Attachment A

Potential Activities in the *2009 Integrated Energy Policy Report* Related to Increasing Renewable Generation in California

Introduction

Increasing the use of renewable energy has been a priority in California since the 1970s. With increased awareness of the impending threat of climate change, expanding the use of renewable energy is clearly an essential strategy in reducing the state's reliance on carbon-based fuels that contribute to GHG impacts.

California currently has a mandate to achieve 20 percent of retail electricity sales from eligible renewable resources by 2010, and the Governor and the state's energy agencies have identified a further goal of 33 percent renewable by 2020. This higher goal is a key strategy for meeting the state's Assembly Bill 32 (Nuñez, Chapter 488, Statutes of 2006) greenhouse gas (GHG) emission reduction targets of 1990 levels by 2020. To help meet the Governor's Executive Order S-3-05 goal to reduce GHG emissions to 80 percent below 1990 levels by 2050, the IEPR Committee believes that California may need to broaden its focus to include even higher renewable goals, such as 50 percent renewables by 2050.

California is behind other major economies in the on-going expansion of global renewable energy supply. The level of total global investment in renewable energy deployment has skyrocketed in recent years from $33 billion in 2004 to nearly $150 billion in 2007.

The cost of increasing the use of renewable energy continues to be a major concern; however, short-term investment to expand California's use of renewable energy will help lower GHG emissions and reduce the long-term costs of catastrophic climate change effects.

It is also important to remember that reducing the use of fossil fuels is not solely a climate change mitigation strategy. The fossil fuel with the largest effect on the electricity sector is natural gas. NYMEX natural gas futures have fluctuated wildly in the past 12 months, from about $6 per million British Thermal Units (MMBtu) to a peak of over $13 per MMBtu.[1] Increased use of renewable sources for electricity could reduce

[1] NYMEX Natural Gas Futures Close (Front Month), http://www.wtrg.com/daily/ngfclose.gif, accessed August 4, 2008.

natural gas consumption in the electricity sector. Currently, the price paid for renewable electricity is often linked to an estimate of long-term natural gas prices. The combination of decoupling the price paid for renewables from long-term natural gas prices with reduced natural gas consumption could reduce the vulnerability of the electricity sector to natural gas price volatility, but more could be done to reduce the effect of rising natural gas prices on electricity prices in California.

As easily accessible fossil fuels continue to be depleted, their costs are likely to rise further. In such circumstances, money spent importing natural gas would be more responsibly invested in expanding sustainable renewable fuels and electricity generation industries that would create jobs, stimulate the economy, and allow California to export its renewable technologies and expertise to other countries. The state needs to begin now to address this issue so that the research, development, technology, manufacturing capability, infrastructure, and knowledge are in place to successfully incorporate expanded use of renewables fuels into our electricity mix.

Clearly, there is a great deal of uncertainty surrounding any analysis of the future electricity system. In the *2008 IEPR Update*, the IEPR Committee is focusing on identifying changes needed in the electricity system, but notes that alternative fuels for transportation will be addressed in the *2009 IEPR*.

The IEPR Committee believes that California must begin now to redesign its electricity system and fundamentally change the way it operates the grid to reduce the state's use of carbon-based fuels while maintaining grid reliability and stability and minimizing costs.

Understanding the changes in infrastructure and policy that may be needed to successfully incorporate higher levels of renewables requires consideration of the following:

- The required future location and mix of conventional resources, which will be affected by:
    - The retirement or repowering of existing aging facilities; policies to reduce the use of once-through cooling; and uncertainty about future development or relicensing of the state's nuclear facilities.
    - The potential for increased competition for natural gas as other states use more natural gas-fired generation in an attempt to reduce their GHG emissions.
    - The availability of imports of renewable electricity from neighboring states that can be used to satisfy Renewables Portfolio Standard requirements.
    - Potential effects on the viability of conventional generation resources from climate change policies.

