Golden Gate University Law Review

Volume 36
Issue 3 *Symposium Issue: California's Renewable Energy Sector*
Article 3

January 2006

Government's Role in Creating a Vibrant Solar Power Market in California

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ARTICLE

GOVERNMENT'S ROLE IN CREATING AVIBRANT SOLAR POWER MARKET IN CALIFORNIA

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> You see, we should make use of the forces of nature and should obtain all our power in this way. Sunshine is a form of energy; wind and sea currents are manifestations of this energy. Do we make use of them? Oh no! We burn forests and coal, like tenants burning down our front door for heating. We live like wild settlers and not as though these resources belong to us. Thomas A. Edison, 1916

INTRODUCTION

For the past thirty years, California has been a world leader in energy efficiency and renewable energy development. "The fifth largest economy in the world, California is only the twelfth largest consumer of

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electricity."[1] Further, California has the highest per capita use of renewable energy in the world.[2]

Despite this progress, California remains overly dependent on unsustainable energy resources, creating market instability, air pollution, global warming, and radioactive waste. In fact, ninety percent of California's electricity comes from sources that pollute the air, harm the environment, threaten public health, and put consumers at the mercy of a handful of power suppliers.[3]

Unless significant changes are made in how California powers itself, this situation will worsen, especially with the state's expected population and economic growth. With more than 8,000 megawatts ("MW") of natural gas coming from power plants licensed since 2003, California's reliance on natural gas - already supplying 40.8 percent of the state's electricity[4] - will increase substantially within the next few years.[5] Yet, "research indicates that there is only a 38-year supply of natural gas [left] in the United States at current rates of consumption and import."[6] As gas deposits dwindle, pressure to drill for oil and gas in fragile natural areas like the California coast will heighten.

In addition, California's two aging nuclear power plants put residents in danger on a daily basis, particularly in light of recent terrorism concerns.[7] The Diablo Canyon plant, located near San Luis Obispo, and the San Onofre plant, located near San Diego, came on-line in the early 1980s.[8] Both plants will require significant upgrades within the next five years to remain operational, made at a great expense to

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[1] Ross Miller, et. al., CALIFORNIA ENERGY COMMISSION ("CEC"), 2002-2012 ELECTRICITY OUTLOOK REPORT 41 (P700-01-004F, February 2002).

[2] UNITED NATIONS ENVIRONMENT PROGRAMME & THE UNITED NATIONS NON-GOVERNMENTAL LIASON, TAKING ACTION: AN ENVIRONMENTAL GUIDE FOR YOU AND YOUR COMMUNITY, Ch. 7 (Roger Adams ed., 1996), *available at* http://www.nyo.unep.org/action/07.htm.

[3] MELISSA JONES ET AL., CEC, 2005 INTEGRATED ENERGY POLICY REPORT 38 (Carolyn Walker & Marilyn Davin eds, CEC-100-2005-007-CTF, Nov. 2005).

[4] *Id.* at 38.

[5] *Id.* at 44.

[6] BRAD HEAVNER & MARIANNE ZUGEL, CALPIRG CHARITABLE TRUST, PREDICTABLY UNPREDICTABLE: VOLATILITY IN FUTURE ENERGY SUPPLY AND PRICE FROM CALIFORNIA'S OVER-DEPENDENCE ON NATURAL GAS 6 (Sept. 2001), *available at* http://www.environmentcalifornia.org/uploads/5A/nH/5AnHPRrDtZ_4Pj3N71nn3A/Predictably_Unpredictable.pdf.

[7] MELISSA JONES ET AL., *supra* note 3, at 84.

[8] ENERGY INFORMATION ADMINISTRATION, *Nuclear Power Plants Operating in the United States as of December 31, 2004, at* http://www.eia.doe.gov/cneaf/nuclear/page/at_a_glance/reactors/states.html *(page last modified on March 18, 2005).*

ratepayers.[9] Given the current political situation, these plants may soon begin shipping their radioactive nuclear waste to Yucca Mountain in Nevada, threatening residents who live along the route.[10]

Whether it is the threat of severe weather changes from global warming, increased health impacts such as asthma and cancer from air pollution, rolling blackouts from market power abuses of energy companies, or the quest for oil in pristine wilderness areas, Californians are increasingly facing the consequences of a flawed energy system that is overly dependent on unsustainable and dwindling resources.

Fortunately, California has only scratched the surface in terms of tapping into the state's abundant clean energy resources such as conservation, energy efficiency, and renewable energy technologies. Given California's strong economy and history of creating new markets for environmentally-beneficial technologies, implementation of state policies that would create a vibrant clean energy market in the coming decade is within reach.[11]

On August 12, 2002, former-Governor Gray Davis signed into law a landmark clean energy bill requiring investor-owned utilities to acquire at least twenty percent of their energy supply from renewable resources by 2017.[12] The state's energy agencies have recently accelerated the effective date of this minimum percentage to 2010.[13] As a result, utility-scale renewable energy resources, such as large wind farms and geothermal power plants, have grown over the past few years to ten percent of the state's total electricity supply.[14] California regulators now estimate the state could reach thirty-three percent renewable energy by

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[9] MELISSA JONES ET AL., *supra* note 3, at 84.

[10] PIERRE SADIK, U.S. PIRG EDUCATION FUND & STATE PIRGS, RADIOACTIVE ROADS AND RAILS: HAULING NUCLEAR WASTE THROUGH OUR NEIGHBORHOODS 3 (June 2002); *See also* MELISSA JONES ET AL., *supra* note 3, at 85.

[11] For further discussion of technological advancements driven largely by California's market *see The History of Electric Vehicles, at* http://inventors.about.com/library/weekly/aacarselectric1a.htm; HybridCars.com (last visited Feb. 20, 2006); *History of Hybrid Cars at* http://www.hybridcars.com/history.html (last visited Feb. 20, 2006); THE CLIMATE INSTITUTE, STATE AND LOCAL ACTION, *at* http://www.climate.org/topics/localaction/beacon_hope.shtml (last visited Feb. 20, 2006); *see also* Judith Lewis, *Clear and Present Danger*, L.A. WEEKLY, Sept. 23-29, 2005.

[12] S.B. 1038, 2002 Leg., 2001-02 Sess. (Cal. 2002) available at http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1038&sess=0102&house=B&author=sher (last visited Feb. 20, 2006).

[13] CEC & CALIFORNIA PUBLIC UTILITIES COMMISSION ("CPUC"), CALIFORNIA ENERGY ACTION PLAN 5 (Adopted May, 8, 2003).

[14] MELISSA JONES ET AL., *supra* note 3, at 106.

2020.[15]

Despite this progress in developing renewable energy, solar power - one of California's most abundant energy resources - makes up less than one half of one percent of the state's electricity supply.[16] While the third largest market for solar power in the world, following Japan and Germany, California's solar power remains today a small and highly specialized market.[17]

With California's abundant sunshine and powerful economy, however, state policy designed to jumpstart a vibrant and cost-effective solar market could easily return California to its former role as the world's solar leader. Since the blackouts of the 2000-01 California energy crisis, coupled with rising energy costs and a greater awareness of the long-term impacts of fossil fuel combustion, such as global warming, more and more Californians are looking to solar energy for relief. Demand for solar rooftop systems among California homeowners and businesses, demonstrated by the number of applications submitted to the state for solar rebates, increased by 2,800 percent between 2000 and 2004.[18]

Recent policy decisions, broadly considered landmark and monumental, promise to put California back on track to taking the lead on this promising clean energy technology.[19] On January 12, 2006, the California Public Utilities Commission ("CPUC") unanimously adopted the California Solar Initiative (the "Initiative"), the nation's largest solar power program.[20] The program is designed to build one million solar

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[15] CEC & CPUC, ENERGY ACTION PLAN II: IMPLEMENTATION ROADMAP FOR ENERGY POLICIES 6 (Sept. 1, 2005), *available at* http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF (last visited Feb. 20, 2006).

[16] MELISSA JONES ET AL., *supra* note 3, at 38.

[17] Solarbuzz, Photovoltaic Industry Statistics: Countries, at http://solarbuzz.com/StatsCountries.htm (last visited Mar. 4, 2006).

[18] DAVE ALGOSO, MARY, BRAUN & BERNADETTE DEL CHIARO, ENVIRONMENT CALIFORNIA RESEARCH & POLICY CENTER, BRINGING SOLAR TO SCALE: CALIFORNIA'S OPPORTUNITY TO CREATE A THRIVING, SELF-SUSTAINING RESIDENTIAL SOLAR MARKET 12 (April 2005) *available at* http://www.environmentcalifornia.org/uploads/CG/RN/CGRNi2aeOwAL_DGcyK9ewA/Bringing_Solar_to_Scale.pdf.

[19] On December 15, 2005, the CPUC unanimously approved the first year of an 11 year, $3.2 billion program designed to build a million solar roofs and 3,000 MW of solar power. The CPUC Commissioners expressed their strong support for the solar policy describing it as "landmark" and "monumental", *see* Marc Lifsher, *PUC approves 11-year solar power plan*, L.A. TIMES C-2, Dec. 16, 2005; Kevin Yamamura, *Solar plan resurrected by PUC*, SAC. BEE A-3, Dec. 18, 2005; and Rick Jurgens, *PUC earmarks $300 million for solar energy subsidization*, CONTRA COSTA TIMES, Dec. 16, 2005, *available at http://www.contracostatimes.com/mld/cctimes/13421251.htm.*

[20] Press Release, CPUC, PUC Creates Groundbreaking Solar Energy Program (Jan. 12, 2006). at http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/52745.htm.

roofs, the equivalent of 3,000 MW of solar power, in ten years.[21] Unlike previous state and national programs, the Initiative's aim is to create a self-sufficient, mainstream, and affordable solar market within a ten-year timeframe, not simply build more solar power – a worthy goal in and of itself.

The Initiative came about after high-profile debate and policy development within the California State Legislature.[22] The most recent policy vehicle to stir this debate was the Million Solar Roofs bill, Senate Bill 1, authored by State Senator Kevin Murray.[23] While this legislation and previous iterations failed to pass the Legislature three years in a row, the widespread support for the policy led the CPUC to adopt this landmark solar power program through their administrative process.[24]

This Article examines solar power in California and the role state policy has and will play in creating a thriving, self-sufficient solar power market. Section I reviews the social benefits of solar power, particularly small-scale solar power systems capable of generating electricity at the point of end-use. Section II reviews the economic benefits of solar power from a consumer point of view. Section III examines California's 30-year history of state policies designed to drive consumers toward solar power. Section IV focuses on Japan and how it, starting in 1994, established a ten-year incentive program aimed at lowering the cost of solar power to the point of self-sufficiency, much like the goal California now pursues with the Initiative. Section V discusses the Million Solar Roofs legislation, the details of the Initiative recently adopted by the CPUC and the impacts the agency's renewed interest in solar power is likely to have on California's solar power market in the years to come. The Article concludes with a brief discussion of how California can move beyond one million solar roofs to the point where energy derived

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[21] CPUC, *Interim Order Adopting Policies And Funding For The California Solar Initiative*, Rule 04-03-017, 4 (adopted Dec. 15, 2005), *available at* http://www.cpuc.ca.gov/word_pdf/COMMENT_DECISION/51266.pdf.

[22] *See id.*

[23] S.B. 1, 2006 Leg., 2005-06 Sess. (Cal. 2005) *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1&sess=CUR&house=B&author=murray (last visited Feb. 20, 2006).

[24] The core policy element of the Million Solar Roofs bill, SB 1, was a directive that the CPUC create a multi-billion dollar, multi-year consumer rebate program funded through a small surcharge on ratepayer bills to grow California's solar market. Given the CPUC's ratemaking authority, the agency has the capability to establish a multi-year, multi-billion dollar rebate program without express legislative direction. In addition, there were several other important policy elements contained in SB 1 - such as lifting the statewide cap on net metering and requiring that all new homes come with solar panels as a standard option - that can only be established through legislation adopted by either the Legislature or ballot initiative. These remaining policy elements are further discussed in the concluding remarks of this paper.

from the sun eclipses unsustainable energy resources such as fossil fuels and nuclear power.

I. THE SOCIAL BENEFITS OF SOLAR POWER

Each "day, the sun provides enough [power] to meet the world's energy needs thousands of times over."[25] In contrast, conventional energy resources, such as oil and natural gas, are becoming increasingly scarce, and others continue to have serious drawbacks, such as nuclear power's radioactive waste. "While governments and energy companies seek out the remaining reserves of fossil fuels, attention is increasingly turning to developing cost-effective [renewable energy technologies], such as wind, geothermal, and solar power."[26]

Over the past decade, clean, alternative energy resources, and particularly solar power, have become among the fastest growing energy markets in the world.[27] Government programs designed to promote clean energy resources largely drove this growth.[28] California, for example, has the nation's strongest renewable energy law, called the Renewable Portfolio Standard ("RPS"). This law requires the state's electric utilities to generate at least twenty percent of their energy from renewable resources by 2010.[29] Already, energy from wind farms, geothermal plants, and biogas facilities make up nearly ten percent of California's electricity supply.[30]

Solar power produces social benefits that are not captured in the upfront cost of the technology such as greater grid stability, reduced demand for limited supplies of natural gas, energy efficiencies gained from on-site generation, and reduced air pollution. Yet, despite the

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[25] DEPARTMENT OF ENERGY, SOLAR ENERGY TECHNOLOGIES PROGRAM, *Solar FAQs - Photovoltaics*,http://www.eere.energy.gov/solar/cfm/faqs/third_level.cfm/name=Photovoltaics/cat=ALL#Q8 (last visited Feb. 20, 2006).

