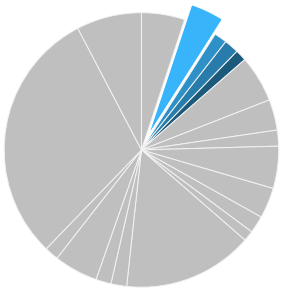
Federal Energy R&D: Solar Energy

BY COLIN CUNLIFF | APRIL 2019

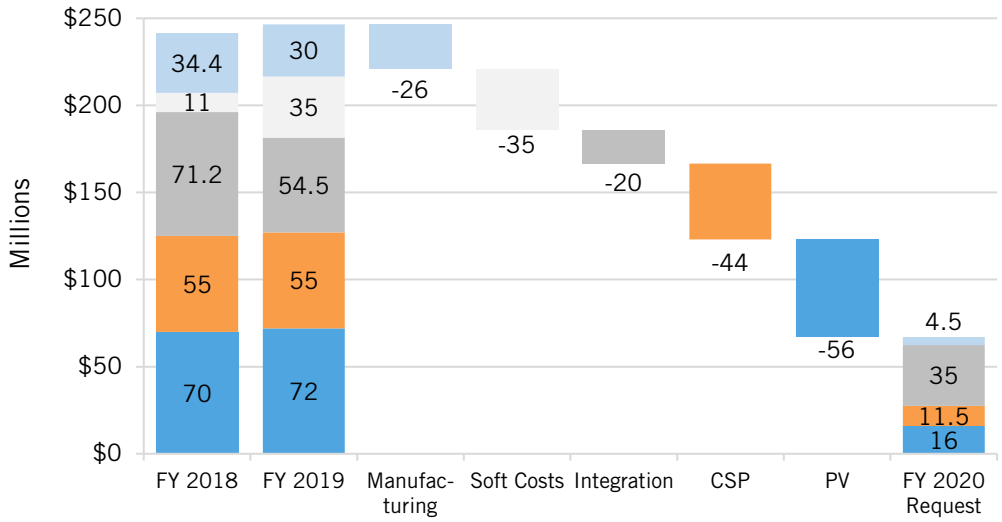
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



Solar (light blue)
Other Renewables
Energy R&D (light grey)

The Department of Energy's (DOE) Solar Energy Program embraces two complementary technologies: photovoltaics (PV), which convert light to electricity via semiconductors, and concentrating solar power (CSP), which converts light to heat that can then be stored and used to generate electricity. The program also works to integrate these electricity generation technologies more effectively into the transmission and distribution grid, and transfer DOE solar innovations into domestic manufacturing capabilities.[1]

Figure 1: The FY 2020 Budget Request Would Cut Solar Energy R&D by 73 Percent.[2]



What's At Risk

DOE's SunShot Initiative program has already achieved its 2020 goal of utility-scale solar PV power at six cents per kilowatt-hour ($0.06/kWh), making it a competitive source for electricity generation in areas with good solar resources and low PV penetration.[3] DOE should build on this success to reduce costs to the point solar PV becomes more competitive for utility, residential, and commercial systems as well—especially when factoring in the costs of integration. SunShot's 2030 goal for utility-scale solar PV is $0.03/kWh, which is 50 percent below today's utility-scale cost. Goals for commercial solar ($0.04/kWh) and residential solar ($0.05/kWh) are even more ambitious, requiring cost reductions of 40–70 percent of today's costs.[4] Achieving these goals would make solar one of the least-expensive sources of electricity generation, costing less than most fossil-fuel-powered sources, thereby contributing to energy affordability while reducing carbon emissions.[5]

The nine CSP systems operating in the United States today have demonstrated solar power's ability to provide 24-hour energy to the grid—although not yet at a competitive cost.[6] DOE's 2030 goal for baseload CSP power is $0.05/kWh, or 50 percent below the 2018 benchmark.[7] These targets are competitive with other dispatchable power generators and would enable greater overall penetration of solar electricity into the grid, while also enabling more reliable solar generation and increasing its value to the grid.

Solar Energy R&D Subprograms

R&D in the Solar Energy program is spread across five subprograms:[8]

- **Photovoltaics (PV)** funds research and development to enable improved PV performance, including advanced silicon processes, multijunction solar-cell efficiency, advanced materials science for cadmium-telluride solar cells, hybrid organic-inorganic perovskites, and impacts of outdoor soiling, temperature cycling, ultraviolet light, and humidity on PV performance.
- **Concentrating Solar Power (CSP)** focuses on component-level research and development in solar collection, receivers and heat-transfer fluids, power conversion, and thermal-energy storage, as well as integration of subcomponent technologies.
- **Systems Integration** coordinates with the DOE Grid Modernization Initiative to address key technical challenges related to the grid integration of solar power, including power variability, voltage regulation, frequency control, unintentional islanding, protection coordination, and two-way power flow.
- **Balance of Systems Soft-Cost Reduction** focuses on reducing non-hardware costs—including financing, customer acquisition, permitting, installation, labor, and inspection—which constitute over half the cost of total system prices for residential, commercial, and community PV systems.
- **Innovations in Manufacturing Competitiveness** funds the development and demonstration of innovative solar manufacturing technologies, and helps companies with promising solar technology survive the funding gaps that often emerge in the development cycle of new technologies.