- Resource adequacy and local reliability requirements.
- System stability and reliability requirements for the interconnected western electricity system.
- The need to provide adequate backup generation for intermittent renewable resources and the availability of energy storage to reduce the need for such backup generation.
- The effects of different renewable resource mixes; for example, a larger solar component will reduce the need for conventional peaking resources.

- Transmission line constraints and costs
  - The need to provide additional transmission to access the large amounts of renewable projects located remotely from the load centers.
  - The need to upgrade and reinforce the existing transmission system to accommodate new generation.
  - The need to integrate large amounts of intermittent renewables with the existing transmission system.

- The future demand for electricity, which will be affected by:
  - Expected population and economic growth.
  - Effects of current and future energy efficiency programs and standards.
  - Increased electrification of the transportation system, including vehicles and port facilities, a component of the strategy to meet the state's GHG emission reduction goals.

- The future resource mix of renewable resources, which will be affected by:
  - Relative costs of renewable technologies both in the near-term and over time as technological advances occur.
  - Expansion of the transmission system to remote renewable energy zones.
  - Electricity system reliability requirements and fuel infrastructure implications.
  - Potential development in other western regions for import to California.
  - Environmental and permitting concerns associated with siting large renewable power plants.
  - Availability of federal and state tax incentives.

- Expected improvements in and commercialization of emerging technologies, including those which increase transmission capacity, provide energy storage, improve grid stability, that would facilitate greater amounts of renewable energy.

The IEPR Committee recognizes that identifying how California's electricity system will need to be configured and what changes will need to be made to grid operation to support increased levels of renewable generation is extremely complex. The Committee also recognizes that it is impossible at this time to identify an optimal design or set of

resource mixes given future uncertainties. The potential analyses, research and development activities, and other strategies identified in this attachment cover a wide range of topics with different levels of importance, relevance, and difficulty. The Committee seeks public comments on the value of each of the various strategies and their relative priority, but notes that due to resource constraints only a subset may ultimately be included in the *2009 IEPR.*

Contribution from Existing Efforts

The Energy Commission's *2009 IEPR* and *2009 Strategic Transmission Investment Plan* efforts and analyses should focus on issues that are not being addressed by other studies currently underway. To the extent feasible, staff believes that the IEPR efforts should build on the important work being done by the Renewable Energy Transmission Initiative (RETI), the California Public Utilities Commission (CPUC), and the California Independent System Operator (California ISO).

RETI[2] is identifying transmission projects needed to accommodate the state's renewable energy goals, identifying competitive renewable energy zones in the state that can be developed in the most cost effective and environmentally benign manner, and preparing detailed transmission plans of service for zones identified for development. The assumptions and results of the RETI process will be an essential input into the Energy Commission's *2009 IEPR* analyses of integrating renewables into the system.

The CPUC is conducting a 33 percent Renewables Portfolio Standard (RPS) analysis to inform the investor-owned utilities' 2010 long-term procurement plans. The intent of that analysis is to define the magnitude of needed renewable resources, estimate preliminary cost and rate impacts, and define implementation barriers and solutions. Deliverables identified by the CPUC from that analysis include likely needed resource build-outs, project-level barrier analysis, and cost estimates of achieving a 33 percent RPS by 2020. Results from the CPUC's analysis are anticipated in early 2009. The IEPR Committee acknowledges the significance of the CPUC's analysis and believes the results from that analysis, along with input from the state's publicly owned utilities, should be incorporated in the *2009 IEPR* analyses to the extent possible. The IEPR

[2] RETI is an open and transparent collaborative process that is supervised by a coordinating committee comprised of California entities responsible for ensuring the implementation of the state's renewable energy policies and development of electric infrastructure, namely the CPUC, the Energy Commission, the California ISO, and publicly-owned utilities (Southern California Public Power Authority, Sacramento Municipal Utility District, and Northern California Power Agency). For more information, see the website at: http://www.energy.ca.gov/reti/index.html.

analysis can also inform the CPUC's 33% percent RPS analysis by providing insight into longer-term policy issues that are identified in this report.

