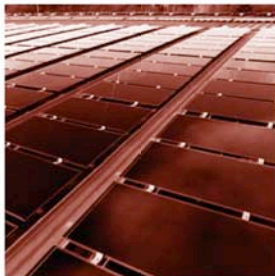
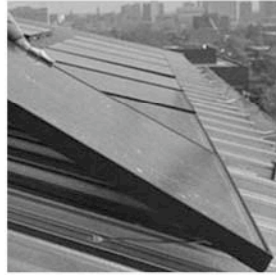


The SOLAR HIGH-IMPACT NATIONAL ENERGY (SHINE) Project

A Call to Action for U.S. Energy
Security and Independence



FEBRUARY 2005



SOLAR CATALYST GROUP

CONTENTS

EXECUTIVE SUMMARY	3
INTRODUCTION: A 'MAN ON THE MOON' FOR SOLAR	13
SHINE'S PROGRAMS	
SOLAR UTILIZATION NATIONAL UNDERWRITING PLAN (SUNUP)	22
U.S. ROOFTOP INITIATIVE FOR SOLAR ENERGY (U.S. RISE)	27
AMERICAN SOLAR ADVANCEMENT PRIZE (ASAP).....	29
FUNDING SHINE	36
SHINE'S BENEFITS IN BRIEF.....	39
NEXT STEPS: BRINGING SHINE TO LIFE.....	42

Publishers	Clean Edge, Inc. Co-op America Foundation
Authors	Joel Makower Clean Edge Ron Pernick Clean Edge
Contributor	Clint Wilder Clean Edge
Research Assistant	Anne Fernqvist
Project Director	Alisa Gravitz Co-op America
Contact	Alisa Gravitz Co-op America Foundation Solar Catalyst Program 1612 K Street NW, Suite 600 Washington, DC 20006 202-872-5307 alisagravitz@coopamerica.org
Download Reports	www.solarcatalyst.org www.cleaneedge.com

EXECUTIVE SUMMARY

This report describes a clear and compelling pathway to an energy future that creates energy and economic security for America. It generates thousands of American jobs in every state and restores U.S. leadership in global energy markets. It is a plan that harnesses market forces, nudged by a small initial government investment, to produce staggering economic, environmental, and social returns. It is revenue-neutral for federal taxpayers, and produces economic returns that cover the cost of the program several times over.

In simplest terms, this report explores the following question: What would an American “man on the moon” effort look like that could rapidly and dramatically transform solar energy into a truly cost-competitive, job-creating energy source?

We’ve outlined such a vision, which we’ve called the Solar High-Impact National Energy (SHINE) Project. It calls for an ambitious and aggressive, three-pronged initiative to make solar both cost-competitive and a significant part of America’s energy mix within 10 years. It emphasizes the positive benefits American-made solar can have on energy security, U.S. business growth, the creation of thousands of jobs across the nation, environmental and public health, and reducing stress on America’s electricity grid.

With Business As Usual, we get none of this. In fact, we are likely to lose yet another American industry, and all the jobs that go with it, to Europe and Asia.

How SHINE Impacts Solar Industry Growth

SHINE achieves significant impact on the growth of the solar PV industry in the U.S. by reducing the price of solar to as low as \$2 per peak watt installed system pricing by 2010. Our analysis shows that such an accelerated time frame could enable the U.S. solar industry to see continued growth rates in the U.S. of 38% per annum through 2025.

	Business As Usual	SHINE
Cummulative megawatts installed	16,372	282,780
Projected cost per peak watt installed (best price without subsidies)	\$2.71	\$0.80
Equivalent in number of U.S. households powered by solar (millions)	2.8	48.6
Average cost per kWh	\$0.10	\$0.03
Percentage of total U.S. electricity generation	0.52%	9%
Avoided tons CO ₂ (millions)	11	190
Equivalent cars removed from the road (millions)	2.1	36.6
Jobs created (if all manufacturing done in U.S.)	28,096	580,922

Results shown for 2025

In short, America stands at an energy crossroads, an historic decision-making moment that could shape the nation’s competitiveness and security. America’s energy crossroads present two divergent pathways for renewable energy in general, and solar in particular. One is Business As Usual, in which solar remains a high-cost, niche technology – produced mainly overseas by Japanese and European companies – continuing its impressive growth rate but never producing more than a tiny percentage of America’s energy needs.

The better, bolder pathway forged by SHINE leads to a far brighter future, producing up to 20 times more clean, renewable energy – and up to 20 times more American jobs – than Business

As Usual. It harnesses the impressive track record of U.S. industry in ramping up promising technologies to bring down costs and improve performance, while helping to ensure America's security by significantly increasing the amount of pollution-free, home-grown energy produced by the sun.

Specifically, SHINE calls for:

*SHINE is centered
on the uniquely
American way of
solving problems: by
stimulating markets.*

- **Solar Utilization National Underwriting Plan (SUNUP)**: a federal block-grant program, providing matching funds to states to implement innovative and cost-effective solar installation programs;
- **U.S. Rooftop Initiative for Solar Energy (U.S. RISE)**: an aggressive, long-term federal commitment to purchase solar systems for government facilities and operations; and
- **American Solar Advancement Prize (ASAP)**: a high-stakes, high-reward competition to develop and deploy new technologies and systems that could dramatically accelerate the reduction in solar's costs within a decade.

SHINE is centered on the uniquely American way of solving problems: by stimulating markets – in this case, to the point where solar can take off and bring jobs, prosperity, and security to America through private-sector initiative. It can address environmental problems such as climate change without resorting to regulations and treaties.

As a program that calls forth the power of markets, SHINE focuses on lowering the price of solar so that it can compete in every energy market and make a major contribution to energy security and independence – on rooftops for homeowners and businesses, in neighborhood and regional installations for utilities, and by providing low-cost energy for the coming generation of hydrogen fuel cells and high-efficiency batteries.

Combined, SHINE's three programs reduce the price of solar far faster than would take place under Business As Usual, thereby creating mass markets for solar far sooner than

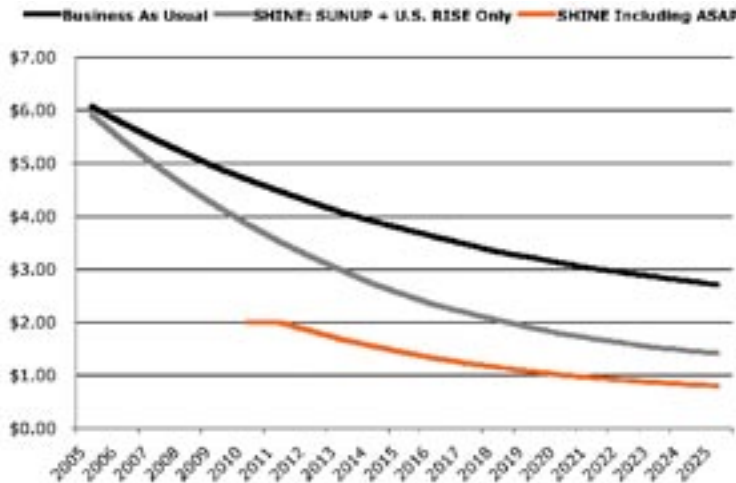
SHINE in Brief

SHINE's three key programs include:

- **Solar Utilization National Underwriting Plan (SUNUP)**, a federal matching-grant program to provide funding to states to implement aggressive solar implementation programs at the local level. Price: About \$3.25 billion in federal funds over 10 years, assuming an equivalent match from states and territories.
- **U.S. Rooftop Initiative for Solar Energy (U.S. RISE)**, a ten-year procurement program that would commit \$100 million a year to purchase and install PV systems on federal facilities, such as office buildings, courthouses, warehouses, and military installations. Price: \$1 billion over ten years.
- **American Solar Advancement Prize (ASAP)**, an international competition that would richly reward the company or team that could bring the price of U.S.-made solar to \$2 per installed watt or less by 2010. Price: \$525 million.

SHINE's programs are designed to be revenue-neutral. See "Funding SHINE," page 36, for more details.

Total Installed Price per Watt



Best system pricing. Assumes ASAP's benefits do not begin until 2010.

they would otherwise develop. By 2025, SHINE would reduce prices to as low as 80 cents per installed watt, compared to about \$2.71 for Business As Usual – a dramatic difference that would make solar cost-competitive with – perhaps cheaper than – fossil fuels and other more polluting energy sources.

And, along the way, SHINE would ensure America's participation in what is expected to be one of the fastest-growing global industries of the next decade. It would reverse the loss of high-paying jobs already taking place in the U.S. renewable energy sector, which has seen companies and jobs depart American

shores for China, Germany, Japan, Korea, and elsewhere. And by reclaiming leadership in this sector, the United States would enjoy the creation of up to 580,000 good-paying U.S. jobs – most of which cannot be exported overseas because they involve local installation and maintenance of solar systems on rooftops and in neighborhoods in every community.

Why Solar? This report focuses on solar photovoltaics (PV), the technology by which sunlight is turned directly into electricity – the types of systems seen increasingly on building rooftops. PV is not the only solar technology. Solar thermal systems – in which the sun heats water for use by a building's occupants – are common primarily outside the U.S. And concentrating solar power technologies – which use reflective materials such as mirrors to concentrate the sun's energy, which is then converted into electricity using any of several technologies – has huge potential for large-scale, utility-like electric generating systems.

All three technologies are important components of a solar energy future, but we believe it is solar PV that holds the largest short-term potential to provide the greatest economic, environmental, social, and national security benefits.

We also believe that a U.S. energy policy that delivers the national security, economic protection, and health and safety that Americans deserve also requires full commitment to energy efficiency as well as to other renewable energy sources, from wind to biomass to geothermal. Yet, after all of these technologies are fully deployed there will still be unmet energy needs; needs that can be uniquely fulfilled by solar.

And solar PV technology is ready. The quality and reliability of solar PV have matured, the price has dropped, and technology is poised for widespread deployment. The Ameri-

can marketplace has rolled out, with great success and prosperity, technologies that were much less mature than solar when they began to scale up – transistors, personal computers, cell phones, and high-definition TV, just to name a few. SHINE's programs will serve to create and accelerate a virtuous circle of technology improvement, market expansion, and price reductions that will only enhance solar's value and appeal.

SHINE aligns U.S. energy-independence goals with the goals of creating businesses and jobs, enhancing national security, reducing environmental impacts, and improving public health.

A National Priority. The need to aggressively deploy solar is a national priority. Today's principal energy sources – coal, natural gas, and nuclear power – have been critical resources for building the global economy, but they also present serious economic, environmental, and social problems and costs. Some of the costs are obvious, such as the cost to mine for coal; drill for natural gas; or build, operate, and secure nuclear power plants. But there are additional costs that do not appear in our energy bills, but for which all Americans pay. These include:

- the significant economic costs of energy market disruptions resulting from conflict, regulation, accidents, or malice;
- the security and military costs of protecting energy facilities and supplies, both domestically and abroad;
- the public health costs from problems caused by air pollution resulting from the burning of fossil fuels to produce electricity, including the alarming rise of asthma among our nation's children;
- damage to land and ecosystems, including threatened or endangered species, from extracting these resources – and the loss of economic benefits these damaged ecosystems would otherwise provide, such as preventing soil erosion, cleaning water, regulating the climate, and pollinating crops;
- the potentially high costs of climate change, in the form of extreme weather, flooding, drought, and other disruptions in weather and natural resources; and
- other environmental problems, such as acid rain and water pollution, that adversely affect public health and local economies.

The goal of SHINE is to renew and accelerate America's solar-generating capacity in a way that aligns U.S. energy-independence goals with the goals of creating businesses and jobs, enhancing national security, reducing environmental impacts, and improving public health. Specifically, SHINE aims to aggressively ramp up domestic solar PV manufacturing and system installations over a ten-year period in a way that:

- plays a significant role in creating energy independence in the U.S.;
- creates jobs, stimulates the economy, and improves environmental health in every community;

SHINE's Goals

- enhances national security by providing access to a reliable, domestic, non-fossil-fuel energy source;
- is revenue neutral – that is, it pays for itself without net increased cost to taxpayers or ratepayers;
- helps drive down the cost of solar so that it becomes cost-competitive with other electricity sources in a wide range of markets and applications within the next decade; and
- enables the U.S. to regain leadership in one of the world’s most rapidly expanding industries.

SHINE’s various programs would cost the federal government roughly \$5 billion over ten years – about \$500 million a year – an investment that would be repaid through energy savings and other means, making SHINE revenue neutral. By 2025, SHINE would result in up to 282 gigawatts (GW) of grid-connected solar PV installations – the equivalent of powering 48 million American households with solar – and create up to 580,000 new jobs spread across all 50 U.S. states.