[26] http://environmentcalifornia.org.

[27] ERIC MARTINOT ET AL., REN21 RENEWABLE POLICY NETWORK, THE WORLDWATCH INSTITUTE, RENEWABLES 2005 GLOBAL STATUS REPORT 4 (2005), *available at* http://www.worldwatch.org/press/news/2005/11/06/ (last visited May 17, 2006).

[28] See ALLISON CASSIDY & KATHERINE MORRISON, ENVIRONMENT CALIFORNIA RESEARCH & POLICY CENTER, GENERATING SOLUTIONS: HOW CLEAN, RENEWABLE ENERGY IS BOOSTING LOCAL ECONOMIES AND SAVING CONSUMERS MORE, 3 (April 2003) *available at* http://www.environmentcalifornia.org/uploads/qx/bE/qxbEmqFCNzpSTq8PDNIoag/Generating_Solutions.pdf; see also ROBERT HARMON, AMERICAN WIND ENERGY ASSOC., CALIFORNIA'S COMPETITIVE ENERGY MARKET: THE FIRST YEAR'S EFFECTS ON THE WIND ENERGY INDUSTRY, (June 1999), *available at* http://www.awea.org/pubs/factsheets/calif99.pdf.

[29] The original requirement was to reach 20% by 2017, but the state recently changed the effective date to 2010. MELISSA JONES ET AL., *supra* note 3, at 107.

[30] Energy Action Plan 5, *supra* note 13, at 5.

steady emergence of clean energy resources and sunlight being the state's most abundant natural resource, solar power makes up less than one half of one percent of California's total electricity supply.[31]

Nearly the entire state of California receives an average of more than 5 kilowatt-hours (kWh) of solar energy per square meter per day. [32] For comparison, the average California household consumes an average of approximately 16 kWh of electricity per day.[33] This means "that the solar energy reaching a four-square-meter [plot] (about 43 square [feet]) could theoretically generate more than enough energy to supply the home, if the energy could be captured, used without loss of energy, and stored" for future use.[34] Since solar energy technologies require sunlight to produce electricity, the issue of storing solar-generated electricity has been a challenge to those wishing to rely solely on solar power for all their electricity needs. For off-grid solar applications, such as remote buildings or road-side signs, batteries are commonly used to store excess electricity generated during daylight hours for use during the night. For grid-tied applications, the grid itself can serve as a storage device (see discussion of net metering policies in Section III below).

The fact that solar power accounts for such a small fraction of California's electricity supply is due in part to the fact that the bulk of California's renewable energy policies focus on wholesale electricity markets which involve utilities or independent power producers with large, central-station power plants and transmission lines to transport energy to population centers from remote locations. Their programs are inherently not designed to promote customer-owned distributed generation in which a private homeowner or business owns and installs a power generating resource for their own use.

This is particularly so for solar photovoltaics ("PV"), which turn the sun's rays into electricity through a chemical reaction, and solar hot water systems, which use the sun to heat water. These distributed-generation solar technologies do not benefit from utility-scale renewable energy policies. Their small-scale application puts them on the retail side of the electricity market as opposed to the wholesale side, outside the control and profit of the traditional utility infrastructure and business

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[31] MELISSA JONES ET AL., *supra* note 3, at 38.

[32] DR. ARNOLD LEITNER, NATIONAL RENEWABLE ENERGY LABORATORY, FUEL FROM THE SKY: SOLAR POWER'S POTENTIAL FOR WESTERN ENERGY SUPPLY, NREL/SR-550-32106, 45 (July 2002).

[33] U.S. DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, 2001 Residential Energy Consumption Survey, *at* http://www.eia.doe.gov/emeu/recs/contents.html (last visited Feb. 20, 2006).

[34] *Id.*

model. The unique application of solar power as a distributed-generation energy source, combined with the economic benefits it shares with many other renewable energy technologies, supports the need for policies structured specifically for this particular technology.

A. GENERATING POWER LOCALLY TO INCREASE EFFICIENCY AND CUT DOWN ON COST

Unlike most other energy technologies, renewable or otherwise, solar power can generate energy at, or close to, the point of end use. This reduces "the need for an elaborate and costly electric infrastructure [that] deliver[s] power from [distant] central station power plants. The electric [utility] industry and government officials nationwide are considering massive investments to improve the transmission grid to accommodate [even] greater-distance transfers of power set loose by the restructuring of the electric [utility] industry. Nationally, the cost of these investments has been estimated at approximately $50 billion, much of which would be paid for by ratepayers." [35] A 2003 study by regional transmission organizations in the West "estimated the cost of transmission investments in the region at $2.6 billion to $16.7 billion over the next decade."[36] Indeed, in California, energy planners consider the problems associated with transmitting electricity the "most critical infrastructure issue."[37]

In addition to reducing pressure to expand and upgrade expensive transmission infrastructure, generating power locally also improves efficiency. This is because when electricity is generated by a large coal-fired power plant in Utah to provide energy for Southern California, for example, the electrons generated by the power plant must travel across hundreds of miles of transmission and distribution lines to reach the point of end-use – a home or business. In doing so, energy is lost in the form of friction. In fact, roughly seven to ten percent of the energy created by the power plant is "lost" in the process of simply transporting the electrons to the electrical outlet in our home and businesses.[38] In

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[35] In the wake of the East Coast blackout of August 14, 2003, Energy Secretary Spencer Abraham suggested that upgrades to the electric grid could cost as much as $50 billion, noting that "[r]atepayers, obviously, will pay the bill because they're the ones who benefit," as quoted in Ceci Connolly, *Search Is On for Blackout Trigger*, WASHINGTON POST, Aug. 18, 2003.

[36] SEAMS STEERING GROUP-WESTERN INTERCONNECTION, *Informational filing of the California ISO, the RTO West filing utilities, and the Westconnect applicants reporting on activities of the Seams Steering Group – Western Interconnection*, Attachment A at 4 (Oct. 31, 2003) *available at* http://www.ssg-wi.org/documents/315-031031_SSGWI_FINAL_Filing.pdf.

[37] MELISSA JONES ET AL., *supra* note 3, at E-1.

[38] Press Release, OAK RIDGE NATIONAL LABORATORY, DOE's ORNL Part of Initiative for

contrast, electrons generated by a solar panel on the roof of a home or business need to travel only a few feet to reach their final destination. On a large scale, therefore, solar power and other forms of distributed generation improve the efficiency of the entire electrical system.

B. REDUCING PEAK DEMAND

California's electric grid is designed to accommodate peak demand for electricity, even though peak conditions occur for only a few hours each day and only during the summer months. "Smoothing the peaks in electricity consumption, therefore, can reduce the costs of operating the electric system even if the overall amount of electricity consumed does not change."[39] Toward this end, solar power is well-suited to reduce peak demand in California since it generates energy at times it is needed most - during heavy air conditioning use.

Researchers with the National Renewable Energy Laboratory ("NREL") have prepared a study that matched the availability of solar energy resources with utility load patterns.[40] The study found that "in most of California the effective load-carrying capacity ("ELCC") of solar power, which measures the ability of solar to contribute to a utility's capacity at times when it is most needed, is very high."[41] This means that solar power can effectively reduce the amount of generating capacity that California utilities need to respond to peak conditions, thus ultimately saving ratepayers money.[42]

A study by the Public Policy Institute of California found that smoothing system peaks also reduces opportunities for individuals or groups to manipulate power markets to generate excessive profits. Such opportunities multiply when the power system is near capacity. Under those conditions, individual generators can demand – and receive – extremely high prices for power. The California energy crisis of 2000-01 was such an example, with energy companies taking advantage of artificial conditions of scarcity to demand unreasonable prices for power. The energy crisis is estimated to have cost California consumers $40 billion.[43]

Superconducting Transformer (Aug. 31, 1998), *available at* http://www.ornl.gov/info/press_releases/get_press_release.cfm?ReleaseNumber=mr19980831-00.

[39] http://environmentcalifornia.org.

[40] NATIONAL RENEWABLE ENERGY LABORATORY, *Photovoltaics Can Add Capacity to the Utility Grid*, at 11 (Aug. 2004), *available at* http://www.nrel.gov/ncpv/documents/pv_util.html.

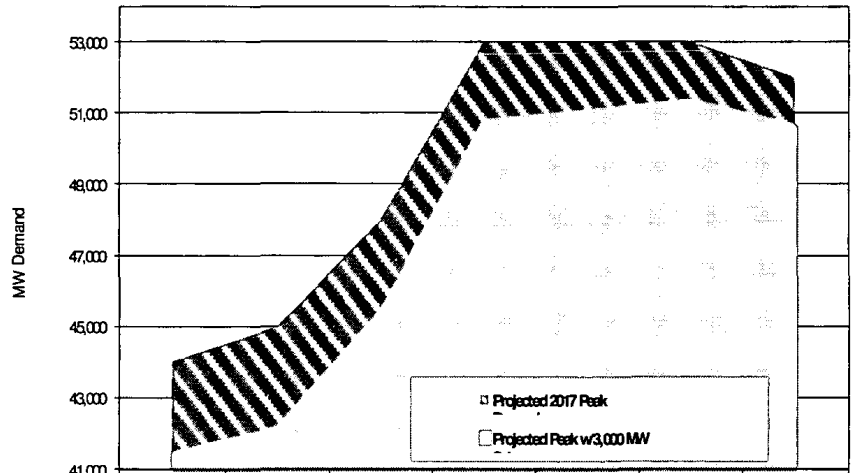
[41] *Id.*

[42] *Id.*

[43] PUBLIC POLICY INSTITUTE OF CALIFORNIA, RESEARCH BRIEF: WHAT CAN BE LEARNED

While it will take years before solar power can prevent the manipulation of California's energy market, aggressively developing distributed-generation resources that are outside the control of large energy companies is a step in the right direction. For example, if California is successful in developing 3,000 additional MW of solar power within the next decade, as called for in the CPUC's California Solar Initiative, the state's peak electricity demand will be reduced by three to five percent.[44] (See Figure 1.)

Figure 1. Impact of 3,000 MW of Solar PV on California's Peak Electricity Demand.



	12	1	2	3	4	5	6
Projected 2017 Peak	44,000	45,000	48,000	53,000	53,000	53,000	52,000
Projected Peak w3,000 MW	41,450	42,150	45,450	50,750	51,050	51,350	50,650

Hours of Day 12 Noon - 6:00 PM

C. PROTECTING AGAINST PRICE VOLATILITY

Volatility in electricity prices has significant economic consequences. Companies or individuals facing unpredictable energy costs must keep extra cash on hand or restrict spending in other areas in

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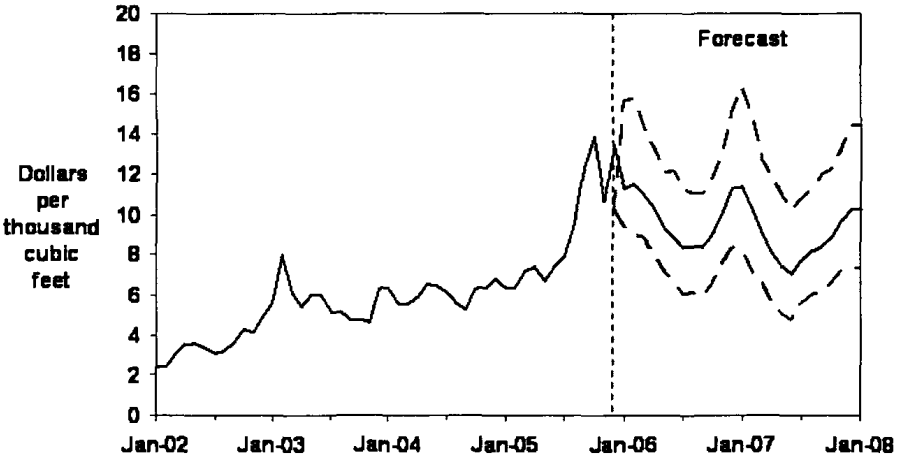
FROM CALIFORNIA'S ELECTRICITY CRISIS ISSUE 66, at 1 (Jan. 2003), *available at* http://www.ppic.org/content/pubs/RB_103CWRB.pdf.

[44] Several assumptions were made by the author in calculating peak electricity demand savings from installing 3,000 MW of solar panels in ten years. First, the author assumes California's electricity demands increase 1.5% per year based on MELISSA JONES ET AL., *supra* note 3, at 39. Secondly, the author assumes the solar photovoltaic panels generate electricity between the hours of 7:00 AM and 7:00 PM, with a maximum 95% output at 1:00 PM that declines by 10% each hour during the afternoon, following the sun as it tracks through the afternoon sky.

order to ensure they can cover their energy costs. As mentioned above, solar power insulates California consumers against price volatility in part by reducing peak demand.

