Renewable Energy Beyond 2020

Next Steps for California

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About this Report

This policy paper is the twelfth in a series of reports on how climate change will create opportunities for specific sectors of the business community and how policy-makers can facilitate those opportunities. Each paper results from one-day workshop convenings that include representatives from key business, academic, and policy sectors of the targeted industries. The convenings and resulting policy papers are sponsored by Bank of America and produced by a partnership of the UC Berkeley School of Law's Center for Law, Energy & the Environment and UCLA School of Law's Environmental Law Center & Emmett Center on Climate Change and the Environment.

Authorship

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Glossary of Terms

California Air Resources Board (CARB): An organization within the California Environmental Protection Agency responsible for providing and maintaining clean air, including enforcement of the state's greenhouse gas reduction law.

California Energy Commission (CEC): An agency that reviews requests to build thermal power plants of 50 megawatts or more in capacity, and which otherwise focuses on energy policy and planning for California.

California Global Warming Solutions Act of 2006 (AB32): California state law which sets out the greenhouse gas emissions reduction goal to be achieved by 2020.

California Public Utilities Commission (CPUC): California's agency in charge of regulating investor-owned utilities.

California Independent Systems Operator (ISO): An independent, non-profit grid operator responsible for maintaining the reliability and accessibility of California's power grid.

California Solar Initiative (CSI): A solar rebate program for California, with the aim of securing approximately 1,940 megawatts of new, solar-produced electricity by the end of 2016.

Carbon Capture and Sequestration (CCS) Technologies: A set of technologies designed to capture carbon dioxide from power plants or industrial processes and to store it underground instead of releasing it into the atmosphere.

Community Choice Aggregation (CCA): Allows California cities, counties, or groups of cities and/or counties in California to supply electricity to customers within their boundaries.

Distributed Generation: Electricity production that is on-site or in close proximity to load and is interconnected to the utility distribution system. In the context of renewables, this is also described as the generation of local renewable energy.

Energy Imbalance Market (EIM): Automated systems designed to reliably and automatically balance real-time imbalances on the grid that result from deviations in energy supply and demand.

Federal Energy Regulatory Commission (FERC): An independent agency with regulatory authority over interstate wholesale power sales and the interstate transmission of electricity, natural gas, and oil.

Feed-in Tariff (FiT): Requires the utility to pay a set amount for electricity generated from specified sources, usually limited to renewable sources.

Investor-Owned Utilities (IOU): A privately-owned electric company that in California is regulated by the CPUC.

Megawatts (MW): A unit of power that is equivalent to one million watts, generally considered as able to provide sufficient power in any given moment to serve approximately 750 households.

Municipal Utility: A political entity, such as a city or county government, that provides utility-related services such as electricity, water, and sewage.

Net Metering: A state-mandated program through which utility customers with on-site renewable generating facilities no larger than one megawatt of capacity can receive bill credit for power not used on-site and delivered to the grid. In effect, sending power to the grid causes the electric meter to run backwards, reversing charges that otherwise would apply for power taken from the grid by those customers.

Power Purchase Agreements (PPA): Agreements to buy power. They are the primary instruments by which utilities acquire power from third-party providers. In addition, these agreements have become promising tools for individual customers who wish to produce renewable energy on-site. In that process, a third party owner/service provider receives tax benefits for installing a renewable technology array on a host's property and then passes those benefits on to the end-user/host in the form of lower energy costs over a contractually arranged term.

Public Utility Regulatory Policies Act (PURPA): A federal legislative act first passed in 1978, and subsequently amended, designed to increase energy efficiency and alternative forms of energy production.

Qualifying Facilities: Renewable energy generators with facilities no larger than 80 megawatts and cogenerators. Utilities have been required to purchase energy from these facilities at the utility's avoided cost in order to encourage energy production from these facilities and to reduce dependence on other sources of energy.

Renewable Energy Transmission Initiative (RETI): A California interagency process to identify renewable energy zones that can be developed cost effectively and with the least environmental impacts. RETI also develops conceptual transmission plans for identified energy zones.

Renewable Energy Credit (REC): A certificate of proof, issued through a state accounting system, that one unit of electricity was generated and delivered to the grid by an eligible renewable energy resource. A REC can be sold either "bundled" with the underlying energy or "unbundled", and utilities in California can use RECs to meet their RPS obligations.

Renewable Portfolio Standards (RPS): Legal requirements that a specific percentage of retail electrical power for California comes from eligible renewable energy resources.

Self-Generation Incentive Program (SGIP): A state program providing financial incentives to California customers for the installation of eligible on-site energy systems.

Smart Grid Technologies: A set of technologies designed to improve the ability to detect and react to grid issues so as to provide better monitoring, control and efficient use of the energy transmission and delivery system.

Executive Summary: A Path Forward for Renewable Energy

California is among the world's leaders in the development and deployment of renewable energy. Businesses, residents, and public entities in the state have harnessed significant amounts of solar, wind, geothermal, biomass, and other renewable sources, putting California on track to procure 33 percent or more of its energy from renewables by 2020.

The state's renewable energy policies have helped spur this progress. Starting in 2002 and accelerated in 2006, California established the "renewables portfolio standard" (RPS) program, which required certain retail sellers of electricity to procure a percentage of their electricity from eligible renewable energy sources. In 2011, Governor Jerry Brown significantly expanded the RPS program to include all utilities and to increase the existing renewables target of 20 percent by December 31, 2010 to 33 percent by December 31, 2020. In 2013, the governor signed a bill authorizing state energy regulators to approve renewable targets beyond this percentage, making the 33 percent 2020 RPS a floor instead of a ceiling. California is presently on course to meet the 2020 target and possibly exceed it.

Despite the progress, significant challenges remain. Ironically, the success of the state's policies may be contributing to a stalled market for renewables. With utilities already poised to meet the 2020 RPS, they now have little incentive to sign new renewable energy contracts.

In addition, the state may not realize the full environmental benefits of renewable deployment without additional policies. California is relying on renewable energy to help meet its long-term goals to reduce the greenhouse gas emissions that cause climate change. California seeks to reduce these emissions to 1990 levels by 2020 and eighty percent below 1990 levels by 2050. Meeting the 2050 goal will necessitate a decarbonized electricity supply, which more renewable energy can help achieve. However, intermittent renewable sources like the sun and wind may lead to a proliferation of fossil fuel-based power plants to balance the variable generation, undermining the carbon benefits of renewables.

To develop a vision and policies for renewable energy deployment beyond 2020 that addresses these challenges, renewable energy developers, finance experts, advocates, utility representatives, business leaders, and public officials gathered at the University of California, Berkeley in June 2013 for a discussion sponsored by the UC Berkeley and UCLA Schools of Law. The group developed a goal for expanded and improved renewable energy deployment and suggested strategies and policies to achieve it.

Ultimately, the group envisioned a future with significantly more renewable energy that would position California to meet its 2050 greenhouse gas reduction goals, including a possible benchmark of 51% or more renewable energy by 2030. According to this vision, Californians in the coming decades would receive more renewable, flexible, and reliable electric service with lower greenhouse gas emissions and expanded consumer choice, while inspiring neighbor states and countries to follow suit.

Three Key Barriers to Realizing this Vision

1) Absence of a structure to efficiently plan for and finance the necessary grid upgrades and renewable technologies to achieve a low-carbon, renewable energy future;

2) Insufficient planning, coordination, and research by grid operators, utilities and policy makers to achieve this future; and

3) Lack of requirement to integrate intermittent renewable energy without increasing greenhouse gas emissions.

Solutions to Overcome the Barriers

- A 51% or higher 2030 RPS that includes specific requirements to pair renewables with necessary grid upgrades, with benchmarks to ensure cost-effectiveness, reliability, and reduced greenhouse gas emissions;

- More state-level and utility planning and research to achieve a low-carbon, renewable energy future by 2050, including a cost-benefit analysis of various renewable scenarios, and an updated state energy action plan that articulates pathways to a 51% RPS by 2030 and the 2050 greenhouse gas goal; and

- Requirements that grid operators prioritize policies and technologies that reduce greenhouse gas emissions associated with integrating intermittent renewable energy, such as through demand response and energy storage technologies and greater integration of other regions into the California grid, possibly through the creation of a regional energy imbalance market, among other solutions.

The following sections summarize the policies that are discussed in greater detail in this report and also contain an overview of California's renewable energy policies and progress.

