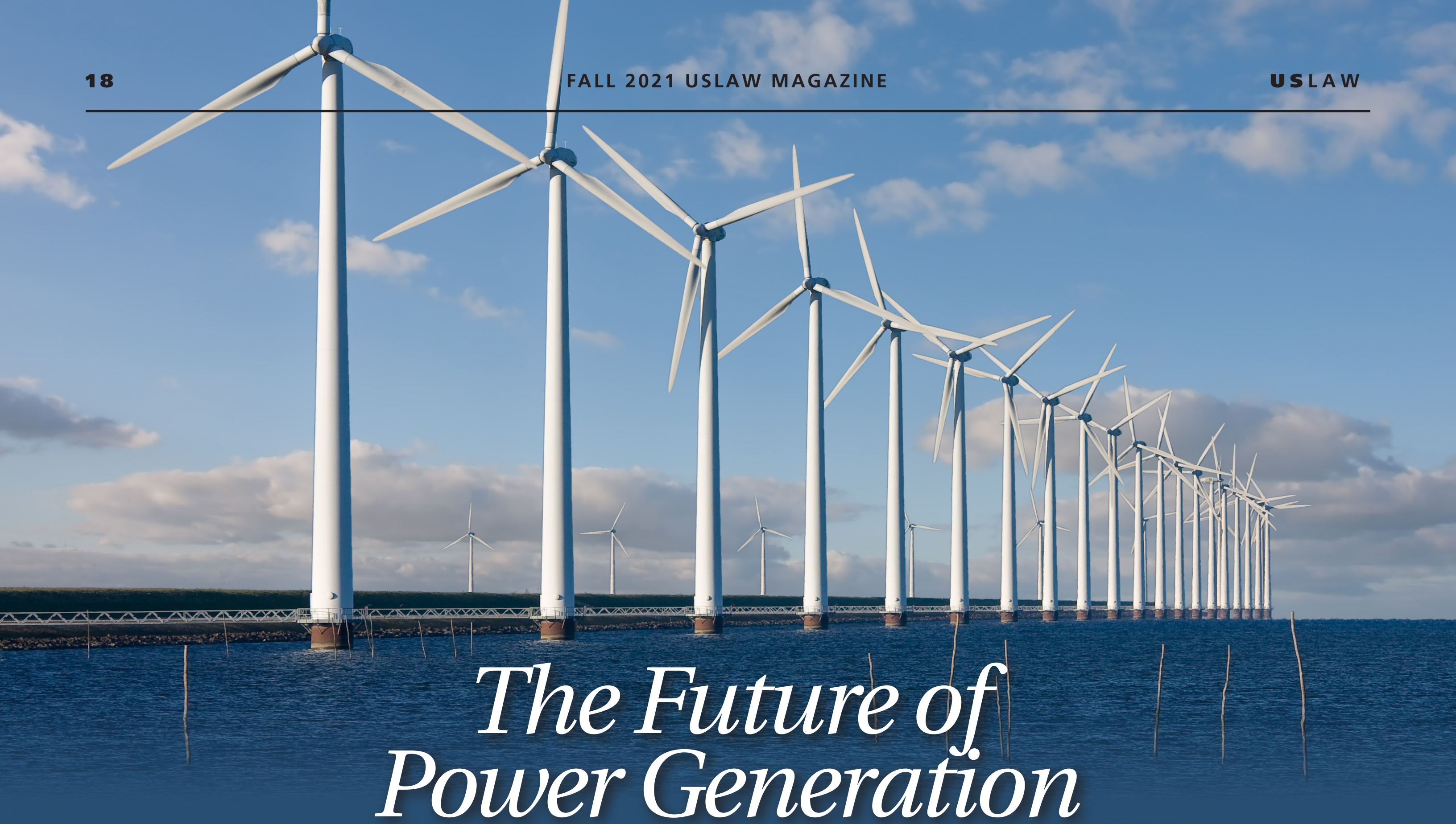

The Future of Power Generation

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The future of power generation in the United States seems to change direction whenever the oval office changes its occupant. One thing, however, seems to be clear over the past decade: fossil fuel and nuclear power generation is phasing out, and renewable generation is phasing in. Large corporations such as Verizon Wireless have entered into renewable energy purchase agreements in the past two years which total nearly 1.7 gigawatts[1]. Meanwhile, Lloyd's of London, one of the world's largest insurance markets, will phase out the investment in fossil fuel power plants, coal mines, and other energy exploration work by 2030[2]. With these continuing trends in mind, it's crucial to explore each generation class, expand upon where power generation will be in the future, and analyze the types of construction and operational issues that can be expected in our country's transition from fossil fuel to renewable generation.