Solar power can also protect consumers by reducing the demand for highly price-volatile natural gas. California's electric system has become heavily reliant on natural gas, the bulk of which is imported, for both baseload and peak demand. Natural gas prices have been extremely volatile in recent years, doubling since 2000,[45] and the U.S. Department of Energy projects that prices will remain high at least through mid-2006. (See Figure 2.) By reducing demand for energy otherwise provided by the statewide electric system, rooftop solar power systems can lessen California's demand for natural gas, thus reducing consumers' exposure to price volatility.

Figure 2. Natural Gas Henry Hub Spot Prices (Base Case and 95% Confidence Interval*)[46]



*The confidence intervals show +/- 2 standard errors based on the properties of the model.

"Historically, the value of solar power has been underestimated, since price predictions rarely consider the possibility of short-term spikes in electricity prices. For example, the actual value of solar power generation in the Sacramento Municipal Utility District in one month during the energy crisis (May 2001) exceeded the predicted value of that

[45] MELISSA JONES ET AL., *supra* note 3, at E-1.

[46] U.S. DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, *Short-Term Energy Outlook January 2006*, http://www.eia.doe.gov/emeu/steo/pub/gifs/Slide4.gif(last visited February 20,2006).

solar generating capacity for the whole year."[47]

D. QUANTIFYING ELECTRIC SYSTEM BENEFITS

Investments in solar power provide direct cost savings and other benefits to utilities and, by extension, consumers. One recent study estimated the potential savings to four utilities from solar power.[48] The study found that the value to utilities ranged from $2,200 to $4,500 per kilowatt of solar power installed, such that the utility could invest that amount in solar power in addition to conventional power at no gain or loss.[49]

Another study, conducted for the Sacramento Municipal Utility District ("SMUD") in 2002, estimated that direct electric system-related benefits of solar power installations, such as grid stability and a lessened need for infrastructure investments, could range from $1,300 to $1,600 per kilowatt.[50] The study also noted that because of the high density of energy consumption within SMUD territory and relatively low levels of transmission and distribution infrastructure required, other utilities with more sprawling developments could experience greater savings in terms of future infrastructure costs.[51]

E. REDUCED AIR POLLUTION

Solar power reduces air pollution that threatens public health and the environment by offsetting the burning of fossil fuels. Each kilowatt of solar power that replaces fossil fuel power in San Diego, for example, is estimated to avert close to a ton of carbon dioxide emissions each year.[52] According to the California Air Resources Board, "in addition, solar power reduces emissions of smog-forming nitrogen oxides and other health-threatening pollutants."[53]

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[47] THOMAS E. HOFF, CLEAN POWER RESEARCH, FINAL RESULTS REPORT WITH A DETERMINATION OF STACKED BENEFITS FOR BOTH UTILITY-OWNED AND CUSTOMER-OWNED PV SYSTEMS 28 (Dec. 10, 2002), *available at* http://www.smud.org/pier/reports/S-034,%201.3.5.2,%2012-02,%20DEL(rev).pdf.

[48] JOSEPH MCCABE & CHRISTY HERIG, ENERGY IDEAS, THE VALUE OF BUILDING INTEGRATED PHOTOVOLTAICS 3.3 (Aug. 11, 2004) *available at* http://www.energyi.mccabe.net/bipvvalues.pdf.

[49] *Id.*

[50] Thomas E. Hoff, *supra* note 47, at 58.

[51] *Id.* at 25.

[52] Calculated using the CEC's CLEAN POWER ESTIMATOR *at* http://www.consumerenergycenter.org/renewable/estimator.

[53] According to the California Air Resources Board ("CARB"), California's power plants

Reducing air pollution can have economic benefits, however difficult to quantify, by reducing "costs attributable to the treatment of air pollution-related illnesses such as asthma."[54] The study conducted for SMUD estimated the range of environmental benefits of solar power at $38 to $1,048 per kilowatt of capacity.[55]

F. LOCAL ECONOMIC BENEFITS

California is a net importer of natural gas, resulting in more dollars being sent out of state than remaining in the local economy. Investments in solar power, on the other hand, create jobs and retain wealth in California. Indeed, solar power creates approximately seven times more jobs per megawatt of capacity than natural gas and more than two times that of a wind farm.[56] (See Table 1.) Investments in solar power would create a market for local businesses that produce, install and maintain solar panels.

Table 1: Employment Rates Per Energy Technology (jobs/MW)

	Construction Employment	Operating Employment	Jobs/MW
Natural Gas	1.02	0.13	1.15
Wind	2.57	0.2	2.77
Geothermal	4	1.67	5.67
Solar Thermal	5.71	0.22	5.93
Landfill/Digester Gas	3.71	2.28	5.99
Solar PV	7.14	0.12	7.26

emit 115 tons per day of nitrogen oxides, the main precursor to smog, and 9 tons per day of sulfur dioxide, per personal email communication with CARB's Stephanie Kato.

[54] EVA Y. WONG ET AL. *Assessing the Health Benefits of Air Pollution Reduction for Children*, ENVIRONMENTAL HEALTH PERSPECTIVES, (Vol. 12, No. 2, Feb 2004), *available at* http://www.ehponline.org/members/2003/6299/6299.pdf.

[55] Thomas E. Hoff, *supra* note 47, at 45 (n.d.).

[56] BRAD HEAVNER & SUSANNAH CHURCHILL, CALPIRG CHARITABLE TRUST, RENEWABLES WORK: JOB GROWTH FROM RENEWABLE ENERGY DEVELOPMENT IN CALIFORNIA 5 (June 2002), *available at* http://www.calpirg.org/reports/renewableswork.pdf.

G. ENERGY INDEPENDENCE

Solar power also contributes to California's – and the nation's – energy independence, reducing the impacts of events and decisions made overseas on the pocketbooks of California consumers. "While the natural gas currently used to fire much of California's [power plants currently] comes from North America, increasing strain in domestic supplies has led some, including [former] Federal Reserve Board Chairman Alan Greenspan, to call for increased imports of liquefied natural gas (LNG) from overseas."[57] These imports may open up a new source of supply to meet growing demand from electric generators and other sources, but new LNG facilities will also be expensive to construct and may lead California and the United States to greater dependence on other nations that supply natural gas.

II. THE CONSUMER BENEFITS OF SOLAR POWER

The benefits of solar power to society are significant and argue for government intervention to promote this technology. But what about the direct costs and benefits to consumers? Will the installation of solar panels on the average new home, for example, result in a net benefit or a net cost to the homeowner? The answer depends on numerous factors, including the cost of a solar power system, electricity prices, government incentives, and future trends in inflation and interest rates. [58]

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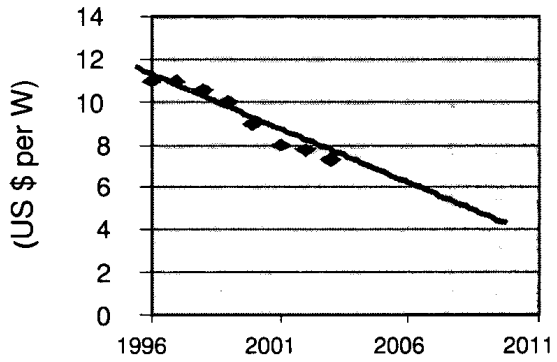
[57] Chairman Alan Greenspan, Testimony at the Federal Reserve Board before the Committee on Energy and Commerce, U.S. House of Representatives (June 10, 2003), *available at* http://www.federalreserve.gov/BoardDocs/testimony/2003/20030610/default.htm.

[58] Key assumptions to the analysis provided in this article include: 1) the solar power "systems to be installed would be 2.5 kilowatts DC, 2.14 kW AC. (Direct current – or "DC" power – is produced by solar panels. The current must then be converted to the alternating current – "AC" – that is commonly used in homes."); 2) electricity costs would escalate at an annual rate of 1.5 percent projected by the CEC (CEC, *California Investor-Owned Utilities Retail Electricity Price Outlook 2003-2013*, Prepared in Support of the Electricity and Natural Gas Report under the Integrated Energy Policy Report Proceeding Docket 02-IEP-01, July 2003) an average mortgage rate of 7.25 percent, based on the average 30-year mortgage rate over the past decade, per the Federal Home Loan Mortgage Corporation; 4) the "average new home will consume an average of 730 kWh of electricity per month," based on projections provided by the CEC; 5) in 2006, the average cost of a solar power "system per kW will be $5,500, and included a 9 percent builder markup, increasing this to $6,000"; 6) "electricity costs in 2006 were based on projections of rates at the state's three main investor-owned utilities made by the CEC, multiplied by estimated monthly consumption as described above, then rounded up to the next increment available in the Clean Power Estimator. Based on the consumption estimates above, these rates translate to an annual $1,200 electric bill for customers of San Diego Gas & Electric, $1,050 for customers of Southern California Edison and $1,000 for customers of Pacific Gas & Electric. Other inputs for the model were household income

A. THE COST OF SOLAR POWER

With the continued help of government programs, solar power is not far "from becoming cost-competitive with fossil fuel power generation, and policies that promote large-scale manufacturing of [solar] cells and associated system parts can help achieve this" goal.[59] The price of solar power has declined four percent annually over the past fifteen years as global demand for solar power has skyrocketed, increasing by twenty-five percent annually over the same period of time.[60] In 2004, the installed cost of solar power in California shows an average cost of $8/Watt (W) and a trajectory toward achieving $7/W or less in the years ahead. (See Figure 3.) Until the cost of solar power is reduced by an additional fifty percent, however, government subsidies are necessary to make investing in solar power cost-effective for the California consumer.

Figure 3. Trend in Price in Residential Grid-Connected Solar Power Systems[61] (1992-2003 actual, 2004-2008 projected)



(assumed to be $110,000), tax filing method (married, filing jointly), and the slope and direction of the PV system (30 degrees, south-facing). For further discussion of the assumptions of this analysis *see* BERNADETTE DEL CHIARO, TONY DUTZIK & JASMINE VASAVADA, ENVIRONMENT CALIFORNIA RESEARCH & POLICY CENTER, THE ECONOMICS OF SOLAR HOMES IN CALIFORNIA: HOW RESIDENTIAL PHOTOVOLTAIC INCENTIVES CAN PAYOFF FOR HOMEOWNERS AND THE PUBLIC (Dec. 2004), *available at* http://www.environmentcalifornia.org/reports/economicssolarhomes.pdf.

[59] http://environmentcalifornia.org

[60] Solarbuzz, *Fast Solar Energy Facts* (June 2004), *at* http://www.solarbuzz.com/FastFactsIndustry.htm.

[61] BERNADETTE DEL CHIARO, TONY DUTZIK & JASMINE VASAVADA, ENVIRONMENT CALIFORNIA RESEARCH & POLICY CENTER, THE ECONOMICS OF SOLAR HOMES IN CALIFORNIA: HOW RESIDENTIAL PHOTOVOLTAIC INCENTIVES CAN PAYOFF FOR HOMEOWNERS AND THE PUBLIC 15 (Dec. 2004), *available at* http://www.environmentcalifornia.org/reports/economicssolarhomes.pdf.

The cost of a solar power system can be broken down into three areas: the cost of the solar panels (or modules), the cost of other components (such as inverters and meters), and installation costs. The cost of solar modules represents sixty percent of the cost of an installed solar power system, while the cost of the other components and the installation represent approximately forty percent of the total cost. (See Table 2.) There are only a few, if any, maintenance costs associated with most solar power systems.

Table 2. Breakdown of Solar Power System Costs[62]

Cost component	% of Total
Solar module	60%
Balance of system (equipment only)	25%
System design and installation	15%

B. THE INFLUENCE OF LOCATION

Location within California can play a significant role in the economic merits of solar power. According to a report by the California Energy Commission, "[t]his [role] manifests itself in two ways. First, the degree to which a California home outfitted with [solar power] can take advantage of solar energy depends partially on the availability of the solar resource. While all of California generally has access to a strong solar resource, the quality of the resource [varies] from place to place within the state."[63] Fortunately, as seen in Table 3, many of the areas experiencing the greatest growth in terms of new housing developments are also the areas best known for hot weather and large amounts of sunshine throughout the year.[64]

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[62] Public Renewables Partnership Website, *Solar PV Cost Factors*, *at* http://www.repartners.org/solar/pvcost.htm (last visited Feb. 20, 2006).

[63] For a more detailed discussion of solar power potential in California by region, *see* GEORGE SIMONS & JOE MCCABE, CEC, CALIFORNIA SOLAR RESOURCES (CEC-500-2005-072-D, April 2005), *available at* http://energy.ca.gov/2005publications/CEC-500-2005-072/CEC-500-2005-072-D.PDF.

[64] *California Construction Review Private Building Construction* (Construction Industry Research Board, Burbank, CA.), May 27, 2004.

