developers to successfully navigate through each of these processes will affect the amount of renewable generation that is ultimately built and contributing toward meeting the state's renewable energy goals. Estimates of the amount of renewable energy needed to meet the 33 percent by 2020 RPS target beyond what is expected to be provided by existing facilities in 2020 range from 35,300 gigawatt hours to 47,000 gigawatt hours. As of May 2011, enough renewable generation was either on-line or under contract to achieve this range, assuming all existing renewable facilities remain on-line in 2020 and all to most of the contracted renewables are built (Figure ES-1).

Figure ES-1: On-Line or Contracted Generation to Meet Renewable Portfolio Standard Goals



Source: California Energy Commission

However, this estimate includes a number of short-term contracts that may not be renewed, as well as existing facilities that may retire due to age or contract expiration, which could reduce the contribution from existing facilities. There is also risk of contract failure; data from the Energy Commission's investor-owned utility contract database indicates that since the start of the RPS program, about 30 percent of long-term RPS contracts (10 years or more) approved by the California Public Utilities Commission have been cancelled. This suggests utilities should be contracting for a renewable net short in the range of 50,500 gigawatt hours to 67,000 gigawatt hours.

Post 2020, additional investments in renewable generation may be needed to replace generation expected to decline over the course of the next decade, such as generation from expiring coal contracts. Generation from a number of these contracts, which currently represents about 10 percent of total generation serving California, is expected to decline by 61 percent between 2010 and 2020 due to constraints imposed by the Emission Performance Standard. Remaining coal contracts are expected to expire between 2027 and 2030, which will require replacement with a mix of renewable and thermal generation with storage to satisfy electricity needs while still meeting greenhouse gas emission reduction goals.

When signing the 2011 RPS legislation, Governor Brown indicated that the 33 percent by 2020 RPS target should be considered a floor rather than a ceiling. This is consistent with the need for additional renewable generation and other zero-carbon electricity resources to meet the state's long-term (2050) carbon reduction goals. A back-of-the-envelope estimate of the amount of renewable electricity needed to serve all new electricity demand through 2050 is 64 percent of total electricity sales in 2050. This assumes that energy efficiency programs in the long-term are developed at rates targeted for 2010-2020, distributed generation targets established in the Governor's Clean Energy Jobs Plan are met, more than five million full electric and hybrid vehicles along with high-speed rail are developed by 2050, existing in-state renewable facilities operate through 2050, and existing nuclear plants are relicensed through 2050. If the nuclear plants are not relicensed, the estimate of renewable energy needed to provide zero-emission generation needed in 2050 rises to 77 percent.

Issues Affecting Future Renewable Development in California

This draft *Renewable Power in California: Status and Issues* identifies many of the challenges that must be addressed in order to achieve California's renewable energy targets and goals. Planning, permitting, and environmental issues can delay or jeopardize project development and also increase development costs. Because many renewable resources are located in remote areas, the state will need to upgrade existing or develop new transmission infrastructure to bring electricity from these areas to the state's load centers. This is made more complex by the current disconnect between generation and transmission planning and permitting processes wherein the length of time needed for transmission development requires transmission projects to proceed while there is still uncertainty about where generators will ultimately be located.

Once generation and transmission infrastructure is in place, there are further issues with integrating large amounts of intermittent renewable electricity, such as solar and wind, into the state's electric grid. Because generation from these resources may vary over time in periods as short as seconds, it can cause difficulties for grid operators who must maintain a constant balance between generation supply and real-time customer demand while also meeting established standards for controlling fluctuations in frequency and voltage. Connecting distributed generation projects to the distribution system also involves challenges because of aging infrastructure that also was not designed to accommodate the two-way flows of electricity that can result from high levels of distributed generation on the system.

On the financial side, there are financing gaps at certain stages of renewable development as well as costs associated with environmental review and permitting, construction, and interconnection of renewable facilities. Significant investment is needed to bring down the costs of existing renewable technologies and develop the new technologies that will be crucial to integrating renewable technologies into the grid. However, investment in energy-related research and development is currently about $1 billion less than a decade ago. In the absence of private and corporate funding for energy-related research and development, government funding for research – such as that provided by the Energy Commission's Public Interest Energy Research Program – becomes even more critical to maintaining the state's leadership role in developing a clean energy economy.

These and other issues discussed in this draft report and current efforts that are helping to address these challenges are summarized below.

Planning, Permitting and Environmental Issues

- **Site selection:** One of the main lessons learned during the Energy Commission's permitting of more than 4,000 megawatts of large solar thermal power plants in the California desert in 2010 is that location matters. Locating renewable facilities on undisturbed and/or sensitive lands in the desert raises a host of environmental concerns, including impacts on sensitive animal and plant species, water supplies and waterways, and cultural resources such as areas of historical or ethnographic importance. There are also land use concerns since the majority of desert lands in California are owned by the federal government and managed for multiple uses, including recreation, wildlife habitat, livestock grazing, and open space.

  To help developers design projects that minimize environmental impacts for renewable projects in the desert, the state's Renewable Energy Action Team in December 2010 published the multidisciplinary *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*. The Desert Renewable Energy Conservation Plan being developed by the Renewable Energy Action Team is also identifying areas in the Mojave and Colorado Desert regions suitable for renewable energy project development and areas that will contribute to the conservation of sensitive species and natural communities. To contribute toward reducing environmental impacts of renewable energy facilities, the Energy Commission's Public Interest Energy Research Program is identifying strategies to reduce the effects of desert solar and wind projects on sensitive species as well as low-risk sites for wind turbine installations to reduce avian impacts.

- **Fragmented or overlapping licensing authority:** A variety of federal, state, and local agencies have licensing authority for different types of utility-scale renewable projects. This can result in inconsistent environmental reviews and standards along with inaccurate and incomplete information on biological and cultural resource impacts. Although state and federal protocols for analyzing these impacts are essentially the same, there is wide variation in the extent of the evaluation, interpretation of results, and mitigation requirements. When involved agencies cannot agree on a set of mitigation or licensing conditions, developers have to satisfy more than one set of conditions, submit duplicate information, or face delays while agencies attempt to come to agreement.

  The Renewable Energy Action Team is working to streamline and expedite permitting processes for renewable energy projects, and state and federal agencies are increasing cross-agency cooperation and coordination of renewable permitting processes through a variety of multi-agency agreements. In addition, the Energy Commission's Order Instituting Information Proceeding is identifying "lessons learned" during the licensing of large-scale renewable energy facilities in 2010 with the goal of identifying new and innovative approaches to planning and permitting in the future.

- **Unclear, duplicative, and uncoordinated requirements for renewable distributed generation projects:** Distributed generation projects are permitted at the local level, but many cities and counties do not have energy elements in their general plans or zoning ordinances to guide renewable development. In addition, the wide variation in standards, codes, and fees among local governments make it difficult for developers to meet permit requirements. Land-use requirements for identical systems can vary significantly from jurisdiction to jurisdiction. Fees also vary widely among municipalities and even within municipalities for the same system size, and are often based on project cost rather than staff time needed for permit review, with many municipalities exceeding estimated cost recovery fees. Developers must also get permit approvals from local fire departments, building and electric code officials, and local air districts, leading to duplication and inefficiency in the permit application process. Finally, while distributed generation projects are subject to an environmental review under the California Environmental Quality Act and in some cases the National Environmental Protection Act, many local permitting agencies only have thorough environmental screening and review processes in place for traditional development and are ill-prepared to assess environmental impacts associated with renewable distributed generation.

There are multiple efforts at the national, state, and local levels to identify and provide solutions to barriers to permitting renewable distributed generation facilities. The U.S. Department of Energy's Solar America Cities Program provided funding for cities that promote solar power and streamline interaction between local government and residents. In addition, the U.S. Department of Energy's SunShot Initiative provides funding to encourage cities and counties to streamline and digitize permitting processes and to develop innovative information technology systems, local zoning and building codes, and regulations. At the state level, the California State Assembly has introduced Assembly Bill X1 13 (V. Manuel Perez, Bradford and Skinner) which would require the Energy Commission to provide $7 million in grants to qualified counties in California to develop or revise rules and policies, including general plan elements, zoning ordinances, and a natural community conservation plan, to facilitate the development of eligible renewable energy resources. At the local level, many jurisdictions are supporting renewable distributed generation through strategies like identifying permitting barriers and developing expedited permitting processes, offering on-line permits for solar photovoltaic systems, and offering permit fee waivers for solar and wind projects. The California County Planning Directors Association is also coordinating a multi-stakeholder effort to draft a model ordinance for solar electric facilities for cities and counties across the state.

Transmission Issues

- **Ensure interconnection of renewable generation projects receiving federal stimulus funding:** There are 13 major transmission projects critical to the interconnection and deliverability of renewable generation in California needed to meet the 33 percent by 2020 renewable mandate (Table ES-5).

Table ES-5: Major Transmission Projects for Interconnection and Deliverability of Renewable Generation in California

Balancing Authority	Transmission	Served CREZ	Cumulative Renewable Deliverability Potential (MW) With Upgrade	Expected Commercial On-line Date
California ISO	Sunrise Powerlink (new 500 kV and 230 kV lines)	Imperial North and South, San Diego South	1,700	2012
California ISO	Tehachapi Renewable Transmission Project	Tehachapi, Fairmont	4,500	2015
California ISO	***Colorado River –Valley Transmission Project and new Colorado River and Red Bluff 500 kV substations.***	***Riverside East, Palm Springs***	***4,700 combined with West of Devers project***	***2013***
California ISO	***Eldorado - Ivanpah 115 to 230 kV conversion***	***Mountain Pass***	***1,400***	***2013***
California ISO	Borden - Gregg (230 kV line reconductoring)	Westlands	800	2015
California ISO	South of Contra Costa (reconductoring)	Solano	535	2015
California ISO	***Pisgah - Lugo 230 kV to 500 kV conversion***	***Pisgah, Mountain Pass***	***1,750***	***2017***
California ISO	***West of Devers 230 kV reconductoring***	***Riverside East, Palm Springs***	***4,700 combined with Colorado River- Valley Project***	***2017***
California ISO	Carrizo - Midway sections of Morro Bay - Midway (230 kV lines reconductoring)	Carrizo South, Santa Barbara	900	2012
California ISO	***Coolwater – Jasper – Lugo (new 230 kV line and other upgrades)***	***Kramer***	***700***	***2018***
California ISO/Imperial Irrigation District (IID)	Path 42 Upgrades	Imperial Valley	1,400	2015
IID	Internal IID Upgrades	Imperial Valley	See above	2011+
Los Angeles Dept. of Water and Power	***Barren Ridge-Renewable Transmission Project***	***Tehachapi, Barren Ridge***	***1,000***	***2016***

Source: California Energy Commission

Many of the projects in Table ES-4 are needed to interconnect renewable generation projects receiving funding through the American Recovery and Reinvestment Act that will be essential to achieving the state's renewable goals (indicated in the table by bold italics). While a number of the 13 projects have been licensed or are currently under construction, several key projects do not yet have active licensing applications.

- **Lack of coordinated land use and transmission system planning:** Transmission planning processes need to be streamlined and coordinated to ensure siting, permitting, and construction of the most appropriate transmission projects to connect renewable resources while ensuring proper consideration of land use and environmental considerations. Currently, the project development process which identifies routing issues and constraints does not begin until after the "wires" planning process is complete. This lengthens the transmission development process and also increases the risk of approved transmission projects not being developed due to environmental issues. In addition, assumptions and processes used by transmission planning organizations are not always transparent or consistent, and the large number of planning forums makes it difficult for stakeholders to participate effectively.

The Renewable Energy Transmission Initiative was a statewide land use planning process to help identify transmission projects needed to meet the state's renewable energy goals. This effort identified approximately 30 "competitive renewable energy zones" (CREZs) throughout the state that were most likely for cost-effective and environmentally benign generation development with corresponding transmission interconnections and lines. This established the precedent for incorporating land use planning into the statewide transmission planning process, and led directly to the collaborative land use planning activity occurring in the Desert Renewable Energy Conservation Plan process. Energy agencies are working together to develop a "virtual" process to ensure integration of land use planning from the Desert Renewable Energy Conservation Plan into the California Independent System Operator's annual transmission planning process.

In addition, the California Transmission Planning Group, formed in 2009, is working to address California's transmission needs in a coordinated manner by developing a conceptual statewide transmission plan that identifies the necessary transmission infrastructure to meet the state's 33 percent by 2020 RPS goal. The California Independent System Operator has also revised its transmission planning process to include transmission upgrades needed to meet California's policy mandates, with the 2010-2011 Transmission Plan focusing on the RPS mandate in identifying policy-driven transmission projects. The California Independent System Operator also requested and received a one-time waiver from the Federal Energy Regulatory Commission to exempt upgrades associated with renewable projects receiving federal stimulus funding from further study in the 2010-2011 transmission planning process to allow generators to meet the construction start date of December 31, 2010.

- **Better use of the existing grid:** Currently, proposed projects are based on existing need demonstrated by individual interconnection requests. Allowing "upsizing" of projects, for example by constructing a double circuit line in an existing right-of-way, can provide unused capacity available for future use and maximize the value of land associated with already necessary transmission investment and avoid future costlier upgrades needed to accommodate additional renewable development.

  One of the goals of the Desert Renewable Energy Conservation Plan is to support consolidation of renewable development, including transmission infrastructure, rather than scattered "leapfrog" development. In addition, the Energy Commission's Public Interest

Energy Research Program has funded a wide variety of projects related to improving the performance of the existing transmission system, including technologies to increase the carrying capacity of existing lines, reduce instabilities that are causing some transmission connections to be operated thousands of megawatts below maximum capacity, and develop transmission cables that can be operated at higher temperatures and allow more power to be transferred over existing transmission rights-of-way.

Integration Issues

- **Grid-level integration:** Maintaining reliable operation of the electric system with high levels of intermittent resources will require regulation to follow real-time ups and downs in generation output, voltage, or frequency caused by changes in generation or load; ramping generation from other units up or down to follow swings in wind or solar generation; spinning reserves provided by generating resources standing by and ready to connect to the grid if needed, and replacement power for outages. In addition, system operators need strategies to address potential overgeneration issues that occur when there is more generation than there is load to use it. California currently relies on large hydropower and natural gas generators to provide many of the services needed to integrate intermittent renewable resources, but as more renewable generating facilities are added to the system, it will become increasingly challenging to maintain system reliability and stability.

  Successful integration will require improvements in forecasting of wind and solar technologies so that transmission and generation dispatchers know how much variability to plan for. In addition, complementary technologies like natural gas-fired power plants, energy storage, and demand response can be used to provide integration services. Natural gas units can provide quick start up, rapid ramping, regulation, spinning reserves, and energy when intermittent resources are not available. Energy storage can provide flexible and controllable ancillary services at the transmission level through voltage support and frequency response, and can also store excess energy when on-line generation exceeds load. Demand response – having electricity customers reduce their consumption at critical times or in response to market prices – can help with integration by combining smaller loads to provide regulation or ramping through automatic controls that turn individual loads up or down as needed.

  There are a number of efforts underway to address integration issues. The California Independent System Operator is working to improve its forecasting techniques to reduce uncertainty and the amount of standby capacity that will be needed to compensate for variations between generation and load. Formal planning for adding cost-effective energy storage to the electric system began with the passage of Assembly Bill 2514 (Skinner, Chapter 469, Statutes of 2010) which directed the California Public Utilities Commission and publicly owned utilities to evaluate the need for and benefits of cost-effective and viable energy storage systems, and determine appropriate targets by October 2013. Demand response is currently being used throughout the United States for ancillary services, and the California Independent System Operator currently offers two demand response products that are laying the foundation for the role of demand response in renewable integration efforts. In addition, the California Independent System Operator is scheduled to implement a regulation energy market in spring 2012 that will allow demand response and energy storage to submit bids to provide ancillary services. The California Public Utilities Commission is also evaluating integration costs as part of its Long-term Procurement Plan proceeding for various scenarios. Finally, the Energy Commission's Public Interest Energy Research Program is funding a wide array of projects intended to develop better forecasting tools for wind and solar generation, develop and demonstrate energy storage technologies, identify ways that demand response can support renewable integration, and develop the smart grid of the future.

- **Distribution-level integration:** There are also significant challenges to integrating large amounts of renewable distributed generation into the distribution system which brings power from substations to consumers. These resources include small projects on the customer side of the meter that produce energy to satisfy a customer's own electric load; medium-sized projects that provide energy for a customer's load, for export to the grid, or some combination of the two; and larger systems that export all of their power to a utility or some other entity. Today's distribution system still uses designs, technologies, and strategies that were developed to meet the needs of mid-20th century customers. While these large and complex systems have historically provided reliable electric power to tens of millions of customers throughout the state, aging infrastructure coupled with modern demands is beginning to erode this capability. One major challenge is that the system is currently designed to move electricity in one direction, from central-station generator to substation to customer. However, as more distributed generation is added to the system, power generated by these resources may exceed demand and flow backwards into circuits or substations, requiring new protection and control strategies to avoid damaging the electric system. Another challenge is the increasing number of requests for interconnection and the need to reduce the complexity, expense, and length of time associated with that process.

  California utilities are already modernizing their distribution systems by replacing equipment at the end of its useful life with new equipment that often has more advanced communication and functional capabilities. This modernization is likely to increase as a result of Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) which requires utilities to develop smart grid deployment plans. To address interconnection challenges, the California Public Utilities Commission has established the Renewable Distributed Energy Collaborative working group. There are also fast-track processes available within each of the state's interconnection processes to streamline interconnection of smaller projects, and utilities are providing information on their websites to allow developers to identify locations on the distribution grid where projects can be interconnected more quickly and at lower cost. The Energy Commission and the California Independent System Operator are also currently funding a study on renewable distributed generation integration in Germany and Spain to identify strategies that can be applied to California's system. Other research funded through the Public Interest Energy Research Program is focused on predicting the impacts of distributed generation on distribution circuits, and developing smart grid and battery storage technologies that can support integration at the distribution level.

Investment and Financing Issues

- **Ensuring adequate financing at critical stages of renewable project development:** Like all emerging industries, there are key financing challenges that face renewable energy development including acquiring significant capital that is injected at the right time, incentives that drive down costs, and solutions that help to reduce or mitigate risk. Lack of funding during early stages of project development can affect the ultimate success of a renewable project. There is little financial incentive for private companies to invest in the types of research and development that are most beneficial to society because there is no certainty of return on their investment. During the later stage of early commercial development, significant capital is needed to finance projects and demonstrate the viability of a project at scale. Technologies currently at or anticipated to be at this stage over the next three years include concentrating solar power towers, advanced solar manufacturing, and energy storage. Because these funding gaps are not addressed by the private sector, government has an important role to play in addressing financing challenges by promoting research and early technology innovations, reducing credit risks, and developing and maintaining stable and predictable regulatory policies to inform medium- and long-term investment decisions.

  National government laboratories are helping to address these funding gaps by performing cutting-edge research on a variety of clean energy technologies. In addition, the federal Advanced Research Projects Agency – Energy funds high-risk, high reward technologies to bridge the gap between basic energy research and industrial application. Other federal government support mechanisms include tax incentives such as the business energy investment tax credit and the renewable production tax credit as well as accelerated depreciation of renewable energy assets and loan and bond financing programs. There are a number of state incentives as well, including programs to support renewable distributed generation and sales and use tax exclusions under California's Advanced Transportation and Alternative Sources Manufacturing Sales and Use Tax Exclusion Program. On the research side, the Public Interest Energy Research Program provided approximately $179 million for renewable energy research between 1997 and 2010, including seed funding for technology incubators that accelerate the growth and development of clean technologies. Other efforts include the state's Innovation Hub initiative which leverages research parks, technology incubators, universities, and federal laboratories to provide an innovation platform for startup companies, economic development organizations, business groups, and venture capitalists. Finally, tools like feed-in tariffs (one of the most widely implemented renewable policies in place in 61 countries and 26 states/provinces) are providing greater certainty of project revenues, reducing transaction costs, and helping projects to secure financing.

Cost Issues

- **Renewable technology costs:** Renewable technologies have a wide range of costs depending on the technology. More mature technologies, like geothermal and biomass, have a narrower range of levelized cost than emerging technologies, although biomass costs too can vary depending on feedstock availability. Historically, technologies like solar thermal electric and solar photovoltaics were thought to have levelized costs greater than those of conventional generation. However, recent contract bids show that this is changing. According to the Energy Commission's investor-owned utility contract database, the majority of solar thermal power tower technology contracts that have been signed and are pending are below the 2009 Market Price Referent, a proxy for the levelized cost of a new 500-megawatt natural gas combined cycle.

  In addition, in the past distributed generation projects were considered more costly due to higher transaction costs and lack of economies of scale. However, standardization of contract terms and the way photovoltaics are manufactured and sold have affected bids for distributed generation systems. Pacific Gas and Electric and Southern California Edison have filed advice letters with the California Public Utilities Commission stating that all contracts signed under their solar photovoltaic programs, which are for projects 20 megawatts and smaller, are also below the Market Price Referent.

  As retail rates increase and solar photovoltaic costs drop, distributed generation projects on the customer side of the meter are also likely to become more cost competitive even without state rebate programs. For example, even though Pacific Gas and Electric is offering a Performance Based Incentive of only 5 cents per kilowatt hour (down from 39 cents per kilowatt hour less than five years ago), systems are continuing to be installed. It is likely that there will be significant changes in the market in the next five to ten years as distributed generation systems become more cost competitive.

  For utility-scale renewable projects, the Energy Commission is continuing to work with the California Independent System Operator and the California Public Utilities Commission to determine the costs of transmission and renewable integration. While costs of both appear significant, they are certainly not insurmountable. Distribution system upgrades and modernization could be significant depending on the location of distributed generation projects and the pace at which they are deployed. However, there are a variety of efforts to identify optimal locations for such projects and to develop the smart grid technologies needed to facilitate integration into the distribution system.

  Finally, in any discussion of the costs of renewable technologies, it is important to recognize that renewables provide important benefits that have not been adequately quantified, such as the value of having a diverse portfolio of generating resources which reduces costs and risk to ratepayers, business and economic development benefits, reduced dependence on natural gas and vulnerability to natural gas supply shortages or price spikes, and reduced greenhouse gas emissions and climate change impacts.

Research and Development Issues

- **Maintaining state funding for energy-related research and development**: Continued public sector investment in energy-related research and development is essential to address the various challenges to achieving California's renewable energy goals. The Public Interest Energy Research Program has funded a wide variety of research activities to identify ways to mitigate the environmental impacts of renewable energy facilities; develop technologies to improve the performance of the state's transmission and distribution systems; facilitate integration of renewable generating technologies at both the transmission and distribution level through the development of smart grid, energy storage, and demand response technologies; and reduce renewable technology costs while improving efficiency. With increasing levels of renewable resources in California's electricity mix, continued research will be required in each of these areas to provide the technological advancements needed to support the state's clean energy policy goals.

Environmental Justice Issues

- **Addressing environmental justice concerns:** Environmental justice is defined in California law as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." Environmental justice organizations have repeatedly voiced concerns about the types of power plants that will be built to meet increased electricity demand and replace aging power plants and plants that may retire as a result of the State Water Resources Control Board's policy on the use of once-through cooling in power plants, particularly in the southern part of the state which has some of the worst air quality in the nation. There are also concerns about the types of fossil generation that may be built to support renewable integration, including flexible natural gas turbines ("peakers") that are less efficient that baseload resources and have increased emissions which may impact the communities in which they will be located.

  The Energy Commission has considered environmental justice issues in its power plant licensing process since 1995, including conducting outreach to community members, identifying areas potentially affected by emissions or other environmental impacts, determining where there are significant populations of minority or low-income residents in an area potentially affected by proposed projects, and determining whether there may be a disproportionate effect on minority or low-income populations. However, given figures in the 2010 census that indicate California has the highest minority population in the nation at 57 percent, it is likely that new power plants, including those that use renewable resources, will be located in areas that could affect minority communities.

Local Government Coordination Issues

- **Coordination between state and local governments on energy decisions**: Renewable development at the local level will be an essential component of the state's efforts to meet its renewable energy goals. Local governments are closely involved in land use decisions, environmental review, and permitting for a wide range of renewable projects. Many local governments face constraints due to scaled-back staffing as a result of the economic downturn, limited expertise about renewable technologies, and lack of energy elements in their general plans and ordinances that could delay the processing of permits for renewable facilities. However, a number of local jurisdictions are showing strong leadership and innovation in promoting renewable energy development, including Kern County, Imperial County, Inyo County, Los Angeles County, San Diego County, San Luis Obispo County, Solano County, Fresno County, Tulare County, Marin County, and the cities of Fremont, Santa Rosa, San Jose, Sacramento, Lancaster, Santa Monica, and Berkeley.

Workforce Development Issues

- **Ensuring a well-trained workforce to support California's renewable policy goals**: Nationwide, the clean economy employs more workers than the fossil fuel industry, with California having the highest number of clean jobs. While the clean economy grew more slowly than the national economy between 2003 and 2010, newer clean tech segments like wind, solar photovoltaics, and smart grid produced explosive job gains. While much of this growth is creating demand for workers in existing occupations, it is also driving the need for workers who need to enhance their skills and for those who need training for emerging occupations. As investment in the clean economy continues to expand, there is a need for a coordinated approach to workforce training that is closely aligned with labor demand. Although there are a number of workforce training programs in place, the fragile economy has made employers hesitant about taking on more employees which has resulted in low placement rates for some of these programs. In addition, expiration of federal stimulus funding for workforce development may make it difficult for community colleges, trade associations, and other training providers to continue their clean energy training curricula in the future.

  California is at the forefront of workforce training efforts for the green economy with its Clean Energy Workforce Training Program, the largest state-sponsored green jobs training program in the nation. In addition, the Energy Commission's Clean Energy Business Financing Program has awarded funding to six companies focused on production of solar photovoltaic panels that are creating 640 jobs throughout the state.

Public Leadership Issues

- **Demonstrating public leadership**: California has the potential to develop renewable energy systems on state owned buildings, properties, and rights-of-way to help meet the state's renewable energy goals, create green jobs, and reduce greenhouse gas emissions and other harmful air pollutants. These investments will also reduce energy costs in state buildings and create new revenue for state government through the lease of vacant or unused land. State leadership will also demonstrate the benefits of renewable distributed generation and help encourage larger-scale deployment throughout the state and across the country.

  In December 2010, the Energy Commission adopted a memorandum of understanding with the Departments of General Services, Corrections and Rehabilitation, Transportation (Caltrans), Water Resources, and Fish and Game to facilitate the development of renewable energy projects on state buildings, properties, and rights-of-way. The California State Lands Commission and the University of California have since signed on to this effort, and there is an option for additional agencies to join in the future. Based on its inventory of state properties to identify opportunities for deployment of renewable distributed generation systems, Energy Commission staff recommended a target of 2,500 megawatts of new renewable generating capacity on state properties. There are already a number of efforts underway by various state agencies that will contribute toward meeting these targets.

Conclusion

Achieving California's aggressive renewable energy goals will require a concerted effort by state agencies, utilities, environmental groups, and other stakeholders to develop a strategic plan that includes a clear vision, quantifiable and measurable goals, a set of strategies for achieving those goals, and milestones against which to measure progress. This staff draft *Renewable Power in California: Status and Issues* is the first step in developing such a strategic plan. The Integrated Energy Policy Report Committee seeks stakeholder input on whether the issues identified in this draft report are accurately characterized and whether they are the highest priority issues that need to be addressed. Stakeholder input will be used to further refine this document in preparation for developing a more comprehensive strategic plan by mid-2012.

Chapter 1: Introduction

California's Renewable Legacy

Governments, businesses, and environmental groups throughout the world are increasingly promoting the use of renewable energy to address a myriad of goals including resource diversification and security, reliability and safety, economic growth and competitiveness, and climate change mitigation. In California, renewable energy and energy efficiency are the cornerstones of the state's energy policy.

However, the concept of renewable energy – energy from natural resources like sunlight, wind, rain, tides, and the Earth's heat that are naturally replenished – is hardly new. Prior to the discovery of fossil fuels in the mid-18th century, renewable resources were the only available sources of energy. More modern applications of renewable resources have been part of Californian's lives since the late 19th century, when one-third of households in Pasadena relied on solar thermal water heating and more than 1,600 solar water heating systems were installed throughout Southern California by 1900.[1] In addition, in 1887, the High Grove Hydroelectric Station in San Bernardino – the first hydroelectric power plant in the West – began operating and providing electricity to customers in California.[2] The first cogeneration (or combined heat and power) systems were also developed at the beginning of the 20th century, such as the Pacific Lumber biomass combined heat and power plant in Scotia built in the 1920s, when industrial facilities generally produced their own electric power and used thermal energy available during the process to provide or supplement process or building heat.[3] In the 1920s, the nation's first geothermal power plant, capable of generating 250 kilowatts, started operating at the Geysers geothermal resource area north of San Francisco, and the country's first large-scale geothermal plant was subsequently developed at the Geysers in 1960 by Pacific Gas and Electric Company.[4]

Renewable energy in the transportation sector has also been used for more than a century. In 1900, electric cars were in their heyday, with about 28 percent of all cars produced in the United States powered by electricity.[5] In 1908, Henry Ford's first Model T left the factory with a flexible hybrid engine capable of using either ethanol – a renewable fuel – gasoline, or kerosene.[6] Other

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1 "The Suns Up Now On Solar Thermal Hot Water; Building on a Rich History," May 2011, http://www.bluepacificsolar.com/blog/?p=2548.

2 U.S. Department of the Interior, Bureau of Reclamation, History of Hydropower Development in the United States, http://www.usbr.gov/power/edu/history.html.

3 http://www.industcards.com/biomass-usa-ca.htm.

4 U.S. Department of Energy, A History of Geothermal Energy in the United States, http://www1.eere.energy.gov/geothermal/history.html.

5 PBS.org, "Timeline: History of the Electric Car," http://www.pbs.org/now/shows/223/electric-car-timeline.html.

6 "Ethanol History: From Alcohol to Car Fuel," http://www.ethanolhistory.com/.

alternative fuels include liquefied petroleum gas (commonly called propane) which has been used as a transportation fuel since the 1930s.[7]

Renewable electricity development was relatively stagnant until the 1970s when, in response to the oil crisis, Congress enacted the Public Utility Regulatory Policies Act (PURPA) in 1978 to diversify and strengthen domestic electricity production. Under Governor Brown's first administration, California instituted policies to aggressively implement this act and stimulate development of renewable electricity generating resources.[8] The California Public Utilities Commission (CPUC) adopted standard contracts for Qualifying Facilities under PURPA that resulted not only in a resurgence of cogeneration fueled by natural gas and biomass, but also in the expansion of geothermal development at the Geysers and commercialization of geothermal power in the Imperial Valley and Coso geothermal resource areas, development and commercialization of wind and biomass energy, and construction of the world's largest solar thermal electricity facility in California's Mojave Desert. By the end of 1991, the standard offer contracts had resulted in nearly 10,000 megawatts (MW) of Qualifying Facilities on-line in California, about half of which used renewable resources.[9] Today, operating Qualifying Facility capacity in California is about 7,300 MW, half of which is provided by renewable facilities, and about 95 percent of which was on-line prior to 1993.[10]

PURPA required utilities to purchase power from renewable generators at the utilities' full avoided cost. In California, standard offer contracts provided escalating fixed energy payments for 10 years. Based on high oil price projections and expensive nuclear power, prices for standard offer contracts often exceeded 10 cents per kilowatt-hour (kWh). As standard offer contracts expired and avoided costs declined to 3 cents per kWh, renewable electricity projects were not able to compete with new natural gas turbines, leading to 300 MW of renewable energy being shut down between 1993 and 1997.[11] Figure 1 shows the drop in renewable generation during this period. Today, California is at a similar crossroads with the availability of cheap and plentiful natural gas.

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7 California Energy Commission, *ABCs of AFVs: A Guide to Alternative Fuel Vehicles*, November 1999, http://www.sceneoftheaccident.org/erg/Alternative%20Fuel%20Vehicles%20Guidebook.pdf.

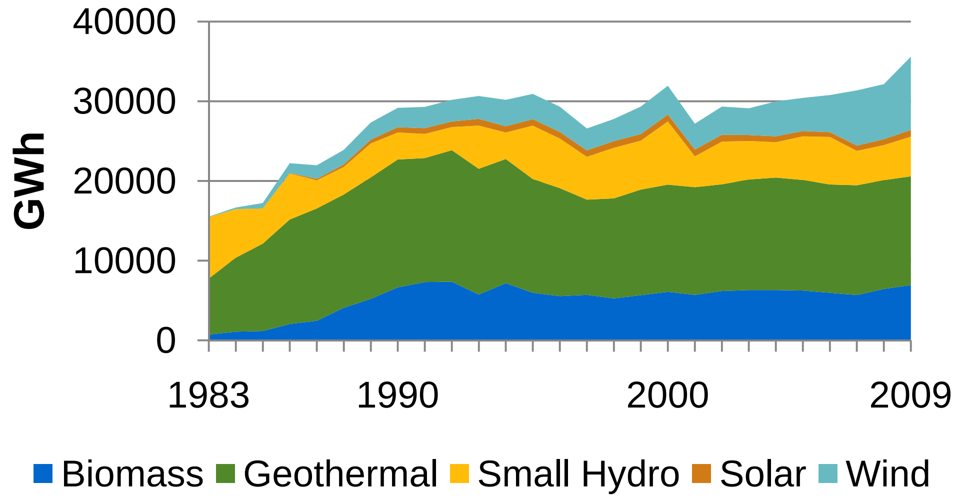
8 California Public Utilities Commission, Order Instituting Rulemaking No. 2, Decision 82-01-103, January 21, 1982.

9 California Public Utilities Commission, Division of Ratepayer Advocates, *Analysis of the Impact of the End of the Fixed Energy Price Period Under Interim Standard Offer 4 Contracts*, October 1992.

10 Southern California Edison Company, *Qualifying Facilities Semi-Annual Status Report to the Califoirnia Public Utilities Commission*, January 31, 2011; Pacific Gas and Electric Company, Cogeneration and Small Power Production Semi-Annual Report to the California Public Utilities Commission, January 2011.

11 California Energy Commission, *Renewable Resources Development Report*, November 2003, http://www.energy.ca.gov/reports/2003-11-24_500-03-080F.PDF.

Figure 1: California Renewable Energy Generation by Fuel Type, 1983-2010



Source: California Energy Commission

The oil embargoes of the 1970s also encouraged new interest in solar water heating, with federal and state tax credits offered to homeowners who wanted to conserve energy. Although the industry declined when tax credits expired in the mid-1980s, renewal of the federal tax credit in 2006 is leading to a resurgence of interest in these systems. In California, as a result of the California Solar Water Heating Pilot Program, which operated from 2007-2009, more than 340 residential and commercial solar water heating systems were installed in the San Diego region.[12] Based on the success of this program, the CPUC in January 2010 established a statewide solar water heating rebate program under the California Solar Initiative with the goal of installing 200,000 systems in the state by 2017.[13] Solar heating technologies can also be used to produce steam for industrial processes like enhanced oil recovery, in which steam is injected into reservoirs to increase the amount of oil that can be extracted. Replacing natural gas-fired boilers with solar technologies to produce the steam for this and other industrial applications like food processing will provide greenhouse gas (GHG) emission reductions and energy savings benefits to industry and the state.[14]

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12 Itron, *California Center for Sustainable Energy Solar Water Heating Pilot Program Final Evaluation Report*, March 30, 2011, http://www.cpuc.ca.gov/NR/rdonlyres/C1C7FD10-05AA-493B-8CD0-F2C24DCA955A/0/CCSE_SWHPP_Rpt.pdf.

13 California Public Utilities Commission, CSI-Thermal Program, http://www.cpuc.ca.gov/puc/energy/solar/swh.htm.

14 For example, UC Merced developed an innovative and cost-effective high-temperature solar collector that can be used in production of heat for industrial processes using funding from the Energy Commission's Public Interest Energy Research Program. See *Developing Renewable Generation on State Property*, April 2011, Appendix B, http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf, and UC Merced website at https://ucmeri.ucmerced.edu/research-focus-areas/thermal-science/research.

The 1970s oil crisis also led to increased focus on developing alternative transportation fuels to reduce dependence on foreign oil. In response to oil shortages, California assumed a national leadership role in encouraging fuel diversity and reduced tailpipe emissions through cleaner alternative fuels and vehicles and more stringent vehicle emission standards. In 1979, the California Legislature instructed the Energy Commission to "investigate the practicality and cost-effectiveness of alternative motor fuel."[15] Early programs at the Energy Commission included demonstration of vehicles using ethanol and methanol, infrastructure development for methanol/gasoline lends, and support for flexible fuel, natural gas, and electric vehicles. Since that modest beginning, California has been at the forefront of alternative fuel and vehicle development, working with automobile manufacturers, fuel providers, utility companies, universities, and research and development (R&D) organizations to advance alternative fuel vehicles.

In 2007, California established the Low Carbon Fuel Standard, with the goal of reducing the carbon intensity of California's transportation fuels by at least 10 percent by 2020.[16] Also in 2007, the *State Alternative Fuels Plan,* jointly developed and adopted by the Energy Commission and the California Air Resources Board (ARB), presented strategies to increase alternative and non-petroleum fuel use for transportation and set goals to reduce petroleum dependence by 15 percent by 2020 and increase alternative fuels use to 26 percent of all fuel consumption by 2022.[17] Currently, the Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program is investing in a wide range of projects including renewable fuel production, installing a robust network of fueling and charging stations for alternative fuel vehicles, and training the workforce that supports this burgeoning industry.[18] Renewable fuels currently comprise approximately 8.3 percent of California's transportation fuel supply.[19]

California's Renewable Resources

California takes advantage of its abundant natural resources and uses many different renewable electricity generation resources and technologies, with five primary renewable resource types represented by existing facilities:

- Biomass – fuel derived from organic sources (not fossil fuels), including solid biomass, digester gas, landfill gas, and biodiesel
- Geothermal

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15 California Energy Commission, "Fifteen Years of Fuel Methanol Distribution," staff paper, 1996, http://www.energy.ca.gov/papers/CEC-999-1996-017.PDF.

16 Executive Order S-01-07, http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf.

17 California Energy Commission and California Air Resources Board, *State Alternative Fuels Plan*, October 2007, http://www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CTF.PDF.

18 California Energy Commission, http://www.energy.ca.gov/drive/index.html.

19 Based on Energy Commission staff estimates of 2010 fuel demand and renewable fuel used. Includes E10, biodiesel, and E85.

- Small hydroelectric – generally limited to facilities with a capacity no greater than 30 MW
- Solar – including solar thermal and solar photovoltaic technologies
- Wind

Other renewable resource types are considered eligible under California's Renewable Portfolio Standard (RPS) – including incremental hydroelectric generation from efficiency improvements, municipal solid waste with some restrictions, and ocean wave, thermal, and tidal current – but few such facilities have been developed in California and such facilities located outside California provide only a fraction of a percent of the renewable generation available to the state. However, it will be important as this plan is updated over time to monitor technology improvements in these technologies and development of new and emerging technologies so those can be reflected in future updates.

California's Renewable Electricity Goals

In 2002, Senate Bill 1078 (Sher, Chapter 516, Statutes of 2002), created California's RPS to diversify the state's electricity system and reduce its growing dependence on natural gas by increasing the percentage of renewable electricity in the state's power mix to 20 percent by 2017.[20] Subsequently, Senate Bill 107 (Simitian, Chapter 464, Statutes of 2006) accelerated the RPS target by requiring retail sellers of electricity to increase renewable energy purchases by at least 1 percent per year with a target of 20 percent renewables by 2010.[21]

In 2011, Senate Bill X1-2 (Simitian, Chapter 1, Statutes of 2011) revised the RPS requirement and required that renewable electricity should equal at least 20 percent of the total electricity sold to retail customers in California per year by December 31, 2013, 25 percent per year by December 31, 2016, and 33 percent by December 31, 2020.[22] The bill also extended these requirements to publicly owned utilities to make the RPS a statewide program.[23] When signing this legislation, Governor Brown indicated that the 33 percent target should be considered a floor rather than a ceiling, stating that "with the amount of renewable resources coming on-line, and prices dropping, I think 40 percent, at reasonable cost, is well within our grasp in the near future."[24]

In addition to reduced dependence on natural gas, renewable development is critical to achieving California's goals to reduce GHG emissions to 25 percent below 1990 levels by 2020

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20 Official California Legislative Information, http://www.leginfo.ca.gov/pub/01-02/bill/sen/sb_1051-1100/sb_1078_bill_20020912_chaptered.pdf.

21 Ibid, http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_0101-0150/sb_107_bill_20060926_chaptered.pdf.

22 Senate Bill X1 2 Simitian, Chapter 1, Statutes of 2011. Available at http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.pdf.

23 Prior to 2011, the Renewable Portfolio Standard law instructed the governing boards of publicly owned utilities to implement and enforce a renewable portfolio standard that recognized the intent of the Legislature to encourage renewable resources, but did not set any specific targets or years.

24 Office of Governor Jerry Brown website, http://gov.ca.gov/news.php?id=16974.

and 80 percent by 2050.[25] In its *Climate Change Scoping Plan* report, the ARB identified the 33 percent RPS target as a foundational policy for meeting the 2020 GHG emission reduction goal.[26] Preliminary estimates of the amount of renewable energy needed to achieve the 2050 GHG emission reduction goal suggest that California's renewable electricity percentage may need to increase to more than 70 percent, depending on the pace and policies affecting electrification of the transportation sector, retiring coal generation, and whether existing nuclear plants are relicensed.[27]

California also has goals for increasing solar photovoltaic (PV) capacity in the state. The Go Solar California campaign – which includes the CPUC's California Solar Initiative, the Energy Commission's New Solar Homes Partnership, and a variety of programs offered through publicly owned utilities – has a statewide goal of adding 3,000 MW of new solar generation capacity by 2017.

Investing in renewable energy is also a central element of rebuilding California's economy. As noted in Governor Brown's Clean Energy Jobs Plan, these types of investments will create jobs, build 21st century businesses, increase energy independence, and protect public health.[28] The Governor's plan calls for installing 20,000 MW of new renewable capacity by 2020, with 8,000 MW of large-scale wind, solar, and geothermal and 12,000 MW of localized generation, which includes small, onsite residential and business installations and intermediate-sized systems close to existing consumer loads and transmission and distribution lines. The Governor's plan also envisions accelerated development of energy storage capacity to support integration of renewable resources into the California grid.

The link between renewable and economic development underscores the need for a statewide strategic plan to identify and address barriers to achieving California's renewable goals. California has seen a surge in the development of renewable generating facilities over the past few years, driven by state clean energy policies and incentives, federal stimulus funding, and the global transition to a clean energy economy.

In 2010, U.S. venture capital investment in clean tech companies increased by 8 percent from 2009 levels to $3.98 billion,[29] and in the first quarter of 2011 investment in clean tech

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25 Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), Official California Legislative Information, http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf, and Governor Schwarzenegger's Executive Order S-3-05, http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm.

26 California Air Resources Board, *Climate Change Scoping Plan*, December 2008, http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

27 Please see Chapter 2 for a description of the amount of renewable electricity generation that may be needed in 2050 to meet the state's carbon reduction goals.

28 http://www.jerrybrown.org/Clean_Energy.

29 PR Newswire, "US Venture Capital Investment in Cleantech Grows to Nearly $4 billion in 2010, an Increase from 2009," Ernst and Young, February 2011, http://www.prnewswire.com/news-releases/us-venture-capital-investment-in-cleantech-grows-to-nearly-4-billion-in-2010-an-8-increase-from-2009-115090229.html.

companies increased 54 percent to $1.14 billion, with California accounting for 56 percent of total investments.[30] This investment in renewable development is creating new jobs. According to a recent report by Next 10, from 1995-2009 the energy generation sector created the most jobs in California's green economy, adding nearly 20,000 jobs, 3,000 of which were added from January 2008-2009.[31] Nationally, in 2008 the American Wind Energy Association reported that there were 85,000 workers employed in the wind industry, exceeding the 81,000 workers employed by the U.S. coal mining industry.[32] In addition, a recent report by the Brookings Institute concluded that nationally, the clean economy employs more people than the fossil fuels and biotech industries, with four of the five fastest growing clean tech segments between 2003-2010 in renewable energy which added approximately 50,000 jobs in the solar thermal, solar PV, wind power, biofuels, fuel cell production, and smart grid industries.[33]

Report Process and Structure

The IEPR Committee has worked closely with stakeholders to develop this draft *Renewable Power in California: Status and Issues* report, with eight public workshops held to date on the following topics:[34]

- Distributed generation (DG) issues, including development of renewable generation on state properties, lessons learned from the European experience on integrating large amounts of DG, R&D projects and strategies to address barriers to DG deployment, and setting interim targets toward the 12,000 MW DG goal.
- Methods for determining the amount of renewable electricity that will be needed to meet the state's renewable targets and for estimating the costs of various renewable technologies.
- Transmission and distribution system additions and upgrades needed to bring renewable electricity from generators to end users.
- R&D on technologies that will enable the integration of large amounts of renewable electricity into the state's electricity grid, including smart grid and energy storage technologies.[35]

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30 http://www.ey.com/US/en/Newsroom/News-releases/US-VC-investment-in-cleantech.

31 Next 10, *Many Shades of Green: Diversity and Distribution of California's Green Jobs*, January 2011, http://www.next10.org/next10/publications/green_jobs/2011.html.

32 http://www.windustry.org/news/wind-energy-jobs-grew-70-in-2008

33 Muro, Mark, Jonathan Rothwell, Devashree Saha, The Brookings Institution Metropolitan Policy Program, *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*, July 2011, http://www.brookings.edu/~/media/Files/Programs/Metro/clean_economy/0713_clean_economy.pdf.

34 Please see the Energy Commission's Integrated Energy Policy Report webpage at http://www.energy.ca.gov/2011_energypolicy/documents/index.html#12172010 for information on specific workshops.

- Strategies to develop the extensive and well-trained workforce that will be needed to support expansion of the state's clean energy economy.

In addition, the Governor's Office held a two-day conference in July 2011 in Southern California to explore challenges to achieving the 12,000 MW DG goal, including the need for financing tools, improvements in existing infrastructure, policies to measure and manage power demand and variable power sources, and efforts in local land use and building and fire codes to accelerate deployment.[36]

This staff draft *Renewable Power in California: Status and Issues* report incorporates the valuable information gleaned from these events and from stakeholder comments. The structure of the report is as follows:

- **Chapter 2** describes California's renewable energy goals and targets, the contribution toward those targets by the existing fleet of renewable electricity generating facilities, the technical potential for additional renewable development, estimates of the amount of renewable electricity that will be needed to meet RPS targets, and progress to date toward those targets.
- **Chapter 3** discusses environmental, planning, and permitting challenges to renewable developers, including potential environmental consequences associated with renewable generating facilities such as impacts on habitat for sensitive species; bird and bat collisions with wind turbine blades; impacts on quantity and/or quality of local water supplies; loss of agricultural or recreational land; aviation and other transportation-related hazards; impacts on areas of historic significance and on Native American tribes; and air quality impacts. The chapter also discusses issues with planning and permitting processes due to overlapping and cross-jurisdictional processes that can delay project development and increase costs to renewable developers.
- **Chapter 4** focuses on issues with planning and building the electricity transmission and distribution infrastructure that will be needed to bring renewable electricity from power plants to consumers.
- **Chapters 5 and 6** discuss issues with integrating high levels of renewable electricity generation, particularly variable resources like wind and solar, into the state's electric grid at both the transmission and distribution levels while maintaining reliability and grid stability.
- **Chapter 7** discusses issues associated with securing financing for renewable development, particularly in earlier stages of development. Ultimately, anything that affects project

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35 "Smart grid" refers to a distribution system that allows for flow of information from a customer's meter in two directions: both inside the house to thermostats, appliances, and other devices, and from the house back to the utility. Smart grid can include a variety of operational and energy measures, like smart meters, smart appliances, renewable energy resources, energy efficiency resources, demand response measures, and energy storage.

36 Office of Governor Jerry Brown website, http://gov.ca.gov/s_energyconference.php.

viability – such as costs associated with renewable technology development, permitting, environmental mitigation, regulatory uncertainty, and the need for new or upgraded transmission or distribution infrastructure – adds risk to a project and can affect a developer's ability to secure financing.

- **Chapter 8** compares levelized cost estimates for renewable technologies, discusses declining cost trends seen in the renewable industry, particularly for solar PV, and describes the impacts of tax benefits on renewable cost calculations. It also outlines cost challenges associated with environmental review, permitting, construction, and interconnection.
- **Chapter 9** describes the important role of R&D in addressing the issues identified in Chapters 3-8 and provides detailed information about R&D efforts in these areas funded by the Energy Commission's Public Interest Energy Research Program.
- **Chapter 10** covers four cross-cutting issues associated with renewable development:
    - Environmental justice: Environmental justice is defined as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies."[37] Although environmental justice organizations generally support renewable development as a strategy to reduce health and other impacts from fossil-fueled power plants, there are still concerns about the impacts on sensitive communities from certain renewable technologies and from fossil-fueled generating plants that will be needed to support renewable integration
    - Local government coordination: Local governments will be a key part of meeting California's statewide renewable energy goals, and many jurisdictions are showing strong leadership in developing renewable resources. State and local governments need to be partners in developing and implementing statewide renewable energy policy goals by identifying and addressing the unique barriers local jurisdictions face in pursuing renewable policies and practices.
    - Workforce development: California will need a variety of skilled workers to support renewable electricity development. Many jobs created by the clean energy economy will be in manufacturing, installation, fabrication, and operations, with other opportunities within more specialized areas like power plant design and operations, facilities management, and consulting and research. California needs to continue developing tools like basic and advanced job training, job placement assistance, and hands-on apprenticeship programs to ensure an adequate and well-trained workforce to support its renewable goals.
    - Public leadership: With the establishment of California's aggressive renewable energy goals, state government is demonstrating its leadership and commitment to these goals

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37 Government Code Section 65040.12.

by setting targets for developing renewable electricity generating technologies on state-owned buildings, properties, and rights-of-way. Making state properties available to renewable developers can reduce existing energy costs in state buildings, create new revenue streams by leasing vacant or unused lands and rights-of-way, and realize cost savings by eliminating the obligation to maintain lands leased to developers.

The issues discussed in each chapter overlap in many ways. Permitting delays and the need for environmental mitigation for both generating and transmission infrastructure can affect project costs and developers' ability to secure financing. Integrating renewable resources into the transmission and distribution system can increase project costs and will require new and innovative technologies, changes in system operation, and investment in R&D to overcome technical challenges and reduce integration costs. Addressing financing barriers will be of little use unless other barriers to ultimate project development are overcome. Environmental justice issues must be considered in permitting and building generation and transmission infrastructure. A well-trained workforce will be needed to assist with permitting, building, installing, and operating new renewable facilities and the technologies to integrate them seamlessly into the grid. Coordination with local governments will be essential to permitting and building renewable infrastructure and to understand the unique challenges local jurisdictions face as they promote renewable development in their communities.

Addressing the issues identified in this draft report will require comprehensive and overarching strategies that recognize the interdependencies between issue areas. This document should be considered a starting point for developing consensus on the status of progress toward the state's renewable goals and on the major issues facing renewable development. The IEPR Committee seeks input from stakeholders on (1) whether the draft report appropriately characterizes renewable status and issues; and (2) suggested strategies to address those issues. This draft report is the first step toward developing a comprehensive strategic plan that contains quantifiable and measurable goals and a set of strategies that will need to be implemented through close collaboration among state agencies, policymakers, utilities, and stakeholders.

Chapter 2: Achieving California's Renewable Electricity Goals

California's goals for increasing renewable electricity generation are very aggressive, with targets of 33 percent of the state's retail sales of electricity met using renewable resources, 8,000 megawatts (MW) of utility-scale renewables, and 12,000 MW of renewable distributed generation (DG) by 2020. The state has a wide variety of renewable resources that will contribute toward these goals, with statewide technical potential at more than 18 million MW.

However, translating this vast technical potential into operating projects is a major challenge. Project developers must secure financing, environmental and land-use permits, transmission, interconnection, and contracts to sell the output of their facilities. Each of these elements affects the market potential for renewable development and the amount of renewable capacity that will be available to meet statewide renewable goals. While an estimate of economic or market potential is beyond the scope of this report, the amount of new renewable generating capacity proposed or being developed in California is an indication of the market potential for new renewable development. Currently, there is approximately 57,000 MW of renewable capacity in the California Independent System Operator's (California ISO) Interconnection Queue[38] and another 5,200 MW in the utilities' Wholesale Distribution Access Tariff queue. Nearly 26,000 MW of proposed renewable capacity is being tracked in the permitting process,[39] with 9,435 MW of renewable capacity permitted by state and local entities in 2010. Utilities have also signed contracts for 9,305-10,505 MW of new renewable capacity. [40,41]

Challenges associated with financing, siting, permitting, and interconnection (discussed in more detail in subsequent chapters of this report), as well as the risk of contract failure, will affect the number of projects ultimately developed and result in a smaller subset of the renewable capacity than is currently being proposed. The state's goal is to ensure that sufficient renewable capacity is built and operating to deliver the estimated amount of renewable generation needed to reach the 33 percent Renewable Portfolio Standard (RPS) target by 2020.

This chapter begins by describing California's renewable goals and targets. The RPS currently requires renewable electricity to equal an average of 20 percent of the total electricity sold to retail customers in California during the compliance period ending December 31, 2013, 25

38 See Figure 9 in Chapter 4.

39 California Energy Commission website, http://www.energy.ca.gov/33by2020/documents/renewable_projects/Tracking_Report_for_Renewable_Projects.pdf.

40 California Energy Commission, Investor Owned Utilities Contract Database, http://www.energy.ca.gov/portfolio/contracts_database.html, as of April 2011.

41 California Energy Commission Publicly Owned Utilities Database, September 2010, http://www.energy.ca.gov/2008publications/CEC-300-2008-005/index.html.

percent by December 31, 2016, and 33 percent by December 31, 2020.[42] In addition, Governor Brown's Clean Energy Jobs plan calls for developing 12,000 MW of renewable localized generation and 8,000 MW of utility-scale renewable generation by 2020. Energy Commission staff is working with the Governor's Office to develop regional and interim targets for the 12,000 MW goal and is also examining regional targets for the 8,000 MW utility-scale goal. Also, because of the significant opportunity for the state to demonstrate public leadership in developing renewable DG, the Energy Commission is participating in a collaborative, multi-agency effort to expand the use of renewable energy on California state property. As discussed in Chapter 10, this effort has identified a target of 2,500 MW of new renewables on state properties that could be economically developed by 2020.[43]

The chapter then provides data on the amount of renewable capacity and generation currently provided by existing renewable facilities, which include five primary resource types: biomass, geothermal, small hydroelectric, solar, and wind. California had nearly 6,000 MW of utility-scale renewable capacity in 2010 along with approximately 2,300 MW of wholesale DG and nearly 1,000 MW of customer-side DG systems.

The chapter then outlines the technical potential for new development (with more detail provided in Appendix C) followed by a discussion of progress made to date toward meeting the state's renewable targets and goals. California appears to be on track to achieve the 20 percent by 2013 RPS target, with nearly 16 percent of statewide retail sales from renewable generation in 2010. In addition, the California Public Utilities Commission's (CPUC) Division of Ratepayer Advocates has stated that investor-owned utilities (IOUs) are well on their way to meeting the 33 percent renewable target at current rates of contract execution and approval.[44] As of May 2011, enough renewable generation was on-line or contracted to achieve the estimated range of generation needed to achieve 33 percent renewables by 2020.[45]

The chapter concludes with a discussion of potentially higher renewable targets for 2050 to contribute toward meeting the state's greenhouse gas (GHG) emission reduction goals. Rough

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42 For the compliance period of January 1, 2011 to December 31, 2013, investor-owned utilities and publicly owned utilities are required to procure generation from eligible renewable resources equal to an average of 20 percent of retail sales. For subsequent compliance periods, utilities must reflect "reasonable progress in each of the intervening years" to ensure procurement achieves 25 percent of retail sales by December 31, 2016, and 33 percent of retail sales by December 31, 2020. http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.html

43 California Energy Commission, *Developing Renewable Generation on State Property*, staff report, April 2011, http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf.

44 CPUC, August 2010, RPS Compliance Reports and Project Development Status Reports, as cited in CPUC, Division of Ratepayer Advocates, February 2011, *Green Rush: Investor-Owned Utilities' Compliance with the Renewables Portfolio Standard*, http://www.dra.ca.gov/NR/rdonlyres/0CB0B986-E93B-462A-BA62-804EDAE43B82/0/RPSReportPublic_FINAL_2011_Feb_14_v2.pdf, page 7.

45 This assumes that all existing renewable generators remain on-line through 2020, low rates of contract failure, and that existing short-term contracts are renewed.

estimates indicate that if new generation needed to serve expected electricity demand in 2050 is served only by new renewables, this supply would represent 67-79 percent of total electricity sales in 2050.[46]

California's Renewable Goals and Targets

Renewable Portfolio Standard Goals

Senate Bill X1-2 (Simitian, Chapter 1, Statutes of 2011) requires investor- and publicly owned utilities to procure generation from eligible renewable resources equal to an average of 20 percent of retail sales for the compliance period of January 1, 2011 to December 31, 2013. For subsequent compliance periods, utilities must reflect "reasonable progress in each of the intervening years" to ensure procurement achieves 25 percent of retail sales by December 31, 2016, and 33 percent of retail sales by December 31, 2020.[47] SB X1-2 also allows a portion of the RPS to be met with tradable renewable energy certificates (TRECs),[48] but limits the use of TRECs for RPS compliance to not more than 25 percent for the compliance period ending December 31, 2013, 15 percent for the compliance period ending December 31, 2016, and 10 percent thereafter.[49]

The *renewable net short* is the estimated amount of renewable electricity needed in addition to generation from existing renewable facilities to meet the 33 percent RPS mandate in 2020. Energy Commission staff estimates for total renewable generation (existing plus the renewable net short) needed to meet the mandate range from 78.8 terawatt hours (TWh) to 90.5 TWh, a difference of 11.7 TWh (15 percent) or equivalent to the generation from about 5,300 MW solar-thermal power plants. Estimates for the renewable net short range from 35.3 TWh to 47.0 TWh, a difference of 32 percent. However, given the risk of contract failure in RPS contracts (discussed later in this chapter), it may be prudent for utilities to contract for some percentage above the estimated renewable net short. For example, if the contract failure rate seen in past RPS contracts continues at 30 percent, utilities may need to sign contracts for generation in the range of 50.5 TWhs to 67 TWhs.

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46 Preliminary electricity supply and demand calculations can be found at: http://www.drecp.org/meetings/2011-05-17_meeting/documents/2050%20RPS%20and%20acreage%20calculator%20background.pdf

47 http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.html

48 A Renewable Energy Certificate or REC is a certificate of proof that one MWh of renewable energy has been generated. RECs used for RPS compliance must be tracked through the Western Renewable Energy Generation Information System and meet requirements of the California RPS program. In addition to TRECs from utility-scale renewable generation, in the future TRECS could come from roof-top photovoltaic systems in California. The Energy Commission plans to revise its Renewable Portfolio Standard Eligibility Guidebook in 2011 to specify the criteria that must be met for these systems to be certified as RPS eligible. Once these rules are in place, owners of self-generation renewable facilities could sell RECs from their facilities to be used for California's RPS. http://www.cpuc.ca.gov/PUC/energy/Renewables/decisions.htm , http://www.energy.ca.gov/renewables/documents/index.html#rps , and http://www.wregis.org/

49 See Senate Bill X1-2 for additional information about criteria related to the use of TRECs for RPS compliance.

The equation for estimating the renewable net short is:

> *Renewable Net Short (TWh) = ([Projected Retail Electricity Sales – Energy Efficiency Programs – Combined Heat & Power Customer Services – Self-Generation Additions – Other Demand Reduction Programs] x Policy Goal Percent) – Generation from Existing Eligible Renewable Facilities likely to be generating in 2020*

Energy Commission staff developed the renewable net short estimates in a draft paper that was the subject of a workshop on March 8, 2011, to seek public comments on the variables, methods, and data sources that should be considered when estimating the amount of new renewable generation needed to meet statewide policy goals. [50] The final staff paper responded to stakeholder comments and provided a recommended set of assumptions for the renewable net short calculation.[51]

Table 1 on the following page presents the ranges of inputs, described in more detail in Appendix D, and the sequence of calculations to estimate the renewable net short. It includes an upper, mid and lower bound range of renewable net short estimates. Values are considered a floor for the amount of renewable generation that may be added to the California electricity supply mix over the next decade.

Anything that reduces electricity retail sales – changes to the economy, energy efficiency program savings, rooftop solar photovoltaic additions, and other customer-side distributed generation projects – will reduce the renewable net short. Estimates of the renewable net short will also change over time as forecasts of electricity demand change. These changes have been particularly noticeable in the last several years due to the effects of the economic downturn and the possible timing of a rebound. Similarly, uncertainties about meeting state goals for energy efficiency, combined heat and power, and rooftop solar will affect the amount of renewable energy ultimately needed. These and other uncertainties are discussed in more detail in Appendix D.

The Energy Commission will post updated renewable net short estimates on August 1 of each year, matching the expected date when information on new generation is submitted under data collection regulations. The renewable net short estimate will also be updated over time as electricity demand forecasts are adopted, when questions regarding the RPS eligibility of customer-side generation are resolved, and when there is more clarity about the amount of TRECS being used for RPS compliance.

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50 California Energy Commission staff, *Proposed Method to Calculate the Amount of New Renewable Generation Required to Comply with Policy Goals*, March 2011, http://www.energy.ca.gov/2011publications/CEC-200-2011-001/CEC-200-2011-001-SD.PDF.

51 The staff renewable net short papers and workshop material can be found on the Energy Commission website at: http://www.energy.ca.gov/2011_energypolicy/documents/index.html#03082011

Table 1: Range of Renewable Net Short Estimates for 2020

	All Values in TWh for the Year 2020	Formula	Low Renewable Net Short	Mid-Case Renewable Net Short	High Renewable Net Short
1	Statewide (Retail Sales-Updated 5/2011)		292.6	297.9	305.3
2	Non RPS Deliveries (CDWR, WAPA, MWD)		13.6	13.6	13.6
3	Small LSE Sales (<0.2 TWh)		0.0	0.0	0.0
4	Retail Sales for RPS	1-2-3	279.0	284.3	291.7
5	Additional Energy Efficiency		19.9	17.1	15.2
6	Additional Rooftop PV		4.1	3.2	2.3
7	Additional Combined Heat and Power		16.2	7.2	0.0
8	Adjusted Statewide Retail Sales for RPS	4-5-6-7	238.8	256.9	274.2
9	**Total Renewable Energy Needed For 33% RPS**	**8 x 33%**	**78.8**	**84.8**	**90.5**
	Existing and Expected Renewable Generation				
10	Total Instate Renewable Generation		34.3	34.3	34.3
11	Total Out-of-State Renewable Generation		9.2	9.2	9.2
12	**Total Existing Renewable Generation for CA RPS**	**10+11**	**43.5**	**43.5**	**43.5**
13	**Total RE Net Short to meet 33% RPS In 2020**	**9-12**	**35.3**	**41.3**	**47.0**

Source: California Energy Commission

Target for 8,000 Megawatts of Utility-Scale Renewable Generation

The Governor's Clean Energy Jobs Plan sets a target for developing 8,000 MW of utility-scale renewable generating capacity by 2020. Determining where this capacity could be located within the state will be informed by recent and current land use and generation/ transmission planning activities for large scale projects both statewide and focused on California's desert regions. The Renewable Energy Transmission Initiative (RETI) was a 2007-2010 statewide, public agency and stakeholder process to identify the transmission projects needed to accommodate California's renewable energy goals (described in more detail in Chapters 3 and 4). This effort identified Competitive Renewable Energy Zones (CREZs) with approximately 80,000 MWs of broad, statewide resource development potential, including approximately 66,000 MW in California's Mojave and Colorado desert regions.[52]

RETI's conceptual renewable potential for the desert areas and for the state as a whole can be refined by examining the California ISO's Interconnection Queue for transmission system study of proposed renewable projects. The queue has approximately 57,000 MW resulting from

52 *Renewable Energy Transmission Initiative Phase 2B Report*, April 2010, http://www.energy.ca.gov/reti/documents/index.html.

renewable projects proposed throughout the balancing areas for San Diego Gas & Electric Company (SDG&E), Southern California Edison (SCE), and Pacific Gas and Electric Company (PG&E), and approximately 40,000 MW currently proposed in the desert regions of Inyo, Kern, San Bernardino, Los Angeles, Riverside, and Imperial Counties.[53] Historically, not all of the proposed projects in the queue have reached the licensing, contract, and construction phases.

These potential renewable capacity numbers are further distilled in the CPUC 33% Proposed Base Case scenario,[54] which the CPUC's Long Term Procurement Planning staff developed for the California ISO's use in its 2011-12 Transmission Planning Process. This scenario includes approximately 11,000 MW for the IOU balancing areas based on power purchase contracts. For the desert regions, approximately 8,400 MW of combined renewable project capacity was projected for nine CREZs based on signed contracts. The CPUC staff recommended that the California ISO use the base case scenario for its 2011-2012 Transmission Planning Process. Ultimately, projects with a combined capacity exceeding the 11,000 MW estimate could be built in the desert and throughout California, but the base case scenario serves as a starting reference point for assessing how much and where large, utility-scale renewable capacity could be built in California.

The Energy Commission continues to support a fully integrated transmission and generation planning process, which includes the land use assumptions and natural resource data being developed in the state/federal Desert Renewable Energy Conservation Plan (DRECP) process. In July 2011, the Energy Commission worked with the California ISO and CPUC staff to evaluate the solar projects expected in the desert, particularly the Kramer Junction area in the West Mojave region.[55] As a result of this work, the CPUC's 33 percent basecase scenario was increased for this area to reflect new land use planning and resource information emerging from the DRECP.

Further, as discussed later in this chapter, more than 9,000 MW of renewable projects were permitted in California in 2010. About 8,000 MW of that amount is associated with identified new California ISO transmission lines and upgrades. If these new lines and upgrades are permitted, built, and on-line before 2020, it could allow more than 16,000 MW of additional generation to flow to load centers at any point in time. With only half of the capacity to fill the lines permitted last year, another 8,000 MW of capacity could be sited in the CREZs associated with these lines in the future. This is consistent with Governor Brown's goal of 8,000 MW of new capacity to be sited and built by 2020. Some of the CREZs are located in California's Mojave and Colorado Desert regions.

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53 California Independent System Operator Interconnection Queue Projects, locations and type as of June 1,2011.

54 CPUC letter to Keith Casey of California ISO regarding 33% Proposed Base Case, June 2011.

55 Energy Commission July 15, 2011 letter to California ISO regarding Transmission 2011/2012 Planning Process. http://foliweb7.caiso.com/2b6d/2b6dd2991e570.html

Table 2 shows the groups of new line additions that enable new generation from specific regions. It also includes the CREZs associated with the lines and the total renewable capacity that could come from each region, capacity associated with projects permitted in 2010, and the remaining capacity that could come from that region. The far right column is a preliminary attempt to establish regional targets for the Governor's 8,000 MW goal.[56]

Table 2: Preliminary Regional Targets for 8,000 Megawatts of New Renewable Capacity by 2020

Identified Transmission Line (s)	CREZ Served	Total Additional Capacity with New/Upgraded Lines (MW)[A]	Project Capacity Permitted in 2010 Associated with the New/Upgrades (MW)[B]	Additional Project Capacity for 8,000 MW of New Large-Scale Renewables (MW)
Sunrise Powerlink	Imperial North and South, San Diego South	1,700	760	940
Tehachapi and Barren Ridge Renewable Transmission Projects	Tehachapi, Fairmont	5,500	2,810	2,690
Colorado River, West of Devers, and Path 42 Upgrade	Riverside East, Palm Springs, Imperial Valley	4,700	1,825	2,875
Eldorado-Ivanpah, Pisgah-Lugo, and Coolwater-Jasper-Lugo	Mountain Pass, Pisgah, Kramer	2,450[C]	1,470	980
Borden-Gregg	Westlands	800	145	655
South of Contra Costa	Solano	535	155	380
Carrizo-Midway	Carrizo South, Santa Barbara	900	800	100
TOTAL				8,620

[A] California Energy Commission data.
[B] Renewable Energy Action Team database. Only projects associated with the transmission projects specified were included.
[C] The total deliverability potential with these lines could be as high as 3800 MW. However, the Eldorado-Ivanpah and the Pisgah-Lugo lines upgrade the same corridor and the capacity associated with the new lines may not be additive..The 2,450 MW includes the deliverability linked to the Pisgah-Lugo and the Coolwater-Jasper-Lugo lines.

Source: California Energy Commission

56 The analysis is limited to only California ISO identified lines, and will need to be updated to include identified transmission lines for the Los Angeles Department of Water and Power and the Sacramento Municipal Utility District.

Target for 12,000 Megawatts of Renewable Distributed Generation

The Governor's Clean Energy Jobs Plan also sets a goal to develop 12,000 MW of localized electricity generation, or DG, by 2020. Achieving that goal is a major undertaking but, like any large task, breaking it down into its component parts by setting regional targets will provide a starting point to help meet the goal and measure progress over time.

Because DG development is linked to local jurisdictional and infrastructure issues, regional targets can help capitalize on opportunities and focus attention on addressing barriers to development. Examples of local conditions that affect development include variations in local permitting requirements and the age of the distribution grid, which is new in some areas and 100 years old in others. Also, targeting development in low-income communities or other areas for job creation can inform the development of regional targets. Finally, resource potential for biofuels, geothermal, small hydro-power, and wind are very heterogeneous throughout the state, while solar insolation tends to be more homogeneous. Setting regional targets will allow the state to take advantage of opportunities to advance public benefits – such as those from job creation in low income communities – and focus the attention needed to address local opportunities and barriers.

The Energy Commission staff's analysis of regional targets (described in more detail in Appendix E) defines localized generation as renewable DG projects 20 MW and smaller that are interconnected to the distribution or transmission grid. The scope includes behind-the-meter installations to serve on-site load as well as projects that produce excess energy for wholesale. The analysis is intended to be technology neutral and includes solar, biomass, geothermal, wind, fuel cells using renewable fuel, and small hydropower. Staff's analysis includes data from the beginning of the California Solar Initiative in 2007 and extends to 2020. This analysis does not include an estimate of costs.

Energy Commission staff's estimates of regional targets for development of behind the meter, wholesale, and an undefined mix of behind the meter and wholesale projects are shown in Table 3.

These regional targets are "soft targets" that serve as a starting point for discussions on a local level, and may be reevaluated annually by the Energy Commission. Staff presented this preliminary methodology at the Governor's Conference on Local Renewable Energy Resources and participants discussed it in breakout sessions. Comments were varied, with some parties questioning the need for regional targets, or for a 12,000 MW target. Many people questioned what is included in the targets, for example, should existing renewables count, are non-PV technologies adequately included, and should other technologies such as storage or demand response count toward the targets. Others raised the concern that basing the analysis on market activity does not account for where local generation would be most beneficial, the political will to meet the targets, or cost issues. Staff is revising the regional targets based on feedback from the Governor's Conference and a May 9 IEPR Committee workshop. The revised targets will feed into a report UC Berkeley is preparing for the Governor. The intent of the report is to outline issues and possible solutions to dramatically increasing the amount of small-scale renewable systems interconnected to the distribution grid. A draft is expected to be available fourth quarter of 2011.

Table 3: Proposed Regional DG Targets by 2020

Region	Behind the Meter (all technologies)	Wholesale	Undefined (mix of behind the meter and wholesale)	Total
Central Coast	280	90	0	370
Central Valley	830	1590	0	2,420
East Bay	420	30	0	450
Imperial	50	90	0	140
Inland Empire	480	430	0	910
Los Angeles, *city and county	970	860	2,170	4,000
North Bay	220	0	0	220
North Valley	120	50	0	170
Sacramento Region	410	170	220	800
San Diego	500	50	630	1,180
SF Peninsula	480	10	310	800
Sierras	30	40	0	70
Orange	420	10	40	470
Total	**5,210**	**3,420**	**3,370**	**12,000**

Source: California Energy Commission

Existing Renewable Power Plants Serving California

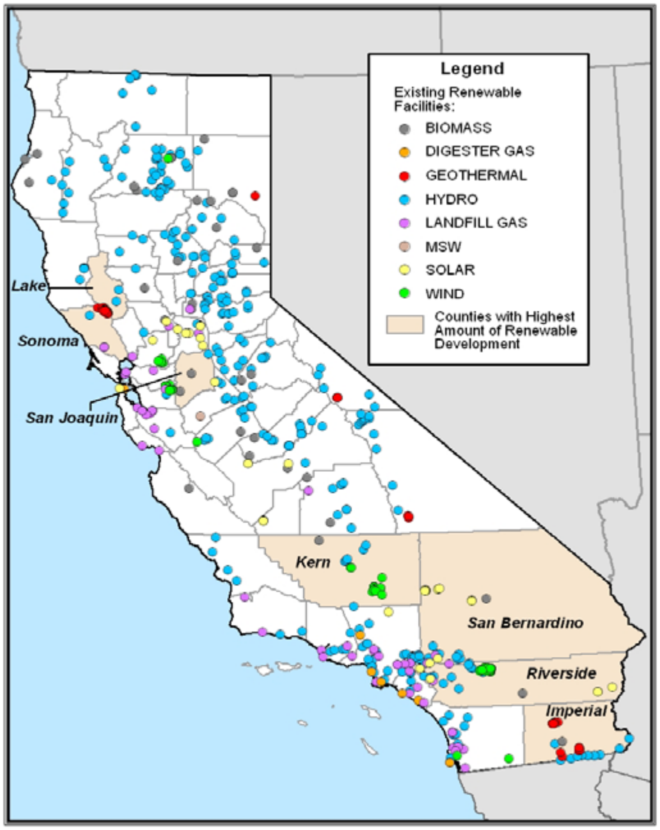
California has a large fleet of existing renewable generating facilities that will contribute toward meeting the state's renewable electricity generation goals and targets (Figure 2). These facilities provided 14.6 percent of total in-state electricity generation in 2010.[57] This fleet is the result of abundant renewable resources available in California, state and federal policies supporting renewable energy, and the commitment of the state's citizens to alternative energy sources. Facilities are divided into three general types that provide electricity to California customers:

- Utility-scale: facilities with a nameplate capacity larger than 20 MW, typically interconnected at the transmission level, and designed to generate electricity for sale to a California utility.

57 California Energy Commission, "2010 Total System Power in Gigawatt Hours," http://energyalmanac.ca.gov/electricity/total_system_power.html. This represents total renewable generation in California as a percentage of total generation for load. This value differs from other calculations showing progress toward achieving RPS targets because Total System Power does not take into account RPS eligibility of that generation and the percentage is based on total generation to meet load rather than total retail sales.

- Wholesale DG: facilities with a nameplate capacity no larger than 20 MW, typically built near electrical load and may be interconnected to the transmission system or at the distribution level, and designed to generate electricity for sale to a California utility.
- Customer-side DG: small facilities built in California to directly serve a customer load that would otherwise be served by a utility. Generation from these facilities may or may not be able to produce excess electricity that is exported to the distribution or transmission system, but all are connected to the grid.

Figure 2: Existing Renewable Facilities in California



Source: California Energy Commission

Installed Capacity

During 2010, 5,954 MW of renewable capacity from 109 utility-scale facilities was in operation. Wholesale distributed generation from 394 facilities provided 2,292 MW, while more than 95,000 customer-side renewable generation systems provided roughly 986 MW of capacity (Table 4). The CPUC reports that 2,001 MW of new renewable capacity has achieved commercial operation since the RPS Program began in 2002,[58] while publicly owned utilities have added approximately 290 MW.[59]

Utility-scale and wholesale distributed generation facilities are located in 53 of California's 58 counties (Figure 2). The top seven counties in terms of installed renewable capacity include Sonoma, Kern, Imperial, San Joaquin, Riverside, Lake, and San Bernardino counties. Counties with high amounts of geothermal capacity include Sonoma County with 1,160 MW of capacity (over 40 percent of all geothermal capacity installed in California), Imperial County with 599 MW, and Lake County with 496 MW. Kern, San Joaquin, and Riverside counties each have large

58 California Public Utilities Commission, *Renewables Portfolio Standard Quarterly Report, 2nd Quarter 2011*, http://www.cpuc.ca.gov/NR/rdonlyres/1D24680C-BDF1-4EE9-A43F-59B309602172/0/Q2ReporttotheLegislatureFINAL.pdf.

59 Based on data submitted to the California Energy Commission through the Quarter Fuel and Energy Report.

amounts of wind capacity, approximately 800 MW, 600 MW, and 500 MW respectively.[60] San Bernardino County is home to 400 MW of solar capacity, which represents nearly 95 percent of all installed utility-scale and wholesale distributed generation solar.[61]

Table 4: Installed In-State Renewable Capacity Providing Electricity to California Customers

Renewable Resource	Utility-scale Capacity (MW) [A]	Wholesale DG Capacity (MW) [B]	DG Generation Capacity (MW) [C]	Total
Biomass	598	454	25	1,077
Geothermal	2,470	130	0	2,600
Small Hydro	308	1,072	0	1,380
Solar	387	16	953	1,356
Wind	2,191	620	8	2,819
Total	**5,954**	**2,292**	**986**	**9,232**

A Capacity numbers represent the total capacity of facilities using renewable resources as the primary or only resource.

B Based on the Energy Commission's "California Power Plant Database." http://energyalmanac.ca.gov/electricity/index.html. A number of the facilities classified as Wholesale Distributed Generation may be grouped together and operated as one larger facility that would be more accurately classified as Utility-scale facility.

C Solar data is taken from http://gosolarcalifornia.org/, biomass and wind data is from the Energy Commission's Emerging Renewables Program and the Self Generation Incentive Program: https://energycenter.org/index.php/incentive-programs/self-generation-incentive-program/sgip-documents/sgip-documents, was also used.

Source: California Energy Commission

Generation from Existing Renewable Facilities

In 2010, in-state and out-of-state renewable electric generating facilities provided 39,796 GWh of renewable electricity for California consumption, or 15.7 percent of California's retail sales, with the bulk of that amount coming from in-state facilities (Table 5).[62] In-state facilities provided around 75 percent of all the renewable generation claimed for the RPS by California load serving entities in 2010, with geothermal resources reported as providing more than twice as much generation as any other renewable in-state renewable resource.

60 Wind data from California Energy Commission Power Plant Database, available at http://energyalmanac.ca.gov/electricity/index.html.

61 Appendix A provides tables listing utility-scale, wholesale distributed generation, and customer-side distributed generation by California county.

62 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html. Total System Power represents total renewable generation in California as a percentage of total generation for load. This value differs from calculations showing progress toward achieving the Renewable Portfolio Standard because Total System Power does not account for RPS eligibility of that generation and because the percentage is based on total generation to meet load rather than on total retail sales.

Table 5: Total Renewable Generation to Serve California Load in 2010

Resource	California In-State Generation (GWh)	Percent of In-State Renewable Generation	Renewable Imports (GWh)	Total Renewable Generation for California (GWh)	Percent of Total Renewable Generation
Biomass	5,745	19.1%	1,149	6,894	17.3%
Geothermal	12,740	42.5%	673	13,413	33.7%
Small Hydro	4,441	14.8%	554	4,995	12.6%
Solar	908	3.0%	51	959	2.4%
Wind	6,172	20.6%	7,364	13,536	34.0%
Total	**30,005**	**100%**	**9,791**	**39,796**	**100%**

Source: 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html.

Additional Renewable Potential

California also has significant technical potential for additional renewable development (Table 6). "Technical potential" in this context is the theoretical potential of renewable generating capacity in MW, taking into account natural and climatic parameters, geographical restrictions, and technical limitations such as energy conversion efficiencies.

Table 6: California's Renewable Technical Potential

Technology	Technical Potential (MW)
Biomass	3,820
Geothermal	4,825
Small Hydro	2,158
Solar	
Concentrating Solar Power	1,061,362
PV	17,000,000
Wave and Tidal	32,763
Wind	
On-shore	34,000
Off-shore	75,400
TOTAL	**18,214,328**

Source: California Energy Commission.

In contrast, "economic potential" represents the technical potential at cost levels considered competitive, while "market potential" represents the total amount of renewable energy that can be implemented in the market after accounting for energy demand, competing technologies, costs and subsidies, and barriers. Rough indicators of the economic and market potential for additional renewable development include the number of renewable projects seeking interconnection, those in the permit review process or permitted during 2010, and the amount of renewable capacity that has signed contracts with utilities.

As of mid-2011, there is approximately 57,000 MW of renewable capacity in the California ISO's Interconnection Queue for projects proposed in the SDG&E, SCE, and PG&E service territories.[63] There are also 450 active interconnection requests for systems in the Wholesale Distribution Access Tariff queue totaling 5,168 MW.[64] The Renewable Energy Action Team is tracking 25,900 MW of renewable projects currently being considered for development.[65] In addition, the Energy Commission has been working with the Governor's Office to track renewable project development in California, and data collected through that effort shows that state and local governments permitted 9,435 MW of renewable capacity in 2010, about 4,100 MW of which were permitted in 2010 by the Energy Commission (Table 7), with about 1,440 MW of that capacity either operational or under construction.[66] IOUs have signed contracts for new renewable capacity for between 8,320-9,520 MW of capacity,[67] while publicly owned utilities have signed contracts for 985 MW of new RPS facilities.[68]

It is important to note that there is overlap between the renewable projects in each of these processes; for example, projects in the interconnection queue may be among those being tracked through the permitting process or those that have signed contracts with utilities. However, the amount of renewable capacity represented in these different processes is a strong indication of the perception by renewable developers regarding the amount of economic and/or market potential for new renewable development in California.

63 See Figure 9 in Chapter 4.

64 Data from utility websites.

65 California Energy Commission website, http://www.energy.ca.gov/33by2020/documents/renewable_projects/Tracking_Report_for_Renewable_Projects.pdf.

66 In addition to the projects listed in Table 6, in 2010 the Federal Energy Regulatory Commission granted preliminary permits for up to 3,291 MW of ocean wave and tidal energy projects off the coast of California. These projects are not expected to contribute significantly to the 2020 goals, but have the potential to lay the necessary groundwork through device testing and/or pilot projects for contributing to longer-term renewable goals.

67 California Energy Commission, Investor Owned Utilities Contract Database, http://www.energy.ca.gov/portfolio/contracts_database.html, as of April 2011.

68 California Energy Commission Publicly Owned Utilities Database, September 2010, http://www.energy.ca.gov/2008publications/CEC-300-2008-005/index.html

Table 7: Renewable Projects Permitted in 2010 by California County (MW)

County	Bio	Cogen*	Geo	PV >20MW	PV <20MW	Solar Thermal	PV/ Solar Thermal	Wind	Total
Imperial			208	1,259					1,467
Kern	44			867	24	250		2,169	3,354
Kings				145					145
Los Angeles		85		337					422
Riverside				175		1,734			1,909
Sacramento					2				2
San Bernardino				20		770	633		1,423
San Diego				45					45
San Luis Obispo				250					250
Shasta								102	102
Solano								155	155
Stanislaus				50	1				51
Tulare				110					110
TOTAL	**44**	**85**	**208**	**3,258**	**27**	**2,754**	**633**	**2,426**	**9,435**

* Cogeneration refers to a pipeline biomethane facility that has applied for RPS precertification.
Source: California Energy Commission

Renewable Portfolio Standard Progress – 20 Percent by 2013

A report by the CPUC's Division of Ratepayer Advocates states "utilities are on track to achieve the 20% RPS goal by the end of flexible compliance in 2013…"[69] In 2010, renewable generation represented 15.7 percent of statewide retail sales (IOUs and publicly owned utilities combined), which in 2010 was 252,746 GWh.[70] According to the CPUC compliance filings, the state's three largest IOUs collectively served 18 percent of their 2010 retail electricity sales with renewable power, with PG&E procuring 17.7 percent, SCE 19.4 percent, and SDG&E 11.9 percent.[71]

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69 California Public Utilities Commission, Division of Ratepayer Advocates, February 2011, *Green Rush: Investor-Owned Utilities' Compliance with the Renewables Portfolio Standard*, http://www.dra.ca.gov/NR/rdonlyres/0CB0B986-E93B-462A-BA62-804EDAE43B82/0/RPSReportPublic_FINAL_2011_Feb_14_v2.pdf, page 4.

70 Based on 2010 Total System Power renewable generation as a percentage of the 2010 retail sales (excluding water pumping load), http://energyalmanac.ca.gov/electricity/total_system_power.html. Appendix B shows how the use of different data sources may yield different percentages of renewable generation in California's electricity mix.

71 As reported by Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric in their March 2011 RPS compliance filings, available at http://www.cpuc.ca.gov/PUC/energy/Renewables/compliance.htm. Data reported by the IOUs for RPS compliance may vary from data collected from generators, as presented in the Total System Power. There are many factors that contribute to the difference. One factor is flexible compliance. The IOUs are allowed to carry over generation from previous years and earmark future generation to meet their RPS compliance target. It is not clear how much generation from other years is included in the 2010 compliance reports.

Preliminary data also suggests that California's publicly owned utilities as a whole procured 19 percent of their retail sales from Energy Commission-eligible renewable resources, with the Los Angeles Department of Water and Power procuring 20 percent and the Sacramento Municipal Utility District procuring 21 percent.[72]

Renewable Portfolio Standard Progress – 33 Percent by 2020

IOUs have made progress in securing contracts for the amount of renewable electricity needed to satisfy the renewable net short. As of May 31, 2011, enough renewable generation was on-line or contracted to achieve the estimated range for 33 percent in 2020, assuming all existing renewable generating facilities remain on-line, with the caveats that (1) additional contracts may be needed for additional renewable energy to ensure that the renewable net short is met if contract failure rates remain at 30 percent as in the past,[73] and (2) not all of the contracts signed to date are long-term contracts and therefore the generation from short-term contracts may not be available to deliver in 2020. IOUs have signed contracts for new renewable capacity not yet on-line for between 8,320-9,520 MW of capacity that are expected to deliver about 23,500 GWh to about 28,600 GWh by 2020.[74] However, the CPUC assumes approximately 12,000 GWh of this amount to have the lowest project viability,[75] leaving 11,500 GWh to 16,600 GWh of renewable generation expected in 2020. Publicly owned utilities have signed contracts for 985 MW of new RPS facilities not yet on-line that are expected to provide 4,831 GWh toward the RPS in 2020.[76] Figure 3 on the following page shows the renewable generation and forecasted targets for 2013,

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One additional cause for the variance is the tracking of generation from fossil fuel plants cofiring with renewable fuels such as biomass and biogas. The renewable portion of the generation from these sources is eligible for the RPS, and is included in the CPUC compliance filings. However, the Total System Power does not break out the renewable portion of the generation.

72 Until 2010, publicly owned utilities defined which renewable resources were eligible to meet their RPS targets. As a result, renewable percentages from publicly owned utilities may contain renewable procurement from sources that are not considered renewable for purposes of the RPS, like large hydro, and are therefore not reflected in the estimate of statewide progress toward the RPS target.

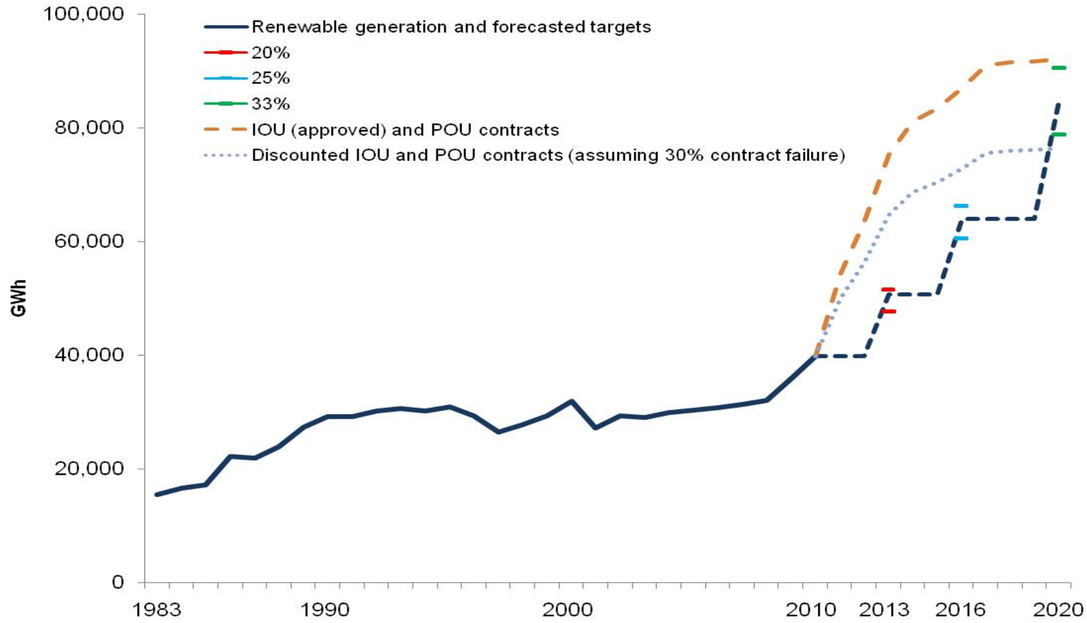
73 If the contract failure rate remains at 30 percent, the signed contracts for new projects plus expected generation from existing facilities will come close to achieving the lower bound of the estimated range for 33 percent in 2020. Energy Commission staff estimate that new contracts – assuming a 30 percent contract failure rate – added to the expected generation from existing facilities will generate 76,439 GWh in 2020.

74 California Energy Commission, Investor Owned Utilities Contract Database, http://www.energy.ca.gov/portfolio/contracts_database.html, as of April 2011.

75 http://www.cpuc.ca.gov/NR/rdonlyres/CFD76016-3E28-44B0-8427-3FAB1AA27FF4/0/FourthQuarter2010RPSReporttotheLegislature.pdf

76 California Energy Commission Publicly Owned Utilities Database, September 2010, http://www.energy.ca.gov/2008publications/CEC-300-2008-005/index.html

Figure 3: Renewable Generation for California and RPS Goals



Source: California Energy Commission Total System Power data and staff estimate of forecasted RPS targets using IOU and publicly owned utility contract databases, CPUC RPS Project Status (May 31, 2011).

2016, and 2020 and includes the IOU approved and pending contracts, publicly owned utility approved contracts, and existing renewable generation.[77]

Bid to Selected Ratio

One of the challenges faced by renewable developers in seeking power purchase contracts is the ratio of bids to selected projects in utility solicitations. The CPUC reports that, "The IOUs' 2009 RPS solicitation bids resulted in more proposed renewable generation than any other solicitation in RPS history. Developers offered to supply enough renewable generation to provide 50% of the IOUs' total load in 2020. The IOUs shortlisted over 23 TWh of the bids, which equates to half of the generation needed to meet a 33% target in 2020."78 At the May 9, 2011, IEPR Committee Workshop on Renewable Localized Generation, PG&E stated that market interest in the last RPS RFO [Request for Offers], held in 2009, was strong "and our

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77 The forecasted targets for 2013, 2016, and 2020 are based on the renewable net short methodology described in this report using 2009 data. The IOU contracts not yet on-line are from the CPUC RPS Project Status Table for May (May 31, 2011). Existing renewable generation from 1983-2009 are from total system power data; total system power data are available at: http://energyalmanac.ca.gov/.

78 CPUC, *Renewables Portfolio Standard Quarterly Report, 1st Quarter 2010,* http://www.cpuc.ca.gov/NR/rdonlyres/7DA38E61-9DB9-4B4E-A59C-D0776AF3B0BB/0/Q12010RPSReporttotheLegislature.pdf, p. 4.

expectation in 2011 based on the number of folks that have been approaching us bilaterally is that we will get an extremely robust response."[79] Regarding market response to PG&E's program for wholesale DG PV systems, PG&E stated that "We received 20 times as many bids as what was actually signed-up. I will caveat that to say one of our experiences with that RFO was that we received a large number of bids from developers who did not demonstrate a lot of sophistication with the development process. There was some basic screens that we put in places for projects to pass through in order to be considered viable. Two-thirds of the projects were unable to pass those screens."[80]

SCE also reports a strong market for PV: "[I]n the 2010 Request for Offers ('RFO') for the SPVP program, the ratio of bids submitted to executed contracts was approximately 4 to 1. As the CPUC has stated, 'SCE's Solar PV Program and its other procurement efforts suggest that the market for smaller scale projects appears robust with a significant number of competing sellers.' Next, in the 2010 Renewable Standard Contract ('RSC') program, SCE's voluntarily adopted predecessor to RAM, SCE received bids from projects representing roughly 2500 MW, 10 times more capacity than the program goal of 250 MW. SCE ultimately signed contracts with 259 MW(ac) of renewable projects, and 239 MW(ac) of this capacity was solar PV projects. Thus, in the 2010 RSC solicitation, solar PV was clearly the most competitive technology. Finally, SCE executed eight contracts through its 2009 RPS solicitation, and all eight projects were solar PV projects, representing over 850 MW of capacity. Based on the data from SCE's recent solicitations, current renewable energy trends have shown a significant market response for PV systems."[81]

Contract Failure

Another issue in the contracting process is the risk of contract failure, which could affect the amount of renewable capacity and generation that is ultimately developed. The Energy Commission first identified the risk of contract failure as a major factor affecting the state's ability to meet its RPS goals in the *2007 Integrated Energy Policy Report*.[82] Currently, the Energy Commission's IOU contract database indicates that about 30 percent of the CPUC-approved long-term contracts (10 years or more) for new renewable projects in California that are not yet

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79 California Energy Commission, May 9, 2011, Integrated Energy Policy Report Committee Workshop on Renewable Localized Generation, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/2011-05-09_Transcript.pdf, p. 27.

80 California Energy Commission, May 9, 2011, Integrated Energy Policy Report Committee Workshop on Renewable Localized Generation, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/2011-05-09_Transcript.pdf, p. 26.

81 SCE, May 23, 2011, Written Comments, May 9, 2011 IEPR workshop, "California Energy Commission Docket No. 11-IEP-1G: Comments Related to Committee Workshop on Renewable, Localized Generation," http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/comments/SCE_Comments_on_Renewable_and_Localized_Generation_TN-60748.pdf , p. 7-8.

82 California Energy Commission, *2007 Integrated Energy Policy Report*, December 2007, http://www.energy.ca.gov/2007_energypolicy/index.html.

on-line have been canceled. Of the remaining active long-term contracts, more than 20 percent have been delayed.[83]

Regarding contract failure, PG&E's draft 2010 RPS procurement plan states, "PG&E's experience with prior solicitations is that developers often experience difficulties with project siting, permitting, and escalating equipment prices, along with problems securing project financing…Recognizing that not all projects will remain on schedule or will ultimately be successful, PG&E's total procurement through its solicitations and bilateral efforts has exceeded the 20 percent target. For the period from 2004 to 2009, PG&E's actual contract signings, on average, exceeded 2 percent of retail sales in each year."[84] The RPS requires retail sellers to procure at least 1 percent of additional eligible renewable energy each year. [85]

In Decision 09-06-018, the CPUC began requiring IOUs to use a project viability calculator as part of the evaluation of bids responding competitive RPS solicitations to screen viable projects. Criteria scored by the tool include project development and ownership experience, technical feasibility, resource quality, manufacturing supply chain, site control, permitting status, project financing status, interconnection progress, transmission system upgrade requirements, and reasonableness of the project's commercial on-line date.[86]

As part of the 2011 RPS procurement plan proceeding at the CPUC, stakeholders raised the concern that contracts would face difficulty finding financing if utilities are allowed unlimited ability to decline procurement due to economic reasons. The CPUC ruled that 2011 RPS contracts must contain provisions limiting the amount of economic curtailment. The CPUC also reiterated that if an IOU fails to meet its RPS targets due to "unreasonable administration" of contracts, the IOU could be subject to penalties.[87]

Beginning in the 2011 RPS competitive bid solicitation, the CPUC requires SCE to assess congestion costs as part of its least-cost best-fit bid selection process. SDG&E and PG&E already include congestion costs in their selection of winning RPS bids. All three IOUs are required to explain the use of congestion costs and buyer-directed economic curtailment to make the least-cost best-fit methodology more transparent.[88]

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83 http://www.energy.ca.gov/portfolio/contracts_database.html, updated July 2011.

84 p. 15, http://docs.cpuc.ca.gov/efile/MISC/119090.pdf.

85 http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm

86 http://www.cpuc.ca.gov/PUC/energy/Renewables/procurement.htm

87 p. 14-18, http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/133893.pdf

88 CPUC, Decision 11-04-030 April 14, 2011 in Rulemaking 08-08-009, http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/133893.pdf, p. 1, Appendix A.

One of the other procurement mechanisms soon to be available for renewable projects is the renewable auction mechanism.[89] To reduce the risk of contract failure, the CPUC's Renewable Auction Mechanism will require projects to meet the following project viability requirements: site control, development experience, commercialized technology, and completed interconnection application. In addition, the bidder must have a complete System-Impact Study, Cluster Study Phase 1, or have passed the Fast Track screens.[90]

Progress Toward the 12,000 MW Localized Electricity Generation Goal

In addition to California's new legislative mandate to increase the renewable generation to 33 percent of all retail sales, Governor Brown has requested another goal of installing 12,000 MW of localized electricity generation. The state has already made significant steps towards this goal, and currently has 3,278 MWs of distributed generation capacity installed.[91] To help progress toward this goal, there are a number of programs underway including:

- 3,000 MW of self-generation DG PV through the programs associated with Senate Bill 1 (Murray, Chapter 132, Statutes of 2006).
- 500 MW of wholesale generation DG PV through PG&E (half of the MW will be utility-owned; half will be provided by independent energy producers).
- 500 MW of wholesale generation DG PV through SCE (half of the MW will be utility-owned; half will be provided by independent energy producers).
- 100 MW of proposed wholesale generation DG PV through SDG&E (26 MW will be utility-owned; 74 MW will be provided by independent energy producers).
- 750 MW of wholesale generation (including non-PV DG, per SB 32) from existing feed-in tariff; plus an additional 66.5 MW contracted by SMUD.[92]
- 1,000 MW of wholesale generation (including non-PV DG) for the Renewable Auction Mechanism (RAM) decision that was adopted by the CPUC.

