Center for American Progress

science progress

ASSOCIATED PRESS

Fulfilling the Promise of Concentrating Solar Power

Low-Cost Incentives Can Spur Innovation in the Solar Market

By Sean Pool and John Dos Passos Coggin June 2013

Center for American Progress

science progress

Fulfilling the Promise of Concentrating Solar Power

Low-Cost Incentives Can Spur Innovation in the Solar Market

By Sean Pool and John Dos Passos Coggin May 2013

Contents

1 Introduction and summary

3 6 reasons to support concentrating solar power

5 Concentrating solar power is a proven zero-carbon technology with high growth potential

6 Concentrating solar power can be used for baseload power

7 Concentrating solar power has few impacts on natural resources

8 Concentrating solar power creates jobs

Concentrating solar power is low-cost electricity

9 Concentrating solar power is carbon-free electricity on a budget

11 Market and regulatory challenges to innovation and deployment of CSP technology

13 Low-cost policy solutions to reduce risk, promote investment, and drive innovation

14 Existing policy framework

15 Policy reforms to reduce risk and the cost of capital

17 Establish an independent clean energy deployment bank

18 Implement CLEAN contracts or feed-in tariffs

Reinstate the Department of Energy's Loan Guarantee Program

19 Price carbon

Policy reforms to streamline regulation and tax treatment

20 Tax reform for capital-intensive clean energy technologies

Guarantee transmission-grid connection for solar projects

21 Stabilize and monetize existing tax incentives

22 Further streamline regulatory approval by creating an interagency one-stop shop for solar power

23 Regulatory transparency

24 Conclusion

26 About the authors

27 Endnotes

Introduction and summary

Concentrating solar power—also known as concentrated solar power, concentrated solar thermal, and CSP—is a cost-effective way to produce electricity while reducing our dependence on foreign oil, improving domestic energy-price stability, reducing carbon emissions, cleaning our air, promoting economic growth, and creating jobs. One physicist has even touted it as the "technology that will save humanity."[1]

Grandiose claims aside, concentrating solar power has recently garnered the attention of the U.S. Department of Energy. The agency has created the SunShot Initiative to lead research into the technology—work that aims to increase efficiency, lower costs, and deliver more reliable performance from concentrating solar power. Additionally, high-profile U.S.-based companies such as IBM have invested in CSP research. Increasingly, private and public stakeholders believe that the technology holds the greatest potential to harness the power of the sun to meet national sustainability goals.[2]

As the White House prepares a climate-change-reform agenda that embodies the bold spirit of this year's State of the Union address, in which President Barack Obama emphasized executive authority to regulate greenhouse gases, Congress has begun debating the nation's new energy future. Concentrating solar power should be a key component of this dialogue.

Some are concerned that clean technologies are too immature and unreliable to produce the vast stores of affordable baseload energy needed to power the 21st century American economy. Others are worried that the nation cannot switch to carbon-free electricity without ruining the economy. CSP technology, however, presents a compelling response to each of these concerns.

In this report we detail why the United States should invest in concentrating solar power and delineate the market and regulatory challenges to the innovation and deployment of CSP technology. We also offer the following low-cost policy solutions that can reduce risk, promote investment, and drive innovation in the CSP industry:

- Reducing risk and cost of capital for clean solar energy

  - Establish an independent clean energy deployment bank.
  - Implement CLEAN contracts for concentrating solar power.
  - Reinstate the Department of Energy Loan Guarantee Program.
  - Put a national price on carbon.

- Streamlining regulation and tax treatment of CSP

  - Reform the tax code to put capital-intensive clean technologies on equal footing with fossil fuels.
  - Guarantee transmissions grid connection for concentrating solar power and other solar projects.
  - Stabilize and monetize existing tax incentives.
  - Streamline the regulatory approval process by creating an interagency "one-stop shop" for concentrating solar power and other clean energy power-generation facilities.
  - Ensure long-term regulatory transparency.

6 reasons to support concentrating solar power

A proven energy technology with a 30-year track record, concentrating solar power is a promising clean electricity source ripe for development in the United States.

Concentrating solar power is a simple technology in principle: It requires reflecting very large amounts of sunlight onto a very small area, creating heat that can be converted into electricity. Indeed, those who took survival-training class, whether in the boy scouts or elsewhere, may remember learning how a simple magnifying glass can be used to concentrate the sun's rays to start a fire. In ancient Greece, historical accounts hold that the Greek army, under instruction from Archimedes, used large oblong mirrors to reflect the sun's rays to set ablaze invading Roman sea vessels in 212 B.C.[3]

The first commercial-scale application of this technology was the Solar Energy Generating System, or SEGS, which was built in California in the 1980s. SEGS continues to operate under new ownership, and today contains more than 900,000 parabolic trough-style mirrors at nine separate sites in Southern California and accounts for 310 megawatts, or MW, of installed generating capacity—enough to power nearly a quarter of a million homes at peak production.[4]

Concentrating solar power, unlike standard solar photovoltaic technology, stores heat rather than electricity, making storage using CSP technology potentially much cheaper and more effective than solar photovoltaic, or PV, technology. This storage capacity allows CSP power plants to generate baseload power, which is the minimum power that a utility must supply to its customers to meet demand at a given time.[5] Since concentrating solar power can support the nation's electricity grid during all hours of the day, it is able to compete on par with natural gas and other traditional fossil-fuel sources of energy, without the need for expensive battery systems. Many other forms of clean energy production do not have this capability, making the electricity generated less valuable and harder to utilize for grid operators.[6]

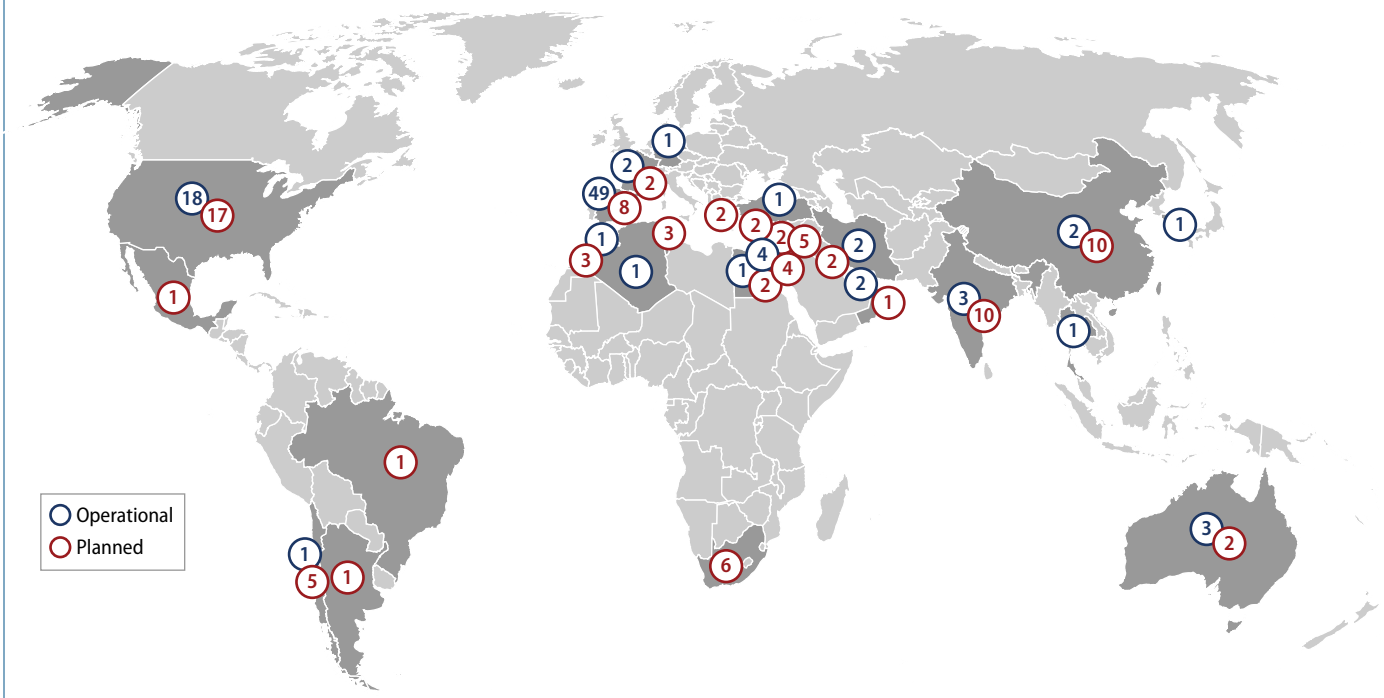
Additionally, concentrating solar power uses relatively cheap, plentiful building materials; creates more jobs per megawatt than any conventional fossil-fuel based technology; and already delivers low-cost electricity to homes across the world.[7]

