TANGIBL

DATA CENTER CHALLENGES AND OPPORTUNITIES

ENERGY ASSOCIATION OF PENNSYLVANIA
MARS, PENNSYLVANIA | APRIL 8, 2025



AGENDA

OVERVIEW | TYPES OF DATA CENTERS

WHY THIS IS IMPORTANT

THE “CO-LOCATION” ISSUE

TECHNICAL IMPLICATIONS

RATE AND INTERCONNECTION IMPLICATIONS

QUESTIONS TO ASK YOUR CUSTOMER

DISCUSSION

CONTACT INFORMATION

TANGIBL

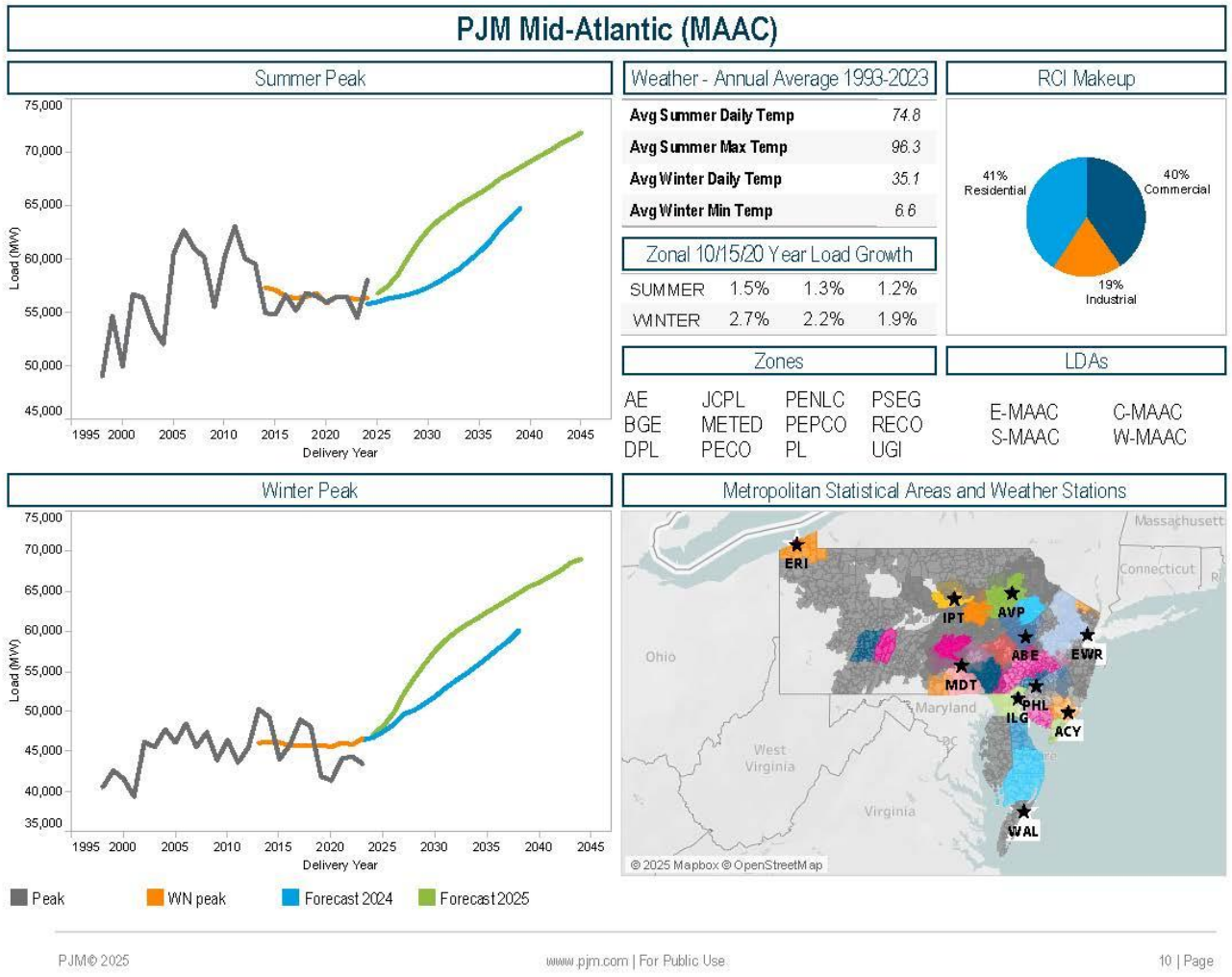
OVERVIEW

TYPES OF DATA CENTERS

- Hyperscaler | a data center, or an array of data centers, with the ability to scale processing power rapidly with demand
  - Cloud Servers (MS Azure, AWS, Rackspace, etc.)
  - Artificial Intelligence (AI) - predictive and generative AI
  - Social media, Internet of Things (IoT)
  - Loads vary and high uptime / redundancy is required
  - Owners / operators typically have strong credit ratings
- Crypto Mining | Bitcoin