The California ISO is completing work on the operational effects of 20 percent renewables integration. Work on analysis of 33 percent renewables is scheduled to begin later this year. The California ISO's 33 percent assessment is considering major drivers such as the mix of all renewable resources (wind, geothermal, and solar) and their location (in state versus out of state), and the future availability of conventional power plants.

Potential Analysis, Research and Development, and Evaluation in the *2009 IEPR*

Transmission to Access Renewable Resources

The Energy Commission staff held a workshop on July 23 to discuss transmission issues, which constitute one of the primary barriers to renewable development. Workshop participants identified several major barriers that need to be overcome to achieve the state's renewable goals. First, there is a need for mechanisms to promote joint transmission projects between publicly owned utilities and investor-owned utilities. Second, there is a need for actions to address grid operability and deliverability issues. Third, in regard to transmission siting, the state needs to address environmental, land use, and NIMBY (not in my backyard) issues.

Potential activities that could be undertaken in the *2009 IEPR* to help address these barriers include:

- Identifying and implementing mechanisms to promote joint publicly owned utility/investor-owned utility transmission projects.
  - Encouraging continued participation by both investor-owned utilities and publicly owned utilities in the RETI Phase 2 development of conceptual transmission plans, which provides a forum for joint planning.
  - Identifying and evaluating changes to California ISO and Federal Energy Regulatory Commission tariffs that would reduce institutional barriers to joint projects.

- Identifying and implementing actions to address grid operability and deliverability issues.
  - Ensuring that transmission conceptual plans consider issues beyond the "base case," such as the effects of accelerated shutdown of existing in-basin generation, which would adversely impact grid operability and deliverability

concerns. This could include making use of the Energy Commission's Transmission Research Program to provide support.
    - Continuing to implement the recommendations made by the Consortium of Electric Reliability Technology Solutions/Electric Power Group in their renewable resource integration work done for the Energy Commission.
    - Conducting real-time research, development, and demonstration through the Transmission Research Program to ensure the necessary software, hardware, and regulatory procedures are in place to meet grid operability needs.

- Identifying and implementing actions to resolve environmental, land use, and NIMBY issues.
    - Ensuring that the Energy Commission's Transmission Corridor Designation staff continues to work with RETI's Environmental Working Group to add value to the RETI Phase 2 conceptual transmission planning process by ensuring that land use concerns are addressed in parallel with the identification of the electrical paths.
    - Ensuring that the RETI Phase 2 conceptual transmission plans inform the 2009 Strategic Transmission Investment Plan process and provide information on potential transmission corridors that may be necessary in the future to help achieve higher levels of renewables penetration.
    - Restoring funding to the Energy Commission's local assistance program established under Public Resources Code section 25616[3] to provide assistance to local governments on the development of energy elements in their general plans. This could include collaborating with the League of Women Voters to work with local governments on their energy elements.

- Evaluating legislative and regulatory reforms that are needed to avoid duplication among the various initiatives and to achieve RETI's objectives, and identifying forums in which these reforms can be vetted and implemented.

Emerging Technologies to Assist in Renewable Integration

Another major barrier to increasing the level of renewables in California is the potential operational and cost impacts of large amounts of intermittent resources on the grid. Research and development is needed on technologies and strategies that can improve grid operations, provide cleaner, lower-cost, and more efficient operation, and provide more options for consumers. Research and development efforts should focus on both

[3] PRC section 25616 directs the Energy Commission, subject to the availability of funds, to: 1) assist local agencies in the siting of energy projects which are not otherwise subject to the Commission's power plant site certification process; 2) encourage local agencies to expeditiously review permit applications to site energy projects, and 3) encourage project developers to consider all cost-effective and environmentally superior alternatives that achieve their project objectives.

the near-term and long-term and how to commercialize technologies in a timely way to meet the needs of the electricity system.

