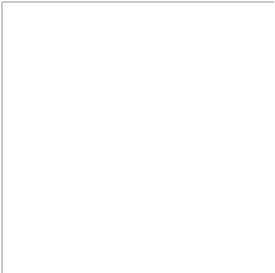
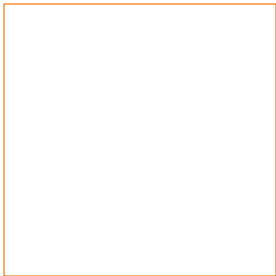


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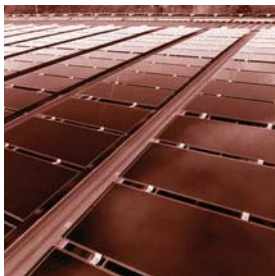
BRINGING SOLAR TO SCALE



A Proposal to Enhance
California's Energy,
Environmental, and
Economic Security



JULY 2002



PREPARED BY

CLEAN **EDGE**

THE CLEAN-TECH MARKET AUTHORITY

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AN EXTRAORDINARY OPPORTUNITY

California faces an extraordinary opportunity to address its needs for energy security and economic stimulus while creating new jobs, building globally competitive markets, and protecting public health and the environment.

This paper presents a bold vision, along with an ambitious plan to capitalize upon a unique confluence of forces to make California the center of the global solar industry while making solar photovoltaics (PV) cost-competitive with other energy sources.

- **The Vision** A California-based, world-class solar industry, manufacturing and installing PV systems for businesses, institutions, and consumers at globally competitive prices. At the heart of the proposed plan is the Solar Underwriting Network (SUN), a financial mechanism capable of funding the purchase of hundreds of MW of solar PV at little or no cost to the state.
- **The Mission** To establish a plan and financial engine capable of 1) attracting and retaining solar PV manufacturers, installers, and allied businesses for the mass deployment of solar PV within the state; 2) enabling state agencies, local governments, businesses, and residents to purchase and install solar PV modules at cost-competitive rates; and 3) establishing California as a dominant, long-term player in the emerging solar PV industry.
- **The Outcome** Within seven years, to catalyze the manufacture and installation of 1,400 MW of “California grown” solar PV through a limited, one-time investment by the state, most or all of which would be repaid to the state at the end of the program. California and its citizens would enjoy all of the energy, security, job creation, economic development, and environmental benefits of becoming a world center for solar energy.

Without a comprehensive plan and coordinated effort, solar is doomed to remain a small, niche technology financially inaccessible to the mainstream in California and elsewhere

The solar photovoltaics market has been developing for decades. In recent years, PV has emerged as one of the fastest-growing energy technologies, but it is still not cost-competitive with fossil fuels or more mature renewable energy sources such as wind power. Solar PV’s small base and limited infrastructure mean higher prices, which depresses demand, which keeps prices high.

Under today’s business-as-usual scenario – even considering the recent impressive efforts by California’s state government and San Francisco’s voter-backed initiative to significantly bolster the use of solar photovoltaics – a solar future will remain elusive. Without a comprehensive plan and coordinated effort, solar is doomed to remain a small, niche technology financially inaccessible to the mainstream in California and elsewhere. Moreover, under current trends, solar’s development will take place in Japan and Germany, making solar yet another American innovation being commercialized abroad. Even as solar develops overseas on its current growth trajectory, PV prices will remain high and installations small in the near- to mid-term.

The potential exists for California to create a world-class, high-tech industry with the potential to meet many of the state's energy needs — and to export that technology to other states and around the world

The potential exists for California, working through state agencies, industry, and key stakeholders, to shepherd California into a leadership role — making the state the center of a globally competitive solar industry by significantly ramping up production and installation and driving down prices. The potential exists for California to create a world-class, high-tech industry with the potential to meet many of California's energy needs — and to export that technology to other states and around the world. Creating such a manufacturing base will generate thousands of jobs and help revitalize disadvantaged communities up and down the state. It also will help Californians build an energy portfolio that will be more resistant to terrorist attacks, marketplace disruptions, fuel shortages, and natural disasters — and that will have less adverse impact on the environment and public health.

It will take just one aggressive, well-orchestrated, well-funded push. The plan that follows calls for an ambitious Solar Catalyst Plan, a multi-partner collaboration that harnesses the purchasing power of state government along with innovative private-sector and nonprofit partners. It also pulls together and leverages an impressive, but so far disparate, network of existing programs, interests, and financing mechanisms to build and support a sustained, orderly commitment to solar in California.

This plan is bold, but it is not unprecedented. In recent decades, California has put its financial and political muscle behind other technologies in order to help build the state's economy and to create new opportunities for its citizens. In doing so, it has helped birth entire new industries that have transformed the economic and social landscape both here and abroad.

Solar represents another such opportunity. It is poised to be competitive with conventional energy sources, providing a clean, distributed, and reliable source of energy for both the developed and developing world. The time is ripe for California to seize the moment.

THE PROJECT IN BRIEF

The goal of the Solar Catalyst Plan is to expand PV manufacturing output and installation capacity within California over the next seven years, making PV cost-competitive at the retail level and positioning California as the undisputed leader in the solar industry. The project is described in greater detail later in this publication. Highlights of the plan include:

For a total price tag to the state of \$1 billion over the life of the program, plus a \$1.5 billion loan or guarantee fund, California can help gain America's leadership in one of the global economy's hottest growth areas

- **Creating a Solar Underwriting Network (SUN)**, a state-backed financial mechanism that would make California-made PV modules available to state and local government, businesses, consumers, and others at attractively low prices. The fund would guarantee the purchase of hundreds of MW of California-manufactured solar modules per year (see chart on page 16 for details). Monies or guarantees from the sale of these modules would replenish the fund each year. The fund would allow residents, businesses, and governments in California to install a total of 1,400 MW of solar PV by 2008. If left in operation for ten years, SUN could catalyze the installation of more than 3,000 MW of solar in California, at little or no net cost to the state. Most important, at the end of the program, SUN can be closed and the initial investment funds returned to the state. One of the many compelling aspects of SUN is that a variety of design choices can be made in how the program operates to make it work for the needs of the state and its constituents.
- **Earmarking funds to provide for the purchase and installation of solar modules on state facilities**, including grid-connected applications for state office buildings, universities, and prisons, and non-grid connected applications for state parks, highways, and other public works. The plan calls for 100 MW of new solar PV procurement and installation by the state over a five-year period.
- **Continuation of the Buy Down program during the phase-in of the Solar Catalyst Plan** to guarantee a gradual, scaled, and orderly introduction.
- **Providing tax and other incentives to bring manufacturing and installation capacity to scale in California.** These incentives would include those typically offered through economic development offices: deferred or reduced tax burdens, infrastructure assistance, job-creation tax credits, and the like. The plan includes incentives for the construction of larger manufacturing facilities, instead of today's typical 20 MW plants. To facilitate this, the state could draw on existing programs that provide incentives to site plants in brownfields, such as the US EPA Brownfields Economic Redevelopment Initiative, or in disadvantaged communities, such as the US Department of Housing and Urban Development's Empowerment Zone and Enterprise Community Initiative.