  - “Mining” is the process by which a) transactions are officially entered on an open ledger known as a “blockchain,” and b) bitcoins are launched into circulation.
  - “Miners” use hardware and software to generate a cryptographic number that is equal to or less than a number set by the Bitcoin network's difficulty algorithm.
  - Loads are stable and can be interrupted with notice
  - Owners / operators typically do not have credit ratings



WHY THIS IS IMPORTANT



PJM

Significant increase in rate of load increase through 2030.

Driven by some traditional industrial load growth (re-shoring, re-industrialization, de-globalization) but also by significant expected development of data centers.

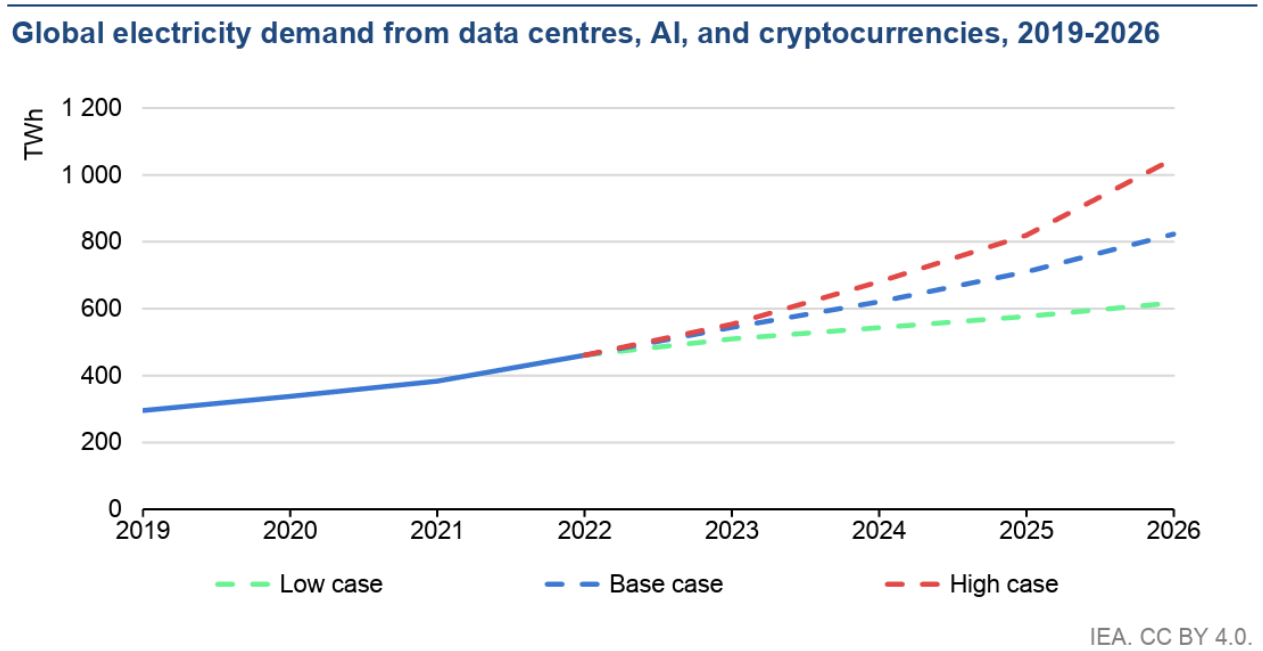
JEFFERIES

From Power, Utilities and Clean Energy Conference, March 2025:

"We continue to stress numerous utilities reporting meaningful progress on data center origination trends."