Concentrating solar power is experiencing a resurgence domestically. The Solana CSP plant in Arizona and the Ivanpah CSP facilities in Southern California, when completed this year, will be two of the largest CSP facilities in the world.[8] They will provide more than 500 megawatts of power, or enough to power more than 150,000 homes. These facilities function by using the sun's concentrated rays to heat fluid to more than 700 degrees Fahrenheit and exploiting that stored heat to power steam turbines.[9] Together, these two plants will provide more than 4,000 union construction jobs and more than 160 permanent operation and maintenance jobs in Arizona and California.[10]

Developers in the European Union are already looking to build 20 gigawatts, or GW, of concentrating solar power in North Africa by 2020.[11] To realize the same kind of innovation and growth in the United States, however, the White House's 2013 energy agenda will have to address many regulatory and market-based obstacles that are holding concentrating solar power back from its full potential. We will describe these obstacles in more detail in the next section.

Concentrating solar power is a proven zero-carbon technology with high growth potential

Existing, planned, and under-construction CSP plants worldwide



Source: CSP World, "CASP World Map," available at http://www.csp-world.com/cspworldmap (last accessed May 2013).

Concentrating solar power is not a new or experimental technology. The first CSP plants were built in California in the 1980s and continue to produce electricity today.[13]

The American Recovery and Reinvestment Act of 2009 provided a bundle of incentives that stimulated the U.S. solar industry and excited its business leaders. In fact, *The Economist* and *The New York Times* both published articles or reports on solar technology's revival in the summer of 2009.[14] Also that year, Sopogy, a Hawaiian solar-thermal technology supplier, built Holaniku, a 2 MW CSP demonstration project, at the National Energy Laboratory of Hawaii, and a California-based CSP firm called eSolar began operation of the Sierra Sun Tower, a 5 MW water- and steam-tower demonstration plant.[15]

In 2010 U.S. cumulative CSP capacity from its 17 operating CSP plants reached 507 MW.[16] In 2011 the Department of Energy announced $3.35 billion in loan guarantees for four different projects, adding more stimulus to the U.S. CSP industry.[17]

The total worldwide wattage produced by CSP has reached 2.5 GW.[18] Plants currently under construction will generate an additional 2 GW, and all plants that are currently in the pipeline at any stage of development will add between 10 GW and 16 GW—the equivalent of more than 30 typical 500 MW gas-fired power plants when complete in the next few years.[19]

Measured by installed capacity, Spain continues to lead the world CSP market; its installed CSP-generating capacity totaled 1,042 MW in 2012, compared to 509 MW in the United States that year. But Spain recently suspended all of its renewable-energy incentives by royal decree in an effort to cut government costs.[20]

Meanwhile, the U.S. CSP industry continues to grow.[21] In Arizona alone, more than 1 GW of CSP is either operating, under construction, or planned.[22]

In this year's State of the Union address, President Obama challenged the country to double the deployment of renewable-energy technologies by 2020.[23] Because concentrating solar power lacks supply-chain bottlenecks and doesn't require expensive material inputs—see below—it has the potential to grow exponentially in the world's sunny regions over the coming decades.[24] Conditions are ripe for the United States to take the lead in the already-global and growing CSP market.

Concentrating solar power can be used for baseload power

Concentrating solar power has many advantages over other clean energy technologies because it can generate electricity around the clock. By storing excess heat energy during the day and releasing it overnight or during periods of cloudy weather, concentrating solar power can generate stable baseload power 24 hours a day. Storing heat energy is 20 to 100 times more cost-effective than battery storage of electricity, with energy-conversion efficiencies already exceeding 90 percent.[25]

Significant advances have recently been made in heat-storage technology, which could make CSP energy-production levels even more stable. New ternary molten

salts using potassium calcium nitrate, or CN-K, have a lower melting point and provide a larger temperature range, better storage capability, and enhanced safety.[26]

Finally, concentrating solar power can be paired with small natural gas-fired plants to further increase efficiency and stability. In 2010 Florida Power & Light Co. completed construction of the Martin Next Generation Solar Energy Center, a 75 MW gas-and-CSP hybrid facility near Indiantown, Florida.[27] Whenever sunlight falls below the necessary level to run the facility, the on-site natural-gas turbine can come online and, within a few minutes, account for the difference, ensuring that the plant can operate with market-expected levels of reliability in any weather condition.

Concentrating solar power has few impacts on natural resources

Unlike solar photovoltaics, which require large amounts of scarce materials such as silicon, copper indium selenide, or cadmium telluride, CSP plants are made from low-cost and durable materials such as steel and glass. In 2005, for example, a global scarcity of silicon caused supply-chain bottlenecks in solar-cell manufacture and drove up the prices of panels considerably.[28] CSP plants, however, when built at scale, are inexpensive and less susceptible to supply chain bottlenecks than are rare earth mineral-dependent photovoltaic power cells.[29]

Furthermore, concentrating solar power uses less land per megawatt than any other form of renewable energy,[30] generating 1.5 to 3 times more power per acre than solar photovoltaic technology.[31] According to a report by the National Renewable Energy Laboratory, CSP plants actually use about the same amount of land as fossil-fuel-based generation "because fossil fuel plants use additional land for mining and exploration as well as road building to reach the mines."[32]

Additionally, CSP plant components such as ternary molten salts, receivers, and collectors continue to make efficiency gains, which decrease the capital and operating expenditures for utility-scale projects. The federal government's SunShot CSP Research and Development program[33] recently announced a $55 million investment in 21 projects to kickstart more breakthroughs in efficiency.[34]

Concentrating solar power creates jobs

CSP plants are more capital intensive than traditional fossil-fuel plants; their installation is quick but expensive. Once online, however, CSP plant operating costs are extremely low since sunshine is free. Investments in CSP plants therefore produce higher economic benefits in terms of jobs created per unit of built capacity than conventional electricity-generation technologies.[35]

A report by the National Renewable Energy Laboratory estimates that investment in 100 MW of concentrating solar power in 2015 will generate 4,000 job years, 94 permanent jobs, and $628 million of economic output. (A job year is the equivalent of one full-time job sustained for one year.) Investment in a 100 MW traditional natural gas-fueled power plant, by comparison, would create just 330 job years, 13 permanent jobs, and $47 million of economic output.[36] This means that CSP investment creates more than 10 times more wealth and employment per megawatt than investments in the same amount of fossil-fuel power.

