FutureBridge

EXECUTIVE BRIEF 2025

From Megawatt to Gigawatt

Is your Power Utility ready for the 24x7 energy demands of the Gen AI era and hyperscale data centers?

A strategic roadmap to lead in the business-critical hyperscale energy market without risking billions on uncertain grid expansion.

Contents

Executive snapshot

As data centers and AI workloads scale exponentially, this report equips senior Power Utility leaders with a strategic lens to navigate infrastructure bottlenecks, volatile CAPEX decisions, and shifting client dynamics—ensuring they remain integral to tomorrow's electricity value chain.

Existing Grid infrastructure is becoming a growth bottleneck for Hyperscalers

Data center energy demand is projected to double over the next 3–5 years, potentially consuming up to 12% of total U.S. electricity. However, transmission and distribution infrastructure is struggling to keep pace, leading to multi-gigawatt connection backlogs in critical regions such as Northern Virginia. Without timely intervention, utilities risk becoming the primary bottleneck to digital economy growth

Future energy volatility is creating strategic gridlock interns of CAPEX planning

Load growth from AI and hyperscalers is highly non-linear and geographically concentrated, rendering traditional CapEx modeling increasingly ineffective. Utilities face a dual risk: underbuilding, which can lead to brownouts, or overbuilding, which risks stranding capital. To de-risk billion-dollar infrastructure decisions, utilities need advanced tools such as multi-horizon planning frameworks, scenario-based modeling, and dynamic load elasticity analysis.

Power Utilities risk losing control as high-value clients explore behind the meter (BTM) solutions

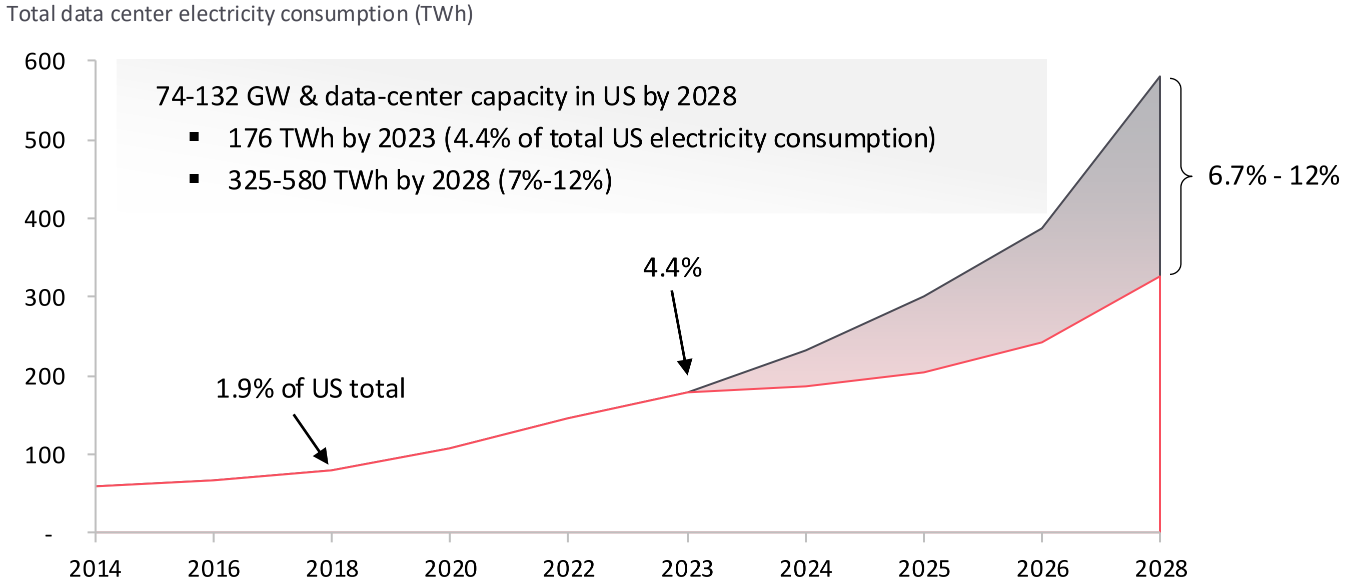
Hyperscalers like Amazon and Google are shifting to on-site generation using natural gas, biofuels, microgrids, and even SMRs. This disintermediation reduces utility revenues, weakens planning visibility, and fragments grid control. To remain relevant, utilities must co-develop hybrid infrastructure models and evolve toward **energy-as-a-service** partnerships.