SHINE’s Programs

1. Solar Utilization National Underwriting Plan (SUNUP), a federal block-grant program, is the powerhouse of SHINE. It would provide funding to implement aggressive, job-creating solar implementation programs in every state across America. SUNUP would empower U.S. states and territories with the models and the financial means to facilitate the implementation of solar PV for state and local government as well as nongovernmental and private-sector entities – homes, commercial and industrial buildings, universities, utilities, etc.

Block grants are funds given to states by the federal government to run programs within defined guidelines. SUNUP is envisioned as a matching grant program, meaning that federal dollars would be used to match state funding on a one-to-one basis.

In essence, SUNUP block grants would help states cover the cost differential between solar PV’s projected market prices and \$2.50 per installed watt – SHINE’s initial market take-off price, where the price of solar becomes competitive for residential and commercial rooftop applications (see Take-Off Prices, page 10). Over a period of 10 years, SUNUP would allow states to provide subsidies or other assistance through any of a variety of means: direct buy-down subsidies, feed-in tariffs, performance-based credits, low-interest loans, or other programs or incentives.

SUNUP comes with just two strings attached. To be eligible for SUNUP funds, states would be required to:

- raise state and local funding for solar procurement and implementation, up to a defined cap, which would be matched by SUNUP funds; and

- develop a Solar Implementation Plan showing how it planned to expand grid-connected and peak-generation solar PV programs over a ten-year period.

Total annual SUNUP awards would be based using a formula that considered each state's or territory's financial commitments, SHINE's total available funds, and a pro-rata distribution formula based on population, energy consumption, and other factors.

Methodology

Clean Edge, Inc., a research and publishing firm focused on clean-energy technologies, was engaged by the Co-op America Foundation on behalf of its Solar Catalyst Group program to prepare SHINE. SHINE is the third in a series of reports looking at building a robust, globally competitive, and profitable U.S.-based solar industry. Earlier reports in the series include *Bringing Solar To Scale: A Proposal to Enhance California's Energy, Environmental, and Economic Security* (published July 2002) and the *Solar Opportunity Assessment Report (SOAR)* (published December 2003).

The survey portion of this research consisted of phone and in-person interviews with a cross-section of public- and private-sector leaders. The interviews covered several key questions, including what programs participants thought would enable solar power to play a key role in building American energy independence. We asked participants to share "big ideas" that could move solar into the energy mainstream.

We also held two half-day strategy sessions, one in San Francisco and one in Washington D.C., with both solar PV and non-PV industry experts, to delve more deeply into a range of program proposals to accelerate the U.S. solar industry.

Organizations involved in the interviews and strategy sessions included: American Council on Renewable Energy, Bonneville Environmental Foundation, California Public Utilities Commission, California Solar Center, Conservation International, Clean Energy States Alliance, Clean Power Markets, Donald Aitken Associates, Ecosa Capital, Electric Power Research Institute, Energy Foundation, Hewlett-Packard, InQTel, Interstate Renewable Energy Council, Kema-Xenergy, Lawrence Berkeley Lab, Milken Institute, PowerLight, Renewable and Appropriate Energy Lab, Sacramento Municipal Utility District, Solar Electric Industries Association, Solar Electric Light Fund, Solar Electric Power Association, Stanford University, The Stella Group, Strategies Unlimited, SunPower, Technology Transition Corp., University of California, University of Delaware, Vinson & Elkins, U.S. Department of Energy, Unisolar, Vote Solar, Winrock, and the World Resources Institute.

In addition to the research efforts outlined above, Clean Edge built upon its knowledge base of clean-energy trends and developments, as well as research conducted for the two earlier Solar Catalyst Group reports. The most relevant of these, SOAR, included in-depth interviews with more than 30 solar PV manufacturers, system integrators, and other industry experts.

Each jurisdiction would be required to apply annually to the administering federal agency – most likely the U.S. Department of Energy.

2. U.S. Rooftop Initiative for Solar Energy (U.S. RISE) is a ten-year federal procurement program that would commit \$100 million per year to purchase and install solar PV systems on federal facilities, including office buildings, courthouses, warehouses, military installations, and the myriad other real estate owned and operated by Uncle Sam.

U.S. RISE would commit the federal government, the nation's biggest energy consumer, to become one of the nation's largest purchasers of solar energy systems – a billion dollars' worth over a ten-year period. Under the program, federal purchases would be recaptured over time in the form of avoided energy costs, with a net-zero impact on the federal budget. Indeed, over the 25- to 30-year expected lifetime of the solar panels installed under this

program, U.S. RISE would yield a net-positive financial benefit to the U.S. Treasury.

U.S. RISE would build on earlier government successes by committing the federal government to more aggressively purchase solar PV systems. The program would, in effect, turn the government's idle roof space into mini-power plants. According to our estimates, the program, when fully implemented, would result in 256 MW of onsite, grid-connected electricity, representing thousands of new grid-connected solar energy systems on federal buildings after ten years.

A successful ASAP would restore a competitive solar industry to U.S. shores while significantly reducing prices nearly a decade ahead of some of the more aggressive projections.

Market Take-Off Prices

3. American Solar Advancement Prize (ASAP) is a national competition that would richly reward the victors for bringing the price of U.S.-made solar from today's best system price of about \$6 per installed watt installed to \$2 per watt or less by 2010. It aims to accelerate deployment of advanced solar technologies into the marketplace at a rate faster than outlined in SUNUP and RISE, and to support further development of many of these promising technologies.

ASAP would be open to any company or consortia of companies, universities, and others. The winner(s) would be awarded both a cash prize and a purchase order for modules to be installed as part of SHINE's SUNUP and U.S. RISE procurement programs.

A successful ASAP would restore a competitive solar industry to U.S. shores while significantly reducing prices nearly a decade ahead of some of the more aggressive projections. In concert with the other components of SHINE, ASAP would guarantee the creation of tens of thousands of U.S.-based jobs and a leadership role in PV technology innovation, manufacturing, and deployment.

SHINE's programs are integrated and synergistic. SUNUP and U.S. RISE form the heart of SHINE, providing proven, predictable programs for priming the market for solar PV. They reduce the price of solar to the market take-off points more than a decade faster than Business As Usual and grow a mass market far more rapidly, catalyzing all of solar's benefits. ASAP is an accelerator, using technological advancements to move the key market take-off points to as early as 2010. However, while SUNUP and U.S. RISE can operate without ASAP, ASAP can't go it alone without the other two programs.

At about \$6 per watt today, solar PV is expensive, the equivalent of 18¢ to 25¢ per kilowatt-hour. This reduces solar applications to a small, niche market. SHINE is strategically designed to accelerate three critical price points at which solar PV becomes cost-competitive for mass markets:

- **At \$2.50 per installed watt** (equivalent to 7¢ to 10¢ per kWh), solar becomes affordable for homeowners and businesses to put solar on their rooftops, and for utilities to install it to produce peak power. SHINE will achieve this milestone in 2010, 11 years faster than Business As Usual.
- **At \$2 per installed watt** (equivalent to 5¢ to 7¢ per kWh), solar becomes cost-competitive for utilities and other energy developers to install solar in regional neighborhood "farms" – on warehouses, parking lots, and brown-fields, for example. SHINE could make this happen as early as 2012, a full 32 years faster than Business As Usual.
- **At \$1 per installed watt** (equivalent to 2¢ to 3¢ per kWh), the price becomes affordable for utilities to start using solar in their baseload; the transportation sector to start using solar to make hydrogen for fuel cells or to power highly efficient batteries; and for industrial power use. SHINE would

achieve this milestone in 2020 – at least three decades faster than Business As Usual.

Funding Shine

We stated earlier that SHINE is revenue neutral – that is, that it pays for itself over time without net increased cost to taxpayers or ratepayers. We believe that the programs we have proposed meet that hurdle. Each of the three programs – and all three together, fully implemented – would provide economic benefits sufficient to offset any new costs incurred by SHINE.

Specifically:

- **U.S. RISE** will produce energy savings for government buildings and produce revenues by selling “excess” energy back to local utilities;
- **SUNUP** will produce similar savings and revenues for state and local governments;
- **ASAP** will generate royalties paid to the federal government to help cover SHINE’s costs.

To cover SHINE’s start-up costs, we propose shifting a small percentage of taxpayer money currently used to support oil, coal, natural gas, and nuclear power. For example, shifting just 5 cents of every dollar that taxpayers now invest in fossil fuel and nuclear power, would yield more than the roughly \$5 billion needed over ten years – about \$500 million per year – to fully fund SHINE at the federal level.

SHINE’s programs will yield a variety of additional economic benefits that will further enhance its value to America’s communities. Among them are reduced need by utilities to build expensive “peaker” generating plants and the resulting savings to consumers and businesses; increased tax revenue from new businesses and jobs created by the U.S. solar industry; and reduced public health costs, such as lower rates of asthma caused by emissions from burning of fossil fuels.

SHINE’s Benefits

As the table on page 11 makes clear, the investment in SHINE’s three programs will yield widespread benefits across the U.S. In short:

- Solar’s price will drop dramatically – far faster than would happen in the business-as-usual scenario.
- Solar energy, as a result of SHINE, will be the source of 9% of all U.S. electricity by 2025 (compared to just one-half percent under Business As Usual) and more than half of all new electric-generation capacity. This is the equivalent of installing solar PV systems on 48 million residential rooftops (compared to fewer than 3 million under Business As Usual).
- By 2010 – more than a decade faster than Business As Usual – solar will

The SHINE Difference

The table below compares Business As Usual — what the solar market would look like in 2025 without SHINE — against the dramatic difference created by a fully deployed SHINE.

	Business as Usual	SHINE with ASAP
SOLAR MARKET SIZE		
Cumulative megawatts installed, U.S.	16,372	282,780
Equivalent in number of U.S. households powered by solar (millions)	2.8	48.6
Projected cost per peak watt installed (best price without subsidies)	\$2.71	\$0.80
Average cost per kWh	\$0.10	\$0.03
Percentage of total U.S. electricity generation	0.5%	9%
GREENHOUSE GAS REDUCTIONS		
Avoided tons CO ₂ (millions)	11	190
Equivalent number of cars removed from the road (millions)	2.1	36.6
JOB CREATION		
Jobs created (assumes all manufacturing done in U.S.)	28,096	580,922
MARKET TAKE-OFF POINTS		
Year price reaches \$2.50/watt without subsidies (market take-off for residential and commercial rooftops, and for utility peak power)	2021	2010
Year price reaches \$2.00/watt (market take-off for neighborhood/regional solar farms)	2044	2012
Year price reaches \$1.00/watt (market take-off for utility base load)	After 2050	2020

become cost-competitive in nearly every community, including for utilities to meet peak-energy needs, reducing the cost of building and operating polluting peak-power plants.

- Solar will reach the cost-competitive point for utility baseload more than thirty years faster – giving Americans the energy and economic security benefits we need now, not two generations from now.
- Solar will be a robust U.S. industry, creating up to 580,000 well-paid jobs located in nearly every state – most of which cannot be exported overseas because they involve local installation and maintenance of solar PV systems.
- Within 20 years – by 2025 – solar will be ready to take off to become one of America’s biggest industries. Thanks to the economies of scale created by SHINE, the price of solar will have fallen by more than 90% from its current levels – and 70% over the business-as-usual case.

Next Steps

SHINE aims to bring cost-competitive solar – and all of its benefits – to the nation within the next few years. But it will not happen on its own. It will require a concerted national effort – solar energy’s “moon shot.”

What will it take to bring SHINE to life? Three things:

The mission behind SHINE should be among the nation's highest priorities: to enhance America's energy independence and economic security by enabling solar energy's full potential as quickly as possible.

- **Political leadership in Washington and the states** to seize this window of opportunity, providing the political will and committing the financial capital needed to implement SHINE's programs. Simply put, SHINE will not happen without strong public-sector support.
- **A public-private partnership** committed to realizing SHINE's initiatives. A first step might be the convening of a summit meeting of solar industry and government leaders.
- **A national organization** to step forward that can provide coordination and leadership. There are many organizations already in place that could work together to carry SHINE forward, including the American Council on Renewable Energy, the American Solar Energy Society, the Solar Energy Industry Association, the Solar Catalyst Group, and Solar Circle.

Among the key roles for these public- and private-sector players would be to take the first steps necessary to enable each of SHINE's programs. For example,

- **SUNUP:** to work out the details of the matching block-grant program, including identifying successful models that states could adopt.
- **U.S. RISE:** to identify the "low-hanging fruit" of installations – that is, the federal buildings most able (because of climate, construction type, local utility rates, and other factors) to accommodate a significant solar PV installation.
- **ASAP:** to establish the panel of judges and other experts that will create the competition's rules, deadlines, and other factors. We believe that the appropriately named ASAP is the SHINE program that could be put into place most quickly.