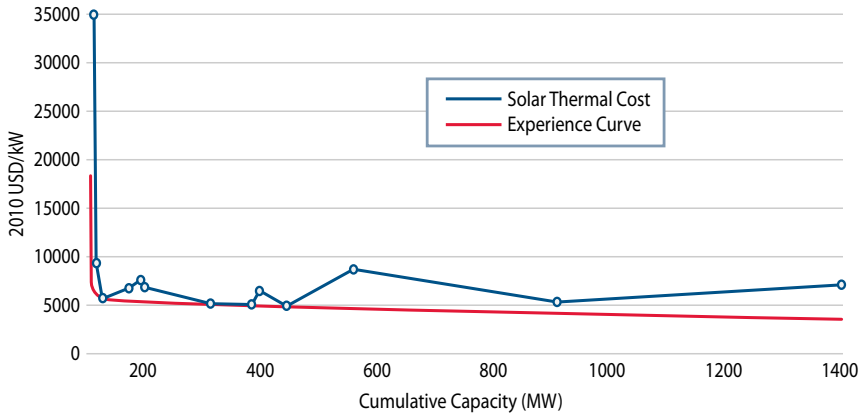
Concentrating solar power is low-cost electricity

Studies show that concentrating solar power is already cheaper than coal with carbon capture and storage, or CCS. It is also in many places cheaper than natural-gas-fired generation without any carbon capture at peak times of the day.[37]

In California, for example, the levelized energy cost, or LEC, of concentrating solar power is already as low as 12 cents per kilowatt-hour, compared to 19 cents per kilowatt-hour for electricity generated in the region by a simple-cycle natural gas-fired plant.[38] Concentrating solar power has the potential to meet demand while lowering energy bills.

The cost of CSP has fallen dramatically and is set to fall even further

The cost per kilowatt of existing and proposed CSP facilities has decreased as the cumulative number of built facilities has incerased globally. This mirrors the classic "experience curve" identified by technology experts.

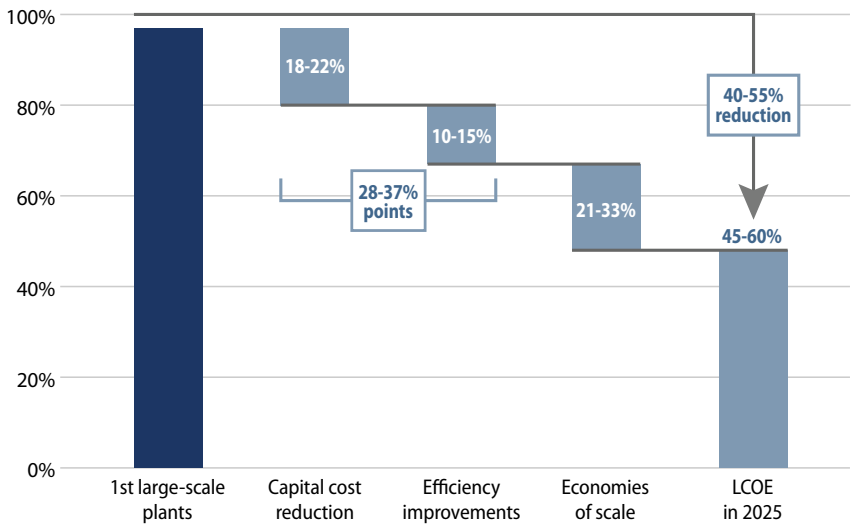


Source: National Renewable Energy Laboratory, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts" (2003). These are forward projections created by the National Renewable Energy Laboratory.

New federal research and development initiatives are aiming to drive the cost of concentrating solar power down to 6 cents per kilowatt-hour.[39] The National Renewable Energy Laboratory concludes that for every 1 percent improvement in the efficiency of electricity generation from sunlight, CSP costs will fall by a whopping 7 percent.[40] The figure below shows the laboratory's predictions for the price path of delivered electricity over the next decade.

Where future cost reductions will come from

Breakdown of reductions in levelized cost of electricity (or LCOE) for CSP plants projected by 2025.



Source: A.T. Kearney and ESTELA, 2010 via in International Renewable Energy Agency, "Renewable Energy Technologies: Cost Analysis Series," page 35. (See endnote 41.)

If current trends continue, the price of concentrating solar power will plummet in the coming decade.

Meanwhile, the cost of building and operating a conventional fossil-fuel-based power plant has more than doubled over the past 10 years and is projected to rise even further, as increasing global demand drives up the price of the limited supplies of fossil fuels.[42] This is one reason why investments in concentrating solar power are already outpacing investments in carbon-capture technology.[43]

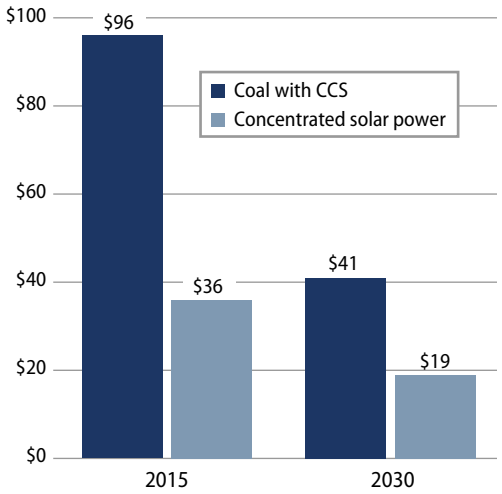
Concentrating solar power is carbon-free electricity on a budget

McKinsey & Company determined that concentrating solar power will be a much more cost-effective way to generate carbon-free electricity than coal with capture and storage. Using very conservative assumptions, McKinsey predicts that by 2015 it will be 3 times more expensive to sequester 1 metric ton of carbon from a coal plant than to avoid the emission of the same metric ton of carbon by generating electricity with concentrating solar power.[44]

Even by 2030, when many hope that the market for carbon capture and storage technology will have become widespread, it will still be roughly twice as expensive per metric ton of carbon avoided than concentrating solar power. This means that as we begin to internalize the costs of carbon pollution, CSP plants will emerge as more profitable and less expensive than coal with CCS technology. According to the Global CSP Outlook 2009, concentrating solar power could meet up to 7 percent of the world's projected electricity needs in 2030, rising to 25 percent by 2050.[45]

Cost of reducing 1 metric ton of CO2

Concentrating solar power becomes profitable at a much lower carbon price than coal with carbon capture and storage



Source: McKinsey & Company, "Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve" (2009). Currency converted using Translatum, "The Textor Currency Converter," available at http://www.translatum.gr/converter/currency.htm?texaccept=site+operator+accepts+conditions+at+http percent3A percent2F percent2Fconv.textor.com&val1=26&cur1=1.000000&cur2=0.724461 (last accessed May 2013).

Market and regulatory challenges to innovation and deployment of CSP technology

Investing in concentrating solar power is a cost-effective way to reduce our dependence on foreign oil, improve domestic energy-price stability, mitigate carbon emissions, clean our air, promote economic growth, and create jobs. But a century of subsidies and special tax loopholes for conventional fossil-fuel technologies,[47] as well as the market's inability to internalize the real cost of rising carbon emissions, have kept the incumbent fossil-fuel-based technologies locked in while keeping innovative carbon-free energy sources such as concentrating solar power locked out of our energy system.

CSP project developers and the investors who fund them face both market-based and regulatory barriers preventing their technology from achieving the scale of mainstream energy technologies, including:

1. **Higher cost of financing:** Because concentrating solar power is mistakenly perceived as a new and risky technology, financing for it is more expensive than financing for fossil fuels. Risk premiums drive up interest rates on loans.

2. **Unnecessary risk exposure:** Although CSP plants do not use fossil fuels to generate electricity, they are still subject to price volatility since conventional-fuel costs shape many regulated regional electricity markets.

3. **No market value of environmental benefits:** Despite the success of the Regional Greenhouse Gas Initiative in the Northeast and California's new cap-and-trade system, there is still no nationwide price for carbon pollution, despite the very real economic harms it is known to cause. This removes a major competitive advantage that concentrating solar power would otherwise enjoy over fossil-fuel-based generation. In today's market, natural gas is cheap.

4. **Capital intensive compared to fossil fuels:** CSP plants have zero lifetime fuel costs, but because concentrating solar power requires a great proportion of capital upfront rather than over the life of the plant in the form of fuel costs, financing the plants is more difficult.

5. **Regulatory uncertainty and high transaction costs:** Obtaining regulatory approval for siting, generation, transmission, and environmental authorization is risky, burdensome, and time-consuming because of the messy patchwork of local, state, and federal regulatory authorities.

