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Attachment to EDF comments

Here is the paper "Growing the Grid" as referenced in the comment letter of EDF.

Additional submitted attachment is included below.

Growing the Grid: A Plan to Accelerate California's Clean Energy Transition

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EDF ENVIRONMENTAL DEFENSE FUND

CATF CLEAN AIR TASK FORCE

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List of Acronyms

CAISO	California Independent System Operator
CARB	California Air Resources Board
CEC	California Energy Commission
CPUC	California Public Utilities Commission
SB 100	California Senate Bill 100 (2017-2018)

Executive Summary

California is a global leader in climate and clean energy policy. The state has already achieved important clean energy milestones[1,2] and its future goals—including 100 percent zero-carbon electricity sales[3] and economywide net-zero greenhouse gas emissions by 2045,[4] among others—set the bar for ambition. The California Legislature and the Governor further cemented the state's reputation as a climate vanguard in 2022 by requiring 90 percent zero-carbon electricity sales by 2035 and 95 percent by 2040. As measured by the time it takes to plan and build major clean energy infrastructure, the first of these milestones is just around the corner. The state now faces the difficult task of transforming these ambitions into reality.

This report identifies the challenges to achieving California's clean energy transition through the lens of the new and repurposed electricity infrastructure needed to reach state climate and clean energy goals.

It recommends the state develop a Clean Energy Deployment Plan with specific quantities, locations, and timing of new resource development and infrastructure expansion to expedite clean energy deployment.

California has made astonishing progress on building clean energy resources. The state has transformed its electricity generation portfolio and now receives roughly sixty percent of its electricity from carbon-free resources.[5] There are over 12,800 megawatts (MWs) of rooftop solar meeting individual customer needs.[6] California has been consistently ranked as a national leader in energy efficiency[7] and has kept per capita electricity demand nearly unchanged in the past 30 years.[8] The state has more than 4,000 MWs of battery storage online to help meet evening electricity demand as the sun sets.[9]

Continued progress toward California's goal to decarbonize the electricity sector and the economy as a whole will limit the state's contributions to global climate change, reduce local air pollution, create nearly half a million energy jobs,[10] and inspire increased ambition worldwide. But even with so much progress already made, much must be done to transform California's economy, and it begins with scaling zero-emissions electricity. As the electricity system is decarbonized, electricity demand from buildings, transportation, and other sectors will increase. Consequently, the scale of clean energy infrastructure that needs to be built in California is staggering. Modeling studies show that eliminating carbon emissions from the state's electricity sector and the entire economy will require

unprecedented amounts and diversity of clean energy resources. These include wind and solar generation, clean firm power,[a] demand management resources, customer-owned resources, energy storage, modern distribution systems, and new large-scale transmission lines. And many new technologies will be needed outside the electricity system too—CO_2 transport and storage infrastructure, carbon capture at industrial facilities, clean hydrogen production, storage, and use, just to name a few.

Many of these technologies require long development lead times, significant financial commitments, and complicated integration into the electricity system, and the current wholesale and retail energy markets are not designed to fully compensate some of these technologies for the value they will add. These potential sources of project delay and financial uncertainty, coupled with the sheer volume and diversity of new resources required to reduce emissions and provide reliable electricity, necessitate urgently accelerating the deployment of clean energy resources and rapid expansion of the transmission system. California must do all of this while ensuring that the transition is affordable, incorporates principles of equity and environmental justice, anticipates and reduces conflicts when siting new projects, and protects biodiversity and ecological systems.

Clean energy deployment in the Golden State will need to dramatically increase to reach its climate and clean energy goals. For example, according to the California Air Resources Board (CARB) at least five gigawatt (GW) of utility-scale solar would have to be built annually for more than 20 years to achieve economywide decarbonization in its least-cost scenario.[11] For perspective, an average of only two GW of utility-scale solar were added to California's grid each year from 2013 to 2017; since then, the pace has fallen by half.[12] Getting back on track will require increasing the rate of utility-scale solar deployment by a factor of five. Similarly, CARB estimates that battery electric storage will need to be built several times faster than current rates. And while the state has managed to install eight GW of new resources in less than two years through a concerted effort by California energy agencies to respond to energy shortages beginning in the summer of 2020, even faster deployment is needed to reach clean energy goals.[13]

CARB's *Draft 2022 Scoping Plan Update* also assumes a substantial amount of new hydrogen, geothermal power, and energy storage resources, requiring adding these types of resources to the system many times faster than recent past. The 20 Year Transmission Outlook prepared by the California ISO estimated that over $30 billion in new transmission will need to be developed by 2040,[14] and the Princeton *Net-Zero America* study finds that electricity transmission capacity would need to triple by 2050.[15] In addition to these requirements, the *Draft 2022 Scoping Plan Update* finds that the state would need to build an average of two GW more zero-carbon resources per year solely dedicated to manufacturing clean hydrogen.[16] Carbon transport and storage infrastructure will also be required to address carbon reduction from industry and past emissions.[17] Even excluding these requirements, California's in-state electricity generation capacity would need to be four times larger than today.[18,b]

The longer it takes to accelerate clean energy deployment, the steeper the climb to reach net-zero. Picking up the pace is not only important for the planet; it's essential for Californians. Delaying the transition away from dirty fossil fuels deprives Californians of cleaner air, healthier communities, and good jobs today. Additionally, with California facing its third straight year of higher-than-normal heat and drought, electricity demand has become more uncertain. Having more resources online sooner can reduce the chances of rolling blackouts. And passage of the Inflation Reduction Act in August 2022, the largest federal climate action in history, has created billions of dollars of financial support for deploying clean energy that phase out after 2032. Building more clean energy earlier is the surest way to pass these clean energy cost savings to California ratepayers. The risks of moving too slow have far eclipsed the risks of moving too fast.

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[a] Clean firm power includes technologies that can produce clean electricity at any time, for as long as needed. These could include, for example, long duration energy storage, geothermal, demand response, certain types of hydropower, fossil fuels with 100 percent carbon capture, or nuclear energy. See: Long, Jane C.S., Ejeong Baik, Jesse D. Jenkins, Clea Kolster, Kiran Chawla, Arne Olson, Armond Cohen, Michael Colvin, Sally M. Benson, Robert B. Jackson, David G. Victor, and Steven P. Hamburg. "Clean Firm Power is the Key to California's Carbon-Free Energy Future." *Issues in Science and Technology* (March 24, 2021). https://issues.org/california-decarbonizing-power-wind-solar-nuclear-gas/

[b] The *Draft 2022 Scoping Plan Update* also notes, "The scale of solar and battery build rates needed could be reduced through the commercialization of new zero-carbon technologies." Page 161.

