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Solar Energy: The Case for Action

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The NDN Green Project

NDN's Green Project, directed by NDN Fellow Michael Moynihan, is a program of the Globalization Initiative that seeks to develop a legislative, regulatory and advocacy framework to address climate change, enhance energy security, and accelerate the development of green technologies to promote economic growth. This initiative is designed to serve as a bridge between key stakeholders in the new clean technology community and public leaders as we build the low-carbon economy of tomorrow.

NDN's Globalization Initiative is an on-going effort to provide a new narrative and set of policy recommendations that address the impact of globalization on the U.S. economy and our workers. While globalization benefits the U.S. economy in terms of GDP growth and productivity gains, many Americans are not prospering in this new economic era. NDN is committed to ***making globalization work for all Americans*** by offering a new economic strategy that would modernize our health care and energy policies; invest in our workers, students, and infrastructure; foster and accelerate innovation across the economy; and seek a national consensus on international trade liberalization. This new economic strategy also includes measures to address our immigration system and ensure universal and affordable access to computers and broadband.

For more information on the Green Project, please contact Green Project Director, Michael Moynihan at mmoynihan@ndn.org or Globalization Initiative Policy Assistant Jake Berliner at 202-384-1215 or jberliner@ndn.org, or visit our Web site at www.ndn.org.

Solar Energy: The Case for Action

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Executive Summary

As a growing global population and higher standards of living drive increasing demand for energy while testing our planet's capacity to sustain humanity, energy has entered a new phase in its history. The stalwart fuel sources of the industrial age -- coal, oil and gas -- that powered the development of the modern economy are running out. If not in the next 10 or 20 years, certainly in the next 50, oil supplies will pass their peak.

Reflecting a tighter market, energy prices have been rising sharply, not only for oil but also for natural gas and coal. Meanwhile, demonstrable and potentially devastating changes in the climate have imposed a need to reduce production of greenhouse gases such as CO2 from carbon-based fuels. New geopolitical challenges, echoing earlier struggles over natural resources, have taken on new import with the proliferation of weapons of mass destruction. In an era of global terrorism and small state nuclear power, territorial conflicts over natural resources pose greater risks than ever before.

It is fortunate, therefore, that at this critical moment, new energy technologies are emerging that not only offer alternatives to fossil fuels but promise to revolutionize the global economy. While a variety of renewable fuels have different strengths, the subject of this paper, solar power -- ubiquitous, not tied to any nation or territory, clean and free once capital equipment to capture it has been installed -- holds special promise.

A Call to Action

We believe that solar will play a key role in creating the new low-carbon economy of the 21st century and that promoting leadership in solar technologies to take advantage of this immense new opportunity must be a major policy priority of the United States. The transformative capability of solar is exceptional and the United States must take a driving role in developing its potential, both for our own economic stake since solar is likely be a huge creator of wealth and central to our national interest, but also for the sake of the world. High-level attention to this vital issue is required by the President, U.S. Congress and other leaders.

The Road Forward

However, the large political and corporate infrastructure supporting fossil fuels has created a huge incumbent advantage that solar energy, like other renewables, must overcome if it is to compete effectively in the marketplace. Fortunately, the barriers to solar energy's proliferation are clear and, so, therefore, are the solutions.

To compete with fossil fuels, solar energy must first and foremost grow more affordable. This is already happening. However, the most critical factor to drive down the cost of solar power is to increase scale (or quantity produced) and here government can play a critical role. Incentive programs such as the Investment Tax Credit have proven crucial to increasing production and driving down costs. The money these programs cost is well worth the investment because of the cost savings that result from lower prices as volume grows and from savings in social and environmental costs.

Second, new technology will be critical to reducing cost. While private capital is flowing into the sector, the cost of clean technology development is high and much of the research and technology needed to unleash solar's potential will require government support.

Third, improved market mechanisms are critical to driving solar adoption. So long as utilities make more money running their plants than selling solar power produced by others, they will resist rather than support solar energy. For this reason, decoupling of utility profits from power production must occur.

To tap the American entrepreneurial spirit, net metering is needed to enable *electronpreneurs* to sell power back to the grid. Additionally, we are proposing a new concept of net billing in which customers are given the opportunity to buy power from *electronpreneurs* or others and take a reduction on their utility bill to increase the influence of market forces.

Finally, a variety of non-cost barriers continue to hamper the deployment of solar energy.

Recommendations

To unleash the power of solar energy, this report makes the following recommendations:

- Congress should extend the Investment Tax Credit for eight years, remove the cap on residential installations and extend it to utilities.
- Congress should pass a renewable electricity standard with a solar set-aside.
- Congress should step up funding for energy R&D.
- Congress, regulators and stakeholders should carry out limited power industry reform that, among other goals, requires decoupling of power profits from production.
- Congress should require *net metering* and what we call *net billing* for electricity.
- Congress and state and local governments should create incentives for homebuyers to more readily finance homes with solar power or install solar power, reflecting the lower cost of ownership of energy producing homes.
- Because renewable power will require better switching and efficiency to move power to where it is needed, government, utilities and other stakeholders should work together to modernize the grid.

I. Introduction

Imagine you had to choose between two energy sources: one is part of our every day lives, readily available at almost any point on earth, and amazingly, once equipment has been installed to capture it, free. The other is dependent on increasingly complex technology, dispersed in hard-to-reach places and growing more expensive daily.

If you were making this choice today—with no prior history—you would almost certainly choose the first option.

The two technologies are, of course, solar power and fossil fuels. Yet today, government as well as capital, continues to favor the latter, not the former. Why?

In large part, the answer is that fossil fuels such as oil, natural gas and coal enjoy the benefits of trillions of dollar in sunk capital investments as well as huge incentives for their development. They are incumbent technologies and have built up not only a competitive advantage, but important political advantages as well. Solar technology is, by comparison, in its infancy. At the time the world first discovered petroleum, few knew the sun could even generate power. Meanwhile, huge lakes of petroleum and seams of coal lay below the surface of places such as Pennsylvania and Texas.

A century later, however, the easy-to-find oil is gone. So is easy-to-tap natural gas and coal close to the surface. What survives is a Byzantine network of wells, mines, tankers, terminals, refineries, storage tanks, pipelines and power plants embedded in a web of complex regulations. The fuel to feed this giant structure now resides in a declining number of pockets miles below the desert sands of Arabia, the frozen tundras of Siberia and the open seas. What once seemed easy to obtain is hard and what once was cheap and plentiful has become increasingly expensive and rare.

In contrast, solar power enjoys free feedstock, is widely distributed, reducing the need to transport it long distances, and is clean. What it lacks, currently, is scale (quantity of production) and support.

Today, solar power represents a miniscule 0.06% of electricity generation in the United States and many important energy markets, such as the powering of cars, remain beyond solar's reach. Does this fledging technology have the capacity to become a meaningful component of the world's energy supply? This paper will argue "yes."

To be clear, the issue is not as simple as choosing between solar power and fossil fuels or other renewables. The world's energy demand in the 21st century will be so great and diverse that every form of energy will be needed. Oil, natural gas, coal and nuclear energy are certain to remain major sources of energy for decades. Wind power, biofuels and other renewables share many of the benefits of solar energy and have some advantages. Wind is, on average, cheaper than solar while biofuels are more portable. They will play important roles in our energy future. (They are, however, beyond the scope of this paper.) But solar power has immense potential to grow as a source of energy and there are many public policy reasons to hope it does so. Yet as a result of the large advantages enjoyed by incumbent technologies, solar power is likely to achieve its potential only if government takes a leadership role in its development—comparable to the role government has played in the development of other technologies through history.

In this paper, I will examine the potential of solar energy, outline its strengths and weaknesses and discuss current barriers to its emergence as a major source of power. In turn, I will propose a series of critical steps that, if taken, can make solar energy a major source of power within a decade.

II. The Potential Benefits of Solar Energy

Why should we support solar energy? It exhibits a variety of exceptional qualities. It has a very positive environmental profile, is ubiquitous, scales nicely and has a very low marginal cost. All of these benefits will only increase in value going forward.

Environmental benefits. Even before concerns about climate change arose, solar won high marks for its environmental profile. The absence of a chemical component in the energy chain makes solar energy essentially pollution free. The only negative environmental effects relate to the use of some toxic materials in the manufacture of certain thin films, an alternative technology to crystalline silicon for converting light to electricity (See ***Box B*** in Section VI), and the impact on the land on which larger plants may be located.

Carbon neutrality. Solar is also carbon neutral, since solar energy is drawn directly from photons or radiant energy—rather than chemical bonds—and no physical matter is transformed at all. Thus, solar produces essentially no carbon (or other emissions) and does not contribute to climate change. With the deterioration of the climate due to carbon emissions, this quality of solar has become more attractive.

Ubiquity. Solar energy has the benefit of being ubiquitous since sunlight touches every point on the earth. While sunlight levels are obviously greatest in the vicinity of the equator and arid regions such as deserts, they are substantial even in cloudy Germany, which, at the same latitude as Canada, is the world leader in solar generation. And while the sun does not shine at night, its rays are strongest at precisely the time of day at which power demands are highest.

Scaleability and Distributability. Solar has another appealing quality: it is highly scaleable up and down, permitting its use in numerous applications, and the ubiquity of its principal input, sunlight, makes it ideal for distributed production of energy.