Grid deployment timelines are lagging behind the pace of data center growth.

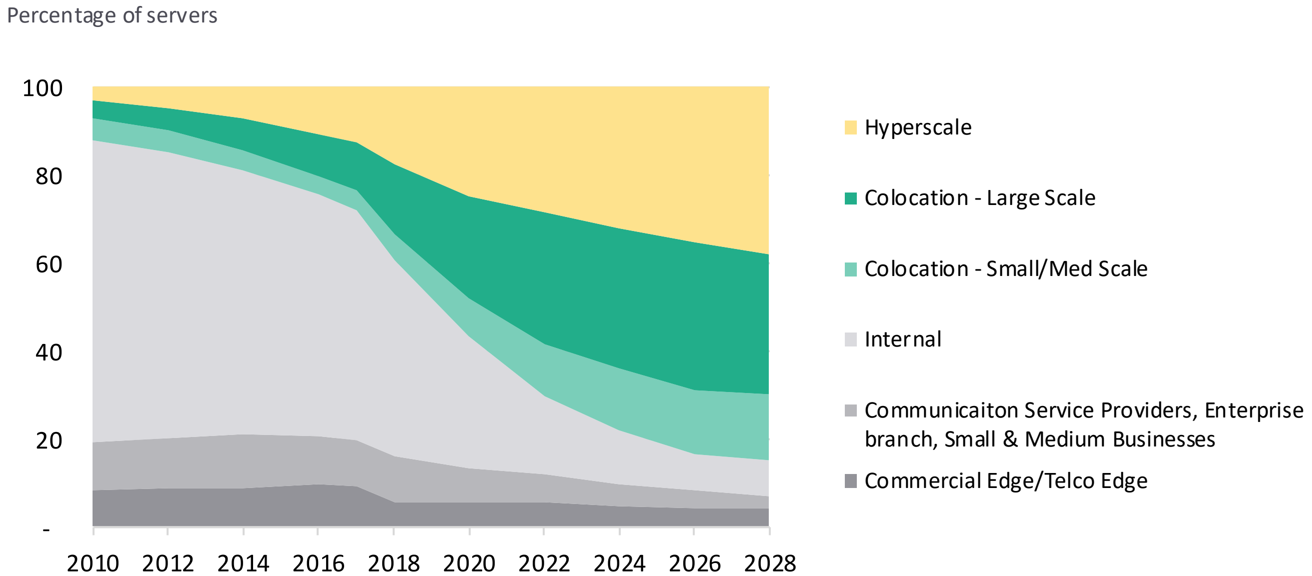
While data centers can be deployed in months, grid infrastructure often takes years. This mismatch is driving urgency for modular, prefabricated substation packages, mobile microgrids, and plug-and-play transformers. To remain embedded in the hyperscaler value chain, utilities must redesign their procurement and engineering processes to significantly reduce deployment timelines.

US data center green energy demand is set for exponential growth (2x in the next 3-5 years)

7-12% of total electricity consumption by 2028 from DCs[1]