The real-world obstacles to clean energy deployment will likely grow if left unaddressed. Energy models used to develop climate policy goals identify the lowest-cost options for reducing emissions from the electricity sector and across the economy. However, these analyses often miss the complex mix of land, social, and institutional barriers that slow clean energy deployment in the real world. For example: while the models California uses assume ample land available for solar siting, in reality, considerations like transmission access, competing land uses, visual impact, and parcel size—to name a few—make identifying suitable solar sites extremely difficult. In addition, maintaining local support, workable permitting processes, and supply chain continuity offer even more challenges once developers identify suitable sites.

Fortunately, these issues are front and center for policymakers in California. The state's energy and clean air agencies—CEC, CARB, CPUC, CAISO, and others—regularly evaluate options, create plans, and engage communities.[19] The agencies have developed several venues to coordinate their efforts, increase transparency, and improve information sharing around the challenges of building new resources,[20,21] and the governor's office advanced clean energy siting reforms to reduce the costs of new clean energy development.[22] The legislature is actively considering various policies to support clean energy deployment.[23]

Even with these laudable and necessary efforts, the state must take additional steps to prevent falling short of its climate goals. The state needs substantially more comprehensive clean energy deployment planning and development. California's current project-by-project, bottom-up approach to clean energy deployment is failing to elicit the pace, scale, and diversity necessary to achieve its ambitious clean energy targets and the benefits of a clean energy transition.

The Clean Air Task Force, in cooperation with Environmental Defense Fund and advised by The Nature Conservancy, analyzed the practical challenges to achieving California's clean energy goals through modeling, analysis, and dozens of interviews, discussions, and workshops. Our conclusion: California needs to develop and implement a state-wide plan that considers the state as the interconnected, diverse, and contiguous whole that it is. This plan should contain explicit roles and responsibilities, developed in concert with local governments and leveraging the state's stakeholder engagement strengths. And it needs to be a plan that can be revised as technology and society evolve.

California needs to develop and implement a state-wide clean energy deployment plan that considers the state as the interconnected, diverse, and contiguous whole that it is.

Specifically, we offer the following recommendations for policymakers to consider while leading California to a clean energy future:

- **Develop a Clean Energy Deployment Plan.** The complexity and rapidity of eliminating emissions from every sector of the economy create a vital role for planning. A lead agency should begin a coordinated, multi-sectoral, and multi-agency process to develop a Clean Energy Deployment Plan *with specific quantities, locations, and timing of new resource development and infrastructure expansion*. This plan must be aligned with the state's economic growth and social equity priorities and incorporate distinctive visions of the clean energy transition for each region, developed by local governments and their communities. And because nothing is certain, the plan should include contingent pathways for when key milestones are not met. Finally, the Clean Energy Deployment Plan should incorporate land, social, and institutional realities that typically fall outside of modeling studies. Existing planning efforts like the SB 100 Joint Agency Report development process could serve as the basis of a more comprehensive planning initiative.
- **Assign a lead agency.** Achieving the physical foundation to achieve California's climate goals is now spread among more than a dozen agencies.[c] But as the old saying goes, "When everyone is in charge, no one is in charge." Therefore, the state should vest primary responsibility and accountability for achieving its clean energy goals to a single entity with sufficient authority to develop and implement the state's Clean Energy Deployment Plan in coordination with the other agencies. In addition, the roles and responsibilities of all agencies should be clarified.

[c] The Climate Action Team (CAT), for example, includes 22 state agency members that coordinate on statewide climate efforts. Other entities not included on the CAT that nonetheless have an important planning, permitting, regulation, or policy role related to climate include the California Independent System Operator, local and county governments, water districts, and others. California Environmental Protection Agency, "Climate Action," Accessed: July 2022. https://calepa.ca.gov/climate-action/

- **Develop a dashboard.** Publicly tracking progress towards milestones established in the Clean Energy Deployment Plan is vital to increase public trust, provide accountability, inform course corrections, and provide private sector certainty. This level of transparency and accountability will improve the odds of success, reduce costs, and minimize political hurdles to a clean energy transition. The Clean Energy Deployment Dashboard should be a publicly available website that tracks progress towards specific milestones established in the Clean Energy Deployment Plan and SB 100, potentially built on the Tracking Energy Development (TED) Task Force efforts or CEC's Tracking Progress reports.[24,25]
- **Engage the public.** California's current public engagement efforts—including the Disadvantaged Communities Advisory Group (DACAG), CPUC's Public Participation Hearings, and CEC's SB 100 Scoping Workshops, just to name a few—demonstrate California's commitment to public engagement and the value of incorporating a diverse set of perspectives in energy and environmental matters of the state. These efforts must continue and be strengthened, especially as deployment accelerates. A particular emphasis should be placed on public education regarding the scale and urgency of the clean energy deployment challenge and providing estimates of the costs, benefits, and tradeoffs among different pathways to inform the Clean Energy Deployment Plan.
- **Advance supportive policy.** The state should consider additional supportive policies that: ensure local economic benefits; clarify differentiated agency roles, including the designation of a lead for developing and implementing the Clean Energy Deployment Plan; harmonize existing policies and programs with the Clean Energy Deployment Plan; and improve the regulatory process. California lawmakers should also consider enhancing the state's role in system planning, siting, and financing.

