Data Center Trends and the Potential power plant possibilities

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CRA Charles River Associates

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About CRA

Charles River Associates is a leading global consulting firm that offers economic, financial, and strategic expertise to major law firms, corporations, accounting firms, and governments around the world.

The firm has over 800 professional staff in offices throughout the world. We believe in using a combination of industry experience and rigorous, fact-based analysis in order to provide clients with clear, implementable solutions to complex business problems.

In the past two years, CRA has worked with:

of the **Fortune 100**

of the **AmLaw 100**

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Agenda

1. **Data Center Growth Trends**
2. Potential power plant possibilities
3. EPA regulations and their potential implications

In 2018 Bitcoin mining was projected to be a new source of demand in the small nation of Iceland

Commentary

- Iceland has a population of around 340,000 people.
- It has seen an increase data centers built by firms wishing to cut costs and improve their green credentials.
  - In 2018 this was mostly Bitcoin miners looking to turn a profit, using massive computers to solve technical questions and be rewarded with Bitcoin.
- Nearly 100% of energy in Iceland comes from renewable sources, namely hydro and geothermal energy.
- Bitcoin mining operations used around 852GWh (97MW avg.) of electricity to supply data center computers and cooling systems in 2019.
  - Residential demand in 2018 was 700GWh (80MW avg.).
- Iceland consumes 20,000GWh (2,283MW avg.) of energy per year, mostly from the industrial sector, but this nevertheless represented a new source of demand with large potential upside.

BBC

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Bitcoin energy use in Iceland set to overtake homes, says local firm

12 February 2018

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Chris Baraniuk
Technology reporter

Nearly 100% of energy in Iceland comes from renewable sources

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Key Messages

Data center load growth is expected to be substantial and sustained across many parts of the country as the AI revolution accelerates demand for computational power, data storage, and processing capabilities.

Recent trends indicate that much of the Midwest, Southeast, and Mid-Atlantic could experience significant data center growth due to its proximity to load, fiber, and potential power sources.

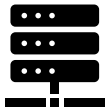
While data center load growth can be beneficial for utilities capable of building infrastructure to supply and transmit power, it can also introduce risks, including destabilizing the wholesale market and creating cross-subsidization challenges.

New natural gas combined cycles would be the obvious choice of resource to meet data center demand in the near term.

A data center strategy should outline the utility's approach to managing, supporting, accommodating, or mitigating the impacts of data center growth within its service territory.

In 2014 when I started in the energy industry demand modifying resources only decreased demand; now load growth is increasing substantially

