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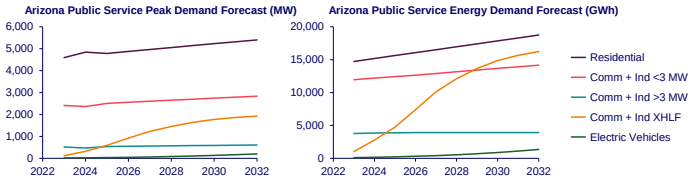
Gridlock: Demand Dilemma Facing US Power Sector

Real Estate Roundtable

May 29, 2025

Slide 2

Large load additions present challenges that are new to the power industry



- Average size of a proposed data center is now 300 MW
- No consistent large load interconnection processes
- Significant uncertainty around which lumpy additions to demand will get built
- Most large loads want renewable energy but high load factors makes it more challenging to meet demand growth through renewables alone and renewables often times are far from the new load requiring more transmission investment

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Sources: Arizona Public Service 2023 Integrated Resource Plan

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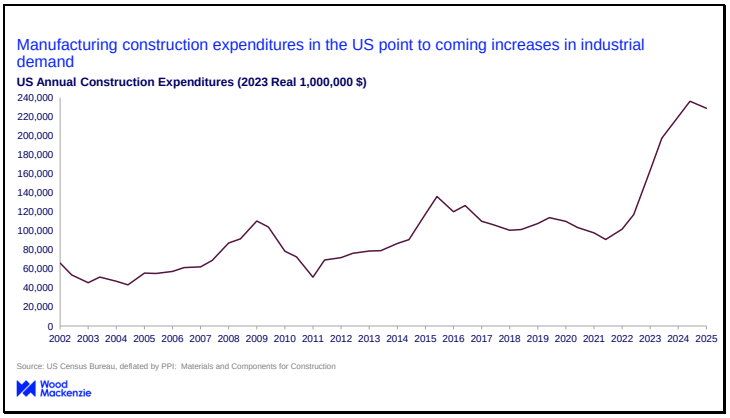
Manufacturing construction expenditures in the US point to coming increases in industrial demand
US Annual Construction Expenditures (2023 Real 1,000,000 $)
240,000
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Source: US Census Bureau, deflated by PPI: Materials and Components for Construction
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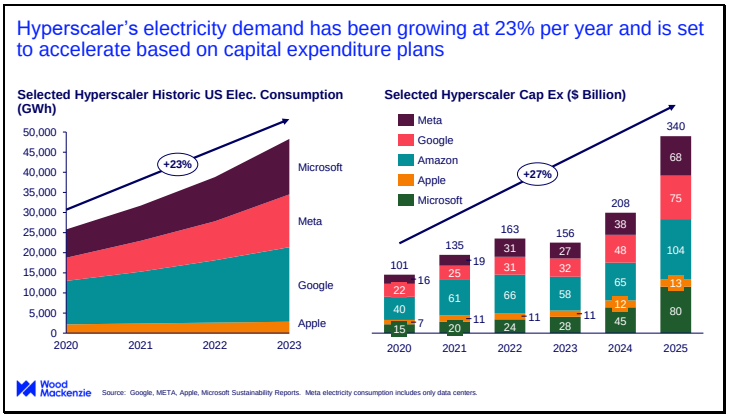
Hyperscaler's electricity demand has been growing at 23% per year and is set to accelerate based on capital expenditure plans
Selected Hyperscaler Historic US Elec. Consumption (GWh)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
+23%
Microsoft
Meta
Google
Apple
2020
2021
2022
2023
Selected Hyperscaler Cap Ex ($ Billion)
Meta
Google
Amazon
Apple
Microsoft
+27%
101
135
163
156
208
340
22
25
31
27
38
68
40
61
66
58
65
75
104
16
19
31
32
48
13
15
7
20
11
24
11
28
11
45
12
80
2020
2021
2022
2023
2024
2025
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Source: Google, META, Apple, Microsoft Sustainability Reports. Meta electricity consumption includes only data centers.