WHY THIS IS IMPORTANT

According to the IEA*, data centers, cryptocurrency mining and artificial intelligence consumed 460 terawatt-hours (TWh) of electricity in 2022. This is expected to grow to between 600 and 1,000 TWh for 2026, equivalent to adding the total electric demand of Sweden on the low end to Germany on the high end in just four years.



In the US alone, data center demand is expected to grow from 200 TWh (4% of total load) in 2022 to 260 TWh (6% of total load) in 2026.

https://iea.blob.core.windows.net/assets/18f3ed24-4b26-4c83-a3d2-8a1be51c8cc8/Electricity2024-Analysisandforecastto2026.pdf

THE “CO-LOCATION” ISSUE



TALEN ENERGY | Docket No. ER24-2172

In March 2024 Talen Energy agreed to sell a planned data center campus to Amazon Web Services (AWS) for $650 million. Talen intends to sell power to AWS from its 2,228 MW (90% ownership) stake in the Susquehanna (nuclear) Steam Station.

- AWS agreed to buy power from Talen in 120-MW increments for the data center, which could grow to 960 MW. It also has a one-time option to cap its commitment at 480 MW.
- On June 3, 2024, PJM asked FERC to approve an amended ISA that would allow Talen to sell 480 MW to the data center without making any transmission upgrades, up from 300 MW under the original ISA.
- AEP and Exelon protested the amended ISA, contending that it raises major issues - including some that FERC hasn’t ever reviewed.*
- FERC convened a Technical Conference (Docket No.: AD24-11-000) to discuss issues around such “co-located” load including co-located load configuration, generation capacity resource status, capacity modifications, and system protection facilities, among others.

*Docket No. ER24-2172, Protest of Exelon Corporation and American Electric Power Service Corporation

THE “CO-LOCATION” ISSUE

PJM’s ANSWER TO THE SHOW-CAUSE ORDER*

“Regardless of what co-location arrangements are ultimately sanctioned by the Commission, permitted by the states, and elected by developers, participants involved in co-location arrangements should pay the costs of any grid services they consume, and the arrangements must be reliable and operationally manageable.”

“Multiple existing pathways are available to facilitate co-location arrangements. Some potential additional pathways are also proposed in this filing.”

PJM Identified Options - Exhibit A**	Existing Option 1	Existing Option 2	Existing Option 3
Description	**Load with a separate Point of Interconnection (POI) that is Network Load (Existing NITS rules)**	**Co-located load that is at the same Point of Interconnection (POI) but separately metered that is Network Load (Existing NITS rules)**	**Existing Behind The Meter Generation (BTMG) where the load is the customer**

* PJM Interconnection, L.L.C., Order Instituting Proceeding Under Section 206 of the Federal Power Act and Consolidating with Other Proceedings, Docket Nos. EL25-49-000, et al. (Feb. 20, 2025) (“Order”).

**Note: each option is subject to state laws that may specifically define and limit when and how load in a jurisdiction can be served by a supplier other than a franchised public utility.

TANGIBL

THE “CO-LOCATION” ISSUE

PJM’s ANSWER TO THE SHOW-CAUSE ORDER*

PJM Identified Options - Exhibit A**	New Option 4	New Option 5	New Option 6	New Option 7	New Option 8
Description	**Co-located load with connection to grid with protections to avoid delivery of system energy to serve the load**	**Co-located load with connection to grid with protections to avoid delivery of system energy to serve the load or receive back-up service from PJM with permission**	**Co-located load that elects to be Network Load and bring own Generation BYOG**	**Co-located load that takes Interruptible Service (Load willing to curtail in advance of Emergency Procedures)**	**Co-located Load that elects to be Network Load and that participates as Demand Response**

* PJM Interconnection, L.L.C., Order Instituting Proceeding Under Section 206 of the Federal Power Act and Consolidating with Other Proceedings, Docket Nos. EL25-49-000, et al. (Feb. 20, 2025) (“Order”).

**Note: each option is subject to state laws that may specifically define and limit when and how load in a jurisdiction can be served by a supplier other than a franchised public utility.