As of June, 2011, under these programs California has installed 543.77 MW of DG capacity. If these programs are fully successful it could add another 5,400 MW or so of additional

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89 Resolution E-4414 implementing the renewable auction mechanism is scheduled to be considered by the CPUC on August 18, 2011. http://www.cpuc.ca.gov/NR/rdonlyres/C12060F4-F23F-4F7C-875B-49B943FF8EA4/0/E4414_Draft_Comment_Resolution.pdf

90 http://www.cpuc.ca.gov/NR/rdonlyres/C12060F4-F23F-4F7C-875B-49B943FF8EA4/0/E4414_Draft_Comment_Resolution.pdf, p. 56

91 See Table 3.

92 SMUD developed a feed-in tariff program for up to 100 MW. Part of the program was in response to Senate Bill 32, which increased the current feed-in tariff project capacity from 1.5 MW to 3 MW and also included an obligation for POUs. SMUD calculated that their portion of the 750 MW would be 33.5 MW and so designed their feed-in tariff to have two buckets. 33.5 MW for projects 3 MW and below and an additional 66.5 MW for projects 5 MW and below. Therefore, the 66.5 MW is above what would be required under Senate Bill 32.

renewable capacity in the next five years. Other programs include the SGIP and ERP, which do not have MW targets but do provide incentives for renewable capacity to serve onsite load. If all programs are successful there would still be a gap of approximately 3,500 MW which may need additional programs or incentives to reach the 12,000 MW goal by 2020.

Renewable Goals Beyond 2020

The 33 percent renewable net short by 2020 is considered to be a floor estimate, allowing for the possibility that additional investments in these generation technologies may occur beyond the policy target. For example, electricity demand may increase beyond current forecasts due to the accelerated penetration of electric vehicles. Renewable generation may also become a viable alternative to replace some of the generation that is expected to decline through the decade, such as the contracts for electricity from coal-fired power plants serving California electricity demand (Table 8). The electricity from existing coal and petroleum coke plants currently represent about 10 percent of the total generation serving California load. The electricity from these coal plants is expected to decline by 61 percent (17,600 GWh) and associated GHG emissions drop from about 30 million tons of CO2e to 12 million tons between 2010 and 2020 due to the constraints imposed by the Emission Performance Standard.[93] Five coal facilities (representing approximately 1,500 GWh/yr) located in California are expected to be repowered and converted to renewable biomass facilities within the next few years.

Table 8: Contracts for Coal-Fired Generation (GWhs)

Plant Name	2010	2020	Contract Status
Four Corners	4,738	0	Expires 2016
Intermountain	11,886	9,258	Expires 2027
Mohave	0	0	Expired 2006
Navajo	5,401	0	Accelerated Timeline in 2014
Reid Gardner	912	0	Expires 2013
San Juan	1,712	2,192	Expires 2030
Boardman	1,030	0	One contract expires 2013, the other 2018
Deseret	0	0	Expired 2009
CA Coal/Petroleum Coke	3,406	0	Expires between 2011 and 2020
Total	29,085	11,450	61% decline from 2010

Source: California Energy Commission

The remaining coal generation contracts are expected to expire between 2027 and 2030. The annual capacity factor for these coal plants range between 83 and 92 percent, so there will need to be a mix of renewable and thermal generation with storage to replace these facilities. The

93 The Emission Performance Standard prohibits California utilities from renegotiating or signing new contracts for baseload generation that exceeds 1,100 lbs of CO2e emission per MWh. A number of contracts with coal generation facilities that exceed the Emission Performance Standard will expire within the decade and cannot be renewed with another long-term contract.

possibility of expanding renewable generation additions will likely require additional supporting infrastructure to integrate the operations into the electricity system. Long term electricity resource planning and infrastructure requirements must also be considered to address expansive energy policy deliberations and the possibility that the 33 percent renewable target by 2020 may shift to a higher threshold level for the following decade. For example, the renewable target could increase to 40 percent of retail electricity sales by 2030, consistent with Governor Brown's recent statement that "with the amount of renewable resources coming on-line, and prices dropping, I think 40 percent, at reasonable cost, is well within our grasp in the near future."[94]

With no current mandate that establishes a long-term renewable target goal, the primary policy driver for long-term renewable development evaluations is based on environmental goals. The ARB's AB 32 implementation plan includes an assumption that the electricity industry will need to surrender 108.6 million metric tons of carbon obligations (either allowances or offsets) by 2020. Additional emissions would be allowed only to the extent that offsets can be purchased from other energy sectors of the economy in lieu of real reductions by electric generators. The 2020 renewable generation targets will, in effect, reduce the need for fossil-fuel generation and ultimately reduce overall carbon emissions within the electricity industry to meet the AB 32 targets.

Executive Order S-3-05 was signed by Governor Schwarzenegger in 2005, setting an emission target of 80 percent below 1990 levels by 2050.[95] Additional renewable generation and other zero-carbon electricity resources will need to be developed to meet the long-term carbon reduction goals. Energy efficiency programs and self-generation will also be needed to reduce overall energy consumption to limit the dependence on electricity generation facilities that burn fossil fuels. Technology advancements also hold great promise to enhance the menu of options that may be available to reach the carbon reduction goal.

If the 80 percent carbon reduction goal were evenly split among the different energy sectors, carbon emissions from fossil fuel-fired generators would need to decline to 23.3 million metric tons (80 percent of 115.8 million metric tons in 1990). This would mean that California's electricity sector can only release the carbon emissions that would be produced by 50,000 GWh per year of generation from new efficient natural gas-fired power plants, assuming that coal fired-generation no longer serves California electricity demand and that the older less efficient gas fired plants are retired. For comparison, reported electricity from specified fossil fuel generation sources (natural gas and coal) was about 150,000 GWh in 2009, with about 46,000 GWh from spot market imports that are mostly served by gas-fired power plants in the West. The coal fuel has a higher carbon content value than natural gas, contributing to a high share of the electricity sector's GHG emission inventory. Older natural gas-fired power plants are also

94 Office of Governor Jerry Brown website, http://gov.ca.gov/news.php?id=16974.

95 Executive Order S-03-05, http://gov.ca.gov/news.php?id=1861.

about 35 percent less efficient that the new combined cycle generators, so retiring the aging plants will contribute to the long-term carbon reduction targets.

Determining the amount of electricity needed from renewable generation can be estimated on a simplistic back-of-the-envelope level, but numerous uncertainties and system reliability requirements must be considered to determine feasibility. If the electricity demand, number of self-generation projects and energy efficiency programs are expected to grow at current rates, electricity retail sales may increase to about 344,000 GWh by 2050. This includes the assumption that there will be an increase of electric vehicles in California, adding about 37,000 GWh of electricity demand for battery recharging. If existing renewable, nuclear and hydro generation levels continue to operate at the same levels in 2050, approximately 187,000 GWh of new zero-emission generation would be needed to meet electricity demand. If the nuclear facilities currently serving California demand are not relicensed, about 229,000 GWh of new generation will be needed. The new zero-emission generation need could be served by new renewable, nuclear, or fossil fuel-fired plants with carbon sequestration technologies. If the new generation is served only by new renewables, this supply would represent about 67 percent (with existing nuclear power plants) to 79 percent (without existing nuclear power plants) of total electricity sales in 2050.[96]

The above estimates are not intended to be used to predict future California electricity supply, but rather a starting point for evaluating the technical considerations when evaluating options for attaining long-term carbon reduction goals. There are significant levels of uncertainty regarding each of the variables used for calculating the amounts and types of generation needed for the future. For example, the electricity demand may vary depending on changing demographics and consumer energy consumptions patterns. The Energy Commission's Zero Net Energy programs goals include a combination of advanced energy efficiency standards and application of distributed generation so that residential and commercial buildings would be carbon neutral by 2030. On the other hand, the electrification of the transportation sector may significantly increase the need for generation beyond what is already assumed in the above calculations. Advances in carbon sequestration technologies may also become commercially available and permit the use of different generation technologies, beyond the reliance on zero-emission renewables.

Given the scope of studies currently underway to evaluate the infrastructure needs to integrate a 33 percent renewable target by 2020, there is even greater reason to exam the electricity system requirements for implementing an expanded policy goal for larger penetration of renewable generation. Potential changes to the daily and seasonal profiles for electricity consumption must be compared to the hourly generation patterns from different renewable technologies to determine whether additional thermal generation must operate, possibly beyond allowable carbon emission restrictions if sequestration technologies are not economically feasible. Energy

96 Preliminary electricity supply and demand calculations can be found at: http://www.drecp.org/meetings/2011-05-17_meeting/documents/2050%20RPS%20and%20acreage%20calculator%20background.pdf.

storage technologies must also be considered to potentially displace the need to use fossil fuel-fired generation technologies to back up intermittent renewable generation.

A 2009 study by E3 provides a starting point for studying the feasibility of achieving the 2050 goals and maintaining electricity system reliability. E3 was commissioned by Hydrogen Energy International, LLC to study scenarios that would meet California's GHG emission reduction goals for 2050. The high renewables scenario consisted of 74 percent renewable energy, 6 percent nuclear energy, 20 percent other (natural gas, large hydroelectric power and unspecified net imports), and 12,000 MW of energy storage beyond the 1,200 MW of energy storage in California already.[97]

> "In order to balance the system in the High Renewables Scenario we will have to rely heavily on solar thermal with energy storage to shape solar output, 'smart charging' of electric vehicles to match demand with non-dispatchable supply, exported or 'spilled' energy in some time periods, and utility-scale electricity storage. With all of these system balancing approaches in place, 74 percent generation is met with renewable energy in this scenario."[98]

The California Council on Science and Technology also prepared a report on the technology requirements for reducing carbon emissions by 2050.[99] The study includes an examination of the electricity system services needed to balance load growth that includes the electrification of the transportation sector and increased penetration of intermittent renewable generation. Advancements in energy efficiency, storage and smart grid solutions will contribute towards meeting the carbon reduction goals. Carbon sequestration will also be needed to offset the use of fossil fuel generation needed to integrate renewables. Nuclear generation scenarios are also considered as an option towards reducing emissions, assuming that the legal issues associated with nuclear waste issue are resolved.

Further study is needed to examine the electricity system reliability issues and possibilities for technological advancements to consider a portfolio of options for accomplishing the environmental goals. The path towards meeting the 33 percent renewable development mandate is an important step towards securing a reliable and clean energy future.

Conclusion

Clearly, California is making significant progress in increasing the amount of renewable energy in the state's electricity mix. The state has thousands of renewable MW seeking permits, interconnection, and contracts, and additional technical potential for further renewable

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97 E3, November 2009, *Meeting California's Long-Term Greenhouse Gas Reduction Goals*, http://ethree.com/public_projects/greenhouse_gas_reduction.html.

98 Ibid.

99 California Council on Science and Technology, *California's Energy Future – The View to 2050*, May 2011, http://www.ccst.us/publications/2011/2011energy.pdf.

development is very high. However, there remain significant challenges that will need to be addressed in order to achieve this potential. The following chapters of this report describe the variety of challenges in detail and discuss current efforts underway to address these challenges. These discussions will lay the groundwork for a comprehensive strategic plan to increase the development of renewable generating and transmission infrastructure in California to ensure that the state reaches its renewable energy goals for 2020 and beyond.

Chapter 3: Planning, Permitting, and Environmental Issues

As discussed in Chapter 2, California has an array of renewable electricity options at the large, utility scale; however, it also has a rich array of unique, fragile environmental resources which often overlap the most promising energy regions. Similarly, the state has a multitude of opportunities for placing distributed generation (DG) in local communities, although siting such systems can be complex due to required changes and upgrades in existing building structures and electricity distribution lines and networks. Complying with federal, state, and local agency environmental and permitting requirements related to these resources can be a challenge for renewable developers. Environmental review and mitigation activities for renewable generating facilities, particularly large utility-scale solar facilities located in the California desert, are complicated. Resolution of these issues can be time consuming, at time resulting in project delays, increased mitigation costs, and potential project disapproval by permitting agencies. While public interest in development of renewable energy is very high, resource advocates, local communities, and residents have equally strong interests in the development of new projects in suitable locations where project impacts are minimal and appropriately mitigated.

This chapter begins by outlining planning, permitting, and environmental challenges with developing utility-scale renewable power plants under the Energy Commission's power plant licensing jurisdiction. These projects can affect plant and animal species, cultural resources like historic sites and tribal lands, water quality and supply, land use, and, in some cases, air quality. The chapter focuses on large renewable power plants in desert locations because these projects face these issues to a greater degree since desert locations often provide habitat for sensitive species, have limited water supplies, and are often on federal lands. Environmental issues also can lead to legal challenges to projects, causing delays and higher costs as well as jeopardizing project approval.

The chapter then describes challenges for renewable projects permitted at the local level, which include renewable DG facilities, non-thermal renewable facilities such as wind and solar PV, and thermal renewable utility-scale facilities smaller than 50 megawatts (MW). While some local government agencies have established zoning and permitting ordinances for such facilities, many others have not, which can complicate and delay project review and approval. Delays also occur due to a wide variety of permitting standards, processes, and fees among local governments, as well as reduced staffing in many planning departments due to the economic downturn. In addition, while cities and counties typically issue land use permits and serve as lead agencies for environmental review, separate permits may be issued by other local and state agencies, further complicating the process.

Next, the chapter describes current efforts to improve permitting processes for both utility-scale and DG renewable facilities. For utility-scale projects, these efforts include those of the Renewable Energy Action Team (REAT) to develop the Desert Renewable Energy Conservation

Plan (DRECP), which will identify areas suitable for renewable energy project development and help conserve sensitive species and natural communities in the Mojave and Colorado Desert regions.[100,101] REAT efforts also include the *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects* that is intended to assist project developers in designing projects that minimize environmental impacts for renewable desert projects.[102] The chapter also touches on efforts by state and federal agencies to streamline the permitting of utility-scale renewable energy projects in California by increasing cross-agency cooperation and coordination, and discusses the Energy Commission's proceeding on "lessons learned" during the licensing of large-scale renewable energy facilities in 2010 that will identify new and innovative approaches to the Energy Commission's planning and permitting process based on lessons from the past.[103]

Efforts to identify and address barriers to permitting of renewable DG facilities include the U.S. Department of Energy's SunShot Initiative, which is providing grant funding for cities and counties to streamline permitting processes and advance innovations in local zoning and building codes and regulations.[104] Other efforts covered in the chapter include recent surveys by the Sierra Club on permitting costs and times for solar PV systems in various jurisdictions throughout California,[105] a January 2011 study by SunRun on reducing permitting and inspection costs for solar energy systems,[106] and a July 2011 report by Aecom estimating the potential economic benefits of permit streamlining applied at the state and local levels.[107]

At the state level, Assembly Bill X1 13 (V. Manuel Perez, Bradford and Skinner) has been introduced to provide $7 million in grants to counties in California to assist in developing or revising general plan elements, zoning ordinances, and natural community conservation plans

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100 Executive Order S-14-08, November 2008, directs state agencies to create comprehensive plans to prioritize regional renewable projects based on renewable resource potential and protection of plant and animal habitat. The Energy Commission and the Department of Fish and Game signed a Memorandum of Understanding formalizing a Renewable Energy Action Team to implement and track progress of this effort. http://www.drecp.org/documents/2008-11-17_Exec_Order_S-14-08.pdf.

101 See Desert Renewable Energy Conservation Plan website at: http://www.drecp.org/.

102 Renewable Energy Action Team Report, *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, December 2010, http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-F.PDF.

103 California Energy Commission, http://www.energy.ca.gov/siting_lessons/.

104 U.S. Department of Energy, http://www1.eere.energy.gov/solar/sunshot/.

105 Sierra Club Loma Prieta Chapter Website, accessed July 22, 2011, http://www.lomaprietaglobalwarming.sierraclub.org/solar.php.

106 SunRun, *The Impact of Local Permitting on the Cost of Solar Power*, January 2011, http://www.sunrunhome.com/uploads/media_items/solar-report-on-cost-of-solar-local-permitting.original.pdf.

107 AECOM, *Economic and Fiscal Impact Analysis of Residential Solar Permitting Reform*, July 2011, http://www.sunrunhome.com/cost-of-solar/solar-panels/local-permitting.

to facilitate development of renewable resources. State agencies are also collaborating on a policy to demonstrate public sector leadership in supporting renewable DG technologies by developing renewable energy systems on state-owned buildings, properties, and rights-of-way. Finally, at the local level, a number of cities and counties are working toward improving planning and permitting of renewable DG in their communities. These efforts are touched on in this chapter, but are covered more fully in Chapter 10.

Challenges for Utility-Scale Renewable Projects

There are two primary planning and permitting challenges for utility-scale renewable energy projects. The first is that such projects, especially solar, tend to be massive industrial scale developments on lands that are natural habitat or rural in nature requiring considerable mitigation of biological resource impacts. Small desert communities may feel overwhelmed by multi-square mile projects that will change the area long term. These industrial developments are often negatively viewed by local residents as an invasion into the solitude and isolation they sought by living in these locations. Because of this potential for large renewable projects to transform the landscape, site selection is a critical factor in project development and environmental mitigation.

The second challenge is the planning and permitting process itself. In California, this process involves many federal, state, and local agencies which provide regulatory review and ultimately issue permits for electricity generation projects depending on their agency mandate or jurisdiction. The level of involvement for these various agencies is unique to each project depending on its technology, size, location, and potential for environmental and system reliability impacts. If improperly coordinated, potentially overlapping levels of jurisdictional review can cause delays in the project permitting and licensing process and add to uncertainty about projects ultimately being developed. Initiatives being carried out by the REAT, discussed later in the chapter, are intended to promote interagency coordination and facilitate the permitting process in order to avoid delays, reduce permitting costs and improve the certainty of permitting decisions.

Many large solar energy projects are being proposed in California's desert area on federal Bureau of Land Management (BLM) land. The BLM has received requests for rights-of-way encompassing more than 300,000 acres for the development of 34 utility-scale solar thermal power plants totaling approximately 24,000 megawatts. Not all of these projects have reached the stage of an Application for Certification (AFC) with the Energy Commission. Table 9 provides a current list of renewable energy projects approved, withdrawn, or under review by the Energy Commission.

Environmental Challenges

Renewable resources tend for the most part to be located in specific parts of the state.[108] Most of the large tracts of land which have the solar or wind resources needed to accommodate utility-scale renewable facilities in California are located in the Mojave and Colorado Deserts of

[108] See Appendix C for maps showing location of renewable resources in California.

Table 9: Status of Large-Scale Renewable Projects under Energy Commission Jurisdiction

Project Name	Location	Size	Status
Abengoa Mojave Solar Project	San Bernardino Co.	250 MW	Approved 9/8/10, construction start 8/29/11
Beacon Solar Energy Project	Kern Co.	250 MW	Approved 8/25/10
Black Rock 1,2 and 3 Geothermal Power Project	Imperial Co.	159 MW	Approved 2/8/11
Black Rock 5 and 6 Geothermal	Imperial Co.	235 MW	Estimated AFC filing date Q4 2011
Ivanpah Solar	San Bernardino Co.	370 MW	Approved 9/22/10, construction start 11/2010
Calico Solar Project	San Bernardino Co.	663.5MW	Approved 10/28/10, petition to amend 3/25/11 to 563 MW PV and 100.5 MW thermal suncatcher
Carrizo Energy Solar Farm	San Luis Obispo Co.	177 MW	Withdrawn
City of Palmdale Hybrid Gas Solar	City of Palmdale	570 MW (50 MW solar)	Approved 8/10/11
Hidden Hills Solar Energy Generating System	Inyo Co.	500 MW	AFC filed 8/5/11
Imperial Valley Solar Project (Formerly SES Solar Two Project)	Imperial Co.	709 MW	Approved 9/29/10, license terminated 8/18/11 due to change from solar thermal to PV
Genesis Solar Energy Project	Riverside Co.	250 MW	Approved 9/29/10, construction start 4/2011
Rice Solar Energy Project	Riverside Co.	150 MW	Approved 12/15/10
Rio Mesa Solar Project	Riverside Co.	750 MW	Estimated AFC filing date Q4 2011
San Joaquin Solar 1 & 2	Fresno Co.	106.8 MW	Withdrawn
Solar Millennium Blythe	Riverside Co.	1,000 MW	Approved 9/15/10, construction start 2/2011, construction stop 8/20/11 to convert to PV
Solar Millennium Palen	Riverside Co.	500 MW	Approved 12/15/10
Solar Millennium Ridgecrest	Kern Co.	250 MW	AFC filed 9/1/09. Applicant exploring switch from solar thermal to PV, filed 6/2011 for jurisdictional waiver asking for CEC review of project.
Victorville 2 Hybrid Power Project	City of Victorville	563 MW (50MW solar)	Approved 7/16/08

Source: California Energy Commission

Southern California, or in the South San Joaquin Valley. There is also wind potential in the Tehachapi and San Gorgonio passes. Geothermal power plants and associated steam/hot water fields are typically utility-scale, industrial facilities with pipe networks located in rural areas on relatively large tracts of land primarily in Lake, Sonoma, Imperial, and Inyo Counties. While biomass facilities can be located throughout the state, most biomass development has occurred in the northern part of the state due to the availability of fuel from forest and agricultural waste.

Because the majority of new renewable project development is currently proposed in the California desert, this section focuses primarily on impacts from utility-scale renewable projects on desert environments. However, solar photovoltaic (PV) facilities, wind farms, geothermal power plants, and biomass plants located in non-desert environments in central and northern California also face environmental issues.[109] Solar PV facilities can cause potential glare and glint hazards to aircraft, trains and highway traffic, and can also impact agricultural lands and open space/habitat lands. Depending on their location, technology, and site design, wind farms have the potential for killing migrating or foraging raptors and bats, adversely affecting the visual landscape, creating aviation hazards, and causing noise problems if located near urban areas. Geothermal facilities can affect rare and endangered plant and animal species, cultural resources, the quantity and quality of local water supplies, and visual landscapes. Geothermal projects can also cause or contribute to local and regional air quality problems through emission of moderate amounts of regulated air pollutants, although they are required to use best available emissions control technology and provide emission offsets to comply with local air district regulations. Biomass plants can cause regional increases in criteria pollutants and particulate matter, and increase water use (if a facility uses water cooling towers or employs "wet scrubbers" to reduce hydrochloric acid emissions), and also pose ash disposal and local land use concerns.

For renewable facilities in desert environments, the primary environmental concerns are biological and cultural resources, water supply, visual impacts, transportation-related visual hazards, and land use, as discussed in more detail below. Depending on the project, there may also be air quality, hazardous materials, noise, public safety, and local community concerns.

Biological Resource Impacts

Proposed desert locations for utility-scale solar and wind energy projects often provide habitat for sensitive species like raptors, bats, desert tortoises, kit foxes, various reptiles and amphibians, Mohave ground squirrels, and sensitive plants. Solar PV and solar thermal technologies generally cause greater habitat loss than wind farms and solar thermal heliostat and power tower projects since the sites for such solar projects often need to be leveled due to their linear design, which typically cannot be altered to avoid sensitive areas. Heliostat and power tower projects do not necessarily require that a site be leveled, so habitat impacts can be less. The site topography can be maintained and some vegetation left intact since that technology has far greater flexibility regarding where the mirrors are located and do not always need to be in a line.

Wind energy projects, if located in key migration routes or foraging areas, are known to affect bird and bat species through collisions with turbine blades and through barotraumas (tissue damage and lung failure) caused by rapid air-pressure reduction when bats and some birds get

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109 While there are no utility-scale ocean wind, wave, current, and tidal projects operating at this time, there is industry and federal government interest in testing and pilot projects to address, among other issues high electricity generation costs. The industry and federal interests may be partially addressed by projects being licensed and permitted offshore Alaska, Maine, Massachusetts, New York, Oregon, and Washington. The Energy Commission, California Ocean Protection Council, and others are addressing regulatory challenges and have identified potential marine renewable energy project environmental impacts that may affect commercial and recreational fisheries, marine mammals, birds and transportation, ocean and coastal habitats, and recreational boating.

too close to moving turbine blades. Wind farms generally cause less absolute habitat loss within a project footprint than utility-scale solar facilities because habitat for plant and wildlife species remains between turbines. Indirect impacts to wildlife can occur between turbines from roads, vehicles, and noise and possibly render a site generally unusable by wildlife depending on usage on the site and density of turbines. Generally it may be easier to protect rare plant populations on a wind energy site. In addition to habitat loss, most large, terrestrial renewable generation projects have the potential to affect wildlife movement patterns, particularly if they are proposed in or near migration corridors or impede the connections between sensitive species populations which can be critical to the species' local and regional health and survival.

As discussed in Chapter 9, research efforts under the Energy Commission's Public Interest Energy Research (PIER) Program are contributing toward reducing these and other environmental impacts. Research areas include identifying ways to reduce the effects of desert solar and wind projects on sensitive plant and animal species and identifying low-risk sites for wind turbine installations to reduce impacts on birds and bats. In addition, in 2010 then-Attorney General Brown brokered an agreement between environmental groups, wind developer NextEra Energy Resources, and the state to replace 2,400 turbines at the Altamont Pass Wind Farm in Alameda and Contra Costa Counties with newer, more bird-friendly models.[110] The project is expected to be complete by 2015 and, as part of the agreement, NextEra will pay $2.5 million to the PIER program, the East Bay Regional Park District, and the Livermore Area Regional Park District for raptor habitat creation.

Water Supply Impacts

Utility-scale solar thermal and PV power plants can require large amounts of water for dust control and soil grading during construction. With sandy, dry, and windy conditions typical in the desert region, the amount of water used for construction activities can be considerable depending on the amount of ground disturbance. Solar facilities also require water for mirror washing.[111] For power plants that use wet cooling technology, sizeable amounts of water are required during operation. Water is limited in desert areas and groundwater basins are often already in an overdraft condition.[112] Fresh water is an increasingly critical resource, not only in the desert regions but throughout California. Increasingly, power plants may be competing with other local users for diminishing water supplies. As California's population and water demand continues to grow, the Department of Water Resources anticipates that the state will

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110 CBS San Francisco, "Wind Turbines to be Upgraded in Altamont Pass," December 6, 2010, http://sanfrancisco.cbslocal.com/2010/12/06/wind-turbines-to-be-upgraded-in-altamont-pass/, accessed August 20, 2011.

111 Water needs for photovoltaic panel washing are estimated as one-tenth of the requirements for concentrating solar power mirror-washing values. *Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States*, Table 3.1-1, http://solareis.anl.gov/documents/dpeis/Solar_DPEIS_Chapter_3.pdf.

112 Overdraft refers to the condition of a ground water basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over time.

experience shortfalls in water supplies in excess of several million acre feet of water within the next ten years.

Surface Water Impacts

Ephemeral and intermittent streams that contain water for only part of the year are found across much of the California desert region. Many of these streams are protected by both federal and state regulations because they are important sources of sediment, water, nutrients, seeds, and organic matter for downstream ecosystems and also provide habitat for many species. Desert streams are different from other streams in California because they typically have relatively long periods where no flow occurs punctuated by episodic flows that have a relatively short duration and high intensity. For example, the Imperial Valley Solar project originally proposed a 750 MW facility on a 6,500 acre site that was later found to contain 880 acres of jurisdictional waters.[113,114]The project was redesigned by the applicant to avoid or minimize these impacts, which reduced the amount of developable area and resulted in a lower generating capacity of 709 MW.

Special consideration must be given to the design and management of project site drainage to ensure there are no on- or off-site impacts. Diversion of high velocity flows through and around a site can be difficult where potential impacts up and downstream of a project site must be minimized and there is a need to mimic natural conditions. Project sites are particularly prone to impacts where construction is underway and natural soils have been disturbed and exposed in excavations. Significant effort must be expended to install temporary erosion and sediment protection. In some cases site design must be modified where important biological resources are identified and site drainage would have an impact.

While thermal renewable facilities have historically used wet turbine cooling technologies, they can use alternative approaches, such as dry cooling (air cooled condensers) and hybrid cooling, which are available and commercially viable. This can reduce a project's water demand by up to 90 percent, and simplify the analysis involved in the permitting process. For example, the Genesis Solar Energy Project estimated that changing the proposed 250 MW parabolic trough solar thermal power plant from wet cooling to dry cooling would reduce project water needs from 1,600 acre-feet per year to about 200 acre-feet per year.[115] This strategy involves an important trade off since use of dry cooling in the desert can decrease plant efficiency by three to eight percent when compared to wet cooling and also require a larger project footprint.

Rather than using fresh water, renewable projects can use degraded water, also known as non-potable water, which can be treated and reused for power plant process water. Some examples of degraded water are: contaminated surface water or groundwater; surface water impacted by

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113 http://www.energy.ca.gov/2010publications/CEC-800-2010-006/CEC-800-2010-006-CMF.PDF.

114 The Army Corps of Engineers mapped a total of 637 acres of primary streams and 244 acres of secondary streams, http://www.blm.gov/ca/st/en/fo/elcentro/nepa/stirling.html.

115 California Energy Commission, *Genesis Solar Energy Project Commission Decision*, September 2010, http://www.energy.ca.gov/2010publications/CEC-800-2010-011/CEC-800-2010-011-CMF.PDF.

agriculture activities; and treated municipal wastewater (recycled water). Currently, degraded water use at power facilities is typically municipal tertiary treated recycled water. There is a need for improved treatment technologies to make other sources of degraded water available in sufficient quantities for commercial viability.[116]

The Energy Commission adopted a water policy in the *2003 Integrated Energy Policy Report* that power plants' use of fresh [surface] water for cooling will be approved only where alternatives cooling technologies are shown to be "environmentally undesirable" or "economically unsound."[117] More recently, in 2010 the Energy Commission's determination during the Genesis Solar Energy Project's licensing proceedings stated that projects seeking to use groundwater for cooling purposes are required to "use the least amount of the worst available water, considering all applicable technical, legal, economic, and environmental factors."[118] As alternative water sources develop and technologies for process use improve, the Energy Commission may choose to update or enhance its water policy to reflect the changing dynamic of California's water use and supply. As part of the Energy Commission's "lessons learned" proceeding, discussed in more detail later in the chapter, a number of policy issues, including water, are under review as a result of staff, stakeholder, and agency experiences during the 2010 review of large solar projects.

Visual Impacts

Utility-scale solar thermal power plants or wind farms can cover many square miles[119], including the power block facilities, access roads and transmission lines. They can introduce major visual changes into typically non-industrialized desert or mountainous landscapes with scenic values. The steam plumes produced by the cooling towers of solar thermal power plants may also cause visual impacts to the landscape. Geothermal power plants, including well pads, steam pipelines, power generation facilities, access roads and transmission lines, may occupy as much as 350 acres and cause similar visual impacts on undeveloped desert or mountainous terrain where they are typically located. Also, similar to solar thermal power plants, geothermal power plant cooling towers can produce steam plumes that cause visual impacts.

Cultural Resources Impacts

Cultural resources are defined under state law as buildings, sites, structures, objects, and historic districts. Three kinds of cultural resources are considered in the Energy Commission's environmental impact assessment, including prehistoric (related to prehistoric human occupation and use of an area); historic (associated with Euro-American exploration and settlement of an area); and ethnographic (materials important to the heritage of a particular ethnic or cultural group, such as Native Americans).

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116 Past research on this topic by the Public Interest Energy Research Program is described in *Use of Degraded Water Sources as Cooling Water in Power Plants*, http://www.energy.ca.gov/pier/project_reports/500-03-110.html.

117 http://www.energy.ca.gov/reports/100-03-019F.PDF, p. 41.

118 http://www.energy.ca.gov/sitingcases/genesis_solar/notices/2010-02-02_Decision_Scoping_Order.pdf, p.3.

119 One square mile = 640 acres.

A major challenge to the development of lands in the southern desert and, to a lesser extent, anywhere in California, is the lack of comprehensive information regarding the locations and significance of cultural resources. While some archaeological sites are small and well-defined, historic and prehistoric landscapes can both stretch for miles. For example, elements of the World War II Desert Training Center, a landscape of historic significance, encompass a large portion of southeastern California and southwestern Nevada. An extensive Native American prehistoric trails network extends throughout that same area, and historic Route 66 ties many small historic outposts together as it traverses the southern desert regions. Many of the elements within these and other areas of historic significance have never been identified or evaluated. Information on both historical and archaeological sites is scattered among city, county, state, and private archives, multiple information centers, and state/federal agencies, such as the California Office of Historic Preservation, National Register of Historic Places, and the California Register of Historic Resources. Scarce and fragmented information, along with confidentiality requirements limiting access to cultural resource information, can make it difficult for developers to select sites that will avoid significant cultural resources. This can cause delays or inaccuracies in the resource analysis during the licensing process and create the need for more extensive site surveys, especially in remote desert areas.

In addition, much of the land under consideration for solar and wind development includes Native American ancestral lands that have been used for centuries. These lands contain artifacts, burials, historic villages, trails, plants, animals, landscapes, and vistas with cultural and spiritual significance. The spiritual value of these areas and artifacts is separate and distinct from the archaeological and historical value of these or other cultural resources and, from a Native American perspective, the loss of the use of these lands or their spiritual context within the landscape cannot be mitigated. Information regarding landmarks and other areas of significance to Native Americans is often known only to tribal elders or tribal historic preservation officers.

Another significant challenge to avoiding or mitigating cultural resource impacts, especially under CEQA, is the lack of flexibility in site location and design. Developers frequently fail to adequately consider the potential cultural sensitivity of a site through appropriate resources studies and discussions with knowledgeable technical specialists and Native American tribal representatives before settling on a final location. Pre-filing meetings and Native American consultations can only be effective if there is a real option to recommend relocation of the proposed project to a less sensitive site. Cultural resources cannot be avoided if staff and tribal representatives do not have the opportunity to identify resources prior to site finalization.

Land Use Impacts

The majority of desert lands in California are owned by the federal government and managed for multiple uses by the BLM and National Park Service. The Department of Defense also owns and manages large tracts of desert land in California for military purposes. Siting renewable energy facilities on BLM and National Park Service lands may preclude and, in some cases, unduly restrict, existing and future multiple uses such as recreation, wildlife habitat, livestock grazing, and open space. For example, solar thermal facilities sited within the BLM's California

Desert Conservation Area Plan have resulted in significant and irreversible impacts and restrictions on these uses. Similarly, siting renewable energy facilities on or near Department of Defense lands may impact their military operations and related programs.

If located in productive agricultural areas, those solar thermal or PV projects which require grading of large numbers of acres may result in the permanent loss of crop and grazing lands. In contrast, wind energy projects are generally compatible with agricultural land uses and may even help farmers preserve their farms by providing them a supplemental income if they are able to lease land to wind developers.[120] The average wind farm requires 5.5 acres of land to produce one megawatt of electricity, allowing lands to remain available for planting and grazing.[121] However, impacts to the agricultural resources can occur from wind projects due to soil disturbance during construction and the loss of agricultural land from installation of access roads, wind turbine towers and transmission lines.

Geothermal facilities, which are usually land intensive, may also result in the permanent loss of productive agricultural land due to geothermal steam well field development, steam pipeline installation, and construction of the power plant facilities and transmission line, as well as permanent access roads to develop and maintain all of the steam field and power plant facilities.[122]

Transportation-related Visual Hazards

Solar thermal, PV, wind, and geothermal technologies may cause significant hazards to general aviation and military flight activities in California, as well as to motorists and railroad crews. Solar thermal and PV plants can emit glint and glare from mirrors or collectors that can pose a nuisance to pilots or even cause flash blindness, especially when plants are located near airports. Motorists and railroad crews may also be temporarily blinded or distracted by the glint and glare. Wind turbines may cause aircraft turbulence due to airflow disruption. The evaporative and dry cooling towers of some solar thermal plants and cooling towers of geothermal plants may emit high velocity, hot air plumes, disrupting airflow and potentially causing severe turbulence to planes when located near airports or areas of low-flying aircraft. The Department of Defense has also raised concerns about thermal plumes from power plants located near military flight areas and impacts on their radar operations. All very tall structures, including wind turbines and solar power towers, have the potential to interfere with low-flying aircraft and with military flight zones that have structure height restrictions.

Planning and Permitting Process Challenges

All proposed generation facilities in California must go through an environmental review and permitting process subject to CEQA and may also be subject to the National Environmental

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120 http://www.powernaturally.org/Programs/Wind/Wind%20Energy%20Toolkit.pdf.

121 California Energy Commission, *Energy Aware Facility Siting and Permitting Guide*, Consultant Report, December 2010, http://www.energy.ca.gov/2010publications/CEC-600-2010-007/CEC-600-2010-007-D.PDF.

122 http://geoscience.web.officelive.com/geothermal.aspx.

Policy Act (NEPA). When utility-scale renewable energy generation facilities are proposed on federally-owned land in California, both CEQA and NEPA processes are necessary. Permitting is done at both the state and local levels, depending on the size and technology of the proposed facility.

Permitting of Large-Scale Thermal Plants

The Energy Commission's licensing process was established in 1974 to provide a comprehensive "one-stop" process for permitting thermal power plants larger than 50 MW, including renewable facilities that use solar thermal, geothermal, and biomass technologies. This streamlined the process by including all other state and local permits that projects previously had to acquire individually. The process generally takes from 12 to 18 months from application to final decision, and includes independent environmental and engineering assessments by Energy Commission staff and coordinated review with federal, state, and local agencies as well as Tribal governments. The resulting Staff Assessment is the functional equivalent of a draft environmental impact report, and includes all proposed mitigation that would be required by other state, local or federal permits. While there is no requirement that federal agencies issue their permits for renewable energy projects prior to or concurrent with the Energy Commission license review process, the Energy Commission cannot approve a project that does not meet Federal requirements. Therefore, federal agency participation in the Energy Commission's power plant licensing process provides the best possible assurance that state actions are consistent with federal requirements.

A major challenge in the permitting process is fragmented licensing authority for different types of renewable energy projects among different state and local agencies. This has resulted in inconsistent environmental reviews and standards along with inaccurate and incomplete information for both biological and cultural resources. This includes the location and condition of previously identified cultural sites or surveyed areas. This fragmentation also unnecessarily complicates the acquisition of data to support the environmental analysis. Agencies may have limited expertise and resources for comprehensive cultural resources analysis, especially at the local level. Also, local agencies often do not update their cultural database which compromises the integrity of information available for cumulative impact analysis by other agencies or for other projects. In addition, mitigation measures, licensing conditions, and enforcement are inconsistent among agencies at all levels of government. As a result, applicants may spend time and money on unnecessary or duplicative analyses and resources may not be adequately protected.

Although state and federal protocols for analyzing the impacts to biological and cultural resources are essentially the same, there are variations in the extent of the evaluation, interpretation of the results, and state and federal requirements for mitigation. When agencies are unable to agree on a set of conditions, project applicants may find it necessary to satisfy two or more sets of mitigation or licensing conditions, submit duplicative information, or face delays while opposing agencies struggle to retain control or find common ground.

There are a number of key federal permit processes that involve multiple agencies and timelines that can add uncertainty and delay to power plant licensing. Examples include:

- Biological resource permit processes under the Endangered Species Act, administered by the U.S. Fish and Wildlife Service (FWS).
    - When renewable resource projects are proposed on privately owned land with federally listed species found on the site or in the vicinity, the process for obtaining an ESA permit can very extended and difficult, due to the lack of a "federal nexus". If there is no federal agency such as the BLM involved in the project, there may not be a ready, timely avenue or "nexus" for the request for consultation which the FWS needs. The request for consultation by another federal agency triggers the FWS Determination process regarding a project's impact on a listed species.
- Air quality Prevention of Significant Deterioration permits under the Clean Air Act, which require a permit or concurrence by the U.S. Environmental Protection Agency (USEPA).
- Water quality permits related to the National Pollutant Discharge Elimination System (NPDES), which adds uncertainty due to changing USEPA regulations and regulatory guidance.
- Federal Land Use Entitlements, which involve federal land management agencies like the BLM or the U.S. Forest Service (USFS) and NEPA compliance.
- Multi-disciplinary permitting of interstate natural gas pipelines, which require Federal Energy Regulatory Commission (FERC) approval along with NEPA compliance.
- Multidisciplinary permitting of transmission lines, which involve permits from the Western Area Power Administration (WAPA) and/or the California Public Utilities Commission (CPUC), and associated NEPA and CEQA compliance documents.

In the past, federal agencies have been responsive to the state's needs for timely review of power plant licensing applications. However, in 2009 the timing of federal permits became especially important with the specific build and timing conditions under which renewable projects proposed on federal land would receive billions of dollars of federal stimulus funding under the American Recovery and Reinvestment Act. Challenges in coordinating federal permits in the Energy Commission licensing process include ensuring that necessary information needed by federal agencies is developed and presented early in the process, including the project application pre-filing phase. Complex biological mitigation measures like desert tortoise relocation plans must be consistent with measures likely to be required by federal agencies; federal agencies need sufficient staff resources for helping identify and address critical issues through written comments and participation in workshops, scoping meeting, and hearings.

Timing of federal permits can affect the licensing process in a variety of ways, including:

- Limiting or delaying information needed to establish project compliance with Laws, Ordinances, Regulations, and Standards (LORS) prior to licensing.
- Delaying information needed to establish mitigation measures prior to licensing decisions, which can result in significant changes to proposed projects, need for additional analyses, and schedule delays.
- Subjecting projects to future appeals when federal permit decisions are made after the Energy Commission has approved a power plant license, appeals over which the Energy Commission may have limited influence.

Permitting at the Local Level

In addition to state and federal permitting efforts, local governments, primarily larger counties through their planning and redevelopment agencies, review and permit utility-scale renewable electrical generating facilities (non-thermal projects such as solar photovoltaic and wind energy, and thermal projects less than 50 MW in size). These permits typically require a multi-disciplinary CEQA analysis and a public comment/hearing process. As discussed in Chapter 10, many local governments do not include utility-scale renewable energy facilities in their general plans or zoning ordinances so developers may have to apply for general plan amendments or rezoning which can complicate and delay the review and approval of renewable generation projects under county jurisdiction. In addition, local governments face resource constraints as planning departments are downsized in response to the economic downturn, and may also lack the technical expertise to address the growing diversity of renewable energy technologies.

As part of its "lessons learned" proceeding, the Energy Commission is reviewing the licensing processes for several PV and wind projects at the local level both in California and out of state to compare and contrast environmental documents from other jurisdictions with the Energy Commission's siting process.

Local government participation and involvement is also important for projects permitted at the state level. When the Energy Commission and BLM permitted numerous large solar thermal projects in 2010, local agency involvement in that process varied but primarily included county fire departments and their involvement with both Worker Safety and Hazardous Material Management analyses and associated mitigation and conditions of certification. Local agencies have expressed an array of fiscal and environmental concerns about large renewable energy projects, and have sometimes intervened in the Energy Commission's permitting process. Their input and participation has generally led to conditions of certification addressing some of their resource concerns and requirements for local review and comment on various plans such as construction traffic control.

Challenges for Distributed Generation Renewable Projects

Similar to utility-scale renewable projects, renewable DG projects (those 20 MW or smaller in size) also face challenges associated with environmental impacts and planning and permitting processes.

Environmental Challenges

Depending on the technology and the site location, DG projects can cause a range of environmental impacts similar to those of utility-scale projects. DG projects in California must comply with a number of environmental requirements including permits for air quality, water discharge, building standards (for systems that potentially impact the building environment or envelope) and waste discharge permits (for DG facilities that process solid materials or have disposable wastes).[123] Due to their smaller size, there is greater opportunity to relocate or redesign renewable DG projects to avoid or minimize environmental impacts. In addition, renewable DG technologies like small PV can be located in industrial areas on already disturbed land or on existing residential, industrial, or commercial buildings, which minimizes their environmental impact. Similarly, individual or small groups of wind micro-turbines can be sited and designed to avoid or minimize land use, noise, visual, or habitat impacts.

Biomass DG projects using forest or agricultural waste have smaller footprints than utility-scale facilities and are typically located at or near existing lumber mills or agricultural facilities to maximize fuel access, and avoid or minimize land use conflicts or other environmental impacts. However, these projects can face challenges in securing air permits, particularly in areas of the state with significant air quality issues.

Small hydroelectric projects cause fewer and less severe impacts than large hydroelectric projects. Many new facilities are and will be located in man-made conduits,[124] involve replacing older turbines at existing dams with more efficient equipment, take advantage of pumped storage opportunities, operate to minimize fish mortality and stream flow, and make use of run-of-river turbines placed in river, stream, and conduit flowing water. In general, taking advantage of existing disturbed locations and avoiding construction of new impoundments eliminates impacts or keeps them to acceptable levels. However, some existing facilities located on natural waterways designated for critical habitat restoration (such as those located on Battle, Kilarc and Cow Creeks, the Klamath River, and in the Trinity River Basin), and new facilities designed with on-stream impoundments adversely affect water resources by changing stream flows, reservoir surface area, the amount of groundwater recharge, water temperature, turbidity (the amount of sediment in the water), and oxygen content. Potential biological impacts include

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123 Itron, Inc., *Impacts of Distributed Generation: Final Report*, January 2010, http://www.cpuc.ca.gov/NR/rdonlyres/750FD78D-9E2B-4837-A81A-6146A994CD62/0/ImpactsofDistributedGenerationReport_2010.pdf.

124 Conduits are defined in Public Utilities Code Section 399.12, Subdivision (a) as pipelines, aqueducts, irrigation ditches, flumes, siphons, tunnels, or other human-made water distribution infrastructure that operate to distribute water for a beneficial use.

new lakes that can flood terrestrial habitat, while changes in water quality and quantity flowing downstream may alter fish migration patterns and cause other aquatic life impacts. New reservoirs can also damage or inundate cultural, tribal, archaeological, or historic sites. Scenic or wilderness resources can be lost or degraded, and projects can increase landslides and erosion.

Planning and Permitting Process Challenges

Through a review of relevant literature and informal discussions with stakeholders from the private and public sectors, Energy Commission staff identified the following primary permitting challenges related to renewable DG:

- **Planning:** If a parcel is not zoned for electricity generation, the process to obtain permission to install renewable DG can be quite lengthy and cumbersome, especially for facilities that require large amounts of land.[125] The impact of zoning is less of a problem for rooftop PV because the Solar Rights Act has been implemented in a way that requires local land use authorities to allow roofs to be used for solar electric facilities. Precedent is less clear regarding the application of the Solar Rights Act to ground-mount solar electric facilities.[126] Similarly, Government Code 65893-65899 establishes regulatory limits that local governments must follow when planning for and permitting small wind turbines.[127] Physical interconnection of DG units to the local distribution network may be complicated, depending on the electricity infrastructure in each community. Upgrades to the distribution system can require local permits.

- **Zoning:** Many cities and counties do not have zoning ordinances that permit and guide the development of renewable DG systems. Without a preferred development pattern for renewable DG projects, developers must request general plan amendments and/or rezoning of developable parcels. General plan amendments and rezones are lengthy and cumbersome processes, and are not preferred choices for expeditious permitting. For example, developers have requested approval to construct larger-scale distributed PV facilities in Alameda County. In response, Alameda County is developing codes and standards for such

125 In California, cities and counties comply with the requirements of Government Code 65300 by adopting a general plan that establishes policy statements that guide how communities prefer to develop. To implement a general plan, communities use their authorization in Government Code 65850 to translate broad general plan policy statements into zoning ordinances or codes regulating specific uses of property and land development standards.

126 See Section 4 beginning on page 12 of "California's Solar Rights Act A Review of the Statutes and Relevant Cases: http://www.sandiego.edu/epic/research_reports/documents/100426_SolarRightsAct_FINAL.pdf

127 Though GC 65893-65899 does not establish a "right" to wind resource access the same way that the Solar Rights Act does for solar resources, GC 65893-65899 does place limits on local regulatory agencies. See http://www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=65001-66000&file=65893-65899.

facilities.[128] In addition, the California County Planning Directors Association (CCPDA) is taking on the role to develop a statewide model ordinance for Solar Electric Facilities.[129]

- **Varying codes, standards, and fees:** Stakeholders indicate the land-use permitting process for identical renewable DG systems varies significantly from jurisdiction to jurisdiction.[130] This inconsistency makes it difficult for developers to create an efficient process to meet permit requirements and increases the risk associated with securing project approval. Additionally, permit fees and calculation methods vary widely across California.[131] In 2010 and 2011, the Sierra Club, Loma Prieta Chapter, conducted surveys on the costs of permitting and permit processing times for solar PV systems in various jurisdictions throughout California.[132] The range of fees in the municipalities surveyed in each county varied widely; in Los Angeles, for example, fees for commercial PV projects 131 kW in size ranged from $0 to $46,000. In general, the surveys found that the cost of a PV project does not correlate with the staff hours a municipality must devote to plan review and inspection. In addition, basing a permit fee on the valuation of a PV system tends to generate higher fees than the actual cost to service a permit, since the time involved for review and inspection does not appear to be linear; for example, it does not take 10 times as long to evaluate a 100 kW system as a 10 kW system. The percent of municipalities in the counties surveyed that exceeded estimated maximum estimated cost recovery fees for commercial systems ranged from 17 percent to 65 percent.
- **Williamson Act issues:[133]** Communities and organizations across California interpret the definition of a compatible use on Williamson Act agricultural preserve lands differently.[134]

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128 See the County staff memo to the Board of Supervisors detailing the County's approach to permitting solar PV. http://www.co.alameda.ca.us/cda/planning/landuseprojects/documents/Board_Transportation_&_Planning_solar_memo_6-6-11.pdf.

129 http://www.ccpda.org/en/model-sef-ordinance/130-ccpda-model-sef-ordinance-development-progress-report.

130 Sun Run's comments to the Energy Commission's solicitation for comments regarding the Renewable Planning and Permitting Program and Large-Scale Solar Association's comments on the proposed RP3 program. Docket 02-REN-1038.

131 Little work has been done in regards to determining the permitting costs of larger renewable DG systems; however, the Sierra Club's Loma Prieta Chapter has completed extensive work to determine the permitting costs of rooftop PV systems in most California jurisdictions. http://lomaprietaglobalwarming.sierraclub.org/solar.php.

132 Sierra Club Loma Prieta Chapter Website, accessed July 22, 2011, http://www.lomaprietaglobalwarming.sierraclub.org/solar.php.

133 The California Land Conservation Act of 1965 (Williamson Act) allows local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In return, landowners receive lower than normal property tax assessments based on farming and open space uses as opposed to full market value. For more information, see California State Department of Conservation Website at: http://www.conservation.ca.gov/dlrp/lca/Pages/Index.aspx.

134 "Solar Request Ignites Debates" http://m.recordnet.com/apps/pbcs.dll/article?AID=/20110716/A_NEWS/107160329/-1/WAP&template=wapart&m_section=WAP

Some claim that renewable DG is a compatible use, while others hold that renewable DG facilities do not fit the intent of the Williamson Act compatibility provisions.[135] Many owners of rural land parcels that can easily accommodate systems up to 20 MW have Williamson Act contracts. Currently, Senate Bill 618 (Wolk) is under consideration at the Legislature; if passed, it will establish the legal process for converting a Williamson Act easement to a solar use easement, thus removing uncertainties regarding compatibility.

- **Vague, duplicative, and uncoordinated permitting processes:** Permit approvals typically require renewable DG builders to secure approval from local fire departments, building and electrical code officials, and local air districts before receiving a zoning clearance to build a facility. If the proposed site for renewable DG development is not privately held, additional permitting requirements may be imposed by the public land holding body (for example, the BLM or the Department of Defense). Because of the cross-section of agencies involved in the review and approval of development applications, there is duplication and inefficiency in the permit application process. According to stakeholders, the lack of coordination among permitting bodies is a barrier for developing all scales of renewable DG, including residential rooftop PV.[136]
- **Unknown environmental review and mitigation requirements:** Similar to utility-scale renewable facilities, DG development in California is subject to an environmental review under CEQA and, in some cases, NEPA. On a project-by-project basis, the environmental review requirement adds uncertainties to renewable DG projects. Further, if a lead permitting agency determines that an Environmental Impact Report (EIR) is necessary for project approval, expensive mitigation requirements will often make a project infeasible. Stakeholders comment that lead permitting agencies have thorough environmental screening and review processes in place for traditional development, yet many lead agencies are ill-prepared to assess environmental impacts associated with renewable DG.[137]

Current Efforts to Address Planning, Permitting, and Environmental Challenges

There is widespread recognition of the importance of streamlining and reducing complexity in renewable permitting processes, with a number of efforts either completed or underway to help facilitate the development of both utility-scale and DG renewable electricity generating facilities in California. This section describes these efforts and current status.

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135 As part of CCPDA's effort to draft a model PV ordinance for California counties, the stakeholder group established an inventory of issues related to planning and permitting solar electric facilities on agricultural land and Williamson Act land. See issues 6a, 15, and 16 on "Issues List and Actions Taken 2011-06-02" at http://www.ccpda.org/en/component/docman/cat_view/81-solar-issues/82-ca-model-photovoltaic-ordinance

136 Comments by SunRun regarding the Renewable Planning and Permitting Program, Docket 02-REN-1038.

137 Comments by San Diego County regarding the Renewable Planning and Permitting Program , Docket 02-REN-1038.

Utility-scale Renewables

Renewable Energy Transmission Initiative

In 2007, the Renewable Energy Transmission Initiative (RETI) was initiated as a joint statewide effort combining land use and transmission planning factors among the CPUC, the Energy Commission, the California ISO, and investor- and publicly owned utilities.[138] The primary goal of RETI was to (1) help identify the transmission projects needed to accommodate California's renewable energy goals; (2) facilitate the designation of corridors for future transmission line development; and (3) facilitate transmission line and renewable generation siting and permitting. RETI operated as a stakeholder planning collaborative and involved a broad range of participants, first to gather information and advice, and then to build active and consensus support for specific plans for renewable energy and related transmission development. RETI resulted in the identification and refinement of Competitive Renewable Energy Zones throughout the state that hold the greatest potential for cost-effective and environmentally responsible renewable energy development. The RETI process is discussed in greater detail in Chapter 4, which focuses on transmission planning and related land use planning activity.

Renewable Energy Action Team

To address challenges with permitting renewable projects in sensitive California desert regions, the Renewable Energy Action Team (REAT) was formed in 2008 with the primary goal of streamlining and expediting the permitting processes for renewable energy projects while conserving endangered species and natural communities at the ecosystem scale.[139] Based in part on recommendations from the RETI project, the REAT is developing a Desert Renewable Energy Conservation Plan (DRECP) for the Mojave and Colorado Desert regions. As discussed below, the DRECP is a land use planning process for identifying areas suitable for renewable energy project development and areas that will contribute to the conservation of sensitive species and natural communities.

The REAT also published the multidisciplinary *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects* in December 2010 to assist project developers in designing projects that minimize environmental impacts for renewable desert projects.[140] The manual provides guidance on initiating permitting processes, conducting land-use assessments and surveys, decisions on water use and quality, roadway planning and avoiding conflicts with aviation, and grid interconnection issues.

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138 For more information about the RETI process and results, please see http://www.energy.ca.gov/reti/index.html.

139 Executive Order S-14-08), which established accelerated RPS targets (33 percent by 2020), also called for the formation of the Renewable Energy Action Team, composed of the Energy Commission, California Department of Fish and Game, U.S. Department of the Interior Bureau of Land Management, and U.S. Fish and Wildlife Service. These organizations signed a memorandum of understanding in November of 2008; in July 2011, the California Public Utilities Commission and the State Lands Commission signed on as well.

140 Renewable Energy Action Team, *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, December 2010, http://www.drecp.org/documents/index.html.

Desert Renewable Energy Conservation Plan

Figure 4: Desert Renewable Energy Conservation Plan Area

Source: California Energy Commission, http://www.drecp.org/maps/.

In conjunction with other federal, state, and local agencies and stakeholder groups, the REAT is developing the DRECP to identify areas in the Mojave and Colorado Desert regions suitable for renewable energy project development and areas that will contribute to the conservation of sensitive species and natural communities.[141] The DRECP encompasses approximately 22 million acres in Kern, Inyo, Los Angeles, San Bernardino, Riverside, San Diego, and Imperial counties (Figure 4). It will facilitate development of solar thermal, utility-scale solar PV, wind, and other forms of renewable energy along with associated infrastructure like transmission lines. The DRECP will be a Natural Community Conservation Plan (NCCP), and will also serve as the basis for one or more Habitat Conservation Plans (HCP).[142] As required by state and federal law, the environmental impact of the DRECP will be analyzed in a joint Environmental Impact Report and Statement which is anticipated to be completed by December 2012, along with the NCCP.

In May 2011, the draft *DRECP Framework Conservation Strategy Report* was released for comment.[143] The draft report discusses work products completed to date, describes key elements and next steps in the conservation planning process, and provides proposed draft principles to guide the quantification of impacts associated with covered activities that are

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141 http://www.drecp.org/.

142 See Department of Fish and Game, http://www.dfg.ca.gov/habcon/nccp/ and U.S. Fish and Wildlife, http://www.fws.gov/endangered/what-we-do/hcp-overview.html.

143 ICF International, draft *DRECP Framework Conservation Strategy Report*, Executive Summary, May 2011, http://www.drecp.org/documents/strategy/00_TOC_Executive_Summary_annotated.pdf.

proposed for take authorization under the DRECP.[144] The DRECP staff is also working on regional maps identifying possible renewable resource development areas, and existing and potential transmission corridors. The Energy Commission's multidisciplinary staff is refining an acreage calculator based on inputs of variables such as load growth, available zero- and low-carbon resources and distributed generation, and desired greenhouse gas reductions or Renewable Portfolio Standard mandates.[145]

Solar Energy Development Programmatic Environmental Impact Statement

At the federal level, the U.S. Department of Energy, Energy Efficiency and Renewable Energy Program, and the U.S. Department of the Interior, Bureau of Land Management are preparing a Solar Energy Development Programmatic Environmental Impact Statement (PEIS) to assess environmental impacts from programs intended to facilitate environmentally responsible utility-scale solar energy in six western states.[146] The Draft PEIS was issued in December 16, 2010, and in May 2011 the Energy Commission and the California Department of Fish and Game (DFG) submitted joint comments on the draft with the following recommendations: [147]

- Abandon further consideration of the Iron Mountain Solar Energy Zone (SEZ).
- Consider designating and studying additional SEZ's on previously disturbed lands in the western Mojave Desert.
- Delay final PEIS-triggered amendments to the affected Land Use Management Plans until the DRECP process is completed in 2012.
- Fully consider and address all Energy Commission/DFG comments made previous to and in response to the publication of the draft PEIS.

On July 14, 2011, after the close of the comment period, the Interior Secretary announced that a supplement to the Draft PEIS would be issued to address many of the comments. The supplement is expected to be released in the fall of 2011.

Energy Commission Order Instituting Informational Proceeding on Siting "Lessons Learned"

In December 2010, the Energy Commission initiated an Order Instituting an Informational (OII) Proceeding on issues that are critical to the licensing of thermal power plants. This proceeding will examine the "lessons learned" in the review of the American Recovery and Reinvestment

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144 The Endangered Species Act prohibits the "take" of listed species through direct harm or habitat destruction. In 1982, congress authorized the U.S. Fish and Wildlife Service to issue permits for the "incidental take" of endangered and threatened wildlife species, and requires a permit applicant to design, implement, and secure funding for a Habitat Conservation Plan to minimize and mitigate harm to the impacted species during the proposed project. For more information, see http://www.fws.gov/Endangered/permits/index.html.

145 As described in Chapter 2, the acreage calculator was used to develop estimates of the amount of zero-emission generation needed to achieve 2050 greenhouse gas reduction goals.

146 States include Arizona, California, Colorado, New Mexico, Nevada, and Utah, http://solareis.anl.gov/.

147 http://www.energy.ca.gov/siting/solar/peis/agency_comments/.

Act (ARRA) solar projects and natural gas-fired power plants during 2009 and 2010. The proceeding will assess the Energy Commission's power plant siting processes and examine critical issues common among solar thermal and/or conventional power plants.

The OII Proceeding began with a scoping workshop to solicit written and oral comments from various stakeholders including project proponents, project intervenors, environmental organizations, local government officials, advocacy organizations, elected officials, and the general public. Comments that were received focused on the following topics:

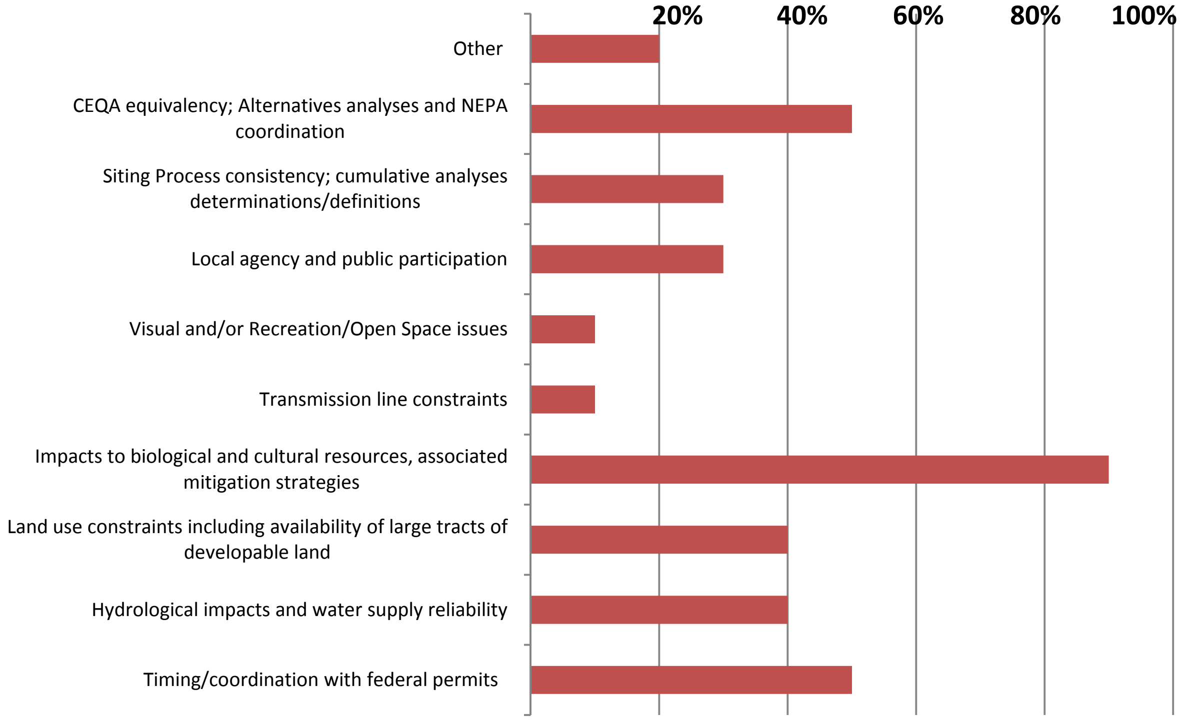
- Timing/coordination with federal permits for large solar projects located on federal land managed by the BLM.
- Hydrological impacts and water supply reliability issues related to licensing large solar projects.
- Land use constraints including availability of large tracts of developable land for siting large solar projects.
- Impacts to biological and cultural resources from siting large solar projects and associated mitigation strategies.
- Transmission line constraints encountered when bringing renewable generation into load pockets in California where the majority of the state's populations resides.
- Visual and/or recreation/open space issues caused by construction and operation of large solar projects in remote desert communities and natural wildlife habitat.
- Local agency and public participation in the planning and permitting of large solar projects.
- Siting process consistency between different solar project proceedings, including cumulative analyses determinations and definitions that affect determinations of significant impact and associated mitigation.
- CEQA/NEPA joint review and coordination of alternatives analyses.

Staff distributed a questionnaire to more than 1,000 individuals and organizations that had either been involved or had a stake in the Energy Commission's siting program during 2010, including both renewable and fossil-fueled projects (Figure 5).

Energy Commission staff have analyzed a number of process improvements since the initial scoping workshop. Improvements fall under three general categories: internal process improvements, external process improvements, and public process improvements.

- **Internal Process Improvements:** The length and complexity of Staff Assessments (SA) and conditions of certification have increased over time, particularly in 2010 in terms of the large solar projects. Staff is evaluating the SA to determine if the document can be pared down in future proceedings while still meeting the requirements of CEQA and Energy Commission regulations.

Figure 5: Responses to Energy Commission Questionnaire on Siting Process Issue Priorities



Source: California Energy Commission

- **External Process Improvements:** Participation by intervenors can also cause process delays, particularly when they get involved late in the process. Changes are being discussed in the Energy Commission's process to balance transparency and public participation with efficiency.
- **Public Process Improvements:**
    - Public noticing of all meetings - the Energy Commission issues public notices for all Energy Commission-sponsored workshops, presentations, conferences, site visits, and hearings to enable public participation in the discussion of project issues. Siting regulations require that "all hearings, presentations, conferences, *meetings*, workshops and site visits shall be open to the public" [148][emphasis added]; and that "all meetings shall be noticed…" no less than ten days in advance.[149] Staff is considering whether more flexible options would expedite the permitting process, and still meet the information needs of public participants.

148 California Code Regulations, Title 20, § 1710.

149 California Code Regulations, Title 20, § 1718.

- Evidentiary hearings - The evidentiary hearing process is complex and staff is reviewing and seeking stakeholder input on how hearings can be improved through improved staff testimony, attorney support, more consistency in the mechanics of the hearings, and the use of Staff Assessments that are more focused, organized, consistent, and publicly available.

The Energy Commission's OII Proceeding will continue to hold public workshops and seek input from stakeholders and the public on ways to improve and streamline the siting process throughout 2011 and may incorporate suggestions accordingly. These recommended changes and revisions of current siting regulations would occur through an Order Instituting Rulemaking (OIR) proceeding, which will most likely occur in early to mid-2012.

Agency Coordination

State and federal agencies are working to streamline the permitting of renewable energy projects in California by increasing cross-agency cooperation and coordination, with several multi-agency agreements already in place:[150]

- In 2007, the Energy Commission, the U.S. Department of the Interior, and the BLM signed a Memorandum of Understanding (MOU) on relative agency roles, responsibilities, and procedures for joint environmental review of solar thermal projects proposed on federal land.
- In 2009, the Energy Commission entered into a Memorandum of Agreement with the California State Lands Commission to ensure timely and effective coordination during the Energy Commission's thermal power plant review process.
- In 2010, the State of California and the Federal Energy Regulatory Commission signed an MOU to coordinate and share information for reviewing offshore wave and tidal energy projects.
- In 2010, the Energy Commission and the Departments of General Services, Corrections and Rehabilitation, Transportation, Water Resources, and Fish and Game signed an MOU to promote the development of renewable energy projects on state buildings, properties, and rights-of-way; the State Lands Commission and University of California subsequently joined the MOU.[151]

Local Government

As described in Chapter 10, the Energy Commission's *Energy Aware Facility Siting and Permitting Guide* provides local governments, developers, and the public with information on renewable

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150 The Energy Commission and Governor's staff are also working on a Memorandum of Understanding with the Department of Defense to facilitate renewable resource development and related environmental protection at the numerous military bases located in California, including several in the Mojave and Colorado Desert regions.

151 For more details about the effort to promote renewable projects on state properties, please see Chapter 10.

energy development planning and permitting for utility-scale electricity generating facilities.[152] To assist local permitting agencies in addressing the potential effects of wind development on birds and bats, in 2007, the Energy Commission and the California Department of Fish and Game published voluntary guidelines to help local agencies avoid, minimize, and mitigate potential impacts.[153] The guidelines include recommendations on preliminary screening of proposed wind energy project sites; pre-permitting study design and methods; assessing direct, indirect, and cumulative impacts to birds and bats in accordance with state and federal laws; developing avoidance and minimization measures; establishing appropriate compensatory mitigation; and post-construction operations monitoring, analysis, and reporting methods.

Several local governments are including elements in their General Plans to promote energy conservation and the development of alternative energy sources, and others are showing strong leadership in renewable development. These energy/land use planning efforts are also described in Chapter 10.

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152 California Energy Commission, Energy Aware Facility Siting and Permitting Guide, December 2020, http://www.energy.ca.gov/2010publications/CEC-600-2010-007/CEC-600-2010-007-D.PDF.

153 California Energy Commission and California Department of Fish and Game, California Guidelines for Reducing Impacts to Birds and Bats from Wind Development, 2007, http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF.

Chapter 4: Transmission Infrastructure Issues

Chapter 3 discussed the challenges in planning and permitting new renewable electricity generating infrastructure that will be needed to meet Renewable Portfolio Standard (RPS) targets and the state's goals of adding 8,000 megawatts (MW) of utility-scale renewables and 12,000 MW of renewable distributed generation by 2020. However, there are also challenges to planning and permitting the power lines and other transmission infrastructure needed to bring electricity generated by large-scale renewable facilities to consumers. Governor Brown's Clean Energy Jobs Plan states: "The [Energy Commission] should 'fast-track' projects based on their anticipated ability to deliver clean energy to market. The permitting time for these projects – which now can take 6 to 8 years – should be dramatically reduced, and in no case be longer than three years." Furthermore, the Plan states, "As Governor, I will ensure that all agencies involved work together with a sense of urgency to permit the new transmission lines without delay."[154]

This chapter explains key transmission challenges to achieving California's renewable goals. First, California currently does not have a fully coordinated and effective statewide transmission planning process that includes both transmission and land use planning. Second is the need for better use of the grid and strategic upgrades to the state's transmission system. Finally, licensing and construction must be completed for transmission projects and upgrades that have already been identified as necessary for meeting RPS targets, particularly interconnection of renewable generation projects receiving funding through the American Recovery and Reinvestment Act (ARRA) of 2009.

The chapter then provides an overview of transmission projects and upgrades necessary to accommodate new renewable generating facilities throughout the state (with a detailed status of each project provided in Appendix F) and summarizes recent and current efforts underway to improve transmission planning in California. These include the 2007-2010 Renewable Energy Transmission Initiative (RETI) process,[155] the Renewable Energy Action Team (REAT) Desert Renewable Energy Conservation Plan (DRECP),[156] transmission planning efforts by the California Transmission Planning Group,[157] and the 2010-2011 California Independent System Operator (California ISO) transmission plan that identifies upgrades needed to meet grid reliability, bring economic benefits to consumers, and meet California's RPS mandate. The California ISO is also spearheading a stakeholder process for better integration of transmission

154 See: http://www.jerrybrown.org/Clean_Energy.

155http://www.energy.ca.gov/reti/index.html, accessed July 7, 2011.

156 See Desert Renewable Energy Conservation Plan website at: http://www.drecp.org/.

157 *Final 2010 California Transmission Planning Group Statewide Transmission Plan* dated February 9, 2011 can be found on the CTPG website at: http://ctpg.us/public/images/stories/downloads/2011-02-09_final_statewide_transmission_plan.pdf

planning and generation interconnection.[158]The latter discussion also covers issues associated with resource adequacy requirements for renewable projects that could adversely affect developers' ability to obtain power purchase agreements needed to support project financing.

The chapter briefly touches on technological advancements (described in more detail in Chapter 9) that can increase the carrying capacity of the existing transmission system to help facilitate the interconnection of renewable generation, followed by a discussion of how California fits within western region system planning efforts for renewable integration.

Description of Challenges

There are many entities with a role in bulk transmission planning and permitting in California (Table 10). Having this many players, each with its own complex and unique scope of responsibilities, makes it difficult and time-consuming to reach coordinated transmission planning decisions that result in permittable, appropriate transmission projects for interconnecting renewable generation projects. This section describes the major planning, permitting/interconnection, and western regional coordination challenges that will affect California's ability to achieve its renewable energy goals.

Planning Challenges

Lack of Coordinated Land Use and Electric Transmission System Planning

With Governor Brown's characterization of the 33 percent RPS by 2020 mandate as a floor rather than a ceiling, it is imperative that transmission planning processes be streamlined and coordinated so that the most appropriate transmission projects to interconnect renewables are sited, permitted, and constructed while avoiding duplication, eliciting opportunities for joint projects among investor-owned utilities IOUs, publicly owned utilities, and/or independent transmission developers, and ensuring appropriate consideration of land use and environmental issues.

In the *2008 Integrated Energy Policy Report Update*, the Energy Commission assessed major transmission barriers to achieving the state's renewable energy and greenhouse gas emission reduction goals and stated that "most notable is the lack of a fully coordinated and effective statewide transmission planning process that includes broad stakeholder support and targets the most cost-effective and environmentally acceptable transmission additions and upgrades to access renewables." In response, the *2009 Strategic Transmission Investment Plan*

158 See California ISO's July 21, 2011 straw proposal on Integration of Transmission Planning and Generation Interconnection Procedures at: http://www.caiso.com/Documents/StrawProposal-TransmissionPlanning-GenerationInterconnectionIntegration.pdf.

Table 10: Agencies with Bulk Electric Transmission Planning and Permitting Authority

Agency	Planning and Permitting Authority
Federal Energy Regulatory Commission (FERC)	Planning: FERC Order No. 890 (February 16, 2007) requires FERC jurisdictional (IOU) transmission providers, including independent system operators and regional transmission organizations, to participate in a coordinated, open and transparent transmission planning process at both a local and regional level, and file revisions to their *pro forma* Open Access Transmission Tariffs to conform to the rule. Each transmission provider's planning process must meet nine planning principles: coordination, openness, transparency, information exchange, comparability, dispute resolution, regional coordination, economic planning studies, and cost allocation. Non-FERC jurisdictional (publicly owned utility [POU]) transmission providers voluntarily comply with Order No. 890 as members of regional planning groups. The Western U.S. has four regional planning groups, including the California ISO, which are under FERC jurisdiction. Permitting: Per the Energy Policy Act of 2005 (EPAct-05), Section 1221, the FERC may issue a construction permit for electric transmission facilities in a designated national interest electric transmission corridor if a state does not have permitting authority or does not have the authority to consider interstate benefits expected of proposed facilities. The FERC may also issue a construction permit if a state has authority to permit proposed facilities but has withheld approval for more than one year after the filing of an application, or after designation of a corridor, or has conditioned approval in such a way that the proposed construction will not significantly reduce congestion.
United States Department of Energy (DOE)	Planning: Under ARRA, the DOE provides direction and funding for production of the first Western Interconnection ten-year regional transmission plan in September 2011. A 20-year plan is due to DOE in 2013 as well as a 2013 Ten-Year Regional Plan. Permitting: DOE issues permits to locate transmission facilities on DOE-controlled lands. DOE issues presidential permits to construct transmission lines that cross the U.S. border.
Federal Land Management Agencies	Planning: Perform corridor identification on federal lands. U.S. Bureau of Land Management (BLM) identified corridors for transmission lines in its California Desert Conservation Area Resource Management Plan. The U.S Department of Agriculture Forest Service must address utility corridors in forest land use plans. BLM and U.S. Fish and Wildlife Service are parties to the DRECP Planning Agreement (along with the Energy Commission and the California Department of Fish and Game.) Permitting: BLM and Forest Service act as lead agencies for environmental impact statements on federal lands and issue land use permits.
Energy Commission	Planning: Assesses electricity supply and demand trends and potential impacts of electricity infrastructure and resource additions on electricity systems, public health and safety, the economy and the environment. (Public Resources Code section 25300 et seq.), with assessment used by other agencies in their planning and permitting procedures. Prepares biennial Strategic Transmission Investment Plan (STIP) identifying transmission projects necessary for the state's electric transmission grid. (Public Resources Code section 25324). Designates transmission corridors on its own or proposed by others for future transmission lines, consistent with the STIP. Participates in the Renewable Energy Action Team in developing the DRECP. Permitting: Energy Commission licenses transmission lines which are associated with thermal power plant projects in its jurisdiction. Also evaluates transmission grid impacts and upgrades needed as a result of the power plant's interconnection with the grid. The Energy Commission permit is in lieu of all other state and local permits, and the process is a certified California Environmental Quality (CEQA)-equivalent process.

Agency	Planning and Permitting Authority
California Public Utilities Commission (CPUC)	Planning: Approves IOUs' biennial long-term procurement plans (LTPPs), which establish authority to contract for new power supplies. (Competitive bids to supply power must include transmission costs; LTPPs are based on Energy Commission demand forecasts and must reflect "loading order" resource preferences.) Participates in the Energy Commission collaborative Integrated Energy Policy Report process. Has the authority to order IOUs to build transmission. Permitting: CPUC issues certificates of public convenience and necessity (CPCNs). This process considers California ISO findings of need and reviews CEQA compliance for IOU transmission lines greater than 200 kV. Issues a permit to construct (which includes CEQA compliance) for projects between 50 kV and 200 kV. CEQA requires other state agencies to use the CPUC's completed environmental document to decide whether or not to grant their required permits for a transmission project. Thus, transmission projects may require other permits after completing the CPUC process.
California Independent System Operator (California ISO)	Planning: Serves as planning authority for the California ISO balancing authority area. Conducts annual stakeholder transmission planning process to determine the need for projects to maintain reliability and/or promote economic efficiency of the California ISO-controlled grid by evaluating reliability projects for each IOU, as well as reliability projects for the California ISO-controlled grid. Functions as the planning authority for its footprint (primarily IOU service areas), and provides FERC with findings of project need prior to FERC determination on whether a utility can recover transmission costs. Uses Energy Commission demand forecasts. Identifies projects needed to meet California's policy goals. Evaluates local capacity requirements on an annual basis. Studies specific areas for potential economic projects. Participates in the California Transmission Planning Group (CTPG), along with IOUs and POUs, to develop a California state-wide transmission plan to meet the state's 33 percent by 2020 RPS mandate. Has a memorandum of understanding with the CPUC that seeks to coordinate the California ISO's revised transmission planning process and identification of needed transmission infrastructure with the CPUC's subsequent siting/permitting process. Permitting: None. However, California ISO provides testimony in CPUC CPCN transmission proceedings in support of IOU-sponsored projects. In collaboration with Energy Commission staff, provides transmission grid impacts assessment related to power plant interconnections in Energy Commission power plant licensing cases. While the California ISO does not have statutory siting authority, as the grid operator it does approve or disapprove generation projects for interconnection with the grid.
Publicly Owned Utilities (POUs) (Municipal, cooperatives, and federal power marketers)	Planning: Voluntarily comply with FERC Order No. 890 as members of regional planning groups that conduct coordinated, open, and transparent transmission planning at both a local and regional level. California municipal utilities participate in the CTPG, along with IOUs and the California ISO, to develop a California state-wide transmission plan to meet the state's 33 percent by 2020 RPS mandate. Permitting: As local agencies, POUs can act as CEQA lead agencies for their own transmission projects.
Local Agencies	Planning: When the Energy Commission has designated a transmission corridor in one or more local agency's jurisdiction, the affected cities and counties must consider whether each subsequent land-development proposal within or near the corridor would threaten future transmission line construction there. If so, the local jurisdiction must notify the Energy Commission. If the land-development project is approved over the Energy Commission's objections, it must provide written justification for rejecting the Energy Commission's comments and recommendations. Permitting: Local agencies issue permits for projects not subject to CPUC jurisdiction.

emphasized the need for statewide coordinated transmission planning and effective ways to resolve environmental and land use conflicts that emerge when permitting transmission lines.[159]

The greatest opportunity for shortening the planning and permitting processes, while also increasing the quality of the decisions, lies with coordinating land use and "wires" planning. For example, the California ISO transmission planning process (Figure 6) takes 16 months to finalize the comprehensive Transmission Plan, seven months to select project sponsors, if applicable,[160] followed by the utility project development process (Figure 7) which can take more than two years. These two timelines are essentially sequential because the California ISO planning process focuses only on "wires" planning, while the identification of routing issues and constraints does not begin until after the "wires" approval. The construction time needed for a large transmission project is typically two years, for a total time of approximately six years from project planning to commercial on-line date. However, as shown in the example of Southern California Edison's (SCE) Transmission Project Development Milestone Timeline in Figure 7, SCE believes its timeline has communication "touch points" with agencies through which it can achieve a shorter processing and approval timeframe for CEQA/NEPA licensing and cooperating agency permits.

The need for a statewide coordinated transmission planning process that includes both transmission planning ("wires") and land use planning has yet to be addressed. Specific planning challenges, many of which were identified by participants in the May 17, 2011 IEPR Committee workshop on transmission needed to meet state renewable goals, include:

- The state needs "to better coordinate planning across the various entities."[161]
- The state needs "to raise the stakes and raise the engagement levels of the agencies so that, at some point, … we have ISO Board members, PUC Commissioners, and CEC Commissioners, all on the same dais, all hearing about these problems, and at that level getting a higher level of commitment to engage with each other."[162] There is a need for "greater linkages between the Federal agencies … that have a piece of this, particularly BLM and U.S. Fish and Wildlife Service and, again, that gets back to the land use – that one

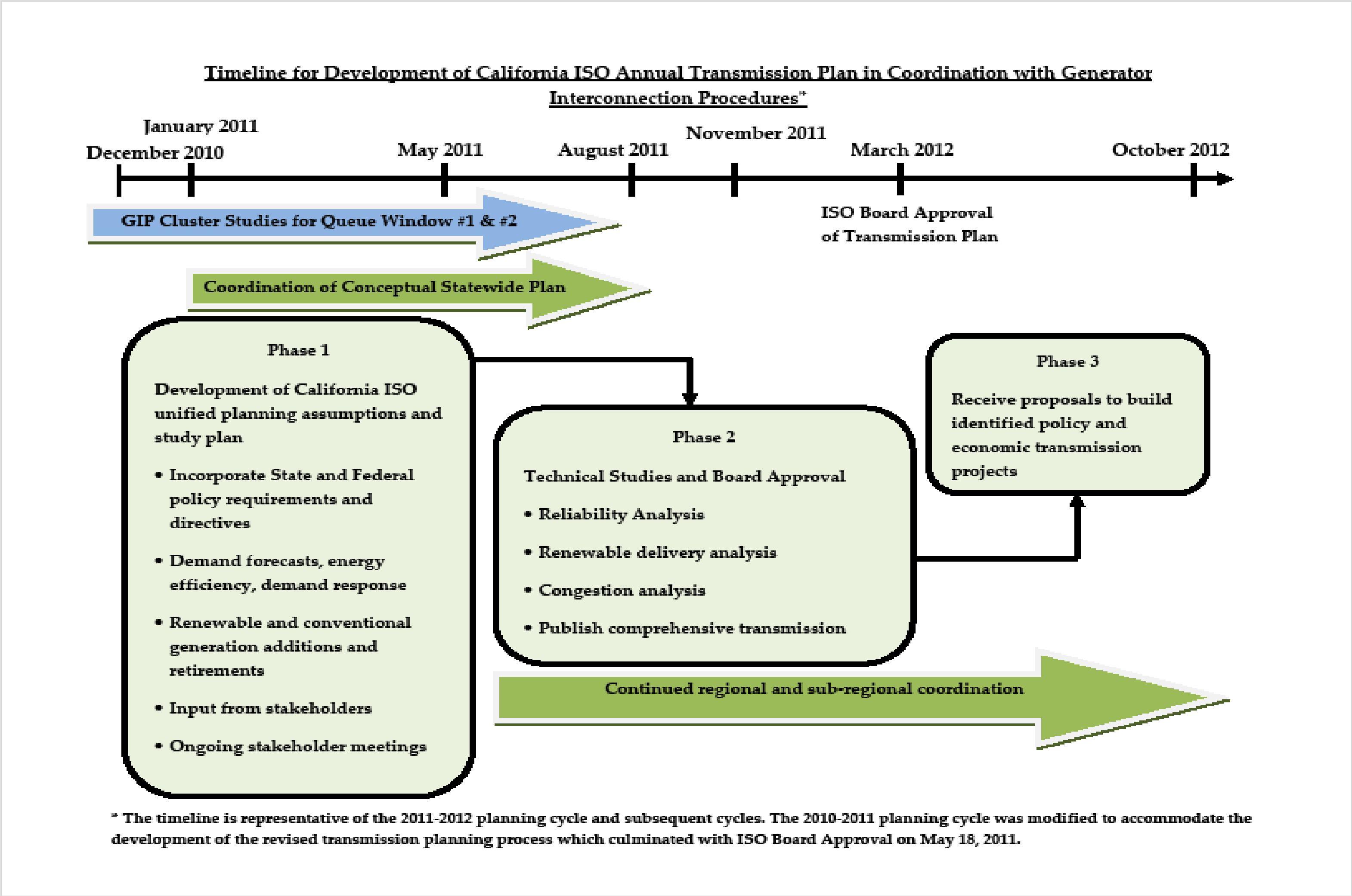
159 *2009 Strategic Transmission Investment Plan*, p. 1, California Energy Commission, Sacramento, California, December 2009, Publication Number CEC-700-2009-011-CMF, http://www.energy.ca.gov/2009publications/CEC-700-2009-011/CEC-700-2009-011-CMF.PDF, posted December 16, 2009.

160 This seven-month process applies to economically driven and Category 1 policy-driven elements identified in the comprehensive Transmission Plan.

161 Zichella, Carl, Natural Resources Defense Council, Transcript of the May 17, 2011 *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 144, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf .

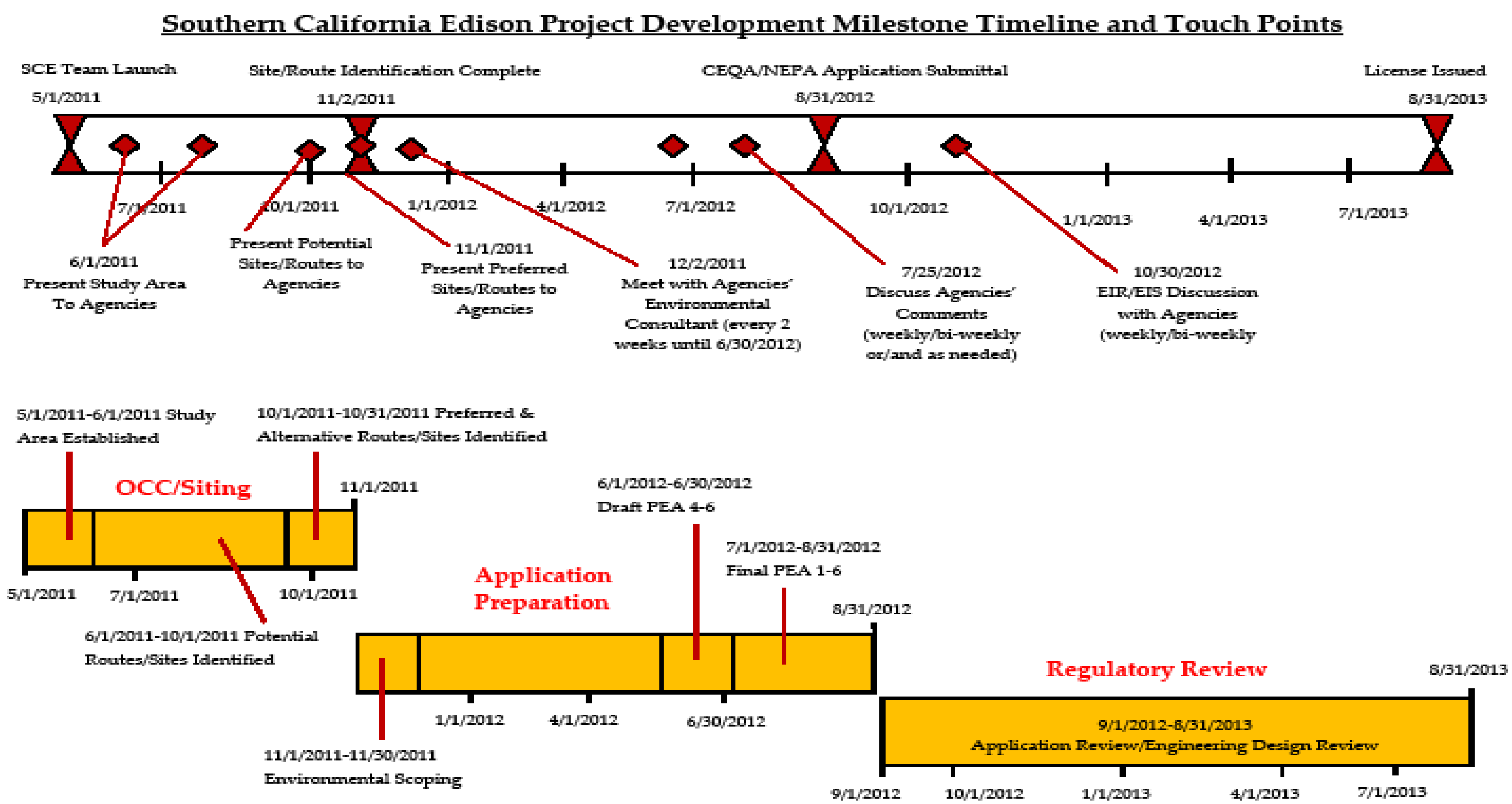
162 White, V. John, Center for Energy Efficiency and Renewable Technologies, Transcript of the May 17, 2011 *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 157, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

Figure 6: Timeline for Development of California ISO Annual Transmission Plan



Source: July 8, 2011 PowerPoint Presentation, slide 8, entitled: "California ISO 2011/2012 ISO Transmission Plan Renewable Portfolios" and November 2, 2010 Board of Governors PowerPoint Presentation, slide 6, entitled: "Generation Interconnection Queue and ARRA Projects Update"

Figure 7: Example of Southern California Edison Transmission Project Development Milestone Timeline



Source: SCE Project Milestones and Agency Coordination: CEQA/NEPA Application and Approval Process Presentation to California REPG on May 20, 2011 agency, as we've learned throughout this process, can delay everybody else's successful work if they're not brought in, and somehow accommodated. And it's not so much a matter of changing or giving in as a matter of people need to understand what these constraints are and we need to not marginalize them."[163]

- "[I]t's difficult to get to a decision point without participating in a number of different processes."[164]
- Results from the DRECP process must be directly usable in the CPUC permitting process.[165]
- The assumptions and processes used by transmission planning organizations are not always transparent and/or consistent.
- The large number of transmission planning forums makes it difficult for stakeholders to participate effectively.
- There is a need to ensure that streamlining/accelerating the process does not hamper effective environmental consideration.
- For independent transmission project developers to be able to compete on a level playing field with incumbent utilities.

Better Use of the Grid and Strategic Upgrades

In 1988 the California Legislature passed Senate Bill 2431(Garamendi, Chapter 1457, Statutes of 1988), which directed the Energy Commission to prepare a report outlining recommended policies and actions to facilitate effective, long-term transmission line corridor planning.[166] One of the major findings of the report was that utilities should take appropriate mitigation measures to reduce the environmental impacts of approved projects.[167] The report also identified the absence of coordinated transmission and land-use planning as a major impediment to transmission development in California. It called for a process to identify

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163 White, V. John, Center for Energy Efficiency and Renewable Technologies, Transcript of the May 17, 2011, *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 157, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

164 Zichella, Carl, Natural Resources Defense Council, Transcript of the May 17, 2011 *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 144, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

165 Alvarez, Manuel, Southern California Edison, *California Energy Commission Docket Nos. 11-IEP-1E and 11-IEP-1G: Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, May 24, 2011, p. 4, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/SCE_Comments_on_Renewable_Policy_Mandates_and_Goals_TN-60905.pdf,

166 California Energy Commission, *Transmission System and Right of Way Planning for the 1990's and Beyond*, p. 1, March 1992, Publication Number P700-91-005.

167 Ibid, p. 7.

environmentally sensitive areas, acceptable areas, and areas where urban encroachment into transmission rights-of-way could pose problems.[168] The basic principles and policies expressed in this effort, emphasizing existing line upgrades and the use of existing rights-of-way whenever possible,[169] formed a sound foundation for assessing and designating transmission corridors then and are still persuasive today.

Specific challenges related to the need for greater grid utilization and strategic upgrades described at the May 17, 2011, IEPR Committee workshop on transmission needed to meet state renewable goals and in subsequent filings include:

- To allow the California ISO to "upsize" proposed projects beyond the current need demonstrated by individual interconnection requests. "When longer-term needs are readily apparent, this will create value for customers because approved transmission projects will eventually be utilized fully by least-cost best-fit sources of power."[170]
    - An example of "upsizing" would be construction of a double circuit line that has unused capacity available for future use when only a single circuit would suffice based on the current queue. This may also provide expanded access to low-cost competitive renewable energy zones (CREZs).[171]
    - "This type of pre-emptive investment can maximize the value of the land associated with already necessary transmission investment, avoid future, costlier upgrades needed to accommodate additional renewable development, and expedite the schedule for interconnecting future resources."[172]
- To identify, develop, and deploy technological fixes that either increase the capacity or the capacity factor of transmission lines. "We need to be thinking about innovative ways to

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168 Ibid, p. 15.

169 The "Garamendi Principles" are expressed as (1) Encourage the use of existing rights-of-way by upgrading existing transmission facilities where technically and economically justifiable; (2) When construction of new transmission lines is required, encourage expansion of existing rights-of-way, when technically and economically feasible; (3) Provide for the creation of new rights-of-way when justified by environmental, technical, or economic reasons, as determined by the appropriate licensing agency; and (4)Where there is a need to construct additional transmission, seek agreement among all interested utilities on the efficient use of that capacity.

170 Alvarez, Manuel, Southern California Edison, *California Energy Commission Docket Nos. 11-IEP-1E and 11-IEP-1G: Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, May 24, 2011, p. 1, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/SCE_Comments_on_Renewable_Policy_Mandates_and_Goals_TN-60905.pdf.

171 Alvarez, Manuel, Southern California Edison, *California Energy Commission Docket Nos. 11-IEP-1E and 11-IEP-1G: Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, May 24, 2011, p. 1, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/SCE_Comments_on_Renewable_Policy_Mandates_and_Goals_TN-60905.pdf.

172 Ibid.

increase the capacity of existing assets … [W]e need to be thinking about the next technology that allows us to better use the assets we have."[173]

- To ensure the coordination of the IOU and POU decision making about both procurement and transmission. "Having better grid utilization and strategic upgrades to the grid, to facilitate that, it seems to me is one of the fastest things we can do to get transmission to happen."[174]

Permitting/Interconnection Challenges for Key Transmission Projects Linked to Renewable Generation

One of the key hurdles to the interconnection and delivery of renewable generation is licensing and constructing the necessary transmission facilities. Some facilities are needed to reliably interconnect generators while others are necessary to allow for delivery of the generation to load centers, which is often a requirement in power purchase agreements (PPAs). The Energy Commission staff believes that the highest priority transmission infrastructure challenge at this time is the successful completion of the transmission upgrades needed to meet the 33 percent by 2020 mandate. In particular, interconnection of ARRA-funded renewable generation projects is an important component to achieve this overall goal. As described earlier in this report, these generation projects are an important part of Governor Brown's Clean Energy Jobs plan, which emphasizes the need to invest in clean energy as a central element to rebuilding California's economy. In addition, Governor Brown has directed the relevant agencies to work together to permit needed transmission lines without delay. The 13 major transmission projects critical to the interconnection and deliverability of renewable generation in California and meeting the 33 percent RPS by 2020 mandate are shown in Figure 8 and described in detail in Appendix F.

Table 11 provides an overview of the projects shown in Figure 8, with the transmission projects needed to deliver renewable energy from ARRA-funded generation projects under the Energy Commission's power plant licensing jurisdiction in italics, and also shows the CREZs served by each transmission project. The column labeled "Cumulative Renewable Deliverability Potential (MW) with Upgrade" shows the total renewable capacity that is able to be delivered from the served CREZs with the addition of the specified transmission project. The deliverability potential of each upgrade has been determined by the appropriate balancing authority through a deliverability assessment, and there is not necessarily a direct correlation between the rated capacity of the upgrade and its contribution to the deliverability potential.

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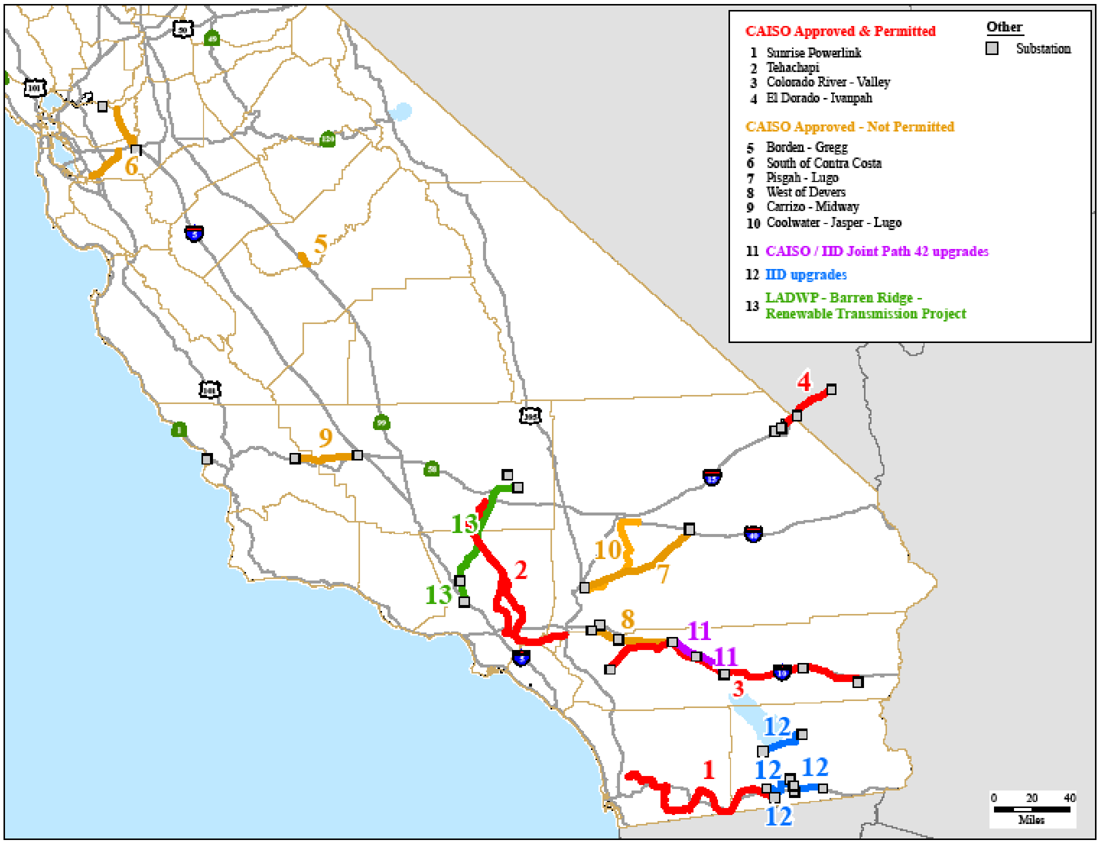
173 Jenkins, Robert, First Solar, Transcript of the May 17, 2011, *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 199, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf , accessed June 7, 2011.

