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News & Highlights

Solar Reaches for Grid Parity

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Solar power purportedly now costs the same, or less, than electricity from the grid in many of the world's countries. This "grid parity" appears to be emerging many years before expected, in China, for example [1].

This is a hopeful sign of progress toward a low carbon future, but it is a notion which needs be taken with a degree of caution: "Grid parity is a great tool for quickly looking at the competitiveness of solar relative to competing sources of energy," said David Feldman, a senior energy analyst at the US National Renewable Energy Laboratory in Golden, Colorado. "However, it will not tell you the optimal way to operate a grid, build new generation, or dispatch energy. For that, more complicated models and metrics are needed."

Nonetheless, claims that grid parity can be on the table are indicative of the great progress that has been made in the solar photovoltaic (PV) arena. This progress has been—and continues to be—driven primarily by rapidly decreasing costs. When researchers from the International Renewable Energy Agency (IRENA), an intergovernmental organization headquartered in Abu Dhabi in the United Arab Emirates that supports countries in their transition to a sustainable energy future, reviewed thousands of renewable projects across the globe for the year of 2018, they found that the cost of electricity from solar PV technologies had dropped by 13% in the 12-month period [2].

"The cost reductions taking place, particularly for solar, but also for wind technology, are an extension of an ongoing trend," said Michael Taylor, a senior energy analyst at IRENA. "As the cost continues to drop, we are seeing solar—without any financial support—increasingly compete head-to-head with fossil-fuel options."

This trend also appears to apply in China, where PV capacity has been projected to grow by more than 7% per year from 2015 to 2040 [3] (Fig. 1). To investigate the status of grid parity in China, a team of researchers led by Jinyue Yan, a professor of energy engineering at the KTH Royal Institute of Technology in Stockholm, Sweden, evaluated the prospects for building commercial and industrial solar projects, without state support, in 344 prefecture-level cities across China. Their results showed that solar PV systems could supply cheaper electricity than the grid in every city tested, even without any subsidies [1]. Additionally, in 22% of those areas, electricity could be produced with solar PV at lower prices than with coal, generally the least expensive—but also most polluting—fossil-fuel option.

Fig. 1. A part of Gansu Dunhaung Solar Park, China's first solar energy generation facility, in the Gansu Province of western China. The area recieves 3250 hours of sunlight per year and the Chinese State Council has set the goal of increasing Dunhaung's solar power generation capacity to 1 GW by 2020 from 50 MW in 2013. Credit: Popolon (CC-BY-SA-3.0).

The main reason for this increased competitiveness lies in the declining cost of crystalline silicon, the predominant semiconductor used in PV panels. Between December 2017 and December 2018, the cost of crystalline silicon modules declined by 26%–32%, much faster than in the previous year when they declined by 1%–7% [2].

Additional price reductions come from declining costs of associated hardware as well as improved efficiencies in labor, permitting, and customer acquisition techniques, Feldman said. In the United States, these reductions have come about due to public and private partnerships, technology innovations, and the industry learning by experience how to better deploy and operate PV. "These same reasons are expected to continue to drive price reductions," Feldman said. Overall, PV system costs in the United States dropped by 63%–80% between 2010 and 2018 [4].

Similar cost declines in China have pushed solar closer to grid parity much sooner than expected. "The price of solar in China is currently lower than most analysts have historically thought would be achieved by this point in time," Feldman said. Whereas in 2000 solar electricity in China cost up to 15.1 CNY (~$2.16 USD) per kilowatt hour, that cost had dropped to 0.29–0.79 CNY ($0.04–0.11 USD) per kilowatt hour by 2018 [1].

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In the last two decades, the Chinese government has initiated multiple policies, including subsidies, to support the PV industry. However, in 2017, to encourage the industry to be more sustainable and efficient, the National Development and Reform Commission approved its first set of unsubsidized renewable energy projects, including 168 solar power projects [5].

Currently, in the United States, 20 states are already at grid parity under present financing conditions, and 42 states are expected to reach that target by 2020 [6]. All energy in the United States, including solar, is subsidized, Feldman said, but "the subsidies have decreased on a per kilowatt basis as the cost of solar energy has decreased."

Grid parity depends on the comparative costs of competing electricity and PV electricity, and these can vary by geography, region, and market, Feldman said. In the United States, for example, it is challenging for PV to compete in the state of Washington, which is relatively north in latitude, often cloudy, and gets much of its electricity from relatively low-cost hydropower. In contrast, solar energy is more competitive in the states of California and Hawaii, which have sunny climates and otherwise rely on more costly natural gas to generate electricity.

While prices are expected to continue to decrease, which will drive increasing use of solar and other renewable energy sources, bringing other technologies to bear could be necessary to further boost their value. One such technology is long ultrahigh-voltage transmission lines, such as those deployed in China. Zhenya Liu, chairman of the Beijing-based Global Energy Interconnection Development and Cooperation Organization, argues that such technology, which can efficiently move power across entire continents, will be necessary for optimizing access to low-cost power generated by wind, solar, and hydropower resources in North America and other regions [7].

Even with grid parity, solar power's intermittent nature poses challenges in many energy markets [8]. There are additional ways of operating the grid, such as using weather monitoring and forecasting systems, that can help diminish the operating issues associated with variable energy supplies, Feldman said.

Such issues are generally not a problem at the early stage of renewable energy deployment, Taylor said. "Until shares of deployment get to very significant levels, there are not a lot of additional costs associated with their integration," he said. "Then, as you get further into deployment, you need to start to look at how you operate the system to minimize those costs."

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