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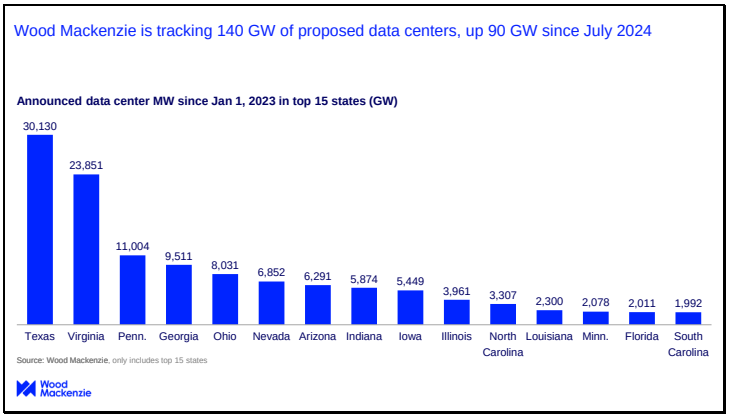
Wood Mackenzie is tracking 140 GW of proposed data centers, up 90 GW since July 2024
Announced data center MW since Jan 1, 2023 in top 15 states (GW)
30,130
23,851
11,004
9,511
8,031
6,852
6,291
5,874
5,449
3,961
3,307
2,300
2,078
2,011
1,992
Texas
Virginia
Penn.
Georgia
Ohio
Nevada
Arizona
Indiana
Iowa
Illinois
North Carolina
Louisiana
Minn.
Florida
South Carolina
Source: Wood Mackenzie, only includes top 15 states
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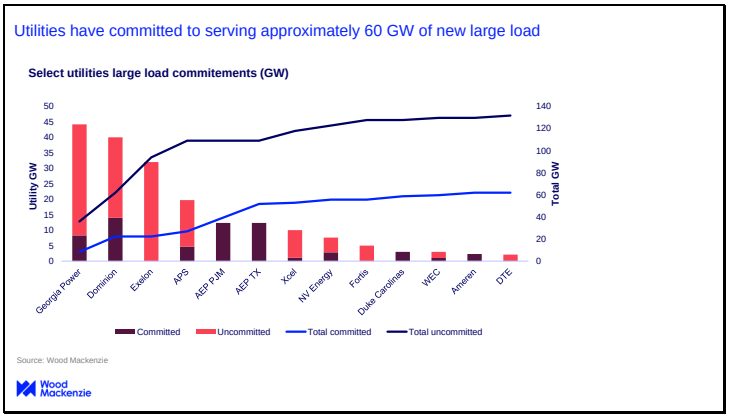
Utilities have committed to serving approximately 60 GW of new large load
Select utilities large load commitements (GW)
Utility GW
Total GW
50
45
40
35
30
25
20
15
10
5
0
140
120
100
80
60
40
20
0
Georgia Power
Dominion
Exelon
APS
AEP PJM
AEP TX
Xcel
NV Energy
Fortis
Duke Carolinas
WEC
Ameren
DTE
Committed
Uncommitted
Total committed
Total uncommitted
Source: Wood Mackenzie
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1999 prediction: half of the electricity grid would be powering the digital economy by 2010

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Dig more coal -- the PCs are coming

May 31, 1999, 12:00am EDT

This article is more than 10 years old.

SOUTHERN CALIFORNIA EDISON, meet Amazon.com. Somewhere in America, a lump of coal is burned every time a book is ordered on-line.

The current fuel-economy rating: about 1 pound of coal to create, package, store and move 2 megabytes of data. The digital age, it turns out, is very energy-intensive. The Internet may someday save us bricks, mortar and catalog paper, but it is burning up an awful lot of fossil fuel in the process.

Under the PC's hood, demand for horsepower doubles every couple of years. Yes, today's microprocessors are much more efficient than their forerunners at turning electricity into computations. But total demand for digital power

- **Prediction in 1999 Forbes article by Mark Mills**: "At least 100 million nodes on the Internet, drawing from hundreds to thousands of kilowatt-hours per year, add up to 290 billion kWh of demand. That's about 8% of total U.S. demand. Add in the electric power used to build and operate stand-alone (unnetworked) chips and computers, and the total jumps to about 13%. **It's now reasonable to project that half of the electric grid will be powering the digital-Internet economy within the next decade."**
- Several power company CEO's and equity analyst cited the study justifying investment plans and stock prices
- Flaws in the study include
  - Not getting the starting point correct due to lack of data
  - Underestimating future efficiency gains
  - Not accounting for structural changes in the economy the use of the internet would bring about impacting other uses of electricity