SECTION 1

Meeting California's clean energy targets will require a rapid expansion of the state's clean electricity generation capacity

Reaching California's climate goals will require enormous investment into clean electricity, including renewable energy resources. The *SB 100 Joint Agency Report* identified up to 170 GW of new clean energy resources needed to reach the state's 100 percent clean electricity goals.[26] The *Draft 2022 Scoping Plan Update* estimates similar amounts of clean energy deployment (Figure 1). These forecasts suggest a quadrupling of the state's electricity generation system over the next twenty years. Other studies suggest even higher deployment rates; Princeton's *Net-Zero America* report includes a high-electrification scenario that identifies a need for more than 320 GW of electricity generating capacity in the state by 2050.[27]

Clean energy will need to be built much faster to reach these levels of clean energy deployment in time to meet California's climate goals (Figure 2). According to CARB, at least five GW of utility-scale solar must be built annually for more than 20 years.[28] For perspective, an average of only two GW of utility-scale solar were added to California's grid each year from 2013 to 2017; since then, the pace has fallen by half.[29] Getting back on track will require increasing the rate of utility-scale solar deployment by a factor of five.[30] Similarly, CARB estimates that battery electric storage will need to be built several times faster than current rates. The longer it takes to accelerate clean energy deployment, the steeper the climb to reach net-zero.[d]

[d] The *Draft 2022 Scoping Plan Update* also notes, "The scale of solar and battery build rates needed could be reduced through the commercialization of new zero-carbon technologies." Page 161.

Figure 1: Draft 2022 Scoping Plan Projections of New Clean Energy Capacity Additions Required to Reach State Climate and Clean Energy Goals[31]

CARB's Draft 2022 Scoping Plan Update estimates that 90 GW of solar and 40 GW of battery storage will be needed to reach the state's climate and clean energy goals. CARB also finds that an additional 41 GW of solar, not shown here, would also be needed to produce clean hydrogen.

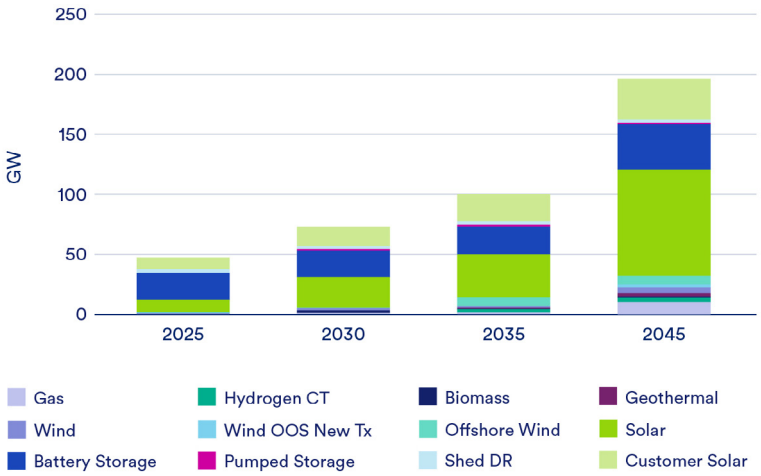
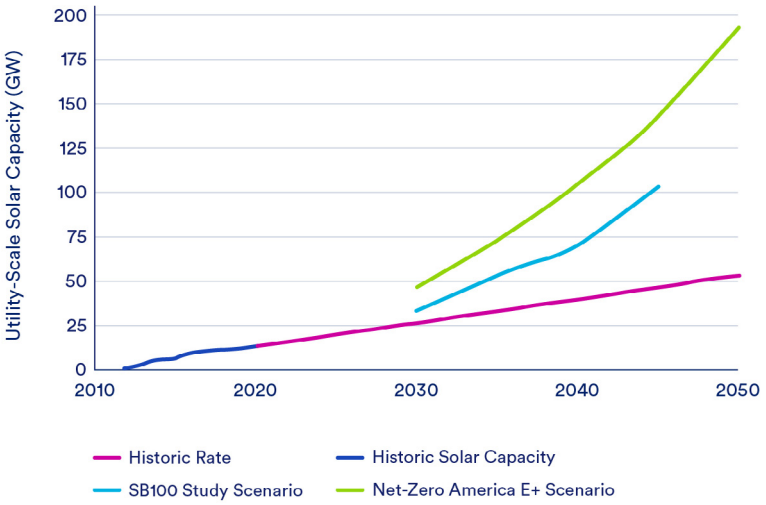


Figure 2: Modeling Projections of Utility-Scale Capacity Additions Compared to the Historic Rate of New Development

The historic rate of utility-scale capacity additions is based on years 2015 to 2020 (1.3 GW per year). Projections of the SB 100 Study Scenario, which models eliminating emissions from the power sector, exclude off-grid solar necessary for clean fuels production, estimated by CARB to be an additional 40 GW by 2045.



Observers are raising alarms about California's ability to reach its clean energy targets. One group anticipates that the state will fall 95 percent short of the CEC's recently adopted 2030 offshore wind target of two-five GW and even fail to meet it by 2035.[32] Others note that "current policy commitments put the state far off course for its next decarbonization milestone,"[33] and that the emissions reduction trajectory between 2018 and 2019 is "far short of what is needed to comply with California's mandate to cut emissions 40 percent below 1990 levels by 2030."[34] In other words, the consequences of delay are already putting near-term climate goals nearly beyond reach.

ELEMENTS OF SUCCESS

Develop a dashboard to publicly track progress towards clean energy deployment milestones to increase public trust, provide accountability, inform course corrections, and provide private sector certainty.

SECTION 2

The electricity transmission system must expand to support electrified end uses and connect new clean energy resources

California cannot reach its clean energy goals without substantially increasing electricity transmission capacity. The 20 Year Transmission Outlook prepared by the CAISO estimated that over $30 billion in new transmission will need to be developed by 2040.[35] By 2050, the Princeton *Net-Zero America* study estimates that the size of California's transmission system needs to triple to deliver clean electricity to homes, businesses, charging stations, and other productive uses of electricity (Figure 3).[36] This level of expansion would be the equivalent of roughly 150 new 100-mile-long transmission lines.

New electricity transmission capacity is vital for connecting new clean energy resources to the grid, requiring expanding existing lines and developing new lines—both which need to occur in parallel. New lines dedicated to clean generation are needed to retire fossil-fueled electricity generation and end pollution exposure to frontline communities. Any delays or missteps in deploying new transmission will therefore delay the clean energy benefits of building more offshore wind, solar, and other clean electricity resources.

California has never undergone planning, siting, and build-out of its transmission system in these circumstances—this pace of deployment is a new horizon for its decision-makers. California policymakers should recognize that building transmission is challenging and plan accordingly: the process can require approval from several local, state, and federal entities; access to land from dozens of landowners; and cost millions of dollars in preparatory work before a single foundation is poured. As a result, major transmission projects take years to complete and major projects in California often require twice as much time as originally anticipated (Figure 4).