GENERATION CLASSES

Fossil Fuels and Nuclear

This generating class consists of fossil fuel power plants that burn coal or natural gas, and nuclear power plants that utilize uranium fuel and a process called fission to create heat. The heat created by either burning the fuel or fission is absorbed by water flowing throughout a boiler, or heat exchanger, to create steam. The steam is then piped to a steam turbine generator that rotates. As this turbine rotates, a generator coupled to the turbine rotates as well, producing power.

Fossil fuels can also be burned through a gas or combustion turbine. In this process, natural gas is being burned which rotates a large turbine. Similar to the steam turbine generator, this combustion turbine is coupled to a generator that also rotates, creating power.

Renewable

Renewable power generation includes many different asset types. The most popular of the renewable power assets are hydro, wind, and solar. Hydroelectric power utilizes the power of water to rotate one, or many, hydroelectric turbines. By storing (damming) water at a higher elevation and allowing it to flow to a lower elevation, the potential energy of the water turns a hydroelectric turbine coupled to a generator where power is produced.

Wind power generation utilizes vastly differing sizes of wind turbines to generate power. Very simply, the wind pushes large surface area blades that cause a shaft within the wind turbine nacelle (the top component of the wind turbine) to rotate. That shaft attaches to a gearbox that changes the relatively low rotational speed of the wind turbine blades into a high rotational speed shaft that rotates the generator, creating power.

The last of the popular renewable generation assets is solar. There are many sub-asset types within solar, but the most common of those is photovoltaic (PV) generation or solar panels. Solar panels are comprised of PV cells and other conductive materials to assist in the transfer of electrons. When light energy hits a PV cell, part of the light energy is absorbed, allowing the flow of electrons.

WHERE ARE WE NOW AND WHERE WILL WE BE IN THE FUTURE?

The power generation industry and class mixture direction seem to change every four years. Some administrations push for the utilization of the coal and natural-gas reserves within our borders, and others push for the "cleaner" renewable generation. As displayed below in Figure 1, regardless of each administration's agenda, coal generation is on the decline with wind and solar on the rise.

BUT WHAT ABOUT NATURAL-GAS GENERATION?

Why has its net generation almost doubled in the last 10 years?

The answer lies in the term "base load demand" or "base load." Throughout the nation, there is always a constant base load (power) demand being provided via base load supply power plants. Base load supply must be reliable, run constantly, and fluctuate power output throughout the day with a "turn of a knob." Base load demand was largely covered by nuclear and coal power plants in the past; however, with the retirement and mothballing of coal-fired power plants, other types of generation are needed to take its place. Natural-gas generation is the current solution.

NUCLEAR STALEMATE?

As seen in Figure 1, the nuclear generation class shows a straight, horizontal line for the past 10 years. Nuclear power is a base load supply asset and has proven to be very reliable for long-term, continuous operation. So why don't we build more? Environmentally speaking, these power plants are clean in the fact that they do not have any emissions, unlike those of a coal or natural-gas power plant. But they are not clean in the fact that the highly radioactive spent uranium fuel rods need to be put somewhere after they are replaced with new rods. Additionally, lack of containment of the radioactive core has proven devastating in some situations (2011 Fukushima, 1986 Chernobyl, 1979 Three Mile Island). These types of accidents have made the containment measures, permitting, and construction near impossible for a utility to swallow, resulting in the lack of new nuclear power plants. The latest completed nuclear power plant finished construction in 2016, the next youngest entered service in 1996.

IS THIS THE RISE OF WIND, SOLAR, AND HYDROELECTRIC?

Due in part to the federal tax credits granted to those who purchase, construct, and begin production of power, wind turbine and PV power generation has become increasingly popular in the past decade. Other reasons for its popularity include an aging fossil fuel fleet, demand for more peak energy producers, consumer opinion, and the competitive prices to construct versus fossil-fuel power plants.

Keeping these facts in mind, will the future include landscapes packed with wind farms and solar arrays? According to Xcel Energy[3], one of the largest electric utilities in the nation, they will be cutting greenhouse-gas emissions from fossil-fuel generation plants by 85% by the year 2030 and will retire their remaining coal-fire fleet by 2040. The power currently being produced by the fossil fleet will need to be produced by other means. That is why Xcel Energy plans on building a combined 5,500 megawatts of combination wind, solar, and battery storage, which will need technological advances to be cost effective.

