Large Loads: Forecasting and Tariff Designs

Western Interstate Energy Board Webinar Series
Challenges and Opportunities presented by Large Industrial Electricity Loads

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ENERGY TECHNOLOGIES AREA
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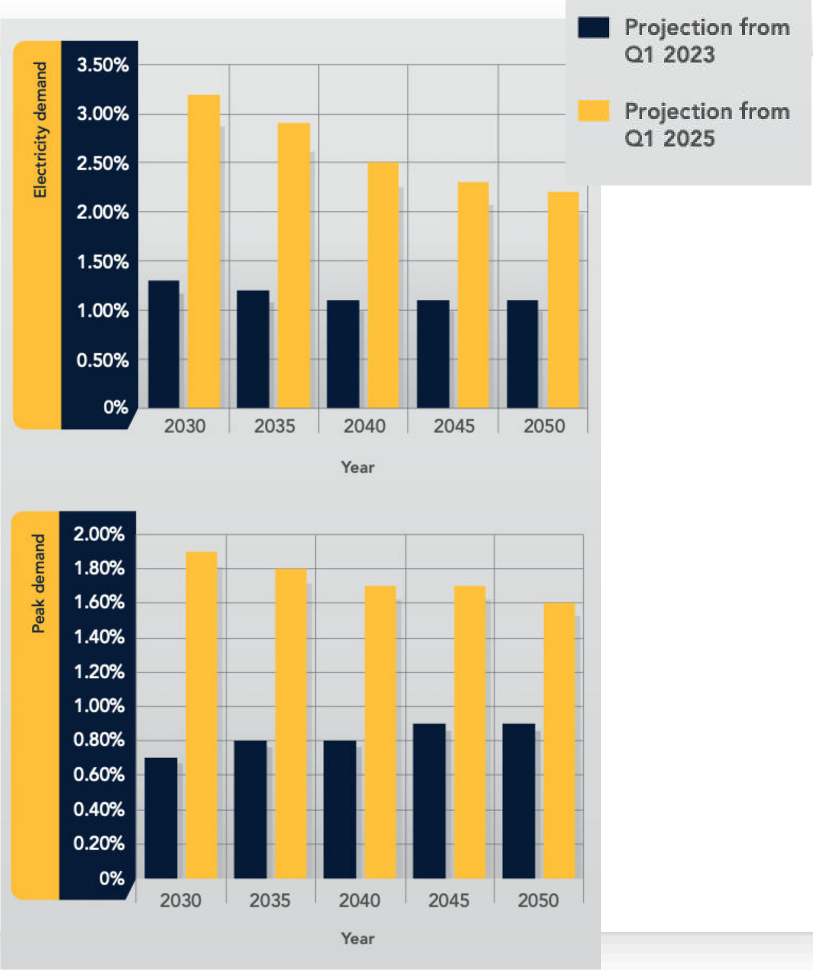
Agenda

- Large load forecasting
  - Approaches to address large loads in forecasting
  - Addressing speculative interconnection requests
- Common elements of large load tariffs:
  - Fair allocation of costs
  - Mitigate ratepayer and utility risk
  - Mitigate operational and resource adequacy risk
  - Accomodating large load customers
- Resources for more information

Load forecasting

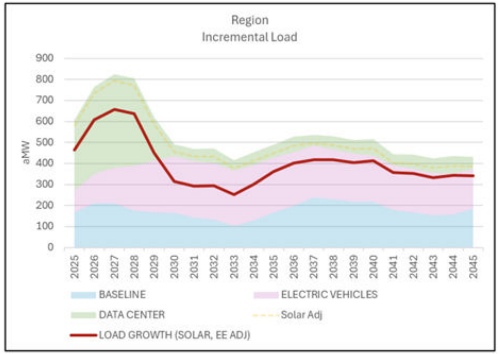
- Many utilities are projecting significant load growth from large customers.
- Information on load growth often appears in utility integrated resource plans (IRP).
- As states evaluate load forecasts, they can consider the timing, type and risk associated with the growth.

