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Meeting the Goal of Net-Zero Carbon Emission

Many countries pledged to take necessary measures and limit the global temperature rise to 2 °C, or better yet, 1.5 °C, at the United Nations (UN) climate summit in Paris. However, according to a survey from *Nature*, many scientists think global temperatures may reach a disastrous 3 °C above preindustrial levels, and around 60% of experts from the Intergovernmental Panel on Climate Change (IPCC) expect average global temperatures to reach that point by the end of the century if governments do not markedly slow the pace of global warming [1]. That dynamic played out again during the 26th UN Climate Change Conference (COP26), in Glasgow, United Kingdom, in November 2021. The prime minister of Barbados, Mia Mottley, declared that 2 °C of temperature rise would be a "death sentence" for island countries. On 13 November 2021, COP26 concluded with nearly 200 countries agreeing to the Glasgow Climate Pact, which aims to limit the global temperature rise to 1.5 °C and finalize the outstanding elements of the Paris Agreement.

In the 2018 IPCC Report, the 1.5 °C goal would require the world to reach net-zero emissions by 2050. As of today, more than 130 countries have declared and planned net-zero emissions targets. U.S. President Joe Biden pledged to reduce the country's greenhouse gas (GHG) emissions by 50–52% from 2005 levels by 2030. In response to governmental, public, and environmental pressure, the transition to a more sustainable, low-carbon future is accelerating. This conversion is driven by the progressive replacement of carbon-based fuels with alternative energy. *Alternative energy* refers to sources other than fossil fuels and includes renewable sources and nuclear power. Although a handful of new nuclear microreactor designs are under development in the United States, they are not projected to be complete until the 2030s. Therefore, renewable energies are the key to expanding alternative energy resources. The U.S. Energy Information Administration reported that the country generated 40% of its power with nonfossil fuel sources in 2020, more than double the 2015 figure. It is expected that renewable energy will be the fastest-growing power source and could provide as much as 80% of U.S. electricity by 2050.

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Pathway of the Industrial Sector

According to a U.S. Environmental Protection Agency report [2], the industrial sector in the country was responsible for 23% of GHG emissions in 2019. When emissions from electricity generation are allocated to the industrial end use sector, industrial activities account for a much larger share of U.S. GHG emissions. In 2013, the U.S. Department of Energy introduced the Clean Energy Manufacturing Initiative to help the country emerge as a leader in the area. Currently, there is a trend toward mandating the use of renewable energy in manufacturing processes. For example, Apple has committed to be 100% carbon neutral for its supply chain and products by 2030. Other manufactures have established similar goals. With its many benefits and potential to contribute to the goal of net-zero carbon emissions, renewable energy is

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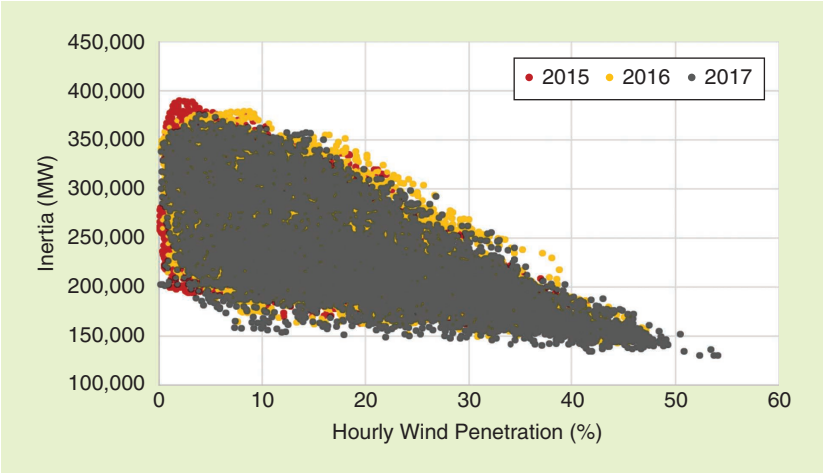

FIGURE 1. The correlation between wind penetration and inertia in 2015, 2016, and 2017 [3].

changing the traditional power delivery model and infrastructure. This has posed challenges and created opportunities for the industrial sectors.

The Challenges

Although developing renewable energy technologies is essential to achieving net-zero carbon emissions, it presents challenges to system reliability. Many alternative energies, such as solar and wind power, are intermittent and difficult to control. The ever-growing share of energy provided by these sources makes it difficult to ensure the consistent power delivery we have grown accustomed to. The other challenge is maintaining system stability. System inertia (Figure 1) determines the initial rate of frequency change following generation trips and sudden load changes and plays an important role in system reliability. System frequency will have larger fluctuations with the same level of disturbance if fewer synchronous generators are committed online due to the high penetration level of renewable energy.

The Opportunities

Battery and hydrogen-based storage systems are considered game changers that have great potential to capture renewable energy whenever it is available and use it on demand. In other words, they can turn intermittent renewable energy into dependable sources. Renewable, hydrogen, and battery market shares continue to rise and play a larger role in the global power supply. This will transform the industrial sector from a consumer to a prosumer that provides opportunities to participate in the energy market, realize GHG reduction by using dependable renewable energy in manufacturing, and provide ancillary virtual inertia services to improve system reliability.

References

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