Table 3. Top Ranking California Cities for Population Change: 2003 to 2004

Rank	City	County	2003 Total Population	2004 Total Population	Numeric Change
1	LOS ANGELES	LOS ANGELES	3,859,400	3,912,200	52,800
2	ELK GROVE	SACRAMENTO	85,900	109,100	23,200
3	SAN DIEGO	SAN DIEGO	1,281,400	1,294,000	12,600
4	BAKERSFIELD	KERN	268,900	279,700	10,800
5	MURRIETA	RIVERSIDE	68,200	77,700	9,500
6	CHULA VISTA	SAN DIEGO	200,700	209,100	8,400
7	FONTANA	SAN BERNARDINO	146,500	154,800	8,300
8	SACRAMENTO	SACRAMENTO	433,400	441,000	7,600
9	RANCHO CUCAMONGA	SAN BERNARDINO	147,400	154,800	7,400
10	IRVINE	ORANGE	164,800	171,800	7,000
11	LONG BEACH	LOS ANGELES	480,400	487,100	6,700
12	SAN JOSE	SANTA CLARA	919,600	926,200	6,600

A second influence on the viability of solar power in California is the impact of varying electricity rates and utility rate structures among California's various electric utility companies throughout the state. "Consumers with higher electric rates benefit more from [solar power] because each kilowatt-hour of power that is generated from their solar power system is a kilowatt-hour that does not have to be purchased. In addition, some California utilities allow consumers to choose time-of-use pricing in which consumers are charged lower rates during" off-peak hours and higher rates during peak hours.[65] Some utilities also have "tiered" rate structures in which consumers pay lower rates below a certain level of usage and substantially higher rates for every unit of power consumed above that threshold. When combined with net metering, which involves the solar power system getting a credit for the excess electricity generated by the system (see Section III), these rate policies can make solar power more advantageous for certain types of consumers – for example, those who consume large amounts of power during peak daytime periods or those who have high monthly electricity

[65] http://environmentcalifornia.org.

consumption and must therefore purchase power at higher rate tiers.[66]

For California's fastest growing communities, the financial characteristics of solar power are the same: a typical 2.5 kW system – a size that typically would be expected to generate at least half of the home's electricity needs – is estimated to cost approximately $20,000. After a buy-down grant of $7,000,[67] the net cost to the homeowner is $13,000. Moreover, in 2006 and 2007, homeowners can deduct up to $2,000 (or thirty percent of the net cost of the solar power system, whichever is less) from their federal income tax returns the year they purchased their solar power system.[68] For many, this will bring the net cost of the system down to approximately $11,000.

Assuming the data inputs above and further assuming the upfront cost of the solar power system is rolled into a tax-deductible low-interest home loan or mortgage, homeowners in California's fastest growing communities would achieve a net economic benefit from their solar investment (as shown in Table 4) within the first month of owning the system. For example, a new homeowner living in San Jose could expect to see their monthly mortgage payments increase by $44 while their monthly electric bill would decrease by $57, leaving the homeowner with a net $13 in savings.

Over a 30-year time period, the average benefit in terms of cumulative cash flow is approximately $4,500 and "simple payback" (the time it takes for an investment to "pay for itself") can be expected within ten to twelve years. Therefore, while a $2,800/kW state incentive might be sufficient to put consumers in the black for their solar investment, it is not likely to generate a substantial windfall for consumers, especially if the cost of inverters (which likely would need replacement at least once during the lifetime of the PV system), does not decline significantly in the coming years as discussed below. That said, as the cost of electricity

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[66] *Id.*

[67] A buy-down grant is a one-time rebate that is used to off-set the upfront costs of a newly installed solar power system. In California, this rebate is valued at $2,000/kW or $7,000 for a 2.5 kW system. These rebates are generated from a small surcharge on monthly electric bills levied on all customers.

[68] In August 2005, Congress passed the Federal Energy Policy Act and President Bush signed it into law. Among many provisions contained in this new law, Congress established a federal income tax credit for homeowners and businesses investing in solar energy systems. The credit is worth 30% of the cost of the solar power system, or up to $2,000 (which ever is less) for residential solar power systems installed in 2006 and 2007. Businesses installing solar power systems can also receive a 30% credit for these two years with no upper cap. After 2007, the credit is reduced to 10% for business installations with no sunset. For details on this credit *see* SOLAR ENERGY INDUSTRY ASSOCIATION, FREQUENTLY ASKED QUESTIONS ON THE NEW FEDERAL SOLAR TAX CREDITS, *at* http://www.seia.org/getpdf.php?iid=21 (last visited Feb. 20, 2006).

continues to rise in California, the value of solar power will continue to rise, giving consumers an ever greater return on their initial investment.

Table 4. Estimated Economic Benefits of 2.5kW (DC) Solar Power System for Purchaser of New Home in 2007. [69]

	Monthly Electric Bill Savings (year 1)	Net Monthly Loan Payment (after tax)	Year 1 Savings	Cumulative Cash Flow (30 yrs.)	Net Present Value
San Jose	$57	$44	$152	$7,662	$2,722
Bakersfield	$53	$44	$100	$5,718	$1,989
San Diego	$54	$44	$122	$6,534	$2,296
Murrieta	$47	$44	$32	$3,144	$1,018
Fontana	$46	$44	$20	$2,702	$851
Rancho Cucamonga	$46	$44	$20	$2,702	$851
Irvine	$49	$44	$58	$4,116	$1,384
Long Beach	$49	$44	$58	$4,116	$1,384
Chula Vista	$49	$44	$52	$3,910	$1,307

C. SYSTEM LIFETIME

The California Solar Center has found that "[t]he above analysis assumes that solar [power] systems and all their components last for the life of the loan used to finance them: 30 years. For [solar] modules, this assumption appears warranted; most modules come with a 20-year warranty for power production and can be expected to continue to produce power reliably beyond the expiration of the warranty."[70] This finding was reaffirmed by an NREL study that also found that "[w]arranties of 25 years for crystalline silicon PV modules are not uncommon."[71]

"The same long life-spans are not shared by all elements of the [solar power system.] Inverters, which convert the direct current

[69] BERNADETTE DEL CHIARO, *supra* note 58, at 18.

[70] California Solar Center, *PV Project Gallery: Grid-Tie Applications*, *at* http://www.californiasolarcenter.org/pvgallery1.html (last visited Feb. 21, 2006).

[71] JOHN H. WOHLGEMUTH, U.S. DEPT. OF ENERGY, NATIONAL RENEWABLE ENERGY LABORATORY, *Long Term Photovoltaic Module Reliability, National Center for Photovoltaics and Solar Program Review Meeting Proceedings*, 179 (NREL/CD-520-33586, 2003), *available at* http://www.nrel.gov/ncpv_prm/pdfs/33586015.pdf.

generated by [solar power] modules into alternating current used in households, have been plagued by short lifetimes and the need for frequent replacement. The industry has set a short-term goal of improving the average lifespan of inverters to ten years or more."[72] The current generation of inverters has a life span of at least seven to nine years, and recent advances in inverters suggest further improvements along these lines in the years to come.[73] Even so, solar power "system owners can expect to replace the inverter at least once during the thirty-year lifespan of their system."[74]

Presently, inverter prices average $0.83 per continuous Watt – translating to about $2,000 for an inverter serving the 2.5 kW system modeled in Table 4.[75] Over the coming ten years, "inverter prices can be expected to [decline] significantly. An European study has estimated that it is technically possible to reduce the cost of inverters by roughly half."[76] Should that cost-reduction target be achieved by 2016, the cost of a replacement inverter would reduce [total savings] for the consumer by somewhat more than $1,000 in today's dollars. The impact of inverter replacement expense could also be reduced if lifetimes are extended beyond 10-15 years, if technological improvements bring about a breakthrough in inverter costs, or if future inverters run at [a] higher efficiency than today's models.[77]

Factoring in the cost of replacing the inverter, California homeowners will still see a return on their investment, assuming availability of net metering and an upfront rebate, of $2.80 per watt as provided by the state of California's Emerging Renewable Program.

D. NON-QUANTIFIABLE BENEFITS

"In addition to the direct costs or savings to consumers from the

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[72] SIGIFREDO GONZALES, CHRIS BEAUCHAMP, WARD BOWER, JERRY GINN, & MARK RALPH, U.S. DEPT. OF ENERGY, NATIONAL RENEWABLE ENERGY LABORATORY, *PV Inverter Testing, Modeling and New Initiatives, National Center for Photovoltaics and Solar Program Review Meeting Proceedings*, 537 (NREL/CD-520-33586, 2003) *at* http://www.nrel.gov/ncpv_prm/pdfs/33586072.pdf.

[73] BERNADETTE DEL CHIARO, *supra* note 58, at 21.

[74] http://environmentcalifornia.org.

[75] Solarbuzz, *Inverter Price Environment*, Sept. 13, 2004, *available at* http://www.solarbuzz.com/Inverterprices.htm.

[76] GERRIT JAN SCHAEFFER, ET AL., ENERGY RESEARCH CENTRE OF THE NETHERLANDS, LEARNING FROM THE SUN: ANALYSIS OF THE USE OF EXPERIENCE CURVES FOR ENERGY POLICY PURPOSES: THE CASE OF PHOTOVOLTAIC POWER. FINAL REPORT OF THE PHOTEX PROJECT 68 (ECN-C-04-035, Aug. 2004), *available at* http://www.nrel.gov/ncpv/thin_film/docs/photex-final-report.pdf. (EU supported project).

[77] http://environmentcalifornia.org.

installation of [solar power systems], consumers also achieve economic benefits from their ability to hedge against future increases in electricity prices and price volatility. A Californian who buys a solar home is effectively able to lock in his or her" electric rates for at least thirty years since the energy generated from the solar power system will not become more expensive than the initial investment.[78] The opposite is expected for utility electric rates. "A rate spike such as that which occurred in San Diego at the outset of the energy crisis of 2000-2001, for example, would yield significant relative benefits for [solar power system] owners in very short order."[79] At a time of increased uncertainty over the future of fossil fuel supplies, as well as the competitiveness of the electric power system overall, this protection against uncertainty would likely have significant value for consumers.[80]

E. SPECIAL FINANCING OPPORTUNITIES

Finally, solar "homes may qualify for special financing available for [energy-efficient] and clean energy homes. Because the upfront investment in a solar home results in lower electricity bills down the line, a number of lenders will grant mortgages that take into account the positive cash flow that homeowners will experience over the life of the system."[81] Major lenders, such as Fannie Mae and Freddie Mac, as well as a host of specialized firms, grant energy-efficient mortgages or clean energy mortgages.[82] "If the solar [power] investment is structured (through buy-downs and other incentives) to result in consumer savings, banks may allow the homeowner to have a larger mortgage and [higher] monthly mortgage [payments] than [normally] would be allowed for his or her income level, increasing the size of mortgages available to Californians purchasing energy-efficient homes. Most banks do not aggressively market clean energy mortgages," nevertheless, these potentially significant tools are available to help new homeowners

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[78] *Id.*

[79] Nancy Vogel, *How California Consumers Lost With Electricity Deregulation*, LOS ANGELES TIMES, Dec. 9, 2000, *at* http://www.commondreams.org/headlines/120900-01.htm.

[80] http://environmentcalifornia.org.

[81] CEC, RESIDENTIAL FINANCING OPTIONS FOR RENEWABLE ENERGY SYSTEMS (CEC, P500-03-031F), *at* www.energy.ca.gov/renewables/marketing/2004-05_RESIDENTIAL_FINANCE.PDF (last visited Feb. 21, 2006).

[82] MARK VON TOPEL, POWER SHIFT, RESIDENTIAL SOLAR FINANCING: HOMEOWNERS SAVE, BANKS PROFIT 4 (2002), *available at* http://www.millionsolarroofs.org/articles/static/1/binaries/PHIL%20FINAL%20VERSION%20SOLAR%20REPORT.pdf.

maximize the value of their solar power systems.[83]

Despite the unique benefits of solar power as a distributed-generation resource, state and federal government have, until now, made relatively slow progress in bringing about a mainstream solar market. In stark contrast to the past fifty years, California's Million Solar Roofs campaign and the resulting California Solar Initiative have set the stage for solar power to become a cost-effective and mainstream energy technology within the foreseeable future. Before discussing this new initiative, it is helpful to have a good understanding of the policies that pre-date the California Solar Initiative and that have helped, at the very least, to keep the solar power market alive over the past thirty years.

III. BRIEF HISTORY OF POLICIES DESIGNED TO DRIVE CONSUMERS TOWARD SOLAR POWER

In 1955, at the first World Symposium on Applied Solar Energy, Vice President of the Radio Corporation of America ("RCA"), Dr. Irving Wolff, stressed the importance of mass production of solar power to achieve future cost reductions. He compared the potential for future development of solar power with the development of communications technologies that became cost effective once mainstream applications were developed.[84] Despite Dr. Wolff's confidence that "industrialists and scientists" would cooperate to make solar power economical, fifty years passed before California became the first state to adopt a program specifically aimed at achieving this very goal.[85]

In the years since 1955, the solar power market has been, by and large, geared toward calculators and other "off-grid" applications such as roadside signs, rural villages, homes, and oil pipelines not easily serviced by grid-supplied electricity. California and the United States government kept the potential for a more mainstream market for solar power alive through a handful of policies, primarily focused on providing consumers financial incentives to invest in solar power.

The initial push for solar power came after the oil crisis of the 1970s when both the federal and state governments turned in earnest to developing conservation, efficiency, and alternative energy resources.[86]

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[83] *Id.* at 4.

[84] ISES 2005 Solar World Congress, *Final Session of the World Symposium on Applied Solar Energy – A summary*, at 300, *available at* http://www.swc2005.org/1955/1955-26.pdf (last visited Feb. 21, 2006).

[85] *Id.*

[86] Charles Smith, *History of Solar Energy*, TECHNOLOGY REVIEW: July 1995, *available at* http://www.solarenergy.com/ws400CS.cgi?category=info_history.html&cart_id= (last visited Feb.