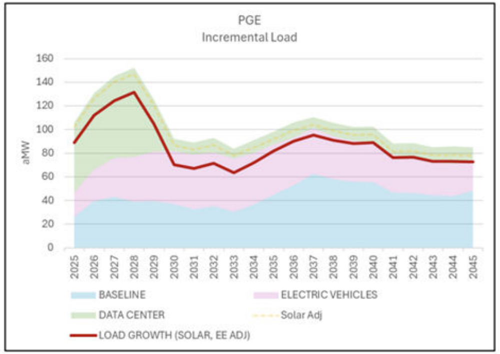


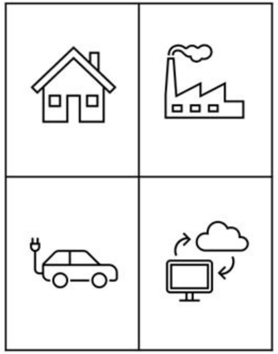
Source: ICF; from ISO/RTO forecasts, NERC ES&D, utility IRPs, ICF

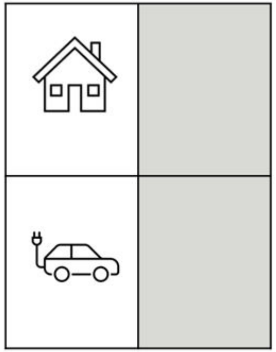
Type and timing

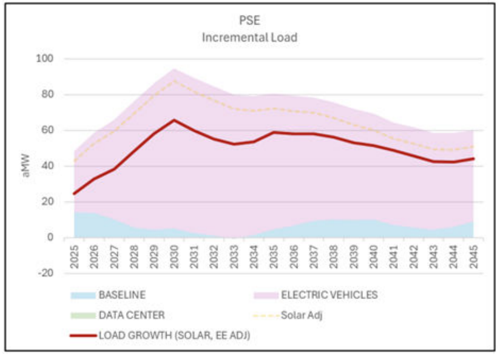
Load growth from data centers, manufacturing, building electrification and EV charging will occur at different times (daily, seasonally and annually) and locations on the grid.

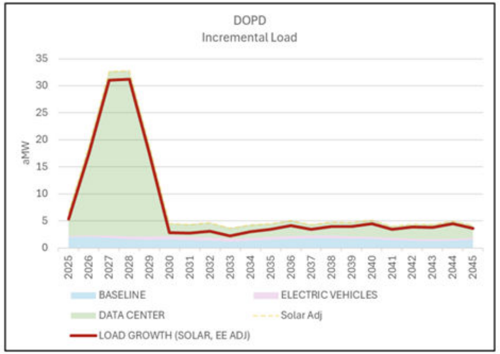








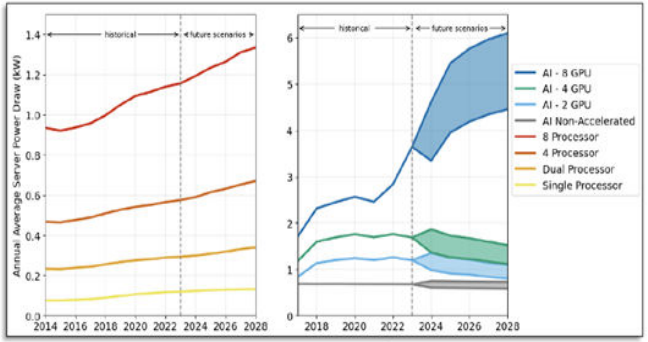




Source: Northwest Power and Conservation Council

Understanding Data Center Growth in Four Charts

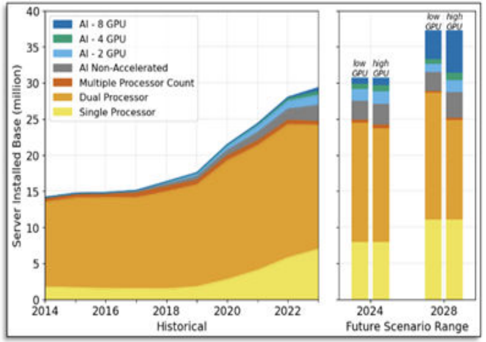
Aggregate average power draw of various server types across each analysis year
(Source: [LBNL](); Figure 3.7)



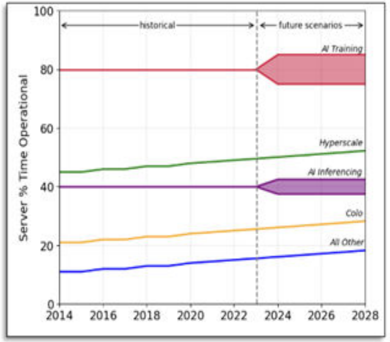
AI GPUs use significantly more energy

Total server installed base for 2014–2028 with higher bound shipments (left). Adjusted installed base with lower bound GPU shipments (right)
(Source: [LBNL](); Figure 3.9)

