Letter from America: Data Centre Demand and How Best to Meet It

Fereidoon Sioshansi

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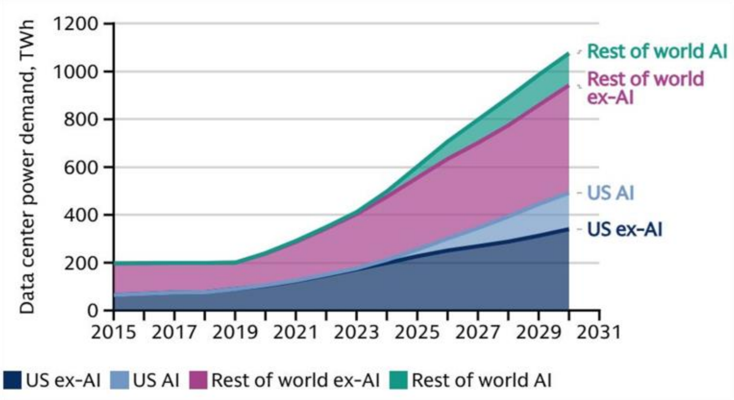
Renewables plus storage superior to nuclear (or anything else)

There has been a surge of speculation about the extent of rising electricity demand, due to several factors including electrification of transport, space and water heating, increased manufacturing and industrial demand due to onshoring as well as growing demand from data centres and artificial intelligence (AI). While there is no doubt that these and a warming climate – which leads to more demand for air conditioning – are real, there is no consensus on the scale of the growth.

Even if there is agreement on the projections, there is a debate about what is the best way to meet the increased demand. Nuclear proponents, always looking for a lifeline, argue that the flat load profile of data centres and industrial customers can ideally be met by nuclear-generated power running as baseload 24/7 with no carbon emissions, aside from those in processing the nuclear fuel. Others are not so sure. And there is always the issue of whose projections to believe. Some forecasts may have a hidden agenda or may be funded by stakeholders who may prefer certain results better than others. The grid operators generally have access to accurate historical data and may be in a better position to produce better forecasts on which they must rely to operate the network.

Figure 1: Global data center power consumption to grow 160% by 2030



Source: Is nuclear energy the answer to AI data centers' power consumption? Goldman Sachs, 23 Jan 2025

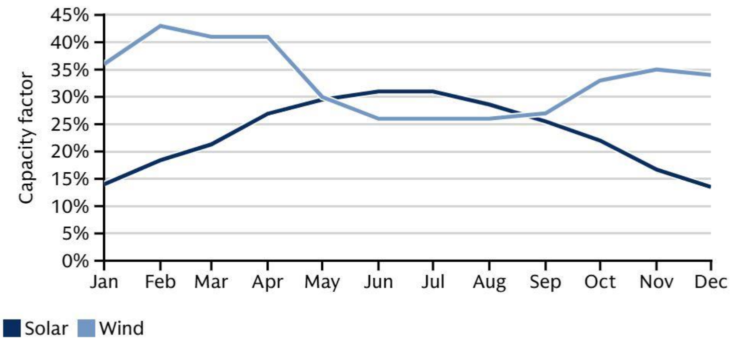
Among the many recent projections, the forecast by PJM Interconnection (PJM), the largest organised wholesale market in the US, offers some clues. The Long-Term Load Forecast Report released in late Jan 2025 projects significant growth in both summer and winter peak energy demand over the next two decades. It said: "The demand for electricity is growing at the fastest pace in years, primarily from the proliferation of data centres, electrification of buildings and vehicles, and manufacturing." PJM expects:

- **Summer peak demand** to grow by 3.1% annually over the next 10 years, slowing to 2.0% over the subsequent decade. By 2045, PJM's summer peak is forecast to reach 228,544MW, a 74,400MW increase from 2025.
- **Winter peak demand** to grow at an even faster rate of 3.8% annually for the next decade and 2.4% over 20 years, reaching 218,760MW by 2045.

