CHAPTER 4 | POLICIES PROMOTING UTILITY-SCALE SOLAR DEVELOPMENT ON PUBLIC LANDS

The high level of interest in solar development of the California desert and the urgent need to determine appropriate siting criteria and land use policies necessitates an understanding of what is driving solar developers to choose this area and which political and economic factors can lead to success or failure of project development. Utility-scale solar projects are eligible for multiple economic incentives from both the state and federal governments. Additionally, state and federal laws and policies have incentivized the use of public lands for renewable energy development.

ECONOMIC DRIVERS OF UTILITY SCALE SOLAR DEVELOPMENT

Solar development benefits economic development while providing an alternative to fossil-fuel based energy sources, and the industry has been growing steadily over the last several years. Yet, solar electricity is still more expensive than traditional energy sources due to the material costs of an installation. Policy measures intended to accelerate solar development and lower costs through economies of scale and advanced technologies have created an industry dependent on and driven by subsidies and incentives. In order to better understand the interactions between policy decisions, siting decisions, economic incentives and market development, we will outline a brief history of key federal and state political milestones and track them against growth of the solar market. Through this lens we will discuss the barriers and drivers of utility-scale solar development.

Early Stages of Utility-Scale Solar Development: A History of SEGS

During the late 1980s and early 1990s, a series of solar thermal generation facilities located in San Bernardino County, California, known as Solar Energy Generating Facilities, or SEGS, I-XII dominated utility-scale solar development in California. Other CSP projects at the time included the 10 MW Solar One central tower research facility, completed in 1981 and operational from 1982 to 1986; Solar Two, which added additional mirrors to Solar One and operated from 1995 to 1999; a 3.19 MW PV system built by the Sacramento Municipal Utility that went on line in August 1984; and the 110 MW Solar 100 project certified by the CEC in 1982 that was never built due to land use issues.[1] The completed projects accounted for about 0.8 percent of California's energy generation capacity in 1991[2] and the SEGS projects alone accounted for 95 percent of the world's solar electricity generation.[3] Although the proposed SEGS projects totaled 594 MW in capacity, only 354 MW of capacity came on line before the developer filed for bankruptcy in 1991. The developer, Luz International Limited, cites a number of policies that contributed to the failure:[4]

- The Public Utilities Regulatory Policies Act (PURPA), passed by Congress 1978, required local utilities to grant grid interconnection access to independent power generators, which stimulated utility-scale solar development. However, PURPA capped the amount of energy that a generating facility could sell at 30 MW. Although this cap was raised to 80 MW in 1989, Luz was forced to build a series of facilities that were less efficient and more expensive per MW than the optimal 200 MW capacity.
- PURPA also required utilities to purchase energy produced by non-utility-owned generating facilities. The California Energy Pricing Policy for solar energy was based on the avoided cost of producing electricity from oil or natural gas, whichever was lower. Although improved technology brought the solar electricity cost down to $0.08 per kWh, gas prices dropped 80 percent between 1981 and 1989 and oil prices fell to $18 a barrel. The avoided cost pricing policy brought the purchase price down to $0.05 per kWh, making more expensive solar projects economically infeasible.
- Annual energy tax credit cycles severely limited the company's ability to secure long-term funding from investors. Each calendar year Luz had to race to obtain site approval, secure financing and complete a facility. In 1989, the tax credit period was cut to nine months and, as a result, Luz endured a cost overrun that consumed two-thirds of their remaining capital.

The failure to complete all of the Luz SEGS projects was due to an unrealistic timeline for tax credit cycles and an electric purchase pricing policy tied to volatile commodity market prices. Conditions remained unfavorable for utility-scale solar development until the 2005 Energy Policy Act increased and extended renewable energy tax credits.

Changing Federal Incentives

Between 1981 and 1989, The Reagan Administration cut funding for renewable energy research and development by nearly 90 percent (Figure 4.1) which left the solar industry unable to continue development of technologies that could compete with lower cost, fossil fuel based sources of energy. For the next decade, while the United States experienced rapid economic development and enjoyed relatively low oil and natural gas costs (Figure 4.2), utility-scale solar developers were on hiatus. The shift in the willingness to invest in renewable energy generation came about in the late 1990s as scientists continued to issue dire warnings about climate change and energy analysts forecasted rapidly rising oil costs tied to peak oil predictions. The September 11, 2001 terrorist attacks further encouraged politicians to renew their efforts to improve energy security and protect against geopolitical risks and rapidly rising oil prices by introducing bills to address climate change and promote renewable energy development.

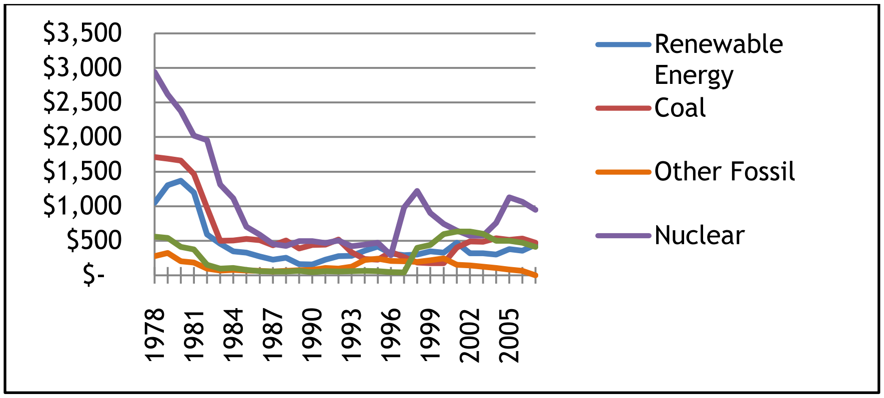


Figure 4.1 Department of Energy Research and Development Expenditures, 1978-2007 (million 2007 dollars). Federal energy research and development expenditures (along with tax incentives and direct subsidies) are intended to accelerate development of cost-effective technologies and bring them to market sooner than if R&D is funded by the private sector alone. President Reagan cut energy research and development budgets by nearly 90 percent and eliminated renewable energy production tax incentives when he took office in 1981. Data Source: Energy Information Administration.[5]

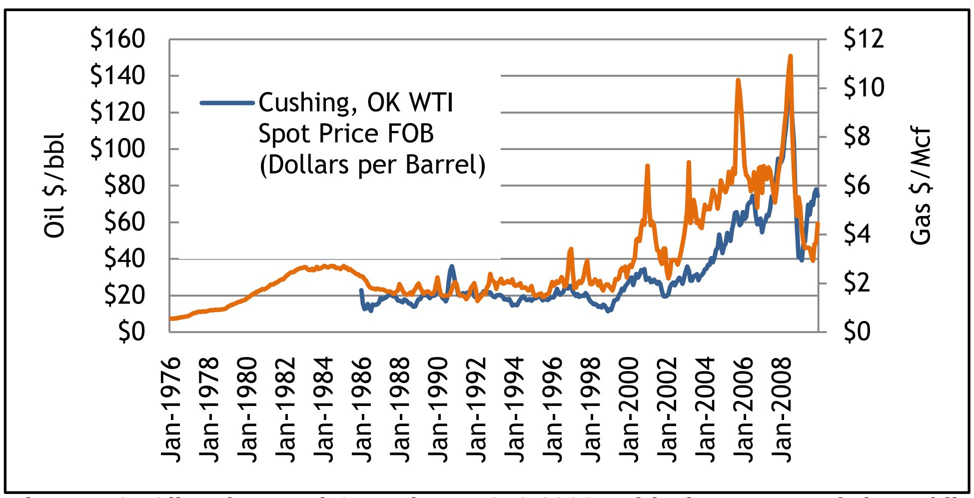


Figure 4.2 Oil and Natural Gas Prices, 1976-2009. With the passage of the Public Utilities Regulatory Policies Act, the California Energy Pricing Policy tied prices for utility-scale solar energy generation to natural gas and oil prices for energy generation. When prices remained low throughout the 1990s, solar developers could not compete with the low cost of fossil fuel-based energy generation until federal and state tax incentives and subsidies improved the marketability of solar energy for both utility-scale and distributed generation. Data Source: Energy Information Administration.[6,7]