6. **Lack of sufficient transmission planning:** While fossil-fuel plants are free to locate wherever sufficient transmission and transportation infrastructure is present, CSP plants have an additional location constraint: the sun. Unfortunately, there is often insufficient transmission infrastructure to support concentrating solar power in the places where it works best, and there are few effective federal policies to assist in siting new transmission.[48]

For the United States to take advantage of the economic opportunities offered by rapid CSP technology innovation and deployment, Congress must work together with federal agencies to address these market and regulatory barriers with a comprehensive and long-term approach.

Contrary to the assumptions of many, industry leaders are increasingly confident that overcoming barriers to CSP technology innovation and deployment does not require an expensive government-led R&D push.[49] Instead, a few simple, low-cost policy reforms and indirect incentives[50] can harness the power of America's innovators and investors to reduce costs, leverage private capital, create jobs, and drive economic growth—without increasing the size of government or the deficit.[51]

Low-cost policy solutions to reduce risk, promote investment, and drive innovation

As Congress and the White House develop separate approaches to combating the deleterious effects of global climate change through energy-policy reform, they should both aim for a few elegant, long-term incentives that will stimulate the CSP industry's next phase of growth.

In a 2008 CAP report titled, "A New Strategy to Spur Energy Innovation," authors Peter Ogden, John Podesta, and John Deutch outlined in broad strokes the necessity of a market-driven approach to energy-innovation policy:

> *Energy innovation, however, requires a market-driven rather than technology-driven approach to R&D, because new energy technologies are only useful insofar as they are adopted and deployed by private industry. This requires that the government work closely with the private sector and environmental regulators to develop and demonstrate technologies that can be profitable given existing and anticipated market conditions and environmental standards. This also has the important benefit of creating some real assets, such as production facilities and intellectual property that could enable the government to recoup a portion of its outlay.*[52]

This kind of approach, they concluded, was more cost effective in terms of value added per taxpayer dollar spent and more effective overall at meeting the goal of increasing market participation by private-sector actors. Building upon this foundation, a market-driven policy framework for CSP innovation should be guided by three principles:

- Policies must be transparent and inclusive of all public and private-sector stakeholders.
- Policies must establish and build upon the commercial feasibility of the technology.
- Policies must be low cost and fiscally responsible.

Given the political realities of today's economic recession and the rising federal deficit, policies need to be designed to harness the latent innovation potential of the private sector, rather than increase direct federal outlays. As Ogden, Podesta, and Deutch point out:

> *… the federal government does not make adequate use of indirect innovation incentives such as guaranteed purchase, loan guarantees, and tax credits. ... By relying on direct cost reimbursement, the federal government increases the risk that it will end up underwriting the development and demonstration of technologies that are not commercially viable, as was the case with the U.S. Synthetic Fuels program.*[53]

In any economic time, smart incentives for high-tech should be easy to administer and should create more socioeconomic benefits than the costs they impose on taxpayers. The incentives outlined here for CSP technology meet this standard. An analysis by the National Renewable Energy Laboratory showed that investment in CSP resulted in 10 times more economic output and 4 times more government revenue than did similar investments in gas-fired generation.[54]

Existing policy framework

Progressives in Congress and in federal agencies have already created a number of policy tools that can help address some of the challenges described above and accelerate CSP innovation and deployment, including:

- **Loan guarantees:** The embattled Title XVII Loan Guarantee Program grants the Department of Energy the authority to guarantee loans that support early commercial use of advanced technologies, including concentrating solar power.[55]

- **Regulatory fast tracking:** Former Secretary of the Interior Ken Salazar announced that the Department of the Interior would set aside 285,000 acres of public lands in the sunny Southwest for solar research and expedited environmental approval under a program called "solar energy zones."[56] The zones have already helped spur a boom in solar-power building, with 27 projects announced since 2008.[57]

- **Research, development, and demonstration:** The National Solar Thermal Test Facility is an R&D partnership among several national labs aimed at providing a test bed and platform where various industry players can come together to collaborate around innovation.[58]

- **Manufacturing innovation:** The 48C federal manufacturing tax credit provides a 30 percent tax credit to manufacturers who build CSP component parts. The program funding is limited, however, so not all companies are able to access the tax credit each year.[59] The funds delivered in just the first round of credits under Section 48 are estimated to have created nearly 60,000 manufacturing jobs.[60]

- **Investment tax credits:** The Business Energy Investment Tax Credit, or ITC, provides up to a 30 percent tax cut to companies developing CSP generation facilities.[61] Additionally, the credit was made more useful to small companies through Section 1603 of the American Recovery and Reinvestment Act, which allows companies that are not yet profitable—and therefore don't yet have any tax liability—to take cash grants in lieu of tax credits.[62] Many U.S. solar firms have exploited this benefit.

- **State policies:** Several state incentives lower the installation costs for CSP developers, including state renewable energy portfolio standards, production tax credits, and net metering provisions.[63]

Despite this potent array of policies, many of these measures are temporary and narrowly tailored. Innovation and cost reduction in capital-intensive industries such as electricity generation require long lead times and stable policy environments within which companies can compete. The existing cluster of federal and state incentives is still too unpredictable to attract most mainstream investors.

Policy reforms to reduce risk and the cost of capital

Eighty percent of the costs of a CSP plant come from construction and associated debt, while only 20 percent of the costs come from operation and maintenance over its lifetime.[64] On the one hand, this relatively high upfront capital cost means that once the loans are repaid after 25 or 30 years, the costs of generated electricity becomes extremely low—around 3 cents per kilowatt-hour.[65] On the other hand, the upfront capital intensity makes securing low-cost financing one of the most

critical bottlenecks in the development of new CSP projects, according to Thomas Mancini, program manager for CSP at Sandia National Lab.[66]

This is because CSP plant developers must take out larger loans at the outset of a project, and must pay higher rates of interest on those loans due to the investors' increased risks when financing new technologies compared to entrenched, status-quo technologies. The result is that simply the cost of financing, or even obtaining loans, represents a significant portion of the final cost of electricity for concentrating solar power—more so than any energy technology other than nuclear.[67] Indeed, an analysis by the International Renewable Energy Agency, or IRENA, found that of 30 different cost centers in the construction of an average CSP plant, the cost of financing made up the fourth-largest source of the cost, accounting for 6 percent.[68]

CSP developers face a broad set of risks when financing a project, starting with the misperception that the technology is new and therefore rife with uncertainty. Will the costs and timeline of construction be predictable? Will the siting authorization or environmental risk assessment create unexpected delays? Will appraisers accurately value the project? Will the project have access to the transmission grid and power markets? Will the regulatory or political incentives change suddenly? Will there be a price on carbon or a credit for carbon-free electricity?

Each of these questions increases the overall risk perceived by investors, and each drives up the cost of financing—and therefore the cost of electricity—by a small but significant amount. As a result, promoting certainty in CSP markets is a powerful way to reduce the overall cost and increase the availability of technology in the United States.

The table below, taken from an NREL analysis, shows that for every 1 percent reduction in the internal rate of return demanded by investors, the final delivered cost of a kilowatt-hour of CSP electricity drops by half a cent per kilowatt-hour.[69]

TABLE 1

Risk premium and cost of capital

The cost of capital has a large influence on the final levelized cost of electricity for concentrating solar thermal

Cost of capital (internal rate of return)	Projected levelized cost of delivered electricity in 2020	Percent difference
13%	$0.051 per kWh	-7.1%
14%	$0.055 per kWh	Base case
15%	$0.059 per kWh	+7.6%

Note: A 1 percent increase in the cost of capital leads to a 7.6 percent increase in the projected levelized cost of delivered electricity.
Source: National Renewable Energy Laboratory, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts."[70]

Below are some of the numerous policy options that exist to mitigate the risk felt by investors, thereby reducing the cost of capital to project developers and the cost of final delivered electricity.