The PJM's net energy load is projected to grow by 4.8% annually over the next 10 years, reaching 1,328,045GWh by 2035, a 495,264GWh increase compared to 2025. Over a 20-year horizon, growth slows to an average of 2.9% annually, with net energy load forecasted to hit 1,482,068GWh by 2045. It said this growth: "Places immense pressure on energy infrastructure, highlighting the need for modernization and proactive investment." The main drivers of growth in the PJM market are attributed to the usual suspects including increased demand from data centres, electrification of buildings and vehicles, and manufacturing. Moreover, PJM expects the rise of behind-the-meter (BTM) generation, battery storage systems and increased electrification to become more noticeable over time. Other grid operators in the US and elsewhere are also updating their forecasts making note of similar trends.

A report by Goldman Sachs Research expects power demand from data centres to grow more than 160% by 2030 relative to 2023 levels. If this were to be met from nuclear generation it would require 85-90GW of new capacity by 2030, which Goldman dismisses because it figures "well less than 10% will be available globally by 2030." Building new nuclear power plants typically takes a decade if not more. Goldman Sachs Research notes that "… nuclear is the preferred option for baseload power, but the difficulty of building new nuclear plants means that natural gas and renewables are more realistic short-term solutions." If the nuclear option is not going to cut it and the Hi-Tech customers insist on meeting their consumption from zero carbon resources, then they must rely on renewables, primarily solar and wind. Both are cheap and plentiful if it were not for their variability.

Figure 2: US Capacity factors for solar and wind, 2023



Source: Goldman Sachs

First, let's examine the costs, setting aside variability. Goldman Sachs Research reckons that the average cost of energy for onshore wind hosted on the site of a data centre is $25/MWh in the US, while solar energy costs $26/MWh, and combined cycle natural gas costs $37/MWh before accounting for the cost of carbon capture. Renewables appear to be the best option but, of course, this is misleading, especially for a data centre with limited demand flexibility, i.e., it needs more or less the same amount of capacity 24/7, all year round. It said: "Our conversations with renewable developers indicate that wind and solar could serve roughly 80% of a data centre's power demand if paired with storage, but some sort of baseload generation is needed to meet the 24/7 demand."

According to Goldman: "The supply cost of renewable energy sources is cheaper than generating electricity from natural gas, before taking into account transmission considerations and filling gaps when the sun isn't shining, and the wind isn't blowing. […] To provide round-the-clock power, data centres are looking to augment solar and wind power using battery storage and either power provided from the grid or onsite natural gas peaking capacity (a power plant that runs during periods of high demand or to fill gaps in intermittent generation). Our analysts estimate a combined solution of solar, battery storage and natural gas would lower emissions by 67% compared to baseline combined cycle natural gas."

The variability of renewables, daily as well as across the seasons must be considered and compensated. According to Goldman Sachs: "…. utility-scale solar plants only run around 6 hours per day on average, while wind plants run for an average of 9 hours per day. There is also day-to-day volatility in the capacity of these sources, depending on the radiance of the sun and the strength of the wind. The average capacity factor of the two technologies also varies across the months of the year with solar production falling during the winter months because of shorter days and cloud cover while wind does poorly during the summer months". The other factors that must be considered are land use and transmission costs, because, as Goldman Sachs notes: "…renewable energy sources often take up a much greater land footprint than natural gas or nuclear power; they are more likely to be located away from big cities, where much of the energy that they generate is used. As a result, the energy they generate may have to travel further before it is used."

In other words, renewables are indeed the cheapest options on a $/MWh basis when available. Their true cost, especially for a customer with a flat load profile, however, must account for the extra costs of firming the variability of renewables as well adding the extra transmission costs – and losses. None of this, of course, is new: "To provide round-the-clock power, data centres are looking to augment solar and wind power using battery storage and either power provided from the grid or onsite natural gas peaking capacity (a power plant that runs during periods of high demand or to fill gaps in intermittent generation)." Batteries can help but ultimately a backup system such as natural gas fired plants may be needed to truly firm up the renewables' output. And this results in residual greenhouse gas emissions, which must be offset one way or another. These extra costs are real and must be considered but in the final analysis, a combination of different types of renewables plus batteries and a backup system should provide the cheapest form of baseload power for a data centre – or for that matter – for any industrial or commercial customer who aspires to achieve zero carbon footprint.