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An Electric Grid Based on 100% Renewable Energy?

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Related Author

- Richard J. Campbell

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Richard J. Campbell, Specialist in Energy Policy (rcampbell@crs.loc.gov, 7-7905)

A recent assessment by the U.S. Global Change Research Program found that if greenhouse gas (GHG) emissions continue at current rates and adaptation actions are not undertaken, climate change impacts will damage U.S. infrastructure, communities, and the economy. This finding combined with significant GHG emissions from the electric power industry has led to an increased focus on U.S energy policy. With growing amounts of today's electricity coming from renewable sources, some stakeholders advocate a shift of U.S. national electric power generation to come from sources that do not emit carbon dioxide. Some observers see greater electrification of the U.S. economy (extending to the transportation sector and electric vehicles) as one way to mitigate climate change. In addition, there have been a variety of discussions advocating a Green New Deal, including the companion House and Senate resolutions, with some calling for U.S. electric power generation to come 100% from renewable electricity by 2030.

For several years, experts have attempted to assess the technical feasibility, needed infrastructure, and potential costs and benefits of converting to electricity generated solely or predominantly from renewable sources.

Today's Electricity Relies Largely on Fossil Fuels

In 2017, according to the Energy Information Administration (EIA), fossil fuels (e.g., coal and natural gas) accounted for about 63% of U.S. electric generation (including utility scale and small scale generation). Renewable electricity sources (defined by EIA as principally hydropower, wind and solar photovoltaic (PV) power) accounted for about 17% of electric generation in the same year. Power generation from fossil fuels has been identified as a major source of anthropogenic greenhouse gas emissions seen as causing climate change.

The electrical grid in the United States comprises all of the power plants generating electricity, together with the transmission and distribution lines bringing power to customers. However, the grid is aging with retirements of coal, nuclear, and natural gas power plants anticipated due to age and market conditions. Distributed energy resources (such as roof-top solar PV), energy efficiency, and demand-side management have been reducing the overall demand for power from the grid, thus reducing the amount of new capacity that would be needed under a 100% renewable scenario.

EIA projects that over the next three decades, additions to electric power generation will likely be dominated by solar photovoltaic (PV) and natural gas-fired capacity. EIA estimates that based on today's laws and regulatory environment, renewables could account for about 24% of total grid-based generation in 2030, and 31% by 2050 (per the 2019 Annual Energy Outlook). Therefore, changing the projected mix to 100% renewable generation would require a large scale buildup of presumably wind and solar PV installations, likely driven by a change from existing law, regulation, and federal tax incentives (due to expire in 2022). Given that power plants typically have depreciable lives of approximately 40 years, an accelerated shift to high levels of renewable electricity sources could potentially lead to some premature retirements of existing fossil power plants. These retirements would possibly result in stranded cost arguments from fossil power plant owners.

Deployment of energy technologies can potentially have a variety of effects, both positive and negative, on national security, the economy, and the environment. To assess these impacts would require the determination of metrics at the technology, sector, and integrated levels, and account for the life cycle of process or product. Reducing GHG emissions from use of fossil fuels to generate power on the grid could require maintaining or increasing reliance on current and additional nuclear power. Whether nuclear power is within the definition of "renewable" energy is a matter of debate at the federal and state level. In addition to GHG emissions, potential effects to be considered include land use change, other air emissions, water quality, fuel diversity, reliability and resilience of the electric grid, and the costs and benefits to the economy of such a change. Incorporation of energy producing or conserving technologies in new, zero energy buildings could mitigate some environmental concerns and reduce future energy demand. However, other technologies potentially developing in the timeframes under consideration (such as power from nuclear fusion or carbon capture, sequestration, or utilization) may help meet climate goals.

Enabling More Renewable Electricity

The "Smart Grid" is the name given to the evolving intelligent electric power network that is replacing the older analog networks on an inconsistent basis across the United States. Some observers see the technologies embodied by the Smart Grid as key to incorporating high levels of variable renewable electricity into the current system. These technologies may have to be facilitated by policies, regulation, and business models to accelerate adoption of the necessary architectures if a reliable and more efficient system is to result.

Renewable resources generally rely on the availability of sun and wind to generate electricity. While energy storage is seen as one way to overcome variability and intermittency issues, generation over a larger balancing area can also help. A Smart Grid could direct power flows from where electricity is generated to where power is needed. However, some investments in renewable energy depend on whether net metering is supported.

The costs of deploying the Smart Grid to fully modernize transmission and distributions systems by 2030 have been estimated between $260 billion and $526 billion (in nominal dollars). While some DOE programs have supported grid modernization, Congress has not explicitly appropriated funding for Smart Grid technologies since the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

Further electrification of the U.S. economy in all U.S. economic sectors may be achievable over time, with careful planning to put in place the federal and state laws, regulations, and infrastructure needed to accomplish a renewable electricity future. Reportedly, new high voltage transmission lines may be required to bring renewable resources based on wind or solar energy to population centers. Building new transmission lines to harness renewable energy reportedly can be slowed by significant community and financial roadblocks.