State Legislators and the California Public Utilities Commission

Develop a 51% or higher 2030 RPS with benchmarks to ensure compliance at regular intervals. The benchmarks would ensure linear and timely utility compliance and prioritize least-cost resources with improved best-fit criteria with reduced impacts on ratepayers and complementary infrastructure planning.

Include distributed generation goals in the 2030 RPS, including accounting for "behind the meter" generation. A new RPS could include specific targets for distributed renewable energy resources, such as large-scale rooftop solar or other facilities located close to consumers and either used onsite or exported to a local distribution grid.

Develop benchmarks to encourage consideration of RPS co-benefits. Energy regulators could include benchmarks that assess co-benefits from increased renewable energy deployment, such as improved localized air quality and economic development in disadvantaged communities.

Develop incentives for utilities to meet benchmarks. Meaningful incentives in the RPS would encourage utility compliance with RPS benchmarks, such as cost-recovery rules for RPS-related investments and additional credit for dispatchable renewable energy that displaces the dirtiest energy sources.

Consider allowing greater reliance on unbundled Renewable Energy Credits (RECs) to stimulate lower-cost renewable energy. Unbundled RECs, which represent the environmental attributes of renewable energy generation, could help finance renewable projects outside of utility jurisdictions and may allow for more cost-effective renewable procurement.

California Public Utilities Commission

Engage in a comprehensive cost-benefit analysis of long-term renewables and greenhouse gas scenarios. Regulators could evaluate all resource options in a single proceeding, which would involve a cost-benefit analysis to determine the amount of renewable resources needed to meet both the future RPS and greenhouse gas reduction targets at the total likely cost.

Ensure that electric utilities and grid operators compile and share data on grid infrastructure, resource needs, and consumer preferences. Greater data transparency regarding current electricity and infrastructure needs at the distribution and transmission levels would help determine the most optimal and cost-effective locations and technologies to deploy.

Update California's "Energy Action Plan." A high-level meeting to develop a new energy action plan could incorporate projected electricity and grid needs through 2030 that is consistent with the state's long term greenhouse gas reduction goals.

Promote the use of smaller planning areas for distributed and utility-scale renewables. California should prioritize procurement of distributed generation and coordinated planning to ensure that utilities and developers locate central-station renewable facilities in the most cost-effective and environmentally beneficial areas with access to planned or existing transmission lines.

Develop policies and rates to boost demand response financing, tariffs, and compatible appliances. A joint proceeding with the California Energy Commission and California Independent Systems Operator could focus on ways to boost demand response (changes in electricity use by customers from typical consumption patterns) through tariffs that fairly value load management to help integrate variable renewables without the need for new generation.

Continue to encourage more energy storage deployment. More cost-effective deployment of energy storage technologies, including by developing parameters for long-term contracts for energy storage by utilities and promoting vehicle-to-grid distributed energy storage from electric vehicles (in addition to successfully implementing the state's October 2013 targets for energy storage procurement), could help integrate variable renewables.

Promote fast-ramping generation products to help balance intermittent renewables. A defined set of fast-ramping products that do not emit greenhouse gases and have specific ramp time, duration, and availability requirements could provide operators with greater flexibility to cover intermittent renewable resources.

Develop "forward procurement mechanisms" to balance renewables without increasing greenhouse gas emissions. Forward procurement mechanisms could ensure that gaps in intermittent renewables are covered through greenhouse gas-free resources.

Grid Operators

Develop criteria for new renewable resources that improve their ability to support grid reliability through greater operational flexibility. Requirements and/or incentives for renewable generators to operate their facilities in ways that support, or even improve, grid reliability, could include curtailment (restricting the flow of power onto the grid), providing ancillary services for the grid, or utilizing technologies that improve dispatchability.

Consider more granular scheduling of power delivery to provide improved and lower-carbon options for renewables integration. Scheduling electricity generation with shorter time periods than currently allowed and for specific resources could provide grid operators with better insight into the available options to balance intermittent renewables without increasing greenhouse gas emissions.

Provide improved renewable forecasting to assist grid integration efforts. Shorter-term forecasting of resource availability could help grid operators better plan for and accommodate intermittent renewables without relying on fossil fuel generation to provide excess backup power as security.

State Legislators

Convene an expert group to assess utility regulations and possible business models that will implement renewable energy plans. New business incentives for utilities could help them better integrate renewables without increasing greenhouse gas emissions.

Require reduced greenhouse gas emissions from the integration of more renewable energy. Key infrastructure upgrades and grid management tools at critical points in the system could enable a high penetration of central-station and distributed renewables, coupled with energy efficiency and load management to achieve California's carbon reduction goals at optimal cost and reliability.

Federal, State, and Multistate Leaders

Remove barriers to an "energy imbalance market" across Western North America to integrate variable renewable energy without using fossil fuel resources. Grid operators can compensate for intermittent renewable energy from specific locations within their territories by broadening access to renewable energy supplies across the western North America region through a region-wide energy imbalance market, provided fossil fuel resources are not replacing local renewables.

California's Renewable Energy and Climate Change Goals

Reducing Greenhouse Gases with Renewable Energy

Through legislation, regulation and executive orders, California has acted to reduce greenhouse gas emissions that cause climate change out of concern for the negative impacts of a changing climate on California's economy, natural resources and quality of life.[1] The California Global Warming Solutions Act of 2006 (AB 32) requires the state to roll back its greenhouse gas emissions to 1990 levels by the year 2020, equivalent to a 30 percent cutback from the business-as-usual scenario projected for 2020.[2] Former California Governor Arnold Schwarzenegger's Executive Order S-3-05 then calls for an eighty percent reduction from 1990 levels by 2050 (see Figure 1).[3]

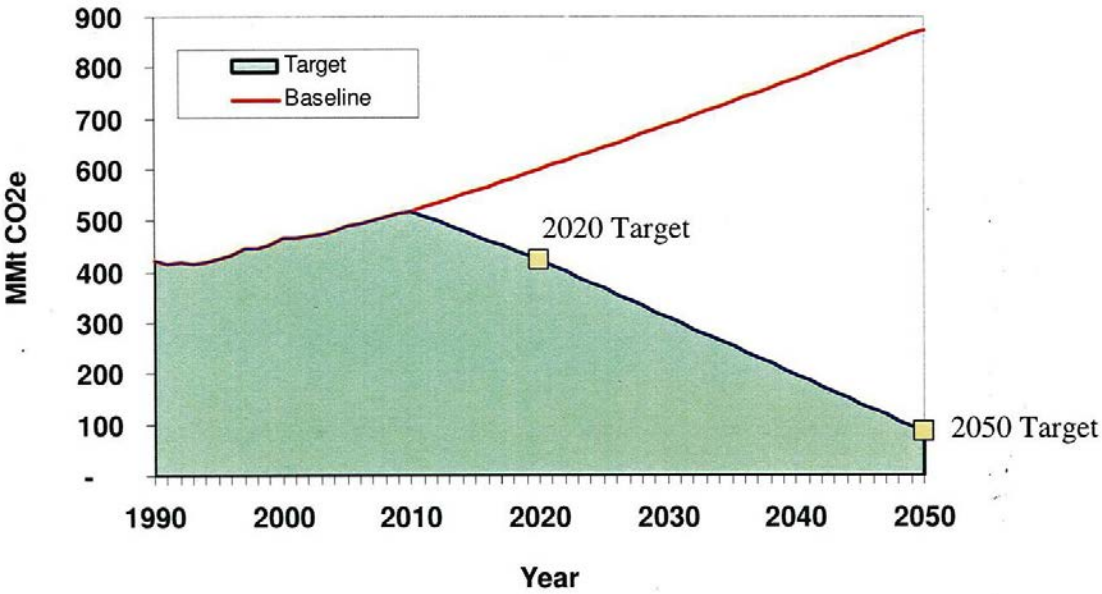


Figure 1. California's Emissions Goals for 2020 (AB32) and 2050 (Executive Order S-3-05)

Source: Energy and Environmental Economics, Inc.

"We need to have scenarios that are zero or carbon-negative. How do we usefully partner and inspire our neighbors?"

