Grid 2.0—Powering the Rising Demand for Electricity

Artisan Partners Global Equity Team

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If you asked ChatGPT how much electricity it uses to answer a single query, you'd get this core response: *"…ChatGPT consumes approximately 0.3 to 1 kilowatt-hour (kWh), though this is a rough range."* That's about the same amount of electricity needed to run a microwave oven for one hour or a laptop for seven hours.

While asking a generative artificial intelligence (AI) chatbot about its energy usage may be self-serving for this article, it also highlights a stark reality. The massive computing power data centers need to support generative AI models consumes significant amounts of electricity, a resource often taken for granted. In 2022, data centers used 460 terawatt-hours (TWh) of electricity globally. By 2026, this demand could more than double, reaching 1,000 TWh, roughly equal to the size of Japan's total electricity usage last year. In addition to AI and cloud computing, electric vehicles (EVs), the reshoring of manufacturing plants and the increased use of air conditioning due to hotter weather patterns have also driven consumption higher in recent years.

UNIT	EQUIVALENT
Terawatt (TW)	One Trillion Watts
Gigawatt (GW)	One Billion Watts
Megawatt (MW)	One Million Watts
Kilowatt (kW)	One Thousand Watts

Supply-Side Challenges

The surge in demand for electricity comes at a critical time for entities that source, transmit and distribute power. One issue is the retirement of coal-fired plants, which further reduces supply. Coal is the most carbon-intensive fossil fuel and phasing it out is a top priority for many countries. In the US, an estimated 40 gigawatts (GW) of coal capacity—about 5% of the nation's electricity supply—will be retired by 2028. While US energy policy could change under the new administration, the fact remains that since 2000, over 163 GW of coal-fired capacity has been retired in the US and no new capacity has replaced it. In fact, the US has not built a new coal plant in over a decade. A similar picture can be seen worldwide with 15% of the global coal operating capacity set to retire by 2050, in line with the Paris Agreement goals. This shift reflects a broader, long-term transition from coal to renewable energy sources like wind and solar, as well as cleaner-burning natural gas.

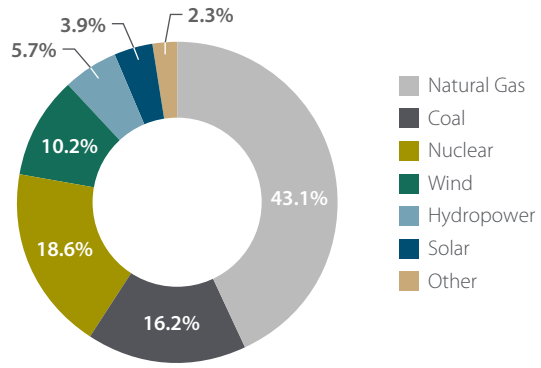
Another issue is integrating alternative energy sources into a system designed and built around fossil fuels, in some cases 80 or more years ago. Expanding this system, or grid, to meet higher demand and adapting it to cleaner and cheaper power sources, as coal use declines, requires physical and technological changes, particularly in terms of how these new sources are coordinated.

Capacity Investments

The good news is that significant investments are underway to expand electrical grids, improve their reliability and resilience, and support the integration of growing renewable energy and increased natural gas supplies. Global capital expenditures rose from approximately $270 billion in 2020 to $330 billion in 2023 and are projected to reach $600 billion by 2030, more than doubling within a decade. In the US, capital spending by major utilities has grown by 50% in recent years, increasing from about $40 billion in 2018 to over $60 billion last year.

These massive investments are expected to increase capacity. Exhibit 1 breaks down electricity generation by source. Wind and solar, the fastest-growing sources, are expected to generate enough energy to replace coal soon. According to the US Energy Information Administration, around 160 GW of renewable energy and natural gas will be available to replace the 40 GW of coal-based electricity lost by 2028. Wind and solar power, however, are intermittent energy sources. Matching peak demand with this supply creates reliability challenges for an aging grid.