The number of installed AI services is growing significantly



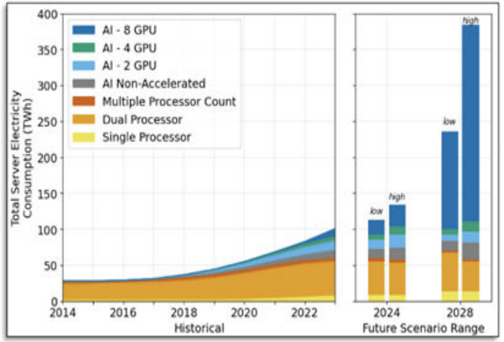
Operational time of servers by server type
(Source: [LBNL](); Figure 3.6)



Server utilization is increasing with AI

Server annual electricity usage by type
(Source: [LBNL](); Figure 5.1)

Combined, these three factors lead to dramatic increases in overall data center demand



Source: [EPE](), [LBNL]()

State-of-the-Industry in Data Center Forecasting

Overall, there is "no consensus" among utilities; practices and forecasting methods vary widely

How Some Utilities Derate Data Center Loads
(Source: EPRI)

Examples of how five utilities derate requested data center capacity values for use in load forecasting:

- **Utility A:**
  - Derating depends on multiple factors, but DC type has largest impact. Also, generally derate colocation DCs more than enterprise.
  - Derates DCs more than other large loads due to less accurate information from DCs.
- **Utility B:**
  - Considers DCs in the forecast process similar to other large loads. But tends to have less information about DCs, which leads to more uncertainty.
  - For corporate load forecast, consider each DC individually but focus is on forecasting DCs in aggregate.
- **Utility C:**
  - Derates all DC requests by 20% based on prior experience. Will also vary the derating when forecasting multiple scenarios, for example, a 10% and 0% derating.
  - DCs are currently the only sector for which their load forecasts are based on connection requests. However, considering applying a similar derating process for electrolysis projects in the future.
- **Utility D:**
  - Derating based on multiple factors, including historical experience with other similar customers.
  - Currently treats DCs differently from other large loads for load forecasting. Within DCs, derating varies based on type of DC, MW size, etc.
  - Current experience has led to derating crypto mining customers more than hyperscalers given hyperscale DCs tend to more closely adhere to their contract loads.
  - Only considers DC customers in five-year load forecast who have signed an agreement with the utility.
- **Utility E:**
  - Derating depends on multiple factors, but biggest factors are (1) whether the data has submitted a formal connection request and (2) whether there is available infrastructure to support the DC's requested capacity.
  - Derating of DCs for load forecasting is more granular than other large loads given the diversity and uncertainty of DCs as a category.

None of the responding utilities provided an explicit calculation/equation for derating DC for load forecasting.

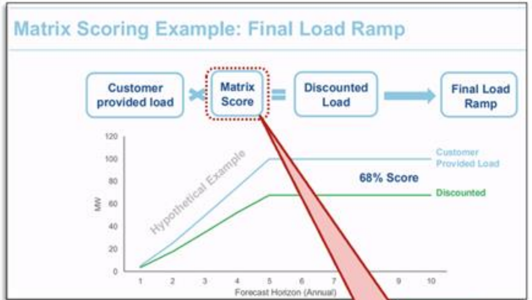
Source: EPE, EPRI

State-of-the-Industry in Data Center Forecasting

Examples of more complex utility data center load modeling approaches design to better address uncertainty.

Southwest Utility Example

(Source: ESIG Large Loads Task Force presentation)



The "Matrix Score" concept is designed to reflect uncertainty across multiple dimensions, such as energy infrastructure, client construction, development permits, land acquisition, and other intelligence.

Southeast Utility Example

(Source: ESIG Large Loads Task Force presentation)

- Likelihood of Connection
  - Binary variable to determine if customer locates on system
  - Uniform distribution (randomized to match probability)
- Magnitude Adjustment
  - Adjustment to reflect lower usage than projected
  - Triangle distribution (trend to internal projection)
- Siting Delay
  - Potential delay in customer connection of 0-3 ye
  - Left-skewed (no delay)
- 50,000 Trials

There are the key simulation parameters determined via a combination of data analysis and expert judgement.

