

## Photovoltaics

Leading the world in clean energy technologies like solar will be critical for the United States to lead the 21st century global economy. To drive domestic innovation, manufacturing, and clean energy, the U.S. Department of Energy (DOE) is undertaking the SunShot Initiative to reduce the total installed cost of solar energy systems by about 75 percent before the end of the decade.

To achieve this cost target, DOE works with national labs, academia, and industry to develop cost-competitive solar energy systems. The Department supports the domestic photovoltaics (PV) industry and research enterprise in achieving widespread cost-competitiveness without subsidies through an applied research and development (R&D) portfolio spanning PV materials, devices, and manufacturing technologies.

To achieve SunShot's goal, DOE has structured its R&D funding to enable efforts along the entire PV technology development pipeline, including new devices and processes, prototype design and pilot production, and systems development and manufacturing. The Next Generation PV Program funds high-risk proof-of-concept projects at the fore of the pipeline. Discoveries made and demonstrated here can then be further



The Minneapolis Convention Center features a 600 kW solar rooftop installation.  
*Photo from Meet Minneapolis 1/PIX 18700*

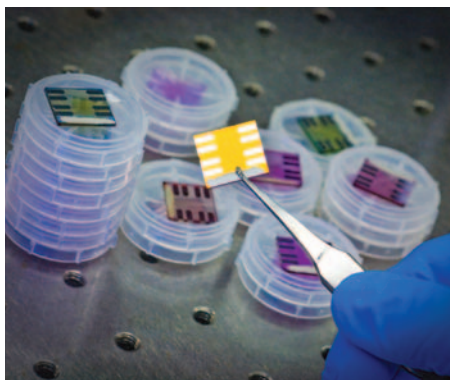
developed and applied to commercial and near-commercial PV technologies under DOE's Foundational Program to Advance Cell Efficiency. Prototype designs are then developed towards commercialization through the Sunshot Incubator Program, and technologies can be refined and advanced through the Supply Chain and PV Manufacturing Initiative. All of these approaches help increase performance and lower the cost of solar PV energy generation.

DOE currently funds projects to advance all major PV module technologies. At the absorber level, these include wafer silicon (Si); amorphous and single-crystal, thin-film Si; cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) thin films; high-efficiency (III-V semiconductor) multi-junction PV cells and concentrating solar power; advanced organic and dye-sensitized PV cells; and emerging PV technologies.

The national laboratories, start-up companies, established companies, universities, and integrated industry teams partner in DOE's solar efforts. The ultimate goal is to reduce the cost of solar energy by 75 percent by the end of the decade, leading to rapid growth of PV electricity use across the United States.

### Current PV Program Portfolio

**The Transformational PV Science and Technology: Next Generation Photovoltaics II Program** supports innovative, exploratory research to create new, disruptive technologies with the potential for much higher efficiency, lower cost, or more reliable performance than existing commercial and near-commercial PV. This early-stage research program is intended to bridge the gap between basic and applied solar research, to advance the state-of-the-art in PV, and to demonstrate and prove new



Solar cells at Lawrence Berkeley National Laboratory. *Photo from Roy Kaltschmidt, Berkeley National Laboratory*

concepts in materials, processes, and device designs. The program moves beyond incremental near-term innovation to explore ways to break through performance barriers and achieve cost-competitiveness.

#### **The Sunshot Incubator Program**

expanded the PV Technology Incubator Program from its original focus on module-related PV technology innovation to include concentrating solar power (CSP), power electronics, and balance of systems (BOS) innovation. Any technological innovation that substantively aids in reducing the installed cost of utility scale solar to 6 cent per kilowatt-hour can be funded through the incubator program.

The SunShot Incubator Program represents a major element of DOE's business strategy. The program links public and private partners to accelerate commercialization of PV, CSP, and BOS R&D and validation to meet aggressive installed cost and market penetration goals. Incubator partnerships leverage

technical capabilities and resources within DOE's National Renewable Energy Laboratory and other DOE laboratories to support small businesses in order to accelerate the technology development toward full-scale manufacturing in the United States. Early-stage incubator assistance helps companies cross technological barriers to commercialization while encouraging private sector investment. Since the program's inception in 2007, \$60 million in government funds invested in incubator companies have leveraged more than \$1.3 billion in venture capital and private equity investment.

The Sunshot Incubator Program consists of two tiers. Tier 1 focuses on accelerating development of innovative technologies from lab scale demonstration to full scale prototype. Tier 2 projects focus on shortening the timeline for companies to transition innovative full-scale pre-commercial prototypes to the pilot stage, and full-scale manufacture.

**The Foundational Program to Advance Cell Efficiency (FPACE)** seeks to overcome fundamental barriers to improved efficiency of commercial and near-commercial semiconductors. FPACE also closes gaps between theoretical maximums and the top efficiencies achieved in laboratories.

**The PV Supply Chain and Cross-Cutting Technologies** effort targets reductions in manufacturing and product costs by improving common PV manufacturing processes and materials that hold the potential to impact the PV industry within two to six years.

**The SunShot Advanced Manufacturing Partnerships** seek to strengthen U.S. competitiveness throughout the PV module supply chain by investing in manufacturing-focused research projects and facilities to speed the rate of innovation and scale-up. The program supports coordinated consortia that bring together U.S. PV companies, universities, and national labs to solve common technological challenges. The manufacturing initiative also establishes joint-use facilities that provide PV companies and suppliers access to equipment and services that accelerate development and demonstration of new PV technologies while making the transition to commercial-scale production. The partnerships strongly leverage industry, state, and local funds and are expected to grow over time, adapting to market conditions and continuously adding new industrial and academic participants. Ultimately, the manufacturing initiative enables the technologies invented in America to be made in America.

The SunShot Initiative is bringing together America's top talent to reduce the installed cost of solar energy systems, including photovoltaic systems. If successful, SunShot will enable PV to meet 15–18% of America's electricity needs by 2030.

To learn more about DOE's solar activities, visit [solar.energy.gov](http://solar.energy.gov) and [energy.gov/sunshot](http://energy.gov/sunshot)

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DOE/GO-102011-3333 • June 2011



*Photos from Solar Energy Systems/PIX 18521, Dennis Schroeder, NREL/PIX 19176, and Rick Matson, PIX 14601*