TANGIBL

TECHNICAL IMPLICATIONS



IMPACTS TO YOUR SYSTEM

"Recent breakthroughs of large language models (LLMs) have exhibited superior capability across major industries and stimulated multi-hundred-billion-dollar investment in AI-centric data centers in the next 3-5 years. This, in turn, bring the increasing concerns on sustainability and AI-related energy usage. However, there is a largely overlooked issue as challenging and critical as AI model and infrastructure efficiency: the disruptive dynamic power consumption [behavior]. With fast, transient dynamics, AI infrastructure features ultra-low inertia, sharp power surge and dip, and a significant peak-idle power ratio. The power scale covers from several hundred watts to megawatts, even to gigawatts. These never-seen-before characteristics make AI a very unique load and pose threats to the power grid reliability and resilience."*

* September 9, 2024: The Unseen AI Disruptions for Power Grids: LLM-Induced Transients; Yuzhuo Li, Mariam Mughees, Yize Chen, Yunwei Ryan Li; Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Canada

TANGIBL

TECHNICAL IMPLICATIONS



IMPACTS TO YOUR SYSTEM | TYPES OF DATA CENTER LOAD

IT Load: This refers to the power consumed by the core IT infrastructure, including:

- **Servers:** The primary computing resources for processing data.
- **Storage:** Devices and systems for storing data, such as hard drives and solid-state drives.
- **Networking Equipment:** Devices like switches, routers, and firewalls that facilitate data transmission.
- **Compute:** The processing power and computing resources of a data center.
- **Load Balancers:** Devices that distribute network traffic across multiple servers.

Building Load: This encompasses the power required to support the data center's physical infrastructure:

- **Cooling:** Systems like chillers and HVAC (heating, ventilation, and air conditioning) to maintain optimal temperatures for equipment.
- **Lighting:** Power for the data center's lighting systems.
- **Power Distribution:** Systems like PDUs (Power Distribution Units) and UPS (Uninterruptible Power Supplies) to deliver and manage power.
- **HVAC Auxiliaries:** The general breakdown for a data center is 40% compute, 40% cooling, and 20% for all other functions.

TANGIBL

TECHNICAL IMPLICATIONS



IMPACTS TO YOUR SYSTEM

THE THREE STAGES OF AI MODEL POWER CONSUMPTION:

1. **Training**
   - Teaching the model
   - Sustained high loads
   - Disruptions are critical at this stage
2. **Optimization/ Fine-Tuning**
   - Adapting existing model or updating datasets
   - More variable consumption than training
3. **Inference**
   - Putting the AI to use
   - Wildly variable power consumption
   - Time between peak and idle are short