Exhibit 1: US Utility-Scale Electricity Generation by Source in 2023[1]



Source: U.S. Energy Information Administration, February 2024. [1]Electricity generation from power plants with at least one megawatt of total generating capacity.

Building Smarter, More Reliable Grids

One company investing heavily in connecting new power sources to the grid is aptly named National Grid, a British utility that generates and transmits natural gas and electricity in the UK and northeastern US. The company recently announced a $75 billion, five-year plan to expand, digitize and decarbonize its electric grids, with a focus on better integrating renewable energy in both regions.

National Grid's *Great Grid Upgrade* represents the largest investment in the UK electricity network in generations. As the network owner, the company plays a critical role in transporting renewable energy to users while balancing the impact on communities, the environment and consumer pocketbooks. The grid integrates energy from nuclear, solar

and wind sources, and is enhanced by "interconnectors"—high-voltage subsea cables connecting the UK to grids on mainland Europe. These interconnectors provide flexibility, a critical benefit for managing intermittent sources. For example, when wind-generated electricity is abundant locally in the UK, the interconnectors allow National Grid to export excess electricity to countries such as France, Belgium and The Netherlands. When wind power is scarce in the UK, the interconnectors enable electricity imports from other grids. This flexibility improves efficiency, stabilizes supply and helps lower wholesale energy prices, ultimately reducing consumer bills.

In addition, National Grid plans to invest approximately $35 billion in New York and Massachusetts to help these states achieve their ambitious decarbonization goals while reliably meeting rising electricity demand. Part of this strategy involves making these grids smarter. For instance, the company uses AI and autonomous drones to predict grid failures before they occur, which reduces downtime and maintenance costs. The drones conduct visual inspections of hard-to-reach infrastructure, such as transmission towers and wind turbines. Specialized software analyzes the visual data to assess asset conditions more accurately and efficiently than traditional methods. This approach enhances grid safety, reliability and resilience.

New cost efficiencies and US and UK grid upgrades have improved margins. For the first half of 2024, the company increased year-over-year operating profit by 15%, primarily driven by higher revenues across its regulated businesses, and earnings per share by 8%. Over the next five years, National Grid expects its continued investments will drive further growth in assets and earnings.