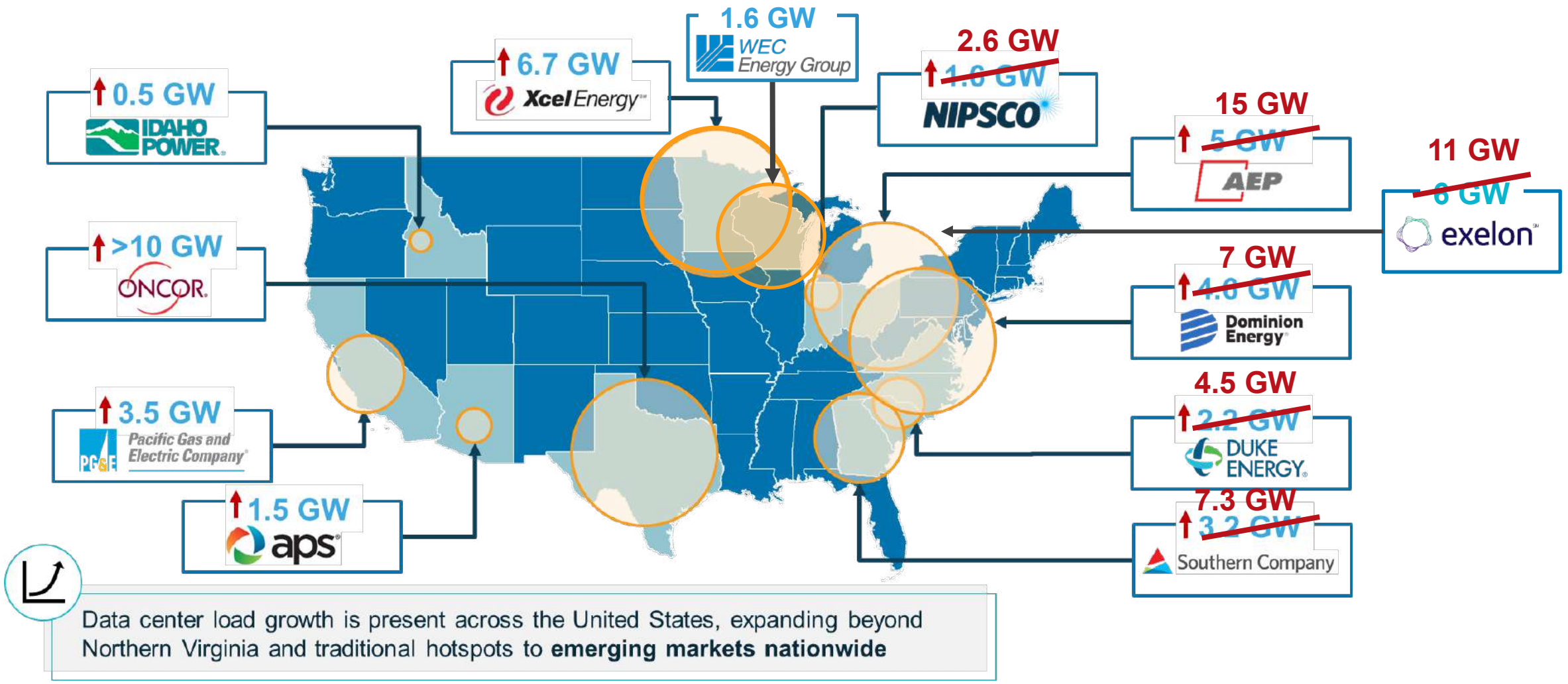
Demand modifying resources

Demand modifying resource	Impact on demand
 *Energy Efficiency*	
 *Demand Response*	
 *Rooftop Solar PV*	
 *Electric Vehicles*	
 *Home Electrification*	
 *Data Centers*	

Commentary

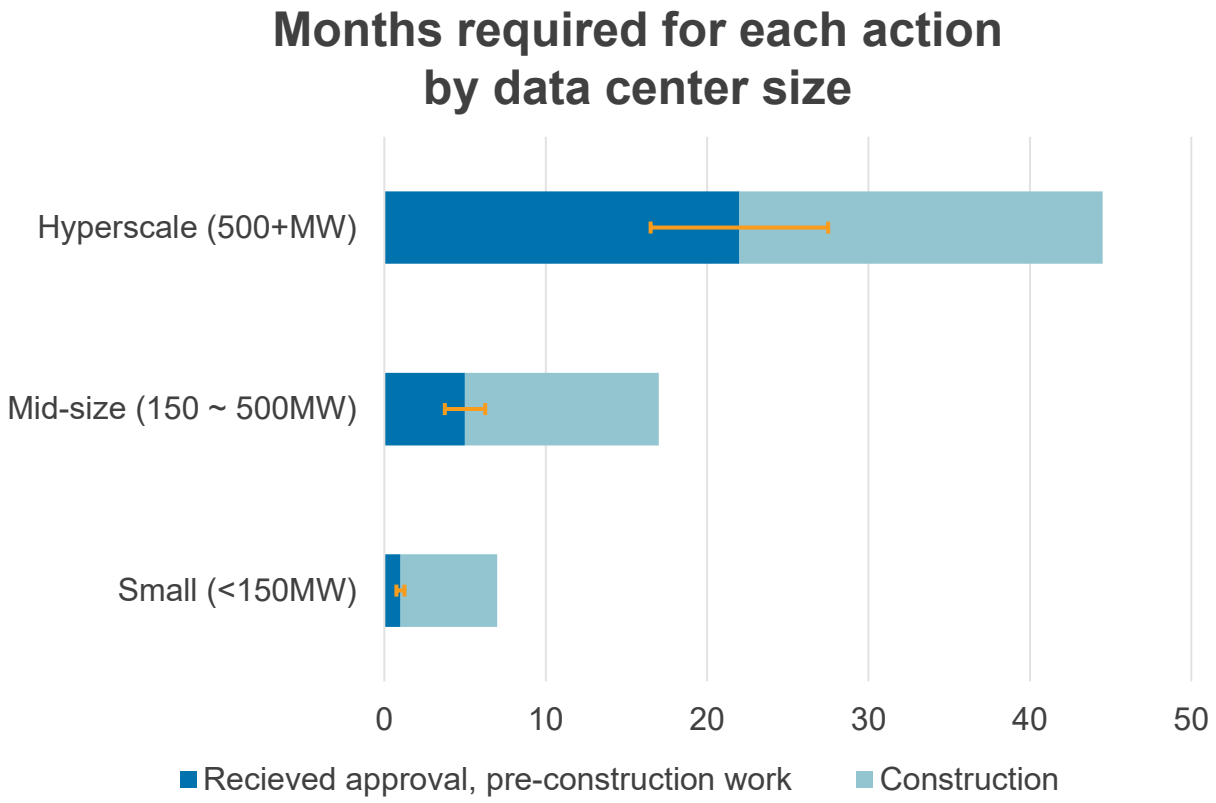
- The earliest forms of demand modifying resources helped to reduce overall electric demand.
- Energy Efficiency: Programs to reduce overall energy consumption
- Demand Response: Programs to have users reduce energy demand during hours of peak high load.
- Rooftop Solar PV: Solar PV to reduce household consumption.
- Electric vehicles: Cars using electricity to run rather than petrol.
- Home electrification: Houses moving from gas heating to electric heating.
- Data Centers: Commercial demand pushing up load growth.