Dominion Virginia Example

(Source: DOM VA 2023 IPR Testimony and 2023 IPR)

Forecasting Methodology

The Company has been tracking data and preparing forecasts for a long period of time and has developed a very robust forecast methodology. Figure 4.1.5.1 compares the Company's forecast to actual data center demand for 2020-2022.

Figure 4.1.5.1 – Data Center Industry Peak Billed Demand in MW Company Service Territory

Forecast Year	Forecast and Results		Variance	% of Variance
	Forecast	Actual	Over/(Under)	To Actual
2020	1,559	1,808	249	14%
2021	2,179	2,302	123	5%
2022*	2,848	2,767	(81)	-3%

* 2022 was the year of the transmission capacity constraint.

The Company models industry demand growth using the following method:

- Segments the modeling using the eight largest or fastest growing customers and a ninth model consisting of all remaining customers combined into one segment – nine models in total
- Statistically models sales in MWh including lost retail choice sales
- Statistically models demand (MW) using three different approaches
  - Approach 1: linear regression of demand
  - Approach 2: polynomial regression of demand
  - Approach 3: linear regression of sales to demand
- One of these three approaches is selected for each of the nine customer segments based on customer provided intelligence
- Estimate future retail choice conversions (lost MWh sales)
- Develop high, medium, and low demand scenarios
- In total, there are 27 models used to develop the forecast

Transparent inclusion of historical data comparing the actual data against past forecasts.

Inclusion of confidential customer intelligence provides unique insights that can help calibrate a forecast

ELECTRIC POWER ENGINEERS

Source: EPE

Load forecasting example

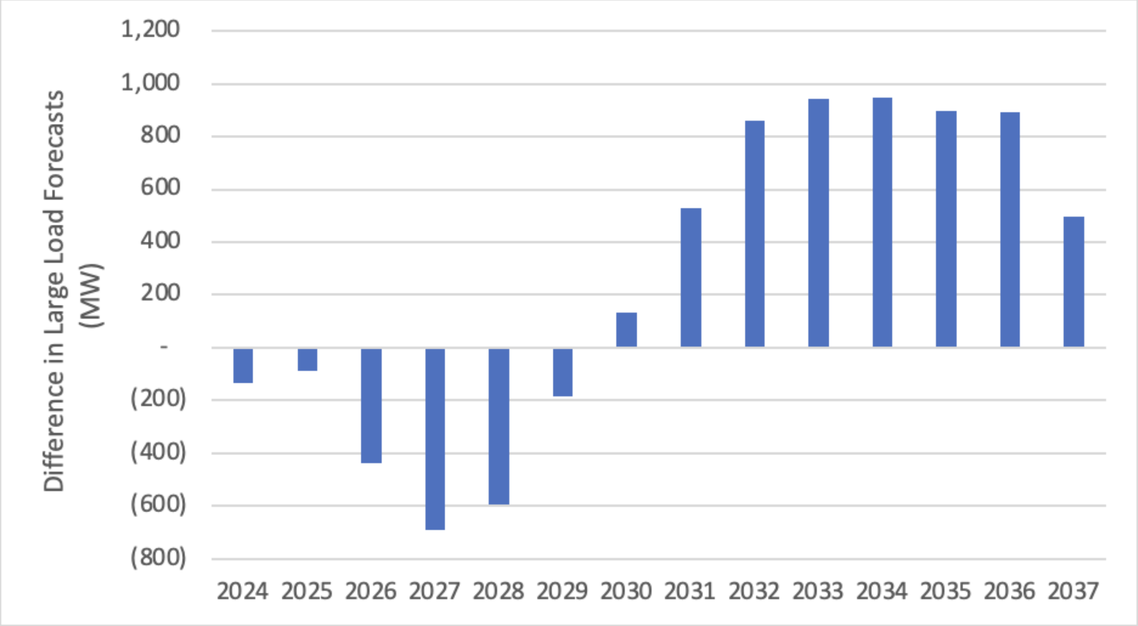
- Georgia Power’s load forecast in their 2025 IRP projected 107% compound annual growth rate for commercial large load summer peak load.
- Georgia PSC Staff testimony found (among other findings)
  - “Since the 2023 IRP Update, the Company has identified a significant rate of project removals and net load reductions in its large load pipeline.
  - Project removals and net load reductions are concentrated amongst data center projects, particularly those in the Technical Review stage.
  - The Technical Review stage refers to projects that have not yet signed a Request or Contract for Electric Service. The Company does not consider these projects as “committed customers.”