Clearly, there is much work to be done. But the time is short and the stakes are high. The mission behind SHINE should be among the nation's highest priorities: to enhance America's energy independence and economic security by enabling solar energy's full potential as quickly as possible.

INTRODUCTION: A 'MAN ON THE MOON' FOR SOLAR

For more than four decades, John F. Kennedy's "man on the moon" speech of May 1961 remains the gold standard for bold vision and national leadership. In that historic speech, before a joint session of Congress, JFK presented a seemingly impossible challenge: that the nation "commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth."

This report explores the following question: What would an American "man on the moon" effort look like that could rapidly and dramatically transform solar energy into a truly cost-competitive, job-creating source of electricity?

Some derided the dream as lunacy; many others were inspired. In the end, history vindicated Kennedy.

Since then, the "man on the moon" vision has become shorthand for any bold, audacious effort that requires bringing together the best and brightest minds to pursue an ambitious vision or tackle a seemingly impossible challenge. Arguably, no such effort has yet matched that original effort, which led, in 1969, to the first humans setting foot on another heavenly body.

With that as background, and amid an era of pressing energy, environmental, economic, and national security challenges, this report explores the following question: What would an American "man on the moon" effort look like that could rapidly and dramatically transform solar energy into a truly cost-competitive, job-creating source of electricity?

This report outlines such a vision, which we've called the Solar High-Impact National Energy (SHINE) Project. It describes a clear and compelling pathway to an energy future that creates energy and economic security for America. It generates thousands of American jobs in every state and restores U.S. leadership in global energy markets. It is a plan that harnesses market forces, nudged by a small initial government investment, to produce staggering economic, environmental, and social returns. It is revenue-neutral for taxpayers and ratepayers, and produces economic returns that more than cover the cost of the program.

SHINE calls for an ambitious, three-pronged initiative to make solar both cost-competitive and a significant part of America's energy mix within 10 years. It emphasizes the positive benefits American-made solar can have on energy security, U.S. business growth, the creation of jobs in every state, reducing American's contribution to climate change, improving public health, and reducing the stress on America's fraying electricity grid.

Specifically, SHINE's programs include:

- **Solar Utilization National Underwriting Plan (SUNUP)**, a federal block-grant program, providing matching funds to states to implement innovative and cost-effective solar installation programs;

- **U.S. Rooftop Initiative for Solar Energy (U.S. RISE)**, an aggressive, long-term federal commitment to purchase solar systems for its own facilities and operations; and
- **American Solar Advancement Prize (ASAP)**, a high-stakes, high-reward competition to develop and deploy new technologies that would dramatically accelerate the reduction in solar's costs to less than 10 years.

SHINE's three programs accelerate price reductions for solar as much as three decades faster than they are expected to take place under Business As Usual.

Combined, these three programs accelerate price reductions for solar as much as three decades faster than they are expected to take place under Business As Usual, thereby creating mass markets for solar far sooner than they would otherwise develop. And, along the way, ensuring America's participation in what is expected to be one of the fastest-growing global industries of the next decade and beyond.

SHINE's programs are integrated and synergistic. SUNUP and U.S. RISE form the heart of SHINE, providing proven, predictable programs for priming the market for solar PV. They reduce the price of solar to the market take-off points more than a decade faster than Business As Usual and grow mass market far more rapidly, catalyzing all of solar's benefits. ASAP is an accelerator, using technological advancements to move the key market take-off points to as early as 2010. However, while SUNUP and U.S. RISE can operate without ASAP, ASAP can't go it alone without the other two programs. However, all three together form a powerful combination, strategically building and accelerating markets.

Solar's Unique Role

This report focuses on solar photovoltaics (PV), the technology by which sunlight is turned directly into electricity – the types of systems seen increasingly on building rooftops. PV is not the only solar technology. Solar thermal systems – in which the sun heats water for use by a building's occupants – are common primarily outside the U.S. And concentrating solar power technologies – which use reflective materials such as mirrors to concentrate the sun's energy, which is then converted into electricity using any of several technologies – has huge potential for large-scale, utility-like electric generating systems.

All three technologies are important components of a solar energy future, but we believe it is solar PV that holds the largest short-term potential to provide the greatest economic, environmental, social, and national security benefits.

Solar itself is just one of several emerging opportunities for renewable energy – a category of technologies that harness the power of wind, the earth's heat, the decay-ing of organic matter, the natural movement of oceans and rivers, and other natural processes to produce electricity and fuel to power our world. Among these promising renewable energy technologies, we believe solar, and photovoltaics in particular, is best suited to enhancing national security by providing locally generated power that can link to, and reduce stresses on, the existing electricity grid; create jobs and economic

How SHINE Compares

SHINE's goals and strategies are consistent with other recent studies that lay out the case for increased and aggressive support for solar PV from the federal government and other sectors. These include:

- *Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap Through 2030 and Beyond*, published in 2004 by SEIA.
- *PV Grid Connected Market Potential Under a Cost Breakthrough Scenario*, published in 2005 by the Energy Foundation and Navigant Consulting.

For example, based on the Energy Foundation/Navigant report, the potential demand for grid-connected solar rooftop PV in the U.S. in 2010 is estimated at up to 2,900 MW if installed system prices reach between \$2.00 and \$2.50 per watt. By way of comparison, less than 90 MW of new solar PV were installed in the U.S. in all of 2004, when per-watt prices averaged more than \$6.

The Navigant study also shows that these 2,900 MW represent only a fraction of what's possible. Based on available rooftop space, Navigant estimates that the "technical ultimate potential" for rooftop PV in the U.S. to be more than 710,000 MW for commercial and residential systems by 2010 (this is not their actual market projection, but the potential market size based on available rooftop space). And Navigant's demand estimates didn't include additional solar applications, such as ground-mounted PV, solar farms, carports, curtain walls, awnings, and other non-rooftop applications.

opportunity in every state; provide peak electricity generation capability, offsetting the need to build expensive natural gas "peaker" plants; and most quickly mitigate environmental problems, such as severe climate change. PV-generated electricity also can play a key role in producing hydrogen to power a new generation of fuel cell vehicles and buildings – and thus create energy security and independence for the U.S. in all three key energy use sections: electricity, transportation, and buildings (residential, commercial, and industrial). As such, we believe solar PV is an emerging technology capable of playing a key role in a renewable-energy future, and one worthy of a concerted national effort.

However, it is important to note that it is critical that we aggressively deploy all renewable energy technologies – as well as energy-efficiency technologies and practices – to address our pressing environmental, climate change, and public health concerns. PV will need to play a large role given that, even if we deploy all of the available efficiency and other renewables strategies, we won't likely adequately mitigate global climate change, achieve energy independence, or adequately reduce asthma and other public health problems. In short, after all other renewables and efficiency measures are deployed, there will still be important energy needs – needs that can be uniquely met by solar PV.

The Case for a Solar 'Moon Shot'

The need to aggressively deploy solar PV is a national priority. Today's principal energy fuels – coal, natural gas, oil, and nuclear power – have been critical resources for building the global economy, but they also present serious economic, environmental, and social problems and costs. Some of the costs are obvious, such as the cost to mine for coal, drill for natural gas and oil, or build and maintain nuclear power plants.

But there are additional costs that do not appear in our energy bills, but for which all Americans pay. These include:

- the significant economic costs of energy market disruptions resulting from conflict, regulation, accidents, or acts of malice;
- the security and military costs of protecting energy facilities and supplies, both domestically and abroad;
- the public health costs from problems caused by air pollution resulting from the burning of fossil fuels to produce electricity, including the alarming rise of asthma among our nation's children;
- damage to land and ecosystems, including threatened or endangered species, from extracting these resources – and the loss of economic benefits these damaged ecosystems would otherwise provide, such as preventing soil erosion, cleaning water, regulating the climate, and pollinating crops;
- the potentially high costs of climate change, in the form of extreme weather, flooding, drought, and other disruptions in weather and natural resources; and
- other environmental problems, such as acid rain and water pollution, that adversely affect public health and local economies.

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 full 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.

In this report, we refer only to *installed* prices.

Solar, like many renewable energy sources, significantly reduces or even eliminates many of these problems. Its fuel source is ubiquitous, free, and secure because the sun shines everywhere – not just in warmer climes. (Keep in mind that generating electricity from the sun requires light, not heat. According to the Solar Energy Industries Association (SEIA), a typical home in Maine needs only 25% more roof space than a home in sunny Los Angeles to meet its electricity needs from solar.) Generating electricity from solar produces no emissions or pollution (though manufacturing solar panels and related equipment uses energy and natural resources and creates modest emissions), dramatically reducing energy-related health and environmental impacts.

And solar energy is an inherently domestic energy resource that cannot be claimed, controlled, or owned by foreign companies or governments. Quite the opposite: Solar is a job-rich technology, creating roughly 30 jobs per installed megawatt – well-paid local jobs of manufacturers, installers, electricians, and others that cannot be outsourced – with potential reach into every American community.

Another Lost Opportunity?

Not many years ago, the manufacture of solar panels and related equipment was an American resource, too. As recently as 1997, U.S. solar companies controlled 100% of the U.S. market and 40% of the global market, according to SEIA. Today, U.S. firms

The goal of SHINE is to renew and accelerate America's solar-generating capacity in a way that aligns U.S. energy-independence goals with the goals of creating businesses and jobs.

SHINE, By the Numbers

The table below shows the impacts of SHINE, not including the accelerated effects of ASAP. (Note that the year 2014 represents last year of SHINE program funding, though the benefits of its programs continue for a decade or more.)

	2005	2010	2015	2025
Annual megawatts installed	124	622	3021	28,648
Cumulative megawatts installed	124	1,931	10,881	155,422
Cost to install a watt of solar PV	\$5.92	\$3.85	\$2.52	\$1.42
Average cost of electricity generated by solar (per kilowatt-hour)	\$0.23	\$0.14	\$0.09	\$0.05
Percentage of total U.S. electricity generation	0.01%	0.08%	0.41%	5%
Percentage of new U.S. electricity generation	0.22%	1.51%	8.01%	53.95%
Avoided tons of CO ₂ (millions)	83	1,296	7,309	104,399
Equivalent number of cars removed from the road	16,000	250,000	1,410,000	20,101,000
Jobs created (if all manufacturing done in U.S.)	3462	11,573	37,939	226,411

control only 73% and 14%, respectively. In 2003, following several years of growth, shipments from U.S. solar manufacturers actually decreased by 10%, while shipments from Europe grew by 41% and from Japan by 45%.

This represents a lost opportunity – yet another energy source for which America must look overseas. The cost can be measured not only in decreased energy independence, but in lost jobs, businesses, and tax revenue. According to *Our Solar Power Future*, SEIA's roadmap for the PV industry through 2030 and beyond:

Increasingly, policies in Europe and Japan are driving technology and market development. The U.S. solar industry is compelled to look overseas for markets and to shift critical manufacturing investments away from the United States. Where U.S. solar markets are supported by state policies, a growing share of the installed solar power systems are being imported. And Europe and Japan reap the benefit of manufacturing jobs and local economic development created by solar technology.

SHINE's Goals

The goal of SHINE is to renew and accelerate America's solar-generating capacity in a way that aligns U.S. energy-independence goals with the goals of creating businesses and jobs, enhancing national security, reducing environmental impacts, and improving public health. Specifically, SHINE aims to aggressively ramp up domestic solar PV manufacturing and system installations over a ten-year period in a way that:

- plays a significant role in creating energy independence in the U.S.;

- creates jobs, stimulates the economy, and improves environmental health in every community;
- enhances national security by providing access to a reliable, domestic, non-fossil-fuel energy source;
- is revenue neutral – that is, it pays for itself without net increased cost to taxpayers or ratepayers;
- helps drive down the cost of solar so that it becomes cost-competitive with other electricity sources in a wide range of markets and applications within the next decade; and
- enables the U.S. to regain leadership in one of the world’s most rapidly expanding industries.

We estimate that SHINE’s various programs would result in the installation of nearly 8 gigawatts (GW) of grid-connected solar PV installations and create up to 30,000 new jobs spread across all 50 U.S. states by 2014 (not including the additional GW and jobs created by ASAP). This represents a roughly 23-fold increase over all solar PV installations made in the U.S. over the past 30 years. By 2025, a fully deployed SHINE would result in 9% of all U.S. electricity and half of all new electricity generating capacity in the U.S. coming from solar PV – along with the creation of more than 525,000 new jobs.