Utilities across the U.S. are revising their 5-year load forecasts upwards in preparation for data center growth to materialize, as is Ontario in Canada



 Source: Utility IRPs, Press Releases

Lead time for data center construction depends heavily on the size of a data center



Timelines vary greatly between different data center sizes

- The larger the data center, the larger the time it takes to complete pre-construction procurement, studies and due diligence
- Larger data centers also face increased uncertainty in their planning horizons due to their outsized impact on local systems
- Developers' speed-to-market requirements also impact preconstruction timelines
- Construction time increases with larger data centers, but does not vary as significantly as pre-construction within data center sizes

Source: Data Center Dynamics, APLD 10-K, MSFT Community Engagement Page, STACK infra

Data center developers prioritize power, market size / demand, and land availability

Power availability is most times the **limiting factor** in getting to market

Data centers need to be located or efficiently connected to demand centers

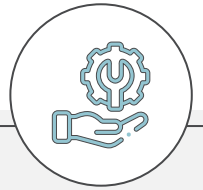
Hyperscale campuses can expand to hundreds of acres limiting some dense markets

- Power prices
- Land prices
- Taxes
- Fiber Optic Network

Power Availability

Market Size and Demand

Land Availability



Other Considerations

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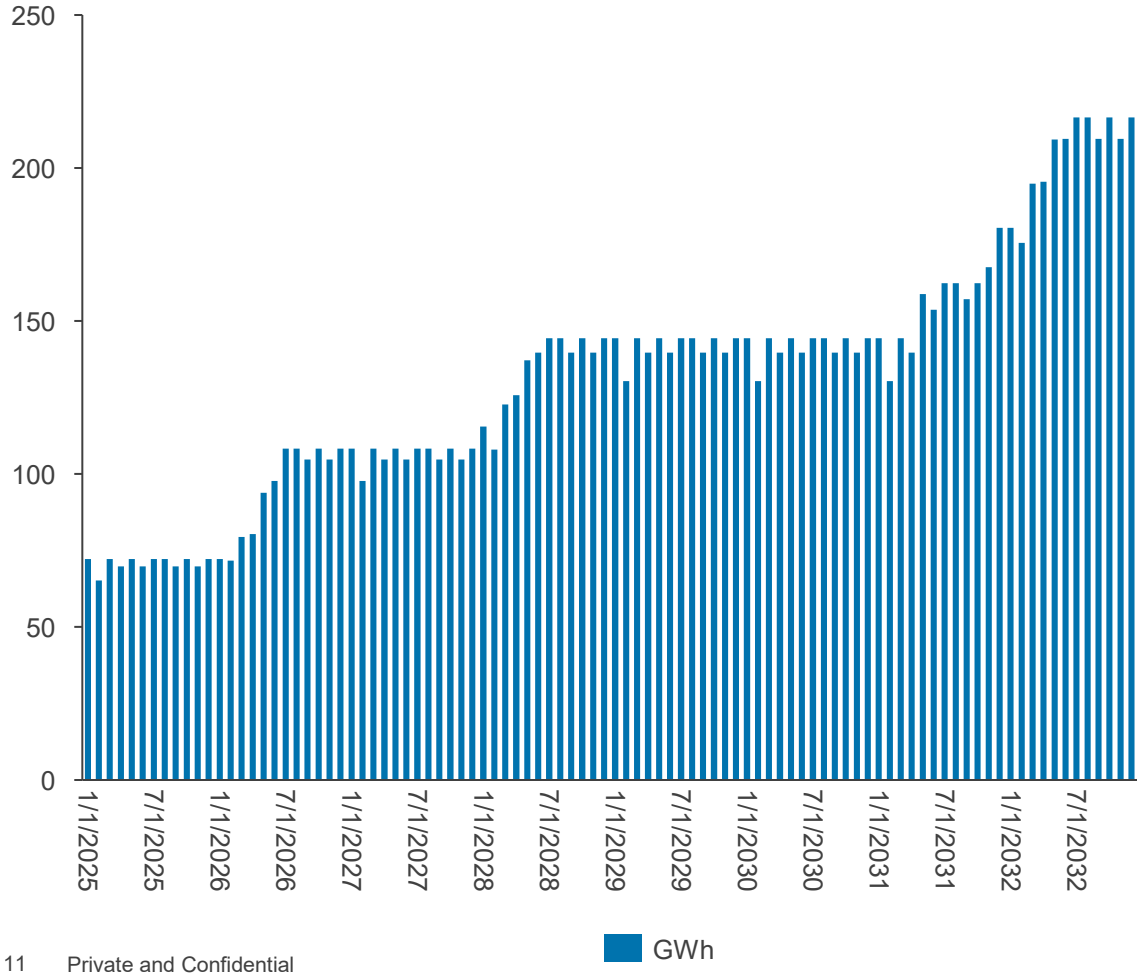
Data centers represents a new kind of demand more akin to industrial demand than other resources