Table 5: B2025 Load Forecast, Key Growth Drivers for Coincident Peak Load, 2024-2032[25]

		Summer			Winter		
Category	Item	Cumulative Growth (MW)	Portion of Cumulative Growth (%)	CAGR (%)	Cumulative Growth (MW)	Portion of Cumulative Growth (%)	CAGR (%)
Organic Load Forecast	Residential	[redacted]	[redacted]	1.3%	[redacted]	[redacted]	0.6%
	Commercial	[redacted]	[redacted]	2.1%	[redacted]	[redacted]	1.9%
	Industrial	[redacted]	[redacted]	1.2%	[redacted]	[redacted]	1.6%
	Governmental Lighting	[redacted]	[redacted]	7.8%	[redacted]	[redacted]	-39.1%
	MARTA	[redacted]	[redacted]	-0.2%	[redacted]	[redacted]	-0.1%
Coincident Peak Adjustments	Cogeneration	[redacted]	[redacted]	32.0%	[redacted]	[redacted]	32.0%
	DSM	[redacted]	[redacted]	28.7%	[redacted]	[redacted]	15.0%
Large Load Adjustments	Commercial Large Loads	[redacted]	[redacted]	107.6%	[redacted]	[redacted]	107.6%
	Industrial Large Loads	[redacted]	[redacted]	56.9%	[redacted]	[redacted]	56.9%
Total		9,702	100.0%	5.8%	8,909	100.0%	5.7%

Load forecasting example (2)

Figure 8: B2025 Large Load Forecast Simulation less February 2025 Large Load Forecast Simulation [79]



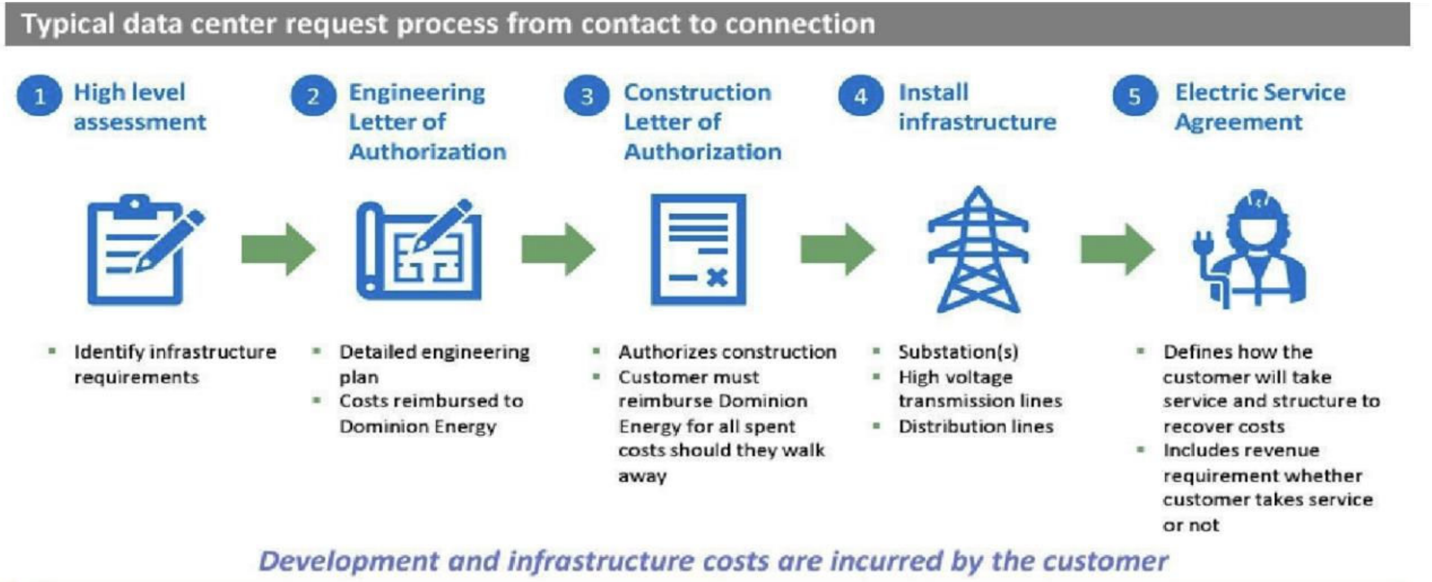
Source: [Georgia PSC]