Establish an independent clean energy deployment bank

One of the most powerful proposals for increasing private capital flows and reducing cost is to create a clean energy deployment bank with the authority to back private loans for CSP and other carbon-free energy projects.[71]

An independent green bank capitalized at $10 billion could use a variety of financial instruments to stimulate $100 billion or more in private investment toward CSP projects and component manufacture.[72] In their issue brief titled, "A Green Bank Is the Right Tool for Jobs," CAP experts Richard W. Caperton and Bracken Hendricks laid out a comprehensive set of principles for how such an institution should function. Included are recommendations that the bank be governed independently of the Department of Energy; have flexibility to use a wide range of financial instruments; and focus on innovation, manufacture, and deployment.[73]

The increased availability of private-capital investment would encourage companies to compete to produce the best technologies at the lowest cost—a major prerequisite for successful innovation in CSP technology.

Implement CLEAN contracts or feed-in tariffs

Since concentrating solar power does not require any fuel, it should theoretically experience no fuel-price volatility whatsoever. Since many utilities across the nation are required to use avoided-cost pricing, however, they ultimately tie the cost of clean energy to the price of other fossil fuels. This means that many regulated utilities set the price of electricity from nontraditional sources based on the estimated cost they would have had to spend on the same electricity from traditional sources—not the actual cost of solar. This creates the potential for situations in which the price of electricity generated from CSP would be priced based on the cost of fossil fuels, unfairly exposing ratepayers and investors to the risk of long-term fossil-fuel price increases. Exposing clean-tech investors to this risk unfairly robs ratepayers and project developers of the price-stability benefits that predictable solar energy should provide.[74]

CLEAN—which stands for Clean Local Energy Available Now—contracts, also known as feed-in tariffs, help power-plant developers reduce their risk exposure by creating a guaranteed price for clean electricity of a set period of time. Moving regulated utilities toward a price guarantee for carbon-free electricity would eliminate unnecessary risk exposure and reduce the cost of financing concentrating solar power, ultimately lowering the cost. Since utilities are regulated mostly at the state level, such an effort would require a patchwork of state policies.[75]

Reinstate the Department of Energy's Loan Guarantee Program

Since 2011 the Department of Energy has awarded a total of $4.235 billion in loan guarantees to five CSP projects accounting for 1.312 GW of output.[76] Late last year, however, the Loan Guarantee Program was terminated because Congress misunderstood its purpose.[77] Congress should, however, revive the program; since it leverages private capital, this approach costs taxpayers nothing unless project developers default. Simply put, under this policy, the government helps take on some of the risk otherwise borne by the project developers and investors, thus signaling confidence in the CSP industry and reducing the cost of financing.

Price carbon

One of the most powerful things the federal government can do to incentivize clean energy technologies such as concentrating solar power is make polluters pay for their atmospheric carbon emissions. The carbon-free nature of concentrating solar power should be a major competitive advantage over incumbent fossil-fuel technologies, but because fossil-fuel companies can emit carbon pollution at no cost in most parts of this country—California and most Northeastern states excepted[78]—concentrating solar power is robbed of that inherent structural advantage. This is why a robust and equitable cap-and-trade system or carbon tax needs to be a critical centerpiece of energy legislation in the 113th Congress.

Policy reforms to streamline regulation and tax treatment

In addition to fixing the market failures listed above, there are many areas where regulatory failures also add to the costs of CSP projects and stall the technology's progress.

CSP developers face a genuine labyrinth of regulatory obstacles. They must seek regulatory approval for siting, grid connection, power production, and environmental performance. This burden can add millions of dollars in legal fees, unexpected delays, and short-term financing costs to a project's budget. In particular, the siting of new transmission lines, which often involves overlapping jurisdictions and many local, state, and federal agencies, creates a major regulatory uncertainty for project developers.

Further, state and federal tax treatment of capital disproportionately affects capital-intensive investments such as concentrating solar power, compared to expense-intensive conventional coal or gas-fired generation. This is because CSP plants must finance more of their capital costs upfront than conventional power plants. According to the National Renewable Energy Lab's analysis:

> *… if a conventional fossil power plant were required to purchase all of its fuel upfront and the fuel were treated as a capital investment from a tax and financing standpoint,* ***the cost of power would be more than double.*** *If this upfront capital investment penalty could be eliminated, [concentrated solar] power could compete directly with the most advanced and efficient fossil fuel technologies.*[79]

While accelerated depreciation, implemented under the Energy Policy Act of 2005 and improved under the American Recovery and Reinvestment Act, has helped mitigate this burden somewhat,[80] the existing policies are not sufficiently long term or predictable to foster investor confidence, especially higher up on the supply chain. Accelerated depreciation allows the owners of power plants to book the lifetime cost of depreciation of their infrastructure in a shorter period of time; for example, two or five years instead of 10 or 20.

Below are some of the simple regulatory and tax changes on the federal level that can effectively mitigate the unnecessary risks and financial burdens that currently inhibit investment and innovation around CSP technology.

Tax reform for capital-intensive clean energy technologies

As CAP's Richard Caperton and Sima Gandhi showed in their 2010 report titled, "America's Hidden Power Bill," U.S. tax policy heavily favors fossil-fuel companies, giving them an unfair advantage in energy markets.[81] Giving tax breaks to CSP projects of the same magnitude as those that have traditionally been given to fossil-fuel plants would be a powerful move toward leveling the playing field for this technology.

Leveling the taxation environment in this way would cost the federal government a fairly small amount of money but would have large impacts on driving down the final cost of electricity and increasing scalability by driving more private capital and reducing the cost of financing. The experience of the Solar Energy Generating Systems, or SEGS, facility in California showed that a 1 percent reduction in the property-tax rate on the value of the solar property corresponded with a decrease of approximately 10 percent in the final cost of the delivered energy.[82]

Guarantee transmission-grid connection for solar projects

In June 2010 the Department of the Interior's Bureau of Land Management, or BLM, released a rental schedule for solar energy right-of-way authorizations on public lands—essentially a set of guidelines explaining when and under what circumstances grid connection could be expected for solar projects.[83] This measure has provided much-needed certainty about the cost of siting CSP projects on public lands.

To be truly effective, however, this schedule must be coupled with a guarantee for CSP grid connection. While the department is "currently engaged in ongoing transmission planning efforts,"[84] Congress needs to empower the Department of the Interior and the Federal Electricity Regulatory Commission to take a more active role in streamlining permitting and transmission issues for clean technologies such as concentrating solar power.

Many countries that have feed-in-tariff laws also require grid operators and utility companies to guarantee grid connection to renewable-energy projects that meet basic criteria. In the United States, access to the transmission grid is one of the hardest steps in the project development process. This complication increases the cost of capital and the final cost of electricity. When energy entrepreneur T. Boone Pickens bought 667 wind turbines in 2009 with plans to install them in his home state of Texas,[85] for example, his company proved unable to obtain approval for grid connection at his site of choice. Financial problems resulted for his firm, ultimately forcing him to abandon the project altogether.

To avoid this uncertainty, the seven southwestern states that have the best CSP development potential should focus on coordinating activities at a regional level to ensure land with high CSP potential is well served by necessary transmission-line development planning.[86]

Going one step further, implementing a guaranteed grid-connection policy in the United States, as was done in Europe with wind energy, would be a powerful accelerator of CSP development.[87] Such policy is difficult given the dissociated structure of local, state, and federal authorities, but Congress this year has the opportunity to fix this broken aspect of energy policy. To do so would remove one of the largest question marks in the project-development process, reducing both risk and cost.

Stabilize and monetize existing tax incentives

Thanks to the Energy Policy Act of 2005 and the American Recovery and Reinvestment Act, a number of tax credits already exist (see the list on page 14). Many of the incentives currently in place, however, such as the 48C manufacturing tax credit and the investment tax credit, are either temporary, limited in supply, or subject to frequent reauthorization. This uncertainty ruins the planning process for CSP developers.

A CSP parts manufacturer considering plant construction in the United States, for example, will want to know that there will be demand for those parts 10 or 15 years in the future. U.S. energy policy should focus on strengthening the stability of incentives for manufacturers, project developers, and power buyers so they can rely on these policies in the context of long-term business planning.