Some Additional Requirements

To succeed in the U.S., solar PV needs additional requirements beyond the principal SHINE programs in order to pave the way for solar’s widespread implementation. They include:

- **National net metering and feed-in laws** would enable solar users to “feed in” unused electricity to the local grid, and have their utility bills reflect the “net metering” — the amount of grid electricity used minus the amount of solar energy sold back to the grid. Such policies, which are key to helping solar buyers offset the cost of their systems, are available in select states and utility districts, but not nationally.
- **Time-of-use metering** results in electricity rates rising and falling at different times of the day, week, and year, with rates highest when demand is greatest (typically on summer weekdays between noon and 6 p.m.). Such pricing structures (which require utilities to install new, “smart” meters on customer premises) favor solar PV systems, which generate the most energy during those same periods of peak energy use. As with net metering, time-of-use metering needs to be implemented nationally to benefit solar PV.
- **National interconnect standards** will facilitate the widespread deployment of solar and other distributed energy resources by standardizing technical issues related to how energy produced by renewable resources like solar feeds into the electricity grid. Currently, inconsistent technical standards and utility business practices for interconnecting non-utility generators into the grid are a major hurdle to growing solar and other renewable energy technologies.
- **Solar-friendly building codes** could remove barriers or disincentives to deploy solar PV in residential or commercial building codes that create barriers or disincentives to deploy solar PV. In some cases, additional or modified code language could help local jurisdictions approve or mandate more solar-integrated projects.
- **Public education** is essential to help solar PV succeed in the marketplace. Public education should focus on the benefits of solar energy as well as the programs available to help residential and business customers buy and install solar PV systems.

Peak Power and Solar's Special Role

In the U.S., utilities frequently turn to natural gas "peaker" plants to meet electricity demand during peak periods. These plants typically sit idle much of the time, coming to life only when electricity demand is high — for example, on summer afternoons. Solar PV can play a critical role in providing a clean, cost-competitive alternative to constructing peaker plants.

Our analysis shows that for many peak-use situations, solar is a preferable option. Solar energy is at its highest output during these same times of peak energy use (hot summer days), is nonpolluting, and is usually available where it is needed. Natural gas peaker plants, on the other hand, are polluting, rely on stressed electricity grids, and need extensive approval to get sited in local communities.

On a pure cost basis, solar is also the winner, with current industrial-scale PV installations costing an average \$.20 per kWh and natural gas peaker plants running approximately \$.28 per kWh, when operated during times of peak use. The cost for natural gas peaker plants could be much higher if natural gas prices rise due to high demand or inadequate supply. Solar prices, on the other hand, would decline to as low as \$.07 per kWh for industrial applications by the end of 2014 (the time-span of SHINE).

Comparing the Costs

Natural Gas Peaker Plant

Plant construction	\$.50/watt	\$.10/kWh
Grid cost	\$.50/watt	\$.10/kWh
Gas pipeline	\$.25/watt	\$.05/kWh
Fuel, operation, and maintenance	\$.04/kWh	\$.04/kWh
Total before transmission losses	n/a	\$.29/kWh
Transmission losses	5%	5%
Total after transmission losses	n/a	\$.30/kWh

Assumptions: Operating 8 hours day/55 days a year, during times of peak-energy use, per data collected from California ISO. Costs are annualized over 20 years with a 6% cost of capital.

Solar PV (Industrial-Grade Installations)

Manufacturing, Installation, and Maintenance	\$6/watt	\$.19 per kWh
Transmission Losses	5%	5%
Total after transmission losses	n/a	\$.20/kWh

Assumptions: Operating 5 hours per day, 365 days per year. Costs are annualized over 7 years, with a 6% cost of capital.

SHINE's programs are designed to be revenue neutral, its initial investment coming from a small shift in existing energy subsidies and its payback captured from reduced energy costs, the value of new jobs and businesses, the savings from avoiding construction of new peak-power generation facilities, and other sources of value, including reduced pollution clean-up and reduced health-care costs.

One important aspect of SHINE is its relatively long-term horizon. SHINE's programs extend for a full ten years, providing incentives and other support that will allow the industry to enjoy sustained, orderly growth — a vital ingredient for the success of any emerging technology. Such multiyear government commitments have enabled other technologies to reach critical mass, such as solid-state electronics, wireless communication, and broadband Internet access. Like solar, all three of these were seen as technologies vital to America's economic growth, global competitiveness, and national security. Long-term commitments to solar have proven key to solar's successful growth in Japan and Germany, the world's solar leaders. Says SEIA: "Effective policies sustained over time increase solar power production, dramatically grow markets, improve technology, and reduce costs. Programs

in Germany, Japan, and California prove it."

SHINE's programs are strategically designed to accelerate the price reductions of solar PV installations — at least 10 to 15 years sooner than they would drop based on current trends and trajectories — while Americans accrue all of the benefits of a robust

Setting the Stage: Challenges and Opportunities

domestic solar industry: energy security, new jobs and businesses, reduced imports, increased exports, and more.

In our 2002 report, *Bringing Solar to Scale*, and our follow-on 2003 study, the *Solar Opportunities Assessment Report*, which examine what is needed to grow the U.S. solar industry to make it competitive, we attempted to outline the challenges and opportunities facing the solar industry. (Both may be downloaded at no charge from www.solarcatalyst.org or www.cleaneedge.com.)

Following are the key takeaways from those reports:

Our research identified three key levers that drive the growth of the solar PV industry and must be addressed both individually and in concert.

Key Challenges. Among the key challenges to growing the U.S. solar marketplace:

- its current small production scale, which keeps quantities low and prices high;
- on-again-off-again government funding of solar research and development;
- a dearth of financing solutions, pricing solar out of reach of most users;
- a patchwork of regulations related to solar, forcing manufacturers and buyers of solar systems to meet different requirements in each state;
- a lack of coordination among companies, government agencies, the solar and building industries, or potential buyers of solar systems;
- a lack of standardized, “plug-and-play” systems that would greatly reduce the complexity and cost of designing and installing a solar-energy system; and
- a lack of education about solar’s benefits to a variety of audiences.

Key Levers. Our research identified three key levers that drive the growth of the solar PV industry and must be addressed both individually and in concert. They are:

- The **technology lever** includes breakthrough improvements, not just incremental ones, that can dramatically reduce solar’s costs and improve its efficiency and reliability – not just at the R&D level, but at the commercial level.
- The **policy lever** centers on government support for solar, relative to conventional energy technologies, including creating large, long-term government incentives and commitments; fixing a patchwork quilt of state-level programs; eliminating subsidy programs that artificially inflate prices; and resisting pressure from utilities and other incumbent players to maintain the status quo.

- The **finance lever** addresses cost and affordability, which are the key detriments for many would-be solar buyers, whether consumers, businesses, or governments. These include easy financing mechanisms, such as mortgage-related instruments, that make financing of solar easier for residential and small-business customers; new financing instruments; and new market players.

Key Strategies. Along with these three levers, we identified three cross-cutting strategies that need to be addressed to help bring solar to scale:

- **Education.** One common frustration is the lack of reliable, comprehensive, and easily accessible information resources about solar – its costs, benefits, and when and how it makes sense to install. Critical information gaps can be found in all corners of the market, from manufacturers and installers to end users and policy makers.
- **Standardization.** The lack of plug-and-play solar systems, whether for residential or commercial/industrial buyers, frustrates buyers and sellers alike. For the former, buying solar requires a dizzying array of options and technical decisions; for the latter, each new installation requires resource-intensive one-off design and installation plans.
- **Market Development and Aggregation.** Leveraging the power of bulk purchases from government agencies, companies, homeowners, and others, thereby lowering prices through economies of scale, is a compelling means of bringing solar to scale. There is a wide range of possible aggregation strategies, each with its own challenges and opportunities.

Through its three principal initiatives, SHINE attempts to overcome the challenges and integrate the strategies identified by SOAR through a coordinated national effort to make solar a vital component of America's renewable energy future.

SHINE'S PROGRAMS

In this section we describe the three principal components of SHINE. These are broad descriptions, with many details to be added. Our intention is not to proscribe specific policies and processes so much as to articulate the larger vision of what a realistic program would look like and accomplish.

SUNUP would empower U.S. states and territories with the models and the financial means to facilitate the implementation of solar PV for state and local government.

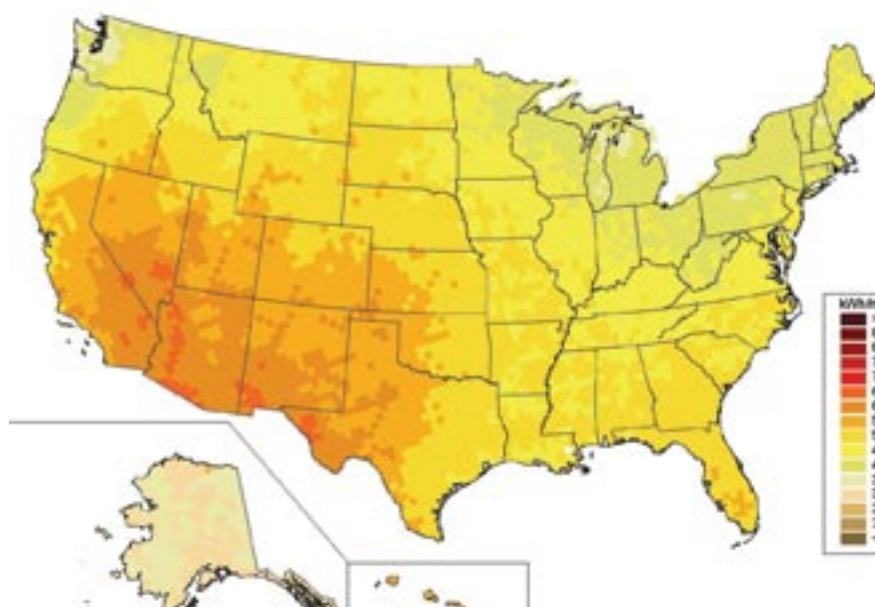
1. SOLAR UTILIZATION NATIONAL UNDERWRITING PLAN (SUNUP)

To borrow from the late Massachusetts congressman Tip O'Neill, "All solar is local." Unlike, say, coal, oil, natural gas, or enriched uranium, each of which must be transported, often hundreds or thousands of miles, to where it can be harnessed as fuels to create electricity, solar energy's value is highest in the places where it is found – which is to say, everywhere. And we believe that one of the smartest, most effective routes to building a globally competitive U.S. solar industry is to leverage this strength, by providing national support for local solar energy programs.

Toward that end, we propose the Solar Utilization National Underwriting Plan, or SUNUP, a federal block-grant program to provide funding to implement aggressive, job-creating solar programs at the local level. SUNUP would empower U.S. states and territories with the models and the financial means to facilitate the implementation of solar PV for state and local government as well as nongovernmental and private-sector entities – homes, commercial and industrial buildings, universities, utilities, etc.

America's Vast Solar Potential

The map on the right, prepared by the U.S. Energy Department's National Renewable Energy Lab, shows the potential for solar photovoltaics across the U.S. Even a casual view of the map shows that nearly all of the U.S. receives solar radiation within the mid range of NREL's scale – meaning that there is vast potential for using solar photovoltaics almost anywhere in the United States. Simply put, the U.S. is the Saudi Arabia of solar.



About SHINE's Target Price

Several well-regarded reports have noted that the market for solar PV becomes self-sustaining once total installed pricing reaches somewhere between \$2.50 and \$3.00 per installed watt — and we concur.

Richard M. Swanson, in his paper "A Vision for Crystalline Silicon Solar Cells," assumed a global market price of \$3 per watt for a competitive solar industry. In the more recent Energy Foundation/Navitant report, the case was made for a robust solar industry once the market reaches \$2.50 or less per watt.

We chose to go with three target prices for this report, each of which opens up significant new markets \$2.50, \$2.00, and \$1.00. See page 30 for details.

Block grants are funds given to states by the federal government to run programs within defined guidelines. Block grants date back to 1966 and are a popular means of shifting decision-making of national to the local level, from health care to transportation to job training. Block grants are, admittedly, controversial: Within the realm of delivering social services, the notion of turning federally managed funding into a block grant, as a scholar at the Brookings Institution put it, "seems to lead to fewer dollars and services."

SUNUP does not shift federal dollars to local control. Rather, it commits federal funds (see "Funding SHINE" section, page 36, for details) to implement solar at the local level while providing incentives to states and localities to commit additional funding for this purpose. SUNUP is en-visioned as a matching grant program, meaning that federal dollars would be used to match state funding on a one-to-one basis.