Figure 3: Projections of Midcentury Electricity Transmission Requirements Necessary to Eliminate Emissions From California's Economy

MW-Mile is a measure of transmission capacity, calculated as the throughput of a transmission line (in megawatts) multiplied by its length (in miles). Transmission capacity can be increased through expanding the capacity of existing lines or building new lines.

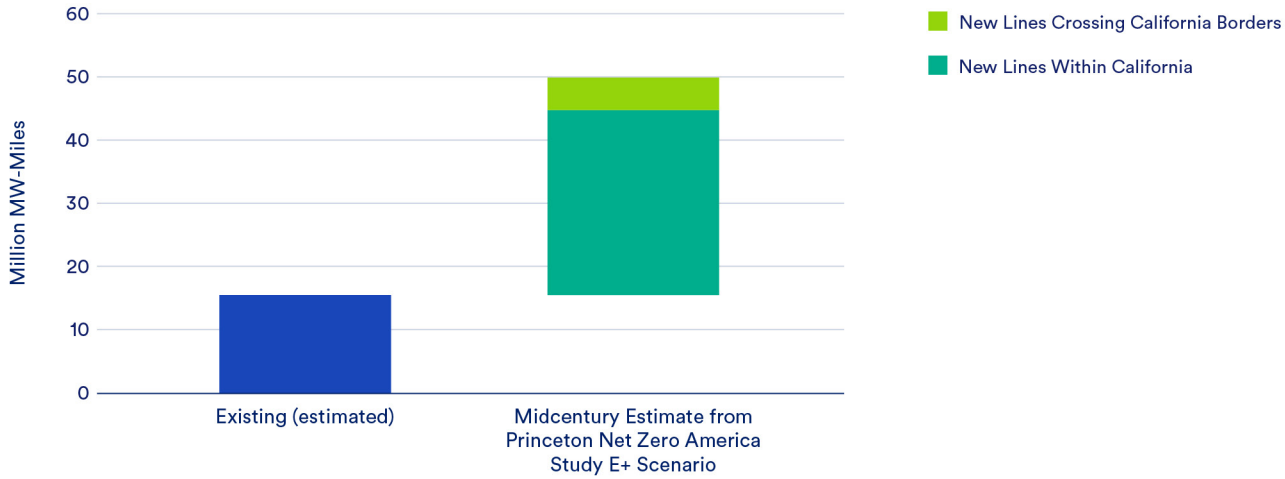
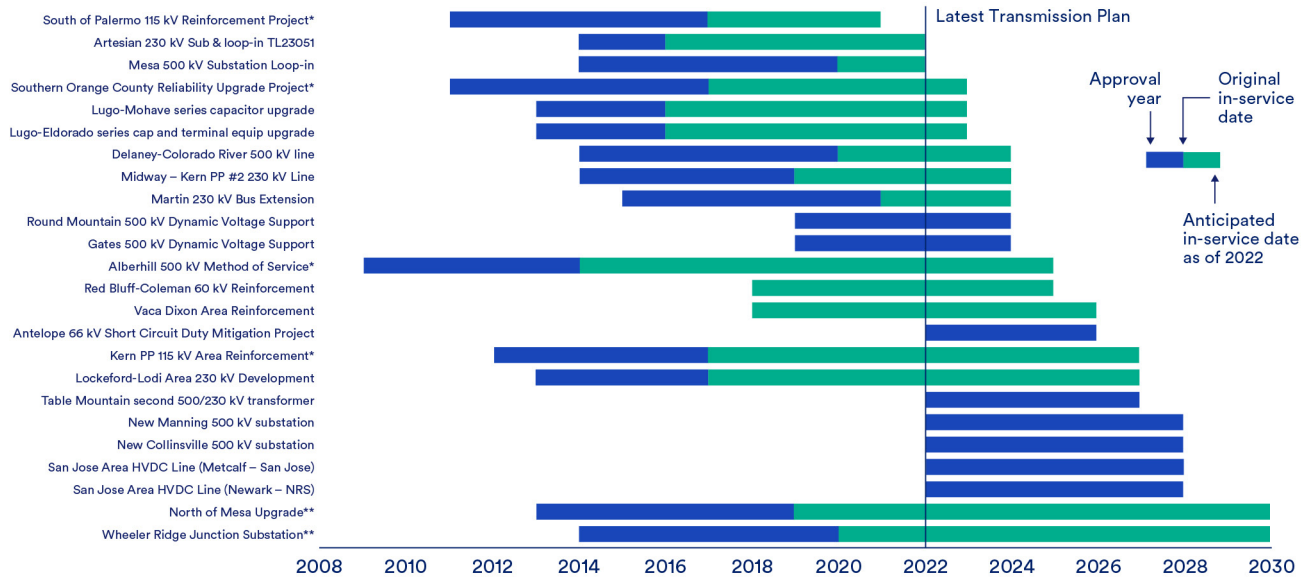


Figure 4: Timelines for Major Electricity Transmission Projects in California

Source: California ISO Transmission Plans for approved projects costing more than $50M. Approval year and Original in-service date are from the Transmission Plan approved by the ISO board of directors in the year indicated as the Approval year.

http://www.caiso.com/planning/Pages/TransmissionPlanning/Default.aspx



* *Approval years* and *Original in-service date* for projects approved prior to 2012 were taken from the 2011-2012 Transmission Plan, the oldest available on the California ISO's website.

** As of the 2021-2022 Transmission Plan, these projects were listed as "on hold" with no definite completion date.

SECTION 3

Clean firm power and rooftop solar are both essential for keeping the lights on and moderating land use change

It is not just the sheer amount of new resource development that the state must contend with; it is also the diversity. Many different types of clean energy resources will be needed to completely reduce emissions from electricity generation while maintaining an affordable and reliable system. In addition to the renewable resources and transmission discussed above, sources of clean firm power—technologies that can produce clean electricity at any time, for as long as needed—are critical to supporting the primary role of renewable energy resources.

Three research teams using five models of California's electricity system all came to the same conclusion: sources of clean firm power like geothermal, carbon capture and storage, clean fuels (such as hydrogen), or nuclear help keep the lights on and prices affordable.[e,37] Sources of clean firm power provide another critical advantage for California: they use substantially less land than renewable energy resources, reducing the pressure that solar resources will place on California's natural and working lands. The researchers found that an electricity system excluding clean firm power could use up to ten times as much land.