-- Dan Kammen
U.C. Berkeley

The state's electricity sector is one of the largest sources of greenhouse gas emissions, contributing almost 20 percent of the statewide emissions (see Figure 2).[4] As a result, the state's climate change goals necessitate reductions from this sector through energy efficiency measures to reduce demand (not the subject of this report) and by switching

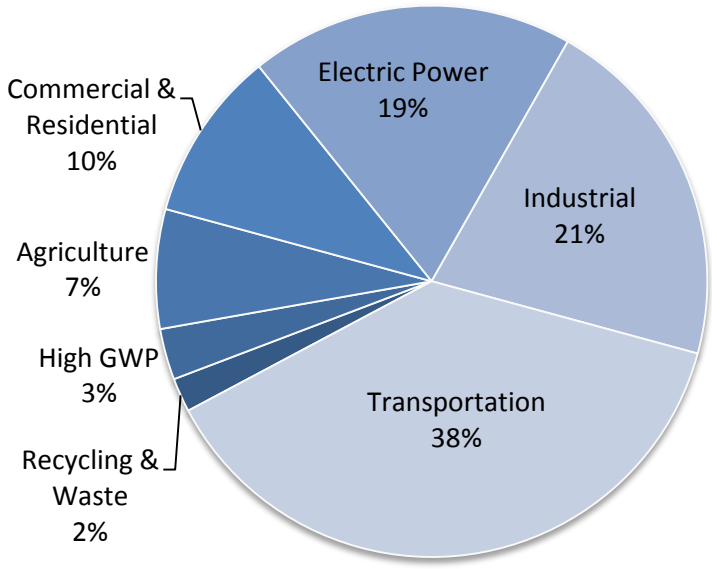


Figure 2. Statewide GHG Emissions by Sector (2011)

Source: California Air Resources Board

from fossil fuel-based energy to renewable sources. The California Air Resources Board, the agency charged with implementing AB 32, stated in its AB 32 scoping plan that achieving the 33 percent goal "is a key part of CARB's strategy for meeting the AB 32 targets."[5]

Achieving the 2050 greenhouse gas reduction goal, however, will almost certainly be impossible without significantly decarbonizing the electricity system. Experts estimate that the 2050 goals will require a 90 percent reduction from business-as-usual emission levels.[6] With energy demand in California projected to double by 2050 due to increasing population and economic growth, meeting the 2050 target will require a significant overhaul of the state's energy systems. Specifically, state leaders will need to focus on increasing low-carbon electricity generation,[7] with options including renewable energy, nuclear energy, and fossil fuels in combination with carbon capture and sequestration (CCS). Given the various political and other limitations of the nuclear energy and CCS options,[8] this report focuses solely on implementing the renewables scenario.

The renewables scenario to meet the 2050 goals involves replacing current power plants that use natural gas and coal with renewable resources like solar and wind. Grid operators will then have to integrate these intermittent energy supplies into the grid with the benefit of non-carbon resources, like energy storage systems (such as batteries and flywheels) and demand response programs that reduce or delay electricity usage to accommodate fluctuating supply. They will also need to draw energy from a broader geographic base of renewables that covers neighboring states and beyond.[9]

Recognizing the need for action, California policy makers have taken important steps to promote renewable energy generation. As referenced previously, Senate Bill 1078 (Sher, 2002) established the "renewables portfolio standard" (RPS) program to require certain retail sellers of electricity to procure 20 percent of their electricity from eligible renewable energy sources by December 31, 2017.[10] In 2006, Senate Bill 107 (Simitian) accelerated the calendar for the RPS program to require the target to be reached by December 31, 2010.[11] In 2011, Governor Jerry Brown then significantly expanded the RPS program

by signing Senate Bill X1-2 (Simitian, 2011), which broadened the program's scope to include all utilities (including municipal utilities) and increased the renewables target to 33 percent by December 31, 2020.[12] Senate Bill X1-2 also established intermediate targets of 20 percent by 2013 and 25 percent by 2016.[13] In 2013, the governor signed AB 327 (Perea), which authorizes the California Public Utilities Commission to increase the renewable procurement beyond the intermediate targets and 33 percent ceiling, if necessary.[14] In his signing statement of Senate Bill X1-2, Governor Brown expressed a belief that reaching 40 percent renewable energy in the near future could be achievable in a cost-effective manner.[15]

In order to reduce transmission congestion, Governor Brown also called for the development of 12,000 megawatts of the roughly 20,000 needed to meet the 2020 targets to come from local renewable energy, as part of his Clean Energy Jobs Plan.[16] Local renewable energy systems (or "distributed generation"), located in close proximity to the consumers they serve, have the advantage of producing power that is either used onsite or exported to a local distribution grid, rather than having to backflow to the transmission grid.[17]

In addition to the environmental benefits, state officials have expressed optimism that actions to address climate change will help California businesses continue to be world leaders in developing the technologies needed to make the transition to a low-carbon economy, leading to possibly thousands of new jobs.[18] Among these technologies, renewable energy from solar and wind resources represent some of the most promising options, both to reduce greenhouse gas emissions and stimulate local economic gains.

California's Progress on Renewable Energy Procurement and Grid Planning

California is on course to meet both its intermediate and 2020 renewables targets. Between 2003 and 2012, state leaders deployed 4,498 megawatts of new renewable energy in commercial operation, including 1,957 megawatts during 2012 alone (See Figure 3).[19] The California Public Utilities Commission (CPUC) forecasted that the RPS

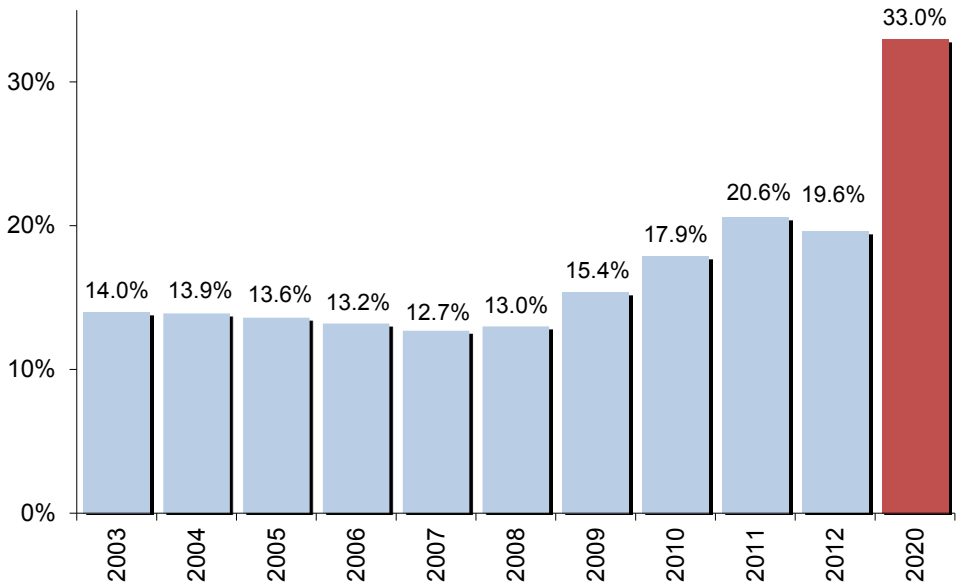


Figure 3. California's RPS Progress

Source: California Public Utilities Commission

program would generate over 3,000 megawatts of new renewable energy capacity in 2013.[20]

More renewable energy is in the pipeline. Between 2002 and 2012, the CPUC approved more than 225 contracts representing an aggregate of more than 19,000 megawatts of renewable capacity.[21] In 2012, the CPUC approved 64 contracts for 3,725 megawatts of renewable capacity.[22] In addition, California is reportedly on track to meet Governor Brown's target of 12,000 megawatts of local renewable energy by 2020, reducing the need for more investment in the transmission grid. The Governor's Office estimated that 7,999 megawatts should already be counted toward this target (either as operating, pending or authorized generation), leaving just 4,001 megawatts remaining to be deployed.[23]

California is also making progress to improve grid planning and reliability in order to accommodate increased renewable deployment. In furtherance of the RPS program, California leaders have begun developing policies to ensure the interconnection and deliverability of renewable energy. In particular, the California Independent System Operator (CAISO), the entity responsible for maintaining the reliability and accessibility of California's power grid, undertakes annual transmission planning to identify the precise infrastructure upgrades needed to meet grid reliability requirements and ensure completion of the RPS program.[24] After considering various scenarios, the CAISO determined in March 2013 that it could maintain grid reliability under the RPS program only with certain infrastructure upgrades.[25] CAISO identified 41 measures that would improve grid reliability and approved 2 of them.[26]

To help utility customers purchase renewable energy technologies, California has created a number of incentive programs. For example, in 2007, the state launched the California Solar Initiative (CSI) with a budget of $2.367 billion over 10 years. The CSI offers incentives for the installation of solar systems on existing residential homes as well as existing and new commercial, industrial, non-profit and agricultural properties.[27] Policy makers aim to install 1,940 megawatts of solar capacity by the end of 2016 under the program. In 2010, the state created the CSI-Thermal Program to provide incentives to both electric and gas customers for the installation of solar thermal systems to replace water-heating systems.[28] California also launched a Self-Generation Incentive Program, which provides incentives to install eligible local renewable energy systems, including energy storage devices, wind turbines, fuel cells, combined heat power generators, pressure reduction turbines, and waste heat capture applications.[29] In 2013, the governor signed SB 43 (Wolk) to authorize any customer of the state's three largest utilities to purchase renewable electricity generated off-site for a credit on utility bills, thereby allowing residents without on-site generating potential access to support and benefits from renewable energy deployment.[30]

Despite the progress to date, however, California still faces challenges to deploying more renewable energy beyond 2020 and integrating existing and future renewables without increasing greenhouse gas emissions. The next section addresses some of the key challenges and offers solutions for policy makers, regulators, utilities, and business leaders.