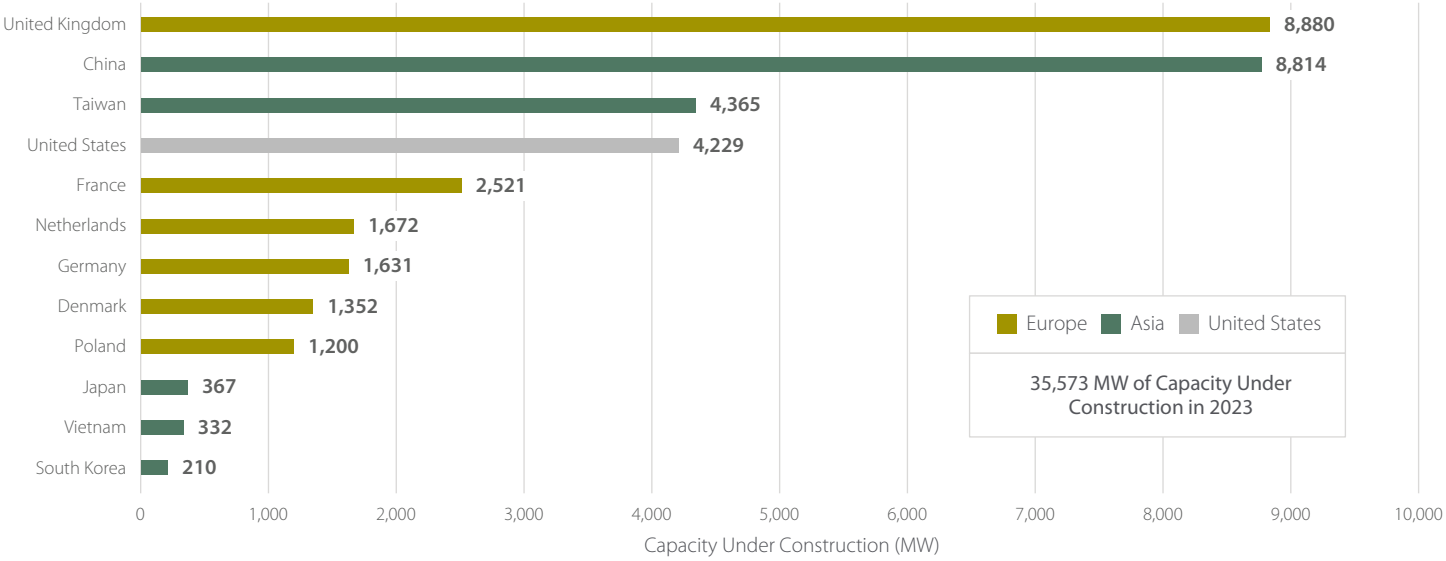
High Voltage Cable Market

In Europe, high-voltage direct current (HVDC) cables, including the undersea cables linking National Grid's UK operations to Continental Europe, are in greater demand than ever. These cables allow for the efficient transmission of power over long distances with minimal loss. Rising electricity consumption from data centers, EVs and heat pumps, coupled with the rapid growth of offshore wind installations, has significantly increased the need for HVDC cables.

Wind turbines, in particular, rely on these cables given that they are often located in remote areas and must transport low-cost, renewable electricity to far-off areas with excess demand, such as large cities. Despite near-term inflation and supply chain challenges, 2023 set a record for adding offshore wind capacity, with a 64% year-over-year increase in projects under construction, adding over 35 GW of supply (Exhibit 2). The International Energy Agency forecasts these annual capacity additions will reach 80 GW by 2030.

Cable manufacturers like Prysmian, Nexans, Sumitomo Electric and Denmark-based NKT are benefiting from the rising demand for HVDCs. All four companies have seen operating margins inflect upward since last year, a product of increased sales growth and stronger pricing. NKT, which leads the industry with a €11 billion high-voltage cable backlog, has particularly good earnings visibility, with about 25% of its orders set to be delivered within two years.

Exhibit 2: Offshore Wind Capacity Under Construction by Country as of 31 December 2023



Source: NREL, August 2024.

Predicting Power

Building smarter, more interconnected grids is crucial in meeting future electricity needs. Equally important is leveraging predictive analytics to optimize energy usage. Engie is one company focused on enhancing system flexibility to reduce costs and carbon emissions over time.

With over $89 billion in revenue in 2023 and operations in 31 countries, Engie is Europe's largest natural gas distributor and the leading wind and solar energy producer in France, where it is headquartered. The company can produce 41 GW of renewable power and aims to reach 50 GW by the end of 2025. As a leader in the energy transition, Engie is closing its coal facilities, expanding renewable energy capacity and helping customers reduce their carbon footprints. The company believes this will be a key driver of net income and its stock price.

In recent years, Engie has pioneered the use of large language models for optimizing its global facilities. For instance, it uses AI models to predict renewable power supply and demand, which helps improve system efficiency. During peak demand, the company mobilizes assets to increase production and, if necessary, purchases energy from the market. When demand drops, Engie sells excess energy back into the market. These changes are made in real-time or planned based on storage and demand forecasts. Similarly, the company integrates data from its global facilities with meteorological, satellite and mapping data to recommend real-time adjustments to assets to reduce carbon emissions and drive cost savings.

Engie sells this know-how to other energy companies as part of its solutions business, a key part of its business strategy in recent years. For example, as a solar and wind supplier to Microsoft in Texas, Engie also helped the tech giant deploy a data management platform to facilitate predictive maintenance and optimize electricity consumption at its data centers. Doing so helps large electricity users, such as Microsoft, secure power, lower costs and reduce their carbon footprint.

In a rapidly changing world, it's reassuring to know that innovative companies are transforming the world's grids to ensure that something as basic, yet critical, as electricity remains available and reliable for future generations. For investors, they are also a reminder of the role active management can play in identifying growth opportunities that are shaping the energy transition and portfolios.

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