One of the best-known examples of block grants was in welfare reform during the mid 1990s, a bipartisan effort of the Clinton administration and the Republican-led Congress. The implicit promise of the Welfare Reform Act of 1996 was to "make work pay." States used the grants to provide child care and transportation and other supports to working poor families, as was deemed appropriate in each jurisdiction.

In a similar vein, the promise of SUNUP is to "make solar competitive."

In essence, SUNUP block grants would help states cover the cost differential between solar PV's projected market prices and \$2.50 per installed watt — SHINE's initial market take-off price. Over a period of 10 years, SUNUP would allow states to provide subsidies or other assistance through any of a variety of means: direct buy-down subsidies, feed-in tariffs, performance-based credits, low-interest loans, or other programs or incentives (see box, "Examples of Proven Successes," page 24).

Block grants already have been used in the energy arena. The Energy Assistance Block Grants currently administered by the U.S. Department of Health and Human Services, provides about \$2 billion in federal funds for fiscal year 2005. Their purpose:

To make Low Income Home Energy Assistance Program (LIHEAP) grants available to States and other jurisdictions to assist eligible households to meet the costs of home energy. Supplemental Leveraging Incentive Funds may be awarded to reward States and other jurisdictions that provide additional benefits and services to LIHEAP-eligible households beyond what could be provided with Federal funds. Up to 25 percent of the leveraging incentive funds may be set aside for LIHEAP grantees that provide services through community-based nonprofit organizations to help LIHEAP-eligible households reduce their energy vulnerability under the Residential Energy Assistance Challenge Option Program (REACH). Training and Technical Assistance: To provide training and technical assistance to States and other jurisdictions administering the LIHEAP block grant program.

SUNUP in Brief

SUNUP comes with just two strings attached. To be eligible for SUNUP funds, states would be required to:

- raise state and local funding for solar procurement and implementation, up to a defined cap, which would be matched by SUNUP funds; and
- develop a Solar Implementation Plan showing how it planned to expand grid-connected and peak-generation solar PV programs over a ten-year period.

Examples of Proven Successes

While states and territories would determine how SUNUP would be used, there are several program models that have proven successful in increasing demand for grid-connected PV solar systems. Here are examples of state and local programs that SUNUP could support:

- **Buy-down or rebate programs.** Several U.S. states offer rebates that “buy down” the upfront cost of purchasing a solar system, thereby lowering its price to end-users. The most mature is California’s Emerging Renewable Program, in which the state pays approximately \$3 per installed watt for residential systems of less than 30 kilowatts (rebates for owner-installed systems are 15% less). The subsidy currently declines by 20 cents every six months. There are also programs for larger solar installations on commercial and institutional facilities.
- **Feed-in tariffs.** Germany has dramatically accelerated demand for solar through a law that permits customers to receive preferential tariffs for solar-generated electricity — between 45 and 62 eurocents (roughly 60 to 83 U.S. cents) per kilowatt-hour — over a 20-year period. This provides a lucrative incentive for customers to install solar in order to profitably sell electricity back into the grid. Largely as a result, Germany had the fastest-growing major PV market in the world in 2003. According to one estimate, the German PV industry already generates more than 10,000 jobs related to solar production, distribution, and installation.
- **Production incentives.** Payments based on performance rather than capital investments can be an effective mechanism for ensuring quality projects. This ensures, for example, that solar PV systems that are installed are actually put into (and kept into) service. In several states, utilities or private-sector firms offer customers who install renewable energy systems the opportunity to sell the “green tags” (also known as renewable energy credits, or RECs) associated with the energy generated by these systems. The amount of the payments are typically \$1 to \$100 per megawatt-hour (\$.001 to \$0.10 per kilowatt-hour), varying by technology and the length of the contract period.
- **Low-interest loans.** Programs offering low- or no-interest financing for the purchase of solar equipment are available from both utilities and state governments, making solar PV purchases more affordable by end users. In many states, loans are available to residential, commercial, industrial, transportation, public, and nonprofit sectors. Repayment schedules vary; while most are determined on an individual project basis, some offer a 7-10 year loan term.
- **Tax incentives.** There are several types, all designed to reduce the overall cost of a solar PV system. *Property tax incentives* typically follow one of three basic structures: exemptions, exclusions, and credits. The majority of the property tax provisions for renewable energy follow a simple model that provides that the added value of the renewable energy system not be included in the valuation of the property for taxation purposes. Many states offer *personal income tax credits* or deductions to cover the expense of purchasing and installing renewable energy equipment. Some states offer *personal income tax credits* up to a certain percentage or predetermined dollar amount for the cost or installation or renewable energy equipment. *Sales tax incentives* typically provide an exemption from state sales tax when purchasing renewable energy equipment.
- **Lease programs.** These reduce the initial cost of a solar system by eliminating the up-front purchase cost and allowing users to pay only a monthly fee. Utility leasing programs typically target remote power customers for which line extension would be very costly. The customers can lease solar equipment from the utility, and in some cases, the customer can opt to purchase the system after a specified number of years.
- **Direct sales.** A few utilities sell renewable energy equipment to their customers as part of a buy-down, low-income assistance, lease, or remote power program, usually offering easy payment terms rolled into the customer’s monthly utility bill.

SUNUP's Costs and Total System Installations

Below are the costs and benefits of SUNUP. The costs associated with SUNUP would be repaid over time through reduced electricity bills, economic growth through new businesses and jobs, and small energy subsidy shifts at the federal level, making SUNUP revenue neutral to taxpayers.

Year	Program Cost (millions)	Federal Share (millions)	MW Installed	Equivalent Number of Households
2005	\$367	\$183	107	18,400
2006	448	224	153	26,300
2007	537	269	216	37,200
2008	631	315	305	52,500
2009	723	362	427	73,400
2010	804	402	596	102,500
2011	857	428	830	142,800
2012	855	428	1,153	198,300
2013	760	380	1,600	275,200
2014	510	255	2,218	391,500
TOTAL	\$6,492	\$3,246	7,605	1,318,100

Total annual awards would be based on a formula that considered each state's or territory's financial commitments, SHINE's total available funds, and a pro-rata distribution formula based on population, energy consumption, and other factors. Each jurisdiction would be required to apply annually to the administering federal agency – most likely the U.S. Department of Energy.

SUNUP, like SHINE overall, is revenue neutral, with investments in solar PV repaid through avoided costs of buying grid electricity, and by selling excess solar-generated electricity back into the grid. In addition, the federal dollars used for SUNUP would

be shifted from programs currently supporting fossil fuels and nuclear power, meaning that no new taxpayer funds would be needed to fund SUNUP.

States, as indicated earlier, would have maximum flexibility on how the money would be used, as long as the funds' impact was to bring the net capital cost of an installed system down to \$2.50 per peak watt or less for the end user. In administering SUNUP, the federal government would provide states and territories with sample program models and best practices, as well as highlight state successes, but would leave the implementation details up to each jurisdiction.

Jurisdictions would have flexibility on where to deploy the money – how much, if any, should be allocated to state government, local government, residential, commercial, industrial, utilities, or other solar PV applications. States and territories also could determine who will administer the money – directly, through a government entity, or indirectly through a utility in the state or, potentially, through any for-profit or nonprofit entity, provided that there be a cap on administrative costs.

States and territories would be required to apply on an annual basis to participate in SUNUP. Each year's Solar Implementation Plan would require details on how the money would be deployed – the type of program, the target audience, and who would administer it – and a progress report detailing the disposition of previous years' funds.

We estimate SUNUP's total cost to be \$6.5 billion over ten years – \$3.25 billion in federal contribution and another \$3.25 billion in matching state contributions.

SUNUP's State-by-State Impact

Following is a state-by-state breakdown of the total 10-year state and federal contributions and the cumulative megawatts installed over the life of SUNUP, assuming each state applied for the full amount for which it was eligible:

	Cumulative Installed (MW)	State Contribution (\$ Millions)	Federal Match (US\$ Millions)	Equivalent Number of Households
Alabama	118	50	50	20,300
Alaska	17	7	7	2,900
Arizona	146	62	62	25,100
Arkansas	71	30	30	12,200
California	928	396	396	159,600
Colorado	119	51	51	20,500
Connecticut	91	39	39	15,700
Delaware	21	9	9	3,600
DC	15	6	6	2,600
Florida	445	190	190	76,500
Georgia	227	97	97	39,000
Hawaii	33	14	14	5,700
Idaho	36	15	15	6,200
Illinois	331	141	141	56,900
Indiana	162	69	69	27,900
Iowa	77	33	33	13,200
Kansas	71	30	30	12,200
Kentucky	108	46	46	18,600
Louisiana	118	50	50	20,300
Maine	34	15	15	5,800
Maryland	144	61	61	24,800
Massachusetts	168	72	72	28,900
Michigan	264	113	113	45,400
Minnesota	132	56	56	22,700
Mississippi	75	32	32	12,900
Missouri	149	64	64	25,600
Montana	24	10	10	4,100
Nebraska	45	19	19	7,700
Nevada	59	25	25	10,100
New Hampshire	34	14	14	5,800
New Jersey	226	96	96	38,900
New Mexico	49	21	21	8,400
New York	502	214	214	86,300
North Carolina	220	94	94	37,800
North Dakota	17	7	7	2,900
Ohio	299	128	128	51,400
Oklahoma	92	39	39	15,800
Oregon	93	40	40	16,000
Pennsylvania	323	138	138	55,600
Rhode Island	28	12	12	4,800
South Carolina	108	46	46	18,600
South Dakota	20	9	9	3,600
Tennessee	153	65	65	26,300
Texas	578	247	247	99,400
Utah	61	26	26	10,500
Vermont	16	7	7	2,800
Virginia	193	82	82	33,200
Washington	160	68	68	27,500
West Virginia	47	20	20	8,100
Wisconsin	143	61	61	24,600
Wyoming	13	6	6	2,200
TOTAL	7603.76	\$ 3,246	\$ 3,246	1,307,500

2. U.S. ROOFTOP INITIATIVE FOR SOLAR ENERGY (U.S. RISE)

Government is a likely aggregator of solar system purchases, much as it has with many previous technologies, from transistors to PCs.

In our *Solar Opportunities Assessment Report*, we described the critical need for government support of solar and other renewable energy technologies. A survey of leading solar industry executives, academics, and others conducted for that report found a majority of respondents stating that consistent, long-term government policies, regulations, and incentives were critical to the healthy growth of solar PV markets. As we've already noted, countries like Japan and Germany that have implemented innovative and supportive national policies lead the world in both PV manufacturing and installations.

SOAR stressed the need for government coordination and support at the national, state, and regional levels for a wide range of incentives and programs including: technology development (R&D, technology transfer, commercialization assistance, etc.); regulatory framework (building codes, net metering, interconnect standards, etc.); financial mechanisms (low-cost government backed mortgages/loans, tax credits, end-user subsidies, etc.); and market development (aggregated government procurement, market coordination efforts, educational campaigns, etc.).

All of those needs remain critical to solar PV's ultimate success in the marketplace. However, it may be the federal government's own purchasing power that could go furthest, fastest in bringing solar to scale.

Government is a likely aggregator of solar system purchases, much as it has with many previous technologies, from transistors to PCs. As we noted in our 2002 report, *Bringing Solar to Scale*, the U.S. Department of Defense, needing a lightweight electronic replacement for vacuum tubes for the development of new weapons for the Cold War in the 1950s, made a significant investment in transistors. At the time, transistors cost \$20 apiece. Within ten years, transistors had dropped to 25¢ to 30¢ each.

Similarly, we believe that substantial and sustained government purchases could cause dramatic cost reductions for solar photovoltaics.

Toward that end, we propose the U.S. Rooftop Initiative for Solar Energy (U.S. RISE), a ten-year federal procurement program that would commit \$100 million per year to purchase and install solar PV systems on federal facilities, including office buildings, courthouses, warehouses, military installations, and the myriad other real estate owned and operated by Uncle Sam.

U.S. RISE in Brief

U.S. RISE would commit the federal government, the nation's biggest energy consumer, to become one of the nation's largest purchasers of solar energy systems – a billion dollars' worth over a ten-year period. Under the program, federal purchases would be

recaptured over time in the form of avoided energy costs, with a net-zero impact on the federal budget. Indeed, over the 25- to 30-year expected lifetime of the solar panels installed under this program, U.S. RISE would yield a net-positive financial benefit to the U.S. Treasury.

The federal government's 500,000 buildings represent roughly one-half of one percent of the nation's total building inventory.