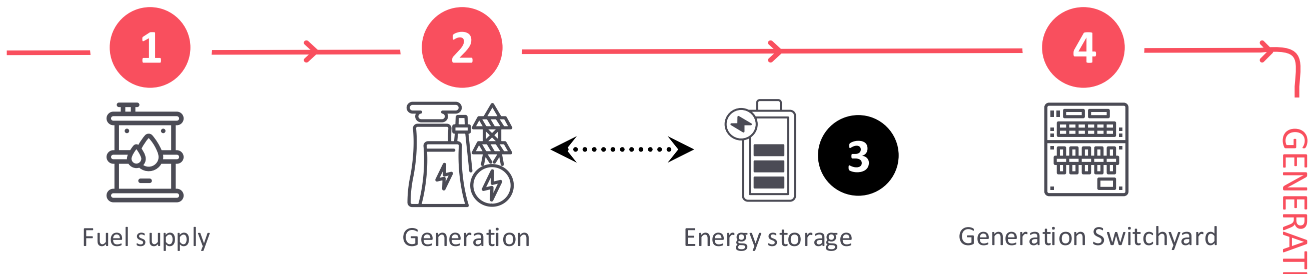


Bulk of the demand is expected to be from hyper-scalers and colos[1]

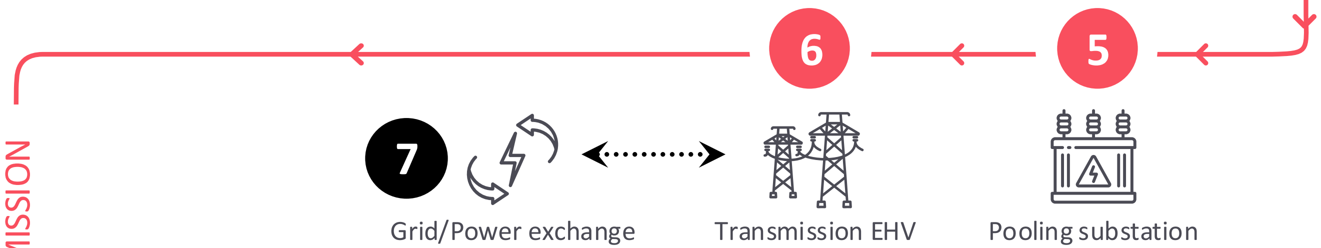


- Aggressive overall shift when considering colocation and hyperscale facilities together (20% in 2014, 57% in 2020)
- With the substantial build out of large-scale facilities for AI and other purposes this proportion will rise to 85% by 2028

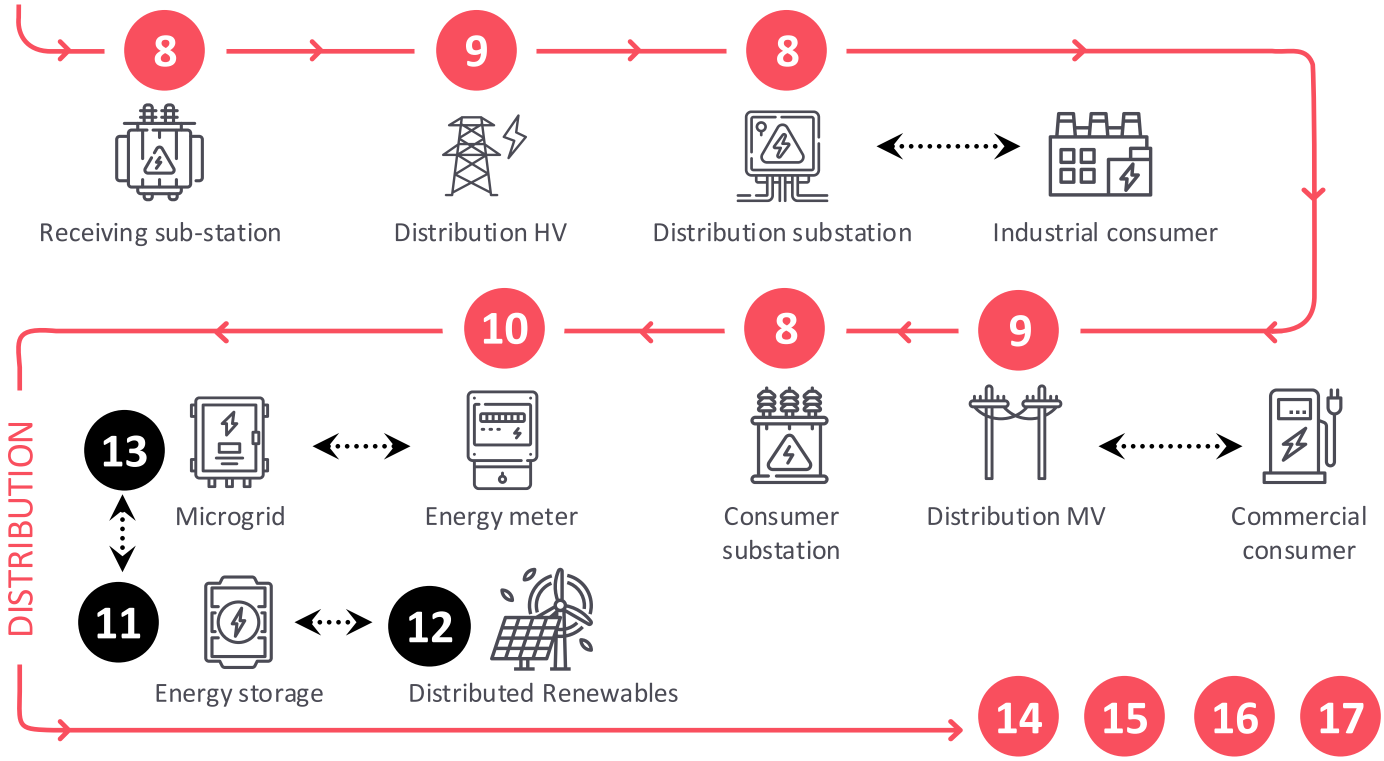
This data center/AI driven demand is creating a profound change across the electricity value chain



