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The Growing Mismatch between US Electricity Demand and US Electricity Supply

Plus, a strategy to relieve some of the pressure contributing to increasing power scarcity

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The US needs to significantly increase generation capacity; and it must happen quickly. This challenge is amplified by the aging baseload fleets of power plants. Hundreds of old coal-fired generating units representing over 110 gigawatts (GW) of capacity are scheduled to retire: most of them between now and 2030. Others will likely be scheduled to retire in the next decade. Their retirement will bring a welcome improvement to the CO_2 emissions per GWh of electricity produced in the US.

But the loss of capacity is contrasted with a potential 175 GW increase in demand over current (pre-retirement) capacity. After coal station retirements, even if there are no retirements in the aging nuclear or hydro generation fleets, a gap of nearly 300 GW's of needed capacity exists between today's output and expected demand 10 years from now. Deepening the challenge, as is shown in this white paper, is the fact that the US nuke fleet is old. Many nuclear power stations are beyond their original useful life estimates. Announced new natural gas fueled generation will help but the gap will remain large.

We are not sure how the US electricity supply will rise to the challenge.

Current policies inhibiting the growth of wind and solar generation (and the needed energy storage capacity to buffer their variability and intermittency) are not rational given what is required to power our future. It is a mistake not to include those sources in a strategic plan for growth in the power generations sector.

Adding to the challenges ahead, a substantial portion of the new demand will be from massive data and artificial intelligence (AI) centers. They need a lot of power, and they need it all the time. Some of the companies in that sector with international exposure to markets in countries that do have policies that recognize carbon dioxide emissions as harmful pollution will seek to purchase power that is produced from CO_2 beneficial sources. Applying that constraint narrows the choices for how their baseload power is generated.

The last part of this paper describes a solution within the existing power generation infrastructure that can, almost immediately, provide highly carbon beneficial baseload power 24x7 that supports the power hungry needs of data and AI centers. We do not pretend to have a solution to the overarching challenge. But we do have promising ideas for how data and AI centers can secure carbon beneficial power.

Demand for Power in the US in 2035

There are many studies and US government forecasts of electricity demand in the US going forward. FutureMetrics has distilled several into Table 1[1].

US Electricity Demand in 2035 (in Terawatt-hours)

Scenario	Total 2035 Demand	Increase from 2025 Demand	Total Demand % Increase from 2025 to 2035	Data Centers & AI in 2035	Data Centers % of Total in 2035	Transport Electrification in 2035	Transport % of Total in 2035	Cooling and Heating in 2035	Heating and Cooling % of Total in 2035
Median	5,140	780	15.2%	450	8.8%	400	7.8%	75	1.5%
80th Percentile	6,200	1,840	29.7%	1,075	17.3%	700	11.3%	350	5.6%

Souces: BloombergNEF, NREL, USDOE, ACP; Apr 2025, Aug 2025, Aug 2025, Mar 2025; Analysis by FutureMetrics

Table 1 - Forecast for US Electricity Demand 2035

This analysis will use the higher estimate[2] in which demand growth over the next decade is nearly 1,850 terawatt-hours.

The increase in data and AI center power demand switches from data center demand being dominant into AI demand becoming dominant at about 70% of total data/AI center demand by 2035[3]. This is for two reasons: (1) Plain vanilla "search engine" queries will become less common, and (2) AI queries are not just looking up

[1] One terawatt (TW) = 1,000 gigawatts; one GW 1,000 megawatts; one MW = 1,000 kilowatt's.
[2] In a previous white paper, we showed how annual estimates have consistently under forecast the actual growth in power demand for AI, transportation electrification, and heat pumps. Given past forecast errors, it is likely that the 80th percentile estimate will move toward the median estimate in a few years.
[3] See HERE.

information in massive databases. They use "reasoning" that requires more processing. Therefore, they use more watts per query than search engine queries [4].

AI power demand is expected to increase by a multiple of 30.75 from current use (from about 35 TWh's to about 1,075 TWh's.

US Data/AI Center Power Demand (in Terawatt-hours)

Year	Total Data and AI Demand	AI-Only Demand	AI Demand Increase
2024	306	35	
AI as % of Data Center Demand ==>		11.4%	
2028	1,153	306	**8.75X**
AI as % of Data Center Demand ==>		26.5%	
2035	1,538	1,075	**30.75X**
AI as % of Data Center Demand ==>		69.9%	

source: Deloitte " Can US infrastructure keep up with the AI economy", June 24, 2025; Analysis by FutureMetrics

Table 2 - Data Center / AI Power Demand Forecast to 2035

As Table 1 on the previous page shows, total electricity demand can potentially increase by 30% in the next 10 years. The additional 1,840 TWh's is the equivalent of nearly 250 gigawatts (GW's) of new generation capacity[5]. A typical nuclear power station is around 1 GW (1,000 megawatts).

Supply of Power in the US

Figure 1 on the following page illustrates the current baseload and/or on-demand utility-scale thermal generation capacity (natural gas, nuclear, and coal) in the US. Thermal generation means that fuel is used to make heat. For nuclear and coal plants, the heat makes steam and drives steam turbines and generators. Natural gas typically powers a combustion turbine (essentially a jet engine) and the shaft power spins the generator. Most natural gas

[4] Estimates of power consumption vary. In general, a Google search is about 0.03 watt-hours. AI query power consumption varies by the complexity of the query and the level of "reasoning" required. It is almost always higher than a plain vanilla search engine query. One set of estimates of AI query power consumption by a researcher at the University of Rhode Island has a minimum at about the same as a Google search and a maximum of over 20 Wh's. For those that remember 60-watt incandescent light bulbs, 20 Wh's will keep that bulb lit for about 20 minutes. A dashboard showing the analysis is HERE. A rigorous description of the model is HERE.

[5] Assuming an average capacity factor of 85%. This average capacity factor assumption is probably high. As wind and solar power are increasingly part of the supply, the average capacity factor will be lower and more GW's of capacity will be needed for a given demand for GWh's. Capacity factor is the ratio of the actual electricity produced by a generating unit compared to the electricity that could have been produced at continuous full power for every hour of the year.

units also make steam from the hot exhaust of the combustion turbine, and that steam spins a steam turbine. This is called combined cycle and is significantly more efficient than a simple cycle plant.

Figure 1 shows that the known retiring coal units will subtract about 110.5 GW's (about 18.5%) of the total on-demand thermal generation capacity from the US's current capacity to produce electricity.