With few, if any, moving parts, photovoltaic (PV) solar, one of two major variants of solar energy, scales down easily to a micro level in which it is used in watches and calculators. PV solar is increasingly used on a slightly larger scale in powering off-grid LED streetlights. It works safely at the level of a single home, and has the potential to scale up dramatically as well, with many utility scale solar plants currently in development. The other main variant of solar energy, solar thermal, can be scaled downward to heat a swimming pool or upward, in the form of concentrating solar power (CSP) to utility scale. (See ***Box A***.)

By virtue of its distributed capability, solar can reduce long-distance transport and the need for large power plants, along with their associated environmental impacts. Because finding and building new transmission lines and power corridors will be a major challenge in the years ahead, the distributed nature of solar is an important advantage.

Box A: Understanding Different Types of Solar Energy: PV, Thermal and CSP

The term solar power actually encompasses a wide variety of technologies. *Photovoltaic (PV)*—perhaps the most commonly known variety of solar used in everything from calculators to solar powered homes to large arrays —converts photons in sunlight into electricity. *Solar thermal* and *solar water* technologies use the sun's heating power to heat a liquid, such as water for a swimming pool, or in some cases, steam, to drive a turbine. *Concentrating solar power (CSP)*, a variant of the above geared toward utility scale, uses mirrors, lenses and other optical technology to collect sunlight over a large area and focus it in such a way that it either heats water or generates electricity. Each of these technologies comes in different forms and possesses unique characteristics.

Zero marginal cost. The cost profile of solar energy, while traditionally viewed as its primary liability, also possesses some advantageous features. Solar has close to zero marginal cost since the energy source, light, is constantly renewed from the sun. While capital costs remain substantial, they are declining as discussed in Sections V and VI.

Finally, solar has other significant, if secondary, advantages.

These include the fact that solar facilities, PV as well as thermal, tend to be low maintenance, contributing to solar's low marginal cost. Most PV facilities and ordinary solar water systems require minimal human intervention or maintenance because they do not need physical fuel, generate almost no waste and have few moving parts. The Geosol plant in Espenhain, Germany, one of the largest in the world when built in 2004, required only three employees to operate it at the outset. Low maintenance requirements make solar well-suited for small-scale, distributed locations as in streetlights, homes or swimming pools, and also makes it relatively reliable.[1]

Photovoltaic solar power also is direct, converting sunlight to electrical energy without a heat stage, eliminating the need for a boiler or other intermediate energy transfer mechanism. The absence of a heat stage eliminates cooling towers, the need to contain and manage heat and, finally, all the moving parts needed to convert energy from fuel to heat to mechanical energy to electricity. Some solar thermal technologies have a heat stage, but others, such as systems to heat pools or water, also are direct.

Of course, solar energy is not perfect. Its disadvantages include that it:

- is intermittent—the sun only shines during the day most brightly near the equator in a cloud-free sky;
- cannot be stored like coal or oil, or refined and concentrated like gasoline or jet fuel (though the energy, once captured as electricity or heat, can be stored using some promising new technologies); and

[1] Whitlock, Craig. "Cloudy Germany a Powerhouse in Solar Energy," *Washington Post*, May 5, 2007; Page A01, www.washingtonpost.com/wp-dyn/content/article/2007/05/04/AR2007050402466.html.

- currently costs more in capital outlays than many other energy sources.

I will return to these issues later. Nonetheless, all told, solar power holds tremendous promise.

III. The Problems with Competing Fuels

In contrast to solar, its principal competitors (not including other renewables such as wind, which lie outside the scope of this paper), fossil fuels and nuclear power, all face various problems.

<u>Fossil fuels</u>

Fossil fuels, including coal, the dominant fuel for electricity generation, gas, the fastest growing one, and oil, share the following disadvantages.

<u>Rising marginal costs</u>. Fossil fuel stocks are growing more expensive across the board. Unlike the cost of solar energy, which is close to zero at the margin, the cost of fossil fuels is steadily rising (and in some instances, soaring.) ***Figure III-1*** shows the rise in the price of electricity from gas- and coal-fired plants, reflecting the rising prices of underlying feedstocks.

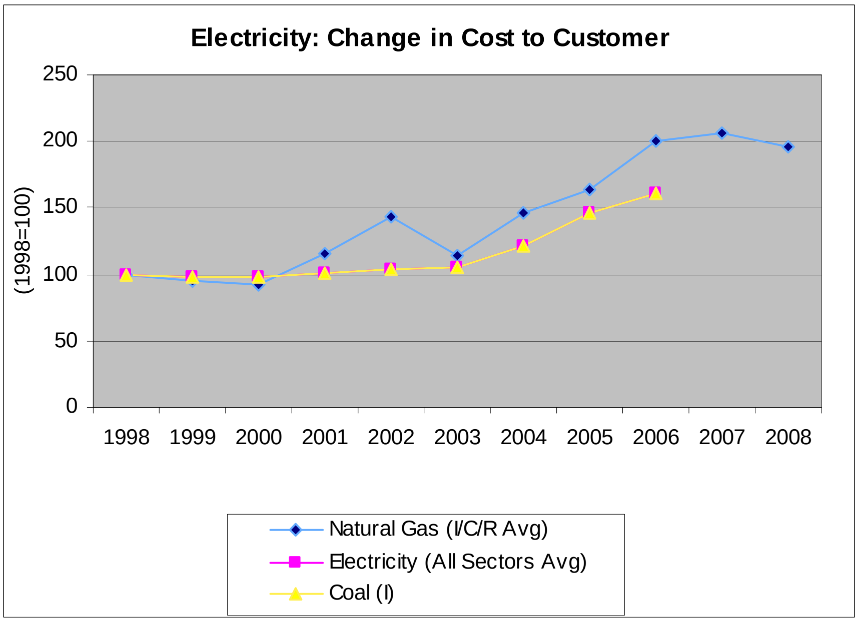

Figure III-1
Source: Energy Information Administration (EIA)

Figure III-2 shows the rising price of crude oil, natural gas and coal. Reasons for rising costs include, on the demand side, rising global demand. On the supply side, costs stem from the increasing difficulty and expense of oil and gas recovery, which increasingly requires offshore drilling and tertiary extraction, as well as supply disruptions in locations such as Iraq and Nigeria.

In addition, natural gas is rising in price, in part, due to its increased use for electricity generation as well as heating use. Even coal, a commodity often preceded by the adjective “cheap,” has been rising in price, virtually doubling in 2008 alone, due to soaring global demand, shortages in key markets and supply constraints. Rising prices may also reflect the declining value of the dollar and activity in the financial markets.

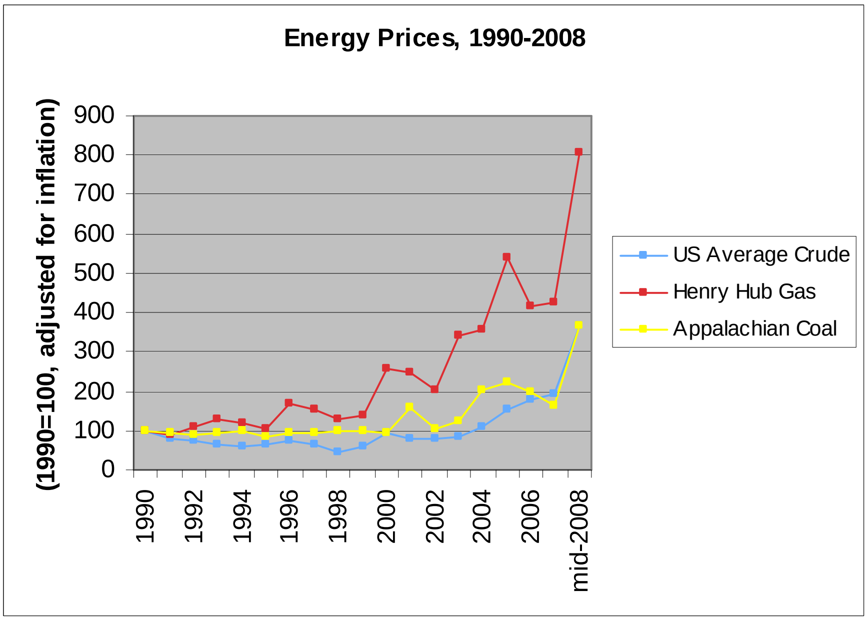

Figure III-2
Source: Energy Information Administration (EIA)

Cost from carbon caps and carbon taxes. Related to the rising marginal cost of fossil fuels that are carbon-based and likely to exacerbate the cost issue further is the prospect of a cap and trade system or, indeed, a carbon tax. Even if no federal action occurs—which is unlikely—state cap and trade systems such as the Regional Greenhouse Gas Initiative in the Northeast and a similar system in California, a member of the Western Climate Initiative, are poised to make coal-generated electricity and the utilization of fossil-fuel generated energy more expensive as companies have to pay for emission permits. If permits are auctioned off, as some plans propose, then even high-efficiency coal producers will have to pay for the ability to pollute; even if credits are initially doled out for free, less efficient plants will see their costs soar. Thus, a cap and trade system or carbon tax will almost certainly increase the cost of electricity from fossil fuels.[2]

Rising capital costs. The capital costs of new coal- and gas-fired electricity plants are rising as well. The cost of traditional plants has soared due to the rising price of steel, concrete and construction labor in the United States. Improved environmental controls have added further to costs. And if a carbon regime becomes law, the alternative to buying credits would be the investment of more capital in new technologies to reduce emissions.