174 Zichella, Carl, Natural Resources Defense Council, Transcript of the May 17, 2011, *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 148, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

Figure 8: Statewide Transmission Projects Supporting Renewable Energy Mandates



Source: California Energy Commission

Figure 9 shows the geographic location, amount, and type of renewable and conventional generation in the California ISO generation queue as of June 1, 2011.

Western Region Challenges

California will rely largely on in-state resources to meet its 33 percent target for renewables. However, abundant and high-quality renewable resources also exist outside of California. Major market and planning initiatives in the Western region can facilitate development, integration, and transfer of renewable energy to Western load centers, including those in California. The challenges for California are to inform regional and sub-regional planning processes and subsequent plans in the Western Interconnection to ensure they are consistent with state policies and to remain open-minded to potential regional opportunities that can complement and harmonize with California goals.[175]

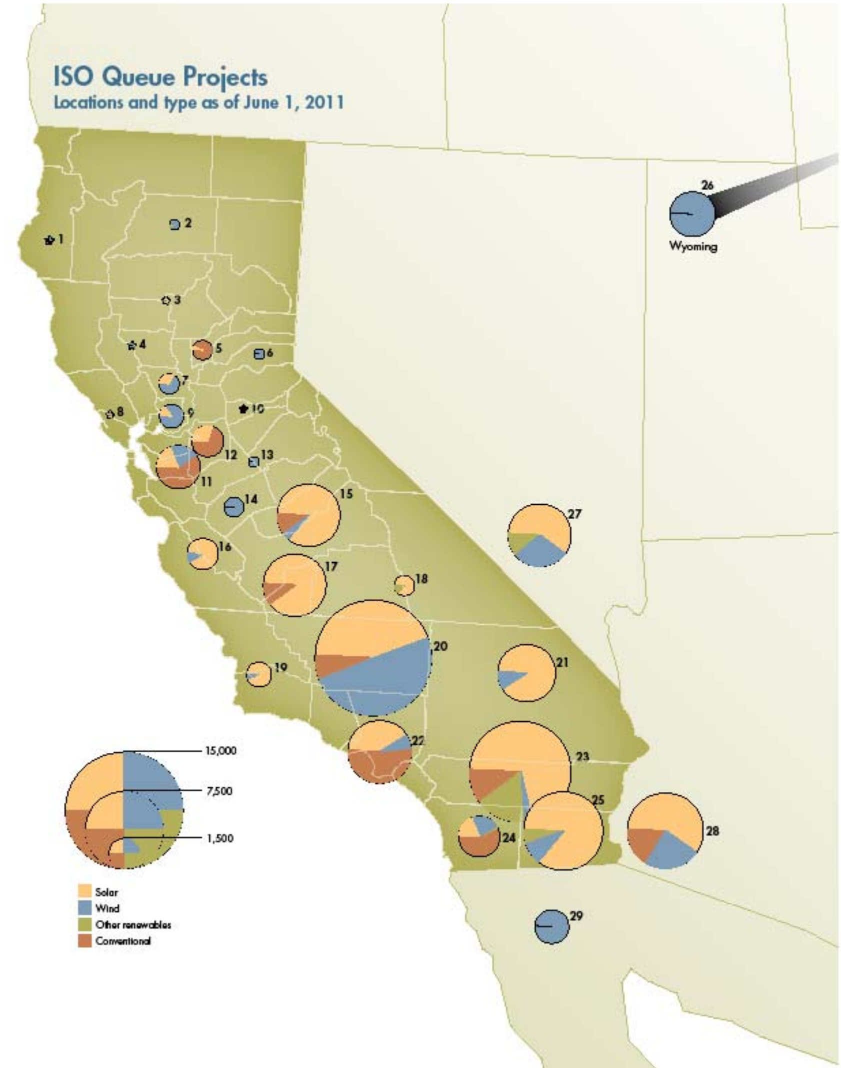
175 Letter from Michael Picker, Senior Advisor to the Governor for Renewable Energy Facilities, to Brad Nickell, Director, WECC Transmission Expansion Planning, August 3, 2011, "Reflecting Current California Trends and Policies in Regional Transmission Planning."

Table 11: Major Transmission Projects for Interconnection and Deliverability of Renewable Generation in California

Balancing Authority	Transmission	Served CREZ	Cumulative Renewable Deliverability Potential (MW) With Upgrade	Expected Commercial On-line Date
California ISO	Sunrise Powerlink (new 500 kV and 230 kV lines)	Imperial North and South, San Diego South	1,700	2012
California ISO	Tehachapi Renewable Transmission Project	Tehachapi, Fairmont	4,500	2015
California ISO	*Colorado River –Valley Transmission Project and new Colorado River and Red Bluff 500 kV substations.*	*Riverside East, Palm Springs*	*4,700 combined with West of Devers project*	*2013*
California ISO	*Eldorado - Ivanpah 115 to 230 kV conversion*	*Mountain Pass*	*1,400*	*2013*
California ISO	Borden - Gregg (230 kV line reconductoring)	Westlands	800	2015
California ISO	South of Contra Costa (reconductoring)	Solano	535*	2015
California ISO	*Pisgah - Lugo 230 kV to 500 kV conversion*	*Pisgah, Mountain Pass*	*1,750*	*2017*
California ISO	*West of Devers 230 kV reconductoring*	*Riverside East, Palm Springs*	*4,700 combined with Colorado River- Valley Project*	*2017*
California ISO	Carrizo - Midway sections of Morro Bay - Midway (230 kV lines reconductoring)	Carrizo South, Santa Barbara	900	2012
California ISO	*Coolwater – Jasper – Lugo (new 230 kV line and other upgrades)*	*Kramer*	*700**	*2018*
California ISO/Imperial Irrigation District (IID)	Path 42 Upgrades	Imperial Valley	1,400	2015
IID	Internal IID Upgrades	Imperial Valley	See above	2011+
Los Angeles Dept. of Water and Power	*Barren Ridge-Renewable Transmission Project*	*Tehachapi, Barren Ridge*	*1,000***	*2016*

Sources: Millar, Neil, presentation to Energy Commission IEPR Committee, May 17, 2011, *Transmission needed to meet State Renewable Policy Mandates and Goals*, slide 9, http://www.energy.ca.gov/2011_energypolicy/documents /2011-05- 17_workshop/presentations/02_CalISO_Presentation.pdf, posted May 13, 2011.
* CPUC Staff Letter to Keith Casey (California ISO) *Attachment 1: Description of the Scenario Recommended by CPUC Staff for Use as the Base Case in the California Independent System Operator's 2011-2012 Transmission Planning Process*, revised June 26, 2011, page 3,http://www.caiso.com/2bad/2bada1882500.html,
** LADWP March 28, 2008 Fact Sheet for the Barren Ridge Renewable Transmission Project, http://www.ladwp.com/ladwp/cms/ladwp009509.pdf

Figure 9: California ISO Queue Projects as of June 1, 2011



Interconnection queue by county

County		Number of Projects	Renewables MW	Conventional MW	Total MW
1	Humboldt	1	50		50
2	Shasta	2	165		165
3	Butte, Glenn, Tehama	5	122		122
4	Lake, Colusa	1	66		66
5	Sutter, Yuba	2	20	600	600
6	Placer	1	220		220
7	Yolo	5	587		587
8	Marin, Sonoma	3	92		10
9	Solano	11	908		908
10	Amador	1	18		18
11	Alameda, Contra Costa Santa Clara	16	1,110	1,698	2,808
12	San Joaquin	11	325	1,020	1,345
13	Stanislaus, Tuolumne	5	202		202
14	Merced	7	612		612
15	Fresno, Madera	79	4,474	594	5,067
16	Monterey, San Benito	4	1,550		1,550
17	Kings	38	4,614	625	5,239
18	Inyo, Tulare	13	625		625
19	San Luis Obispo, Santa Barbara	6	896		896
20	Kern	109	13,802	1,100	14,902
21	San Bernardino	21	4,395		4,395
22	Los Angeles, Orange	50	2,390	2,650	5,040
23	Riverside	34	10,667	1,420	12,087
24	San Diego	29	1,094	1,453	2,545
25	Imperial	27	7,683		7,683
In-state Totals		481	56,787	11,159	67,947
26	Wyoming	1	3,000		3,000
27	Nevada	18	5,252		5,252
28	Arizona, New Mexico	10	1,094	1,250	7,128
29	Mexico	3	1,628		1,628
Out-of-state Totals		33	10,974	1,250	12,224
TOTAL ALL PROJECTS		**514**	**67,761**	**12,409**	**84,955**

as of 06/01/2011

Source: California Independent System Operator

Current Efforts to Address Transmission Infrastructure Challenges

This section describes the status of current efforts underway to successfully complete transmission upgrades needed to meet the 33 percent by 2020 RPS mandate, improve transmission planning processes, identify technological fixes to maximize the use of the existing transmission system, and incorporate California's renewable energy goals and progress into Western regional transmission planning forums.

Permitting/Interconnection Efforts for Key Transmission Projects Linked to Renewable Generation

Many of the facilities shown in Figure 14 and described in Table 13 have been licensed or are currently under construction, including:

- San Diego Gas and Electric (SDG&E) Sunrise Powerlink
- SCE Tehachapi Renewable Transmission Project
- SCE Colorado River – Valley transmission line (including the Colorado River Substation and Red Bluff Substation)
- SCE El Dorado-Ivanpah Upgrade
- Imperial Irrigation District (IID) upgrades
- Los Angeles Department of Water and Power (LADWP) Barren Ridge Renewable Transmission Project.

Several key projects that do not yet have active licensing applications include the following:

- Pacific Gas and Electric Company (PG&E) Borden – Gregg 230 kV reconductoring
- PG&E South of Contra Costa reconductoring
- SCE Pisgah – Lugo 500 kV upgrade
- SCE West of Devers upgrades
- PG&E Carrizo – Midway 230 kV reconductoring
- SCE Coolwater – Jasper – Lugo 230 kV line
- California ISO/IID Joint Path 42 upgrades.

Getting these identified projects licensed and constructed is a key part of California utilities' ability to interconnect and deliver the renewable generation required to meet the 33 percent RPS by 2020.

Improvements in Transmission Planning to Facilitate Renewable Development

Renewable Energy Transmission Initiative – 2007-2010

RETI was a statewide land use planning process to help identify transmission projects needed to accommodate the state's renewable energy goals, support future energy policy, facilitate transmission corridor designation, and facilitate transmission and generation siting and permitting.[176] A new concept, called CREZs, was developed for assessing areas in California, neighboring states, Baja California, and British Columbia which could provide significant electricity to California consumers by the year 2020. RETI identified approximately 30 CREZs throughout California, including approximately 20 in the California desert, representing a rough potential of 80,000 MW[177] statewide, and a subset of roughly 66,000 MW in the desert region. These CREZs, and their corresponding transmission interconnections and lines, were the areas identified in the state for the most cost effective renewable generation development with the least impact to the environment. The RETI effort led to development of an ongoing metric, the "renewable net short," as described in Chapter 2.

RETI established the precedent for incorporating land use planning into the statewide transmission planning process by bringing together representatives of the state, federal, and local agencies and entities responsible for permitting transmission projects. Joining these groups were representatives of the environmental community, the developers of the various renewable technologies, investor- and publicly-owned utilities, Native American tribes, the U.S. military, and consumers. RETI produced maps of CREZs and related conceptual transmission line segments which helped guide potential developers, for the first time, to areas that had been screened at a high level for environmental concerns and combined this with assessments of the renewable energy potential of the CREZs.[178] RETI's state/federal agency and stakeholder process for identifying generation clusters to minimize site impacts and make the most efficient use of existing and new transmission lines has led directly to the current, collaborative land use planning activity occurring in the DRECP process (see Chapter 3 for more detail). RETI was a pioneering effort to use an environmental screen to inform transmission planning, but by necessity, it relied on limited data and did not constitute a detailed environmental analysis.

Renewable Energy Action Team/Desert Renewable Energy Conservation Plan

The DRECP has built on RETI's work, both refining it with the most recent biological resource survey and land use data and expanding it in the Mojave and Colorado Desert areas of California. Specifically, the DRECP is incorporating new data on desert tortoise connectivity developed by the USFWS, plant surveys, and Mohave Ground Squirrel surveys. BLM, which is a DRECP partner, is developing additional species connectivity and migration corridor

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176http://www.energy.ca.gov/reti/index.html, accessed July 7, 2011.

177 *Renewable Energy Transmission Initiative Phase 2B Final Report*, p.1-3, RETI Coordinating Committee, May 2010, Publication Number RETI-1000-2010-002-F, http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF, posted May 20, 2010, accessed August 16, 2011.

178 http://www.energy.ca.gov/reti/index.html, accessed July 7, 2011.

information. The Energy Commission commits to share data and preliminary information from the DRECP as appropriate in order to ensure that transmission planners have access to the most current land use and biological information.

Consistent with RETI, one of the goals of the DRECP will be to support the consolidation of development rather than scattered "leap frogging" development. This will also support "upsizing" proposed transmission projects to be able to carry the amount of power that is reasonably anticipated to occur in the foreseeable future in appropriate locations instead of building several smaller lines. DRECP's calculator tool for estimating needed levels of renewable generation capacity and related acreage is briefly described in Chapter 3.

Chapter 3 also discussed the role of the REAT in streamlining and expediting permitting processes for renewable generating projects while conserving endangered species and natural communities at the ecosystem scale through its efforts in developing the DRECP.[179] This coordinated approach between state and federal partners will also help expedite transmission and land use permitting and reduce the time and expense associated with developing renewable energy on federally-owned California land, including the priority Mojave and Colorado Desert regions. Completion of the DRECP should enhance and accelerate transmission construction and project location throughout the California desert region, result in better synchronized on-line dates for transmission and generation projects, and lead to better consolidation of land use and transmission wires planning.

The Energy Commission, CPUC, and California ISO are meeting and working out a "virtual" process using a memorandum of understanding (MOU) to ensure the integration of the land use planning from the DRECP into the California ISO's annual transmission planning process. Additionally, the various stakeholder groups and constituencies that care about the natural resources will remain engaged in helping to make the best locational decisions from a geospatial perspective.[180,181]

2010 California Transmission Planning Group Statewide Transmission Plan

The California Transmission Planning Group (CTPG) was formed in early 2009 as a result of discussions facilitated by the Federal Energy Regulatory Commission (FERC) to address California's transmission needs in a coordinated manner with the balancing authority areas (BAAs) in the state. The CTPG is a coalition of entities within California responsible for

179 See Desert Renewable Energy Conservation Plan website at: http://www.drecp.org/.

180 Zichella, Carl, Natural Resources Defense Council, Transcript of the May 17, 2011, *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 145, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

181 White, V. John, Center for Energy Efficiency and Renewable Technologies, Transcript of the May 17, 2011, *IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, pp. 157-158, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf.

transmission planning. The role of the CTPG is to coordinate transmission planning studies and develop a conceptual Statewide Transmission Plan that identifies transmission infrastructure needed to reliably and efficiently meet the state's 33 percent RPS goal by 2020. The information contained in the plan is assessed in greater detail by the BAAs within California as part of their own respective transmission planning processes since the CTPG is not a decision-making body.

CTPG members include:

- Publicly owned utilities: IID, LADWP, Sacramento Municipal Utility District (SMUD), and Turlock Irrigation District
- IOUs: PG&E, SCE, and SDG&E
- Other planning organizations: Southern California Public Power Authority, and Transmission Agency of Northern California

Non-member participants include:

- California ISO
- Western Area Power Administration

CTPG's 2010 planning cycle was completed in four phases with each phase building upon the previous based on input from RETI, state agencies, and other interested parties. Throughout the 2010 planning cycle, CTPG continued to improve on conducting a coordinated, open, and transparent transmission planning process consistent with FERC Order No. 890.[182] On February 9, 2011, CTPG completed the conceptual 2010 Statewide Transmission Plan.[183] The goal was to identify high-potential transmission needs for further consideration by BAAs within California and medium-potential transmission needs to be studied further in the next planning cycle. The plan identified 26 high-potential transmission upgrades/additions (23 in Southern California and 3 in Northern California), 34 medium-potential transmission upgrades/additions (17 in Southern California and 17 in Northern California), and three high-potential transmission corridors in the Western states (Pacific Northwest, Northwest Nevada, and Southwest). The corridor identifications provide potential options for accessing future in-state and out-of-state renewable resources and are intended to inform load-serving entities (LSEs) and state policy makers.

One of the key observations about CTPG's overall 2010 study process was the need to improve upon its stakeholder process by receiving early input from state agencies and interested parties in developing the baseline study scenario, identifying feasible alternatives that satisfy policy

182 See Table 1 for a description of FERC Order No. 890. Because CTPG includes both FERC jurisdictional and non-FERC jurisdictional transmission providers, it seeks to conduct a transparent transmission planning process as outlined in Order No. 890.

183 *Final 2010 California Transmission Planning Group Statewide Transmission Plan* dated February 9, 2011, can be found on the CTPG website at: http://ctpg.us/public/images/stories/downloads/2011-02-09_final_statewide_transmission_plan.pdf

objectives, and drafting study plans and reports. CTPG also identified other lessons learned that were provided by stakeholders during the 2010 study process and will be taken into account in future planning cycles:

- Clarify study objectives and better describe ongoing processes.
- Develop a single baseline study scenario with limited number of sensitivities designed to explore uncertainties in key assumptions made in baseline scenario.
- Develop select number of scenarios with stakeholder input.
- Create a continuing regional-local-regional planning cycle with CTPG providing input at the regional level and incorporating regulatory approvals at the local level.

California Independent System Operator's Role in Facilitating Renewable Development

In 1998, the California ISO assumed operational control of 25,526 circuit-miles of transmission lines from the state's three major IOUs. The California ISO's control area currently includes more than 80 percent of the state's electric load and serves more than 30 million residents. As the planning authority for its footprint, a core responsibility of the California ISO is an annual transmission planning process that identifies the transmission needs of the system over a 10-year planning horizon. The California ISO also provides findings of project need to FERC, as FERC considers whether a transmission provider can recover its transmission costs. As discussed below, the 2010-2011 Transmission Plan is a comprehensive evaluation of the California ISO transmission system that identifies the upgrades needed to meet grid reliability requirements, economic projects that could bring economic benefits to consumers, and projects needed to meet California's 33 percent RPS by 2020 mandate.

Other California ISO activities related to transmission planning discussed below include the Large Generator Interconnection Procedures (LGIP), a parallel process that provides results as input to its transmission planning process, and assessing the eligibility of renewable resources to provide resource adequacy capacity.[184]

- **2010-2011 Transmission Plan:** In 2009, in response to California's adoption of new environmental policies and goals, particularly increasing renewable energy resources, the California ISO initiated a stakeholder process to design the needed changes within its transmission planning process. The California ISO's revised transmission planning process tariff amendment was approved by FERC on December 16, 2010.[185] The California ISO 2010-2011 Transmission Plan was the first plan produced under the revised transmission

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184 The California Public Utilities Commission's Resource Adequacy program is intended to ensure that sufficient generating capacity is available to meet the peak load and reserve requirements of CPUC jurisdictional load serving entities, which include all investor-owned utilities, Electricity Service Providers, and Community Choice Aggregators. See http://www.cpuc.ca.gov/PUC/energy/Procurement/RA/ for more information.

185 The FERC approved the California ISO's Revised Transmission Planning Process on December 16, 2010 subject to certain modifications to the tariff, with an effective date of December 20, 2010.

planning process and the first to include transmission upgrades needed to meet California's policy mandates.[186]

The policy-driven category the California ISO focused on for the 2010-2011 Transmission Plan was the state's 33 percent RPS by 2020 mandate. The California ISO used the best available information and worked with the Energy Commission, CPUC, RETI, and CTPG[187] in the development of four 33 percent RPS portfolios. The four portfolios included: (a) high in-state, (b) high out-of-state, (c) high distributed generation, and (d) hybrid, which served as the base case for the study. The California ISO included 10 transmission projects that were either approved in previous transmission planning cycles or the LGIP [188] network upgrades that were permitted for construction or far enough along in the LGIP approval process to have executed or tendered LGIAs. To identify the transmission projects needed, the California ISO used the renewable net short calculation developed by RETI and CTPG with input from Energy Commission staff, as well as the Energy Commission's electricity demand forecast published in 2009. Renewable generation projects were ranked and assigned to potential transmission connections in the following order: Energy Commission-permitted projects, CPUC "discounted core"[189] projects, and projects selected by most favorable environmental score. For the 2010-2011 planning cycle, the California ISO developed renewable portfolios with the CPUC without stakeholder input due to time constraints. For the 2011-2012 planning cycle, after the California ISO and CPUC develop the renewable portfolios, the California ISO will solicit and take into consideration stakeholder input prior to finalizing the portfolios.

The California ISO identified 32 reliability-driven projects and one category 1 policy-driven transmission project in the 2010-2011 Transmission Plan that was presented and approved at its May 18, 2011 Board of Governors meeting.[190] Category 1 policy-driven elements are those elements which are found to be needed and are recommended for approval as part of the

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186 The Board of Governors Approved California ISO 2010/2011 Transmission Plan dated May 18, 2011 can be found on the California ISO website at: http://www.caiso.com/2b88/2b8872c95ce10.pdf

187 The California ISO, after conducting its own independent analysis, found that the high-potential transmission elements within its BAA identified in CTPG's 2010 Statewide Transmission Plan were found to be needed in its 33% RPS transmission plan.

188 The Generator Interconnection Procedures is a FERC-approved process that is not required to be FERC Order 890 compliant and is therefore not required to be open for stakeholder review.

189 CPUC "discounted core" includes projects having a signed power purchase agreement and an application for a permit to construct the project from the responsible permitting entity (Energy Commission and/or U.S. Bureau of Land Management.) The discounted core is the set of projects used by the CPUC in the development of its portfolios for its Long Term Procurement Plan.

190 The list of reliability-driven projects and one policy-driven transmission project is located on pages 522-524 of the Board of Governor Approved California ISO 2010/2011 Transmission Plan dated May 18, 2011.

comprehensive transmission plan in the current cycle.[191] The policy-driven upgrade project replaces the double-circuit 230 kV transmission lines from the Mirage to Devers Substations (SCE's portion of Path 42) with new lines that have higher electrical carrying capacity. This upgrade complements IID's approved Coachella – Mirage 230 kV upgrade (IID's portion of Path 42) that is a critical path to deliver renewable energy from IID's service area to the California ISO-controlled grid.

The California ISO also identified eight additional projects as category 2 that will be further evaluated in the 2011-2012 planning cycle (Table 12).[192]

Table 12: California ISO 2010-2011 Category 2 Projects

Category 2 Transmission Upgrades	Lead Time for Implementation
400 MVAr reactive power support at Sycamore, Mission, and Talega 230 kV substations (SDG&E area)	36 months for reactive power support
Third Miguel 500 kV transformer (SDG&E area)	60 months for the third Miguel 500 kV transformer
Upgrade El Dorado – Pisgah 500 kV series capacity to higher emergency rating (2700 Amp) (SCE area)	24 months for El Dorado – Pisgah 500 kV series capacity upgrade
Fresno area (PG&E area): 1) Build the new Midway – Gregg 500 kV line 2) Reconductor Gregg – Herndon 230 kV line 3) Reconductor Warnerville – Wilson 230 kV line 4) Reconductor Barton – Herndon 115 kV line 5) Reconductor Manchester – Herndon 115 kV line	72 months for Midway – Gregg 500 kV line 36 months to reconductor multiple 230 kV lines

Source: California Energy Commission

Category 2 policy-driven elements are those elements that could be needed to achieve state or federal policy requirements or directives but have not been found to be needed in the current planning cycle based on the criteria set forth in the California ISO's tariff.[193]

- **LGIP:** For the 2010-2011 cycle, the California ISO asked for and received a one-time waiver from FERC exempting LGIP upgrades associated with ARRA generators with a construction start requirement of December 31, 2010, from further study in the 2010-2011 transmission planning process (TPP)[194] in order to receive ARRA funding. For the 2011-2012 cycle, large

191 See the California ISO's Fifth Replacement FERC Electric Tariff, p. 466-467, available at: http://www.caiso.com/Documents/CombinedPDFDocument-FifthReplacementCAISOTariff.pdf.

192 Policy-driven transmission upgrades are identified as category 1 and category 2. Category 1 upgrades are presented for Board of Governor approval and category 2 upgrades are identified for further review in the next planning cycle.

193 See the California ISO's Fifth Replacement FERC Electric Tariff, p. 467, available at: http://www.caiso.com/Documents/CombinedPDFDocument-FifthReplacementCAISOTariff.pdf.

194 Order Conditionally Accepting Tariff Revisions and Addressing Petition for Declaratory Order Issued December 16, 2010, Docket No. ER10-1401-000, FERC

network upgrades/additions originally identified in the LGIP Phase II studies will be reassessed in Phase 2 of the TPP to determine whether these upgrades/additions are the best system solution or if better alternatives are available.[195,196] Any upgrades/additions identified within Phase 2 of the TPP will be open to independent transmission developers to build and own.

FERC approved a one-time exemption from this competitive process for the 2010-2011 cycle due to ARRA funding deadlines. However, going forward the California ISO recognized the need for greater integration between the Generator Interconnection Procedures[197] (GIP) and the TPP. In an attempt to further integrate these two parallel processes, the California ISO initiated a Generator Interconnection Procedures Phase 2 (GIP 2) stakeholder process in February 2011. The California ISO identified five working groups that were open to stakeholders' participation. Work Group 1 was responsible for developing greater integration between the GIP and TPP. Based on the complexity of the topics and sub-issues raised in the work group and stakeholder comments, the California ISO has decided to move this task out of the GIP 2. The California ISO's new stakeholder initiative, Transmission Planning and Generator Interconnection Integration,[198] held its first stakeholder meeting on July 28, 2011 and will present a proposal for Board of Governors approval in December 2011.

- **Resource Adequacy (RA):** For a renewable resource to be eligible to provide RA capacity, the California ISO performs an annual deliverability assessment for all capacity resources located inside the California ISO BAA and the interties connecting the California ISO to adjacent BAAs. The purpose of the deliverability assessment is to determine if the California ISO grid is able to receive energy and reserves from the designated RA capacity simultaneously during peak load conditions without exceeding grid capacity limits or having adverse reliability impacts.

  There are two RA deliverability issues for new renewable generation that currently limit a renewable resource developers' ability to provide RA capacity to LSEs within the California ISO BAA. Issue 1 pertains to renewable resources located outside the California ISO BAA,

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195 Section 24.4.6.5 of California ISO's tariff defines the criteria for evaluating LGIP network upgrades in the TPP: (1) new lines 200 kV or above with capital costs of $100 million or greater; (2) are a new 500 kV substation facility with capital costs of $100 million or greater; and (3) have capital costs of $200 million or greater.

196 Please note that "Phase II" refers to the interconnection study of the LGIP and "Phase 2" refers to the second phase of the California ISO's TPP.

197 In 2010, the California ISO combined its Large Generator Interconnection Procedures and Small Generator Interconnection Procedures into a single set of procedures, which is now called the Generator Interconnection Procedures (GIP). The GIP initiative is located on the California ISO website at: http://www.caiso.com/275e/275ed48c685e0.html. The California ISO's tariff amendment filed and approved by FERC became effective on December 16, 2010.

198 The California ISO Transmission Planning and Generator Interconnection Integration initiative is located on the California website at: http://www.caiso.com/2ba3/2ba39d31a0b0.html

and issue 2 to the lag time between the start of commercial operation and the completion of network upgrades required to make them fully deliverable for RA purposes. The concern in both issues is that the resources' limited ability to provide RA capacity will adversely affect their ability to obtain contracts with LSEs that provide a revenue stream to support project financing. The California ISO and CPUC presented the following proposal in response to a request from Governor Brown's Senior Adviser.[199]

- *Issue 1: Deliverability of Resource Adequacy Capacity on Interties*. Issue 1 pertains to resources located outside the California ISO BAA. The total amount of RA capacity these resources can currently offer is limited to a quantity called the maximum import capability (MIC), which is determined annually by the California ISO based on a historical snapshot of net schedules at the intertie points during selected hours of the year. Stakeholders raised concerns that the historical approach results in excessively low MIC values for a few selected ties. One primary example is the intertie between the California ISO and IID at the Imperial Valley Substation. At this intertie point, the MIC is set to zero because IID generally imports from the California ISO at that intertie. Thus, under the historical methodology, renewable resources seeking to deliver at the Imperial Valley Substation to the California ISO cannot count for RA capacity for LSEs within the California ISO.

  To address the issue of excessively low MIC values at selected intertie points, the California ISO is in the process of implementing a proposed solution[200] to revise the MIC methodology and expand the amount of import capacity available to LSEs for obtaining RA capacity from external resources. The California ISO's proposal contains two elements: (1) revise the California ISO procedure for determining MIC values to expand RA import capacity on the identified interties beyond the historical amounts; and (2) use the California ISO's annual TPP to identify targeted resource areas and associated interties that require expanded RA import capacity, along with required transmission needed to ensure deliverability.

  The California ISO's new approach to the MIC methodology will apply to its annual RA import allocation process in 2012 for the 2013 RA compliance year. Stakeholders, including IID, have expressed concerns that this approach is a long-term solution that does not address the immediate need. As noted in IID's comments in Docket 11-IEP-1E:

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199 See California ISO and CPUC Letter to Michael Picker dated April 18, 2011, entitled "Resource Adequacy Deliverability Issues for New Renewable Generation", California Energy Commission Docket No. 11-IEP-1E, available at: http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/California_ISO_Comments_Regarding_Resource_Adequacy_Deliverability_Issues_TN-60856.pdf

200 The California ISO initiated a stakeholder process in April 2011 which culminated with the completion of the California ISO Draft Final Deliverability of Resource Adequacy Capacity on Interties Proposal on May 5, 2011 and is located on the California ISO website at: http://www.caiso.com/2b42/2b42b9378530.html.

> "…IID expresses its support of the California ISO proposal but remains concerned about the interim period while this proposal is being implemented. Currently the three investor-owned utilities (IOUs) are engaged in a request for offers (RFO) solicitation that will result in the IOUs entering into PPAs with renewable generation projects. During this RFO process the IOUs should evaluate offers from generation projects as if the proposed MIC methodology is already in place. IID has reason to believe that the IOUs intend to evaluate offers during RFO using the existing criteria for resource adequacy. This will result in offers from the Imperial Valley generators being shut out of the current RFO process and hinder the development of renewable resources in the Imperial Valley."
>
> "IID urges the California ISO, CPUC, CEC, IOUs and other stakeholders to work to ensure that offers received from solicitations during the current RFO process are evaluated under the RA MIC methodology that will be put in place as a result of the Draft Final Proposal." [201]

In response to IID and other entities affected by the current MIC methodology, CPUC Assigned Commissioner Ferron ruled that it was unreasonable for PG&E, SCE and SDG&E to use a MIC of zero or near zero for imports from the IID BAA for the 2011 RPS solicitation currently underway pursuant to Decision 11-04-030. Instead the three utilities should use a MIC of 1,400 MW for imports from projects within the IID BAA in the 2011 RPS solicitation or provide clear and convincing evidence why they did not.[202]

- *Issue 2: For some renewable resources connecting to the California ISO grid, there is a lag of up to five years between the start of commercial operation and the completion of the transmission upgrades required to make them fully deliverable for RA purposes.* The California ISO and CPUC propose the following solution that would apply only to projects that meet the terms for the ARRA cash grants and have contracts with LSEs that are under renegotiation as a result of additional deliverability analysis by the California ISO.

  The proposal is for these LSEs to agree to provide replacement RA capacity for up to three years after the date of full deliverability agreed to in the signed LGIA. To determine the amount of replacement capacity required, the LSE will apply the CPUC rules for determining RA capacity. The LSE would provide this RA capacity and in turn bill the developer the market price for the replacement capacity at a cost not to exceed the per-MW price of the California ISO's backstop procurement authority of $55 per

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201 See TN-60874 05-24-11 Comments of the Imperial Irrigation District in Docket 11-IEP-1E (pages 2-3) located on at: http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/.

202 California Public Utilities Commission, *Assigned Commissioner's Ruling Regarding Resource Adequacy Value of RPS Projects in the Imperial Irrigation District Balancing Authority Area*, June 7, 2011, in Rulemaking 11-05-005, http://docs.cpuc.ca.gov/efile/RULINGS/136670.pdf.

kW/year. For any months the LSE is short of its RA requirement, the California ISO could procure backstop RA capacity under its tariff provisions and bill the cost of the capacity to the deficient LSE, who would in turn bill the renewable generator at the tariff defined backstop level. In these instances, the LSE can ask the CPUC to waive any associated RA deficiency charges.

Research and Development

Building double-circuit lines rather than single circuit lines under specific circumstances is one method for enhancing transmission system utilization. Recent technological advancements offer additional opportunities to enhance the utilization of the existing transmission system by increasing transfer capability in existing rights-of-way. As described in Chapter 9, the Energy Commission's Public Interest Energy Research Program has funded a wide variety of research projects to improve operation and use of the state's transmission system, and will continue to evaluate new technologies to facilitate connection of renewable generation projects to the state's transmission grid.

Western Region Initiatives: Markets and Planning

Background

The West has an abundance of renewable resources that can be used to meet state/provincial policy goals for developing carbon-free electricity generation. Nine of eleven western states have statutory RPS requirements and are generally procuring in-state or "close-to-home" resources to meet these requirements.[203] Many states would also like to export their resources to other states, particularly interior West states such as Wyoming, Montana, and New Mexico which have high-quality wind resources but limited electricity demand. Arizona also seeks to provide high quality solar for the Western Interconnection and beyond. More work is needed to address risk and benefit tradeoffs of local versus remote resources for both wind and solar. This will shed light on critical economic development values, risks of rapid technology cost shifts and cost risks/benefits of lines, such as Canada to Northern California or other ties with Wyoming, Montana, Nevada and New Mexico.

California hopes to exceed its 33 percent RPS requirement and become a net exporter to the north and east, relying not only on large, in-state central station projects but also on distributed local resources. In his August 3, 2011, letter to Mr. Brad Nickell (Director of Transmission Expansion Planning for the WECC), Mr. Michael Picker (Senior Advisor to Governor Brown for Renewable Energy Facilities) cited several recent developments that point to an increased ability for California to meet its 33 percent RPS goals with in-state resources:[204]

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203 Western Utility Resources Planners Forum(s), 2009 and 2010. Economic development and job creation are key drivers of in-state resource procurement policies. Load serving entities also have concerns regarding the economic risks and uncertainties on the timely availability (and cost) of remote resources and the transmission needed to move energy to load centers.

204 Letter from Michael Picker, Senior Advisor to the Governor for Renewable Energy Facilities, to Brad Nickell, Director, WECC Transmission Expansion Planning, August 3, 2011, "Reflecting Current California Trends and Policies in Regional Transmission Planning."

- Significant reductions in the technology cost of solar generation and the availability of investment tax credits have resulted in large-scale resource development within California's borders.
- The Brown Administration has put into place strong policies supporting additional in-state and distributed local generation.
- In 2010 the state approved 11 large solar and wind projects totaling over 5,000 MW of renewable generation capacity.
- In 2011, the state has thus far permitted an additional 1,000 MW of solar PV projects. By the end of 2011 the state expects to permit another 5,000 MW of solar and wind.

The interest in export by California as well as its neighbors, as well as the immediate need to integrate significant amounts of renewables into the western system, have focused western region system planning on renewable integration and transmission additions that could facilitate delivery of renewables. Western market and integration initiatives, regional transmission plans, and proposed regional projects reflect this focus.

Western Market and Integration Initiatives

In the August 3, 2011, letter discussed above, the Governor's Office expresses its support for the efforts the WECC has underway to develop a dynamic grid that allows for the flexible importing and exporting of power and ancillary services in real time among balancing authorities. These include movement toward sub-hourly scheduling and the study of energy imbalance markets. As noted in the letter, "By enabling additional renewable generation output while helping to minimize reserve requirements and load following requirements, such initiatives balance responsible and prudent system operation with the increasing need for flexibility."[205] A wide range of market and associated integration initiatives and studies are in varying stages of implementation throughout the West. Of particular interest to California are the innovative efforts shown in Table 13 and summarized below.[206]

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205 Letter from Michael Picker, Senior Advisor to the Governor for Renewable Energy Facilities, to Brad Nickell, Director, WECC Transmission Expansion Planning, August 3, 2011, "Reflecting Current California Trends and Policies in Regional Transmission Planning," p. 3.

206 For a complete list of initiatives and integration studies, see the following document posted on July 25, 2011 entitled "Western Interconnection Initiatives, Studies, and Groups Tables": http://www.wecc.biz/committees/StandingCommittees/JGC/VGS/Shared%20Documents/Forms/AllItems.aspx

Table 13: Western Variable Generation Initiatives

Initiative	Description	Initiative Start Date
WECC		
• Energy Imbalance Market	A real-time centralized energy dispatch market.	
Joint Initiative		
• Intra-Hour Transmission Purchasing & Scheduling	Project designed to facilitate intra-hour schedule changes to address unanticipated changes in generation, and to allow better use of capacity within and from outside BAs by developing common business practices that allow shorter time frames for scheduling.	July 2011
• Dynamic Scheduling System	Project to provide a more agile delivery mechanism for dynamic energy products, including dynamic schedules and pseudo-tie resources.	March 2011
• Intra-Hour Transaction Accelerator Platform I-TAP	Project to facilitate bilateral transactions from both within and outside a BAA.	October 2011
Wind Integration Study Team (NTTG/ ColumbiaGrid)		
• Dynamic Scheduling Assessment	Western Interconnection experts are evaluating the potential limits to dynamic transfers and options for enhancing transfer capability.	2010
Bonneville Power Authority (BPA)		
• Customer Self-Supply of Generational Imbalance	The purpose of the Customer Self-Supply of Generation Imbalance (CSGI) effort is to provide customers a choice of balancing reserve suppliers and to reduce the overall dependence on the FCRPS for balancing capacity and energy.	Sept. 2010
• DSO 216	Operating Procedure to delimit BPA's reserve obligations and ensure the reliability of the BPA BAA. It has also been deployed as a way to reduce wind integration costs by substituting infrequent wind curtailments for additional reserves.	October 2009
• Third Party Supply of Regulation Reserves	As a pilot effort, BPA purchased 75 MW of generation imbalance dec reserves from a Calpine natural gas fired plant from Sept. to Nov. 2010. BPA is implementing a Pilot in 2012-13.	2012

Source: Adapted from WECC Variable Generation Subcommittee, Draft for Comment July 7, 2011

- **WECC Energy Imbalance Market:** The concept for a voluntary energy imbalance market that is currently being examined in the West would be a real-time, centralized, energy dispatch market. It would use a security-constrained economic dispatch that addresses energy and balancing needs, resource characteristics, transmission characteristics, and energy offers. The result would seek to create an optimal five-minute dispatch operation for those balancing authorities who opt in to rely on the market. At present, WECC is evaluating the benefits and costs of establishing a market and considering critical questions such as who would administer the market, how many BAAs might participate, and many other foundational issues. Initial cost analyses indicate a market would be beneficial if start-up and operation costs were moderate and benefits were above mid-range estimates. A "go-no go" decision may be reached in the fall of 2011.

If Western utilities and policymakers choose to pursue a voluntary energy imbalance market framework, many new opportunities for flexible scheduling and pricing of resources and ancillary services could become available in 2013.

- **Joint Initiatives for Markets and Integration:** A group of 30 LSEs and others are pursuing a series of voluntary initiatives designed to make more efficient use of the West's existing (and future) transmission and generation infrastructure. Initiatives include:
    - Intra-hour scheduling with partial implementation of 30-minute scheduling in July 2011, or as soon as automated scheduling tools are available, using standardized practices (IID and SMUD are working toward this goal and the California ISO is coordinating through dynamic scheduling).
    - Dynamic Scheduling System implemented in March 2011 (communications).
    - Intra-hour Transaction Accelerator Platform, a web-based trading exchange that is in the software development stage and could be available in late 2011.
- **Dynamic Scheduling Assessment:** Under the leadership of the Western Wind Integration Team, technical experts are reviewing dynamic transfer capability and the possible need for limits on the number and size of transfers. Limits could be needed to address potential system instabilities due to rapid and/or frequent changes in flows of power. Initial conclusions from Phase 1 of the team's review include:
    - Increases in dynamic transfer capability do require system enhancements.
    - Improvements are needed that target the ability of the transmission system to respond automatically, including enhanced state awareness;[207] automation of controls; additional reactive equipment; and increased staffing at control centers.

  A second phase is underway to simulate the transmission/generation system power flows with differing levels of transfers to evaluate effects on system operation. This work will continue through 2011 and will identify potential recommendations for system enhancements and potential limits if needed in 2012.
- **Bonneville Power Authority (BPA) Initiatives:** BPA has undertaken important initial steps to address integration of significant wind resources already interconnecting to their system. These include:
    - Customer self-supply of generation imbalance, which provides customers a choice of balancing reserve suppliers.

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207 State awareness is a measure of the system operators' nearly instantaneous ability to know the frequency and stability behavior of the transmission and generator system westwide, using visual, electronic and mechanical data and display tools.

- Operating procedures that delimit BPA's reserve obligations and ensure reliability, potentially a way to reduce wind integration costs by substituting infrequent wind curtailments for additional reserves.
- Third party supply of regulation reserves, including the Dec Acquisition Pilot for 2012-13.

Regional Transmission Plans for Renewables

In December 2009, the U.S. DOE awarded the WECC $14.5 million in ARRA funding to conduct the first-ever interconnection-wide transmission planning studies in the Western Interconnection. The funding allows WECC to significantly expand existing regional transmission planning activities and broaden stakeholder involvement in planning processes through the Regional Transmission Expansion Planning (RTEP) Project. The RTEP is developing 10- and 20-year transmission plans for the Western Interconnection which will be provided to the DOE in 2011 and 2013, respectively. These new transmission plans largely limit the study of new fossil fueled generation to plants already under construction and instead focus the effects of RPS requirements, energy efficiency goals and other low-carbon public policies on transmission needs throughout the Western Interconnection.

Proposed Regional Transmission Projects

As mentioned earlier, many Western states seek to export renewables to load centers, particularly to those in California that are seen as large and lucrative. Wind resources with high capacity factors (for example, 40-45+ percent in Wyoming) in remote locations drive interest in long lines connecting to California. Utility and independent developers rely on FERC's Order 890 framework to position their projects for evaluation in RTEP.[208] WECC expansion cases show the benefits of developing remote resources for some locations and transmission alternatives. However, the CPUC staff has pointed out that these conclusions are not consistent with results found in CPUC procurement analyses and utility power purchase contracts. Others argue remote development can offer wind profile diversity, lower cost, competition and risk mitigation associated with potential delays in large solar deployment. Figure 10 identifies major projects reviewed in WECC studies.

Completing the initial development stages of transmission projects is essential to ensure potential projects are poised for investment when/if continuing procurement activities indicate benefit from a portfolio of both in-state and out-of-state generation. Developers that are willing to pursue full permitting at their own cost and risk will be best positioned to compete successfully to meet California renewable procurement goals.[209]

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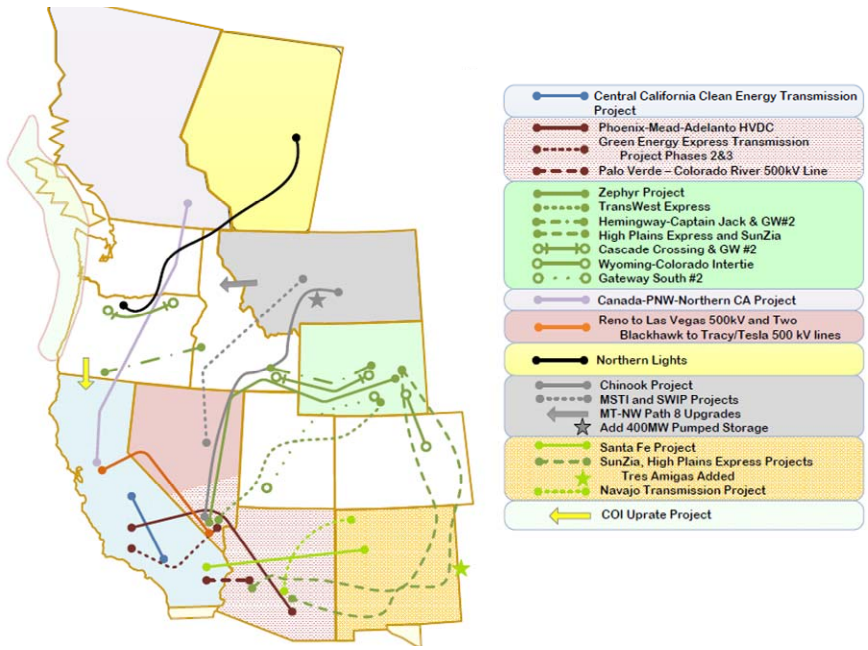
208 FERC Order 890 requirements allow any stakeholder to request expansion studies in the "open window" process.

209 See comments of TransWest Express, David Smith.

Figure 10: Sustained Interest Multi-State Expansion Projects



Source: WECC Staff, Brad Nickell Presentation to CREPC SPSC, April 12, 2011, "10-Year Plan," slide no. 20, available at: http://www.westgov.org/wieb/meetings/crepcsprg2011/briefing/present/b_nickell2.pdf.

Chapter 5: Grid-level Integration Issues

In California's complex system of power resources, generation must instantaneously and continuously match demand. The process of balancing electricity generation to load while maintaining the voltage and frequency within operational tolerances is achieved through resource commitment and dispatch. Fitting any particular generating unit into that process, whether conventional or renewable generation, is called "integration." Integration is generally invisible to the consumer, and allows generation and load to be in harmony.

Electricity system operators routinely plan for outages of significant resources such as nuclear plants or transmission lines, and the need to bring grid frequency back into balance within minutes. As more intermittent renewable electricity generating resources, like wind and solar, are added to California's electricity resource mix, it becomes increasingly challenging to integrate variable resources while maintaining grid reliability, safety and security.[210] Wind and solar output can rise or drop from moment to moment, across hours, and over days or months. Solar resources begin production after sunrise and more or less shut down at sunset. High variability means that operators need to forecast what renewable generation will be provided, what services from other sources will be needed, the options to provide these services, what they would cost, and how to make good choices among the options.

Integrating increasing amounts of renewable resources into California's electricity system poses a number of challenges and opportunities discussed in this chapter. Intermittent renewable resources that increase the minute-to-minute and hourly variability of the electric system require more ancillary services and ramping capabilities that permit the grid to operate reliably. Better weather and operational forecasting will be necessary to reduce the uncertainty over the availability of and need for resources. Market incentives will need to be aligned with new technical operating requirements to ensure that sufficient resources are made available.

Currently, California relies on the flexibility of its existing generation fleet, particularly large hydropower and natural gas units, to integrate the renewables now on-line. Integration across a mix of generation resources is not a new problem, but the scale and diversity of resources is increasing. Going forward, the system may no longer be able to rely on excess capacity and rules designed before the enormous growth of variable renewable resources. Increasing levels of intermittent renewable resources will require a suite of complementary services to help manage the entire grid and match instantaneous load to generating resources. Maintaining a reliable electricity system while adding increasing levels of variable resources will require increasingly sophisticated controls, new market designs, complementary generation, energy storage, and demand response that can be turned up or down as needed.

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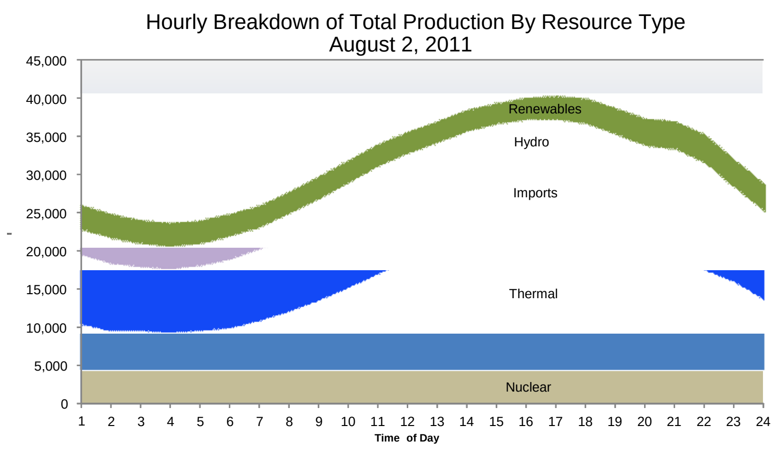
210 Variable energy resource is the term used by the Federal Energy Regulatory Commission to describe renewable resources that have variable or intermittent production. Geothermal, biogas and biomass resources generally follow fixed hourly schedules and are not considered variable.

Description of Integration Challenges

Grid operators must plan not only for hourly, daily, and seasonal fluctuations in electricity demand and the available supply of electricity, but also for unplanned outages of operating power plants and transmission lines. Each electricity supply source has its own unique operating characteristics, constraints, costs, and environmental impacts. At any given moment, system operations must take into account these combined characteristics to commit or dispatch resources to meet demand, and also to have additional reserves to deal with unplanned contingencies. Federal and industry reliability standards require each grid operator to maintain its frequency and voltage levels within tight standards for every ten minutes.

In the most general terms, a load pattern is forecasted each day. Figure 11 is an example of the hourly demand (need) and the resources used to meet it. Units with the best operating features are selected to serve load at the least cost while maintaining reliability. This is called "merit order" or "economic" dispatch. Some units, such as nuclear and coal, are baseload units that function best at a steady state without a lot of stops and start, and may take days to start up. Others, such as "load-following" natural-gas generating units, can slowly increase or decrease their operating levels, and a third group can respond rapidly to quick changes from a generator outage or sharp increase or decrease in demand, and may be started up within as few as 10 minutes.

Figure 11: Daily Load Curve and Resources



Source: California ISO

Scheduled power generation for the day-ahead rarely matches the actual load. Ancillary services help balance those demand and supply fluctuations, maintain grid conditions within prescribed limits, and provide reserves for unexpected events (Table 14). Together they support the transmission of energy while maintaining reliable operation. Ancillary services may be procured through a market or awarded through contract. The California Independent System Operator (California ISO) currently procures regulation and spinning/non-spinning reserves as ancillary services. These are paid for by all customers. Ancillary service types and needs may change at higher levels of wind and solar penetration and may vary more by season.

Operating reserves are a combination of two categories: regulating reserves and contingency reserves for unexpected deviations in load or generation. The California ISO, for example, maintains sufficient capacity (about 1.0 – 1.5 percent of load) under automatic generation control (AGC) to continuously balance generation and imports in real time – this is regulating reserve.[211] Ancillary services manage various fluctuations over different time horizons:[212]

Table 14: Ancillary Services and Related Terms

Regulation	Units can change output in response to signals every four seconds provided through automatic generation control (AGC) to maintain a balance between load and generation in real time.
Load Following	Similar to Regulation, but slower (10 minutes to a few hours).
Spinning Reserve	On-line (synchronized) and available to increase output immediately; reach full output within 10 minutes and maintain for 30 minutes
Non-spinning Reserve	Similar to above, but unit may be offline and capable of quickly restarting.
Black Start	Generation able to come on-line without an external source of electricity following a system blackout; energize transmission and start other units.
Voltage Control	Adding or subtracting reactive power to keep system transmission voltages in required range for stability
Inertia/Frequency Response	Sufficient spinning mass to dampen changes in frequency to avoid Area Control Error (also called "ride-through")

- Regulation services address normal short-term up and down fluctuations (second-to-second and minute-to-minute) in the aggregate output of resources, voltage or frequency. This requires dispatchable generation under AGC.
- Ramping capabilities address predictable changes in aggregate wind or solar output over the course of the day, which requires generation resources designed to cycle on a daily basis.
- Spinning reserves deal with unexpected fluctuations over slightly longer periods. A resource that can ramp up and down within 10 minutes and that is able to operate for at least 30 minutes to several hours from the time the needed level is reached is effective for this. Cost-effective provision of this service requires that a unit be able to do so without a substantial drop in efficiency.
- Non-spinning reserves handle changes in aggregate wind or solar output over the 30-minute to two-hour range. The response does not need to be instantaneous, but must still be

211 California Independent System Operator, *Integration of Renewable Resources*. November 2007, http://www.caiso.com/1ca5/1ca5a7a026270.pdf, p. 78.

212 California Energy Commission, *Framework for Evaluating Greenhouse Gas Implications of Natural Gas-Fired Power Plants in California*, Consultant Report, May 2009, http://www.energy.ca.gov/2009publications/CEC-700-2009-009/CEC-700-2009-009.PDF.

able to reach their maximum output in 10 minutes. Fast start units are necessary to provide non-spinning reserves.

- Inertia is needed to maintain system stability and reduce frequency deviations or oscillation. Inertia is provided through sufficient spinning mass (rotating turbines, for example) that effectively dampens (reduces) frequency changes.

According to the recent analysis by the California ISO/California Public Utilities Commission (CPUC) in the Long Term Procurement Plan Proceeding (Trajectory Case), the share of California's electricity provided by variable energy resources is expected to rise to 22 percent in 2020.[213] With the introduction of large numbers of variable energy resources, large, fast ramps up or down that are difficult to forecast are of particularly concern. Variable energy resources share several characteristics that require increased operational flexibility:

- A variable fuel source that is difficult to accurately forecast.
- A typical generation pattern that does not match system load and, in the case of solar, may be ramping down in the late afternoon as load is picking up.
- Current technologies that do not in themselves smooth out the variations in order to flow a predictable product onto the grid.
- An inability of current technologies to dispatch on command, and an inability of solar photovoltaic (PV) resources and wind resources to significantly contribute to system inertia or frequency control.

Successful integration of high levels of intermittent renewable energy facilities connected to the grid will require technologies and resources to accommodate the resulting increase in short-term fluctuations in the output, voltage, and frequency of the electric system. The California ISO anticipates new operational challenges that will change the look and procurement of ancillary services.

Intermittency and Variability

Building large amounts of intermittent renewable technologies introduces challenges which did not exist when California's dominant renewable resources were geothermal and biomass. While geothermal and biomass have fuel availability issues, they are much more like large, baseload units that run at a steady state or units that can ramp up or down as needed. They also can provide some level of system inertia.

Solar and wind generation patterns, on average, complement each other. Solar energy is highest in the early afternoon compared to system peaks in the later afternoon or early evening. Wind patterns vary considerably over seasons and locations, but a common pattern during the summer is highest production at night. While each technology has a basic daily pattern, that pattern can also change from moment to moment and day to day, so system operators must

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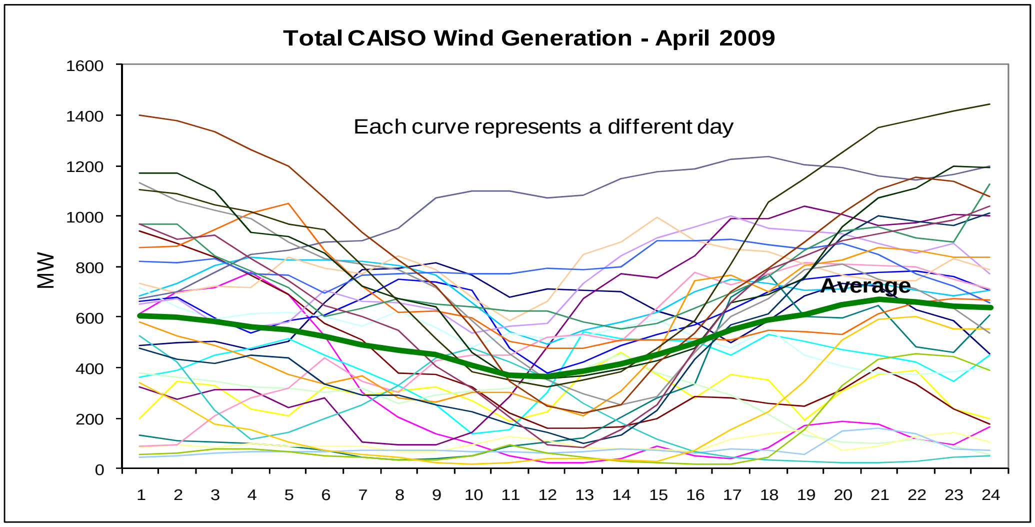
213 2020 share is from California ISO study of 33% renewables for the CPUC Long-term Procurement Proceeding.

deal both with tiny, frequent changes and with bigger swings over hours and days. In these cases, each resource's variability may either cancel out or compound the total system variability. For example, the California ISO experienced an upward swing in one hour of 845 MW and a downward drop in another hour of -349 MW on July 6, 2011.[214] Day to day wind variability is shown in Figure 12**.**

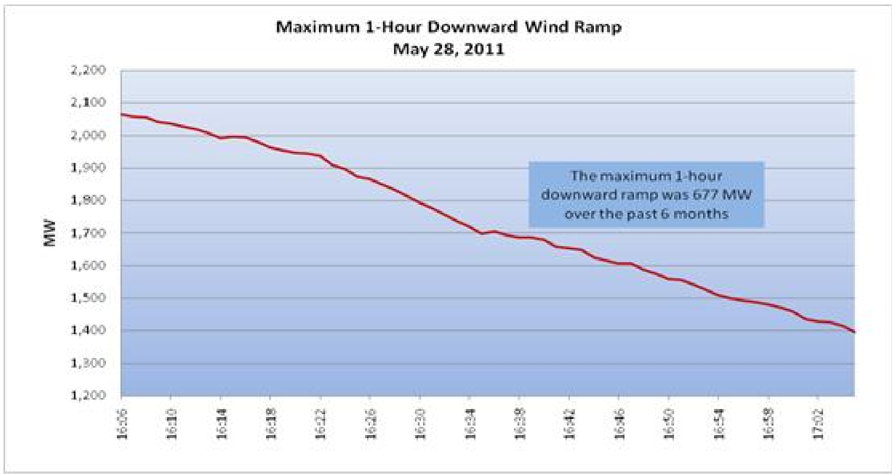
Figure 12: Daily Wind Variation Over One Month



Source: California ISO

Wind production can drop off significantly in any hour, as shown in Figure 13**,** when 677 MW of wind generation was lost within one hour on May 28, 2011.

Figure 13: Sudden Loss of Wind Production



Source: California ISO

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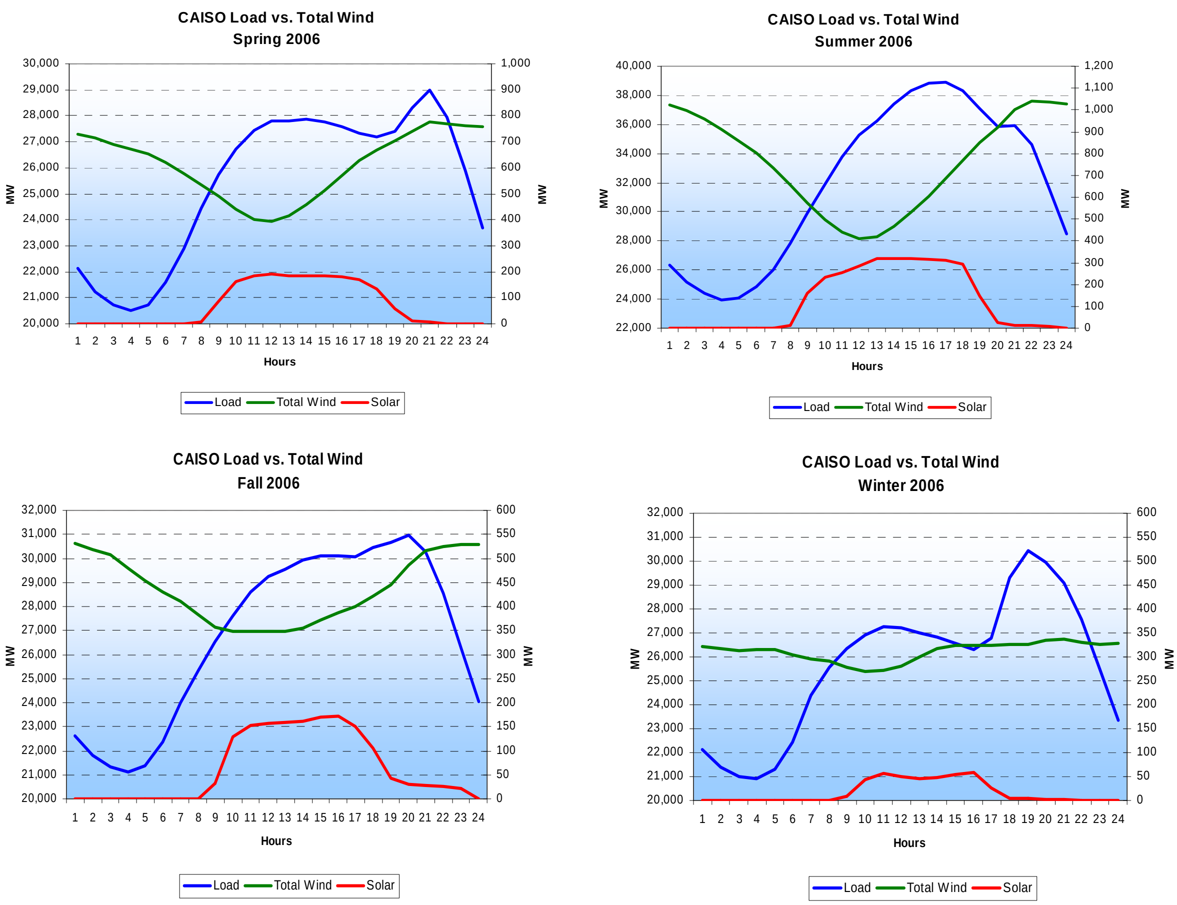
214 Dennis Peters, California ISO, e-mail communication, August 8, 2011.

Within these big swings there are smaller variations such as when PV generation drops suddenly when a cloud passes over or wind currents gust or drop off. Figure 14 illustrates the daily load profiles for wind and solar over a twenty-four hour period in the California ISO. These large, fast changes pose operational challenges. For example, if wind ramps down during the same period solar production begins, thermal units will have to be dispatched to fill the gap.

Figure 14: Daily Load Profiles for Wind and Solar



Source: California ISO 2007 Intermittent Renewables Integration Report

Forecasting Under Increasing Variability

Real-time data and forecasting improvements are needed to reduce uncertainty associated with intermittent renewable resources. Knowing how much variability to plan for is essential for grid operators. As previously discussed, greater amounts of variable energy interconnected to the grid can increase the magnitude of forecasting errors. Solar and wind generation can swing by several hundred megawatts in a short period of time due to cloud cover, moisture or dust in the air, or wind conditions. Load can also drop unexpectedly with unexpected weather changes or other unexpected system interruptions. This variability must be covered by other generation, which is ramped up and down to keep the system in balance. Inaccurate forecasts make it harder for grid operators to ensure that committed resources have the necessary capabilities (ramp rate) to meet expected variability.

Accurate forecasting of variable energy in the day-ahead and real-time operational timeframe is important because resources have to be procured ahead of the time so that transmission and generation dispatchers will have sufficient and appropriate complimentary resources available to meet demand. The larger the disparity between when resources need to be procured and actual conditions, the higher the probability that more resources will have to be dispatched at higher prices and the system will rely on more expensive regulating reserves.

System operators already deal with forecast error associated with electricity demand which is highly weather-sensitive. Accurate weather forecasts are a critical element of reducing forecast error to allow cost-effective balancing of supply and demand. For example, in the California ISO system, for temperatures over 100 degrees F, a forecast error of one degree can result in a 980 MW over- or under-estimation of load. [215] As discussed in the previous section, wind and solar generation variability can be quite sudden and dramatic. Forecast error of hour-ahead demand increases as loads are higher, typically being more pronounced in summer when they can deviate up or down by as much as 2,000 MW.[216] Concerns have been raised that the introduction of forecast error from intermittent renewables on the generation side, coupled with existing forecast error on the demand side, may result in larger discrepancies between forecasts and what would be needed in real time. This increased forecast error introduces additional operational challenges discussed in the next section.

The California ISO has taken steps to improve its forecasting techniques to reduce uncertainty with wind and solar generation. Significant reduction in hour-ahead load forecast error is being observed. The load forecast is now based on forecasts produced 75 minutes prior to the actual operating hour. Earlier forecasts were produced 2 hours before the operating hour.

The California ISO is evaluating promising new enhancements that offer short-term event predictor and ramp forecasting tools that recognize correlated meteorological and system events. The Energy Commission's Public Interest Energy Research (PIER) Program is providing

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215 California Independent System Operator, *Integration of Renewable Resources*. November 2007, http://www.caiso.com/1ca5/1ca5a7a026270.pdf, p.62.

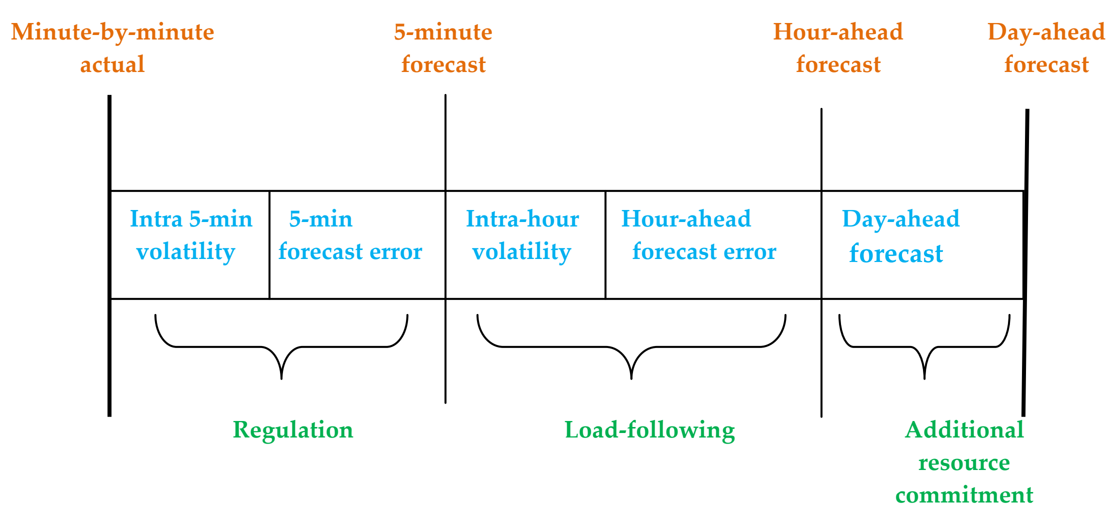
216 Ibid, pages 49-56.

funding to support grid-level activities that will reduce the uncertainty created by variable energy resources for control/balancing requirements, as discussed in Chapter 9. The transmission research section of Chapter 9 discusses R&D to address wind forecasting and operational issues, including projects such as the Real Time Dynamic Measurement System that is now commercially available and is being used by the California ISO. This synchrophasor-based tool enables enhanced situational awareness and increased sharing of regulation services between two control areas for balancing renewable generation. New forecasting tools for wind and solar generation including a "ramping tool," are being tested. Future opportunities for research in this area, also discussed in the transmission research section of Chapter 9, include the need for solar generator modeling, improved solar and wind forecasting, dynamic thermal circuit rating that allows faster integration of wind energy, and power flow control devices.

Operational Challenges with Increased Variability

Integration of variable energy resources will require increased operational flexibility — notably the ability to provide services to match real-time upward and downward movements and at ramp rates that are faster than what is generally provided today. Anticipated load growth to 2020 will drive the overall system flexibility needs from the present level of about 4,300 MWh to about 6,000 MWh.[217] Impacts of large-scale penetration of variable generation should be considered in terms of time frames: seconds to minutes, minutes to hours, hours to days, and days to a week and beyond. Figure 15 illustrates this flexible pattern of forecasts and associated services.

Figure 15: Flexible Services and Time Frames



For seconds to minutes, automatic equipment and AGC systems manage the system. From minutes to days, the operators commit and/or dispatch needed facilities to re-balance, restore,

217 California Energy Commission, *Intermittency Analysis Project: Appendix B Impact of Intermittent Generation on Operation of California Power Grid*, July 2007,CEC-500-2007-081APB. Page 5.

and position the system to maintain reliability through normal load variations or contingencies and disturbances. The following operational challenges and associated ancillary services to support them are discussed below:

- Increased procurement of regulation up and regulation down energy.
- Increased frequency, duration, and magnitude of ramps.
- Mechanical or electrical inertia to lessen the impacts of frequency changes.

Regulation

Regulation is the automatic control of second-to-second variations in system frequency caused by changes in generation or load.[218] These services include generation or automated demand response that are on-line and ready to immediately respond to automatic generation control signals sent by the system operator, and spinning reserves synchronous to the grid.[219] Regulation up and down are existing market products and can be provided by gas-fired units, storage, demand response, or large hydropower that uses variable speed pumps. Regulation and balancing needs are expected to increase as more variable energy resources are added to the generation fleet. The need for intra-hour regulation capacity is also likely to increase as variable energy resources are added.

Ramping (Load Following)

Wind production in California typically peaks at night and falls off in the afternoon. Solar production is the inverse, peaking in the afternoon. Ramping capability balances the less predictable energy production patterns of renewable resources such as wind and solar. These resources do not have the ability to firm and shape their production output.

Ramping is changing the operating level of a generating unit at a constant rate over some fixed interval using economic dispatch. It ensures that the system remains in balance to meet the average demand moving from one 5-minute dispatch interval to the next. The combination can produce ramp rates higher than experienced in the past. The California ISO needs flexible resources committed to sufficient ramping capability (both quick start ups and slow downs) to balance the system within the operating hour, including second-to-second real-time imbalances. One of the ways the California ISO could accommodate the scheduling of intermittent resources

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218 Frequency is measured in cycles per second or in Hertz. In North America, frequency must remain near 60 Hertz. Maintaining a steady and safe frequency range is essential to the instantaneous balance between generation and load on an interconnected electric power system. See Joseph H. Eto, et al, December 2010, *Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation*, Lawrence Berkeley National Laboratory, LBNL-4142E, http://www.ferc.gov/industries/electric/indus-act/reliability/frequencyresponsemetrics-report.pdf.

219 Spinning reserves are immediately responsive to system frequency and are capable of being loaded in 10 minutes and running for 30 minutes from the time it reaches desired capacity. See California Independent System Operator Corporation Fifth Replacement Tariff April 1, 2011, Appendix A Master Definition Supplement. http://www.caiso.com/Documents/AppendixA-FifthReplacementCAISOTariff.pdf.

would be to implement a 15-minute market that would increase bidding opportunities for all resources closer to real time.

Units providing ramping, or load-following, services must be on-line or available for quick start and be capable of changing from one operating level to the next in a fixed time frame. Ramping up (increasing output) and ramping down (decreasing output) are separate products; a unit might be able to ramp down from its current operating level but not be able to ramp up. Currently, load-following is not explicitly procured by the California ISO in its day-ahead and real-time markets, but developing such a market is the subject of discussion.[220] The role of ramping will grow because both wind and solar add or subtract power from the grid irrespective of the load and operations of other generation.

Inertia and Frequency Response

Integration also has to consider the reliability concern of whether the system has sufficient system inertia. Inertia is the ability of the system to use the properties of synchronous generators to slow frequency deviation. If a frequency excursion starts to develop, it can be reduced if there are large rotating masses or their equivalent on-line that will slow down the excursion of the frequency from its desired levels. Keeping the lights on requires that power generators respond automatically within seconds to halt a swing in frequency and restore levels to the 60-cycle per-second standard. Demand and generation are constantly changing, meaning there is some unintentional outflow or inflow of energy at any given moment. This mismatch, along with the obligation to maintain stable system frequency, is measured by Area Control Error (ACE). Balancing authorities must maintain sufficient regulating reserves to meet regional and national reliability standards for keeping ACE within limits.

A 2010 study released by Lawrence Berkeley National Laboratory (LBNL) reports that frequency levels are dropping further than realized on the nation's two largest grid systems, particularly at the start of the day when electricity demand ramps up and when it ramps down in the evening.[221] In large part, this situation is the result of operating choices by conventional generation and the lack of a unified method of paying generators to provide instantaneous frequency support. Intermittent resources are currently too small a factor to contribute to the decline, but as wind and solar increase, they could both add to the frequency deviation problem and help prevent such frequency swings if the operations are managed to that purpose.

The LBNL study points out the essential role played by frequency control reserves in ensuring reliability. If there is suddenly too much demand for the amount of generation on-line, control systems send an automatic signal to speed-regulating governors at power plants to get them to ramp up power within seconds. This "primary" frequency response is designed to halt a drop

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220 California ISO, Integration of Renewable Resources: Operational Requirements and Generation Fleet Capability at 20% RPS, August 31, 2010, http://www.caiso.com/2804/2804d036401f0.pdf.

221 See Joseph H. Eto, et al, *Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation*, Lawrence Berkeley National Laboratory, LBNL-4142E, December 2010, http://www.ferc.gov/industries/electric/indus-act/reliability/frequencyresponsemetrics-report.pdf.

in frequency until other automatic but slower-responding "secondary" controls come into play. Finally, control room personnel acting within the hour can issue orders to bring other generators on-line to restore frequency to the proper level. Baseload coal-fired and natural gas-fired generating plants, equipped with governors, whose spinning generators have sizable inertial power, were ideal for the answering the need for primary response. This reserve capability, called "head room," is shrinking as plants operate at peak efficiency or to produce a set output. Compounding the situation is the fact that generators may be paid for slower-responding frequency support, but not for the instantaneous response to stop a sudden frequency deviation.

The California ISO is concerned that as intermittent resources displace conventional generation, the system may have insufficient inertia to maintain system frequency or enough governor response to stabilize system frequency following a grid disturbance. The ability to automatically reduce energy output in response to frequency deviations may become an increasingly important attribute as the percentage of variable resources in the supply portfolio increases over time. [222] The Texas system has already had to confront inertia issues and found that "inertia of the grid helps limit the rate of change of frequency to allow conventional synchronous generators time to deliver Primary Frequency Response and stabilize grid frequency."[223]

Wind turbines and solar PV provide little to no inertia, so when the frequency rises or falls, they do not smooth out their departures from the frequency balance, which needs to be maintained at all times. Wind does offer a quick capability of moving down and can respond quickly to add energy if there is head room and could be very influential in the one- to two second period.[224] For example, wind turbines with pitch control, which allows their output to be curtailed in real-time by adjusting the turbine blade pitch, can contribute to primary frequency regulation. Type 3 and 4 wind turbines have a wider speed range and finer control of active power production, more closely resembling conventional synchronous generators able to provide fast voltage control. These types are the majority of wind turbines built since 2006.[225] Other technologies, such as flywheels and battery storage, can also add to the mix of stabilizing technologies.

Complementary Technologies: Demand Response, Storage, and Gas-Fired Units

Three types of infrastructure are being studied to support high levels of renewable integration – demand-response, energy storage, and gas-fired units. Each has integration values and costs in terms of effectiveness, commercial availability, relative cost, locational attributes, and environmental consequences. Some, like demand response, can also provide bill-reducing

222 California ISO. Renewables Integration Market Vision & Roadmap, Day-of-Market. Initial Straw Proposal. July 6, 2011

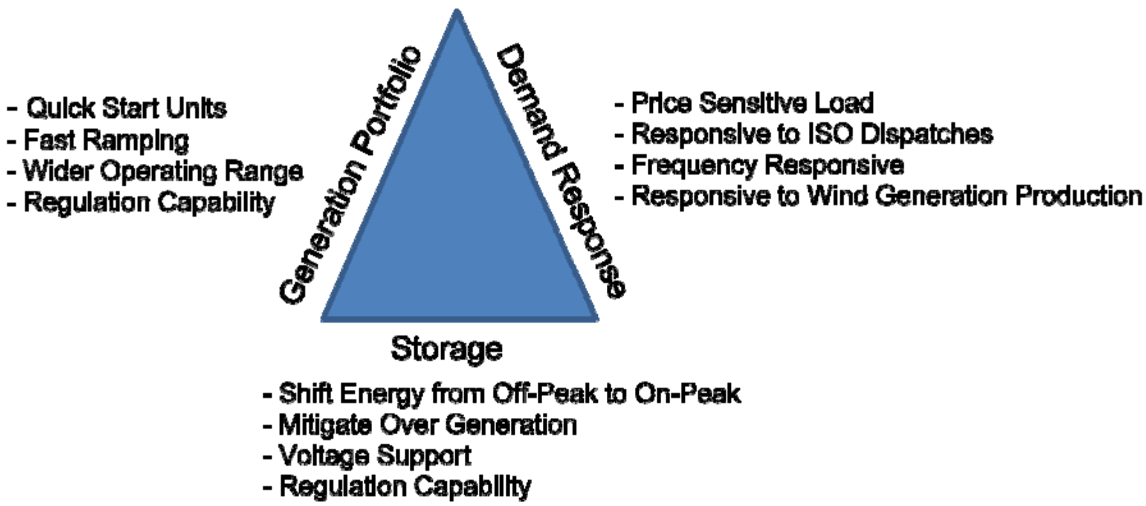
223 ERCOT, Emerging Technologies Integration Plan, draft October 22, 2010, page 43.

224 North American Electric Reliability Council, *Accommodating High Levels of Variable Generation*, April 2009, http://www.aeso.ca/downloads/IVGTF_Report_041609(1).pdf , pp.16-23.

225 California Independent System Operator, *Integration of Renewable Resources*. November 2007, http://www.caiso.com/1ca5/1ca5a7a026270.pdf, p. 29.

benefits to individual customers, while others, like gas-fired turbines, are also a source of energy and capacity. The California ISO calls these three resources "Partners for Success" in renewable integration. Figure 16 shows the different roles these complementary resources can play in integrating renewable resources.

Figure 16: Complementary Strategies for Integrating Renewable Generation



Source: California Energy Commission, modified from a California ISO depiction

The challenges and opportunities for renewable integration associated with energy storage, demand response, and natural gas-fired resources are discussed below.

Energy Storage

Energy storage for integration of renewables could provide flexible and controllable ancillary services at the transmission level and neutralize the impact of intermittent and volatile renewable generators at the source in a variety of ways.[226] Through voltage support, it could reduce flicker and meet voltage standards.[227] It could also automatically inject energy to provide frequency response. In addition, it could provide grid stability by supplying immediate energy to stop grid oscillations and improve grid damping. It may even be able to provide a service similar to inertia through smart inverters.[228] To the extent energy storage options are available

226 Please see Chapter 9 for a complete description of various energy storage technologies as well as current research efforts on energy storage.

227 Power-line flicker is a visible change in brightness of a lamp due to rapid fluctuations in the voltage of the power supply. Flicker is generated by load changes. Only the amplitude of the load change is relevant, not the absolute value. A reduction in flicker can be attained through making less frequent load changes, or smaller load changes. If the load is changed gradually (for example, by the help of power electronics instead of step fashion, this also makes flicker less perceptible.

228 David Hawkins, KEMA, Energy Storage Applications and Economics, presentation at the IEPR Committee Workshop, April 28, 2011, page 7.

and can competitively participate in providing ancillary services, they can also provide additional benefits not commonly available through conventional, fossil-fuel generated ancillary services. These include supplying ancillary services without greenhouse gas (GHG) emissions and offering a place for excess energy to go when on-line generation exceeds load.

To manage frequent and wide variations in solar and wind energy output, storage must offer rapid response and operational flexibility to provide regulation and load following capabilities. For better integration at transmission level, the different ramp rates (MW power delivered per minute) become an important consideration. Their economic value depends on their ability to deliver on these characteristics. Table 15 shows the relative ramp rates of various storage technologies.

Table 15: Ramp Rates of Different Generation & Storage Technologies

Types of Technology	Ramp Rates (MW/Minute)
Conventional Steam Generation	3 - 10
Conventional Peaker	10
Conventional Combined Cycle	12 - 15
Next Generation Fast Ramp Combined Cycle[229]	30
Next Generation Fast Ramp Peaker	30
Pumped Storage	40
Compressed Air Energy Storage (CAES)	90
Battery Technology	Depends on size and technology

Source: Roy Kuga presentation at Integrated Energy Planning Annual Meeting, September 24, 2010

While many forms of energy storage have been installed, pumped hydro systems are by far the most widely used, with more than 127,000 megawatts (MW) installed worldwide. Compressed air energy storage (CAES) installations are the next largest (444 MW), followed by sodium-sulfur batteries (316 MW). All remaining energy storage resources worldwide total less than 85 MW combined, and consist mostly of a few one-off installations. Underground CAES and pumped hydro are found to be the lowest cost in terms of $/kWh (total cost divided by hours of storage duration), but face constraints of identifying developable sites, environmental permitting, and availability near transmission assets. [230] Table 16 provides a summary of various storage technologies and their attributes for grid stability compiled by the Electric Power Research Institute. Pilot studies and other potential applications being tested are discussed in more detail in the storage section of Chapter 9.

229 General Electric's press release on its web site on May 25, 2011 on new Flex-Efficiency Combined Cycle claims a ramp rate of 50 MW/minute.

230 For more details on costs of different storage technologies, see EPRI, *Electricity Energy Storage Technology Options, A White Paper on Applications, Costs, and Benefits*. Technical Update, December 2010, http://www.smartgridlegalnews.com/epri_report.pdf.

Table 16: Electricity Energy Storage Technology Options

Technology Option	Maturity	Capacity (MWh)	Power (MW)	Duration (hrs)	% Efficiency (total cycles)	Total Cost ($/kW)	Cost ($/kW-h)
Bulk Energy Storage to Support System and Renewable Integration							
Pumped Hydro	Mature	1680-5300	280-530	6-10	80-82 (>13,000)	2500-4300	420-430
		5400-14,000	900-1400	6-10		1500-2700	250-270
CT-CAES (underground)	Demo	1440-3600	180	8	(>13,000)	960	120
				20		1150	60
CAES (underground)	Commercial	1080	135	8	(>13,000)	1000	125
		2700		20		1250	60
Sodium-Sulfur	Commercial	300	50	6	75 (4500)	3100-3300	520-550
Advanced Lead-Acid	Commercial	200	50	4	85-90 (2200)	1700-1900	425-475
	Commercial	250	20-50	5	85-90 (4500)	4600-4900	920-980
	Demo	400	100	4	85-90 (4500)	2700	675
Vanadium Redox	Demo	250	50	5	65-75 (>10,000)	3100-3700	620-740
Zn/Br Redox	Demo	250	50	5	60 (>10,000)	1450-1750	290-350
Fe/Cr Redox	R&D	250	50	5	75 (>10,000)	1800-1900	360-380
Zn/air Redox	R&D	250	50	5	75 (>10,000)	1440-1700	290-340
Energy Storage for ISO Fast Frequency Regulation and Renewable Integration							
Flywheel	Demo	5	20	0.25	85-87 (>100,000)	1950-2200	7800-8800
Li-ion	Demo	0.25-25	1-100	0.25-1	87-92 (>100,000)	1085-1550	4340-6200
Advanced Lead-Acid	Demo	0.25-50	1-100	0.25-1	75-90 (>100,000)	950-1590	2770-3800
Energy Storage for Utility T&D Grid Support Applications							
CAES (underground)	Demo	250	50	5	(>10,000)	1950-2150	390-430
Advanced Lead-Acid	Demo	3.2-48	1-12	3.2-4	75-90 (4500)	2000-4600	625-1150

Source: Electric Power Research Institute

Formal planning for adding cost-effective storage to California's electricity system has been set in motion by Assembly Bill 2514 (Skinner, Chapter 469, Statutes of 2010) which directed the CPUC and the publicly owned utilities to evaluate the need for and benefits of cost-effective and viable energy storage systems, and determine appropriate targets by October 2013. The first target is to be achieved by December 2015 and a second target, if appropriate, by December

2020. The CPUC opened its proceeding in December 2010.[231] The first phase of the proceeding will develop overall policies and guidelines for energy storage systems, including where and how storage could be deployed to provide maximum benefits to the electric system. Costs and benefits for energy storage systems and cost allocation will be developed in a second phase. [232]

The findings of the proceedings will also provide insights about the size and scope of energy storage on the California grid that would directly or indirectly help renewable integration. Assessments by both the CPUC and the publicly owned utilities will draw heavily on the results of pilot projects being constructed in California for all types of storage. To support this AB 2514 process, PIER is sponsoring an multi-agency Energy Storage Vision Project to conduct a technical status review of various technologies and produce 10-year scenarios highlighting the value of energy storage to meet state goals.[233] A white paper is expected later this year.

The energy storage section in Chapter 9 discusses in more detail the different types of storage technologies, and their current status, including pumped hydro, CAES, batteries, flywheels and thermal energy storage. Opportunities for R&D on storage are also addressed in Chapter 9. The PIER program is currently funding demonstrations of several storage technologies and systems including sodium-sulfur Battery Energy Storage Systems (BESS), a lithium-ion battery system and smart inverter, grid-connected zinc-based flow battery system, a new class of advanced lithium ion rechargeable batteries, zinc bromine flow battery systems, utility-scale flywheel, and advanced, "second generation" CAES design system.

There is also a strong connection between energy storage and the smart grid because these technologies can help integrate intermittent renewables, provide ancillary services, manage peak demand, and relieve transmission and distribution congestion. Smart grid research is addressed in the integration section of Chapter 9.

Demand Response

Demand response (DR) refers to "changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized."[234] DR benefits reliability by reducing customer demand for power, which in turn can alleviate strain on supply-side and transmission

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231 California Public Utilities Commission, R.10-12-007, *Order Instituting Rulemaking Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems*, December 16, 2010, http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/128658.htm.

232 California Public Utilities Commission. R.10-12-007. Scoping Memo and ruling of Assigned Commissioner and Administrative Law Judge. May 31, 2011. http://docs.cpuc.ca.gov/efile/RULC/136248.pdf.

233 2020 Energy Storage Vision for California. Slide presentation by Ethan Elkind and Byron Washom, 2011 IEPR Committee Workshop on Energy Storage for Renewable Integration, April 28, 2011. http://www.energy.ca.gov/2011_energypolicy/documents/2011-04-28_workshop/presentations/02_UCB_UCSD_2020_Energy_Storage_Vision_for_CA.pdf.

234 http://www.ferc.gov/industries/electric/indus-act/demand-response/dem-res-adv-metering.asp.

resources. Demand response can play an important role in providing short-term load reductions, allowing system operators to determine if dispatching thermal resources is warranted.

The Energy Commission was given the authority to develop load management standards in 1976 in three suggested areas: rate structure adjustments (with final authorization by the CPUC), end-use storage systems (thermal, pumped), and mechanical or automatic control devices.[235] California utilities have used reliability-based DR programs like air conditioning cycling and industrial process curtailments since the 1980s. A resurgence of interest in demand-side reliability services was seen during the energy crisis of 2001 and the heat storm of 2006. The most basic DR programs are structured to maintain system reliability and prevent blackouts, but in recent years DR has evolved into a more dynamic resource that can also provide price mitigation and ancillary services to utilities and grid operators. While research is still needed to better understand the role of DR in renewable integration, much of the infrastructure and many market products exist to provide demand-side ancillary services in the current market.

Reliability-based DR needs to be available more hours throughout the year and provide a wider range of load response. In addition to hot summer day load reductions (downward regulation), load increases may be needed (upward regulation). DR must be able to respond in different time frames: slow (day ahead), fast (10 minutes), and instantaneous (less than 5 minutes). A portfolio of DR approaches is best to mitigate the combined variability of wind and solar generation. [236]

DR potential role for integrating renewables comes from its ability to aggregate smaller loads to provide regulation or ramping through automatic controls that turn individual loads up or down as the need occasions.[237] Economic or price response programs involve a voluntary response to a price signal. In these programs, DR can be scheduled and dispatched by a utility or system operator when a price reaches a level at which a DR resource is willing to respond. Emergency or reliability programs differ in that the response is not voluntary and a capacity payment for being available is generally involved. Many of these programs are sufficiently dispatchable to be called upon as needed with 10 minutes or day-ahead notification.

In November 2006, the CPUC called for the expansion and augmentation of the investor-owned utilities' demand response programs.[238] Since that decision, utilities have increased their reliability and price-responsive DR programs and have created a utility portfolio projected to be

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235 California Energy Commission, *2007 Integrated Energy Policy Report,* December 2007, http://www.energy.ca.gov/2007_energypolicy/index.html, p. 97.

236 Kiliccote, Sila et al. *Integrating Renewable Resources in California and the Role of Automated Demand Response*. Lawrence Berkeley National Laboratory. LBNL-4189E. November 2010. Pages 20-26.

237 ENERNOC White Paper, *Demand Response: A Multi-Purpose Resource for Utilities and Grid Operators*, 2009, http://www.enernoc.com/resources/files/whitepaper-dr-a-multi-purpose-resource.pdf.

238 California Public Utilities Commission, *Order Adopting Changes to 2007 Utility Demand Response Programs*, D.06-11-049, November 30, 2006, http://docs.cpuc.ca.gov/published/FINAL_DECISION/62281.htm.

3,000 MWs in the summer of 2011.[239] The characteristics of many of these utility programs show potential to provide supporting energy and capacity services in markets with increasing penetration of intermittent renewable generation.

Utility demand response programs may also be adapted to provide integration services. The Demand Response Measurement and Evaluation Committee composed of members from the CPUC, the Energy Commission, and California IOUs is developing a Request For Proposal to provide an assessment of utility DR programs and their potential to provide renewable integration services.

In certain markets, DR is eligible to provide ancillary services, including spinning reserves and regulation services. Customers who can provide near instantaneous response to dispatch signals without significant impact on business operations are effective ancillary resources. The duration is typically 10-60 minutes.

There are several barriers to integrating DR into open markets. While many DR products are capable of providing fast response times, they often are limited in the length of time they can provide load reductions. Similarly, DR products may not fulfill the current continuous energy requirement for spin, non-spin, and regulation products. While DR services can come on-line in a short time and easily last for minutes or a few hours, longer-term responses of 4-6 hours are more difficult to provide.

Other ISOs in the U.S. have modified their tariff structures to allow load resources to participate in their markets. PJM, a regional transmission organization that coordinates the movement of wholesale electricity in 13 eastern states and the District of Columbia, allows load resources to provide forward capacity, synchronized reserve, and regulation. PJM uses demand response products for regulation and spinning reserve. Demand resources can bid into the Synchronized Reserve Market alongside generation to provide operating reserves resources. End users curtail within 10 minutes for approximately 15 minute periods.

The increasing penetration of wind resources in Texas helped spur innovation in ERCOT's energy management processes. In December of 2010, ERCOT moved from a zonal to nodal market structure.[240] The design of ERCOT's new nodal market includes provisions for load participation in ancillary service markets. ERCOT has developed market rules allowing load resource participation as regulation, responsive reserve, non-spinning reserve and curtailment resources. Demand resources, known as Load Acting as a Resource, can provide Responsive Reserve Service. Resources are required to reduce automatically through an under frequency relay when grid frequency falls below a certain level and within 10 minutes.

The California ISO currently offers two demand response products – the Participating Load Product and the Proxy Demand Resource. The Participating Load Product is dispatched directly by the California ISO and can provide non-spinning reserve or curtailable load in the real-time

239 http://www.narucmeetings.org/Presentations/Demand_CPUC.pdf.

240 ERCOT, Texas Nodal Market Implementation, http://nodal.ercot.com/.

market, while the Proxy Demand Resource submits bids into the day-ahead or real-time markets at the discretion of the customer or aggregation company.[241] Both of these products are laying the foundation for the role of DR in renewable integration efforts.

Peaking alternative programs are another type of DR program. These share many of the characteristics of emergency programs, but are dispatched more frequently. Participation is not voluntary (capacity obligations are guaranteed) and both energy and capacity payments made. The value of these programs is their high flexibility to be dispatched in periods of high prices, system need, and/or during shoulder periods.

A comparison table of more than 50 North American DR programs is published by the ISO/RTO Council.[242] The document contains summary information on programs, products and services with a high-level overview of more in-depth rules and procedures.

There are a number of challenges to the use of DR in addressing renewable integration issues including the need for additional R&D. These are discussed in greater detail in the demand response section of Chapter 9. Areas of past R&D on DR include projects to demonstrate using demand response as spinning, non-spinning reserve product and regulation services, and communication and automation infrastructure for integrating renewables. R&D underway includes projects to evaluate how much energy storage and automated demand response is needed to support integrating high levels of renewables, speed of response of several potential DR loads for ancillary services, and integrating larger quantities of automated DR onto the grid using the OpenADR protocol.

Gas-fired Generation – Existing, Retiring, and New

With the construction of new, more efficient gas-fired units and the retirement of older ones over the last several years, natural gas generation currently comprises more than half of the in-state energy production and today produces the same level of energy while using 17-23 percent less natural gas than it did just a decade ago.[243] California's fleet of natural gas generators include gas-fired combined cycles, steam boilers, peaking plants, and turbines that can provide some of the operational characteristics which can be used to integrate variable renewable resources.

Dispatchable, flexible gas-fired turbines have the operational characteristics to integrate renewables. Regulation services can be provided by gas-fired resources under AGC, which tend to be newer combined cycles that are expected to be on-line a significant number of hours of

241 http://www.caiso.com/271e/271ee8df2c760.pdf.

242 *North American Wholesale Electricity Demand Response Program Comparison*. 2010 Edition. http://www.isorto.org/atf/cf/%7B5b4e85c6-7eac-40a0-8dc3-003829518ebd%7D/IRC%20DR%20M&V%20STANDARDS%20IMPLEMENTATION%20COMPARISON%20(2009-05-18).PDF

243 California Energy Commission, *Thermal Efficiency of Gas-Fired Generation in California*, staff paper, August 2011, http://www.energy.ca.gov/2011publications/CEC-200-2011-008/CEC-200-2011-008.pdf.

during the year. Aging steam turbines, such as those expected to retire or be retrofit or repowered due to the State Water Resources Control Board (SWRCB) policy on once-through cooling (OTC), also provide regulation services during periods when they are on-line, if they are equipped with AGC. Peaking facilities, whose operation is limited to far fewer hours, do not provide regulation as a rule as it is not economic to fit them for AGC given their limited hours of operation.

This same set of gas-fired resources can provide spinning reserve during those hours when they are on-line and operating at less than full load. Aging steam turbines currently provide substantial amounts of spinning reserve. They are able to ramp down to very low operating levels but need to be kept on-line if they are to be made available later in the day or for the next day given their slow start-up. Their unloaded upper blocks, or the "idle share" of these units, can be a substantial source of potential output at a few minutes' notice. Peaking facilities also provide spinning reserve to the extent that they can meet California ISO requirements for providing energy on short notice.

Non-spinning reserves are provided by both newer combined cycles and peakers, although the former are generally only able to provide non-spin under warm start conditions, meaning that the generation stopped within a matter of hours earlier. Because of their slow-start nature, aging steam turbines are not relied upon for non-spinning services. If on-line at less than full load, these resources provide spinning reserves but, if off-line, cannot ramp up quickly enough to meet the requirements for non-spinning reserve delivery.

New gas-fired resources are expected to provide different ancillary services and different amounts of ancillary services depending upon the speed at which they ramp up and operate over wide ranges of output. Faster-starting combined cycles capable of operating at well below full load will be increasingly able to participate in the non-spinning reserve market since they can come on-line and meet their non-spinning reserve obligation within 10 minutes, more quickly provide larger amounts of spinning reserves within a 10 minute period, or provide load-following due to their ability to operate at a lower load levels.

One of the challenges going forward is the need to modify revenue streams for natural gas units that provide integration services to cover the incremental costs of shifting the use of these units from maximizing efficient energy production to providing flexible products more for operating reserves or regulation. The California ISO's market tariffs will be a major avenue for these changes, as will be the contracts offered by utilities and energy service providers.[244] Market activities are discussed in a later section.

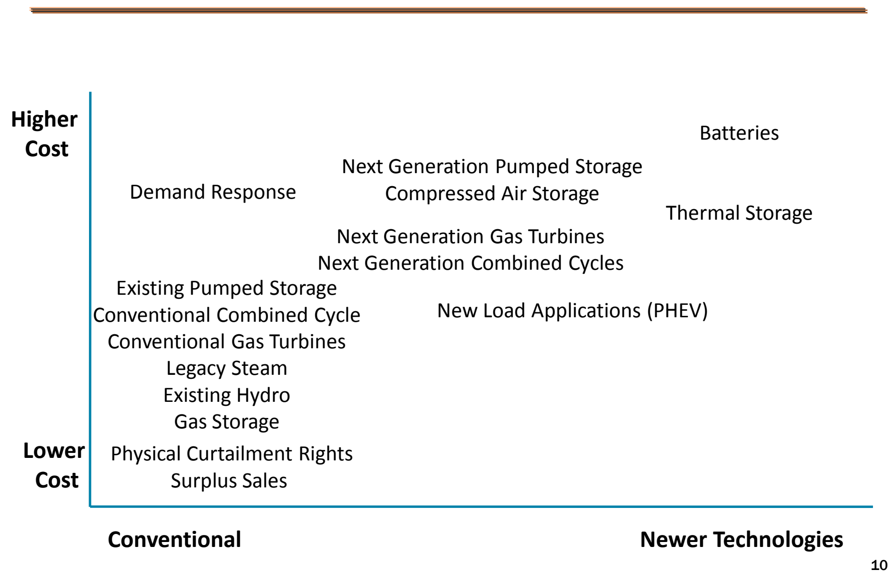
The three complementary services of energy storage, demand response and existing fossil generation offer a wide spectrum of choices for rapid response, operationally flexible resources useful for renewable integration. Two key dimensions, costs and technology deployment, are

244 Much of this section is summarized from *Framework for Evaluating Greenhouse Gas implications of Natural Gas-Fired Power Plants in California*, CEC-700-2009-009-F, December, 2009, pages 91-96.

summarized in Figure 17. These aspects of the various technologies are further discussed in Chapter 9.