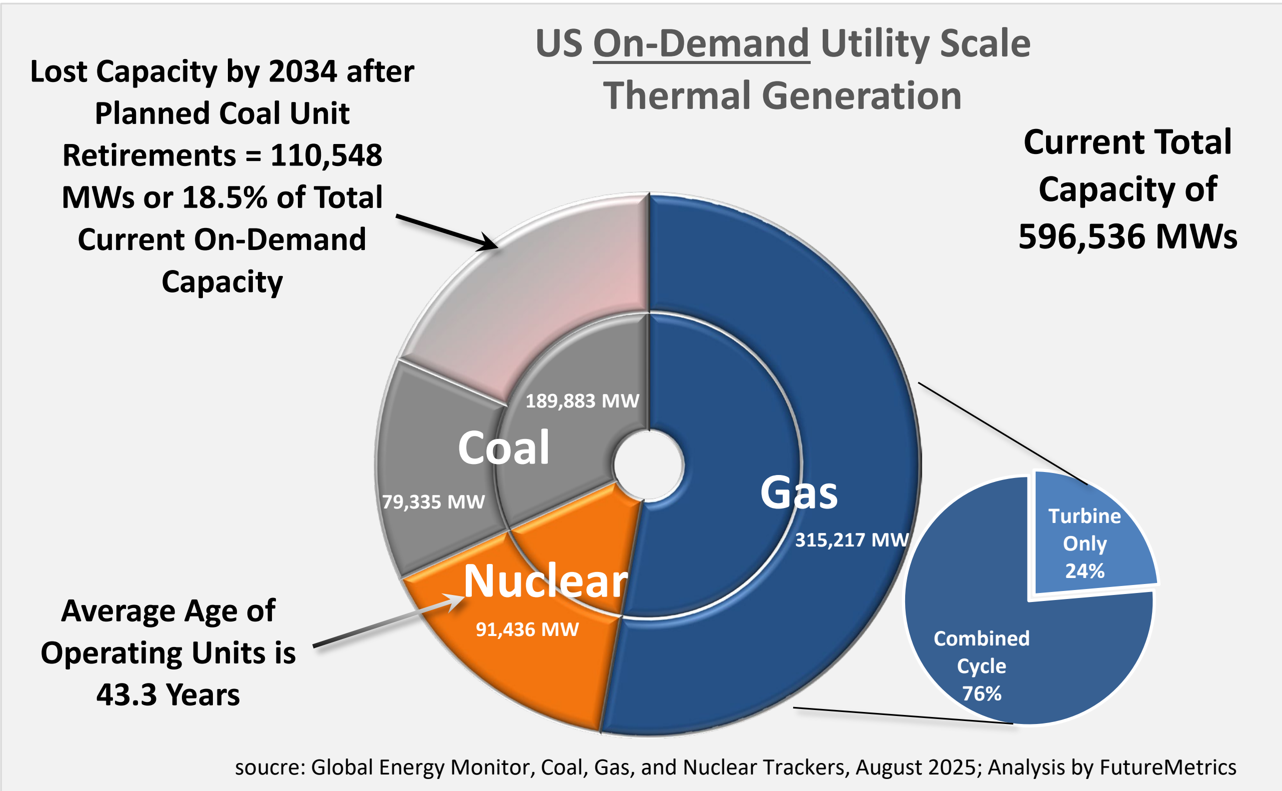

Figure 1 - Current On-Demand Thermal Generating Capacity

Wind and solar generation are not "on-demand". And due to the nature of nature, they are variable and intermittent. Using data from the US Energy Information Administration for the average capacity factors, Table 3 shows the effective total average US supply in terawatt-hours after subtracting the planned coal station retirements.

Totals After Announced Coal StationRetirments

	Capacity (MW's)	Average Capacity Factor	Effective Supply (MW's)	Supply in TWh's
On-Demand Thermal	485,988	85%	413,090	3,619
Solar	103,196	25%	25,799	226
Wind	151,429	34%	51,486	451
Hydro	91,812	37%	33,970	298
		TOTAL	**524,346**	**4,593**

source: Global Wind and Solar Tracker; US EIA, US DOE, August 2025;
Analysis by FutureMetrics

Table 3 - Effective Supply from All Utility Scale Generation AFTER Subtracting Coal Station Retirements

The gap from the 2035 estimate for demand in Table 1 is about 1,600 TWh's. Using the weighted average of the capacity factors, that is equivalent to about 290 GW's of needed new capacity by 2035.

Power generated from biomass is not included in the accounting in Figure 1. The reasoning for this is as follows.

As Figure 2 below shows, total capacity for biomass generated power in the US that is available to the grid is about 4,180 MW's[6]. This is about 0.44% of the total capacity of the sum of current capacity (excluding paper mill wastes). We assume that most of the power generated from pulp and paper mill waste is used internally by those mills. In other words, biomass for power in the US is almost insignificant.

Contrast that with other nations which are far more advanced in using sustainably sourced bioresources for heat and power. For example, in the UK where biomass (mostly wood pellet fuel) has been producing baseload power for several years. See Figure 3. The snapshot of the UK generation mix in mid-August 2025 shows that pellet fuel generation produced about 12.6% of England's electricity needs.

[6] To see the locations of the plants and data on each, use this map.

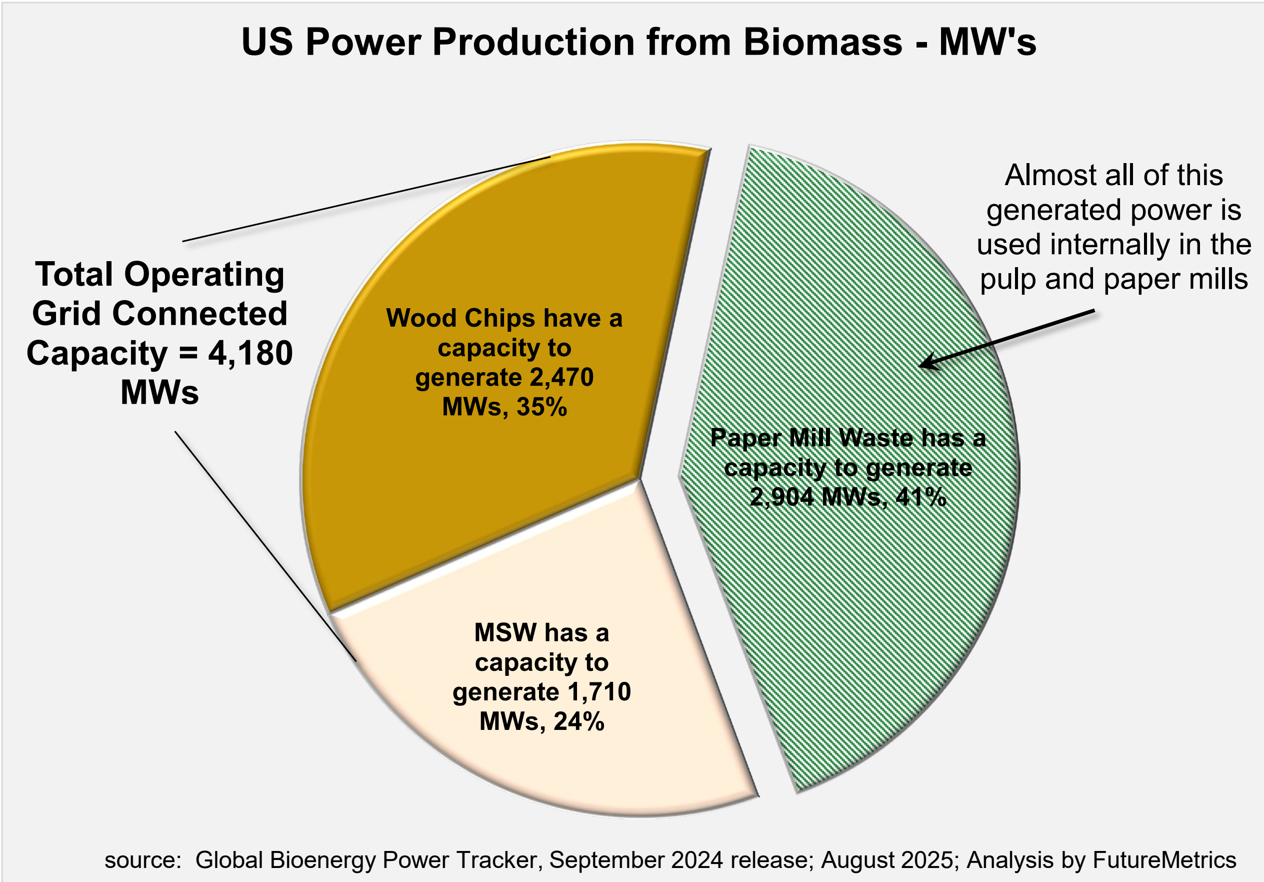

Figure 2 - Power from Biomass in the US

Furthermore, given the current relatively low wholesale power rates and a lack of policy support, there is significant uncertainty regarding the viability of the business models for both MSW and purpose-built wood chip power plants. Plants using low grade biomass for fuel need a power sale price of nearly $100/MWh to breakeven[7].