PJM Hypothetical Single Data Center Site - two buildings

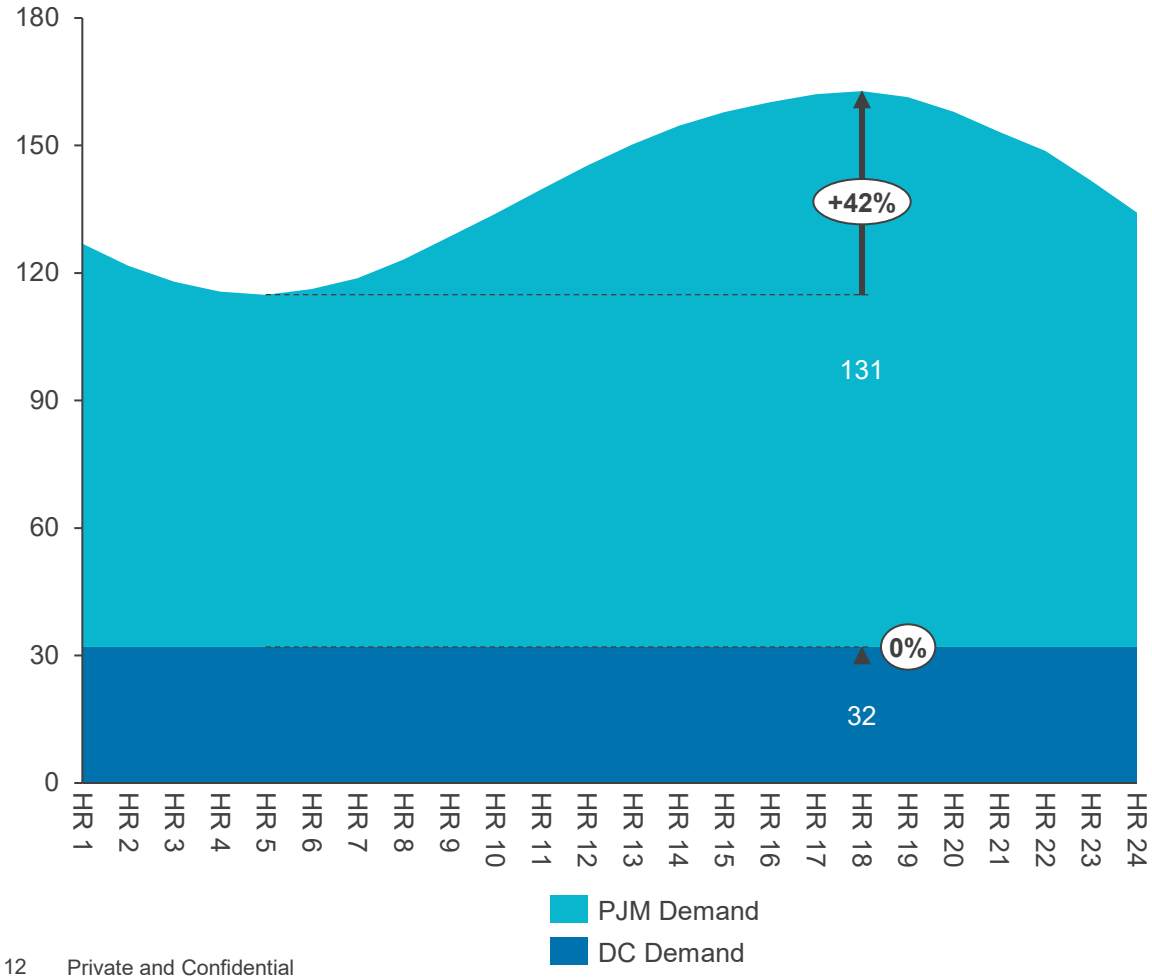


Commentary

- Typically, residential and commercial demand sees seasonal variations.
  - Demand is highest in summer when air conditioning is in use,
  - Demand is also high in winter in places where electrical heating is common, and
  - Demand is weakest in spring and autumn when the weather is nice outside and people just open their windows.
- Industrial and new data center sectors see steady year-round demand as provided in the example provided by PJM.
  - There is typically a spike in summer demand due to the need for increased cooling.

It isn't just seasonal demand which will be affected; hourly profiles will also be impacted substantially

PJM Avg. July Hourly Demand Profile and planned DC Demand



Commentary

- In July, 2024, PJM demand averaged 107GW per hour.
  - This ranged from 152GW at peak and 70GW at its lowest.
- Data centers do not have such swings in demand.
- 33GW of data centers are planned PJM in the coming years and would dispatch around 95% of their capacity hourly.
  - This would add 22% to PJM's peak demand in 2024 if online today.
- To address this concern will require:
  1. Firm resources which can supply electricity hourly year-round.
  2. Careful planning by utilities to manage their entry.
     - Could datacenters get separate rates like industrial customers?
     - Can datacenters be part of demand response programs?

