Federal Energy R&D: Solar Energy

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

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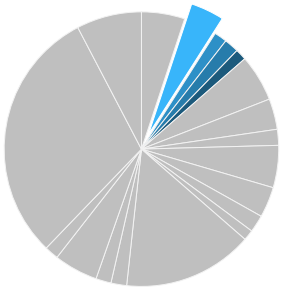
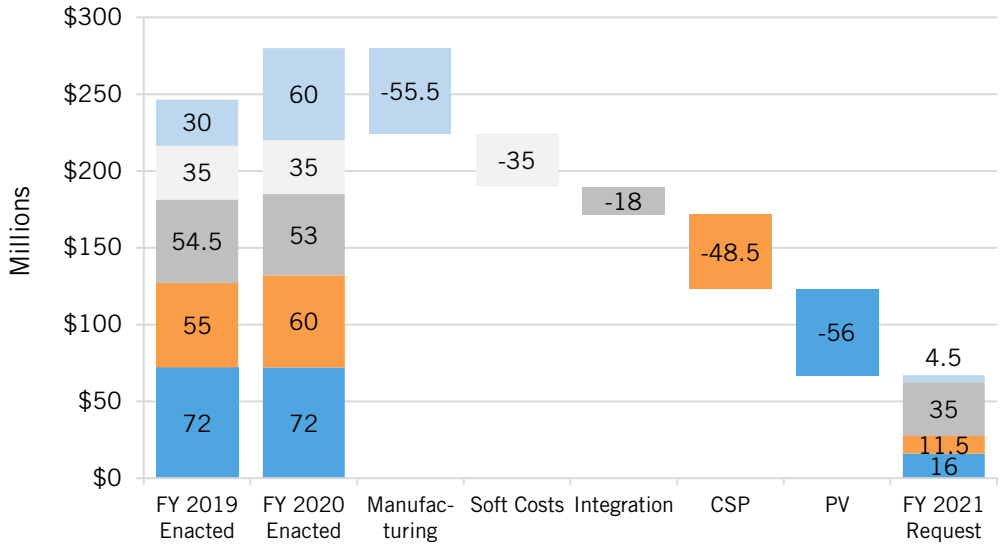


Solar (light blue)
Other Renewables (darker blue)
Energy R&D (light grey)

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 in order to run a steam turbine to generate electricity—and may also be stored for electricity generation at a later time. The program also works to integrate these generation technologies more effectively into the transmission and distribution grid, and to transfer DOE solar innovations to domestic manufacturing capabilities.[1]

Figure 1: The FY 2021 budget request would cut solar energy research and development (R&D) by 76 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 in order 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 40 percent below the 2018 benchmark of $0.05/kWh.[4] Goals for commercial solar ($0.04/kWh) and residential solar ($0.05/kWh) are even more ambitious, requiring cost reductions of more than 60 percent from 2018 benchmark costs.[5] 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.[6]

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.[7] As of 2019, only two CSP developers were operating in the United States. DOE's 2030 goal for baseload CSP systems is $0.05/kWh, or almost 50 percent below the 2018 benchmark of $0.098/kWh.[8] 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:[9]

- **Photovoltaics (PV)** funds R&D 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, multicrystalline and tandem device models, and impacts of outdoor soiling, temperature cycling, ultraviolet light, and humidity.
- **Concentrating Solar Power (CSP)** focuses on component-level R&D in solar collectors, receivers, heat-transfer fluids, power conversion, and thermal-energy storage, as well as integration of subcomponents.
- **Systems Integration** coordinates with the DOE Grid Modernization Initiative to address key grid-integration challenges, including generation variability, voltage control, frequency regulation, system stability, and cybersecurity.
- **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.
- **Manufacturing and Competitiveness** funds the development and demonstration of innovative solar manufacturing technologies in order to increase U.S. competitiveness in solar energy manufacturing.