[7] Based on wood chips at 50% moisture content costing US$35 per US short ton, and levelized cost data from the US EIA HERE.

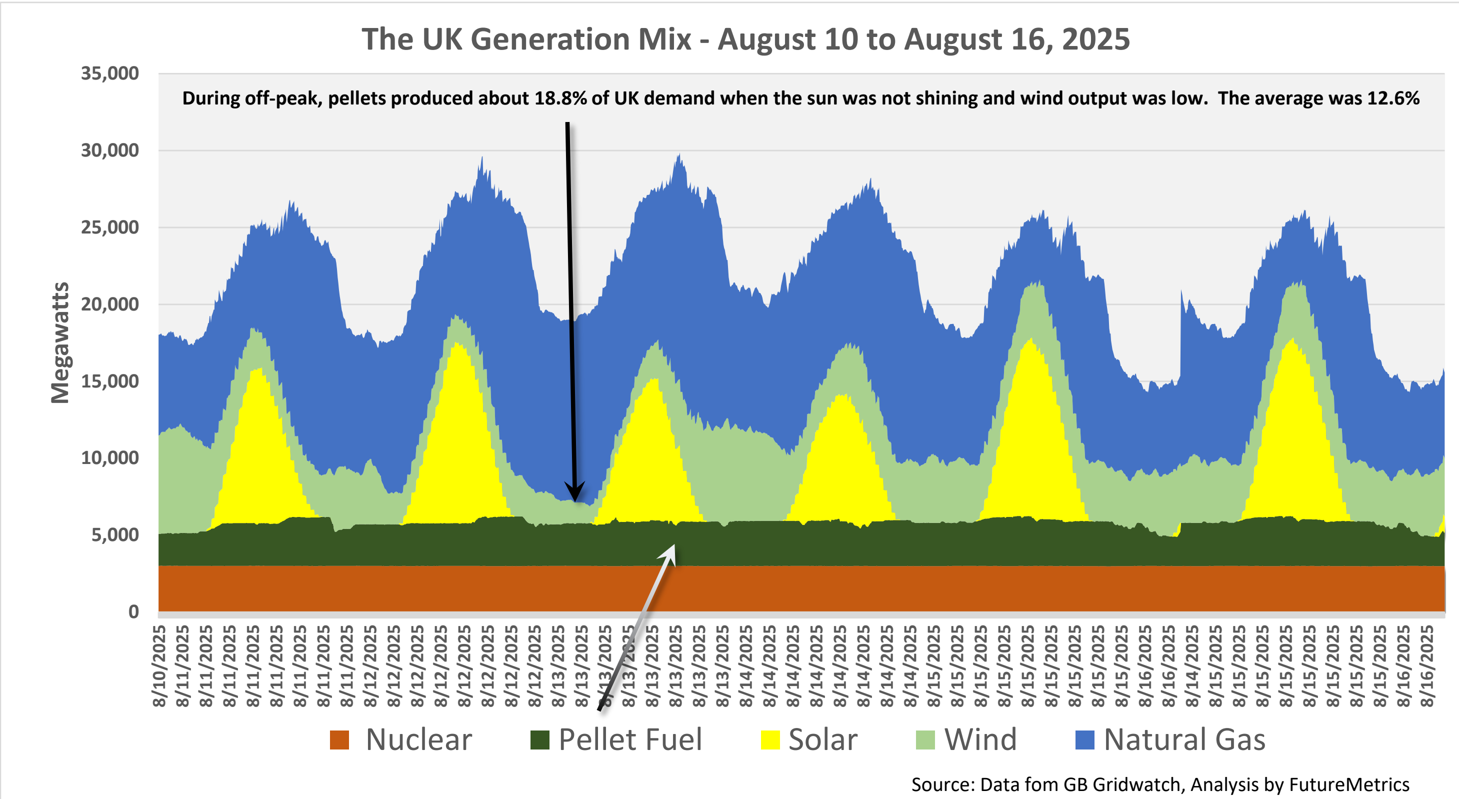

Figure 3 - UK Generation Mix Weel of June 6. 2025

Hydroelectric generation capacity in the US is significant at about 92 GW's[8]. However, it is highly unlikely that any significant new hydro capacity will be built in the US. As Figure 4 below shows, of the 320 operating hydro stations in the US, only 10 have been built in the past 30 years. The total capacity of those 10 new stations is only about 2,250 MW's. The US has already fully developed utility scale locations for hydro projects.

[8] To view the locations of the hydro plants and data on each, use this map.