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[2] For detailed analysis of the impact of a carbon tax on different forms of electricity production, see Shapiro, Robert et al. *Addressing Climate Change Without Impairing the U.S. Economy: The Economics and Environmental Science of Combining a Carbon-Based Tax and Tax Relief*, U.S. Climate Task Force, June 2008. www.climatetaskforce.org/pdf/CTF_CarbonTax_Earth_Spgs.pdf.

Environmental costs. Fossil fuels have a generally negative environmental footprint, though the specific environmental profile of each form of fossil fuel differs:

- *Coal*, in addition to producing sulfur dioxide, is implicated in the spread of mercury across the planetary ecosystem, notably into the oceans where high levels of mercury have contaminated fish. Coal mining, particularly strip mining, poses local environmental issues. And coal also produces substantial quantities of CO2 as well as carbon-based particulate matter. T.S. Eliot wrote of London's yellow fog and residents of Pittsburgh well through the 1960s would awake to a layer of soot on outside surfaces. While state-of-the-art coal plants no longer turn the sky dark and deposit soot onto clothes and sidewalks, many coal plants built today are far from modern, and coal is responsible for much of the particulate matter blocking the sun in China and many parts of the developing world.
- *Natural gas*, a fuel that burns clean enough to use in the kitchen, nonetheless produces CO2.
- Traditional *oil and diesel*, used in some power facilities, and of course extensively in cars, produces CO2 and other airborne pollutants.

Geographic remoteness. Fossil fuels are far from ubiquitous and generally either hard to find and extract or, at a minimum, challenging to transport. In the United States, clean coal in the West is constrained by a lack of rail lines. In the East, coal is concentrated geographically in places such as West Virginia and Pennsylvania that are separated from some major population centers by mountains.

Natural gas, usually found in the vicinity of oil, is dependent on pipelines and thus, vulnerable to disruption.

Within the United States, oil and gasoline are increasingly hard to find in the onshore lower 48 states. Oil experts believe the most promising fields are likely to lie offshore or in Alaska.

Hostage to political instability. Much of the world's oil is situated in countries not viewed as friends of the United States. One can argue that when oil production (like the production of other valuable natural resources) dominates an economy, it can encourage political instability and autocracy as opposed to democracy because oil production renders competing business uncompetitive (by driving up prices through the phenomenon known as Dutch Disease) and entices competing political factions to vie for its control. Since it is difficult to distribute oil wealth through any means other than welfare, the flow of wealth to one faction can lead to disenfranchisement of others and, eventually, instability. Oil, like other natural resources, also is associated with territory and therefore has been implicated in territorial conflicts.

Not downwardly scaleable or distributable. Fossil fuel power plants tend to be large and hostage to their location. Coal-fired plants, for example, are most economical when situated in the vicinity of coal. Natural gas-fired plants, while more versatile and distributable than coal, are nonetheless sizable industrial facilities that often provoke resistance to their placement by communities. As building new transmission corridors proves more difficult due to zoning and right-of-way issues, the cost of long-distance transmission is likely to rise.

Nuclear Fuels

Nuclear energy, sometimes heralded as an alternative to fossil fuels, faces its own set of challenges:

Safety concerns. Since the Three Mile Island accident in 1979 and to a lesser degree, the Chernobyl accident in 1986, nuclear energy has had to contend with questions about safety. Until last year, no new nuclear facility had been permitted in the United States in 30 years and recent permits are in their earliest stages. Even minor incidents, such as recent leakage from a plant in France, generate headlines due to the potential for catastrophe.

High capital costs. Nuclear remains a highly expensive technology due to its intense technical demands and safety issues. (Once built, however, nuclear plants generate electricity at a comparatively low marginal cost.) While no new U.S. facility has been built recently to afford an accurate picture of cost, estimates have soared.

Lack of trained engineers. As a result of the moratorium on new nuclear facilities, most engineering schools have ended, or significantly downsized, their nuclear programs. According to some estimates, it would take 10 years to retrain a critical mass of nuclear engineers.

Environmental and litigation risks. Even apart from issues of human safety, nuclear facilities place additional burdens on the environment. Though carbon free, they require immense quantities of water for cooling and the warmed water can pose a hazard to fish and other wildlife. Transport of nuclear waste also raises issues of contamination.

Problem of waste disposal. Huge litigation risks dog nuclear projects, which face liability, not only over operations, but over how to handle nuclear waste. The proposed solution to the nuclear waste issue in the United States, the Yucca Mountain Nuclear Waste Repository, remains stalled in litigation. The Yucca mountain site, about 80 miles from Las Vegas and adjacent to the Nevada Test Site, has been criticized by opponents for its proximity to a major city and lack of geological soundness. As a result, U.S. nuclear facilities today must preserve their own waste. This creates an even greater incentive for communities to oppose a nuclear plant in their backyard, particularly in light of renewed concern about vulnerability to terrorism.

Lack of distributability. Finally, nuclear power plants are even more difficult to site than fossil fuel plants due to safety and logistical concerns. They generally must be located near bodies of water. And siting must balance hazards to humans with the cost of long-distance transport of power.

IV. The Economic Promise of Solar Investment

While the aforementioned benefits of solar are impressive, particularly in comparison to the increasing problems associated with traditional energy sources, there is yet another potential benefit to solar: its potential contribution to the U.S. economy.

Besides its environmental advantages, solar, if implemented on a large scale, has the capacity to create many new jobs in coming years. And because solar has a large local component, immune to international wage differentials, most of these jobs are likely to remain in the United States.

Types of jobs include:

- High-tech design and manufacturing jobs;
- Managerial and professional jobs; and
- Green collar jobs in installation that can provide high wages to skilled, but not necessarily highly educated, American workers.

Indeed, solar energy, and more broadly, the creation of the new, low-carbon economy, is shaping up as one of the major economic challenges and opportunities of the 21^{st} century. Already, a number of other countries are vying to establish leadership in new solar businesses. Unfortunately, in a pattern witnessed in too many industries in recent years, leadership in important components of the solar industry, for example, in the production of solar cells, is shifting away from the United States, which pioneered this new technology.

Broadly speaking, the growing solar industry can be divided into three major components:

- Development and sale of solar design and manufacturing technology;
- Manufacture of solar components; and
- Installation of solar capacity.

While the United States continues to play an important role in designing and building the technology used to advance solar power, already the second category — manufacture of solar components — is moving overseas. And the United States has fallen behind many smaller countries in the installation of solar capacity sector, which has the potential to generate new green collar jobs.

Figure IV-1 shows market share in the production of PV cells. Europe leads the pack, having recently edged out Japan; China is growing rapidly and the United States is in fifth place, behind Taiwan. ***Figure IV-2*** ranks leading companies in the manufacture of solar cells. Germany and Japan are well represented. Chinese and American companies, notably First Solar, which uses thin film technology, saw strong growth between 2006 and 2007, the most recent year for which complete data is available. Nonetheless, the poor U.S. showing as a whole remains a matter of concern.