How California Benefits

Solar Manufacturing	500 MW of annual solar PV manufacturing capacity by the end of 2008, making California a world leader in solar production, with roughly a third of total global manufacturing output.
Solar Installation	Dramatically scaled-up use of solar PV, with more than 1,400 MW of new installation in California by the end of 2008.
Job Creation	Up to 15,000 new full-time jobs in solar manufacturing, installation, service, sales, marketing, and other high-paying clean-tech sector positions by 2008. New economic opportunities in disadvantaged communities.
Solar PV Costs	PV costs dropping to 10-12 cents per kWh, making solar PV cost-competitive on the retail energy market.
Industry Leadership	Establishing California as a center of the global PV marketplace.
Export Markets	Multibillion-dollar export industry for the state, with high potential to sell PV modules both domestically and globally.
Economic Security	Lower long-term energy costs for California homes, businesses, schools, and government facilities. Increased tax base resulting from new industries, businesses, and jobs.
Energy Security	Reduced reliance on coal, natural gas, and other price-volatile energy sources. Reduced susceptibility to energy shortages, market manipulations, and other disruptions. Reduced stress on the existing grid.
Public Health	Easing of pollution-related problems, such as those currently causing unprecedented increases in asthma in California's children.

- **Drawing on existing economic and community development funds to provide training for installers**, particularly in low-income communities throughout the state. There are potential investment funds available through CALPERS, which has shown interest in community development projects that support renewable energy. Additionally, other state programs, such as the California Technology, Trade and Commerce Agency's Enterprise Zone Program, could be brought to bear.
- **Developing educational programs aimed at residents, businesses, and local governments** about the availability of low-cost solar in California. Part of this education effort would be a mass-communication, public-service nature effort similar to the state's highly successful "Flex Your Power" campaign.
- **Creation of a Solar Catalyst Group** that would help coordinate involvement of industry and investors (supply side) and facilitate consensus and participation among consumers – state residents, businesses, and governments (demand side).

THE CASE FOR 'SCALE'

In absolute terms, solar's numbers are frustratingly small – and will remain small, even at the current growth rates

The dream of making solar photovoltaics a significant and viable clean-energy source has existed for more than a quarter century but has only recently begun to be realized. Over the past few years, solar PV has experienced dramatic growth as manufacturing costs have dropped and technology and efficiency have improved. Worldwide, solar sales have grown sixfold since 1996 to \$2.5 billion and, according to Clean Edge research, are projected to rise nearly tenfold by the end of the decade to more than \$23 billion. For the past decade, solar and wind power have experienced double-digit annual growth rates, making them the fastest-growing new energy technologies in the global economy.

Large, global companies such as BP, Kyocera, Sanyo, Sharp, and Siemens have made significant investments in the production and delivery of solar energy products and services. Governments have helped. The Japanese government, for one, has helped to drive down the cost of solar PV through aggressive subsidies to Japanese companies. Germany has seen its solar industry flourish via tax incentives and a nationwide 100,000 solar roofs program. Japan and Europe now lead an industry once dominated by the US.

Still, while solar's global growth rate may seem impressive to some, the US growth rate is anemic when compared with the trajectories experienced by other technologies as they came to scale – such as microprocessors and wireless telecom. And in absolute terms, solar's numbers are frustratingly small – and will remain small, even at the current growth rates.

The total global manufacturing output of Solar PV cells was less than 300 megawatts (MW) in 2000, and about 350 MW for 2001. The US contributed about a quarter of the 2000 output – just under 75 MW – about 70% of which was exported, leaving less than 25 MW for domestic installation. In contrast, some 2,000 MW of new wind-power capacity was installed in the US during 2001.

Wholesale vs. Installed Prices

Solar prices typically are quoted in either wholesale prices or installed prices, usually in terms of price per watt.

Wholesale prices refer to the price per watt of a PV module purchased from the manufacturer.

Installed prices refer to the price of an entire solar PV system, once it is installed in a business or residence.

Unfortunately, many solar energy advocates refer to wholesale and installed prices interchangeably, thereby confusing analysis.

World Production of PV Systems [in Peak Megawatts]

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Japan	19.9	18.8	16.7	16.5	16.4	21.2	35.0	49.0	80.0	128.6
US	17.1	18.1	22.4	25.6	34.7	38.8	51.0	53.7	60.8	74.9
Europe	13.4	16.4	16.5	21.7	20.1	18.8	30.4	33.5	40.0	60.7
Others	5.0	4.6	4.4	5.6	6.3	9.7	9.4	18.7	20.5	23.4
Total	55.4	57.9	60.1	69.4	77.6	88.6	125.8	154.9	201.3	287.6

Source: Paul Maycock, PV Energy Systems Inc.

Small Quantities, High Prices. Solar’s tiny contribution to overall US energy production is directly linked to its small production scale. Most crystalline PV manufacturing facilities are relatively small – typically producing about 20 MW of modules a year or less – and unable to reach the economies of scale needed to bring costs down from the current range of \$3 to \$4 per wholesale watt. (See accompanying box for an explanation of “wholesale” versus “installed” prices.) According to the research of Paul Maycock of PV Energy Systems, one of the leading PV experts, it will take new and larger plants to see significant wholesale price declines for PV modules. New 25 MW and 50 MW facilities can produce PV panels at close to \$2.50 per wholesale watt or less. Maycock predicts that a 100 MW facility could bring costs down to about \$1.25 per wholesale watt.

The success of any such ramp-up program will come from ensuring that PV growth is sustained and orderly

Maycock isn’t alone in his assessment of solar’s potential economies of scale. A 1999 study by KPMG Netherlands for Greenpeace UK concluded that at a 500 MW production level, PV module prices would fall by a factor of 3.6. Another study, dubbed MUSIC-FM (for *Multi-Megawatt Scale-up of Silicon and Thin Film Solar Cell and Module Manufacturing*), under the leadership of T. Bruton of BP Solar for the Commission of the European Union, similarly concluded that the price of solar panels could be reduced by a factor of four by enlarging the production scale by a factor of 25 – say, from 20 megawatts to 500 megawatts.