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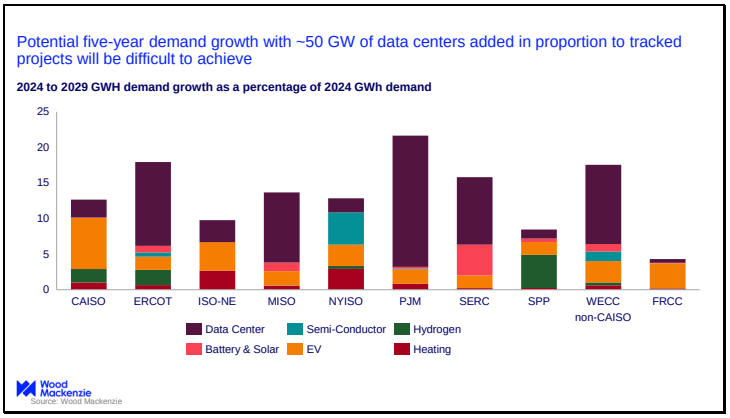
Potential five-year demand growth with ~50 GW of data centers added in proportion to tracked projects will be difficult to achieve
2024 to 2029 GWH demand growth as a percentage of 2024 GWh demand
25
20
15
10
5
0
CAISO
ERCOT
ISO-NE
MISO
NYISO
PJM
SERC
SPP
WECC non-CAISO
FRCC
Data Center
Semi-Conductor
Hydrogen
Battery & Solar
EV
Heating
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Source: Wood Mackenzie

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Power market trends make meeting demand growth even more challenging
Changing Market Regulation
Capacity Accreditation
• Reducing capacity available to meet demand at times of constraint
Supply-constrained world
Supply, not demand, is the active constraint
• Transformer lead times have tripled since 2021: 50-150+ weeks ARO
• Heavy frame gas turbine backlogs growing
• Forecast coal retirements 9% to 24% of peak demand in some regions
Extreme weather
Carbon emissions are not being reduced sufficiently to slow climate change
• Extreme weather will continue to stress the power sector with both colder and hotter temperatures
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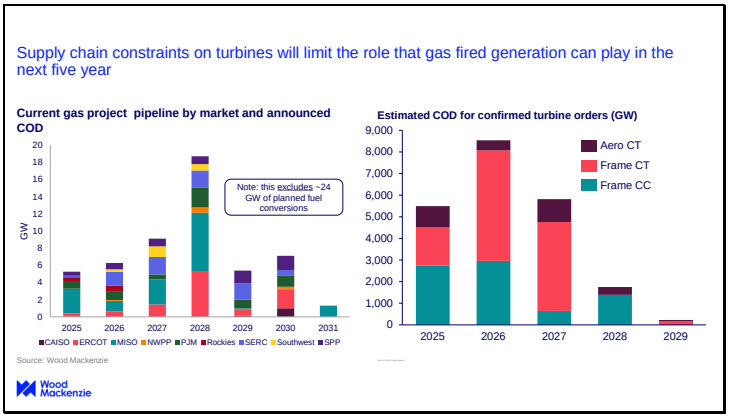
Supply chain constraints on turbines will limit the role that gas fired generation can play in the next five year
Current gas project pipeline by market and announced COD
GW
Note: this excludes ~24 GW of planned fuel conversions
2025 2026 2027 2028 2029 2030 2031
CAISO ERCOT MISO NWPP PJM Rockies SERC Southwest SPP
Source: Wood Mackenzie
Wood Mackenzie
Estimated COD for confirmed turbine orders (GW)
Aero CT
Frame CT
Frame CC
2025 2026 2027 2028 2029

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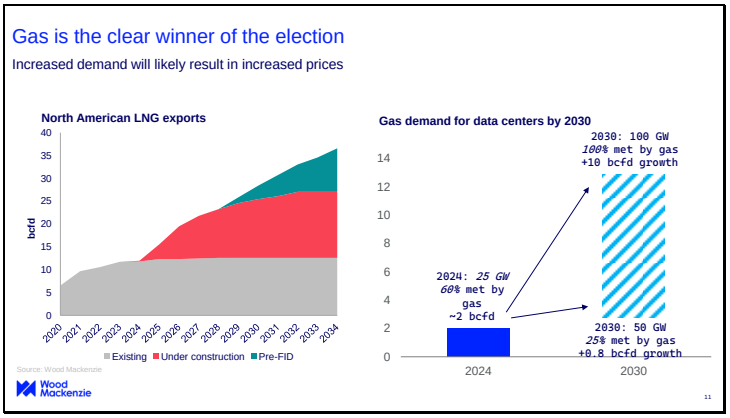
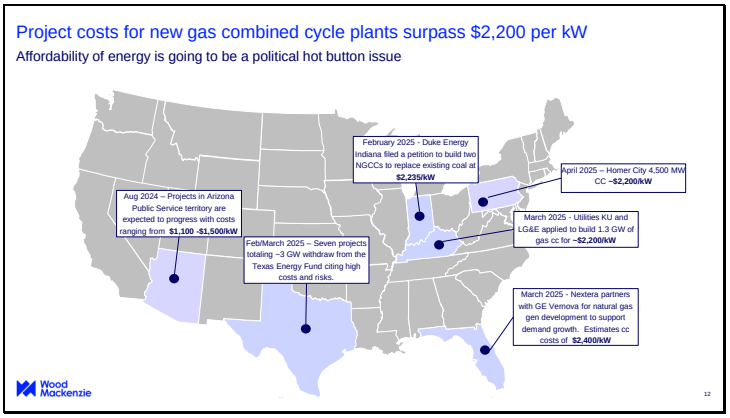

