Celebrate the 10th Anniversary of *IEEE Electrification Magazine* and Embrace a New Era

By Saifur Rahman

IN THE 10 YEARS SINCE I founded this magazine, it has grown both in depth and breadth. Electrification has now become synonymous with decarbonization, which is a major tool in addressing climate change. As the society moves away from using fossil fuel for end-use applications, like internal combustion engines, boilers and furnaces for space heating, gas water heating, and gas cooking stoves, etc., electrification becomes the preferred alternative. But heavy electrification comes with its own challenges, which I will discuss in the following.

United States electricity consumption exceeded 4,100 TW in 2021, which was supplied by utilizing 1,143 GW of installed capacity. There is a strong push for electrification to decarbonize the economy to meet the Paris Climate Sustainability goal of keeping the global temperature rise since the Industrial Age to below 1.5 °C. To achieve this electrification goal, the installed electric power generation capacity in the United States needs to more than double by 2050. And globally, the electricity generation capacity has to triple to reach the same goal. The major issue is: How do we produce this electricity with the least possible carbon footprint? The United Kingdom government has plans to fully decarbonize the electricity generation by 2030. In the United States the target is to make electricity 80% carbon-free by 2035. China has a goal of a fully carbon-free electricity by 2035.

In the United States, the electricity generation from renewables exceeded that from coal for the first time in 2022, as seen in Figure 1, according to data from the U.S. Energy Information Administration.

The country is on track to have 30 GW of offshore wind deployed by 2030. The United Kingdom is planning to reach a capacity of 50 GW of offshore wind and quadruple its solar photovoltaic (PV) generation by 2035. China is the world's largest renewable energy-based electricity generator and will remain so for a long time to come. These will require massive deployments of very large-scale inverter-based resources, which effectively alters the nature of the power system. Such levels have raised red flags about grid stability issues with system operators in many countries, including the United Kingdom and the United States. The UK National Grid Electric System Operator is concerned with instabilities in distant wind farms in northern Scotland, with a heavy wind penetration in a weak grid by 2030. In the United States wind farms and solar PV farms (in Texas and

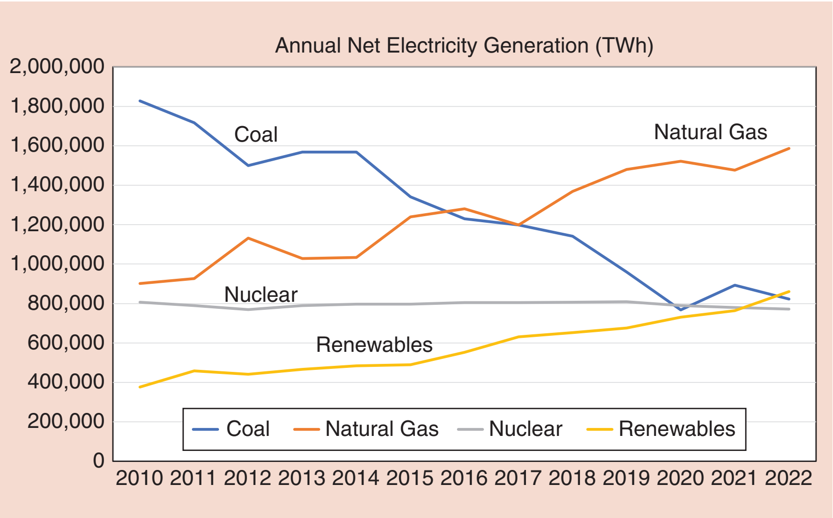

Figure 1. Net electricity generation. This plot is generated based on the data provided by the Energy Information Administration.

Digital Object Identifier 10.1109/MELE.2023.3291182
Date of current version: 29 August 2023

California, respectively) have reported to have caused many large-scale power disruption events in the grid. To make matters worse, full adoption of electric vehicles to replace internal combustion engines remains a daunting challenge, as it requires wholesale infrastructure upgrading and technology breakthroughs.

In the broader scheme of things, the "grid-edge" paradigm is evolving. The grid-edge is the new and complex landscape encompassing distributed energy resources and energy storage devices, as well as smart grid technologies, such as distribution automation, advanced metering infrastructure, and digital controls. It also includes the behind-the-meter consumer replete with smart appliances, smart buildings with onsite generation, electric vehicle charging, and energy storage devices. These will be taking part in two-way energy transactions and demand side management programs. The grid-edge is fast expanding in size as well as capacity, as increasing numbers of distributed energy resources and energy storage systems are being deployed.

Financial and permitting difficulties associated with capacity expansion prohibit using past practices as a guide to building the required capacity to double the generation, transmission, and distribution infrastructures in the United States, United Kingdom, and other industrialized countries. To address this situation, it will be necessary to develop an innovative, sustainable, and multifaceted approach to generating, delivering, and consuming electricity. Technologies such as wind, hydro, solar power, energy storage (including battery and hydrogen), advanced nuclear reactors, and the smart grid, and best practices like energy efficiency and transactive energy, will play increasing roles in providing clean and sustainable electricity.

Investments in research and development are critical to optimize the utilization of new technologies, such as advanced nuclear reactors, carbon capture, and storage. The transition to a sustainable energy future will require collaborations between policymakers, investors, equipment vendors, utilities, and consumers to implement new policies and regulations. Simultaneously, financial incentives and public awareness campaigns to encourage conscious energy consumption will have to play major roles. In turn, these advancements will facilitate better social acceptance and policymakers' approval. I hope the *Electrification Magazine* will publish articles addressing these and other related topics in its future issues. This will help to maintain the magazine's role as a leading provider of timely and meaningful information as the world gets ready to face the effects of climate change.

Biography

Saifur Rahman (s.rahman@ieee.org) is the Joseph Loring Professor of electrical and computer engineering, Virginia Tech, Arlington, VA 22203 USA. He served as the EIC of *IEEE Electrification Magazine* from 2013 to 2015.