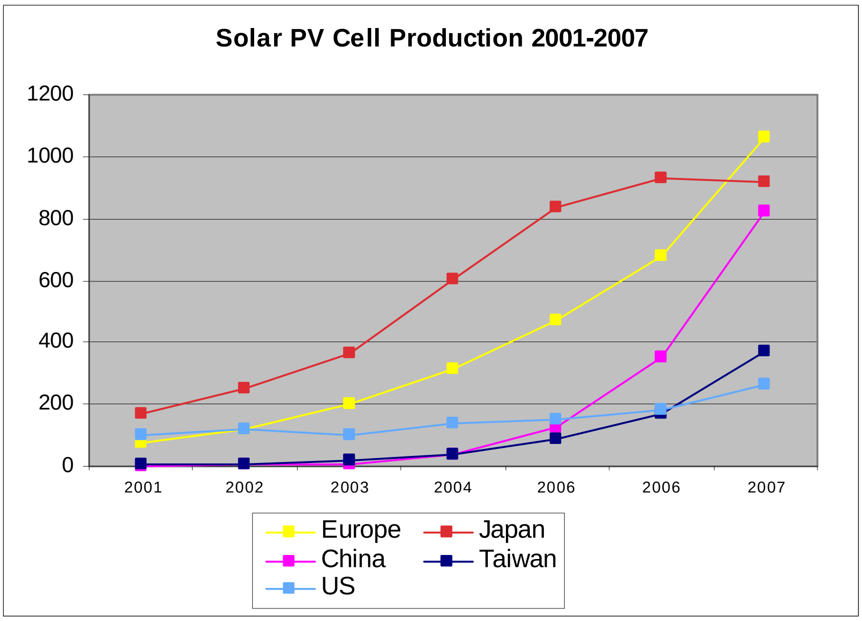

Figure IV-1
Source: *PV News*, March 2008

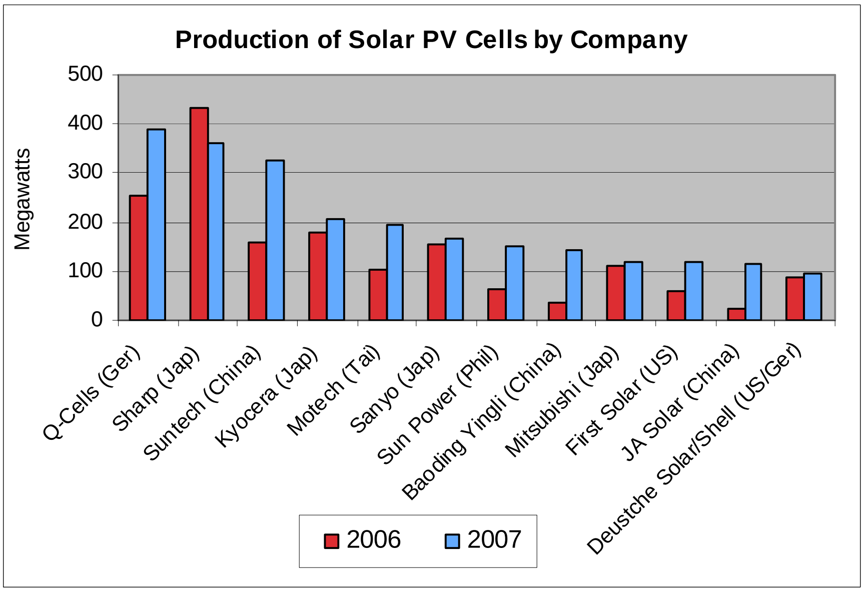

Figure IV-2
Source: Prometheus Institute, *PV News*

The situation is not much better with respect to the third category mentioned above, installation of solar capacity.

Figure IV-3 shows how the U.S. share of the solar industry has declined since its peak in 1995, and ***Figure IV-4*** shows how other countries such as Germany are moving rapidly to enhance their leadership in this area.

As ***Figure IV-3*** shows, the vast majority of new PV shipped has been outside the United States, lowering U.S. market share from a peak of about 45% of the global market in 1995 to a mere 10% a decade later. The market leader today, revealed by ***Figure IV-4***, is Germany, thanks to its aggressive targeting of the PV industry through a generous and consistent subsidy package discussed below.

Japan reinforces its dominant role in producing solar components by placing second in new solar capacity and the United States, with more than three times the population of Germany and twice that of Japan, places third.

Declining US Market Share of the Global PV Market

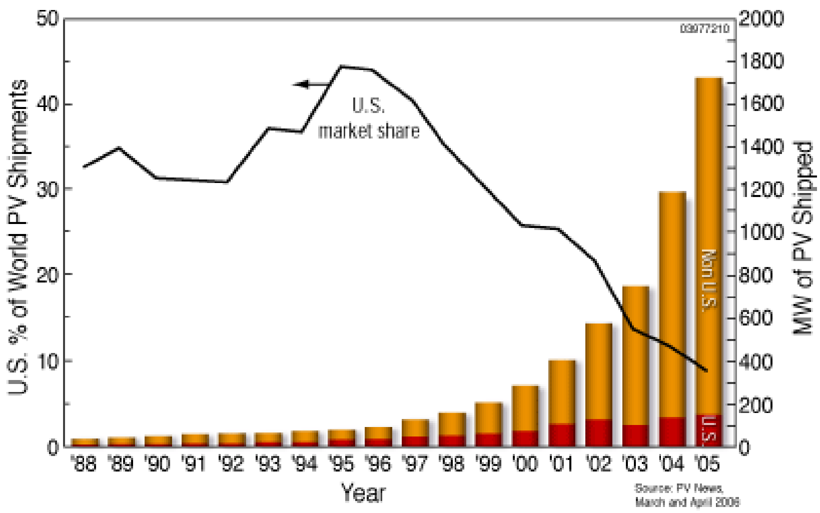

Figure IV-3
Source: NREL, PV News

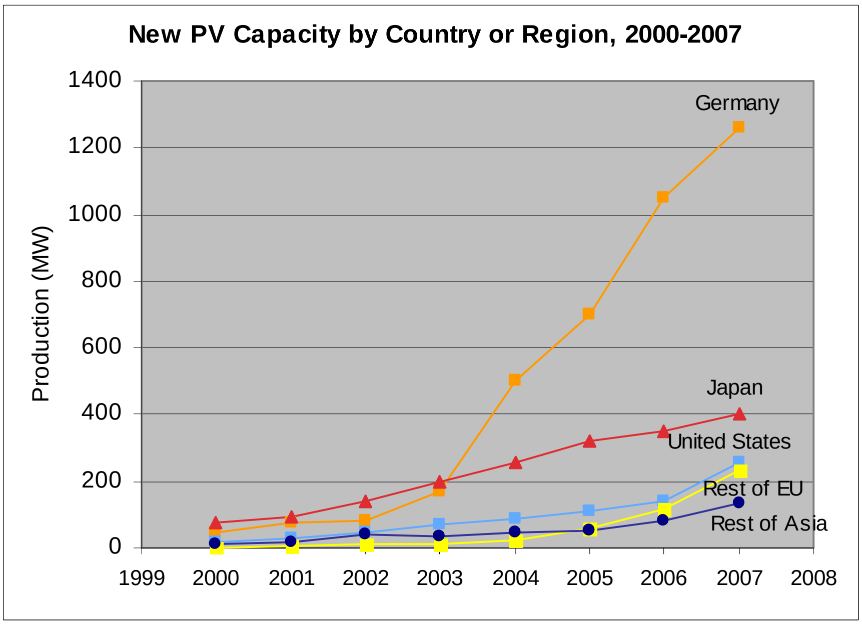

Figure IV-4
Source: Prometheus Institute, *PV News*

The United States does remain the world leader in some of the most cutting-edge technologies, such as those at the intersection of solar energy and nanotechnology. For example, the United States leads in the highly promising field of thin film technologies with their promise to slash PV costs. However, as ***Figure IV-5*** shows, the lead is not overpowering. Given the potential strategic importance of this sector, the United States should be doing everything in its power to ensure that this industry has a fair chance to develop.

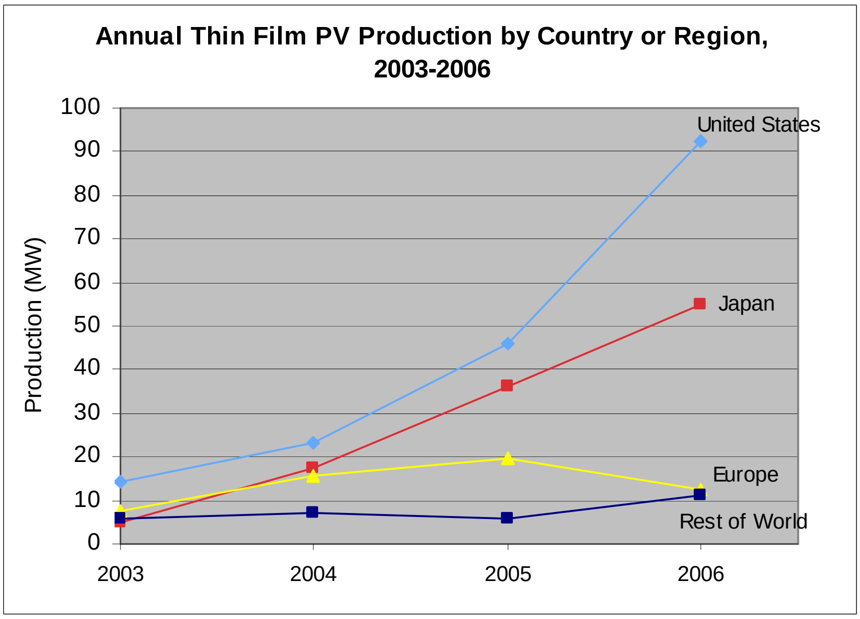

Figure IV-5
Source: Prometheus Institute, *PV News*, April 2007

How important is the solar industry to America's economic future?

While the future cannot be predicted evidence suggests that it has the potential to create large numbers of high-paying jobs and contribute meaningfully to economic growth. A new generation of high-tech workers will be needed to design, build and install the solar systems of the future. As a result, solar is likely to be an important driver of growth in the overall economy. Many of these jobs—particularly so-called green collar jobs in solar construction and installation—will be inherently domestic. These jobs will offer opportunity to less-skilled workers. A second variety of jobs, in science, engineering and technology, as well as in the manufacture of high-tech component manufacturing machinery, will service the export sector. While they thus will be vulnerable to international competition, high-tech and export jobs both pay significantly more than average.

The growth of a large U.S. solar technology export industry—or conversely—the failure of such an industry to develop, also will have important consequences for the U.S. balance of payments.

Other Economic Benefits

Besides the overall benefits to the U.S. economy, the unique qualities of solar make it especially well-suited to provide targeted benefits to industry and electricity production.

Because solar peak generation corresponds with peak demand, solar can provide much needed *peak capacity*. Just as a city's bus system must be sized to its rush hour demand, electric power generation must be sized to peak demand. Distributed solar power, installed and financed by customers, by helping to meet peak loads, can reduce the need for utilities to build new capacity.