Several acts passed by Congress in the following years significantly increased funding and incentives available to state governments and developers for renewable energy programs and projects (Table 4.1). The Energy Policy Act of 2005 gave a short term boost to the developers and investors waiting for better economic incentives to build utility-scale solar facilities by increasing tax incentives available to commercial developers from 10 to 30 percent for a period of two years and by extending the production tax credit through 2007. Although this helped stimulate the market, the timeframe for the

Table 4.1 Federal Policies Impacting Solar Development.[8,9,10,11]

	Investment Tax Credits	Production Tax Credits	Renewable Energy Grants	Loan Guarantees	Clean Renewable Energy Bonds	Direct Spending Measures
2005 Energy Policy Act	Increased the commercial solar investment tax credit from 10 percent to 30 percent for 2 years	Extended renewable energy production tax credit of $.019/kWh for first ten years of operation through 2007			Allocated a total of $1.2 billion over 2 years for non-taxable entities that could not use ITC or other tax benefits ($84 million for solar in 2007)	
2008 Energy Improvement and Extension Act	Extended commercial 30 percent investment tax credit for solar energy through 2016. Allowed using ITCs to offset alternative minimum tax	Extended the placed-in service date for production tax credit for solar facilities through December 31, 2010			Authorized an additional $2.4 billion for a period of 3 years ($839 for solar)	
2009 American Recovery and Reinvestment Act	Established 30 percent advanced energy manufacturing credits for manufacturing facility retrofits; Repealed subsidized energy financing limitation on investment tax credit		Established 30 percent grant program in lieu of investment tax credit for facility construction beginning in 2009 or 2010.	Established renewable energy loan guarantee program for generation and transmission projects underway by September 30, 2011		Appropriates direct spending for renewable energy projects, grid development, research and development

incentives was not long enough to provide certainty to developers since projects could take many years to complete and come on line. Without certainty about tax incentives and their impacts on the project development costs, utility-scale solar development remained sluggish.

Between 2002 and 2007, tax expenditures for renewable energy increased from $238 million to $790 million.[12] For example, tax expenditures for Clean Renewable Energy Bonds (CREBS) were appropriated as part of the Energy Policy Act and the American Recovery and Reinvestment Act. CREBS are one tax mechanism whereby tax exempt entities may issue interest-free bonds. The government or public utility issuing the bond pays back only the principal while the bond holder receives a tax credit in lieu of interest payments. Although direct spending for renewable energy research and development declined slightly between 2002 and 2006, 2007 appropriations grew by 23 percent over 2002 amounts, including an increase from $99 million for solar energy in 2006 to $203 million in 2007 (Figure 4.1).[13] Returns associated with solar stock investments grew through the fall of 2008, reflecting optimism among investors until the collapse of the banking industry caused sources of private capital necessary for a new solar industry to dry up practically overnight (Figure 4.3).[14] The Energy Improvement and Extension Act of 2008, passed on October 3, created some certainty about access to financing by extending production and investment tax incentives, which eventually helped lure investors back to utility-scale solar energy projects. By 2009, with the passage of the American Recovery and Reinvestment Act, federal investment programs such DOE's Solar Energy Technologies Program (SETP) also provided significant support for renewable energy implementation by focusing on market transformation, systems integration, CSP deployment, and PV development (Table 4.2, Figure 4.4). The SETP is partnering with the BLM to develop the Solar PEIS in order to promote successful project development.

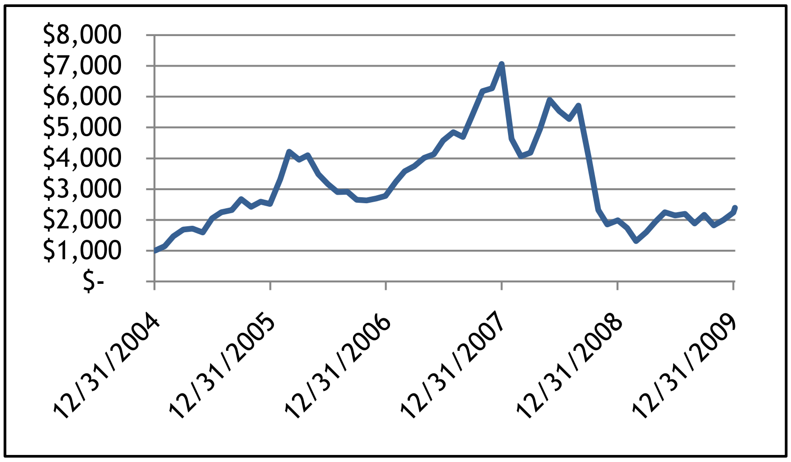


Figure 4.3 Ardour Global Solar Energy Index Total Returns in $US. Returns for investors in solar energy dropped following the credit crisis of 2008 and developers suffered from the loss of private capital for project development.

Table 4.2 Subprograms of the DOE's Solar Energy Technologies Program.[15]

Market Transformation	•Address non-R&D barriers to solar energy adoption •Partner with various organizations to develop codes and standards, coordinate decision-makers, promote workforce development, provide technical assistance and support the Solar America Cities program
Systems Integration	•Address economic bariers to solar energy grid integration •Develop technologies and strategies in partnership with utilities and solar industry
Concentrating Solar Power	•Leverage industry partners and national laboratories to increase R&D and deployment efforts •Achieve market competitiveness by 2015 and baseload competitiveness by 2020 •Work with the BLM to develop Programatic Environmental Impact Assessment and other activities necessary for utility-scale solar development in the southwest United States
Photovoltaics	•Invest in technologies across the development pipeline •Minimize cost of solar energy through new devices and processes, prototype design and pilot production, systems development and manufacturing

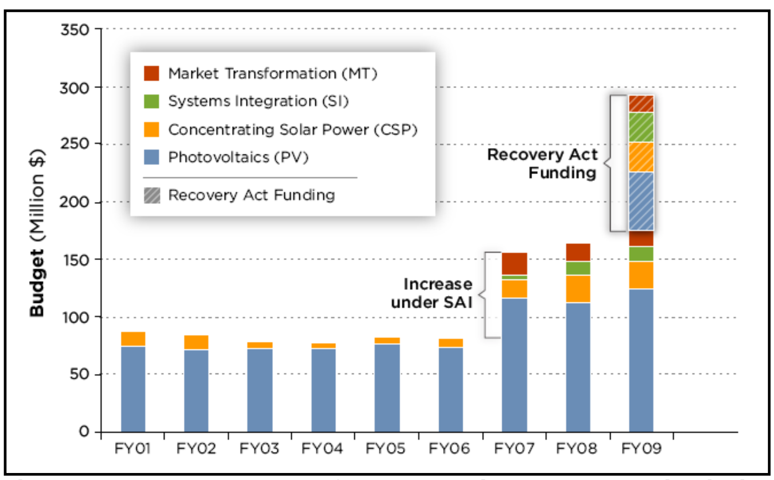


Figure 4.4 Department of Energy Solar Energy Technologies Program Investment. Renewed federal investment in solar industry technologies improved after 2006 with the Department of Energy's Solar Energy Technologies Program (SETP). The Solar America Initiative (SAI) accounted for most of the $75 million budget increase from FY 2006 to FY 2007. The American Recovery and Reinvestment Act added nearly $118 million to the SETP budget, including $26 million for CSP.[16]

Private financing for solar industry development is often directed towards entrepreneurial entrants and early actors in market development. The financing may be different forms of equity or debt, carrying different levels of risk and attracting different kinds of investors. The infusion of private capital is critical for moving technologies developed through federal research and development dollars to the market. In 2008, the solar industry in the United States experienced an increase of venture capital and private equity investment from $61 million in 2004 to $2.3 billion in 2008, corresponding to a four-year capitalized annual growth rate of 148 percent.[17] Today, the risk for solar investors remains high as the market develops and public funding in the form of tax credits, special bonds, or loan guarantees are important incentives for investment in projects and businesses along the solar value chain. Without both private and public sector financial support, utility-scale solar projects cannot be developed.