Furthermore, the level of funding for the 48C program to date has only been sufficient to cover about one-third of the demand from advanced energy-technology manufacturers.[88] Congress should fully fund the 48C manufacturing tax credit and remove the cap, as was proposed in Sen. Sherrod Brown's (D-OH) Security in Energy and Manufacturing, or SEAM, Act of 2012.[89]

Congress should also reauthorize the U.S. Department of Treasury 1603 cash grants for renewable energy in lieu of tax credits for 10 years and add additional language to expand the 1603 program so it can be applied to 48C tax credits in addition to the investment tax credit. The 1603 grant has become the centerpiece of many solar business plans; CSP firms need assurance that federal budget sequestration will not dilute the payout of approved grants.[90]

Finally, Congress should heed the message of President's Obama's 2013 State of the Union address and make the renewable energy production tax credit permanent, refundable, and applicable to concentrating solar power for 10 years.[91]

Further streamline regulatory approval by creating an interagency one-stop shop for solar power

The costs of obtaining regulatory approval are substantial and can add millions of dollars to the cost of CSP project development. Project developers must obtain regulatory approval from agencies as diverse as the Environmental Protection Agency, the Department of the Interior, the Department of Energy, and the Federal Energy Regulatory Commission. Depending on location, they must also seek certification from various municipal, county, and state authorities. In some cases these approval processes can slow projects down by months or even years. Congress should expand upon the current BLM solar zones fast-tracking process to create a true one-stop shop interagency approval process to cut costs, reduce regulatory risks, and increase the flow of private capital.

Regulatory transparency

Uncertainty about the regulatory environment and availability of incentives caused a lot of problems for the first CSP project in California in the 1980s.[92] Arbitrary restrictions on the allowed size of CSP plants and the timeframe for construction were written into the legislation. This dramatically increased the cost of financing by preventing economies of scale and accelerating construction schedules beyond the cost-efficient speed.[93] Incentives in the 113th Congress's climate and energy bill should have a long-term approach that establishes certainty in CSP markets.

Conclusion

Concentrating solar power promises to become a keystone technology in America's renewable-energy portfolio. CSP enjoys rapidly falling costs, few bottlenecked supply chains, relatively low land and water requirements, and a rapidly growing international market. It presents a great opportunity for U.S. energy and manufacturing industries.

Amid such excitement, we must still take care to avoid picking winners and losers in the national energy market; concentrating solar power is just one of a menu of clean energy options. "Low-Carbon Innovation," a Center for American Progress report from 2010, discussed the nuanced role of government investing in new technologies without picking winners and losers:[94]

> *America is unique among industrialized nations in or our disdain for the term "industrial policy." For many Americans, the very term conjures up an image of managed and centrally planned economies that cuts against the grain of our political and economic culture. In fact, the term is mostly used in other countries as shorthand for a comprehensive competitiveness and jobs strategy, rather than as an indication of central planning or a desire to "pick winners and losers."*
>
> *Even in a policy environment shaped by differentiated state policies and diverging political interests, it should nonetheless be possible to develop a common framework for clean-tech expansion, grounded within deep federalist traditions of economic development, to help speed the growth of a truly national market for advanced low-carbon energy technologies.*

In keeping with this philosophy, the reforms in this paper are all designed to put concentrating solar power on even footing with other renewable-energy technologies and entrenched fossil-fuel competitors. Nearly all of the recommendations presented here—from pricing carbon to establishing a federal clean energy investment fund and addressing transmission and cost-of-capital issues—would benefit the entire renewable-energy industry and further the cause of a clean energy economy.

While this report is focused on bringing some much-deserved attention to concentrating solar power, it is important to reiterate that no single technology will be the sole solution to climate change. Concentrating solar power is just one of many tools that we must develop and explore as humanity grapples with the existential, environmental, and economic threat of anthropogenic climate change.

The reforms proposed here are designed to promote fiercer and healthier competition among clean energy technologies and companies, while ensuring that all of these nascent industries can engage in fair competition with the fossil-fuel industry.

About the authors

Sean Pool is a Policy Analyst and Managing Editor of Science Progress, the Center for American Progress's online science and technology policy journal. Previously, Sean supported CAP's energy team, focusing on regional and state-level climate-change policies, clean energy innovation networks, and enhancing U.S. industrial competitiveness through research, commercialization, and deployment of new technology. Before coming to American Progress, Sean researched international voluntary and policy-driven carbon markets at the Yale Center for Environmental Law and Policy, at the Yale Office of Sustainability, and at the Australia National University Green Office in Canberra. Sean holds a bachelor's degree in environmental engineering and international studies from Yale University.

John Dos Passos Coggin is a freelance writer and environmental analyst. A graduate of Yale University, he holds a master's degree in public policy from the University of Maryland. He has worked in the solar industry as an incentives specialist and worked at several environmental nonprofits over the past decade. His first book, an authorized biography of legendary Florida politician Lawton Chiles, titled *Walkin' Lawton*, was published last year. His second book is in development.

Acknowledgements

The authors would like to thank Daniel J. Weiss, who accidentally launched this report thinking it would be a short column, as well as Kate Gordon and Jonathan Moreno for their patience, Richard Caperton and Darryl Banks for their expert guidance.

Endnotes

1 Joseph Romm, "The Technology That Will Save Humanity," Salon.com, April 14, 2008, available at http://www.salon.com/news/feature/2008/04/14/solar_electric_thermal/index1.html.

2 Shane McGlaun, "IBM scientists research concentrated solar radiation power source," SlashGear, April 22, 2013, available at http://www.slashgear.com/ibm-scientists-research-concentrated-solar-radiation-power-source-22278702/.

3 UnMuseum, "Archimedes and the Burning Mirror," available at http://www.unmuseum.org/burning_mirror.htm (last accessed April 2013).

4 Nextera Energy Resources, "Fact Sheet: Solar Electric Generating Systems," available at http://www.nexteraenergyresources.com/pdf_redesign/segs.pdf (last accessed May 2013); Nextera Energy Resources, "Solar Electric Generating Systems," available at http://www.nexteraenergyresources.com/content/where/portfolio/pdf/segs.pdf (last accessed May 2013).

5 Britt Childs Staley and others, "Juice from Concentrate: Reducing Emissions with Concentrating Solar Thermal" (Washington: World Resources Institute, 2009).

6 Dr. Christoph Richter, Sven Teske, and Rebecca Short, "Concentrating Solar Power: Global Outlook 09" (Washington: Greenpeace, 2009), available at http://www.greenpeace.org/international/Global/international/planet-2/report/2009/5/concentrating-solar-power-2009.pdf.

7 Ibid.

8 Kathleen Zipp, "Ivanpah Solar Project is More than 92% Complete," Solar Power World, May 22, 2013, available at http://www.solarpowerworldonline.com/2013/05/ivanpah-solar-project-is-more-than-92-complete/.

9 Kathleen Zipp, "World's Largest Concentrated Solar Plant," Solar Power World, July 17, 2012, available at http://www.solarpowerworldonline.com/2012/07/worlds-largest-concentrated-solar-plant/.

10 Andrew Proteus, "Green Jobs & Solar Power At Night: Abengoa's 280 MW Solana CSP Plant Nearly Ready," December 1, 2012, available at http://cleantechnica.com/2012/12/01/green-jobs-solar-power-at-night-abengoas-280-mw-solana-csp-plant-nearly-ready/#91ybui7OmJbAo3zD.99; "BrightSource Ivanpah," available at http://ivanpahsolar.com/ (employment figures summed).

11 James Kanter, "Solar Power and Geopolitics in the Mediterranean," The New York Times, February 13, 2009, available at http://green.blogs.nytimes.com/2009/02/13/solar-power-and-geopolitics-in-the-mediterranean/.

12 CSP World, "CSP World Map," available at http://www.csp-world.com/cspworldmap (last accessed May 2013).

13 "NextEra Energy Resources Portfolio—Fuel Type," available at http://www.nexteraenergyresources.com/pdf_redesign/portfolio_by_fuel.pdf (last accessed May 2013).