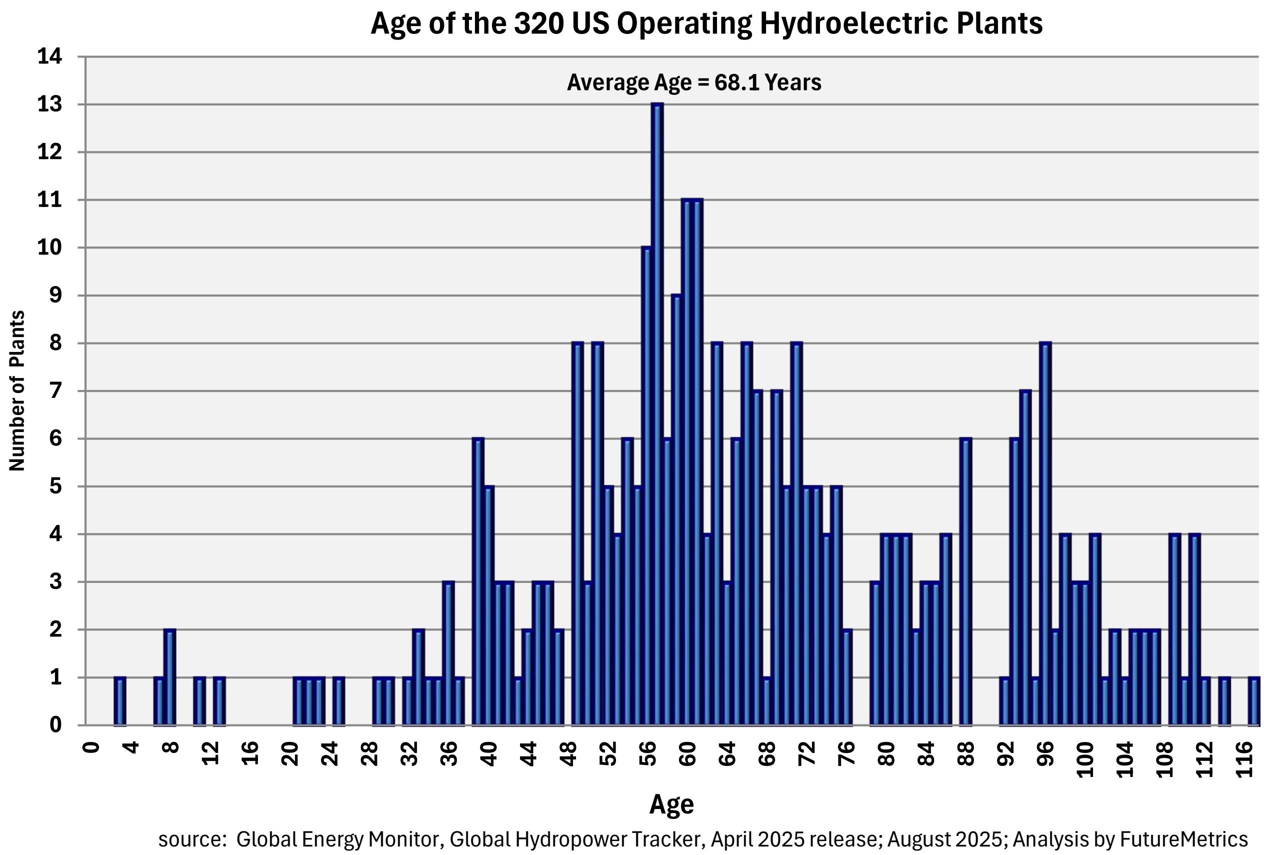

Figure 4 - US Hydroelectric Generating Capacity

The average age of operating hydroelectric plants is about 68 years. Many are much older. There are 29 hydro plants that are over 100 years old. Those centenarian plants still have the capacity to produce about 3,100 MW's.

Hydro will not fill the coming gap between demand and supply.

The advanced age of the generation assets is not limited to hydro. Coal and nuclear generation assets in the US are also quite old.

Figure 5 shows the age distribution of US coal fueled power units[9]. As noted in the chart, the average age of currently operating units is about 45 years.

[9] Coal stations often have more than one generating unit.

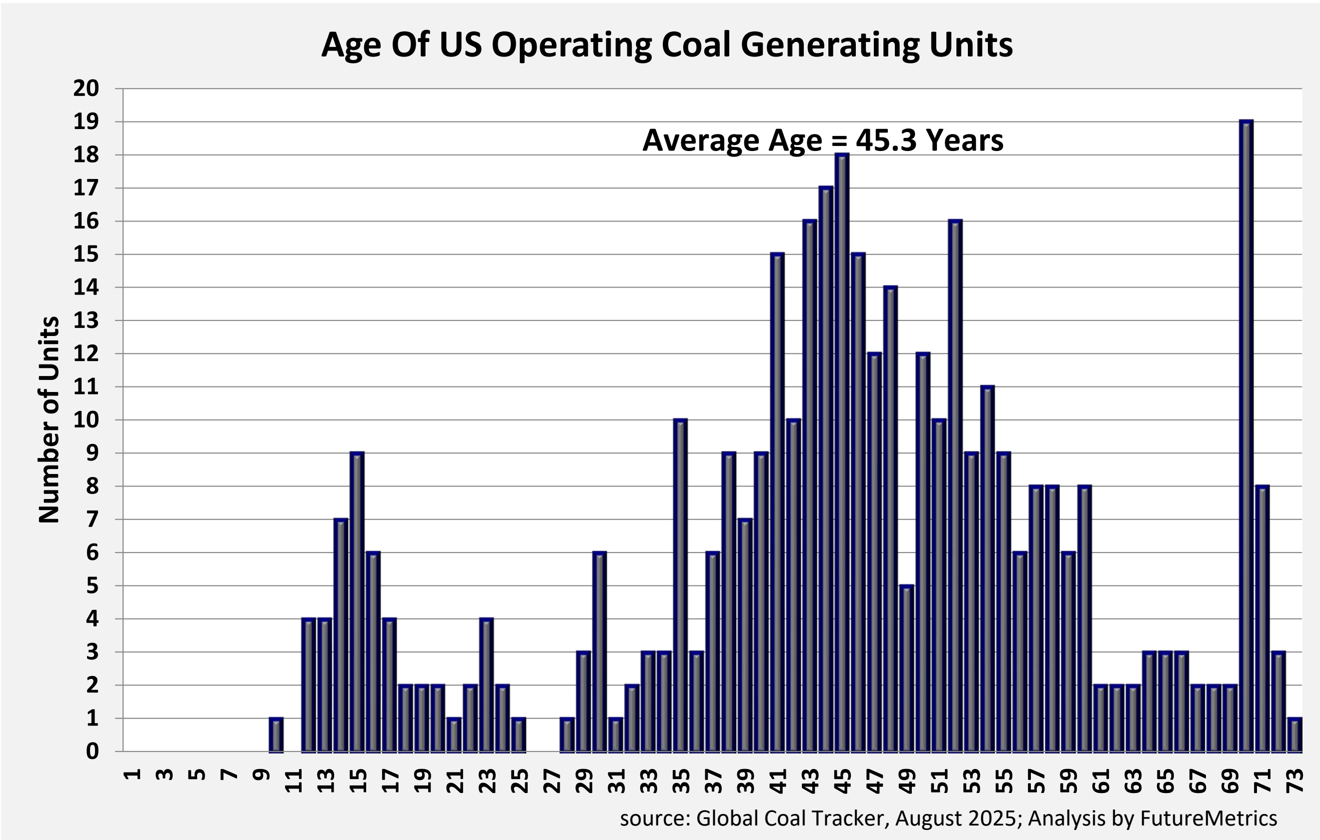

Figure 5 - Age of US Currently Operating Coal Generating Units

The large spikes at age 70 and 71 years are mostly from a number of Tennessee Valley Authority (TVA) projects that started producing electricity in 1954 and 1955[10]. Those plants continue to produce power.

However, as noted earlier in this white paper, hundreds of coal fueled generating stations are scheduled to retire in the next few years. The median retirement date for the 208 announced closures is just a few years away: 2028. See Figure 6 below.

[10] Rapid expansion of the power transmission and distribution systems in post-world war II caused the demand for electricity to outstrip TVA's capacity to produce power from hydroelectric dams. As a result, TVA began building coal-fired steam plants, and by 1955, coal surpassed hydropower as the system's primary power source. https://www.tva.com/about-tva/our-history/1950s