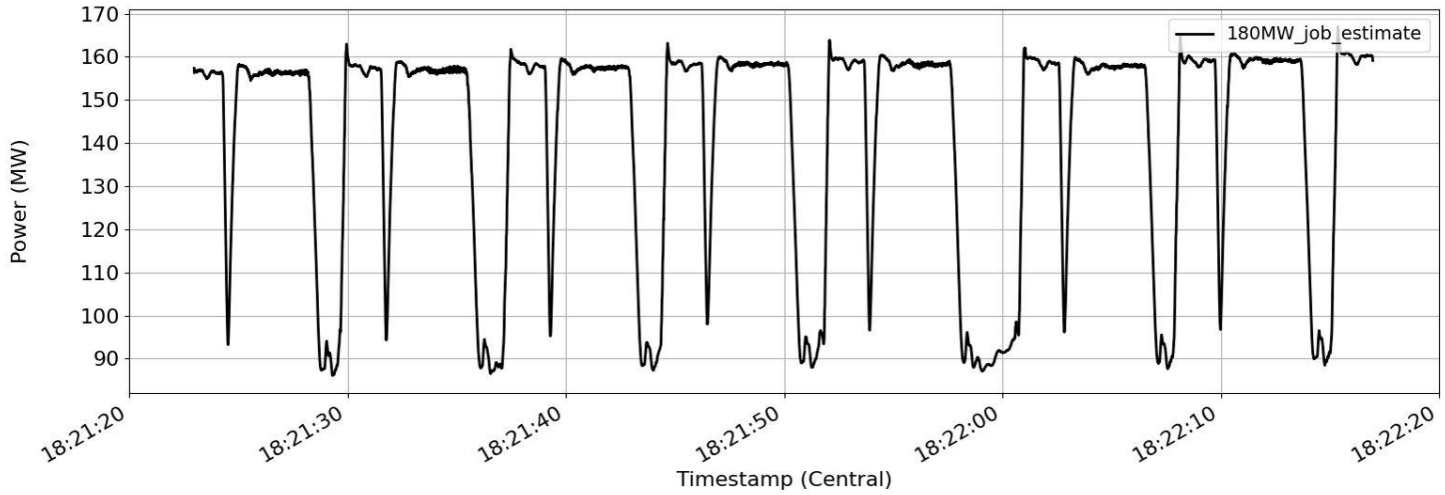
TANGIBL

TECHNICAL IMPLICATIONS



IMPACTS TO YOUR SYSTEM

This load profile is from an existing data center (anonymous):

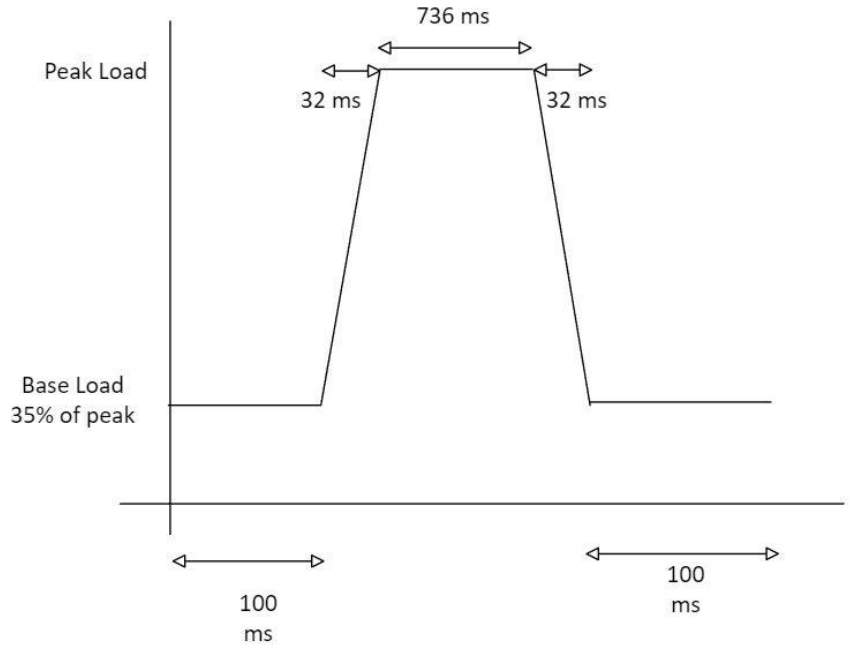


TECHNICAL IMPLICATIONS



IMPACTS TO YOUR SYSTEM

Load swings can be significant, causing rapid voltage change and other impacts to your system and to your other customers.