Key Elements of the FY 2021 Budget Proposal[10]

- **Elimination of the Balance of Systems Soft Costs Reduction subprogram.** Soft costs are the non-hardware costs of installing solar projects, including permitting, inspection, and financing. In the United States, there are 18,000 jurisdictions and 3,000 utilities with different rules and regulations for how to adopt solar, creating barriers for solar adoption and inflating soft costs.[11] For residential systems installed in the United States, soft costs accounted for 63 percent of total system costs in 2018.[12] However, soft costs in Germany (15 percent) and Australia (25

percent) are substantially lower, indicating there is significant potential to lower the cost of solar in the United States.[13] Elimination of this subprogram threatens to derail progress toward the 2020 and 2030 cost goals for residential and commercial solar.

- **A 93 percent reduction in the Manufacturing and Competitiveness subprogram,** including a discontinuation of funding for the SunShot Initiative's Incubator program, which provides early-stage assistance to solar start-ups; and the elimination of all manufacturing and value-chain R&D. The United States' share of global solar PV manufacturing is very small even though tariffs have been imposed on imports on multiple occasions.

- **An 81 percent reduction in the Concentrating Solar Power subprogram**, with no new funding for competitive awards in high-temperature thermal systems and power cycles; and no additional funding for demonstrations of supercritical CO_2 power cycles integrated with thermal storage. The domestic CSP industry appears to be struggling even as foreign markets are beginning to take off, jeopardizing U.S. leadership in the emerging CSP industry.[14]

- **A 78 percent reduction in the Photovoltaic Technologies subprogram**, including a discontinuation of funding for research in thin-film PV materials such as cadmium telluride and perovskites, which might allow the industry to break away from the dominant crystalline-silicon technology, and no new funding for any competitive PV research.

- **A 34 percent cut in the Systems Integration subprogram,** with reduced funding in solar microgrids and hybrid systems that integrate solar with other technologies.

ENDNOTES

1. U.S. Department of Energy (DOE), "About the Solar Energy Technologies Office," https://www.energy.gov/eere/solar/about-solar-energy-technologies-office, accessed January 31, 2020.
2. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 87 (DOE Chief Financial Officer DOE/CF-0163, February 2020), https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1.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. DOE, FY 2021 Congressional Budget Justification Volume 3 Part 1, 92; Ran Fu, David Feldman, and Robert Margolis, "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018," NREL Technical Report, November 2018, 37, https://www.nrel.gov/docs/fy19osti/72399.pdf.
5. 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. DOE, FY 2021 Congressional Budget Justification Volume 3 Part 1, 92.

6. For comparison, the levelized cost of electricity from a natural gas combined-cycle power plant was $0.044–0.068/kWh in 2019. Lazard, "Lazard's Levelized Cost of Energy Analysis—Version 13.0" (Lazard, November 2019), https://www.lazard.com/perspective/lcoe2019.
7. National Renewable Energy Laboratory, "Concentrating Solar Power Projects in the United States," project database accessed January 31, 2020, https://solarpaces.nrel.gov/. 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.
8. DOE, "Goals of the Solar Energy Technologies Office"; DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 1, 103.
9. Summarized from DOE-SETO websites and DOE, FY 2021 Congressional Budget Request.
10. DOE, FY 2021 Congressional Budget Justification Volume 3 Part 1, 85–100.
11. DOE, "Soft Costs" (May 2016), https://www.energy.gov/sites/prod/files/2016/05/f32/SC%20Fact%20Sheet-508.pdf.
12. Fu et al., "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018," Figure ES-2.
13. Solar Energy Industries Association (SEIA), "Solar Soft Costs" (May 2019) https://www.seia.org/sites/default/files/2019-05/Solar-Soft-Costs-Factsheet.pdf.
14. Jason Deign, "America's Concentrated Solar Power Companies Have All but Disappeared" (Greentech Media, January 20, 2020) https://www.greentechmedia.com/articles/read/americas-concentrated-solar-power-companies-have-all-but-disappeared.

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