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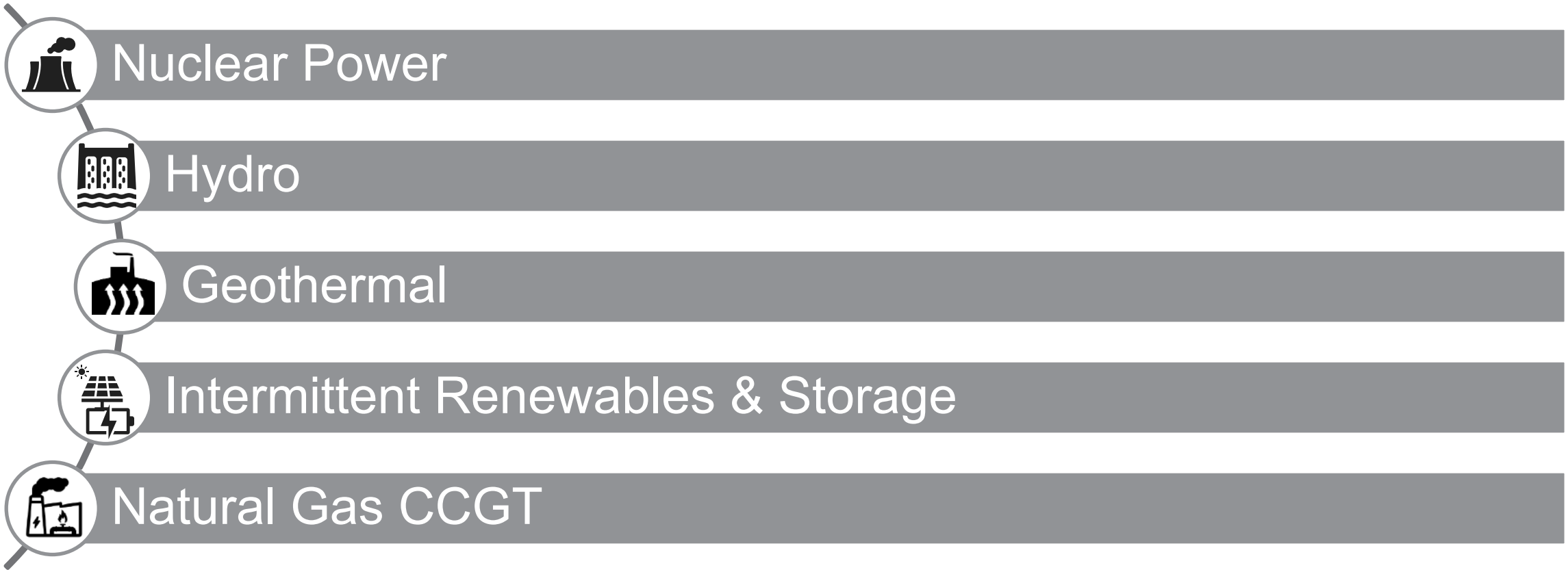
What are the options for meeting data center demand?