The most influential of these government-led efforts were federal tax credits established in 1978 under President Jimmy Carter and state tax credits established under California Governor Jerry Brown. From 1980 to 1983, for example, California homeowners could claim a state tax credit worth up to $3,000 for any solar energy system installed on their homes.[87] As a result, demand for solar power grew rapidly. By 1984, more than 19,000 people were employed as solar installers in California, and the industry was growing rapidly.[88]

These early policies of the Carter and Brown Administrations, however, were not permanent. In the 1980s, just as the solar industry was becoming established, the price of oil fell and with this came a lack of interest on the part of government to maintain the new solar programs. In 1985, the federal tax credit expired and was not renewed by President Ronald Regan. A few years later, California Governor George Deukmejian terminated the state tax credit as well.

This sudden collapse in government support for a budding market caused a 2,000 percent drop in annual revenue for California's solar industry from an estimated $475 million to $20 million in just two years.[89] The solar industry retreated from the larger, urban markets and settled down into California's northern counties, targeting the "do-it-yourselfers" and "off-grid hippies" for the next fifteen years.

Not until the mid-1990s when rising energy prices and fossil fuel supply limits began to resurface - this time for natural gas - did California policymakers look again to solar power as a way of easing demand and lowering energy costs. In 1995, California passed its first net metering law, Senate Bill 656, establishing a key financial driver for homeowners to invest in small solar power systems (under 10 kilowatts) cost-effectively.[90]

Net metering remains a key financial incentive for investing in solar. Namely, when a solar power system generates more electricity than is being consumed at any given time, the extra electricity is fed back to the grid for use by other utility customers.[91] In California, and in

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21, 2006).

[87] DANIEL M. BERMAN & JOHN T. O'CONNOR, WHO OWNS THE SUN?: PEOPLE POLITICS AND THE STRUGGLE FOR A SOLAR ECONOMY 256 (Chelsea Green Publishing 1996).

[88] *See id.* at 77.

[89] *See id.* at 33.

[90] S.B. 656, 1996 Leg., 1995-96 Sess. (Cal. 1995), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_656&sess=9596&house=B&author=senator_alquist_(coauthor:_assembly_member_takasugi) (last visited Feb. 21, 2006).

[91] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

many other states, grid-connected solar power system owners can sign up to receive a credit for their excess solar power valued at a retail rate.[92] This structure is known as net metering because the electric meter literally runs both directions, measuring the net amount of electricity drawn from the grid. If, over the course of a month, the solar power system owner generates more electricity "than he or she consumes, the credit can be rolled forward to the next month for up to a year."[93] In this way, the electric grid acts like a giant battery, storing excess electricity for use during times when the sun is down or clouded over. It also encourages conservation and efficiency since the greater the amount of electricity sent back to the grid, the more a homeowner saves.

It would be another seven years, just after the 2000-2001 energy crisis, before the Legislature would extend net metering to large-scale commercial projects.[94] A year later, with Assembly Bill 58, the California Legislature would remove the 2002 sunset on net metering, but replace it with a cap equal to one half of one percent of a utility's total aggregate peak demand.[95] In other words, any homeowner or business interested in benefiting from net metering can do so up until the point that one half of one percent of their utility's total peak load comes from solar power.[96] This cap on net metering still exists today in the state's two largest utility districts, Pacific Gas & Electric in northern California and Southern California Electric in southern California. The cap was reached in San Diego Gas & Electric territory in 2005 but lifted slightly with the passage of Senate Bill 816.[97]

In addition to net metering, California has also created significant growth in the solar market via direct financial incentives, namely ratepayer-funded buy-down grants. In 1996, California created a $180 million solar rebate program for small-scale solar power systems (under

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[92] *See* Database for State Incentives for Renewable Energy for complete list of state by state incentives for solar power, *available at* http://dsireusa.org/.

[93] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

[94] *See* A.B. X1 29, 2002 Leg., 1st Ex. Sess. 2001-02 (Cal. 2001) (extending net metering to large-scale commercial projects installed by 2002), *available at*, http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=abx1_29&sess=0102&house=B&author=kehoe (last visited Feb. 21, 2006).

[95] A.B. 58, 2002 Leg., 2001-02 Sess., (Cal. 2002), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_58&sess=0102&house=B&author=keeley (last visited Feb. 21, 2006).

[96] *Id.*

[97] S.B. 816, 2006 Leg., 2005-06 Sess. (Cal. 2005), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_816&sess=CUR&house=B&author=kehoe (last visited Feb. 21, 2006).

30 kW in size) installed primarily on homes. The new solar rebate program, run by the California Energy Commission ("CEC"), came about via the state's electric deregulation law, Assembly Bill 1890.[98] In 2002, facing increased demand for solar power from homeowners and businesses that was spurred largely by the blackouts of 2000-01, the Legislature passed Senate Bill 1038, extending the original rebate program established with Assembly Bill 1890 through 2007 and allocating an additional $118 million for small scale solar.[99] To date, more than $371 million has been spent in direct consumer rebates for small solar power systems installing more than 60 MW of solar power on more than 15,000 buildings, primarily homes.[100]

In 2000, Assembly Bill 970 called for the creation of a similar rebate program, called the Self-Generation Incentive Program ("SGIP"), for large-scale installations (between 30 kW and ultimately limited to 1 MW). [101] In complying with this new law, in 2001 the CPUC authorized spending $138 million on incentives for large distributed-generation technologies, including solar power.[102] In late 2003, Assembly Bill 1685 extended the SGIP through 2007 and added $500 million to the program.[103]

By lowering prices and growing demand, both of these direct consumer rebate programs have been major drivers of California's modern solar power program. This "'demand-pull' approach allows the

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[98] A. B. 1890, Leg. 1996, 1995-1996 Sess (Cal. 1995), available at http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_1890&sess=9596&house=B&author=assembly_member_brulte_(principal_coauthors:_assembly_members_conroy,_kuykendall,_and (last visited Feb. 21, 2006).

[99] S. B. 1038, 2002 Leg., 2001-2002 Sess. (Cal. 2002), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1038&sess=0102&house=B&author=sher (last visited Feb. 21, 2006).

[100] CPUC, DRAFT DECISION, INTERIM ORDER ADOPTING POLICIES AND FUNDING FOR THE CALIFORNIA SOLAR INITIATIVE 3 (Mailed Dec. 13, 2005), *available at* http://www.cpuc.ca.gov/word_pdf/AGENDA_DECISION/52719.pdf.

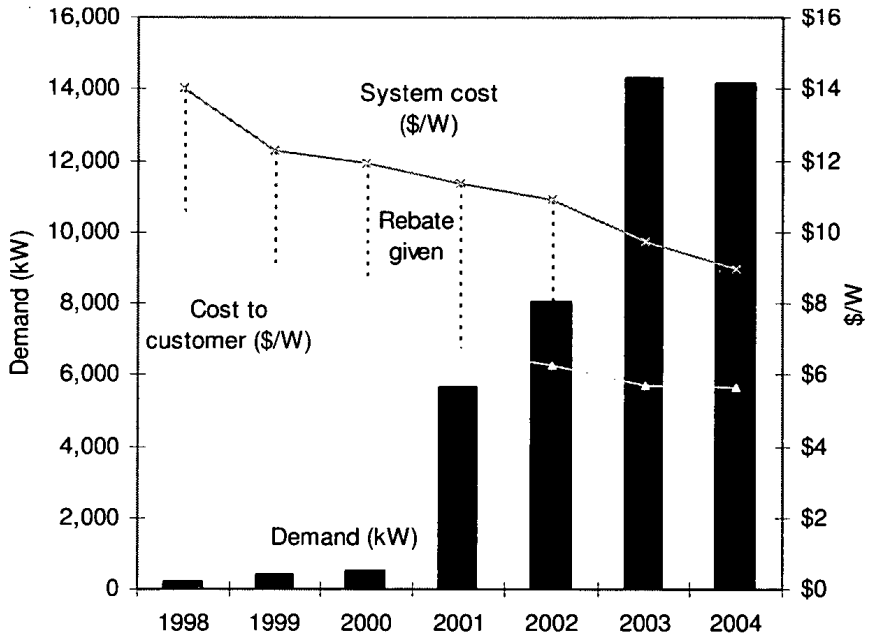
[101] A.B. 970, 2000 Leg., 1999-2000 Sess. (Cal. 2000), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_970&sess=9900&house=B&author=ducheny (last visited Feb. 21, 2006).

[102] CPUC, INTERIM OPINION: IMPLEMENTATION OF PUBLIC UTILITIES CODE SECTION 399.15(B), PARAGRAPHS 4-7; LOAD CONTROL AND DISTRIBUTED GENERATION INITIATIVES 1 (Decision 01-03-073, March 27, 2001), *available at* http://www.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/6083.DOC.

[103] A.B. 1685, 2004 Leg., 2003-04 Sess. (Cal. 2003), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_1685&sess=PREV&house=B&author=leno (last visited Feb. 21, 2006).

industry to sort through the best way to supply the market," allowing the companies with the most promising technologies and optimal structure to compete successfully for market share.[104] This, in turn, leads to cost reductions, making the incentives less needed and putting solar power in a stronger position over time.[105] During the past seven years, annual demand for solar incentives has risen steadily despite the periodic reduction in the value of the rebate currently at $2.80/Watt.[106] (See Figure 4.)

Figure 4. Residential Retrofit Solar Power Cost and Demand in CEC's Emerging Renewables Program



This brief history of California's solar market, and the state level policies that have largely driven it, confirms that increasing demand via government-supported consumer incentives can have a positive downward effect on prices. Economists call this effect *experience curves*, or *progress ratios*—the concept "that price reductions

[104] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

[105] *Id.*

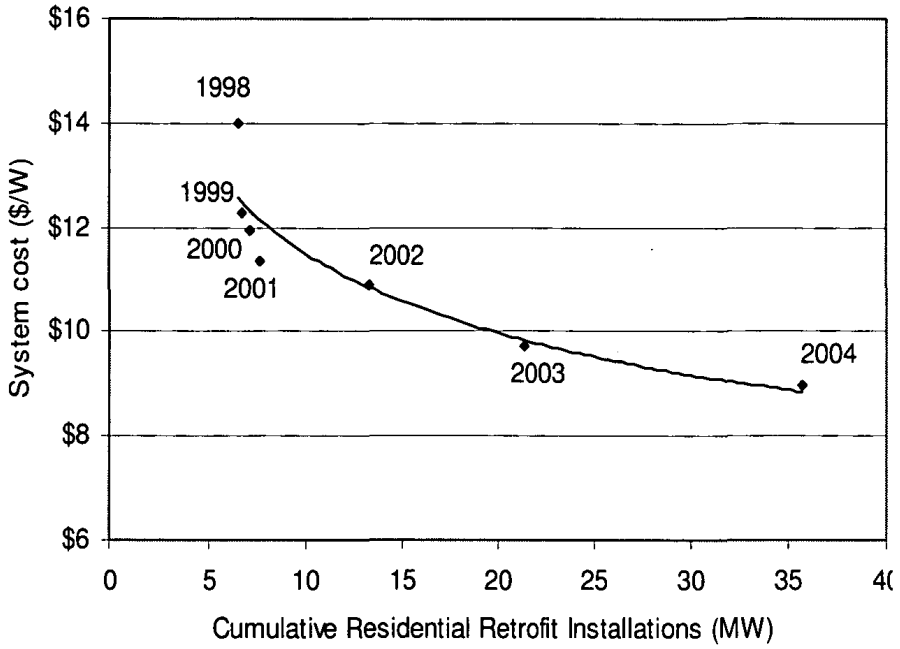
[106] CEC Emerging Renewables Program, *Data Showing Approved and Completed Systems* Pre-2005, *at* http://www.energy.ca.gov/renewables/emerging_renewables/2005-11-02_pre_1_1_2005_pc.xls; *and* post 2005 *at* http://www.energy.ca.gov/renewables/emerging_renewables/2005-12-13-post_1_1_2005_update.xls.

accompany increasing cumulative installations at a steady rate."[107] (See Figure 5.) It is important to note that these price reductions have "been due not only to installations in California, but also to [solar] modules and inverters manufactured to meet global demand," as discussed in greater detail in Section II, *supra*. In fact, "to fully understand how installations in California can affect prices, one must apply two *experience curves* to two separate groups of solar products – those components of the system that are commodities supplied globally and those components and services that are primarily local."[108] That said, California demand is significant, in and of itself, "because the state is already the world's third-largest market for solar installations (after Japan and Germany), and because giving incentives in California can have an especially large impact on cost reductions in aspects of [solar power] systems that are more specific to California, such as installation costs." (*See* Figure 7 in Section V, *infra*.)