Staff held a workshop on July 31 to discuss emerging technologies with the potential to increase the amount of renewable resources on the California grid. These new technologies need to be assessed to determine which are appropriate for both near-term and long-term implementation. These emerging technologies can provide new options and solutions to increase renewable energy to 33 percent or more of the state's electricity while maintaining reliability and stability of the electricity system.

The workshop discussed emerging technologies that can address increased transmission throughput capability, renewable supply uncertainties, and grid reliability. These technologies include:

- High temperature low sag conductors
- Real-time thermal conductor rating technology
- Large- and small-scale energy storage technology
- Sensors
- Smart controls
- Intelligent software agents
- Power electronics for controlling bulk power flows
- Small-scale renewable technology
- More accurate wind forecasting systems

Presentations at the workshop discussed ongoing and planned research to determine the current state of these technologies and to help indentify key emerging technologies that should receive support in the future to accelerate commercial acceptance. Once identified, future research efforts to develop these technologies will need to be accelerated and expanded. Based on discussions and input from the workshop, staff believes the following emerging technologies have the highest potential to impact the future implementation of renewable resources to meet the 33 percent goal.

- Phasor measurement technologies: Recent research both nationally and in California has demonstrated the value of these technologies to provide increased information about grid conditions to system operators and allow time-sensitive decisions to be made. As more renewable resources are integrated into the grid, grid operators need this kind of technology to respond to unpredicted changes in output that are characteristic of some renewable technologies. Additional demonstrations and pilot projects are needed along with continued and expanded research in this area.

- Electricity storage technologies: These technologies have significant potential to resolve grid stability and operations issues related to higher penetrations of

renewables. Energy storage can be applied as generation, on the transmission or distribution system, and even at the end-use customer's location. Smaller energy storage systems can provide significant grid support whether they are connected at the distribution or end-use customer level, and aggregating these distributed systems can provide grid support when more renewables are introduced. Field demonstrations and pilot projects are needed to address the use of larger energy storage systems (greater than 5 megawatt (MW) ratings for at least four hours) that can be connected to the distribution or transmission system. Additional research should evaluate very large energy storage systems, such as compressed air energy storage (CAES) or pumped hydroelectric, for situations in which there is a need for storage systems that can store hundreds of MWs for several hours.

- Transmission dynamic thermal rating capability: Transmission of electric power has historically been limited by the thermal constraints of transmission lines. Line ratings continually change depending on the cooling effect of the wind, on-line-current, and solar heat. New technologies now allow monitoring of transmission line characteristics and environmental conditions, enabling calculation of real-time line ratings. Real-time line rating systems potentially allow using existing transmission lines to their full capacity, thereby reducing the need for new transmission lines. Fewer new lines mean fewer land and environmental impacts. The ability to monitor transmission lines in real-time would also improve system reliability and safety.

- Increase the capability of wind forecasting tools: As penetration of wind energy increases, accurate wind forecasts are required to integrate wind electric potential into scheduling and dispatch decisions. Accurate wind forecasts also help overcome the perceived barriers of wind intermittence and unpredictability, and can increase the value of wind generation to the system. Research and development in this area should focus on working with a combination of physical and statistical models and developing a combination of deterministic and probabilistic algorithms.

- Assess the increased potential for renewables connected below the transmission level: California's RPS eligibility guidelines do not allow generation from net-metered systems or facilities that receive incentives from certain ratepayer funded programs to be counted toward the RPS. As a result, most customer-sited renewable resources are not eligible for the RPS. The magnitude of this distributed generation capacity and its potential to contribute to the RPS has not been analyzed. There is a need for research into expanding the use of renewables below the transmission level and developing a methodology to better understand and assess this future energy management opportunity.

- Evaluate the potential for and barriers to direct renewable energy supply to communities: Net zero community initiatives emphasizing renewable energy, energy

efficiency and demand response will reduce the need for additional transmission capacity to deliver increasing amounts of renewable electricity. Solar PV, wind and biogas pipeline injection projects in the 10 MW range are now common, and many are owned by communities. Renewable heating and cooling technologies such as solar and biomass water and space heating, solar cooling, and ground source heat pumps can be deployed, while electricity and biogas can be distributed economically over relatively short distances via electricity and biogas micro-grids. Community scale deployment of these solutions, though progressing rapidly in other states and overseas, is in its infancy in California. One obstacle is that community-owned renewable energy resources do not count toward utility RPS obligations.