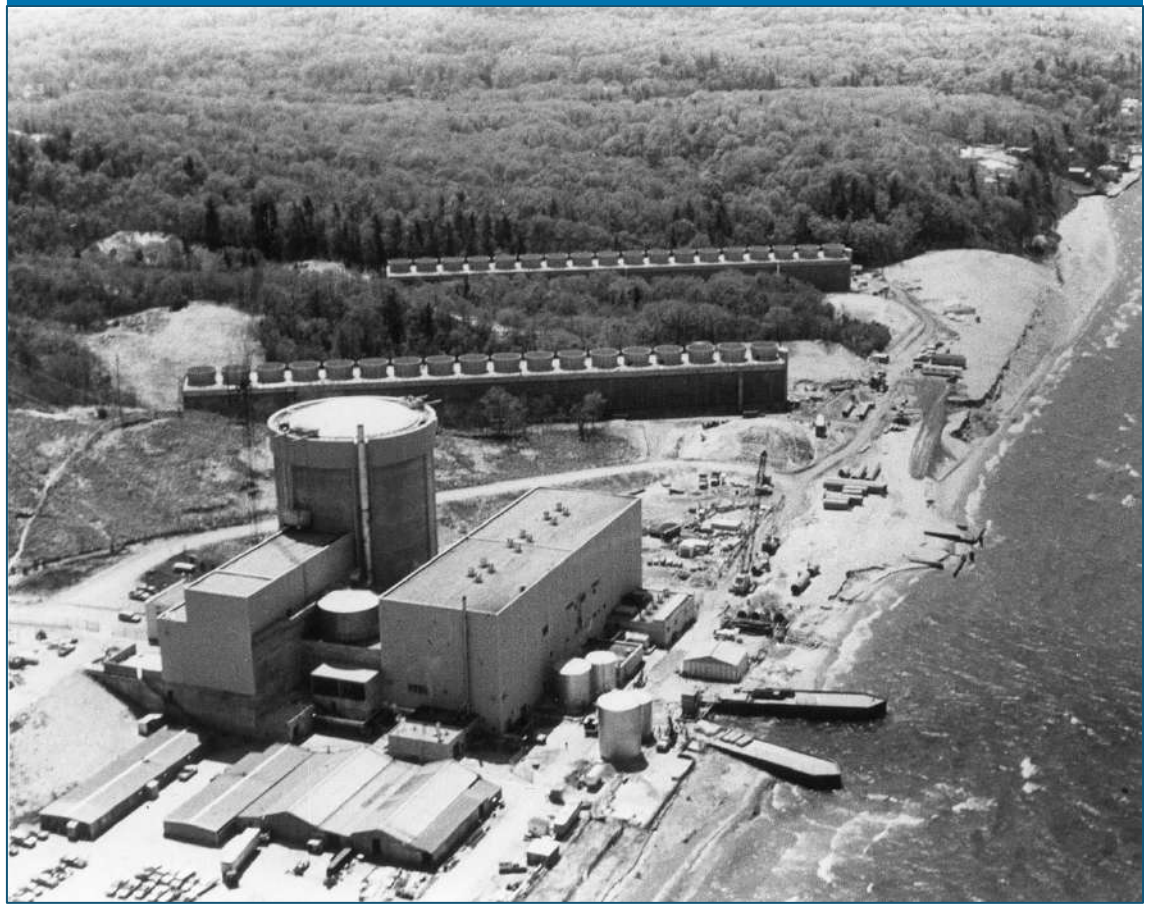
HOLTEC INTERNATIONAL

Nuclear power has stumbled in recent years with cost overruns and delayed projects, but could now see a renaissance

Pros and Cons

- Pros:
  - Baseload resource with high reliability.
  - Shutdown power plants are being brought back online (Palisades).
  - New Small Modular Reactors (SMR) offer new potential technology.
  - Environmentalists have begun to recommend keeping nuclear power online to reduce GHG emissions.
- Cons:
  - SMR remains experimental with no projects beyond the planning phase.
  - Last nuclear power plant built (Vogtle) was late to build and very over budget.
  - Heavy opposition to new nuclear power from local communities.

Palisades Nuclear Generating Station



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Hydroelectric and Geothermal energy are proven reliable renewable resources which can meet data center demand

Hydro & Geothermal Pros & Cons

- Pros:
  - Baseload resource with high reliability (geothermal more so than hydro).
  - Hydro Quebec has large amounts of hydroelectric power which can be sold to the United States if sufficient transmission capability is built.
  - Carbon free resource.
- Cons:
  - No new hydro being planned due to limited geographical availability and environmental damage caused.
  - Geothermal limited to Western US and already mostly developed.
  - Attempts to build transmission to Quebec has met resistance at the local level.

Hydro Pros & Cons

Intermittent renewables are the most desirable resources from tech companies' optics, but have very limited viability

Pros & Cons

- Pros
  - Cheapest renewable options on a MW basis.
  - Fewer headwinds from local organizations and environmentalists.
  - Necessary for many tech companies' renewable goals.
- Cons
  - Intermittent generation cannot provide reliability without oversized capacity buildout.
  - Does not substantially contribute to regional reliability requirements (especially in winter).

- Solar PV produces no energy 14 hours a day in January, so that requires two sets of 8-hour battery storage to be fully charged each day to overcome the shortfall at night.
- Long term Winter peak accreditation for battery storage in MISO is only 56% vs 77% for CCGT. Solar winter peak accreditation is 0%.

Tech company goals vs reality

Company	Scope 1, 2 and 3 emission reduction targets*	2023 CO2 Emissions vs 2022 CO2 Emissions
	*Reduce combined absolute greenhouse gas emissions by 50% over next six years.*	14.3 million metric tons +13% 
	*Be carbon negative by 2030 (With the Internal carbon fee funds, it has purchased over 30TWh of green power).*	15.4 million metric tons +19.4% 
	2030: Reduce emissions by 75% across its operations vs. 2015. 2050: Cut emissions by 90% compared with 2015.	16.1 million metric tons -20% 

* Scope 1 and 2 are direct operational emissions; scope 3 emissions come from indirect business activities and are the main source of emissions for the companies