[107] "Economists have long noted that, for many products across many industries, per unit costs decline in relation to cumulative production. This has led to the study of what economic theory calls experience curves, which are based on the basic idea that the cost of producing an object goes down as production levels increase due to the accumulated knowledge that comes from experience. This encompasses cost reductions that result from a wide range of factors including production improvements, product development, and decreases in the costs of inputs (like parts and materials)." For a more detailed discussion of the application of experience curves and progress ratios to energy technologies, *see* RICHARD DUKE & DANIEL KAMMEN, THE ECONOMICS OF ENERGY MARKET TRANSFORMATION PROGRAMS 15-64 (THE ENERGY JOURNAL, 20(4):1999), *available at* http://ist-socrates.berkeley.edu/~kammen/dukekammen.pdf; CHRISTOPHER HARMON, EXPERIENCE CURVES OF PHOTOVOLTAIC TECHNOLOGY 8 (International Institute for Applied Systems Analysis, Interim Report IR-00-014, Mar. 30, 2000), *available at* http://www.iiasa.ac.at/Publications/Documents/IR-00-014.pdf; GERRIT JAN SCHAEFFER, ET. AL, LEARNING FROM THE SUN: ANALYSIS OF THE USE OF EXPERIENCE CURVES FOR ENERGY POLICY PURPOSES: THE CASE OF PHOTOVOLTAIC POWER. FINAL REPORT OF THE PHOTEX PROJECT (Energy Research Centre of the Netherlands ECN-C-04-035, Aug. 2004), *available at* http://www.nrel.gov/ncpv/thin_film/docs/photex-final-report.pdf.

[108] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

Figure 5. Decreasing Installed Cost ($/W) of Solar Power as Cumulative Residential Retrofit Capacity Increased in California



In addition to the direct consumer rebate programs established in 1996 and 2000, California has established a few other key policies designed to drive demand for solar power. In 2001, for example, Governor Gray Davis called for an extraordinary session to deal strictly with electricity supply shortages that struck the state during the 2000-01 California energy crisis. During the legislative session, a state tax credit was created, allowing a 15% income credit from 2001 through 2003 and a 7.5% credit from 2004 through 2005.[109] The credit expired January 1, 2006, and while there was an effort to extend the credit through 2016, in one of the earlier versions of the 2005 Million Solar Roofs bill, Senate Bill 1, the provision was later dropped from the bill.[110] Another policy developed in 2005 through Assembly Bill 1099, which excluded all new solar energy systems from property tax assessments through 2009.[111]

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[109] S. B. 17, 2001 2nd Ext. Sess. 2001-2002 (Cal. 2001), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sbx2_17&sess=0102&house=S&author=brulte.

[110] S.B. 1, 2006 Leg., 2005-06 Sess. (Calif. 2005) (as amended Feb. 28, 2005), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1&sess=CUR&house=B&author=murray (last visited Feb. 21, 2006).

[111] A.B. 1099, 2006 Leg., 2005-06 Sess. (Cal. 2005), *available at*

The Legislature has also turned its attention to state-owned buildings, passing Senate Bill 82x in 2001. This bill requires solar energy systems to be installed where cost-effective, on all new and existing state buildings and parking facilities by 2007.[112]

As a result of these various solar incentive programs over the past decade, coupled with external drivers such as the rolling blackouts of 2000-2001, demand for solar power has grown substantially. In fact, the state's residential rebate program recently came close to running out of funds, and in 2005 the rebate program for large-scale commercial projects had to create a waitlist when funds ran out mid-way through the year.[113] As a result, on December 15, 2005, the CPUC unanimously approved adding $300 million to the large-system rebate program to cover waitlisted projects and new projects in 2006.[114]

Ultimately, the best way for California to not only increase the amount of solar-powered homes and businesses throughout the state, but also lower the price of solar power to the point at which government incentives are no longer needed, is to commit to long-term market development programs. These programs must "include financial incentives and new construction design policies. Experience in California and in other countries, especially Japan, has shown that such government programs can lead to increased demand, lowered prices, and, ultimately, a robust, self-sufficient solar market in which government incentives are no longer necessary."[115] The next section describes Japan's highly successful solar rebate program, on which California's Million Solar Roofs initiative is largely modeled.

IV. HOW INCENTIVES HELPED BUILD THE SOLAR INDUSTRY IN JAPAN

Long before Enron and other energy traders would learn to manipulate California's electricity market, causing severe energy

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http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_1099&sess=CUR&house=B&author=leno (last visited Feb. 21, 2006).

[112] S.B. X2 82, 2nd Ex. Sess. 2001-02 (Cal. 2001), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sbx2_82&sess=0102&house=B&author=murray (last visited Feb. 21, 2006).

[113] CPUC, INTERIM ORDER ADOPTING POLICIES AND FUNDING FOR THE CALIFORNIA SOLAR INITIATIVE 8 (Supercede Prior Version Mailed Nov. 15, 2005) *available at* http://www.cpuc.ca.gov/word_pdf/COMMENT_DECISION/51180.doc.

[114] Press Release, CPUC, PUC Increases Funding For Solar Technologies (Dec. 15, 2005), *available at* http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/52080.htm.

[115] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

shortages and unprecedented price spikes, Japan apparently recognized the value of solar power and decided to invest heavily in developing a cost-effective solar power market. In the early 1990s, the Japanese government decided to invest heavily in alternative energy and, specifically, solar power as a means of bringing the oil-less country greater energy independence and reducing the threat of global warming for the island-nation.[116]

From the beginning, the Japanese recognized that the best way to lower the cost of solar power systems was to stimulate demand and develop manufacturing capacity. The logic being that if the solar industry installs 100 MW of solar power capacity over a year time period, it will learn more about how to do it better and for less money than if it installs just 50 MW during the same amount of time.[117] "Conversely, no matter how much time passes, if the industry does not install any more systems, then very little progress will be made toward reducing costs."[118]

In 1994, therefore, Japan set a target of installing 400 MW of solar capacity by 2000 and 5,000 MW by 2010.[119] The primary vehicle for achieving these targets was the residential solar incentive program.[120] Unlike other government-sponsored programs that only focus on industry development, such as the programs that dominated the Clinton Administration during the same time-period, this program aimed to build the industry through increased total installed capacity.

As a result, Japan today enjoys a predominant position in both producing electricity from solar energy and supplying the growing worldwide market for solar power.[121] "With 47.5 percent of the world's

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[116] MARK BOLINGER AND RYAN WISER, Berkeley Lab and the Clean Energy Group, *Case Studies of State Support for Renewable Energy: Support for PV in Japan and Germany* (Sept 2002).

[117] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf

[118] *Id.*

[119] PETER HOLIHAN, TECHNOLOGY, MANUFACTURING, AND MARKET TRENDS IN THE U.S. AND INTERNATIONAL PHOTOVOLTAICS INDUSTRY, (Renewable Energy 2002: Issues and Trends, Feb. 2001) http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/solar.html.

[120] "The residential photovoltaic incentive program has gone by many different names and slight variations in the past 10 years. Some of these names include: The Ten Thousand Roofs Program, the 70,000 Roofs Program, the New Sunshine Program, the Building Integrated Photovoltaic Program (the BIPV Program), the Subsidy Program for Residential Applications, the Residential PV Systems Dissemination Program, and the Residential PV System Monitoring Program. These programs have consistently been supported by the Japanese Ministry of Economy, Trade and Industry (METI). However, prior to 2000 METI was named the Ministry of International Trade and Industry (MITI). METI works in close alliance with the New Energy and Industrial Technology Development Organization (NEDO) to supervise development of the solar power in Japan." (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

[121] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

installed photovoltaic capacity in 2003, Japan converts more solar energy into electricity than any other country in the world."[122] Japan's solar capacity "far surpasses the second and third largest solar countries: Germany has 22.7 percent of global photovoltaic capacity and the United States has 15.2 percent."[123] Japan also leads the way in terms of installed capacity per capita.[124]

The Japanese program has been highly successful. The original goal of Japan's solar program "was to equip 70,000 homes with 3 kWp systems by 2000 and to install building-integrated [solar power] systems on half of [all] new homes by 2010."[125] The first part of this goal was achieved "with only one year's delay and the [country's] present development of production capabilities and market growth indicates that the 2010 target can be met as well."[126]

"The cost of installing residential [solar power] systems has fallen dramatically in Japan since the residential incentive program began—from $26.54/W in FY 1994 to $6.50/W in FY 2003. (See Figure 6.) As rising demand drove industry expansion, experience was gained and economies of scale resulted in cost savings, [which drove] down the cost of electricity from solar cells."[127]

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[122] INTERNATIONAL ENERGY AGENCY PHOTOVOLTAIC POWER SYSTEMS PROGRAMME, *Trends in Photovoltaic Applications: Survey Report of Selected IEA Countries Between 1992 and 2003*, (Sept. 2004).

[123] It is important to note that while Japan remains the dominant market for solar power, over the past two years, Germany's solar market has grown exponentially and is soon to exceed Japan's annual market. Germany's solar incentive program is different than that of Japan or California as it does not offer upfront rebates but rather pays the owner of a solar power system a set amount of money per unit energy generated over twenty years. This program is called a "feed-in tariff", i.e. a tariff offered for every electron fed into the grid. For more information on Germany's solar market *see* http://www.solarbuzz.com/FastFactsGermany.htm.

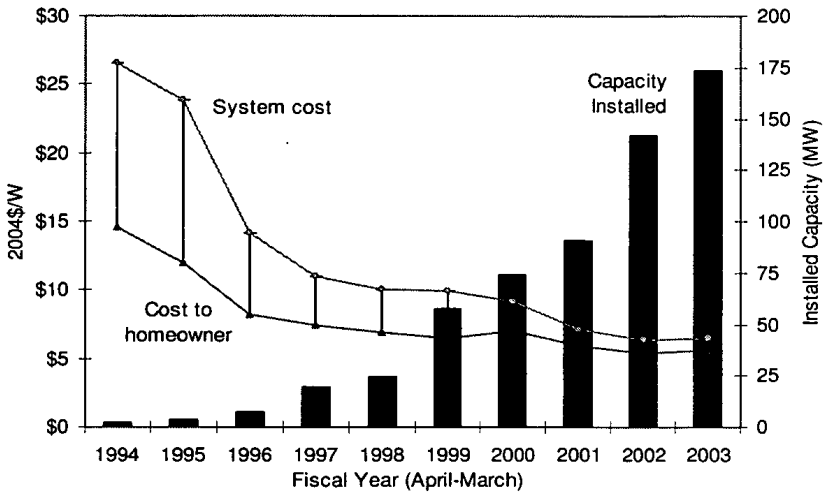
[124] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

[125] PETER HOLIHAN, *supra* note 119.

[126] ARNULF JAGER-WALDAU, PV STATUS REPORT 2003: RESEARCH, SOLAR CELL PRODUCTION AND MARKET IMPLEMENTATION IN JAPAN, USA AND THE EUROPEAN UNION 10 (European Commission Joint Research Centre, Sept. 2003), *available at* http://www.nrel.gov/ncpv/thin_film/docs/world_pv_status_rpt_2003.pdf.

[127] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

Figure 6: The Success of Japan's Residential Solar Incentive Program: 1994-2003[128]



"Decreasing costs of installing residential [solar power] systems allowed Japan to decrease the maximum incentive provided to homeowners while simultaneously increasing the amount of solar capacity installed annually. The average governmental contribution dropped from $11.94/W in FY 1994 to $0.85/W in FY 2003."[129]

"Not only has the total incentive per household decreased during this period, but the incentive as a fraction of the total installation costs has also decreased. From 1994 to 2003, the maximum incentive per system shrunk from 50 percent to 10 percent of installation costs."[130] This is a sign of the solar power incentive program's success. "The industry is rapidly approaching the point where the cost of installing a system is low enough that government incentives are no longer necessary."[131]

"The cost reductions resulting from the Japanese market expansion have not translated into equal cost reductions in California or other markets. Reduced cost of balance-of-system components and installation have been a significant portion of the price reductions in Japan, [however,] these components tend to be more regional in nature, specific to the type of house and the companies themselves. This means that

[128] DAVE ALGOSO, *supra* note 18, at 19.

[129] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

[130] PAUL MAYCOCK, *PV Market Update*, RENEWABLE ENERGY WORLD, (Vol. 7 (4), July-August 2004).

[131] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf.

system costs in California will respond most to increased demand in California. Also, because electricity rates and household electricity consumption vary between California and Japan, the system price may need to be lower for a California homeowner to break even."[132] Therefore, while the Japanese have helped lower the cost of solar on a global scale, to bring a self-sufficient solar market to California, the state needs its own version of the Japanese solar program. The next section discusses the California Solar Initiative, which is based largely on the Japanese model, and is similarly intended to bring about a self-sufficient, mainstream solar market in ten years.

V. ONE MILLION SOLAR ROOFS: CREATING A THRIVING, SELF-SUFFICIENT SOLAR MARKET IN CALIFORNIA

It is "said that it is not a question of if, but when solar power will become cost-competitive with traditional electricity sources. By adopting the right programs and policies today, California can have a great deal of control over the future cost of solar power and how rapidly it becomes cost-competitive. By getting in on the ground floor of this new market, California can also benefit economically."[133]

As discussed in the previous two sections, California's experience over the last ten years and the experience of Japan's solar program show that by creating the demand for solar power, the solar industry will be able to manufacture and install solar power systems more cheaply. And, as it learns how to build solar power "systems more cheaply, demand will increase, creating a cycle that will give solar power a tremendous boost in becoming a major source of California's power."[134]

"While government incentives can increase California's installed solar capacity, an even better reason for these incentives is that they can push down the cost of solar in the long run, to the point where incentives are no longer needed."[135] To achieve this goal, California opinion leaders and decision makers have spent the past three years debating and grappling with how to create a market large enough to drive down prices and achieve the goal of affordable, readily available solar power technologies.[136] The end result has been a widely heralded program

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[132] *Id.*

[133] *Id.*

[134] *Id.*

[135] *Id.*

[136] Bill Stall, *Schwarzenegger's second act,* LOS ANGELES TIMES, Dec. 29, 2005, *available at* http://www.latimes.com/news/opinion/commentary/la-oe-stall29dec29,0,1450190.story (last visited March. 12, 2006).

preceded by a colorful, and at times raucous, political battle.