Additional research is needed on the roles that these and other technologies can provide to address the need for system inertia so that the modern grid can continue to be supported properly. PIER research is investigating inertia and ways to increase the flexibility of the current generation fleet.[245]

Figure 17: Cost and Technology Deployment for Energy Storage, Demand Response, and Fossil Generation



Environmental Impacts

Another challenge may be the potential for environmental impacts from integrating renewables depending on what supply and market strategies are selected. Integration services may be obtained with minimal incremental environmental impacts if they can be provided by better use of existing infrastructure. However, recent California ISO studies indicate that integration issues will limit the air quality and environmental benefits of renewable resources. At some point additional physical infrastructure will be needed. That could include additional demand response, energy storage, or flexible gas-fired units. In addition, if existing units need to be cycled more frequently, there may be trade-offs between decreased energy production and

245 See for example, California Energy Commission. *Renewable Resource Integration Project – Scoping Study of Strategic Transmission Operations, and Reliability Issues.* PIER Final Project Report. December 2008. CEC 500-2008-081. http://www.energy.ca.gov/2008publications/CEC-500-2008-081/CEC-500-2008-081.PDF.

increased production of ancillary services which may increase or decrease local air pollution impacts.

The California ISO is considering market changes that would overcome some of the incentives that renewable resources have for continuing to produce in overgeneration situations. This occurs when there is more generation and imports than load and exports can use. It is typically caused by load and resource forecast errors, more imports scheduled than load, and high hydro conditions, load conditions (that is, nights or weekends) and high wind/solar generation. Without such changes, power is sold at a loss or resources are told to start backing off or shutting down to balance the system. If it is not fossil generation that is backed out, fuel use is not reduced and environmental benefits of the renewable generation are lost. Devices that can consume more, such as storage, and being compensated for storing that energy, may be one way to manage over generation situations. [246]

In general, if a new gas-fired power plant provides renewable integration services more efficiently than the existing fleet, then the new plant could provide a net reduction of greenhouse gases directly emitted in electricity generation.[247] Adding non-fossil fuel resources, such as demand response or storage, to help support intermittent renewable generation could reduce emissions further.

The question is complicated because integration services are not added in a vacuum; systems may also need units for local reliability purposes or system support. Additional study in this area, such as the Joint Energy Agencies studies being conducted as part of the SWRCB's implementation of OTC rules related to gas-fired generation, will help to clarify the role of new, replaced or repowered OTC gas-fired generation, which in turn will help with assessing their potential environmental impacts. An additional environmental question that will need to be addressed is the environmental impacts of different placement of integration services, whether close to generation or load or in an intermediate location.

Environmental impacts may also extend to the indirect impacts caused by the production and disposal of new equipment types. For example, pumped storage, flywheels, and lithium batteries have differing environmental footprints. Pumped hydropower storage facilities can

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246 Comments by Mark Rothleder and Chairman Robert Weisenmiller, IEPR Committee Workshop on Energy Storage for Renewable Integration, April 28, 2011. Pages 56-58.

247 "Although a single natural gas-fired power plant produces GHG emissions, under certain circumstances the addition of a gas-fired plant may yield a GHG emission benefit. The authors conclude that this would be the case if the plant provided support to integrate renewable energy under a 33 percent RPS, if the addition raised the overall efficiency of the electric system, or if the new plant served load growth more efficiently than the existing fleet." McClary, Steven C., Heather L. Mehta, Robert B. Weisenmiller, Mark E. Fulmer and Briana S. Kobor (MRW & Associates). 2009. *Framework for Evaluating Greenhouse Gas Implications of Natural Gas-Fired Power Plants in California*. California Energy Commission. CEC-700- 2009-009. http://www.energy.ca.gov/2009publications/CEC-700-2009-009/CEC-700-2009-009-F.PDF. Page 8.

have mixed environmental impact depending on the location, size, and design of the reservoirs.[248]

Current Efforts to Address Integration Challenges

California Independent System Operator

Forecasting Improvements

As California moves toward modernizing its electric grid into a "smart grid, several technological advances will enable system operators to monitor every important element of the grid and transmission network with much more accuracy. Existing technologies, such as synchrophasors, have the ability to monitor grid conditions at sub-second intervals. Deployment of this technology is accelerating under Department of Energy initiatives and a project conducted by the Western Electricity Coordinating Council. Expected benefits from smart grid technology to integration of variable resources include the ability to recognize grid problems sooner, make customers more active participants in reacting to grid conditions, and leveraging demand response, storage, and distributed energy resources to address variable energy challenges.[249] Chapter 6 discusses smart grid potential in more detail.

The California ISO has already taken steps to improve its forecasting techniques to reduce uncertainty in its integration-related forecasting by:

- Shortening the length of time in advance of real time that load and generation forecasts need to be made from two hours ahead to 75 minutes to allow operators to more effectively deal with potential under- or overgeneration issues.
- Basing solar profiles on new National Oceanic and Atmospheric Administration satellite irradiation data rather than the previous less accurate NREL land-based solar measurements. This will become increasingly important as large solar PV interconnects to the bulk power grid. Currently California ISO operators deal with only about 100 MW of solar PV and 400 MW of solar thermal, which is much lower than future levels of solar PV and solar thermal generation.
- Evaluating a regulation prediction tool developed by the Pacific Northwest National Laboratory with PIER support to estimate the upward and downward regulation requirements in terms of capacity, ramp rate, and ramp duration for each operating hour of the day.

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248 For example, the Lake Elsinore Advanced Pumped Storage project encountered significant public opposition due to expected environmental impacts and related concerns. FERC dismissed its application on July 12k 2011. See http://lakeelsinore-wildomar.patch.com/articles/feds-question-viability-of-leaps-project. See also, http://www.evmwd.com/depts/admin/public_affairs/leaps/about_leaps.asp.

249 California Independent System Operator, *Smart Grid Roadmap and Architecture*, December 2010, http://www.caiso.com/2860/2860b3d3db00.pdf.

- Evaluating a ramp/load following prediction tool developed by the Pacific Northwest National Laboratory with PIER support. A ramp capacity operational forecasting tool is being developed to predict, in the three-to-five hour ahead period, load following capacity and ramping requirements affected by uncertainties in forecasts of loads and renewable generation. [250]

Addressing the geographic diversity of renewable resources in operational forecasting is an area of increased attention. One of the first comprehensive studies to address the issue of geographical diversity of wind plants was done at Lawrence Berkeley National Laboratory for the Energy Commission in 1978, by Edward Kahn, using California wind and utility data.[251] Kahn found that reliability does increase as a function of geographic dispersal, but this increase is limited by the geographic wind diversity and the barrier of large wind plant penetrations relative to the conventional generator mix.

Many of the early studies lack high-quality data from multiple sites. More recent studies of wind have demonstrated the significant smoothing effect of geographic diversity. These studies are documented in work by Andrew Mills and Ryan Wiser from LBNL, who also worked with the California ISO on improvements in forecasting methodology through geographic modeling of solar PV plants. [252] Solar has been less studied than wind, but the authors find indications in the previous research that with "enough" geographic diversity, the sub-hourly variability due to passing clouds is smoothed. Available land or rooftops or transmission capacity could lead to sufficient geographic dispersion. On the other hand, getting sufficient geographic dispersion could lead to more transmission losses from distant sites or plants sited in lower quality areas. These are complex trade-offs, deserving further study by the Energy Commission and others. Benefits of increasing the distance within individual plants, between plants in one area, and between plants in the same balancing authority need to be studied, including cost comparisons.

Additional study results show that, at individual sites, PV production is more variable than wind for sub-hourly time scales, but that the distances between sites required to obtain diversity and therefore smooth the output for sub-hourly variability are slightly less than for wind. While the study results indicate geographic diversity has some beneficial potential for smoothing variable output, questions remain for productive research.[253] An earlier section of

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250 Incorporating Wind Generation and Load Forecast Uncertainties into Power Grid Operations. Wind Energy Management System EMS Integration Project. Pacific Northwest National Laboratory. PNNL-19189. January 2010. Also John W. Zack, "Wind Forecasting Efforts to Improve Renewable Penetration," Presentation at IEPR Workshop, July 31, 2008.

251 Kahn, Edward. *Reliability Planning in Distributed Electric Energy Systems.* Lawrence Berkeley Laboratory, University of California. Prepared for the Systems Integration Office, California Energy Resources Conservation and Development Commission. LBL-7787. October 1978.

252 Mills, Andrew and Ryan Wiser. *Implications of Wide-Area Geographic Diversity for Short-Term Variability of Solar Power. Lawrence Berkeley National Laboratory*. LBNL-3884E. September 2010.

253 Thomas Hoff and Richard Perez of Clean Power Research are conducting similar geographic diversity analysis for solar PV as part of the CPUC's Long-Term Procurement Proceedings. Their results validate the LBNL study.

this chapter addressed PIER research to deal with forecasting under increasing variability, which is also discussed in greater detail in the transmission research section of Chapter 9 on R&D. Patterns of geographic diversity for renewable generation build-out may carry the similar environmental justice concerns associated with more conventional resources. See Chapter 10 for more on this cross-cutting issue.

Market and Product Changes

In concert with FERC's leadership on this issue, the California ISO has embarked on a several-year market and product review for renewable integration. Sound market design can address operational issues by aligning technical requirements and market incentives. This is important in systems such as the California ISO in which market rules are used instead of vertical integration to coordinate efficient performance of the electricity system.

In 2010, the California ISO began a stakeholder process[254] to restructure its wholesale market design, including new market products and market rules. Rules such as the Participating Intermittent Resource Program (PIRP) were originally designed in 2002 without recognition of the California ISO's need to economically dispatch variable resources in a real-time market. Changes are needed to improve non-discriminatory access; allow more non-traditional resources to compete in the energy, capacity and ancillary services markets; and assign costs fairly among competitors. It is also addressing how revenues for conventional generators will change as they switch roles from providing primary sources of energy to providing more load-following and grid supportive functions for integrating renewables.

In the energy market, California ISO has identified the following market reforms as having potential to help with renewable integration:

- Increase operational flexibility by reducing generation self-scheduling.
- Economic dispatch of variable energy resources.
- Changes to the energy bid floor to encourage ramping down.
- Day-ahead scheduling of renewables and exploration of allowing intra-hour scheduling.
- Dynamic transfers with neighboring balancing authorities.

The California ISO is scheduled to implement a regulation energy market in spring of 2012 that will allow demand response and energy storage to submit bids to provide ancillary services. It is working on allocating renewable integration costs, and has developed a starter list of issues for the next phase of design reform, such as dealing with the impact of adding renewables to the wholesale energy market.[255] Operational conditions that require curtailment of renewable

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254 Renewable Integration — Market and Product Review. http://www.caiso.com/27be/27beb7931d800.html. Phase I identifies short-term solutions while Phase 2 considers mid- and longer-term solutions.

255 California Independent System Operator, *Issue Paper: Renewable Integration Market and Product Review Phase 1*, September 30, 2010 , and Mark Rothleder, Energy Storage for Renewable Integration, presentation for IEPR Committee Workshop on April 28, 2011, slide 9.

energy are expected to increase in magnitude and frequency, particularly overgeneration in spring high hydro, light load conditions, but possibly other times as well. The current self-scheduling rules of the PIRP do not favor economic dispatch that can accurately determine the most efficient amount of each resource to resolve overgeneration conditions. The overarching goal is to minimize reliance on administrative measures to participate in the markets and to provide the correct incentives for economic bids.[256]

Moving toward more intra-hour scheduling on interties among the various balancing authorities could significantly aid in integrating variable renewables. Extending dynamic transfer of renewable resources on the interties (across balancing area authorities) raises issues not encountered with conventional resources. Significant growth in renewables could mean bringing intermittent power into the control and responsibility of the California ISO through dynamic transfer agreements. The California ISO is engaged in a pilot project with Bonneville Power Authority (BPA) to increase scheduling frequency and is continuing discussions with other balancing authorities to develop a dynamic transfer policy. Lessons from various pilots will feed into rules on how to import and export variable resources without losing grid efficiency and reliability.

In July 2011, the California ISO released a vision to accommodate more variable energy resources and other emerging technologies into the grid through a "day-of market" concept. Large, fast ramps that are difficult to forecast are a particular concern. The effort's goal is to develop a roadmap to translate the operational challenges into market changes. The California ISO expects to need increased amounts of load following capacity to cover for forecast uncertainty related to wind and solar output variability, and increased amounts of ramping capacity fast enough and often enough to match variable energy resources' production patterns. Market changes will also need to consider increased starting and stopping of flexible, gas-fired generators causing more wear and decreasing market revenues. The ability to automatically reduce energy output to maintain system frequency levels and provide active power control over variable energy resources as a grid protection strategy is desired.

The California ISO vision presents two alternative options for modifying real-time dispatch for consideration. Option A changes the Real time Economic Dispatch and pricing interval from today's 5 minutes to 15 minutes, while Option B keeps the 5-minute dispatch and pricing interval the same. Both options add a new ancillary service, Real Time Imbalance Service, which would provide resources that can be dispatched on a minute-by-minute basis (between the full economic dispatch runs), allowing focus on ramping capabilities within the minute.[257] This service also incentivizes resources that can ramp most quickly separately from slower resources.

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256 California Independent System Operator, Third Revised Straw Proposal, Renewable Integration: Market and Product Review, Phase I, July 12, 2011, http://www.caiso.com/27be/27beb7931d800.html.

257 California Independent System Operator, Renewables Integration Market Vision & Roadmap, Day-of Market, Initial Straw Proposal. July 6, 2011. http://www.caiso.com/2bb3/2bb3e594394f0.pdf.

Market rules will also be important in ensuring that storage technologies can effectively provide integration services. The ability of a storage technology to provide ancillary services, such as frequency regulation and load balancing, is not enough to support deployment of such technologies. The market rules under which such services are procured by the balancing authorities need to be changed to recognize the additional system benefits provided by the newer energy storage technologies compared to the traditional generating sources.

New market rules and standards will be important to ensure DR, storage, and distributed energy resources are able to participate fully in the California ISO market as generating resources that provide integration services. Other ISOs have taken initiatives to consider the time limitation of energy storage and DR while recognizing that such assets have other benefits (for example, high ramping capabilities) that might compensate for the relatively shorter duration of their availability. The California ISO outlines a vision for including roles for these new and emerging advanced storage and DR technologies in its *Smart Grid Roadmap and Architecture* document.[258] The real-time interface of building automation systems and home area networks with prices and grid conditions could mean devices that respond to grid stress are able to shift or curtail use even before the system event actually occurs. Pilots and research efforts for devices to directly react to grid condition indicators are expected to begin in later this year. The California ISO also actively participates in wholesale standards development at the national level and DR policies being considered at the Energy Commission and smart grid proceedings at the CPUC.

Federal Energy Regulatory Commission

FERC approves the standards for regulation services and the rules by which the California ISO procures integration services. Several efforts are underway to facilitate new renewables and emerging technologies through its regulatory authority. In November 2010, FERC issued a notice of proposed rulemaking on variable energy resources.[259] According to FERC, among other changes the proposed rule would:

- Provide generators with the option of using 15-minute transmission scheduling intervals so they may adjust their schedules to more accurately reflect power production forecasts.
- Require variable energy resources to submit meteorological and operational data to the transmission providers so the providers can implement power production forecasting tools that will reduce the amount of regulation reserves needed to maintain reliability.

FERC issued an order on March 14, 2011 conditionally accepting proposed revisions to the New York System Operator's market rules and tariffs to permit more frequent, intra-hour transaction scheduling at its borders, consistent with other balancing authorities in the region.

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258 California Independent System Operator, *Smart Grid Roadmap and Architecture*, December 2010. http://www.caiso.com/Documents/SmartGridRoadmapandArchitecture.pdf, pp.11-13.

259 FERC, November 18, 2010, *Notice of Proposed Rulemaking, Integration of Variable Energy Resources*, http://www.ferc.gov/whats-new/comm-meet/2010/111810/E-1.pdf.

Some stakeholders in California and the WECC urge FERC not impose a unilateral requirement as they are pursuing other options for improving operational and coordination issues to achieve inter-hourly scheduling across interties. Examples of these efforts are the joint California ISO/Bonneville Power Administration pilot study on 30-minute intra-hour scheduling between the two balancing authorities. Standard intra-hour scheduling practices are the objective of another west-wide initiative being undertaken by WECC. The California ISO may require flexible implementation of intra-hour scheduling given the benefits of its 5-minute energy redispatch practices regardless of intra-scheduling on the interties. [260]

Other initiatives by FERC related to integration of renewable energy include a February 2011 Notice of Proposed Rulemaking on frequency regulation compensation in organized wholesale power markets. This rule would compensate electric storage systems and other new technologies that can provide faster ramping up and down of generation than previously available. [261]

FERC is also undertaking efforts to allow DR to participate in wholesale markets to address integration issues. To address the shorter time-frame that DR products can provide, the California ISO has submitted language to the Federal Energy Regulatory Commission as part of its Non-Generator Resources in Ancillary Services Market Initiative. This language reduces some of these limiting duration and capacity requirements. The revised tariff is complete and implementation is pending. [262] These changes will also benefit storage and other demand-side resources wanting to participate in California ISO markets.

The inclusion of DR as capacity products and ancillary services provides an additional resource that will increase the competitiveness of wholesale energy markets. With this goal in mind, the FERC has issued a Notice of Proposed Rulemaking calling for the compensation of load reductions at the current market price. [263] While DR participation has increased in a number of ISOs in the U.S., this rulemaking will standardize compensation mechanisms and attract addition load participation in ISO markets.

CPUC Long Term Procurement Plan

The CPUC has consolidated its resource planning process into Long term Procurement Plans (LTPP) that integrate policy direction on energy efficiency, combined heat and power, renewables, distributed generation, customer costs, system stability, and utility performance. The 2011 *33 Percent RPS Integration Study*, led by the California ISO and filed at the CPUC on July 1, identifies operational requirements to reliably operate the California grid in 2020 with a

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260 Comments by the California Public Utilities Commission in FERC Docket No. RM10-11-000, March 2, 2011. http://www.westgov.org/wieb/meetings/crepcsprg2011/briefing/comments/ver/capuc.pdf.

261 FERC, February 17, 2011, Notice of Proposed Rulemaking, http://www.ferc.gov/whats-new/comm-meet/2011/021711/E-4.pdf.

262 http://www.caiso.com/2415/24157662689a0.html.

263 http://www.ferc.gov/whats-new/comm-meet/2010/031810/E-1.pdf.

33 percent RPS mandate. [264] The results of this study are only preliminary at this point. The scenarios being examined in the study are summarized in Table 17**.**

The California ISO analyzed the first four scenarios and also scenario 6, the 33 percent trajectory high load, as a bookend. The trajectory high load case assumes 10 percent higher peak load. After running production cost simulation modeling, no system capacity shortfalls were identified in the four CPUC cases with lower load assumptions based on energy efficiency. However, 4,600 MW of incremental upward balancing need (including 2,000 MW of OTC replacement capacity) was observed in the 33 percent trajectory high load scenario, as well as 800 MW of downward balancing shortage. [265]

Table 17: Scenarios Studied in CPUC LTPP

	Scenario	Description
1	33% Trajectory Base Load	Intended to model future similar to current IOU contracting and procurement actions
2	33% Environmentally Constrained	High solar and distributed generation
3	33% Cost Constrained	Resources that are lowest cost
4	33% Time Constrained	Resources that can come on-line quickly
5	20% Trajectory	Intended as comparison
6	33% Trajectory High Load	Reflective of future uncertainties in load growth and/or program performance
7	33% Trajectory Low Load	Reflective of future load uncertainties

Upward violations would occur if enough units could not increase output quickly either because they were already at maximum operating points or could not change output fast enough. There are a few hours of load following down constraint violations, with a maximum violation of about 1,200 MW during the month of December. Availability of flexible generation is limited in the late winter and early spring as units are often out or in maintenance mode while loads are light.

In general terms, this means that the modeled fleet of resources can provide the integration needed in most cases by changing the way it is dispatched. All parties believe that the few hours of downward constraint could be met by a mix of curtailment, increased use of out-of-state ancillary services, DR, and energy storage.[266]

These preliminary findings depend heavily on the input assumptions such as the 2009 load forecast and the 54,269 incremental renewables target used in the study to achieve 33 percent by

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264 See Memorandum from Keith Casey to ISO Board of Governors, August 18, 2011, for a summary. http://www.caiso.com/Documents/110825BriefingonRenewableIntegration-Memo.pdf.

265 Memorandum from Keith Casey to ISO Board of Governors, August 18, 2011. http://www.caiso.com/Documents/110825BriefingonRenewableIntegration-Memo.pdf.

266 Slides 26 and 27, California Independent System Operator Summary of Preliminary Results, May 10, 2011).

2020.[267] On the generation side, the study assumed that gas-fired units that use once-through cooling will be retired by December 2019 and that no new generation in addition to what is identified in the CPUC's technical assumptions would need to be added to meet minimum planning reserve margins. A more complete 10-year view of local capacity needs that incorporates once-through cooling regulations is expected by December 2011.

In addition to the California ISO study's production cost model results regarding costs, the utilities and the consulting firm E3 will develop the additional capital cost component needed by the CPUC in its LTPP proceeding to evaluate the total cost, including integration costs, for each CPUC-defined scenario. Preliminary estimates presented by the joint utilities in April-May 2011 suggest that integration costs in the California ISO balancing area will not vary greatly among the different resource mixes of central station generation, or between central station and localized energy resources.[268] Work to date has addressed production costs of incremental services but not the actual market prices that would need to compensate generators for lost energy revenues or other market impacts of integration.

Publicly Owned Utility Integration Efforts

California's publicly owned utilities are developing integration strategies that allow procurement of renewable generation while maintaining a stable electricity supply. Unlike IOUs, electric service providers, and community choice aggregators, most publicly owned utilities are full service, vertically integrated utilities. However, they still have a combination of utility-owned and contracted resources to meet load. Most participate in the California ISO markets as well as other commercial markets.

Sacramento Municipal Utility District (SMUD) has undertaken a diverse set of strategies to integrate renewable generation. One part of this strategy is procuring baseload geothermal generation including a recent contract with Vulcan Power for 500 gigawatt hours of generation per year that may eventually ramp up to 1,000 gigawatt hours per year. Vulcan Power, however, is now relocated to Reno, Nevada as Gradient Resources. [269] This baseload renewable generation would allow SMUD to increase its renewable portfolio while avoiding many of the challenges involved with integrating intermittent generation. Beyond procuring baseload renewables, SMUD also procures substantial out-of-state wind resources using the California ISO's Participating Intermittent Resource Program (PIRP). PIRP assists SMUD's integration

267 The California Independent System Operator estimate does not include additional incremental energy efficiency for the 2013-2020 period.

268 Joint Utilities, slides for 2011 Long-Term Procurement Plan Systems Analysis: Preliminary Results, posted April 29,2011 and presented in a workshop on May 10, 2011.

269 Press release, August 27, 2010, available at http://www.gradient.com/2010/08/geothermal-energy-developer-moves-corporate-headquarters-in-reno-bringing-jobs-and-clean-energy-to-the-state/. No California projects are listed on the website.

efforts by allowing the scheduling of wind energy delivery without the utility having to incur imbalance charges when the delivered energy differs from the scheduled amount.[270]

With an RPS target of 35 percent renewables by 2020, the Los Angeles Department of Water and Power (LADWP) proposes in its annual resource plan to complete a comprehensive study of issues associated with integrating increasing amounts of variable energy resources to "reflect possible megawatt limits for the LADWP electric power system." [271] Recognizing the scarcity of transmission lines available to develop renewable generation facilities in resource rich areas, LADWP will develop strategies to locate them as close as practical to load centers.[272] LADWP primarily uses its Castaic pumped-storage hydroelectric plant in conjunction with its gas-fired generation fleet to integrate its variable renewable resources. New integration strategies LADWP is implementing include increasing the use of directed biogas in conventional generators that they believe will respond well to integration needs, and exploring the possibility of using municipal solid waste conversion technologies. Also in the next 2-4 years, LADWP indicates plans to assess whether new transmission will be necessary to deliver electricity generated from new facilities.

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270 The California Independent System Operator has proposed to replace the PIRP with a new program, Variable Energy Resources Program (VERP). The objective of both programs is to eliminate barriers to "non-standard" renewable resource development. Reactions from stakeholders are mixed with some stakeholders suggesting delaying any replacement or modifications pending review of other market reforms that may impact variable resources.

271 City of Los Angeles Department of Water and Power , *2010 Power Integrated Resource Plan, Final,* December 15, 2010, pp.5-27. http://www.ladwp.com/ladwp/cms/ladwp014239.pdf.

272 Ibid.

Chapter 6:
Distribution-Level Integration Issues

Chapter 5 discussed challenges with integrating large-scale renewable generating facilities into California's transmission grid which delivers electricity from power plants to distribution substations. There are also significant difficulties integrating large amounts of renewable distributed generation (DG) into the distribution system which delivers power from those substations to end-use consumers, and evaluation of these issues has only just begun. The electricity distribution system is the largest element of the overall electric system with well over 244,000 miles of distribution circuits.[273] Over the next five to ten years, California utilities will invest billions of dollars to expand, replace, and modernize aging distribution infrastructure. This creates an important opportunity to upgrade the system to facilitate integration of renewable energy at the distribution level to meet the state's renewable energy goals while continuing to provide reliable, safe, and reasonably priced power to customers.

This chapter discusses the major challenges to integrating high levels of DG into the state's distribution system, many of which are due to historic design of this system that allows electricity to flow in only one direction from central-station generation to substation to customer. As more DG is added to the system, the amount of power generated by these resources may exceed demand and flow backwards into circuits or substations, requiring new protection and control strategies to avoid damage to the electric system. In addition, increased amounts of renewable DG may result in significant voltage changes that could exceed current standards for allowable voltage variations. Much of the distribution system is based on mid-20th century technology that was designed to provide power to simple analog devices like incandescent light bulbs, motors, and clocks, while electronic equipment used in today's homes and businesses is much more sensitive to voltage variations and frequency deviations. There also exists the need for better coordination between distribution and transmission planning to maintain system operations and reliability, as well as uniform and open standards necessary to integrate intelligent technologies, renewable generation, and communication devices into a "smart grid." Finally, given the large number of facilities needed to meet the Governor's goal of 12,000 megawatts (MW) of DG, the complexity, expense, and length of time associated with interconnection processes must all be reduced.

The chapter then outlines the efforts underway in California to address these challenges. The Renewable Distributed Energy Collaborative (Re-DEC), formed by the California Public Utilities Commission (CPUC) in 2009, is working to identify and address challenges to DG integration. Utility engineers are working with regulators and DG developers to identify new standards, technologies, and planning approaches, and utilities are providing detailed maps on their websites to help DG developers identify grid locations unlikely to trigger expensive studies and upgrades to the distribution system. Energy agencies are working with utilities and

273 Totals for investor-owned utilities' distribution circuits.

stakeholders to reduce the time and costs associated with processing interconnection requests, revise existing standards, and develop new standards for DG equipment like inverters. The Energy Commission and the California Independent System Operator (California ISO) are also studying past and current European strategies for integrating large amounts of renewable DG.

Description of Challenges

This section discusses difficulties in interconnecting large amounts of renewable DG projects to the distribution system as well as challenges faced by distribution operators and planners as DG penetration increases.

Interconnection Challenges

There are three categories of DG resources, all of which require interconnection to the grid. The first is located on the customer-side of the meter and produces energy to offset some of the customer's own electric load. These projects are typically small (10 kW up to 1 MW) projects. The second type of DG is slightly larger (1 MW – 5 MW), and is usually within or close to load centers. These resources may either export all of the power they generate or use some and export the excess to the utility. The third type of DG is larger (5 MW – 20 MW) systems located on the utility side of the meter that export all of their generation. With the price of ground-mounted solar photovoltaic (PV) decreasing and the substantial amount of reasonably priced land available in rural areas, there is considerable developer interest in this latter category.

Over the past decade, California utilities have successfully interconnected more than 95,000 small self-generation PV projects at customers' homes and businesses across the state.[274] This success is due to a confluence of state rebates, federal tax incentives, net metering incentives and an efficient and quick Rule 21 interconnection process.[275] Because these are small projects (generally less than 10 kW), they have little impact on the local grid and qualify for a fast track Rule 21 interconnection; however, as higher penetrations of small projects accumulate on a circuit, even these projects may pass the threshold and trigger the need for a more in-depth review process and distribution grid upgrades.

With increased numbers of interconnection requests, stakeholders have identified interconnection as a major challenge that affects both project developers and grid operators. Figure 18 shows the large increase in interconnection requests at the distribution level beginning around early 2010 through Southern California Edison's (SCE) Wholesale Distribution Access Tariff (WDAT).[276] Similar trends are being noted for Pacific Gas and Electric Company (PG&E) and San Diego Gas and Electric (SDG&E), with this dramatic increase possibly driven by the increase in programs dedicated to systems 20 MW and smaller. An expanded feed-in tariff, the Renewable Auction Mechanism (RAM), and utility PV programs

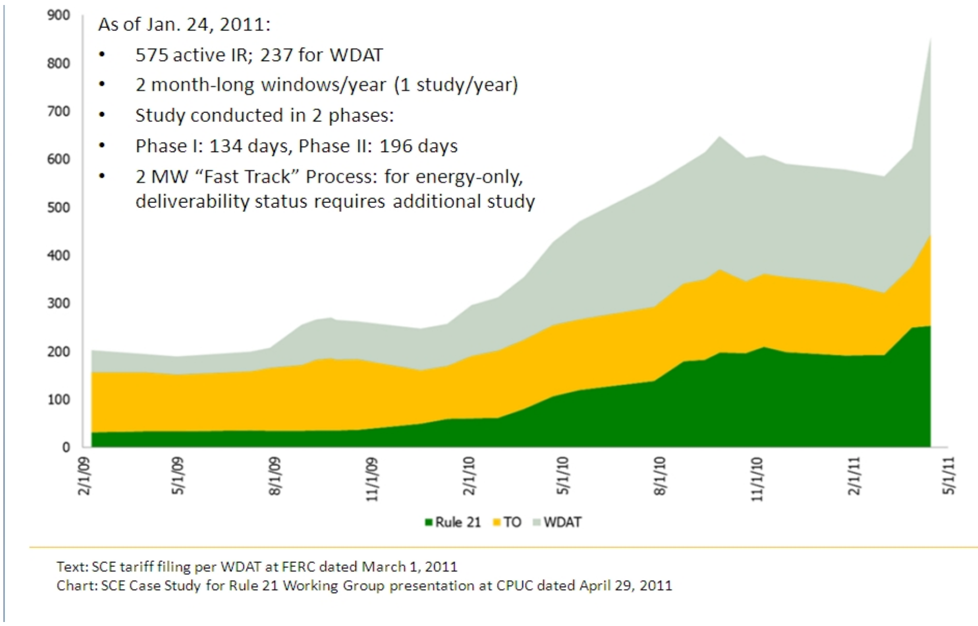
274 Go Solar California website: http://www.gosolarcalifornia.org/.

275 California Public Utilities Commission, http://www.cpuc.ca.gov/PUC/energy/DistGen/rule21.htm.

276 The WDAT Interconnection Process is FERC jurisdictional and applies to 20 MW or smaller projects that want to interconnect to SCE's distribution system (all lines below 200 kV) and sell all their power at wholesale.

have sparked greater interest of late in these projects. However, many of these programs require commercial on-line dates within 18 months of when the contracts are signed. Having to go through both phases of the interconnection process may take up to a year. Further, there is only one study per year with a two-month window to get into the study. Therefore, developers entering one of the utility solicitations may not be able to receive the interconnection results, let alone start construction, in time to meet the 18-month commercial on-line date. To overcome this hurdle, many developers have placed speculative multiple projects into the interconnection queues, leading to the recent increase in interconnection requests, as shown in Figure 18.

Figure 18: Southern California Edison's Active Interconnection Requests (excluding net energy metering)



Source: SCE Case Study for Rule 21 Working Group presentation at CPUC, April 29, 2011. Represents interconnection requests through Rule 21, Transmission Operators (TO), and Wholesale Distribution Access Tariff (WDAT).

The CPUC has acknowledged that Rule 21 needs to be reformed to meet the technical needs and policy goals of interconnecting DG. One area of consensus is the need for review and potential reconsideration of technical screens within Rule 21 to ensure that the appropriate issues are being studied.[277] These screens – a group of questions or thresholds that determine if the proposed interconnection affects local circuits or substations – are used in both CPUC and Federal Energy Regulatory Commission (FERC) jurisdictional procedures to determine what projects are subject to additional and often costly studies. CPUC staff announced on August 19, 2011, that the CPUC is sponsoring settlement discussions as the next step in the "Rule 21 Group" process. The goal is to reach a global settlement on issues regarding DG interconnection to the investor-owned utility (IOU) distribution system in California. It is anticipated that

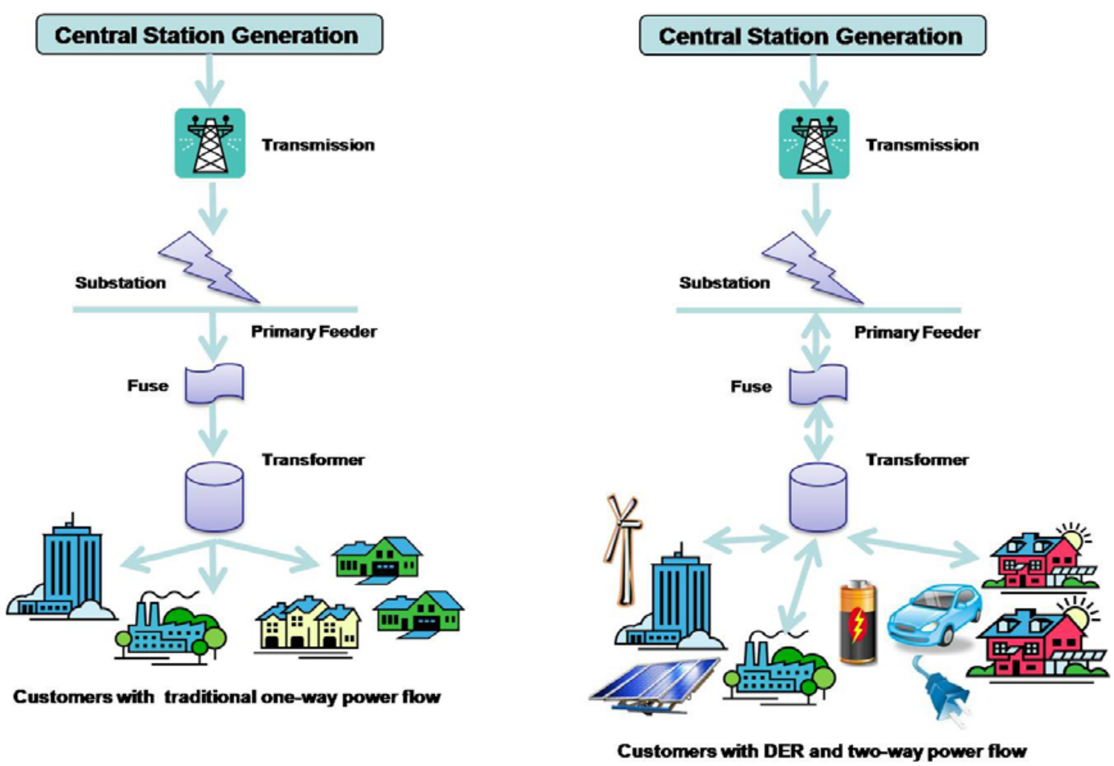
277 http://www.cpuc.ca.gov/PUC/energy/DistGen/rule21.htm.

parties will reach agreement on terms of a comprehensive, multi-jurisdictional interconnection tariff (and associated forms of agreement) by December 31, 2011, for presentation to the CPUC for approval and possible subsequent approval by the Federal Energy Regulatory Commission. This settlement process will continue a stakeholder process begun in recent months under the auspices of the CPUC's Rule 21 Working Group. CPUC staff also anticipates proposing opening an Order Instituting Rulemaking (OIR) on interconnection-related issues in September 2011, but the intent is that the settlement discussions among the stakeholder parties will resolve issues identified in such an OIR.[278]

System Planning and Operation Challenges

The most common distribution design used in California is radial circuits. These circuits are designed and operated based on the principle of centralized generation, in which electricity flows in one direction to the distribution substation and then down to the end-use customer (Figure 19). These substations provide power through circuits to customers based on their demand and, at the same time, ensure adequate power quality and reliability using circuit breakers and fuses if a fault is detected on the line.

Figure 19: Traditional Power Flow Versus Smart Grid



Source: California Energy Commission

278 Email from Rachel A. Peterson to Rule 21 Working Group list serve on the following subject: Notification: Distribution System Interconnection Summit –Settlement Process, August 23, 2011.

As increasing amounts of customer-generated power, usually solar PV, are installed at customer's homes and businesses throughout California, generation may exceed load at different times of the day and flow backwards into the circuit or substation. Currently, load levels are controlled by adjusting transformer taps or by voltage regulators installed on the lines. These are near-term solutions, but continued use of voltage regulators to manage constant voltage fluctuations can reduce the useful life of this equipment. New and emerging smart grid technologies will include not only new protection and control strategies, enhanced distribution automation,[279] and voltage and volt-ampere reactive (VAR) management, but also new devices. For instance, transformers are used by utilities today as single-function devices. They change the voltage of electricity from one level to another (for example, stepping power down to the 120- and 240-volt levels used in homes). In the near future, these devices will be replaced with flexible solid-state transformers that will be engineered to handle high power levels and very fast switching.

Additionally, in response to signals from a utility or a home, smart transformers will be able to change the voltage and other characteristics of the power they produce. They will have built-in processors and communications hardware that will allow them to communicate with utility operators, other smart transformers, and consumers. This is an example of a new emerging technology that will make today's distribution grid smarter. Alex Huang, director of the FREEDM System Research Center[280] that is developing these types of devices says, "If smart meters are the brains of the smart grid, devices such as solid-state transformers are the muscle." These devices could help change the grid from a system in which power flows one way to one in which homeowners and businesses commonly produce power to feed back into the grid as well.[281]

California utilities have been aware for at least a decade that their distribution systems need to be modernized. As equipment comes to the end of its useful life, utilities replace it with new equipment that often has more advanced communication and functional capabilities. This modernization is likely to accelerate as a result of Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) which requires utilities to develop smart grid deployment plans.[282] The bill's author has noted that California "has 273,000 miles of transmission and distribution lines

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279 Distribution automation includes a suite of technologies that allow real-time adjustment to changing loads, generation, and failure conditions of the distribution system, usually without operator intervention.

280 The FREEDM Systems Research Center proposes a smart-grid paradigm shift that will enable the U.S. to take advantage of advances in renewable energy for a secure and sustainable future. Research facilities are located at North Carolina State University, Arizona State University, Florida State University, Florida A&M, Missouri University of Science and Technology, http://www.freedm.ncsu.edu/index.php?s=1.

281 Technology Review, Kevin Bullis, "A Way to Make the Smart Grid Smarter," December 22, 2010, http://www.technologyreview.com/energy/26979/, accessed August 28, 2011.

282See California Public Utilities Commission, *Decision Adopting Requirements for Smart Grid Deployment Plans Pursuant to Senate Bill 17 (Padilla), Chapter 327, Statutes of 2009*, June 28, 2010, http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/119902.htm.

delivering power to homes and businesses, yet the antiquated electrical grid is neither clean, efficient, nor stable enough to meet California's future needs."[283]

On July 1, the IOUs filed smart grid deployment plans at the CPUC that identify smart grid technologies to be evaluated for inclusion in their General Rate Cases.[284] Publicly owned utilities are developing similar plans. Many new smart technologies are already being installed and used by utilities throughout the state to improve system visibility and operations. Other technologies are actively being piloted and evaluated to address many of the challenges associated with the design of the existing one-way systems and the integration of large amounts of renewable DG.

Following are discussions of some of the significant issues and challenges distribution operators and planners will have to deal with as DG levels increase and some of the existing and potential technologies used to support the evolution of the 21st century modern grid in California. Additional information on research and development of technologies to improve distribution level integration is provided in Chapter 9.

Voltage Regulation Challenges

Voltage regulation is a challenge facing distribution operators as DG levels increase. "Power quality" is the term most often used in this context, but it is actually the quality of the voltage that concerns utilities and, ultimately, their customers. As residential, business, and industrial customers use more sophisticated electronic equipment in their homes and businesses, it will become more apparent to them how voltage variability impacts equipment operation and longevity. The CPUC's Rule 2 currently sets the standard for voltage and the limits of variations and allowable exceptions.[285]

Voltage problems can originate with a utility if a line short circuits or with a customer starting a large motor. These types of momentary voltage sags, swells, and even interruptions usually last only a few seconds and do not usually cause problems like brownouts or even customer lights flickering. However, voltage problems may become more difficult to manage as higher penetrations of distributed generation interconnect to a circuit, thus increasing two-directional power flow.

Voltage problems associated with PV systems are generally avoided by simply having inverters inject the power into the system, following whatever voltage appears at its terminals, rather than attempting to directly regulate the voltage. Regulating the voltage for PV can be managed as long as the amount of distribution level PV remains low and high concentrations of PV near the end of the circuit or a single large PV near the end of a regulation zone are avoided.

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283 Senator Alex Padilla's website http://dist20.casen.govoffice.com/index.asp?Type=B_PR&SEC={5EACFA15-EA6B-41D8-9711-C030F9FAD5EE}&DE={C680A9F0-F80A-4055-BFFA-4AF89BA84C57}.

284 For more information about what was required in smart grid deployment plans, please see Chapter 9.

285 Rule 2 is a tariff addressing voltage class for electricity delivery points of service. See PG&E's Rule 2 tariff at http://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_2.pdf for an example.

However, as penetrations increase, so will problems. In the near term, as part of its smart grid plan PG&E is proposing to test the efficacy of commercially available voltage control systems (Volt/VAR optimizations tools) in its laboratory and in a pilot environment to address concerns about voltage control in areas with high penetrations of solar PV.[286] As utilities throughout the state continue to update and modernize their systems to provide increased functionality and information, the increased use of these new commercially available systems will allow better management of voltage with increased integration of DG.

Challenges in voltage regulation were discussed during a June 22, 2011 Integrated Energy Policy Report Committee Workshop on distribution infrastructure challenges.[287] One of the biggest challenges utilities face when managing voltage is a lack of experience absorbing and managing increasing amounts of distribution-connected DG and a lack of historic data on operational profiles of circuit behavior with DG. SDG&E reported that it has 263 circuits with >30 percent PV and 667 circuits with >20 percent PV and has observed changes and issues with system performance on those distribution circuits with high levels of conventional DG. SDG&E presented field measurements from its system showing the impact of 1 MW of PV over 10 minutes on a cloudy day, with extreme fluctuations in voltage caused on the SDG&E circuit.[288] These results underscore the need for increased monitoring of the behavior of distribution circuits in response to increased penetrations of PV to understand how best to accommodate DG on the state's predominately radial distribution systems. Also, the Sacramento Municipal Utility District (SMUD) indicated that voltage regulation is a particular concern on bus regulated substation transformer banks (one regulating device for multiple distribution feeders) and that that local voltage issues are likely to be more of an issue than protection, load, fault, harmonic, and stability issues as penetration increases.[289]

At the June 22 workshop, Dr. Alexandra von Meier reported that the Public Interest Energy Research (PIER) Transmission and Distribution Research Program is leading an effort that includes several California utilities to measure and share information on how distributed PV generation is impacting circuit voltage, power flow, and harmonics on the distribution system. Once this data is collected and analyzed, utilities will have real world insights and data on how PV affects circuit operations, which will help them identify strategic upgrades and smart grid

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286 June 22, 2011 IEPR Committee Workshop, presentation by Jon Eric Thalman, PG&E, Interconnecting and Integrating DG into the Distribution System, Slide 8, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

287 June 22, 2011 IEPR Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12,000 Megawatts of Distributed Generation. http://www.energy.ca.gov/2011_energypolicy/documents/index.html#06222011.

288 Docket 11-IEP and 11 IEP-1H Distribution Infrastructure and Smart Grid, July 14, 2011, Presentation by Tom Bialek, SDG&E,Slide 6.

289 Dockets #11-IEP-1G, 11-IEP-1H "Distribution Infrastructure and Smart Grid", Comment of Sacramento Utility District, July 20, 2011, LEG 2011-0372, p.12.

technologies needed to ensure the continuing safe and reliable operation of the distribution system with increasing levels of PV.[290]

Protection Systems

Overcurrent or fault protection is essential to the safe operation of power systems.[291] Protection practices allow momentary nonconsequential faults – for example, if a tree momentarily touches a conductor – to be quickly cleared from the system, and also allow permanent faults caused by failed equipment to be isolated to prevent further damage to the system and minimize the number of customers experiencing power interruption. Equipment like circuit breakers, relays, reclosers, sectionalizing switches, fuses, and practices that have evolved during the last 100 years of field experience with power systems were developed without taking into account any distribution-connected DG energy resources.[292] Because all radial distribution systems deliver power and fault current from the substation out to loads, there is no other source for fault current so the protection practices do not account for the presence of distribution-connected generation between the substation and load that can change the direction of flow and create new fault-current paths and other unexpected outcomes. These issues can cause network protection equipment to operate unnecessarily, confusion for automatic switches, and increased damage to conductors or equipment.[293] To deal with these problems, utilities are modifying protection practices to accommodate current levels of DG interconnected to the system.

SCE is actively studying a range of issues related to protection of their circuits as part of PV Generation Studies being performed by their Advanced Technology Transmission & Distribution Unit.[294] For example, better overall circuit protection coordination, and the use of bi-directional over current relays instead of one-way relays, is being evaluated as a way of avoiding unnecessary tripping of distribution facilities when reverse power flow is present. These studies will enable SCE and other utilities to determine the need for and value of replacing older relay systems that use electromechanical technology with new microprocessor-

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290 June 22, 2011 IEPR Committee Workshop, presentation by Dr. Alexandra von Mieier, California Institute for Energy and Environment, "Distribution System Monitoring: Intelligence to manage variability and uncertainty," http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

291 Overcurrent is a condition in an electrical circuit when the current (amperage) in the circuit exceeds the rated amperage capacity of that circuit or of the connected equipment on that circuit.

292 Circuit breakers are automatically operated switches designed to protect electrical circuits from damage caused by overload or short circuit by immediately discontinuing electrical flow. Relays detect electrical faults. Reclosers are circuit breakers that can automatically close the breaker after it has been opened due to a fault. Sectionalizing switches are protective devices that observe fault current and circuit interruption by a recloser and if the fault persists, act to isolate the faulty section of the circuit.

293 *Renewable Systems Interconnection Study: Advanced Grid Planning and Operations*, Mark McGranaghan, Thomas Ortmeyer, David Crudele, Thomas Key, Jeff Smith, Phil Barker, Prepared by Sandia National Laboratories, SAND2008-0944P, Unlimited Release, Printed February 2008.

294 June 22, 2011 IEPR Workshop, presentation by Bob Yinger, SCE, Operational Challenges with High Inverter Penetration, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

based relays that will safely and efficiently manage faults when DG is present on the line. These and other protection issues are actively being evaluated by SCE and other utilities so that new distribution infrastructure upgrades can include equipment such as relays that can detect DG on circuits throughout their systems.

Islanding

"Islanding" refers to a situation in which a DG generator continues to provide energy to a circuit even though power from the utility is no longer present. From an operational perspective, islanding is a very important issue because it can cause safety concerns for utility workers. There are two forms of islanding. An intentional island is specifically planned and designed to meet all safety requirements to provide critical customers like airports, military bases, and data centers with continuous high-grade power using local generation, especially when there is outage or emergency. In other cases, a customer or group of customers may want the ability to meet all or most of their own energy needs so they develop an integrated energy system consisting of interconnected loads and distributed energy resources. This integrated system or "microgrid" can operate in parallel with the grid or in an intentional island mode. In contrast, an unintentional island is accidental, unplanned, and can be dangerous even if it lasts for just a few seconds. For example, if a building has solar panels that can feed power back to the electrical grid during a blackout, the building becomes an "island" of power surrounded by unpowered buildings which can pose a danger to utility repair workers.

To deal with this problem, distributed generators include anti-islanding devices designed to detect islanding and immediately stop producing power. Utilities are concerned that increasing penetrations of PV inverters and other DG installed on a single circuit may cause active anti-islanding algorithms to fail and result in increasing incidences of unintentional islanding. To manage this issue, additional logic and communications capabilities may need to be added to the distribution grid to initiate a remote tripping signal to any DG units that become isolated.

Another islanding issue, identified by SDG&E at the June 22 workshop, is that utility operators are concerned about serious problems that could result from possible tripping of large amounts of DG (up to 12,000 MW in the case of California) in response to a transmission level outage or fault. SMUD expressed a similar concern in its presentation, indicating that a loss of more than 50 percent of PV on their system in one minute would exceed their contingency requirements.[295] SCE also indicated that this was a system operational issue being studied in its PV Generation Studies.[296] Utility transmission and distribution operators both agree that losing a large amount of DG at one time, no matter the reason, is something they need to understand and plan for.

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295 June 22, 2011 IEPR Committee Workshop, presentation by Jeff Berkheimer, SMUD, Research and Development Manager, "Can the Smart Grid Enable More DG and Does Storage Have a Role," http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

296 June 22, 2011 IEPR Workshop, presentation by Bob Yinger, SCE, Operational Challenges with High Inverter Penetration, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

As DG penetration increases, IOUs, publicly owned utilities, and the California ISO will need to coordinate studies on this issue and model and assess transmission level fault events to determine the impacts if large amounts of DG are tripped, and whether low-voltage ride-through (LVRT) requirements should be imposed on some sizes of DG units.[297] In addition, more advanced systems and/or research is needed to develop new and better islanding protection algorithms, equipment, and practices to safely accommodate high penetrations of future DG.

An Evolving Distribution System

While meeting California's aggressive renewable energy goals, utilities will need to balance maintaining system reliability and dealing with aging distribution infrastructure. This is particularly challenging for the electricity distribution grid where there are still "blind"[298] and manual operations and electromechanical components that must evolve over time into a modern and flexible system that can manage complex operations in real time.

At the June 22 IEPR workshop, IOUs and publicly owned utilities reported that they are investing significant amounts of money upgrading aging infrastructure to increase visibility, flexibility, safety, and reliability. SCE indicated that in a recent General Rate Case (GRC) filing, expenditures for distribution infrastructure replacement in 2009 totaled $66.6 million, with an additional $212.3 million for capital distribution inspection and preventative maintenance programs.[299] Because PG&E's 2011 GRC was slightly ahead of the CPUC's smart grid proceeding, it essentially maintained spending at historical levels on activities that are now viewed as related to the smart grid, such as automation and relay upgrades. For key technology infrastructure upgrades necessary to lay the foundation for all smart grid deployment, PG&E included approximately $66 million in its 2011-2013 capital expenditure forecast. However, the CPUC's final decision resulted in a lower revenue requirement level so spending over that period will be less. The technology upgrades PG&E focused on in its GRC were in the areas of information exchange, data management, and data storage.[300] The line between what is a smart grid technology and what is a smart grid foundational technology will be the subject of discussion at the CPUC, as well as before publicly-owned utility governing boards. In the end, no matter how these investments are categorized, the utility must demonstrate that it provides

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297 Low voltage ride through is a generating facility's ability to stay interconnected to and synchronized with the transmission system during disturbances.

298 Those locations on the distribution grid where the system operator has no visibility and/or control. There are still locations on the distribution systems throughout the state where the first notification of a problem comes from a customer calling in and indicating they do not have power.

299 Docket 11-IEP-1G and 11-IEP-1H Distribution Infrastructure and Smart Grid, Southern California Edison Company Follow-up Comments Regarding the Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12,000 Megawatts of Distributed Generation, p. 2.

300 Docket No. 11-IEP-1G, 11-IEP-1H, Distribution, Infrastructure and Smart Grid, July 14, 2011, Pacific Gas & Electric Comments in Response to the June 22, 2011 IEPR Workshop on Distributed Infrastructure Challenges and Smart Grid Solutions to Advance 12, 000 Megawatts of Distributed Generation, p.4-5.

value to the utility's ratepayers and customers and be compatible with future smart grid investments and technologies.

The timeframe for the evolution and modernization of the distribution system is unknown, but every utility in the state is actively moving in that direction. The CPUC is expected to have a proposed decision on smart grid this fall or winter. Emerging "smart" technologies are evolving quickly and will offer opportunities to develop and use intelligent and highly automated technologies as discussed in Chapter 9. SDG&E reports that it is expanding its use of supervisory control and data acquisition (SCADA) systems and synchrophasors[301] to provide data to better assess grid conditions and respond early to problems.[302] Further discussion of how synchrophasors can help with grid congestion issues is discussed in Chapter 9.

Utilities are pursuing other promising technologies like distribution management systems with advanced load control systems that will provide better monitoring and overall control of the distribution system through increased automation and the use of energy storage in combination with solar PV to mitigate distribution system impacts. Research efforts in these areas are described in Chapter 9. Pilots and research programs will help establish the performance of smart grid and small-scale storage technologies and their value to facilitate the redesign of the distribution system to support the reliable and cost effective integration of 12,000 MW of DG into utility systems.

SMUD indicates that while it supports state goals and clean local generation, it is concerned that:

> ". . . implementation should not get too far ahead of the necessary research to get an adequate understanding of the cumulative impacts on the grid and the best solutions for those impacts for smooth and reliable integration. Further research is needed on issues related to integrating and interconnecting DG into the existing electricity system and grid, the potential operational impacts on utilities of increased interconnected DG capacity, and potential ways to mitigate these impacts. This research will help point to the amount of and timing of new DG that will be optimal for California."[303]

Balancing the value and risks associated with deploying these new technologies and systems will be difficult because, unlike more traditional technologies with which utilities have long

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301 SCADA systems are software applications used for process control and gathering real-time data from remote locations to exercise control on equipment and conditions. Similarly, synchrophasors allow real-time measurement of grid conditions by collecting and reporting information to grid operators 30 times per second.

302 Docket 11-IEP and IEP-1H presentation of SDG&E at the IEPR Committee Workshop, June 22, 2011, Tom Bialek, slides 5-12, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

303 Dockets #11-IEP-1G, 11-IEP-1H "Distribution Infrastructure and Smart Grid", Comment of Sacramento Utility District, July 20, 2011, p.2-3.

experience, the long-term performance and value of new and emerging technologies may still be uncertain and difficult to justify economically.[304] When calculating the benefits of smart grid technologies, PG&E and SCE reported that establishing the value of the social benefits associated with state goals (for example, carbon reduction) is unclear and work needs to be done, with utilities and stakeholders, to develop consensus on these values.[305,306] Both utilities suggested a standard approach to valuing these types of benefits; while PG&E included these benefits in their smart grid deployment plan, it did not quantify them.

The Environmental Defense Fund reported at the June 22 IEPR workshop that they have developed a Smart Grid Evaluation Framework for California as a tool for regulators to use when evaluating the utilities' smart grid plans and their ability to deliver benefits required by the CPUC.[307] SMUD also reported that the societal benefits to its customers are recognized in the SMUD Board Strategic Directives, and that it includes an anticipated cost of carbon in the evaluation of efficiency programs and resource procurement.[308] The Environment Defense Fund tool and the values developed by SMUD can be used to support the development and quantification of these important benefits.

Investments in distribution infrastructure are substantial and depreciated over 20- to 30-year timeframes. The value of traditional infrastructure investments compared with investments in new emerging smart grid technologies is the first challenge regulatory agencies and boards must consider. Over time, quantifying and attributing the costs and benefits of investments in system upgrades and additions related to DG integration will also have to be determined.

System Analysis and Modeling

Increased DG penetration levels calls for precedent-setting changes in distribution system operations, planning, and design. Distribution system modeling helps utility operators, designers and planners understand the impact of new additions or changes in basic operations. At the June 22 IEPR workshop, SDG&E discussed the impact large-scale DG penetration would have on voltage and power quality and suggested extensive data gathering and analytical

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304 SDG&E Smart Grid Development Plan:2011-2020 Section 8-Benefits Estimates page 256.

305 Presentation at June 22, 2011 IEPR Workshop, Interconnecting and integrating DG into the Distribution System, Jon Eric Thalman & John Carruthers, Slide 14, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

306 Docket 11-IEP and 11-IEP-1H Distribution Infrastructure and Smart Grid, Southern California Edison Follow-up Comments Regarding the Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12, 000 Megawatts of Distributed Generation, p. 12.

307 Environmental Defense Council, Timothy O'Connor Presentation, June 22, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

308 Dockets #11-IEP-1G, 11-IEP-1H "Distribution Infrastructure and Smart Grid", Comment of Sacramento Utility District, July 20, 2011, LEG 2011-0372, p.11.

modeling to gain insights into the new dynamics.[309] In follow-up comments to the workshop, SCE mentioned its use of models such as Cyme Cymdist and General Electric's PLSF[310] load flow model to simulate certain key characteristics such as voltage and power quality, and changes to these characteristics under different conditions. SDG&E believes that distribution operators should be able to go beyond their current analytical practices that use existing models and develop capabilities to analyze dynamic conditions such as transient currents and wide voltage fluctuations.[311]

A report by Sandia National Laboratories also suggests the following analytical challenges must be addressed for integration of DG to be achieved economically, efficiently and safely:[312]

- Current analysis tools used by utilities must evolve to address a new and more interactive distribution system.
- Distribution engineering tools must become better suited to handle distributed and renewable generation related issues.
- Better analytics need to be developed to determine the effects of high penetrations of DG on capacity limits.
- Modeling and specification requirements for DG interconnection equipment must be determined.
- Cost and benefit evaluation tools that better capture the value of distributed resources to power system operations and dispatching need must be developed.

From an operations perspective, the report suggests that no matter what the existing system looks like, new and updated software (for example, load-flow programs) is needed so operational engineers can accurately determine basic capacity and voltage regulation issues associated with increasing DG interconnections. The complexity associated with time- and location-dependent relationships between feeder segment loads and PV output require many studies to understand the range of conditions the new system will experience. New tools will allow these studies to be done more quickly.

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309 SDG&E Presentation by Dr. Tom Bialek at the June 22, 2011 IERP Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12,000 Megawatts of Distributed Generation, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

310 Southern California Edison Company ("SCE") Follow-up Comments Regarding the Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions, page 6. Docket #11-IEP-1G and #11-IEP-1H.

311 SDG&E Presentation by Dr. Tom Bialek at the June 22, 2011 IERP Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12,000 Megawatts of Distributed Generation, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

312 Ortmeyer, Tomas, Roger Dugan, David Crudele, Thomas Key, and Phil Barker, *Renewable Systems Interconnection Study: Utility Models, Analysis, and Simulations Tools*, Prepared by Sandia National Laboratories, February 2008, p vii, http://www1.eere.energy.gov/solar/pdfs/utility_models_analysis_simulation.pdf.

In response to this need, the Energy Commission's PIER Program sponsored the development and demonstration of a simulation methodology that can model the impact of DG on the distribution grid.[313] The methodology provided an area-wide simulation of an integrated transmission and distribution network using information from routinely maintained legacy utility data. Simulation results were validated with field measurements to ensure that the model correctly assessed the grid conditions at any point in the network under any operating scenario. The simulation enabled observation of the direct impact of any change at any point in the network.[314] Simulation models like this as well as similar models developed by other vendors[315] are an improvement over static power flow models used until now by distribution planners. Access to new data from sensors and new distribution management systems, along with Geographic Information System displays, will also improve the quality and accuracy of future system modeling and analyses. For a more detailed discussion of modeling and forecasting, see the Chapter 5 section on forecasting error for variable resources and the Chapter 9 sections on research to address transmission challenges, distribution level integration and smart grid.

Modeling a higher penetration of solar and wind DG for system analysis and management is incomplete without an accurate hour- or day-ahead forecast of solar and wind resources. Such forecasts can alert the distribution operators of impending drops in solar output if a large cloud cluster is expected in a given geographic region. The University of California, San Diego is working with the local utility to model solar radiation forecasts within a defined geographic region to assess the variations in solar output.[316] The models used for analyzing the near-term distribution system changes (such as voltage and currents) will be enriched by the addition of weather forecasting capabilities. These multidimensional models will allow system operational engineers and dispatchers to anticipate and plan for variations in weather and the impacts of these variations on intermittent PV and wind resources.

Standards

Standards are especially important with regards to investments in distribution infrastructure equipment and systems that will enable installation of higher quantities of renewable generation on the distribution system. Standards establish consistent protocols that are

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313 Verification of ENERGYNET® Methodology. California Energy Commission Report. CEC-500-20101-021 August 2010.

314 DG and Utilities: Sweet Spots in the Distributed Generation Grid. Energynet® High-definition Power System Simulation. Presentation by Peter Evans at Energy Commission IEPR Committee Workshop on Renewable Localized Generation, May 9, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/presentations/.

315 GRIDfast™: Advanced Grid Management Software by Gridiantcorp; BASS &Company/EDD Integrated System Model (ISM) by EDD-US corporation.

316 "How geographic smoothing and forecasting RD&D can help high penetration of distributed generation," Dr. Jan Kleissl, University of California , San Diego. Presentation at May 9, 2011 IEPR Committee Workshop on Renewable Localized Generation, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/presentations/.

universally understood and adopted to ensure that products function well, are compatible, and facilitate interoperability and communication between technologies. However, the intense effort, expertise, and financial commitment required to develop new standards is prohibitive for many stakeholders who – while acknowledging the urgency for uniform standards – often do not have the time or finances to participate in the development process. While utilities, manufacturers, and regulatory entities acknowledge the necessity of standards, the actual development, consensus, and adoption is slow to occur. Progress towards a truly smart grid, where technologies communicate and are controllable, could be delayed due to a lack of consensus on critical standards.

Currently, neither California nor the federal government mandates the adoption of specific standards related to smart grid technologies and generation devices. However, FERC was mandated by Congressional statute to open a docket in October 2010 on smart grid standards for both transmission and distribution level technologies. On October 6, 2010, the National Institute of Standards and Technology (NIST) notified the FERC that it had identified five families of protocols and standards developed by the International Electrotechnical Commission as ready for discussion for adoption.[317] On January 31, 2011, FERC convened a Technical Conference on Smart Grid Interoperability Standards in Washington, D.C. to discuss the proposed NIST standards.[318] At the conclusion of the workshop where stakeholders expressed concern that adoption by FERC of the proposed NIST standards was premature, FERC asked the public to provide comments.

As a result of the FERC workshop and public comments urging FERC not to adopt the proposed NIST standards, FERC announced on July 17, 2011, that it is cancelling the formal rule making and finds:

> "… there is insufficient consensus at this time to adopt, under section 1305(d) of EISA, the five families of IEC standards that NIST identified. Commenters are nearly unanimous that we should not adopt these standards at this time, citing concerns with cyber security deficiencies and potential unintended consequences from premature adoption of individual standards."[319]

Further, FERC indicated:

> "…that the best vehicle for developing smart grid interoperability standards is the NIST interoperability framework process, including the work of the Smart Grid Interoperability Panel (SGIP) and its committees and working groups. This work includes harmonization and extensions of existing smart grid interoperability standards as well as the development

317 The International Electrotechnical Commission is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. http://www.iec.ch/about/.

318 http://www.ferc.gov/industries/electric/indus-act/smart-grid.asp.

319 136 FERC ¶ 61,039, United States of America, Federal Energy Regulatory Commission, Docket No. RM11-2-000, Smart Grid Interoperability Standards, Issued July 19, 2011, pp. 6-7.

of new standards. The SGIP brings together smart grid stakeholders from numerous industries and areas of expertise to guide the development of smart grid interoperability standards within the context of the NIST interoperability framework process. The SGIP mission is supported by several standing committees on architecture and testing/certification as well as a permanent working group for addressing smart grid cyber security."

The CPUC is actively monitoring activity on the development of these critical standards at FERC.

Cyber Security and Inverter Standards

In the FERC standards process and the CPUC's smart grid proceeding, cyber security tops the list of concerns. From securing customer data at the meter to communication and control of the transmission system, cyber security measures must ensure system integrity, consumer privacy, and maintenance of a safe and reliable system. To strengthen security, utilities and industry need technologies that work across varying geographic areas and with an array of new and aging equipment. At the state level, the CPUC has responsibility for developing comprehensive cyber security standards through its smart grid rulemaking.[320] In California, working groups have been established under the CPUC's smart grid proceeding that include cyber security experts from the investor- and publicly owned utilities along with staff from the Energy Commission and the California ISO to identify critical issues that will inform the CPUC rulemaking. In addition, California's utilities are working closely with systems integrators, infrastructure suppliers, and standards bodies to develop a robust framework for smart grid cyber security across multiple domains from transmission to customer meters.

Inverter standards are another area of concern. In written comments submitted after the June 22 IEPR workshop, SCE stated that it has been testing PV inverters and modeling the effects of high penetrations of inverters on the transmission and distribution system. SCE's analysis has identified potential challenges including overvoltage, harmonics, and visibility and control. Development and validation of DG inverter standards that allow customer-owned PV inverters to be controlled by distribution system operators to address these challenges is critical to meeting California's renewable generation goals.

During the June 22 workshop, several utilities noted the importance of standards like IEEE's proposed 1547.8 standard.[321] This standard is intended to make high penetrations of DG and similar technologies more user-friendly to utilities and includes solutions that incorporate advanced functionality inverters. The goal of the IEEE 1547.8 standard is to ensure that DG units disconnect or "do nothing" when there is problem such as undervoltage or overvoltage.

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320 California Public Utilities Commission, Rulemaking 08-12-009, http://docs.cpuc.ca.gov/published/proceedings/R0812009.htm.

321 June 22, 2011, IEPR Workshop Presentations by Frances Cleveland of Xanthus Consulting, Tom Bialek of SDGE, Robert Yinger of SCE, Ben Kropowski of NREL, Tom Von Dollen of EPRI, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/

However, the utilities have indicated that if they could communicate with and have the authority to manage and control these DG resources, they have an interest in a long list of potential grid-supportive functions. These include voltage regulation and reactive power, overvoltage protection, limit fault current contribution, and potential for low voltage ride-through that could be provided by inverter-based resources including PV, storage, and plug-in electric vehicles.[322]

It is unclear how long it will take to develop new advanced communications and control technologies and standards. At the June 22 workshop, Ben Kroposki from the National Renewable Energy Laboratory indicated that the standards adoption process takes many months if not several years to occur, and that the IEEE Standard Working Group only began meeting late in 2010 to discuss the IEEE 1547.8 standard.[323] Workshop participants and panelists expressed concern that without close coordination between the working group, utilities, and manufacturers progress could be slow, and suggested that in the interim California's utilities could potentially explore and demonstrate the standard's capabilities and report findings to the IEEE.

The June 22 workshop included a discussion of inverter functions and suggestions by the Electric Power Research Institute (EPRI) that making smart inverters does not necessarily require high bandwidth. EPRI presented a list of functionalities that could be achieved as progress is made toward broad consensus on IEEE 1547.8 standard functionalities and development of advanced communications and controls. This is similar to Germany's approach of gradually requiring increased inverter functionality to integrate large amounts of DG. Options that were discussed included:

- Autonomous "smart" behaviors responding to local voltage and frequency, steady-state, and transients.
- Centralized control via infrequent configuration to achieve desired outcomes.
- Configurable "modes" that can enable fast management of many devices.
- Common Automated Meter Infrastructure (AMI) and SCADA systems to be used for this kind of management.[324]

As California continues to lead the nation in DG deployment, utilities must be able to manage multiple DG inverters in groups and at various locations on circuits throughout their systems. Based on experience in Germany, if inverters in the U.S. were required to include equipment

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322 Comments filed by SCE regarding June 22, 2011, IEPR Committee Workshop http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/comments/SCE_Follow-up_comments_TN-61394.pdf, p113-14.

323 Presentation from June 22, 2011, IEPR Workshop, Ben Kroposki, NREL, . http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

324 Presentation by Brian K. Seal and Don Von Dollen, EPRI Perspective on Distribution Infrastructure Challenges for DG, Slide 3, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

that allows utilities to actively manage the inverter, then interconnection studies and costs associated with these interconnections could be completed quickly and at lower cost. At the June 22 workshop, representatives from SMUD discussed the SMUD PV and Smart Grid Demonstration Pilot which includes a project funded by the U.S. Department of Energy to demonstrate inverter communications via SMUD's smart meter AMI. By December of 2012, SMUD plans to develop software that will interface with PV inverters and existing AMI infrastructure in the pilot area. In concept, the pilot will allow the inverters to communicate data, query for faults, and send control signals.[325] Pilots such as this will prove valuable to future standards development and activity in the areas of distribution infrastructure and cyber security.

Current Efforts to Address Challenges to Interconnecting and Integrating Distributed Generation

Interconnecting Distributed Generation

Table 18 lists interconnection processes currently available in California for projects 20 MW or smaller. Each of these processes has an expedited procedure or fast track for small projects not expected to have any impact on the grid that can be demonstrated by passing various screens (Table 19). Generator qualifications for these expedited or fast track processes vary across utilities and the California ISO, ranging from up to 2 MW or 5 MW, so interconnection differs depending on the process and utility or transmission operator used to interconnect.

In response to the desire to increase the capacity of small scale localized electricity generation, the CPUC developed new programs and solicitations, including programs such as the Renewable Auction Mechanism (RAM) that target the development of larger wholesale renewable DG projects.[326] The RAM is a simplified and market-based procurement mechanism for renewable DG projects up to 20 MW in size on the system side of the meter and is capped at 1,000 MW for the three IOUs over the next two years, with the first auction expected later this year. As part of the program, the CPUC directed the IOUs to provide detailed maps that allow DG developers to identify locations on the grid where they could interconnect new solar DG projects without triggering expensive studies and upgrades to the distribution system (Table 20 and Figure 20). Each utility also posts and regularly updates queues detailing the amount of DG that could be interconnected on a circuit with minimal studies (up to 15 percent of peak load of the circuit). This new information should result in an increased number of successful DG interconnections.

325June 22, 2011, IEPR Workshop Presentation by Jeff Berkheimer of SMUD, http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/.

326 California Public Utilities Commission, *Decision Adopting the Renewable Auction Mechanism*, D. 10-12-048, December 16, 2010, http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/128432.pdf.

Table 18: State and Federal Interconnection Processes

Process	Project Size Limit	Jurisdiction	Grid	Status	Timing
Rule 21	None	CPUC or Publicly Owned Utility	Distribution or Transmission[A]	In use today; typically used with customer programs or qualifying facilities	90 -180 Business Days
Wholesale Distribution Access Tariff (WDAT)	None	FERC	Distribution	In use today. PG&E and SCE recently changed study process from serial process to cluster study process. FERC approved changes in May 2011	+/- 330 Calendar Days[B]
Small Generator Interconnection Procedure (SGIP)	20 MW	FERC	Transmission	No longer available. Reformed from serial to cluster study process in 2010.	n/a
Large Generator Interconnection Procedure (LGIP)	None	FERC	Transmission	No longer available, merged with SGIP into GIP. Reformed from serial to cluster study process in 2009.	n/a
Generator Interconnection Procedure (GIP)	None	FERC	Transmission	In use today. Combines SGIP and LGIP into one cluster study.	+/- 420 Calendar Days[B]

[A] Note: Rule 21 has not yet been used for interconnection to the transmission system
[B] Estimates of Calendar days
Source: California's Path to 12,000 Megawatts of Local Renewables, Governor's Local Renewable Power Working Conference, Interconnection and Approval Processes Panel Discussion Paper, July 2011.

Table 19: Expedited Interconnection Processes

Interconnection Process	Expedited Review	Project Size Limit	Screens	Timing
Rule 21	Initial Review, Simplified Interconnection	None	Must pass 8 Screens [A]	< 1 month
WDAT	Fast Track	2 MW (SCE and SDG&E) 5 MW (PG&E)	Must pass 10 screens; which were derived from Rule 21 [B]	≈ 1 month
GIP	Fast Track	5 MW	Must pass 9 screens [C]	≈ 1 month

[A] See http://www.energy.ca.gov/distgen/interconnection/application.html.
[B] See http://www.sce.com/NR/sc3/tm2/RPA/Reg_Info_Ctr/OpenAccess/WDAT/attachment_g.pdf, Section 2 on pages 6-8.
[C] The California ISO revised the Fast Track through the SGIP stakeholder process, raising the project limit from 2 MW to 5 MW and removing the 10th screen which did not allow a project to proceed through the fast track if it triggered any grid connection upgrades.
Source: California's Path to 12,000 Megawatts of Local Renewables, Governor's Local Renewable Power Working Conference, Interconnection and Approval Processes Panel Discussion Paper, July 2011.

Table 20: Utility Website Information for Potential Available DG Capacity

Utility	Program	Link
PG&E	Solar Photovoltaic and Renewable Auction Mechanism Program Map	http://www.pge.com/b2b/energysupply/wholesaleelectricsuppliersolicitation/PVRFO/pvmap/
SCE	Renewable and Alternative Power	http://www.sce.com/EnergyProcurement/renewables/renewable-auction-mechanism.htm
SDG&E	SDG&E Distribution System Available Capacity for Distributed Generation	http://sdge.com/builderservices/dgmap/
SMUD	Solar Interconnection Map	http://www.smud.org/en/community-environment/solar-renewables/Documents/InterconnectionMap.pdf

Source: California Energy Commission

In the near term, new system-side renewable projects will also benefit from FERC's approval of combining the Small Generator Interconnection Procedure and the Large Generator Interconnection Procedure into a coordinated Generator Interconnection Process for the California ISO that uses a single cluster approach for studying interconnection requests. This should ensure that interconnection of large and small projects on a transmission line are coordinated and reduce interconnection study times and costs for developers.[327]

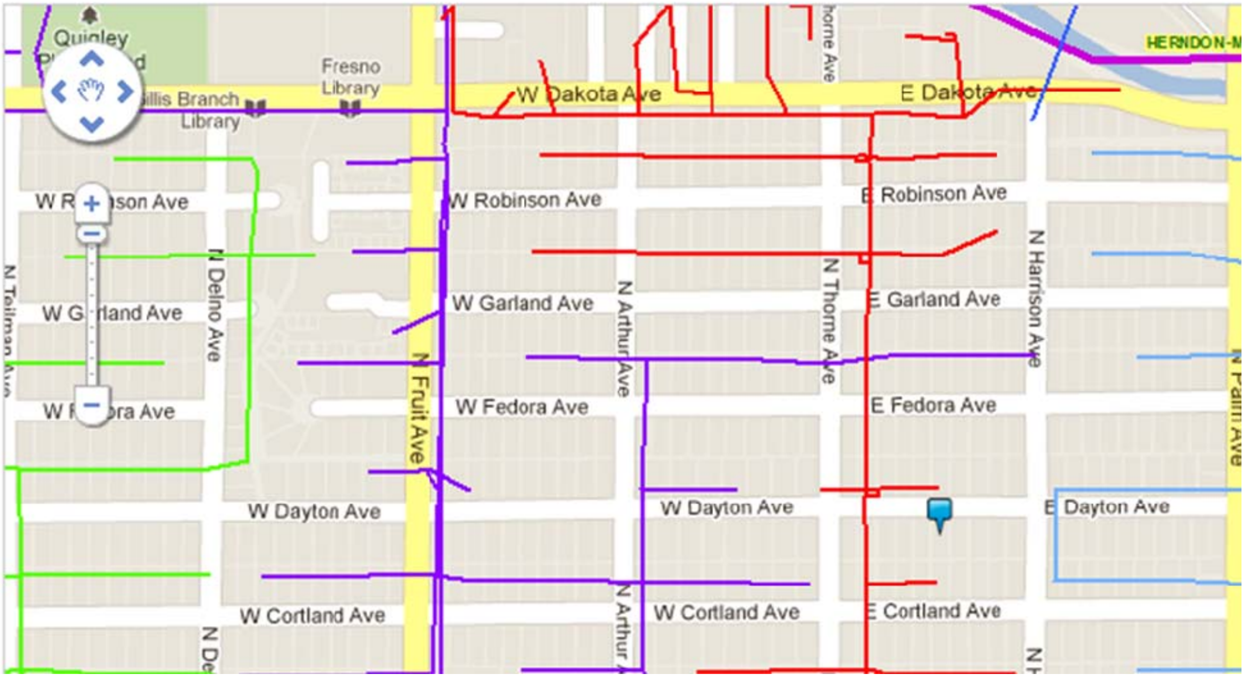
An additional change to the WDAT is the new cluster study process for distribution-connected generators that was approved by FERC for SCE and PG&E.[328] The previous "one-at-a-time" serial approach required the generator who triggers an upgrade to pay 100 percent of the upgrade cost regardless of the size of the project or how many other generators had requested interconnection earlier on the same circuit. Now, if distribution upgrades are required the costs are allocated pro-rata to all generating facilities in the cluster. This allocation is different from the California ISO process in which costs of transmission upgrades are socialized and developers are not required to absorb the costs.[329]

327 133 FERC ¶ 61,223, United States of America, Federal Energy Regulatory Commission, California Independent System Operator Corporation, Docket No. ER11-1830-000, December 2010.

328 SCE WDAT Revision at FERC, http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20110301-5198; PG&E WDT Revision at FERC, ¶ 61,094, United States of America, Federal Energy Regulatory Commission, Order Conditionally Accepting Tariff Revisions and Denying Motions in favor of PG&E's WDT amendment, April 29, 2011.

329 Docket 11-IEP-1G and 11-IEP-1H Distribution Infrastructure and Smart Grid, SCE Follow-up Comments Regarding the Committee Workshop on Distribution Infrastructure Challenges and Smart Grid Solutions to Advance 12,000 Megawatts of Distributed Generation, pp. 4-5.

Figure 20: Example of PG&E's Interconnection Map Showing Circuit Detail



Source: California Energy Commission. Image generated using PG&E's PV RAM Program with residential address in Fresno, CA. Colors indicate different line segments throughout the sample area.

Another effort to improve the interconnection process is the Re-DEC working group, formed by the CPUC in 2009, to identify and address the challenges associated with system-side renewable DG.[330] The CPUC held Re-DEC workshops in December 2009 and March 2011. The CPUC plans to convene the Re-DEC twice a year and is planning a workshop for the fall of 2011. Re-DEC members include utility grid operators, renewable DG project developers, renewable DG technology experts, and policymakers. The Energy Commission is working closely with the CPUC and the Re-DEC working group to develop technical and policy solutions that will support timely, least-cost, and successful interconnection of renewable DG. In particular, the Energy Commission leveraged earlier PIER research for a pilot study with the CPUC to evaluate the use of advanced analytics to identify and screen locations on the distribution system where DG projects can be interconnected safely without triggering expensive system upgrades. This study is being used to identify what new interconnection study processes can be used to achieve faster and more efficient study timelines for interconnection.

Lessons Learned from Germany and Spain

The Energy Commission and the California ISO are currently funding a study by KEMA on the experience in Germany and Spain with integrating large amounts of DG. The study was

330 CPUC Re-DEC website: http://www.cpuc.ca.gov/PUC/energy/Renewables/Re-DEC.htm.

discussed at the May 9, 2011 IEPR Committee Workshop on Renewable Localized Generation and compares key similarities and differences in California's grid structure to identify lessons that be applied to California from the European experience.[331]

Germany and Spain have interconnected and integrated high penetrations of renewable DG without significant modifications to their existing distribution grid infrastructures. Following the May 9, 2011 workshop, KEMA prepared a draft report responding to feedback. The draft report notes the following similarities between the California, German, and Spanish distribution systems:

- There is general correlation between nominal voltage levels used for the extra-high, high, medium, and low-voltage alternating current (AC) network levels in all three systems.
- Most of the DG PV in Germany and Spain is currently not visible to the system operator or equipped with remote curtailment capability. This contributed to a large-scale operating emergency in Germany on September 6, 2010, when a large deviation occurred between the forecast for the day ahead and the actual PV output (over 7,000 MW more than expected due to errors in forecasting and weather changes). This unexpected deviation in PV output far exceeded the negative balancing reserves available in the German grid and resulted in a very costly dumping of electricity to neighboring countries. This highlighted the need for expanding the ability to curtail generation from DG PV to reduce the risk of excess generation, as well as the need to install telemetry that provides PV output data to grid operators in real-time and related improvements to forecasting methods for DG PV. Germany is taking steps to retrofit existing systems with this technology. California could encounter a similar problem as the amount of DG PV increases unless the system operator has telemetry and curtailment capability for a significant portion of the PV or there is some means of limiting the output from DG PV when excessive levels are forecast.
- Many California distribution lines have voltage levels similar to medium-voltage (for example, 10 kV to 30 kV) distribution lines in Germany and Spain. However, based on the looped (dual source) arrangement often used for medium-voltage lines in Germany and Spain, the capacity of many medium-voltage lines in California is probably lower than in Europe. Also, most medium-voltage lines in California need key upgrades to protection systems and/or voltage regulating equipment to be able to accommodate high levels of DG.
- With appropriate changes to protection and voltage regulation, high-voltage distribution lines in California (such as SCE's 66 kV and 115 kV lines) should be able to handle similar DG levels as high-voltage (45 kV – 132 kV) distribution lines in Germany and Spain. This is also true of SDG&E's 138 kV and 69 kV systems and much of PG&E's 115 kV system, although technically they are considered transmission (not distribution) and are under the California ISO's operational control.

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331 Christian Hewicker, KEMA, May 9, 2011 IEPR Workshop, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/presentations/04_KEMA_Morning_5-9-11.pdf.

Differences between the California, German, and Spanish distribution systems that could limit DG expansion in California include:

- Many of the older medium-voltage distribution lines in California are lower voltage than typical medium-voltage lines in Europe. For example, California has a substantial number of older distribution lines with a voltage level below 5 kV, which can accommodate much less DG than higher voltage lines. Upgrading the design voltage of existing distribution feeders would be costly.
- In Germany, standard distribution protection relay system designs allow back-feed on feeders and from distribution to transmission voltages. The existing protection systems on distribution lines and substations in California are not typically designed or configured to handle back-feed. Widespread relay modifications would be required to make this possible.
- Medium-voltage distribution lines in California typically branch out from a substation to individual end-users in a radial configuration, but medium-voltage grids throughout Germany (and in urban areas in Spain) are normally laid out in loops. In general, a looped configuration can accommodate higher levels of DG than a radial configuration. Converting existing California feeders to this topology would be costly.
- Both medium-voltage and low-voltage (such as 400 Volt) distribution grids in Germany and Spain are always built using three-phase construction, and in many cases low-voltage grids also use a looped or networked design. Almost all low-voltage ("secondary") grids in California are a radial design and use single-phase construction, and many sections of the medium-voltage grid in California are also single phase. While selective conversions of medium-voltage feeder sections to three-phase could be used to integrate individual DG projects in California, the uniform use of three-phase low voltage networks in Europe may make it easier in general to connect smaller DG projects in the 5 kW to 50 kW range than in California. Widespread conversion of low-voltage (secondary) grids in California to three-phase design is infeasible.
- Other than DG PV, renewable energy interconnected to the distribution system in Germany, 100 kW and above, is required to have telemetry and remote control. New rules introduced in 2011 in Germany will extend this requirement to many PV projects in an effort to provide grid operators with the level of DG observability and control needed for reliable grid operation. Such requirements are not currently in place in California and may create an impediment to maintaining grid reliability.

In Germany, about 18 GW of solar PV capacity has been installed[332] without sweeping changes to distribution infrastructure beyond local distribution upgrades near the distributed generation interconnection.[333] This has been possible, in large part, because the German distribution grid

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332 Corfee, Karin, D. Korinek, C. Hewicker, M. Pereira Morgado, H. Ziegler, J. Zillmer and D. Hawkins, KEMA. *Distributed Generation in Europe*. California Energy Commission, Renewable Energy Office. Expected September 2011.

333 Ibid.

uses fault and overload protection system design that can accommodate backflow. In contrast, much of California's distribution grid cannot currently accommodate backflow. One solution identified in the KEMA study could be changing protection system equipment at the feeder level where it may be possible to simply modify settings on newer solid-state (microprocessor based) relays already installed on some feeders, and in other cases replace older electro-mechanical over-current relays with solid-state relaying, in order to accommodate backflow.[334]

Another approach that can be used to connect significant amounts of DG at relatively low cost is simply to restrict the amount of DG that can be interconnected to feeders, substations, and/or local load areas of the system. Establishing a uniform cap on DG deployment levels, even as an interim measure, minimizes the risk of backfeed and other impacts on grid operation.[335] Spain has placed a limit on the amount of DG that can interconnect to each load area, medium-voltage distribution facility and low-voltage distribution facility to 50 percent of the respective demand level. They also impose strict limits on DG short-circuit contribution.[336] As a result of implementing these restrictions, Spain has experienced only minimal backfeed issues to date.[337]

In California, transmission system operators can monitor or control very few electricity generation systems smaller than 20 MW.[338] The KEMA study suggests that this lack of observability and control poses a serious constraint to the total amount of intermittent renewables that can be integrated into California's grid.[339] At the May 9 IEPR workshop, the California ISO noted that a thoughtful approach is needed to establish observability and control while containing costs.[340] Based on experience with high penetrations of renewable DG in Germany and Spain, the KEMA study suggests that:

> ". . . it would be beneficial to explore the range of DG scheduling/redispatch/ curtailment options that could be implemented in DG interconnection agreements, tariffs and market models in California to increase participation by DG producers in

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334 Ibid.

335 E3 study for CPUC Energy Division staff as cited in Appendix B of Feed-in Tariff for Renewable Generators Greater Than 1.5 MW Energy Division Staff Proposal March 27, 2009. Available as Attachment A to CPUC Administrative Law Judge's Ruling on Additional Commission Consideration of a Feed-In Tariff, Rulemaking 08-08-009, http://docs.cpuc.ca.gov/efile/RULINGS/99105.pdf. For example, Figure 1 of this E3 study suggests that more than 500 IOU distribution substations can interconnect 10 MW or more of renewable distributed generation "without the need for upgrades." (p. 6) See also 2009 IEPR, http://www.energy.ca.gov/2009publications/CEC-100-2009-003/CEC-100-2009-003-CMF.PDF, p. 198.

336 Corfee, Karin, D. Korinek, C. Hewicker, M. Pereira Morgado, H. Ziegler, J. Zillmer and D. Hawkins, KEMA. *Distributed Generation in Europe*. California Energy Commission, Renewable Energy Office. Expected September, 2011.

337 Ibid.

338 Ibid.

339 Ibid.

340 Heather Sanders, California ISO, May 9, 2011 Workshop Transcript, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/2011-05-09_Transcript.pdf, p. 184.

> supporting the operational reliability needs of the distribution and transmission grids. Regulators can help to steer the direction of such options through policies regarding equitable compensation for curtailments, lost opportunity costs, and so forth."[341]

Due to recent operating experience with renewables, Germany has passed new legislation updating the telemetry and control requirements for DG PV.[342] If this legislation becomes law, the following requirements will take effect in 2012:

- Telemetering and remote control for new and existing PV installations larger than 100 kW. Existing installations will have six months to comply.
- Technical equipment for remote control for PV systems between 31-100 kW that began operating in 2009 or later. Existing systems have until 2014 to comply; however, telemetering will not be required.
- PV systems 30 kW and smaller must either have technical equipment for remote control or limit active power to 70 percent of the PV system's capacity. Telemetering will not be required.[343]

As discussed in Chapters 5 and 9, improved forecasting of wind and solar can improve integration by providing grid operators with better information about expected generation from such facilities. While Germany and Spain have developed excellent forecasting methods for these technologies, forecasting improvements have not yet been widely adopted at the distribution level in Germany:

> "Forecasts for wind and solar power are mainly used by the German TSOs today, whereas DNOs have not made regular use of such tools so far. A recent position paper by the federal regulator … explicitly called on DNOs to implement adequate forecast methodologies by April 1, 2011. This new requirement stems from the increase of forecast errors for solar power in 2010, resulting in the need [to] activate 100 percent of all contracted operating reserves for several hours on September 6, 2010. However, it is important to note that the corresponding provisions of the position paper are not immediately binding for DNOs. It remains to be seen how German network operators will implement them in practice."[344]

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341 Corfee, Karin, D. Korinek, C. Hewicker, M. Pereira Morgado, H. Ziegler, J. Zillmer and D. Hawkins, KEMA. *Distributed Generation in Europe*. California Energy Commission, Renewable Energy Office. Expected September, 2011.

342 Ibid.

343 Corfee, Karin, D. Korinek, C. Hewicker, M. Pereira Morgado, H. Ziegler, J. Zillmer and D. Hawkins, KEMA. *Distributed Generation in Europe*. California Energy Commission, Renewable Energy Office. Expected September 2011.

344 The position paper mentioned here is Bundesnetzagentur. Positionspapier zur verbesserten Prognose und Bilanzierung von Solarstromeinspeisungen. November 2010. As cited in KEMA, Memo 2, p. 15.

Chapter 7: Investment and Financing Issues

The financial crisis of 2008 has had a significant impact on the development of renewable energy projects. Repercussions are still being felt by investors, developers, and consumers. Federal stimulus funding through the American Recovery and Reinvestment Act of 2009 (ARRA) offered short-term relief to the sector and stimulated job growth and economic recovery while advancing technology deployment. Although California was a significant beneficiary of these programs, ARRA's provisions are nearing their end and renewable development in California will revert to traditional financial markets and project finance strategies unless the ARRA programs can be extended.

This chapter identifies key financing challenges that face renewable energy development. Consumer education, renewable technology advancement, and generous financial support have enabled market growth during troubled economic times. However, when compared to other infrastructure-dependent sectors, such as transportation, renewable energy development is still a young asset class. Renewable development does not enjoy the same technological, financial, and marketplace advantages afforded to traditional infrastructure whose supply markets and support structures are more mature.

The chapter begins by describing the stages involved in successful development of renewable technologies. Financing the renewable energy value chain from research to commercial deployment is time and capital intensive and fraught with many technological, project management and financing challenges. Technology complexity, high capital and transaction costs, and a suite of market subsidies combine to complicate utility and consumer choices when deciding to invest in renewable generation technologies. Financing early stage, large commercial or utility-scale renewable projects includes additional challenges and risks such as designing the appropriate project finance structures and investment partners, quantifying and pricing risk, and meeting required internal rates of return. Additionally, once technologies are commercialized, risk remains over the life of a project for such elements as operations and maintenance and product replacement.

Financing challenges to developing both utility-scale and distributed generation (DG) renewable energy projects include funding gaps in the research and development (R&D) and early commercial stages that can affect project development. This chapter describes the role of private and public investment in energy-related R&D, including "angel" and venture capital investors, as well as investment in basic research by universities. In addition, given the significant capital required in the early commercial stage of project development to address technology performance issues and regulatory risk, the chapter discusses the role of power purchase agreements and financing instruments, like debt and tax equity, in resolving barriers to renewable development.

The chapter also describes current efforts underway to address these financing gaps, which include R&D at the state and federal levels, tax incentives, accelerated depreciation, and loan and bond financing programs. Efforts in neighboring states and countries are also highlighted. The chapter provides examples of projects in the financing process that illustrate capital needs, funding sources used, and issues encountered during project development.

Description of Challenges to Financing Renewable Technologies

Financing renewable energy from research and development to project deployment is dynamic and capital intensive. Successful development of renewable technologies includes five stages (Figure 21). Each of these stages requires significant resources to complete and developers and companies face critical financing gaps that must be addressed for technologies to move to commercial maturity in a timely manner.[345,346]

- R&D: In this stage, ideas and intellectual property are generated and tested. Generating intellectual property is critical and its successful development can leverage needed funds further along the development continuum. Nevertheless, it is a high-risk stage for potential investors given high failure rates.
- Demonstration/proof-of-concept: This stage includes building the company, designing and testing prototypes, and further developing intellectual property. Proof-of-concept is needed to demonstrate the feasibility of an idea or technology.
- Pilot facility: The pilot facility stage is characterized by a technology that moves out of the laboratory to be proven and validated in the field. Data and results are quantified to improve the prototype and to provide technical information to potential investors. In this phase, companies also begin to market the technology.
- Early commercial: In this stage, a company demonstrates the viability of its technology at scale and also proves that manufacturing and/or power generation can be economically scaled.
- Commercial maturity: This is the widespread adoption stage in which a technology is commercially proven, sold, and distributed at scale.

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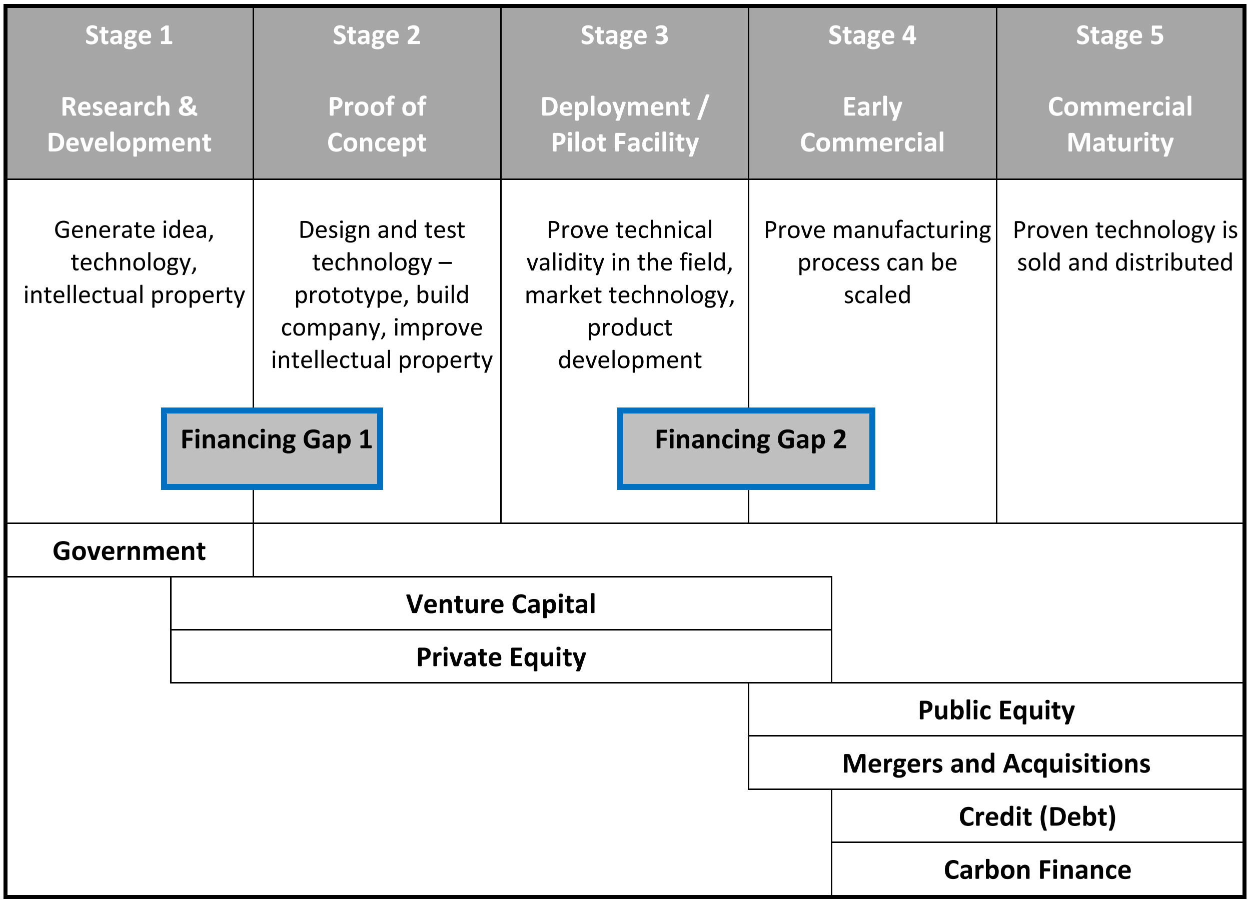
345 Bloomberg New Energy Finance, *Crossing the Valley of Death: Solutions to the Next Generation Clean Energy Project Financing Gap*, June 21, 2010, http://bnef.com/free-publications/white-papers/.

346 The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? G-20 Clean Energy Factbook,* 2010, http://www.pewtrusts.org/our_work_report_detail.aspx?id=57969.

Figure 21: Primary Capital Investment for Renewable Development



Source: The Pew Charitable Trusts, Bloomberg New Energy Finance

The availability of financing is a crucial element in the development continuum. In particular, funding gaps in the R&D and early commercial stages can affect the ultimate development of a renewable project. The inherent uncertainties involved in R&D can make it difficult to obtain financing, and significant capital is required in the early commercial stage to address technology performance issues and regulatory risk.

Financing Research and Development

California is endowed with abundant natural resource assets. These assets lend themselves to renewable development but first require research and development, resource assessment, and use impacts. As such, California requires public and private investment in research and development that differs from the other states due to its variety of renewable resources. However, a recent American Enterprise Institute report[347] indicates that despite a clear

347 American Enterprise Institute, *Post-Partisan Power: How a Limited and Direct Approach to Energy Innovation can Deliver Clean, Cheap Economic Productivity and National Prosperity*, October 2010, http://www.aei.org/docLib/Post-Partisan-Power-Hayward-101310.pdf.

innovation imperative, neither public nor private sector currently invests the resources required to accelerate clean energy innovation and drive down the cost of clean energy. Multiple barriers prevent private firms from adequately investing in new technologies including the higher price of clean energy technologies, knowledge spillover risks from private investment in research, inherent technology and policy risks in energy markets, the scale and long time-horizon of many clean energy projects, and a lack of wide-spread enabling clean energy infrastructure.

Figure 21 shows the hypothetical funding need and financing gaps associated with renewable technology development. Externalities and challenges exist in R&D that can lead to financing gaps (Financing Gap 1 in Figure 21) and less than socially optimal technology innovation. The International Energy Agency estimates that globally, solar and wind energy technologies are facing an annual R&D shortfall of between $2.68 billion and $6.28 billion.[348] To a large extent, knowledge is a public good. In economic terms, it is non-excludable and non-appropriable because it is difficult for owners to establish enforceable property rights or to dole out usage rights to particular individuals. Because almost anyone can access the knowledge developed in R&D and a private firm cannot monetize all the public benefits and spillovers of its R&D, private companies tend not to invest in the level of R&D that is most beneficial to society. Patents help reduce this concern but generally offer limited protection for intellectual property rights. The underinvestment in R&D can be further exacerbated for clean energy technologies because the positive environmental attributes of these technologies, like greenhouse gas emission reductions, may not be adequately valued in the market.