Gas is the clear winner of the election
Increased demand will likely result in increased prices
North American LNG exports
bcfd
40
35
30
25
20
15
10
5
0
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Existing
Under construction
Pre-FID
Source: Wood Mackenzie
Wood Mackenzie
Gas demand for data centers by 2030
14
12
10
8
6
4
2
0
2024: 25 GW
60% met by gas
~2 bcfd
2030: 100 GW
100% met by gas
+10 bcfd growth
2030: 50 GW
25% met by gas
+0.8 bcfd growth
2024
2030
11

Slide 12


Project costs for new gas combined cycle plants surpass $2,200 per kW
Affordability of energy is going to be a political hot button issue
February 2025 - Duke Energy Indiana filed a petition to build two NGCCs to replace existing coal at $2,235/kW
April 2025 – Homer City 4,500 MW CC ~$2,200/kW
Aug 2024 – Projects in Arizona Public Service territory are expected to progress with costs ranging from $1,100 -$1,500/kW
March 2025 - Utilities KU and LG&E applied to build 1.3 GW of gas cc for ~$2,200/kW
Feb/March 2025 – Seven projects totaling ~3 GW withdraw from the Texas Energy Fund citing high costs and risks.
March 2025 - Nextera partners with GE Vernova for natural gas gen development to support demand growth. Estimates cc costs of $2,400/kW
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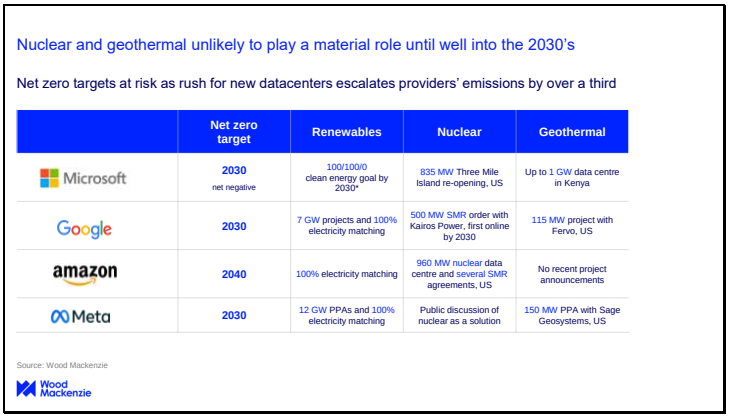

Nuclear and geothermal unlikely to play a material role until well into the 2030's

Net zero targets at risk as rush for new datacenters escalates providers' emissions by over a third

	Net zero target	Renewables	Nuclear	Geothermal
Microsoft	2030 net negative	100/100/0 clean energy goal by 2030*	835 MW Three Mile Island re-opening, US	Up to 1 GW data centre in Kenya
Google	2030	7 GW projects and 100% electricity matching	500 MW SMR order with Kairos Power, first online by 2030	115 MW project with Fervo, US
amazon	2040	100% electricity matching	960 MW nuclear data centre and several SMR agreements, US	No recent project announcements
Meta	2030	12 GW PPAs and 100% electricity matching	Public discussion of nuclear as a solution	150 MW PPA with Sage Geosystems, US

Source: Wood Mackenzie

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Brave new world: disruption to geopolitics, trade and tackling climate change causing daily whiplash for the power industry

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Executive orders impacting the energy industry

Near term impact

- US exit from the Paris Agreement
- LNG export approvals
- Wind restrictions
- Stopping grants and loan guarantees
- Tariffs increasing costs

Longer term impact

- Supporting increased oil and gas production
- Removing barriers to energy infrastructure
- Ending incentives for EVs, California's right to set vehicle emissions standards
- Tariff uncertainty creating challenges for industry