- Large scale investment in capacity addition especially of renewable energy accompanied with Long duration energy storage
- Innovations in peaking plants for flexible and efficient operations



- Investment in upgrades and modernization of existing assets and capacity addition for meeting additional traffic especially inter-regional transfers
- Optimal asset utilization, advanced energy management enabled by digitalization to address complexities

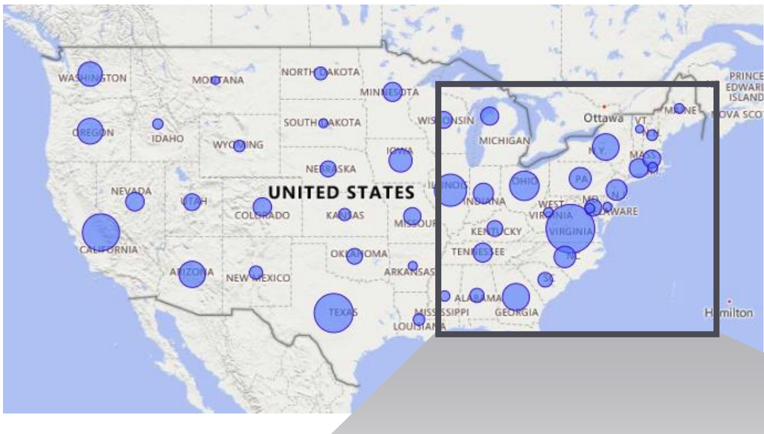


- Decentralized renewable energy, installed behind the meter
- Microgrids and localized energy transactions