Other R&D challenges increase risk due to the high variance of the distribution of expected returns, the specialized and sunk (and as such not transferable) nature of the asset, and intangibility.[349] Uncertainty and intangibility make financing through capital markets difficult since investors typically want some certainty of return on their investment. Information asymmetry, where one party has better information than another, can exacerbate uncertainty since a technology developer is in a better position to assess the potential of a technology than investors, so investors will require bigger return to address this uncertainty.

These challenges and the decentralized and multi-firm nature of start-up markets contribute to a financing gap for R&D. This financing gap is particularly noticeable for energy-related R&D. Although overall R&D investment in the United States has grown annually by 6 percent, investment in energy-related R&D is about $1 billion less than a decade ago. The private sector's share of energy R&D investment has also declined to 24 percent from nearly half in the

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348 International Energy Agency, *Global Gaps in Clean Energy RD&D*, 2010, http://www.iea.org/papers/2010/global_gaps.pdf, p. 15.

349 Intangibility is used in marketing to describe the inability to assess value gained from engaging in an activity using any tangible evidence. Palmer, Adrian (2000). Principles of Marketing. Oxford: Oxford University Press. p. 631.

1980s and 1990s. For comparison purposes, total private sector energy R&D is less than the R&D budgets of a few large individual biotech companies.[350]

Corporate R&D spending (reinvestment) can be a significant driver of new technology development. However, the National Science Foundation[351] has indicated that corporate R&D spending as a percent of domestic sales in 2008 was 25 percent for communications, 15 percent for software, and only 0.3 percent for energy, which is spent primarily on improving current technologies and not in the development of new technologies. This underinvestment in the renewable energy sector must be filled up with other funds to ensure next generation, lower cost technologies are developed. The public sector, therefore, can play a critical role in accelerating the demonstration of new clean technologies in the absence of private funding.

Contrary to private and public sector investment trends, venture capital investments continue to increase and are still on the same scale as private R&D by large companies. The contribution of venture capital firms to innovation is especially important since studies have found that in general, venture capital investment is 3-4 times more effective than R&D at stimulating patenting.[352]

The biggest private sector actors in the R&D stage are "angel investors." An angel investor is typically an individual or a network of individuals with the ability to provide capital to start-ups in exchange for ownership equity or convertible debt.[353] Such capital fills the gap between seed funding—usually provided by the start-up members and their friends and family—and venture capital. Angel capital typically ranges from the hundreds of thousands of dollars to less than $2 million.

The angel investor market has improved greatly since the financial crisis. After declines of 26.2 percent in 2008 and 8.3 percent in 2009, total angel investments in the United States in 2010 increased 14 percent over 2009 to $20.1 billion, according to a study by the University of New Hampshire's Center for Venture Research. The clean tech sector received approximately 8 percent (about $1.6 billion) of those investments. The study also reported that roughly 61,900 start-ups (8.2 percent more than 2009) received funding from about 265,400 individuals (2.3 percent more than 2009) in 2010. However, the study also revealed that angel investors have

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350 Nemet, G.F. and D.M. Kammen (2007) \U.S. energy R&D: declining investment, increasing need, and the feasibility of expansion" Energy Policy 35(1): 746-755, http://www.sciencedirect.com/science/article/pii/S0301421505003551. Authors note that the figures provided were for pre-ARRA funding. The current trend of R&D is unclear given uncertainty about the impact of ARRA funding.

351 National Science Foundation, *US Business Report 2008 Worldwide R&D Expense of $330 Billion: Findings from New NSF Survey,* May 2010, http://www.nsf.gov/statistics/infbrief/nsf10322/nsf10322.pdf.

352 Kortom S. and Lerner J. 2000. "Does Venture Capital Spur Innovation?" Rand Journal of Economics 31, 674-692.

353 Convertible debt is the option of converting an outstanding balance due to some other form of security or asset.

lessened their interest in this stage of technological development as seed or start-up capital decreased in 2010 by 4 percent from 2009.[354]

The financing gap (Financing Gap 1 in Figure 21) for energy-related R&D may also persist at the proof-of-concept stage as companies continue to require capital for applied research and pre-commercial growth and activities. The most active private sector actors in this stage are angel investors and venture capital (VC) firms. Venture capital firms invest the financial capital of third-party investors in enterprises that are too risky or too complex for the standard capital markets. Targeted investments are early-stage and high-potential startups that have already received seed investments and have a technology and idea beyond the initial R&D stage. When analyzing a potential investment, VC firms look closely at the technology, business model, management team, potential market size, capital requirements, and how long it will take to scale, among other considerations. The ultimate goal of making these investments is to earn significant financial returns, usually accomplished by way of an initial public offering or trade sale. Sectors of great interest to VC firms are biotechnology, information technology, software, and clean technology.

According to a study conducted by Ernst & Young,[355] in 2010 United States venture capital investment in clean tech companies increased by 8 percent from 2009 levels to $3.98 billion and the number of total deals increased 7 percent to 278. In a more recent study, Ernst & Young reported VC investment in clean tech companies increased 54 percent to $1.14 billion in the first quarter of 2011 over the same period last year, with California accounting for 56 percent of total investments.[356]

California perennially tops the list of regions impacted by venture capital. The state's continued strength flows from a number of factors. Unlike other regions of the United States, California is home to more than one venture hub: Silicon Valley in the north, San Diego in the south, and a burgeoning new corridor in Orange County. Also, California-based venture-backed firms and their investors have worked consistently with state policymakers to ensure that young innovative start-ups and the technologies they develop have the opportunity to grow and succeed within the state's larger business climate. These factors have led to nearly $200 billion in venture investment in California since 1970.[357]

Historically, state and federal government have played a pivotal role in funding research and demonstrating high-risk technologies through direct procurement. The state provides funding

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354 Center for Venture Research, University of New Hampshire, *The Angel Investor Market in 2010: A Market on the Rebound*, 2010, http://www.unh.edu/news/docs/2010angelanalysis.pdf.

355 "US Venture Capital Investment in Cleantech Grows to Nearly $4 billion in 2010, an Increase from 2009," Ernst and Young, February 2011, http://www.ey.com/US/en/Newsroom/News-releases/US-venture-capital-investment-in-cleantech-grows-to-nearly-4-billion-Dollar-in-2010.

356 http://www.ey.com/US/en/Newsroom/News-releases/US-VC-investment-in-cleantech.

357 National Venture Capital Association, *Venture Impact: The Economic Importance of Venture Capital-Backed Companies to the U.S. Economy,* 2009, http://www.nvca.org/index.php?option=com_content&view=article&id=255&Itemid=103.

for research primarily through the state and private universities. The University of California research system received more than $4.3 billion in total research funding in fiscal year 2009-10, produced more patents than any university in the nation, and secured $8 in federal and private dollars for every $1 in research funding provided. In addition to directly funding energy research, the university system contributes to technology transfer and the overall development of the state's expertise in renewable generation technologies. The Public Interest Energy Research (PIER) Program (see Chapter 9) funds public and private entity research, in addition to universities, and has a significant R&D role in renewable technologies. In addition to direct funding impacts, PIER has seed funded incubators such as the Sacramento Area Regional Technology Alliance (SARTA) and the Environmental Business Cluster which accelerates growth and development of technology. Fostering R&D through such organizations as SARTA, CleanTECH San Diego, CleanTechOC, Clean Tech Los Angeles, Silicon Valley Leadership Group, Greenwise Sacramento, and the Bay Area Council is important to renewable energy technologies. These entities serve young companies and provide economic benefits that accrue to local communities.

The state's Innovation Hub (iHub) initiative stimulates partnerships, economic development, and job creation around specific research clusters through state-designated iHubs. The iHubs leverage assets such as research parks, technology incubators, universities, and federal laboratories to provide an innovation platform for startup companies, economic development organizations, business groups, and venture capitalists. The support and integration of innovation hubs embedded deeply into the local landscape is a community asset, meets research needs, and sustains economic development.

The federal government is the primary source of funding for basic research across all sectors, providing some 60 percent of funding, with the second largest source of basic research funding coming from the academic institutions themselves. Universities conduct the majority of basic research in the United States (55 percent in 2008) with business and industry conducting less than 20 percent.[358]

Financing Early Commercial Development

Another financing gap (Financing Gap 2 in Figure 21) occurs at the early commercial stage of development. Early commercial can be defined as one of the first three to five deployments at a scale that generates revenue and within the size range consistent with a company's long-term rollout plan.[359] In this stage, companies and technologies face the convergence of high capital needs and scarcity of capital. Significant capital is needed to finance projects to demonstrate the viability of a technology at scale, as well as to prove that the manufacturing and/or power generation can be economically scaled. It should be noted that there is a significant difference in

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358 "Sparking Economic Growth: How Federally Funded University Research Creates Innovation, New companies and Jobs," The Science Coalition, April 2010, http://www.sciencecoalition.org/successstories/.

359 California Clean Energy Fund, *From Innovation to Infrastructure: Financing First Commercial Clean Energy Projects*, June 2010, http://calcef.org/2010/06/01/from-innovation-to-infrastructure-funding-first-commercial-clean-energy-projects/.

installed renewable capacity between the residential and commercial sectors for early commercial technologies that can be attributed to 1) greater federal tax benefits and accelerated tax depreciation provided to commercial systems, (2) the larger commercial project size,[360] and (3) the appropriate project finance structure.

Project finance varies according to project scale, risk profiles, and financing structure. Small-scale renewable systems, often found on residential and small commercial properties, have limited financing options. These include established financing tools such as equity loans and cash in combination with applicable public programs. Alternatives including leases, small-scale power purchase agreements, and on-bill financing are also solutions.[361] New financing opportunities, such as third-party models, open up for community scale systems. Partnering with an investor such as project developers and other organizations can also take advantage of tax and depreciation benefits through various partnership structures and power purchase agreement models to reduce costs.[362] Utility or large scale renewable projects are most commonly financed by a combination of equity and debt. Financings include the use of corporate balance sheets, use of debt (loan guarantees), equity (1603 cash grants)[363], and asset depreciation.

The U.S. Partnership for Renewable Energy Finance has noted several emerging renewable technologies are currently at or are anticipated to be at this commercial juncture in the next three years. Technologies such as concentrating solar-power towers, advanced solar manufacturing, and energy storage will encounter this financing gap should funding not be available as these technologies need significant capital to reach further deployment and commercial maturity. These technologies are currently seeking approval for U.S. Department of Energy Loan Guarantee Program funding which could be leveraged for additional private capital. However, it should also be noted that funding for traditional renewable technologies such as solar PV, wind, and geothermal will also require funding to advance these technologies in the market.[364]

Traditionally, private equity, debt, and tax equity markets have served as options to firms in this stage. However, since the financial crisis these options are either impractical given economic conditions, depend on government incentives to function well, or do not provide sufficient returns for investors. Project finance options and financing structures have evolved in response to the patchwork of incentives and the preferred choice depends on a host of factors

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360 Ernest Orlando Lawrence Berkeley National Laboratory, *Financing Non-Residential Photovoltaic Projects: Options and Implications*, January 2009, http://eetd.lbl.gov/ea/EMS/reports/lbnl-1410e.pdf.

361 http://www.nrel.gov/docs/fy09osti/44853.pdf.

362 http://www.b-e-f.org/business/files/downloads/2011/02/49930.pdf.

363 http://eetd.lbl.gov/ea/ems/reports/63434.pdf.

364 The Importance of the Loan Guarantee Program in Financing Innovative Renewable Technologies, US PREF, February 2011.

including return and yield rates, presence of a tax investor, cash and financial position (balance sheet financing), exit strategies, and risk-adjusted mitigation measures. Financial innovations are increasingly reducing investment barriers such as high upfront costs, technology and performance risk, and low tax credit appetite. These mechanisms allow investors to extract maximum value from the myriad of local, state, and federal support programs.

Equity

This particular financing gap has posed a challenge for equity investors such as angel investors, venture capital firms and other early-stage investors accustomed to traditional technology companies speedy and relatively low-cost paths to commercialization. First, capital requirements for renewable energy projects can be tens to hundreds of millions of dollars, depending on size and technology, for a single project. This is beyond the capacity and appetite of the great majority of VC firms. These renewable projects also rely heavily on project finance, which is not the traditional business model used by venture capital firms. Project finance relies heavily on the complex management of project risks, mitigation strategies, legal and commercial structuring, significant debt financing, and coordination with a variety of stakeholders, including contractors, large industrial partners and potential customers. Lastly, private equity firms, particularly VC firms, anticipate higher equity returns than those expected (low to mid teens) from renewable energy projects.

Debt

Two other means by which project developers might access debt financing is through loans or bonds. Some developers are able to use their own balance sheets to guarantee repayment on such debt; however, if that is not possible or preferred, a project finance structure is pursued. Access to project finance debt requires sufficient equity from the developer or a sponsor company, external investors and/or strategic partners. This equity would be invested in a special purpose project company. In either case, the combination of this equity with limited recourse project-level debt would fund the capital cost of the project.

The financial crisis of 2008 significantly impacted the debt markets.[365] Financial institutions found it difficult to secure money to lend and to syndicate and underwrite loans. Therefore, available capital became limited and competitive within a financial institution's varying business priorities. This led to the cost of lending rising substantially and unfavorable loan terms, with many banks reluctant to offer long terms for debt. Non-core or new clients found accessing debt very difficult. It has been recently with the advance of stimulus financing solutions, that renewable energy projects have aggressively pursued debt financing. With the reduced need for tax equity providers to assist in financing projects due to the United States Department of Treasury cash grant program and the Department of Energy loan guarantee program (described later in the chapter), project developers now seek debt to finance project construction.

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365 United Nations Environment Programme Sustainable Energy Finance Initiative, Virginia Sonntag-O'Brien, *Private Financing of Renewable Energy – A Guide for Policymakers*, December 2009, http://www.unep.fr/energy/finance/pdf/Finance_guide%20FINAL.pdf.

Tax Equity

Tax credit incentives and the tax equity market have been key drivers of financing and investment in renewable energy projects until being significantly impacted by the financial crisis. The tax equity market developed because of the need to monetize tax attributes (federal and state investment tax credits) that incentivize renewable energy development. Initially, renewable energy developers typically do not generate taxable income necessary to use these tax credits and, therefore, monetize them by partnering with tax equity investors who can more efficiently use the project's tax benefits. In addition to securing tax benefits, a tax equity investor is seeking a return on its investment from the project.

The tax equity market reached $6.1 billion in 2007 and counted on at least twenty investors. By 2009, the market dropped to $1.2 billion and had lost half of its participants since potential investors no longer had profits to be taxed. Moreover, the credit crisis has increased the required returns by tax equity investors. While in 2008 the internal rate of return for renewable energy deals was around 7.5 percent, estimates now suggest the rate may need to be as much as 15 percent or higher for renewable energy projects to attract investors.[366] In 2010, the market rebounded to about $3 billion and is expected to stay stable through 2012. Hence, the amount of tax equity investment available from traditional sources will be insufficient to fully support near-term renewable energy project development.

Power Purchase Agreements, Feed-in-Tariff, and Renewable Auction Mechanism

Power purchase agreements (PPA) and Feed-in-Tariffs are important in financing projects and securing debt as they provide greater certainty of project revenues.[367] Absent a PPA, a project may not receive the project financing needed to monetize a project's revenue stream. The PPA is especially critical in addressing the early commercial financing gap especially for large commercial projects.

A feed-in tariff (FIT) guarantees payment for electricity, access to the grid, and a stable long-term contract. FITs provide a relatively guaranteed revenue stream and are easy to monetize if they are simple and have a transparent incentive structure. The FIT remains the most widely implemented renewable policy and is in place in at least 61 countries and 26 states/provinces worldwide. Most FIT-related activity in 2010 focused on revisions to existing policies in response to strong markets that exceeded expectations, particularly in the case of PV. New FIT policies were implemented in several developing/transition countries in 2010 and early 2011.[368] Additionally, the three large investor-owned utilities have offered limited FITs for smaller renewable energy projects. The 100 MW FIT offered by the Sacramento Municipal Utilities

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366 National Renewable Energy Laboratory, *Renewable Energy Project Financing: Impacts of the Financial Crises and Federal Legislation*, July 2009, http://www.nrel.gov/docs/fy09osti/44930.pdf.

367 Power Purchase Agreement Checklist for State and Local Governments, NREL October 2009.

368 REN21. 2011. Renewables 2011 Global Status Report (Paris: REN21 Secretariat). http://www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf , p. 13-14.

District (SMUD) was fully subscribed. The Los Angeles Department of Water and Power (LADWP) is proposing a FIT for up to 150 MW.[369]

A 2010 KEMA study recommended specific FIT design characteristics to help keep risk low from an investor's perspective and attract financing for renewable energy projects.[370] However, not all of the recommendations would minimize ratepayer risk or costs. Some of the recommendations recognize that:

- The FIT should provide a long-term contract with price certainty for all revenues. The contract price may step down over time, provided that the price change is stated in the contract. The contract should account for the risk of increases in the price of obtaining feed-stock, where applicable. The contract should be for fifteen to 20 years.
- Because the cost of generation varies across renewable energy technologies, a separate feed-in tariff price level for each technology is recommended, based on cost plus an adequate return on capital, if possible. In the United States, investor-owned utilities and other utilities under the Federal Energy Regulatory Commission's jurisdiction face restrictions related to setting prices for wholesale electricity.[371] The price level offered for future projects should be adjusted periodically to reflect market conditions and place pressure on manufacturers to lower costs of generation over time. The adjustments should maintain a sufficient rate of return for each technology category. The CPUC has adopted a Renewable Auction Mechanism (RAM) for RPS-eligible facilities that are 20 MW and smaller in size. The RAM is different from a feed-in tariff because it selects low-costs bids rather than setting a publicly available price for all applicants. The RAM provides a streamlined contracting process for investor-owned utilities.[372]

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369 For SMUD, see http://www.smud.org/en/community-environment/solar-renewables/pages/feed-in-tariff.aspx. For LADWP, see http://www.ladwp.com/ladwp/cms/ladwp014295.jsp.

370 Corfee, Karin, W. Rickerson, M. Karcher, B. Grace, J. Burgers, C. Faasen, H. Cleijne, J. Gifford, and N. Tong. KEMA. 2010. *Feed-In Tariff Designs for California: Implications for Project Finance, Competitive Renewable Energy Zones, and Data Requirements.* California Energy Commission. Publication Number: CEC-300-2010-006. Sacramento, Calif. http://www.energy.ca.gov/2010publications/CEC-300-2010-006/CEC-300-2010-006.PDF, p. 2.

371 FERC, October 21, 2010. "FERC said a proposal to employ a multi-tiered resource approach for determining avoided costs, which would set different levels of avoided costs and thus different avoided cost rate caps for different types of resources, could comply with the Public Utility Regulatory Policies Act and FERC regulations." http://www.ferc.gov/media/news-releases/2010/2010-4/10-21-10-E-2.asp. For further information, see FERC docket EL10-64 and EL10-66. See also, http://www.ferc.gov/whats-new/comm-meet/2010/071510/E-1.pdf.

372 http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/Renewable+Auction+Mechanism.htm. For proposed modifications to the Renewable Auction Mechanism, see http://www.cpuc.ca.gov/NR/rdonlyres/C12060F4-F23F-4F7C-875B-49B943FF8EA4/0/E4414_Draft_Comment_Resolution.pdf. Proposed modifications are scheduled to be considered by the CPUC on August 18, 2011.

Adoption Strategies

To address the adoption of renewable technologies, California provides various incentives aimed at spurring widespread use. These incentives come in several forms and are administered by several state entities.

- The California Solar Initiative (CSI) offers solar customers of the investor-owned utilities different incentive levels based on the performance of their solar panels. The CSI program has a total budget of $2.167 billion available until 2016 with goals to install approximately 1,940 MW of new solar generation capacity. The CSI-Thermal portion of the program has a total budget of $350 million available until 2017, and a goal to install 200,000 new solar hot water systems. The rebates automatically decline in "steps" based on the volume of MW of confirmed incentive reservations within each utility service territory. There are two incentive paths available to consumers: Expected Performance Based Buydown (EPBB) and Performance Based Incentive (PBI).
- The Emerging Renewables Program (ERP) provides various incentives to encourage the adoption of fuel cells using renewable fuels or small wind turbines. The ERP provides rebates for eligible systems up to 50 kW in size with incentives capped at 30 kW. The current rebate level for small wind is $2.50 per watt for the first 10 kW and $1.50 per watt for any incremental kW up to 30 kW. The current rebate level for fuel cells is $3.00 per watt up to 30 kW.
- The New Solar Homes Partnership (NSHP) provides incentives to home builders to encourage the installation of eligible solar energy systems on new residential construction which will achieve 400 MW of installed PV electricity generation by 2016. The NHSP has a budget of $400 million through 2017.
- The Self-Generation Incentive Program (SGIP)[373] provides various incentives on a per watt basis for specified distributed generation facilities such as wind turbines, fuel cells, and advanced energy storage systems between 30 kW and 5 MW, although the incentives are capped at 3 MW.
- Net Energy Metering (NEM) policy improves the economics of distributed generation by compensating the self-generation distributed generation owner for electricity generated beyond what is consumed onsite. Installed solar generation systems with capacity up to 1 MW and wind with capacity up to 50 kW are eligible for "full retail NEM" and receive a credit from the interconnecting electric utility. Wind projects greater than 50 kW, fuel cells, and agricultural biogas generators are eligible for "generation-rate NEM" and receive a credit from the utility.

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373 For more information, see: http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/.

Current Efforts to Address Financing Challenges for Utility-Scale Renewable Projects

Government has a crucial role to play in four broad areas of renewable energy development and the requisite financing policies and mechanisms needed to address financing challenges. First, it can address gaps in R&D financing by promoting and funding basic research and early technology innovation. Second, it can ease the significant capital costs faced by early stage commercial companies and projects. Third, it can improve access to capital by reducing credit risks. Fourth, the government can develop and maintain stable, predictable regulatory policies that allow for medium- and long-term investment decisions. Providing regulatory certainty assists not only with the funding gaps discussed in this chapter, but also with moving technologies across all innovation stages. Both federal and state governments have created programs to address these concerns, but while both have had significant successes there is room for improvement, expansion, and innovation.

Supporting Early Technology Innovations

Because of the high failure rates inherent in the earliest stages of technological discovery, private markets under invest in this type of basic research. Pushing this knowledge barrier, however, has vast societal and economic value, and is crucial for downstream technology development. This makes early innovation a high-value target for government research.

The public sector is filling this financing gap by way of national government laboratories such as the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory. In addition such programs as the Advanced Research Projects Agency-Energy (ARPA-E) within the U.S. Department of Energy (DOE) and the California Energy Commission's Public Interest Energy Research (PIER) Program offer financing opportunities.

National Laboratory Research

In addition to university research noted above, the national laboratories and technology centers house world-class facilities where cutting edge research is performed and technology/knowledge is transferred.[374] The 21 facilities provide information on various aspects of the environment, science, and energy that is used by myriad international governments, industries, and academia.

For example, the National Renewable Energy Laboratory (NREL) provides a unique service called Renewable Energy Project Finance which analyzes project financing, market issues, and policies. Two of the tools NREL has developed as part of this service include the Renewable Energy Finance Tracking Initiative (REFTI)[375] and the Cost of Renewable Energy Spreadsheet Tool (CREST).[376] The REFTI project is designed to track renewable energy project financing

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374 http://www.energy.gov/organization/labs-techcenters.htm.

375 http://financere.nrel.gov/finance/REFTI.

376 http://financere.nrel.gov/finance/content/CREST-model.

terms including debt interest rates, equity returns, financial structure applied, PPA duration, and other information. The primary goal is to help developers, new investors, utilities and regulators understand project financing terms by technology and project size. CREST is an economic cash flow model to enable public utility commissions and the renewable energy community assess projects, design cost-based incentives (like feed-in tariffs), and evaluate the impact of tax incentives or other support structures. CREST is a suite of three analytic tools for solar (photovoltaic and solar thermal), wind, and geothermal technologies.

Advanced Research Projects Agency-Energy

At the federal level, the Advanced Research Projects Agency-Energy (ARPA-E) funds high-risk, high-reward technologies to bridge the gap between basic energy research and industrial application. Its objectives include:

- Focusing on creative "out-of-the-box" transformational energy research that industry by itself cannot or will not support due to its high risk but where success would provide dramatic benefits for the nation.
- Using an ARPA-like organization that is flat, nimble, and sparse, capable of sustaining for long periods of time those projects whose promise remains real, while phasing out programs that do not prove to be as promising as anticipated.
- Creating a new tool to bridge the gap between basic energy research and development/industrial innovation.

As of April 2011, ARPA-E has awarded $363 million in Recovery Act funding to 121 groundbreaking energy projects based in 30 states, with approximately 39 percent of projects led by universities, 33 percent by small businesses, 20 percent by large businesses, 5 percent by national laboratories, and 3 percent by non-profits.

One of the recipients of this funding is Envia Systems of Newark, California. In partnership with Argonne National Laboratory, Envia Systems received $4 million from ARPA-E in December 2009 to develop lithium-ion batteries with the highest energy density in the world. In January 2011, Envia Systems received an additional $17 million in venture capital funds, including $7 million from General Motors Venture LLC. Another recipient was Stanford University, which received $6.3 million in ARPA-E funding with a $500,000 match from the Energy Commission for a Large Scale Energy Reduction through Sensors Feedback and Information Technology project.

Public Interest Energy Research Program

The Energy Commission supports public interest energy research, development, and demonstration by providing contracts and grants for research and development of energy technologies and related scientific activities. Between 1997 and 2010, the Public Interest Energy Research Program (PIER) has provided approximately $179 million in funding for renewable energy research. The Energy Commission has also provided approximately $4 million in cost-share match for renewable energy projects, which leveraged almost $25 million in DOE funds and nearly $ 71 million in match funds. Past and current PIER funding investments are discussed in detail in Chapter 9. In addition, the Energy Commission's Energy Innovations Small Grant Program provides up to $95,000 for projects to conduct research which "establishes the feasibility of new, innovative energy concepts."[377]

Reducing Significant Capital Requirements

Energy production has high fixed costs, and renewable energy is no exception. High initial capital costs combined with the associated project risks are difficult for the private market to finance, resulting in high attrition of projects as they move into the high capital cost stages of product development (Financing Gap 2 in Figure 21). Different technologies have different capital intensity characteristics and timelines. Furthermore, different classes of investors will face different capital constraints in any given project. These varied challenges cannot be solved by a single policy. Instead, governments provide a number of targeted programs that investors can use. These programs can help projects get the upfront cash necessary to get steel in the ground, boost returns over the life of a project, or work directly to decrease the overall project costs.

Tax Incentives

Tax incentives or subsidies have long served the development of conventional energy. However, these incentives or subsidies are relatively new in supporting renewable generation and are more or less beginning to level the playing field.

Large up-front costs can be a major stumbling block for smaller developers. At the federal level, renewable energy projects are eligible for the business energy investment tax credit (ITC) or the renewable electricity production tax credit (PTC). Under the American Recovery and Reinvestment Act of 2009 (ARRA), the ITC can be converted to a cash grant once 5 percent of a project's overall costs have been incurred in the building process. These grants can offset as much as 30 percent of an eligible project's cost and provide crucial infusions of cash in the early project development stages.

The PTC provides incentives for electricity generated. In 2005, the United States Energy Information Administration conducted an analysis on the effects of the PTC assuming that the PTC would be extended through 2015. The analysis determined that the PTC would increase installed capacity of wind power by 580 percent, biomass by more than 65 percent, and geothermal by more than 20 percent. The analysis also determined that wind power expansion would cease once the PTC expires.[378]

The ITC provides tax credits of 10 percent or 30 percent depending on technology. Section 1603 of ARRA allows eligible projects to claim cash grant in-lieu of the ITC but projects must begin construction by 2012. Project developers indicate that Section 1603 is critical in maintaining the renewable market because of transaction costs. A recent National Renewable Energy Laboratory publication notes that transaction costs associated with tax credits are 60 percent higher than

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377 PIER mission statement.

378 http://tonto.eia.doe.gov/oiaf/aeo/otheranalysis/aeo_2005analysispapers/prcreg.html.

transaction costs for grants (23.3 percent versus 14.5 percent). As of October 2010, over $5 billion in cash grants have been awarded, with $491 million going to California organizations for 337 projects. Of the $5 billion in grants, the lower transaction costs have freed up an estimated $460 million nationwide for developers, allowing these savings to be spent on renewable energy projects.[379]

Uncertainty about continuation of the 1603 Program is problematic to the state and to commercial development of innovative technologies.[380] The US Partnership for Renewable Energy Finance noted that the anticipated total financing available for renewables in 2011 was expected to decrease by approximately 56 percent in 2011,[381] with approximately $7.5 billion in renewable energy projects in California that would not proceed without an extension. The cash grant was extended at the end of 2010 through the end of 2011, but its fate post-2011 is uncertain.

At the state level, the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) in the Treasurer's Office offers renewable energy companies sales and use tax exclusions on property used for their "design, manufacture, production, or assembly." California's Advanced Transportation and Alternative Sources Manufacturing Sales and Use Tax Exclusion Program (SB 71) program have provided some relief from absorbing the complete costs of acquiring assets that manufacture renewable equipment. SB 71 reduces some of the capital requirements of renewable energy manufacturers, allowing these manufacturers to address gaps in private lending. As of August 2011, 31 projects have successfully applied for this exclusion, which will potentially result in $104,074,721 saved on more than $1 billion in qualified property. CAEAFTA also has authority to develop a similar program for renewable energy generation projects. However, plans to implement a program have been put on hold until 2012.

Accelerated Depreciation

The federal government has recently promoted the use of accelerated depreciation to help provide project capital at the front end. Most renewable energy assets can be depreciated over a 5-year period, which reduces taxable income. The impact of accelerated depreciation is significant. A 2009 Lawrence Berkeley National Laboratory study found that the accelerated depreciation schedule reduces total PV system costs by 26 percent. The accelerated nature of the schedule contributes 12 percent, and the remaining 14 percent would also be realized under the traditional 20-year depreciation schedule.[382] The Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 extended the bonus or accelerated depreciation to

379 http://financere.nrel.gov/finance/content/treasury-cash-grant-transaction-costs.

380 Alternative Energy Projects Affected by 1603 Expiry, US PREF, December 2010.

381 Prospective 2010-2012 Tax Equity Market Observations v1.2, US Partnership for Renewable Energy Finance, July 2010.

382 Bolinger, M. (2009). Financing Non-Residential Photvoltaic Projects: Options and Implications. Lawrence Berkeley National Laboratory. LBNL-1410E.

allow 100 percent first year depreciation reduction for qualified renewable energy projects that are placed in service before January 1, 2012.

Loan and Bond Financing Programs

Loan and bond financing programs aim to provide capital at below-market rates. Firms often face major challenges in securing sufficient capital because they lack appropriate project development experience and/or use unproven technologies, therefore posing credit risks. The federal government has stepped up in a significant way to minimize this risk.

Under ARRA, the United States Department of Energy has offered competitive loan guarantee programs designed to "support innovative clean energy technologies that are typically unable to obtain conventional private financing due to high technology risk." The loan itself is still provided by private lenders, but federal underwriting protects investors from the risk of default and lowers interest rates on borrowed capital.

Established in 2005 to spur investment through private lending, the United States Department of Energy Section 1703 loan guarantee program partially addressed high technology risk and financing gaps for innovative technologies. In 2009, the Section 1705 loan guarantee program (LGP) was established under ARRA to address commercial technologies. Until the end of the 2010, the key difference between the two programs was federal payment of the credit subsidy costs for Section 1705.[383] Currently, both 1703 and 1705 programs are eligible for federal payment of the credit subsidy cost and are significant financial tools for progressing commercial technologies. The United States Partnership for Renewable Energy Finance notes that elimination of the federal payment of the credit subsidy costs will require borrowers to pay the subsidy, substantially reducing the internal rate of return on a project.[384]

The LGP mitigates financing risks associated with clean energy, and has received more than 400 applications and committed nearly $31 billion to support 31 clean energy projects across 21 states.[385] This represents a greater investment in clean energy generation projects than was made by the entire private sector in 2009 ($10.6 billion), and almost as much as was invested in such projects in 2008 – the peak financing year to date ($22.6 billion). There are nine California projects taking advantage of the LGP for a total value of more than $11 billion. The U.S. DOE has recently indicated to some companies the likely approval or rejection of their applications, as the review process is lengthy. The fate of all project proposals is not yet known, but the recent notifications help provide applicants with time to adjust course prior to the September 30, 2011 construction start requirement.[386]

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383 https://lpo.energy.gov/?page_id=2975.

384 US Partnership for Renewable Energy Finance, "Prospective 2010-2012 Tax Equity Market Observations v1.2," July 2010, http://www.novoco.com/energy/resource_files/reports/us_pref_tax-equity-market_0710.pdf.

385 https://lpo.energy.gov/?page_id=45 accessed June 3, 2011.

386 "Cleantech Loan Guarantees: A Tangled Tale," Pete Danko, May 2011, http://www.earthtechling.com/2011/05/cleantech-loan-guarantees-a-tangled-tale/.

A lesser-known program is the United States Department of Agriculture's Rural Utilities Service (RUS) program, which can provide renewable energy developers with Treasury and municipal rate loans and loan guarantees. The RUS loan and loan guarantee programs, which can also be used for other electrical utility infrastructure (distribution, transmission and utility facilities), were funded at $6.6 billion for fiscal year 2009 and at $7.1 billion for fiscal year 2010. In 2010, $313 million was awarded in loans and loan guarantees to renewable energy applicants. Such programs can be useful for California-based projects as other federal programs sunset and renewable energy development continues in rural areas like the Central Valley and Imperial Valley. Potential is exemplified in the $204 million loan guarantee announced by the RUS program for PrairieWinds wind farm, a 151.5 MW, $340 million project in central South Dakota.

Financing projects using bonds can be a straightforward financing option and has been used at the federal and state level. The federal New Clean and Renewable Energy Bonds (CREBS), tax-exempt bonds issued by public entities, have provided over $2.4 billion in authority with California having issued approximately $640 million in project financing. Federal Qualified Energy Conservation Bonds (QECBs), tax credit bonds issued by public entities, have provided more than $3.2 billion in authority with California having issued approximately $381 million in project financing.[387] There are several state and local entities that issue bonds including CAEATFA, the California Infrastructure and Economic Development Bank (I-Bank), and local municipalities. It should be noted that private sector funding does not typically take the form of bonds. Funding comes in the form of equity financing from venture capital and loans made by investment funds and commercial banks.

Pension Fund Investments

The California Public Employees Retirement System (CalPERS) invests state funds. CalPERS' private equity investment has a total market value of $28.8 billion, with a California value of $2.9 billion or 10.1 percent. The Alternative Investment Management (AIM) Environmental Technology Program invests in clean technologies such as renewable energy across stages of development, strategies, geographies, and structures.[388] Since 2007, CalPERS has committed $600 million to the Program's investment managers.

On-Bill Financing

On-bill financing programs rely on capital from the energy consumer to finance the upfront costs of renewable energy systems. Repayments for the system are automatically added to the consumer's utility bill. Ideally, the payments are less than the energy savings from the renewable energy project, saving the consumer money from the first day of operation. Unlike traditional loans, the debt is linked to the property's utility meter rather than the property owner. This allows for easy transfer of ownership and debt should the property owner choose to sell before the system is paid off.

387 Note: All federal funding for CREBS and QECBs has been allocated.

388 http://www.calpers.ca.gov/.

Though not widely implemented yet, on-bill financing programs have the opportunity to increase the access to affordable capital to install renewable energy systems. Despite the opportunities with on-bill financing programs, several hurdles must be overcome prior to widespread adoption. Programs such as these require legislative and regulatory approval as well as engagement with customers through appropriate marketing and outreach. Participating utilities also face uncertainty with program administration, billing logistics, and default scenarios.[389]

Policy Adoption and Transparency

The final role that the federal and state governments play in fostering renewable energy financing is to develop and maintain stable, predictable regulatory policies. Stable and predictable regulatory policies increase investor confidence, allow greater leverage of private funding, and can facilitate favorable financing structures and partnerships.[390] In April 2011, Governor Brown took a solid step in this direction when he signed the 33 percent Renewable Portfolio Standard into statute, removing the uncertainty that surrounded the mandate when it was an executive order mandated regulation. Similarly, as discussed in Chapter 3, state and federal agencies are collaborating on permitting and siting processes, creating comprehensive plans for California's sensitive habitat areas, and helping developers to site projects with the fewest environmental impacts possible.[391] By fast-tracking renewable energy projects vying to qualify for the abovementioned ARRA programs, state and federal agencies demonstrated they can reduce project costs by accelerating permitting and approval time. Over the past two years the state of California has managed to vastly improve this process, siting nine solar thermal power plants with total capacity of more than 4,000 MW.

Other Renewable Energy Financing Efforts

Neighboring States

Neighboring states and California vary in the incentives they provide to encourage investment in renewable energy generation facilities and manufacturing facilities. Arizona and Oregon have personal and corporate tax incentives, while Arizona and Nevada has sales tax incentives for renewable energy. While these differences exist, California has the significant benefit of venture capital and research institutions that contribute to advancements in technology and project deployment.

Arizona has an estimated solar energy generation potential of 101 million megawatt-hours per year.[392] Key efforts include Arizona Renewable Energy Standard and Tariff of 2006 similar to

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389 http://www.nrel.gov/docs/fy11osti/49340.pdf.

390 Barradale, M., *Impact of Policy Uncertainty on Renewable Energy Investment: Wind Power and PTC*, 2010, discusses the effect of the "boom and bust" cycle on the federal PTC on wind development contracts. http://www.iaee.org/en/students/best_papers/Merrill_Barradale.pdf.

391 Please see Chapters 3 and 4 for more information about permitting and transmission challenges.

392 Renewable Energy Atlas of the West pg 27.

California's renewable portfolio standard.[393] Arizona project development is also bolstered by net metering, state corporate production tax credit, income tax credit, a property tax exemption and incentive, and a sales tax exemption.[394] Most of these efforts do not expire until 2018, providing certainty to the market. While existing in-state solar generating capacity is relatively low at approximately 50 megawatts, over 2,200 megawatts of solar projects have been announced or planned.[395] Arizona also has a sales and use tax exemption on renewable energy manufacturing equipment.

Nevada has a large geothermal resource from which it produces approximately 4 percent of its electricity,[396] and also has the potential to generate approximately 83 million megawatt hours per year of solar energy. Renewable energy development is supported by a renewable portfolio standard, net metering, various rebates and incentives, and laws that would prohibit siting restrictions of solar and wind energy systems.[397] Nevada, like California, has state legislation for a Property Assessed Clean Energy (PACE) Program. The Renewable Energy Producers Property Tax Abatement provides a property tax abatement of up to 55 percent for up to 20 years for real and personal property used to generate electricity from renewable energy resources including solar, wind, biomass, fuel cells, geothermal, or hydro. Generation facilities must have a capacity of at least 10 MW. The Nevada Energy Renewable Generations Rebate Program provides solar rebates from $2.30 per watt AC; wind rebates from $2.50 per watt; and small hydro rebates from $2.00 per watt.

Oregon's Small-Scale Energy Loan Program (SELP) was created as a result of a voter-approved constitutional amendment that authorized the sale of bonds to finance small-scale local energy projects. The SELP offers low-interest loans for projects that save energy, produce energy from renewable resources, create products from recycled materials, use alternative fuels and reduce energy consumption during construction or operation of a facility. Generally the loans range from $20,000 to $20 million. Oregon also has the Energy Trust of Oregon which provides cash incentives and development assistance for renewable energy projects that have a capacity of 20 MW or less. Funding is available for grant writing, feasibility studies, or technical assistance with design, permitting, or utility interconnection. The Energy Trust will pay up to 50 percent of eligible project costs for a maximum of $40,000. Incentives are based on the project's costs in comparison to the market value of energy produced.

Global Investments

Mexico achieved the biggest increase in renewable energy investment in Latin America, excluding Brazil, due in part to the enactment of the Renewable Energy Development and

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393 http://www.cc.state.az.us/divisions/utilities/electric/environmental.asp.

394 http://www.acore.org/files/pdfs/states/reamerica_mar11.pdf pg 19.

395 http://www.acore.org/files/pdfs/states/reamerica_mar11.pdf pg 18.

396 Renewable Energy Atlas of the West pg 47.

397 http://www.acore.org/files/pdfs/states/reamerica_mar11.pdf pg 72, 73.

Financing for Energy Transition Law (LAERFTE) in November 2008. Mexico saw renewable investment grow 348 percent, stimulated by major wind projects and geothermal. Mexico's government raised renewable energy capacity from 3.3 percent in 2009 to 7.6 percent by 2012 and wind is intended to make up 4.3 percent by 2012. Projects are expected to reach $8 billion in 2011 by foreign investment into Mexico with primary interest in the borderland between northern Mexico and southern US. The Baja California region has grid connectivity with California and the potential of exporting renewable energy to the state. Historically, most foreign investment in Mexico comes from the United States. As an example, San Diego-based Cannon Power Group is investing $2.5 billion in Mexico to build wind farms to generate more than 300 MW of electricity.[398]

Canada has invested $CDN 4.9 billion in renewable energy. In 2009, the Canadian Province of Ontario introduced a feed-in tariff for solar PV projects. Developers using modules with at least 50 percent of their costs based on local goods and services would have access to the solar PV projects more than 10kW. Canadian incentives for investment[399] include: 1) a 50 percent accelerated capital cost allowance for clean energy generation, 2) underwriting R&D activities that lead to new, improved, or technologically advanced products or processes, 3) a $CDN 1.5 billion investment to increase clean electricity from renewable sources, and 4) a $CDN 230 million investment in clean energy science and technology that will fund RD&D to support next- generation energy technologies.

Germany and Spain are active participants in expanding renewable energy generation, investing $4.3 billion and $10.4 billion, respectively, in 2009. With estimated populations of 81.5 million[400] and 46.75 million,[401] Germany and Spain invested approximately $52.75 and $222.50 per capita in renewable energy. The bulk of investment in these countries has been in the solar and wind sectors, supported by carbon markets, renewable energy standards, clean energy tax incentives, feed-in tariffs, and government procurement requirements. As of 2009, 29 percent of German power capacity and 30.1 percent of Spanish power capacity was generated from renewable sources.[402] The German and Spanish feed-in tariffs have resulted in the installation of thousands of megawatts of renewable capacity. Germany has already achieved its renewable energy goals and was able to increase generation targets by 5 percent. The Spanish feed-in tariffs are also highly utilized.[403] In response to the higher than expected demand for FITs,

398 http://www.cannonpowergroup.com/.

399 http://investincanada.gc.ca/eng/default.aspx.

400 https://www.cia.gov/library/publications/the-world-factbook/geos/gm.html.

401 https://www.cia.gov/library/publications/the-world-factbook/geos/sp.html.

402 The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? G-20 Clean Energy Factbook*, 2010, http://www.pewtrusts.org/our_work_report_detail.aspx?id=57969.

403 http://www.renewableenergyworld.com/rea/news/article/2011/01/spains-solar-sector-sues-government-over-retroactive-tariff-cuts?cmpid=rss.

regulators were forced to cap annual eligible installations and reduce incentives.[404] This disruption provided market uncertainty and resulted in a period of excess panels supply, and decreasing prices, as global supply outpaced demand. Spain's incentive policy was not a long-term sustainable design nor was it market responsive. This lead to taxpayer backlash and market uncertainty as a boom/bust effect was felt in the growing solar PV market.[405] China led the world in total renewable energy investment in 2009, with a total investment of $34.6 billion. With an estimated population of 1.33 billion,[406] China invested approximately $26.00 per person in renewable energy. Renewable investment in China has primarily been in the wind energy sector, accounting for 71.1 percent of the total investment. Similar to Germany and Spain, China supports renewable energy with a renewable energy standard and clean energy tax incentives. In August 2011, China recently announced a national feed-in tariff for solar power installations. While China does not have a carbon market or government procurement requirements, the government does offer green energy bonds to encourage development.[407] Chinese-manufactured solar panels entered the market in at a time when global demand was high and supply was low. Bloomberg New Energy Finance (BNEF) notes that the international solar module production price is $1.88 per watt while China is at $1.64 per watt which can translate to downward cost curves and reduced project economics.[408]

Current Efforts to Address Financing Challenges for Distribution-Scale Renewables

Historically, there have been few financing options for distributed generation. Public grants and tax credits greatly reduce the cost of distributed generation systems; however, the customer is still left with significant upfront expenses. Lending institutions may provide equipment loans for distributed generation systems, but the loan costs and terms are often unfavorable for the purposes of renewable energy with monthly repayments far exceeding the energy savings. As such, early adopters of renewable technologies have had little choice but to use traditional financing methods such as equity loans, mortgages, lines of credit, or cash.[409] High transaction costs associated with project financing essentially eliminates this as an option for small-scale projects.

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404 KEMA, *California Feed-In Tariff Design and Policy Options*, draft consultant report prepared for the California Energy Commission, September 2008, http://www.energy.ca.gov/2008publications/CEC-300-2008-009/CEC-300-2008-009-D.PDF pgs 15 - 19.

405 http://www.nytimes.com/gwire/2009/08/18/18greenwire-spains-solar-market-crash-offers-a-cautionary-88308.html?pagewanted=2.

406 https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html.

407 Whole paragraph: The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? G-20 Clean Energy Factbook,* 2010 , http://www.pewtrusts.org/our_work_report_detail.aspx?id=57969, p. 26.

408 Chinese Investment in US Renewable Energy, ACORE webinar, June 2011.

409 Whole paragraph: http://www.nrel.gov/docs/fy09osti/44853.pdf, p. 24.

Fortunately, opportunities exist to make distributed generation systems cheaper and easier to finance. Leases, comparable to those for cars, can minimize or eliminate the upfront costs to consumers while keeping monthly payments less than or equal to energy savings. In such a situation, an outside company would rent a distributed generation system to consumers for a monthly payment. The company may also take care of maintenance and provide an option to purchase the system at the end of the lease. Ideally, the monthly payment would be less than the utility savings, allowing the consumer to save money.[410]

Power purchase agreements are similar to leases since an outside company owns the distributed generation system and is able to take advantage of incentives. However, unlike a lease, the consumer purchases electricity generated by the system from the company rather than renting the equipment. Although the distributed generation system would be located on the customer's property, the customer would not have any ownership. This closely resembles traditional electricity purchases from a utility. This financing tool provides another opportunity for consumers to utilize renewable energy while minimizing or eliminating upfront costs and maintenance requirements.[411]

Obtaining distributed generation systems through either a lease or power purchase agreement have additional advantages when compared to traditional financing methods since commercial owners can take advantage of additional incentives. While both residential and commercial owners may take advantage of the cash grant from the Federal Section 1603 and Business Energy Investment Tax Credit programs, only commercial owners may accelerate depreciation on the system. As noted earlier, depreciation provides a tax benefit of 26 percent of the total system cost, greatly lowering the overall cost of the distributed generation system to both the commercial owner and the consumer.

Property tax assessments are unique forms of loans in which a city or county provides funding for a property owner to purchase and install distributed generation systems. The initial investment from the city can be financed through bonds or from the general fund and is paid back through a special property tax.[412] Using property tax assessments for distributed generation is a relatively new concept. As such, the feasibility is unproven and there are many challenges to implementation.

In 2008, California passed AB 811 (Levine, Chapter 159, Statutes of 2008), which authorized cities and counties to create local Property Assessed Clean Energy (PACE) programs. Under a PACE program, citizens can opt to have the cost of energy efficiency and renewable energy generation infrastructure added to their property tax bill, allowing them to reap the benefits of energy savings without paying significant upfront costs. These property tax assessments also stay with the home should the deed be transferred, ensuring that those who benefit from the

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410 Whole paragraph: http://www.nrel.gov/docs/fy09osti/44853.pdf, p. 28.

411 Whole paragraph: http://www.nrel.gov/docs/fy09osti/44853.pdf, p. 31.

412 http://www.nrel.gov/docs/fy09osti/44853.pdf, p. 33.

energy savings are the ones paying the bill. In July 2010, however, the Federal Housing Finance Agency (FHFA) directed Fannie Mae and Freddie Mac to revise their lending policies, effectively halting PACE programs on federally-backed mortgages.[413] Halting PACE in the residential sector has created a considerable setback to distributed generation financing. However, a recent report suggests that there are active commercial PACE programs – including counties of Placer and Sonoma, and the cities of Berkeley, Fresno, Los Angeles, and Palm Desert – representing $9.7 million and 71 projects. The report suggests that solutions using PACE for the commercial sector should explore underwriting criteria, loan-to-value ratios, different financing structures, and credit enhancements.[414] Other PACE-related efforts include federal legislation introduced in July 2011, the PACE Assessment Protection Act of 2011 (HR 2599), to address FHFA concerns regarding residential and commercial PACE programs. In California, AB X1 14 (Skinner, Chapter 9, Statutes of 2011) was signed into law on August 2 which appropriates up to $50 million for CAEATFA to work with the Energy Commission to assist in financing and administration of the Clean Energy Upgrade Program. The program would provide financial assistance to participating financial institutions that make loans to residential and small commercial property owners for the installation of energy efficiency improvements, electric vehicle charging infrastructure and DG renewable energy.

The United States Department of Agriculture Rural Energy for America Program (REAP) provides competitive grants and loans up to $25 million for rural energy projects and efficiency improvements.[415] The REAP Guaranteed Loan Program encourages the commercial financing of renewable energy and the Rural Development Electric Program offers financing assistance for the construction of electric distribution, transmission and generation facilities. The use of these financing tools to create new partnerships, financing structures, and address distributed generation needs in the rural areas will be important in meeting renewable generation goals.

To finance renewable energy installations, state and local governments have the authority to issue bonds even though the current economic condition may limit this as a financing option. California also provides tax relief to solar projects by not including the value of the system in property tax assessments.

Case Studies

Case studies are provided below to illustrate the combination of renewable technologies, project scale, financing structures, programs, and unique attributes that are used to finance projects.

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413 http://www.comstocksmag.com/Archive/1010_F_A-Slow-Pace-.aspx.

414 Ken Hejmanowski, Scott Henderson and Mark Zimring, Renewable Funding, Clinton Climate Initiative, Lawrence Berkeley National Laboratory, Property Assessed Clean Energy (PACE) Financing: Update on Commercial Programs, March 2011, http://eetd.lbl.gov/ea/ems/reports/pace-pb-032311.pdf.

415 http://www.rurdev.usda.gov/ca/bi/REAP%20index.htm.

County of Yolo

The County of Yolo installed a 1 MW solar photovoltaic (PV) project to supply renewable power to a jail and juvenile center.[416] This project represents the first known combined use of QECBs and CREBs in the nation. QECBs and CREBs, known as qualified tax credit bonds, are an inexpensive approach for state and local government to finance renewable energy installation.

The county chose to own the solar PV system and did not select a PPA provider because the financial benefits of the PPA were insubstantial. A variety of funding sources were used to help finance the project including CREBs, QECBs, an Energy Commission Energy Conservation Assistance Act loan, a Pacific Gas and Electric (PG&E) rebate, and a Tax Exempt Lease Program (TELP) loan. The county was eligible for two incentives including $2.5 million from California Solar Initiative (CSI) and a $1.9 million PG&E rebate. The total cost of the project with interest payments is $9.4 million; with total utility bill savings estimated at $18.1 million over 25 years. The county took advantage of the low interest Energy Commission loan, CSI incentive and PG&E rebate, which are only available in California. If it were not for these low cost finance options, the county might not have been able to finance the project. The county negotiated a lag time of six months between the system going on-line and when initial payments were due. This was an advantage because it allowed the county to generate funds from the utility savings that were used to make the first payment.

Jefferson Union High School District

Perpetual Energy Systems (PES) financed a 1.5MW solar energy project at the Jefferson Union High School District located south of San Francisco. The project includes over 8,500 solar photovoltaic (PV) panels and generates over 2.3 million kWh of solar energy during the year. The project required no upfront costs from the school district because it was funded by PES. The district will buy the power from PES at a lower rate than the utility company. In return for the financing, the company will get tax and investment credit. The school expects to save 3 percent on annual energy costs over the next 25 years.[417]

Hudson Ranch Project

Hudson Ranch I is a 49.9-MW geothermal generating power facility in the Salton Sea area in California. EnergySource is the project developer. The electricity produced from the geothermal facility will be sold under a 30-year power purchase agreement. The local water board granted the project 800 acre-feet of water annually to the facility. Also, the facility took advantage of federal tax incentives under ARRA worth more than $100 million. The $399 million project is expected to create 200 jobs and provide $3.5 million in annual property taxes.[418]

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416 http://www.nrel.gov/docs/fy11osti/49450.pdf.

417 Personal communication: Dustin Keele, Executive Vice-President, Photon Energy Services Inc., May 20,2011.

418 http://www.hannonarmstrong.com/press/pfhrdoty_article.pdf.

Dixon Ridge Farms[419]

Dixon Ridge Farms (DRF) located in Winters grows, buys, and processes California organic walnuts since 1979 on a 1,200 acre farm site. In 2007, DRF was faced with rising energy costs and established a goal of making their facility energy self-sufficient by 2012 with the energy using the inedible portion of walnuts. DRF began working with the Community Power Company (CPC) of Colorado to evaluate the installation of a 50 kW biogas powered generator (BioMax 50) that converts walnut shells into energy, powers a 12,000 square foot freezer, and uses waste heat for their operations. The BioMax 50 produces about $40,000 worth of electricity a year and $12,000 of gas to off-set propane use. The total project cost $400,000 and DRF provided $30,000 and the Energy Commission provided the balance as a grant through the Public Interest Research Program. DRF also installed solar PV financed through a mix of incentives and equity.

419 http://www.dixonridgefarms.com/

Chapter 8: Cost Issues

There are a variety of cost challenges to developing the generating facilities needed to meet California's renewable energy goals. Development costs are a major driver of the prices sought by renewable energy developers in contracts with utilities, which ultimately must be approved by either the California Public Utilities Commission (CPUC) for investor-owned utilities (IOUs) or a Board of Directors for publicly owned utilities. According to the CPUC's Division of Ratepayer Advocates, project failure seen in Renewable Portfolio Standard (RPS) contracts is most often the result of difficulties in securing financing, permits, and transmission, in that order.[420]

This chapter compares levelized cost of generation studies, discusses how renewable costs can vary by project, and provides information on cost trends seen in recent years. The chapter then summarizes federal tax incentives and describes the impacts of tax benefits on levelized cost calculations. This discussion is followed by an explanation of the value of a mix of renewable energy sources in the state's electricity portfolio and the value of renewable energy to society. Finally, the chapter outlines cost challenges in the areas of environmental review, permitting, construction, and interconnection, and briefly describes the potential contribution to cost reductions in these areas from efforts to address the issues identified in earlier chapters of this report. For example, Chapter 3 discusses efforts by the Renewable Energy Action Team (REAT) and the Desert Renewable Energy Conservation Plan (DRECP)[421] to streamline environmental review and permitting, which will help reduce project delays and costs. Similarly, Chapter 7 describes financing mechanisms, including a number of federal and state rebates, tax credits, low-interest loans, loan guarantees, and renewable development bonds, which can reduce project capital costs.

Levelized Cost of Renewable Technologies

Levelized cost is the present value of the total cost for financing, building, and operating a generating plant over its economic life, converted to equal payments per megawatt hour (MWh). The Levelized Cost of Energy (LCOE) consists of seven main components that are grouped into "fixed" and "variable" costs.[422] Fixed costs include capital and financing costs, fixed operating and maintenance costs (primarily labor to operate a facility), insurance costs, ad valorem taxes, and corporate taxes (both Federal and state). Variable costs depend on how much a unit operates, and include costs for fuel and for operating and maintaining a facility

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420 Green Rush, Investor-Owned Utilities' Compliance with the Renewables Portfolio Standard, February 2011, CPUC, page 9.

421 Established by Executive Order S-14-08, November 2008, http://www.drecp.org/documents/2008-11-17_Exec_Order_S-14-08.pdf.

422 Transmission costs to interconnect a facility to the grid are sometimes included in the LCOE calculation.

such as periodic inspection, replacement, and repair of system components. Variable costs may represent 50 to 80 percent of the calculated levelized costs for a combined cycle natural gas plant, depending on fuel price trajectories, while the LCOE for most renewable generation technologies (with the exception of biomass) consists primarily of fixed costs.

Although levelized costs are often presented as representative average costs, the actual costs of specific projects can be very different. This is due to the variability of many individual cost components. For example, transmission interconnection costs can vary significantly depending on project location. In addition, the purchase price of a wind turbine can vary depending on manufacturer inventory levels. Financing costs can also differ between investor owned utilities, municipal utilities, and merchant developers.

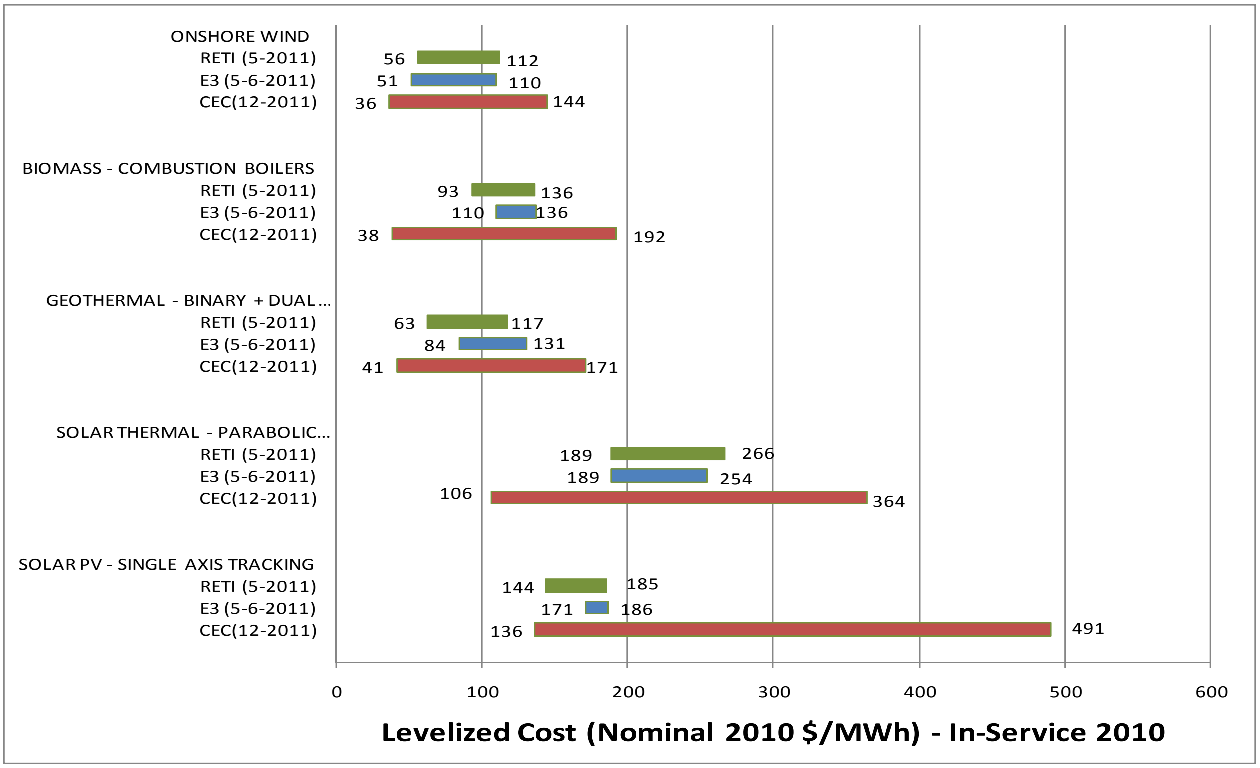
Renewable generation projects have unique characteristics that distinguish them from other projects that are capital intensive. Compared to conventional generation, renewable projects generally have higher capital costs, and a larger per-megawatt (MW) footprint in more ecologically sensitive areas, leading to larger direct land costs and indirect mitigation costs. Although some renewable technologies like solar photovoltaics and solar thermal electric may have higher LCOE per MWh than conventional generation, they are able to produce generation when it is most valuable and can actually be competitive with conventional generation on a time of delivery basis. Compounding these factors in California are higher property values as well as stringent environmental regulations, which add time, expense, and business and financial risk to renewable generation projects.

Figure 22 compares three sets of levelized cost estimates for different renewable generation technologies developed in California. These include LCOE range forecasts prepared by Black & Veatch for the Renewable Energy Transmission Initiative (RETI), estimates developed by the E3 Renewables Portfolio Standard Calculator for the CPUC's Long Term Procurement Proceeding,[423] and estimates from the Energy Commission's *2009 IEPR* Cost of Generation project. The figure shows that the range of costs for a technology can be more significant than the differences in average costs between technologies.

For comparison purposes, the LCOE estimates presented in Figure 22 do not include transmission interconnection charges that can vary significantly for remote projects because not all of the studies included this variable.

423 http://www.energy.ca.gov/siting_lessons/notices/2010-12-02_Order_Instituting_Informational_Proceeding_TN-59112.pdf.

Figure 22: Comparison of Levelized Cost of Generation Studies



Sources:

1. CEC 2009 IEPR Cost of Generation Report: http://www.energy.ca.gov/2009publications/CEC-200-2009-017/CEC-200-2009-017-SF.PDF
2. RETI Phase 2B RETI Report: http://www.energy.ca.gov/reti/documents/index.html
3. E3 Renewable Energy Costing Tool: http://www.ethree.com/public_projects/renewable_energy_costing_tool.html

Other variables can further spread the range of levelized costs for different generation technologies. Energy Commission staff recreated the RETI supply curve in Figure 23, which shows how total cost (including transmission, LCOE, and integration) varies by project.[424] These cost curves were developed in 2009 and do not take into account significant cost reductions that have occurred over the past few years. Nor do they take into account time of delivery payments and integration cost factors. Recent market trends show that factoring in time of delivery has made solar PV look extremely cost competitive. In SCE's 2010 reverse bid under their Renewable Standard Contract, all of the lowest bids by levelized cost were for solar PV.[425]

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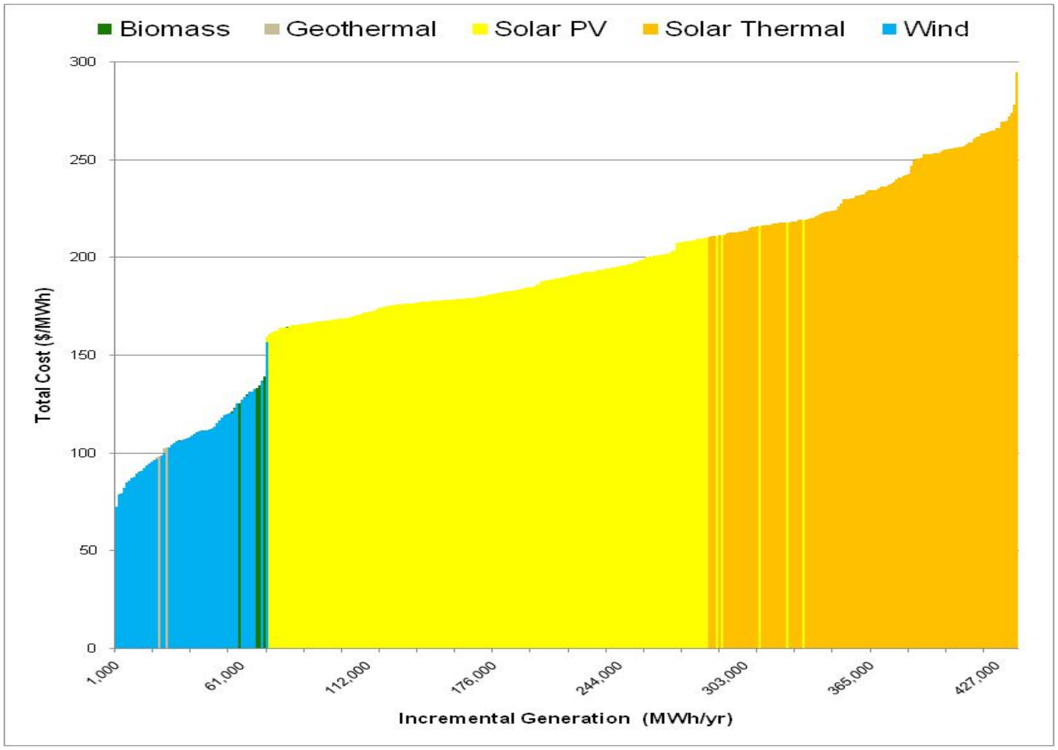
424 Figure 23 represents the average total costs used in the RETI Phase 2b cost ranking model. This graph does not reflect the uncertainty in the model, which is estimated to be between 25- 35 percent for wind projects and between 12 and 20 percent for all other renewable technologies. See http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF Page 7-10 for more information.

425 SCE's Advice letter 2547-E, http://www.sce.com/NR/sc3/tm2/pdf/2547-E.pdf. "On September 15, 2010, SCE received a large number of offers for the 2010 RSC Program, representing over ten times the program's goal of 250 MW. SCE conducted a competitive solicitation using a reverse auction. All interested parties were allowed to

Further, all of the bids' levelized costs were below the Market Price Referent (MPR), which is a proxy for levelized cost of a new 500-MW natural gas combined cycle. Major transmission cost drivers include the length of the transmission line, the number of substations required for the pathway taken, and the line utilization.[426]

Figure 23: RETI Renewable Supply Curve – California Only



Note: The renewable net short is estimated to be between 35,000 and 47,000 GWh in 2020.
Source: http://www.energy.ca.gov/reti/documents/phase2B/CREZ_name_and_number.xls

Although a comparison of levelized costs is useful in understanding the challenges faced by renewable energy developers, it does not tell the whole story. Several other factors affect the viability of projects, including environmental and cultural concerns, out-of-state renewable

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comment on the pro forma contract and SCE incorporated many suggested changes prior to accepting offers. Project offers were submitted by offerors at a bid price they determined. Projects were then ranked by levelized price and selected from lowest to highest levelized price up to the 250 MW program cap. SCE seeks approval in this Advice Letter for 20 contracts executed through the 2010 RSC Program. All of the RSC Contracts are for 20-year terms and are for solar photovoltaic ("PV") projects constructing new facilities. Solar PV is a mature and proven renewable energy technology that has been supplying a substantial amount of renewable energy to SCE and other California load-serving entities ("LSEs") for several years. All RSC Contracts are priced below the approved 2009 market price referents ("MPRs"), the most current MPRs available when the offers for the RSC Contracts were received."

426 http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF, pp. 6-29.

goals, time-of-delivery energy prices, over generation during off-peak periods, and integration costs.[427, 428]

There is a larger amount of low-cost renewable energy potentially available for California's RPS in the WECC-wide supply curve than in the California-only supply curve. However, out-of-state resources may face greater risk than in-state renewable resources because they may need to build transmission to avoid falling under one of the capped RPS facility categories.[429]

Because most of the cost to develop a renewable generating facility is upfront capital cost, appropriate government policy and regulation can provide value in minimizing the expense and delays associated with these capital costs. For example, soft costs, such as permitting and inspection, can add $5,000 to a typical $20,000-30,000 residential rooftop PV system in California. Two-thirds of these soft costs could be avoided.[430] As well, regulatory barriers, such as those recently experienced by the Fiscalini Farms dairy digester, more than doubled the initial estimate of the project's cost from $2 million to $4.5 million.[431]

Cost Trends

In a 2009 "Levelized Cost of Energy Analysis," the investment firm Lazard observed that in some cases, renewable technologies were already cost-competitive with conventional generation technologies, even without factoring in the societal value and other external benefits of certain renewable energy generation technologies. The Lazard study found that, with solar PV technologies, there is significant potential over time for economies of scale along the entire production value chain. In contrast, mature conventional generation technologies are experiencing capital and fuel cost inflation, with little prospect for cost-reducing manufacturing improvements.[432]

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427 California Independent System Operator, *Initial Testimony of the California Independent System Operator Corporation, PART II*, A.06-08-010, March 7, 2007, http://www.caiso.com/1b95/1b95e891277b0.pdf, pp. 58-61.

428 Ibid.

429 To avoid being in a capped category, an RPS facility must have its first point of interconnection to a California Balancing Authority, first point of interconnection to a customer of a California Balancing Authority, or generation from the facility must be scheduled for delivery without substitution to a California Balancing Authority. The CPUC is developing rules regarding the "buckets" of renewable resources for the RPS programs they administer. Rules regarding this aspect of SB X1 2 for POUs have not been developed. If the capped RPS categories are fully subscribed, out-of-state renewable resources may need transmission lines crossing multiple states to bring renewable energy to California. The RETI Phase 2B study indicates that the costs of multi-state transmission lines tend to make resources located far from California more expensive than other renewable resources.

430 http://www.fresnobee.com/2011/05/01/2370247/permit-process-clouds-solar-energy.html.

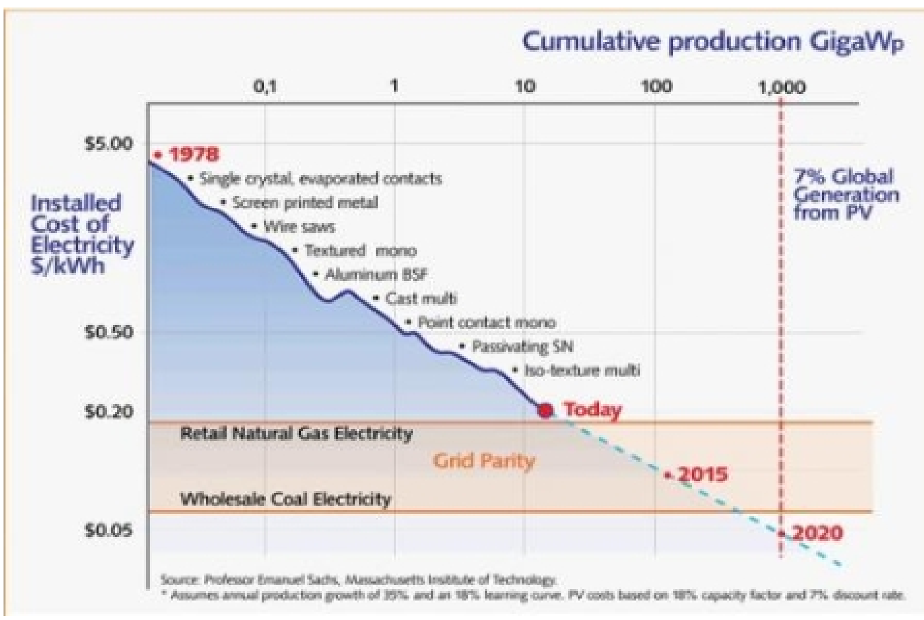
431 http://www.dairyherd.com/dairy-news/latest/Commentary-Dairy-industry-pioneer-thwarted-by-regulations-124810264.html.

432 "Levelized Cost of Energy Analysis – Version 3.0," February 2009, http://blog.cleanenergy.org/files/2009/04/lazard2009_levelizedcostofenergy.pdf, accessed July 21, 2011.

The CPUC's MPR has been used as a proxy for long-term natural gas prices when evaluating renewable procurement contracts. This metric is used because marginal capacity added to the California grid is typically from combined cycle natural gas plants, which would presumably be displaced by renewable generation. Recent MPR prices have been stable, with low expected growth over time. Senate Bill X1 2 (Simitian, Chapter 1, Statutes of 2011) deletes the existing MPR provisions and instead requires the CPUC to establish a limitation for each electrical corporation on procurement expenditures for all eligible renewable energy resources used to comply with the RPS. At this time, the MPR is still in use while as the CPUC reformulates the MPR under SB X1 2, but the CPUC expects to release a proposed decision by the end of the year.[433]

Studies used to estimate the levelized costs in Figure 22 were completed prior to 2010. Since then, a number of variables affecting the cost drivers have changed. For example, PV costs are lower than shown in Figure 22. Figure 24 provides the calculated average installed cost of electricity ($/kWh) for a new solar PV project built in each of the next 10 years, assuming the 30 percent federal tax credit is renewed before it expires in 2016.

Figure 24: 10 Year Average Installed Cost of Electricity for a Solar PV Project



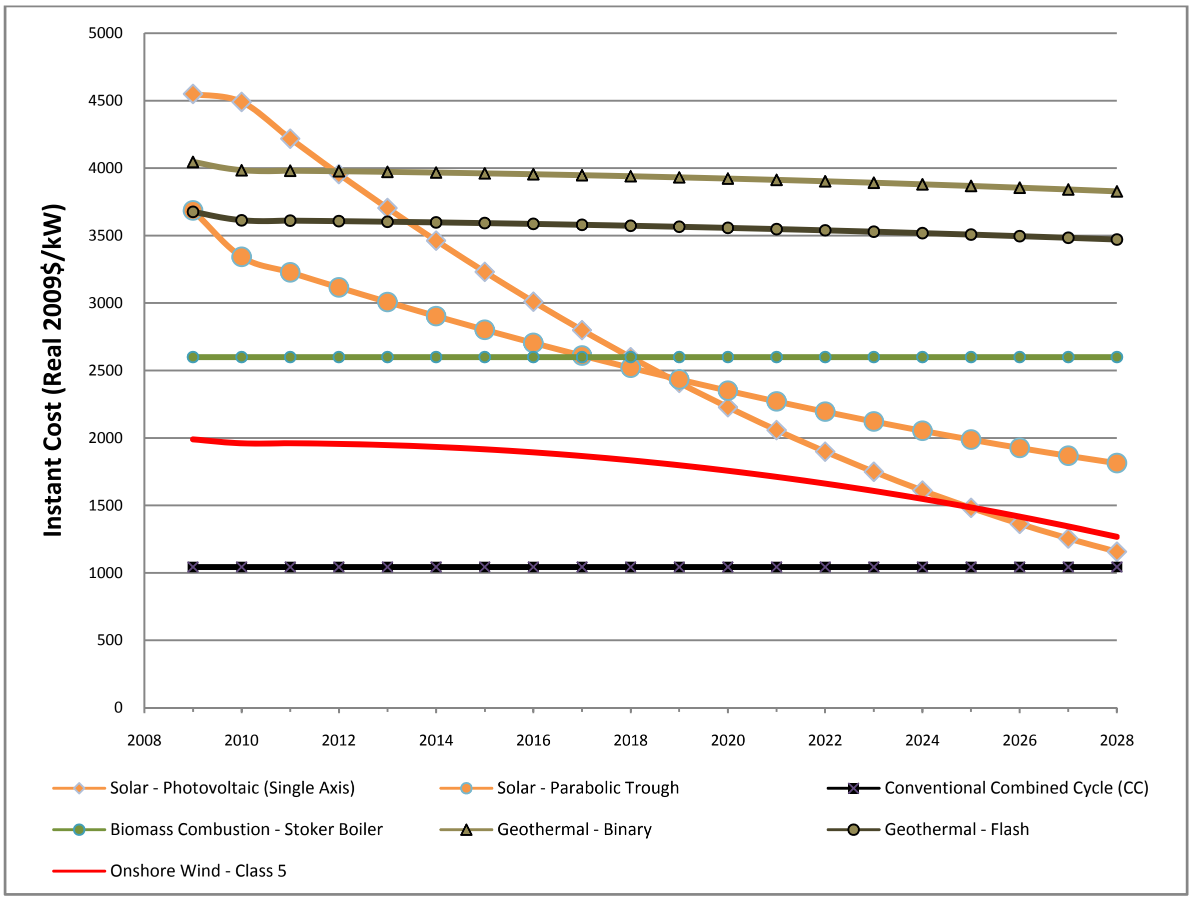
Source: http://www.renewableenergyworld.com/rea/news/article/2011/07/anatomy-of-a-solar-pv-system-how-to-continue-ferocious-cost-reductions-for-solar-electricity.

The figure reflects the trends utilities have seen in solar PV bid prices. Bids come in at an anticipated price for panels once the project makes it through permitting and interconnection studies. Typically this takes about two years, so developers are also banking on increased cost reductions for solar PV panels.

433 http://docs.cpuc.ca.gov/published/proceedings/R1105005.htm. For a breakdown of eight factors proposed in SB X1 2 to calculate the Market Price Referent, please see page 6 of http://docs.cpuc.ca.gov/efile/RULINGS/138055.pdf.

The Energy Commission conducted surveys to determine the long-term changes in cost variables that drive the levelized cost estimates of different generation technologies. The most significant driver for renewable LCOE estimates is capital cost. Figure 25 summarizes the long-term projection of capital costs in real 2009 dollars. There have been significant cost reductions for utility-scale solar PV generation in the last five years, and more improvements are expected in the next several years that could bring capital costs within range of natural gas-fired combined cycle units near the end of the study period. Instant costs do not reflect the cost of fuel and maintenance over the life the project. Most renewable technologies have low to zero fuel costs, and maintenance costs may be much lower than conventional generation. Further, instant costs do not take into account any additional savings that may occur in a world with cap and trade.

Figure 25: Expected Instant Cost Trends



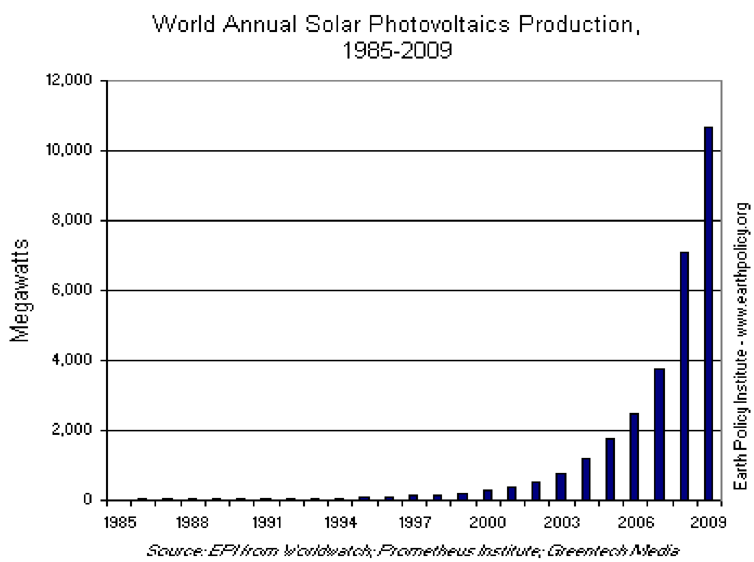
Source: California Energy Commission, Comparative Cost of California Central Station Electricity Generation, Staff Report, January 2010, http://www.energy.ca.gov/2009publications/CEC-200-2009-017/CEC-200-2009-017-SF.PDF

To reflect recent technological advances in renewable generation technologies, the Energy Commission will update the cost driver information used to calculate levelized costs in the 2013

IEPR cycle. This updated analysis is expected to include an evaluation of both utility-scale and distributed generation (DG) technologies.

Declining cost trends for PV (in addition to environmental considerations) is one reason developers of approximately 1,850 MW of concentrated solar thermal projects have switched to PV.[434] The long-term trend has been that solar generating technologies, particularly PV, have experienced significant declines in price. Global production capacity of PV panels (much of which is based in China) was 10,700 MW in 2009 and has been doubling every two years since 2002 (Figure 26).[435] At the same time, the costs of PV panels, which currently account for roughly half of the cost of PV systems, decline roughly 20 percent each time this capacity is doubled.[436]

Figure 26: World Annual Solar Photovoltaics Production, 1985-2009



A Lawrence Berkeley National Laboratory study released in 2010 concluded that "PV installed costs exhibit significant economies of scale" and that "international experience suggests that greater near-term cost reductions may be possible with increased market scale in the United States." [437] The study found that PV module prices declined by 40 percent from 1998 to 2009, and based on preliminary data for 2010 may have declined again in systems installed through the California Solar Initiative. The trend in PV cost reductions is also illustrated in a recent

434 http://news.cnet.com/8301-11128_3-20076065-54/solar-thermal-plants-scrap-steam-for-photovoltaic/.

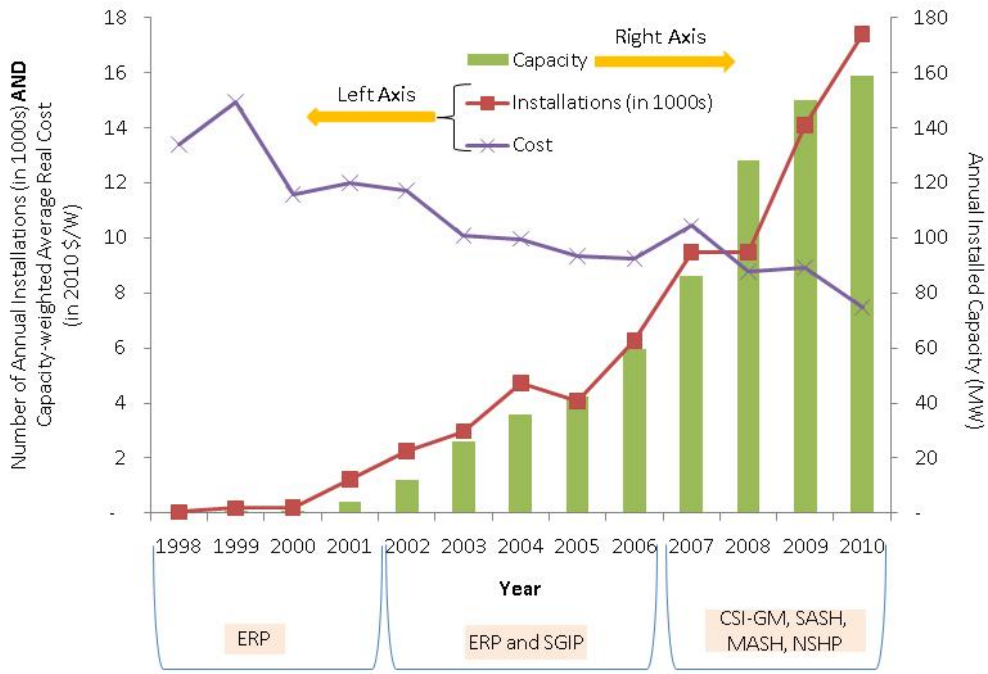
435 http://www.earth-policy.org/indicators/C47/.

436 http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf.

437 Barbose, Galen, Naim Darghouth, Ryan Wiser, Tracking the Sun III: The Installed Cost of Photovoltaics in the U.S. from 1998-2009, December 2010, http://eetd.lbl.gov/ea/emp/reports/lbnl-4121e.pdf.

evaluation of the CPUC's California Solar Initiative (CSI) program, which notes that PV costs under the CSI have decreased rapidly (Figure 27).[438]

Figure 27: California IOU Public Purpose Program PV Systems—Trends



Source: Itron Inc.
Programs include the Emerging Renewables Program (ERP), the Self-Generation Incentive Program (SGIP), the CSI General Market (CSI-GM), Single-family Affordable Solar Homes Program (SASH), Multi-family Affordable Solar Housing (MASH), and the New Solar Homes Partnership (NSHP)

Of late, PV system prices are declining even more rapidly, with first quarter 2011 system prices 15 percent lower than those in the first quarter of 2010.[439] Non-module costs for inverters, mounting hardware, labor, permitting and fees, shipping, taxes and installer profit also dropped by 40 percent during that time period. Over the past few years, the study suggests "that the drop in wholesale module prices during the preceding years translated into a large reduction in installed costs in 2010." Currently, the price of PV panels is dropping so steeply that by 2012, panels will amount to less than half of system costs (from 55% in 2010), and the focus of cost-reduction efforts is likely to shift towards balance of system cost components.[440] According to the DOE, of these non-module capital costs, the largest is installation, followed by

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438 Itron, Inc., *CPUC California Solar Initiative, 2010 Impact Evaluation*, June 2011, http://www.cpuc.ca.gov/NR/rdonlyres/E2E189A8-5494-45A1-ACF2-5F48D36A9CA7/0/CSI_2010_Impact_Eval_RevisedFinal.pdf.

439 http://www.greentechmedia.com/articles/read/US-Solar-Market-Stats-Q1-2011-by-the-Numbers-/.

440 http://www.greentechmedia.com/articles/read/solar-pv-balance-of-system-costs-to-surpass-modules-by-2012-according-to-gt/.

inverter, racking hardware, wiring, and indirect project costs.[441] However, this declining cost trend for some renewable technologies could be mitigated by a resurgence of overall economic demand or commodity inflation (especially for rare earth and other metals needed for solar modules and wind turbines).

Given the importance of federal and state subsidies and tax incentives in reducing the overall cost of renewable energy projects, there are questions about how the industry may be affected if existing programs sunset over the next few years. Non-ethanol Federal renewable energy subsidies totaled approximately $12.2 billion from 2002-2008; fossil fuel subsidies, in contrast, are permanently written into the Federal tax code and have totaled nearly $75 billion during the same time period.[442] One possibility is that as subsidies decline, so will the cost of raw material. According to a recent article in the San Francisco Chronicle, the price for solar-grade silicon, the main raw material in solar panels, "fell to $53.40 a kilogram ($24.27 a pound) in June, the lowest in more than six years, from $78.90 in March," with the price declines attributed to cuts in European government solar incentives.[443] This could in turn reduce the costs of PV systems. A recent article in Photon International described the survey results of turnkey solar system prices in major PV markets throughout Europe and the U.S.[444] These findings suggest that, despite similar component prices across different countries, PV system prices vary significantly due to government incentives affecting anticipated rates of return.[445] In other words, with costs falling but prices supported by government incentives, producers, distributers, and installers in such countries could end up collecting the increasing difference.

Effect of Tax Benefits

Tax benefits can have a significant impact on levelized cost calculations, particularly for renewable technologies. It is important, therefore, to understand how the tax codes can benefit projects and to plan for the possibility that tax benefits may expire or change over time.

Tax benefits fall into three categories: accelerated depreciation, tax credits and deductions, and property tax exemptions (for solar units only). Solar has the largest benefits of any of the technologies. Natural gas power plants have minimal tax benefits reflected in the levelized cost of generation estimates. However, there are a number of subsidies and depreciation benefits applied to natural gas exploration, production, and sales. There are also hedging opportunities

441 Presentation by John Lushetsky, "The Prospect for $1/Watt Electricity from Solar," August 10, 2010, http://www1.eere.energy.gov/solar/sunshot/pdfs/dpw_lushetsky.pdf.

442 http://www.elistore.org/Data/products/d19_07.pdf. Fossil fuel subsidies are not specific to electricity generation.

443 San Francisco Chronicle, "Asia Doubles Solar Silicon Factories, Pursuing Gain in Slump," July 11, 2011, http://www.sfgate.com/cgi-bin/article.cgi?f=/g/a/2011/07/11/bloomberg1376-LNWOBG1A74E901-18V2TMP81AU917V753QK4RH4QD.DTL&ao=2, accessed July 22, 2011.

444 Photon International, "A Price for Every Market." Matthias Krause, May 2011.

445 In the study, production costs as well as module and inverter prices were found to have an insignificant amount of variation across markets. Installation, transportation, and certification did account for some, but not all, of the differences reported in the study.

that are not available for renewable generators. It is difficult to actually quantify the subsidy and hedging effects on the embedded natural gas prices that are applied to the levelized cost estimates to illustrate a comparable benefit that are available to renewable generators.

Table 21 summarizes the technologies that are eligible for renewable energy production tax credits (PTC) and renewable energy production incentives (REPI) for municipal utilities. The table also summarizes those plants eligible for federal business energy or investment tax credits (BETC/ITC) under the 2005 and 2008 federal Energy Policy Acts (EPAct) and the American Recovery and Reinvestment Act of 2009 (ARRA).

Table 21: Summary of Tax Credits

Federal Renewable Energy Tax Incentives - 2008 EPAct and 2009 ARRA

			Biomass					
Technology	**Coal IGCC[1]**	**Wind**	**Open Loop (Ag waste)**	**Closed Loop**	**Geothermal[2]**	**Small Hydro**	**Ocean Wave**	**Solar[3]**
Production Tax Credit								
Credit (2008$)/MWh	$ 1.26	$ 21	$ 10	$ 21	$ 21	$ 10	$ 10	
Credit (1993$)/MWh		$ 15	$ 7.50	$ 15	$ 15	$ 7.50	$ 7.50	
Duration (Years)	10	10	10	10	10	10	10	
Expiration	2009	2012	2013	2013	2013	2013	2013	
Eligibility	Merchant	Merchant	Merchant	Merchant	Merchant	Merchant	Merchant	
Investment Tax Credit								
Credit	20%				10%			*30%/10%*
Depreciable Value reduced	10%				5%			*15%/5%*
Expiration	2009				NA			2016
Loss Carryforward Period (Yrs)	20				20			20
Eligibility	Merchant/IOU				Merchant/IOU			Merchant/IOU
ARRA Grant								
ITC in-lieu of PTC	30%	30%	30%	30%	30%	30%	30%	30%
Expiration	2014	2014	2014	2014	2014	2014	2014	2014
Eligibility	Merchant/IOU	Merchant/IOU	Merchant/IOU	Merchant/IOU	*Merchant*	Merchant/IOU	Merchant/IOU	Merchant/IOU
Production Incentive[4]								
Tier I Payment		$ 4.10		$ 4.10	$ 4.10		$ 4.10	$ 4.10
Tier II Payment			$ 3.90					
Duration (Years)		10	10	10	10		10	10
Expiration		2017	2017	2017	2017		2017	2017
Eligibility		POU/ Coops	POU/ Coops	POU/ Coops	POU/ Coops		POU/ Coops	POU/ Coops

1. IGCC Production Credit is separate from REPTC, but similarly structured. Based on "refined coal" = $4.375/(13900 Btu/ton for anthracite / HR*(1+ParasiticLoad) for IGCC). Expiration date for ARRA ITC ambiguous.

2. Geothermal ITC does not expire. Unclear as to whether the ARRA increased the ITC for geothermal to 30% until 2014, and whether self-sales are eligible

3. Solar ITC reverts to 10 percent in 2016

4. REPI payments scaled based on 2007 shares of paid to applications

Source: Aspen

ARRA made most of the technologies that had been eligible for the PTC also eligible for the ITC if the latter provided a larger benefit. The ARRA also allows those technologies claiming the ITC to be able to recover the entire benefit in a single year as a "grant" rather than capping the ITC that can be claimed at the amount of net taxable income in any single year. The REPI amount is adjusted for the proportion that is actually paid out from available federal funds, which is currently 19 percent of amounts eligible. In addition, the table lists the amount of the state property tax exemption for solar technologies in the average case. Many of these tax credits and exemptions are slated to expire in the next five years and will affect developer costs and ultimately the terms for power purchase agreements.

The Value of Renewables in Electricity Portfolios

There is concern that adding renewable energy to California's energy portfolio will drive electricity prices higher. However, even if individual renewable energy projects cost more than conventional generation, diversifying the state's portfolio with renewable energy could ultimately reduce the overall cost of energy to the consumer.[446] The LCOE of renewable energy can be higher, but when adjusted for market risk it is, in most cases, lower than natural gas. Similar to how diversified investment portfolios can decrease risk and increase returns, incorporating renewable energy into electricity portfolios can provide valuable portfolio benefits without increasing costs.[447]

Renewable energy technologies can also act as insurance during periods of economic downturn and fossil fuel price shocks. Although the per-MWh price of some renewable generating technologies is higher than conventional fossil fueled generation, this price does not reflect the volatility or unpredictability of future fossil fuel prices. In 2000, Oak Ridge National Laboratory estimated that this volatility cost the U.S. economy $7 trillion in employment and Gross Domestic Product growth from 1970-2000.[448] The security of an energy portfolio solely comprised of fossil fuels is extremely vulnerable to movements in fossil fuel prices, which tend to move together.

The Value of Renewable Energy to Society

Renewable energy provides a number of societal benefits, not all of which can be easily quantified and are therefore often undervalued, such as increased competition between energy

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446 Awerbuch, Shimon, "Portfolio Based Capacity Planning: How Renewables Really Impact Overall Generating Cost and Energy Security," Presentation at DC World Bank Energy Week 2005, http://www.awerbuch.com/shimonpages/shimondocs/Awerbuch_Plenary_EW05.pdf.

447 Awerbuch, Shimon, and Raphael Sauter, "Exploiting the oil-GDP effect to support renewable deployment," June 21, 2005, http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V2W-4GFNGB6-1-B&_cdi=5713&_user=10&_orig=search&_coverDate=06%2F21%2F2005&_sk=999999999&view=c&wchp=dGLbVlz-zSkzV&_valck=1&md5=8de34c361c9cf3503c71cec8a360a74b&ie=/sdarticle.pdf.

448 Awerbuch, Shimon, "Portfolio Based Capacity Planning: How Renewables Really Impact Overall Generating Cost and Energy Security," Presentation at DC World Bank Energy Week 2005, http://www.awerbuch.com/shimonpages/shimondocs/Awerbuch_Plenary_EW05.pdf.

generation technologies and mitigation of long-term, strategic risks and costs associated with fossil fuel price volatility.

The current pricing of electricity does not include externalized costs to society associated with fossil fuels. For example, air pollution produced by burning fossil fuels plays a well-documented role in asthma attacks. The costs to hospitalize and treat asthma patients are paid by society in the form of higher health insurance premiums, greater use of public emergency rooms, and reduced productivity, but are not included in the price of electricity.

The generation of electricity from renewable resources generally produces fewer greenhouse gas emissions and less air pollution than conventional fossil fuel generation. This helps to reduce or avoid the environmental, economic, and health costs associated with conventional power plants. According to the German Federal Ministry for the Environment,[449] the combined costs of climate change and air pollution resulting from natural gas-fired generation are more than 3 times higher than solar PV and 13 times higher than wind energy. The Ministry estimates the societal costs of wind energy at ¼ cent per kWh, solar PV at 1 cent per kWh and biomass from 2/5 cent to 5 cents per kWh depending on the technology. The cost of natural gas is near 5 cents per kWh and coal is more than 8 cents per kWh.

As an example of how renewable generating resources provide value in addition to energy, the Oregon Forest Resources Institute estimated the environmental benefits of using forest biomass for energy at more than 11 cents per kWh in 2006. The value of avoided forest overgrowth was estimated to be an additional 20 cents per kWh. "These results suggest that the environmental benefits of forest biomass use for energy are well in excess of the market value of the electricity produced."[450] The benefits of converting biomass into energy in a controlled environment include the displacement of fossil fuel use, as well as the prevention of air pollution from open-field burning and wildfires. Research in the southern San Joaquin Valley sponsored by the California Air Resources Board showed a 98 percent reduction in criteria air pollutants from a biomass boiler compared to open field burning.[451]

Cost Challenges

Environmental Review and Permitting Costs

According to Black and Veatch, "many renewable energy project developers report uncertainty about what is needed to obtain permits," which adds risk to the development process. When a

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449 "Renewable Energy Sources in Figures: National and International Development," Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, June 2010.

450 "Biomass Energy and Biofuel from Oregon's Forests," Oregon Forest Resources Institute, June 30, 2006.

451 Emission factors from "Hydrocarbon characterization of Agricultural Waste Burning," CAL/ARB Project A7-068-30, University of California, Riverside, E.F. Darley, April 1979.

delay occurs, increasing costs, developers may be required to resize or refinance a project, which can lead to project termination, project sale, or a contract failure.” [452]

Delays in the environmental review and permitting of projects can also be expensive. These delays can arise due to the variety of environmental impacts associated with utility-scale renewable electricity facilities and by developing projects in environmentally sensitive areas, as discussed in detail in Chapter 3. It is difficult to generalize about the difference in costs for environmental review and permitting across technologies, as even within the same technology, the cost may vary greatly depending on the permitting authority, as well as the proposed project site’s resource availability and environmental sensitivity.

In addition to environmental issues associated with land use, costs associated with air quality permitting can be burdensome for some renewable facilities such as biomass and biogas projects, particularly those that use previously untested feedstocks. Many farms and dairies in California produce waste material that could be converted to electricity, but the high costs and complex local and state permitting requirements present a barrier to electricity generation projects at these sites.

Mitigating potential environmental impacts identified during the permitting process can also add significantly to the cost of developing a renewable project. For example, mitigation costs for the 370 MW Ivanpah solar tower project located in San Bernardino County were estimated at $34 million, which includes costs for desert tortoise, rare flora, and streambed compensation.[453]Another example is the Imperial Valley Solar 709 MW solar Stirling engine project, with an estimated $10 million in mitigation costs.[454]

Chapter 3 also noted the permitting obstacles renewable projects face due to overlapping and often confusing permitting processes. For example, DG technologies such as PV, biomass, and small wind face challenges given the multitude of agencies involved in permitting renewable energy projects. Verengo Solar Plus, a residential solar panel installer in Orange County, notes that there are “50 different permitting authorities within 50 miles of [their] office.” A recent article in the Sacramento Bee noted that “cumbersome and inconsistent regulations are undermining” the growth of the solar industry, and are “increasing costs to consumers.”[455]

As renewable energy development increases, the workload for cities, counties, and other local jurisdictions will also increase, adding to potential delays in permit review processes. In

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452 Black and Veatch, Memo to the Energy Commission: “Renewable Energy Program: Cost Reduction;” B&V File CEC-KEMA; June 16, 2011.

453 California Energy Commission, *Ivanpah Solar Electric Generation System Commission Decision*, September 2010, http://www.energy.ca.gov/2010publications/CEC-800-2010-004/CEC-800-2010-004-CMF.PDF.

454 California Energy Commission, *Imperial Valley Solar Energy Project Commission Decision*, September 2010, http://www.energy.ca.gov/2010publications/CEC-800-2010-006/CEC-800-2010-006-CMF.PDF.

455 Sacramento Bee, May 1, 2011, “Permit process clouds solar energy projects,” http://www.sacbee.com/2011/05/01/3590755/permit-process-clouds-solar-energy.html, accessed July 22, 2011.

addition, permitting staff at local agencies may also be unfamiliar with renewable DG technologies, which can increase the time needed for project review and issuance of permits. Some solar contractors say that installation of rooftop solar panels can take two to three months from start to finish , whereas "installing a central air conditioning system, which requires about the same amount of work, can take two weeks."[456] In addition, as discussed in Chapter 3, some jurisdictions charge permitting fees based on the total cost of a project rather than on the actual time and resources it takes to review a project and issue a permit.