At the production scale envisioned by Maycock and others, solar becomes cost-competitive with conventional electricity sources. Maycock predicts that at \$3 per installed watt (which includes additional components as well as installation costs), a mass market for solar will materialize. At \$2 per installed watt, he predicts a potential annual US market of 10,000 MW – more than 400 times the current US market. On a kilowatt-hour (kWh) basis, the unit of measure by which residences, businesses, and most others

purchase electricity, \$2 per installed watt translates to about 8¢ per kWh. Today, customers of investor-owned utilities like PG&E and Southern California Edison pay 11¢ to 19¢ per kWh for residences, 10¢ to 15¢ for small commercial customers, and 5¢ to 9¢ per kWh for most larger commercial and industrial customers. (Rates in each category can vary based on time of year, level of use, and other factors.)

Even at current high prices PV demand outstrips supply, leading to manufacturing backlogs of as long as nine months. Moreover, there is evidence that PV costs remain artificially high. “It is ironic that in the past 15 years, PV prices have not significantly decreased, while manufacturing costs of all [PV components] have decreased by at least 50%,” notes Maycock. Indeed, he adds, the high demand for solar, caused in part by the booming Japanese and German markets, resulted in wholesale prices *rising*, not falling, during 2001. Rising prices notwithstanding, demand for solar remains strong – at least among the relatively small number of buyers willing to pay the price.

Top Global PV Producers, 2000

COMPANY	COUNTRY	MW
Sharp	Japan	50.4
Kyocera	Japan	42.0
BP Solar	UK	41.9
Siemens Solar	Germany	28.0
Astropower	US	18.0
Sanyo	Japan	17.0
Photowatt	France	14.0
ASE GmbH	Germany	14.0
Mitsubishi	Japan	12.0
Total		235.3

Source: Paul Maycock, PV Energy Systems Inc.

Chicken-and-Egg Dilemma. As noted, new manufacturing capacity could help drive prices down dramatically, but construction of new PV plants won't take place without a strong, steady demand for the facilities' output. It's a classic chicken-and-egg dilemma: manufacturers won't commit to increasing capacity – thereby driving down prices – without an assurance of an increase in demand. And buyers – especially large institutional buyers – won't commit to purchases without the assurance of lower prices.

Public Support for Renewables

Public sentiment supports the widespread adoption of clean-energy sources.

According to a November 2001 Gallup Poll, nine out of ten Americans support investments in new energy sources such as solar, wind, and fuel cells, while more than half oppose increasing the use of nuclear power or in opening up the Arctic National Wildlife Refuge to oil exploration.

In San Francisco this fall, voters overwhelmingly approved a landmark \$100 million solar bond initiative, the first of its kind in the nation.

How to break through this logjam? We believe an aggressive and innovative public-private partnership, described in this report, is the most effective way to increase supply and demand in lockstep. What's key to building strong, sustainable markets is not merely a substantial commitment to large-scale purchases of PV modules and related products and services. The success of any such ramp-up program will come from ensuring that PV growth is sustained and orderly – that is, that demand of photovoltaics increase gradually, steadily, and predictably, allowing manufacturers to build new capacity and reduce production costs through economies of scale – and ensuring that prices drop sufficiently to ensure continued demand once subsidies and other incentives are phased out.

Building capacity isn't the only means for bringing solar to scale. Continuing improvements in solar technology will play a further role in bringing down PV costs. New thin-film technologies, for example, already show tremendous promise for lowering the price of PV – not just of the modules themselves, but of their total installation cost. Improved efficiencies also will allow PV modules to convert more sunlight into electricity, thereby reducing the amount of PV material needed to do a given job.

All of these factors – increased demand, financial incentives and subsidies, and continued technological improvements – will be required to build a globally competitive solar industry and to ensure the long-term viability of photovoltaics as a cost-competitive energy source. And all three can be influenced by an aggressive public-private partnership in California.

Cumulative Installed PV Power, US [in Megawatts]

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Off-Grid	25.5	31.3	37.6	45.1	53.5	62.5	72.2	84.2	98.7
Grid-Connected	6.0	7.0	8.2	9.7	11.0	13.7	15.9	21.1	28.1
Total	31.5	38.3	45.8	66.8	64.5	76.2	88.1	105.3	126.8

Source: International Energy Agency, 2001. Includes only installations greater than 40 watts.

THE NEED FOR A BOLD INITIATIVE

One of the biggest obstacles to the growth and development of solar photovoltaics has been the inconsistent level of support solar has received in the form of purchases and financing incentives on the part of federal and state governments. This is a missed opportunity. Over the past half century, many technologies have been born, raised, and brought to market largely on the basis of government support. In the 1950s, for example, the Department of Defense, needing a lightweight electronic replacement for vacuum tubes for the development of new weapons for the Cold War, made a significant investment in transistors. At the time, transistors cost \$20 apiece. Within ten years, they had dropped to 25¢ to 30¢ each.

More recently, California played a critical role in the commercialization of wind energy. Between 1981 and 1985, California added 1,700 MW of new wind power capacity to the states' power plant portfolio, writes wind expert Peter Asmus. Approximately \$1 billion was diverted from federal and state taxes between 1981 and 1985 to jump-start the world's wind power industry in California. At one point the state was host to 90% of global wind power capacity. Writes Asmus in his book, *Reaping The Wind: How Mechanical Wizards, Visionaries and Profiteers Helped Shape our Energy Future*:

The various federal and state financial incentives played a critical role in attracting almost \$2 billion in private capital (some of which came from foreign investors) to develop wind farms in California in less than five years. Because of the tax credits, wind turbine technology achieved the maturity in five years that typically takes 15 to 30 years in secluded government labs.

While the wind-energy experience clearly demonstrated the potential for California to use economies of scale to dramatically lower prices – wind energy costs have declined by more than 80%, from about 38¢ per kWh in the early 1980s to 4.5¢ per kWh or less in today's newest wind farms – California failed to succeed on another important front: keeping manufacturing in the state. When both federal and state investment tax credits were terminated in 1986, the wind industry started to shift overseas. “In 1985, 67% of the wind turbines installed in California were manufactured in the US,” writes Asmus. “By 1999, these percentages had reversed themselves as 65% of the wind turbines operating in California were manufactured overseas, according to recent data compiled by the [California Energy Commission]. Today, 90% of the world's wind turbine manufacturers are based in Europe, with Denmark remaining the world's dominant supplier of wind turbines.”