Uncertain Impact

- Inflation Reduction Act

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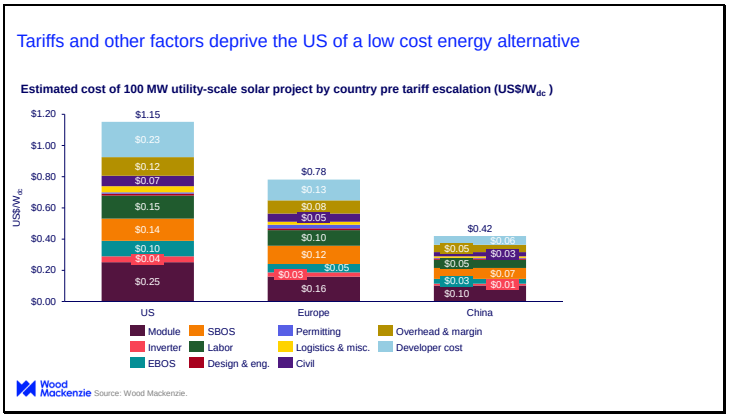
Tariffs and other factors deprive the US of a low cost energy alternative
Estimated cost of 100 MW utility-scale solar project by country pre tariff escalation (US$/W$_{ac}$)
US$/W$_{ac}$
$1.20
$1.00
$0.80
$0.60
$0.40
$0.20
$0.00
$1.15
$0.23
$0.12
$0.07
$0.15
$0.14
$0.10
$0.04
$0.25
$0.78
$0.13
$0.08
$0.05
$0.10
$0.12
$0.03
$0.05
$0.16
$0.42
$0.06
$0.05
$0.03
$0.05
$0.07
$0.03
$0.01
$0.10
US
Europe
China
Module
SBOS
Permitting
Overhead & margin
Inverter
Labor
Logistics & misc.
Developer cost
EBOS
Design & eng.
Civil
Wood Mackenzie
Source: Wood Mackenzie.

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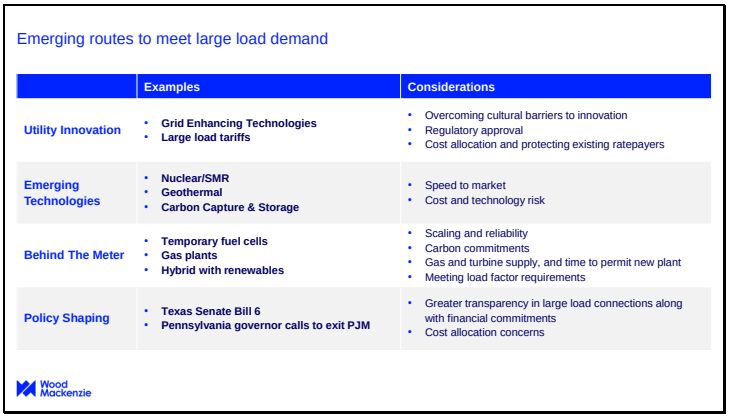

Emerging routes to meet large load demand

	Examples	Considerations
Utility Innovation	• **Grid Enhancing Technologies** • **Large load tariffs**	• Overcoming cultural barriers to innovation • Regulatory approval • Cost allocation and protecting existing ratepayers
Emerging Technologies	• **Nuclear/SMR** • **Geothermal** • **Carbon Capture & Storage**	• Speed to market • Cost and technology risk
Behind The Meter	• **Temporary fuel cells** • **Gas plants** • **Hybrid with renewables**	• Scaling and reliability • Carbon commitments • Gas and turbine supply, and time to permit new plant • Meeting load factor requirements
Policy Shaping	• **Texas Senate Bill 6** • **Pennsylvania governor calls to exit PJM**	• Greater transparency in large load connections along with financial commitments • Cost allocation concerns