A recent study by SunRun Inc. estimates that nationally, these permitting issues add an average of $2,500 to the cost of each residential solar installation.[457] The executive director of SolarTech, a San Jose-based solar industry trade group, was recently quoted as saying that "cumbersome and inconsistent regulations are undermining" the growth of the solar industry, and are "increasing costs to consumers," and that permitting or "'soft costs' for a typical $20,000 to $30,000 residential solar project can add up to $5,000"[458] or 17-25 percent of total costs.

Construction Costs

As discussed earlier in this chapter, the capital cost of renewable projects can represent a significant portion of levelized cost. The first steps in building a renewable energy facility include buying or leasing land, obtaining permits, and purchasing capital equipment and building materials, or direct capital costs. Indirect capital costs include longer-term and soft costs such as financing, insurance, labor for installation, and taxes during construction. For utility-scale technologies, direct capital costs are the primary drivers of the total capital cost. Overall costs for these technologies are significantly offset by the availability of tax incentives, such as accelerated depreciation, and in the case of single axis solar PV can be reduced by as much as 55 percent.[459] Table 22 and Table 23 describe major cost drivers for utility-scale and building, and community-scale renewable technologies.

Similar to utility-scale renewables, direct capital costs for DG represent a significant share of the overall capital cost; however, as project size decreases, installation and labor costs have a proportionately larger share of the total capital cost. This is because these costs do not escalate in direct proportion to the size of the project; larger projects benefit from economies of scale.

456 Ibid.

457 SunRun, *The Impact of Local Permitting on the Cost of Solar Power*, January 2011, http://www.sunrunhome.com/uploads/media_items/solar-report-on-cost-of-solar-local-permitting.original.pdf.

458 Sacramento Bee, May 1, 2011, "Permit process clouds solar energy projects," http://www.sacbee.com/2011/05/01/3590755/permit-process-clouds-solar-energy.html, accessed July 22, 2011.

459 Assumptions to the Annual Energy Outlook 2010 EIA.

Table 22: Summary of Cost Drivers - Utility-scale Technologies

Technology	Cost Drivers	Tax Incentive Cost Impacts
Biomass		
Fluidized Bed	Fuel type, uniformity, & proximity.	Can reduce by up to 34%
Stoker Boiler	Fuel type, uniformity, & proximity.	Can reduce by up to 29%
IGCC	Boiler/gasifier, fuel type, uniformity, proximity.	Can reduce up to 33%
Geothermal		
Binary	Vary significantly by site. Includes: size, exploration, site development, & resource temperatures.	Can reduce up to 50%
Flash	Vary significantly by site. Includes: size, exploration, site development, & resource temperatures.	Can reduce up to 48%
Hydroelectric		
Small & developed	Construction, environmental mitigation, and fish & wildlife mitigation.	Can reduce up to 51%
Incremental	Construction, environmental mitigation, and fish & wildlife mitigation.	Can reduce up to 18%
Solar		
Parabolic Trough	Solar field, thermal storage, power block.	Can reduce as much as 53%
PV (Single Axis)	Solar modules, inverters, installation, & steel prices.	Can reduce by as much as 55%
Wind – Onshore Class 3/4/5	Turbine cost (33% overall cost), permit, grid connect, reliability costs.	Can reduce by as much as 49%

Source: California Energy Commission

Table 23: Summary of Cost Drivers - Distributed Generation Technologies

Technology	Significant Cost Drivers
Biogas – Anaerobic Digester	Capital cost, type of food or manure used, amount of clean-up equipment needed, and electric/thermal load at facility
Biogas – Landfill Gas	Capital cost to include turbine modifications to run on low to medium fuel, gas clean-up equipment
Biogas – Wastewater Treatment	Equipment, skilled labor, & maintaining consistent temperatures
Solar PV Residential Fixed Tilt Commercial Fixed Tilt Ground-based Tracking	Solar module raw materials; inverters, installation, and steel prices.
Wind – Community-scale	Turbine cost (33% overall cost), permit, grid connect, reliability costs
Geothermal Heat Pump	Equipment, design (type and size of system), land, drilling, and installation
Integrated Solar Space & Water Heating	Installation cost, building retrofits, proximity of buildings, size of building, use of building, and local climate

Source: California Energy Commission

Interconnection Costs

Interconnection procedures can be a lengthy and expensive barrier to developers of both large-scale renewable energy projects and smaller-scale self-generation projects. The decision to invest in renewable projects and the economic viability of developing such projects often depends on transmission interconnection costs. Many renewable projects are intermittent, in addition to being sited in areas with little or no load and no transmission lines. Such factors require significantly more detailed study than currently exists to understand the impacts of renewable generation on distribution and/or transmission systems, leading to higher interconnection costs for renewables. Large-scale wind and solar projects in particular may find it difficult to locate and obtain approval for economic and ecologically suitable transmission corridors, which can jeopardize project viability. Projects may be required to pay for new lines, poles, substations, and other infrastructure which can add significantly to development costs.

Wholesale and customer-side DG will need to be integrated into the distribution system, which was not designed to accommodate large amounts of DG. The number of DG projects requesting interconnection at the distribution level continues to increase. While tens of thousands of small self-generation PV projects have been connected all over the state, the increased size and number of projects, lack of on-site load, and location-dependent issues have made interconnection much more complicated.[460] Current interconnection procedures are not able to process large numbers of projects seeking to interconnect within the same short time frame, resulting in long queues of backlogged applications and studies. This results in costly delays for developers and can result in proposed projects not being built.

In addition, delays may be caused by project developers as they decide whether to proceed with a project once interconnection, negotiation, and transaction costs are known.[461] The KEMA study on the European experience in integrating DG that was summarized in Chapter 8 noted that, like California, the amount DG projects must pay to interconnect in Europe is slowing the pace of development. To address this issue, pending legislation in Spain would institute greater sharing of interconnection costs between developers.[462]

Current Efforts to Address Cost Issues

Reducing Permitting and Other Regulatory Costs: An efficient and environmentally responsible regulatory framework is critical to making renewable generating resources economically competitive. For example, the DRECP, as described in Chapter 3, will help

460 According to ongoing research being conducted by KEMA for the Energy Commission, a significant amount of renewable generation may be located in the Central Valley due to the availability of low-cost disturbed or damaged agricultural land. This would lead to a need for additional transmission.

461 IEPR workshop transcript, Energy Commission, May 9, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/2011-05-09_Transcript.pdf.

462 Memo from KEMA to Integrated Energy Policy Report Committee on Distributed Generation in Europe, April 29, 2011, p. 51, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/documents/Memo%201_Physical%20Infrastructure%20and%20DG%20Interconnection.pdf.

developers to consider environmental issues early in the planning process and thereby reduce delays and other issues that can increase project costs. Chapter 3 also discusses permit streamlining efforts by the REAT, the Energy Commission, and a variety of local jurisdictions.

Other tools to facilitate renewable permitting that are discussed in more detail in Chapter 3 include the REAT's *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects,*[463] the *California Guidelines for Reducing Impacts to Birds and Bats from Wind Development*,[464] the *Energy Aware Facility Siting and Permitting Guide*,[465] the *Energy Aware Planning Guide,*[466] and the *Developing Renewable Generation on State Property* report.[467] Chapters 3 and 10 also outline the many efforts underway in local jurisdictions to incorporate permitting of utility-scale and other renewables in their general plans and to facilitate permitting of DG-scale renewable.

Reducing Construction and Installation Costs: Rebates, tax credits, grants, low-interest loans, and loan guarantees are tools that can reduce the upfront costs for renewable projects. Financial tools at the Federal level include federal stimulus funds through the American Recovery and Reinvestment Act of 2009 (loan guarantees, tax credits, various expanded tax-credit bond programs); several tax credits; various accelerated depreciation programs; and renewable energy grants. These are covered in more detail in Chapter 7 which discusses financing challenges.

At the state level, several California cities are participating in the Property Assessed Clean Energy (PACE) program to provide innovatively financed, low-interest loans for installing energy efficiency additions and renewable energy systems on buildings.[468] While only the commercial portion is currently active, a bipartisan group of Representatives is seeking to

463 Renewable Energy Action Team Report, *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, September 2010, http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009.PDF.

464 California Energy Commission and California Department of Fish and Game, *California Guidelines for Reducing Impacts to Birds and Bats from Wind Development*, 2007, http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF.

465 California Energy Commission, *Energy Aware Facility Siting and Permitting Guide*, December 2020, http://www.energy.ca.gov/2010publications/CEC-600-2010-007/CEC-600-2010-007-D.PDF.

466 California Energy Commission, *Energy Aware Planning Guide*, February 2011, http://www.energy.ca.gov/2009publications/CEC-600-2009-013/CEC-600-2009-013.PDF, Section C.2.2.

467 California Energy Commission, *Developing Renewable Generation on State Property: Installing Renewable Energy on State Buildings and Other State-Owned Property*, staff report, April 2011, http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf. Please see Chapter 10 for a more detailed description of the findings and recommendations from the report.

468 In 2008, California passed Assembly Bill 811 (Levine, Chapter 159, Statutes of 2008), which authorized cities and counties to create local Property Assessed Clean Energy (PACE) programs. Challenges to PACE programs are discussed in Chapter 7.

resolve issues with the residential side of the PACE program.[469] Other state incentives include the Property Tax Exclusion for Solar Energy Systems and the Sales Tax Exemption for Alternative Energy Manufacturing Equipment.

For DG projects, the CSI provides rebates for solar installations on existing buildings,[470] while the Emerging Renewables Program[471] and the Self Generation Incentive Program (SGIP)[472] provide rebates to qualifying small wind systems and fuel cells. The New Solar Homes Partnership Program,[473] which is part of the CSI, provides rebates to builders of qualifying new homes with solar PV systems. Utilities and some cities also provide rebates for residential PV systems.[474] Due to its popularity, the CSI is running low on funds, and has completely depleted funding for its low-income components, the Single-Family Affordable Solar Homes Program (SASH) and the Multifamily Affordable Solar Housing Program (MASH).[475] Similarly, many publicly owned utilities have exhausted funding for their programs, while funding for the SGIP and other programs provided by the state's Public Goods Charge, such as ERP and NSHP, will sunset at the end of 2011 without legislative reauthorization.

Reducing Interconnection Costs

Chapter 6 discusses the multiple efforts underway to reduce the complexity, expense, and length of interconnection procedures in California. These include recent reforms by the California Independent System Operator of its grid interconnection process as well as the CPUC's Rule 21 proceeding and the Renewable Distributed Energy Collaborative (Re-DEC).[476] Other efforts include utilities' release of detailed maps of their distribution networks, as required in the CPUC's Renewable Auction Mechanism (RAM) proceeding, to help developers of DG projects identify locations that would not trigger expensive studies and upgrades to the distribution system.

469 http://blogs.forbes.com/toddwoody/2011/07/20/bipartisan-bid-to-revive-pace-solar-financing-program/.

470 http://www.gosolarcalifornia.ca.gov/about/csi.php.

471 http://www.consumerenergycenter.org/erprebate/program.html.

472 http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/.

473 http://www.gosolarcalifornia.ca.gov/about/nshp.php.

474 http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=CA.

475 Please see the environmental justice section of Chapter 10 for more information about these programs.

476 See Chapter 6 for more information about Re-DEC and Rule 21.

Chapter 9: Research and Development to Support California's Renewable Generation Goals

As discussed in previous chapters, investments in energy-related research and development (R&D) are essential in the development of technologies to displace fossil fuels with renewable energy. Development of innovative, cost-effective, and efficient clean energy technologies will strengthen California's economy, protect the environment, and increase energy independence. Maintaining California's leadership role in energy-related R&D is also critical to the state's ability to compete in the global race to create a clean energy economy.

Past R&D efforts have been instrumental in developing today's renewable industry, but meeting California's renewable goals today and in the future will require additional R&D investments to develop new technologies, infrastructure improvements, and integration strategies, both for meeting 2020 Renewable Portfolio Standard (RPS) targets as well as longer-term greenhouse gas (GHG) emission reduction targets. As noted in a recent report by the California Council on Science and Technology, "significant levels of research, development, invention, and innovation" will be necessary to develop the technologies needed to achieve the state's 2050 GHG emission reduction target. The report discusses the need by 2050 to develop emission-free electricity production while also dealing with an expected doubling of electricity demand, which will require a combination of strategies that could include new energy storage technologies and advances in the smart grid.[477]

There is little financial incentive for private companies to invest in R&D when there is no certainty of return on their investment. Government has an important role in addressing this gap by funding research that provides significant societal and economic value from the earliest stages of technological discovery to technology demonstration and deployment. As discussed earlier in this report, several key research challenges include resolving intermittency and integration issues – two cost and reliability barriers impeding broader adoption of renewables.

This chapter outlines past, current, and future research efforts to address renewable challenges. It draws on research needs to overcome some of the major challenges facing renewable development outlined in earlier chapters. These include R&D related to the following:

- Planning, permitting, and environmental challenges for renewable generation and transmission.
- Integration issues associated with distributed generation and intermittent utility-scale renewable development in the state.

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477 California Council on Science and Technology, *California's Energy Future – The View to 20*50, May 2011, http://www.ccst.us/publications/2011/2011energy.pdf.

- Integrating smart technologies, renewable generation and communication devices on the distribution system into a "smart grid."
- Demand response and storage to provide ancillary services and grid support to integrate renewable resources into the transmission grid.
- Cost reduction and financing.

Descriptions of PIER-funded projects in this chapter are organized by the challenge they will help address, with completed projects discussed first, followed by those that are underway or planned for the future.

Overview of PIER Program

In California, the primary government-funded research effort is the Energy Commission's Public Interest Energy Research (PIER) Program, which was established by the California Legislature in 1996. Recognizing the need to continue energy-related public interest R&D after deregulation of the state's electricity industry, the Legislature shifted administration of public interest R&D from the state's investor-owned utilities (IOUs) to state government and established a public goods surcharge on retail sales of electricity to fund this effort.

The PIER Program annually provides approximately $86.5 million for R&D projects that provide tangible benefits to ratepayers in the following areas:

- Increased energy efficiency in buildings, appliances, lighting, and other applications.
- Increased use of renewable energy resources, improved transmission and distribution of electricity generated from renewable energy resources and reduced/eliminated consumption of water or other finite resources.
- Reduced GHG emissions from electricity generation and cost-effective approaches to evaluating and resolving environmental effects of energy production.
- Advanced transportation technologies that reduce air pollution and GHG emissions.

Figure 28 shows PIER funding allocations for these activities from 1997 to 2010. Over the 13-year life of the PIER Program, the Energy Commission has leveraged millions of dollars in matching funds from private and public sources for R&D that benefits California's ratepayers. These efforts have resulted in $1.7 million in total research for every $1 million of PIER funds invested. In addition, in 2010, the PIER Program was successful in leveraging more than $500 million in federal stimulus funding under the American Recovery and Reinvestment Act of 2009 and $900 million in private investment funds using only $20 million in program funding. Additional benefits include nearly $1 billion in annual energy cost savings for electric and natural gas ratepayers as a result of PIER-funded energy efficiency projects whose results have been incorporated into California's building and appliance efficiency standards.[478]

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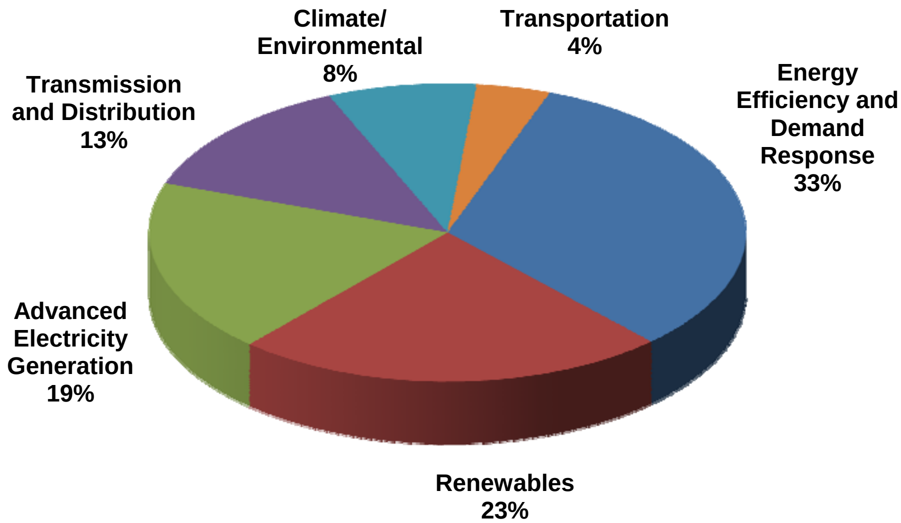
478 California Energy Commission, *Public Interest Energy Research 2010 Annual Report*, March 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-031/CEC-500-2011-031-CMF.PDF.

Figure 28: PIER Electric and Natural Gas Research Budget Allocations ($ millions)



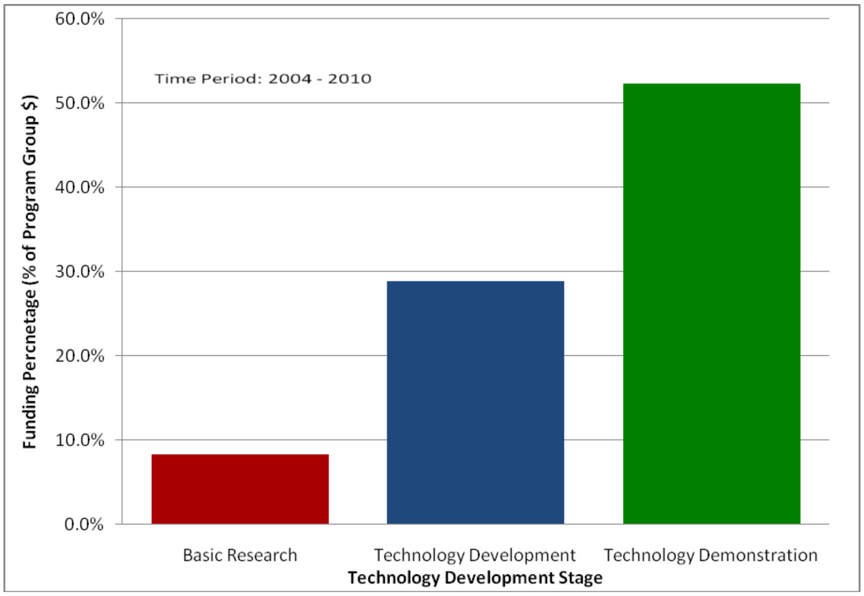
Source: California Energy Commission

The PIER Program has provided approximately $179 million in R&D funding for a wide variety of activities in support of California's renewable energy goals. These include R&D aimed at mitigating environmental concerns of renewable development, enhancing transmission and distribution grid reliability, facilitating renewable integration, and improving renewable technology performance and costs. These investments are not limited to basic research; in fact, more than half of PIER funding awarded related to renewable energy between 2004 and 2010 was for technology demonstrations (Figure 29).

Research to Address Permitting and Environmental Challenges

As discussed in Chapter 3, utility-scale renewable development can have significant environmental impacts on sensitive species and habitats. Given the number and scale of proposed renewable facilities in California, it is essential to understand and identify ways to mitigate the potential environmental effects of these facilities to help inform the permitting process. PIER has funded dozens of projects over the years focused on evaluating and resolving the environmental effects of energy production, delivery, and use in California and exploring how new electricity applications and products can solve environmental problems. Examples of past research include:

Figure 29: Breakdown of PIER Renewable Investments by Technology Development Stage



Source: California Energy Commission

- A life cycle assessment to identify and evaluate the environmental impacts of emissions, resource consumption, and energy use associated with the production of electricity by existing and emerging distributed generation (DG) technologies.[479]
- An assessment of current knowledge about potential environmental impacts of increased use of forest biomass for energy production with suggested areas for future research that regulators can use to develop guidelines for using woody biomass for energy production.[480]
- Multiple studies on reducing the impacts of wind energy development on birds and bats as well as reducing bird deaths from electrocution and collision with power lines.[481]
- Research to improve forecasting of hydroelectric reservoir inflow and provide reservoir managers with tools to facilitate choices between competing demands like flood control, water supply, environmental protection, and electricity generation.[482]

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479 National Renewable Energy Laboratory, *Life Cycle Assessment of Existing and Emerging Distributed Generation Technologies in California*, July 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-001/CEC-500-2011-001.pdf.

480 William Stewart et al, *Potential Positive and Negative Environmental Impacts of Increased Woody Biomass Use for California*, July 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-036/CEC-500-2011-036.pdf.

481 See http://www.energy.ca.gov/research/environmental/reports.html for a list of reports on PIER projects addressing this topic.

482 *Hydrologic Research Center, Integrated Forecast and Reservoir Management (INFORM) for Northern California: System Development and Initial Demonstration*. March 2007, http://www.energy.ca.gov/pier/project_reports/CEC-500-2006-109.html.

- A study on the efficiency and effectiveness of environmental flow evaluations conducted during the Federal Energy Regulatory Commission's hydropower relicensing process, one of the most contentious issues during relicensing.[483] Approximately 4,000 MWs of in-state hydropower capacity is up for relicensing in the near future; because these licenses are for 30 to 50 years, it is critical that the best science is used in the relicensing process.

Going forward, ongoing and new PIER-funded research will continue to contribute toward reducing the environmental impacts of renewable development and assist in the permitting of renewable electricity generation facilities, particularly those in the California desert. Projects currently underway include:

- Six ongoing PIER-funded environmental research projects are addressing the major siting issues facing utility-scale solar energy development in the desert. These research projects are focused on biological issues that caused uncertainty and delay in the permitting of solar thermal generating projects in 2010. The intent is to improve the scientific basic for management decisions to promote resource conservation, resolve biological issues, and ensure environmental protection while also facilitating permitting. Current projects include evaluation of rare plant transplanting success[484] and tools to enhance the survival of desert tortoises affected by solar energy development.[485, 486]
- Research to identify the lowest-risk sites for wind turbines and improve the accuracy and cost-effectiveness of bird and bat surveying and monitoring methods, such as the use of radar, to reduce bird and bat deaths.[487]

Research to Address Transmission Challenges

Chapter 4 on transmission issues noted the need to promote better use of the existing transmission grid to handle the large amount of new renewable generation needed to meet statewide goals. Examples of optimizing the existing grid include building double-circuit lines rather than single circuit lines to make best use of existing transmission rights-of-way and increasing power flow through existing lines by removing thermal and dynamic stability physical constraints that limit the allowed capacity of the lines. The PIER Program's

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483 Peter Moyle et al., *Improving Environmental Flow Methodologies Used in California FERC Relicensing*, August 2011, http://www.energy.ca.gov/pier/project_reports/CEC-500-2006-109.html.

484 California Energy Commission, *Plant Population Viability and Restoration Potential for Rare Plants Near Solar Installations Fact Sheet*, March 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-FS/CEC-500-2011-FS-014.pdf.

485 California Energy Commission, *Decision Support Tool for Desert Tortoises Near Solar Installations Fact Sheet*, April 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-FS/CEC-500-2011-FS-007.pdf.

486 California Energy Commission, *Minimizing Conflicts between Desert Tortoises and Energy Development Projects in the Mojave Desert Fact Sheet*, January 2011, http://www.energy.ca.gov/2010publications/CEC-500-2010-FS/CEC-500-2010-FS-015.PDF.

487 California Energy Commission, *Assessing Bat and Bird Movements and Mortality Relative to Wind Turbines Fact Sheet*, March 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-FS/CEC-500-2011-FS-013.pdf.

Transmission Research Program has funded a wide variety of projects largely focused on preparing the transmission system for large penetrations of both utility-scale and distributed renewable generation.

Past Research Efforts

- Development of a prototype Real Time Dynamic Measurement System (RTDMS) installed at the California ISO for monitoring and testing.[488] The RTDMS, like other synchrophasor-based tools,[489] allows greater awareness of impending problems, increased grid capacity, and improved reliability of the grid. In 2009, the California ISO decided to bring the system into its mainstream operation. This system is now in version 8 release and is commercially available from the manufacturer

- Wide-Area Energy Storage and Management System to Balance Intermittent (Renewable) Resources in the California ISO: [490] This project showed that sharing power system regulation services between two control areas (California ISO and the Bonneville Power Administration in the Northwest) using two types of energy storage (flywheels in the California ISO for fast regulation and hydro in the Northwest for smooth/slow regulation) would provide fast, cost-effective, and efficient ancillary services for balancing renewable generation in the power grid. The study projected a savings of 30 percent in additional reserve resource requirements with substantial dollar savings.

- Western Electricity Coordinating Council Wind Generator (Model) Development: [491] California transmission operators and planners rely on models for how various types of electric generators behave during sudden changes in the power grid and the impacts of that behavior on reliability throughout the Western grid. This project, co-funded by the PIER Program and the U.S. Department of Energy (DOE), developed and validated models for four types of wind generators. These models are now included in standard model libraries used by transmission operators and planners in the western United States.

- Developing Tools for On-line Analysis and Visualization of Operational Impacts of Wind and Solar Generation: [492] This project is developing forecasting tools for wind and solar generation to allow the California ISO to better manage the California electric grid. One of these, a "Ramping Tool," predicts the system ancillary resources – conventional generators,

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488 http://www.phasor-rtdms.com/

489 Synchrophasors provide better information to grid operators about real-time grid conditions by collecting and reporting information 30 times per second.

490 Pacific Northwest National Laboratory, *Wide-Area Energy Storage and Management System Phase 2*, August 2010, http://uc-ciee.org/images/downloadable_content/electric_grid/Final_WAEMS_Report_CIEE.pdf

491 National Renewable Energy Laboratory, *WECC Wind Generator Development*, March 2010, http://uc-ciee.org/downloads/WGM_Final_Report.pdf.

492 The project fact sheet can be found at: http://uc-ciee.org/images/downloadable_content/electric_grid/OT_FactSheet.pdf.

energy storage or demand response – needed to handle ramping up or down caused by intermittent renewables for 24 hours ahead. Another tool, the "Transmission Planning" tool, forecasts possible power flow congestion issues. A prototype of the ramping tool has been operating at the California ISO and successfully predicted a significant shortfall of balancing reserve that led to a spike in pricing to $1,000/MWh for purchasing "backup" power. Because of this success, the California ISO plans to use both of these tools in its control room display screen.

- Real-Time Grid Reliability Management: [493] The PIER Program has funded a series of projects using synchrophasor measurements for real-time situational awareness, diagnostics, and control of the entire electric grid by transmission system operators. This new measurement technology gives operators an unprecedented ability to know what is happening throughout the system and provides "over the horizon" early warnings of developing problems in real time (Figure 30). As these measurement devices are being deployed in the electric grid, PIER funding is helping to develop applications for using the data to improve grid operating reliability and economic efficiencies, especially under high penetrations of renewable generation. This particular research effort has been developing a "platform" for using these applications, with an early generation prototype in use by the California ISO and utilities.
- Oscillation Rapid Detection and Mitigation Analysis: [494] PIER funded a series of research projects targeted at reducing instabilities in the western electric transmission system that can cause large, expensive blackouts, such as the 1996 West Coast blackout that affected more than 7.5 million people. As a precaution against instabilities, some transmission connections for California are being operated thousands of MW below maximum capacity. Tools are being developed that use synchrophasor measurements to help transmission operators rapidly detect oscillations and advise the operator on what actions to take to mitigate these threats to reliability. Early generations of these tools are already in use at the California ISO. The goal is to eventually control these oscillations so that transmission capacity can be used at full capacity and transmit additional power.

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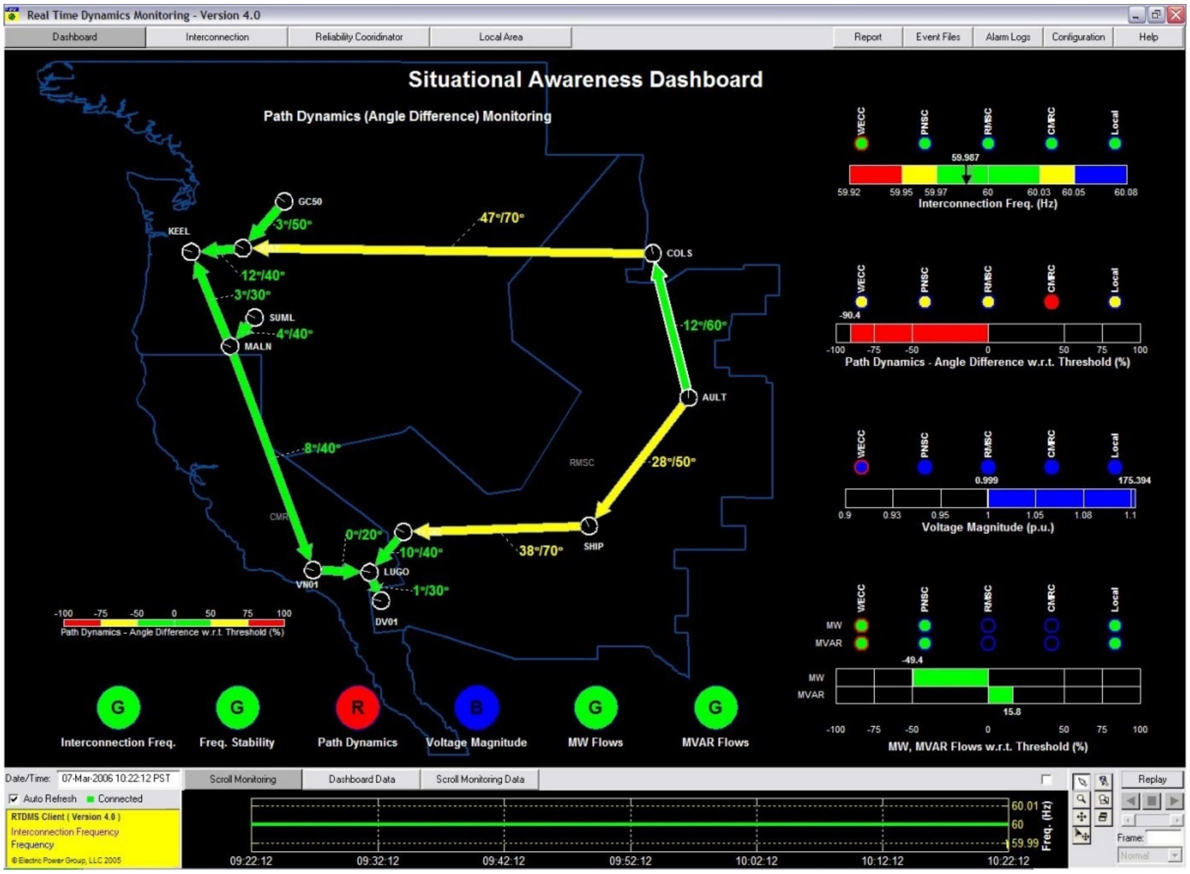
493 Lawrence Berkeley National Laboratory, *Real Time Grid Reliability Management 2005*, February 2007, http://uc-ciee.org/images/downloadable_content/electric_grid/RTGRM2005_FactSheet.pdf andReal-Time Grid Reliability Management, December 2008, http://www.energy.ca.gov/2008publications/CEC-500-2008-049/CEC-500-2008-049.PDF.

494 Pacific Northwest National Laboratory, *Oscillation Detection and Analysis*, August, 2010, http://uc-ciee.org/images/downloadable_content/electric_grid/ODA_Final_Report.pdf.

Figure 30: Situational Awareness Dashboard



Source: Courtesy of Joe Eto, LBNL/CERTS, Principal Investigator, from the Transmission Research Program Colloquium, Sacramento, CA, September 11, 2008, Synchrophaser Dashboard

- Application of Advanced Wide Area Early Warning Systems with Adaptive Protection:[495] The PIER Program has funded a series of projects for improving the reliability of systems that protect grid equipment and people from excess power flows. Analyses of large blackouts in the past have shown that some conventional protection systems actually made the blackouts worse.[496] The modern grid needs smarter protection systems, particularly given expected high penetration of renewable resources. PIER has developed a number of tools, using synchrophasor measurements, that can adapt protection relays for different situations encountered on the grid at various times. PIER is now co-funding with the federal government demonstrations of two of these new tools in the PG&E and SCE transmission systems.

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495 Stuart Consulting, *Multi-Area Real-Time Transmission Line Rating Study*, October 2007, http://uc-ciee.org/images/downloadable_content/electric_grid/IGPS_Final_Report.pdf.

496 Hazel R. O'Leary, Secretary of Energy, *The Electric Power Outages in the Western United States*, July 2-3, 1996; Report to the President, August 2, 1996.

- Development of Fault Current Controller Technology Phase I: [497] Due to ever-increasing load on the electric system, fault currents are increasing beyond the ability of circuit breakers to safely interrupt the fault currents and protect vulnerable substation equipment. PIER funded a successful field demonstration of a prototype fault current controller, a new grid device that can limit maximum current flows, at the 15 kilovolt (kV) level at SCE that provided valuable learning experience for how to deploy these devices and make next generation with improvements, such as the ability to withstand higher voltages.
- The California Field Test of the 3M High-Temperature Low-Sag (HTLS) Conductor: [498] Ordinary transmission cables made with a steel core wire wrapped with aluminum conductors can carry only so much power before the heat produces temperatures that cause too much sag or damage in the line. New core materials allow replacement lines to be operated at much higher temperatures, allowing more power to be transferred over the same towers in the right of way. PIER co-funded a demonstration of 3M's version of a HTLS conductor at SDG&E which demonstrated that the line behaved as designed, and showed that special handling techniques could accommodate new physical properties of these emerging types of conductors.
- Extreme Events:[499] A wide-area blackout is a typical example of an extreme event in the transmission system that can be initiated by an earthquake, a power plant tripping offline, or even a line sagging into a tree. However, analyzing and predicting extreme events is very difficult. This PIER project used modeling and stochastic analysis techniques that were new to the electric grid community to develop and test a small-scale network model and the science and conceptual framework and advanced mathematical techniques needed for the complexity of multiple component and system failures in a transmission system. The methodologies were then applied to realistic network models to test their practicality.
- SCE, working with Waukesha Electric Systems, Inc. will design, develop, fabricate, and install a smart grid compatible fault current limiting superconducting transformer on SCE's utility host site.[500] The 28 MVA, three-phase, medium power utility fault current limiting transformer twill be placed within SCE's MacArthur Substation, located in Newport Beach, and within the project area of SCE's Irvine Smart Grid Demonstration Project. By incorporating fault current limiting capability, the transformer is better able to handle fault currents and represents a cost and space efficient means to bring fault current limiting

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497 http://www.energy.ca.gov/pier/portfolio/Content/ar07/Development%20of%20Fault%20Current.htm.

498 http://www.energy.ca.gov/pier/portfolio/Content/06/ESI/High%20Temperature%20Low%20Sag%20Conductor2.htm.

499 The Extreme Event Research project fact sheet can be found at http://uc-ciee.org/images/downloadable_content/electric_grid/EE_FactSheet.pdf.

500 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf

capability into the substation without adding a separate device, and ultimately improves the grid performance and reliability.

Future Research Efforts

In the future, the Energy Commission will encourage utilities to work in collaboration with the PIER Program to identify opportunities for deployment of new technologies to further optimize the use of the existing transmission system. Technologies should include:

- New grid operating tools for accommodating solar and wind generation's unique characteristics with increasingly higher levels of penetrations.
- Solar generator modeling: As the amount of both utility- and distributed-scale solar generators grows, dynamic stability models, similar to the Wind Generator Models developed with PIER and DOE funding, are needed.
- Solar and wind forecasting: The ability to forecast solar and wind resources expected in minutes to many hours ahead at given generator locations is important for the reliable, economic, and efficient operation of the electric grid. Existing technologies need improved accuracy and precision.
- Dynamic Thermal Circuit Rating (DTCR): DTCR can provide transmission congestion relief and improve grid reliability while providing increased transmission line capacity in real time. This technology also allows faster integration of wind energy.[501] Transmission lines have limitations on the amount of power they can carry, determined by the performance of the line conductors at high temperatures. System design engineers and planners establish limits (ratings) on the capacity of the individual lines so that under high loading and extreme weather conditions when the lines typically sag or might be damaged, the operator will be assured that the lines will safely and securely maintain the minimum ground clearances.[502] However, actual transmission line capacity changes constantly as a result of variations in wind, solar radiation, ambient temperature and other weather conditions in combination with line loading, and at most times the real-time line rating can be significantly higher than the static line rating. Real-time line rating systems such as DTCR include monitors that communicate data on the real time line conditions allowing the system operator to load existing transmission lines more closely to their "full" capacity, reducing the need for new transmission.[503,504] Use-case studies of DTCR, and diagnostic,

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501 Aivaliotis, Sandy K., "Dynamic Line Ratings for a Reliable and Optimized Smart Transmission," PowerPoint presented at the Seventh Annual Carnegie Mellon Conference on the Electricity Industry 2011, May 8-9, 2011.

502 California Energy Commission, *Development of a Real-Time Monitoring/Dynamic Rating System for Overhead Lines* by EDM International Inc., Publication No. 500-003, December 2003, ES-1.

503 *Demonstration of Advanced Conductors for Overhead Transmission Lines*, 1017448, EPRI, July 2008, p. 6-1.

504 *Dynamic Circuit Thermal Line Rating*, California Energy Commission Publication P600-00-036, October 1999. http://www.energy.ca.gov/reports/2002-01-10_600-00-036.PDF, ES-2.

forecasting and visualization tools are needed to enhance adoption rates by utilities and enhance the benefits of DTCR

- Voltage-source converter high-voltage direct current cables: Conventional high-voltage direct current (HVDC) cables are currently used for bulk transmission lines over long distances. They require extremely costly converter stations at each end of the cable to convert voltage between direct current (DC) and alternating current (AC), and typically carry from 300 to 3,000 MW of power. Newer voltage-source converter technology, such as ABB's HVDC Light® and Siemens's HVDC Plus, can carry lower capacity amounts in the range of 50 to 1,200 MW at bulk transmission voltages, can be run underground, and are particularly useful for interconnecting wind and off-shore power sources.[505,506]
- High capacity cables: Advanced HTLS conductors are designed to improve performance by being capable of continuous operation at high temperatures without losing tensile strength and also sag less with temperature than normal. The same size of HTLS conductor can carry multiple times the current than a conventional conductor can. There is a need to track experiences in the field as these conductors begin to be deployed throughout the world to examine possible premature failure mechanisms and installation issues.
- Fault current controllers: Utilities increasingly have a critical need for a highly efficient fault current controller (FCC) technology. Traditional methods of limiting fault currents include the use of circuit breakers that may not be economical or efficient. Developments in superconductivity and power electronics are resulting in a number of different innovative designs for fault current controllers. While PIER has funded the successful demonstration of one concept, other promising concepts need to be tested, especially for the ability to handle higher voltages.
- Power flow control devices: With today's technology, the grid operator has little control of how power flows through the transmission network. This limits the ability to avoid congestion, overload lines, increase the power flow into some locations, and make optimum use of existing grid infrastructure. Largely due to developments in power electronics, new devices are being developed to provide additional ability to control power flows that could also complement power flow control of energy storage, leading to even greater efficiency in the use of grid infrastructure.

Research to Address Integration Challenges

As discussed in Chapters 5 and 6, meeting Governor Brown's goal of adding 20,000 MW of new renewables, including 12,000 MW of renewable DG, will place increasing burdens on the state's existing transmission and distribution systems. System operators will need improved tools and

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505www.abb.com/industries/us/9AAC30300394.aspx.

506 http://www.energy.siemens.com/us/en/power-transmission/hvdc/hvdc-plus/.

strategies to provide the forecasting and ancillary services needed to facilitate integration of high levels of renewables into grid operations.

Many of the research projects to optimize the transmission grid described in the previous section will also facilitate the integration of renewable resources. This section describes further PIER-funded research on activities that will support integration at both the transmission and distribution levels. Because of the major roles that the smart grid, energy storage, and demand response will play in the future integration of renewables, this section provides an overview of state policies in these areas and describes specific technologies, followed by descriptions of PIER Program research in these areas.

Transmission-Level Integration

Smart Grid

Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) makes development of smart grid technology state policy. SB 17 defines "smart grid" as modernization of "the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service, with infrastructure that can meet future growth in demand and achieve all of the following, which together characterize a smart grid:

- Increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, with cost-effective full cyber security.
- Deployment and integration of cost-effective distributed resources and generation, including renewable resources.
- Development and incorporation of cost-effective demand response, demand-side resources, and energy-efficient resources.
- Deployment of cost-effective smart technologies, including real time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status, and distribution automation.
- Integration of cost-effective smart appliances and consumer devices.
- Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air-conditioning.
- Provide consumers with timely information and control options.
- Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.

- Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services."

A more simplified definition of the smart grid provided by the Electric Power Research Institute is: "…one that incorporates information and communications technology into every aspect of electricity generation, delivery and consumption in order to minimize environmental impacts, enhance markets, improve reliability and service, reduce costs, and improve efficiency."[507]

As discussed in Chapter 6, SB 17 directed the CPUC to consult with the Energy Commission and the California ISO regarding the development of investor-owned utility smart grid deployment plans, which were filed at the CPUC on July 1, 2011.[508] Smart grid deployment plans were required to address the following topics:

- Smart grid vision statement.
- Deployment baseline.
- Smart grid strategy.
- Grid security and cyber security strategy.
- Smart grid roadmap.
- Cost estimates.
- Benefits estimates.
- Metrics.

The smart grid deployment plans will be unique for each utility. The pathway will also be very individualized and require utilities to work closely with their customers to understand their needs. The first step is smart customer meters that will empower customers and allow them to manage their energy use. While most of California's utilities have reported smooth Smart Meter rollouts, some PG&E customers complained of performance issues reflecting increased usage and charges with their newly installed SmartMeters. Initially, PG&E maintained that the customer usage was accurate; however further exploration determined there may be problems with the meter software and meter calibration. The CPUC has hired a consultant firm to investigate the faulty meters and ensure continued smart meter deployment statewide.[509]

Past Research Efforts

Most of the past PIER research projects that pertain to smart grid applications in the transmission system were described in the previous section. Smart grid development began first in the transmission system, but with the Governor's goal of adding 12,000 MW of new renewable DG and the expected large rollouts of electric vehicles over the next few years, research is needed on smart grid technologies to support the distribution system.

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507 Electric Power Research Institute, http://www.smartgrid.epri.com/.

508 Publicly owned utilities are required to submit their smart grid deployment plans by July of 2012.

509 CPUC Press Release RE: Independent Evaluation of PG&E's Smart Meters http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/115561.htm

When American Recovery and Reinvestment Act (ARRA) funding became available in 2009, the Energy Commission recognized the opportunity to use the PIER Program to leverage federal dollars and bring additional stimulus funding to California. These efforts were highlighted in the 2010 IEPR Update, which noted that "California is receiving $1.3 billion for smart grid projects, representing a tenfold increase in smart grid funding from PIER's past spending levels of $10 million to $14 million." These projects were awarded approximately $13 million in PIER cost-share funding. Over the next three to four years, the PIER Program will work actively with—and learn from—more than 20 smart grid projects. Many of these projects include an energy storage component, and are described in more detail later in the chapter in the energy storage section.

Other PIER-funded smart grid related research has included:

- California Utility Vision and Roadmap for the Smart Grid of Year 2020: [510] This project collected information from the state's three largest utilities to develop a common California smart grid vision and roadmap to achieve this vision by 2020 to provide the direction for a comprehensive RD&D plan supporting Smart Grid deployment. The final project report details findings in six domains of technical expertise: Communications Infrastructure & Architecture; Customer Systems; Grid Operations & Control; Renewable & DER Integration; Grid Planning & Asset Efficiency; and Workforce Effectiveness. These domains define a structure of technical areas under which the project provides further findings on vision, baseline, technology readiness roadmaps, gaps and recommendations. This project also addressed the CPUC's Order Instituting Rulemaking (OIR) #R.08-12-009 to "Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's own Motion to Actively Guide Policy in California's Development of a Smart Grid System." Additionally, this research will help the Energy Commission develop information for the requirements currently defined under SB 17.
- Performance Testing Protocols and a Database for Distributed Generation:[511] This project, completed in 2010, promoted the adoption of DG and combined heat and power (CHP) units by providing performance data comparisons for power generating systems. Systems included microturbine generators, engine generator sets, small turbines, and fuel cells. The database will encourage appropriate DG and CHP applications that provide real benefits to system owners. The project facilitated adoption by providing globally accessible information of CHP systems via the internet.

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510 Electric Power Research Institute, *California Utility Vision and Roadmap for the Smart Grid of 2020*, July 2011, http://www.energy.ca.gov/2011publications/CEC-500-2011-034/CEC-500-2011-034.pdf.

511 The final report can be found at http://www.energy.ca.gov/2010publications/CEC-500-2010-017/CEC-500-2010-017.PDF. The database can be found at http://www.dgdata.org.

- Storage Viability and Optimization Tool: [512] This research project helps end-users determine if energy storage and photovoltaics (PV) together are appropriate for their facility. The technology is currently available for public use on the Lawrence Berkeley National Laboratory website. Users include universities, private companies, and utilities.
- Modeling Validation Benefits of Distributed Energy Resources to Power Grid:[513] This project demonstrated tools that can be used by a utility to identify the best sites for distributed energy resources. These tools can identify beneficial projects and quantify their benefits for California. The key feature of the Energynet® methodology is the simulation of the power system in full detail, with all distribution and transmission equipment integrated into a single model, to allow the direct observation of the grid impacts of individual distribution-connected generation and storage.

Current Research Efforts

The Energy Commission is working closely with the CPUC on smart grid issues and has developed a research program to assist in their regulatory determinations. In December 2010, the Energy Commission conducted a joint workshop with the CPUC to highlight the PIER program's three smart grid research, development, and demonstration road mapping projects that will support the state's goals to develop a smart grid and provide a research framework to be used in development of smart grid deployment plans.[514] Roadmaps are being developed for IOUs, publicly owned utilities, and the commercial industry to reflect the distinctly different markets and opinions for each of these entities.

Stakeholder recommendations at the December 2010 workshop identified smart grid issues that need to be addressed in the future:

- California has more than $1 billion of Smart Grid efforts ongoing as part of the DOE ARRA funding. The PIER Program should collect and share lessons learned from these diverse and important projects to ensure all parties can learn from the results.
- The integration of existing and new technologies is critical to the success for the future California Smart Grid. The utilities and other interested stakeholders need to work actively to ensure that integration issues are raised and solutions are shared.[515]

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512 Ernest Orlando Lawrence Berkeley National Laboratory, *Storage Viability and Optimization Web Service* : http://der.lbl.gov/sites/der.lbl.gov/files/LBNL-4014E_approved_0.pdf. The Storage Viability and Optimization Tool can be downloaded from: http://der.lbl.gov/microgrids-lbnl/current-project-storage-viability-website.

513 New Power Technologies, *Verification of Energynet® Methodology*, December 2010, http://www.energy.ca.gov/2010publications/CEC-500-2010-021/CEC-500-2010-021.PDF.

514 Workshop presentations and a full transcript are available at http://www.energy.ca.gov/2011_energypolicy/notices/index.html.

515 California Energy Commission, *Transcript of the December 17, 2010 joint IEPR Committee/CPUC Workshop on Smart Grid Research Road Mapping Projects*, comments by Kevin Dasso, Southern California Edison, http://www.energy.ca.gov/2011_energypolicy/documents/2010-12-17_workshop/2010-12-17_Transcript.pdf.

- Microgrids are an alternative energy delivery model that have the potential to benefit our customers in many ways. SDG&E views micro grids as an excellent tool to evaluate new and emerging technologies and to address these integration issues. SDG&E is exploring microgrid implementations advancing technology and additional funding should be given in the future to sponsoring additional micro grid research efforts.[516]
- Smart Grid standards are very important and California entities need to ensure that new smart grid activities are compatible with the national smart grid standards that are being approved by the National Institute of Standards and Technology.[517]

Other ongoing PIER-funded research activities in support of the smart grid include:

- Smart Grid Demonstration Project: [518] The Los Angeles Department of Water & Power (LADWP) will develop and demonstrate a network of smart grid technologies which also involves battery energy storage systems for electric vehicles. The project goal is to facilitate the establishment of protocols and standards in the Smart Grid Demonstration Project that allow for the measurement and validation of energy savings and fossil fuel emissions reductions associated with an Electric Vehicle Program by specifying, acquiring, and installing a sufficiently-sized Electric Vehicle demonstration network.

Future Research Efforts

Future smart grid research should encompass two distinct approaches: (1) assessing and developing individual component technologies; and (2) examining the interaction of these component technologies at the system level. Individual smart grid technologies include those that provide increased information and control over various components of the system. These technologies that will need to work in conjunction with the legacy hardware to manage different aspects of the grid include:

- Telemetry on generators.
- Renewable resource forecasting.
- Hardware and software control of generators, including inverters.
- Voltage regulation.
- Protection hardware, advanced relays and algorithms.

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516 California Energy Commission, *Transcript of the December 17, 2010 joint IEPR Committee/CPUC Workshop on Smart Grid Research Road Mapping Projects*, comments by Lee Kravet, San Diego Gas & Electric, (page 130), http://www.energy.ca.gov/2011_energypolicy/documents/2010-12-17_workshop/2010-12-17_Transcript.pdf.

517 California Energy Commission, *Transcript of the December 17, 2010 joint IEPR Committee/CPUC Workshop on Smart Grid Research Road Mapping Projects*, comments by Mike Montoya of SCE (page 63), http://www.energy.ca.gov/2011_energypolicy/documents/2010-12-17_workshop/2010-12-17_Transcript.pdf.

518 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

- Advanced switchgear and algorithms for circuit reconfiguration.
- Automated metering infrastructure (AMI).
- Hardware and software to enable demand response, including Home Area Networks (HAN).
- Interfaces for the above, where applicable, for transmission and distribution operators.

Several of the items listed above are particularly urgent because advancements in these areas are needed to facilitate the integration of renewable resources as mandated by state policy:

- Intermittent Resource Forecasting: Grid operators will need practical, real-time tools to better anticipate rapid changes and ramp rates due to variable generation, with increased resolution in time and space. Better knowledge of variability will enable more economic use of firming resources.
- Generator Modeling and Control: Generator modeling focuses on the electrical behavior of wind and solar power relative to the grid. Of particular concern are switch-controlled generators, which include the inverters used for solar PV as well as modern wind generators. Advances in these technologies allow them to provide electric output with desired characteristics (such as reactive power, voltage control, and dynamic response to help stabilize grid frequency). However, to be useful to the grid, these capabilities must be thoroughly understood by grid operators and proven to be dependable. Furthermore, algorithms must be developed along with the communications and control infrastructure that will enable grid operators to call upon these generators to provide the specific attributes that best support the grid.
- System of Systems: Grid operators, owners, and their engineers often model and analyze the performance of particular subsystems as part of the process of designing and deploying smart-grid technologies to manage a particular challenge. However, research is needed on how these subsystems work together from the standpoint of overall system performance and operating reliability. With advanced deployment of individual smart grid technologies, the problem of subsystem interaction merits increasing attention. Because of the depth, breadth and difficulty of this problem, an initial scoping study and problem definition will need to be completed to outline a path for ongoing research in this area. Some specific research areas that follow the systemic approach include:
    - System-Wide Impacts of Variable Generation: This research would develop tools to predict and assess the impacts of large contributions from variable and switch-controlled generators on wide-area stability, for example inertia, and reliability on increasingly shorter time scales. This includes the impact of renewable generation on the dynamic response of the WECC system, notably low-frequency oscillations, as well as the system's resilience with respect to disturbances and extreme events.
    - Resource Coordination: This research area addresses the optimal coordination of a growing number of contributing resources, including variable renewable generation,

storage, and demand response. Due to the many variables involved, it is difficult to determine the best implementation of such a diverse portfolio at any given instant. Work in this area would analyze the complementarities and optimal management of specific sets of resources – for example, geographically and technically diverse storage resources (building on previously Energy Commission-funded work on Wide-Area Energy Storage and Management Systems). Further work would explore how the uncertainty in the availability or cost of resources can be most efficiently and economically addressed in managing highly diverse portfolios.

- Resource Aggregation: A related research area will need to focus on the aspect of information management, with ultimate implications for control architectures. As the grid draws upon many individual distributed resources, sometimes with information flow and control actions on short time scales, the volume of data to be processed increases exponentially. An overarching concern is how to aggregate data effectively and preserve vital technical and economic information while lowering the transaction costs for system operators of managing a vast fleet of resources. Research in this area should investigate approaches and algorithms for information flow and control, focusing on ways in which resources might be most effectively bundled or coordinated so as to collectively provide services to the grid. Such aggregation might include local clusters of diverse resources, such as generation combined with storage and/or flexible demand, capable of operating with some degree of self-sufficiency (microgrids).

Energy Storage

Energy storage has the ability to radically change the electric power system from one where electricity must be instantaneously generated and used at the same time, to one where instantaneous balancing of supply and demand becomes less of an issue. The many benefits of energy storage include reducing reliability risks, enhancing economic efficiencies, mitigating environmental impacts, and accommodating growing amounts of renewable generation and electric vehicles.

Chapter 5 noted the potential for energy storage technologies – including pumped hydroelectric, compressed air energy storage, batteries, flywheels, and thermal energy storage – to increase the reliability and dispatchability of California's energy supply. There is a strong connection between energy storage and the smart grid because these technologies can help integrate intermittent renewables, provide ancillary services, manage peak demand, and relieve transmission and distribution congestion. Building a portfolio of energy storage options will address these system challenges and balance the development of newer, distributed storage technologies like batteries and flywheels with development of well-established technologies such as pumped storage and compressed air energy storage.

Energy storage technologies include:

- Pumped Hydro: These are the oldest energy storage systems and several exist in California. There are nine pumped hydro projects in California with an aggregate capacity of 3,758

MW.[519] Efforts are underway to extend the functionality of existing pumped hydro at the 1,200 MW Castaic facility in Los Angeles County and the 1,050 MW Helms facility in Fresno County. Besides providing ancillary services, pumped hydro can also firm up wind and solar resources and is especially well suited for storing hundreds of MW of energy over many hours. However, adding pumped storage requires finding environmentally acceptable sites close enough to transmission to be cost-effective. Closed-loop systems that use two captive reservoirs that do not interfere with recreational uses, aquatic life, flood control, or irrigation face fewer environmental barriers.

As of April 2011, 14 pumped storage projects with a combined capacity of 9,900 MW have applied for or have received permits from FERC (Table 24). One example is the 1,300 MW Eagle Mountain project in Riverside County that is awaiting approval of its FERC license. The Eagle Crest project is also proposing variable speed pumps that make it suitable for meeting a wider range of ancillary services than other pumped storage projects. The project is projected to have a ramp rate of 10 MW per minute. Many new pumped hydro projects plan on using variable speed pumps, which provide greater control in pumping mode and can increase response time to compensate for power fluctuations and improve the stability of the power system.[520] Retrofitting existing pumped hydro plants with variable speed pumps could improve their ability to support intermittent renewable resources, but the cost of retrofitting is more prohibitive compared to installing these pumps at new plants, assuming that construction of a new plant is underway. The cost of retrofitting existing power plants is generally less expensive than breaking new ground and constructing a new plant.

- Compressed Air Energy Storage: This technology can provide ancillary services and also help firm up wind and solar power and shape wind generation which allows these resources to bid for renewable contracts that seek firm capacity.[521] This technology can store hundreds of MW of energy over many hours but is limited by difficulty of finding suitable underground reservoirs for storing compressed air. The technology has been used in Alabama since 1991 and new projects are being built in Iowa and New York. Compressed air loses heat when it is compressed and requires a heat source to decompress it so that it can drive turbines. Commercial projects use natural gas to do so, but emissions are lower than emitted by a full natural gas unit. Future projects will reduce or eliminate emissions, but any compressed air installations over the next 5 years will not have that option.

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519 The number and capacity of California pumped hydro plants from the Hydropower Review March 2011.

520 *Variable Speed Pumped Storage Hydropower Plants for Integration of Wind Power in Isolated Power Systems*, published by InTech - Open Access Publisher, ISBN 978-953-7619-52-7.

521 The longest running CAES plant is the Huntsdorf plant in Germany which has been operating since 1979. A second plant in Alabama has been operating since 1989. The critical components for CAES technology such as turbines, compressors, and expanders are all considered commercially available as are the technologies for developing or assessing the underground reservoirs. Source: Communications with Robert Shainker, EPRI CAES Manager. June 2007.

Technologies that eliminate emissions completely are still at the concept level and need to be more fully developed and demonstrated at a pilot scale before they are adopted for a full size plant. PG&E and other California utilities are actively exploring development of a full-scale demonstration project using ARRA funding. PG&E has also received ARRA/PIER cost-share for a 300 MW 10-hour CAES project, tentatively located in Kern County.

Table 24: Proposed Pumped Storage Projects in California

Applicant	Facility	Application date	Status	Proposed Capacity (MW)
SMUD	Iowa Hill	March 2008	Permit Received	400
Nevada Hydro	Lake Elsinore	May 2008	Permit Received	500
Pacific Gas & Electric Co	Kings River	September 2008	Permit Received	350
Pacific Gas & Electric Co	Mokelumne	September 2008	Permit Received	380
San Diego County Water	San Vicente	September 2008	Permit Received	550
Eagle Crest Energy Co	Eagle Mountain	October 2008	Permit Received	1,300
Eldorado Pumped Storage, LLC	Eldorado	October 2010	Applied for Permit	400
Pajuela Peak	Pajuela Peak	November 2010	Permit Received	250
Turlock Modesto Irrigation	Red Mountain Bar	November 2010	Permit Received	900
Brookfield Generation	Mulqueeney Ranch	January 2011	Permit Received	280
Bison Peak LLC/Gridflex Energy, LLC	Bison Peak	April 2011	Applied for Permit	1,000
Storage Development Partners, LLC	Camp Pendleton Project	April 2011	Applied for Permit	1271
Storage Development Partners, LLC	Vandenberg #3 Project	April 2011	Applied for Permit	1,136
Storage Development Partners, LLC	Vandenberg #5 Project	April 2011	Applied for Permit	1,196
TOTAL				9,913

Source: Hydropower Society. Courtesy Steve Lowe Eagle Crest Mountain LLC.

- Batteries: Battery storage technology provides near-term availability for several applications that can help with renewable integration. Using batteries to provide distributed energy storage can also provide frequency control and reduce variations in the localized solar output on the distribution circuits, which in turn reduces the need for integration services on the transmission level. When properly sized, some battery types can provide adequate ramp rates to meet the load balancing and frequency regulation requirement, although ramp rates vary by battery technology and size.[522] Modularity and scalability of various battery types and many vendors of different battery chemistries provide the promise of drop in cost over next few years. However, the cost-effectiveness of each battery type must be evaluated in the context of its potential application. Capacity costs ($/kW), energy costs ($/kWh), the level to which a battery could be discharged, the number of charge-discharge cycles it can deliver, the duration for holding charge, and round trip efficiency varies substantially based on battery type. The predominant battery types currently available are: lead- acid, lithium ion (Li-ion) batteries, Nickel-Metal Hydrides, Sodium Sulfur (NaS), and flow batteries such as zinc-bromine or vanadium oxides.[523] Costs vary widely; for some recent stationary utility-grade applications, costs have been "upwards of $2000/kWh", but some li-ion batteries have been installed at $1000/kWh. For many grid connected applications, batteries must come down to a level of $500/kWh.[524] Factors such as improvement in battery performance due to advances in material sciences and also mass production would bring the cost down. Energy storage capacity of battery systems will need to be properly sized to match the load to avoid any additional back-up systems needed as the batteries discharge.

Different battery chemistries, some driven by the promise of a large electric vehicle market, are now available. Many technologies are commercially[525] available although their economic and technical viability must be matched to the specific energy and power needs of ancillary services. The cost per kWh is much higher than pumped hydro or compressed air storage, but their compact size make batteries better suited for integrating renewable resources at distributed locations, particularly for PV systems and for mitigating second-to-second fluctuations in output at wind farms. Batteries have a smaller footprint, are easy to site, are modular, and can be brought on-line fairly quickly. They can therefore match the rate of deployment with the anticipated pace of renewable distributed generation penetrating the grid.

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522 Roy Kuga presentation at Integrated Energy Planning Annual Meeting, September 24, 2010.

523 National Renewable Energy Laboratory. http://www.nrel.gov/vehiclesandfuels/energystorage/battery_types.html. September 2009.

524 "Start-up Battery Could Provide Cheaper Grid Storage" MIT Technology Review, June 7th, 2011.quoting Haresh Kamath, Strategic Program Manager, EPRI, Palo Alto, California.

525 A technology is deemed commercially available when it has a track record of proven performance and has at least one manufacturer who can supply or build it as standard equipment. Yet a new application of a commercially available technology could be considered as a demonstration. In 1988 Southern California Edison used commercially available lead-acid batteries (same technology as used in a car battery) for peak-shaving and load management but considered the project as a demonstration.

Xtreme Power has several battery systems operating in Hawaii and Japan to assist renewable integration with the grid.[526] These battery systems are being used to manage wind intermittency, ramp rates, and provide frequency control. Batteries are also being used for frequency regulation in New York and the same capability was demonstrated in Huntington Beach, California by AES Energy Storage LLC till 2010. Lacking a suitable tariff for energy storage in under existing market rules at that time, AES terminated the demonstration project and is currently bidding in other ISO territories for providing frequency regulations services.[527] The California ISO, however, developed a straw proposal to accommodate energy storage technologies, including batteries, in order to competitively provide some ancillary services support products to the grid.[528] Stakeholders, including many storage vendors, are currently providing comments, and the California ISO expects the process, including FERC filings and implementation, to conclude by 2014.

Several California utilities are deploying lithium-ion, sodium-sulfur and zinc-bromine battery chemistries. The battery sizes and associated power electronics are designed to match the functions served by these technologies. Smaller (25 kW up to 3-4 hours) are used for community scale storage for distribution level integration while larger (4 to 8 MW and for 4-8 hours) are being used to integrate large scale PV and wind systems. The technologies are available and are being tested as part of "smart-homes" by utilities. The batteries are typically sold in a basic module of certain kW capacity and in some instances, such as a sodium-sulfur or lithium-ion battery, the power capacity (kW) and energy (kWh) are tied to the battery design. For flow-batteries, the membrane determines the power while the liquid electrolyte delivers the energy and allows for increasing the energy without altering power. Therefore, scale-up potential is a function of proposed application of the battery technology, with the ability to add more battery modules to scale up the storage system to the size required.

California utilities are cautiously optimistic about battery performance and treat these projects as demonstrations until battery efficiency, life, and reliability are established. Therefore, many of these projects are not financed through utility base rates but instead are being co-funded through ARRA and the PIER Program. The ultimate adoption of batteries as a standard equipment for managing renewable integration would depend on the economic viability. SCE has developed an elaborate framework to assess the economic viability and proposes to do so in the context of specific utility application and functions

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526 "Importance of Energy Storage to California's Renewables Future," Presentation by Amanda Stevenson, Xtreme Power Inc. slide # 17 to 22 at the 2011 IEPR Workshop on Energy Storage, April 28, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-04-28_workshop/presentations/06_Xtreme_Stevenson_IEPR_Storage_Workshop.pdf.

527 Communications with Praveen Kathpal. Manager for Markets and Regulatory Affairs. AES Energy Storage LLC. August 4, 2011.

528 Renewable Integration Market Vision & Roadmap: Day-of Market Initial Straw Proposal. By California Independent System Operator, July 6th, 2011.

delivered by the energy storage technology.[529] Small scale modular batteries can also provide home/small commercial level energy storage that can facilitate demand response, which can then be bid in the ancillary services market by an aggregator.

- Flywheels: Flywheels store energy from the momentum created by fast spinning cylinders driven by an electric motor. Electricity is retrieved by spinning the motor backward to act as an electric generator. More than one flywheel can be combined to increase stored electrical power. The use of this technology for frequency control was proven first in California, and Regional Transmission Operators in two Northeastern states are now using flywheels to provide frequency control service. Flywheels are modular and can be combined with wind systems to compensate for second-to-second variations and can also provide frequency regulation services. Flywheels also have some unique characteristics. For instance, unlike batteries, they are not affected by life-cycle limits or how deeply they are discharged. Also, ramp rates could be much higher and response to system operators requests much faster (less than 4 seconds) than the existing fleet of combustion turbines, or hydro plants in some instances, that provide frequency regulation services.[530] In addition to fast response, unlike combustion turbines flywheels can operate without fossil fuels and are capable of both up and down regulation. System operators in other regions have recognized this benefit of flywheels and have redesigned their product requests to avoid discriminating against flywheels or any other technologies with similar capabilities. Following the lead of other independent system operators, the California ISO is redesigning its procurement specifications to accommodate this technology.

  The PIER program has played a critical role in making ISOs and other national stakeholders aware of the flywheel's ability to provide frequency controls and laid foundation for its subsequent commercialization. In 2004, PIER funded a demonstration of the Beacon flywheel at PG&E's San Ramon testing site to demonstrate a 15 kW/100 kWh bank of seven flywheels to show their ability to respond to the California ISO's Area Generation Control signal. PIER also funded research at Pacific Northwest Laboratories[531] to demonstrate flywheels' ability to react faster and with a higher ramp rates and consequently reduction in the MW needed to meet the frequency control and load following leads compared to other generation assets.

- Thermal Energy Storage: Heat energy from large-scale concentrating solar plants can be stored directly or indirectly in a molten salt medium, and then released after sunset or to

529 Moving Energy Storage from Concept to Reality: Southern California Edison's Approach to Evaluating Energy Storage. May 2011. http://www.edison.com/files/WhitePaper_SCEsApproachtoEvaluatingEnergyStorage.pdf.

530 "Coordinated Multi-Objective Control of Regulating Resources in Multi-Area Power Systems with Large Penetration of Wind Power Generation" by Yuri Markow, Dave Hawkins et al. 7th International Workshop on Large Scale Integration of Wind Power and on Transmission Networks for Offshore Wind Farms. Madrid, Spain. May 2008.

531 http://www.energy.ca.gov/2011_energypolicy/documents/2010-11-16_workshop/presentations/10_Dagle_How_to_Integrate_Energy_Storage_and_Demand_Response_Into_the_Wide-Area_Network_Control.pdf.

smooth out interruptions in the electric output that result when clouds pass over a solar field. Thermal storage can reduce the sudden ramping up or down of solar output, thereby reducing or eliminating the need for other balancing power. However, thermal energy storage is not as versatile in its ability to directly provide ancillary services compared to other electricity storage options.

Current Research Efforts

The following list of PIER projects illustrates the scale and scope of energy storage R&D efforts in California:

- The Strategic Analysis of Energy Storage Technology Project will develop a strategic analysis of energy storage technologies and will provide a vision for energy storage in California by the year 2020.[532] Working interactively with utilities, the energy storage industry, and other stakeholders, this project will identify and define the necessary research on the energy storage technologies and applications for achieving greater penetration of renewable energy resources. Research projects will be developed from the resulting roadmap and include the development of technologies to integrate energy storage into the smart grid and have it interoperate with other grid assets.
- PG&E Sodium Sulfur Energy Storage Demonstration: [533] This is the first utility-scale demonstration of a sodium-sulfur Battery Energy Storage System (BESS) in California. The sodium-sulfur BESS is one of the most advanced battery storage technologies on the market, with both fast discharge and slow energy release capabilities, a high efficiency of about 80 percent, and a long life span of 15 years. This specific installation will be a 4-megawatt system with a 28-megawatt-hour storage capacity. Once installed and operating, this system will be the largest battery storage system in California and will provide critical data on the use of large-scale battery energy storage technologies to meet California's future renewable energy needs. Future research will investigate other applications of battery storage systems.
- As part of its Tehachapi Wind Energy Storage Project, SCE will design and build a 32 MWh lithium-ion battery system and smart inverter, and connect it to its Monolith Substation near the Tehachapi Wind Resource Area.[534] This project will demonstrate the ability of the battery storage system to enhance grid operations and integrate intermittent wind power in a remote, transmission-constrained area. The installed system will help achieve utility load shifting, increased dispatchability of wind generation, and enhanced ramp rate control to minimize the need for fossil fuel-powered back-up generator operation. The project will leverage the data and results of an ongoing PIER-funded study on the Antelope-Bailey 66 kV system. The ongoing study aims to determine the ways in which energy storage can

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532 http://uc-ciee.org/images/downloadable_content/electric_grid/ESV2020_Factsheet.pdf.

533 http://www.next100.com/2010/02/pges-big-battery.php.

534 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

address wind integration issues to help meet California's renewable energy goals. One of the key early findings of this study was that a 32 MWh energy storage device located at the Monolith Substation can prevent overloaded transmission lines.

- Primus Power Corporation will work with the United States Department of Energy, Sandia National Laboratory, Pacific Gas and Electric Company (PG&E), and Modesto Irrigation District to develop, field test, and install and evaluate a 25 MW/75 MWh grid-connected Zinc-based flow battery energy storage system.[535]The project will provide a low-cost energy storage system with a footprint consistent with or smaller than other competing technologies and demonstrate primary and secondary applications including: renewable firming, strategic local peak shaving, automated load shifting, and ancillary services.
- Under its Solid State Batteries for Grid-Scale Energy Storage project, Seeo Inc. (Seeo) will develop the first ever large-scale or grid-scale prototype of a new class of advanced lithium ion rechargeable batteries, with unprecedented safety, lifetime, energy density, and cost.[536] The primary focus of this project will be the development and deployment of a 25 kWh prototype battery system based on Seeo's proprietary nanostructured polymer electrolytes. This will validate the transformational performance advantages of this technology for use in grid-tied energy storage applications. In particular, Seeo seeks to address the utility market needs for clean energy systems, which envision small (<100 kW) distributed energy storage systems alongside pad-mounted and pole-mounted transformers, and grid-connected electric vehicle systems.
- In the Premium Power Distributed Energy Storage Systems Demonstration, the Sacramento Municipal Utility District (SMUD) will install and demonstrate a fleet of two Premium Power Corporation’s Zinc Bromine Flow Battery energy storage systems in Sacramento, one at the SMUD Headquarters (East City Substation) serving the SMUD campus micro-grid, and one at a substation serving the nearby Anatolia III SolarSmart Homes community development.[537] The SMUD Headquarters storage system will explore its utility in improving micro-grid operations; emergency operations, including campus islanding; and augmenting peak period campus operation with non-peak generated electricity. The storage system at SMUD's Anatolia-Chrysanthy substation will be integrated with the Anatolia III SolarSmart Homes community, which will have 600 homes totaling 1.2 MW of PV generating capacity. The two storage systems will be controlled from a common control system at the SMUD headquarters site to demonstrate fleet control of multiple distributed storage devices. Over a four year period, this project and the technology validation it

535 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

536 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

537 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

supports will demonstrate competitively-priced, multi-megawatt, long-duration advanced batteries for utility grid applications and validate the potential penetration of zinc bromine flow batteries, particularly in PV and micro-grid applications by demonstrating multiple use cases.

- Amber Kinetics, Inc., will demonstrate a prototype utility-scale flywheel energy storage system employing technology advances in composite flywheel rotor materials, magnetic bearing systems, and high efficiency motor-generators.[538] These new technologies, when integrated into a flywheel system, can prove that flywheel energy storage can be competitive with pumped hydro in terms of cost and efficiency. The goal of the project is to clearly demonstrate the economical and technical viability of bulk flywheel energy storage and renewable energy integration for the electric grid.
- Flow Battery Solution to Smart Grid Renewable Energy Applications: [539] EnerVault Corporation (EnerVault) will partner with Ktech Corporation to demonstrate the commercial viability of EnerVault's novel iron-chromium redox flow BESS. This demonstration comprises of integrating EnerVault's Vault-20 BESS (250kW, 1MWh) with an intermittent renewable energy source - a dual-axis PV system. The 36-month project will culminate in the deployment of a Vault-20 Beta system in conjunction with a 150kW PV system at a site in California's Central Valley. Additionally, the operating results will be analyzed and compared to the baseline for final quantification of benefits and operating costs. The capital costs, operating costs, and benefits will be used to determine total cost of ownership.
- Advanced Underground Compressed Air Energy Storage Demonstration Project: [540] PG&E will design, build and demonstrate the world's first advanced, "second generation" CAES design system that requires less fuel, uses standardized less expensive turbo-machinery, and captures the waste heat from the compression cycle. This design uses readily available proven turbo-machinery that will result in lower capital and operating costs than first generation designs. The plant design will also include the option for future use of thermal storage to test the potential of adiabatic CAES, a "third generation" technology that would completely eliminate the use of fuel for a CAES plant.[541] The project will use depleted gas fields, located within PG&E's service territory, for compressed air energy storage.

Future Research Efforts

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538 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

539 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

540 http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FINAL-REV_Combined_SGDP_Selections_2011_01_04.pdf.

541 An adiabatic process is one in which no heat is gained or lost by the system.

The Energy Commission held public workshops on November 16, 2010 and April 28, 2011 to address energy storage technologies and the actions necessary to make energy storage more available in the future.[542] In addition, a December 17, 2010 workshop on smart grid issues also included discussions about energy storage issues. The November workshop focused on the current state of energy storage technology and the activities ongoing in California and the U.S. to demonstrate the capability and value of energy storage technologies. The November workshop also addressed the ability of automated demand response to provide equivalent services to that of energy storage in some areas of ancillary services and how a combination of both energy storage and automated demand response provides California ratepayers the very cost effective solution to some of the renewable integration challenges.

Stakeholder recommendations at the workshops identified areas that should be addressed in the future to encourage the increased use of energy storage and automated demand response in the future:

- The Energy Commission and the PIER Program needs to continue to support and sponsor field demonstration of new and commercially available energy storage technologies. For distribution level integration, energy storage projects in the 1 MW to 5 MW range are the highest priority for these demonstrations.[543]
- Research should be completed to better estimate the amount of energy storage and automated demand response necessary to meet the integration challenges of the RPS by 2020.[544]
- Research and workshops on financial models and tariffs need to address how a fee system can be developed to allow energy storage systems to be compensated for all the values they provide the grid such as: reliability improvements, integration of renewables, ancillary services, power quality improvements and others.[545]

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542 Presentations and written transcripts from these meetings are available at: http://www.energy.ca.gov/2011_energypolicy/notices/index.html.

543 California Energy Commission, *Transcript of the November 16, 2010 Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration*, comments of Janice Lin , California Energy Storage Alliance, http://www.energy.ca.gov/2011_energypolicy/documents/2010-11-16_workshop/2010-11-16_Transcript.pdf, page 111.

544 California Energy Commission, *Transcript of the November 16, 2010 Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration*, comments of Albert Chui, PG&E, http://www.energy.ca.gov/2011_energypolicy/documents/2010-11-16_workshop/2010-11-16_Transcript.pdf, page 111.

545 California Energy Commission, *Transcript of the December 17, 2010 joint IEPR Committee/CPUC Workshop on Smart Grid Research Road Mapping Projects*, comments by David M. Tralli of JPL (page 96) and Chris Villareal of the CPUC (page 127), http://www.energy.ca.gov/2011_energypolicy/documents/2010-12-17_workshop/2010-12-17_Transcript.pdf.

- The results of the many ARRA and PIER funded energy storage and automated demand response demonstrations need to be made available as soon as possible so these results can be used in developing future demonstrations.[546]

Demand Response

Demand response (DR) will be an important element of integrating renewables into California's electricity system. Demand response consists of changes in electric usage by consumers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. As previously discussed in Chapter 5 on grid-level integration, there are several barriers to employing DR for integrating renewable resources. While DR has already been area of considerable research over the last few years, additional R&D efforts will be necessary to ensure that DR can play a important role in integrating renewable resources.

Past Research Efforts

The Energy Commission has more than eight years of history in R&D for new DR technologies and capabilities. The focus of these efforts over time has evolved from manual individual customer or small clusters DR capabilities for commercial, industrial, and residential customers to the automation of DR and the opportunity to provide thousands of MWs of load reduction energy responses to the grid as peak load reductions and ancillary services. Currently, most of these DR services are implemented through utility programs as opposed to markets solutions as in some other states.[547]

Past PIER-funded research in this area includes:

- Industrial sector research conducted in 2008 by the PIER's Demand Response Research Center (DRRC) at Lawrence Berkeley National Lab (LBNL) looked at DR opportunities at industrial wastewater facilities. A scoping study was conducted that concluded that energy intensive wastewater facilities with their high summer electrical loads are potential good candidates for DR[548]. The scoping study also acknowledged that these wastewater facilities have the necessary controls systems to allow for integration of automated demand response strategies. The result of this scoping study lead to a pilot demonstration project at the San

546 Compilation of various comments received at the November 16, 2010 Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration; the December 17, 2010 joint IEPR Committee/CPUC Workshop on Smart Grid Research Road Mapping Projects; and April 28, 2011 IEPR Committee Workshop on Energy Storage for Renewable Integration, http://www.energy.ca.gov/2011_energypolicy/documents/index.html#11162010.

547 http://drrc.lbl.gov/system/files/lbnl-212e.pdf.

548 http://drrc.lbl.gov/system/files/lbnl-1244e.pdf.

Luis Rey[549] Wastewater Treatment Plant in Oceanside to demonstrate and quantify demand response capability of a wastewater treatment plant.

- Past PIER research shows that giving end use customers the ability to automate their response can provide the predictable and reliable load reductions to the grid. A standard open architecture protocol has been developed called Open Automated Demand Response (OpenADR).[550]The PIER Program has several years of experience in developing, evaluating, testing and demonstrating OpenADR with commercial and industrial customers and OpenADR is becoming the preferred protocol for these customers. Currently, several fully commercialized programs in California and other state utilities use OpenADR for their utility service territory.
- In 2009, three large commercial and industrial facilities with OpenADR enabled energy management systems provided load reductions through PG&E's Participating Load Pilot. This pilot program successfully demonstrated using demand response as a non-spinning reserve product in the California ISO market.
- Research conducted in 2010 by the PIER Program's DRRC at Lawrence Berkeley National Lab (LBNL) to summarize the response time, duration and market characteristics of building and process automation with the corresponding requirements of spin, non-spin and regulation services.[551] The project evaluated heating, ventilation, and air conditioning systems, lighting, plug loads, and other end-uses to characterize the response times and potential duration of load reduction to be used for renewable integration products. The research also included a series of case studies to demonstrate the performance of automated DR for fast DR with four-second telemetry on the loads. Some of the case studies examined thermal energy storage systems, refrigerated warehouses, industrial processes, and wastewater treatment facilities. These case studies employ OpenADR to facilitate response to DR price and event signals and spur innovations in building control technologies. This platform also provides a basis for a standardized, lower cost communication protocol which historically has limited DR participation in the market.
- The communication and automation infrastructure needed to deliver consistent and dependable load reductions is the key to employing demand response for renewable integration purposes. The DRRC is working within the commercial, residential and industrial sectors to provide demonstration projects and develop end-use communication and visualization infrastructures. In addition, the DRRC is working with standards

549 http://drrc.lbl.gov/system/files/lbnl-3889e.pdf.

550 Piette, Mary Ann, Girish Ghatikar, Sila Kiliccote, Ed Koch, Dan Hennage, Peter Palinsky, and Charles McParland. *Open Automated Demand Response Communications Specification (Version 1.0)*, 2009. LBNL-1779E.

551 Kiliccote, Sila, Pamela Sporborg, Imran Sheikh, Erich Huffaker, and Mary Ann Piette. 2010. *Integrating Renewable Resources in California and the Role of Automated Demand Response*, (LBNL-4189E), http://drrc.lbl.gov/sites/drrc.lbl.gov/files/lbnl-4189e.pdf

organizations to develop protocols and model standards for energy information management and control.

- Another study by LBNL involved a demonstration of DR as spinning reserve.[552] Spinning reserve is an electricity grid operator's first strategy for maintaining system reliability following a major contingency, such as the unplanned loss of a large generation facility or critical transmission line. The LBNL study used SCE customers on the Summer Discount Plan, an air conditioning load management program. Customers' air conditioning systems were cycled off for short durations of time and coordinated through a central energy management system. The centralized control allowed precise calibrations of load drops with response times significantly faster than the current North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) requirements. In the second phase of the demonstration project, connectivity was established to the California ISO to explore the capabilities of the system to respond directly to requests for dispatch of spinning reserve.

Current Research Efforts

- The Integrating Renewable Resources (IRR) Pilot Project expands on the work done through the 2009 PG&E Participating Load Pilot to provide additional customer-side products for renewable integrations. The pilot involves a collaboration effort of the California ISO, Akuacom, PG&E and LBNL's PIER Demand Response Research Center (DRRC) to assess the feasibility of providing load following and ramping products to the California ISO using thermal and process storage technologies.[553]
- The PIER program is currently completing research to evaluate how much energy storage and automated demand response is needed to support integrating high levels of renewables on the California grid.[554]
- The Demand Response Research Center is conducting demonstrations in 2011 to evaluate the speed of response of several potential DR loads for ancillary services. These loads will

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552 Eto, J., J. Nelson-Hoffman, E. Parker, C. Bernier, P. Young, D. Sheehan, J. Kueck, and B. Kirby. 2009. *Demand Response Spinning Reserve Demonstration – Phase 2 Findings from the Summer of 2008*. (LBNL-2490E), http://certs.lbl.gov/pdf/lbnl-2490e.pdf.

553 Kiliccote, Sila, Pamela Sporborg, Imran Sheikh, Erich Huffaker, and Mary Ann Piette. 2010. *Integrating Renewable Resources in California and the Role of Automated Demand Response*, (LBNL-4189E), http://drrc.lbl.gov/sites/drrc.lbl.gov/files/lbnl-4189e.pdf.

554 AutoDR: Dave Watson, Mary Ann Piette, Nance Matson, Sila Kiliccote, Janie Page (Lawrence Berkeley National Laboratory); Karin.Corfee, Betty Seto, Ralph Masiello, John Masiello, Lorin Molander, Samuel Golding, Kevin Sullivan, Walt Johnson, David Hawkins (KEMA). *Automated Demand Response as a Grid Balancing Resource for the Integration of Renewables*. Prepared for the California Energy Commission. In Press. 2011. Storage: KEMA, Inc. 2010. *Research Evaluation of Wind and Solar Generation, Storage Impact, and Demand Response on the California Grid*. Prepared for the California Energy Commission. http://www.energy.ca.gov/2010publications/CEC-500-2010-010/CEC-500-2010-010.PDF

include both storing electricity as well as reducing electric loads. Current research is examining what loads are available at different times of the day.[555]

- The next phase of ADR research is focused on integrating larger quantities of ADR onto the grid using the OpenADR protocol not only in the commercial and industrial markets but also into the residential market. The lessons learned from using the OpenADR protocol for commercial and industrial customers will be directly transferrable to the residential homes as Open ADR has several years experience with commercial and industrial customers. As smart meters are installed throughout California, the opportunities to increase the ADR capabilities to support the grid are substantial. Currently, PIER is funding several research projects to demonstrate the potential value of AMI installations. For example, the Residential Energy Display Survey (REDS) project will allow residential consumers to viscerally experience near real-time energy information from their newly installed smart (interval) meters when they want it and in ways of their own choosing using display devices that they already own and know how to use.[556] These devices include smart phones, computers, televisions, programmable communicating thermostats, etc. The smart meters will communicate with a secure gateway that will eventually become part of a consumer-owned router, cable box, or other communications center. The REDS gateway will act as the firewall between the homeowner and the utility to retrieve near real-time meter data. The REDS gateway will use only a restricted portion of the Smart Energy Profile (SEP) 1 software that is already embedded in California smart meters. The REDS approach allows consumers to explore practical uses of their smart meter while the utilities resolve logistical and technical issues with the proposed more secure SEP 2 software.

Future Research Efforts

PIER-sponsored research has demonstrated that it is technologically feasible to provide spinning reserve using DR, and that relying on DR response may be preferable because it can be targeted geographically and its performance is superior to generation resources. As a result, research has now successfully transitioned from a demonstration project to pre-commercialization activity that is largely funded by California's IOUs. In addition, the research has provided a technical basis for the development of new market products by the California ISO to take advantage of the unique characteristics of demand response in providing this critical reliability function. Research also needs to be done to show that DR can provide load following and mitigate the use of new technologies such as electric vehicle charging.

Distribution-Level Integration

Chapter 6 discusses challenges associated with integrating high levels of renewable DG into the state's distribution system. Many of the PIER projects discussed earlier in the chapter, particularly related to the smart grid, will facilitate integration of renewable resources at the

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555 Ancillary Services field demonstrations are in process and are funded by PG&E's Emerging Technology Program.

556 The draft specification for the REDS gateway is located at: http://drrc.lbl.gov/news/residential-energy-display-survey-reds-pilot.

distribution level. This section outlines additional PIER research initiatives underway that will support the deployment of renewable DG and also discusses future research pathways and major initiatives that could have a significant impact in helping California achieve the Governor's DG goals. Many of these future research pathways will help achieve the Governor's goal of adding 6,500 MW of combined heat and power systems as well.

Current Research Efforts

PIER research initiatives that will support the deployment of renewable DG include:

- Renewable Energy Secure Communities (RESCOs): [557] In 2008, the Energy Commission released the first RESCO solicitation to cross-leverage between natural gas and electricity research funding sources. RESCO projects (see Table 25) develop and demonstrate mixed renewable technologies in an integrated and sustainable way coupled with advancements in energy efficiency, demand response, smart grid integration, energy storage, combined cooling, heating and power, and co-production of value-added products like biofuels to help make California's electricity and transportation fuels more diverse, safe, cleaner, and affordable. Implementation of RESCOs requires reliable, secure energy supply at a competitive cost that can be estimated and forecast with high confidence. Reliability of products and systems is typically achieved through design, development, piloting, pre-commercial demonstration, and later incremental improvement and/or innovation. The RESCOs are helping to build the market connectedness of renewable technologies with grid integration, storage, and efficiency, while reducing costs.

- PIER is currently funding a number of projects to develop and demonstrate advanced energy technology solutions for wastewater treatment facilities. Sonoma County is conducting a pilot project to demonstrate the integration of multiple distributed generation technologies at the Santa Rosa Airport's Wastewater Treatment Plant. The Dublin/San Ramon Services District's Regional Wastewater Treatment Facility in Pleasanton is demonstrating an energy storage system combined with on-site fuel cell power generation. Furthermore, the Energy Commission – along with the City of Riverside and Viresco Energy LLC of Riverside – is co-funding the further development of a promising new waste-to-energy technology known as a Steam Hydrogasification Reactor.[558]

- Current PIER-funded projects are demonstrating advanced energy technology solutions that are helping to turn waste products from California's industrial and agricultural communities into energy. Gills Onions, located in Oxnard, is demonstrating an onsite process that converts onion peel waste products into clean power and heat. The process works by digesting the onion waste in a 145,000-gallon anaerobic digester to produce biogas which is cleaned, conditioned, and fed into two high efficiency fuel cells that each generates

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557 RESCO project summaries can be found at: http://cal-ires.ucdavis.edu/research/.

558 2010 Pacific Southwest Organic Residuals Symposium presentation, *Steam Hydrogasification Research Overview, September 2010,* http://www.epa.gov/region9/organics/symposium/2010/4-Park-SHR%202.pdf.

Table 25: PIER-Funded Renewable Energy Secure Communities Projects

Recipient	Title	Goals
Alameda County	Consortium for Electric Reliability Technology Solutions, Smartgrid Demonstration with Renewables and Large-Scale Energy Storage Integration Project at Santa Rita Jail	• Demonstrate the commercial implementation of a CERTS Supergrid • Enable effective interface to local utility grids • Reduce the peak load and reduce air emissions • Improve grid reliability, efficiency and security • Enhance security reliability w/onsite power
El Dorado Irrigation District	El Dorado County Water Systems Energy Generation, Storage, Efficiency, Demand Management and Grid Support Project	• Quantify peak demand generation and load shifting that could be achieved with existing facility reoperation; peak and off-peak period energy savings form efficiency, new storage, and load shifting; and amount of temporary load shedding available on-call to the serving utility • Estimate costs
Local Power, Inc.	San Luis Obispo Renewable Energy Secure Community (SLO-RESCO)	• Produce an inventory of resources and sites with potential for renewables development. • Develop methods, policy tools, models, spreadsheets and strategies for designing a renewable portfolio. • Produce a policy-technical-financial-commercial template for RESCO communities.
Los Angeles Community College District	Energy Demand Optimization Program for LA Trade Tech College Building F	• Offset 96% of building's energy consumption and demand during peak periods. • Develop a program to train and educate a future technical work force. • Demonstrate integration of renewable technologies.
Makel Engineering	Biogas Fueled Homogenous Charge Compression Ignition Power Generation System for Distributed Generation	• Demonstrate the market ready potential of low-emission conversion technology. • Generate electric power (200 kW target). • Meet or exceed current and future California atmospheric emissions requirements.
Redwood Coast Energy Authority	Planning for Renewable-based Energy Security and Prosperity in Humboldt County	• Strategic plan that will delineate options and identify preferred ones, develop a roadmap, and identify near-term pilot scale projects.
Sonoma County Water Agency	Renewable Energy Secure Sonoma County	• An anaerobic digester using manure from surrounding dairies • Solar photovoltaic (PV) with a peak output of 500kW • 10 kW wind turbine • A geothermal heat pump system using treated wastewater to reduce heating and cooling costs. • Buildings retrofit and conservation measures • A web-based integration model

Recipient	Title	Goals
Southern California Edison	Proposed Deployment Study of a High Penetration of Renewable Energy on Santa Catalina Island	• Perform analysis to optimize renewables and energy storage • Achieve self-sustainability for the island
Summers Consulting	Energy, Economic, and Environmental Performance of Dairy Bio-power and Biomethane Systems	• Analyze mass, volume, and energy flows for the integrated dairy power system • Cost/benefit information
UC Davis	West Village Renewable-based Energy Secured Community	• Become a zero-net energy community by integrating renewables into the grid and lower energy usage by improving energy efficiency
UC Irvine	Piloting the Integration and Utilization of Renewables to Achieve a Flexible and Secure Energy Infrastructure	• A roadmap for 100% renewable secure energy for the campus • A methodology for a renewable energy infrastructure at UCI that is transferable to other communities • Demonstrate 1 MW of PV, EVs, Smart BEV charging, necessary energy storage, 24/7 H2 production and power for transportation.
UC Merced	Piloting an Integrated Renewable Energy Portfolio for the UC Merced Community	• A 1 MW solar generation system • A 300 kW pilot plasma gasification system • Energy efficiency improvements • An integration model to identify an optimal generation strategy.
UC San Diego	Regents of the University of California, San Diego	• The goals of this project will provide intelligence driven solutions that enables multiple and individual customer renewable energy generation that: -Reduces electricity and natural gas costs with better efficiency -Reduces carbon -Allows direct electricity market participation

Source: California Energy Commission

300 kW of power.[559] PIER is also funding research to demonstrate a process that will produce fuel locally, from non-food sources, in a manner less complex and more efficient than competing processes. Initially, this process will concentrate on waste from almond and grape processing. Almond hulls and wine grapes present a challenge to conventional biofuel processes. Thus the successful demonstration of economically viable biofuel production from these two sources gives confidence that the method can be extended to a wide array of non-food based, agricultural waste feedstocks and thus yield maximum economic and environmental benefits.

- The PIER Program is conducting an industrial scale demonstration project at Community Fuels Biodiesel (American Biodiesel) production plant in Stockton.[560] The proposed water treatment system will integrate three distinct technologies, distillation, ultrafiltration and reverse osmosis for treating and recycling spent biodiesel wash water. This system will reduce the consumption of water for biodiesel washing by an estimated 85% and result in a zero-discharge wash process. It will constitute the first industrial-scale demonstration of these combined technologies applied to treating effluent from biodiesel production.

- The PIER Program is currently funding a number of projects to demonstrate energy storage at commercial and industrial facilities. Premium Power, Wal-Mart and SDG&E are working together to demonstrate the technical and economic performance of a 150 kWh battery energy storage system – connected on the customer side of the meter – that will store power during off-peak hours and discharge during peak hours. The system is constructed with milk jug-grade plastics and uses inexpensive and readily available salt brine complexes to make it cost competitive with lower performance, lead acid storage technologies.[561]
- Distribution Monitoring Initiative: This project is coordinating collection of data among California IOUs from distribution feeders to analyze and predict the impacts of DG on distribution circuits. A scoping study was prepared by CIEE, and a stakeholder working group has formed to cooperatively develop criteria for the installation of new monitoring equipment, data specifications and information sharing. Future CEC funding will support data analysis and modeling based on information provided by utilities. This initiative is critical in view of utility concerns about technical challenges

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559 California Energy Commission, *The Natural Gas Research, Development, and Demonstration Program Proposed Program Plan and Funding Request for Fiscal Year 2009-2010*, April 2009, http://www.energy.ca.gov/2009publications/CEC-500-2009-069/CEC-500-2009-069.PDF.

Press release about State Leadership in Clean Energy (SLICE) award found at: http://www.energy.ca.gov/releases/2010_releases/2010-11-01_slice_awards.html

560 California Energy Commission, Staff Decision Memo for American Biodiesel, "Integrated System for Reducing Water Consumption and Wastewater Discharge of Biodiesel Production Facilities in California, http://www.energy.ca.gov/business_meetings/2010_packets/2010-08-25/2010-08-25_Item_09_American_Biodiesel/.

561 California Energy Commission, Staff Decision Memo for Premium Power Corporation, Demonstration on Zinc Flow Energy Storage System, http://www.energy.ca.gov/business_meetings/2010_packets/2010-07-14/2010-07-14_Item_08/.

associated with the implementation of 12,000 MW of DG, combined with the relative paucity of sensing data available on most distribution circuits to date.

- The PIER Program is also currently funding a number of research projects to demonstrate how smart grid technologies can support the integration of renewable resources in California's residential communities.
    - In 2009, SDG&E began research to demonstrate how smart grid technologies such as microgrids can coordinate and manage various integrated distributed resources. This demonstration is taking place in Borrego Springs, California, an area with an average of nine blackouts per year. PIER-funded microgrid research is demonstrating through the San Diego Gas & Electric Microgrid Project how a microgrid can use multiple advanced and innovative technologies to support the integration and management of utility and customer based energy resources in an interconnected network. Multiple customers interconnect and receive their power from a local portfolio of utility and non-utility interconnected resources. This network relies on a mix of high efficiency and renewable distributed generation, storage, as well as energy reduction programs and strategies to meet most of the demand of customers on the network. Distribution Automation and other smart grid technologies are being used to address operational and stability issues. The research also evaluates every day operations of the network to assure it can consistently provide reliable and stable power to all customers. Attention is focused on understanding how to optimize system performance in both peak and non-peak periods.[562]
    - The PIER Program is also providing funding to the Sacramento Municipal Utility District (SMUD) to demonstrate and validate technologies developed under the Energy Commission-funded Microgrid Laboratory Test Bed by the Consortium for Electric Reliability Technology Solutions (CERTS). The SMUD microgrid will demonstrate the integration of distributed generation, renewable technologies, combined heat and power systems, and energy storage. SMUD hopes to demonstrate that the microgrid can successfully separate from the utility system and provide reliable power.[563]

Future Research Efforts

Additional distribution research through PIER should focus on:

- Modifications that will have to be made to protection practices to accommodate current levels of DG interconnected to the system.

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562 http://cal-ires.ucdavis.edu/files/events/2011-resco-symposium/torre-william_cal-ires-resco-sdge.pdf.

563 2010 Microgrid Symposium presentation, Microgrid and Smart Grid Activities at SMUD, July 2010, http://der.lbl.gov/sites/der.lbl.gov/files/vancouver_rawson.pdf

- Advanced systems to develop new and better islanding protection algorithms, equipment, and practices needed to accommodate high penetrations of DG.[564]
- The time and location dependent relations between feeder segment loads and PV output.
- The impact of increased DG through detailed modeling of voltage profiles that will be necessary to manage voltage sags, imbalances, transients and harmonics in the future. This type of model will help distribution operators have more visibility into the distribution system to address problems created by increased amounts of DG.
- Exploration of smart grid technologies such as using smart meters to enable dynamic conservation voltage reduction that adjusts automatically to keep voltages within Rule 2 limits.
- Distribution Feeder Characterization: Building on the Distribution Monitoring Initiative and past Energy Commission-funded work on distribution feeder modeling, future research will be needed to generalize from these models and predict impacts of increasing DG penetrations in specific situations.

In addition to the research areas listed above, addressing the state's energy needs will require new systems-based approaches to optimally package, deploy, and integrate next-generation energy technologies into California's communities. The PIER Program is uniquely positioned to incent utilities, institutions, developers, and businesses to develop integrated research approaches to the state's energy issues. These innovative and novel approaches will help lead to the development and implementation of market-changing partnerships, decision-support tools, business models, and finance mechanisms that will be needed to achieve California's energy and sustainability goals:

- Advanced Technology Development and Demonstration: The PIER Program has developed a number of advanced DG technologies over the past decade. However, individual technology development has recently received a significant boost in funding from USDOE, including a number of projects awarded in California. By continuing to fund technology development and commercialization at some level, California can leverage private and federal funding and continue to be a clean tech research hub for the nation.
- Integrated Community Energy Development and Demonstration: High upfront cost, risk, consumer demand, lack of demonstration, and other issues prevent decision-makers from moving forward with the deployment of advanced energy technologies and methods. Research is needed to demonstrate integrated approaches that address these issues in California's existing communities within the context of existing jurisdictional boundaries - including buildings, districts, municipalities and counties. Integrating DG, CHP, energy storage, smart grid and other advanced technologies in these settings offers California the

564 As described in Chapter 6, islanding refers to a situation in which a DG generator continues to provide energy, even though power from the utility is no longer present.

potential to achieve its energy and environmental goals with the full-fledged involvement of local governments, communities, and business park owners.

Research to Address Cost and Financing Challenges

By reducing technology costs and improving efficiency, R&D can demonstrate to the financial community, utilities, ratepayers, and the environmental community that these technologies are ready for the marketplace. In addition, as mentioned in the beginning of this chapter, PIER cost-share funding helped to leverage more than $500 million in ARRA funds and more than $900 million in private investment funds to help finance renewable research efforts.

