The Giant Grid Bottleneck Threatening Climate Goals: QuickTake

By Lars Paulsson and Naureen S. Malik

(Bloomberg) -- The shift to a zero-carbon economy won't happen just by blanketing the landscape with solar panels and wind farms. It also requires power networks that can absorb the intermittent supplies from these new sources to deliver a constant, reliable flow of electricity to consumers. For the most part, grids are still configured to handle electricity generated in massive coal, gas and nuclear plants built in the 20th century. That's slowing the pace at which renewables can take over from fossil fuels as the world's main energy source.

1. What's the challenge?

Reaching "net zero" carbon emissions means electrifying parts of the economy that still rely on oil, gas and coal, such as transportation, home heating and steelmaking. Power capacity will need to grow to 39.7 gigawatts by 2050 from 8.5 gigawatts in 2022, with the proportion of that energy derived from wind and solar rising to 70% from 25%, according to BloombergNEF. So grid operators face a dual challenge: enabling a huge expansion in generation while being able to handle a greater volume of renewable supplies that rise and fall with the availability of wind and sunshine.

2. What will that entail?

It means building grids dense enough to absorb these renewable sources while still achieving the stable frequency that's vital for the smooth functioning of electrical equipment and electronics. It will also require more high-voltage lines to carry surpluses from regions where the sun is shining and the wind blowing to meet demand elsewhere. Right now, the lack of long-distance transmission means a lot of recently installed renewable capacity is going to waste. BNEF estimates it will cost around $21.4 trillion to adapt grids to a net zero world and require 152 million kilometers of new cables — enough to stretch from Earth to the Sun if laid end to end. That implies a surge in consumption of copper — more than the mining industry can currently supply. But the biggest obstacle to grid development right now isn't sourcing the materials or finding the money to pay for it all.

3. What's the hold-up?

Local communities often oppose new wind farms, solar arrays and power lines and projects can face years of consultations involving multiple stakeholders. State regulators impose detailed technical studies and other bureaucratic hurdles. There are almost 1,000 gigawatts of solar projects stuck in the interconnection queue across the US and Europe, close to four times the amount of new solar capacity installed around the world in 2022. If all the wind and solar projects stuck in limbo were completed and connected to the grid, they'd add up to more than the present electricity generation capacity of the US.

US President Joe Biden's Inflation Reduction Act is expected to advance 121 gigawatts of new renewables capacity by 2030. But the lack of a federal authority to approve new long-distance transmission lines makes it hard to plan for a renewables-led future. One family for years managed to stymie a $3 billion power line project designed to bring Wyoming wind power to Southern California. In 2021, voters in Maine rejected a transmission line that would have supplied New England with hydropower from Quebec.

The UK has led the world on wind power but new projects were facing waits as long as 15 years by mid-2023, with more than 200 gigawatts of renewables waiting to be connected.

Plans for three "power autobahns" connecting Germany's industrial heartlands to wind farms on its breezy northern coast at a combined cost of around €50 billion ($54 billion) have been delayed by several years after an outcry from citizens and politicians.

4. What's the impact of all this?

It's pushing up the price of renewables as investors assess the cost of delays. Grid connections for wind projects in the US Midwest cost between $9 per kilowatt and $681 in 2021, more than triple the spread in 2017, according to BNEF. Some projects are being scrapped as a result. According to Lawrence Berkeley National Laboratory, less than a quarter of wind and solar projects that seek a grid connection in the US actually end up operating. All this is delaying the point at which wind and solar become cheap enough to supplant fossil fuels across the world.

5. What are the risks with bigger grids?

The more sprawling a network and the more sources of power, the harder it is to manage. Transmission grids need to stay at a frequency of 50 hertz in Europe and 60 hertz in the US to operate smoothly. Any deviations, caused by a variety of failures from power plants to substations, can damage anything that's connected. Europe came close to a massive blackout in January 2021 after a fault at a Croatian substation, highlighting the dangers of integrated networks. Blackouts in Texas show what can go wrong when renewables take off before the grid has been modernized to handle them.

6. How can technology help?

The ultimate goal is to achieve total "situational awareness" by installing sensors and other digital equipment to predict supply and demand and manage power flows at a local and national level. Grid operators would get more visibility on how much power would be required at certain times of day, and where they can source it. They'd be able to cap usage at times of high demand by influencing patterns of consumption via data from smart meters in homes and businesses. And as solar panels and battery-powered cars grow in popularity, consumers will turn into suppliers by selling surplus electricity back to the grid to save money. That would make it easier to balance supply and demand within local areas, so that fewer high-voltage transmission lines would be required to even out surpluses and deficits between regions.

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