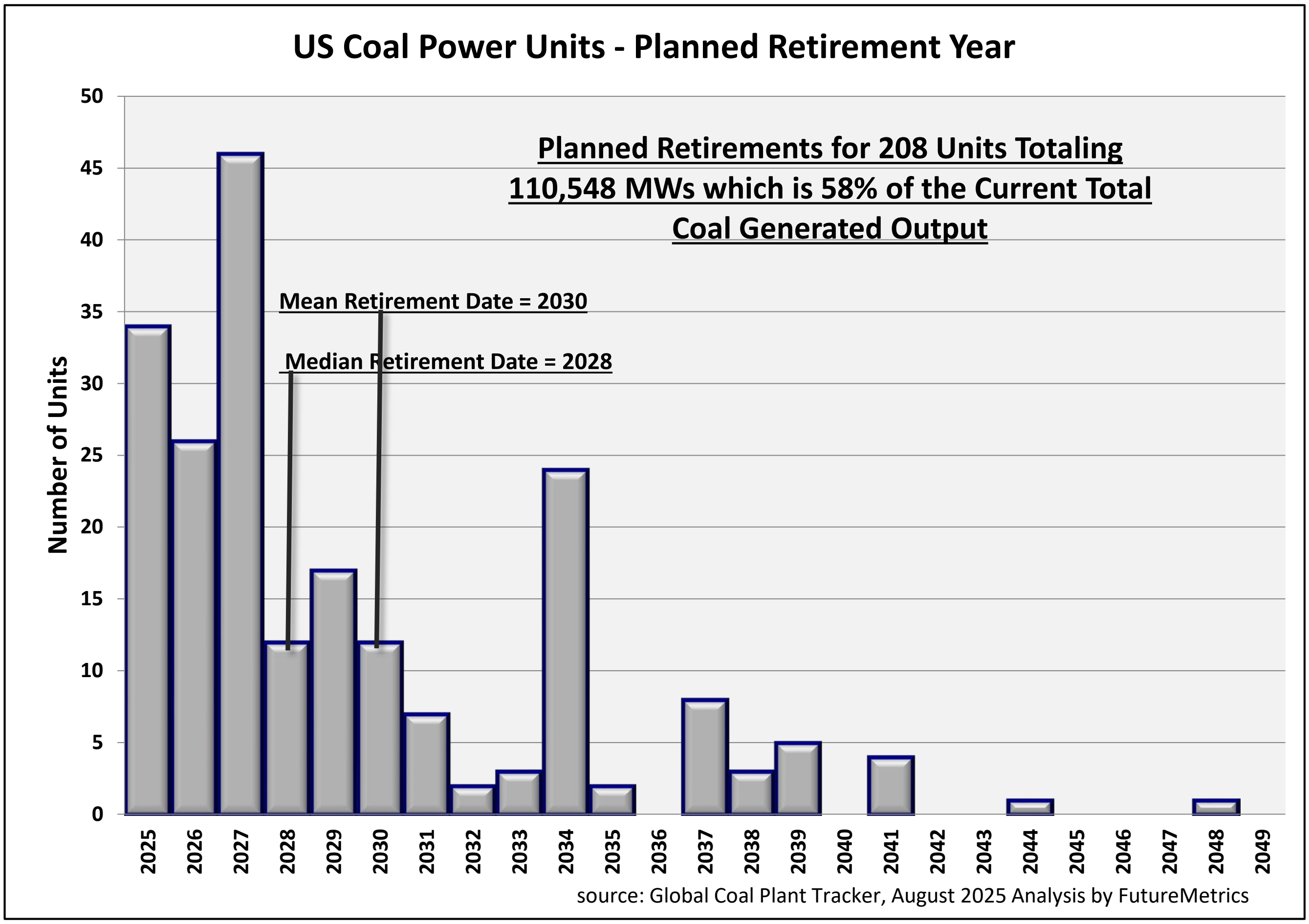

Figure 6 - Planned Announced Retirement Years for US Coal Power Generating Units

The capacity that will be lost from those coal fueled units that are retiring by the end of 2028 is about 54,000 MW's.

This loss is significantly contributes to the coming gap between demand and supply,

Nuclear power also faces aging challenges. The average age of a nuke plant is about 43 years (see Figure 7).

Currently there are about 30 announced new nuclear power projects[11]. Most are small modular reactors (SMR). 15 of those SMR's are 80 MW units proposed to be built using Xe-100[12] design.

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[11] From Global Nuclear Power Tracker, July 2024 release. The nuclear power database we are getting the data from is a year old. Current data may reflect evolving strategic ideas for the future of the US nuclear power sector.
[12] See HERE.

Current total pre-construction plus announced new nuclear capacity is about 7,350 MW's. This will not fill the supply and demand gap.

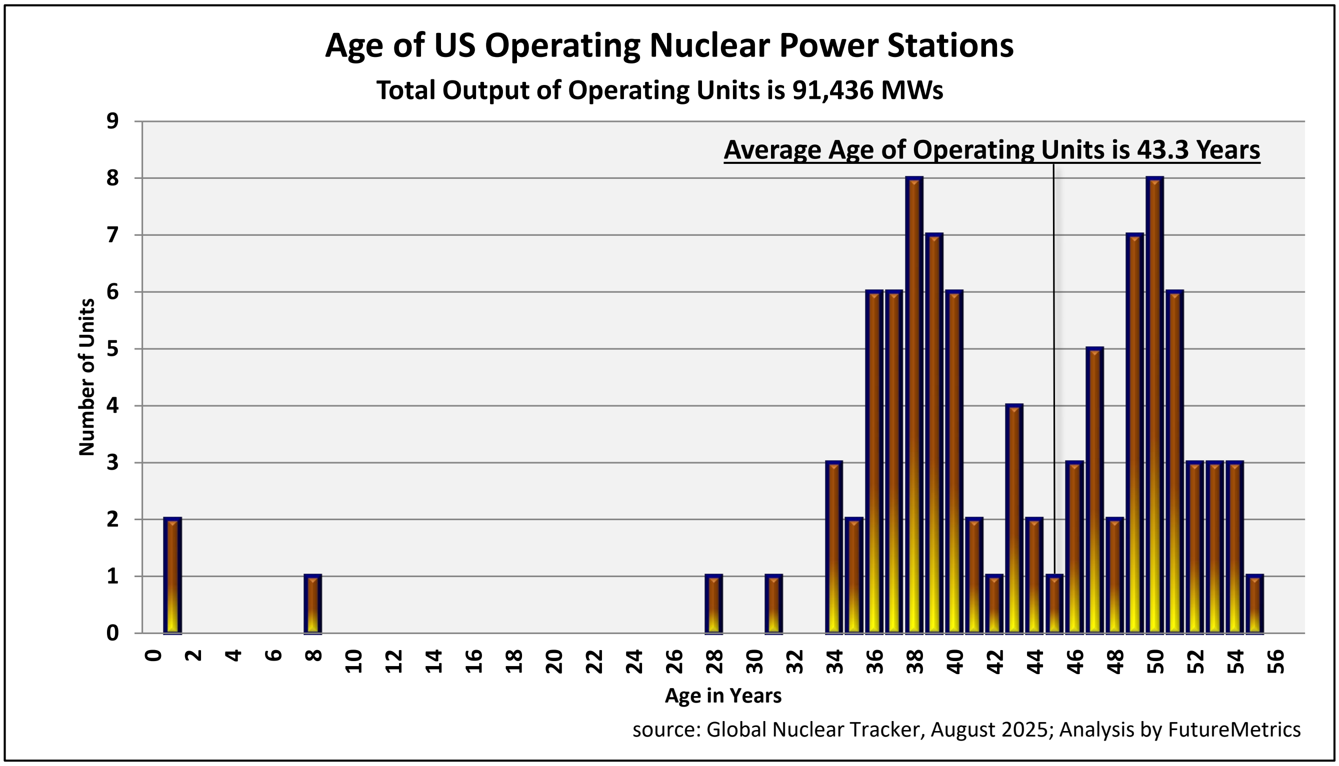

Figure 7 - Age of US Operating Nuclear Power Stations

Recent proclamations by the Trump administration advocate for a large and rapid increase in nuclear power in the US[13]. This is a rational and pragmatic policy for low carbon baseload power. Time will tell as to how quickly these ambitious goals are met. SMRs may have much shorter lead times and lower capital cost per installed MW. But that is not yet proven.

And finally, there is natural gas (NG).

As Figure 1 shows, natural gas generation currently dominates the US electricity power supply. It also dominates the announced new capacity. Table 4 below shows that there are 215 projects in the pipeline totaling about 92,500 MW's. One hundred and twenty three of the projects are simple cycle and 92 are combined cycle.

[13] See HERE.