Current Research Efforts

Following is a brief list of PIER research projects (and prime partners) intended to reduce technology costs and improve technology efficiency.[565]

Solar

- Low Cost Installation of Concentrating Photovoltaic (GreenVolts, Inc.): GreenVolts, Inc. is demonstrating a new concentrating photovoltaic (CPV) system with low installation and manufacturing costs, technical performance improvements, and minimal ground footprint. This new CPV system will speed the deployment and adoption of CPV technology in various applications. Because of its scalable nature, it can be used for distributed near-load locations, as well as scaled up to multi-megawatt utility-scale power plants. The system's design for rapid deployment and simple assembly significantly reduces installation costs which help increase the number of deployment sites, serving the commercial, industrial, agricultural and wholesale (utility) markets.
- Development and Demonstration of a Concentrating PV System for Commercial Applications with Integrated Active Micro-inverters and an Optional Daylighting Subsystem (UC Merced):[566] UC Merced is demonstrating the efficacy of a dual-axis concentrating photovoltaic (PV) system with integrated panel-level micro-inverters. Micro-inverters offer increased mitigation for losses due to partial shading and include maximum power point tracking in order to optimize generation of each panel at any given time. The results of this project will provide valuable lessons learned toward the ultimate goal of developing cell-level micro-inverters for use with PV systems.
- Enabling Photovoltaic Markets in California Through Building Integration, Standardization and Metering in the Carbon Economy (Silicon Valley Leadership Group):

  The goal of this project is to accelerate the growth of solar PV systems in California through cost reduction, energy efficiency increase, and removing barriers that prevent market growth. This will be achieved through a demonstration of best practices for solar

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565 PIER publishes annual reports that highlights and summarizes research projects and activities including some of these examples. The reports are available at http://www.energy.ca.gov/research/annual_reports.html.

566 https://ucmeri.ucmerced.edu/research-focus-areas/solar-concentration/current-research and http://www.energy.ca.gov/2010publications/CEC-500-2010-FS/CEC-500-2010-FS-004.PDF.

PV plug and play advanced technologies, optimizing energy generation and utilization profile through overall system design and monitoring, and developing innovative financial models and market mechanisms to ease the financing and permitting processes.

- Hybrid Solar-Fossil Thermophotovoltaics (EDTEK): EDTEK developed, manufactured, and demonstrated a hybrid prototype Solar-Fossil Thermophotovoltaics (SFTPV) cogeneration power system that can produce electric power and thermal energy on a 24-hour basis. This power system converts sunlight to electricity with 25 percent overall efficiency and natural gas to electricity at an overall efficiency of 20 percent while producing process grade hot water at a recovery efficiency of 83 percent. In this system, highly concentrated sunlight is directed into a cavity where the surrounding walls are heated to incandescence, the state where visible light is emitted from a hot object. A natural gas flame is also directed into the cavity to heat its walls and excite the PV cells, as does the concentrated sunlight.

Biomass

- Valley Fig Growers Anaerobic Digester (Valley Fig Growers, Inc.): California has over 3,000 food processing establishments, i.e. about 27 percent of the national total. Conversion of food processing wastes into energy is an economically and environmentally viable solution and also responds to an urgent need to solve issues that are currently faced by the food processing industry. The Valley Fig Growers designed and constructed an anaerobic digester to pre-treat wastewater prior to disposal in the municipal sewer system. The Valley Fig Growers project demonstrated to other food processors the quantifiable economic and environmental benefits gained by installing and operating a digester. The goal was to create an economically feasible solution to energy and waste water issues facing food processors.

- Development and Demonstration of a Distributed Biogas Energy System Utilizing Organic Solid Wastes (UC Davis):[567] University of California, Davis demonstrated the anaerobic phased solids (APS) digester technology with advanced design features that enhance the effectiveness of bacterial degradation of organic wastes, provide efficient material handling solutions, and combine favorable features of both batch and continuous operations in a single biological system. Testing and analysis of the APS-Digester at scales larger than bench-scale were needed prior to full-scale system commercialization. This project demonstrated that the APS Digester, in conjunction with a clean burn engine-generator, is an environmentally sound, cost-effective distributed energy system capable of degrading high solid wastes (food residues, community green wastes, and agricultural byproducts) while producing renewable energy, soil amendments and fiber products.
- Development and Demonstration of 50 kW Small Modular Biopower System (Community Power Corporation): The Community Power Corporation's BioMax 50 is a modular biopower system that converts a wide range of biomass residues such as nut

567 http://www.energy.ca.gov/pier/portfolio/Content/06/Ren/Development%20and%20 Demo%20Wastes.htm.

shells, forest thinnings, wood scraps, etc. into clean and green power and heat. This biomass gasifier system was installed in November 2007 at the Dixon Ridge Farms in Winters, California, where it is used to produce combined heat and power by gasification of the walnut shells. This project offsets host site electrical needs by up to 40 percent, and provides heat for walnut drying operations and buildings. This work built upon a prior project (a small modular biopower (SMB) system rated at 12 ½ kW) that was successfully developed and demonstrated using waste forest slash and thinnings to provide utility grade power to the greenhouse complex and heat to maintain seedling bed temperature at Hoopa Valley.

- Biogas Fuelled HCCI Power Generation System for Distributed Generation (Makel Engineering Inc.): This project is a follow-on phase of Makel's prior project that developed the homogenous charge compression ignition (HCCI) technology. Makel Engineering is demonstrating generation of up to 200 kW of electric power under this project using the HCCI technology while meeting or exceeding California's emissions standards. Under the previous PIER co-funded agreement, Makel successfully developed and demonstrated a 30 kWe landfill gas-fueled HCCI power generation system. This system demonstrated power generation at an active California landfill site (Neal Road Landfill, Chico), which is currently flaring land fill gas. This project has already achieved over 500 hrs of operating time with LFG, operated at an efficiency of 35 percent with NOx emissions on the order of 5 PPM.

Wind

- The Next Generation Turbine Development Project (The Wind Turbine Company): The Wind Turbine Company developed a two-bladed, downwind, horizontal-axis wind turbine with flexible blades as a proof-of-concept vehicle for demonstrating cost savings by reducing the weight and manufacturing cost of key wind turbine components. Lessons learned from the 250 kilowatt prototype, which amassed over 1,000 operating hours at the National Renewable Energy Laboratory test facility in Colorado, led to a follow-on project to scale-up the design to a more commercially viable 500 kilowatt platform and to further refine the innovative flap motion controls developed for the prototype to achieve optimal performance and safety.

- Wind Turbine Company EMD Turbines (The Wind Turbine Company): Building on successful demonstration of its innovative prototype downwind, horizontal-axis wind turbine in the Next Generation Turbine Development Project, the Wind turbine company scaled-up the design to a more commercially viable 500 kilowatts. The anticipated cost-reducing features of the design included the use of two (as opposed to three) light weight, flexible turbine blades; employing innovative flap motion controls to optimize performance and enhance safety of the design; and using large diameter commercial steel pipe with guys instead of conventional tubular or lattice tower technology. The 500 kilowatt demonstration unit was deployed near Lancaster, California and saw 70 hours of operation when it experienced a blade-tower strike due to an error in the blade protection software. Subsequent efforts to recover from the mishap were unsuccessful.

- Composite Taller Towers for Low to Moderate Wind Shear (Wind Tower Systems LLC): Wind Tower Systems designed a space frame tower that would expand California's recoverable wind resource in marginal areas by permitting developers to economically reach higher wind speeds available at greater heights above ground level. Tower cost reductions over conventional tubular towers are achieved by avoidance of oversized trucking charges, and self-erecting tower technology permits the use of smaller cranes than would otherwise be employed. Though unable to deploy and demonstrate the technology itself, Wind Tower System sold to sell the concept to General Electric.
- SMUD - 4.5 Distributed Generation Geartrain for Megawatt Turbines (Sacramento Municipal Utility District): Under a programmatic subcontract with SMUD, Clipper Windpower designed and built a commercial scale (1.5 MW) distributed generation drive train and controller, and successfully tested the system for over 600 hours on a dynamometer at the National Wind Technology Center. The innovative geartrain splits torque on the low-speed side of the gearbox along multiple parallel pathways thereby reducing gear tooth stress and improving gearbox life and reliability. Lessons learned from this project were subsequently employed by Clipper Windpower to develop its Liberty 2.5 MW wind turbine which splits torque between four permanent magnet generators.

Geothermal

- Dual Horizontally Completed Injection Well To Enhance Geothermal Production at the Geysers (Northern California Power Agency): A dual horizontally completed injection well was drilled to a depth of about 8,000 feet at The Geysers geothermal field in northern California. The purpose of this project was to develop and demonstrate a substantially more effective means to inject and distribute an increasing supply of wastewater for additional recovery of injection derived steam. The increase in steam production resulted in an increased electricity being generated from the existing power plants for distribution to consumers.
- Geothermal Exploration Under The Salton Sea Using Marine Magnetotellurics (Schlumberger Carbon Services, a division of Schlumberger Technology Corporation): The purpose of this project was to apply new marine magnetotelluric technology to delineate potential geothermal reservoirs extending beneath the Salton Sea which will help developers effectively explore, develop, drill fewer dry holes, and reduce the cost of electricity generation. This project demonstrated the first ever combined land/marine magnetotelluric survey which delineated the geothermal reservoir extending beneath the Salton Sea, Imperial County, and provided valuable structural geophysical data of the area previously unknown.
- Pilot-Scale Geothermal Silica Recovery at Mammoth Lakes (Lawrence Livermore National Laboratory): Lawrence Livermore National Laboratory (co-funded by DOE) led the development of a silica extraction technology that produced high purity colloidal

silica from geothermal waters. The process used reverse osmosis to concentrate the silica up to 1,000 parts per million to enhance and resulted in 99.6 percent silica purity. Colloidal silica was also captured in extraction tests. The resulting product is potentially marketable to various industrial users of silica, including the solar industry. The technology will enable geothermal operators to secure a second revenue stream, which increases the cost effectiveness of geothermal generated energy.

- Improving Energy Recovery at The Geysers Geothermal Field by Delineation of In-Situ Saturation (Stanford University): This project used three related approaches to examine the best way to determine the measurement of fluid filled spaces (fluid saturation) in the rock at The Geysers. This project considered (1) making laboratory measurements of the saturation in rock cores; (2) collecting historical field data to use to infer saturation from model matching; and (3) applying theory and models to estimate saturation from output characteristics. Knowing the initial and current fluid saturations at The Geysers allowed for more effective energy production and the development of the best strategy to prolong the resource's life. The project aided in developing a more efficient strategy in determining where and how to engineer future large and small scale injection programs.

Future Research Efforts

- Surveying best practices and policies that have been used to reduce costs in other states and nations to determine the greatest opportunities for cost savings. For example, the installed cost of solar PV is $5.9/W in Japan, compared to $7.5/W in the United States. One strategy Japan is using is to limit rebates for rooftop PV to systems for which installation costs are under a certain percentage that gradually becomes lower over time. California should continue to monitor activities in other states and countries to learn from their efforts and implement cost reduction strategies that could apply to California's system.
- Developing strategies to encourage solar manufacturers to standardize the manufacture of components, and to design ground-up integrated systems to make it easier and faster for installers (plug and play). PIER has funded more than 40 bioenergy projects and studies, and will build on those efforts in the future on the following research areas to expand the use of biomass and biogas for electricity generation:[568]
  - PIER will investigate possible research on co-locating biopower or biofuel refineries with other biomass to energy projects, manufacturing facilities, or waste diversion, composting, transfer/processing, or disposal facilities.
  - PIER will explore research to reduce the cost of biomethane gas clean up to meet gas quality standards for injection into the natural gas pipeline.
  - PIER will explore working with the California Biomass Collaborative, the Department of Food and Agriculture, the U.S. Environmental Protection Agency, and industry associations to update and renew an existing Web-based database to provide location,

568 California Energy Commission, *2011 Bioenergy Action Plan*, http://www.energy.ca.gov/2011publications/CEC-300-2011-001/CEC-300-2011-001-CTF.PDF.

volume, quality, and seasonality of biodegradable waste suitable for codigestion at wastewater treatment plants. The database will include waste from California's agriculture, food processing, and dairy industries.

Chapter 10: Environmental Justice, Local Government Coordination, Workforce Development, and Public Leadership

In addition to the specific challenges to renewable energy development discussed throughout this report, there are broader issues associated with achieving California's renewable goals. These include environmental justice issues, local government coordination, workforce development, and developing renewables on state properties.

An important consideration when developing and permitting any electricity generating facility is environmental justice. Environmental justice is defined in California law as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies."[569] Environmental justice organizations have repeatedly voiced concerns about the environmental impacts on their communities from fossil-fueled electricity generation and have supported the state's higher renewable targets, including those for renewable distributed generation (DG).[570] Rooftop solar photovoltaic (PV) in urban areas has the potential to help environmental justice communities by reducing the environmental impacts of fossil plants and by creating local green jobs.

Local governments are key players in meeting California's statewide renewable energy goals, and have shown strong leadership in developing renewable resources in their jurisdictions. Cities and counties are working to attract and retain renewable technology companies, recognizing their contribution not only to meeting the state's renewable and greenhouse emission (GHG) reduction goals, but also to local economic development opportunities. It is therefore crucial for state and local governments to be partners in developing and implementing renewable energy policy goals. State government must work with local jurisdictions to understand the barriers they face in pursuing renewable policies and practices and provide assistance in overcoming those barriers.

California will need a variety of skilled workers to support achievement of statewide policy goals for renewable energy development. Many of the jobs being created by the clean energy economy are in traditional labor sectors like manufacturing, installation, fabrication, and operations. Other opportunities exist within more specialized areas like power plant design and operations, facilities management, and consulting and research. To provide the well-trained workforce needed to sustain the growth of California's renewable industry, the state needs to continue developing tools like basic and advanced job training, job placement assistance, and hands-on apprenticeship programs.

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569 Government Code Section 65040.12.

570 California Environmental Justice Alliance press release, April 12, 2011, http://www.environmentalhealth.org/PDFs/PressRelease_SBX1_2_FINAL.pdf.

Finally, California state government is demonstrating its leadership through efforts to increase the amount of renewable development on state-owned buildings, properties, and rights-of-way. Government agencies are large users of energy and there are significant opportunities to reduce energy use in state facilities and operations while also saving taxpayer dollars and avoiding emissions of air pollutants and greenhouse gases. Public sector leadership is also an important first step in market transformation with government creating entry markets and setting an example for other sectors to adopt renewable energy technologies.

Cross-Cutting Issue 1: Environmental Justice

Environmental justice (EJ) communities are commonly identified as those where residents are predominantly minorities or low-income; where residents have been excluded from the environmental policy setting or decision-making process; where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices and activities in their communities.

Environmental Justice Challenges

Often, these communities are located near oil refineries, power plants, industrial facilities, and other sources of pollution,[571] and may have minimal awareness of environmental hazards, little ability to organize, lack of political influence in land-use decisions, and insufficient financial resources to participate in state and local permitting processes. As a result, these communities can be disproportionately affected by environmental hazards associated with conventional energy production and feel excluded from environmental policy-setting or decision making processes. EJ advocates also believe that these communities will suffer the worst effects of climate change.[572]

One of the primary concerns in the EJ community today relates to the types of power plants that will be built to meet increased electricity demand, replace aging power plants, and replace plants that may retire as a result of the State Water Resources Control Board's (SWRCB) policy on the use of once-through cooling in power plants,[573] particularly in the southern part of the state which has some of the worst air quality in the nation. Assembly Bill 1318 (Perez, Chapter 285, Statutes of 2009) requires the California Air Resources Board, in consultation with the Energy Commission, the California Public Utilities Commission (CPUC), the California

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571 "In California, communities residing within 2.5 miles of major air polluting plants are 63% African American, Latino/a, and Asian/Pacific Islander." Comments of California Environmental Justice Alliance on the 2011 Integrated Energy Policy Report: Committee Workshop on Renewable Localized Generation, submitted May 23, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/comments/.

572 *Transcript of the 2011 Integrated Energy Policy Report Committee Workshop on Renewable Localized Generation*, May 9, 2011, comments of Nicole Capretz, p. 62. See also Hoerner, J. Andrew and Nia Robinson, A Climate of Change, July 2008, http://www.greendmv.org/reports/climateofchange.pdf.

573 State Water Resources Control Board, *Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling*, May 4, 2010, http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2010/rs2010_0020.pdf.

Independent System Operator (California ISO), and the SWRCB, to prepare a report for the Governor and Legislature that evaluates the electrical system reliability needs of the South Coast Air Basin given the need to ensure compliance with Assembly Bill 32, once-through cooling mitigation requirements, state and federal air pollution laws and regulations, resource adequacy requirements, and renewable and energy efficiency requirements. At the February 15, 2011 Joint Agency Workshop on Emission Offset Challenges for Fossil Power Plants that discussed the workplan for the AB 1318 report, EJ advocates and environmental organizations stressed the need for agencies to examine load reductions from energy efficiency, the use of energy storage, and meeting electricity needs with renewable resources – including distributed resources like solar on public buildings, fuel cells for local reliability, and facilities that use landfill gas or wastewater treatment gas – when analyzing the amount of fossil power that will be needed to meet electricity and reliability needs in the South Coast Air Basin.[574] At this time, the Air Resources Board anticipates development of a draft AB 1318 report by the end of 2011 with a final report to the Legislature in the spring of 2012.

EJ advocates also have concerns about the types of fossil generation that will need to be built to help support renewable integration. As noted in Chapter 5, dispatchable and flexible natural gas turbines ("peakers") can provide the operational characteristics needed to integrate variable renewable; however, because these plants cannot operate as efficiently as baseload resources, they may have increased emission rates which could impact the communities in which they will be located.

Efforts to Address Environmental Justice Challenges

The Energy Commission has integrated EJ considerations in its power plant licensing process since 1995 and conducts significant outreach to notify, inform, and involve community members, including non-English speakers, to provide every opportunity for affected communities and groups to participate in environmental decisions. For all power plant siting cases, the Energy Commission conducts an EJ analysis composed of three parts: 1) identification of areas potentially affected by various emissions or impacts from a proposed project; 2) a determination of whether there is a significant population of minority or low-income people living in an area potentially affected by the proposed project; and 3) a determination of whether there may be a disproportionate high and adverse effect on a significant population of minority or low-income people caused by the proposed project alone, or in combination with other existing and/ or planned projects in the area. According to the 2010 census, California leads the nation with the largest minority population (22.3 million, or 57 percent).[575] Therefore, with the exception of large solar power plants proposed in remote areas with little population, new

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574 Transcript of and written comments on the 2011 Integrated Energy Policy Report Joint Agency Workshop on Emission Offset Challenges for Fossil Power Plants, February 15, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/index.html#02152011. Oral comments by David Pettit, Angela Johnson Meszaros, Jane Williams, and V. John White; written comments submitted by Drew Bennett, Noah Long, Adrian Martinez, and David Pettit on behalf of Natural Resources Defense Council.

575 http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf.

power plants – including those that use renewable resources – may be located in more populated areas that could affect minority communities.[576]

While EJ organizations generally support renewable energy to offset the use of fossil fuel technologies, some renewable technologies cause concerns. For example, in February 2011, two biomass plants in California's San Joaquin Valley, which is home to many EJ communities, were fined for violations of the federal Clean Air Act and local air district rules, including excess emission of air pollutants like nitrogen oxides – a precursor to ozone – and fine particulates.[577] The San Joaquin Valley exceeds national health requirements for both ozone and particulate matter. There are also concerns with potential waste and water impacts from geothermal facilities. Investigations of geothermal facilities in the Imperial Valley, which also has 50 percent or more minority residents, that were conducted by the Department of Toxic and Hazardous Substances resulted in fines totaling $910,000 against plant owners, with violations including the illegal storage, treatment, and disposal of hazardous waste; the failure to label and cover hazardous waste containers; and failure to properly train employees. In 2007 a geothermal plant was fined by the SWRCB more than $230,000 for exceeding the levels of lead, arsenic, and copper in wastewater sent to the Salton Sea. Air quality problems have also been found in the steam associated with cooling towers in the Salton Sea region.[578]

However, EJ communities do see the value of renewable generating resources in their communities. Participants in the May 9, 2011 IEPR workshop on Renewable Localized Generation noted the value of renewable DG, such as rooftop PV, in EJ communities. Rooftop PV in urban environments can potentially provide value to these communities through reductions in the health and environmental impacts of fossil-fueled power coupled with economic revitalization and creation of local green jobs. However, rooftop solar is not always accessible to these communities because of the high up-front cost of these systems. In addition, many residents of EJ communities live in multi-unit residential rental properties whose landlords may not see any benefits for allowing solar system construction, especially in situations where they are paying for the systems and additional wiring while tenants are receiving the benefits of reduced energy costs.

There are several options currently available to help offset the costs of installing rooftop PV on affordable and low-income housing. The Energy Commission's New Solar Homes Partnership (NSHP) offers affordable housing projects higher incentives than standard market-rate housing

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576 The Council on Environmental Quality's "Environmental Justice: Guidance Under the National Environmental Policy Act" dated December 1997, defines minority individuals as members of the following groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

577 GreenEnvironment News, "Central Valley Biomass Power Plants Fined in Excess of $830,000 for Clean Air Act Violations," February 15, 2011, http://www.greenenvironmentnews.com/Environment/Air/Central+Valley+Biomass+Power+Plants+Fined+In+excess+of+$830,000+For+Clean+Air+Act+Violations.

578 Imperial Visions Action Network, "Geothermal Power in Imperial Valley – Only as Clean as the Corporations and Fluid Sources and Fluid Source Allow," December 2010, http://www.ivanonline.org/index.php?option=com_k2&view=item&id=5:geothermal-power-in-imperial-valley.

projects. Of the overall 400 megawatt (MW) goal for the entire NSHP program, 36 MW will be made available for new affordable housing during the ten-year program.[579] Under the California Solar Initiative, the CPUC has two programs, the Single-Family Affordable Solar Homes Program (SASH) and the Multifamily Affordable Solar Housing Program (MASH). The goals of these programs include improving energy use and the quality of affordable housing through use of solar and energy efficiency technologies and decreasing electricity use and costs without increasing monthly household expenses for residents. Programs provide solar incentives for qualifying affordable housing in the service territories of Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric.[580]

The SASH Program provides a one-time payment under the Expected Performance Based Buydown structure to help reduce a homeowner's upfront cost of PV solar installation. Homeowners can receive either a partial or full subsidy, capped at $10,000, depending on program eligibility criteria. The program will operate until December 31, 2015 or until all funds are allocated, whichever comes first. As of the first quarter of 2011, the SASH Program achieved its first MW of installed solar PV, with nearly 75 percent of the 466 installed systems between 1-3 kilowatts (kW). Another 195 projects have been reserved and are awaiting installation or interconnection, and another 331 applications are under review.[581]

The MASH program offers two types of incentives. Track 1 provides upfront capacity-based incentives for solar PV systems that offset common area and tenant loads, and Track 2 offers higher incentives to applicants that provide operating costs savings from solar that are shared with tenants. Currently, Track 1 incentives have been filled and a waiting list has been established, and program administrators are developing a statewide application and review process for Track 2 incentives. As of July 2011, 3.8 MW of solar capacity was interconnected under the MASH program on 67 multi-family affordable housing buildings serving 4,213 tenant units. There are also 271 Track 1 projects currently reserved, with capacity of more than 16.7 MW.[582]

Another effort is the non-profit Grid Alternatives Solar Affordable Housing Program, which provides training to install solar electric systems for low-income homeowners.[583] This program began in 2004, and as of August 2011 has installed 1,145 solar electric systems in partnership with low-income families throughout California. These systems represent nearly 3 MW of

579 Go Solar California website, http://www.gosolarcalifornia.ca.gov/affordable/nshp.php.

580 California Public Utilities Commission, CSI Single-Family Affordable Solar Homes Program website, http://www.cpuc.ca.gov/PUC/energy/Solar/sash.htm, and CSI Multifamily Affordable Solar Housing Program website, http://www.cpuc.ca.gov/puc/energy/solar/mash.htm.

581 California Public Utilities Commission, Single-family Affordable Solar Homes (SASH) Program, Q1 2011 Program Status Report, April 2011, http://www.cpuc.ca.gov/NR/rdonlyres/BE2A2B11-A16A-4687-A556-39E337E9F1E4/0/2011Q1SASHREPORT.pdf.

582 California Public Utilities Commission, http://www.cpuc.ca.gov/puc/energy/solar/mash.htm.

583 Grid Alternatives website, http://www.gridalternatives.org/impact-numbers.

generating capacity and are reducing each family's electric bills by approximately 75 percent. Grid Alternatives has also trained nearly 7,000 community volunteers and job trainees on the theory and practice of solar electric installation.

Another PV effort aimed at low-income communities is the "Solar for All California" program, implemented by the California Department of Community Services and Development (CSD) using funding from the Low Income Home Energy Assistance Program (LIHEAP).[584] This program has a goal of installing 1,000 new PV systems on single- and multi-family low-income homes throughout California by October 2011. As of June 2011, the program has installed 274 single-family systems and approved installation for an additional 319 single-family systems and one project that will benefit 75 multi-family units. The CSD used a competitive bid process and asked energy providers to: install optimally-sized PV systems on single- or multi-family homes; develop creative partnerships to provide systems with no loans, liens, or out-of-pocket costs for the low-income owners or residents; put energy efficiency first to further reduce the energy consumption of each home before installing PV; and develop green jobs by training low-income workers to become solar installers. At the end of the contract term, CSD and providers will determine which approaches were most effective and look for ways to expand and duplicate the program statewide. The following four providers were selected and have 18 months to fulfill their contracts:

- North Coast Energy Services proposes to install approximately 150 PV systems, averaging 3.5 kW in size, in single family homes in the counties of Lake, Marin, Mendocino, Napa, Solano, Sonoma and Yolo.
- Community Resource Project intends to install approximately two hundred 3-4 kW systems in single-family homes in Sacramento County.
- Fresno County Economic Opportunities Commission, acting as the lead agency to four other CSD LIHEAP providers, intends to install PV systems on a mixture of single- and multi-family homes, totaling more than 150 units and ranging in size from 1.5 to 2.5 kW. Systems will be installed in the counties of Fresno, Merced, Madera, Tulare, Kings and Kern.
- Central Coast Energy Services will partner with 11 existing CSD providers to install up to 600 PV systems on multi-family units, ranging in size from 1.5 to 2 kW, in counties throughout California.

The City of Los Angeles is also looking at ways to increase installation of rooftop solar on multi-family units. A recent preliminary study by the Los Angeles Business Council notes that there is tremendous capacity for multi-family housing to contribute to a broad-based solar program in the city.[585] The study estimates there is potential capacity for more than 300 MW of rooftop PV,

584 California Department of Community Services and Development, Solar For All California website, http://www.csd.ca.gov/AboutUs/Solar%20For%20All%20California.aspx.

585 Los Angeles Business Council, Making a Market: Multifamily Rooftop Solar and Social Equity in Los Angeles, April 2011, http://www.labusinesscouncil.org/online_documents/2011/LABC-Exec-Summary-Brochure-2011-Final-r-1.pdf.

with the multi-family building sector likely to be the second most cost-effective market for solar development in the city after commercial and industrial. Many of the multi-family housing units with the greatest solar potential – those with large, flat rooftops – are in economically depressed neighborhoods. However, the study notes that to achieve this potential, property owners will need to be adequately incentivized. The study indicates that 24 to 26 cents per kWh would be enough to encourage broad participation in the multi-family market by paying building owners a reasonable rate of return. The rate could be in the form of direct payment, such as a feed-in tariff, or a combination of payment and rebates, such as net metering. The study also found that a 300 MW program would produce more than 4,500 direct and indirect jobs in local professional services, construction, and ongoing system maintenance.

Recently, the Los Angeles Department of Water and Power announced that is relaunching its Solar Incentive Program with applications accepted beginning September 1, 2011. As part of the program, LADWP staff have been asked to investigate more options for making solar affordable to low income customers with the goal of developing leasing options and other proposals for lower income households.[586]

While each of these efforts are helpful, during the IEPR proceeding EJ advocates suggested the state should set more specific policy goals for the 12,000 MW DG target to ensure EJ communities receive at least their fair share local environmental and economic benefits. As discussed in Chapter 2, the Energy Commission staff's analysis of regional targets for the 12,000 MW DG goal recognizes the value of these targets to provide opportunities to advance public benefits such as job creation in low income communities.

Suggestions from the EJ community included:[587]

- Focus investment on communities with the highest need and greatest opportunity for benefit, both urban and agricultural, with at least 50 percent of the 12,000 MW goal focused on projects located on commercial and residential buildings and parking lots.
- Implement policy mechanisms such as revamping the California Solar Initiative to capture more low-income homes and multi-family buildings and adopting a feed-in tariff to make small-scale projects affordable and effective.
- Ensure a fair allocation of regional targets to benefit all parts of the state, not just wealthiest communities.

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586 Los Angeles Department of Water and Power, "LADWP to Relaunch Solar Incentive Program with Revised Incentive Levels and Streamlined Customer Service," press release, August 2, 2011, http://www.ladwpnews.com/go/doc/1475/1153343/.

587 Comments of California Environmental Justice Alliance on the 2011 Integrated Energy Policy Report: Committee Workshop on Renewable Localized Generation, submitted May 23, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/comments/.

- Set more specific goals than just regional targets to make certain the state meets social, economic, and EJ goals, and use environmental screening to evaluate proposed allocations based on equity and economic development in underemployed and underserved areas.
- Ensure robust community participation in the design and implementation of any program to achieve the 12,000 MW target, with workshops and hearings in different regions of the state to get diverse feedback and make energy policy accessible and understandable to a broader network of Californians.

The Energy Commission intends to continue to work closely with EJ communities throughout California to ensure that their concerns are addressed in both the power plant licensing process and in implementation of the state's Renewable Portfolio Standard (RPS). As noted in Chapter 3, early involvement by these communities in power plant siting cases is vital to ensuring that their interests are appropriately considered in licensing decisions.

Cross-Cutting Issue 2: Local Government Coordination

Renewable development at the local level will be an essential component of the state's efforts to meet its renewable energy goals. Local governments are closely involved in land use decisions, environmental review, and permitting for a wide range of renewable projects. More than half of the 9,435 MW of large-scale renewable generation that was permitted in 2010 fell under the purview of local governments.[588] In addition, local governments will be responsible for permitting localized generation that will contribute toward the state's 12,000 MW DG goal.

There are 482 incorporated cities and 58 counties in California. In addition, California has approximately 3,400 special districts, which are "separate local government(s) that delivers a limited number of public services to a geographically limited area."[589] Because each of these jurisdictions has different population sizes, demographics, geography, and renewable resource potential, implementing a one-size-fits-all energy policy for renewable development is impossible and unproductive. For example, more than half of California's counties consider themselves predominantly rural, [590] and face challenges in adapting to solutions and tools that may have been designed for urban environments. In addition, 45 percent of California's cities have a population of less than 25,000, and 65 percent have populations under 50,000.[591] Jurisdictions with lower populations generally have smaller electricity loads, so their renewable energy generation policies may not be as aggressive as those of larger jurisdictions with higher electricity system demands. Demographic differences such as income and education levels, political leanings, and value placed on renewable energy also play a role, as do geographic differences that affect the type of renewable resource that is best suited for each jurisdiction.

588 See Chapter 2 for totals of renewable facility permits by county.

589 What's so Special about Special Districts?; A Citizens Guide to Special Districts in California, 4th Edition (October 2010)

590 http://www.rcrcnet.org/rcrc/

591 http://www.cacities.org/index.jsp?zone=locc&previewStory=53

State government will need to work closely with local jurisdictions to understand these differences and the unique challenges local governments face in pursuing renewable energy policies and practices, and provide assistance in overcoming those challenges.

Challenges for Utility-Scale Renewables at the Local Level

As discussed in Chapter 3, local governments, primarily larger counties through their planning and redevelopment agencies, review and permit solar PV and wind energy projects, as well as thermal projects less than 50 MW in size. These projects face the same permitting and land use challenges identified in Chapter 3 for utility-scale renewable facilities, including the potentially large footprint of the facilities as well as the location of renewable resources in environmentally sensitive areas. Permits typically require a California Environmental Quality Act (CEQA) analysis. While cost of the review is the responsibility of the project developer, as lead agency local governments will need to provide the staffing and expertise to conduct these reviews. For example, several large-scale solar thermal projects already permitted at the state level are switching to PV technologies due to the decreasing cost of PV as compared to solar thermal technologies. Projects larger than 50 MW that switch from solar thermal electric to PV may require a new permitting and environmental review process. If the project is not on federal land, the responsibility for this review will fall on local county governments. Many local jurisdictions are scaling back their planning department staff due to the economic downturn, and this lack of resources combined with the increased number of renewable project applications may lead to delays in processing these applications.

In addition, while some counties and cities have adopted energy elements as part of their general plans and established specific ordinances for permitting generation facilities, many have not. Often, local governments lack the regulatory framework and technical expertise to address the growing number and diversity of renewable energy technologies. Without appropriate general plans or energy elements, local governments face difficulties in properly planning and siting renewable energy projects, which can complicate and delay the review and approval of renewable generation projects under their jurisdiction. Many local government land use plans do not include utility-scale renewable energy facilities as a general plan land use designation and/or a principal permit land use of a zone district by the zoning ordinance, thereby requiring discretionary approval by the local government. In such cases, a developer of a utility-scale renewable energy facility would have to apply for an amendment to the city or county general plan. If a city or county zoning ordinance does not allow the building of an utility-scale renewable energy facility, the developer must file an application to rezone the land. The developer may need to apply for a conditional use permit from the city or county.

Another issue for many local governments is siting of utility-scale projects on land in a Williamson Act contract, which provides for long-term agricultural use.[592] If a proposed project site is land under a Williamson Act contract, the contract may need to be canceled if it does not

592 California Land Conservation Act of 1965--commonly referred to as the Williamson Act--enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use.

stipulate utility-scale energy generation type facilities under its list of uses. The process time for the cancelation of the contract by the local government can be lengthy.

For example, local governments may face challenges with regulating large wind energy projects. As part of developing a guidebook on community planning strategies for successful implementation of wind energy, the American Planning Association, in partnership with the National Renewable Energy Laboratory, Clarion Associates, and the American Wind Energy Association, conducted a national survey to identify challenges local planners face in planning for, regulating, and implementing wind energy facilities.[593] Issues most commonly identified included the need for accurate and unbiased information about wind energy, better public education, and a proper balance between the benefits and potential impacts of wind energy. Survey respondents also identified challenges associated with local ordinances that prohibit, limit or inadequately address wind energy, as well as difficulties planning for and regulating wind energy as technologies continue to evolve.

Efforts to Facilitate Utility-scale Renewable Development at the Local Level

As noted in Chapter 3, a number of local governments include or are working toward including energy elements in their General Plans to promote development of alternative energy sources:

- Kern County has a long history of excellence in permitting large-scale wind energy projects with more than 800 MW currently on-line and more than 3,600 MW of new wind capacity in the permitting process. In addition, the county has approved applications for nearly 900 MW of large-scale solar development with another 500 MW in process.[594] To facilitate the growth in permit requests, the county has included renewable energy facilities as part of the County General Plan Energy Element as well as the County Zoning Ordinance.[595] By pre-designating areas and defining development standards for renewable energy facilities throughout the county, developers have experienced fewer permitting roadblocks from the County Planning Department. In addition, the county has surveyed and designated areas appropriate for wind and solar development, completed programmatic level Environmental Impact Reports (EIRs) in specific areas, and approved cancellations for Williamson Act contracts to develop renewable energy on unproductive farmland.[596]
- Imperial County has more than 500 MW of installed geothermal generating capacity and in 2004 adopted a General Plan Geothermal Element to guide development of geothermal

593 American Planning Association, Wind Energy Planning: Results of the American Planning Association Survey, July 2010, www.planning.org/research/wind/surveyreport.htm.

594 Kern County Planning Department data, http://www.co.kern.ca.us/planning/renewable_energy.asp, accessed August 5, 2011.

595 Kern County Energy Element of the General Plan: electricity generating sources begin on page 201. http://www.co.kern.ca.us/planning/pdfs/kcgp/KCGPChp5Energy.pdf. Kern County Zoning Ordinance: Chapter 19.64 establishes a Wind Energy Combining District http://www.co.kern.ca.us/planning/pdfs/KCZOMar09.pdf

596 See http://www.co.kern.ca.us/planning/renewable_energy.asp.

energy projects.[597] The county has designated four Geothermal Overlay Zones totaling more than 140,000 acres, and has adopted several Master EIRs that reduce documentation needed for subsequent projects when projects are proposed within those areas.

- Inyo County has more than 300 MW of geothermal capacity and has prepared an overlay district for solar and wind resources, including an in-depth assessment of the best suitable locations for renewable energy development.[598]
- Los Angeles County's Department of Regional Planning is meeting with community stakeholders to develop a needs assessment surrounding renewable energy facility siting and development.
- San Diego County developed a Strategic Energy Plan for 2009 to 2012 that includes policies and directives to facilitate planning for and permitting of renewable energy systems. In addition, the San Diego Association of Governments (SANDAG) adopted its Regional Energy Strategy in 2003 that was incorporated into the SANDAG Regional Comprehensive Plan in 2004. This plan identifies energy policies and objectives including promoting local production of environmentally sensitive energy, creating opportunities to coordinate energy supply strategies between governments in the greater border region, and locating energy facilities like power plants and transmission lines so that they do not disproportionately affect lower income and minority communities.[599]
- San Luis Obispo and Fresno counties have adopted General Plan policies and updated their Zoning Ordinances to include sections addressing permitting and approval of energy facilities, including renewable energy sources. San Luis Obispo County is also preparing a climate action plan that relies on small-scale or distributed renewable energy sources as well as larger facilities to meet its GHG emission and renewable energy goals.
- Tulare County, as part of its current 2025 General Plan update, is adopting goals and policies to plan and permit renewable energy development and to integrate renewable energy permit processing into its on-line geographic information system.[600]
- The city of Fremont recently adopted a General Plan 2030 update that includes a sustainability element that includes climate protection goals and policies. Notably, the city adopted a 25 percent GHG reduction goal for 2020 over its 2005 baseline emissions.[601]

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597 Imperial County Planning and Development Services website, http://www.icpds.com/?pid=833, accessed August 5, 2011.

598 http://inyoplanning.org/RE-NOA-GPA2010-03.pdf.pdf

599 California Energy Commission, *Energy Aware Facility Siting and Permitting Guide*, 2010, http://www.energy.ca.gov/2010publications/CEC-600-2010-007/CEC-600-2010-007-D.PDF, page 101.

600 See section 8.4 of the Draft 2025 General Plan http://generalplan.co.tulare.ca.us/documents/GeneralPlan2010/GeneralPlan2030Update.pdf. Also, see the County's comments regarding on-line permitting interoperability plans http://www.energy.ca.gov/rp3/documents/comments/Tulare_County.pdf.

Other local governments that are demonstrating leadership and innovation in promoting renewable energy development include:

- In Marin County, Marin Clean Energy is California's first community choice aggregation program, which allows the county to procure electricity on behalf of electric customers in its jurisdiction. Phase I service was launched in May 2010 to more than 7,000 customers, with Phase II to expand that to the more than 70,000 remaining customers in mid-2011. The program delivers 25 percent renewable energy from wind, hydro, geothermal, and other sources, and also offers a 100 percent renewable energy product. The program also offers a net metering program in which customers are paid for generating their own energy from rooftop solar and other sources.[602]
- In Santa Rosa, the city's Laguna Treatment Plant, in collaboration with Sonoma State University, is using aquatic vegetation to treat wastewater and produce energy from the harvested vegetation and local organic waste. The Fuel from Aquatic Biomass Project will include two anaerobic digesters to transform harvested biomass into methane-rich biogas which will be used for on-site power at the plant. This technology could provide other municipalities with a renewable energy source.[603]
- The City of Santa Monica has set a target of 25 percent citywide electricity use coming from renewable sources and 1 percent coming from clean DG by 2010. In addition, the city has a contract with Commerce Energy to purchase renewable energy to meet 100 percent of the city government's electric needs.[604] The city is also very active in development of solar PV, with more than 2.5 MW of solar PV installed at 310 sites throughout the community on both public and private buildings.[605]

In addition to efforts at the local level, the state has provided detailed guidelines to assist local planners in planning and permitting of renewable facilities. In 2007, the Energy Commission and the California Department of Fish and Game published voluntary guidelines to help local permitting agencies avoid, minimize, and mitigate potential impacts to bird and bat populations [606] In 2010, the Energy Commission updated its *Energy Aware Facility Siting and Permitting Guide* to provide information to assist local governments with developing general plan energy and transmission elements and provide guidance on electricity generation and

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601http://www.fremont.gov/index.aspx?NID=399.

602 http://www.ca-ilg.org/node/2726.

603 http://ci.santa-rosa.ca.us/departments/utilities/Projects/Pages/FuelFromAquaticBiomass.aspx.

604 City of Santa Monica, Office of Sustainability and the Environment, http://www.smgov.net/Departments/OSE/Categories/Sustainability/Sustainable_City_Progress_Report/Resource_Conservation/Renewable_Energy.aspx, accessed August 7, 2011.

605 Solar Santa Monica, http://www.solarsantamonica.com/see-our-progress.html.

606 California Energy Commission and California Department of Fish and Game, *California Guidelines for Reducing Impacts to Birds and Bats from Wind Development*, 2007, http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF.

transmission planning and permitting.[607] The guide provides information on planning and regulatory structures, laws and policies to promote renewable resources and transmission, and permitting steps and timelines for generation and transmission facilities. The guide also provides suggestions for permit process streamlining, including one-stop permit centers, pre-application packages and conferences, simplified permit language, a single point of contact for all local permits, cross training of staff, and the use of program-level EIRs. Also in 2010, the Renewable Energy Action Team issued the *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, [608] discussed in Chapter 3, which provides recommendations to local and tribal governments regarding best practices for desert renewable energy facility permitting.

Challenges for Renewable Distributed Generation at the Local Level

Chapter 3 discussed the variety of challenges associated with planning and permitting renewable DG at the local level. These include the lack of zoning ordinances, varying codes, standards, and fees, Williamson Act issues; unclear, duplicative, and uncoordinated permitting practices; and unknown environmental review and mitigation requirements.

Efforts to Facilitate Renewable Distributed Generation at the Local Level

As noted in Chapter 3, identifying areas that are suitable for renewable energy generation is a key aspect of energy planning. At the July 25-26, 2011 *Governor's Conference on Local Renewable Energy Resources*, a panel on land use and siting presented a discussion paper that identified priorities that should be used to locate local renewable energy in order to minimize environmental impacts.[609] These priorities correctly stress the importance of identifying the best locations for local renewable energy projects. A key priority would be placing systems on the rooftops of existing buildings and in parking lots. This will use the existing built environment and minimize the impact to communities. Another priority would be siting systems on land that has no value as habitat, open space, or farmland; in other words, brownfield sites and/or disturbed lands. Finally, localized renewable generation should be located near load centers to optimize system efficiency. These priorities can potentially provide critical guidance to long-term energy planning and could be an important strategy to be incorporated into every energy element.

The importance of location has been highlighted by the U.S. Environmental Protection Agency (EPA), which has recognized and is encouraging the use of disturbed lands, such as closed

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607 California Energy Commission, *Energy Aware Facility Siting and Permitting Guide*, 2010, http://www.energy.ca.gov/2010publications/CEC-600-2010-007/CEC-600-2010-007-D.PDF.

608 Renewable Energy Action Team, *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, December 2010, http://www.drecp.org/documents/index.html.

609 The Governor's Conference on Local Renewable Energy Resources: California's Path to Local Renewables, Land Use and Siting Panel Discussion Paper (http://gov.ca.gov/docs/ec/Land_Use_and_Zoning.pdf).

landfills, for siting clean and renewable energy facilities.[610] The EPA's Re-Power America's Land initiative identifies the renewable energy potential of disturbed land sites and provides useful resources for those interested in reusing these sites for renewable energy development.[611] One of the resources they have developed and provided to the public is brownfield site maps in California.[612]

The Energy Commission is also exploring the feasibility of siting PV facilities on landfills. The Energy Commission awarded Project Navigator, LTD of Brea, California a $120,000 grant to study the effects of PV energy systems on landfill caps and to develop a guidance manual for landfill-based PV. The information will help develop more landfill-located PV solar projects in California. According to Project Navigator, there are thousands of acres of closed landfills in the state with potential for solar energy technologies.[613]

Retired agricultural land also has potential for renewable energy generation, although there are challenges associated with Williamson Act contracts. Currently, legislation is under consideration in California that would allow landowners with Williamson Act designation to enter into an agreement with the city or county to allow for a solar easement on their property.[614] Removal of this barrier could allow local jurisdictions to identify Williamson Act land in the jurisdiction's energy element to allow project developers to work with land owners that are willing to participate in this type of agreement.

There are also thousands of special districts in California that could potentially have unused or disturbed lands for ground mounted installations or roof-top surfaces for PV installations. Additionally, waste water and solid waste districts have potential for waste-to-fuel projects. Special Districts are already engaged in energy generation, including the Desert Healthcare District in Palm Springs which equipped 22 canopies over its new parking lot with 1,700 solar panels that are expected to generate in excess of 550,000 kilowatt hours of electricity annually.[615] Another example is the Los Angeles County Sanitary District which has almost 130 MW of generating capacity at its wastewater and solid waste facilities.

Identifying areas suitable for renewable development can also help with interconnection. Local governments do not have authority in the lengthy interconnection process, but can facilitate the process by identifying potential project sites near transmission and/or distribution

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610 Sampson, G., U.C. Santa Barbara, *Solar Power Installations on Closed Landfills: Technical and Regulatory Considerations.* September 2009, http://clu-in.org/download/studentpapers/Solar-Power-Installations-on-Closed-Landfills-Sampson.pdf, p. 1.

611 http://www.epa.gov/renewableenergyland/index.htm.

612 http://www.epa.gov/renewableenergyland/maps_data_ca.htm.

613 http://www.pvnavigator.com.

614 Proposed Senate Bill 618 (Wolk, 2011).

615 California Special Districts Association, Desert Healthcare District Goes Green with Energy Generating Parking Facility (http://www.csda.net/index.php?option=com_content&view=article&id=1290%3Adesert-healthcare-district-goes-green-with-energy-generating-parking-facility&catid=31%3Ain-the-news&Itemid=1).

infrastructure, which can reduce the interconnection costs for a project developer. There are many potential sites for energy generation within local jurisdictions, such as roadways, rooftops, brownfields, landfills, and disturbed lands. While local governments may not own such sites, they can make the process for siting renewable generation on the land easier through zoning ordinances and permitting. Local governments can coordinate with utilities that are demonstrating their commitment to this effort by posting online the capacity of their distribution systems at various locations, as discussed in Chapter 6.[616] Distribution system maps are valuable to project developers to identify potential locations for their projects, especially if they can overlay it with land use maps.

To address permitting challenges for renewable DG, there are a number of initiatives underway at the national, state, and local levels to streamline and standardize permitting processes. The U.S. Department of Energy (DOE) has been particularly engaged in this area, working with local jurisdictions to accelerate the adoption and deployment of solar technologies. In 2007, DOE selected 25 U.S. cities, six of which are in California, as "Solar America Cities" as part of the agency's Solar America Communities program.[617] This unique federal-local partnership initiative aims to identify barriers to greater adoption of solar technologies and develop solutions to those barriers. California's Solar America Cities are described below:

- San Diego is partnering with the California Center for Sustainable Energy and Envision Solar and is developing a "Sustainable Energy 2050 Plan," which will create an energy infrastructure capable of supporting the region on a sustainable path. Issues that will be addressed for a sustainable solar infrastructure include tariffs, data management, expedited permitting, strengthened private-sector involvement, training and technical expertise, and long-term implementation.[618]

- San Jose has set goals of 100 percent renewable energy by 2023 and reducing GHG emissions to 80 percent below 1990 levels by 2045.[619] The SunShares Program is part of this effort and is a solar group-buy model that companies and local governments can use to reduce the costs of installing solar on homes and businesses. Within a year of beginning educational workshops, San Jose city employees achieved the lowest dollar-per-watt cost in California to date and installed nearly 120 kW of new solar power throughout the Bay Area.[620]

- Sacramento's Solar America Cities effort is "Sacramento Solar Access," which "seeks to increase the adoption of solar energy by addressing current market barriers and preparing

616 http://www.sdge.com/builderservices/dgmap/.

617 http://solaramericacommunities.energy.gov/.

618 http://solaramericacommunities.energy.gov/solaramericacities/san_diego/.

619 http://solaramericacommunities.energy.gov/solaramericacities/san_jose/.

620 http://energy.sanjoseca.gov/solar/PDFs/SunSharesGuide.pdf.

infrastructure to optimize solar production in the future."[621] Part of the initiative is to develop design guidelines, best practices, and educational materials on solar integration and how solar can co-exist with urban tree canopies.

- San Francisco will pursue a three-point approach to remove market barriers to solar deployment that includes developing a program to group commercial and residential customers into one or more large, aggregated purchasing pools to be marketed to two different types of prospective solar installers; identifying sites for large installations and market to those building owners; and developing a plan to address problems installing solar on multi-tenant buildings.[622]
- Santa Rosa, in partnership with eight neighboring cities, Sonoma County, and interested stakeholders, in April 2010 developed a countywide Solar Implementation Plan to support the goals of Solar Sonoma County. These include adding 25 MW of new solar generation by March 2011 which will reduce the county's carbon emissions by 8,500 tons annually; replacing 250 MW of peak demand with a combination of solar generation and energy efficiency, and supporting countywide and state GHG reduction targets. Among other things, the plan provides strategies to reduce barriers to installation of solar thermal electric system.[623]
- Berkeley has created the SmartSolar Program to promote cost-effective investment in solar hot water and solar electric technologies in the residential and small-to-medium commercial/public building sectors. Under its Solar America Cities Special Project, the city will expand its community-based solar advising program to serve the cities of Berkeley, Oakland, Emeryville, Albany, El Cerrito, and Richmond and promote the annual installation of 800 kilowatts of PV at residential and commercial sites.[624]

Additionally, DOE has funded the Solar America Board for Codes and Standards (Solar ABCs) that dedicates experts to transform solar markets. As part of the overall strategy to reduce barriers to the adoption of solar technologies and to stimulate market growth, they work to improve building codes, utility interconnection procedures, and product standards, reliability, and safety.[625] Solar ABCs has recommended a national standard permit process for small scale (< 15 kW) PV systems that would expedite and simplify the permitting process.[626]

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621 http://solaramericacommunities.energy.gov/solaramericacities/sacramento/.

622 http://solaramericacommunities.energy.gov/solaramericacities/san_francisco/.

623 http://solaramericacommunities.energy.gov/solaramericacities/santa_rosa/.

624 http://solaramericacommunities.energy.gov/solaramericacities/berkeley/.

625 www.solarabcs.org.

626 *Solar America Board of Codes and Standards, Expedited Permit Process for PV Systems: A Standardized Process for the Review of Small-scale PV Systems*, October 2009, http://www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Expermitprocess.pdf .

In June 2011, DOE launched the $12.5 million "SunShot Initiative: Rooftop Solar Challenge" that aims to reduce the administrative costs for photovoltaic systems.[627] This is a national competition for local and regional teams of government, utilities, installers, and others to "compete for funds to implement their plan to reduce administrative barriers to residential and small commercial solar PV installations by streamlining, standardizing, and digitizing administrative processes."[628]

At the state level, the Energy Commission's *Energy Aware Planning Guide* provides information for local governments to use in encouraging DG in their jurisdictions and suggests a wide variety of implementation strategies to facilitate DG projects.[629] Some of these strategies include: providing a single point of contact at the permit/planning department for all DG permits; developing review timelines consistent with other types of city/county review; revising zoning ordinances to facilitate DG use; providing design standards for typical DG technologies to building permit seekers; expediting and standardizing approval procedures for DG permits of certain sizes; coordinating with home builders and developers for construction of zero energy homes; working with utilities to identify optimal locations for grid interconnection to reduce the need for transmission and distribution upgrades; and working with neighboring jurisdictions to standardize zoning and permitting requirements; and developing expedited review for PV systems.

Examples of local government efforts to promote renewable DG include:

- The City of Lancaster in Los Angeles County is home to a 5-MW solar thermal power plant built in 2009 by eSolar, which is backed by several venture firms including IdeaLab, Oak Investments, and Google. The project began transmitting power to Southern California Edison in August 2009 and took only 14 months to complete, with the developer crediting the tremendous cooperation it received from the city as instrumental in making that possible.[630] In addition, in 2009 the city partnered with KB Home and China-based battery-manufacturer BYD to build a prototype earth-friendly home that uses solar, battery, and LED lighting systems along with green building practices to produce more electricity than it consumes on an annual basis.[631] The city is also partnering with SolarCity to install 2.5 MW of new solar capacity at six city facilities that, when complete, will be one of the largest city-

627 http://www.eere.energy.gov/solarchallenge/.

628 http://www1.eere.energy.gov/solar/pdfs/rooftop_solar_challenge.pdf.

629 California Energy Commission, *Energy Aware Planning Guide*, February 2011, http://www.energy.ca.gov/2009publications/CEC-600-2009-013/CEC-600-2009-013.PDF, Section C.2.2.

630 City of Lancaster, Outlook Newsletter and Activity Guide, September 2009, http://www.cityoflancasterca.org/.

631 http://www.renewableenergyworld.com/rea/news/article/2011/06/lancaster-ca-determined-to-become-alternative-energy-capital-of-the-world.

initiated solar projects in California, providing the city with more than $7 million in energy cost savings over the next 15 years.[632]

- San Diego County's regional planning body, SANDAG, is taking an increasing role in assisting cities within the county to plan for integrating renewable DG.[633]
- The Marin Clean Energy community choice aggregation program offers a net metering program in which customers are paid for generating their own energy from rooftop solar and other sources.[634]
- Many cities and counties have implemented property assessed clean energy (PACE) programs to allow property owners to finance renewable energy projects on their homes or businesses and pay project cost back as a line item on their property tax bill over 20 years. This innovative financing mechanism was first piloted by the City of Berkeley in 2008-2009. As discussed in Chapter 7, PACE residential programs are suspended pending further direction from the Federal Housing Financing Agency regarding the eligibility of homes with federal mortgage loans, but there are active commercial PACE programs in a number of California cities. Under Energy Upgrade California, the City of Los Angeles Large Commercial Buildings Municipal Financing Program is a commercial-only owner-arranged PACE financing program in collaboration with the Los Angeles Department of Water and Power. This program will also partner with the Clinton Climate Initiative to encourage the adoption of this type of PACE model starting with Placer County and the City and County of San Francisco.
- There are several local entities receiving funding from the Public Interest Energy Research (PIER) Program's Renewable Energy Secure Communities (RESCO) Program, including Sonoma County Water Agency, Alameda County, Redwood Coast Energy Authority, and El Dorado Irrigation District. These and other RESCO projects are described in more detail in Chapter 9.

Cross-Cutting Issue 3: Workforce Development

Development of both utility- and distribution scale renewable facilities to meet California's renewable energy targets will create thousands of jobs in California. Many of the jobs created by the clean energy boom will require specialized training, but others can take advantage of skills transferrable from other sectors. For example, steel mills and appliance manufacturers can shift to building wind turbine components, as is being done in Pennsylvania and Iowa.[635] In California, where the construction industry has been hit particularly hard by the recession, building trades workers can build renewable power plants and install rooftop solar PV.

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632 http://www.solarcity.com/pressreleases/61/City-of-Lancaster-and-SolarCity-Announce-One-of-the-Largest-City-Initiated-Solar-Projects-in-California.aspx.

633 http://www.sandag.org/index.asp?projectid=332&fuseaction=projects.detail.

634 http://www.ca-ilg.org/node/2726.

635 Repower America, http://www.repoweramerica.org/solutions/roadmap/renewable-energy/

California far outpaces the rest of the country in the attraction of clean technology venture capital, fueling job creation in renewable energy. As noted in Chapter 7, in 2011 venture capital investment in clean tech companies in the United States increased 54 percent to $1.14 billion in the first quarter of 2011 over the same period last year, with California accounting for 56 percent of total venture capital investments.[636]

Unlike some recent innovation-led economic surges, the green economy is distributed throughout the state, though technologies and types of investment vary widely. In San Diego and Imperial counties, for example, new applied research is transforming the region to the premier hub for biofuel development. In the Mojave Desert, construction is beginning on utility-scale solar projects, and the proliferation of distributed generation and rooftop solar is driving demand not only for installers, but for sales and marketing professionals.

The Next 10 second edition of "Many Shades of Green" published in 2011 tracks employment and business growth related to California's green economy.[637] Top findings in the report include:

- While total state employment grew by 18 percent since 1995, employment in the green economy has expanded 56 percent during the same period. From January 2008 to 2009, green employment increased three percent while growth in total employment was less than one percent.
- Employment growth has been particularly noticeable in energy generation, energy storage, and clean transportation.
- There are strong employment shares in manufacturing, which represents 26 percent of all green employment but only 11 percent of California's total employment.

These findings are supported by a recent national and regional green jobs assessment by the Brookings Institution which concluded that:[638]

- The clean economy employs more workers than the fossil fuel industry, with most jobs in mature segments such as manufacturing and the provision of public services such as wastewater and mass transit and a smaller portion in newer segments including the solar PV, wind, fuel cell, smart grid, biofuel, and battery industries. California has 318,156 clean jobs, the highest in the nation and well over 100,000 more than the next largest state, New York. The Sacramento-Arden-Arcade-Roseville metro area is third is the top ten of the 100 largest metropolitan areas in the country with the highest share of clean economy jobs; the clean economy in this area grew 59 percent from 2003-2010.

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636 http://www.ey.com/US/en/Newsroom/News-releases/US-VC-investment-in-cleantech.

637 Next 10, Many Shades of Green, 2011, http://www.next10.org/next10/publications/pdf/2011_Many_Shades_of_Green_FINAL.pdf.

638 Muro, Mark, Jonathan Rothwell, Devashree Saha, The Brookings Institution Metropolitan Policy Program, Sizing the Clean Economy: A national and Regional Green Jobs Assessment, July 2011, http://www.brookings.edu/~/media/Files/Programs/Metro/clean_economy/0713_clean_economy.pdf.

- The clean economy grew more slowly than the national economy between 2003 and 2010 but newer clean tech segments such as wind, solar PV, and smart grid produced explosive job gains and the clean economy outperformed the nation during the recession.
- The clean economy is manufacturing and export intensive, with roughly 26 percent of all clean economy jobs in manufacturing compared to 9 percent in the broader economy. On a per job basis, establishments in the clean economy export twice the value of a typical U.S. job ($20,000 versus $10,000).
- The clean economy offers more opportunities and better pay for low- and middle-income workers than the national economy as a whole.
- The Sacramento region's efforts to become a hub for clean energy technology through the Green Capital Alliance, the Sacramento Regional Technology Alliance, and the University of California at Davis are an example of using regional networking to advance the clean economy.

Challenges for Workforce Development

While much of this economic growth is creating demand for workers in existing occupations, it is also driving the need for workers who need to enhance their skills and for those to be trained for emerging jobs in the renewable sector such as PV/ solar thermal installers and solar and wind operations and maintenance technicians. The need for a coordinated approach to workforce training that is closely aligned with labor demand will grow as investment in the clean energy economy continues to expand. Successful strategies will create better linkages between training providers and businesses in young but expanding fields as well as increasing training and education opportunities from high school to the post-graduate level.

There are various challenges facing clean energy workforce development in California. First, the current recession has caused difficulty in creating a steady bridge between workforce training programs and actual employment on the other end. Employers are currently hesitant to take on more employees in the fragile economy which has resulted in low placement rates for some of the programs. This issue can be addressed by solidifying the hiring bridge with short-term on-the-job training (OJT) with employers throughout the state. Providing funding for the first three to six months of employment, while the employee has an opportunity to apply classroom learning and gain practical experience can drastically improve the hiring and placement of trainees. Many employers are open to OJT and are willing to make the commitment of continued employment after the OJT ends.

The goal of installing 12,000 MW of new DG in California offers an opportunity to align job training that has occurred in some low-income communities with labor demand. Some workers who have received training funded by the American Recovery and Reinvestment Act (ARRA) in clean energy fields have reported difficulty finding employment. Rooftop solar and other renewable energy investments are not accessible to most low-income people, leaving communities with a mismatch of trained workers but little demand. A challenge in the deployment of DG is to channel investment into disadvantaged communities so that they may enjoy both the environmental and job creation benefits. This will require strategies to incentivize installation of small scale renewables in renter and owner occupied residential buildings as well as commercial buildings, parking lots and ground mounted locations.

Another challenge to California's current workforce development efforts is the upcoming expiration of ARRA funding. Currently a large portion of the available government funding for workforce development is tied to ARRA with expiration dates ranging from 2011 to 2013.[639] As a result, community colleges, trade associations and other training providers may have difficulty continuing their clean energy training curricula into the future. Continued funding (either from federal, state or private sources) will be needed to sustain the current level of training.

One last challenge for programs, particularly in the area of finding jobs, has been the delay and ultimate elimination of programs such as HomeStar and PACE. Both of these programs presented opportunities for graduates to find employment with the increased demand for residential retrofits. However, with the elimination of such programs, and due to the costs for rooftop solar and small-scale renewables still being prohibitive for many consumers, trainees are finding jobs hard to come by.

Efforts to Address Workforce Development Challenges

In 2010, the Center for Energy Efficiency and Renewable Technologies (CEERT) surveyed 14 clean energy developers in Southern California to better understand their workforce needs. The survey provided a sample of the type and number of jobs being created by the development of large-scale renewable energy facilities in the area. Jobs created included welders, pipefitters, millwrights, laborers, ironworkers, engineers, electricians, cement masons, carpenters, sheet metal workers, and operating engineers. The survey indicated that thousands of workers will be needed between 2010-2015 to build the power plants being proposed in Southern California, with hundreds of operations and maintenance jobs needed for the next 20-30 years.

On the distribution side, CEERT estimates that construction jobs to build 2,000 PV projects totaling 6,000 MW over a 10-year period would create a monthly average of 10,400 jobs in trades similar to those identified for utility-scale renewables.[640] The "National Solar Jobs Census 2010" by the Solar Foundation notes that nationally, solar companies expect to add jobs at a much faster pace than the general economy.[641] This trend is important for California since more than 30 percent of the estimated solar jobs in the U.S. in 2010 were in the state.[642] A 2010 labor market

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639 For more information about ARRA funded workforce development programs, please see California Energy Commission, 2010 Integrated Energy Policy Report Update, January 2011, http://www.energy.ca.gov/2010publications/CEC-100-2010-001/CEC-100-2010-001-CMF.PDF.

640 Center for Energy Efficiency and Renewable Technologies, presentation to Inter-Solar North America, July 12, 2011, http://www.ceert.org/PDFs/reports/110712_DG-Jobs_CEERT_InterSolar-NA.pdf.

641 The Solar Foundation, *National Solar Jobs Census 2010*, October 2010, http://www.thesolarfoundation.org/sites/thesolarfoundation.org/files/Final%20TSF%20National%20Solar%20Jobs%20Census%202010%20Web%20Version.pdf.

642 SolarTech, *California Green Innovations Challenge: Renewable Energy Labor Market Study*, Report 1, 2010, http://www.solartech.org/index.php?option=com_st_document&view=general&Itemid=58.

analysis by SolarTech noted that in 2010, California was home to 1,072 solar firms with an estimated 36,000 employees. Because there are a large number of workforce programs already servicing the solar PV installer occupation, the SolarTech study suggests there is a need to focus on training qualified solar PV system sales and system design engineers. SolarTech estimated that there will be 650-1,300 new PV sales jobs in California in 2011.

California is already at the forefront of workforce training efforts for the green economy. Using federal stimulus funding, the Energy Commission worked with the California Employment Development Department (EDD) and the California Workforce Investment Board to establish the Clean Energy Workforce Training Program, the largest state-sponsored green jobs training program in the nation. Among other things, this program is training workers needed to operate large-scale renewable power plants and install PV systems. Besides providing training, the program is also funding grants that will establish community college and other training programs as part of established curricula, which will provide the basis for long-lasting and sustainable changes in clean energy workforce training in California. Training will also provide a foundation for career pathways into higher-skilled specializations within the energy industry, building strong career ladders for workers over time.

Several community colleges in the Clean Energy Workforce Training Program have worked to make their programs sustainable by applying for accreditation for the coursework. For example, Imperial Valley College now has a certificate program in Energy Efficiency Technology. Other grantees have taken additional steps toward making their programs sustainable by training the staff in green and clean energy occupations or partnering with relevant organizations so they can better facilitate occupational goals for trainees. Grossmont-Cuyamaca College, for example, has partnered with the California Center for Sustainable Energy on the delivery of its training program and coordination with Energy Upgrade California.

Other grantees, such as the RichmondBUILD program, have found innovative ways to help trainees find employment. The city of Richmond has a local employment ordinance that requires employers to hire a certain percentage of city residents. In addition, the city adopted commercial and residential green building standards in 2010, so the market for the trainees' skills is already in existence.[643]

One portion of the Clean Energy Workforce Training Program is the approximately $24 million in ARRA State Energy Program and Workforce Investment Act funding that was awarded in October 2009 to 28 grantees as part of an interagency agreement with the EDD. As of December 31, 2010, 55 percent of the funds awarded have been expended and 70 percent of the total planned participants have been enrolled in the program. A total of 78 percent were enrolled in training, 15 percent have exited the program and 40 percent were placed in unsubsidized employment. The projects have cultivated effective partnerships with education and industry and have issued over 2,400 certificates that can be used for various green occupations.[644] The

643 http://www.ci.richmond.ca.us/index.aspx?NID=1816.

644 Employment Development Department, *Clean Energy Workforce Training Program 2010 Annual Report*.

bulk of these certificates relate to energy efficiency occupations, but about 10 percent are for skills related to renewable electricity generation including energy fundamentals, general construction, solar electric installation and design principles, certified solar PV installer, and wind turbine technician. At the end of the program, the grantees are expected to train approximately 5,000 trainees.

Demand created by the Energy Upgrade California program has helped to address workforce challenges associated with the delay and ultimate elimination of programs such as HomeStar and PACE, although the demand has come later than expected for many trainees. Regardless, many of the CEWTP programs are working closely with Energy Upgrade to ensure a smooth transition into jobs for their graduates. To spur investment and job growth in the clean energy economy, financing and incentive programs have assisted clean technology companies with financing. In October 2011, the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) started granting sales and use tax exemptions on manufacturing equipment purchased for clean energy manufacturing facilities and renewable energy generators. The exemption was authorized under Senate Bill 71, and as of July 2011, 30 companies had received sales and use tax exemptions for a total of $89 million in exemptions on $963 million in qualified purchases. The total number of a jobs associated with the sales tax exemption program is estimated to be 6,386. The exemption is available to a wide range of qualified purchases for manufacturing equipment in the clean energy economy. About a third of the exemptions have been issued to PV manufacturers who have applied, but power plant operators who have decided to repower from fossil fuel to renewables have also taken advantage of the program. For example, a sales and use tax exemption was granted for $10 million in equipment purchases that will be used to convert a coal cogeneration plant at the Port of Stockton to a biomass facility, a project that will create 54 construction jobs and eight permanent jobs.

Additionally, the Energy Commission is using $24 million in ARRA funds for a low-interest revolving loan fund for clean energy manufacturing businesses in California. The Clean Energy Business Finance Program has six loans ranging from $2.7 million to $5 million with companies focused on the production of PV solar panels. Together these companies are creating 640 jobs throughout the state.[645]

The Clean Energy Workforce Training Program also has an interagency agreement with the Employment Training Panel which provided $4.5 million in ARRA/State Energy Program funds to 14 grantees to perform career advancement training. These grantees train incumbent workers in clean energy skills while also meeting a 90 day employment retention period after the training is completed. The program is set to train nearly 3,000 incumbent workers.

For example, the Kern Community College District has developed curricula for its PowerTech, SolarTech, and WindTech programs, which are targeted to entry level positions with utility

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645 For a description of the Clean Energy Business Finance Program, please see California Energy Commission, *2010 Integrated Energy Policy Report Update*, January 2011, http://www.energy.ca.gov/2010publications/CEC-100-2010-001/CEC-100-2010-001-CMF.PDF.

companies, utility contractors, utility-scale solar thermal and PV companies, residential and commercial solar installation, and utility-scale wind and wind turbine companies. The district also has a pre-apprenticeship program to introduce women to the green jobs industry and provide a variety of apprenticeship trade opportunities like electrician, solar and wind technician, plumber and pipefitter, and sheet metal worker.

Another example is the College of the Desert, which is working closely with solar developers like First Solar, Solar Millennium, Solar Reserve, and NextEra. First Solar has donated and installed two 40-foot arrays of thin film modules and rack-mounting equipment to train workers on a system that will be used in a 550 MW project planned for Desert Center. In addition, Gossamer Space Frames, an engineering design firm, arranged for the donation of eight 8-meter parabolic trough frames, mirrors, and tracking drive unit for training. Solar Millennium, Solar Reserve, First Solar, Schott Solar and a host of other industry and labor partners have also provided support in the curriculum development and training.

As part of the Clean Energy Workforce Training Program, the Energy Commission partnered with the Employment Training Panel to fund workforce training to advance green job skills in efficiency and renewable energy. This efforts targets placement for unemployed workers and upgrading the skills of incumbent workers in jobs that reduce energy or water use in the building trades (e.g., retrofitting, green plumbing, efficient lighting manufacturing) or that produce or transmit renewable energy (e.g., solar panel manufacturing, smart grid installation).

Complementing the Clean Energy Workforce Training Program is a workforce training grant program administered by the Labor and Workforce Development Agency and the EDD to provide training for up to 3,000 workers in the clean energy economy. The $19 million Green Innovation Challenge Grant program is helping community college students in the Bay Area learn the skills to perform after-market repairs and maintenance to electric and alternative fuel vehicles; helping the San Diego region to develop college-level curriculum and certificates for workers in the biofuel industry; and helping to train PV solar installers, system designers, and marketing professionals.

Vital to the success of the future clean energy workforce is career technical education at the high school level. Past efforts in this area include investment by the PIER Program of $12 million in the California Partnership Academies' Green/Clean Initiative to build clean energy career pathways for students in grades 10-12.[646] This effort funded approximately 60 programs through the Department of Education that integrated academic and career technical education, business partnerships, mentoring, and internships with a focus on green careers such as green buildings, sustainable design, and green engineering.

To further expand the pipeline of students who want to pursue careers in renewable energy and other green industry sectors, SBX1 1 will provide $8 million in funding annually to the Superintendent of Public Instruction (SPI) to implement and administer a grant program to fund clean energy partnership academies in public schools for grades 9-12. The partnership

646 Funding for this effort was appropriated by Assembly Bill 519 (Budget Committee, Chapter 757, Statutes of 2008).

academies, which serve primarily at-risk students, will focus on preparing students for careers in energy and water conservation, renewable energy, pollution reduction, and similar technologies. The Energy Commission is developing guidelines through a public process to ensure academy programs receiving grant funding from the SPI align themselves with current energy policies and priorities and provide skills and education linked to the current needs of the clean energy industries. Energy Commission staff held a workshop on July 29, 2011 to seek input on the guidelines and will have a follow-up workshop on September 9. Guidelines are tentatively expected to be adopted by the end of 2011.

Other PIER efforts include providing cost-share funding to a number of smart grid research projects that will create new jobs in the application of computers and computer-controlled equipment and the increased use of communications systems. With the increased integration of renewable resources into the grid, workers will be needed to support industries that sell and install small-scale renewable energy systems and to operate and maintain utility-scale generators. Other jobs will include energy engineers, who design the systems and write the specifications, as well as the technicians who install, program, and service the equipment. The PIER program also provided cost-share funding that helped leverage ARRA funding for the California State University, Sacramento to develop a clean energy workforce curriculum for the electric power sector, specifically targeted toward training needed for jobs being created in smart grid applications.

In addition, PIER sponsored research on the need for a National Center for the Clean Energy Workforce (NCCEW) to provide a clearinghouse for information on best practices and technical assistance to translate this information into practical changes in workforce development strategies. The research has led to the development of an unsolicited proposal for a national center, initially with a regional hub in California and one on the East Coast, to provide strategic support to businesses, educators, workforce agencies and related stakeholders to strengthen the capacity of states to build a clean energy economy. The objective is to attract federal and cost-share funding to launch the NCCEW activities by the start of the 2012-13 fiscal year. The center will play a leadership role in catalyzing the development of skill standards and certification processes that meet the workforce needs on the one hand and the needs of industry and economic development on the other. It will also serve a clearing house function by serving as a repository for information on model practices as well as ensuring that the information will be effectively communicated to key targeted audiences. The focus will be on building communication between the workforce development and clean energy communities and to assist them in their collective work on building the clean energy economy.

At a March 14, 2011 IEPR workshop on the NCCEW, stakeholders noted the value of a national center in providing a central clearinghouse for information about the types of training and curricula available to workforce development agencies as well as certification standards for a variety of green jobs.[647] A central source of information reduces costs associated with workforce

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647 *Transcript of the March 14, 2011 IEPR Workshop on the National Center for the Clean Energy Workforce,* comments by Benjamin Goldstein, http://www.energy.ca.gov/2011_energypolicy/documents/2011-03-14_workshop/2011-03-14_transcript.pdf, page 38

research, which can be very expensive, by having a single clearinghouse where people can take advantage of job surveys and other research done by other organizations.[648] In addition, a national center can help align and integrate government goals for energy efficiency and renewables with industry job needs and standards.[649]

Cross-Cutting Issue 4: Public Sector Leadership

California has the potential to develop renewable energy systems on state owned buildings, properties, and rights-of-way to help meet the state's renewable energy goals, create green jobs, and reduce GHG emissions and other harmful air pollutants. Developing renewable generation on state properties can reduce energy costs in state buildings and create new revenue for state government through the lease of vacant or unused land. State leadership will also demonstrate the benefits of renewable DG and help encourage larger-scale deployment throughout the state and across the country.

In December 2010, the Energy Commission adopted a memorandum of understanding (MOU) with the Departments of General Services, Corrections and Rehabilitation, Transportation (Caltrans), Water Resources, and Fish and Game to facilitate the development of renewable energy projects on state buildings, properties, and rights-of-way. The California State Lands Commission and the University of California (UC) have since signed on to this effort, and the MOU includes an option for additional agencies to join in the future. The MOU commits agencies to collaboratively study, plan, and develop energy generating infrastructure, coordinate consistent procurement strategies and contract language in requests for proposals, and develop one or more statewide solicitations to make state properties available to interested developers in the future.

As the first step to jump start implementation of the MOU, the Energy Commission staff released a report in April 2011 that discussed current development of renewable energy on state properties, barriers and solutions to future deployment, opportunities for further development, and recommended next steps, as summarized below.[650]

Inventory of Opportunities

Beginning in October 2010, Energy Commission staff began to identify and inventory state properties to understand potential opportunities for rapid deployment of renewable DG systems. The focus was on clusters of state buildings within seven load centers near existing distribution lines, but buildings not in load centers with high onsite load, such as correctional

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648 *Transcript of the March 14, 2011 IEPR Workshop on the National Center for the Clean Energy Workforce*, comments by Phil Jordan, http://www.energy.ca.gov/2011_energypolicy/documents/2011-03-14_workshop/2011-03-14_transcript.pdf, page 38

649 *Transcript of the March 14, 2011 IEPR Workshop on the National Center for the Clean Energy Workforce*, comments by Tim Rainey, http://www.energy.ca.gov/2011_energypolicy/documents/2011-03-14_workshop/2011-03-14_transcript.pdf, page 38

650 California Energy Commission, *Developing Renewable Generation on State Property*, staff report, April 2011, http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf.

facilities, state hospitals, and developmental centers, were also examined. Staff also collected annual and monthly metered load and utility billing data on many of these buildings and estimated the square feet of available roof and parking lot space.

Based on its inventory, the staff recommended a target of 2,500 MW of new renewable generating capacity by 2020 (Table 26).

Table 26: Target for Renewable Development Allocated by Type of State Property

State Property Category	Potential Renewable Generation Capacity (MW)*
State Buildings in Load Centers	14 – 26
State Property With Potential for Wholesale Generation	54.5 – 195
Land Lease for Wholesale Generation	14,460 – 26,030
Total State Properties Renewables Target	**2,500**

* The megawatt ranges reflect staff's assumption that 1 megawatt of PV can be developed on 5 to 9 acres.

Source: California Energy Commission

Staff also developed interim targets that will be useful in monitoring progress toward the 2,500 MW goal. Although there are near-term opportunities to develop renewables on state buildings, the majority of the target will likely be met with projects developed on land leased for wholesale generation, including large-scale projects that take longer to deploy. Given deployment expectations, staff proposed the following interim targets: one-third by 2015 (833 MW); one-third by 2018 (1,666 MW, cumulative); and one-third by 2020 (2,500 MW, cumulative).

Current Efforts to Increase Renewables on State Properties

Many state agencies are already advancing deployment of renewable DG on state properties through a variety of efforts that will contribute toward these targets:[651]

- The Department of General Services has released two solicitations to develop PV generation on several state buildings using third-party financing and power purchase agreements, and is working on releasing a third solicitation in 2011. The first solicitation resulted in eight installed projects totaling 4.25 MW of capacity located at California State University (CSU) campuses, state prisons, mental hospitals, and a Caltrans facility. The second solicitation awarded power purchase agreements for 8 MW of PV capacity at 16 CSU campuses and 8 MW at nine state agency projects.

- Caltrans is installing solar facilities at Maintenance and Safety Roadside Rest Area buildings and is evaluating DG development along state highways consistent with Governor Brown's support of the California Solar Highway, including discussions with Republic Cloverleaf Solar regarding a potential long-term lease to develop a 15 MW PV system on seven

651 For more detailed descriptions of agency efforts, please see California Energy Commission, *Developing Renewable Generation on State Property*, staff report, April 2011, http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf.

intersections along Highway 101 in Santa Clara County. Caltrans also received federal approval to install PV panels at 70 Caltrans facilities totaling more than 2 MW.

- The Sacramento Municipal Utility District is partnering with Caltrans on the Sacramento Solar Highway pilot program, with proposed locations for solar development along U.S. highway 50 in the Sacramento and Rancho Cordova areas. This project is receiving cost-share funding from the Energy Commission's PIER Program.
- The Department of Water Resources is exploring ways to develop solar on its own property and has partnered with the UC to explore the feasibility of installing solar along or over the California Aqueduct and identifying areas suitable for a demonstration project. If successful, this could be applied to other feasible sites along the entire State Water Project. DWR is also working with UC on development of a 10-20 MW solar project on property owned by DWR next to an existing pumping plant in Southern California, and is exploring the feasibility of adding new small hydropower generation to the existing State Water Project and developing wind generation on Sherman Island in the Delta.
- California's fairgrounds have installed solar PV at 26 of the 74 state fairgrounds ranging in size from 41 kW to 1 MW, with a total installed capacity of 6.5 MW.
- The California Department of Forestry and Fire Protection examining the potential for using forest wood waste to provide local electricity generation for their facilities located in remote areas.
- The California Department of Corrections and Rehabilitation currently has two operational 1 MW PV solar arrays, a fixed-mount system on nine acres of land at Chuckwalla Valley State Prison and a single-axis tracking array occupying 10 acres at Ironwood State Prison, which have saved $150,000-$300,000 annually in energy costs. There are contracts for expansions of both systems that will total nearly 9 MW and offset nearly all the power required by both facilities. In addition, the department has signed agreements for three systems at the North Kern State Prison, the California Correctional Institution, and the Los Angeles County Prison that will add 13 MW. The department has also identified 14 additional locations suitable for PV systems.
- The California State Lands Commission is focusing on utility-scale renewable development on school lands set aside under the School Land Bank Act, and has leased thousands of acres for geothermal projects on school lands. In addition, the commission is processing new applications for solar, geothermal, and wind energy projects.
- The UC currently has 6.3 MW of PV installed or under construction, and by fall of 2011 expects to have an additional 6.2 MW of renewable generation from biogas. UC has also invested in cogeneration and thermal energy storage, with six cogeneration plants with a combined capacity of 130 MWs and seven UC sites with 26 million gallons of thermal energy storage. UC is also partnering with the Department of Water Resources to explore development of a 20 MW PV array at the Pearblossom pumping station, and is exploring opportunities to substitute biogas for natural gas. The Energy Commission's PIER program

has provided funding to UC to study the integration of onsite renewable generation, energy storage, and smart grid technologies.

Challenges to Development Renewables on State Properties

Barriers to the development of renewables on state properties are generally the same as those identified throughout this report and fall into four broad categories: economics, integration, interconnection, and permitting. Economic barriers include high upfront costs and the transaction costs associated with installation of small-scale DG. Costs can be reduced through technology advancements, such as those pursued through research by the PIER Program, and through incentives aimed at lowering cost, increasing demand, and improving economies of scale. Cost reduction strategies include the use of net energy metering, state and federal incentives and tax credits, feed-in tariffs, and streamlined contracting mechanisms such as the CPUC's Renewable Auction Mechanism.[652] Renewable Energy Credits can also offset capital costs.

Integration and interconnection challenges for renewables on state properties are the same as those discussed in Chapters 5 and 6. Technologies like smart grid, microgrids, energy storage, and demand response as well as improved forecasting of renewable resources will help integrate these resources into the grid and reduce the need for backup generation to support intermittent resources like solar and wind. Similarly, installing renewables on state buildings will require interconnection studies to assure that they will not adversely affect the operation and safety of distribution or transmission systems. For small-scale systems, efforts to streamline and reform distribution system interconnection processes underway through the CPUC's Rule 21 process will facilitate interconnection of renewables on state properties.

Many of the renewable systems expected to be installed on state properties to meet the 2,500 MW target will be small-scale DG and therefore will not involve many of the environmental permitting challenges associated with developing large-scale facilities that were discussed in Chapter 3. However, permitting of renewable projects on state properties is still subject to compliance with CEQA, although categorical exemptions may be appropriate for renewable projects located on state buildings. A negative declaration or mitigated negative declaration may also be appropriate for projects located on a state building, but an environmental impact report could also be required, depending on the nature and severity of potential impacts.

State agencies regulate the private use of state land and resources through permitting authority established by statute. Multiple agencies can be involved in the approval of renewable projects and in many cases individual agencies develop additional administrative rules and permitting requirements. Small-scale PV projects located on state-owned buildings would be permitted through the Department of General Services or those agencies with separate permitting authority that evaluate potential environmental issues, approve project plans, and perform inspections during and after project construction. Larger renewable projects located on state-owned rights-of-way, aqueducts, or lands would be subject to review and approval, including

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652 CPUC, *Decision Adopting the Renewable Auction Mechanism*, Decision 10-12-048, Rulemaking 08-08-009, December 16, 2010, http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/128432.pdf

CEQA evaluation, by the state agency with appropriate jurisdiction. Larger projects may also involve upgrades to the distribution or transmission system and will require evaluation by utilities or the California ISO, as well as greater coordination with local governments and affected stakeholders. These larger projects may not be developed as quickly as those on state buildings because they will require more in-depth environmental evaluation and have the potential for greater environmental impacts.

While local governments do not have permitting authority over renewable energy projects on government-owned (state, federal) buildings, rights-of-way, or properties, state agencies are often required to ensure that projects are consistent with local laws, ordinances, regulations, and standards. In addition, facilities related to the project, but not located on state property, may require review and approval from the local jurisdiction (for example, a city or county planning agency). Further, local governments, the public, and other stakeholders will be encouraged to participate in the licensing and review of projects proposed on state property.

List of Acronyms

AB	–	Assembly Bill
AC	–	Alternating current
ACE	–	Area control error
AFC	–	Application for Certification
AGC	–	Automatic generation control
AIM	–	Alternative Investment Management
AMI	–	Automated Meter Infrastructure
ARB	–	California Air Resources Board
ARPA-E	–	Advanced Research Projects Agency-Energy
ARRA	–	American Recovery and Reinvestment Act of 2009
BAA	–	Balancing authority area
BESS	–	Battery Energy Storage Systems
BLM	–	Bureau of Land Management
BPA	–	Bonneville Power Authority
CAEAFTA	–	California Alternative Energy and Advanced Transportation Financing Authority
CAES	–	Compressed air energy storage
California ISO	–	California Independent System Operator
CalPERS	–	California Public Employees Retirement System
CCPDA	–	California County Planning Directors Association
CEERT		Center for Energy Efficiency and Renewable Technologies
CEQA	–	California Environmental Quality Act
CERTS		Consortium for Electric Reliability Technology Solutions
CHP		Combined heat and power
CPUC	–	California Public Utilities Commission
CREB	–	Clean and Renewable Energy Bond
CREST	–	Cost of Renewable Energy Spreadsheet Tool
CREZ	–	Competitive Renewable Energy Zone
CSD		California Department of Community Services and Development
CSGI	–	Customer Self-Supply of Generation Imbalance
CSI	–	California Solar Initiative
CSP		Concentrating solar power
CSU		California State University
CTPG	–	California Transmission Planning Group
DC		Direct current
DFG	–	California Department of Fish and Game
DG	–	Distributed generation
DOE	–	U.S. Department of Energy
DR	–	Demand response

DRECP	–	Desert Renewable Energy Conservation Plan
DRRC		Demand Response Research Center
DTCR		Dynamic thermal circuit rating
EDD		Employment Development Department
EIR	–	Environmental Impact Report
EJ		Environmental justice
EPBB	–	Expected Performance Based Buydown
EPRI	–	Electric Power Research Institute
ERP	–	Emerging Renewables Program
FCC		Fault current controller
FERC	–	Federal Energy Regulatory Commission
FHFA	–	Federal Housing Finance Agency
FIT	–	Feed-in tariff
FWS	–	U.S. Fish and Wildlife Service
GHG	–	Greenhouse gas
GIP	–	Generator Interconnection Procedures
GRC	–	General Rate Case
GWh	–	Gigawatt hour
HAN		Home area networks
HCP	–	Habitat Conservation Plan
HTLS	–	High-temperature low-sag
HVDC		High-voltage direct current
iHub	–	Innovation Hub
IID	–	Imperial Irrigation District
IOU	–	Investor-owned utility
IRR		Integrating Renewable Resources Pilot Project
ITC	–	Investment Tax Credit
kW	–	Kilowatt
kWh	–	Kilowatt hour
LADWP	–	Los Angeles Department of Water and Power
LBNL	–	Lawrence Berkeley National Laboratory
LCOE	–	Levelized cost of energy
LGIP	–	Large Generator Interconnection Process
LGP	–	Loan guarantee program
LIHEAP		Low Income Home Energy Assistance Program
LORS	–	Laws, Ordinances, Regulations, and Standards
LSE	–	Load serving entity
LTPP	–	Long-term Procurement Plan
LVRT	–	Low-voltage ride through
MASH	–	Multi-family Affordable Solar Housing Program
MIC	–	Maximum import capability
MOU	–	Memorandum of Understanding

MPR	–	Market Price Referent
MW	–	Megawatt
MWh	–	Megawatt hour
NCCEW		National Center for the Clean Energy Workforce
NCCP	–	Natural Community Conservation Plan
NEM	–	Net Energy Metering
NEPA	–	National Environmental Protection Act
NERC		North American Electric Reliability Corporation
NIST	–	National Institute of Standards and Technology
NPDES	–	National Pollutant Discharge Elimination System
NREL	–	National Renewable Energy Laboratory
NSHP	–	New Solar Homes Partnership
OII	–	Order Instituting Informational Proceeding
OIR	–	Order Instituting Rulemaking Proceeding
OpenADR		Open Automated Demand Response
OTC	–	Once-through cooling
PACE	–	Property Assessed Clean Energy Program
PBI	–	Performance Based Incentive
PEIS	–	Programmatic Environmental Impact Statement
PG&E	–	Pacific Gas and Electric
PIER	–	Public Interest Energy Research
PIRP	–	Participating Intermittent Resource Program
PPA	–	Power purchase agreement
PTC	–	Production Tax Credit
PURPA	–	Public Utility Regulatory Policies Act
PV	–	Photovoltaic
QECB	–	Qualified Energy Conservation bonds
R&D	–	Research and development
RA	–	Resource adequacy
RAM	–	Renewable Auction Mechanism
REAP	–	Rural Energy for America Program
REAT	–	Renewable Energy Action Team
Re-DEC	–	Renewable Distributed Energy Collaborative
REDS		Residential Energy Display Survey
REFTI	–	Renewable Energy Finance Tracking Initiative
REPI	–	Renewable energy production incentive
RESCO		Renewable Energy Secure Communities
RETI	–	Renewable Energy Transmission Initiative
RFO	–	Request for Offers
RPS	–	Renewable Portfolio Standard
RSC	–	Renewable Standard Contract
RTDMS	–	Real Time Dynamic Measurement System

RTEP	–	Regional Transmission Expansion Planning Project
RUS	–	Rural Utilities Service Program
SA	–	Staff assessment
SANDAG		San Diego Association of Governments
SARTA	–	Sacramento Regional Technology Alliance
SASH	–	Single-family Affordable Solar Homes Program
SB	–	Senate Bill
SCADA	–	Supervisory control and data acquisition
SCE	–	Southern California Edison
SDG&E	–	San Diego Gas and Electric
SELP	–	Small-Scale Energy Loan Program
SEZ	–	Solar Energy Zone
SGIP	–	Small Generator Interconnection Procedure
SGIP	–	Self Generation Incentive Program
SMUD	–	Sacramento Municipal Utility District
STIP	–	Strategic Transmission Investment Plan
SWRCB	–	State Water Resources Control Board
TELP	–	Tax Exempt Lease Program
TPP	–	Transmission planning process
TRECs	–	Tradable renewable energy certificates
TWh	–	Terawatt hour
UC		University of California
USEPA	–	U.S. Environmental Protection Agency
USFS	–	U.S. Forest Service
VAR	–	Volt-ampere reactive
VC	–	Venture capital
WAPA	–	Western Area Power Administration
WDAT	–	Wholesale Distribution Access Tariff
WECC		Western Electricity Coordinating Council

Appendix A: Renewable Generating Capacity in California

The following tables provide totals for different resource types by California county for utility-scale, wholesale distributed generation, and customer-side renewable distributed generation.

Table A-1: In-State Utility-Scale Renewable Facilities (> 20 MW)

	Capacity (MW)						Facilities					
County	Biomass	Geothermal	Small Hydro	Solar	Wind	Total	Biomass	Geothermal	Small Hydro	Solar	Wind	Total
Alameda	0	0	0	0	172	172	0	0	0	0	5	5
Alpine	0	0	0	0	0	0	0	0	0	0	0	0
Amador	0	0	24	0	0	24	0	0	1	0	0	1
Butte	0	0	29	0	0	29	0	0	1	0	0	1
Calaveras	0	0	0	0	0	0	0	0	0	0	0	0
Colusa	29	0	0	0	0	29	1	0	0	0	0	1
Contra Costa	0	0	0	0	145	145	0	0	0	0	2	2
Del Norte	0	0	0	0	0	0	0	0	0	0	0	0
El Dorado	0	0	30	0	0	30	0	0	1	0	0	1
Fresno	57	0	0	0	0	57	2	0	0	0	0	2
Glenn	0	0	0	0	0	0	0	0	0	0	0	0
Humboldt	33	0	0	0	0	33	1	0	0	0	0	1
Imperial	0	512	0	0	0	512	0	12	0	0	0	12
Inyo	0	302	0	0	0	302	0	3	0	0	0	3
Kern	58	0	25	0	635	718	1	0	1	0	14	16
Kings	0	0	0	0	0	0	0	0	0	0	0	0
Lake	0	496	0	0	0	496	0	7	0	0	0	7
Lassen	36	0	30	0	0	65	1	0	1	0	0	2
Los Angeles	88	0	0	0	0	88	2	0	0	0	0	2
Madera	25	0	0	0	0	25	1	0	0	0	0	1
Marin	0	0	0	0	0	0	0	0	0	0	0	0
Mariposa	0	0	0	0	0	0	0	0	0	0	0	0
Mendocino	0	0	0	0	0	0	0	0	0	0	0	0
Merced	0	0	25	0	34	59	0	0	1	0	1	2
Modoc	0	0	0	0	0	0	0	0	0	0	0	0
Mono	0	0	0	0	0	0	0	0	0	0	0	0
Monterey	0	0	0	0	0	0	0	0	0	0	0	0
Napa	0	0	0	0	0	0	0	0	0	0	0	0

County	Capacity (MW)						Facilities					
	Biomass	Geothermal	Small Hydro	Solar	Wind	Total	Biomass	Geothermal	Small Hydro	Solar	Wind	Total
Nevada	0	0	27	0	0	27	0	0	1	0	0	1
Orange	0	0	0	0	0	0	0	0	0	0	0	0
Placer	24	0	22	0	0	46	1	0	1	0	0	2
Plumas	28	0	46	0	0	74	1	0	2	0	0	3
Riverside	54	0	0	0	259	313	1	0	0	0	8	9
Sacramento	0	0	0	0	0	0	0	0	0	0	0	0
San Benito	0	0	0	0	0	0	0	0	0	0	0	0
San Bernardino	0	0	24	387	0	411	0	0	1	8	0	9
San Diego	0	0	0	0	50	50	0	0	0	0	1	1
San Francisco	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin	23	0	0	0	561	584	1	0	0	0	5	6
San Luis Obispo	0	0	0	0	0	0	0	0	0	0	0	0
San Mateo	0	0	0	0	0	0	0	0	0	0	0	0
Santa Barbara	0	0	0	0	0	0	0	0	0	0	0	0
Santa Clara	0	0	0	0	0	0	0	0	0	0	0	0
Santa Cruz	0	0	0	0	0	0	0	0	0	0	0	0
Shasta	94	0	0	0	0	94	2	0	0	0	0	2
Sierra	0	0	0	0	0	0	0	0	0	0	0	0
Siskiyou	0	0	27	0	0	27	0	0	1	0	0	1
Solano	0	0	0	0	336	336	0	0	0	0	3	3
Sonoma	0	1,160	0	0	0	1,160	0	11	0	0	0	11
Stanislaus	0	0	0	0	0	0	0	0	0	0	0	0
Sutter	0	0	0	0	0	0	0	0	0	0	0	0
Tehama	0	0	0	0	0	0	0	0	0	0	0	0
Trinity	0	0	0	0	0	0	0	0	0	0	0	0
Tulare	0	0	0	0	0	0	0	0	0	0	0	0
Tuolumne	22	0	0	0	0	22	1	0	0	0	0	1
Ventura	0	0	0	0	0	0	0	0	0	0	0	0
Yolo	28	0	0	0	0	28	1	0	0	0	0	1
Yuba	0	0	0	0	0	0	0	0	0	0	0	0
Total	598	2,470	308	387	2,192	5,955	17	33	12	8	39	109

Source: California Energy Commission's "California Power Plant Database." http://energyalmanac.ca.gov/electricity/index.html

Table A-2: In-State Facilities – Wholesale Renewable Distributed Generation (20 MW or less)

	Capacity (MW)						Facilities					
County	Biomass	Geothermal	Small Hydro	Solar	Wind	Total	Biomass	Geothermal	Small Hydro	Solar	Wind	Total
Alameda	16	0	1	0	114	131	2	0	1	0	13	16
Alpine	0	0	0	0	0	0	0	0	0	0	0	0
Amador	0	0	14	0	0	14	0	0	2	0	0	2
Butte	19	0	72	0	0	90	1	0	12	0	0	13
Calaveras	0	0	13	0	0	13	0	0	6	0	0	6
Colusa	0	0	0.3	0	0	0	0	0	1	0	0	1
Contra Costa	8	0	0	0	0	8	3	0	0	0	0	3
Del Norte	0	0	0	0	0	0	0	0	0	0	0	0
El Dorado	0	0	43	0	0	43	0	0	7	0	0	7
Fresno	0	0	11	0	0	11	0	0	2	0	0	2
Glenn	0	0	6	0	0	6	0	0	2	0	0	2
Humboldt	15	0	2	0	0	17	1	0	2	0	0	3
Imperial	18	87	64	0	0	169	1	6	10	0	0	17
Inyo	0	0	35	0	0	35	0	0	10	0	0	10
Kern	0	0	50	0	170	220	0	0	4	0	25	29
Kings	12	0	0	0	0	12	1	0	0	0	0	1
Lake	0	0	6	0	0	6	0	0	2	0	0	2
Lassen	35	3	0	0	0	38	3	1	0	0	0	4
Los Angeles	47	0	110	0	0	157	6	0	24	0	0	30
Madera	0	0	37	0	0	37	0	0	11	0	0	11
Marin	0	0	0	0	0	0	0	0	0	0	0	0
Mariposa	0	0	9	0	0	9	0	0	1	0	0	1
Mendocino	0	0	14	0	0	14	0	0	4	0	0	4
Merced	0	0	17	0	0	17	0	0	6	0	0	6
Modoc	0	0	0	0	0	0	0	0	0	0	0	0
Mono	0	40	21	0	0	61	0	3	4	0	0	7
Monterey	13	0	4	0	0	18	1	0	1	0	0	2
Napa	2	0	12	0	0	13	1	0	1	0	0	2
Nevada	0	0	44	0	0	44	0	0	9	0	0	9
Orange	49	0	13	0	0	62	5	0	5	0	0	10
Placer	32	0	69	0	0	101	2	0	10	0	0	12
Plumas	12	0	7	0	0	19	1	0	2	0	0	3
Riverside	4	0	24	0	245	273	1	0	10	0	20	31
Sacramento	9	0	14	2	0	25	1	0	1	2	0	4
San Benito	0	0	0	0	0	0	0	0	0	0	0	0

	Capacity (MW)						Facilities					
County	Biomass	Geothermal	Small Hydro	Solar	Wind	Total	Biomass	Geothermal	Small Hydro	Solar	Wind	Total
San Bernardino	6	0	15	14	0	35	4	0	12	1	0	17
San Diego	39	0	14	0	5	58	8	0	9	0	1	18
San Francisco	2	0	0	0	0	2	1	0	0	0	0	1
San Joaquin	5	0	11	0	53	69	1	0	1	0	4	6
San Luis Obispo	0	0	2	0	0	2	0	0	3	0	0	3
San Mateo	2	0	0	0	0	2	1	0	0	0	0	1
Santa Barbara	3	0	0	0	0	3	1	0	1	0	0	2
Santa Clara	12	0	0	0	0	12	6	0	0	0	0	6
Santa Cruz	3	0	0	0	0	3	1	0	0	0	0	1
Shasta	35	0	93	0	0	128	3	0	27	0	0	30
Sierra	20	0	14	0	0	34	1	0	3	0	0	4
Siskiyou	0	0	45	0	0	45	0	0	6	0	0	6
Solano	0	0	0	0	34	34	0	0	0	0	2	2
Sonoma	6	0	3	0	0	9	2	0	1	0	0	3
Stanislaus	0	0	17	0	0	17	0	0	6	0	0	6
Sutter	0	0	0.4	0	0	0	0	0	1	0	0	1
Tehama	0	0	21	0	0	21	0	0	3	0	0	3
Trinity	0	0	15	0	0	15	0	0	7	0	0	7
Tulare	9	0	40	0	0	49	2	0	7	0	0	9
Tuolumne	8	0	64	0	0	72	1	0	8	0	0	9
Ventura	10	0	2	0	0	11	3	0	2	0	0	5
Yolo	4	0	0	0	0	4	1	0	0	0	0	1
Yuba	0	0	3	0	0	3	0	0	3	0	0	3
TOTAL	454	130	1,072	16	620	2,292	66	10	250	3	65	394

Source: California Energy Commission's "California Power Plant Database." http://energyalmanac.ca.gov/electricity/index.html

Table A-3: In-State Facilities - Customer-Side Distributed Generation Facilities

	Capacity (kW)				Facilities			
County	Biomass	Solar	Wind	Total	Biomass	Solar	Wind	Total
Alameda	2,000	37,154	20	39,174	3	3,809	4	3,816
Alpine	0	0	9	9	0	0	1	1
Amador	0	1,105	11	1,117	0	190	5	195
Butte	1,070	13,824	188	15,082	2	826	18	846
Calaveras	0	1,864	16	1,880	0	321	3	324
Colusa	0	1,313	3	1,316	0	49	1	50
Contra Costa	480	26,917	35	27,431	2	3,386	6	3,394
Del Norte	0	0	1	1	0	0	1	1
El Dorado	0	6,884	4	6,888	0	1,241	2	1,243
Fresno	670	31,190	12	31,873	2	3,140	3	3,145
Glenn	0	837	129	967	0	97	10	107
Humboldt	0	1,234	48	1,282	0	448	7	455
Imperial	0	8	0	8	0	2	0	2
Inyo	0	1,136	0	1,136	0	44	0	44
Kern	453	21,162	404	22,018	2	1,559	64	1,625
Kings	0	4,869	0	4,869	0	260	0	260
Lake	0	5,246	23	5,270	0	372	8	380
Lassen	0	195	0	195	0	13	0	13
Los Angeles	4,730	62,296	1,083	68,110	9	5,543	30	5,582
Madera	0	4,250	4	4,254	0	476	2	478
Marin	27	12,891	3	12,920	1	2,020	4	2,025
Mariposa	0	433	0	433	0	76	0	76
Mendocino	0	3,577	14	3,592	0	555	5	560
Merced	700	5,766	2	6,467	2	272	2	276
Modoc	0	0	0	0	0	0	0	0
Mono	0	617	0	617	0	76	0	76
Monterey	0	5,725	0	5,725	0	710	0	710
Napa	210	15,138	1	15,349	1	843	1	845
Nevada	0	3,452	4	3,456	0	846	3	849
Orange	320	31,789	1	32,110	2	4,093	1	4,096
Placer	0	15,727	8	15,735	0	2,081	5	2,086
Plumas	0	1,077	0	1,077	0	80	0	80

	Capacity (kW)				Facilities			
County	Biomass	Solar	Wind	Total	Biomass	Solar	Wind	Total
Riverside	1,700	41,495	67	43,261	2	3,644	11	3,657
Sacramento	0	2,170	3	2,173	0	144	2	146
San Benito	0	643	9	652	0	102	1	103
San Bernardino	500	37,607	2,769	40,876	1	2,189	214	2,404
San Diego	3,220	69,349	76	72,645	6	9,399	29	9,434
San Francisco	250	10,185	3	10,438	1	2,044	2	2,047
San Joaquin	290	11,335	24	11,649	2	1,073	7	1,082
San Luis Obispo	240	12,097	36	12,374	1	1,501	7	1,509
San Mateo	660	14,082	8	14,750	2	2,214	4	2,220
Santa Barbara	1,870	8,902	10	10,783	4	1,134	2	1,140
Santa Clara	4,250	53,128	16	57,393	8	5,490	9	5,507
Santa Cruz	0	8,645	11	8,655	0	1,917	3	1,920
Shasta	0	4,396	104	4,500	0	409	13	422
Sierra	0	10	0	10	0	3	0	3
Siskiyou	0	0	9	9	0	0	1	1
Solano	0	12,868	387	13,255	0	729	22	751
Sonoma	36	31,402	280	31,718	1	3,594	14	3,609
Stanislaus	0	6,040	0	6,040	0	230	0	230
Sutter	300	3,103	50	3,453	1	270	3	274
Tehama	0	1,277	82	1,358	0	141	14	155
Trinity	0	24	0	24	0	4	0	4
Tulare	1,400	13,319	3	14,722	2	898	2	902
Tuolumne	0	1,251	0	1,251	0	211	0	211
Ventura	670	17,119	5	17,794	2	1,771	2	1,775
Yolo	0	12,038	19	12,058	0	1,112	7	1,119
Yuba	0	990	28	1,018	0	219	9	228

Source: Non-confidential information from the California Energy Commission's Emerging Renewables Program and the New Solar Homes Partnership, the California Solar Initiative, http://www.californiasolarstatistics.ca.gov/current_data_files/, and the Self Generation Incentive Program, https://energycenter.org/index.php/incentive-programs/self-generation-incentive-program/sgip-documents/sgip-documents

Appendix B: Additional Data on Renewable Percentages

Calculations of the percentage of renewable generation in California may vary depending on the source of data used, as shown in Table B-1.