Barrier #1: Lack of a Structure for Grid Upgrades and Renewable Technologies

Participants at the convening noted that California's renewable energy industry has largely become a victim of its own success. Due to the faster-than-expected decrease in the cost of solar photovoltaic panels, utilities have made more rapid progress in meeting the 2020 RPS than policy makers anticipated. The Governor's Office estimates that the current pipeline of projects currently holds more than twice the renewable capacity required to meet California's renewables target for 2020.[31] While AB 327 may lead to a higher RPS through future regulations, utilities presently lack incentive to procure additional renewable energy to meet the 2020 target. As a result, renewable energy developers do not have a strong market to sell their technologies at precisely the moment when prices and regulations have converged to lower barriers to entry.

"The market and the industry need a clear signal. Companies need to innovate with a market signal to pursue, and we need a number, a higher RPS."

-- Mark Tholke
EDF

Solution: A 51% by 2030 Renewable Portfolio Standard that Reduces Greenhouse Gas Emissions

California policy makers should consider increasing the current renewable portfolio standard to a possible 51% or higher benchmark by 2030, either through AB 327-authorized regulation or by statute, provided that this increase includes a requirement to reduce greenhouse gas emissions to help meet California's 2050 reduction goals. To ensure that increased reliance on renewables does not compromise grid reliability with increasing levels of intermittent resources, a 51% RPS would need to include new operation requirements for RPS resources to facilitate integration and grid reliability. In addition to the 51% renewables target, policy makers could set a target for a percentage of the state's energy by 2030 to come from other zero greenhouse gas emission resources, such as hydroelectric, nuclear power, or conventional generation with carbon capture sequestration (CCS). Some participants suggested 75% as a starting point. The following policies represent options to implement this new RPS.

Legislators and the California Public Utilities Commission should develop 2030 RPS benchmarks to ensure compliance at regular intervals.

The new 2030 RPS should include detailed benchmarks for utilities to meet at regular intervals, such as every two or three years. The benchmarks will ensure that progress bringing renewables on-line will be linear and steady, that utilities are complying with the mandate, and that policy makers can adjust the standards as needed to reflect changing market and technology conditions. The benchmarks could include timeliness of bringing projects on-line (not just in contract), selection of least-cost resources with improved best-fit criteria, and reduced impacts on ratepayers. Policy makers could also identify an entity to determine resource needs and condition the expanded RPS on new infrastructure planning.

"Companies have reduced their costs, yet the RPS is already full. The technology curve is all dressed up with nowhere to go."

-- Nancy Pfund
DBL Investors

State leaders should develop RPS co-benefit benchmarks.

Energy leaders, possibly at the CPUC or CEC, could include co-benefit benchmarks from increased renewable energy deployment such as improved localized air quality from reduced fossil fuel-based power plants replaced by renewable energy sources, economic development

in disadvantaged communities from the installation of distributed renewable generation facilities (such as on urban brownfields, commercial and industrial rooftops, and unproductive or marginal lands near rural or agricultural communities), and hedging against natural gas price increases and future electricity infrastructure needs that could negatively impact ratepayers without alternative, renewable energy supplies.

State regulators and grid operators should develop criteria for new renewable resources that improve their ability to support grid reliability through greater operational flexibility.

State regulators, working with grid operators, could develop requirements and/or incentives for renewable generators to operate their facilities in ways that support, or even improve, grid reliability. These operational characteristics could include curtailment (restricting the flow of power onto the grid), providing ancillary services for the grid from the renewable energy generation, or integrating technologies like energy storage that allow for improved dispatchability.

"We need to maintain grid reliability, or this conversation about renewables is irrelevant."

-- Jim Kelly
Southern California Edison (retired)

State regulators should develop incentives for utilities to meet benchmarks.

State elected officials and regulators should include meaningful incentives in the RPS to encourage utility compliance with these benchmarks. Incentives could include rules that ensure certainty of cost recovery for investments made to achieve the standards, including necessary distribution upgrades with incentives for cost-effective spending. Officials should also consider other jurisdictions' approach to incentives, such as additional credit for dispatchable renewable energy and renewable energy that displaces the dirtiest energy sources or otherwise can guarantee a reduction in greenhouse gases.

State policy makers should include distributed generation goals in the 2030 RPS, including accounting for "behind the meter" generation.

Some participants felt that a new RPS should include specific targets for distributed renewable energy resources. Such a target would ensure that utilities prioritize procurement of localized resources to reduce transmission needs and locate energy close to load. Policy makers should explore ways to prioritize distributed generation, either through specific inclusion in a new RPS or through other design parameters.[32]

"The situation now is where are the next renewable contracts going to come from? What do we do now?"

-- Adam Browning
Vote Solar

As part of this effort, state leaders could account for "behind the meter" generation in meeting a 2030 RPS. The net metering program could help utilities meet their renewable obligations, although the energy produced under the program currently does not count toward a utility's RPS obligation. Policy makers could set a separate target or goal for renewable energy from net energy metering resources as part of the distributed generation targets. Utilities have objected to the current program by arguing that net metering customers do not pay their fair share of infrastructure and generation costs. In part to address these concerns, AB 327 creates a process for the CPUC to develop new rates to bolster or replace net energy metering in future years that accurately accounts for the program's costs and benefits for utilities.

State leaders could consider allowing greater reliance on unbundled Renewable Energy Credits (RECs) to stimulate lower-cost renewable energy.

Current policy restricts reliance on unbundled RECs, which represent the environmental attributes of renewable energy generation (one REC is equivalent to one megawatt-hour of renewable energy), in an expanded RPS. "Unbundled" RECs can be freely traded in a market, and policy makers should explore options for allowing greater use of them. The CPUC and Legislature in 2011 approved the use of tradable RECs with temporary price and quantity caps for utilities to meet up to 25% (and declining over time) of the RPS.[33] Unbundled RECs can help finance renewable projects outside of utility jurisdiction and may allow for more cost-effective renewable procurement, although critics believe that RECs may be subject to price variability that increases ratepayer costs.

The state legislature should convene an expert group to assess utility regulations and future business models that will implement renewable energy goals.

Some participants at the convening cited the need for an assessment of utility business models in order to adapt to changing technologies and energy policies. They referred to concerns that utilities could soon enter a "death spiral" with greater on-site renewable energy that leads to less electricity usage and therefore increasingly higher rates for customers, which in turn motivates more customers to rely on on-site generation and energy storage technologies to avoid the high charges. Policy makers may therefore need to create new business incentives for utilities to offer customers more choices for managing their electricity usage and selecting preferred resources. This effort may require a legislative process to determine which incentives or changes in regulation would be necessary to encourage utilities to adopt and integrate greater levels of renewables and greenhouse gas-free energy sources.

Participants envisioned a number of options for utilities to adapt to a changing world of electricity provision. One possibility is that the electric utility of the future becomes a "network" owner or operator that provides a platform for a diverse market of energy services. The utility would then focus on accounting for and socializing the cost of the basic infrastructure to provide reliability for customers. At the same time, the utility would create an open business environment that fairly allocates connection costs for service providers while providing a competitive marketplace for all resource developers. Community choice aggregation (CCA), which allows California local governments individually or collectively to aggregate the electric load of their ratepayers in order to purchase electricity on their behalf, may represent an increasingly common example of energy providers that utilize utility infrastructure.[34] Ultimately, policy makers should strive to provide customers with a wider range of electric service options that enable them to choose electricity plans that include greater renewable proportion, varying degrees of system reliability, and power quality.