- Evaluate the potential for and barriers to direct renewable energy supply to buildings: The *2007 IEPR* recommended that all new residential buildings and all new commercial buildings be net zero by 2020 and 2030 respectively. Renewables are an essential ingredient to achieving this goal. Technologies to serve major building energy loads include ground source heat pumps, which are penetrating other markets in the U.S. and Europe, and solar water and space heating and cooling systems, which in some European countries enjoy market shares in the range of 50 percent. Retail capacity to professionally install and service these options are largely lacking in California but could be developed using the same mechanisms that have so successfully supported the creation and public awareness of California's energy efficiency programs.

Additional potential research areas:

- The role of demand response in helping to integrate renewables.
- Lower-cost large- and small-scale energy storage devices.
- Technologies for synchrophasors, intelligent software agents, sensors, smart systems, and controls, need to be designed, field tested, standardized, and integrated with the operation of electric transmission and distribution systems.
- Lower cost power electronics devices such as Flexible Alternating Current Transmission Systems devices, high-voltage direct current (HVDC), and fault current controllers are needed for controlling bulk power flows on the transmission system and for operating the smart grid.
- New transmission line designs. These include underground transmission, HVDC systems, more compact line designs, and interactive siting tools.
- Alternative distribution and transmission system concepts such as DC grids, high voltage, and multi-frequency technologies.
- Technologies to aid renewables integration, such as thermal energy storage can be coupled directly to intermittent renewable resources to allow their output to follow load.

- Revising restrictive local ordinances and permitting to encourage greater deployment of renewable resources, such as small-scale wind (100 kilowatts and below). Common statewide permitting requirements similar to small-scale solar (such as rooftop photovoltaics) could help increase penetration into the California market. Additionally, community-level solar will require state and local governments to facilitate interconnection, streamline permitting, and ease restrictive building codes and land use regulations.
- Comprehensive and coordinated statewide smart grid planning. A coordinated statewide approach to achieving a "smart grid" to support renewables will be more effective and less costly than piecemeal attempts.

Conventional Resources to Maintain System Reliability

Depending on renewable resource mix assumptions in a 33 percent scenario, there could be the need for significant amounts of natural-gas fired generating units to provide back up for intermittent renewable resources. Analysis of reliability requirements will need to consider a variety of issues, including: the type and location of conventional resources needed to provide reliability services; the effect of policy goals to retire aging steam generation facilities and move away from the use of once-through cooling; limitations on technology choices resulting from environmental constraints on the development of conventional resources in selected areas of the state; and local community considerations affecting alternative generation options and development decisions.

There is a need to better understand the potential mix of conventional resources – the generation resources that will remain, retire, and be developed over the forecast period. Issues associated with this analysis include: planning reserve margin targets and other system and local reliability requirements; and responses to the expiration of coal contracts both before and after 2020.

Role of Imports

California imports 20 to 30 percent of its electricity, both to serve electricity demand requirements and to displace the need to operate more expensive generation within the state.[4] There are currently several power purchase contracts with renewable generation facilities in the Pacific Northwest. An analysis may be needed to determine whether additional renewable generation can be developed in other western regions to serve a 33 percent renewable goal for California. There are numerous regions throughout the

[4] The amount of electricity imported into California fluctuates depending on the price and availability of surplus generation in the western wholesale power market, mostly due to hydro variations in the Pacific Northwest.

West that have large renewable generation development potential, with high wind corridors or availability of biomass fuel feedstock. The analysis would include an evaluation of the existing transmission system and if new additions would be needed to accommodate deliverability requirements. If the deliverability requirements are changed, the amount of new transmission development needed to bring renewables to California by 2020 could be reduced, provided that Renewable Energy Credits or other similar contract mechanisms under California's RPS Program are used to dedicate the resource attributes to California.