Natural Gas Electricty Generation Projects

Capacity (MW's)	Number of Projects	Status
9,283	36	Under Construction - Average start date = July, 2025
59,144	127	In Pre-Construction Phase - Average start date = May, 2027
24,141	52	Announced - Average start date = January, 2029
92,568	**215**	**<==Totals**

source: Global Oil and Gas Plant Tracker, August 2025 release; Analysis by FutureMetrics

Table 4 - Announced New US Natural Gas Generation

Simple cycle plants can be brought online quickly and are typically used to provide power at peak demand loads when the more efficient baseload generation is insufficient to meet demand. Their capacity factors are on average about 15% (that is, they need to operate only about 15% of the hours in a year).

According to the US Energy Information Administration[14], the average capacity factor for combined cycle plants is between 50% and 70%. Based on these data, the 215 new NG power stations will add an effective 40 GW's of new supply by the end of the decade.

New US Natural Gas Fueled Electricity Suppy (in GW's)

	Capacity	Average Capacity Factor	Effective Supply
Simple Cycle	34.6	15%	5.2
Combined Cycle	58.0	60%	34.8
		TOTAL =>	**40.0**

source: Global Oil and Gas Plant Tracker, August 2025 release; EIA data on average capacity factors; Analysis by FutureMetrics

Table 5 - New Natural Gas Fueled Electricity Supply

Where Does this Leave the US in Terms of Supply and Demand for Electricity?

Using data from the Global Energy Monitor[15], we have added to the exiting capacity all of the announced new capacity that is expected to be built for each major source of generation. The electricity supply build up is shown in Figure 8 below.

[14] See HERE.
[15] Homepage is HERE.

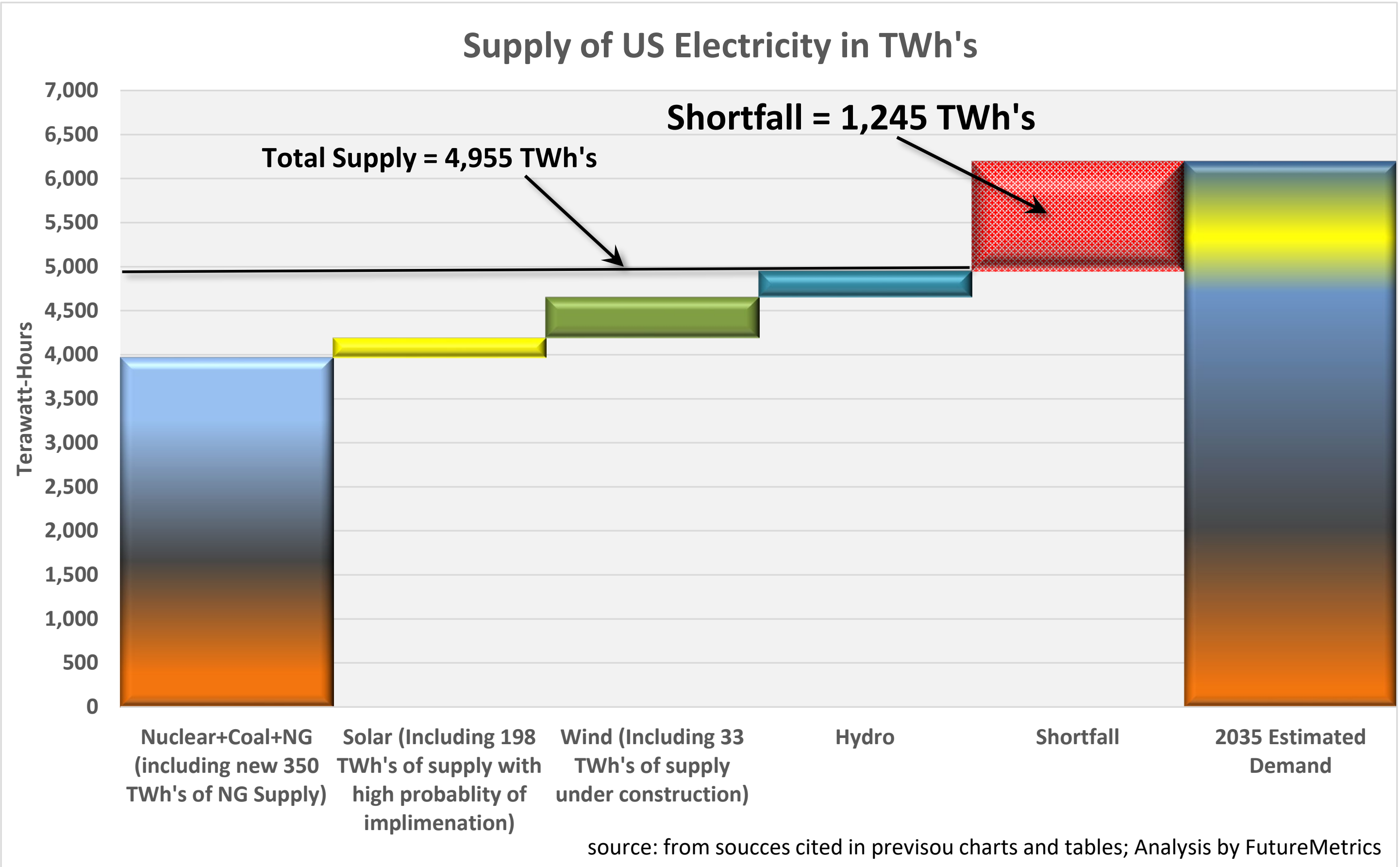

Figure 8 - Electricity Supply Build Up Versus Demand

Based on this analysis, the US still needs to install about 1,250 TWh’s of new supply.

Using the same average capacity factor that matches the current generation mix in the US (63%), that amount of power will require about 225 GW’s of new capacity that is not already announced or in the pipeline; all between now and 2035. However, given current policy inhibiting the growth of wind and solar generation, at least in the near-term if policy does not change, the average capacity factor may be higher due to a lower proportion of intermittent supply.

If we assume an 85% capacity factor, that works out to be about 167 GW’s of new capacity needed. For perspective, a typical nuclear generation station is about 1,000 MW’s (one gigawatt) so if there were no other sources of generation built, it would take 167 new large scale nuke power stations to be built and fully operational within the next 10 years. That will not happen.

There is no doubt that a lot of new projects that are not currently known will emerge to try to fill the gap. But the challenge is daunting.

Adding to this seemingly impossible challenge is the prospect for shortages. Some recent studies suggest that the mismatch between demand and supply will put significant upward pressure on power prices[16]. Scarcity in the power sector is usually a condition relegated to developing nations.

It is unlikely that we will see 167 new nuclear power stations built in the next 10 years. Perhaps if policy changes, more wind and solar generation will be deployed. But, given the low capacity factors of those variable and intermittent sources (assuming an average capacity factor of 30%) if the entire gap was filled with wind and solar, about 475 GW's would be needed along with the massive energy storage needed to buffer the intermittency into a more or less reliable baseload flow. That is not going to happen over the next 10 years.

It is likely that NG will be a major contributor to the build out. That also has challenges.

First, lead times from conception to operation for new NG combined cycle plants are around 8 years[17]. To hit the 2035 mark, a massive number of projects would have to be out of the gate in the next year or two. The flood would likely push lead times on turbine delivery out farther. The build out will not happen fast enough.

Second: What are the constraints on natural gas production and distribution in the US? We are not experts in this area but it would seem that the rapid increase in NG demand would require higher extraction rates and perhaps investment in new pipelines. The increase in demand and the costs associated with the increased needs for extraction infrastructure would likely put upward pressure on NG prices. This would not only make power generation more costly, but it would also impact the millions that heat their homes and businesses with NG. If gas prices go high enough, and there is no US policy on carbon emissions, coal may make a comeback!