Key Elements of the FY 2020 Budget Proposal[9]

- **Elimination of the Soft Costs subprogram**, including elimination of workforce training for veterans and other activities to address workforce gaps, as well as activities to reduce permitting, inspection, and interconnection costs and to improve access to low-cost financing. Elimination of this subprogram threatens to derail progress toward the 2020 and 2030 cost goals for residential and commercial solar, given that soft (non-hardware) costs constitute more than half of total system prices for residential, commercial, and community PV systems.

- **An 85-percent reduction in the Innovations in Manufacturing subprogram,** including a discontinuation of funding for the SunShot Incubator program, which provides early-stage assistance to small businesses commercializing innovative solar technologies. Funding to support scalable production methods, such as roll-to-roll manufacturing and solution processing, would also be discontinued.

- **A 79-percent reduction in the Concentrating Solar Power subprogram,** with no new funding to support solar thermal desalination, and reduced funding to support CSP R&D at the national labs on long-term thermal energy storage, new materials and manufacturing techniques, and autonomous solar field operation. Remaining activities would support energy storage and power cycle integration as part of the administration's crosscutting Advanced Energy Storage Initiative.

- **A 78-percent reduction in the Photovoltaic R&D subprogram**, including a discontinuation of funding for new PV materials and R&D to improve PV efficiency. The Regional Test Centers in Nevada, Vermont, and Florida, which provide facilities to study and validate the performance of PV technologies, would not be funded.

- **A 36-percent cut in the Systems Integration subprogram**, with decreased attention to power system planning and operation, grid sensing and communication integrity, data analytics, and integrating distributed solar systems with building loads and energy storage. Remaining funding would support developing lab and field test capabilities for power electronics-based PV, as well as the administration's crosscutting Advanced Energy Storage Initiative.

ENDNOTES

1. Department of Energy, "About the Solar Energy Technologies Office," https://www.energy.gov/eere/solar/about-solar-energy-technologies-office, accessed March 22, 2019.
2. The FY2020 budget for EERE would use $353 million in prior year (FY 2018 and FY 2019) balances to fund FY2020 programs. Thus the numbers shown in the figure underestimate the magnitude of cuts included in the proposed budget. Department of Energy, "FY 2020 Congressional Budget Request: Budget in Brief," (DOE CFO, March 2019), p 3, https://www.energy.gov/sites/prod/files/2019/03/f60/doe-fy2020-budget-in-brief.pdf; DOE, "FY 2020 Congressional Budget Justification" Volume 3 Part 2, 103 (DOE Chief Financial Officer DOE/CF-0153, April 2019), https://www.energy.gov/sites/prod/files/2019/04/f61/doe-fy2020-budget-volume-3-part-2_0.pdf.
3. DOE, "2020 Utility-Scale Solar Goal Achieved" (Washington, D.C.: DOE/SETO, September 2017), https://www.energy.gov/eere/solar/articles/2020-utility-scale-solar-goal-achieved.
4. All PV cost targets are nationwide average, unsubsidized costs. The 2018 benchmarks for utility-scale, commercial, and residential PV are $0.05/kWh, $0.11/kWh, and $0.15/kWh, respectively. Ran Fu, David Feldman, and Robert Margolis, "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018," (NREL Technical Report NREL/TP-6A20-72399, November 2018), https://www.nrel.gov/docs/fy19osti/72399.pdf; Department of Energy, "Goals of the Solar Energy

Technologies Office," https://www.energy.gov/eere/solar/goals-solar-energy-technologies-office, accessed March 19, 2019;

5. For comparison, the levelized cost of electricity from a natural gas combined-cycle power plant was $0.042–0.078/kWh in 2017. Lazard, "Lazard's Levelized Cost of Energy Analysis—Version 11.0," (Lazard, November 2017), https://www.lazard.com/perspective/levelized-cost-of-energy-2017/.
6. National Renewable Energy Laboratory, "Concentrating Solar Power Projects in the United States," https://solarpaces.nrel.gov/, project database accessed March 22, 2019. The NREL CSP Projects database lists 17 operational CSP systems, but we are counting multiple systems at the same site as a single project. For example, the Solar Electric Generating Station includes seven operational CSP systems in San Bernardino County, California that are counted here as a single system.
7. DOE, "Goals of the Solar Energy Technologies Office;" DOE, "FY 2020 Congressional Budget Justification," Volume 3 Part 2, 101.
8. Summarized from DOE-SETO websites and Department of Energy, *FY 2019 Congressional Budget Request*, Volume 3 Part 2 (DOE/CF-0141, March 2018), 109-125.
9. DOE, FY 2020 Congressional Budget Justification Volume 3 Part 2, 101-114.

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