Large load interconnection

- There number of large load interconnection requests is rapidly increasing.
- Interconnecting large loads can be complex, intersecting with distribution system planning, integrated resource planning and utility or RTO transmission planning.
- Often, there is not a publicly available description of a standardized process to interconnect a large load to a utility system. Information may be available, with varying degrees of specificity in a variety of proceedings (e.g., integrated resource plan, rulemaking, tariff).
- **Speculative load interconnection requests have contributed to difficulties in developing load forecasts.**
- Standardized and transparent processes can assist with incorporating large load service requests into load forecasts.

Dominion Energy (1)

Data center interconnection request process



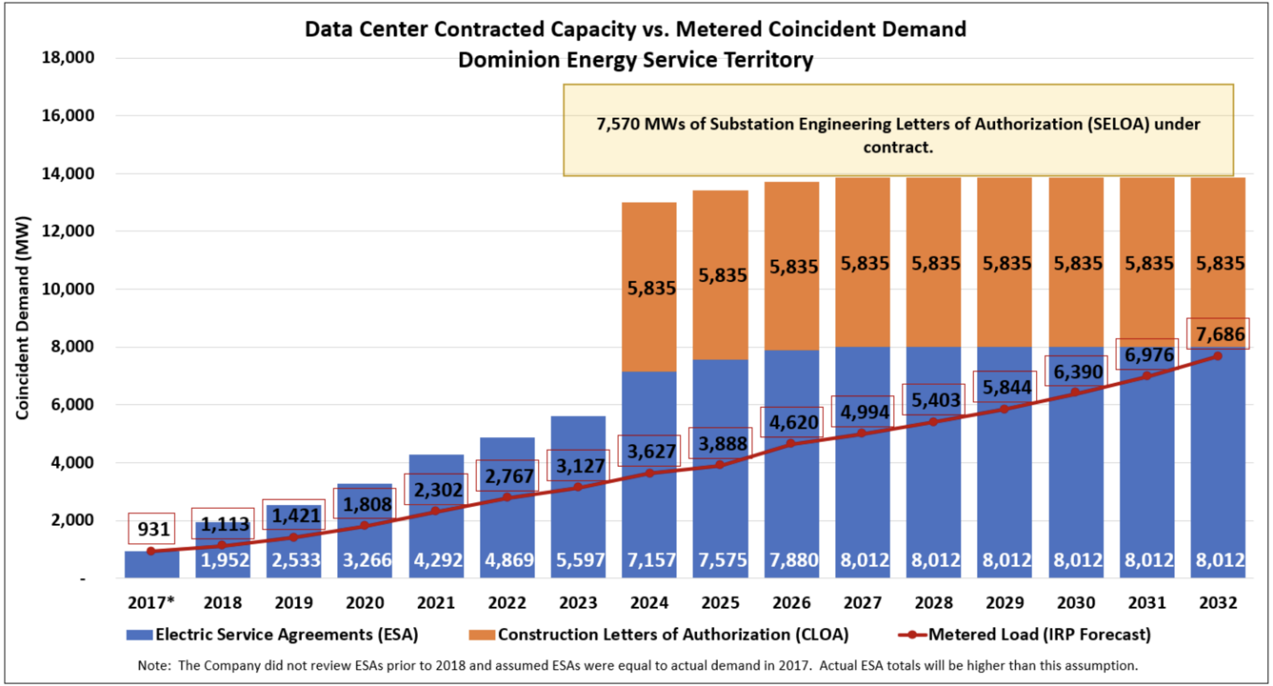
Source: Dominion Energy

Dominion Energy (2)

Dominion provides information on the quantity of load in different stages of interconnection in their IRP.