The federal government's 500,000 buildings represent roughly one-half of one percent of the nation's total building inventory. These half-million buildings require taxpayers to spend more than \$3 billion each year for heating, cooling, lighting, and powering these facilities. Over the past 20 years, actions have been taken to reduce that energy bill through energy efficiency and a relatively tiny investment in renewable energy, mostly solar systems, on federal buildings. The federal government is committed to installing solar photovoltaic and solar thermal energy systems (the latter using the sun to heat air and water, but not to generate electricity) on 20,000 federal buildings by 2010. Under the Clinton Administration, the government exceeded an interim goal of installing 2,000 systems on federal buildings by the end of 2000. However, the program has stalled in recent years, and reaching the official 20,000 target is now under question.

U.S. RISE would build on earlier government successes by committing the federal government to more aggressively purchase solar PV systems. The program would, in effect, turn the government's idle roof space into mini-power plants. According to our estimates, the program, when fully implemented, would result in 256 MW of onsite, grid-connected electricity, representing thousands of new grid-connected solar energy systems on federal buildings after ten years.

U.S. RISE INSTALLATIONS

Year	Annual cost (millions)	Annual MW Installed	Cumulative MW Installed
2005	\$100	17	17
2006	\$100	18	35
2007	\$100	20	55
2008	\$100	22	77
2009	\$100	24	101
2010	\$100	26	127
2011	\$100	28	155
2012	\$100	31	186
2013	\$100	34	220
2014	\$100	36	256

One vision of how such a program might work comes from a 2001 amendment to a congressional energy bill proposed by Minnesota Rep. James L. Oberstar. (Oberstar is the ranking Democratic member of the House Committee on Transportation and Infrastructure, which has jurisdiction over federal buildings.) The amendment originally called for approximately \$1.3 billion over five years to deploy solar electric systems

on federal buildings. This dollar amount was later reduced to a smaller commitment in the final conference report on the energy bill. The Oberstar Amendment was never implemented, as the energy bill never passed through Congress, though the amendment serves as a realistic model of what a strong federal procurement commitment might look like.

PV systems would provide the government with virtually free electricity for an additional 20 years beyond the payback period – a small but significant bit of “tax relief” for all Americans!

The Oberstar Amendment called for the administrator of the General Services Administration – the agency responsible for operating most of the federal government’s non-military facilities – to establish “a photovoltaic energy commercialization program for the procurement and installation of photovoltaic solar electric systems for electric production in new and existing public buildings.” It mandated that “The acquisition of photovoltaic electric systems shall be at a level substantial enough to allow use of low-cost production techniques with at least 150 megawatts (peak) cumulative acquired during the 5 years of the program.”

The initiative, according to Oberstar’s office, would have funded the purchase and installation of some 18,000 photovoltaic systems.

Clearly, Oberstar’s intent aligns nicely with SHINE’s goals. In introducing his amendment, Oberstar observed: “The federal government, which purchases billions of dollars of energy each year, is in a unique position to facilitate a breakthrough for photovoltaics. These purchases give industry the resources and incentives to develop the technology and mass production efficiencies necessary to make photovoltaics competitive.”

U.S. RISE Costs and Benefits

By the end of the program, when prices have reached approximately \$2.50 watt, the payback time for PV installations under U.S. RISE would average 10 years across the system. (For purposes of comparison, according to the Energy Foundation and Navigant Consulting, the payback for small and medium commercial installations at \$2.20 peak watt installed in 2010 would be around 9 years). Since most federal buildings have long life spans – usually several decades – and because today’s solar PV systems are warranted to last up to 30 years, the PV systems would provide the government with virtually free electricity for an additional 20 years beyond the payback period – a small but significant bit of “tax relief” for all Americans!

3. AMERICAN SOLAR ADVANCEMENT PRIZE (ASAP)

SUNUP and U.S. RISE are strategically designed to bring the price of solar down within ten years to the market take-off target price of \$2.50 watt installed for residential and commercial rooftop installations.

But what if we could do it faster? A dizzying array of technologies have been proposed that could bring solar’s cost down to under \$2 per watt installed. Such a price would

Where Solar Power Makes Sense

Installed Price/Watt	Equivalent Cents/kWh	Application
Current Pricing (\$5-\$7/watt)	18¢ to 25¢	Remote power, distributed peak generation, high-cost utility markets (such as Japan), and regions with rebates and subsidies
\$2.50/watt	7¢ to 10¢	Most residential and commercial markets in the U.S. and abroad
\$2.00/watt	5¢ to 7¢	Most markets, including regional power, commercial and residential, and peak power
\$1.00/watt	2¢ to 3¢	All markets, including broad utility implementation

dramatically accelerate solar's market acceptance – and its contribution to curb climate change and other environmental problems, all while making America an undisputed world leader in solar system manufacture, with all of the energy security,

economic, job-creation and environmental benefits that come with fully developing the solar energy component of America's energy strategy.

More than a score of firms have created designs, prototypes, pilot installations, and, in a few cases, manufacturing operations using advanced materials and processes designed to decrease solar's costs and increase its efficiencies.

Market Take-Off Prices. As solar's price drops, it becomes cost-competitive in a growing number of market applications. There are three critical take-off points:

- **At \$2.50 per installed watt** (equivalent to 7¢–10¢ per kWh), solar becomes affordable for homeowners and businesses to put solar on their rooftops, and for utilities to install it to produce peak power. SHINE will achieve this milestone in 2010, 11 years faster than Business As Usual.
- **At \$2 per installed watt** (equivalent to 5¢–7¢ per kWh), solar becomes cost-competitive for utilities and other energy developers to install solar in regional neighborhood "farms" – on warehouses, parking lots, and brown-fields, for example. SHINE could make this happen as early as 2012, a full 32 years faster than Business As Usual.
- **At \$1 per installed watt** (equivalent to 2¢–3¢ per kWh), the price becomes affordable for utilities to start using solar in their baseload; the transportation sector to start using solar to make hydrogen for fuel cells or to power highly efficient batteries; and for industrial power use. SHINE would achieve this milestone in 2020 – at least three decades faster than Business As Usual.

Technology Marches On. The past few years have seen great advances in the design, manufacture, and operation of solar cells – at least at the research-and-development level. More than a score of firms around the world – both start-ups and established incumbents – have created designs, prototypes, pilot installations, and, in a few cases, manufacturing operations using advanced materials and processes designed to decrease solar's costs and increase its efficiencies.

Unfortunately, many of these promising technologies won't get far beyond the lab. It's the classic chicken-and-egg syndrome: Investors won't ramp up funding and deployment of these technologies without adequate demand, but the demand won't exist

without the lower prices and increased efficiencies these technologies offer.

ASAP would help leapfrog today's technologies and jumpstart the U.S. solar industry while enabling manufacturers to reach aggressive pricing targets more than two decades ahead of Business As Usual.

To accelerate deployment of advanced solar technologies into the marketplace at a rate faster than outlined in SUNUP and RISE, and to support further development of many of these promising technologies, we propose a third component to SHINE: the American Solar Advancement Prize, or ASAP, an international competition that would richly reward the victors for bringing the price of U.S.-made solar from today's \$6 per installed watt installed to \$2 per watt or less by 2010.

ASAP would help leapfrog today's technologies and jumpstart the U.S. solar industry while enabling manufacturers to reach aggressive pricing targets nearly a decade ahead of current SHINE projections and more than two decades ahead of Business As Usual. This significant step would make solar PV cost-competitive with conventional forms of retail electricity in nearly all regional U.S. markets sooner than many anticipate.

The Competition in Brief

ASAP would be open to any company in the world, including consortia of companies, public-private partnerships, universities, and others. The winner(s) would be awarded both a cash prize as well as a guaranteed purchase order for modules that could be installed as part of SHINE's SUNUP and U.S. RISE procurement programs.

Applicants would be required to show how, by 2010, they could manufacture and install solar systems with the following minimum characteristics:

1. an installed system price of \$2 per watt;
2. a system conversion efficiency of at least 12%; and
3. at least half of system components manufactured or assembled in the U.S.

Creating Scale in a "Solar City"

One vision of how a dramatic ramp-up of production could radically lower prices for solar PV came in 2004 in a report funded by the federal government National Renewable Energy Laboratory.

Dr. Marvin S. Keshner, who for 25 years has led advanced technology development for high-volume, low-cost manufacturing at Hewlett Packard (HP), and Rajiv Arya, formerly Vice President for Research and Development for BP's thin-film solar division, detailed a design for a "Solar City" factory module that could produce more than 2 gigawatts solar panels per year. That's more than two times the volume of the entire solar module industry in 2004.

In their report, Keshner and Arya showed that with a reasonable selection of materials this "Solar City" can hit a price target of \$1 per watt as the total price for a complete and installed solar energy system — less than one-sixth current prices. This breakthrough in the price of solar energy was made without any significant new invention. Price reductions came almost entirely from the design of a large factory and the cost savings inherent in operating at such a large manufacturing scale.

Keshner's and Arya's "Solar City" factory was designed to be large enough to obtain dramatic breakthroughs in manufacturing costs, small enough to be affordable in capital cost, and small enough to be well matched to the needs of local markets. Inputs to the "Solar City" are raw materials in bulk form that are easy and inexpensive to transport, say Keshner and Arya. Outputs are finished solar panel products, ready for simple installation.

The factories would require a capital investment of \$600 million, significantly less than semiconductor and flat panel display factories, which cost well over \$1 billion each.

How ASAP Compares

Similar to the Ansari X Prize, which ignited the private sector's race to space travel, and the Golden Carrot award, which spurred development and marketing of energy-saving refrigerators in the early 1990s, ASAP would aim to put America back into the solar business.

	Golden Carrot	Ansari X-Prize	ASAP
Description	\$30 million awarded to manufacturer of a "super-efficient" refrigerator	\$10 million for the first company to develop a privately built, piloted spaceship	Up to three companies each awarded \$75 million in cash award and \$100 million in purchase orders. Total price tag of \$525 million
Date Awarded	1993	2004	Projected 2007
Principal Goal	Design and manufacture the most energy-efficient, CFC-free refrigerator at the lowest cost	Design and launch a spacecraft to fly twice, within a two-week period, carrying a pilot and the weight equivalent of two additional people	Design and installation of PV systems costing \$2 per peak watt, with system efficiency of at least 12%, and at least half of system components manufactured in U.S.
Sponsor	A consortium of 24 energy utilities, which committed between \$150,000 and \$7 million each	X Prize Foundation	U.S. federal government and possible consortium of private industry and foundations
Award Winner	Whirlpool Corporation	American Mojave Aerospace Team, developer of SpaceShipOne, led by research aircraft developer Burt Rutan and financier Paul Allen	To be determined. The winners will likely become the industry leaders of one of the fastest-growing technologies.

Details of the competition would be determined by its organizers, which could be a partnership between the U.S. Department of Energy and a major U.S. university, a consortium of utilities or other private-sector initiatives, or any number of other partnership types. Here, in broad strokes, is one vision of how the competition could work, though there are many other ways it could be structured:

- Applicants would be required to demonstrate how they would deliver such systems by 2010 utilizing a sustainable, profitable business model, as opposed to a one-off, subsidized effort. This would involve a detailed business plan showing manufacturing partners; marketing and distribution channels to reach the targeted end-users; targets and timetables; funding sources; and a prototype of the proposed system.
- Applicants would be judged by an independent, blue-ribbon panel comprised of experts both in solar technology as well as in manufacturing, marketing, distribution, and installation of systems. Included would be CEOs of major companies, technology experts from government labs, and leading academics. Judges would need to certify that they are free of conflicts of interest and would not receive any direct financial benefits from ASAP's outcome.
- The judges would consider the full scope of each application, with the aim of choosing the winner(s) most likely to successfully market and install solar systems with the target characteristics. A point system would be developed that would consider the full scope of an application. Points would be awarded

How ASAP Impacts Solar Industry Growth

ASAP could have a significant impact on the growth of the solar PV industry in the U.S. by reducing the price of solar to \$2 per peak watt installed system pricing by 2010. Our analysis shows that such an accelerated time frame could enable the U.S. solar industry to see continued growth rates in the U.S. of 38% per annum through 2025. The table below shows the results for 2025.

	Business As Usual	SHINE without ASAP	SHINE with ASAP
Cumulative megawatts installed	13,255	155,422	282,780
Projected cost per peak watt installed (best price without subsidies)	\$2.71	\$1.42	\$0.80
Average cost per kWh	\$0.10	\$0.05	\$0.03
Percentage of total us electricity generation	0.42%	5%	9%
Avoided tons CO ₂ (millions)	8.9	104.4	189.9
Equivalent cars removed from the road (millions)	1.7	20.1	36.6
Jobs created (if all manufacturing done in U.S.)	23,181	226,411	580,922

for such criteria as the quality of the technology, the qualifications of the management team and supply-chain partners, the understanding of the target market, the likely ability to execute the proposed plan, and the highest percentage of U.S. jobs and businesses that would be created.