And third, NG is a fossil fuel. CO_2 emissions from combustion are lower than coal emissions by about 50%, but they are still significant[18]. And fossil fuels are a depleting resource. Peak NG is inevitable (when we hit peak in the US is highly uncertain – EIA forecasts peak supply in 2032![19]). But is it strategically wise to depend heavily on an energy source that will become increasingly scarce?

Is There a Solution?

It would seem that the answer is "no" if data and AI center growth, combined with the electrification of transportation and the growth in heat pumps, actually happens as predicted. It would seem that to achieve an outcome that matches power demand with supply, either miracles happen on the supply side, or the demand for power from AI will be much less than currently forecast (a combination of the two could be needed!).

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[16] See HERE in which the authors suggest both households and industry will pay much higher prices for their electricity.
[17] See HERE.
[18] Average CO_2 emissions for coal are about 950 kg/MWh and for NG are about 410 to 500 kg/MWh for combined cycle and simple cycle respectively.
[19] See HERE.

We have an Idea that will Help

As frequent readers of FutureMetrics white papers know, we are proponents of a solution that is ready to deploy now, will provide 24x7 near gigawatt scale baseload power, and is not only carbon neutral[20], but can also be carbon negative with carbon capture and storage (CCS) added on[21].

The solution is to convert existing utility scale power stations that use coal to a compatible coal-replacement solid fuel produced from the by-products of the industries that produce lumber, paper, and many other common products made from wood. The upgraded and energy densified coal-replacement solid fuel has the low-tech name of "wood pellets".

Figure 3 shows how the UK has replaced coal with pellet fuel with great success for supplying baseload power. Interestingly, the UK imports the majority of its coal-replacement solid fuel from the US (see Figure 10 below).

The US exported just under 7,000,000 metric tonnes of pellet fuel to the UK in 2024. That is the equivalent of three 45,000 metric tonne Handymax size shiploads per week. Figure 9 shows just such a vessel that was built to carry wood pellet fuel for the UK utility Drax[22].

Figure 9 - Handymax Carrying Pellet Fuel

[20] Please see these FutureMetrics white papers that discuss, among other things, the carbon benefits of this strategy. HERE and HERE.
[21] For descriptions of bioenergy CCS (BECCS) projects in Europe and England see HERE and HERE.
[22] See more HERE.

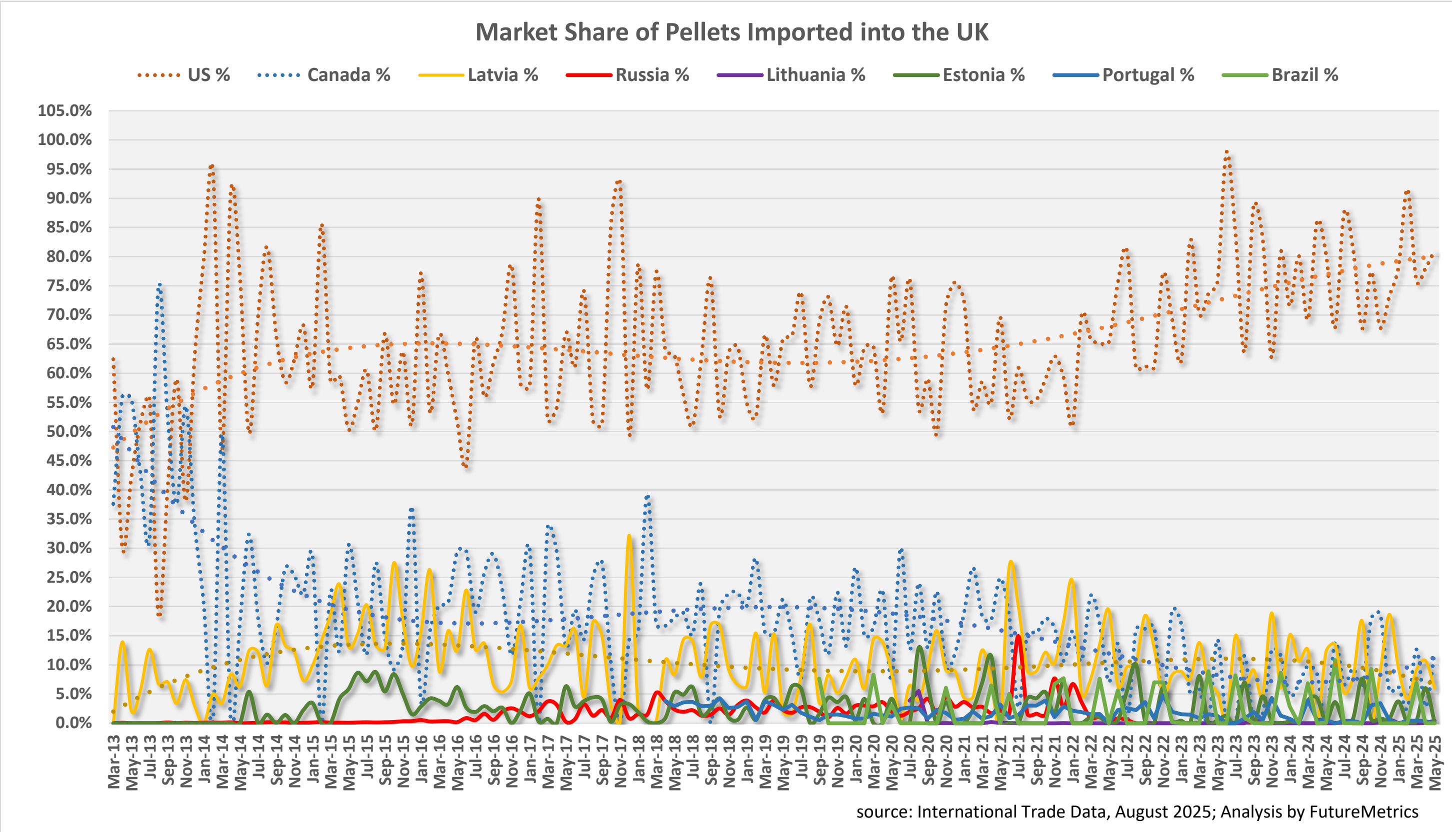

Figure 10 - Wood Pellet Imports into the UK - Market Shares of Exporters

The US is <u>the</u> major supplier to the world of upgraded solid fuel made from wood waste that is replacing coal for power generation. But none of that is used domestically. That should change.

US operators of power-hungry AI data centers that care about CO_2 emissions could take advantage of this proven strategy and benefit from reliable always-on power that is highly carbon emissions beneficial.

In a recent white paper, we discussed the basis for this strategy based on newer US coal fueled units[23]. We did not look at the older units. It is worth noting that there are 19 large units averaging about 620 MW's each that will be less than 40 years old when they reach their scheduled retirement years (see Figure 11). As the chart shows, those units could be expected to run for many more decades; if the economics from generation and sale of power support their operation.

[23] See HERE.