Construction Letter of Authorization are less certain (orange bars)

Electric Service Agreements are certain (blue)



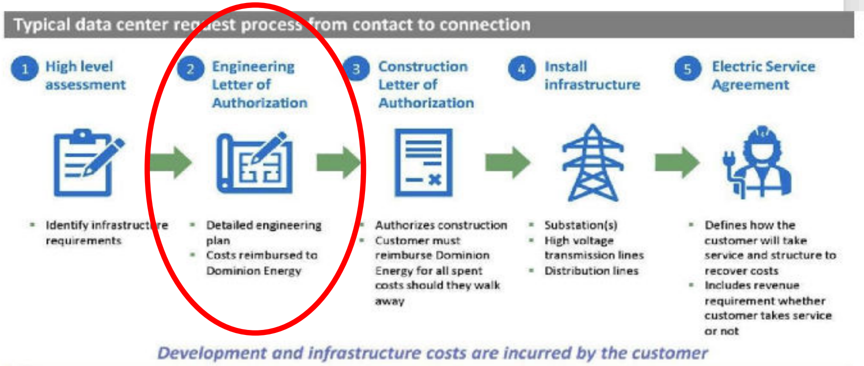
Source: Dominion Energy

Dominion rate case

- Dominion forecasted $1.5B in data center capital spending between 2025-2027.
- Staff removed $853 million in speculative data center expenditures
  - Recalculate the revenue requirement
  - Reduction revenue requirements by $80.5M

Table 5
Impact on Staff's Revenue Requirement from Reduction to Data Center CapEx (in 000's)

Adjustment	2026 Rate Year	2027 Rate Year
Plant	($5,234)	($18,306)
Construction Work in Progress	($11,991)	($26,449)
Accumulated Depreciation	($1,506)	($4,140)
Accumulated Deferred Income Taxes	$384	$1,057
Depreciation Expense	($1,740)	($5,913)
Property Tax	($1,860)	($4,855)
Total Revenue Requirement Impact	**($21,947)**	**($58,606)**



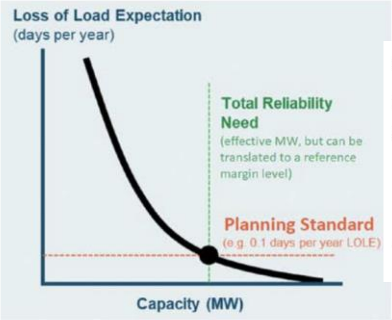
Source: [VA SCC Staff]

Large load tariff designs

With contributions from Andy Satchwell, Peter Cappers, Sanem Sergici, Ryan Hledik, Goksin Kavlak, and Glenda Oskar

Utilities and regulators may have specific rate design objectives for data centers

Resource adequacy



Source: NARUC

Affordability

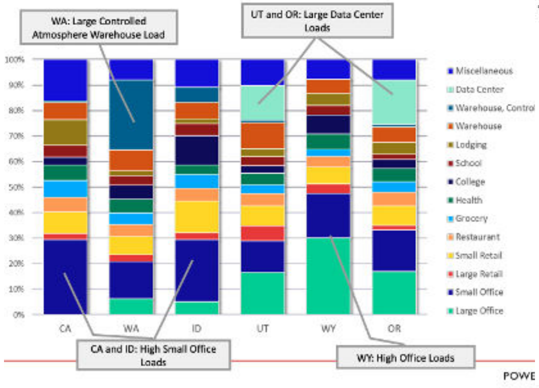
Source: Bureau of Labor Statistics

Desire to attract large load customers

Air pollutant reductions

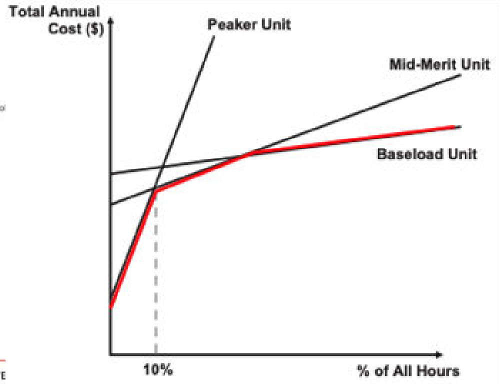
Tariff elements to fairly allocate electricity system costs

Applicability to specific customer type



Source: [PacifiCorp]

Marginal pricing



Source: [Brattle]

Economic development payments

Source: [Area Development]