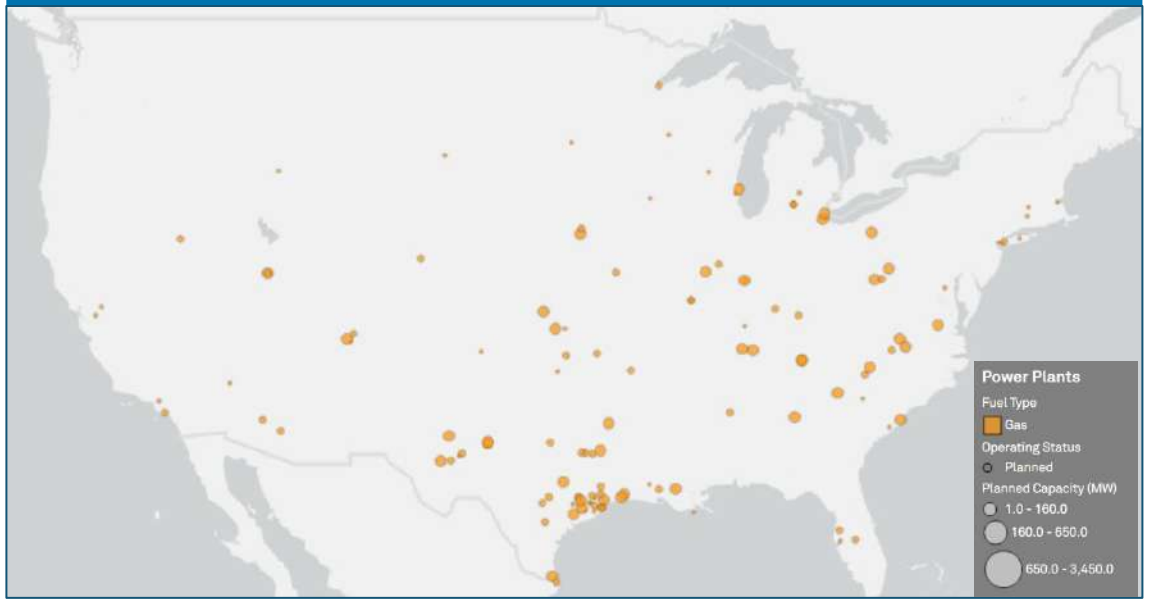
Natural Gas Combined Cycles are well placed in the near term to meet demand created by data centers

Pros & Cons

- Pros
  - Cheapest baseload power plant technology.
  - Lowest carbon emitting thermal resource.
  - Natural gas fuel prices remain low around $2/MMBtu for most of 2024.
  - Planning rules for CCGTs in US are expected to be easier in coming years.
- Cons
  - Strong resistance from environmentalists and local activists.
  - Many states have decarbonization goals for 2050 which affect the value of CCGTs.

- If a power plant has a debt life of 30 years but can only feasibly operate for 20-25 years then its value has to take a haircut.

Proposed New Natural Gas Plants (MW)*



* Source: S&P Global

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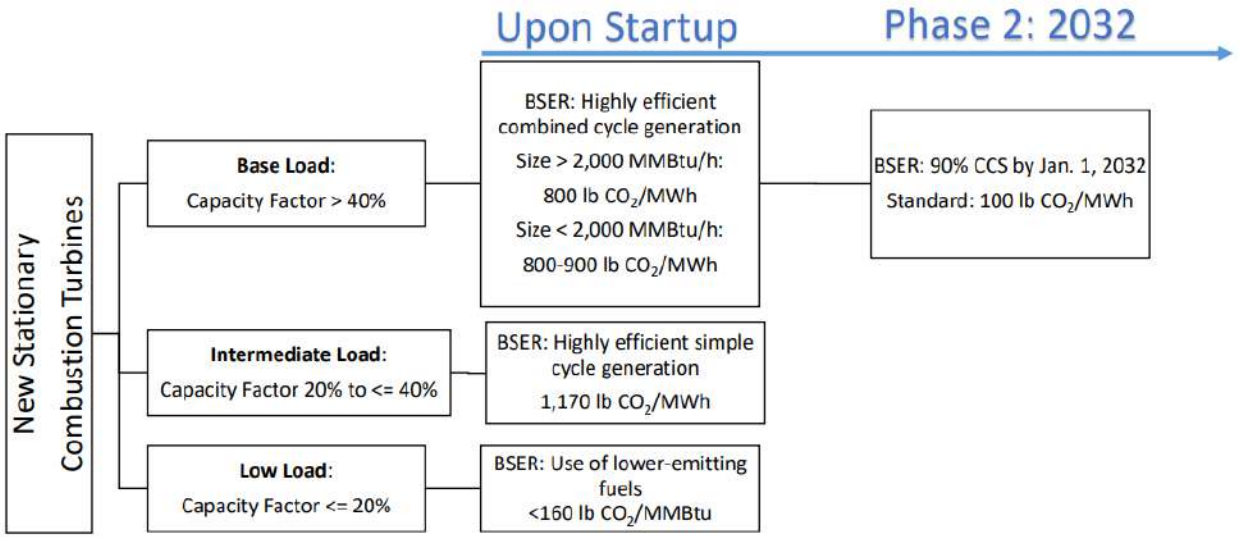
EPA had look set to place constraints on the dispatch of standard CCGTs

