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ECONOMIC Synopses

Renewable Sources of Electricity: Where Excess Capacity Is Built-In

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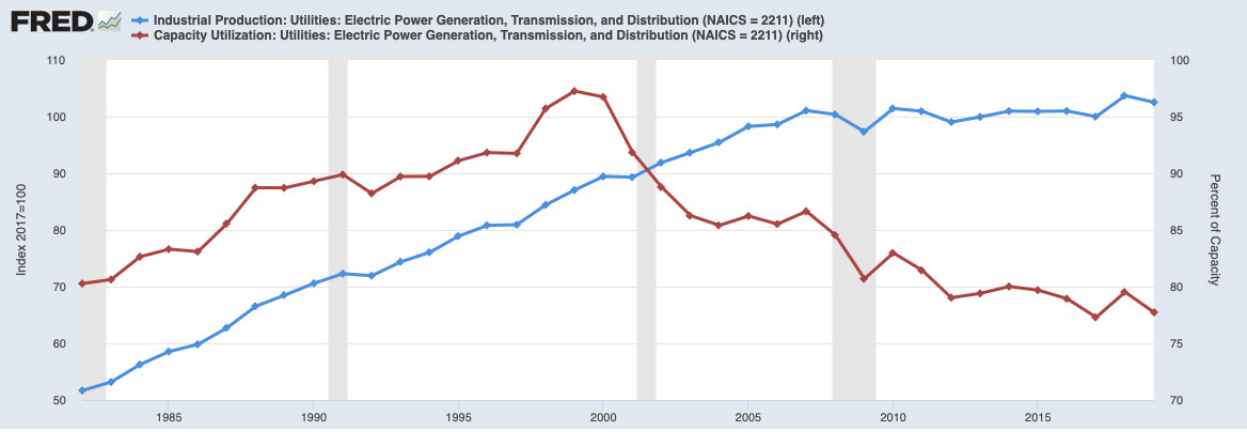
Although electricity can be generated in multiple ways, it is costly and impractical to store electricity in large amounts. When there is high demand for electricity, for example, during a hot day when air conditioners run for hours, electricity must be produced rather than taken from storage facilities. In other words, consumption and production of electricity generally move in lockstep.[1] If there is not enough electricity, appliances stop working. But maintaining production capacity at the ready for when there is more demand is an expensive investment for utility companies.[2] The challenge for utility companies is to provide energy at low costs for uncertain and variable demand.[3]

In the figure, data from the Survey of Industrial Activity by the Board of Governors of the Federal Reserve System show annual electricity production (blue line) and capacity utilization (red line) between 1982 and 2019. Electricity production is measured by an index, which is equal to 100 in 2017, and capacity utilization is measured as the percent of total electricity production capacity that is actually put to use, on average. Between 1982 and 2000, production grew by 71 percent and average capacity utilization increased from 80 percent to 97 percent. In other words, as the demand for and the supply of electricity increased, the unused production capacity of electricity decreased. Utilities operated closer to their maximum production capacity. Between 2001 and 2019, this trend reversed. Electricity production increased an additional 16 percent, while capacity utilization decreased from 92 percent to 78 percent. Utilities operated with greater spare capacity from 2001 to 2019.

> As renewable sources of electricity have expanded, production capacity utilization has gradually decreased.

The development of renewable electricity sources—for example, solar and eolic—might help explain this increase in spare capacity from 2001 to 2019. The rapid expansion of solar parks and wind turbine farms has made those methods of generating electricity the largest renewable source of electricity in the United States. In 2019, their combined output surpassed hydroelectric production by

Industrial Production and Capacity Utilization: Electric Power Generation, Transmission, and Distribution (1982-2019)



NOTE: Gray bars indicate recessions as determined by the National Bureau of Economic Research.

SOURCE: Board of Governors of the Federal Reserve System and FRED®, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/graph/?g=uXJp.

36 percent.[4] Yet, like solar parks, the electricity output of wind turbines depends on the weather. Thus, to ensure a regular supply from those sources, windmills must be built over a broad area and in sufficient quantities to allow them to sufficiently accommodate variation in consumer demand. That is, to meet both periods of low production—due to cloudy or windless days—and of peak demand, excess production capacity must be built in. For example, in Germany, where the federal government set targets for the share of renewable sources in electricity consumption, electric capacity utilization declined 20 percentage points between 2003 and 2017 while actual power generation remained constant.[5]

Maintaining excess production capacity in renewables is costly, however, as equipment must be purchased and serviced but is not regularly used. This excess capacity and increasingly stringent emissions requirements for coal-burning plants have raised energy costs over the past two decades. Higher electricity prices, then, can be interpreted as an increase in the quality of each megawatt of energy. While the energy content of a megawatt of electricity has not changed, the modes of generating electricity have become increasingly cleaner. By displacing more polluting modes of production based on fossil fuels, renewable sources of electricity contribute to lowering overall air pollution and carbon dioxide (CO2) emissions in the electric utility industry. ■

Notes

[1] For a description of the growing gap between electricity production and sales, see the following: Zimmermann, Christian. "There's Electricity in the Air! But It's Not for Sale." Federal Reserve Bank of St. Louis *The FRED® Blog*, March 29, 2018; https://fredblog.stlouisfed.org/2018/03/theres-electricity-in-the-air-but-its-not-for-sale/.

[2] For a theoretical treatment of the overcapitalization problem in this industry, see the following: Douglas, Stratford; Garrett, Thomas A. and Rhine, Russell M. "Disallowances and Overcapitalization in the U.S. Electric Utility Industry." Federal Reserve Bank of St. Louis *Review*, January/February 2009, *91*(1), pp. 23-31; https://files.stlouisfed.org/files/htdocs/publications/review/09/01/Douglas.pdf.

[3] For a theoretical treatment of electricity capacity markets, both under perfect competition and monopoly, see the following: Creti, Anna and Fabra, Natalia. "Supply Security and Short-Run Capacity Markets for Electricity." *Energy Economics*, March 2009, *29*(2), pp. 259-76; https://doi.org/10.1016/j.eneco.2006.04.007.

[4] For definitions and data, see the following: U.S. Energy Information Administration. "Electricity Explained: Electricity Generation, Capacity, and Sales in the United States." March 19, 2020, update; https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.

[5] For a description of this phenomenon in Germany, see the following: Auer, Josef and Heymann, Eric. "Steady Decline In Capacity Utilisation in the German Electricity Sector." Deutsche Bank Research *Talking Point*, June 6, 2019; https://www.dbresearch.com/PROD/RPS_EN-PROD/PROD0000000000495243.pdf.

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