Barrier #2: Lack of Planning, Coordination, and Research

Participants at the convening cited disjointed and insufficient planning processes for renewable energy deployment across multiple federal and state agencies and grid entities, utilities, and local governments, making it less likely that policy makers and renewable energy developers will invest in the most efficient and cost-effective renewable energy technologies at the best locations and scale. For example, distributed renewable resources may be most valuable and cost-effective when placed at key congested distribution nodes to avoid expensive infrastructure upgrades at those locations.

Solution: Improved Renewable Policy and Planning Coordination to Reduce Greenhouse Gas Emissions

State elected officials and regulators should consider studying, funding, and requiring comprehensive planning and coordination at all levels of the electricity system. Policy makers will need additional data about the greatest system needs and most cost-effective and efficient policy options to address them. They should then enshrine these priorities into law and policy for grid operators and utilities to implement.

The California Public Utilities Commission should engage in a comprehensive cost-benefit analysis of long-term renewables and greenhouse gas scenarios.
Improved planning and coordination for renewables deployment and integration will require an assessment or analysis of the costs and benefits of various options and technologies. Participants recommended that state policy makers begin an "all-in" resource valuation in a single state regulatory proceeding at the CPUC. This proceeding would undertake cost-benefit analysis to determine the amount of renewable resources needed to meet future RPS and greenhouse gas reduction targets and the total likely cost of these investments, including for transmission and distribution system upgrades and new demand-side management, energy storage, and renewable technologies. The analysis should also include estimates of the alternative pathway (business-as-usual or more reliance on fossil fuels) and calculate the costs (and therefore avoided costs) of this alternative, factoring in the health and environmental costs of continued fossil fuel usage.

State elected officials and energy regulators should ensure that electric utilities, and grid operators compile and share data on grid infrastructure, resource needs, and consumer preferences.
A coordinated energy planning process will require greater data transparency from utilities and grid planners regarding current electricity and infrastructure needs at the distribution and transmission levels in order to determine the most optimal and cost-effective locations and technologies to deploy. Data on grid needs at the distribution level in particular will ensure optimal placement for energy storage and distributed resources and could help policy makers offer more effective incentives to promote them. AB 327 requires utilities to develop a plan that optimizes distribution-level resources

and analyzes costs and benefits. In addition, policy makers will need to ensure that the planning process incorporates projections for consumer pricing preferences and demand for new technologies and electricity options. The plans should result in improved flexibility and options for customers to meet their electricity needs.

State energy regulators should update California's "Energy Action Plan" to incorporate plans for a future low-carbon grid.

Policy makers should convene a high-level meeting to develop a new energy action plan that would incorporate projected electricity and grid needs through 2030 that is consistent with the state's 2050 greenhouse gas reduction goal. The current energy action plan is 10 years old, having been adopted in 2003 by the state's major energy agencies to prioritize electricity resources through a "loading order," starting with energy efficiency and conservation. As a result, the plan generally does not reflect the most current thinking and priorities of a rapidly changing policy and technology environment. Specifically, policy makers should consider changing the loading order to increase the prioritization of low-carbon resources. The loading order should also ensure that California takes advantage of the jobs and capital of the renewable energy economy. Agency leaders at the CPUC, California Energy Commission (CEC) and CAISO could convene to discuss goals and policies and develop an agreed-upon plan with proper enforcement and accountability mechanisms.

"We need quarterly en bancs with all four agencies, with one meeting on energy storage, demand response, market barriers, and another one on planning."

-- V. John White
Center for Energy Efficiency and Renewable Technology

The 2030 grid will likely involve products and services promoted by stakeholders who have not previously been part of utility planning, like electric vehicle manufacturers and related suppliers, demand response purveyors, energy efficiency contractors and financiers, and energy storage developers. Representatives from these sectors should be part of the coordinated agency planning.

State leaders should promote the use of smaller planning areas for distributed and utility-scale renewables.

As part of the planning and coordination process, policy makers should focus specifically on distributed generation. With the governor's goal of 12,000 megawatts of distributed generation by 2020, coupled with the benefits of more distributed resources to avoid transmission upgrades and bring generation resources closer to demand, policy makers and utilities should prioritize the procurement of distributed generation. However, proper planning will be critical to locating distributed resources in the most cost-effective manner. Planners will need to assess the renewable energy potential in key areas within each region of the state, as well as the integration needs, and determine the most efficient locations. As discussed, AB 327 requires utilities to develop a plan for optimizing distributed resources. Federal, state, and local decision makers will then need to ensure that sufficient incentives exist to steer deployment to these locations.[35]

"We've identified 1000 megawatts, a handful of projects, that are in jeopardy because of transmission delays."

-- Mike Eckhart
Citi

In addition, large central-station renewable facilities will also need regional and coordinated planning. Many of these facilities will require new transmission lines and the associated permits and environmental review. Agencies at the federal, state, and local levels will need to continue coordinating siting efforts to ensure that utilities and developers locate central-station renewable facilities in the most cost-effective and environmentally beneficial areas with access to planned or existing transmission lines.

Barrier #3: Lack of Requirement to Integrate Variable Renewable Energy without Increasing Greenhouse Gas Emissions

Grid operators must integrate variable renewable energy generation, such as solar or wind power that is subject to natural conditions and fluctuations, by either bringing other generation resources on-line or reducing demand to compensate for drop-offs. Many participants noted that the current grid is not well-suited for this task, given its aging infrastructure, lack of "smart" communications tools, relative geographic isolation, dearth of energy storage assets to manage demand and supply more effectively, and lack of transmission lines to important renewable resource locations. Without better technologies (such as energy storage and demand response) and resources (such as geographically diverse renewable installations and improved forecasting) to deploy, grid operators will likely balance variable renewable resources with additional fossil fuel-based generation, which will undercut the greenhouse gas savings from renewables. An expanded RPS must therefore include and prioritize requirements to integrate variable renewable resources in a manner that does not increase greenhouse gas emissions.

"We need public acceptance of the concept of a lower-carbon grid."

-- Diane Fellman
NRG

Participants identified key barriers to lower-carbon integration of renewables, including uncertainty about the cost-effectiveness of emerging technology like energy storage; balkanized balancing authorities and regulatory jurisdictions; complex overlap of federal, state, and regional authorities; and fear of compromising system reliability, bankrupting utilities, or driving up costs for ratepayers.

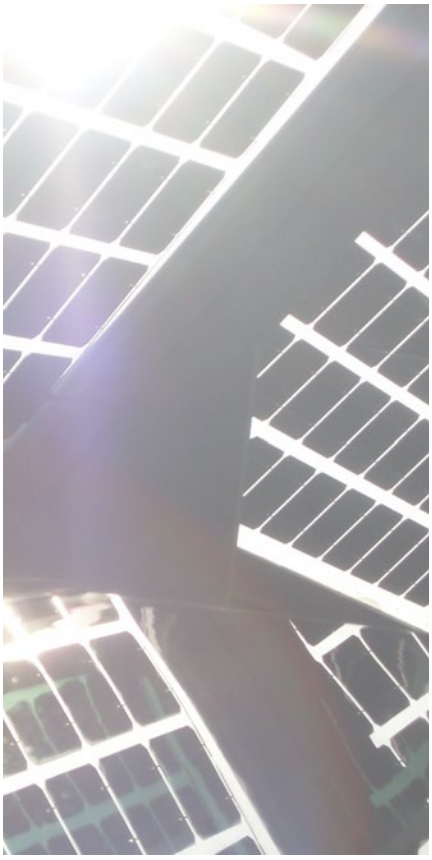
Solution: Require reduced greenhouse gas emissions from the integration of more renewable energy

Policy makers should strive to create a "flexible grid" that features bidirectional flow of power and information to facilitate a market in which numerous supply- and demand-side resources compete to balance load and generation. The state can encourage key infrastructure upgrades and grid management tools at critical points in the system to enable a high penetration of central-station and distributed renewables, coupled with energy efficiency and load management to achieve California's carbon reduction goals at optimal cost and reliability.

Grid operators could consider more granular scheduling of power delivery to provide improved and lower-carbon options for renewables integration.