Second, solar power offers an advantage to its consumers by virtue of its *price predictability*. The cost of solar power is largely a function of the capital cost of the plant and not hostage to future price increases of the fuel stock. Once the plant is built, the price is essentially locked in for the duration of its period of service.

Finally, by virtue of *proximity to demand*, distributed solar power, whether in the form of electricity generated by solar panels, or thermal in the form of energy used to heat water, can reduce transmission levels, the need to build new long-distance transmission lines, and thus, demand on bottlenecks or constrained points of the grid. (This is less true of utility scale solar power.)

V. Barriers to Solar Proliferation

Given solar's advantages and the problems faced by its competition, why is it not competitive? The reasons can be divided into two categories: capital cost and non-cost issues.

The close-to-zero marginal cost of solar is entirely offset by its higher capital costs. While the impact of capital costs on unit price is dependent on the period of amortization and capital cost recapture, when you figure in the cost of building new plants and equipment, solar—at the utility scale—remains more expensive than fossil fuel alternatives. ***Figure V-1*** shows the comparative capital costs of different power sources.

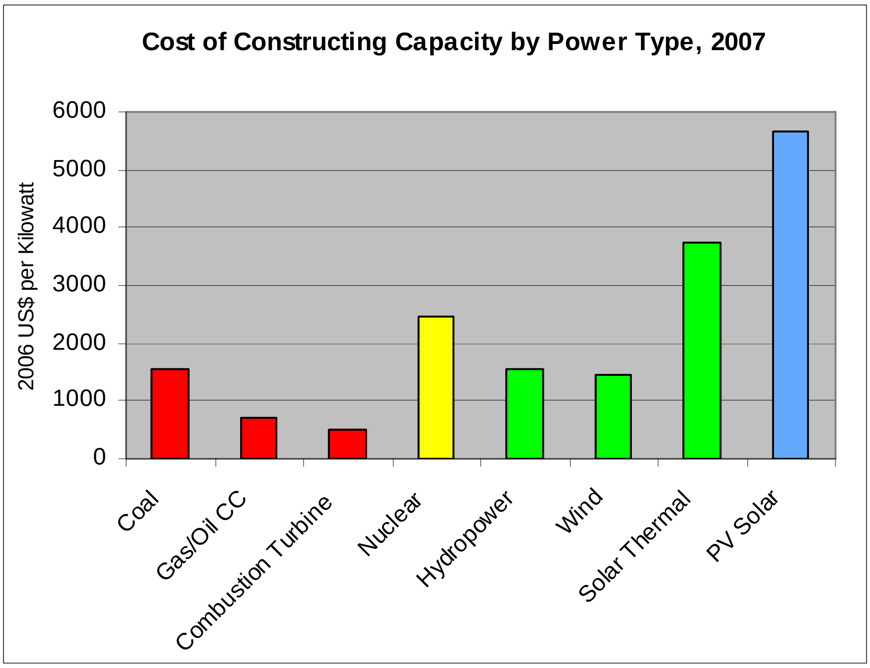

Figure V-1
Source: Energy Information Administration (EIA)

As the graph shows, the capital costs of solar energy are high.

In contrast, the ongoing maintenance costs of solar thermal power are moderate (and those of PV solar quite low). ***Figure V-2*** depicts fixed operating costs for a variety of energy types. Though not shown in the graph, renewable forms have no variable operating costs apart from their fixed operating costs due to their free feedstock. Thus, it is the capital costs of solar, as opposed to its ongoing costs, that account for its current price disadvantage and *de minimus* market share.

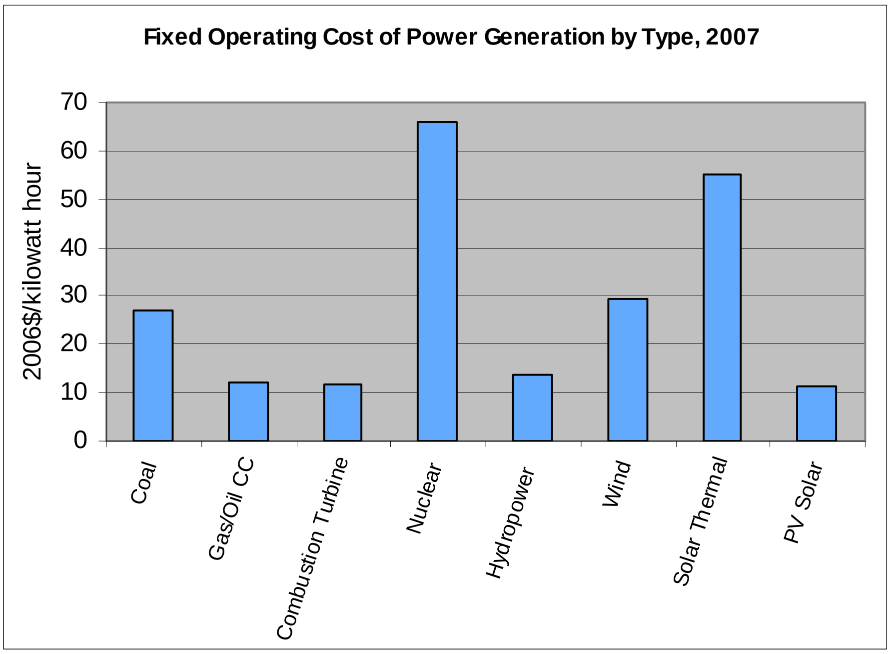

Figure V-2
Source: Energy Information Administration (EIA)

The Cost Barrier: Why Solar is Expensive

According to a recent report by Cleanedge, the cost of building a PV solar plant currently is on the order of $5 billion to $7 billion per billion watt capacity compared with $1 billion to $3 billion for a coal plant.[3] A CSP plant costs $3 billion to $4 billion, still significantly more than coal. This significant capital cost differential means that even though solar's marginal cost is low, its cost after amortizing the $4 billion in capital cost over, say 30 years, exceeds that of coal by a substantial margin.[4]

Why does a solar plant cost more than a coal plant? In the case of PV solar, the primary reason is the cost of solar cells themselves. Apart from wiring and a location site, solar plants require little other construction. (Indeed, smaller installations can be placed on roofs of existing structures.) For this reason, the cost of a plant is linked closely to that of a silicon cell. (CSP plants and solar thermal plants have a somewhat more convex cost profile, reflecting scale economies, but a detailed discussion of the cost profile of all forms of solar is beyond the scope of this paper.) Thus, the cost of PV ultimately comes down to the cost of PV cells.

Why are cells expensive? In recent years, a shortage of pure silicon—the element most often used in cells—relative to skyrocketing demand caused the price of silicon ingots

[3] Pernick, Ron and Clint Wilder. *Utility Solar Assessment (USA) Study*, Cleanedge, 2008. www.cleanedge.com/reports/reports-solarUSA2008.php.

[4] For purposes of comparing solar PV to coal, I am looking at the plant level since there is no coal equivalent to a small household installation. In fact, coal plants tend to be large and PV installations, by comparison, small.

(the hunks of silicon from which wafers are sliced) to rise. However, this shortage has eased and, indeed, the shortage itself is not due to the primary material from which silicon is refined, sand, but rather to purification and manufacturing constraints.

As more manufacturing capability comes on line, prices are declining. In short, since cell costs are declining with volume, the answer to why solar energy is expensive is, primarily, lack of scale. This, incidentally, also is the case in solar thermal facilities, although the key components are not solar cells but specialized mirrors, lenses, turbines and related technologies. The strong inverse relationship between scale and cost of solar is demonstrated clearly in ***Figure V-3***.

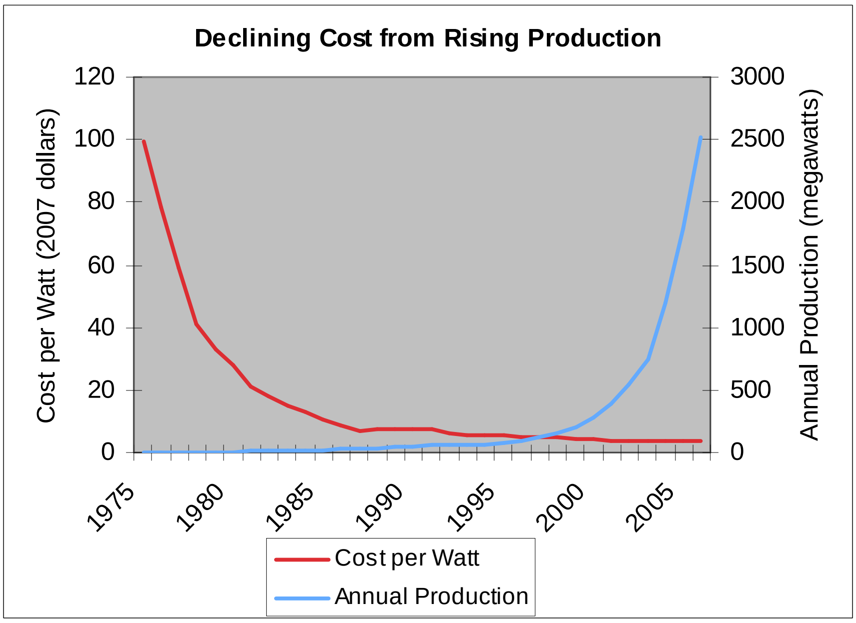

Figure V-3
Source: Compiled by Earth Policy Institute from Worldwatch Institute[5]

Were solar production to ramp up dramatically, it is likely that prices would drop significantly further, even without major advances in technology. But advances in technology will cut prices even faster. Currently solar power is declining in cost at the rate of up to 40% per year with comparatively modest increases in volume.