There is significant room for growth in California, just within the public sector. While there are not yet any firm estimates about the potential for solar on the 17,000 state office buildings in California, a study by the National Renewable Energy Lab for the Local Government Commission found that the rooftop space of the local government

Solar's potential is by no means limited to the Golden State. There are potential exports markets today for thousands of megawatts of solar PV panels in neighboring states — especially Nevada, New Mexico, and Arizona — as well as throughout the US and abroad.

(city and county) buildings would accommodate 200 MW of PV (assuming 40% of the space is south-facing), and the state's K-12 schools could accommodate another 1,500 MW. Solar has the potential of playing a key role in the CPA's "Greening Public Buildings" program, which calls for targeting "clean resources to meet by 2006 20% of the estimated 3,300 MW electricity demand of all public buildings — state and local government and schools and the possible participation of federal facilities." In addition to the energy savings resulting from PV installations on government buildings, these systems also save taxpayers money through reduced energy expenditures.

Of course, solar's potential is by no means limited to the Golden State. There are potential exports markets today for thousands of megawatts of solar PV panels in neighboring states — especially Nevada, New Mexico, and Arizona — as well as throughout the US and abroad. And many US cities, counties, and states are examining how to emulate San Francisco's recent landmark commitment to renewable energy.

The need for a bold initiative to lure and support private-sector solar PV manufacturers in California is clear. By partnering with a broad spectrum of interests to incentivize manufacturers to ramp up production in California, the state could reclaim a leadership role for renewables, building a PV manufacturing base that could compete globally. To do that will require a sustained commitment to ensuring a market in California for solar photovoltaics.

THE SOLAR CATALYST PLAN

Solar PV is on the verge of being a competitive source of energy in California and around the globe. But it will take an aggressive, well-orchestrated, well-funded push to make it actually happen.

The proposed Solar Catalyst Plan will significantly accelerate PV's development while serving many of California's immediate needs: job creation, economic stimulus, and energy security. For a total price tag to the state of \$1 billion over the life of the program – an annual commitment averaging \$150 million – plus a \$1.5 billion loan or guarantee fund, most or all of which will be repaid at the program's end, California can help gain America's leadership in one of the global economy's hottest growth areas.

California, as the world's fifth largest economy, has much to offer the nascent solar industry. With its solar-rich landscape, sophisticated technology infrastructure, and its institutional and financial capacity, California is perfectly positioned to make a bold and strategic investment in its own energy and economic future.

Under the Solar Catalyst Plan, the state would help grow the market for photovoltaics, committing to significant purchases of PV modules manufactured in-state by providing financial incentives to both manufacturers and consumers, and by partnering

Why This Plan Is Different

Proposals to build or bolster solar photovoltaics technology have existed for years, dating back to the creation of a Solar Energy Research Institute by President Carter in 1977. Since then, the US and other countries have promoted solar's growth, with limited results.

Why is this plan different? Here are five key reasons:

Scale	It calls for an unprecedented ramp-up of production, building far more photovoltaic modules faster than ever before, and is structured to take advantage of dramatically improved economies of scale to bring down prices. Unlike end-user subsidies that, by themselves, have failed to grow the solar industry beyond its current market niche, this more comprehensive plan can deliver 1,400 MW of solar to California by 2008.
Sustained orderly growth	The plan calls for increasing PV production and purchases in lockstep over the life of the plan, giving manufacturers assurance of a market for their product in the mid-term, thereby allowing manufacturers to bring new and larger plants online with relatively low risk. The financial heart of the plan, SUN, guarantees purchases by the state for little or no recurring cost to the state.
Matching supply and demand	The plan increases supply and demand simultaneously through guaranteed purchase agreements, thereby eliminating the vexing chicken-and-egg problem of having supply without demand, or vice versa.
Harnessing market forces	It significantly reduces the role of government subsidies, harnessing private-sector initiative and innovation to improve solar PV's economies of scale. Indeed, by the end of the program, price reductions in solar panels resulting from the initiative could make further subsidies unnecessary.
Economic development	The plan looks beyond energy needs to incorporate and incentivize economic development, workforce training, and job creation.

with economic development organizations throughout the state to train Californians to build, install, maintain, and repair solar PV systems.

Ten Key Ingredients. Below are the key ingredients of the proposed Solar Catalyst Plan, including the roles of principal government, nonprofit, and private-sector players needed to bring the cost of solar to competitive levels. They include:

- 1 Long-Term Procurement Commitments.** The financial heart of the plan is the Solar Underwriting Network (SUN), which would guarantee the purchase of hundreds of MW of California-manufactured solar modules for little or no recurring cost to the state. The SUN program would incentivize manufacturers to set up shop in California by offering long-term purchase guarantees for “California grown” solar PV. Starting in 2004, once new manufacturing facilities have had a chance to ramp up production, the state would facilitate the purchase of 100 MW of solar PV, rising to 500 MW in Year 5 of the program. Monies from the sale of these modules to businesses, residences, and government facilities would replenish the fund each year. The fund would help enable residents, businesses and governments in California to install a total of 1,400 MW of solar PV by 2008. If left in operation for ten years, SUN could catalyze the installation of more than 3000 MW of solar in California. Most importantly, at the end of the program, SUN may be closed, with the initial investment funds returned to the state.

SUN would be structured in such a way to guarantee a competitive price for long-term sales contracts for manufacturers (starting at \$2.50 per watt (plus installation) in year one and falling to \$2.00 per watt by Year 4). At the same time, SUN would enable end-users to purchase solar PV at the globally competitive price of \$2 per watt (plus installation) during the life of the program (see Buy-Down details below).

One of the many compelling aspects of SUN is that a variety of design choices can be made in how the program operates to make it work for the needs of the state and its constituents. Whether it operates as a self-replenishing loan or purchase guarantee fund, this \$1 billion fund would help eliminate the vexing chicken and egg problem – by enabling both adequate supply and demand, at little or not cost to the state.