Table B-1: Renewable Percentages Using Different Data Sources

Data Source	In-state Renewables (GWh)	In-state Renewables Percentage to In-state Generation***	Total Renewables (GWh)	Renewables Percentage to 2010 Retail Sales**
CPUC RPS Compliance Filings*	No Data	No Data	41,790	16.5%
Energy Commission RPS Tracking *	No Data	No Data	38,194	15.1%
Total System Power	30,005	14.6%	39,796	15.7%
Power Source Disclosure Program	31,054	15.1%	40,846	16.2%

Source: California Energy Commission

* Includes estimated 2010 POU deliveries of 8,822 GWh based on public records of signed contracts assumed eligible for the RPS.

** California's RPS targets are based on renewable procurement as a percentage of retail sales (excluding water pumping load). In 2010, California retail sales were 252,746 GWh.

*** Total In-state generation from the Total System Power was 205,018 GWh in 2010.

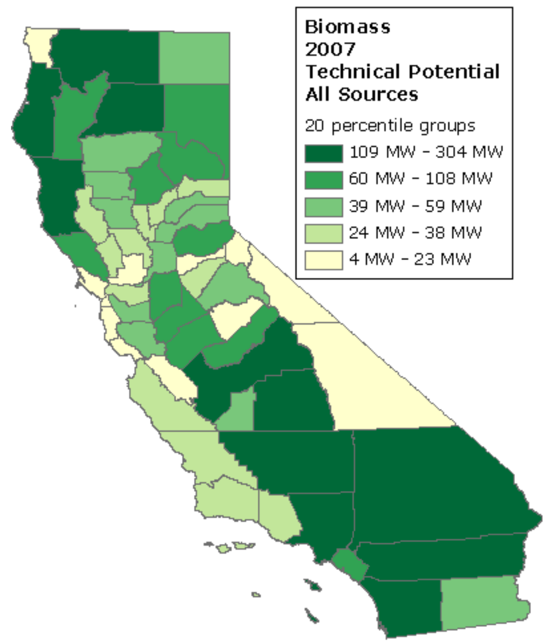
Appendix C: Renewable Technical Potential in California

Chapter 2 of this report discussed the high level of technical potential for renewable electricity generating technologies in California. This appendix provides additional information about that potential by technology, and identifies some of the issues that will affect how much of that technical potential could ultimately be developed.

Biomass

Biomass generation currently represents nearly 20 percent of generation from in-state renewable resources,[653] but additional potential may be limited because of cost, air quality issues, and regulatory barriers. Existing biomass power generation capacity in the state totals 1,767 MW, which includes capacity from solid-fueled combustion power plants and engines, boilers, and turbines operating on landfill gas; sewage digester gas; and biogas from animal manures. In 2007, an assessment of biomass estimated technical potential for additional biomass development to be 3,820 MW; the assessment also suggested that by 2020, technical potential could reach 6,800 MWs as a result of resource growth and improvements in conversion efficiencies.

Figure C-1. Biomass Technical Potential by California County



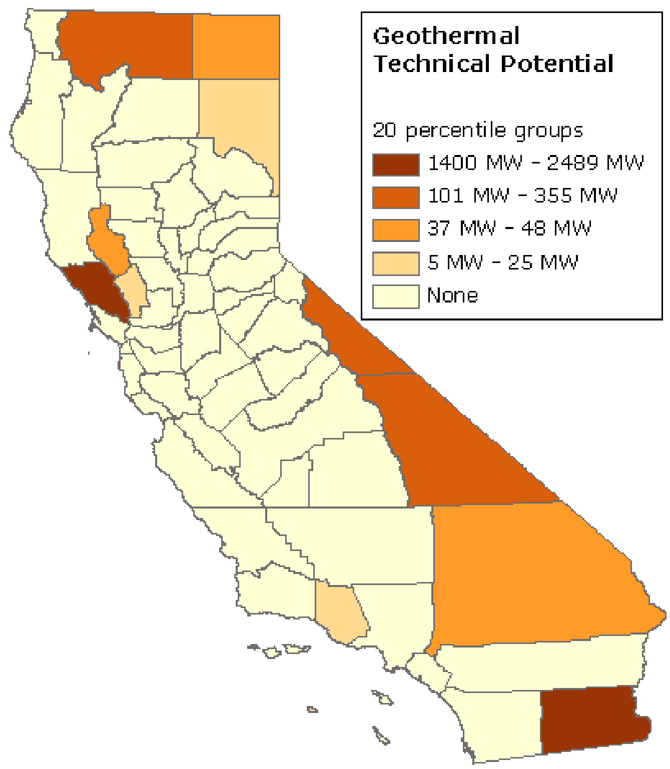
Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov.

Factors that could affect the amount of this technical potential ultimately developed include varying electricity prices and difficulty securing long-term contracts; permitting and utility interconnection challenges; fuels issues like feedstock prices, rules, and collection and delivery costs, as well as competition with the transportation sector for feedstocks; ability to meet local air quality regulations; issues with gas quality standards for biogas injected into utility pipelines; the ineligibility of some biomass systems for net metering programs; and lack of demonstrated commercial success for new technologies.

653 California Energy Commission, 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html

Key support programs for biomass technologies include the Energy Commission's Existing Renewables Program, which provides production incentives for solid fuel biomass facilities;[654] the CPUC's Renewable Auction Mechanism, a streamlined procurement process for renewable DG projects 20 MW or less in size;[655] state goals for meeting 20 percent of RPS targets using biomass resources;[656] the federal Investment Tax Credit and Production Tax Credit; and the Bioenergy Action Plan, which identifies strategies to address barriers to development of bioenergy in California.[657]

Figure C-2. Geothermal Technical Potential by California County



Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov.

Geothermal

Geothermal is a mature industry. There have also been many technology improvements and innovations over the past few years that have made geothermal energy one of the most cost-competitive renewable energy resources on a levelized cost basis.

Geothermal power plants currently provide 42 percent of in-state renewable generation. There are more than 40 geothermal power plants in California's geothermal resource areas with installed generating capacity of 2,574 MW. An additional 2,096 MW of capacity is in various stages of development.[658] California also imports geothermal power from the Southwest.[659]

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654 The Existing Renewables Program is scheduled to sunset at the end of 2011 unless the Public Goods Charge is reauthorized by the California Legislature.

655 California Public Utilities Commission, Renewable Auction Mechanism, http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/Renewable+Auction+Mechanism.htm.

656 Executive Order S-06-06 commits California to a target of generating 20 percent of the state'srenewable energy from biomass by 2010 and maintaining this ratio through 2020.

657 California Energy Commission, *2011 Bioenergy Action Plan*, http://www.energy.ca.gov/2011publications/CEC-300-2011-001/CEC-300-2011-001-CTF.PDF.

658 Geothermal Energy Association, 2011. Stages of geothermal development include resource procurement and identification, resource exploration confirmation, permitting and initial development, and resource production and

Although the total geothermal resource base that could potentially support power generation is uncertain, the most recent estimate by the U.S. Geological Survey suggests that the additional, readily accessible resource in California is between 800 MW and 4,600 MW. Resources that are likely to exist, but which have yet to be discovered, could provide an additional ~3,200 MW to ~25,000 MW.

Geothermal steam resources can be depleted over time, leading to a reduction in electricity generation.[660] Another challenge facing geothermal development was the scheduled expiration of federal production tax credits in 2010, which discouraged investments in geothermal from 2005 onward.[661] Also, geothermal companies are forced to compete for access to drilling rigs and pipe with oil and gas companies, which typically have a larger market presence and incentives. Geothermal exploration is time consuming because of the difficulty in establishing what, exactly, is in the subsurface. Other challenges include resource characterization (including steam quality and drilling depth), which could be addressed by technologies such as aerial or underground imaging for geothermal exploration. Particularly important and costly are studies required to define geothermal reservoir properties, volume, and geometry. Although there have been recent articles in the media regarding seismicity issues with geothermal projects, extractive industries such as geothermal, oil, gas, and mining, have dealt with seismic activity for many years and have substantial experience in this area.[662] Areas of geothermal development are also areas of seismic activity, so it can be difficult to ascertain whether or not a particular seismic event is related to the geothermal activity or is naturally occurring. While geothermal activities can result in "micro-seismic activity" (in the range of 1-3 on the Richter scale), these events are not perceptible to humans and not considered a safety issue for plant operation.[663]

Support programs for geothermal resources include the RPS program; the federal Investment Tax Credit and Production Tax Credit; and the Energy Commission's Geothermal Program which was established in 1981 and has cost-shared in research, development, and

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power plant construction. Seven of these projects are "unconfirmed;" the Geothermal Energy Association based information on these projects on publicly available information but did not confirm with respective developers.

659 California Energy Commission, 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html

660 See Chapter 9 for descriptions of PIER-funded projects to inject wastewater into geothermal wells for more effective energy production and to prolong the life of geothermal resources.

661 The American Recovery and Reinvestment Act of 2009 extended the production tax credit for certain renewable energy sources, including geothermal. See http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F.

662 See http://www.geo-energy.org/pdf/Geothermal_Energy_and_Induced_Seismicity_Issue_Brief.pdf, http://esd.lbl.gov/research/projects/induced_seismicity/references.html, and http://www.geothermal.org/GRCEGSBio.pdf.

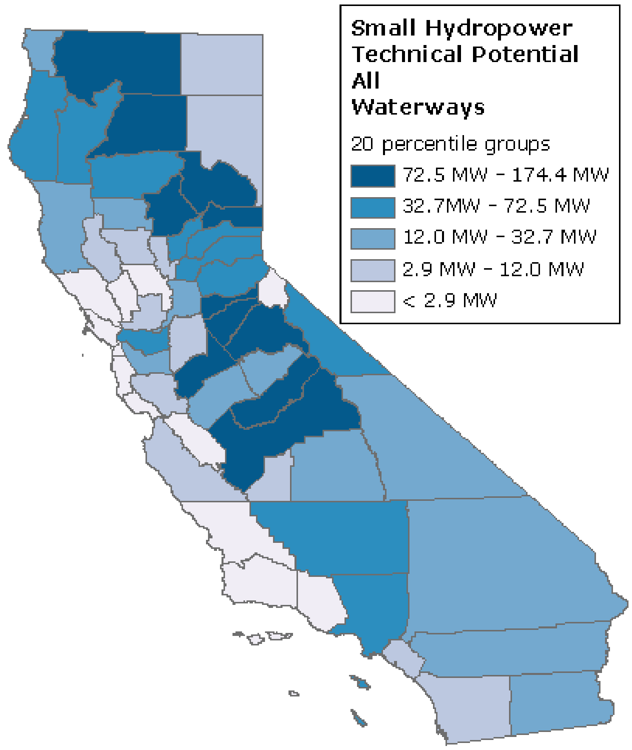
663 http://www.darlenecypser.com/induceq/induceq.html.

demonstration partnerships with more than 170 public and private entities through the Geothermal Resources Development Account.[664]

Small Hydroelectric

Small hydroelectric power, defined as systems 30 MW or less in capacity, currently represents 15 percent of in-state renewable generation.[665] Hydropower is considered to be a mature technology, and hydro projects with storage capability have some of the best operating characteristics of any renewable technology including dispatch predictability, ability to ramp up and down quickly, voltage control, high availability and reliability, and reactive power control for grid support when synchronous machines are used.

Figure C-3. Small Hydroelectric Potential by California County



Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov.

The amount of energy available from small hydro systems depends largely on snow and rainfall, so the amount of hydroelectricity produced varies significantly from year to year. Small hydroelectric power is typically highest in July and August and lowest in December and January. Currently, California has 1,386 MW of existing small hydro capacity, with an additional 7,011 MW of potential capacity from man-made conduits and impoundments and natural waterways. Furthermore, some additional potential comes from increasing generation through retrofitting existing hydropower plants, adding turbines to existing dams lacking generation capacity, and undeveloped sites. Although hydropower energy is available in 52 of California's 58 counties, the counties with the highest potential lie in mountain ranges to the north and east of the Central Valley.

664 California Energy Commission, Geothermal Resources Development Account, http://www.energy.ca.gov/geothermal/grda.html.

665 California Energy Commission, 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html

Table C-1. California Small Hydropower

Resource Type	Capacity MW	Generation GW-h/year
Impoundments & Natural Waterways	1,927	5,880
Man-made Conduits	255	1,131

Source: California Energy Commission, *California Small Hydropower and Ocean Wave Energy Resources*, April 2005, CEC-500-2005-074. Capacity and annual energy production potential. Assumes that no site exceeds 30 MW combined existing and potential generation.

A variety of equipment options and plant configurations exist that can accommodate nearly every site condition. The equipment also has the added benefit of a long life of up to 50 years. Manufacturers continue to make mechanical and economic improvements to the equipment so that "water to wire" units will have reduced upfront costs of design and installation and are sized to fit the site. In addition many power facilities have been reconfigured, or their operations have been altered to address adverse effects on stream flows and migrating fish.

Less than 10 percent of the hydropower units within the state are 30 MW or smaller. Units located in natural waterways may be operated as run-of-the river where the amount of energy produced at any one time is determined by the current flow in the river. The vast majority of run-of-the-river facilities within the state have a small generating capacity—usually less than one megawatt. Other facilities are associated with a dam that allows water to be retained in a reservoir and controls the amount and timing of generation. Downstream discharges from such facilities are controlled by a variety of factors, including retaining water for municipal and agricultural water supply, flood control, recreation, and environmental concerns. The Federal Energy Regulatory Commission (FERC), which permits all small non non-federal hydropower projects within the state, provides exemptions for small conduit projects (usually less than 15 MW) and for projects 5 MW or smaller. All other projects require a license from FERC. Challenges facing small hydropower development within California are often exacerbated by their remote location and include interconnection requirements, suitable market and permitting requirements.

Solar

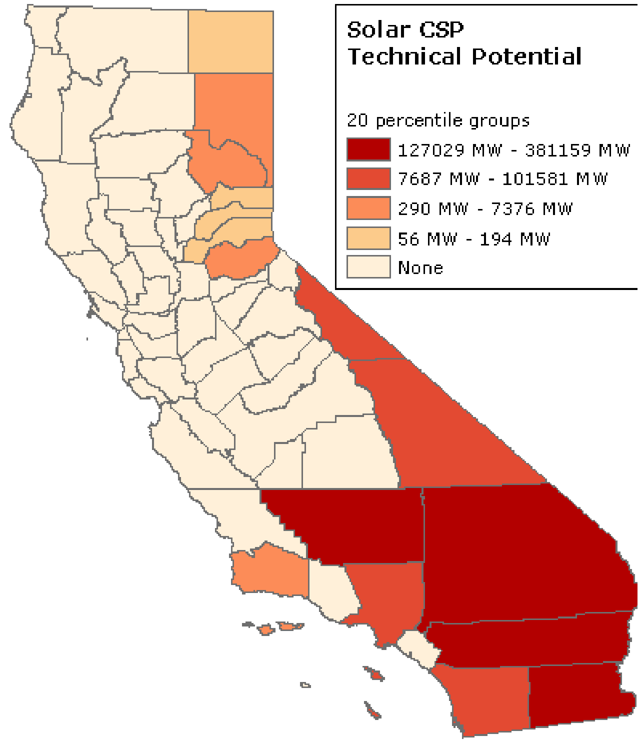
Generation from solar resources in California totals about 3 percent of in-state renewable generation.[666] Solar technologies in California include concentrating solar power (CSP) and photovoltaics (PV). Fundamental challenges in solar generation being addressed with active support from the U.S. Department of Energy and the solar industry include reducing overall cost, improving efficiency, and integration with energy storage technologies.

666 California Energy Commission, 2010 Total System Power, http://energyalmanac.ca.gov/electricity/total_system_power.html

Concentrating Solar Power

Current installed capacity of CSP in California is less than 400 MW with an additional 2,473 MW characterized as "in development" as of June 2011.[667] In 2010, the Energy Commission approved licenses for nine CSP plants totaling 4,124 MW, a portion of which is included in the "in development" total. Three of these plants totaling 1,620 MW of capacity have begun construction.[668] Technical potential for CSP has been estimated to be as much as 1 million MW.[669]

Figure C-4. Concentrating Solar Power Technical Potential by California County



Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov.

CSP requires direct sunlight, and is only cost competitive when located in arid and semi-arid areas at low latitudes due to greater sunlight availability in these areas. This can be challenging since these areas are usually located far from existing transmission lines. Also, utility-scale solar developments require large tracts of land, roughly eight acres per MW; the nine solar projects approved by the Energy Commission are expected to require 44,937 acres or more than 70 square miles in California's desert. This significant land requirement can have impacts on species habitats, agricultural or recreational use, and cultural resources like Native American historic or ancestral sites. When CSP is combined with thermal storage, these plants can generate dispatchable electricity depending on daily resource constraints. Recent trends include a renewed interest in power towers that are capable of attaining higher operating temperatures than trough systems, and incorporating thermal storage to enable dispatchable generation and higher capacity factors.

Key support programs for solar thermal projects include the RPS program; federal loan guarantees and tax credits under the American Recovery and Reinvestment Act of 2009; and the federal Investment Tax Credit and Production Tax Credit.

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667 California Public Utilities Commission, "RPS Project Status Table – June," http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm.

668 See Table 8 in Chapter 3 for more information about solar thermal plants licensed by the Energy Commission.

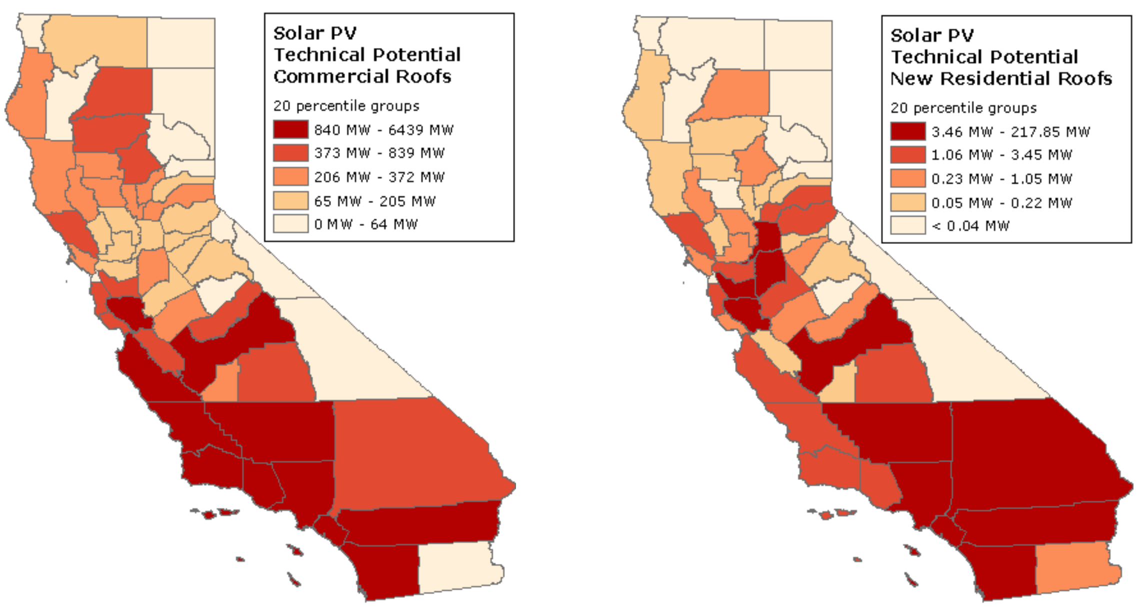
669 http://www.energy.ca.gov/2005publications/CEC-500-2005-072/CEC-500-2005-072-D.PDF.

Solar Photovoltaics

Installation of distributed solar generation continues to increase in California, with current installed capacity approaching 1 GW. Technical potential for PV, ignoring economic constraints and including both utility-scale and DG, has been estimated to be as much as 17 million MW.[670]

PV technologies can be installed at the distribution level, generating power at a residence or business. PV can also be installed as a utility application, either near load centers to produce power for municipalities or in large remote installations, and connected to high voltage transmission resources. PV price and performance have improved consistently over the past several decades through technical innovation, and over the past few years costs have declined rapidly (see Chapter 8). Further cost-reduction efforts include the Department of Energy's SunShot Initiative, which has a goal of reducing the cost of solar energy systems by 75 percent before 2020 and bringing total installed cost for utility-scale solar to 6 cents/kWh without subsidies. However, PV still faces challenges since these technologies generate electricity only when sunlight is present and not on command and are therefore not dispatchable. In addition, like any intermittent resource, integration can be a challenge, as discussed in more detail in Chapter 5.

Figure C-5: PV Technical Potential for New Residential and Commercial Roofs by California County



Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov.

670 http://www.energy.ca.gov/2005publications/CEC-500-2005-072/CEC-500-2005-072-D.PDF.

Some CSP power plant project developers are converting their plants to use PV. There are several reasons for this switch including financing issues, the market crisis, the state of each technology, and reduced environmental review. In recent years there was a significant demand for PV, and development of this technology occurred at a highly rapid rate resulting in significant cost reduction. In addition, compared to CSP, PV requires less initial capital investment.

There are a number of programs in California supporting DG PV, including the CPUC's California Solar Initiative, renewable feed-in tariff, and Renewable Auction Mechanism; utility PV programs; and the Energy Commission's New Solar Homes Partnership Program.

Wind

Wind resources provide 21 percent of California's in-state renewable generation. Wind is considered a mature technology but continues to face challenges due to intermittency of the resource, lack of transmission access in remote areas, and environmental issues. As of the end of 2010, there was 3,177 MW of on-shore wind generation installed capacity in California, with the American Wind Energy Association (AWEA) reporting an additional 594 MW under construction.[671] The majority of on-shore wind development is concentrated in four regions of the state: Tehachapi, San Gorgonio Pass, Altamont Pass, and Solano-Montezuma Hills (Figure 6). The Energy Commission's Intermittency Analysis Project conducted in 2007 indicated that there is 34,000 MW of economic potential for new wind development in California.[672]

Land-based wind turbines are commercially available from many companies, and are cost competitive with some conventional energy technologies both on an installed-capacity basis and on a cost-of-energy basis. Small, incremental improvements over the next few decades are expected to improve cost effectiveness by 30-40 percent through a combination of decreased capital cost and improved turbine performance. Areas of improvement include: turbine components (rotors, gearboxes, and towers), power electronics and controls, and manufacturing.

Wind faces challenges because it is a variable resource, with average capacity factors ranging from about 20 to 40 percent, and cannot be dispatched at will so it needs back up from other generation or storage. Abrupt changes in wind speed can also cause large and rapid changes in wind power output, which adds difficulty for system operators who plan for and mitigate these severe ramping events.[673] During low-load periods (for example at night), wind generation has the potential to overload the system with excess capacity and may need to be curtailed in

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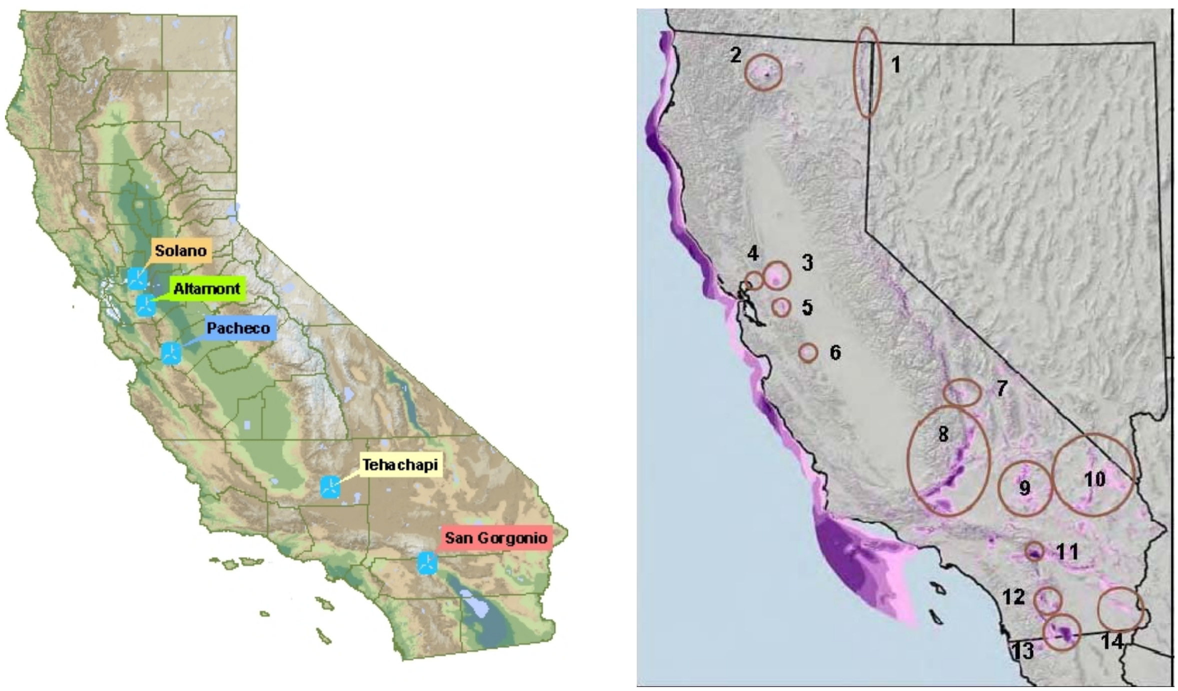
671 This total differs from the wind capacity shown in Table 1 due to the addition of a 150 MW wind project that came on-line at the end of 2010 which has not yet reported through the Energy Commission's Quarterly Fuel and Energy Report.

672 *Intermittency Analysis Project*, July 2007, CEC-500-2007-081.

673 Please see Chapter 5 for charts showing wind and solar variability.

absence of effective storage.[674] Regardless, utilities must continue to purchase the curtailed "generation" at agreed-to rates. If storage is not available, utilities may even have to pay other utilities to take this excess wind production in over generation periods.[675] On the other hand, if a utility can refuse to accept wind power whenever there are overgeneration conditions, it will not be financeable.[676] Wind is also a widely disbursed resource with many of the best resources occurring in remote areas with insufficient or no transmission. Existing transmission assets may need to be upgraded to accommodate additional wind resources.

Figure C-6. Wind Resource Areas in California and Locations for Additional Economic Potential



Source: California Renewable Resource Portal, https://calrenewableresource.llnl.gov and Intermittency Analysis Project, July 2007, CEC-500-2007-081

Wind also faces environmental challenges that include potential impacts on bird and bat populations from collisions with turbine blades, although siting guide development[677] and

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674 *Transcript for the April 28, 2011 Integrated Energy Policy Report Committee Workshop on Energy Storage for Renewable Integration*, presentation by Mark Rothleder of the California ISO, http://www.energy.ca.gov/2011_energypolicy/documents/2011-04-28_workshop/2011-04-28_Transcript.pdf, page 45.

675 Ibid, page 57.

676 Ibid, presentation by Mark Irwin of Southern California Edison, pp. 191-193.

677 California Energy Commission, *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development*, October 2007, http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF.

ongoing research to help solve avian and bat mortality have mitigated this to some degree.[678] These and other environmental issues associated with wind development are discussed in more detail in Chapter 3.

Support programs for wind development include the RPS Program and the federal Investment Tax Credit and Production Tax Credit. Programs targeted toward small wind systems include the CPUC's Self-Generation Incentive Program and Renewable Auction Mechanism; net metering; and the Energy Commission's Emerging Renewables Program.

Off-shore Wind

Shallow water off-shore wind technology has been commercialized in Europe but has not yet been deployed in the United States. However, there are 9 offshore wind projects totaling 2,322 MW of capacity proposed to be located along the Northeastern and Mid-Atlantic coastlines that are in the permitting and development process. Additional projects have also been proposed for the Great Lakes and Gulf of Mexico.[679] All of these projects are in shallow water and are accessible with existing technology. To date, there are no offshore wind projects being proposed off California and the shallow water opportunities may be limited since only a very small portion of California coastal waters are 20 meters or less.

To date, no offshore wind projects have been installed in the United States and the development of an offshore wind power market still faces challenges. Nonetheless, significant offshore wind capacity exists off California's coast, mainly in deep waters. According to a Stanford University study, there is large potential for off-shore wind along California's coast.[680] Potential was based on acceptable depths for three categories of offshore wind farms: 20 meter depth for monopile turbine foundations, 50 meter depth for multi-leg turbine foundations, and 200 meter depth for deep water floating turbines. Estimated potential from these three categories was 1.4–2.2 GW for deepwater monopile turbine foundations, or floating platforms, 4.4–8.3 GW for multi-leg turbine foundations, and 52.8–64.9 GW from floating turbine.[681]

Deep water off-shore wind is an emerging technology that is only now undergoing full-scale demonstration in Europe. Challenges facing development of offshore wind in California's deeper coastal waters include high cost, permitting and siting uncertainties, and technological limitations. Despite potential benefits offshore wind can provide the state, including superior capacity factors and proximity to load centers compared to on shore wind, until development of suitable (and affordable) deep water structures and floating platforms, significant offshore wind development will not occur of California's coast.

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678 See Chapter 9 for a description of ongoing research on bird and bat mortality.

679 Musial, Walter, and Bonnie Ram, *Large-Scale Offshore Wind Power in the Unites States: Assessment of Opportunities and Barriers,* September 2010, NREL/TP-500-40745, http://www.nrel.gov/wind/pdfs/40745.pdf.

680 Michael J. Dvorak, Cristina L. Archer, Mark Z. Jacobson. 2009. California offshore wind energy potential.

681Ibid.

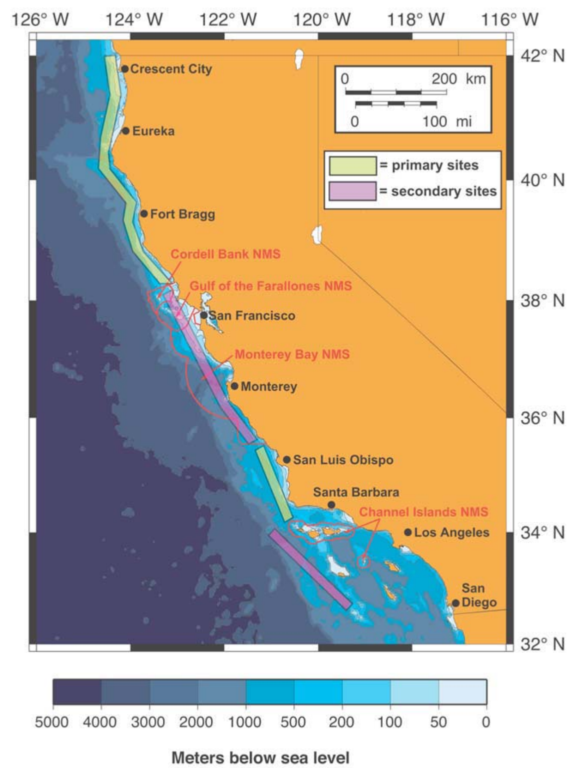
Potential environmental concerns with off-shore wind turbines include interference and/or exclusion of other offshore activities like fishing or shipping, aesthetic impacts on scenic coastal viewsheds, seabird and bat interaction with turbines, disruption of marine mammal migration patterns, sea floor disturbance from anchors or power cables, and mooring line impacts on sea life such as whales.

Wave and Tidal Energy

Traditional tidal electricity generation involves building a barrage across an estuary to block the incoming and outgoing tide.[682] Newer technologies rely on free flowing kinetic power resulting in turbines that do not need dams or sluices. Golden Gate Energy Company has applied for permits for a project located in San Francisco Bay using free-flowing tidal energy devices.

Wave energy technologies rely on the up-and-down motion of ocean waves produced by wind to generate electricity. Although ocean wave energy is still in its infancy, there appears to be significant wave resource potential offshore in the northern and central parts of the state.

Figure C-7. Wave Energy Potential in California



Source: California Ocean Wave Energy Assessment, CEC-500-206-119-D, May 2007

While there is some potential in southern California, those resources are located seaward of the Channel Islands, well offshore the Los Angeles and San Diego areas and onshore transmission infrastructure. California has the potential to support wave energy due to large population centers in San Francisco and the central cost, high-energy wave climate, and deep water close to shore. A study funded by the Energy Commission indicated that California has 32,763 MW of ocean wave capacity available for development,[683] but this capacity is unlikely to be developed in the near future since technologies are not yet ready for commercial use. Some technologies are close to commercialization, while others are emerging. Recent experience with several projects proposed offshore California demonstrate that complex permitting issues, stakeholder

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682 http://www.oceanenergycouncil.com/index.php/Tidal-Energy/Tidal-Energy.html.

683 California Small Hydropower and Ocean Wave Energy Resources, April 2005, CEC-500-2005-074, pg. 1.

skepticism, and high cost preclude wave energy as a near-term option in helping the state meet its renewable energy goals. Agency efforts to address regulatory challenges and projects such as the Reedsport OPT Wave Park in Oregon may help advance technologies and provide a roadmap for addressing other issues.[684]

684 The Reedsport project is likely to receive its construction/operation license by the end of 2011.

Appendix D: Renewable Net Short Input Variables

This appendix provides detailed information about the assumptions and methodology used to calculate the renewable net short estimates presented in Chapter 2. A standardized approach and set of assumptions to estimate the renewable net short will improve the ability to understand the context for studies and to transfer findings from one research area to another. This will also promote consistency and establish an analytical link between the different infrastructure studies, leading to better informed policy development. The proposed equation for calculating the renewable net short is as follows:

> *Renewable Net Short (TWh) = ((Projected Retail Electricity Sales – Energy Efficiency Programs – Combined Heat & Power Customer Services – Self-Generation Additions – Other Demand Reduction Programs) x Policy Goal Percent) – Generation From Existing Eligible Renewable Facilities*

The assumptions used for the renewable net short calculation are based on the most current electricity system assessments and projections. These inputs and assumptions are not static. They are constantly being revised and updated as new information becomes available. There are numerous studies and proceedings underway that will ultimately update some of the key input assumptions. The Energy Commission will update these variables each year to revise the renewable net short estimates.

Key Assumptions and Uncertainties That Affect the Renewable Net Short

Anything that reduces electricity retail sales – changes to the economy, energy efficiency program savings, rooftop solar photovoltaic additions, and other customer-side-of-the-meter distributed generation – will reduce the renewable net short. The need for additional renewable generation to meet policy goals also depends on how much renewable power is already flowing into the system. Estimates of the renewable net short will also change over time as forecasts of electricity demand change. These changes have been particularly noticeable in the last several years due to the effects of the economic downturn and the possible timing of a rebound. Similarly, uncertainties about meeting state goals for energy efficiency, CHP, and rooftop solar will affect the amount of renewable energy ultimately needed. The wide variation between estimates illustrates the need for common assumptions and counting conventions so that the public can be confident in both the goals and reported progress.

Prudent consideration of these kinds of uncertainties should be applied to renewable net short calculations and infrastructure studies. The use of a single-point forecast will not reveal potential economic and system reliability risks of an infrastructure investment decision.

Each of the elements of the renewable net short calculation has contributing sources and uncertainty factors included in this appendix are organized as follows:

- Projected Retail Electricity Sales

- Retail Sales From California Energy Demand Forecast
- Treatment of Transmission and Distribution Losses

- Demand Reduction Programs
  - Energy Efficiency Impacts
  - Incremental Self-Generation Goals
  - Incremental Combined Heat and Power
- Generation From Existing Eligible Renewable Facilities
  - Estimating Existing Renewable Generation

Projected Retail Electricity Sales

Projected retail sales are the foundation for the calculation of renewable goals and renewable net short. As part of the biennial Integrated Energy Policy Report, Energy Commission staff develops a full statewide energy and peak demand electricity forecast, the *California Energy Demand Forecast (CED),* which is the appropriate starting point for calculating the renewable net short.

The key drivers for the electricity retail sales forecast are population, household, and economic growth. Electricity retail sales forecasts also include assumptions for electrifying transportation sector, such as the Governor's 1 million electric vehicles goal. Economic growth remains highly uncertain, and conditions could change markedly within the next few years. The most current *CED* was prepared for the *2009 IEPR*, and was recently updated to incorporate the latest economic assessments. The updated *2009 CED* electricity retail sales projection for the California load serving entities is 297.9 TWh by 2020. Staff also developed alternative retail electricity sales forecasts using more optimistic and pessimistic economic projections than used in the base case forecast, escalating the projection by 2.3 percent for a high case and -1.9 percent for the low end of the range.[685] The resulting retail electricity sales range is 292.5 TWh to 305.3 TWh for 2020. These statewide retail sales projections include water delivery agency electricity demand of 13.6 TWh, which must be subtracted for the renewable net short calculation.

There are other demand reduction policy goals and an expectation that some progress towards those goals will likely occur. These additional programs are not included in the *CED* forecast and must be considered as an adjustment to the electricity retail sales estimate for the renewable net short calculation. Other programs to consider include uncommitted energy efficiency programs, self-generation additions, and CHP policy goals.

Energy Efficiency Impacts

The Energy Commission's retail electricity sales forecast does not include all load reductions expected to occur or required by policy. The *2009 CED* incorporated committed utility efficiency

685 Kavalec, Chris, Tom Gorin. 2009. *California Energy Demand 2010-2020, Adopted Demand Forecast*, CEC-200-2009-012-CMF. Page 6.

programs[686] through 2012 (the end of the current three-year CPUC program cycle) for the investor-owned utilities and through 2009 for publicly owned utilities, along with efficiency codes and standards implemented through 2005.

Beginning with the *2009 CED*, staff also estimates potential uncommitted efficiency impacts[687] that are in addition to committed impacts. Forecasts of uncommitted energy efficiency impacts are subject to a great deal of uncertainty, given lack of firm funding. Estimates of committed utility program net impacts, both historical and projected, are also fairly uncertain. For example, efficiency measures might be purchased but not installed, or may not perform as expected. The most recent CPUC Evaluation Measurement &Verification study,[688] for 2006–2008 IOU programs found utility-reported savings to be overstated. Staff therefore included an adjustment to the *2009 CED* forecast to reflect the lower percentages estimated in the CPUC study during the forecast period. The amounts of uncommitted efficiency for 2020 range between 15.2 TWh and 19.9 TWh, which are applied to the renewable net short calculations.

Incremental Distributed Generation Goals

Forecasted retail sales are calculated by subtracting projected private electricity supply consumed on-site (self-generation) from projected consumption. In general, projected self-generation is developed by trend analysis and then included in the IEPR demand forecast. Including the value of distributed generation (DG) in the renewable net short calculation is done if it is prudent to plan on more distributed generation than is already included in the IEPR demand forecast.

DG can be categorized two ways, self-generation and wholesale distributed generation. Self-generation is produced on site by consumers for their own use, while wholesale DG is a small generating station meant to serve electrical load elsewhere on the system. New self-generation from a DG project affects the calculation of renewable net short differently than wholesale DG. New self-generation DG will reduce projected retail sales by the amount of generation. Wholesale DG is sold into the electricity market instead of being used to serve the on-site electricity needs. The primary self-generation DG supply considered for the renewable net short calculation is the amount of electricity expected from small scale rooftop photovoltaic (PV) systems.

Assumptions about various DG policy goals affect the net short calculation in different ways. Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006) requires the California Air Resources Board (ARB) to develop regulations and market mechanisms that will reduce California's

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686 These include utility and public agency programs, codes and standards, and legislation and ordinances that have final authorization, firm funding, and a design that can be readily translated into characteristics that can be evaluated and used to estimate future impacts.

687 Uncommitted impacts include future initiatives that are less firm than committed yet reasonably likely to occur. Examples include utility efficiency programs beyond 2012 and Assembly Bill 1109 (Huffman, Chapter 534, Statutes of 2007).

688 http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/2006-2008+Energy+Efficiency+Evaluation+Report.htm.

greenhouse gas (GHG) emissions by 25 percent by 2020. The ARB's *Climate Change Scoping Plan* for the implementation of AB 32 calls for 3,000 MW [689] (4.5 TWh of electricity) of additional self-generation rooftop PV beyond what was identified in the *2007 IEPR CED* forecast. New rooftop PV has been built since 2007 and must be adjusted in the *2009 IEPR CED* demand forecast.

In 2010, the *California Clean Energy Future,* a multi-agency effort between state energy and environmental agencies and the California Independent System Operator to expand collaboration on state energy policies, set a new goal of 5,000 MW by 2020 for renewable distributed generation.[690] Work is underway to revise the Clean Energy Future goals to reflect the Governor's 12,000 MW goal. If fully subscribed, existing programs for renewable distributed generation would meet or exceed 5,000 MW by 2020:

- 3,000 MW of self-generation DG PV through the programs associated with Senate Bill 1 (Murray, Chapter 132, Statutes of 2006).
- 500 MW of wholesale generation DG PV through PG&E (half of the MW will be utility-owned; half will be provided by independent energy producers).
- 500 MW of wholesale generation DG PV through SCE (half of the MW will be utility-owned; half will be provided by independent energy producers).
- 100 MW of proposed wholesale generation DG PV through SDG&E (26 MW will be utility-owned; 74 MW will be provided by independent energy producers).
- 750 MW of wholesale generation (including non-PV DG, per SB 32) from existing feed-in tariff; plus an additional 66.5 MW contracted by SMUD.[691]
- 1,000 MW of wholesale generation (including non-PV DG) for the Renewable Auction Mechanism (RAM) decision that was adopted by the CPUC.[692]

Given the combined AB 32 Scoping Plan and California Clean Energy Future goals, increased PV additions are assumed to range between 2.3 TWh and 4.1 TWh for the renewable net short calculations.

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689 *Climate Change Proposed Scoping Plan Appendices*, Volume I: Supporting Documents and Measure Detail, Page C-121.

690 *California's Clean Energy Future - An Overview on Meeting California's Energy and Environmental Goals in the Electric Power Sector in 2020 and Beyond*, http://www.cacleanenergyfuture.org/2821/282190a82f940.pdf.

691 SMUD developed a feed-in tariff program for up to 100 MW. Part of the program was in response to Senate Bill 32, which increased the current feed-in tariff project capacity from 1.5 MW to 3 MW and also included an obligation for POUs. SMUD calculated that their portion of the 750 MW would be 33.5 MW and so designed their feed-in tariff to have two buckets. 33.5 MW for projects 3 MW and below and an additional 66.5 MW for projects 5 MW and below. Therefore, the 66.5 MW is above what would be required under Senate Bill 32.

692 For more information, please see:
http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/Renewable+Auction+Mechanism.htm.

Incremental Combined Heat and Power

CHP projects are a specific type of distributed generation project that combines elements of both self-generation and wholesale DG. CHP reduces the need for an industrial customer to purchase electricity, thereby affecting the retail electricity sales forecast. Any number selected for use in a renewable net short calculation will be in addition to the amount already embedded in the *2009 CED*.

Staff included a range of possible CHP additions for the renewable net short calculation based in part on the AB 32 *Climate Change Scoping Order* and the 2009 *Combined Heat and Power Market Assessment.*[693] The ARB Scoping Plan set a goal of 4,000 MW of installed CHP capacity by 2020 that would displace about 30 TWh of demand from other generation sources.[694] The ARB also assumed that a substantial portion of existing CHP projects will continue to operate. The 2009 market assessment includes a range of incremental CHP capacity from 2,259 MW to 5,532 MW, with the amount serving the customer side of the meter ranging up to 90 percent which would affect the renewable net short.

Based on these factors, the range of incremental CHP energy to be included in the preliminary renewable net short calculation is between 0 TWh and 16.2 TWh. The lower bound represents the possibility that all of the CHP generation will be sold to the grid or replacing existing facilities and will not affect the renewable net short. The higher bound captures the possibility of greater CHP development levels and increasing amounts of the generation serving owner loads to reduce overall retail electricity sales in California.

Estimating Existing Eligible Renewable Generation

To estimate the renewable net short, staff must consider renewable generation currently in place and expected to be operational for California retail electricity sales in the target year, both in-state and out-of-state. New generation is added each year or procured under contract, and the amount also fluctuates depending on weather conditions that affect the amounts of electricity produced by wind or solar.

The Energy Commission uses a combination of reported energy and capacity data to estimate the existing renewable generation for renewable net short calculations. The most current full year of generation data that has been submitted to the Energy Commission is 2010. For subsequent years, staff used an annual generation value for non-intermittent renewable projects that are operating in California. Small hydroelectric generation is averaged over five years to account for annual hydropower availability. For intermittent wind and solar, the reported installed capacity is used with an average capacity factor to estimate the amount of electricity that can be generated under normal weather conditions. Capacity factors are also applied to plants currently under construction that have power purchase agreements and are expected to

693 ICF International, Inc., prepared the Public Interest Energy Research (PIER) final project report *Combined Heat and Power Market Assessment*, CEC-500-2009-094, in October 2009.

694 California Air Resources Board *Climate Change Scoping Plan*, pp. 42-43.

be operational by the end of each update calendar year (capacity factors currently represent facilities anticipated to be on-line by December 31, 2011).

Out-of-state renewable electricity generation delivered to California is based on the most recent set of Power Source Disclosure Program filings to the Energy Commission. Only imports associated with long-term contracts are applied to the imports estimate, since there is a degree of uncertainty about whether short-term transactions will continue to occur at current observed levels. Similar to the in-state small hydro generation estimates, an average of historical year generation is used to normalize water variations in out-of-state hydropower.

The total amount of existing renewable generation used for the renewable net short calculation is 34.3 TWh. The amount of electricity imports from renewable generation under long-term contract is 9.2 TWh.

Appendix E: Methodology for Setting Regional and Interim Targets for 12,000 MW of DG by 2020

Background

Staff presented a previous iteration of these regional targets at the Energy Commission's May 9, 2011 Integrated Energy Policy Report (IEPR) Committee Workshop titled "Distributed Generation – Getting to 12,000 MW by 2020." The current analysis is modified to reflect public comments from the workshop and continued staff analysis.[695] Changes from the May, 2011 analysis includes:

- More emphasis on development in low-income areas.
- An estimate of the potential capacity to interconnect on local distribution lines.
- A broader mix of technologies.
- A category of "undefined mix" instead of allocating all capacity as either behind the meter or wholesale. In this sense, the current analysis is less prescriptive and more open to future market developments.
- Targets allocated by region instead of county.

More information about the preliminary methodology that staff presented on May 9 is available at: http://www.energy.ca.gov/2011_energypolicy/documents/index.html#05092011

Behind the Meter

Staff assumed that the state's SB 1 goals will be met through the continuation of current market trends. Described below is the methodology for developing regional targets for the California Solar Initiative, Multifamily Affordable Solar Housing program, Single-family Affordable Solar Homes program, New Solar Homes Partnership, Self Generation Incentive Program and Emerging Renewables Program, and Publicly Owned Utility SB 1 programs. The total allocation of solar PV for behind the meter is 3,330 MW. To include non-solar technologies behind the meter, staff also estimated potential wind and biomass development by region.

California Solar Initiative

Data source for PV installation: http://www.californiasolarstatistics.org/current_data_files/

The California Solar Initiative (CSI) program provides two data sets to the public, a working data set and a raw data set. Staff used the working data set because applications with data

695 Staff's presentation and public comments from the workshop are available at: http://www.energy.ca.gov/2011_energypolicy/documents/index.html#05092011 A total of 31 parties representing utilities, environmental groups, developers, environmental justice advocates, and local government provided written comments to the Energy Commission.

errors were removed from it. Staff included projects that were installed, received funding, or for which funding was reserved between January 1, 2007 and June 15, 2011.[696]

Staff categorized projects by year based on the "First Reservation Request Review Date." Staff used this filter because it was identified for all projects regardless. Staff made the following assumptions:

- There were a few projects that had a "First Reservation Request Review Date" from the end of 2006. These projects were added to the 2007 category.
- Due to budgetary constraints, the CSI program is not currently issuing reservations, but is still accepting applications. These applications are added to a waitlist and will be processed as funding becomes available. Staff assumed that additional funding for the CSI program would become available in 2012, and so all waitlisted projects were added to the 2012 category.
- Because the data points were kilowatts (kW) reserved annually, and the CSI program is not currently issuing reservations, staff assumed that the capacity reserved to date in 2011 would be the total capacity reserved for the entire year.[697] Staff then used project location information to categorize each project by the 13 regions used in this analysis.
- Staff identified the number of MW reserved per region and assumed the same trends would continue until the goals of the CSI were met. The data from 2007 to 2011 were plotted and the best fitting trend line was selected to come up with regional projections through 2020.

Multifamily Affordable Solar Housing

The California Public Utilities Commission (CPUC) implements the Multifamily Affordable Solar Housing (MASH) program to provide incentives for PV development on existing, low-income multifamily residences. The MASH program is one of the CSI's two low-income programs. The MASH program is structured to offer incentives under two "tracks." Although Track 1 is now closed, it provided up-front incentives for eligible photovoltaic (PV) installations on low-income residential units or common areas. Track 2 is still open and provides incentives through a bid process. Staff used program data for Track 1 incentives for Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E). Staff chose not to use Track 2 data because there is an inconsistent correlation between project size and rebate level which made it problematic to extrapolate trends.

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696 Staff included all projects that had a current status of "reservation" or a stage beyond that. Staff included projects that had a status of "Pending RFP-Reservation Reserved", "Pending Payment" and "System Removed". Staff did not include projects that had a current status of "Cancelled" or "Withdrawn".

697 Using the reservations that had occurred so far for 2011 to represent the reservations for all of 2011 would have affected the trends for some regions more than others, especially those areas that had seen a high number of reservations in the previous year or two, and then showed a large drop in 2011 due to only having a half year of reservations.

To estimate how much solar could have been installed if MASH continued through 2020, staff first identified the duration of the Track 1 program for each utility. PG&E's, SCE's and SDG&E's programs lasted 9, 12, and 17 months, respectively.[698]

Staff extrapolated program activity to the end of 2020 assuming that it would have remained constant over time. For each utility, staff divided the amount of time from the end of the program to 2020 by the program duration. This resulted in a factor of 15 for PG&E, 11.25 for SCE, and 8 for SDG&E. Staff multiplied these factors by the number of MW installed in each county at the close of Track 1. The result was 244 MW of potential PV installation in multifamily low-income housing.

Single-Family Affordable Solar Homes

The CPUC also oversees the Single-Family Affordable Solar Homes (SASH) program which provides incentives for PV installations on eligible, existing, low-income homes. The SASH program is also under the CSI. The SASH PV-solar incentive is available to qualifying low-income homeowners in the PG&E, SCE, and SDG&E service territories.[699]

The CPUC contracted with Navigant to do a market assessment of the SASH program. Navigant concluded that there are 128,000 SASH-eligible households in Enterprise Zones (EZs) in the IOU service territories.[700] With an average system size of 2.5 kW in the SASH program,[701] single-family low income homes represent a market potential of 320 MW.

Staff uses data on SASH installations to estimate the regional distribution of the potential identified by Navigant, assuming that all 128,000 eligible households identified will install PV. Staff first identifies the county and then EZ for systems installed in a county with an EZ. Although there are 42 EZs state-wide, the SASH data only covers the IOU service territories. Also, not all EZs in the IOU service territories have participated in SASH. To estimate distribution, staff calculates the percent of PV installed in each EZ relative to all PV installations in EZs and then multiplies this percentage by the 128,000 household potential. Staff then multiplies the number of homes in each county by the average 2.5 kW project size to estimate SASH development per region.

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698 http://www.cpuc.ca.gov/NR/rdonlyres/C0EEF9DF-1EF4-4C9A-965D-683205D59293/0/MASHSemiAnnualProgressReport_July2010.pdf, page 14.

699699 California Public Utilities Commission, "Single-family Affordable Solar Homes (SASH) Program Q1 2011 Program Status Report," April 2011, www.cpuc.ca.gov/NR/rdonlyres/BE2A2B11-A16A-4687-A556-39E337E9F1E4/0/2011Q1SASHREPORT.pdf.

700 Page 27: http://www.cpuc.ca.gov/NR/rdonlyres/EB601615-61B3-43B2-B034-EEC95AF46708/0/CSISASHandMASHMarketAssessmentReport.pdf.

701 Page 8, http://www.cpuc.ca.gov/NR/rdonlyres/BE2A2B11-A16A-4687-A556-39E337E9F1E4/0/2011Q1SASHREPORT.pdf.

New Solar Homes Partnership (NSHP)

The NSHP is administered by the Energy Commission and provide rebates for PV installations at newly constructed homes. Staff accounted for projects approved for reservation from January 1, 2007 – July 7, 2011 by county. This totals about 31.5 MW. Staff assumed that the 400 MW NSHP program target would not be met due to the following reasons:

- The depressed housing market
- The NSHP program is for new residential construction. Projects reserved for this program may not be realized for one to three years and the PV installation is dependent upon the builder obtaining and maintaining financing for the construction of the new home(s).
- The incentive for the PV system is tied to the new home achieving specified energy efficiency levels. Even with decreasing equipment costs, builders may not be able to afford the costs associated with achieving the required energy efficiency levels.

Staff assumed a slower growth trajectory for the new homes market, returning to the 150,000 new unit level of the early 2000s, but not the highs of 2004 to 2006.[702] Staff assumes that the program will be successful in achieving its goal of placing PV systems on 50 percent of new homes by the end of the program. Staff's analysis of the NSHP installations shows that the average size for all installed or reserved systems is 2.63 kW. Excluding installations and reservations for common areas, the system size decreases to 2.38 kW. Staff assumed an average system size of 2 kW in part to reflect a market trend toward smaller systems[703]. Also, the assumption that system sizes will continue to get smaller reflects the NSHP program emphasis on properly sized systems. As the energy efficiency requirements increase, the systems should be smaller. Based on the assumed level of housing starts and applying an estimated average system size of 2 kW, staff estimated that 150 MW would be installed through NSHP.

Staff categorized systems by year of their payment approval date. In the NSHP program, developers apply for funds and then make a payment claim after the project is complete. Staff assumes that all NSHP applications would result in completed projects within the timeframes required by the program as follows:

- Staff assumed that systems reserved in 2007 that have not yet received an incentive payment would be completed in 2011, systems reserved in 2008 would be completed in 2012, and systems reserved in 2009 would be completed in 2013. These completion dates correspond to the latest possible date before the project application expires.

702 http://www.cbia.org/go/cbia/?LinkServID=FE5ED931-F09E-44C7-96836630388F21F7&showMeta=0.

703 http://www.cbia.org/go/cbia/government-affairs/cbia-reports1/june-18-2010/square-footage-shrinking-in-new-american-homes/?keywords=new http://www.nahb.org/news_details.aspx?newsID=11485&fromGSA=1 .

- Staff assumed that systems reserved in 2010 that have not yet received an incentive payment would be completed in 2012, and unpaid systems reserved in 2011 would be completed in 2013. Staff assumed these systems would be completed and would receive payment in 2 years instead of 3 years because changes to the NSHP program which allow housing developments to be split up into multiple applications. This allows applicants to apply for funds in timeframes that better match their build-out schedules.
- Since available 2011 payment data only accounts for half of the year, staff assumed an equal capacity of systems would be paid in the second half of the year.

Staff then calculated the installed capacity from 2007 to 2011 per region and the percentage of capacity per region. The percent for each region was then multiplied by 150 MW to estimate the MW per region in 2020.

Publicly Owned Utilities (POUs)

Staff assumes that the POUs will meet their SB 1 targets. Collectively, the target for all POUs is 700 MW. The City of Lompoc and Plumas-Sierra Electric Cooperative did not provide the Energy Commission with their SB 1 megawatt goals. To determine their MW projections, staff developed a trend line with the existing data from 2007 to 2010 and the projections for 2011 through 2016 are based on the extension of the trend line.

Self Generation Incentive Program and Emerging Renewables Program

Staff identified DG installations under the CPUC's Self Generation Incentive Program (from 2007 to present) and all non-PV installations under the Energy Commission's Emerging Renewables Program from 2007 to April 28, 2011.

The data for the Self Generation Incentive Program is available at: https://energycenter.org/index.php/incentive-programs/self-generation-incentive-program/sgip-documents/sgip-documents. Staff first categorized the projects by year based on their payment date. They were further categorized by county and then region. The statewide total is 22 MW.

The data for the Emerging Renewables Program is available online at: http://www.energy.ca.gov/renewables/emerging_renewables/index.html. Staff first categorized the projects by year based on their payment date, then by county and region. The regional totals added up to 1.92 MW.

Estimate of Biomass and Wind Potential

Staff made a rough estimate of biomass potential from dairy cattle populations. Preliminary work from Central Valley Dairies indicates that every 6,000 cattle can produce 1 MW of electricity production from manure.[704] Staff selected counties with dairy cattle populations greater than 6,000 and concluded that the potential from manure is about 275 MW.

704 Personal correspondence with Paul Fukumoto of Flex Energy on July 6, 2011.

To estimate wind potential, staff used an estimate from Foundation Windpower which identified about 100 MW of projects in various stages of construction, permitting, development, negotiation, or proposal.[705] Foundation Windpower also stated that they believe there is at least an additional 100 MW of potential projects in California. Table C-26 shows the estimates of wind potential by region.[706]

Table E-1: Allocation of Small Wind Potential by Region

Region	MW
Central Valley	30
North Bay	10
Los Angeles	10
East Bay	20
Central Coast	50
Inland Empire	50
Imperial	10
Orange County	10
San Diego County	10
TOTAL	**200**

Wholesale Distributed Generation

Energy Commission staff is maintaining a list of renewable energy projects sized 20 MW and smaller that are under environmental review or permitted at the state or local level in California in 2010, 2011, and 2012.[707] The Energy Commission also maintains databases for renewable facilities under contract to the investor-owned utilities (IOUs) and the publicly owned utilities.[708]

The IOU contract database is available at: http://www.energy.ca.gov/portfolio/IOU_Contract_Database.xlsx.

The publicly owned utility contract database is available at: http://www.energy.ca.gov/2008publications/CEC-300-2008-005/CEC-300-2008-005_rev.xls.

Staff carefully reviewed the Energy Commission's IOU and publicly owned utility contract databases and the environmental review project database to remove projects that were on-line before 2007, located out of state, were behind the meter, or exceed 20 MW, including project

705 Personal correspondence with John Pimentel of Foundation Windpower on July 13, 2011.

706 Foundation Windpower suggested 20 MW wind in Orange and San Diego Counties combined. For the purpose of this regional analysis, staff assumed 10 MW in each county.

707 The data on environmental reviews used for this analysis was last updated on June 14, 2011.

708 For this analysis, staff used the database on IOU-RPS contracts that was last updated in April, 2011 and the POU database was last updated November 17, 2010.

expansions that increased the overall project size to a capacity of more than 20 MW. Staff also removed projects that were determined likely to fail, such as a tidal generation project. However, staff does not have detailed information on all the projects to make these determinations, and as a result there may be minimal double counting or inclusion of projects that serve on-site load. Staff identified 645 MW under contract and 2,320 MW going through environmental review at the local level, and about 197 MW both under contract and environmental review.

Staff intended to identify projects under contract or in environmental review that were also in the distribution and transmission interconnection queues, but were only able to obtain the necessary data to identify the projects located in the California Independent System Operator's (California ISO) generation interconnection procedure (GIP) queue. Staff did this analysis through a review of confidential data received from the California ISO from a quarterly subpoena. To date, staff has been unable to determine the WDAT queue status of the projects due to Federal Energy Regulatory Commission restrictions on data confidentiality.

Next, staff assigned regions to the wholesale projects by the county in which the project is located. Staff used Microsoft Excel's pivot table function to divide the projects into the categories shown below, also by region and technology.

- Wholesale projects that are on-line, 50 MW.
- Wholesale projects in the environmental review database, the IOU or POU contracts database, and the GIP interconnection queue, 20 MW.
- Wholesale projects in the IOU or POU contracts database and the environmental review database, 197 MW.
- Wholesale projects in the IOU or POU contracts database and the GIP interconnection queue, 0 MW (one project would qualify for inclusion in this category, but because it is also under environmental review, the project is included under the second bullet).
- Wholesale projects in the GIP interconnection queue and the environmental review database, 169 MW.

Estimated Potential for Interconnection at the Distribution Level

For the final piece of analysis, Energy Commission staff investigated California's distribution infrastructure, hoping to gain visibility into which geographic areas had capacity to interconnect distributed generation projects without requiring extensive upgrades. Following the California Public Utilities Commission's (CPUC) Rule 21 guidelines, staff estimated total distributed generation interconnection capacity by first applying a screen based on "15% of the distribution line section annual peak load,"[709] commonly referred to as "excess capacity." Next, staff estimated region's total available capacity by adding in its queued and waitlisted CSI and NSHP capacity, and its previously calculated wholesale capacity. This final number, a region's

709 California ISO's Small Generator Interconnection Procedures: http://www.caiso.com/27c3/27c3ecd2556e0.pdf.

total capacity available for localized generation, estimates a cap on feasible interconnections on current infrastructure. Staff assumes that projects developed in areas with available capacity will have low interconnection costs. However, staff recognizes that application of the 15% screen does not guarantee that project development will not require costly circuit upgrades to accommodate interconnection. Also, staff recognizes that although a line may have interconnection capacity, there may not be adequate space available to develop a project, or there may be other site constraints that preclude development.

Staff generated estimates for 9 of its 13 identified regions. For this effort, the Energy Commission requested substation capacity information calculated under the CPUC's Renewable Auction Mechanism procurement program from the state's three largest investor owned utilities. The utilities made this data available to the public in a limited fashion through the Renewable Auction Mechanism maps, which are accessible through each utility's website. Considerable heterogeneity exists between different utilities' data, which constrained staff's ability to conduct the analysis. PG&E provided geographic data for all of its substations; SCE and SDG&E did not. For this reason, staff made the simplifying assumption that all of SDG&E's substations were in San Diego County, despite the fact that SDG&E's territory extends into southern Orange County. The Energy Commission staff did not obtain data from publicly owned utilities or smaller investor owned utilities, and therefore does not have excess capacity numbers for Imperial County, Los Angeles, Orange County, or the Inland Empire. The numbers provided for Central Coast, Central Valley, East Bay, North Bay, North Valley, SACOG, SF Peninsula, and Sierras only reflect capacity on the PG&E distribution grid.

SCE provided interconnection potentials that were originally calculated for their Solar Photovoltaic Program (SPVP). This program sought to encourage the installation of 1 to 2 MW rooftop solar PV systems. SCE capped each line's interconnection potential at 2 MVA, following the Merchant Plant interconnection under the federal WDAT application. This cap remained in place for the numbers provided for staff's analysis, making it unclear just how reflective the provided capacities are of SCE's true interconnection potential. Instead, staff attempted to use public information from SCE's RAM program.[710] Unfortunately, SCE's RAM maps identify only preferred geographic areas for interconnection, without including any indication of an area's interconnection potential. Nevertheless, SCE has stated that their RAM program target is 500 MW; looking at the maps provided, Energy Commission staff estimate that at least one tenth of this appears to be along the Central Coast. Based on these basic parameters, staff added 50 MW of excess capacity to the Central Coast region.[711]

Staff used the calculated available capacity for each region as a ceiling for a region's capacity to accommodate relatively inexpensive interconnection, seeking to ground a region's total goal in feasible possibilities for future project development. Ultimately, however, these regional goals

710 The maps are available at: http://www.sce.com/EnergyProcurement/renewables/renewable-auction-mechanism.htm.

711 Ventura County and parts of Santa Barbara are in SCE's territory, while PG&E serves the rest of the Central Coast region.

reflect policy decisions. Therefore, staff used regional targets set by the Governor's Office,[712] which took economic development and resource potential[713] into account, in addition to other considerations, to set their overall distribution. Staff's analysis and projections for wholesale and behind the meter installations resulted in some areas exceeding these regional targets. This meant that the Governor's Office goals were used as a guideline for the final capacity allocation, but staff's final projections do not perfectly match these original allocations.

The results of this analysis are a rough cut for development potential. As California strives to integrate more distributed generation into the grid, the shortcomings of Rule 21 and its underlying screen have become more apparent. Stakeholders and utilities have convened workshops to revise these guidelines, recognizing that technology, existing distribution and substation infrastructure, and facility characteristics are also important in determining grid impacts.

The resulting goals distribute local generation across the state, focusing on urban centers like Los Angeles and San Diego that have relatively good climate and available space relative to the San Francisco Peninsula and East Bay regions, and areas of high resource potential, like the Central Valley. Staff's final distribution places 571 MW on the Central Coast, 2054 MW in the Central Valley, 682 MW in the East Bay, 147 MW in Imperial County, 1000 MW in the Inland Empire, 3842 MW in Los Angeles, 223 MW in the North Bay, 316 MW in the North Valley, 740 MW in SACOG, 1091 MW in San Diego, 770 MW on the San Francisco Peninsula, 66 MW in the Sierras, and 500 MW in Orange County.

Challenges

Staff recognizes that there are several challenges with this methodology. One challenge is developing a common definition of a renewable localized generation facility to clarify discussion and planning related to achieving the Governor's goal for 12,000 MW of renewable localized generation by 2020.

Staff recognizes that achieving the assumption for aggressive development in low income housing areas totaling 564 MW will be challenging. The analysis assumes that installations under the MASH program's Track 1 continue on the initial program activity trajectory, despite the closure of the rebate due to lack of funding. According to the MASH Semi-annual progress report, there has been 2.031 MW installed through Track 1.[714] There is no data on installation for Track 2 but so far only 1.327 MW has been reserved. Staff estimates that if MASH had continued on its current trajectory through 2020, there would be 244 MW installed on multifamily low-

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712Presentation by Michael Picker at the May 6, 2011 Integrated Energy Policy Report workshop, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-09_workshop/presentations/02b_Off_of_Gov_Picker_Background.pdf.

713 The estimate of technical potential was based on a NREL/Lawrence Livermore study available at the California Renewable Resource Portal, January 28, 2010. www.calrenewableresource.llnl.gov/solar/potential-by-county.php.

714 ftp://ftp.cpuc.ca.gov/gopher-data/energy_division/CSI/MASHSemi-AnnualProgressReport_Feb 2011.pdf.

income housing. Clearly, there is a large disconnect between program progress to date and the policy direction pursued through these regional targets.

For the SASH program, the methodology assumes build-out of the technical potential in the Enterprise Zones of PG&E, SCE, and SDG&E service territories, totaling about 320 MW. The SASH Program budget is $108.34 million, with $92 million allocated to incentives. As of the first quarter of 2011, a total of 992 homes requested $17 million in incentives, for 2 MW of solar.[715] If SASH continues on its current trajectory, an estimated 5,700 solar homes would be incentivized by the end of the program, for approximately 14.5 MW. Achieving the targets proposed in this paper for low income housing will be extremely challenging.

Another challenge is that some of the most promising, and possibly least-cost, resource areas are in the Central Valley where load is relatively low. Wide-scale development of distributed generation in the Central Valley may not be "localized" resources and may not create as many jobs in low-income areas, but may be a lower-cost course of development in a time when the state is undergoing a financial crisis.

Also, this methodology largely builds off market trends as a proxy for future development. This approach does not account for new developments that are not yet considered in the market. Further, staff is reviewing comments from the Governor's Conference on Local Renewable Energy Resources and the May 9th Workshop to further refine these targets and explore other options beyond a market-based approach.

715 http://www.cpuc.ca.gov/NR/rdonlyres/BE2A2B11-A16A-4687-A556-39E337E9F1E4/0/2011Q1SASHREPORT.pdf.

Appendix F: Description of Transmission Projects Needed to Support California Renewable Energy Mandates

Sunrise Powerlink Transmission Project

The San Diego Gas & Electric Company's (SDG&E) 117-mile Sunrise Powerlink is under construction and is expected to be in service by 2012.[716] The project will increase the import capability into San Diego from the renewable energy rich Imperial Valley by an additional 1,000 MW for a total of 1,700 MW. As of May 24, 2011, the California Independent System Operator (California ISO) Interconnection Queue included more than 7,600 MW of renewable generation in Imperial County that could use the Sunrise Powerlink to provide power to SDG&E and the rest of California.[717] There are also another 3,000 MW of renewable generation in the Imperial Irrigation District (IID) Interconnection Queue that could make use of the Sunrise Powerlink.[718]

Tehachapi Renewable Transmission Project

Southern California Edison's (SCE's) Tehachapi Renewable Transmission Project (TRTP) will provide the electrical facilities necessary to integrate new wind generation – up to approximately 4,500 MW – in the Tehachapi Wind Resource Area and accommodate solar and geothermal projects either planned or expected in the future. As of May 24, 2011, the California ISO interconnection queue had 13,774 MW of renewable generation in Kern County and 2,390 MW in Los Angeles County that could use transmission capacity provided by the TRTP.[719]

The TRTP addresses reliability needs of the California ISO-controlled grid due to projected load growth in the Antelope Valley and the South of Lugo transmission constraints in Hesperia, California. The project includes more than 300 miles of new and upgraded high-voltage electric transmission lines and substations to deliver electricity from new wind farms planned by independent power producers in Eastern Kern County to the Los Angeles Basin. A new major substation component of the TRTP, SCE's Whirlwind facility, is currently under construction

716 http://www.sdge.com/sunrisepowerlink/.

717 California ISO Controlled Grid Generation Queue and Map, Docketed 5-24-11.

718 Keene, Stephen, Imperial Irrigation District, *Transcript of the May 17, 2011 IEPR Committee Workshop on Transmission Needed to Meet State Renewable Policy Mandates and Goals*, p. 71, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/2011-05-17_Transcript.pdf , accessed June 9, 2011.

719 California ISO, Renewable Generation in the ISO Queue as of 5/24/11, Docket Nos. 11-IEP-1E and 11-IEP-1G, May 24, 2011, http://www.energy.ca.gov/2011_energypolicy/documents/2011-05-17_workshop/comments/CAISO_Controlled_Grid_Generation_Queue_and_Map_TN-60916.pdf, posted June 3, 2011, accessed June 9, 2011.

and is expected to be completed in 2113.[720] The entire project is expected to be completed by 2015.[721]

Colorado River – Valley 500 kV Project (and Red Bluff Substation)

SCE's Colorado River – Valley 500 kV transmission project includes the Colorado River to Devers project (which has also been called the California only portion of the Palo Verde – Devers #2 project). With the West of Devers upgrade (discussed below), this project would allow for delivery of about 4,700 MW from Riverside County. In 2007, SCE received a Certificate of Public Convenience and Necessity (CPCN) from the California Public Utilities Commission (CPUC) for the Palo Verde – Devers #2 line, and in 2009 SCE was issued a modified decision that allowed the termination of the project at the proposed Colorado River Substation in California rather than the Palo Verde (Harquahala) Substation in Arizona.[722]

The Colorado River – Valley 500 kV Project will consist of the following main components:

- A new 500/220 kilovolt Colorado River Substation near Blythe.
- A new 111-mile 500 kilovolt transmission line between SCE's Devers Substation near Palm Springs and the new Colorado River Substation that would parallel the existing Devers-Palo Verde transmission line.
- A new 42-mile 500 kilovolt transmission line between Devers Substation and SCE's Valley Substation in Menifee that would parallel the existing Devers-Valley transmission line.[723]

In Riverside County, there are currently more than 8,700 MW of renewable generation in the California ISO Generator Interconnection Queue. This project would allow generators in eastern Riverside County to connect with the Devers Substation in Southern California. SCE expects to begin construction on the project in 2011. SCE applied for the Permit to Construct (PTC) for the expanded Colorado River Substation in November of 2010.[724] The CPUC granted the PTC for the Colorado River Substation on July 14, 2011. Also on July 14, 2011 the BLM issued its Record of Decision for the Devers – Palo Verde No. 2 Transmission Project[725] (now called the Colorado River – Valley project.)

If the required federal permits for the 220 kV bus expansion are issued by late 2011, the interconnecting bus for generators could be completed by summer 2013. SCE has also proposed

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720 SCE Petition for Declaratory Rate Treatment, December 2010, Exhibit E, Page 9.

721 (http://www.sce.com/PowerandEnvironment/Transmission/ProjectsByCounty/Multi-CountyProjects/TRTP1-3/default.htm), and http://www.sce.com/PowerandEnvironment/Transmission/ProjectsByCounty/Multi-CountyProjects/TRTP4-11/tehachapi-4-11.htm.

722 http://docs.cpuc.ca.gov/published/FINAL_DECISION/110360.htm.

723 http://www.sce.com/PowerandEnvironment/Transmission/ProjectsByCounty/RiversideCounty/DPV/default.htm.

724 http://docs.cpuc.ca.gov/efile/A/126246.pdf.

725 See: http://www.blm.gov/ca/st/en/prog/energy/fasttrack/devers.html.

to build the 220/500 kV Red Bluff Substation as a second interconnection point for generators in Riverside County. The would tie into the SCE transmission network by looping in the Colorado River – Valley 500 kV line and the existing Devers – Palo Verde 500 kV line while providing another interconnection point for generators near Desert Center, California. SCE applied for a PTC from the CPUC in November of 2010. The CPUC granted the PTC for the Red Bluff Substation on July 14, 2011. SCE plans to begin construction as soon as the project receives all federal approvals and could complete construction as early as the summer of 2013.[726]

Eldorado to Ivanpah Transmission Project

The Final Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for SCE's El Dorado – Ivanpah Transmission Project was published November 9, 2010 and the CPCN was granted December 16, 2010.[727] The proposed project will provide the electrical facilities necessary to integrate more than 1,400 MW of new solar energy generation in the Ivanpah Dry Lake area. The project's major components include: (1) construction of a new Ivanpah Substation in San Bernardino County; (2) removal of approximately 35 miles of existing 115 kV transmission line and replacement with a new double-circuit 220 kV transmission line between the new Ivanpah Substation and the existing Eldorado Substation in Clark County, Nevada; and (3) installation of associated telecommunication infrastructure. The El Dorado – Ivanpah Project is expected to be on-line in 2013.

Borden – Gregg 230 kV Reconductoring Project

Pacific Gas and Electric Company's (PG&E's) Borden – Gregg 230 kV project would allow for the delivery of 800 MW of new solar generation proposed in the Fresno area, specifically the Westlands area.[728]

South of Contra Costa Reconductoring Project

Pacific Gas and Electric's (PG&E) South of Contra Costa Reconductoring project has the potential to deliver 535 MW of new wind generation in the Solano Competitive Renewable Energy Zone (CREZ). Without reconductoring the lines south of the Contra Costa Substation, none of the renewable generation proposed in the Solano area would be considered deliverable.[729]

Pisgah – Lugo Renewable Transmission Corridor Project

SCE's Lugo – Pisgah Renewable Transmission Corridor Project is needed to interconnect and deliver power generated by the Calico Solar Project and other generators near Newberry Springs in the Mojave Desert. The project consists of nearly 67 miles of new 500 kV transmission

726 http://docs.cpuc.ca.gov/efile/A/126666.pdf.

727 http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/128873.htm.

728 California Independent System Operator 2010/2011 Transmission Plan, page 341.

729 California Independent System Operator 2010/2011 Transmission Plan, page 255.

line from the new Pisgah substation to the Lugo Substation. The majority of the project, 51 miles, would replace the existing Lugo – Pisgah No. 2 220 kV line and use the existing transmission corridor. The remaining 16 miles, between the Lucerne Valley area and the Lugo Substation, would require a new corridor because the existing corridor is not wide enough for a 500 kV line.[730] According to the California ISO 2010-2011 Transmission Plan, the Lugo – Pisgah Project would provide access to about 1,750 MW of renewable capacity in the Mojave Desert.[731] SCE anticipates submitting permit applications to the CPUC and the BLM in early 2012 and having the project operational by 2017.

West of Devers Transmission Upgrades

SCE's West of Devers transmission upgrades have been identified as network delivery upgrades in the California ISO's Generator Interconnection process. The West of Devers upgrades consist of the relocation and upgrade of the four 230 kV circuits heading west from the Devers Substation, two circuits to the San Bernardino Substation and two to the Vista Substation. SCE has approval from the Federal Energy Regulatory Commission (FERC) and the California ISO through acceptance of the non-conforming Large Generator Interconnection Agreement (LGIA) for the Blythe, Genesis and Palen solar generating projects in Riverside County.[732] SCE is beginning to develop routes and gather the environmental information required to apply for required state and federal permits. Without the West of Devers upgrades, most of the renewable generation proposed in eastern Riverside County will be unable to meet the deliverability requirements in their power purchase agreements. The current expectation is that unless there are unforeseen licensing issues, the West of Devers upgrades could be completed by 2017.

The California ISO identified an interim solution that would allow much of the generation proposed in eastern Riverside County and the Imperial Valley to meet deliverability requirements until the West of Devers upgrades are operational. The interim solution, which would cost less than $50 million, consists of series reactors on existing lines and a special protection scheme to trip generation and/or load under various contingencies. These upgrades would not require environmental licensing; however, they would not have any value once the West of Devers Upgrade was operational.[733]

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730 Southern California Edison, http://www.sce.com/PowerandEnvironment/Transmission/ProjectsByCounty/SanBernardinoCounty/LugoPisgah/lugopisgah.htm.

731 California Independent System Operator 2010/2011 Transmission Plan, Table 4-2.1 page 222.

732 http://www.caiso.com/2b28/2b28811743ed0.pdf, http://www.caiso.com/2b1b/2b1bbe5734440.pdf, http://www.caiso.com/2875/2875ed9e5d360.pdf, and http://www.caiso.com/2867/2867bfb23c1b0.pdf.

733 California ISO 2010/2011 Transmission Plan, page 289.

Carrizo – Midway 230 kV Reconductoring Project

On May 5, 2011 PG&E submitted a Notice of Construction to the CPUC for transmission facilities that would connect renewable generators in the Carrizo Plain to the PG&E grid. The proposed project consists of two new PG&E switching stations associated with two solar PV projects and reconductoring about 35-miles of the existing Morro Bay – Midway 230 kV transmission line. Permits for the switching stations were issued by San Luis Obispo County as part of the Conditional Use Permits granted for two PV projects: the California Valley Solar Ranch Project and the Topaz Solar Farm Project. PG&E plans to begin construction in July of 2011 with the project completed and able to deliver up to 900 MW of new solar generation by the end of 2012.[734]

Coolwater – Jasper – Lugo Transmission Project

SCE's Coolwater – Jasper – Lugo transmission project is a network delivery transmission upgrade identified through the Large Generator Interconnection Procedures for the Abengoa Mojave Solar Project. The project would facilitate solar development in the Kramer area, San Bernardino-Lucerne Valley, Inyokern, and Owens Valley, as well as geothermal development in Nevada that interconnects near Mono Lake. The project consists of substation upgrades at SCE's existing Coolwater and Lugo Substations, a new Jasper Switching Station, and 63 miles of new transmission facilities between the Coolwater and Lugo Substations. Forty-seven miles of the project would be new 220 kV facilities, and the remaining 16 miles would be built as 500 kV towers with the line energized at 220 kV.[735] The majority of the transmission line will likely require a new corridor. The project will allow for the delivery of up to 700 MW of new generation to California load centers.[736] The project could be on-line by 2018.

In addition, the project would increase deliverability for generation in the Western Mojave area, one of the most promising areas for solar development in California with some of the highest solar insolation in the world. This area also has a high concentration of disturbed land, including former and marginal agricultural land, which generally has little value as habitat for endangered species and can therefore be developed with minimal adverse impacts to biological and cultural resources.[737]

California ISO/IID Joint Path 42 Upgrades

The joint SCE/IID upgrade of the path is critical for delivery of renewable generation in the IID area into the California ISO. Upgrading Path 42 requires improvements to facilities under the control of SCE and the California ISO as well as facilities under IID control. The IID upgrades

734 Source: Advice 3842-E, Notice of Construction for the Carrizo – Midway Reconductoring Project, PG&E May 5, 2011, http://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_3842-E.pdf.

735 Source: SCE Petition for Declaratory Rate Treatment, December 2010.

736 Source: California ISO 2010-2011 Transmission Plan, page 222.

737 See http://www.caiso.com/Documents/CaliforniaEnergyComments_RenewablePortfolioAssumptions_2011-2012TransmissionPlanningProcess.pdf.

consist of replacing the 220 kV circuits between the Coachella Valley Substation and the Mirage Substation with bundled circuits, two conductors per circuit. The IID portion of the upgrades would increase the capacity of IID's portion of the path by around 800 MW and could be completed by the end of 2011. The SCE portion of the upgrade received California ISO Board of Governors approval upon adoption of the 2010-2011 Transmission Plan. SCE is studying ways to upgrade the existing Mirage – Devers 220 kV line without replacing the transmission poles to reduce the licensing/permitting time. The total renewable potential for the California ISO/IID Path 42 upgrades is approximately 1,400 MW.

Imperial Irrigation District Upgrades

IID has promoted renewable energy in the Imperial Valley for many years. Nearly 20 years ago, IID upgraded its transmission system by building a 230 kV collector system to accommodate the interconnection of new geothermal generation and export of this renewable energy to the California ISO balancing authority area. Currently, IID wheels approximately 550 MW of geothermal energy from Imperial Valley into the California ISO.[738]

IID has developed a detailed long-term transmission plan (10 years plus timeframe) to define the transmission improvements necessary to continue meeting its load service requirements in future years as well as allowing for the export of renewable resources from the Imperial Valley area. The plan has primarily focused on the upgrade of certain sections of IID's 161 kV transmission system to 230 kV to integrate the existing 230 kV collector system and create a 230 kV transmission loop that will cover most of IID service area to allow for the export of renewable generation to the north, south and east of IID's service area. The individual projects were described in detail in Appendix C of the Energy Commissions' *2009 Strategic Transmission Investment Plan*.

Licensing and construction of transmission upgrades by IID could be completed for generators in their transition cluster by December of 2013 but require the execution of LGIAs. One key component of these upgrades is the Path 42 Upgrade, which would increase the export capability from IID to SCE by about 855 MW but requires line upgrades on the IID and SCE parts of the path from the Mirage Substation to the Devers Substation.[739] The IID portion consists of upgrading the existing double-circuit line from the Coachella Valley Substation to Mirage, and IID estimates that it could complete this upgrade by the end of 2011.[740]

Barren Ridge Renewable Transmission Project

The Los Angeles Department of Water and Power's (LADWP) Barren Ridge Renewable Transmission Project consists of a new 61-mile double-circuit 230 kV transmission line between the Barren Ridge Switching Station and a new Haskell Canyon Switching Station. The Barren Ridge Switching Station is a newly constructed facility along the existing Inyo to Rinaldi line,

738 RETI Draft Phase 2A Report, Appendix G, pp. 13-18.

739 Transcripts from May 17, 2011 workshop, Keene page 74.

740 Source: IID Transmission F&I response, page 7.

approximately 20 miles north of the City of Mojave. The project also includes reconductoring of the existing line from Barren Ridge to Haskell Canyon. The construction of the new line and the reconductoring will provide access to 1,000 MW of wind, solar, and other renewable resources.[741] The project is in the environmental analysis process with the final EIR/EIS expected in mid-2012 and the Notice of Decision/ Record of Decision issued in late summer 2012. The project could be on-line in early 2016.[742]

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741 Source: LADWP March 28, 2008 Fact Sheet for the Barren Ridge Renewable Transmission Project, available at: http://www.ladwp.com/ladwp/cms/ladwp009509.pdf

742 Source: http://www.ladwp.com/ladwp/cms/ladwp009508.jsp

Appendix G: Additional Information Resources for Renewable Distributed Generation Planning and Permitting Assistance

National

- **American Planning Association (APA)**
  "Wind Energy Planning: Results of the American Planning Association Survey", July 2010 (DG)
  This ongoing survey assesses the current state of wind energy planning in communities across the country. It also inquires about challenges that planners are facing in the process of planning, regulating and implementing wind energy facilities.
  For more information,
  visit: www.planning.org/research/wind/surveyreport.htm

- **American Wind Energy Association (AWEA)**
  "Permitting Small Wind Turbines: A Handbook", September 2003. (small-scale DG)
  This is an informative guide to assist public officials and property owners in understanding the permitting process for small wind systems; it includes best practices for siting.
  For more information,
  visit: www.consumerenergycenter.org/erprebate/documents/awea_permitting_small_wind.pdf

- **Department of Energy (DOE)**
  Solar America Cities / Solar America Communities (Community-scale DG)
  The Solar America Cities program provided awards and funding for special projects to cities throughout the U.S. that demonstrated a strong effort to promote solar power and streamlined interaction between local government and residents.
  For more information, visit: www.solaramericacommunities.energy.gov/home.aspx

  SunShot Initiative (DG)
  The SunShot Initiative focuses on increasing the efficiency of equipment in the solar market, and on reducing the cost of installation and permitting for solar systems. Recently, $27 million has been made available for grants intended to assist in decreasing non-hardware costs of solar energy systems, specifically focusing on rooftop, distributed generation solar systems.
  For more information, visit: http://www1.eere.energy.gov/solar/sunshot/index.html

  Solar America Board for Codes and Standards (Solar ABC's) – "Expedited Permit Process for PV Systems," October 2009 (Small-scale DG)
  This report presents industry and local officials with a standardized process for reviewing and issuing permits for solar PV systems. These standards have been adopted by several building departments nationwide.

For more information, visit: www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Expermitprocess.pdf

"Solar Educational Resources for Code Officials" (Small and community-scale DG)
This site offers a portal to a variety of technical documents aimed at assisting code officials with planning, monitoring, and overseeing PV markets locally.
For more information,
visit: http://www1.eere.energy.gov/solar/code_official_resources.html

"Solar Powering Your Community: A Guide for Local Governments", January 2011. *(Community-scale DG)*
This Guide was created for local government and stakeholder use in developing and implementing a strategic local solar plan.
For more information, visit: www.solaramericacommunities.energy.gov/pdfs/Solar-Powering-Your-Community-Guide-For-Local-Governments.pdf

Wind Powering America - "Siting Wind Turbines" (DG)
This web portal provides important information and links to other resources on siting and permitting practices for distributed generation wind systems.
For more information, visit: http://www.windpoweringamerica.gov/siting.asp

- **National Renewable Energy Laboratory (NREL)**
  "Analysis of the Status and Impact of Clean Energy Policies at the Local Level", 2010 (DG and Utility Scale)
  This report provides a background on the role of local government, an overview of the current status of local clean energy policy, a summary of results from a questionnaire of local government officials, and advice for further local government research. The report highlights that there is little diffusion of clean energy policies across local governments.
  For more information,
  visit: www.nrel.gov/applying_technologies/state_local_activities/pdfs/49720.pdf

- **National Wind Coordinating Collaborative (NWCC)**
  "Permitting of Wind Energy Facilities: A Handbook", 2002
  This document presents suggestions for permitting officials to improve the efficiency and flow of the permitting process. The publication applies to both small-scale and utility-scale wind, and also points out the differences between distributed generation and wind farms, as applicable to specific difficulties in permitting that arise in each venue.
  For more information,
  visit: http://www.nationalwind.org/assets/publications/permitting2002.pdf

- **SolarTech**
  SolarTech Permitting Committee Initiative, "Online Permit Application Interoperability Standard", November 11, 2009 (DG)

This document represents Phase 1 of the Online Permit Application process interoperability standards and describes a general approach to automating the building permit process and its interfaces to various stakeholders.
For more information, visit:
www.solartech.org/index.php?option=com_st_document&view=documentdetail&id=14&Itemid=58

- **SunRun**
"The Impact of Local Permitting on the Cost of Solar Power", January 2011 (DG)
This report includes a detailed breakdown of the permitting and inspection costs and a series of practical recommendations the federal government should encourage to improve the onerous requirements and processes.
For more information, visit:
www.sunrunhome.com/cost-of-solar/solar-panels/local-permitting

- **The Energy Foundation**
"Community Wind 101: A Primer for Policy Makers", September 2008 (DG and Utility Scale)
This report lays out a set of public policies designed to increase local wind investment and ownership.
For more information, visit:
www.ef.org/docs/CommWind_web.pdf

- **The Vote Solar Initiative**
This website provides users with a map comparing current permitting costs and processing times for cities throughout the U.S. It also includes a toolkit for local governments, including a list of best practices for permitting.
For more information, visit:
www.votesolar.org/city-initiatives/project-permit/.

California

- **California Air Resources Board**
"Guidance Resources for Power Plants", Updated 2008 (community-scale DG and utility-scale)
This web site compiles short descriptions and links to various documents that discuss best practices for siting and permitting power plants. http://www.arb.ca.gov/energy/powerpl/powerpl.htm

  "Air Quality Guidance for Siting Biorefineries in California", DRAFT, October 2010 (community-scale DG and utility-scale)
  This document provides guidance on best practices for siting biofuel production facilities in California. Technologies covered by this document can also be used for siting biomass to electricity conversion facilities under 50 MW.
  For more information, visit:

http://www.arb.ca.gov/fuels/lcfs/101110_DRAFT_Air_Quality_Guidance_for_Siting_Biorefineries.pdf

- **California Energy Commission**

  "Solar Electric Photovoltaic/Solar Thermal Hot Water Systems Survey Report", (small-scale, residential DG)

  This report is in the process of being developed and examines trends in permitting fees and processing times for solar electric photovoltaic and solar thermal hot water systems on new and existing residences throughout California. Survey data for the report was collected in 2007, 2009, and 2010.

  For more information, visit: contact the Renewable Energy Office at renewable@energy.state.ca.us

  "Energy Aware Planning Guide", February 2011 (DG and Utility Scale)

  This guide is a comprehensive resource for local governments seeking to reduce energy use, improve energy efficiency, and increase usage of renewable energy across all sectors.

  For more information, visit: www.energy.ca.gov/energy_aware_guide/index.html

  "Energy Aware Facility Siting and Permitting Guide, Consultant Report", December 2010 (DG and Utility Scale)

  This guide assists local governments with developing general plan energy and transmission elements and provides guidance on electricity generation, transmission, and permitting.

  For more information, visit: www.energy.ca.gov/energy_aware_guide/siting.html

  "Distributed Generation: CEQA Review and Permit Streamlining", 2000 (DG)

  This report summarizes the results of a stakeholder workshop and surveys with local government planning directors and building officials that focus on the CEQA review process, issuance of permits, and technical assistance needed to establish a regulatory framework for processing DG projects.

  For more information, visit: www.energy.ca.gov/reports/2000-12-21_700-00-019.PDF

  "The Role of Land Use in Meeting California's Energy and Climate Change Goals", August 2007 (DG and Utility Scale)

  Chapter 7 of this staff report is helpful for local jurisdictions that seek guidance on including utility planning with land use planning.

  For more information, visit: www.energy.ca.gov/2007publications/CEC-600-2007-008/CEC-600-2007-008-SF.PDF

  "Solar PV Permitting Study, Study and Recommendations for Residential Permitting", June 2010 (prepared for the Energy Commission (PIER) Program (small scale, residential DG)

  This Study provides recommendations, based on the results of a survey of 33 San Francisco Bay Area cities, for standardizing the permitting process of solar photovoltaic technologies. A copy of this report is available to Energy Commission staff at no cost; cost for non-members is $45.

  For more information, visit:
  www.solartech.org/index.php?option=com_st_document&view=general&Itemid=143

California Guidelines for Reducing Impacts to Birds and Bats from Wind Development, 2007,
These voluntary guidelines provide information to help reduce impacts to birds and bats from new development or repowering of wind energy projects in California. They include recommendations on preliminary screening of proposed wind energy project sites; pre-permitting study design and methods; assessing direct, indirect, and cumulative impacts to birds and bats in accordance with state and federal laws; developing avoidance and minimization measures; establishing appropriate compensatory mitigation; and post-construction operations monitoring, analysis, and reporting methods.
For more information, visit: http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF

"Developing Renewable Generation on State Property", 2011
This report focuses on the potential for developing renewable distributed generation - onsite or small energy systems located close to where energy is consumed - on state-owned properties to contribute toward the goal of installing 20,000 megawatts of renewable generation by 2020. In addition to distributed generation, the report explores the potential for developing utility-scale renewables on state properties as well. Making state properties available to renewable developers could reduce energy costs in state buildings, create new sources of revenue by leasing vacant or unused lands and highway rights-of-way, and provide cost savings to the state through reduced land maintenance costs that would be assumed by renewable developers who use those lands.
For more information, visit: http://www.energy.ca.gov/2011publications/CEC-150-2011-001/CEC-150-2011-001.pdf

- **Climate Change, Land Use, and Infrastructure Web Portal, 2011 (CCLU-In) (DG and Utility Scale)**
  This web portal allows local governments to access existing state programs, projects, guidance and resources related to land use and sustainable community planning.
  For more information, visit: www.climatechange.ca.gov/action/cclu/index.php

- **Sierra Club, Loma Prieta Chapter**
  "Reducing Local Barriers to the Installation of Solar Power Systems", Last updated 2011 (residential DG). This chapter of the Sierra Club conducted survey studies on the costs of permitting and permit processing times for solar photovoltaic systems in various jurisdictions throughout California.
  For more information, visit: http://lomaprietaglobalwarming.sierraclub.org/solar.php