Scheduling refers to grid operators stating the intended delivery of power or energy from one location to another via a specific transmission path. This path could include an interconnection between two specific grid areas, a transmission tie between two parties within the same grid area, or a transmission tie between two locations within one party's system. Grid operators schedule electricity supplies in advance, based on forecasted demand. They strive to balance reliability needs with economic costs. Some participants believed that a move to more granular (i.e. shorter time periods and for specific resources) scheduling of generating resources could provide grid operators with better insight into the

available options to balance intermittent renewables. On a shorter time frame, for example, non-carbon resources like certain energy storage technologies that capture renewable energy for later dispatch may outperform conventional, fossil fuel-based resources. In addition, specific resources at points along the electricity system, like a distributed energy storage system or demand response action, could balance intermittent renewables at a specific geographic locale.



Renewable energy developers and operators should provide improved renewable forecasting to assist grid integration efforts.

Forecasting of wind and solar resources involves predicting likely patterns in the wind and cloud cover, which can alert grid operators to potential shortages that need to be covered by other resources. If policy makers require renewable energy developers and operators to provide shorter-term forecasting of resource availability, that information could help grid operators better plan for and accommodate intermittent renewables without relying on fossil fuel generation to provide excess backup power as security.

State regulators and energy officials could develop policies and design rates to boost demand response financing, tariffs, and compatible appliances.

Demand response refers to changes in electricity use by customers from typical consumption patterns. These customer-side changes come in response to fluctuations 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 excess demand jeopardizes system reliability. Demand response represents a market-based tool that could involve aggregating smaller loads and allowing grid operators to regulate them to balance grid resources. Most programs would be voluntary, while involuntary programs cut electricity supply in times of extreme need.

Demand response often involves new technologies, such as “smart” appliances like dishwashers, refrigerators, or industrial equipment that grid operators can manage by delaying usage. It also involves transparent, real-time pricing to motivate customers to reduce electricity usage. These technologies require financing to implement. Utilities could provide the funds through government-backed on-bill financing, in which customers receive loans through their utilities that they repay through on-bill payments over time (the CPUC issued a proposed decision in September 2013 to expand this type of financing arrangement for nonresidential energy efficiency projects[36]). Government guarantees for these programs could reduce borrowing costs significantly.

Participants recommended that the CPUC begin a joint proceeding with the California Energy Commission and California Independent Systems Operator to focus on ways to boost demand response in the electricity system. The en banc proceeding could study tariffs that fairly value load management capabilities and offer sufficient certainty to providers to support financing efforts. The proceeding could also recommend time-of-use rates that encourage shifting electricity usage to cheaper, off-peak hours. Electricity rates help determine consumer willingness to moderate electricity usage and invest in renewable technologies. Current rates, however, do not encourage carbon-free optimization. Many customers do not have rate incentives to curtail energy usage to maximize energy efficiency and reduce fossil fuel usage by shifting to off-peak hours. In addition, utilities are reluctant to encourage net energy metering for renewables out of fear that they will not be compensated for infrastructure needs. Policy makers at the CPUC should design rates to maximize carbon-free renewables integration by encouraging demand response technologies through transparent pricing information. The rates can also help avoid ongoing political fights over net energy metering by balancing customer choice with fairly allocated costs.

To further this goal, policy makers should encourage the development of smart appliances that enable residential load management by responding to operator signals to curtail load when the alternative would be expensive, fossil fuel-based energy. Policy makers can institute tariffs and payment plans for participating customers and fund technology research and pilot projects.

State regulators should continue to ensure more energy storage deployment. Energy storage technologies hold the promise of balancing intermittent renewable energy by storing surplus renewable energy for dispatch at a later time. This dispatched energy can compensate for dips in solar or wind power. Diverse energy storage technologies exist in various states of commercialization, from well-established pumped hydro facilities that pump water uphill and then release it later to recapture the energy to more advanced batteries. Pursuant to AB 2514 (Skinner, 2010), the first state legislation in the nation to contemplate mandatory energy storage targets for utilities, the California Public Utilities Commission issued a decision in October 2013 to require the three investor-owned California utilities to procure 1,325 megawatts of energy storage by 2020.[37] Policy makers should ensure compliance with this mandate and continue to encourage cost-effective deployment of energy storage technologies, including by developing parameters for long-term contracts for energy storage by utilities and promoting vehicle-to-grid distributed energy storage from electric vehicles connected to the grid.

"Part of our goal is making customers responsible, for those willing to pay for more reliability. We can create market mechanisms where someone says, 'I'll take three hours of outages a week for a lower bill.'"

-- Tom Starrs
SunPower

Energy regulators should promote fast-ramping generation products to help balance intermittent renewables.
As the sun rises or sets or wind patterns change, grid operators need highly flexible resources that can "ramp" (rapidly produce more power or less power) in a timely fashion to compensate for the steep supply curve changes. Currently, grid operators plan to compensate for changes in renewable supply mostly with natural gas-fired power plants, which emit greenhouse gases. Policy makers should instead define a set of fast-ramping products that do not emit greenhouse gases and have specific ramp time, duration, and availability requirements to provide operators with greater flexibility to cover intermittent resources.

Energy regulators should develop "forward procurement mechanisms" to balance renewables without increasing greenhouse gas emissions.
Policy makers at the CPUC could create forward procurement mechanisms to ensure that gaps in intermittent renewables are covered through greenhouse gas-free resources. Such mechanisms could include an assessment of existing generating capacity and tools to ensure that grid operators prioritize carbon-free resources. The tools could use physical characteristics to determine the best resources to firm and shape supply without increasing greenhouse gases. Policies could also allow grid operators to compensate generators for being available rather than just for generating, while guarding against overpayment.

"From a developer viewpoint, there are problems you know the answer to and problems you don't. If we don't have the answer, like will energy storage get cheaper, you make choices that enable you to make both options available, if possible."

-- Arno Harris
Recurrent Energy

Federal, multi-state, and California leaders should develop an "energy imbalance market" across Western North America to integrate variable renewable energy without using fossil fuel resources.
Grid operators can compensate for intermittent renewable energy from specific locations within their territories by broadening access to renewable energy supplies across the western North America region. The Western Electricity Coordinating Council (WECC) has been exploring the possibility of creating a region-wide energy imbalance market (EIM) to allow states like California to import renewable energy from Nevada and other neighboring states when local resources dwindle. A WECC-wide EIM would provide a greater generating area and options for grid operators to accommodate variable resources with lower reserve requirements. In order to create this market, policy makers will need to resolve various jurisdictional issues. For example, the Federal Energy Regulatory Commission (FERC) governs wholesale prices, while uncoordinated independent system operators and regional transmission operators address most grid operations across the region. No single entity otherwise exists to cover this territory. Ultimately, EIM rules must ensure that resources used to balance California's renewable supply are free of greenhouse gas emissions in order to guarantee that out-of-state fossil fuel resources are not replacing local renewables.

Conclusion: The Future of Renewable Energy

California has an opportunity to continue its global leadership on renewable energy and greenhouse gas reductions by instituting the policies discussed in this report, including the participant-recommended 51% by 2030 RPS. However, as discussed, the RPS should contain criteria to reduce greenhouse gas emissions and integrate renewable energy in the most cost-effective, low-carbon manner. Ultimately, California's success will depend on neighboring jurisdictions following suit, in order to provide an increased geographic base of renewable deployment that can balance renewables and decrease carbon emissions. As decarbonizing the electricity grid represents one of the critical paths to avoiding the worst of global climate change, California is well-positioned to spur the innovation and experience necessary to achieve a more renewable future.

"We are looking at being the leading edge and remaining prosperous while we do so."

-- Kate Gordon
Center for the Next Generation

Participant Bios

Andrew Beebe
Nextera Energy

Andrew is Vice President of Distributed Generation for Nextera Energy, the country's largest green energy company. Previously, Andrew served as Chief Commercial Officer at Suntech. Andrew oversaw Suntech's global sales and marketing organization, including all aspects of worldwide revenue generation. With over $2 billion in sales in 2011, Suntech was the largest solar company in the world during Andrew's tenure. He managed five global business units and the centralized global marketing function. Andrew also served as Vice President of Global Product Strategy, where he drove Suntech's global product roadmap. Andrew joined Suntech in 2008 when his company, EI Solutions, was acquired by Suntech Power Holdings. Previous to the acquisition, Andrew grew EI Solutions from a 3-person installer to a major regional player supporting customers such as Google, Disney, Sony Pictures, and British Telecom. The 2MW installation at Google's world headquarters is the largest corporate installation in US history. Andrew graduated in from Dartmouth College in 1993 with a degree in Government. He lives in Burlingame, CA with his wife and three children.