- 2 State Government Installations.** A portion of California PV module production would be purchased directly for the state’s own use on buildings and other facilities. Specifically, the state would purchase and install 100 MW of solar modules over five years, starting in 2002. The estimated cost for this program would be \$500 million, or an average of \$5 per installed watt (includes the manufactured cost of \$2.00 to \$2.50 per watt plus installation), to be recouped by the state through reduced utility bills. These state purchases align with the state’s “Greening Public Buildings” proposal, which suggests that “a Clean Energy pro-

gram can be developed that uses a two-pronged strategy of price discounts via large-scale purchases over many years, plus tax-exempt financing.”

- 3 **Buy-Down Program.** The California Energy Commission’s current Energy Renewables Buy-Down Program would remain intact for two years, decreasing from the current \$4.50 rebate per watt in 2002 to \$3.50 per watt in 2003 (as less-expensive PV modules begin to emerge from new in-state manufacturing facilities). During the early phases of the Solar Catalyst Plan, buy-downs would remain in place to guarantee retail prices for California PV customers of \$2 per watt – paying for the difference between what the state is guaranteeing manufacturers via the SUN program and end-user pricing of \$2 per watt. It is anticipated that solar PV installation prices will similarly drop during this period, resulting in overall end-user pricing that makes new solar installations cost competitive and appealing for industrial, commercial, and residential consumers. Together, these buy-down programs would cost \$300 million over five years. By the end of the Solar Catalyst Plan, they will likely phase out altogether.

- 4 **Manufacturer and Installer Incentives.** To lure manufacturers to California and encourage manufacturers, installers, and systems integrators already

Project Summary

Here is a summary of the roles of the various players in this project, and the potential financial commitments of each.

ENTITY	DESCRIPTION	AMOUNT
Loans and Guarantees		
Various state agencies	Establishment of the Solar Underwriting Network (SUN), a fund that would purchase, or guarantee the purchase of, approximately 1,400 MW of solar PV modules by 2008 for use by public-sector, nonprofit, and private-sector entities.	\$1 billion revolving loan fund or guarantee fund.
Various state agencies	Purchase and install 100 MW of solar PV modules on state government facilities over five years.	\$500 million, to be offset by savings from reduced state energy expenditures.
Total Loans and Guarantees	Repaid through loan payments and state energy savings.	\$1.5 billion
Expenditures		
Federal, State, and Local Government	Tax rebates and investment incentives to cover the cost of building 500 MW of new PV manufacturing facilities	\$250 million
CEC	Extension of Buy-Down Program for annual installation of 20 MW in 2002 at \$4.50/watt and 20 MW in 2003 at \$3.50/watt.	\$150 million
CEC	Buy-Down payments to guarantee \$2/watt price for all PV module purchases through the SELF/SUN program.	\$150 million
State Treasurer, Workforce Investment Bond, others	Training of installers in disadvantaged and underemployed communities.	\$150 million
CEC	R&D investments in thin-film, roll-to-roll, and other advanced solar technologies via CEC’s PIER program.	\$150 million
CEC and others	Public and industry education on solar programs.	\$150 million
Total Expenditures		\$1 billion

Total Projected PV Purchases (2002-2008) by Category and Program [in Megawatts]

	2002	2003	2004	2005	2006	2007	2008	TOTAL
SUN Program								
Purchased for state facilities	20	20	20	20	20	0	0	100
Purchased for sales to local government facilities	0	0	20	30	40	50	75	215
Purchased for sales to state K-12 schools, colleges, universities	0	0	15	25	50	75	145	310
Purchased for sales to US military bases in California	0	0	5	15	25	40	50	135
Purchased for sales to residential retrofits, big-box retailers, new home construction, manufacturing facilities, etc.	0	0	40	80	100	150	230	600
Current Buy-Down Program								
Current Buy-Down program enhancement and extension during 2002 and 2003	20	20	0	0	0	0	0	40
Total Installed Megawatts	40	40	100	170	235	315	500	1400

in the state to scale up, it may be necessary to provide any of the incentives typically offered through economic development offices: deferred or reduced tax burdens, infrastructure assistance, job-creation tax credits, low-interest loans, and the like. It would be beneficial to the program for the state to further incentivize the construction of larger manufacturing facilities – for example, those producing 50 MW or even 100 MW, as opposed to today’s typical 20 MW manufacturing facility. This could dramatically improve manufacturers’ cost-efficiency. Finally, the state may want to consider providing further incentives to site PV manufacturing facilities in brownfields or in disadvantaged communities. (Some of the current programs that might help with these efforts are briefly described below, under “Promoting Economic Opportunity.”) We anticipate an estimated \$250 million in such incentives would be needed over five years.

- 5 Workforce Training.** To ensure an ample supply of PV installation capacity, the state will need to provide up to \$150 million in workforce training and other assistance to train installers in disadvantaged and underemployed communities, and to establish PV installation and maintenance courses through the state’s community colleges.
- 6 Public Education.** The state would undertake an aggressive public education campaign to promote solar in general and to entice end users to procure low-cost, California-made modules. Some of the campaign would be of the mass-communication, public-service nature, similar to the state’s highly successful “Flex Your Power” energy-conservation campaign. In addition, the state or its representatives would need to engage in highly targeted outreach efforts to specific customer groups through a variety of media and means. Total projected cost for this campaign during the life of the program is \$150 million.

PV Cost Projections: Running the Numbers

There are many factors that affect the projected costs of solar PV installations, measured on a cents-per-kilowatt-hour basis. These include the type of installation (industrial, commercial, or residential), average hours of daily sun exposure, the cost of capital, and the payback time. Calculations can vary widely, depending on which of these factors are included, and what values are assigned to each.

The table below takes a middle-of-the-road tack. It assumes 25% “dispatchable” solar (six hours of sun per day in California), a 20-year system life, and 5% cost of capital. It shows current costs, and those in five years resulting from the implementation of this project.

Application	CURRENT COSTS (2002)		PROJECTED COSTS (2007)		
	Per Installed Watt	Per kWh	Per Installed Watt	Per kWh (Conservative Estimate)	Per kWh (Midrange Estimate)
Grid-Connected Industrial and Large Commercial	\$6.00	\$.23	\$3.00	\$.12	\$.10
Grid-Connected Small Commercial	\$8.00	\$.31	\$4.00	\$.15	\$.12
Grid Connected Residential	\$10.00	\$.38	\$4.50	\$.17	\$.15

In the conservative scenario above, PV costs - currently ranging from \$.23 kWh for grid-connected industrial and large commercial systems to \$.38 kWh for grid-connected residential systems - would be cut in half. This would make PV prices comparable to those most California residential consumers currently pay - \$.12 to \$.19 per kWh. In the midrange calculations, which assume a 25-year system life, the cost of grid-connected industrial systems drops to \$.10 per kWh and grid-connected residential systems drop to \$.15 per kWh.