Tariff elements to mitigate utility and ratepayer financial risks

Upfront payment and exit fees

Source: Giorgio Trovato on Unsplash

Credit rating and collateral requirements

MOODY'S	S&P	FITCH	DESCRIPTIONS	GRADE
Aaa	AAA	AAA	Highest credit quality, minimum credit risk	INVESTMENT
Aa	AA	AA	Very high credit quality, very low credit risk	
A	A	A	High credit quality, low credit risk	
Baa	BBB	BBB	Good credit quality, moderate credit risk	
Ba	BB	BB	Issuer faces adverse conditions and uncertainty, substantial credit risk	HIGH YIELD (or "junk")
B	B	B	High credit risk, issuer able to meet financial commitments	
Caa	CCC	CCC	Vulnerable and default likely	
Ca	CC	CC	Issuer is highly vulnerable or near default	
C	C	C	Lower ratings, issuer in default	
	D	RD	Lower ratings, issuer in default	
		D	Lower ratings, issuer in default	

Source: Financial Edge

Contract duration, sizing and resizing

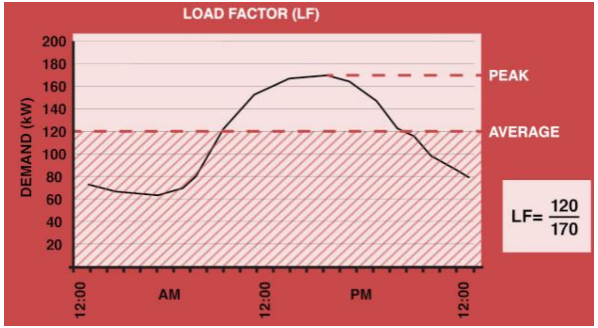
Source: FreePik

Minimum load requirements and demand charges

Total Contract Cap. (MW)	Min. Demand (MW)	Percentage
113	95.50	84.51%
114	96.50	84.65%
115	97.50	84.78%
116	98.50	84.91%
117	99.45	85.00%
117+	85.00%	

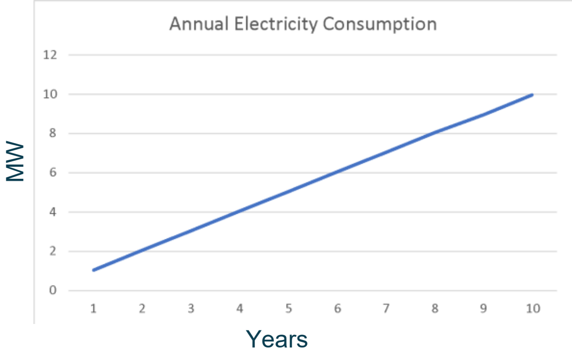
Tariff elements to mitigate operational and resource adequacy risks

Minimum load factor



Source: APS

Ramp times

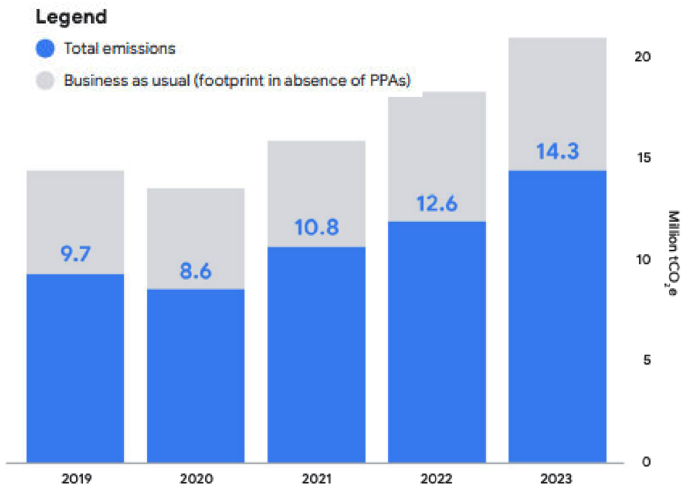


Behind-the-meter resources as backup and supplemental power

Source: Sunlogix

Tariff elements to accommodate the diverse needs of large-load customers

Clean energy requirements



Source: Google

Opportunities to leverage specific generation technologies

Source: Google

Resources for more information

- Large Load Literature Review - summaries of ~60 reports and large load resources, grouped into 11 categories (Load forecasting, Reliability and resource adequacy, Large load interconnection, Demand flexibility, Generation, Co-location, Data center location/infrastructure, Large load tariffs, Policy options, Maps and tools, Design and operations)
- Electricity Rate Design for Large Load: Evolving Practices and Opportunities
- Center of Expertise in Data Centers – datacenters.lbl.gov

Thank you

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