Deborah Behles
Golden Gate University School of Law

Deborah Behles teaches and is a staff attorney at the Environmental Law and Justice Clinic at Golden Gate University School of Law. At the clinic, she leads efforts on complex regulatory and energy cases that examine long-term energy policy for the State of California. Her research focuses on renewable energy policy, climate change mitigation, air pollution, and environmental justice. She was previously a trial attorney at the Department of Justice's Environmental Enforcement Section where she litigated civil environmental cases and received several awards including the John Marshall Award.

Adam Browning
Vote Solar

Adam is the co-founder and Executive Director of the Vote Solar Initiative, a non-profit organization with the mission of bringing solar energy into the mainstream. Vote Solar got its start with a successful ballot initiative for a $100 million solar revenue bond in San Francisco in 2001, and since then has been working with state and municipal governments on pro-solar policies, with the goal of jumpstarting the national transition to renewable energy. Vote Solar has 10 advocates spread across the country, working full-time to advance solar markets. Prior to Vote Solar, Adam spent eight years with the U. S. Environmental Protection Agency's San Francisco office, where he won the Agency's top pollution prevention award for developing a program that reduced air emissions of mercury. Adam received a BA with Distinction from Swarthmore College in 1992, and served with the Peace Corps in Guinea-Bissau, West Africa.

Rick Counihan
EnerNOC

Rick Counihan is the Vice-President of Government Affairs for EnerNOC, Inc., a leader in demand response and energy management services for the commercial and industrial sectors. In that capacity he is responsible for government relations with the Federal and State governments. Prior to joining EnerNOC, Rick was Vice President at the Electricity Innovation Institute (E2I), a nonprofit research institute affiliated with the Electric Power Research Institute (EPRI) to build public/private partnerships to improve the nation's electricity systems and an early research center on the Smart Grid. Rick has also been Vice President at Green Mountain Energy Company, a retail energy service provider selling renewable power. Rick worked in regulatory affairs for five years with Southern California Edison and was a professional staffer for the Energy and Power Subcommittee of the U.S. House of Representatives for six years. Rick has a Bachelors degree in Economics from Pomona College and a Masters in Public Policy from Harvard University.

Michael T. Eckhart
Citigroup

Michael T. Eckhart is a Managing Director and Global Head of Environmental Finance and Sustainability at Citigroup in New York City. He supports Citi's goal to be the leading financial services firm in renewable energy, energy efficiency, clean water and related areas, serving clients with corporate banking, investment banking, equity and debt capital market origination, global transaction services, trade finance and private banking. From 2001 to 2011, he was President of the American Council On Renewable Energy (ACORE), a Washington DC-based nonprofit organization with members in wind, solar, hydro, ocean, geothermal, biomass, biofuels and waste sources of electricity and fuels. Previously, he developed financing for solar energy under the SolarBank Initiative in South Africa and India; was CEO of the power development firm United Power Systems, Inc.; Vice President of the venture capital firm Areté Ventures, Inc.; a strategic planner of General Electric Company's power systems sector; and a Principal with the energy practice of Booz, Allen & Hamilton where he conducted many of the original national studies on new energy technologies. He served in the US Navy Submarine Service. He received a degree in Electrical Engineering from Purdue University and an MBA from Harvard Business School.

Shannon Eddy
Large-Scale Solar Association

Shannon is Executive Director of the Large-scale Solar Association (LSA), a non-partisan, solar advocacy association dedicated to advancing the utility-scale solar market in California and the Western US. Member companies in the LSA represent leaders in the utility-scale solar industry who

Participant Bios, *continued*

share a common understanding of and concern in the issues facing development of the utility-scale solar sector. Shannon is also the President of the Conscious Ventures Group, a consulting firm specializing in climate-smart policy and project advancement. CVG provides strategic and political consulting for government, business, philanthropic, and non-profit sectors. She was previously an appointed advisor to the Schwarzenegger administration on energy efficiency and renewables, and prior to that lobbied the CA legislature on behalf of environmental and renewable energy organizations in support of air quality and clean energy mandates. Last year, Shannon was appointed by Governor Brown to serve on the California Workforce Investment Board.

Diane Fellman
NRG Energy, Inc.

Ms. Fellman serves as Senior Director, West Region, Regulatory and Governmental Affairs for NRG Energy, Inc. and NRG Solar, LLC. Her work has focused on the advancement of governmental policies to encourage the development of solar resources (both utility scale and distributed generation), independent energy generation and electric vehicles. Previously, Ms. Fellman represented private energy developers before the California Public Utilities and Energy Commissions as well as in negotiations with the utilities for power purchase agreements. Diane Fellman started her career in public service as an Administrative Law Judge with the Ohio Power Siting Commission. She came to California during the first Brown Administration to serve as a Hearing Officer and Office Manager at the Energy Commission and staff counsel for the Public Utilities Commission. Ms. Fellman has a law degree from the University of Cincinnati and an undergraduate degree in political science from the Ohio State University.

Kate Gordon
Next Generation

Kate Gordon is a nationally recognized expert on the intersection of clean energy and economic development, most recently as Vice President for Energy and Environment at the Center for American Progress (CAP) in Washington D.C., where she still serves as a senior fellow. She contributes regularly to the Wall Street Journal as one of the paper's "Energy Experts," blogs for the Huffington Post, and writes a weekly update on California energy and climate news for Next Generation. At CAP, Kate led an energy team focused on developing policies and communications strategies to move the U.S. to a clean energy economy. Prior to joining CAP, she was the co-director of the national Apollo Alliance (now part of the Blue Green Alliance), where she still serves on the Board of Directors. Earlier in her career, she was a senior associate at the Center on Wisconsin Strategy and an employment and consumer rights litigator at Trial Lawyers for Public Justice in Oakland. She earned a J.D. and master's degree in city planning from the University of California-Berkeley and an undergraduate degree from Wesleyan University.

Arno Harris
Recurrent Energy

Arno Harris is CEO of Recurrent Energy, one of North America's leading solar project development companies with 2GW of solar projects in development and a more than 700MW portfolio contracted with utilities. Arno is a passionate advocate for solutions to climate change through the intersection of business and public policy. He has spent the last 10 years working in the solar industry to help solar make the transition to mainstream energy markets. His success was recently recognized with the Rising Star at the 2011 Platts Global Energy Awards. Arno is board chair of the Solar Energy Industry Association (SEIA), representing 1000+ member companies as the voice of the solar industry in the U.S. He also serves on the board of Advanced Energy Economy and as an advisory committee member of the Division on Earth & Life Studies at the National Academies.

Dan Kammen
U.C. Berkeley

Dr. Kammen is the Class of 1935 Distinguished Professor of Energy at the University of California, Berkeley, with parallel appointments in the Energy and Resources Group, the Goldman School of Public Policy, and the department of Nuclear Engineering. He was appointed the first Environment and Climate Partnership for the Americas (ECPA) Fellow by Secretary of State Hilary R. Clinton in April 2010. Kammen is the founding director of the Renewable and Appropriate Energy Laboratory (RAEL), Co-Director of the Berkeley Institute of the Environment, and Director of the Transportation Sustainability Research Center. Dr. Kammen was educated in physics at Cornell and Harvard, and held postdoctoral positions at the California Institute of Technology and Harvard. He has authored or co-authored 12 books, written more than 300 peer-reviewed journal publications, testified more than 40 times to U.S. state and federal congressional briefings, and has provided various governments with more than 50 technical reports. He is a frequent contributor to or commentator in international news media and hosted the six-part Discovery Channel series Ecopolis. Dr. Kammen is a Permanent Fellow of the African Academy of Sciences, a fellow of the American Physical Society. In the US, he serves on two National Academy of Sciences boards and panels.

James A. Kelly
Edison International (retired)

Jim Kelly retired from Edison International (EIX) on July 1, 2011, after almost 38 years of service with the Company. EIX is the parent company of Southern California Edison, a regulated electric utility, and Edison Mission Group, an independent power company. Prior to his retirement, Mr. Kelly

Participant Bios, *continued*

was the senior vice president of Transmission & Distribution for Southern California Edison. Kelly was previously the vice president of Engineering & Technical Services, responsible for planning, engineering, and designing SCE's electrical grid, as well as research and development, safety and training. He is the CEO and a member of the board of ARES, a firm pioneering the use of electric locomotive technology for large-scale energy storage. Jim is the co-founder of and partner in Coachella Partners, a venture that provides specialized advisory services to Native American tribes on matters related to energy. He is co-founder of Muni-Fed Streetlight Solutions, a firm that delivers innovative approaches to municipal street lighting needs. Jim earned a bachelor's degree from California State University, Long Beach, and a master's degree from California State Polytechnic University. Jim is married to Leigh, and has two grown daughters, Maren and Jan. He resides in Arcadia and Newport Beach, California.