Industrial and large commercial applications are defined as 100 kW or larger flat-roof mounted systems. These systems are most commonly found on “big-box” retail stores, schools, factories, correctional facilities, and other large buildings. Small commercial applications typically run about 50 kW in size and are situated on the ground or on sloped roofs. Residential applications are defined as small home systems, usually in the 2 kW range.

Up to 10 jobs are created for every megawatt of solar manufacturing capacity, and 10 to 20 jobs per MW are created during the process of installation, retailing, maintenance, and providing other local services

- 7 Export Promotion.** An aggressive initiative to promote the sale of California-made PV modules both domestically and globally could further incentivize manufacturers, and could further help them build manufacturing capacity that would improve their economies of scale. There are several existing state programs that could help, briefly described below, under “Promoting Economic Opportunity.” A “California Solar” brand could be developed to signal a single cost-effective, high-quality solar source.
- 8 Expanded R&D.** There are a variety of new solar PV technologies in the pipeline, any of which could lead to cost-busting breakthroughs. A state commitment to invest \$150 million over five years in continued R&D funding through CEC’s Public Interest Energy Research (PIER) program, as well as from investments funds, and other sources could help ensure the development of emerging technologies such as thin-film, advanced materials, battery storage, and others.

More than 90% of new energy-generating capacity in California operates on natural gas, yet the state produces less than 20% of its natural-gas needs in-state.

9 Net Metering. Net metering allows solar users to connect their systems to the electricity grid, and to feed “excess” energy (electricity that is not used at the time it is generated) to be distributed back into the grid, thereby generating credits on consumers’ energy bills that offset the solar customer’s ownership costs. To maximize end-user’s incentives to install solar PV systems, California will need to strengthen and extend its net-metering laws. In April 2001, Governor Davis signed into law ABX1 29, modifying the state’s net-metering law by raising the capacity requirement for eligible solar and wind systems from 10 kilowatts to 1 megawatt (although, to date, implementation of this change has not been approved by the state Public Utility Commission). Under the law, utilities must develop standard net-metering contracts and provide customers with net electricity consumption information on a monthly basis. This provision is slated to expire at the end of 2002. Net-metering must be made permanent to ensure that solar and other decentralized energy sources remain attractive to California customers.

10 Building Codes. Currently, Title 24, which regulates the energy efficiency of new residential and nonresidential construction in California, does not give builders credit for integrating PV into their designs. Changes to the code currently are being considered, which would go into effect in 2005, which would remedy this. It is essential that the California Energy Commission include credits for PV installations in the calculation of a building’s energy efficiency to incentivize builders to incorporate solar PV into their project designs.

Natural Gas vs. Solar

In the past, California has turned to natural gas peaker plants as one alternative to staving off future energy shortages during times of peak-energy use. However, our analysis shows that for many peak-use situations, solar is a preferable option.

Solar PV provides a hedge against volatile natural gas prices that have fluctuated by as much as 300% over the past year. Solar PV, once installed, provides a long-term stable supply of energy. It is at its highest output during times of peak-use (hot summer days), is nonpolluting, and distributed (located near the source of use). Natural gas peaker plants, on the other hand, are polluting, rely on overtaxed electricity grids, and need extensive approval to receive approval in local communities.

On a pure cost-basis, solar is also competitive, with industrial-grade PV installations costing approximately \$.23 per kWh today and a projected \$.10-.12 per kWh by 2008. According to California Power Authority estimates, natural gas peaker plants currently cost between \$.10-.35 per kWh, depending on amount of usage. These prices could go much higher if natural gas demand once again outstrips supply, as California experienced during its 2000-2001 energy crisis.

Comparing the Costs:

Natural Gas Peaker Plant	
Current Costs*	\$0.10 - \$0.35/kWh
Industrial Solar PV	
Current Costs	\$0.23/kWh
Projected Costs (2008)	\$0.10 - \$0.12/kWh

*According to California Power Authority data, the cost for natural gas is 10 cents at a 10% capacity factor and 35 cents at a 2% capacity factor. Most natural gas peaker plants would likely run at a 5% capacity factor or less—resulting in costs at or significantly above current solar PV levels.

Source: California Energy Commission data for California Power Authority, December, 2001

BOLSTERING CALIFORNIA'S SECURITY

The price of solar – measured in the per-kilowatt-hour price of the electricity it generates – doesn't describe its full value. That value comes from a wide range of security benefits not typically factored into the unit price of energy.

Energy Security. First and foremost is solar's contribution to energy security. As a distributed, renewable energy resource, solar PV represents distributed generation at its best: the ability to locate energy supplies where the energy is needed, reducing the need for centralized plants, computer-controlled grids, and transmission and distribution lines, all of which can be subject to terrorist attacks, technological failures, marketplace disruptions, natural disasters, or dramatically fluctuating prices.

Solar, of course, also can play a major role in reducing America's reliance on oil – both foreign and domestic. That yields further security benefits by reducing the need to import petroleum from unstable regions of the world, or to drill for oil in environmentally sensitive parts of the planet.

But while much of the energy-security focus has centered on oil, California's growing reliance on natural gas represents another troubling energy-security risk. More than 90% of new energy-generating capacity in California operates on natural gas, yet the state produces less than 20% of its natural-gas needs in-state. That requires reliance on interstate pipelines, which are subject to a variety of disruptions, and increases the risk that natural-gas suppliers could dramatically increase prices, as they did during the winter of 2000-2001, leading to blackouts and other disruptions.

As the California Power Authority stated in releasing its January 2002 Energy Resource Investment Plan (ERIP):

We dare not forget that there are no controls on the commodity price of natural gas and it was three times its current cost just a year ago. Renewables, once built, provide an inflation-proof hedge against higher prices and dirtier air.

Solar also can play a key role in reaching California Power Authority's goal of ensuring a 22% energy reserve – a much cheaper option than paying high prices for spot energy, as the state did in 2000 and 2001. Analysis by Cambridge Energy Research Associates across the US has found that spot market prices can more than double when reserve margins drop below 10% versus being near 20%. The phenomenon was experienced by the state of California, which paid about \$40 billion extra in energy – \$20 billion extra in both 2000 and 2001 – for power when reserves fell to precipitously low levels, according to data from the California Independent System Operator Department of Market Analysis. As stated in CPA's ERIP:

CPA's ability to accelerate the use of clean resources to enhance reserves provides good insurance for the State's electricity reliability. Moreover, even if lower loads are the order of the day in the future, the increase in efficiency, load management, and renewables facilitated by the CPA will still provide the State with significant economic and environmental benefits and allow the earlier retirement or repowering of older, dirtier fossil-fueled plants.