The path to widespread adoption of solar energy technologies is currently dependent on incentives that create price parity between solar electricity and electricity generated from non-renewable sources. As the market expands, technical improvement and innovation will lower the cost of solar electricity generation. Increased deployment will allow the solar industry to reach economies of scale, reducing the need for subsidies. But whether the goal should be to phase out solar subsidies is questionable. At a recent solar industry conference, one panelist noted: "Other [subsidized energy] industries don't say 'how do we get rid of our subsidy.' Are we picking the wrong battle? We should be working on a level playing field."[18] The solar industry has fought a long battle to bring both utility-scale and distributed solar energy technology into the mainstream. Renewable energy policies and subsidies are necessary for maintaining the industry and bringing solar energy on line.

Utility-Scale Solar Development in California

In 2002, the State of California recognized the economic, social and environmental benefits of renewable energy and adopted one of the country's first RPS. The RPS required Investor Owned Utilities (IOU) to increase sales of energy generated from renewable resources by at least 1 percent each year to reach a total of at least 20 percent by 2017. The RPS legislation modified the pricing policies for renewable energy by directing the CPUC to establish market price referent (MPR) to represent the avoided costs of non-renewable power purchases. The MPR is used to calculate the net present value of the levelized cost of energy (LCOE) for a long term contract. Unlike previous pricing policies, the MPR is calculated based on installed capital costs, fixed and variable operations and maintenance costs, natural gas fuel costs, cost of capital, and environmental permitting and compliance costs. If an IOU enters a contract with pricing below the MPR, the cost can be recovered in retail sales. Contracts for long term purchases above the MPR may qualify for above-MPR funds from the state's RPS program.[19] However, these funds are limited. The modified pricing policies help utilities control the costs of meeting RPS goals and the contracts help to make utility-scale projects feasible once again from a developer's perspective.

The recent rise in the number of utility-scale projects in development is attributable to two key factors: the longer-term extension of production and investment tax credits to match the development timeline, which can take several years, and the implementation of aggressive RPS goals in California. Longer-term tax credits provide some certainty for investors and RPS goals create market demand among utilities seeking renewable energy power purchase agreements.

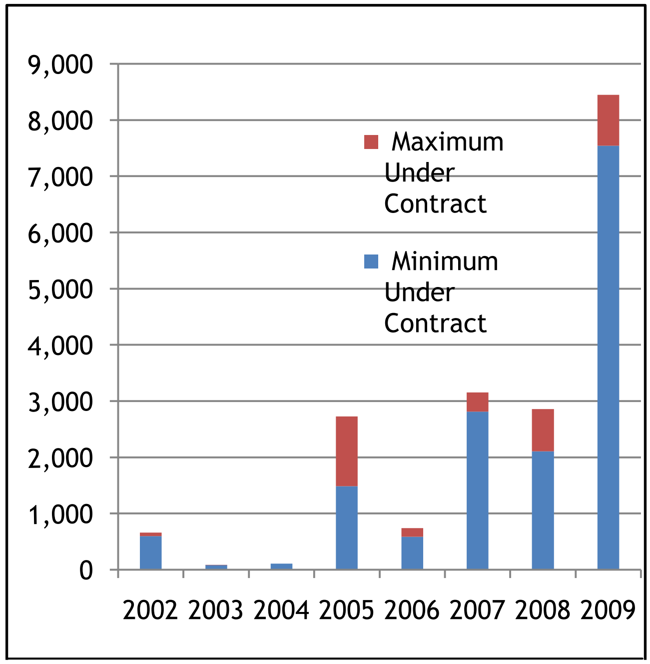


Figure 4.5 Total Renewable Energy Capacity Under Contract by Year for Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric (Capacity in MW). The RPS was amended in 2009 to 33 percent of peak load capacity by 2020 and the number of contracts increased significantly. Base cases used in implementation studies indicate that 7,200 MW of solar thermal and 3,200 MW of utility-scale PV resources can realistically be developed by 2020.

By the end of 2009, utility-scale development was expected to grow significantly[20] and the state of California once again amended the RPS by adding a secondary target of 33 percent by 2030. This new target covers IOUs as well as publicly owned utilities and is truly a statewide goal, leaving many utilities wondering how much utility-scale generation would be needed to meet the targets (Figure 4.5). Once again, pricing may be an issue as “nearly half of the projects submitted for CPUC approval have been above the MPR” since 2007.[21] This is an indication that the cost of producing electricity from solar energy is still more expensive than other resources but the number of renewable energy contracts available to utilities is limited. Transmission issues will also have an impact on utility-scale development because new or upgraded transmission infrastructure will be required in order to bring a large number of projects online.

The potential for utility-scale solar energy development in the California desert is clear in terms of the available solar resource and improved financial incentives. However, utility-scale developers also desire an expedited process for accessing large tracts of public land as they moved forward with siting decisions development plans. In 2008, the BLM announced it would soon revise land use plans to incorporate renewable energy development. The market incentives combined with a potentially easier permitting process catalyzed a public land grab among developers eager to secure inexpensive land, attract recovering investors, and build the expansive facilities that could meet the IOU’s pressing need for renewable energy created by the more aggressive RPS targets. In order to meet the California RPS goal of 33 percent renewable energy by 2020, 48 terawatt hours of new renewable energy need to be brought online.[22] In response to utilities' requests for proposals for renewable energy generation capacity needed to meet RPS goals, solar developers began to submit their bids and in 2007 four contracts for utility-scale PV installations were filed with the CPUC (Figures 4.6[23] and 4.7[24]). The CPUC predicted increases in development activity in its 2008 first-quarter RPS procurement status report:

> "Solar energy has historically been a high-cost resource due to supply chain production constraints and other factors. However, its on-peak energy production and relatively consistent capacity are valuable, and increased developer activity is expected to drive prices downward. As prime wind resources are developed, leaving resources with lower capacity factors and higher prices, the price gap between wind and solar energy may narrow, making solar facilities more attractive and further boosting solar development."[25]

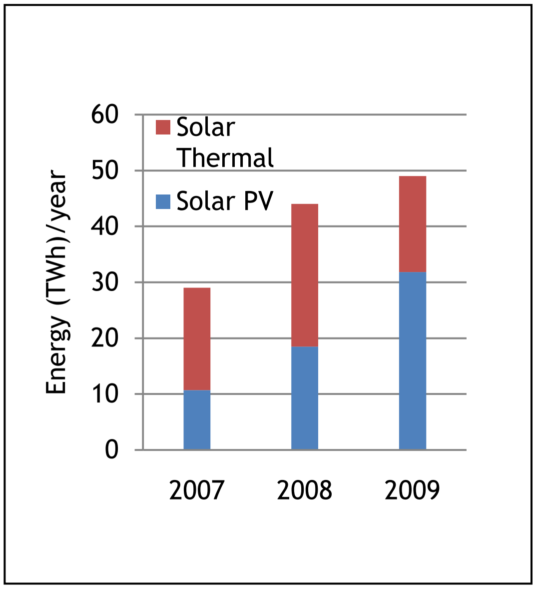


Figure 4.6 Large IOU RPS Solicitation- Solar Bids by Technology. The number of solar PV applications increased significantly in recent years and is expected to increase over the next decade.