Peter Miller
Natural Resources Defense Council

Peter Miller is a Senior Scientist at the Natural Resources Defense Council (NRDC) with over 25 years experience in energy and climate policy. His work is focused on California energy policy, AB32 implementation, GHG emissions accounting and offsets. He is currently a boardmember of the Climate Action Reserve (CAR) and has served on the California Board for Energy Efficiency and on both Independent Review Panels evaluating the Public Interest Energy Research program at the California Energy Commission. Mr. Miller has degrees from Dartmouth College and Reed College.

Nancy Pfund
DBL Investors

Nancy E. Pfund is Founder and Managing Partner of DBL Investors, a venture capital firm located in San Francisco, whose goal is to combine top-tier financial returns with meaningful social, economic and environmental returns in the regions in which it invests. Ms. Pfund currently sponsors or sits on the board of directors of several companies, including; SolarCity, Solaria, BrightSource Energy, Primus Power, Eco.logic Brands, EcoScraps, OPx Biotechnologies, Powergenix and, prior to their public offerings, Tesla Motors and Pandora Media. From 1977-1984, Ms. Pfund worked at Intel Corporation, the State of California Department of Health Services and the Governor's Office of Appropriate Technology, Stanford University School of Medicine, and the Sierra Club. In 1988, President Bush appointed Ms. Pfund as a charter member of the National Advisory Council for Environmental Policy and Technology. In 1999, Ms. Pfund was appointed by President Clinton to serve on the Congressional Web-Based Education Commission. Ms. Pfund received her BA and MA in anthropology from Stanford and MBA from the Yale School of Management.

Tom Starrs
SunPower

Tom Starrs serves as SunPower's vice president, market development and policy for the Americas. He has more than 20 years' experience in and around the solar power industry, including senior management positions with Iberdrola Renewables, PPM Energy, and Schott Solar. Starrs is widely recognized as a leading strategist on solar market assessment, business development and policy. He has served on the boards of the American Solar Energy Society, the Center for Energy Efficiency and Renewable Technologies, the Solar Alliance, the Solar Energy Industries Association, the Solar Electric Power Association, and Vote Solar. Tom holds a Ph.D. from the University of California, Berkeley's Energy and Resources Program, and a J.D. from the University of California's School of Law (Boalt Hall). He lives and works in Portland, Oregon.

Todd Strauss
Pacific Gas and Electric Company

Todd Strauss leads PG&E's policy and planning group focused on providing energy supply that is safe, reliable, affordable, and clean. His scope has included: policies for greenhouse gas reductions and renewable resources, market design issues, resource planning (integrating demand-side and supply-side, generation and transmission, and electric and gas), market assessment, evaluation of structured transactions, portfolio strategy, carbon trading implementation, and risk management. He has 20 years of experience applying quantitative modeling to business and policy issues in energy and the environment. He has been Director of Quantitative Analysis at PG&E National Energy Group, Principal at the consulting firm PHB Hagler Bailly, and Assistant Professor of Public Policy and Management Science at the Yale School of Management. He was a Regulatory Fellow at the California Public Utilities Commission and a Gilbert White Fellow at Resources for the Future. He holds a Ph.D. in IEOR from UC-Berkeley and an S.B. in Mathematics from MIT.

Mark Tholke
EDF Renewable Energy

Mark Tholke serves as EDF-RE's Vice President, Development West Region. In his role, Mark is responsible and accountable for identifying, evaluating, structuring and developing renewable energy projects throughout the Western Electricity Coordinating Council area. Mark joined enXco in November, 2006, as the Regional Project Development Manager; was promoted to Director of the Southwest Region in August, 2008; and was promoted to Vice President for the West Region in April 2011. Under his leadership, EDF-RE's West Region developed and built 1.25MW solar PV in Sacramento (2008), 100MW wind in Solano County (2011), 100MW wind in Solano

Participant Bios, *continued*

County (2012), 140MW wind in Kern County (140MW) and begun construction on 143MW solar PV (Kern County). Prior to joining enXco, Mark held positions of Vice President for Business Development at Eurus Energy, Commercial Leader at GE Wind Energy, and Western Region Marketing Manager at Green Mountain Energy. Prior to his career in renewable energy, Mark worked at a research affiliate of the Heinz Foundation and the Nature Conservancy in Washington, DC. Mark holds a joint MBA/MS in Environmental Science from the University of Michigan and undergraduate degrees in Environmental Science & Economics from the University of California, Santa Cruz.

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Dawn Weisz

Marin Energy Authority

Dawn Weisz is the Executive Officer for the Marin Energy Authority. Ms. Weisz coordinated efforts to explore and launch the Marin Clean Energy program which is the first Community Choice Aggregation program in California. Under her watch Marin Clean Energy has launched service to over 90,000 customers, entered into power supply agreements that have doubled the amount of renewable energy purchased in the community, and exceeded state requirements for renewable energy supply. Ms. Weisz has 18 years of experience developing and managing renewable energy and energy efficiency programs while working for leading public agencies in the field. Before joining MEA Ms. Weisz managed energy and sustainability initiatives for the County of Marin, and served as the Executive Director for Sustainable North Bay. Ms. Weisz has been a guest lecturer at UC Berkeley, UC Davis, and for the National American Planning Association. She has also received awards from the U.S. Environmental Protection Agency, the U.S. Department of Energy and the Power Association of Northern California.

V. John White

Center for Energy Efficiency and Renewable Technologies

V. John White has been a writer, commentator, advocate, and leader of the green energy movement in California for 35 years. He is executive director of CEERT, the Center for Energy Efficiency and Renewable Technologies in Sacramento, and principal of the environmental and energy lobbying practice, V. John White Associates, representing public interest environmental and local government organizations, and new energy technology companies. White's career has been devoted to air quality improvement and clean energy development. As chief consultant to the California Assembly Subcommittee on Air Quality, he became the leading legislative expert on air quality technology and regulation, helping to draft the California Clean Air Act and subsequent clean air and energy statutes. In 1990 he co-founded CEERT, which has become the premier energy advocacy voice for key environmental public interest groups and clean energy technology companies. He played a central role in the passage of the Pavley Clean Car bill, AB 32, and many of California's renewable energy incentive and regulatory programs. He serves on a number of nonprofit boards and organizations. John is a graduate of U.C. Riverside – Political Science.

Dr. Jim Williams

Energy and Environmental Economics (E3)

Dr. Jim Williams is Chief Scientist at Energy and Environmental Economics (E3), a San Francisco consulting firm that plays an important analytical role in many of the critical issues facing California's electricity sector. Dr. Williams has consulted on many aspects of electricity supply and demand for government, utility, and industry clients. He led E3's analysis for state agencies on greenhouse gas reduction strategies for the electricity and natural gas sectors, which became a key input into the AB32 Scoping Plan. Recently, he was lead author of a widely-cited article in Science that analyzed California's path to an 80% greenhouse gas reduction below 1990 levels by 2050. Dr. Williams is also Associate Professor of International Environmental Policy at the Monterey Institute of International Studies. His international research interests include the technical and institutional challenges of decarbonizing China's power sector. He received his B.S. in Physics from Washington and Lee University, and his M.S. and Ph.D. in Energy and Resources from U.C. Berkeley.

Dr. Ryan Wiser

Lawrence Berkeley National Laboratory

Dr. Ryan H. Wiser is a Staff Scientist and Deputy Group Leader in the Electricity Markets and Policy Group at Lawrence Berkeley National Laboratory. Ryan leads and conducts research and analysis on renewable energy, including on the planning, design, and evaluation of renewable energy policies; on the costs, benefits, and market potential of renewable electricity sources; on electric grid operations and infrastructure impacts; and on public acceptance and deployment barriers. Ryan regularly advises state and federal agencies on issues related to renewable energy; is an advisor to the Energy Foundation's China Sustainable Energy Program; is on the Corporate Advisory Board of Mineral Acquisition Partners; and serves on numerous other advisory committees. Prior to his employment at Berkeley Lab, Ryan worked for Hansen, McOuat, and Hamrin, Inc., the Bechtel Corporation, and the AES Corporation. Ryan holds a B.S. in Civil Engineering from Stanford University and an M.S. and Ph.D. in Energy and Resources from the University of California, Berkeley.

Endnotes

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