Distributed energy resources, batteries, and microgrids are changing how homes and businesses access electricity and in most modeling are a key part of achieving a carbon free electricity grid. Still, they are insufficient to power an entire clean economy. Modeling shows time and again that these resources are most useful in the context of a large, interconnected grid, and they alone will be unable to meet all of California's clean energy demands.[38,39] The potential role of rooftop solar is challenging to estimate, but the *SB 100 Joint Agency Report* estimates 39 GW by 2045—in addition to the 70 GW of utility-scale solar the agency finds may also be needed.[40,f]

[e] The study also noted that long duration energy storage could provide some of the same benefits as zero carbon firm generation but would have to be charged using non-carbon emitting generation.

[f] Rooftop solar is typically estimated outside of electricity system models and included as an input, as CEC did in their SB 100 analysis.

SECTION 4

Using scarce land for clean energy development means navigating land use tradeoffs

Renewable energy resources require much more land than the fossil-powered facilities they displace. For example, the largest solar array in the world, the 2.2 GW Bhadla Solar Park in India, rests on more than 20 square miles.[41] Zeroing out emissions from California's electricity system would require 40 such projects by 2045, according to SB 100 modeling, covering an area equivalent to the cities of Los Angeles and San Diego combined. Figure 5 shows 6 GW of solar arrays—just seven percent necessary to eliminate emissions from the power sector—to help visualize just how expansive large solar farms could be.

Siting this much large-scale renewable energy must balance other important land uses in the state: environmental conservation, agriculture, recreation, housing, and others. In its 2019 *Power of Place* study, The Nature Conservancy examined the potential impacts of zero-emissions electricity scenarios on natural and working lands.[42] They studied several land availability scenarios and identified lands they considered most suitable for each generation technology. Figure 6 shows the five million acres potentially suitable for utility-scale solar siting in California after excluding legally and administratively restricted lands and those with high conservation value. Of that, we estimate that roughly 10 percent would be needed to achieve the goals of SB 100.

This math may suggest an abundance of suitable land for solar. However, not all suitable land is potentially developable land (Figure 7). Project development considerations like transmission access, permitting barriers, and available landholders willing to lease their land considerably narrow the number of suitable sites where solar might be reasonably built.

Figure 5: Rendering of Large-Scale Solar Expansion in Merced and Stanislaus Counties in California

This rendering of a hypothetical grouping of six GW of solar arrays was developed by Stantec for Clean Air Task Force using an aerial photo of Merced and Stanislaus counties. Transmission capacity of this scale would require much more transmission capacity than currently available in this region.

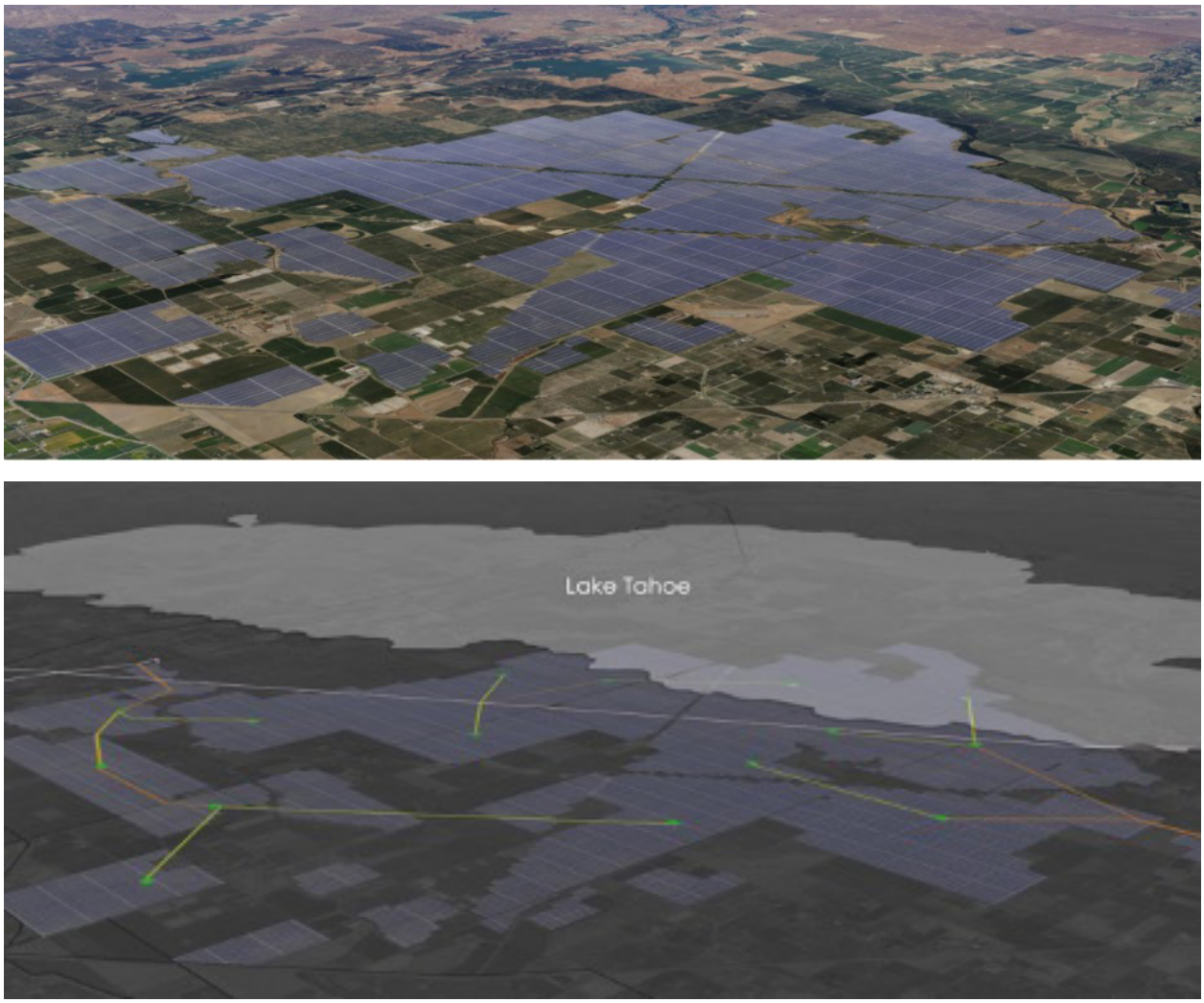


Figure 6: Potentially Suitable Land for Siting Utility-Scale Solar Resources in California

This map was constructed using data from The Nature Conservancy's Power of Place study (2019). Potentially suitable land considers ecological, social, and techno-economic criteria. TNC also emphasizes the need for further site-specific environmental, social, and economic impact assessment for individual projects.