Commentary

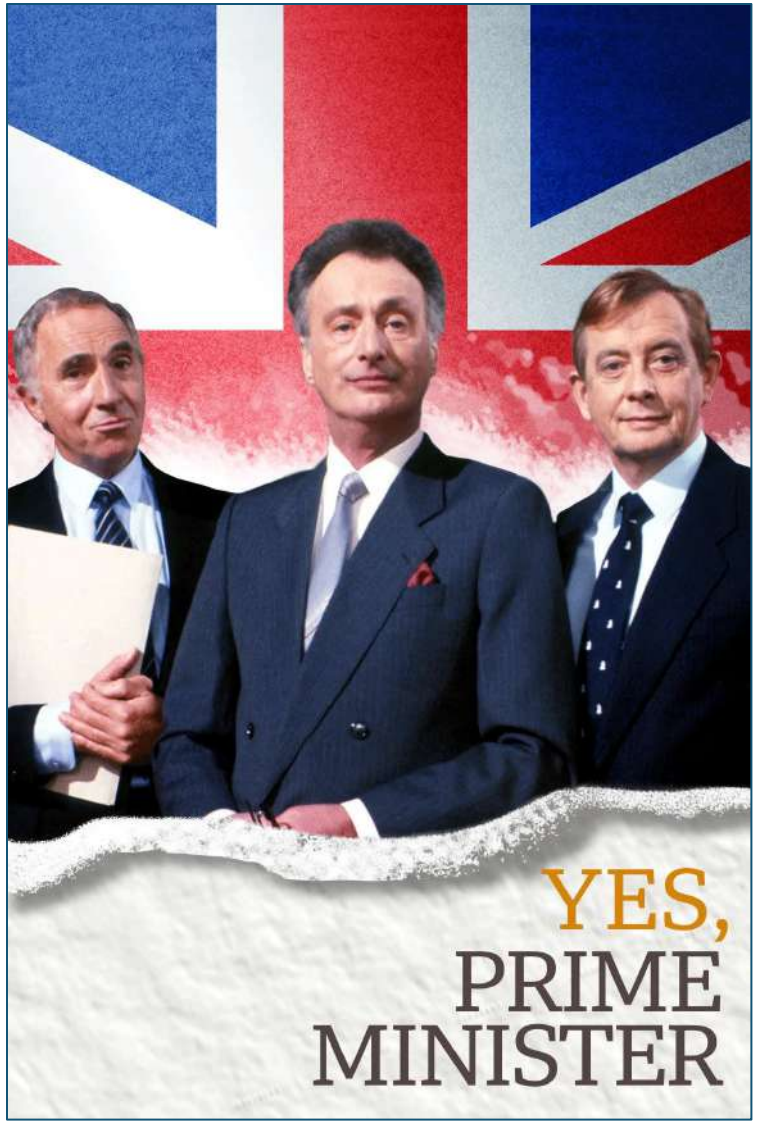
- The EPA is set to regulate the maximum dispatch of new gas plants beginning in 2032.
- Such constraints could:
  1. Result in more gas plants being built to meet the same amount of demand.
  2. See fewer gas plants built given the limitations on their revenue.
- CCGT with CCS still remains more expensive than CCGT limited to 40% CF

Final Standards for New Stationary Combustion Turbines

- Standards effective from date of proposal publication (May 23, 2023)
- Three subcategories: base load, intermediate load, low load
- Standards are technology neutral, affected sources may comply with it by co-firing hydrogen



Instead of an analysis of what a 40% Capacity Factor limit would have on the US, I instead want to leave you with a quote from Yes Minister that seems apt:



The feeling of your average EPA employee probably has right about now

- **Bernard Woolley:** It makes me feel rather downcast. If it's our job to implement Government Policies, shouldn't we believe in them?
- **Sir Humphrey Appleby:** What an extraordinary thing to say.
- Bernard Woolley: Why?
- **Sir Humphrey Appleby:** Bernard, I have served 11 Governments in the last 30 years, if I believed in all their policies, I would have been passionately commited to keeping out of the Common Market and passionately committed to going into it, I would've been utterly convinced of the rightness of Nationalising Steel, and of denationalising it, and renationalising it. On Capital Punishment I would have been a fervent retentionist and an ardent Abolitionist, I would have been a Keynesian and a Friedmanite, a Grammar School Destroyer and Preserver, a Nationalisation Freak and a Privatisation Maniac, but above all, I would have been a stark, staring, raving Schizophrenic.

Thank you for listening.

Closing questions or comments?

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Thank you for listening

Please contact us for more information

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