14 The Economist, "Social-thermal technology: The other kind of solar power," June 4, 2009, available at http://www.economist.com/science/tq/displaystory.cfm?story_id=13725855; James Kanter, "Bigger Role of Concentrating Solar Power?," The New York Times, June 3, 2009, available at http://greeninc.blogs.nytimes.com/2009/06/03/bigger-role-for-concentrating-solar-power/.

15 The Economist, "Social-thermal technology: The other kind of solar power," June 4, 2009, available at http://www.economist.com/science/tq/displaystory.cfm?story_id=13725855; James Kanter, "Bigger Role of Concentrating Solar Power?," The New York Times, June 3, 2009, available at http://greeninc.blogs.nytimes.com/2009/06/03/bigger-role-for-concentrating-solar-power/.

16 Belén Gallego and others, "The history of American CSP: A timeline" (Last Vegas: CSP Today, 2012), available at www.csptoday.com/usa/pdf/USAtimeline.pdf.

17 CSP Today, "US Concentrated Solar Power Industry receives its biggest boost yet by American DoE," Press release, June 17, 2011, available at http://www.renewableenergyworld.com/rea/partner/first-conferences/news/article/2011/06/us-concentrated-solar-power-industry-receives-its-biggest-boost-yet-by-american-doe.

18 CSP World, "CSP World Map."

19 "Projects Tracker Overview," available at http://social.csptoday.com/tracker/projects/table.

20 Oliver Ristau, "Spain suspends FITs," PV Magazine, January 28, 2012, available at http://www.pv-magazine.com/news/details/beitrag/spain-suspends-fits_100005605/#axzz2RJiCNQ6c.

21 Gallego and others, "The history of American CSP."

22 Beatriz Gonzalez, "Arizona Corporation Commission to talk future growth at CSP Today USA," CSP Today, February 18, 2013, available at http://social.csptoday.com/technology/arizona-corporation-commission-talk-future-growth-csp-today-usa.

23 Daniel J. Weiss, "State of the Union; More Investments in Clean Energy, Less Carbon Pollution," Center for American Progress, February 13, 2013, available at http://www.americanprogress.org/issues/green/news/2013/02/13/53267/state-of-the-union-more-investments-in-clean-energy-less-carbon-pollution/.

24 Richter, Teske, and Short, "Concentrating Solar Power: Global Outlook 09."

25 Joe Romm, "Solar baseload outshines 'clean coal'—and it always will," Climate Progress blog, November 21, 2008, available at http://climateprogress.org/2008/11/21/solar-baseload-outshines-clean-coal-and-it-always-will/; NREL, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts" (2003), available at http://www.nrel.gov/docs/fy04osti/34440.pdf.

26 Emilio Iglesias Sola, "Concentrated Solar Power: Next-Generation Technologies Poised to Ramp up Utility-Scale Production," Renewable Energy World, January 3, 2013, available at http://www.renewableenergyworld.com/rea/news/article/2013/01/concentrated-solar-power-next-generation-technologies-poised-to-ramp-up-utility-scale-production.

27 Gallego and others, "The history of American CSP."

28 John Gartner, "Silicon Shortage Stalls Solar," Wired, March 28, 2005, available at http://www.wired.com/science/planetearth/news/2005/03/67013.

29 Sun Rays Are Free, "Conventional Solar Cell Materials," April 18, 2009, available at http://sunraysarefree.com/articles/2009/04/18/conventional-solar-cell-materials.

30 Peter Viebahn and others, "Final report on technical data, costs, and life cycle inventories of solar thermal power plants" (DLR and CIEMAT, 2008).

31 For comparison, see Bernadette Del Chiaro, Sarah Payne, and Tony Dutzik, "On the Rise: Solar Thermal Power and the Fight Against Global Warming" (Boston: Environment America, 2008), available at http://www.environmentamerica.org/reports/ame/rise-solar-thermal-power-and-fight-against-global-warming; David R. Mills and Robert G. Morgan, "Solar Thermal Electricity as the Primary Replacement for Coal and Oil in U.S. Generation and Transportation," September 2009, available at http://www.wired.com/images_blogs/wiredscience/files/MillsMorganUSGridSupplyCorrected.pdf

32 NREL, "Concentrating Solar Power: Energy From Mirrors" (2001), available at http://www.nrel.gov/docs/fy01osti/28751.pdf.

33 U.S. Department of Energy, "SunShot Concentrating Solar Power Research and Development," available at http://www1.eere.energy.gov/solar/sunshot/financial_opps_detail.html?sol_id=452 (last accessed May 2013).

34 Sola, "Concentrated Solar Power: Next-Generation Technologies Poised to Ramp up Utility-Scale Production."

35 L. Stoddard, J. Abiecunas, and R. O'Connell, "Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California" (Washington: NREL, 2006), available at http://www.nrel.gov/Fdocs/Ffy06osti/F39291.pdf.

36 Ibid.

37 Ibid; McKinsey & Company, "Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve" (2009).

38 Stoddard, Abiecunas, and O'Connell, "Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California."

39 Sola, "Concentrated Solar Power: Next-Generation Technologies Poised to Ramp up Utility-Scale Production."

40 NREL, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts."

41 Ibid; International Renewable Energy Agency, "Renewable Energy Technologies: Cost Analysis Series" (2012), available at http://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-CSP.pdf.

42 Joe Romm, "Power Plants Cost Double Since 2000—Efficiency Anyone?," Climate Progress blog, February 29, 2008, available at http://climateprogress.org/2008/02/29/power-plants-costs-double-since-2000-efficiency-anyone/.

43 Romm, "Solar baseload outshines 'clean coal'—and it always will."

44 McKinsey & Company, "Pathways to a Low-Carbon Economy"; Translatum, "The Textor Currency Converter," available at http://www.translatum.gr/converter/currency.htm?texaccept=site+operator+accepts+conditions+at+http percent3A percent2F percent2Fcconv.textor.com&val1=26&cur1=1.000000&cur2=0.724461 (last accessed May 2013).

45 Richter, Teske, and Short, "Concentrating Solar Power: Global Outlook 09."

46 McKinsey & Company, "Pathways to a Low-Carbon Economy"; Translatum, "The Textor Currency Converter."

47 Rebecca Leber, "Happy 100th Birthday, Big Oil Tax Breaks," Climate Progress blog, March 1, 2013, available at http://thinkprogress.org/climate/2013/03/01/1654501/oil-subsidies-century/.

48 Solar Feeds, "BLM restrictions cause solar thermal to seek private land," available at http://www.solarfeeds.com/blm-restrictions-cause-solar-thermal-to-seek-private-land/ (last accessed May 2013).

49 Michael Lotker, "Barriers to Commercialization of Large-Scale Solar Electricity: Lessons Learned from the LUZ Experience" (Washington: Sandia National Laboratories, 1991); Peter Ogden, John Podesta, and John Deutch, "A New Strategy to Spur Energy Innovation" (Washington: Center for American Progress, 2008); Joe Romm, "Do We Need a Massive Government Program to Generate Breakthroughs to Make Solar Energy Cost-Competitive?," Climate Progress, April 10, 2008, available at http://climateprogress.org/2008/04/10/do-we-need-a-massive-government-program-to-generate-breakthroughs-to-make-solar-energy-cost-competitive/.

50 Ogden, Podesta, and Deutch, "A New Strategy to Spur Energy Innovation."

51 Lotker, "Barriers to Commercialization of Large-Scale Solar Electricity"; Romm, "Do We Need a Massive Government Program to Generate Breakthroughs to Make Solar Energy Cost-Competitive?"

52 Ogden, Podesta, and Deutch, "A New Strategy to Spur Energy Innovation."

53 Ibid.

54 Stoddard, Abiecunas, and O'Connell, "Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California."

55 Solar Energy Industries Association, "Loan Guarantee Program," available at http://www.seia.org/policy/finance-tax/loan-guarantee-program (last accessed May 2013).