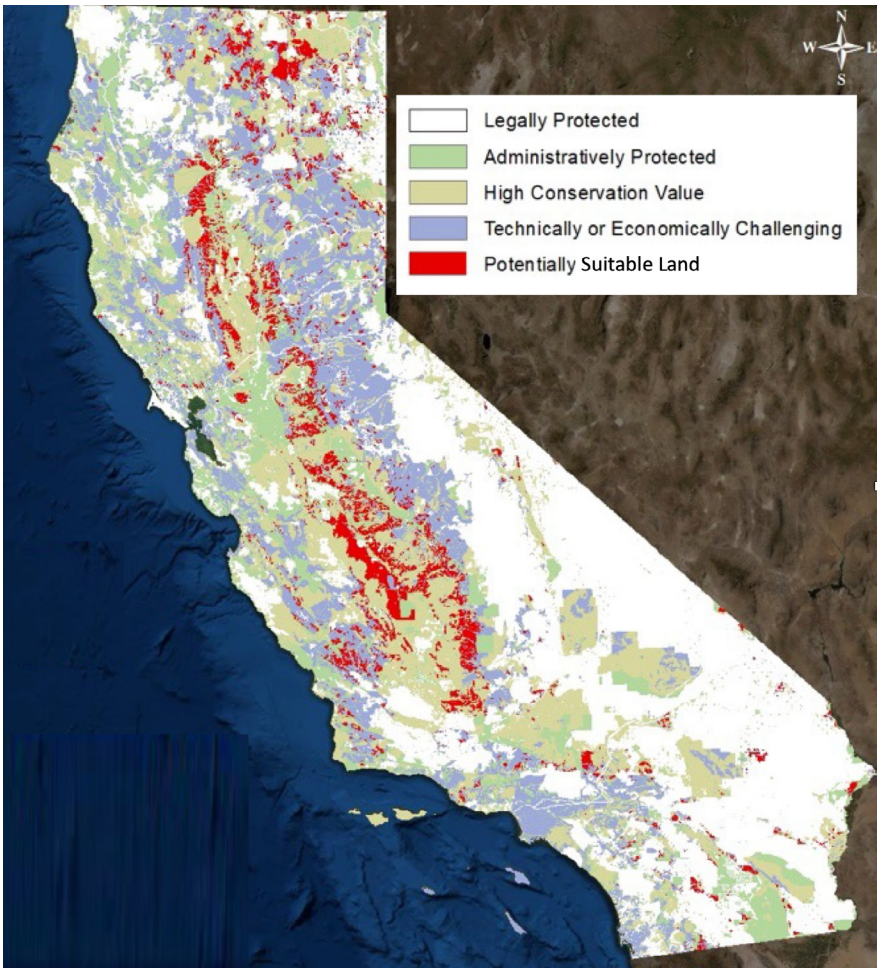


Figure 7: Practical Limits to Available Land for Wind and Solar Resource Development

Developed by Lucid Catalyst, building on The Nature Conservancy's Power of Place Study (2019).

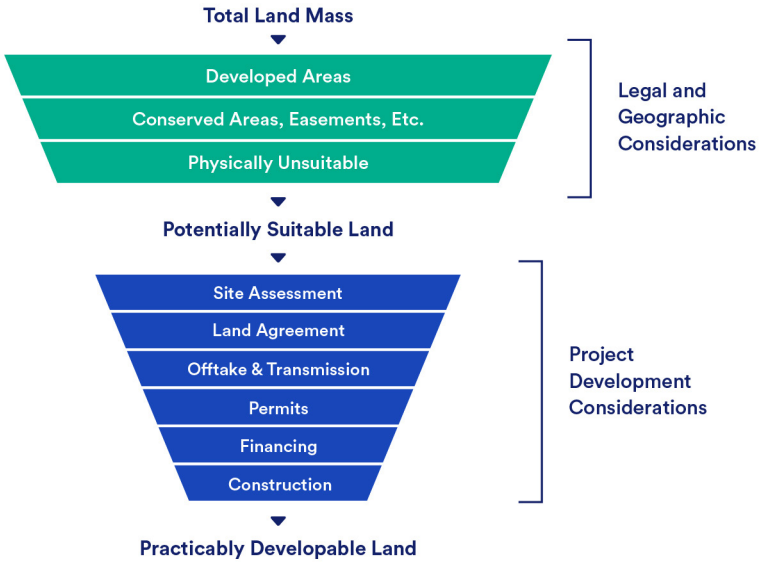
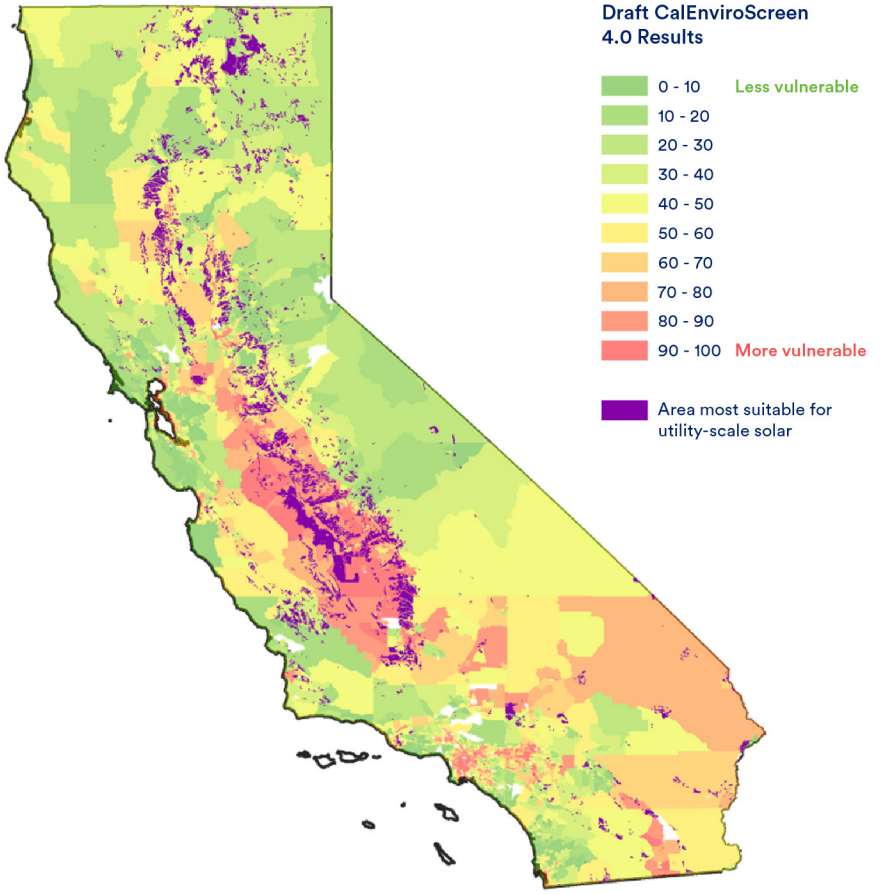