Solar's benefits also extend to another scarce energy resource: the state's transmission capacity. Several areas of the state have experienced transmission bottlenecks that prevent local load from accessing the most economic generation available and therefore creating localized threats to energy reliability. As CPA states: "This is expensive and unnecessary."

The bankruptcy of Enron and the serious financial trouble of California's major investor-owned utilities also have contributed to the state's energy insecurity. Solar provides additional energy-security benefits because it is not dependent on such energy providers.

Increased attention to all types of security issues in the aftermath of September 11 also helps make solar a compelling addition to California's energy portfolio. By

spreading the state's investment in energy technologies among a variety of technologies – with an emphasis on making distributed, clean-energy sources competitive – California can bolster its energy security over the long term.

The Critical Need for Public Education

To succeed, the Solar Catalyst Plan must be bolstered by an aggressive public education initiative focusing on the benefits of solar energy as well as the programs available to help residences and businesses buy and install solar PV systems.

To date, California has not succeeded in making its programs well known. Only 14% of California residents and 9% of businesses, for example, were aware of the state's solar buy-down program, even after the program had been operating for two years, according to a study by the Lawrence Berkeley National Laboratory.

Experience indicates that success breeds success. According to the Lawrence Lab report,

As California's market for renewable energy sales has shown, increasing renewable energy demand by large customers — especially governmental customers — can lead to increased coverage of the market by the press and consequently a higher degree of customer education and a stronger market for renewable energy marketing overall.

It's important to note that education alone isn't the solution to creating scale and reducing the prices of PV. However, it is a key ingredient to bringing solar into the mainstream.

Economic Security. In addition to helping to avoid the financial woes experienced in California's energy market during the past year, solar offers other economic benefits. The job-creation potential of solar is one attractive component. According to a variety of findings, up to 10 jobs are created for every megawatt of solar manufacturing capacity, and 10 to 20 jobs per MW are created during the process of installation, retailing, maintenance, and providing other local services. Thus, according to these calculations, each 100 MW of solar manufactured and installed in California could create as many as 3,000 jobs in the state. If the state, as outlined in this plan, were to bring on 500 MW of annual manufacturing capacity and install more than 1,400 MW of new PV over the next seven years, the jobs benefit to the state could exceed 15,000 new full-time jobs by 2008.

California's economic security will also be impacted by its ability to compete in this high-growth technology sector. Not surprisingly, high-tech leaders such as Sharp, Sanyo, and Kyocera are leading the solar revolution in Japan. Japanese-based solar manufacturers have expanded their manufacturing base from under a quarter of total global output in 1995 to nearly half of total global output in 2000. During that same period, the US has seen its share of solar manufacturing output drop from nearly half to roughly a quarter of global output. California, the high-tech epicenter of the US, could reverse this trend and reap considerable economic benefits.

Environmental Security. Solar will provide a variety of environmental benefits as the state meets its goal of retiring older, less-efficient power plants, which are also the dirtiest. People living near the older and dirtier plants, sometimes located near minority and lower income neighborhoods, can experience significant concentrations of pollutants. Because the operation of PV systems produces no atmospheric emissions or greenhouse gases, it can play a major role in reducing both pollution as well as risks to public health resulting from power-plant emissions of NO_x, SO_x, and particulate matter.

As businesses and communities move increasingly to reduce their emissions of greenhouse gases, solar can become a critical part of an energy portfolio. In coming years, as markets develop for emissions trading and "green tags," in which avoided emissions of greenhouse and other gases can be sold on the open market, businesses and communities that install solar PV systems may gain further economic benefits.

Solar is particularly effective in reducing emissions in areas not in compliance with federal clean-air standards, which includes a significant portion of California's cities and suburbs. Compared to fossil-generated electricity, each megawatt of PV electricity offsets up to 35,000 pounds of nitrous oxides, 20,000 pounds of sulfur oxides, 1,300 pounds of other particulates, and more than 5 million pounds of carbon dioxide per year.

Other Benefits. Solar's other benefits include:

- The ability to be installed and operational much faster than conventional, centralized energy facilities.
- The ability to use existing rooftops as energy-generating facilities, rather than having to use new space to build conventional generating plants or wind farms, which often face opposition from NIMBY ("not in my back yard") forces.
- Similarly, the reduced need to construct more grid capacity to reduce transmission bottlenecks, which is not only extremely expensive but also subject to further NIMBY opposition.
- Minimal repair or maintenance required after installation.

*California's
commitment to solar
can engender a variety
of social benefits in
addition to the energy,
economic, and
environmental benefits*

- The ability to operate either independently or in concert with the existing grid, providing flexibility based on location, weather conditions, energy prices, and other factors.
- Maximum efficiency and peak output typically occur at the time when energy is in greatest need: during summer's sunniest days.
- The ability of licensed electricians and other tradespeople to install and maintain solar systems, offering the ability to quickly ramp up a corps of solar professionals in nearly every community.

Even though not all of these factors can be easily monetized individually, collectively they help make a compelling case for solar as a key component of the state's energy portfolio.

PROMOTING ECONOMIC OPPORTUNITY

One key component of the Solar Catalyst Plan is to harness the power of economic development to grow local economies and to increase job training and community rebuilding among those left behind California's economic boom – or affected by the current recession. By leveraging a wide range of federal and state programs aimed at such things as job training and brownfield development, and by partnering with government, private-sector, and nonprofit economic development programs, California's commitment to solar can engender a variety of social benefits in addition to the energy, economic, and environmental benefits.

One example of the wealth of potential programs to tap is the National Photovoltaic Construction Standards & Certification Partnership, established to design and implement training opportunities on PV installation and maintenance for individuals in disadvantaged communities. The partnership, launched in 2001, is a joint project of the International Brotherhood of Electrical Workers and the National Electrical Contractors Association. Its mission is to establish a nationally recognized means of providing proper accreditation and certification for all electrical workers performing this specialized work.