At what point will the cost of solar cross that of fossil fuels, achieving the holy grail of grid parity?

There are several key relevant comparisons. To understand at what point solar becomes competitive, it is important to understand the tiered nature of electricity production.

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[5] Vital Signs 2001 (Washington, DC: 2001); Paul Maycock. "Boomer," *PVNews*, July 2007, p. 12. Prices adjusted to 2007 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, "Implicit Price Deflators for Gross Domestic Product," www.bea.gov/bea/dn/nipaweb/TableView.asp#Mid.

Utilities have one class of "baseload" generators that run steadily around the clock. These plants include nuclear and hydro facilities, if available, and coal plants that provide electricity at the lowest marginal cost. Depending on supply and demand, utilities also may have to run more expensive generators, such as natural gas turbines. However, since electricity generation requires managers to precisely balance supply and demand (also known as load) to prevent either brownouts if there is not enough supply or overheating of lines if there is too much, operators bring a second class of capacity on line as needed to respond to hour-by-hour to demand. As load moves up, operators turn on increasingly more expensive generators and when load decreases, they turn off generators as much as possible in order of cost.

Thus, it is likely that solar energy will become competitive with the second class of generators, switched on at times of highest load, before it becomes competitive with fully amortized baseload coal, hydro or nuclear power. And solar power is likely to become competitive with retail prices—making solar installation profitable to end users—long before it becomes profitable at the wholesale level. Many analysts consider the retail price the key benchmark; due to the distributed nature of solar power, end users are often decision-makers.

Indeed by this measure, solar already has achieved grid or near-grid parity in some markets such as Italy, Hawaii and parts of California where a combination of ample sunshine and high peak rates makes solar especially competitive.

In its recent report, Cleanedge projects that solar will be as or less expensive than retail prices for electricity in many major markets by 2015. If fossil fuels technologies jump in price due to shortages or putting a price on carbon (through a tax or system of caps), solar energy would achieve parity even sooner.

Non-cost Barriers: Other Obstacles to Solar Proliferation

In addition to a cost disadvantage, solar suffers from other obstacles. These include:

<u>Intermittency</u>. As previously discussed, solar power disappears at night and varies during the day. For this reason, in the absence of some method of storage, solar cannot act as a 24/7 power source. While a discussion of promising electricity and heat storage technologies (as used in solar thermal) is beyond the scope of this paper, intermittency is less of a barrier than one might think as utilities typically have an excess of power available at night and face their greatest loads during the day.

<u>A utility planning paradigm based on central generation of bulk power</u>. Few utilities like or even "get" solar power because a chief advantage, its distributed nature that cuts down on the need for high voltage lines and long-distance transmission, is at odds with the utilities' historic, centralized model for production and transmission. While new utility scale solar facilities do not challenge this model, smaller decentralized installations do.

In fact, early electrical electricity installations were decentralized, servicing particular factories or buildings. This was a consequence, in part, of DC power that, in its heyday, was not readily transportable across long distances. (DC subsequently has overcome this issue). AC power arguably triumphed over DC power because its voltage can be easily stepped up for long-distance transmission at a low-loss factor and then stepped down for usage. However, the triumph of the grid over single-point generation led to a model in which utilities invested in huge, centralized facilities they owned and from which they sent power out to customers. This centralized model then was enshrined in utility business models and further memorialized in the ratebase system of rate setting and utility regulation that allows utilities to earn a specified rate of return on costs added to their ratebase.

In contrast, much solar power may be sited near or at the customer's premises, reducing the need for long-distance power lines and centralized utility-owned plants—key elements of the ratebase. Distributed power may thus actually decrease utility profitability.

Coupling of ratebase and profit performance to electricity generated. Indeed, solar power further suffers from the fact that most utilities make money on quantity of power served and actually lose revenues and thus profits if customers install solar power. The primary method of rate setting, moving costs into the rate base on which utilities then are allowed to earn a measure of profit, is an incentive to utilities to invest in large plants, but a disincentive for energy savings or reduction of transmission loads.

Lack of uniform grid connection standards with respect to power quality (e.g. voltage, frequency, harmonics, and DC/AC issues). Solar power manufacturers and installers of equipment also must contend with a variety of different grid connection standards, making connecting to the grid unnecessarily expensive and complex.

Complex and uncertain billing procedures. Finally, garnering any benefit from solar generation in excess of one's unique demand is problematic in the United States. While approximately 36 states use net metering to allow individuals or companies that generate power to sell excess power back to the grid, standards are not uniform. Indeed, many states do not allow customers to receive any return for power sent back to the grid.

The effect of this is to lead to undersized as opposed to oversized solar installation. This is in stark contrast to countries such as Germany and Spain that encourage people and companies that install solar systems to generate as much power as possible.

Together, cost and non-cost barriers are slowing implementation of this highly promising technology.

VI. Breaking the Barriers

To break these barriers, strategies must address both cost and non-economic barriers. I will address the cost issue first.

(1) Breaking the Cost Barrier

There are two principle ways to reduce cost over the long term. The first is by scaling production since solar, as previously indicated, benefits from economies of scale. The second is through the development and deployment of new technology.

Breaking the Cost Barrier: Economies of Scale

As previously discussed, the cost of most PV is largely a function of the semiconductor used to transform light to electricity, which in most cases is silicon, similar to the silicon used to make computer chips. While silicon for the PV industry is not quite as pure as that used in computer chips, it is sometimes said that the PV industry exists on the leavings of the semiconductor industry. As a result, the chip industry provides an excellent model for forecasting the sensitivity of PV cell pricing to scale.

In the semiconductor industry, each doubling of production volume, on average, has led to a drop in unit costs of 28%. The figure is probably comparable to the impact of a doubling of volume on solar energy cost as well. Indeed a recent McKinsey article found that, "Over the last two decades, the cost of manufacturing and installing a photovoltaic solar-power system has decreased by about 20% with every doubling of installed capacity."[6]

This relationship provides a model for estimating the point at which solar power may achieve grid parity through greater volume alone.

- For example, let's assume that solar power currently costs $0.15 per KwH compared with $0.05 for coal. Let's further assume that coal stays constant in price (a conservative assumption given that coal's price is likely to increase). For solar to drop to the price of coal, it would need to realize a 67% decline in price. At a 22% reduction in price for every doubling in volume, achieving a 67% decline would require doubling global solar production three times or, in other words, a sixfold increase in volume. Using these assumptions, increasing solar's share of electricity production sixfold, from 0.16% to a still-modest 0.96%, has the capacity to bring solar cost down to price parity with coal.

Just as with computer chips, in which it did not matter whether scaling occurred through the sale of servers or home computers, in the case of PV, it does not matter if utilities or homeowners end up purchasing more solar power. Mass adoption of solar power, when it

[6]Lorenz, Peter, et al. "The Economics of Solar Power," *The McKinsey Quarterly*, 26 June 2008. www.mckinseyquarterly.com/The_economics_of_solar_power_2161_abstract.

eventually occurs, will radically drive down prices in the way that mass adoption of the PC, VCR and other devices containing chips has driven down their prices.

The key, however, is to bring solar to the tipping point at which scale begins to drive down prices. When this tipping point occurs, solar's price will drop so precipitously relative to fossil fuels that solar power may well steal an accelerating share of the market.

While the specific dynamic is different in the case of solar thermal and CSP, scale in these technologies has translated to lower costs and will continue to do so.

Breaking the Cost Barrier: Improved Technology

The second key way that solar can decline in price is through new technology. For example, if silicon could be sliced more thinly, costs would be reduced. Eliminating a step in the manufacturing process also could cut costs. One problem faced by the PV sector of the solar industry is that it must compete with chip makers for silicon. Thus, one promising approach is to skip the crystalline stage — when silicon is grown into crystals — by using amorphous silicon (see ***Box B***). Other promising technologies substitute other semiconductors for silicon, for example, CIGS, a blend of four different elements. Indeed, the premise of some thin films is that they can be deposited using technology similar to that of an inkjet printer onto a substrate that can be manipulated as easily as foil or plastic. While thin films typically exhibit lower efficiency rates of converting sunlight into energy as shown in ***Figure VI-1***, their cheaper manufacturing cost can make them highly cost competitive. Again, scale only will help lower the cost of these technologies as they reach commercial status.

Scale also is likely to drive down the cost of solar thermal technology whose principal components are mirrors, optics, turbines and heat transfer systems. Improved scale also should bring down the cost of solar thermal storage.

Box B - Types of Photovoltaic (PV) Technology

There are two major types of photovoltaic technologies, crystalline silicon, the traditional workhorse of PV technology, and thin films.

Crystalline Silicon (C-Si)

Crystalline silicon, used in the 1962 Telstar satellite, is still the most efficient technology for converting light to electricity. However, it requires precision manufacturing techniques similar to those for manufacturing computer integrated circuits. It comes in two main varieties, mono-crystalline and multi-crystalline.