Figure 8: Overlap of Potentially Suitable Land for Utility-Scale Solar and Vulnerable Populations

The areas designated as most suitable for utility-scale solar is from The Nature Conservancy's Power of Place study (2019). Potentially suitable land considers ecological, social, and techno-economic criteria. TNC also emphasizes the need for further site-specific environmental, social, and economic impact assessment for individual projects.



Further, as highlighted in Figure 8, the land identified as suitable for solar closely correlates with communities the state deems highly vulnerable due to the cumulative impacts of pollution exposure, environmental effects, sensitive population characteristics, and socioeconomic factors.[43] Therefore, careful prioritization and tradeoffs must accompany land use planning to reach the state's clean energy goals, informed by community consultation and stakeholder engagement. Furthermore, site-specific environmental, social, and economic impact assessment should be considered for individual projects.

ELEMENTS OF SUCCESS

Engage the public to incorporate a diverse set of perspectives in energy and environmental matters of the state.

SECTION 5

Absent concerted effort, the headwinds to clean energy deployment will grow stronger

Hardware costs, particularly for solar, have fallen dramatically and developers have found good project sites, affordable transmission access, and supportive local communities (Figure 9). However, as more solar, wind, and other land-intensive clean energy resources are built in California, project siting will grow more difficult, risky, and costly as early projects exhaust the most favorable locations: the supply of large, connected, suitable lands with high wind and solar potential will diminish; the willingness of communities to host clean energy projects could erode and restrictive siting ordinances proliferate; and transmission interconnection will become more costly and distant, requiring more rights-of-way from additional landowners and at a higher cost.

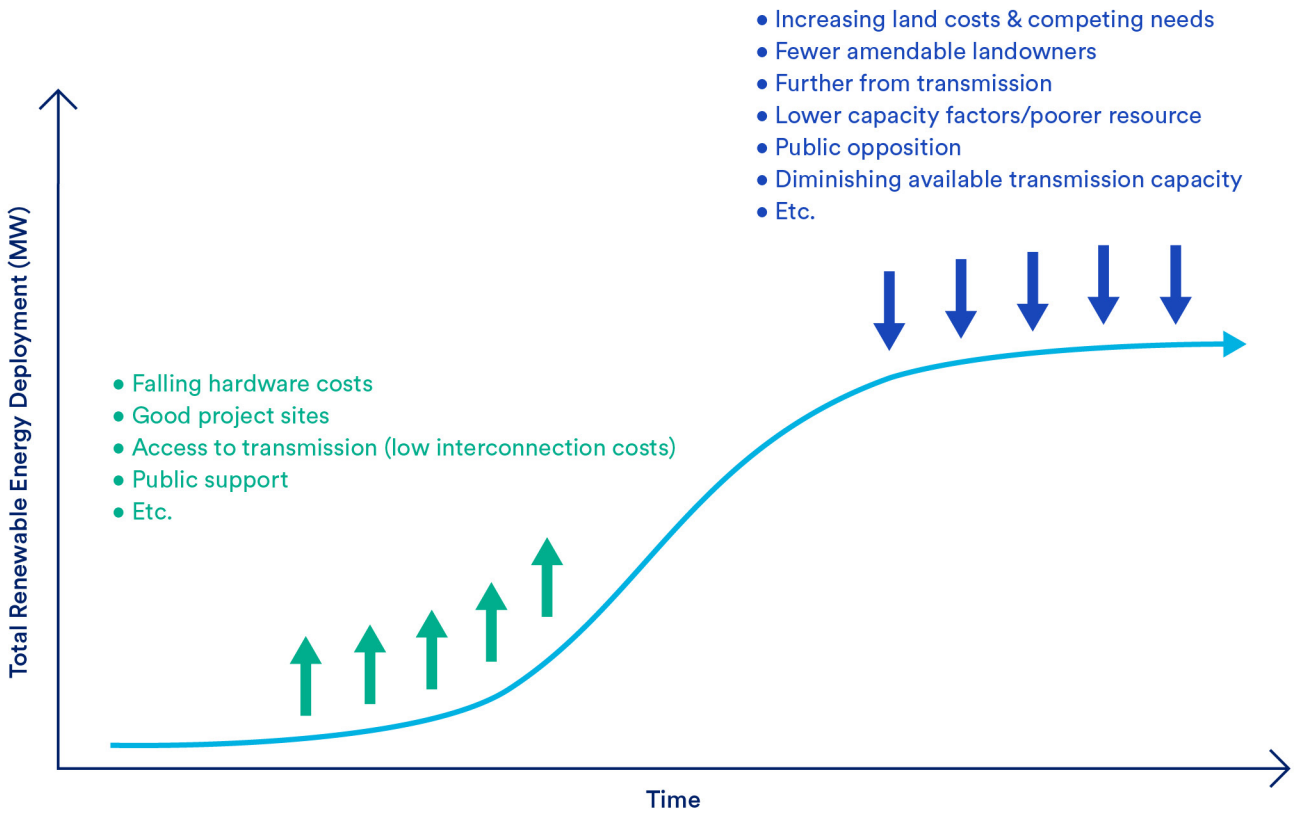
The sum of these forces threatens to make clean energy deployment in the state harder just when it most needs to accelerate. The necessary rapid acceleration in clean energy deployment in the face of increasing headwinds was one of the most severe challenges identified in the dozens of conversations had with experts and advocates throughout the state.

