FACT SHEET: Department of Energy Investments in Solar Energy

Over the past decade, the Department of Energy (DOE) has invested more than $1 billion to pursue an integrated set of research and development (R&D) investments to advance solar energy technologies and bring down the costs of solar energy systems. Innovations in both science and technology have helped to reduce solar energy costs by more than 60 percent since 1995. Throughout this period, DOE has worked closely with industry to capitalize on these federal investments. For example, since 2007, DOE has awarded $50 million to support the Photovoltaic (PV) Incubator project that aims to accelerate the commercialization timeline for promising technologies. This funding has been leveraged with $1.2 billion in private investments, delivering a 24-to-1 private-to-public investment ratio for the American taxpayers.

Through the Department's Office of Science, DOE's Solar Energy Program, and recently the Advanced Research Projects Agency-Energy (ARPA-E), the federal government has been partnering with universities, national laboratories, and the private sector to advance game-changing breakthroughs in solar photovoltaic performance and cost. Federal investments have included, among other areas, fundamental science research to develop new semiconductor materials, applied research for new solar array technologies, efficiency improvements in the manufacturing processes, and the construction of state-of-the-art solar energy test facilities.

As part of the **SunShot Initiative**, the Department will continue to drive innovations in the ways that solar cells are conceived, designed, installed and manufactured, enabling large-scale solar energy to achieve cost-competitiveness with fossil-based electricity by the end of the decade, without any subsidies.

DRIVING EARLY SCIENCE RESEARCH AND DEVELOPMENT

Through its core research budget and **Energy Frontier Research Centers (EFRCs),** DOE's Office of Science is supporting fundamental science research efforts at both universities and national laboratories that are applying the latest advances in nanotechnology, materials science, and scientific instrumentation to the development of radically new semiconductor materials and more cost-effective methods of producing semiconductors. Solar cells are made of the same kinds of semiconductor materials used in the microelectronics industry, such as silicon, so these materials innovations are helping to deliver higher efficiencies and greater reliability for solar energy systems.

The Research Centers are bringing together small groups of researchers focused on achieving breakthroughs in science. Seven of the DOE-supported EFRCs – receiving a total of $23.6 million in federal funding - are focused specifically on driving innovations in solar photovoltaics (PV), including centers led by the University of Arizona, Columbia University, University of Massachusetts, University of Michigan, University of Southern California, Los Alamos National Laboratory, and the National Renewable Energy Laboratory.

MOVING TECHNOLOGIES TO MARKET

In partnership with national laboratories, start-up companies, universities, and integrated industry teams, the DOE Solar Energy Technologies Program is pursuing a broad range of applied research, development, demonstration and deployment (RDD&D) initiatives that are reducing the life-cycle costs of solar energy systems. These include efforts to increase the efficiencies of solar cell technologies, ways to scale up or improve the manufacturing process for cells, and steps to streamline and integrate the deployment and installation of complete solar energy systems.

Solar Cell Technology Advancements

Solar cells are the basic building blocks of solar panels, which convert sunlight to electricity. The efficiency with which a solar cell material or technology can make this conversion is one of the most important determinants in the cost of the solar system. DOE's investments in advanced solar cell materials, such as thin-film cadmium telluride (CdTe), ultra-thin nanocrystal films, and copper indium gallium diselenide (CIGS), have played a major role in increasing the efficiency of these technologies that can be produced at high volumes.

Support from the federal government has been instrumental in improving the efficiency of today's technologies from 7 percent in the late 1970s to over 20 percent today. A key example is **SunPower Corporation**, a California-based solar energy manufacturer, which, since 2007, has been partnering with DOE to develop a highly-efficient, full-sized solar module that would be able to be manufactured at high volume. The company's full-sized, commercial modules are comprised of world record 22.4 percent efficient solar cells, meaning fewer panels are needed to meet a home's energy needs. With DOE support, SunPower will also soon dedicate a new factory in Milpitas, California to manufacture new high-efficiency solar panels.

Improvements in Solar Panel Manufacturing

The Department's efforts to improve solar cell manufacturing processes are also leading to significant reductions in the total cost of solar panels. By developing ways to manufacture cells in higher volumes and increasing the efficiency of the manufacturing processes, DOE is helping to strengthen the U.S. manufacturing base and increase the use of solar energy.

For example, under the Office of Energy Efficiency and Renewable Energy and the ARPA-E program, the Department is investing $4.5 million in the Massachusetts-based company **1366 Technologies** to develop a novel manufacturing process for crystalline silicon wafers, which are commonly used in PV cells. In this new manufacturing process, the wafers are plucked directly from molten silicon, which could cut the cost of installed photovoltaic systems in half and reduce wafer capital costs by 90 percent.

The U.S. has consistently enjoyed technical leadership in the development of thin-film solar technologies. For example, **First Solar**, a U.S.-based company, is the world's largest thin-film solar PV manufacturer. Early federal investments helped the company to scale up their manufacturing efforts to be able to reduce costs and manufacture at high volumes.

Reductions in Complete System Costs

In addition to increasing the efficiency of solar cells and manufacturing processes, DOE is also taking significant steps to lower the costs associated with the installation of complete solar energy systems. DOE research into these "balance of system costs" is enabling faster and more efficient system installation. For example, building-integrated PV, developed in part by DOE, allows the PV material to replace a functional outer surface of commercial and residential buildings. This will allow a roofing membrane like shingles or roofing tiles that include integrated PV devices to take the place of conventional roofing.

The Department is also investing in ways to address the technical and market challenges to integrating solar into the grid. DOE is focused on RDD&D efforts to safely, reliably and cost-effectively integrate complete solar energy systems into the U.S. distribution, transmission and smart grid power systems. Projects include the Solar Energy Grid Integration System (SEGIS) and partnerships under the High Penetration Solar Deployment program. DOE is also working with industry and government partners such as the National Oceanic and Atmospheric Administration (NOAA) to enhance the available methods of characterizing and forecasting solar energy, which will help grid operators to better utilize the vast solar resource potential in the U.S.

Additionally, DOE is focused on simplifying the solar installation process for consumers by streamlining and standardizing local permitting and inspections. The agency is working with national and international technical code-making bodies, the solar industry and local communities nationwide to develop and implement efficient processes that ensure consumer safety without adding additional costs. Specifically, the DOE is working towards the automation of the permitting and application process, narrowing the time windows for inspectors, and increasing the use of a standard checklist by local building inspectors.

PERFORMANCE TESTING

DOE laboratory and testing facilities allow the private sector to advance their technologies through advanced simulation and testing. The **National Center for Photovoltaics at the National Renewable Energy Laboratory** is considered the "gold standard" when it comes to solar cell performance and reliability testing. The Center has not only helped the U.S. solar industry advance state-of-the-art photovoltaic materials and devices, but has also helped to ensure uniformity on a global level.

SUNSHOT

Through a cohesive approach driven in conjunction with industry, national labs, academia and financial institutions, DOE will continue to drive innovations that will bring down the price of large-scale solar electricity by about 75 percent by the end of the decade. By driving down the installed price of utility scale solar energy to a $1 a watt, which would correspond to roughly 6 cents per kilowatt-hour, solar energy will be cost-competitive with fossil fuel-based electricity sources without any subsidies. These efforts will help win the future for the American people, making American businesses more competitive and enabling the U.S. to regain its global leadership position in worldwide solar PV manufacturing.