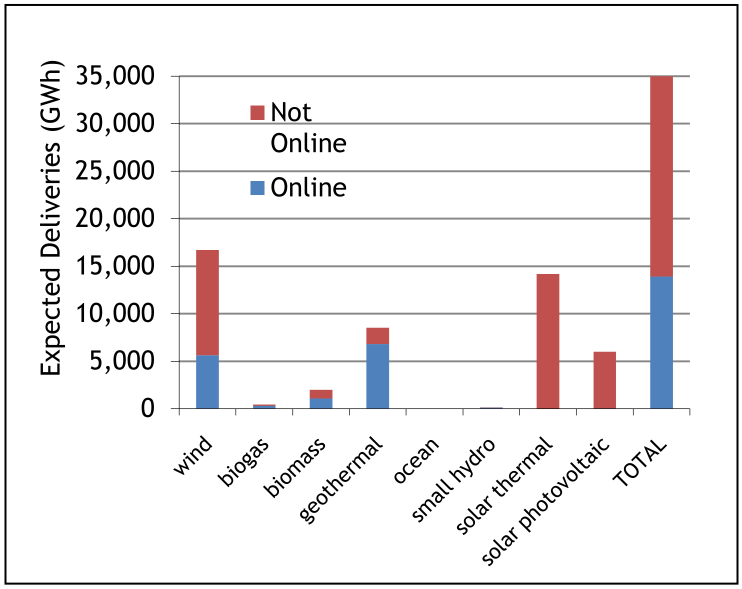


Figure 4.7 Total Expected Renewable Deliveries from Contracts Signed Since 2002, by Operational Status (minimum GWh). The majority of RPS contracts online are from wind and geothermal sources. As optimal locations for these resources are developed, the price gap for solar is expected to narrow and result in an increase in solar contracts.

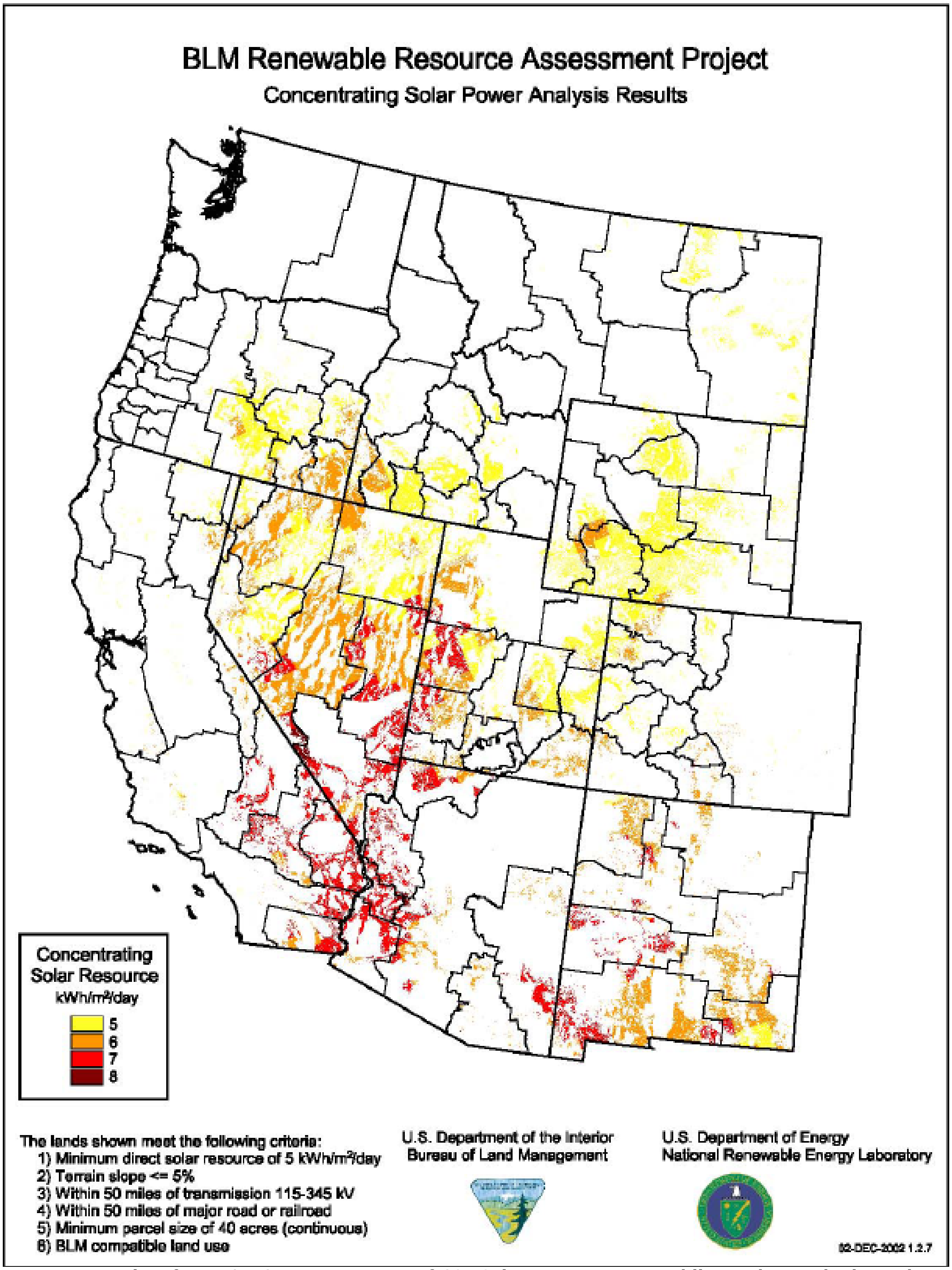
POLICIES AFFECTING SITING OF UTILITY-SCALE SOLAR DEVELOPMENT ON PUBLIC LAND

Besides economic drivers for utility-scale solar development there are state and federal policies that incentivize the use of public lands for renewable energy generation. In 2003 the US Department of the Interior (DOI) and the DOE released "Assessing the Potential for Renewable Energy on Public Lands." This report identified areas with the best solar energy potential in terms of sun, slope, transmission access, road availability, size, and are located where federal, state, and local policies are supportive.[26] This information generated a map identifying areas with the best potential for solar energy development, most of which are concentrated in southern California and portions of Nevada and Arizona (Map 4.1).

Both the DOI/DOE report and the California RPS encouraged solar developers to study public lands in Southern California for utility-scale development. Knowledge of the primary policy drivers of utility-scale solar development on public lands is necessary to understand the current situation in the California desert (Table 4.3).

Table 4.3 Policy Incentives and Disincentives for Solar Development on Public and Private Lands.