CONSTRUCTION AND OPERATIONAL ISSUES-RENEWABLE ENERGY

Insurance claim and legal professionals can expect a rise in matters in the renewable energy sector as we move forward into the future. Construction of utility scale wind and solar farms is similar work to that of an assembly line. There are multiple different crews of workers that perform the same tasks every day, however, the risks within the wind turbine erection process during construction outweigh those of solar farm construction. The most at-risk task is erecting a wind turbine. This involves multiple critical lifts that in most cases, require engineered lifting plans due to the weight of individual turbine components, available crane capacities, and dangers with varying environmental conditions. These lifts can be hazardous, often resulting in injury if procedures are not properly followed.

Operation of both wind and solar farms presents unique problems that were not displayed in the fossil-fuel and nuclear-generating classes, having double or triple redundancy on most critical pieces of equipment. This prevents down time and keeps larger pieces of equipment (i.e., steam turbine generators and boilers) from catastrophically failing . There is no such redundancy in the wind and solar generating class. As a result, you have more assets that can experience failure. For example, think of a wind farm with 300 individual wind turbines. That is 300 individual assets that can experience a minor failure in a lube oil system, which can trigger a much larger failure in a gearbox. This brings the asset to a standstill, resulting in loss of generation revenue and often high-dollar repair work that requires third party cranes and crews.

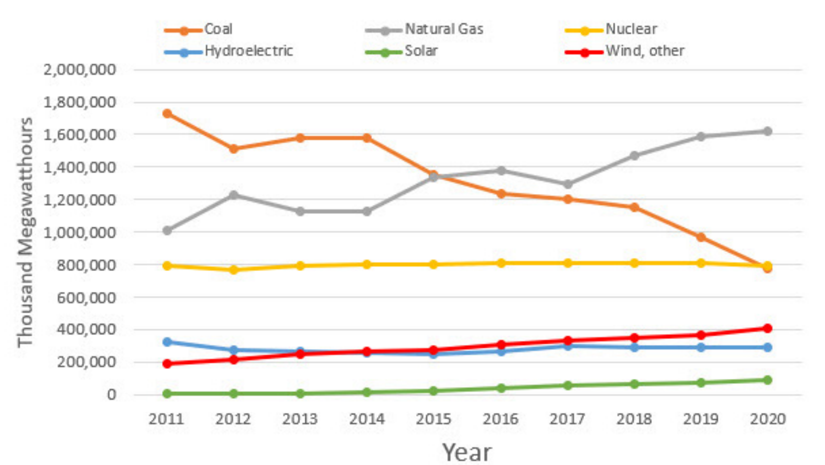

Figure 1: National Net Generation Changes (data via eia.gov).

Another example of the differences in operation between a coal-fired power plant and a 300 wind-turbine farm is the amount of personnel attending to the unit(s). In this example, both the coal-fired and wind farm generation facilities produce a total of 600 megawatts. The coal-fired power plant will have maintenance, electrical, instrument and controls, engineering, and operating staff monitoring and attending to the unit at all times. On the wind farm, however, there may be a handful of operation staff onsite full time. The maintenance work is usually carried out by third party contractors who come onsite at scheduled maintenance intervals. There is rarely anyone onsite checking over the "machine" every day.

Major corporations are making big statements on their intention to invest in renewable energy. In turn, the increase in demand for more renewable power indicates the need for more utilities to keep pace on construction and operation of new renewable generation facilities. While the failures we will see in the commercial, renewable class generating facilities may not be as catastrophic as a fossil fuel or nuclear failure, it is anticipated that the quantity and frequency of failures will increase as we move into the future of power generation.

Sean Buczek, P.E. earned his Bachelor of Science in mechanical engineering from the University of Colorado. At S-E-A, he is responsible for investigating accidents and failures and performing design reviews of mechanical equipment and systems, including power plant auxiliary systems, power generation systems, district heating/cooling systems, and wind power systems.

1. https://www.verizon.com/about/news/verizon-becomes-leading-corporate-buyer-us-renewable-energy
2. https://www.bloomberg.com/news/articles/2020-12-17/lloyd-s-of-london-plans-to-exit-fossil-fuel-insurance-by-2030
3. https://www.denverpost.com/2021/02/25/xcel-energy-colorado-renewable-energy-plan/?utm_source=Energy+News+Network+daily+email+digests&utm_campaign=ccf85b03b8-EMAIL_CAMPAIGN_2020_05_11_11_44_COPY_01&utm_medium=email&utm_term=0_724b1f01f5-ccf85b03b8-89257515