ELEMENTS OF SUCCESS

Develop a Clean Energy Deployment Plan with specific quantities, locations, and timing of new resource development and infrastructure expansion, aligned with the state's economic growth and social equity priorities and incorporating distinctive visions of the clean energy transition for each region.

Figure 9: Growing Headwinds to Clean Energy Deployment Could Slow New Project Development

Developed by Lucid Catalyst for Clean Air Task Force based on interviews with utility-scale PV developers.



SECTION 6

Today's approach to meeting state climate goals is insufficient for today's needs

The clean energy systems we need to build in the coming years are complex, interconnected, and capital intensive. There is little room for error; delays or failure in one part of the system ripple through the rest, threatening to slow progress, increase costs, and threaten reliability. For example, a delayed transmission line forestalls the addition of many gigawatts of remote solar farms while increasing its financing costs; insufficient distribution system capacity precludes electric vehicle charging infrastructure; and delayed clean electricity generation capacity causes unwelcome extension of fossil fuel use on reliability grounds. Project development risks like these increase the costs to investors and consumers. These are the consequences of today's project-by-project approach to infrastructure deployment.

The state agencies should be applauded for their collaboration and planning efforts in recent years to tackle the challenges of massive clean energy deployment. While these collaborative efforts are valuable, they remain mostly informal and *ad hoc*, with diffuse responsibilities remaining spread among state agencies for planning for and delivering on the state's climate goals. Absent consolidating and clarifying responsibilities, the state is unlikely to achieve its most ambitious climate goals through coordination alone.

ELEMENTS OF SUCCESS

Assign a lead agency and vest it with sufficient authority to develop and implement the state's Clean Energy Deployment Plan in coordination with the other agencies.

SECTION 7

Recommendations: A Plan to Accelerate California's Clean Energy Transition

California has a finite time to build an unprecedented amount of clean energy and supporting infrastructure. But, done right, this clean energy transition will do more than reduce planet-warming greenhouse gases. It will reduce toxic pollution in homes and communities, provide hundreds of thousands of jobs,[44] and place California at the forefront of the battle against climate change.

California's current project-by-project, bottom-up approach to clean energy deployment is failing to elicit the pace, scale, and diversity necessary to achieve its ambitious clean energy targets and the benefits of a clean energy transition. The enhanced coordination efforts by the state's agencies, legislature, and executive are helpful. Still, they do not overcome the fundamental shortcoming of a piecemeal deployment approach: considering each project in isolation will increase costs, delay deployment, and reduce the benefits of the complete infrastructure transformation required to reach the state's climate goals. And there isn't a moment to waste: failing to rapidly deploy clean energy today compounds the difficulty of reaching targets tomorrow.

To put the state on track to success, we offer the following recommendations for policymakers to consider while leading California to a clean energy future:

Develop a Clean Energy Deployment Plan.
The complexity and rapidity of eliminating emissions from every sector of the economy create a vital role for planning. A lead agency should begin a coordinated, multi-sectoral, and multi-agency process to develop a Clean Energy Deployment Plan *with specific quantities, locations, and timing of new resource development and infrastructure expansion.* This plan must be aligned with the state's economic growth and social equity priorities and incorporate distinctive visions of the clean energy transition for each region, developed by local governments and their communities. And because nothing is certain, the plan should include contingent pathways for when key milestones are not met. Finally, the Clean Energy Deployment Plan should incorporate land, social, and institutional realities that typically fall outside of modeling studies. Existing planning efforts like the *SB 100 Joint Agency Report* development process could serve as the basis of a more comprehensive planning initiative.

Assign a lead agency. Achieving the physical foundation for achieving California's climate goals is now spread among more than a dozen agencies.[9] But as the old saying goes, "When everyone is in charge, no one is in charge." Therefore, the state should vest primary responsibility and accountability for achieving its clean energy goals to a single entity with sufficient authority to develop and implement the state's Clean Energy Deployment Plan in coordination with the other agencies. In addition, the roles and responsibilities of all agencies should be clarified.

Develop a dashboard. Publicly tracking progress towards milestones established in the Clean Energy Deployment Plan is vital to increase public trust, provide accountability, inform course corrections, and provide private sector certainty. This level of transparency and accountability will improve the odds of success, reduce costs, and minimize political hurdles to a clean energy transition. The Clean Energy Deployment Dashboard should be a publicly available website that tracks progress towards specific milestones established in the Clean Energy Deployment Plan and SB 100, potentially built on the Tracking Energy Development (TED) Task Force efforts or CEC's Tracking Progress reports.[45,46]

The dashboard could include, at a minimum:

- Time-series data on key milestones and indicators of progress, including emissions, generation capacity, transmission capacity, and storage capacity
- A scorecard that tracks achieved or missed milestones
- Designated single agency with responsibility for achieving each milestone
- Measures of equity impacts, jobs, and other social indicators

Engage the public. California's current public engagement efforts—including the Disadvantaged Communities Advisory Group (DACAG), CPUC's Public Participation Hearings, and CEC's SB 100 Scoping Workshops, just to name a few—demonstrate California's commitment to public engagement and the value of incorporating a diverse set of perspectives in energy and environmental matters of the state. These efforts must continue and be strengthened, especially as deployment accelerates. A particular emphasis should be placed on public education regarding the scale and urgency of the clean energy deployment challenge and providing estimates of the costs, benefits, and tradeoffs among different pathways to inform the Clean Energy Deployment Plan.

Advance supportive policy. The state should consider additional supportive policies that: ensure local economic benefits; clarify differentiated agency roles, including the designation of a lead for developing and implementing the Clean Energy Deployment Plan; harmonize existing policies and programs with the Clean Energy Deployment Plan; and improve the regulatory process. California lawmakers should also consider enhancing the state's role in system planning, siting, and financing.

[9] The Climate Action Team (CAT), for example, includes 22 state agency members that coordinate on statewide climate efforts. Other entities not included on the CAT that nonetheless have an important planning, permitting, regulation, or policy role related to climate include the California Independent System Operator, local and county governments, water districts, and others. California Environmental Protection Agency, "Climate Action," Accessed: July 2022. https://calepa.ca.gov/climate-action/

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