Policy	Incentive or Disincentive	Level	Land Affected	Details
Energy Policy Act of 2005	Incentive	Federal	Public	• Mandated 10,000 MW on public lands by 2015
2008 BLM Energy and Mineral Policy	Incentive	Federal	Public	• Land use plans must incorporate renewable energy potential • Encourages private industry to develop energy sources on public lands
Obama Administration Policy	Incentive	Federal	Public	• 25 percent renewable energy by 2025 • DOI to increase renewable energy capacity on public lands by 9,000 MW by 2011
California Land Conservation Act of 1965 (Williamson Act)	Disincentive	State	Private	• Prevents development on 16 million acres of farmland protected statewide
California Desert Protection Act of 2010 (Proposed)	Disincentive	Federal	Public	• Would prohibit renewable energy development on 1.2 million acres of BLM land



Map 4.1 Results of BLM & DOE's Assessment of CSP Solar Resources on Public Lands. Lands shown have solar resource of 5 kW per m^2 per day, less than 5 percent slope, are within 50 miles of 115 to 345 KV transmission lines and a major road or railroad, have at least 40 acres, and are BLM lands compatible with solar development. Source: BLM, DOE. 2003. Assessing Renewable Energy Potential on Public Lands.

Public vs. Private Land

While BLM land in the desert is very much a checkerboard of public and private land, it is thought by BLM employees that solar developers have found the BLM ROW process easier than trying to purchase or lease multiple tracks of land from multiple private landowners. As one BLM employee stated in regards to why developers are choosing public over private land, “There are a number of reasons for it. How feasible is it if you’re looking at an area that’s as large as areas that they’re trying to develop? If there’s a large number of landowners for a 4,000 acre project, that’s 20 or 30 landowners, it’s much harder to deal with and reach agreements and pull a project together with that many landowners than with one federal landowner.”[27] Solar developers choosing BLM land also have the benefit of returning the land to the BLM should the project no longer be viable at the end of the lease agreement. If developers chose to purchase land, they would have to find a buyer for degraded desert lands after the solar project’s life span ended, for which there is a small market base.

Policies Affecting Siting

Energy Policy Act of 2005

The United States does not currently have a national RPS. However, the Energy Policy Act of 2005 states, “It is the sense of the Congress that the Secretary of the Interior should, before the end of the 10-year period beginning on the date of enactment of this Act, seek to have approved non-hydropower renewable energy projects located on the public lands with a generation capacity of at least 10,000 megawatts of electricity.”[28] This stipulation has incentivized solar development on public lands in California by requiring DOI to meet this quota. However, one setback is that the law does not mandate which agency is responsible for fulfilling the renewable energy requirement or which technology should be used. A BLM employee stated, “We have a national goal of 10,000 MW, but where are they coming from? From BLM? From Forest Service? Which agency is responsible for responding to those goals? Which portion does each of us play in those goals? We have 260 million acres in the West. Does that mean we should bear the burden of all that when our lands are used by so many other people?”[29]

2008 BLM Energy and Mineral Policy

In 2008, the BLM revised their Energy and Mineral Policy to provide principles to guide BLM management of energy and mineral resources on public lands. The new policy stipulates that land use plans must incorporate and consider energy assessments and potential on public lands, including renewable energy.[30] The policy also endorses that BLM “actively encourages private industry development of public land energy and mineral resources.”[31] This policy has incentivized solar development in California by changing the agency outlook on renewable energy and making it more acceptable for the agency to approve permits for solar development.

Obama Administration Policy

The Obama Administration and the Secretary of the Interior have chosen renewable energy development to be a top priority. The Administration has set a goal of generating 25 percent of the Nation's energy from renewable sources by 2025.[32] To realize this goal, Secretary Salazar introduced the "New Energy Frontier" in DOI's Fiscal Year 2010 budget. This program allocated $16.1 million for the BLM to support four Renewable Energy Coordination Offices, including one in California, to expedite authorization of renewable energy projects on public lands.[33] Secretarial Order 3285 was also issued in 2009 by Secretary Salazar to create an Energy and Climate Change Task Force to develop a strategy to increase development and transmission of renewable energy on public lands.[34] Secretary Salazar has declared an additional DOI goal to increase approved capacity of renewable energy sources on DOI lands by at least 9,000 MW by 2011.[35] Both the administration and departmental goals have incentivized solar development in California on public lands by providing set targets with deadlines and infrastructure to BLM employees in processing applications.

California Land Conservation Act of 1965 (The Williamson Act)

The California Land Conservation Act of 1965, commonly referred to as the Williamson Act, is a state law that enables local governments in California to enter into contracts with private landowners to preserve private land as agricultural land or other related open space.[36] In return for limiting development on their land, landowners receive lower property tax assessments. Contracts must be no shorter than 10 years, and they automatically extend each year beyond the end of the contract unless a notice of cancellation or nonrenewal is given.[37] The act is a disincentive for utility-scale solar development on private lands in the state, as the approximately 16 million acres of lands protected under the act cannot be sold or leased for development while under contract.[38]

California Desert Protection Act of 2010

Senator Diane Feinstein, D-Calif., introduced the proposed California Desert Protection Act of 2010, S. 2921, in December 2009. If enacted, the act would alter solar development in the California desert through new restrictive land designations and changes to the renewable energy permitting process. Approximately 1.2 million acres of land would be closed to solar energy development through two national monument designations, one special management area designation, and land transfers to the NPS. Even though the bill has not been enacted, its announcement has already caused developers of proposed facilities within the proposed national monument boundaries to postpone or abandon their plans.[39]

CAN DISTRIBUTED GENERATION ELIMINATE THE NEED FOR UTILITY-SCALE SOLAR DEVELOPMENT?

Meeting renewable energy goals in California will require both utility-scale and distributed generation approaches to solar development. The complementary approaches to electricity generation and delivery enable utilities, developers, and consumers to cooperatively invest in solar energy development in a number of market sectors and take advantage of a variety of investment incentives that economize investment at all scales. California's preliminary analysis of the implementation scenarios for meeting the 33 percent RPS goal explored the potential for a high level of distributed solar electricity generation capacity[40] based on three screens: ease of interconnection, site suitability, and customer's willingness to install the technology (Figure 4.8). GIS mapping of available rooftop area and analysis of peak load service were used to construct the screens and the statewide potential for PV applications totaled 17,300 MW,[41] or about 30 TWh (assuming a 20 percent capacity factor). California will require approximately 75 TWh of new renewable electricity generation capacity by 2020 in order to meet the RPS goal.[42]

Distributed generation has the potential to contribute significantly to the state's energy portfolio but will not replace utility-scale development. While distributed generation offers many benefits, such as rapid deployment and use of rooftops or disturbed land in developed areas, several barriers exist, including behavioral preferences, higher costs and questions about ownership of Renewable Energy Credits (RECs).

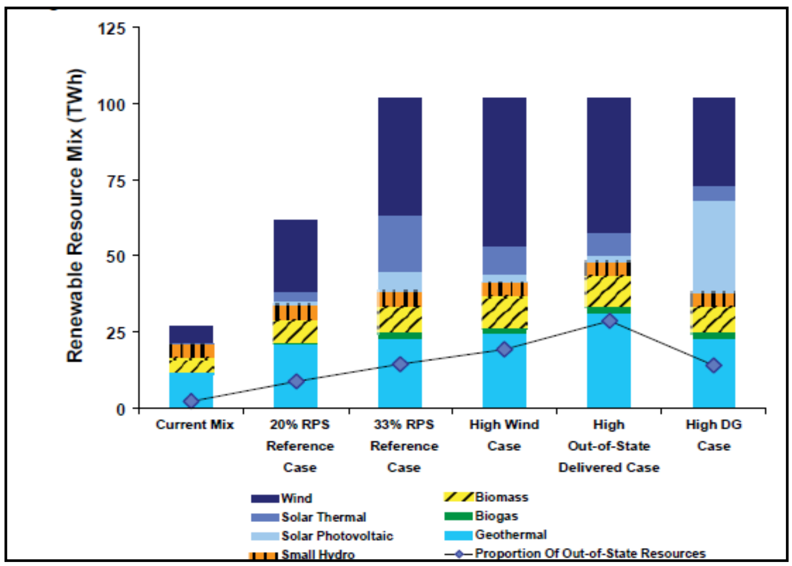


Figure 4.8 Renewable Resource Mixes in 2020 under Different Cases. The 33 percent RPS Implementation Analysis Preliminary Results produced by the CPUC includes a scenario for high distributed generation capacity using solar photovoltaic technology.