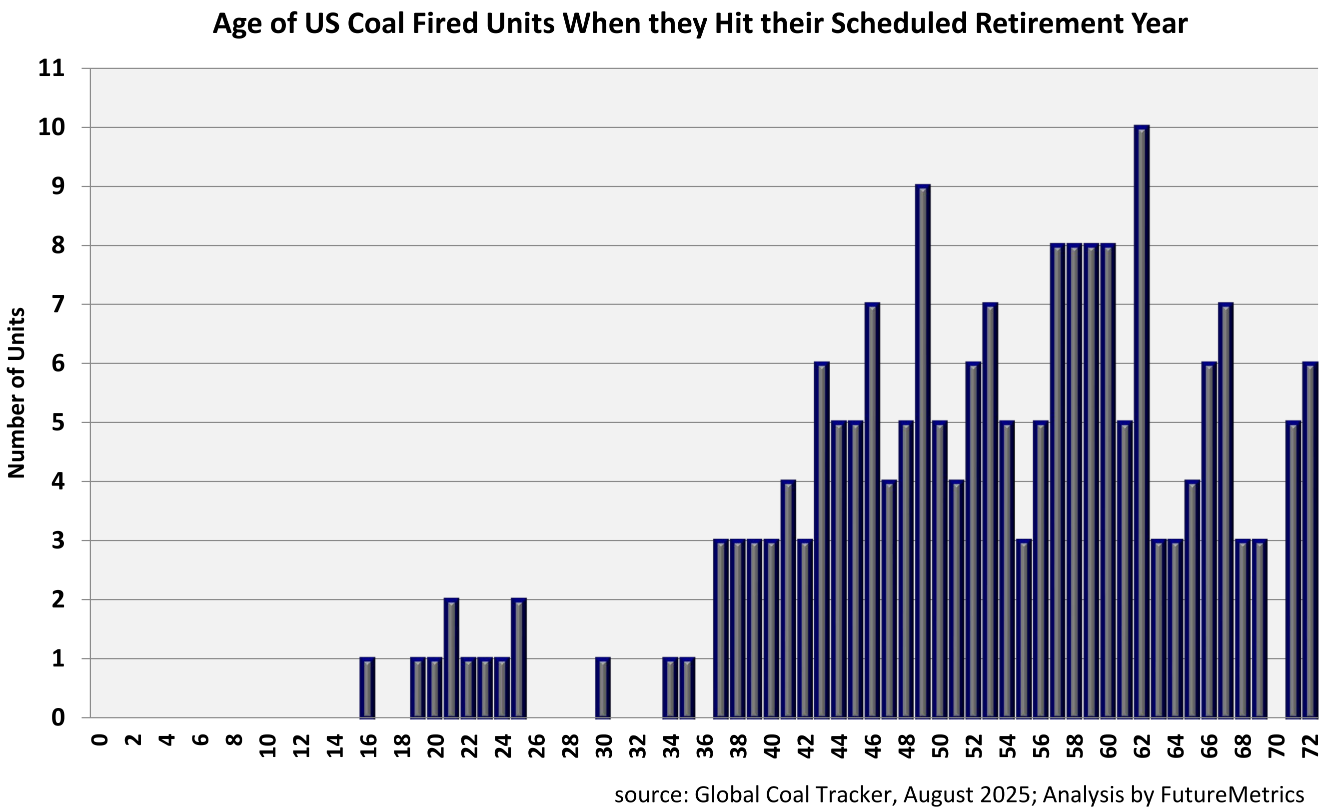

Figure 11 - Age of US Coal Fired Units when they Hit their Scheduled Retirement Year

The generation cost per MWh will be higher with pellet fuel in those converted units if coal prices remain low[24]. If there were no worries about the build out of US generations supply, and CO_2 footprint was not part of their "cost" analysis, AI data center power buyers may not follow this strategy.

But, as this white paper has shown, that is not the case. There should be worry about where the electricity will come from everyone, and many should consider the carbon footprint of their services.

If the AI center power buyer is internalizing the cost of CO_2 emissions, they should choose to pay a higher price for baseload low-carbon electricity. The decision could be supported by monetary benefits from credits for low carbon emissions generation (carbon markets), and by regulatory benefits that will help to avoid problems with their ability to do business in countries that do pay attention to the carbon impact of providing virtual services. They will also gain reputational benefits that will bolster the value of their brand in a world that is increasingly conscious of the negative impacts of using fossil fuels for energy.

[24] You can experiment with critical inputs to see what the increase or decrease on the cost to generate a MWh is with pellet and coal with the FutureMetrics dashboard.

The supply of sustainably sourced coal-replacement solid fuel from US producers to these converted coal stations supplying low carbon power to the AI centers will not be a problem.

Even in the short-run, fuel supply for US stations could be had in large quantity from US producers in early 2027. UK demand will be changing dramatically in early 2027[25] and millions of metric tonnes will become available.

Growth beyond current pellet fuel production in the US is not a problem. The ability of the US pellet fuel production market to grow is a long way from the boundaries of sustainability. US fuel pellet production for coal replacement overseas uses about 3.5% of the total annual harvest (about 26 million tonnes per year of feedstock into the pellet fuel manufacturing plants). Paper production is about 26% and lumber, furniture and flooring are 43% (213 and 250 million tonnes per year of input respectively into making sawn products and paper products)[26].

We are not experts on how large the overall forest products industry can become. But we do have a strong understanding of, and commitment to, forest sustainability. The fundamental sustainability criteria that annual removals never exceed annual growth is a basic metric that sets a hard and fast boundary beyond which we cannot go.

If the ratio of annual growth to annual removals across a region's forest lands that ae managed to supply the raw materials to the forest products industries is greater than one, that means the forest landscape is not being depleted. It is renewing at a rate that exceeds removals. In other words, more new tonnes of wood are in the forest each year than were there at the beginning of the year. That also means that the stock of carbon sequestered in that forest landscape is growing. If some of that harvest is combusted as upgraded solid fuel, the CO_2 produced is more than compensated for by the CO_2 removed by the same forest landscape[27].

Most states' forest service agencies gather growth-to-removal data. We asked ChatGPT to summarize that data. Table 6 shows some selected results.

[25] See the FutureMetrics white paper on this topic HERE.
[26] You can view the flows on the FutureMetrics dashboard HERE.
[27] For an analysis of forest growth dynamics, see this FutureMetrics white paper from 2021 HERE.

Selected US States' and Regions' Growth to Removal Status

Geographic Area	Growth to Removal Ratio	Comments
Minnesota	~3.67	Growth greatly exceeds removals
U.S. North region	~2.4	Robust growth
Pacific Coast region	~2.0	Healthy growth
National average	~1.9	Balanced but growth-leading
South region	~1.8	Growth still exceeds removals
South Dakota	~0.35	Unsustainable (removals > growth)
Colorado, Utah, Wyoming	Negative net growth	Mortality exceeding growth

source: ChatGPT query

Table 6 - Growth to Removal Ratios for Selected States and Regions

The data suggests that the sustainability boundary for many locations is far from being breached.

Conclusion

We have shown that, going forward in time, there is a critical mismatch between the supply of electricity and the demand for electricity in the US. The gap is expected to be significant. A plausible scenario envisions scarcity and increasing electricity costs.

The rapid growth of power-hungry AI processing centers is a major contributor to the recent and rapid acceleration in demand for electric power.

As this paper has shown, the build out of the new generation supply needed is unlikely to keep up with growth in demand.

While this white paper does not offer an overarching solution, it does offer a way to take a bit of the pressure off.

The owners and operators of AI processing centers should integrate into the existing infrastructure that is already built and already connected by offering to buy baseload electricity over a reasonable term (perhaps 10 years) at a rate that supports the conversion of selected coal stations from coal to upgraded energy-dense sustainably sourced low-carbon solid fuel made in the US.

This will not only take some pressure off the need for future capacity, but it will also give a longer life to the large fixed assets that otherwise will become the fossils of the fossil fuel power generation sector.