Source: RMS Energy Co, LLC

RATE AND INTERCONNECTION IMPLICATIONS



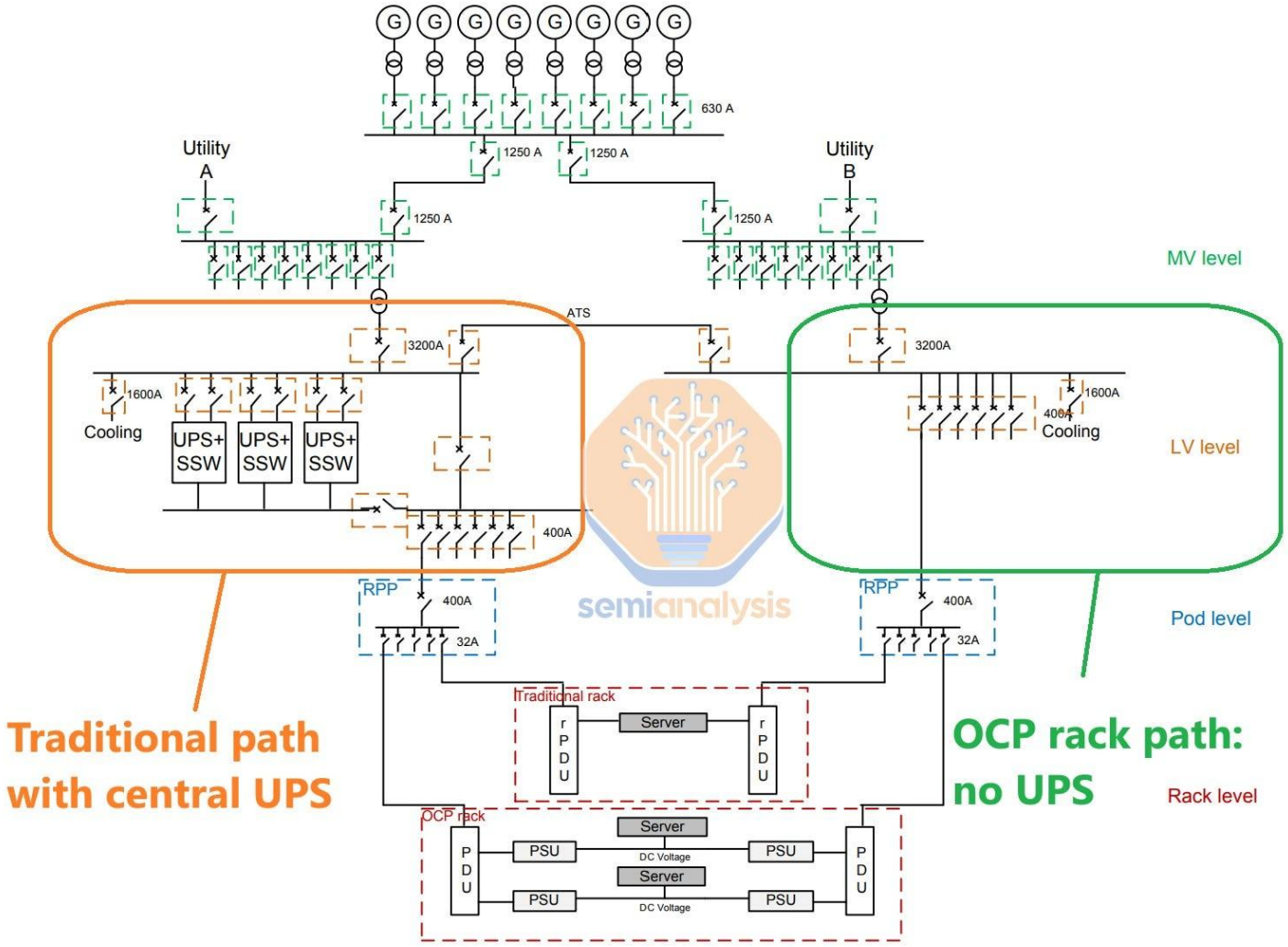
INTERCONNECTION IMPLICATIONS

STUDY COST, TIMING, AND PROCESS

How to treat / model the following:

- Peak demand and demand profile
- Total energy usage
- Onsite backup generation
  - Will generation be deployed for active load management, peak shaving, or only in the event of an outage?
- UPS implementation
- Additional BESS / battery backup

RATE AND INTERCONNECTION IMPLICATIONS



Source: https://semianalysis.com/2024/10/14/datacenter-anatomy-part-1-electrical/

TANGIBL

RATE AND INTERCONNECTION IMPLICATIONS

RATE IMPLICATIONS

HOW DO WE CHARGE CUSTOMERS?

There are a growing number of proposals from utilities, regulators, and state governments around how to charge and manage data center loads.

Texas:	Senate Bill 6
Virginia:	House Bill HB2101 and Senate Bill SB960
Ohio:	AEP Ohio minimum demand charge proposal
Indiana:	IMPC industrial tariff modification for loads over 70 MW



RATE AND INTERCONNECTION IMPLICATIONS

RATE IMPLICATIONS

TEXAS: SENATE BILL 6 (passed Senate, currently in the Texas House)

- Requires the Texas Public Utility Commission to "implement minimum rates that require all retail customers in that region [ERCOT] served behind-the-meter to pay retail transmission charges based on a percentage of the customer's non-coincident peak demand from the utility system as identified in the customer's service agreement.“
- Requires large loads to disclose whether multiple interconnections have been filed in other areas, and whether approval of those interconnection requests moving forward will result in a change or withdrawal of a request.
- Requires approval by the electric utility, co-op, or municipal electric authority of any new net metering arrangements.
- Allows ERCOT to, with notice, demand deployment of any co-located / backup generation.