The most common technology used for distributed generation is combined heat and power for industrial processes (i.e. using waste heat to generate energy), but policy-based incentives are fueling the growth of the PV market for commercial and residential distributed generation. The modular nature of PV panels is appropriate for rooftop applications or ground-level arrays sized according to the energy demand of the site or the space available. Utility customers can take advantage of many of the same economic incentives as a developer of a large solar facility but have the advantage of streamlined interconnection rules and regulations, which cuts overall project costs. Because a distributed generation solar electric system reduces demand for electricity from the grid during peak periods of demand, customers with time-of-use rate pricing can take advantage favorable net metering rates. Pacific Gas and Electric, for example, offers residential customers with PV installations up to 1 MW a time-of-use net metering rate that values solar energy produced during peak periods at a rate three times higher than during non peak periods.[43] Utilities support distributed generation because projects can come on line quickly, reduce peak load demand, and contribute to RPS goals. However, PV remains more expensive per MWh[44] (Figure 4.9), which is a major barrier to widespread adoption despite numerous economic incentives.

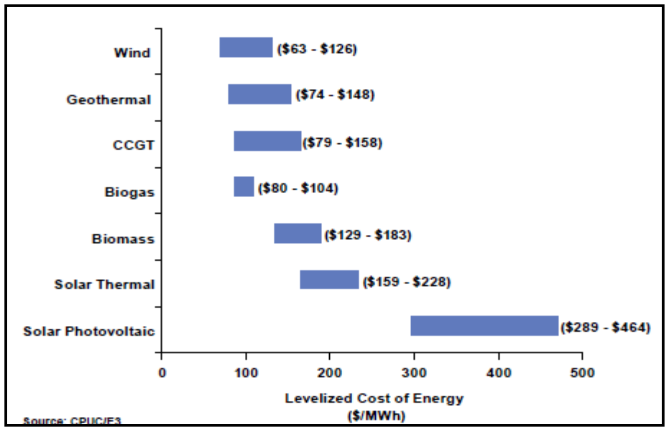


Figure 4.9 Developer Levelized Cost of Generation by Technology Type. The cost of PV for distributed generation per MWh of electricity produced is currently significantly higher than for other renewable energy resource technologies, including solar thermal used in utility-scale applications.

California's Incentives for Distributed Generation

During the period from 1990 through 1999, overall electricity demand in California increased by 11.3 percent while electric generating capacity decreased by 1.7 percent over the same period.[45] The imbalance between electricity supply and demand came to a head during California's energy crisis of 2000 to 2001, when the state endured rolling blackouts during the summer peak demand periods. Skyrocketing wholesale electricity costs forced utilities to limit supply to customers who enjoyed artificially low, regulated electricity billing rates. Wholesale electricity market prices exhibited "significant departures from competitive pricing during the high-demand summer months and near-competitive pricing during the lower-demand months" between 1998 and 1999 and increased significantly in 2000.[46] This increase was likely due to rent-seeking behaviors and inequitable market power among generators in the recently restructured market rather than to rising fuel costs or environmental costs. While an in-depth discussion of California's energy market restructure and consequences is outside the scope of this review, it is worth noting for its contribution to the energy crisis and the subsequent policies created to address market failures and increase alternative, competitively priced distributed electric generation capacity. Today, not only is distributed generation important for California's energy security, it is a boon to the state's economic development and plays a significant role in meeting renewable energy goals.

As policy measures are introduced and extended to reduce uncertainties and enable widespread adoption of solar technologies, opportunities for improvements and investment in the distributed generation solar market arise. As with utility-scale projects, the PV market creates a value chain starting with research and development, followed by investment, material supply and manufacturing, project development, labor and installation, legal, financial and environmental consulting, and ultimately, the consumer. Rapid evolution of the industry over the past decade coupled with uncertainty of policy incentives and market externalities over the extended economic life cycle of product creates points throughout the value chain that are dependent on favorable policy and incentives. The market for PV is growing rapidly in California (Figure 4.10) with the support of progressive and ambitious renewable energy goals. California's incentive programs (Table 4.4) and pricing policies (Table 4.5) for distributed generation resulted in over 24,000 distributed PV installations with a combined capacity of 459 MW between 1998 and 2008.[47] California's innovative programs targeted specifically at adoption of residential solar power also support a growing workforce of specialized distributers and installers.

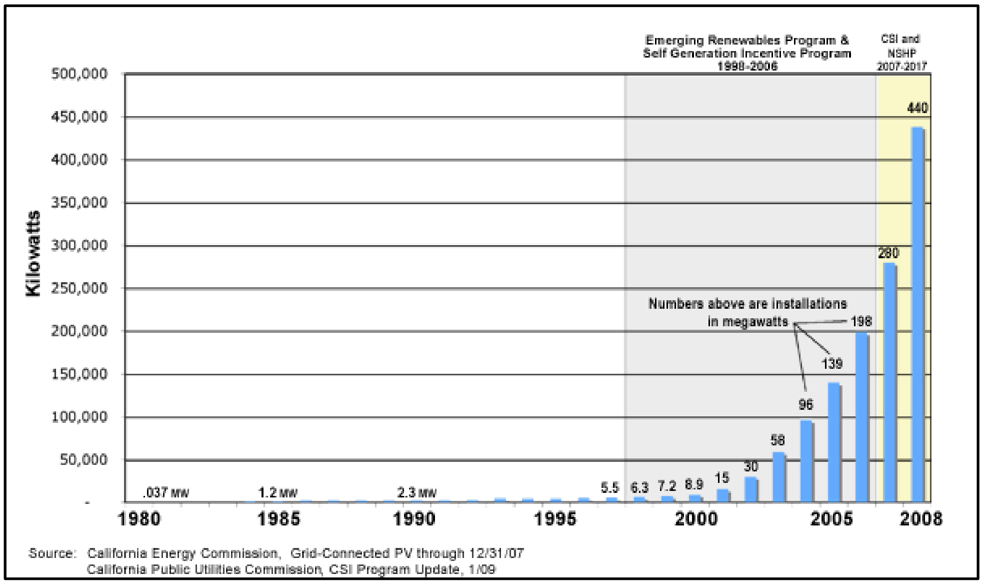


Figure 4.10 Grid-Connected Solar Photovoltaic Installed Capacity in California-Cumulative by Year, 1981to 2008. Market penetration of PV systems is rapidly accelerating. California's goal is to reach 3,000 MW of installed capacity by 2020.

Emerging Renewables Program

In 1998, the California Legislature created the Emerging Renewables Program (ERP), which established an incentive fund managed by the CEC to support installation of household-sized (less than 30 kW) photovoltaic systems, among other technologies. The program required California's major utilities to contribute a total of $540 million collected from ratepayers to an Emerging Renewable Resources Account between 1998 and 2001. The goal was to stimulate the near-term market for PV systems and "encourage manufacturers, sellers, and installers to expand their operations and reduce their costs per unit."[48] While the ERP was expanded to $135 million per year through 2011, other programs came online to support the growing market for distributed generation.