Technical potential for the development of renewable resources in neighboring states is substantial. Analysis may be necessary to determine the extent to which these resources can be used to meet state renewable energy targets. This requires consideration of the types of resources that can be economically developed, the ability of the transmission system to import renewable energy and the set of policy measures that may allow and facilitate procurement of these resources by California utilities.

Cost of Generation

In evaluating the impacts of higher levels of renewable penetration in California, cost assumptions will need to be made about renewable generation resources. The CPUC's 33 percent RPS implementation analysis will be evaluating statewide cost and rate impacts, relying on RETI cost estimates to the greatest extent possible, and the Energy Commission plans to consider the conclusions from that study and RETI, as well. Key questions associated with the cost assumptions that could be considered in the *2009 IEPR* analyses include: future potential declines in costs of existing and emerging renewable generation; the cost variables for each technology and developer type; future biofuel costs; outlook for material costs; and the relationship to market-driven escalations.

Impacts on Natural Gas Demand, Supply, and Price

At the July 21 workshop, panelist Snuller Price from E3 suggested that the impacts of potentially switching from coal to natural gas in response to a future federal GHG emissions reduction policy should be included in an evaluation of the inverse elasticity of future gas supply.

Evaluation of this issue could include an examination of the regional price impacts from changes in natural gas demand and supply opportunities. Also, there is a need to better understand physical changes to natural gas supply, delivery, and storage systems to support a 33 percent renewable energy future. There may be a need for new natural gas transport capability to California and additional storage to provide the fuel that is necessary for generation that must cycle periodically to back up intermittent renewable energy resources.

Price Support Mechanisms for Renewables

At the July 21 workshop, Jan Hamrin, a panelist at the July 21 workshop representing the Center for Resource Solutions, discussed the potential role for feed-in tariffs as a mechanism to complement existing RPS procurement by providing another opportunity for large-scale (greater than 20 MW) renewable energy development projects with transmission access, site control, and permitting to obtain RPS contracts. As recommended in the *2007 IEPR*, staff is holding workshops over the next several months to get input on possible expanded use of feed-in tariffs and their role in helping the state meet its renewable energy goals. Staff plans to publish a final report by the end of 2008.

Lessons Learned from the Voluntary Market

Jan Hamrin, a panelist at the July 21 workshop representing the Center for Resource Solutions, stated that California is the source of approximately 20 percent of all renewable energy being traded in the national voluntary REC market. This indicates that renewable projects are being developed outside of the RPS process. A topic for analysis in the *2009 IEPR* could be lessons learned from the development of these projects.

Operational Characteristics of New Solar Technologies

In the July 21 workshop, David Hawkins from the California ISO stated that the California ISO plans to conduct additional studies related to changes needed to accommodate higher levels of renewable energy. As an input for these studies, he identified the need for information regarding the operational characteristics of new types of solar generation.

Meeting Biomass RPS Goals

In the Bioenergy Action Plan, the Governor identified a goal of 20 percent of the RPS met with biomass resources. To date, biomass makes up a small portion of the renewable resources with RPS contracts. Also, this amount of biomass has not been modeled in the reliability and operational impacts analysis for 33 percent completed to date.

Electrification of the Transportation Sector

Given the state's alternative transportation fuel goals, there will be a need to assess the incentive structure needed to stimulate timing of electrical load associated with aggressive electrification of transportation in California to help integrate high levels of renewable generation into the electricity system.

Contribution of Publicly Owned Utilities to RPS Goals

Publicly owned utilities provide 25–30 percent of the retail electricity sold in California, making their participation in the RPS essential to meeting statewide renewable and GHG reduction goals. There is therefore a need to work with the publicly owned utilities to understand their plans for helping the state to meet the 33 percent goal by 2020, and their views on challenges, opportunities, and changes needed to achieve 50 percent renewables by 2050.