56 Solar Energy Development Programmatic EIS, "Solar Energy Zones," available at http://solareis.anl.gov/sez/index.cfm (last accessed May 2013).

57 Susan Kraemer, "Obama Drives Clean Energy Boom On Public Lands," Earth Techling blog, January 10, 2012, available at http://www.earthtechling.com/2012/01/obama-drives-clean-energy-boom-on-public-lands/; U.S. Department of the Interior, "Secretary Salazar Approves Renewable Energy Projects in California, Oregon," Press release, December, 29, 2011, available at http://www.doi.gov/news/pressreleases/Secretary-Salazar-Approves-Renewable-Energy-Projects-in-California-Oregon.cfm.

58 Sandia National Laboratories, "Concentrating Solar Power (CSP)," available at http://energy.sandia.gov/?page_id=2445 (last accessed May 2013).

59 Database of State Incentives for Renewables & Efficiency, "Qualifying Advanced Energy Manufacturing Investment Tax Credit," available at http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US52F&re=1&ee=1 (last accessed May 2013).

60 Sherrod Brown Senator for Ohio, "Sen. Brown Introduces Legislation to Expand Manufacturing Tax Credit," Press release, May 6, 2010, available at http://www.brown.senate.gov/newsroom/press/release/sen-brown-introduces-legislation-to-expand-manufacturing-tax-credit.

61 Richard W. Caperton, "Good Government Investments in Renewable Energy" (Washington: Center for American Progress, 2012), available at http://www.americanprogress.org/issues/green/report/2012/01/10/10956/good-government-investments-in-renewable-energy/.

62 Solar Energy Industries Association, "Issues & Policies: Solar Manufacturing Incentives," available at http://www.seia.org/policy/manufacturing-trade/solar-manufacturing-incentives (last accessed May 2013).

63 Database of State Incentives for Renewables & Efficiency, "Home page," available at http://dsireusa.org/ (last accessed May 2013).

64 Richter, Teske, and Short, "Concentrating Solar Power: Global Outlook 09."

65 Ibid.

66 The Economist, "Social-thermal technology: The other kind of solar power."

67 Institute for Energy Research, "Electric Generating Costs: A Primer," August 22, 2012, available at http://www.instituteforenergyresearch.org/2012/08/22/electric-generating-costs-a-primer/.

68 International Renewable Energy Agency, "Renewable Energy Technologies: Cost Analysis Series."

69 NREL, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts."

70 Ibid.

71 Richard Caperton and Bracken Hendricks, "The Green Bank is the Right Tool for Jobs" (Washington: Center for American Progress, 2011), available at http://www.americanprogress.org/issues/labor/report/2011/09/02/10281/a-green-bank-is-the-right-tool-for-jobs/.

72 Jake Caldwell, "The Green Bank Is Essential for a Clean-Energy Strategy" (Washington: Center for American Progress Action Fund, 2009), available at http://www.americanprogressaction.org/wp-content/uploads/issues/2009/08/pdf/green_bank.pdf.

73 Ibid.

74 Lotker, "Barriers to Commercialization of Large-Scale Solar Electricity."

75 Richard Caperton and others, "CLEAN Contracts: Making Clean Local Energy Accessible Now" (Washington: Center for American Progress, 2011), available at http://www.americanprogress.org/issues/green/report/2011/01/18/8957/clean-contracts-making-clean-local-energy-accessible-now/.

76 CSP Today, "US Concentrated Solar Power Industry receives its biggest boost yet by American DoE."

77 Andrew Williams, "The U.S. CSP Sector after Loan Guarantees—Ready to Fly Solo?," CSP Today blog, December 21, 2012, available at http://social.csptoday.com/markets/us-csp-sector-after-loan-guarantees-ready-fly-solo.

78 Sean Pool, "Success of Northeast Regional Cap-and-Trade System Shows Market-Based Climate Policy Is Well Within Reach," Center for American Progress, February 7, 2013, available at http://www.americanprogress.org/issues/green/news/2013/02/07/52356/success-of-northeast-regional-cap-and-trade-system-shows-market-based-climate-policy-is-well-within-reach/; Climate Guest Blogger, "Big oil showdown in California: Economists agree, don't block AB 32!," Climate Progress blog, July 19, 2010, available at http://thinkprogress.org/climate/2010/07/19/206452/proposition-23-big-oil-economists-ab32/.

79 Henry W. Price, "Parabolic Trough Solar Power for Competitive U.S. Markets" (Golden, Colorado: NREL, 1999), available at http://large.stanford.edu/publications/coal/references/troughnet/market/docs/25798.pdf.

80 Database of State Incentives for Renewables & Efficiency, "Modified Accelerated Cost-Recovery System (MACRS)+Bonus Depreciation (2008–2013)," available at http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F&re=1&ee=1 (last accessed May 2013).

81 Richard W. Caperton and Sima J. Gandhi, "America's Hidden Power Bill" (Washington: Center for American Progress, 2010), available at http://www.americanprogress.org/wp-content/uploads/issues/2010/04/pdf/energytaxexpenditures.pdf.

82 Lotker, "Barriers to Commercialization of Large-Scale Solar Electricity."

83 U.S. Department of the Interior, "Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States," available at http://www.doi.gov/news/loader.cfm?csModule=security/getfile&pageid=321960 (last accessed May 2013); NREL, "BLM Announces Solar Energy Rental Rates for Public Lands," Press release, June 22, 2010, available at http://www.nrel.gov/csp/news/2010/862.html.

84 U.S. Department of the Interior, "Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States."

85 Reuters, "UPDATE 2-Pickens' Mesa Power orders GE wind turbines," May 15, 2008, available at http://www.reuters.com/article/2008/05/15/mesa-ge-idUSN1521224020080515.

86 Solar Energy Industries Association, "Issues & Policies: Transmission," available at http://www.seia.org/policy/power-plant-development/transmission (last accessed May 2013).

87 European Wind Energy Association, "CHAPTER 1: WIND IN THE EUROPEAN POWER MARKET," available at http://www.wind-energy-the-facts.org/en/part-4-industry--markets/chapter-1-wind-in-the-european-power-market/ (last accessed May 2013).

88 Sherrod Brown Senator for Ohio, "Sen. Brown Introduces Legislation to Expand Manufacturing Tax Credit."

89 Ibid.

90 Solar Industry, "Department of Treasury Clarifies 1603 Grant Reductions Under Sequestration," February 1, 2013, available at http://solarindustrymag.com/e107_plugins/content/content.php?content.12028#.USp3_mf4JDw.

91 Weiss, "State of the Union; More Investments in Clean Energy, Less Carbon Pollution."

92 Lotker, "Barriers to Commercialization of Large-Scale Solar Electricity."

93 Richter, Teske, and Short, "Concentrating Solar Power: Global Outlook 09."

94 Bracken Hendricks, Sean Pool, and Lisbeth Kaufman, "Low-carbon Innovation" (Washington: Center of American Progress, 2011), available at http://www.americanprogress.org/issues/green/report/2011/05/31/9700/low-carbon-innovation/.

The Center for American Progress is a nonpartisan research and educational institute dedicated to promoting a strong, just, and free America that ensures opportunity for all. We believe that Americans are bound together by a common commitment to these values and we aspire to ensure that our national policies reflect these values. We work to find progressive and pragmatic solutions to significant domestic and international problems and develop policy proposals that foster a government that is "of the people, by the people, and for the people."

Science Progress, a project of the Center for American Progress, is designed to improve public understanding of science and technology and to showcase exciting, progressive ideas about the many ways in which government and citizens can leverage innovation for the common good. Since its inception in the fall of 2007, Science Progress has helped shape the conversation about our country's investment in science.

science progress

1333 H STREET, NW, 10TH FLOOR, WASHINGTON, DC 20005 • TEL: 202-682-1611 • FAX: 202-682-1867 • WWW.AMERICANPROGRESS.ORG