Table 4.4 California Programs Incentivizing Distributed Photovoltaic Systems.[49,50]

Program	Description
Emerging Renewables and Self-Generation Incentive Programs 1998 to 2006	•Provided rebates for residential installations •The CEC offered rebates for PV systems <30kW •The CPUC offered rebates for renewable energy systems >30 kW •192,792 kW of grid connected PV by 2006
California Solar Initiative 2006 to Today	•Provides an up-front Expected Performance-Based Buydown payment for smaller systems OR Performance-Based Incentive payments for larger systems •Payment values decrease over time as installed capacity increases •Includes New Solar Homes Partnership Program to incentivize installation of PV on new construction •Available to customers of IOUs •299.2 MW of grid connected PV as of February, 2010
Property Assessed Clean Energy Financing 2008 to Today	•The state adopted AB811 in 2008, which allows municipalities to sell bonds to finance a renewable energy and energy efficiency loan fund •Property Assessed Clean Energy financing allows property owners living in participating municipalities to obtain low-interest loans and repay them through a special assessment on the property •Repayment obligation stays with the property in the event of a sale

Table 4.5 Economic Incentives for Distributed PV Installation .

Incentive	Description
Net Metering	•Beginning in 1996, customers with small systems (less than 1MW) are allowed to feed excess generation back to the grid and earn credit against electricity used on site •Credit from one billing cycle is rolled into the next and the customer has the option to cash out credit balance after a 12-month period
Feed-In Tariff	•Production incentive established in 2006 for customer-generators •Currently allows owners of small systems (up to three MW) to enter into 10-, 15-, or 20-year contracts for sale of electricity to utility •Price paid is based on CPUC MPR and is adjusted for time-of-use to reflect value of electricity during peak demand periods
Residential Financing	•Lowers up-front costs and likely reduces utility bills in the future •Property Assessed Clean Energy financing enabling legislation was passed in California in 2008 and is a model for many other states •Several additional options with improved or streamlined structures are coming to market for residential PV financing

Self Generation Incentive Program

The rolling blackouts of the early 1990s occurred during the summer months, when peak demand exceeded supply. As a response, and in addition to establishing a RPS, the CPUC established the Self Generation Incentive Program (SGIP) in 2001 to bring new distributed generation capacity online. The program continues to provide up-front capital costs for ratepayer-owned, grid-connected distributed generation projects. Utilities benefit from an offset to peak demand wholesale market pricing impacts and, as a result, ratepayers benefit because utilities have less need to build new utility-scale generation capacity that would likely result in a rate increase. The SGIP complimented the ERP by providing incentives for qualifying solar PV systems with up to one MW capacity between 2001 and 2006. Although the program continues to offer incentive payments to other generation technologies, PV projects no longer qualified when California Solar Initiative was established in 2006. By 2008, completed PV projects accounted for 133 MW (40 percent) of SGIP capacity, contributed 197,178 MWh to California's statewide energy use, resulted in 65 percent of the SGIP's greenhouse gas emission reductions, and developers received a total of $454 million in incentive funding (76 percent of total).[51]

California Solar Initiative

The annual statewide production capacity for solar energy reached 1,868 MW by 2006. At this point, incentives for residential and commercial customer-owned solar PV were relocated to the new California Solar Initiative (CSI) program, established by the CPUC and the CEC, in order to better serve the needs of the market. The goal for the CSI is to install an additional 3,000 MW of distributed generation capacity and include solar PV on 50 percent of new homes built by 2020. The 10-year program was allocated $2.17 billion (2007 to 2016) to enable utilities to provide direct incentives to consumers for PV and non-PV technologies, fund low-income solar programs, pilot a solar water heating program, and stimulate research, development and deployment.[52] The diversity of rebate, grant and loan programs included in the CSI encourages growth of the solar industry in a number of market sectors and technologies for residential and commercial applications. The CSI framework encourages manufacturers to improve performance because the incentives are based on performance (kWh produced) rather than nameplate capacity. This framework benefits the industry as a whole by rewarding manufacturers that can deliver the least cost, highest performing products that are essential for creating a self-sustaining industry. In addition, the incentive payments are scaled to favor early adopters since payments decrease as the total number of MW installed increases.

Net Metering

Net metering (or co-energy metering for publicly owned utilities) laws passed in 1996 in California allow IOU and public utility customers with small PV systems (less than 1 MW) to put any excess energy generated on the electric grid and carry the net generation forward to their next energy bill. Since there are no interconnection, standby or other charges to the customer, this significantly lowers the payback period for residential and commercial PV installation and encourages property owners to install PV. The safety and manageability concerns often cited by utilities concerned about the impacts of cumulative inputs to the grid are addressed through an aggregate capacity limit of the utility's peak demand. Originally, the cap was set at 2.5 percent of a utility's peak demand and some utilities were close to reaching the cap in 2009. Solar advocacy groups lobbied the state to increase the cap to 10 percent and avoid the roadblock to reaching the 3,000 MW of new solar capacity goal set by the CSI. When a bill to raise the cap was introduced to the state assembly, Assemblyman Skinner stated "according to recent estimates by the PUC, each IOU share of the 3,000 megawatt goal represents between 4.5 to five percent of the utility's aggregate peak load. Even with the grant program created under the CSI and federal tax credits, distributed generation solar is not economical for the customer generator unless the utility participates in some form of a buy-back program such as net-metering."[53] Although Skinner's bill sought to increase the cap to 10 percent, the legislature passed a revised cap of five percent in February 2010.

Utilities and some customers resisted more significant increases to the net metering cap because, some believe, it creates a disparity among electricity customers when those who do not have renewable energy installed for net metering are effectively subsidizing the electricity use of those who do.[54] While Pacific Gas and Electric and Southern California Edison supported increasing the cap to five percent through 2010, they called for additional studies of not only the economic impacts of the program but also the impacts on grid stability, which might be impacted by voltage spikes created by multiple residential systems. Matching the feed-in-tariff caps to the desired distributed generation installed capacity is important for avoiding boom-bust cycles in the solar PV industry. Property owners are heavily incentivized by the net-metering program which drives the market for residential PV installation.

Feed-In Tariffs

Feed-in tariffs (FIT) are used around the world to incentivize and streamline incorporation of renewable energy in existing electricity grid networks. In the United States, the basic requirements include a requirement for a utility to purchase electricity from renewable energy generators, payment guarantees and assurance of access to the grid.[55] California adopted FIT legislation in 2006 and starting in 2010 it will include all IOUs and publicly-owned utilities serving more than 75,000 customers. Customers with solar thermal electric or photovoltaic systems (among other eligible renewable technologies) may enter into 10-, 15-, or 20-year contracts to sell the electricity and associated Renewable Energy Credits to the utility. The 2009 amendments to the 2006 legislation increased the maximum generation capacity of the customer-owned systems from 1.5 MW to three MW and also allows for the system to be located off-site from the customer's property as long as the system is within the service area of the contracted utility. The tariff rate is based on market prices with time-of-use adjustments which provide a higher rate during peak demand periods. The mechanism is specifically directed towards assisting utilities with meeting RPS goals and will be available until the statewide cumulative capacity installed equals 750 MW.[56]

The provisions of California's amended FIT expand solar market opportunities by increasing the number of potential projects and, because of the certainty afforded by a sales contract, provide leverage for capital by developers. The FIT compliments California's RPS goal by offering alternatives to utility-scale developments that face project financing uncertainty, high contract failure rates, permitting delays, and market concentration. In addition, RPS policy alone limits the potential for renewable energy development because utilities employ a competitive bidding process for projects that "increase the return on investment requirement, which ultimately increases the required payment price. These high transaction costs also make it difficult for smaller investors to participate."[57] However, the payment structure in California may not be sufficient for attaining the desired market results. California's FIT payment structure is based on the utility's avoided cost rather than the actual cost of the project. As a result, the returns are based on market electricity prices and the variability increases the uncertainty for investors.