- Judges could choose up to three winners. Each winner would receive \$75 million in funding targeted to research, development, and deployment of the modules and systems, as well as a guaranteed purchase order of \$100 million over a four-year period for the finished products. Funds would be dispersed according to an agreed-upon schedule that required the recipient to meet specific targets and timetables.
- A small royalty on the sales would be paid by the winners to the federal government, helping to offset SHINE's costs and make it revenue neutral.

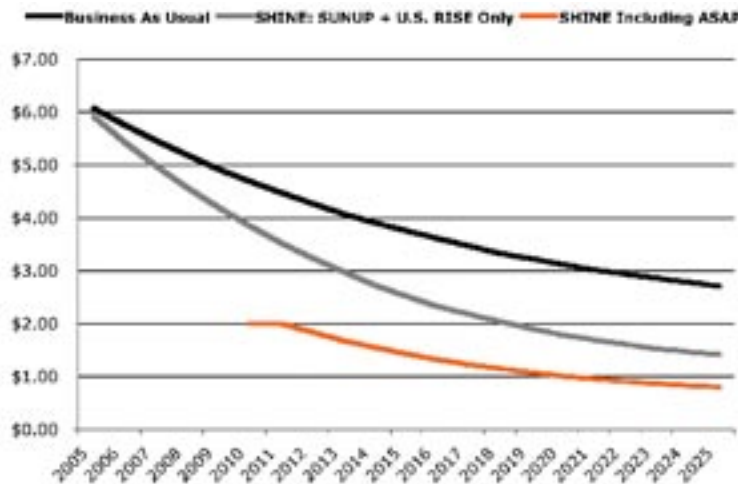
ASAP's Impacts

A successful ASAP would restore a competitive solar industry to U.S. shores while significantly reducing prices about a decade ahead of some of the more aggressive projections. In concert with the other components of SHINE, ASAP would guarantee the creation of tens of thousands of U.S.-based jobs and a leadership role in PV technology innovation, manufacturing, and deployment.

Among ASAP's benefits will be to incentivize new collaborations and creative thinking among the various players: silicon feedstock, cell, and module manufacturers; balance of system manufacturers; and system integrators/installers. In our 2003 *Solar Opportunities Assessment Report*, we noted that one of the greatest opportunities for solar technology would come from new ways of "packaging" systems to bring down capital costs and streamline installation. At present, approximately two-thirds of the cost of

ASAP's Declining Prices

The impact of ASAP is that solar reaches \$2 per watt by 2012, a full 32 years faster than Business As Usual.



Best system pricing. Assumes ASAP's benefits do not begin until 2010.

an installed PV system is in turning solar cells into modules (which combine the cells with electronics components and connection devices); adding the “balance-of-system” components, such as inverters (which turn solar’s direct current, or DC power, into alternating current, or AC power, used in most buildings) and racks (devices for mounting multiple modules); and installation (mounting all this onto a building and connecting it to the building’s electrical system and to the larger grid). This means that there is considerable opportunity to drive down costs on all aspects of a PV system.

In SOAR we outlined some of the specific breakthroughs that could dramatically lower installed PV costs. ASAP could

catalyze any number of key developments that could dramatically lower the cost of solar PV in the coming decade. Three key areas ripe for advancement include:

1. **The rapid scale-up of large, centralized PV manufacturing facilities.** Sharp, the world’s largest manufacturer of solar PV modules, has been successful in being an industry leader by improving economies of scale. Since 2000, Sharp has grown its PV manufacturing operations from 50 MW per year to a projected 400 MW in 2005. It now controls approximately a third of total global solar PV manufacturing output. Meanwhile, Q-Cells in Germany is emerging as the largest manufacturer of PV cells in Germany in just five years – growing from 0.4 MW production output in 2001 to a planned output of more than 200 MW in 2005.

Many experts believe that if the U.S. (or any other country) were to invest in large-scale manufacturing facilities – that the nation could significantly reduce manufacturing costs. According to a recent paper from the National Renewable Energy Lab by Marvin S. Keshner and Rajeeva Arya, a mega-factory producing up to 3.6 GW (3,600 MW) of solar panels per year could enable installed pricing in the vicinity of \$1 per peak watt. (See box on page 31.)

ASAP would build on the groundwork laid by these companies and others that have demonstrated that scale can bring significant advantages in quality, craftsmanship, and pricing. It would call forth the competitive spirit to make solar’s price a priority focus, created the partnerships needed to scale up,

and get the U.S. to \$2 per watt within five years – our “man on the moon” mission.

2. **Breakthrough advances in silicon, thin-film, and nano-based technologies.** For the past two decades, inventors and entrepreneurs have touted the “next breakthrough” that would revolutionize the solar industry. To some extent, they’ve been right. It’s just taking longer than expected.

We believe that a number of advanced solar technologies are reaching a tipping point – where breakthroughs are not only possible, but likely.

We believe that a number of advanced solar technologies are reaching a tipping point – where breakthroughs are not only possible, but likely. These include high-efficiency, low-cost silicon feedstocks; new molecular-scale technologies that enable manufacturers to spray solar-collecting coatings onto plastics, aluminum foil, and other substrates; and the adoption of low-cost, highly efficient “sputtering” technologies to apply solar coatings to cells, similar to technologies used to manufacture computer disk drives. ASAP’s focus on harnessing new technologies for rapid industry scale-up could accelerate these technologies’ entry into the marketplace

3. **Streamlined, application-specific systems design, packaging, and installation.** As we said, great efficiencies and savings lie in the way PV equipment is assembled and installed. To date, the solar industry has been a niche industry that has taken a one-size-fits-all approach to the design and installation of solar PV systems: the solar systems used on residential rooftops aren’t significantly different from that used on large industrial facilities.

New products are coming that signify a shift in thinking. From roof-integrated PV (where the solar panels are the roof) to advanced solutions where solar PV is integrated into glass (for building windows, etc.) – a design revolution is afoot. Again, ASAP would likely accelerate research, development, and deployment in the design of systems that will reshape the solar landscape, rapidly leading to a new generation of plug-and-play and application-specific solar PV systems.

FUNDING SHINE

We stated earlier that SHINE's goal is to be revenue neutral – that is, that it pays for itself over time without net increased cost to federal taxpayers. We believe that the programs we have proposed meet this hurdle.

Specifically:

A revenue-neutral shift of just 5 cents of every dollar that taxpayers now invest in fossil fuel and nuclear power, would yield more than enough to fully fund SHINE's start-up costs at the federal level without costing taxpayers one extra dollar.

- **U.S. RISE** will produce energy savings for government buildings and produce revenues by selling “excess” energy back to local utilities, covering its costs;
- **SUNUP** will produce similar savings and revenues for state and local governments, achieved through a shift in federal expenditures (described below);
- **ASAP** will generate royalties paid to the federal government to cover its costs.

To cover SHINE's start-up costs, we propose shifting a small percentage of taxpayer money currently used to support oil, coal, natural gas, and nuclear power. For example, a revenue-neutral shift of just 5 cents of every dollar that taxpayers now invest in fossil fuel and nuclear power, would yield more than the roughly \$5 billion needed over ten years – just \$500 million per year – to fully fund SHINE at the federal level without costing taxpayers one extra dollar.

Each year, billions of dollars flow to energy companies through direct and indirect subsidies and tax credits. The money flows into all types of energy – including solar and other renewable energy sources. But the overwhelming lion's share, by some estimates more than 90 percent, goes to support oil, natural gas, coal, and nuclear power. Suffice to say that if clean energy, including solar, got a small part of this taxpayer investment, it could make a world of difference in helping renewable energy sources be competitive with electricity from fossil fuels and nuclear power and move us closer to the day when solar will help fuel the nation's cars and trucks..

In addition to this revenue-neutral model of energy savings, royalties, and a small shift in federal funding, SHINE's programs will yield a variety of other economic benefits that will further offset SHINE's cost. Among them are reduced energy bills on federal facilities boasting solar panels; reduced need by utilities to build expensive “peaker” generating plants; increased tax revenue from new businesses and jobs created by the U.S. solar industry; and reduced public health costs, such as lower rates of asthma caused by the burning of fossil fuels.

The Federal Role

A brief look at the wind industry illustrates how federal investment policy can help – and sometimes hinder – the growth of a renewable energy market.

SHINE’s funding recommendations come amid a chorus of bipartisan renewable energy advocates calling for a shift in federal energy priorities. For example, in December 2004, the nonprofit, bipartisan American Council on Renewable Energy announced the goal of a new federal energy policy framework dubbed “Phase II.” ACORE defines Phase I as the three decades starting in 1974, when the first OPEC oil embargo sparked a wave of attention, legislation, and funding for renewable energy development. Direct research, development, and demonstration (RD&D) funding for renewables and energy efficiency went from zero to more than \$25 billion over the next 30 years. (These figures do not include tax credits and other indirect subsidies).

These investments helped propel the development of renewable energy technologies from the lab to the current level of residential and commercial application. Examples of solar technologies developed and improved over that period include solar PV systems, solar hot water heaters, and concentrated solar parabolic trough collectors.

Federal RD&D Investments (\$ billions)

Energy Source	1948-1972	Share	1973-2004	Share
Nuclear	\$24.3	81.5%	\$49.1	49.5%
Fossil Fuels	\$ 5.5	18.5%	\$24.8	25.0%
Renewables	\$ 0	0%	\$14.2	14.3%
Energy Efficiency	\$ 0	0%	\$11.1	11.2%
TOTAL	\$29.8	100%	\$99.2	100%

Source: Congressional Research Service

However, a look at total investments – which includes direct subsidies and tax breaks – reveals that the relative support of renewables, and solar in particular, is far less. According to the Renewable Energy Policy Project, solar received only 3% of the total subsidies awarded to the nuclear industry from 1947-99. During that time frame total subsidies for nuclear power were \$145.4 billion, while solar (PV and thermal electric) received just \$4.4 billion.

Building Markets, Not Just Panels

ACORE points out that the so-called Phase I funding did not address the seeding and development of markets for solar and other renewable technologies. Steve Zwolinski, president of GE Wind Energy, America’s largest wind turbine manufacturer, put it bluntly in 2004: “As it works now, U.S. policy is not conducive to developing industry, just technology.”

A brief look at the wind industry illustrates how federal subsidy policy can help – and sometimes hinder – the growth of a renewable energy market. The federal production tax credit for wind, first introduced in 1992, provides a 1.8-cent-per-kWh tax credit,

How Other Countries Fund Solar

Japan and Germany both stand out as excellent models of how government support and funding can seed a nation's solar industry, bringing installation costs in line with conventional energy sources. Both countries have surpassed the U.S. in total solar installations, despite their far smaller geographic areas and populations.

The Japanese government set specific targets — 400 MW of installed solar by 2000 (which was met) and 4,820 MW by 2010 — and created several public funding programs to meet them. Among the most successful was the 70,000 Solar Roof Program, also known as the Residential PV System Monitor Program, a residential subsidy program funded with more than \$1 billion from 1994 through 2004. Homeowners installing grid-connected, net-metered PV system of less than 5 KW were given 50% of the cost in the first three years, 33% in the next five, and less in subsequent years. The annual amount grew from approximately \$20 million in 1994 to a peak of approximately \$200 million in 2001. The declining subsidy helped PV systems become cost-effective on their own, instead of remaining subsidy-dependent.

Germany also offers a good case study of how subsidies can decrease as an industry matures. Germany's success has created such a demand for PV products from manufacturers worldwide that American solar distributors faced temporary inventory shortages. Germany surpassed the U.S. in total PV installations in 2001 and has extended its lead ever since, with annual growth rates in the 70% range. That's due in large part to the German government's feed-in program, the most generous in the world. Under the Renewable Energy Sources Act, the federal government in 2000 began buying solar-generated electricity from homeowners and businesses at roughly 52 cents per kWh, almost quadruple the average price of conventional electric power. As in Japan, the subsidy declines annually, about 5% per year. In 2004, Germany installed approximately 300 MW of new solar PV systems, a 15-fold increase from 1999 — and roughly 10 times that of the U.S., which has a population roughly four times larger than Germany's.

adjusted periodically for inflation, for power generated from a wind farm during the first 10 years of its operation. It has been a boon for the industry, allowing utilities and other wind farm developers to recover capital costs and, in some areas, sell wind-generated electricity at rates competitive with fossil-fuel power plants.