With *mono-crystalline* silicon, a pure crystalline silicon ingot is grown and then sliced. Since impurities would ruin the product, the silicon must first be vaporized and then resolidified. Finely sliced layers are deposited one onto another in a precision manufacturing process to produce the final product.

With *multi-crystalline* silicon cells, multiple crystals are grown together by melting and then freezing the molten silicon. While this is less demanding than mono-crystalline technology, the resulting modules are somewhat less efficient.

Thin Films

Because of the expense and exacting requirements of the C-Si process, a number of companies have been developing thin film technologies that would facilitate high-volume manufacturing techniques from the plastics, metals or even printing industries. For example, if silicon could be attached to a surface using something like an inkjet printer, this would vastly simplify the manufacturing process even if the resulting module was not quite as efficient. The thin film market is growing rapidly.

Prominent thin film technologies include *amorphous silicon* that uses jumbled silicon in place of crystals stabilized by the addition of hydrogen and deposited one micron thick; *copper indium diselenide* that uses copper, indium gallium and selenide (CIGS) in the place of silicon; and *cadmium telluride* (used by First Solar), another alternative to silicon.

Thin film installations require more space than C-Si installations due to their lower efficiency.

Efficiency of Photovoltaic Technologies – Crystalline and Thin Films				
	Material	**Cell Efficiency at Standard Test Conditions***	**Module Efficiency at Standard Test Conditions***	**Annual Energy per Square Meter (Sacramento)****
Crystalline	Monocrystalline Silicon Wafer	Superb 14-17%	12-14%	238.1 kWh/sq. meter
	Multicrystalline Silicon Wafer	Very Good 11-17%	8-14%	141.9 kWh/sq. meter
Thin Films	Amorphous Silicon Thin Films	Good 7-10%	5-7%	117.8 kWh/sq. meter
	CIGS Thin Film	Very Good 12-13%	9-11%	165.9 kWh/sq. meter
	Hybrid Silicon Wafer	Excellent 18-19%	14-16%	304.7 kWh/sq. meter
	Back Contact Silicon Wafer	Best 20-22%	16-20%	318.6 kWh/sq. meter
*25 degrees centigrade, 100, W/square meter **fixed tilt angle = 35 degrees				

Figure VI-1
Source: Applied Materials

Breaking the Cost Barrier: Accelerating Cost Reduction

From the preceding analysis, it follows that the two primary ways to reduce cost are to drive scale and deploy new technologies. While private capital is funding much of the cost of scaling up the industry and developing new technologies, capital is flowing to those markets to which governments have provided incentives for production.

<u>The Power of Incentives</u>

Through their broad impact on the industry, tax credits and similar incentives work at a variety of different levels:

- By lowering the cost of solar, they increase volume and scale of adoption, lowering cost in turn;
- By making solar companies profitable, they increase incentives for private companies to invest in new technologies; and
- By promoting solar, they encourage structural changes to utilities that support solar power (such as practices that promote distributed generation).

As a result, solar energy today is highly dependent on incentives.

Those regions with the most solar power today are not the countries with the most sun, but rather the countries with the greatest incentives. The European leader in solar production, Germany, is known for its clouds, not its sun. According to a recent article, 15 of the 20 biggest PV plants in Europe are in Germany, although it has only half as many sunny days Portugal.[7] As previously discussed, most of the world's solar capacity is installed in Germany and Japan, not the United States. ***Figure VI-2*** shows that Germany's, and even Europe's, solar exposure are quite low by global standards.

Global Solar Radiation
(hours of sunlight per day during month of least average sunlight)

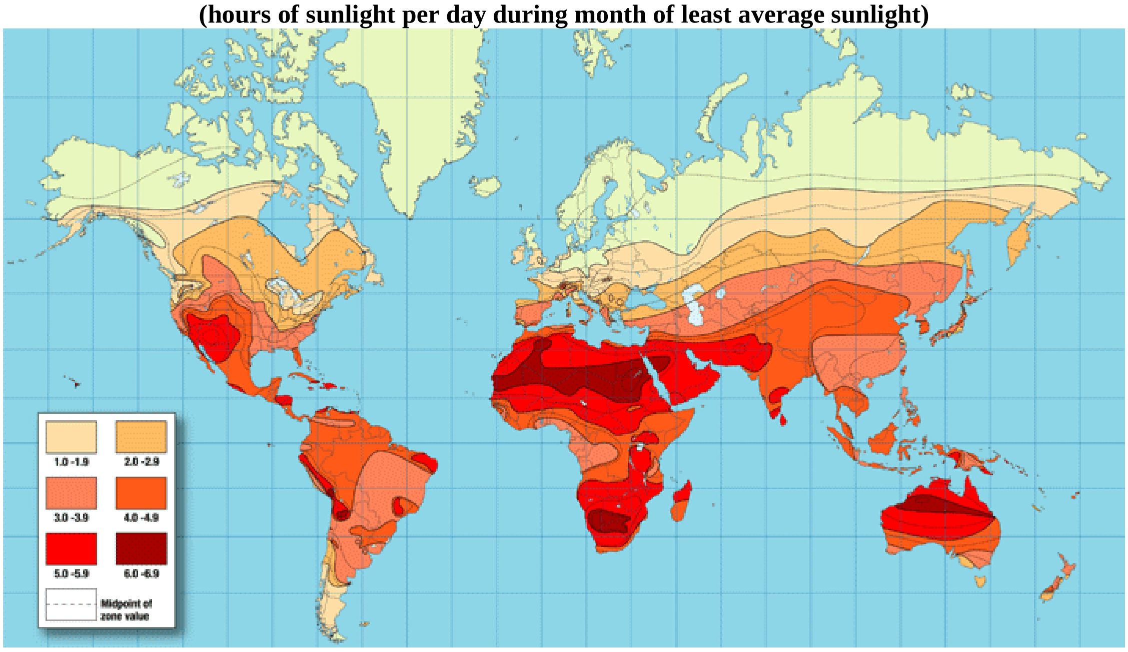

Figure VI-2
Source: Alternative Energy Store[8]

Germany and Japan have driven their industry through incentives. These typically take one of two forms, either a guaranteed "feed-in" tariff, or price at which utilities must buy renewable power, as in Germany, Korea and much of Europe, or tax credits and incentives toward the purchase of power, as in the United States.

Feed-In Tariffs

In the case of Germany, a feed-in tariff known as the GEC encourages German homeowners as well as businesses to install solar as an investment. Every kilowatt of power exported to the grid earns a payment that began at 0.57 euros per kWh but is steadily declining to reward early adopters. However, German households still are allowed to pay for the power they draw from the grid at much lower than normal rates. (They do not net the two, but rather get the feed-in tariff for all renewable power they produce and pay the lower standard rate for all they consume, earning a nice differential.) All told, those who install solar systems receive a return that has been estimated to be about 7% on their solar investments, which exceeds the return on German government

[7] Whitlock, Craig. "Cloudy Germany a Powerhouse in Solar Energy," *Washington Post*, May 5, 2007; Page A01, www.washingtonpost.com/wp-dyn/content/article/2007/05/04/AR2007050402466.html.
[8] http://howto.altenergystore.com/Reference-Materials/Solar-Insolation-Map-World/a43/.

bonds. The cost of the plan is borne by taxpayers, who pay slightly more for their electricity. However, the impact on prices has been negligible so far because solar remains a small component of total power.

The adoption of a feed-in tariff in Spain of 0.44 euros/kWh has jump-started solar energy in that nation. Greece offers a 0.45 euros/kWh tariff, Italy a 0.40 euros/kWh tariff and France a 0.30/kWh tariff. The programs have worked less well in France and Italy due to non-cost barriers to installing a solar system.

The U.S. Investment Tax Credit (ITC)

The main alternative to supporting the price of solar generated electricity is to subsidize its production. Passed by Congress in 2005, the U.S. ITC is credited with reviving solar power in the United States after a long period of dormancy. The ITC offers a 30% tax credit that is unlimited for commercial building owners but capped at $2,000 per year for homeowners. A tax credit, unlike a "deduction," is actually taken off your tax bill.

The lack of a cap for commercial projects has made the incentive highly attractive to building owners. Big box retailers operating buildings with roof areas that are large relative to the space inside, in particular, have availed themselves of the credit. In many cases, a third party such as Sun Power actually installs the system, takes the credit and, in turn, sells power back to the building owner at a reduced price under what is known as a power purchase agreement (PPA). Companies such as Safeway, Whole Foods and Wal-Mart have installed solar on many facilities. Thus, a system for a big box that might otherwise cost $500,000, after taxes, would cost $367,000. However, due to the $2,000 cap for homeowners, a home system that might otherwise cost $20,000 would cost $18,000.

However, unlike European feed-in tariffs that have a long time frame—20 years in the case of Germany—and enjoy widespread political support, the ITC has been authorized for only one or two years at a time.

The problem of uncertain renewal is particularly acute in the case of larger projects such as CSP projects that can take multiple years to plan, build and complete. The failure of Congress to renew the production tax credit, a credit similar to the ITC used by the wind industry, led to severe contractions in the wind industry and serves as a cautionary flag to potential solar investors.

For this reason, ITC advocates seek an eight-year credit to extend to 2017, when many solar proponents expect solar power to cost no more than coal. However, Congress has not yet passed this legislation.