Residential financing programs

The California legislature AB 811 in 2008 and gave local municipalities the authority to establish Property Assessed Clean Energy financing districts. This innovative financing mechanism allows municipalities to sell bonds and create a lending fund for property owners who wish to install energy efficiency measures or renewable energy technologies. The money borrowed from the local government is paid back through a special tax assessment and the loan is senior to any other debts, including the mortgage. One advantage of this kind of lending is that the 20-year payback obligation can be transferred to a new owner in the event of a property sale, which incentivizes investment in systems with a long payback period such as PV and solar hot water heaters. The financing also helps property owners overcome the high up-front costs associated with installing PV systems.

Private sector start-ups are beginning to enter the market for residential financing and will offer homeowners additional options and structures for obtaining low-cost capital for PV systems. One alternative recently offered by SunRun, Inc. in California is third-party ownership of the solar PV system. The structure involves establishing a power purchase agreement whereby the homeowner provides a down payment and agrees to purchase electricity produced by the system at a locked-in rate over 18 years.[58] SunRun installs, owns, and maintains the system, thus reducing overall costs for the homeowner. This approach may prove to be an attractive complement or alternative to PACE financing. Additional financing structures are summarized in Table 4.6.

Table 4.6 Advantages and Disadvantages of Residential PV Financing Structures.[59]

Residential PV Matrix from Homeowners' Perspective	Purchase with Cash	Home Equity Loan	Solar Lease	Residential PPA- SunRun Power Plan	Property Tax Model- PACE	PSE&G Solar REC Loan Program
Up-front cost to homeowner	36-70%	None/Low	0-20%	5-25%	None/Low	36%
Homeowner has maintenance responsibilities	Yes	Yes	Depends on program	No	Yes	Yes
Homeowner Pays for Inverter Replacement	Yes	Yes	Depends on program	No	Yes	Yes
Likely impact on future utility bills*	Lower	Lower	Lower	Lower**	Lower	Lower
Required cash payments (above utility bills)	No	Yes- loan payment	Yes- lease payment	Yes- electricity payment	Yes- property tax payment	No- although annual true-ups possible
Ownership of PV system in Year 1	Yes	Yes	No	No	Yes	Yes
Take residential federal tax credit	Yes	Yes	No	No	Yes***	Yes***

*** Compared to buying 100% of the electricity from the local utility. This does not mean that other costs, such as a loan or lease payment will be 100% offset by retail utility bill savings.**
**** The third-party PPA ownership model assumes that retail electricity prices will exceed the PPA price. While likely unless structured as a fixed discount to retail prices, it is not guaranteed.**
***** Based on the proposed changes to the subsidized energy financing concept in the stimulus bill.**

The Future of Utility-Scale Solar Development in California

After a promising year in 2008, developers have been stalled by delays over permits and siting decisions by the BLM, which has created uncertainty in project timelines for developers and investors. Pressure has grown as developers try to bring power on line in time to take advantage of the December 31, 2010 deadline for production tax credits. Pressure also grew among IOUs to secure their target RPS, which led to a record number of new power purchase agreements, some of which had contract prices above the MPR, with facilities located on public lands throughout the desert. Once the policies regarding permitting of solar project development on public lands are established, it is likely that a secondary push for utility-scale development on public land will ensue if conditions are favorable and result in a lower LCOE compared to private land development. Key factors in determining project costs, and by extension the LCOE, include reaching economies of scale, the technology efficiency, optimization of the solar resource, availability of and access to capital, land use costs, and access to transmission.

A lower LCOE is a competitive advantage for securing a PPA since the MPR rate will be lower for the utility. Currently, some developers are choosing to avoid BLM lands in order to avoid the uncertainty and delays facing projects proposed for public lands. One panel discussion among utility-scale project developers at the Greentech Media Solar Summit on utility scale solar development strategies highlighted the differences in location and technology choices for two projects in development.[60] Developers of Mojave Sun Power's 340 MW solar trough project in Arizona purposely avoided public land in favor of a suitable parcel that was aggregated for a residential development project deal that failed. The representative from Mojave Sun Power explained that the technology choice was secondary to other factors such as available subsidies and financing options that would lower the project cost and expedite development. Although other technologies are considered more efficient than solar trough, they are not proven in the market and, therefore, face financing barriers which limits their market entry potential. Tessera Solar's three dish/engine projects (2,150 total MW) on public lands are facing delays and project cost uncertainties due to undefined land use and mitigation costs. The choice of dish/engine technology is based on the higher efficiency of the installed project and the economies of scale achieved for the purpose of lowering the LCOE.

Solar trough technology currently dominates CSP development in California with 4,606 MW of the total 7,647 MW of potential generation capacity.[61] A study conducted by the National Renewable Energy Laboratory (NREL) found that the LCOE for the first CSP plants installed in 2009 was $148 per MWh, which is competitive with the simple cycle combustion turbine LCOE of $168 per MWh, assuming that the temporary 30 percent Investment Tax Credit is extended, although still higher than the $104 per MWH for a combined cycle combustion turbine plant.[62] A number of CSP technologies, including concentrating PV, dish engine and power towers, are beginning to enter the market (Appendix B). While some technologies pose a higher risk for investors, the ability to generate more power per acre and the possibility of lower land use costs makes the project attractive. As more efficient technologies are proven in the market, LCOE and land use impacts per MW produced will be reduced for future projects. For example, concentrating PV requires two acres to produce 1 GWh per year while thin film requires 2.3 acres to produce the same amount of electricity.[63] The land use impacts varies based on technology type used and the fact that some, less efficient technologies are more easily financed presents a dilemma to BLM staff who review permit applications on a first-come, first-served basis. At this point, the permit review process does not prioritize proposals that have a more efficient land use footprint, reduced need for water, or do not require extensive land grading. If the process can be modified to give priority to technologies that have a reduced impact on the environment, this will incentivize investment in CSP technologies that are in the early stages of market deployment.

While there are some smaller utility-scale solar facilities in development, typically economies of scale are not achieved unless facilities are located on large parcels of land and in close proximity to one another. For example, two NREL reports on the preferred plant size and siting arrangements for a parabolic trough facility found that the levelized cost of electricity decreased by about $0.02 per kWh when the plant size was increased from 88 MW to 220MW[64] and that siting multiple plants in close proximity to one another decreased levelized electricity costs by an additional 10 to 12 percent.[65] However, the permitting process and limited availability of large, contiguous parcels of suitable land can delay projects and create a barrier to developing utility-scale systems. As an alternative, many developers are exploring smaller, decentralized facility projects on private land. This approach incorporates medium-sized generation facilities (five to 300 MW) located near load centers to satisfy peak load demands. While optimal economies of scale might not be achieved with smaller plants, the proximity to load reduces the impact a project may have on the landscape and environment because smaller parcels of disturbed land are located nearer to loads than are remote tracts of public lands. Load centers are also locations where peak demand can cause stress on the delivery system and decentralized facilities help power providers manage and maintain electric reliability, thus adding value to the project.

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Chapter 4

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