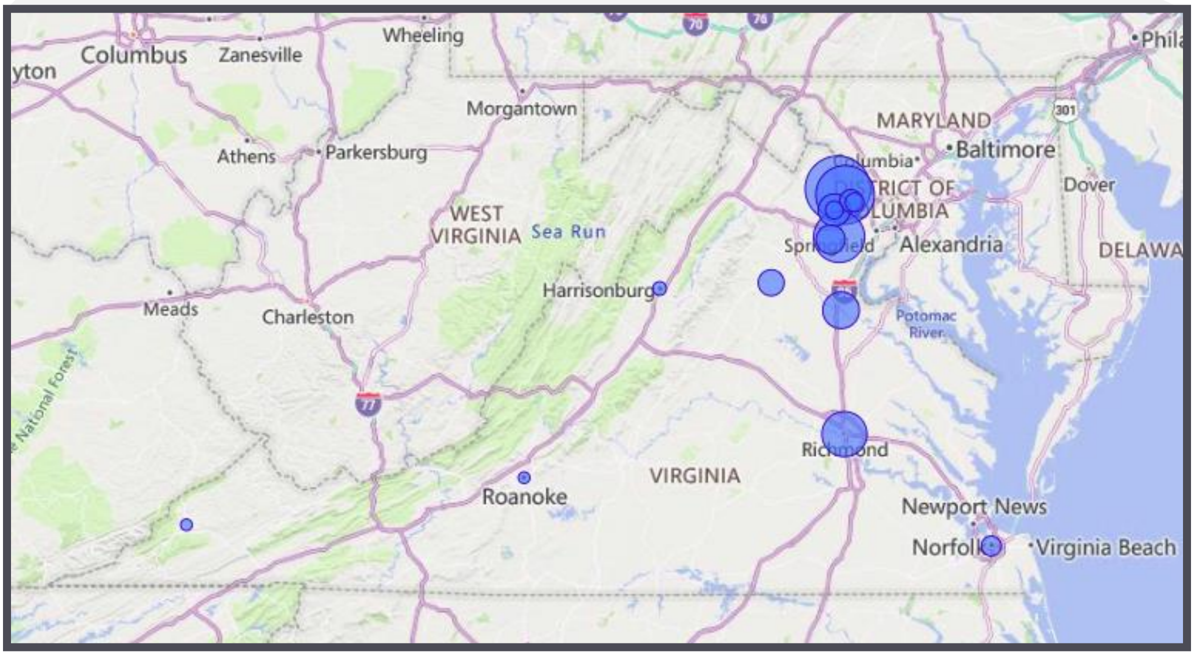
Nodes in the value chain

Data centers in the US are largely concentrated along the east coast especially Northern Virginia

~70% of the world's internet traffic runs through Northern Virginia[2]



- Data centers already consume a quarter of the total electricity in the state[3]
- As of June 2024, demand from DCs is ~4.6 GW largely met through utilities[4]
- 1.5 GW under construction and 2.9 GW in earlier stages of development as of Dec 2024[5]