The job-creation and economic-development benefits of solar are rarely included in most analyses of the cost-competitiveness of solar energy, but they are a tangible benefit that must be included in the equation to accurately assess the benefits to the state of aggressively building a solar industry

There already exists ample support for such programs. In May 2000, for example, the California State Treasurer launched a major public policy initiative, “The Double Bottom Line: Investing in California's Emerging Markets,” to direct more than \$8 billion in investment capital – through state programs and the State's pension and investment funds – to spur economic growth in those California communities left behind during the economic expansion of the past decade. The initiative recognizes that the growing chasm between the “two Californias” – one of economic success and one of struggle – will dim the state's long-term economic prospects if action is not taken.

When he announced the initiative, Phil Angelides, the State Treasurer, said this approach called for investments “which support livable communities, sustainable development, and sound environmental practices, and increased public investment in the communities left behind in California's economy.” Clearly, the benefits of solar PV to the state fit such criteria.

There are other state and federal government programs that could be brought to bear on building a solar manufacturing base and accompanying installation network. A small sampling:

- **The California Technology, Trade and Commerce Agency's Enterprise Zone Program**, which targets economically distressed areas throughout the state.

- **The California Technology, Trade and Commerce Agency's Environmental Technology Export Program**, which helps California companies export their technologies, services, and equipment to international markets. ETEP partners with various federal, state, local, and nonprofit entities to reach out to export-ready environmental technology firms. ETEP's core activities include: marketing assistance, grant sponsorship, trade lead dissemination, and trade event promotion.
- **The California Air Resources Board's Innovative Clean Air Technologies (ICAT) Program** helps technology innovators to nurture and further develop their clean air solutions by providing co-funding and guidance through the critical pilot, prototype, and demonstration stages of product development. Funded projects support ARB's goal by promoting new technologies that will not only produce cleaner air, but may also lead to new industries in California.
- **The California Infrastructure and Economic Development Bank** helps local governments and businesses secure the capital they need in order to invest in major public, private, and nonprofit ventures.
- **The California Technology, Trade and Commerce Agency's Renewable Energy Loan Guarantee Program** offers a loan guarantee program to businesses that need financial assistance to purchase and install renewable energy systems.
- **The US Department of Housing and Urban Development's Empowerment Zone and Enterprise Community Initiative**, which promotes business development and new employment opportunities in designated economically distressed US cities and rural areas. Other federal agencies have business assistance and tax-relief programs that could apply.
- **The US EPA's Brownfields Economic Redevelopment Initiative**, designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. EPA is funding: assessment demonstration pilot programs (each funded up to \$200,000 over two years), to assess brownfields sites and to test cleanup and redevelopment models; job training pilot programs (each funded up to \$200,000 over two years), to provide training for residents of communities affected by brownfields to facilitate cleanup of brownfields sites and prepare trainees for future employment in the environmental field; and, cleanup revolving loan fund programs (each funded up to \$500,000 over five years) to capitalize loan funds to make loans for the environmental cleanup of brownfields.

There are still other potential resources to tap. For example, CALPERS, the state employee pension fund, which has some \$2 billion invested in conventional energy generation, has shown increased interest in investing in community development

projects that support renewable energy, including the use of solar in public housing projects.

Bundling the economic-development incentives with the financial incentives outlined above further bolsters the economic case for solar in California. The job-creation and economic-development benefits of solar are rarely included in most analyses of the cost-competitiveness of solar energy, but they are a tangible benefit that must be included in the equation to accurately assess the benefits to the state of aggressively building a solar industry.

PROJECT BENEFITS

According to our estimates and projections, the benefits to the state of the Solar Catalyst Plan would include:

What's needed now is a fast-track project that will cut through bureaucracies and quickly build a network of players and interests capable of moving forward aggressively

- **Annual total solar installation reaching 500 MW a year** by 2008 via the state's various programs. During the Solar Catalyst Plan, California would install 1,400 MW of new solar PV within the state. Fourteen hundred megawatts is roughly equal to four times current total annual global PV installation.
- **Annual PV production of 500 MW in California** by 2008, representing a third of total projected global manufacturing output.
- **PV costs dropping to less than \$3 per installed watt for grid-connected commercial and industrial facilities**, or close to 10-12 cents per kWh, making solar cost-competitive for many applications.
- **Create up to 15,000 new full-time jobs in the state**, many of which are skilled technical and manufacturing positions.
- **Increase the energy security of state residents and businesses** by being less susceptible to price spikes, supply disruptions, and attacks or other events that lead to the shutdown or disruption of major generating facilities and the overall electricity infrastructure.
- **Position California as the world leader of the emerging PV industry**, with more manufacturing capacity and installed capacity than any other state, region, or country, and products that can be marketed competitively around the world. At the projected cost of PV modules in 2007 under this project, California could capture a third of the global PV market, adding roughly \$1 billion annually to the state's gross domestic product for the PV module sales alone.
- **Provide training to workers** in disadvantaged and underemployed communities in California, and new business opportunities to tradespeople, entrepreneurs, and larger companies.
- **Reduce health risks to state residents** through lowered air emissions from fossil-fuel power plants.
- **Reduce the stress on the electricity grid** by generating solar power on a year-round basis, with the highest generation of solar power occurring during the hottest, sunniest days, when electricity demand is highest.

THE ROAD FROM HERE

It will take a concerted effort by a wide range of players and interests to turn the Solar Catalyst Plan into reality. Most likely, it will be done in stages. First would come a full-blown business plan, describing in detail the means and objectives of a Solar Catalyst Plan along with a detailed financial plan.

Beyond that are several concurrent pathways that could facilitate the development and execution of such a program. Some examples:

- A **Solar Summit** could be convened to bring together manufacturers, state officials, and other key players to discuss the opportunities and challenges of bringing solar to scale in California, and to map possible solutions.
- A **Solar Catalyst Group** could serve as a coordinating body, working with solar manufacturers and state agencies to help conduct and assemble research, write a business plan, offer guidelines and advice, coordinate efforts, and conduct an educational and media-outreach campaign.
- A **Solar Buyers Group**, which could be a part of the Solar Catalyst Group, could help aggregate PV purchases from both large and smaller buyers from among all sectors, thereby keeping purchase quantities large and prices low.

The goal of such efforts would be to identify and quickly engender action on both the supply and demand fronts. In the process, these efforts could solve the chicken-and-egg dilemma in which prices remain high due to low demand, and demand remains low due to high prices.

What's needed now is a fast-track project that will cut through bureaucracies and quickly build a network of players and interests capable of moving forward aggressively. With a concerted effort and the commitment of the state's considerable resources, California can seize the opportunity to build a solar future that will bring a wealth of energy, economic, environmental, and social benefits to its citizens for decades to come. ■



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