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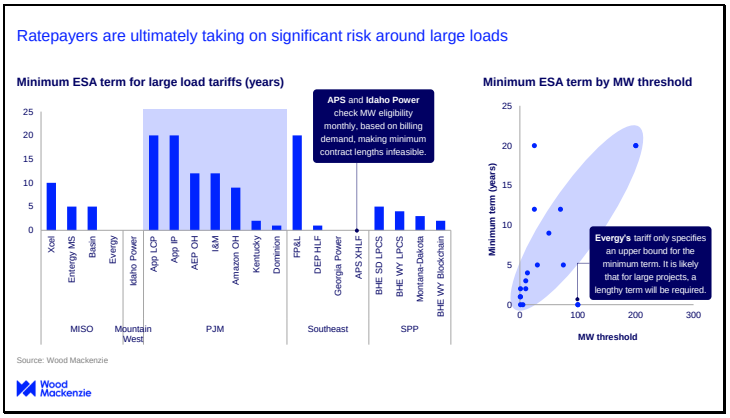
Ratepayers are ultimately taking on significant risk around large loads
Minimum ESA term for large load tariffs (years)
APS and Idaho Power check MW eligibility monthly, based on billing demand, making minimum contract lengths infeasible.
25
20
15
10
5
0
Xcel
Entergy MS
Basin
Evergy
Idaho Power
App LCP
App IP
AEP OH
I&M
Amazon OH
Kentucky
Dominion
FP&L
DEP HLF
Georgia Power
APS XHLF
BHE SD LPCS
BHE WY LPCS
Montana-Dakota
BHE WY Blockchain
MISO
Mountain West
PJM
Southeast
SPP
Source: Wood Mackenzie
Wood Mackenzie
Minimum ESA term by MW threshold
Minimum term (years)
Evergy's tariff only specifies an upper bound for the minimum term. It is likely that for large projects, a lengthy term will be required.
0
100
200
300
MW threshold

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The path forward

- The electric industry sits at the center of national security, economic growth, and decarbonization priorities
- Intersection of a buyer willing to pay a substantial premium for energy, scarcity of energy, and rising prices and costs will reshape power business
- The industry is not prepared for large loads – interconnection policies, software tools, first real test of deregulated power markets
- Substantial opportunities will emerge even as the industry may have to "hunker down"
- This will not be the last whiplash…climate change is not going away

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Photo by Joe Rosenthal

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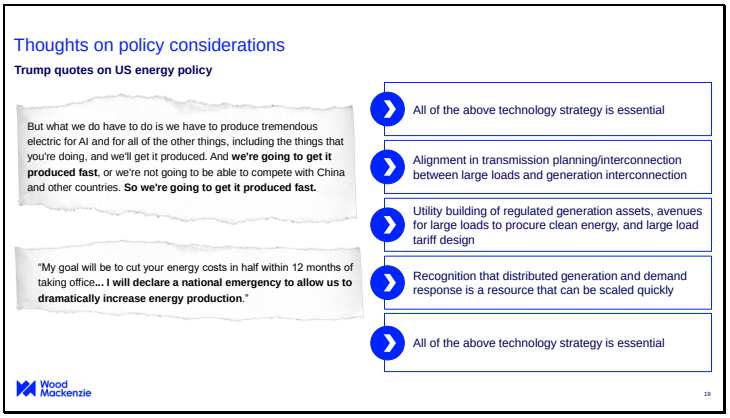
Thoughts on policy considerations
Trump quotes on US energy policy
But what we do have to do is we have to produce tremendous electric for AI and for all of the other things, including the things that you're doing, and we'll get it produced. And we're going to get it produced fast, or we're not going to be able to compete with China and other countries. So we're going to get it produced fast.
"My goal will be to cut your energy costs in half within 12 months of taking office... I will declare a national emergency to allow us to dramatically increase energy production."
All of the above technology strategy is essential
Alignment in transmission planning/interconnection between large loads and generation interconnection
Utility building of regulated generation assets, avenues for large loads to procure clean energy, and large load tariff design
Recognition that distributed generation and demand response is a resource that can be scaled quickly
All of the above technology strategy is essential
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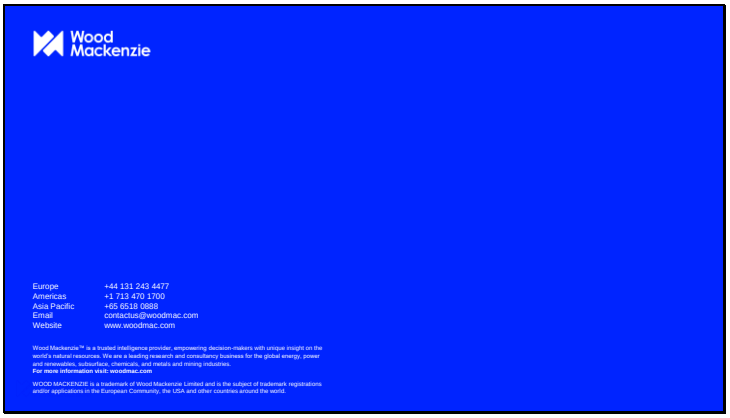
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