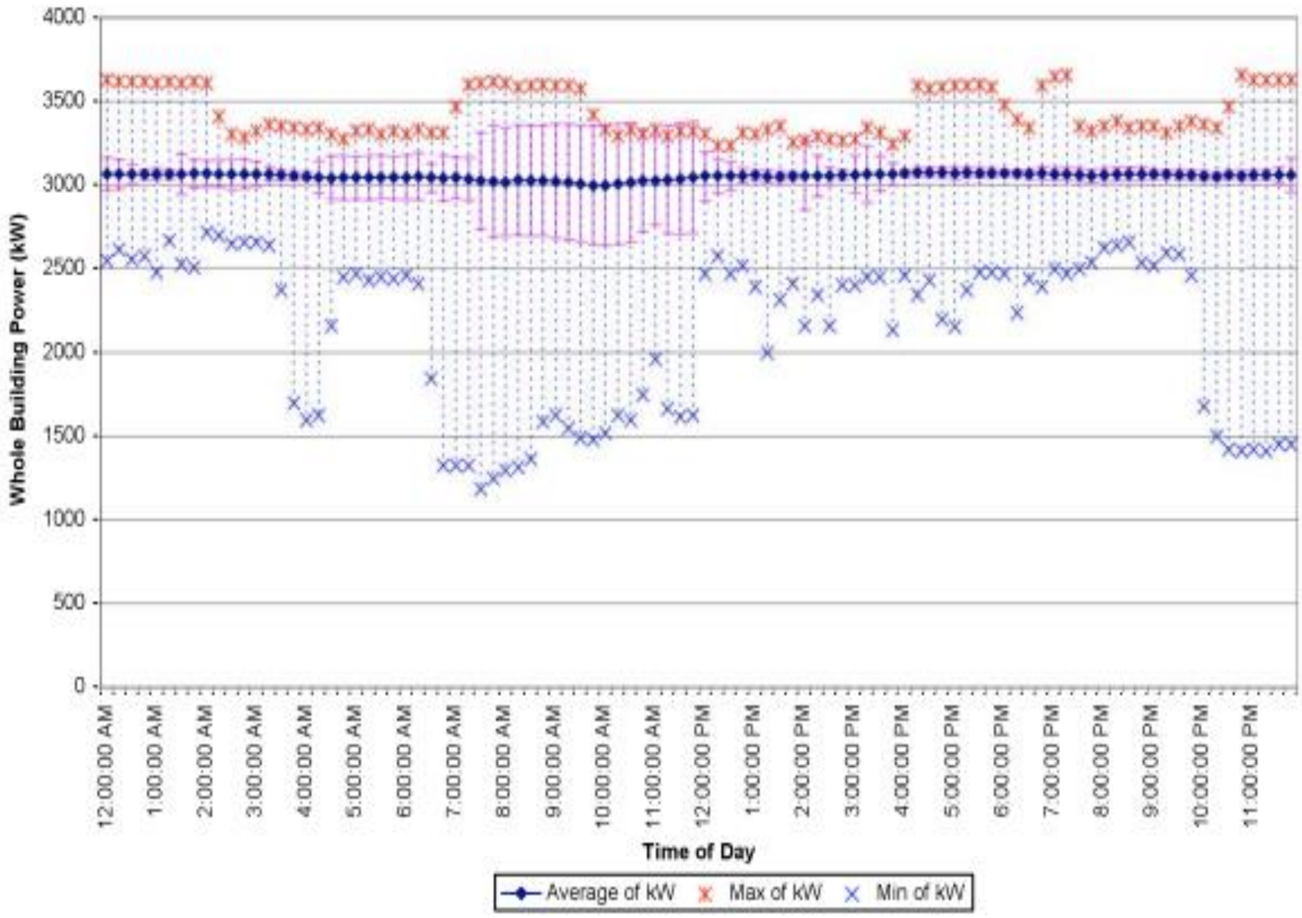


AWS is leading development into localities along Interstate-95 corridor as part of its agreement with the state to invest $35 billion in data centers in new Virginia locations by 2040[5]

Most of Virginia's data center industry is concentrated in Northern Virginia

A typical data centre requires 50-150 MW of reliable, sustainable and affordable power 24x7

Typical load profile of data centers[6]



- Training energy use has dominated historical analysis of AI's energy footprint due to its discrete, measurable nature[1]
- Inference energy consumption presents a more complex modeling challenge with greater long-term implications[1]

REQUIREMENTS[7]

Reliability

- Ensure grid access
- Manage fluctuations
- 99.999% uptime requirement

Sustainability

- Adoption of renewable energy
- Decarbonize back up power
- SF6-free technology

Affordability

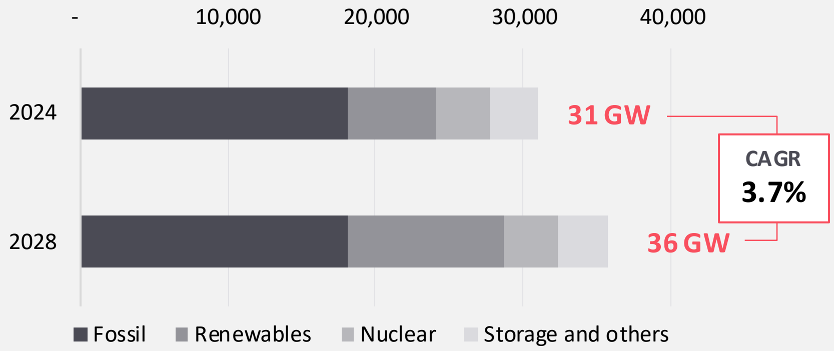
- Better PPAs and innovation in BTM plants
- Evolving prosumer nature
- Participation in markets

Utilities in Northern Virginia may struggle to meet rising data center demand, driving interest in behind-the-meter solutions.