This effort began in 2003 with Senate Bill 289, introduced by Senator Kevin Murray (D-Culver City), which aimed to jumpstart a cost-effective, mainstream, and robust solar energy market by mandating solar power systems on a percentage of new single-family homes.[137] The bill passed the Senate Housing Committee by a vote of 6-2 before it was held a month later in the Senate Appropriations Committee.[138]

Despite not advancing beyond its house of origin, SB 289 struck a cord with many Californians, including the influential political figure, then-gubernatorial candidate Arnold Schwarzenegger. In September 2003, Schwarzenegger promised, if elected, to "[r]educe energy consumption by twenty percent within two years" through, among other strategies, "the use of solar power, with the goal of fifty percent of new homes equipped with solar photovoltaics by 2005."[139]

Six months later, after many conversations with the Schwarzenegger Administration, Senator Murray introduced another "big-idea" solar bill, Senate Bill 1652, again aimed at jumpstarting a cost-effective and enlarged solar power market in California.[140] This time, Senator Murray's solar bill passed the Senate Housing Committee, the Senate Floor, and the Assembly Housing Committee before failing to pass the Assembly Utilities and Commerce Committee. In the Utilities and Commerce Committee, the bill faced a nearly identical and competing bill, Senate Bill 118, authored by Senator Debra Bowen (D-Redondo Beach).[141] Had these bills, SB 1652 and a subsequent version, SB 199, passed, they would have required the CPUC to provide adequate funding for an enlarged consumer-oriented incentive program, large enough to lower the cost of solar power and to create a self-sufficient

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[137] S.B. 289, 2004 Leg., 2003-04 Sess. (Cal. 2003), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_289&sess=PREV&house=B&author=murray (last visited Feb. 21, 2006).

[138] *See* S.B. 289, 2003-04 Sess. bill history *available at* http://leginfo.ca.gov/pub/03-04/bill/sen/sb_0251-0300/sb_289_bill_20040202_history.html (last visited Feb. 21, 2006).

[139] Press Release, Californians for Arnold Schwarzenegger, Schwarzenegger Details Specifics of Environmental Action Plan (Sept. 21, 2003) *at* http://www.schwarzenegger.com/news.asp?id=1287.

[140] S.B. 1652, 2004 Leg., 2003-04 Sess. (Cal. 2004), available at http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1652&sess=PREV&house=B&author=murray (last visited Feb. 21, 2006).

[141] *See* S.B. 1652, 2003-04 Sess., Bill history *available at* http://leginfo.ca.gov/pub/03-04/bill/sen/sb_1651-1700/sb_1652_bill_20041130_history.html); S.B. 118, 2003-05 Sess. (Ca. 2004).

solar market.[142] The legislation also would have created standards for the inclusion of solar on new single-family homes.[143]

Despite the failure to pass a significant solar power bill two years in a row, support for the policy continued to grow, especially among leading newspapers in the state. In May 2004, for example, the *Los Angeles Times* editorialized on the legislation:[144]

> Thousands of new rooftops are going up in hot, sunny places from Riverside to the Central Valley. Done a little differently, they could be solar collectors, absorbing energy from the sun. Aiming to create more progressive homebuilding, state Sen. Kevin Murray (D-Culver City) proposes requiring large-scale developers to install solar power systems in a percentage of houses starting in 2006.

In 2005, Senate Bill 1 was introduced.[145] This time, Senator Murray was joined by co-author Senator John Campbell (R-Orange County) and bill-sponsor Governor Schwarzenegger. This bill became dubbed the "Million Solar Roofs Initiative" for the simple reason that it aimed to build one million solar-powered homes and businesses over ten years. Similar to previous iterations of the bill, SB 1 had three main goals, as analyzed by Chuck Nicol, Assembly Appropriations Committee analyst, "(a) placing solar energy systems on one million residential and commercial sites or providing 3,000 megawatts of generating capacity by 2019; (b) establishing a self-sustaining solar industry in 10 years; (c) placing solar energy systems on 50% of new homes in 13 years."[146]

SB 1 also contained three main policy elements. First, it required that all new commercially-built homes include solar panels as a standard option for homebuyers, similar to the way marble countertops are today. Second, it required the CPUC to create a new $1.8 billion fund to provide a rebate to homeowners and businesses toward the purchase of a qualified solar power system. The rebate would come from a small

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[142] *Id.*

[143] S.B. 199, 2004 Leg., 2003-04 Sess. (Cal. 2004), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery.

[144] Editorial, *Giving Solar a Bright Future*, LOS ANGELES TIMES EDITORIAL B12 (May 21, 2004).

[145] S.B. 1, 2006 Leg., 2005-06 Sess. (Calif. 2005) (as amended Feb. 28, 2005), *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=sb_1&sess=CUR&house=B&author=murray (last visited Feb. 21, 2006).

[146] *See* S.B. 1, 2005-06 Sess. (Assembly Committee Analyses, August 25, 2005), *available at* http://info.sen.ca.gov/pub/bill/sen/sb_0001-0050/sb_1_cfa_20050824_175125_asm_comm.html (last visited Feb. 21, 2006).

surcharge on electric bills of ratepayers living within the territory of the state's three investor-owned utilities, Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric. The rebate would be required to decline each year. California's publicly-owned utilities, such as Sacramento Municipal Utility District and Los Angeles Department of Water and Power, would also be required to establish a similar solar rebate program.[147] Third, it would raise the cap on net metering to 5% of a utility's total peak load.[148]

Over the course of 2005, the Million Solar Roofs bill, SB 1, received an outstanding level of support and attention among the general public and opinion leaders throughout the state. For example, in March, the *Los Angeles Times* editorial board wrote:[149]

> How strange that solar energy remains a rarity in a state with such dependable sunshine, which beats down, wasted, on our rooftops. New legislation backed by the governor fixes gaps that plagued previous solar-construction bills and provides the first real chance for new-home solar to get off the ground. . .. But legislators and the governor should resist any efforts to weaken the bill. This is the minimum needed to give solar a shot. Surely a state this sunny can do at least this much to boost an energy source that doesn't involve despoiling wilderness, doesn't pollute, never runs out and is a lot more reliable than OPEC.

The leading proponent of the measure, Environment California, collected more than 80,000 signed postcards in support of the bill, leading state legislators to cite extraordinarily large numbers of constituent contacts in support of the policy.[150] For example, Assemblymember Paul Koretz reported that more than 1,000 constituent contacts were in favor of the Million Solar Roofs initiative, by far the largest showing of public interest among all issues tallied in 2005.[151] Committee analyses reported more than 60 organizations and elected officials supporting the legislation.[152]

As the bill moved steadily through the Senate and through two

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[147] *Id.*

[148] *Id.*

[149] Editorial, *A Ray of Hope for Solar*, LOS ANGELES TIMES, B-10 (March 25, 2005).

[150] Environment California alone collected more than 50,000 signed postcards in support of SB 1.

[151] Paul Kortez, *End of Session Review*, in NEWS FROM THE 42ND DISTRICT Nov. 2005, Vol. 3, Issue 4 at 2, *at* http://democrats.assembly.ca.gov/members/a42/newletter/Fall2005.pdf.

[152] S.B. 1, 2006 Leg., 2005-06 Sess. (Assembly Committee Analyses, July 5, 2005), *available at* http://info.sen.ca.gov/pub/bill/sen/sb_0001-0050/sb_1_cfa_20050705_111232_asm_comm.html.

committees in the Assembly, it started to become a victim of its own success. The tremendous amount of attention and support it had garnered made it a target for multiple special interests. As the *San Francisco Chronicle* editorialized on June 26th:[153]

> The Campbell-Murray bill cleared the Senate on a bipartisan 30-5 vote, but it faces a difficult course in the Assembly, where some members have a disturbing tendency to "take a walk" on measures opposed by powerful interests. Homebuilders are skeptical about the prospects for solar; utilities and manufacturers are objecting to the ratepayer surcharges; labor unions want to be assured a piece of the action. Nothing is ever easy in the politics of Sacramento. The biggest hurdle to passage of SB1 may be the effort by organized labor to include a provision that would require the payment of "prevailing wage"—or union scale—to installers of solar panels on all homes and businesses that receive state subsidies.

And, again, the *Los Angeles Times* weighed in on August 25th:[154]

> The bill sailed through the Senate on a 30-5 vote and breezed through its first two Assembly committees. But now it's snarled in partisan politics and special-interest bargaining . . . . Many observers blame the delay on Assembly Speaker Fabian Nuñez (D-Los Angeles), saying the speaker is reluctant to give the governor a victory going into the Nov. 8 special election campaign. If so, it's a foolish and shortsighted strategy. If this bill dies, it will only make the Assembly look bad. Besides, the bill's author, state Sen. Kevin Murray (D-Culver City), was sponsoring solar legislation long before Schwarzenegger ran for governor . . . Another hurdle is that some labor unions and electrical contractor groups are demanding guarantees in the law that their members will get the work on the solar systems. Ideally, the bill would be silent on those issues, but pressures from those sources have prevailed up to now.

Lastly, the *Sacramento Bee*'s editorial on August 23 attempted to save what appeared to be a doomed bill:[155]

> Supported by Gov. Arnold Schwarzenegger and co-sponsored by Sen. Kevin Murray, D-Los Angeles, and Sen. John Campbell, R-Costa

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[153] Editorial, *How To Brighten Solar Power's Future*, SAN FRANCISCO CHRONICLE, F-4 (June 26, 2005).

[154] Editorial, *A Ray of Hope*, LOS ANGELES TIMES (Aug. 25, 2005)

[155] Editorial, *Solar Nexus: Nunez Has a Chance To Lead on Solar Bill*, SACRAMENTO BEE B-6 (Aug. 23, 2005).

> Mesa, SB 1 is revolutionary. Thus, it has many enemies. Utilities don't like the measure because it furthers the trend toward decentralized electricity generation in California. Many home builders don't like the measure because it requires them to offer solar as an option on new production homes. Some unions don't like SB 1 as it is written and won't like it unless it is changed to specify who can install solar panels and what they will be paid. Democrats largely support solar power, but many are miffed that Schwarzenegger is behind the bill and don't want to hand him a major environmental victory. All these pressures are now weighing on Núñez, who must decide if the merits of SB 1 outweigh the political downsides of offending certain constituencies, particularly the state's divided labor unions.

Despite the public support and media spotlight, SB 1 failed to pass the California State Assembly by the end of the 2005 legislative session. The Orange County Register recounted the bill's demise in an in-depth story that ran a week after the legislative session ended:[156]

> Senate Bill 1, the Million Solar Roofs Initiative, began as a top priority for Republican Gov. Arnold Schwarzenegger and a bipartisan group of lawmakers, including an Irvine state senator. It passed the Senate on a 30-5 vote in June, and a poll found 76 percent of Californians supported the plan in July. But in August, something went wrong. . ..Lawmakers passed hundreds of bills before adjourning for 2005 last week. They passed a $118 billion budget close to deadline for the first time in five years. They passed a "car buyers bill of rights." They toughened sex-offender laws. But they couldn't make the solar-roofs initiative happen.

After SB 1 ran aground in the final hours of the 2005 legislative session, Governor Schwarzenegger took an administrative approach, working with the CPUC to use its authority to create the California Solar Initiative ("CSI") based largely on the Million Solar Roofs bill.[157] On December 13, 2005, the CPUC officially proposed an 11-year, $3.2 billion incentive program to install 3,000 MW of solar on one million homes, businesses, farms, schools, and municipal buildings. The

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[156] John Gittelson, *Politics obscures the sun*, ORANGE COUNTY REGISTER, Sept. 11, 2005, *available at* http://www.ocregister.com/ocr/2005/09/11/sections/news/news/article_671319.php; *See also* Kevin Yamamura, *Governor backs off solar energy plan*, SACRAMENTO BEE, A-3, Aug. 31, 2005; Ed Mendel, *Sun sets over bid for solar program: Governor will seek PUC's help on plan*, SAN DIEGO UNION TRIBUNE, Sept. 9, 2005 *available at* http://www.signonsandiego.com/news/state/20050909-9999-1n9solar.html.