Industry growth averaged 28% annually from 1999 to 2003, but Congress has never authorized the PTC to last for more than three years at a time, causing uncertainty for wind developers — a frustrating and damaging boom-and-bust cycle for the wind industry. In the latest “bust” round of this cycle, new wind installations in the U.S. fell roughly 72% after the PTC expired at the end of 2003. Congress extended the tax credit about eight months later and the industry anticipates a record year in 2005, with more than 2,000 MW of new installations. But the PTC extension currently is set to expire at the end of 2005, threatening another bust cycle in 2006 if it is not renewed.

The defining entity of Phase II, according to ACORE, should be “a policy framework that is oriented to success in the marketplace, about putting the technologies into use.” We believe that with the right type of consistent, well-targeted start-up funding to finance SHINE's programs, solar energy could become a vital, growing, and cost-competitive segment of the nation's electric power mix within the next decade.

SHINE'S BENEFITS IN BRIEF

The revenue-neutral investment in SHINE will yield widespread benefits across the U.S. In short:

Thanks to SHINE, by 2010 – more than a decade faster than Business As Usual – solar will become cost-competitive for consumers and businesses in nearly every community.

- Solar's price will drop dramatically – far faster than would happen in the business-as-usual scenario.
- Solar energy by 2025 will be the source of up to 9% of all U.S. electricity (compared to just one-half percent under Business As Usual) and more than half of all new electric-generation capacity. Solar will be installed on the equivalent of 48 million residential rooftops (compared to fewer than 3 million under Business As Usual).
- Within a decade, solar will become cost-competitive for consumers and businesses in nearly every community. Solar also will be cost-competitive for utilities to meet peak-energy needs, reducing the cost of building and operating polluting peak-power plants.
- Solar could reach the cost-competitive point for utility baseload as well as applications in transport and industrial use more than thirty years faster – giving Americans the energy and economic security benefits we need now, not two generations from now.

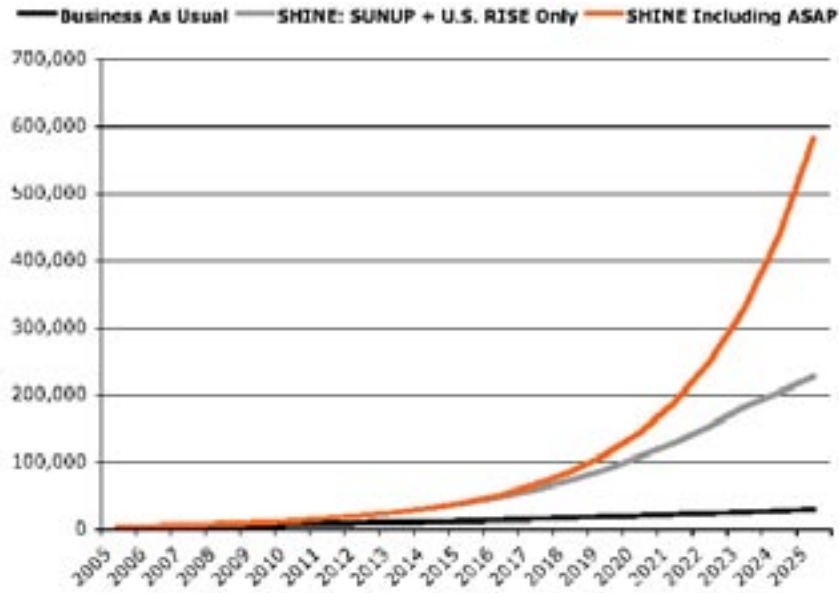
The SHINE Difference

The table below compares the business-as-usual case — what the solar market would look like in 2025 without SHINE — against the dramatic difference created by a fully deployed SHINE.

	Business as Usual	SHINE
SOLAR MARKET SIZE		
Cumulative megawatts installed, U.S.	16,372	282,780
Equivalent number in U.S. households powered by solar (millions)	2.8	48.6
Projected cost per peak watt installed (best price without subsidies)	\$2.71	\$0.80
Average cost per kWh generated	\$0.10	\$0.03
Percentage of total U.S. electricity generation	0.52%	9%
GREENHOUSE GAS REDUCTIONS		
Avoided tons CO ₂ (millions)	11	190
Equivalent number of cars removed from the road (millions)	2.1	36.6
JOB CREATION		
Jobs created (assumes all manufacturing done in U.S.) (thousands)	28	581
MARKET TAKE-OFF POINTS		
Year price reaches \$2.50/watt without subsidies (market take-off for residential, commercial rooftops; utility peak power)	2021	2010
Year price reaches \$2.00/watt (market take-off for neighborhood/regional solar farms)	2044	2012
Year price reaches \$1.00/watt (market take-off for utility base load)	After 2050	2020

Total Jobs Created (if all manufacturing in U.S.)

SHINE's job-rich potential is evident in this graph. Compared to Business As Usual, a fully implemented SHINE produces roughly 20 times more jobs.

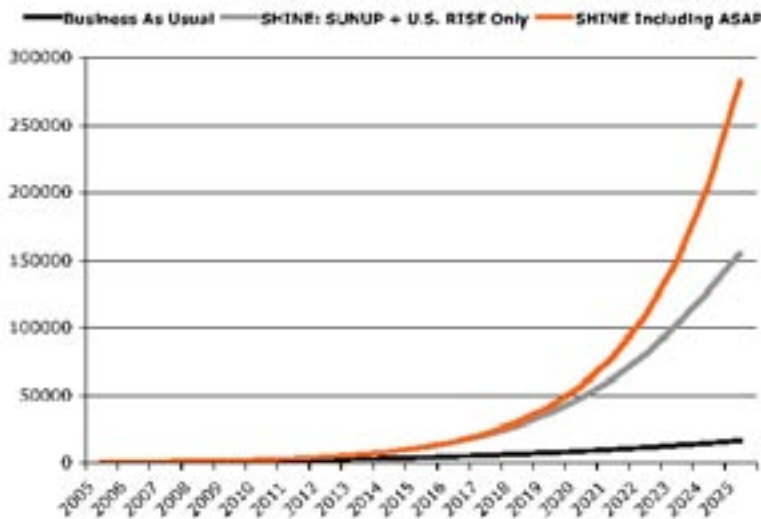


- Solar will be a robust U.S. industry, creating more than a half-million well-paid jobs located in nearly every state – jobs that cannot be exported overseas because they involve local installation and maintenance of solar PV systems.
- Within 20 years – by 2025 – solar will be ready to take off to become one of America's biggest industries. Thanks to the economies of scale created by SHINE, the price of solar will have fallen by more than 90% from its current levels – and 70% over the business-as-usual case.

A full-picture assessment of the funding landscape for SHINE must also include the

U.S. Cumulative Installed Solar (MW)

SHINE's rapid scale-up of solar installations will cause prices to fall dramatically compared to Business As Usual, making solar affordable for nearly all applications



economic benefits of reduced CO₂ emissions and other pollution, the value of creating new jobs, the cost avoidance of reducing the need for building and operating peak generation plants (particularly for natural gas), and the economic benefits of improved grid reliability. These factors, once relegated to the category of “intangibles” and “externalities,” are now quantifiable in both direct dollars and overall economic impact.

For example, the total cost of the August 2003 grid-failure blackout across the northeastern U.S. and Canada has been estimated at \$7 billion to \$10 billion by ICF Consulting and the Electricity Consumers Research Council. On the jobs issue, as noted earlier in this report, every

megawatt of solar panels produced creates approximately 30 new jobs in manufacturing, installation, servicing, sales, and marketing, according to one study.

Our projections show that by 2025 SHINE, even without ASAP, would result in the creation of up to 226,000 new jobs, represent approximately 50% of all new electricity generation brought online that year, and remove more than 20,000,000 cars from the road – all for a ten-year investment from 2005 through 2014 of about \$500 million per year. With the addition of ASAP's accelerating effect, the number of jobs, and the accompanying pollution reductions, roughly double. This represents a significant return on a modest investment.

NEXT STEPS: BRINGING SHINE TO LIFE

Solar energy as a cost-competitive energy source sits on the cusp of realization. On its current path, without a concerted private-public investment, cost-competitive solar will likely happen at some point in the distant future – more than two decades from now.

***SHINE's programs
give the industry
and the market the
push needed to reach
its full potential,
providing new value,
security, and freedom
for the United States
and the world.***

Waiting that long will come at a high cost to our nation: the loss of jobs and businesses that could have been created had America more aggressively reclaimed the solar industry that it invented, but which now belongs to other nations; further burdens on our nation's creaky and distressed electricity grid; the potential of further disruptions due to America's reliance on foreign energy sources; increased risks of catastrophic weather due to climate changes; and increased risks of childhood asthma and other respiratory problems caused by the burning of fossil fuels.

SHINE aims to avoid those costs and burdens, and to capitalize on the opportunity that confronts us: to catalyze a new, job-rich, high-tech industry that provides a wealth of economic, environmental, and social benefits. This wealth of benefits can't be understated: economic benefits that rival the recent tech boom; environmental benefits that include real solutions to climate change; and social benefits that mean keeping us – and generations of our children – healthier and safer.

SHINE aims to bring cost-competitive solar – and all of its benefits – to the nation within the next few years. But it will require a concerted national effort – solar energy's “moon shot.”

SHINE's three programs aim to accelerate the rise of solar – to give the industry and the market the push needed to reach its full potential, not only avoiding these costs but providing new value, security, and freedom for the United States and the world. SHINE's strategies are designed to create an industry – an American industry – that can serve our nation and the world with affordable, efficient solar power. And SHINE's programs are revenue neutral, making it possible for the U.S. to capture all of the benefits of solar now, with no long-term cost to America's taxpayers.

Here are the questions we must ask: Will our energy future – and all of the economic and quality-of-life impacts that stem from our continued reliance on fossil fuels and nuclear energy – depend, as it has to date, on a seemingly half-hearted effort to move to a more sustainable, renewable-energy future? Or will it reflect a strategic, ambitious, collective effort on the part of industry, government, and consumers to transform our energy future to fully exploit the untapped power of the sun and other renewable energy sources?

To us, the answer is clear.

So, what will it take to bring SHINE to life? Three things:

- **Political leadership** in Washington and the states to seize this window of opportunity, providing the political will and committing the financial capital needed to implement SHINE's programs.
- **A public-private partnership** between industry and government committed to realizing SHINE's initiatives. A first step might be the convening of a meeting of solar industry and government leaders.
- **A national organization** to step forward that can provide coordination and leadership. There are many organizations already in place that could carry SHINE forward, including the American Council on Renewable Energy, the Solar Energy Industry Association, the Solar Catalyst Group, and Solar Circle.

The mission behind SHINE should be among the nation's highest priorities: to enhance America's energy independence and economic security by enabling solar energy's full potential as quickly as possible.

Among the initial roles for each of these public- and private-sector players would be to take the first steps necessary for each of SHINE's programs. For example,

- **SUNUP:** to work out the details of the matching block-grant program, including identifying successful models that states could adopt.
- **U.S. RISE:** to identify the "low-hanging fruit" of installations – that is, the federal buildings most able (because of climate, construction type, local utility rates, and other factors) to accommodate a significant solar PV installation.
- **ASAP:** to establish the panel of judges and other experts that will create the competition's rules, deadlines, and other factors. We believe that the appropriately named ASAP is the SHINE program that could be put into place most quickly.

Clearly, there is much work to be done. But the time is short and the stakes are high. The mission behind SHINE should be among the nation's highest priorities: to enhance America's energy independence and economic security by enabling solar energy's full potential as quickly as possible.

ABOUT CO-OP AMERICA'S SOLAR CATALYST GROUP

The Solar Catalyst Group (www.solarcatalyst.org) is a nonprofit consortium of business, government, investors, labor, and environmental and community groups and individuals working to catalyze the solar energy portion of a renewable energy future by creating a mass market for solar photovoltaics (PV). Its mission:

To harness market forces to dramatically lower the price and accelerate the growth and development of solar energy around the world in a way that aligns energy needs with sound business practices, economic development, environmental protection, and social equity .

The Solar Catalyst Group is a project of the national nonprofit Co-op America Foundation (www.coopamerica.org), which advocates market solutions to the social and environmental problems facing America today.

ABOUT CLEAN EDGE, INC.

Clean Edge, Inc. (www.cleandedge.com) is a leading research and publishing firm that helps companies, investors, and policymakers understand and profit from clean-energy technologies. Founded in 2000, the company is devoted to tracking and analyzing clean-tech market trends and opportunities. Its offerings include customized research and reports; online services; co-sponsored conferences and events; and strategic marketing services.