State and Local Incentives

In addition to the federal ITC, which remains hostage to Congress' annual budget process, many states and localities also offer innovative programs. For example, Berkeley, CA, offers a novel program that allows homeowners to borrow the cost of a solar installation from the city and pay it off as an addition to their property taxes. The city provides the financing and then merely adds the debt service for the cost of the installation to annual real estate taxes. Unlike taking out a home equity loan to pay for solar, you don't have to pay it back when you sell your home and you don't place an additional lien on your property that could complicate getting a mortgage or home equity loan.

The effect of the program is to socialize borrowing, lowering borrowing costs and hurdles for homeowners and landlords, but also giving real estate owners the option of installing solar power.

Many other states and localities offer more traditional tax credits, rebates and similar incentives. However, these vary greatly by locality, making it difficult for homeowners and businesses to learn about programs and take advantage of them.

Support for R&D

Another way to reduce costs to make solar more competitive with fossil fuels is to improve technology. To achieve breakthrough innovation that, in addition to scale, will accelerate cost reduction and improve performance, science and technology investments are critical. Currently, the United States performs outstanding science in the energy arena. And for the time being, the private sector has stepped forward to support solar energy with venture capital. However, many companies do not survive the "valley of death," the period between initial investment and commercialization of technologies. Accordingly, the government should provide:

- Additional science funding;
- Peer-reviewed grant funding for middle stage companies; and
- Improved technology transfer from the government to the private sector.

(2) Breaking Non-Cost Barriers

In addition to incentives focused on the cost issue, action is need on non-cost barriers as well.

While there is no easy cure for the issue of *intermittency*, solar power does match up well with the highest periods of demand. Thus, while solar power may never become the sole source of power—unless the intermittency problem is totally resolved—it can play a key role in meeting peak demand and reducing the need to construct new high carbon plants.

To overcome the problem of intermittency:

- Government should encourage the development of new storage technologies through innovative support of R&D;
- Utility regulators should encourage the use of solar power as a source of peak power in place of dirty power and other spinning reserves; and

- Utilities should encourage the use of customer-generated solar power as a way to reduce load at peak times.

To address the other non-cost barriers described above, the appropriate bodies in the federal government should implement measures to:

- Improve and standardize billing such as net metering to unleash *electronpreneuers*: individuals or small businesses that produce their own power;
- Permit *net billing*, the ability of consumers to purchase power directly in open access markets from producers and deduct that cost from their regular bill;
- Create uniform standards for hookup to the grid;
- Promote funding and initiatives to modernize the grid to better and more intelligently move power to where it is needed;
- Decouple profit incentive from generation levels; and
- Encourage other industry changes that work to decentralize the industry.

VII. An Agenda to Unleash the Power of Solar

In light of the arguments and suggestions put forth in this report, NDN makes the following recommendations. Congress and regulators should:

- *Extend the ITC for eight years until the industry anticipates price parity with fossil fuels; remove the cap of $2,000 per household; and extend the credit to utility-scale projects.*

Experience has shown that incentives such as credits or favorable tariffs are needed to drive solar investment; waiting for the market to bring prices down would cost the United States dearly in terms of market share, jobs, technology and its eventual position in the global industry food chain. Currently the industry is in a Catch 22 in the sense that it needs scale to drive down prices. However, until prices drop, scale is unlikely to happen on its own. Rather than wait for incentives in other countries to drive down global prices, the United States should act now to continue to make solar competitive here at home. Moreover, to create a stable, predictable and favorable investment climate, Congress should commit to extending the ITC for eight years until solar becomes cost competitive. Otherwise, other countries are likely to take even larger shares of important markets than they already possess.

- *Enact a National Renewable Portfolio (or Electricity) Standard of 25% by 2020 with a solar set-aside.*

To further drive the adoption of solar, Congress should do what many state legislatures have done and adopt a renewable electricity standard, that is, a percentage of electrical capacity that must be derived from renewable sources. The advantage of a federal standard is that it would simplify and streamline the complex rules that currently drive solar investment at the state and local level. However, because wind energy currently is far less expensive than solar, a solar set-aside is required if a national renewable portfolio standard is to benefit the solar industry.

- *Encourage banks to offer either an interest rate deduction or allow a higher loan-to- value ratio on mortgages for houses that generate their own electricity, reflecting their lower cost of ownership.*

As an additional financial incentive to investing in solar, NDN proposes that Congress, as part of its role in the housing markets, encourage banks to lend money for solar installations as part of the mortgage process. Solar installations lower the overall cost of home ownership because they lower the cost of energy. Thus, banks should be encouraged to lend more money or at lower interest rates reflecting this lower cost of ownership.

- *Enhance R&D Support.*

To accelerate the cost reduction curb, Congress should provide enhanced R&D support to the solar industry through a peer-reviewed process that makes money available to fund promising companies and technologies. Rather then reinvent the wheel, this should be accomplished through the expansion of existing advanced technology and Small Business Innovation Research (SBIR) grants to solar companies.

- *Require Decoupling.*

Currently the solar industries, as well as other renewable energy sectors, are hampered by the business model and regulatory structure by which many utilities calculate rates and profits based on the amount of current they move without regard for savings. States, such as California, that have decoupled profitability from these outdated metrics, have seen energy use decline and use of renewables increase. Decoupling should be mandated at the federal level to create the right incentives to drive the use of solar energy. At the same time, however, utilities should receive a fair rate of return on their investments in utility scale solar energy.

- *Require Net Metering and Standardize Billing Procedures.*

Would-be *electronpreneurs* often are stymied by complex billing procedures or the inability of net metering in their state to allow them to profit from electricity they produce. National net metering would 1) allow people with solar power to enjoy the assurance that they may always sell power to the grid, and 2) stimulate the entrepreneurial spirit of the American people to produce solar energy in innovative ways.

- *Require Net Billing.*

Currently, competition is reduced even in open access markets by the difficulty faced by consumers in purchasing power from producers. A simple provision to allow consumers to purchase a portion of their power directly from alternative producers and then deduct this amount from their regular bill would greatly increase competitive forces in electricity markets.

- *Simplify and Standardize Grid Hookup Procedures.*

National standards also are needed to simplify grid hookup procedures to safely connect solar producer to the grid and reduce the cost of acquiring solar power.

- *Carry Out Limited Electricity Industry Reform to Eliminate Bias Toward Centralized Generation.*

In addition to mandating net metering and simplified hookup and billing procedures, Congress and the states should carry out limited electricity reform to make it easier for people to connect to the grid and move their power across it.

This involves reigning in incentives now on the books for utilities to bar access to the grid, sell their own power instead of renewable power from *electronpreneurs* and otherwise block innovation. Consistent with safety and quality assurance, utilities should be encouraged to partner with producers of renewable power to increase consumer choice.

- *Modernize the Grid.*

Congress and regulators should create the right incentives and provide sufficient funding to modernize and update our antiquated grid. This is important for reasons of power assurance and security—to safeguard the grid from terrorism, improve performance and reduce the chance of blackouts; it also is critical to moving power from renewable sources to points of demand given regional variations in costs, quantities, demand and prices.

This is an ambitious agenda. But the rewards of success are incalculable and the consequences of failure unimaginable. If the United States fails to reign in energy costs, reduce its dependence on foreign oil and lower CO2 and other greenhouse gas emissions, the costs will be huge to our environment and, indeed, the American way of life. Accordingly, NDN strongly urges participants in the energy community to work together to make the changes needed to unleash the potential of solar energy and facilitate America’s transition to a low-carbon economy.

About Michael Moynihan

NDN's Green Project Director Michael Moynihan is currently a William Bowen Merit Fellow at The Woodrow Wilson School of Public and International Affairs at Princeton University and on the faculty of New York University's Real Estate Institute. In 1999, Mr. Moynihan founded the first Internet video sharing community and Web site, AlwaysonTV, pioneering such innovations as personal video channels and video greetings. From 1996 to 1999, he served in the Clinton Administration in which he held the Internet portfolio and advised Secretaries Robert Rubin and Lawrence Summers as Senior Advisor for Electronic Commerce. While in the Clinton Administration, he led successful efforts to pass the Internet Tax Freedom Act, helped negotiate e-commerce agreements on payments, taxation and other issues with the European Union and Japan and oversaw the e-commerce efforts of Treasury's 140,000 employees. Prior to assuming the Internet portfolio, he advised Secretaries Rubin and Summers on a variety of other issues including managing debt crises, reforming the global financial architecture, balancing the budget and modernizing the IRS.

Mr. Moynihan has been a fellow of the Center for Strategic and International Studies and was the Robert C. Seamans Fellow in Technology and Public Policy at Harvard University's John F. Kennedy School of Government. He holds degrees from Columbia and Harvard and is currently a PhD candidate at Princeton.

Mr. Moynihan is the author of the critically acclaimed book, *The Coming American Renaissance* (Simon & Schuster) and other books. His forthcoming book, *Mankind Unbound: The History of Freedom* (Palgrave-McMillan) is scheduled for publication in 2009. His writing has appeared in *Harper's*, The *New York Times*, The *Washington Post* and other publications. He also is the author of an original paper for NDN, entitled *Investing in Our Common Future: U.S. Infrastructure* (November 2007).