[157] Daniel Weintraub, *Governor finds way to implement his solar vision*, SACRAMENTO BEE B-8, Dec. 20, 2005.

program would become the nation's largest solar power investment and the first-ever program designed to make solar power mainstream and affordable, without aid of subsidies, within a decade. A December 13, 2005 Associated Press article described the proposed CPUC program:[158]

> State energy regulators on Tuesday unveiled one of the nation's most ambitious programs to expand the market for solar power, proposing to offer more than $3 billion in consumer rebates over the next decade. The California Solar Initiative, proposed by the state Public Utilities Commission, aims to install 3,000 megawatts of solar energy on 1 million homes, businesses and public buildings over 11 years . . .Environmentalists hailed the proposal, which they said would help drive down the cost of solar energy, create jobs and reduce emissions of greenhouse gases blamed for global warming . . . 'With rising energy prices and continued air pollution, this is exactly the kind of landmark initiative California needs,' said Bernadette Del Chiaro, clean energy advocate for Environment California. 'From this, we're going to see cleaner air, affordable solar energy and California regaining its world leadership in solar power.' The initiative revives an essential component of Gov. Arnold Schwarzenegger's bid to expand use of renewable energy in California. The governor's widely publicized 'Million Solar Roofs' initiative had bipartisan support, but it died in the Legislature this year after construction unions demanded high wages for solar panel installers. The governor bypassed the Legislature by asking the PUC to sponsor the California Solar Initiative, which shares many provisions of the 'Million Solar Roofs' program.

Looking to the future, the key policy question asked by both the Million Solar Roofs bill and now its successor, the California Solar Initiative, is what policies are needed to lower the price of solar power? And, related, at what point does the cost of solar power dip below the "break-even" mark, for example, the point at which the cost of the solar power system drops below the cost of the electricity it offsets without the use of government subsidies? Given conservative projections of future electricity rates, the cost of solar power will have to come down to at least $4.00-$4.50/W in order for a California homeowner to break even without government aid.[159]

As discussed in previous sections, the best way to lower the cost of

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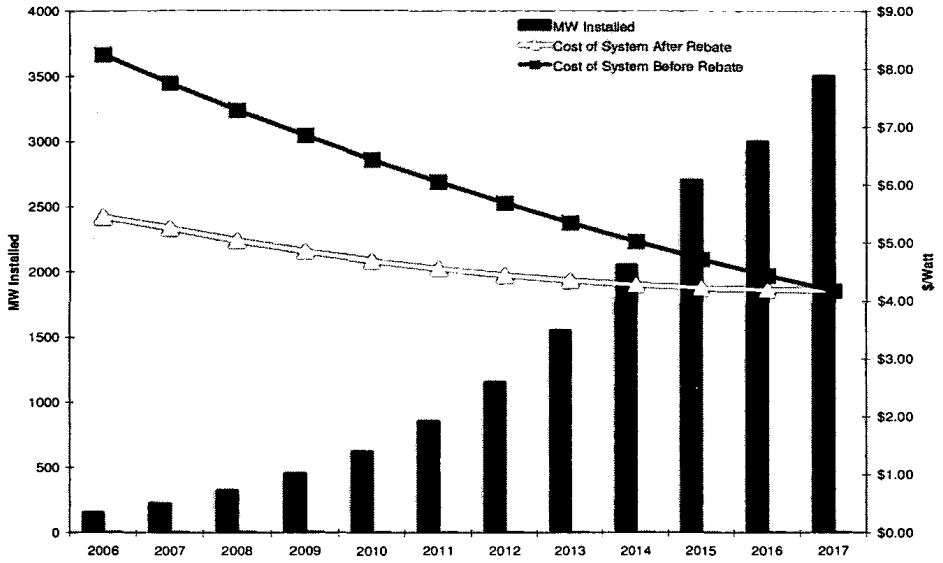
[158] Terence Chea, *Calif. regulators unveil $3.2 billion plan to expand solar power*, ASSOCIATED PRESS (Dec. 13, 2005) *available at* http://www.sfgate.com/cgi-bin/article.cgi?f=/n/a/2005/12/13/state/n184448S92.DTL.

[159] BERNADETTE DEL CHIARO, *supra* note 58, at 10.

solar is to grow the market through incentives, mandates, or both. This growth allows manufacturers and installers to achieve economies of scale and lower prices. Such is the goal of the California Solar Initiative, officially adopted by the CPUC on January 12, 2006.[160] By increasing the state's market for solar power from approximately 100 MW to 3,000 MW by 2017, this thirty-fold increase could be expected to lower costs to the break-even point identified above. The following chart demonstrates this demand/cost curve.[161]

Figure 7: Lowering the Price of Solar Through Increased Demand



The newly created $3.2 billion solar program will be funded through a surcharge on gas and electric ratepayer bills. The rebates will be available beginning in 2006 at a level of $2.80/watt and will decline by ten percent per year, in line with the expected reduction in the cost of installing solar power.[162] By making this upfront investment, the California Solar Initiative is expected to save ratepayers more than $10 billion over twenty years.[163] (See Figure 7 *supra*.) This is because for every 100 MW of solar power installed in California, ratepayers are

[160] Press Release, *supra* note 20.

[161] *Id.*

[162] CPUC, DRAFT DECISION, *supra* note 100, at 6.

[163] CPUC and CEC, JOINT STAFF RECOMMENDATIONS TO IMPLEMENT GOVERNOR SCHWARZENEGGER'S ONE MILLION SOLAR ROOFS PROGRAM 13 (June 14, 2005).

saved from having to either build a new peaking natural gas power plant or purchase expensive peak electricity.[164] Additionally, by subsidizing less than a third of the cost of the solar power system, ratepayers leverage considerable amounts of private dollars otherwise sent out of state in the form of payments for imported fossil fuels. Table 6 below shows this cost/benefit analysis in greater detail.

Table 6: Cost Benefits of Solar Incentives for California Ratepayers

Total Installed capacity (MW)	3,000
Avoided costs per MWh per year	($/MWh)
Peak	$225
Partial-peak	$78
Winter Partial Peak avoided costs	$72
Average solar PV generating hours per year	(hours)
Average Peak hours	360
Average Partial-peak hours	420
Average winter operating hours	788
Total annual operating hours	1,568
Annual Avoided Costs Per 3,000 MW Installed Per Year	($/millions)
Total Peak avoided costs per year (millions)	$243
Total Partial-Peak avoided costs per year (millions)	$98
Total winter avoided costs per year (millions)	$170
Total annual avoided costs (millions)	$511
Technology Life (years)	20
Annual avoided energy costs over life of 3,000 MW ($billion)	$10.23
Cost of 10-year Program to Ratepayers (billions)	$3.2
Cost of 10-year Program to Private Investors (homeowners/businesses) ($billions)	$5.3
Total Cost of 3,000 MW (ratepayer and private investment) ($billions)	$8.5
Net Benefit to Californians (ratepayer and private) ($billions)	$4.92
Net Benefit to Ratepayers Only ($billions)	$7.03

[164] *See id.* at 14.

There are other meaningful details in the California Solar Initiative. These include shifts toward performance-based incentives in which the consumers receive rebates based on the actual output of the installed system over time rather than an upfront rebate based on the rated capacity of the solar power system. Such a rebate program would be structured to encourage the production of more efficient solar panels and installations.[165] Another important detail is a ten percent set-aside in the total pot of money for low-income and affordable housing projects. The Initiative also exempts low-income ratepayers, up to 200% of poverty level, from having to contribute to the solar program.[166] Finally, the Initiative gives solar technologies other than solar photovoltaics, such as solar hot water heaters and energy efficiency technologies, an opportunity to benefit from the program.[167]

Two of the three CPUC Commissioners that cast a yes vote for the California Solar Initiative on January 12, 2006, summarized the importance of the policy and the task ahead for California to make the vision of a thriving, affordable solar power market a reality:[168]

"The California Solar Initiative is the largest solar program in the country and I hope it will be a model for other states," said Commissioner Dian M. Grueneich. "The program will be a major source of dependable and environmentally friendly electricity, and is a major tool in the State's promise to address climate change and meet the Governor's goals to reduce greenhouse gas emissions."[169]

"Today's decision signals California's vote for a cleaner, more reliable energy future," commented Commissioner Rachelle Chong. "Now it's up to Californians to make this a reality by stepping up to the plate to go solar."[170]

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[165] CPUC Press Release, *supra* note 20.

[166] The CPUC will exempt all ratepayers participating in the CARE program (California Alternate Rates for Energy) from paying into the solar fund. Ratepayers qualified for CARE are within 200% of federal poverty level, for example a family of four earning $39,200 or less per year.

[167] CPUC Press Release, *supra* note 20.

[168] CPUC Press Release, *supra* note 20.

[169] *Id.*

[170] *Id.*

VI. CONCLUSION: MOVING BEYOND ONE MILLION

> We have crafted the California Solar Initiative proposal to help bring about this transformation in the next ten years or so. As we proceed to implement this Initiative, we may find that it takes a little bit less or a little bit more time. Much depends on how many other states and countries embrace this technology. The market for solar is a global one, and we can be helped or hindered in our goals by the actions of other major players. I hope that California can play a strong and positive leadership role and that many other states and countries will also adopt solar incentive programs in the near future.
>
> - California Public Utilities Commission President Michael R. Peevey, February 2006[171]

The installation of solar energy systems on one million new homes and businesses throughout California over the next ten years has the potential to yield positive economic benefits for the state at-large, such as reduced electric system costs, reduced air pollution, greater energy independence, and a stimulus to local economies.

Policies, such as the landmark California Solar Initiative, that aim to increase demand for solar power are the best way to simultaneously increase California's solar generating capacity and reduce solar power system costs.[172] An increase in the amount of electricity generated from clean, distributed sources will strengthen California's solar industry, and "pave the way for further growth in generation from clean solar power in the decades ahead."[173]

Governor Schwarzenegger set goals of 3,000 MW of total new solar power capacity and half of all new homes to be "built with solar power over the next 10 years."[174] Meeting these goals will require bringing down system costs. The CEC's "Emerging Renewables Program and Japan's residential incentives program have proven the strength of this approach."[175] However, an aggressive consumer incentive program

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[171] ENVIRONMENT CALIFORNIA, 3 *Winter Report* (Los Angeles, CA.), 2006 at 7.
[172] (10-4-05) http://environmentcalifornia.org/reports/solartoscale.pdf
[173] *Id.*
[174] *Id.*
[175] *Id.*

alone, such as the California Solar Initiative, may not be sufficient to spur widespread installation.

Other important policies, including those that incorporate "solar photovoltaic systems into new housing design and construction, [have] been key to Japan's success at creating a robust, self-sufficient solar market. California should do [likewise] by establishing policies that [better] ensure Governor Schwarzenegger's goal of building half of all new homes with solar power is reached. Such policies will maximize ratepayer and taxpayer investments by driving prices down and increasing installation efficiencies."[176]

Another important policy needed to ensure that homeowners who install solar power systems maximize the return on their investment is a lift on the current net metering cap. As discussed in Section III *supra*, California state law currently allows customers to sign a net metering contract with their local utility but only up to the point where the utility's total peak load coming from solar power equals one half of one percent. Several utilities are approaching this limit today, and in order for a million new solar customers to benefit from this critical financial incentive, the cap must be raised to at least five percent. Along similar lines, California utilities need to make time-of-use billing an option for all electric power customers. With this form of billing, where energy produced during peak hours is worth more non-peak hour energy, the credit given to net-metered electricity from a residential power system is closer to its actual worth.

California, as well as the federal government, needs to consider renewing various tax incentives for solar power systems and other renewable energy technologies. Some examples include: "an exemption from property taxes, a personal tax deduction on the interest paid on loans used to purchase [solar power] systems, and income tax credits for the purchase and installation of [solar power] systems."[177]

Further, California's publicly-owned utilities need to adopt, at a minimum, programs that are at least as strong as those required of the investor owned utilities. With control of twenty percent of the state's energy market, the state's municipal utilities, especially the largest, Los Angeles Department of Water and Power and Sacramento Municipal Utility District, will play major roles in creating a thriving, self-sufficient solar market in California.

In addition, as new suppliers and installers of solar energy systems "enter the market, the state should ensure safety and installation

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[176] *Id.*
[177] *Id.*

standards, minimum warranties on systems, and adequate training for installers and developers. The state should also continue policies that can help improve the progress ratio – the rate at which prices decrease in relation to production increases."[178] Programs that support improvements in the various photovoltaic conversion technologies (inverter engineering, factory production, and other technical aspects) can develop knowledge that will then disseminate throughout the industry, helping companies make better decisions about how to reduce costs as they meet increasing demand.[179] "In particular, encouraging builders and utility companies to install [solar] on new homes could alleviate many of the barriers, including informational barriers, high up-front costs, utility interconnection issues, and others, that deter consumers from [installing solar power] as a retrofit on existing homes. Encouraging the use of solar in new residences could also bring down the cost of [solar power] by allowing builders to negotiate bulk discounts and gain experience in [solar] installations."[180]

Similarly, in-depth analyses of the economics of owning a solar energy system highlight the important role played by utility rate structures in determining the economic competitiveness of solar power. Utilities that offer net metering, tiered-rate structures that increase the per-kilowatt-hour cost for heavy users, and time-of-use pricing that reflects the true cost of peak power enable both utilities and consumers to take full advantage of solar power's ability to add capacity to the system during peak demand conditions.

California is overly dependent on a limited supply of imported fossil fuels. Ultimately, developing a cost-effective, homegrown, and environmentally sustainable energy economy with solar power as the cornerstone resource is critical to the state's continued growth, economic development, and environmental and public health. With history as a primary teacher, California regulators have embarked on a journey to bring solar power to scale by creating a vibrant, self-sufficient solar market within ten years. Doing so will bring tremendous environmental and economic benefits to the state and will put California back on track to becoming the world's solar energy leader.

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[178] *Id.*

[179] *Id.*

[180] http://environmentcalifornia.org.