https://www.klgates.com/Texas-Senate-Bill-6-and-Impacts-on-Large-Load-Development-in-ERCOT-2-17-2025



RATE AND INTERCONNECTION IMPLICATIONS

RATE IMPLICATIONS

VIRGINIA: House Bill HB2101 and Senate Bill SB960 (both failed to pass)

- HB2101 would have mandated the State Corporation Commission to investigate whether non-data center customers are subsidizing data center costs. If subsidies were to be found, the bill mandated implementing new rules by January 1, 2026, to mitigate them. It also temporarily halts new projects benefiting data centers until a potential investigation concludes.
- The Senate counterpart to HB 2101, SB960, would have directed the SCC to ensure fair energy cost distribution and protect non-data center customers from bill increases tied to infrastructure investments for data centers. The bill initially passed 26-23-1 in the state's Senate, though it ultimately failed to pass in conference committee with the House.
- Two other bills (HB 1601 and HB 2035) under consideration relate to local environmental assessments and mandatory public reporting of water and electricity use by data centers. Both are pending.

Source: https://www.latitudemedia.com/news/the-rules-around-data-center-cost-allocation-are-getting-clearer/



RATE AND INTERCONNECTION IMPLICATIONS

RATE IMPLICATIONS

OHIO: AEP Ohio Data Center Settlement Agreement (hearing held January 17, 2025)

- AEP Ohio filed a settlement agreement in October 2024 that would require new large data centers to pay a minimum of 85% of the power they say they need each month, even if they use less.
    - AEP Ohio had previously implemented a moratorium on connecting new large scale data centers in central Ohio.
- Adds additional financial requirements to data center customers.
- Introduces an exit fee if projects are canceled or fail to meet the requirements under their service agreement, and a 12-year contract term with a 4-year ramp up period.
- Certain Data Center customers filed a separate agreement that proposes a 75% payment minimum and removes certain customer protections
- A hearing was held on January 17, 2025, and reply briefs were filed by February 28, 2025. The outcome is pending with the PUC.

https://dis.puc.state.oh.us/CaseRecord.aspx?CaseNo=24-0508&x=0&y=0



TANGIBL

RATE AND INTERCONNECTION IMPLICATIONS

RATE IMPLICATIONS

INDIANA: Indiana-Michigan Power Company - Commission Approval on large load tariff settlement agreement (Issued February 19, 2025)

- Requires large load customers (over 70 MW at a single location or 150 MW in total) to make upfront, long term financial commitments designed to protect ratepayers from paying for stranded assets.
- The Order added an additional term to the Settlement Agreement: Any reduction of more than 20% of a large load customer's contracted peak capacity, that is mutually agreed upon between I&M and the large load customer, must be submitted to the IURC for its review and approval before becoming effective.
- AWS in 2024 announced an $11 billion data center campus in New Carlise, while Google announced a $2 billion data center in Fort Wayne.

https://www.indianamichiganpower.com/company/news/view?releaseID=10036



QUESTIONS TO ASK YOUR CUSTOMER



VOLTAGE AND FREQUENCY PERFORMANCE

- Voltage sag and swell levels / durations at which the computer/server and cooling loads disconnect from the utility source?
  - How are sag and swell levels measured (per phase, or 3-phase RMS), with duration time in seconds?
- Highest and lowest frequency in Hz at which data center will disconnect from the utility source?
- Voltage and frequency levels, and associated deadbands, at which the data center will reconnect to the utility source?
  - If immediate reconnect, time in milliseconds; if delayed reconnect, time in seconds?
- Reconnect rate stepwise or ramped, and if ramped, at what rate?

QUESTIONS TO ASK YOUR CUSTOMER



ONSITE GENERATION, BATTERY STORAGE AND REDIRECTION

- Onsite generation and/or battery discharge duration and islanding capability?
- Percentage of data center load that can be:
  - Carried by onsite generation or batteries,
  - Redirected to other data centers, and
  - Set to participate in demand response programs?



CONTACT INFORMATION

Tangibl Group, Inc.
201 King of Prussia Road, Suite 110
Radnor, PA USA 19087
+1 610-255-2333

Tangiblinc.com

Principal: Wade.Horigan@Tangiblinc.com

Project Engineer: Gary.Blacksmith@Tangiblinc.com