CASE STUDY: VIRGINIA

Generation[9]

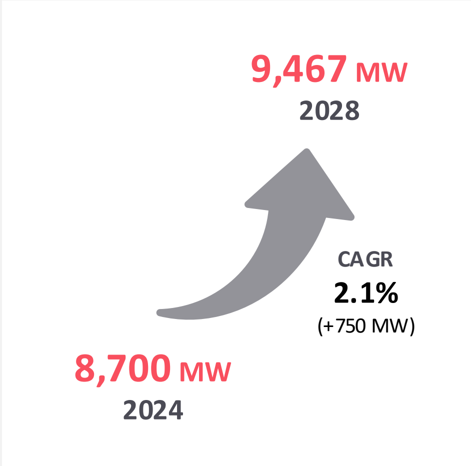
Change in generation mix (MW nameplate capacity)[10]



Estimated based on CAGR projection for 2040;

Transmission[8]

(inter-zonal)



Around 5 GW of renewable capacity addition is expected by EIA by 2028[9]

Observations of JLARC report[8]

- Many data center companies are looking at ways to generate their own power using on-site power generation.
  - Utility-owned generation on or adjacent to a data center site
  - "**behind the meter**" generation
  - "microgrid" where the operates its own generation and may not be connected to the utility grid
- Natural gas power plants seem to be the only option which is presently available which can be viable for on-site generation, however, proximity to pipeline infrastructure is essential
- Other technologies, such as **small modular nuclear reactors**, are being actively pursued by the industry as a potential future power source, but most stakeholders believe these will not realistically be **available until 2035**

Data centres are addressing this gap between demand and supply by entering into private PPAs

CASE STUDY: VIRGINIA

amazon

- Amazon has an agreement with utility company Dominion Energy to explore the development of a 300 MW SMR project near Dominion's existing North Anna nuclear power station.[10]

Google

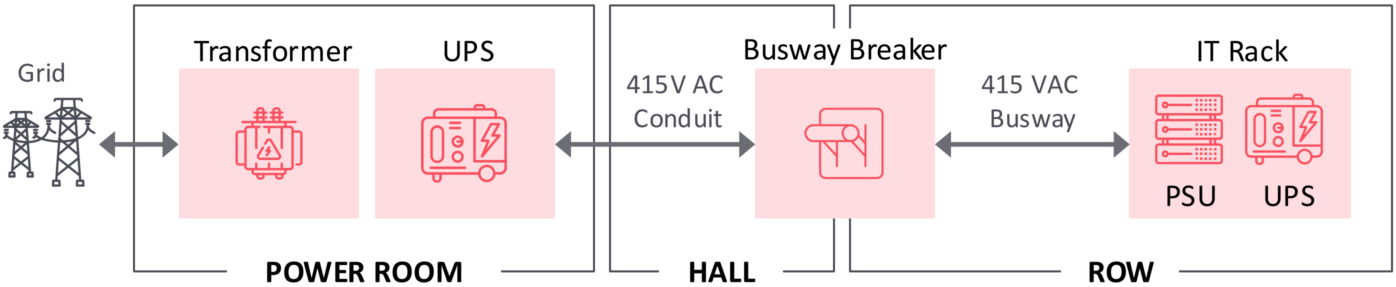
- Google has signed a Power Purchase Agreement (PPA) with Apex Clean Energy for 79MW Rocky Forge Wind project in Virginia[11]
- Goal to match our energy consumption with carbon-free energy (CFE), every hour and in every region by 2030
  - To characterize each region, a metric: "CFE%" is used[12]

Microsoft

- Is committed to 100% renewable energy coverage globally by 2025[13]
  - 2025: long term PPA with Clearway for 335 MW of wind energy from its Mount Storm project in West Virginia[14]
  - Three long-term Virtual Power Purchase Agreements (vPPAs) with EDP Renewables North America for 389MW of power across Illinois and Texas – supply RECs[15]
- In Virginia, transitioning datacenters' backup generators to be powered by a renewable biofuel
- Water: datacenters designed after August 2024, will be built with zero water evaporated direct to chip cooling

Further, the data centre ecosystem players like Nvidia are working towards reducing the overall energy demand from the servers

Present system[16]



Decentralized power supply: AI chips are supplied with power by a large number of PSUs

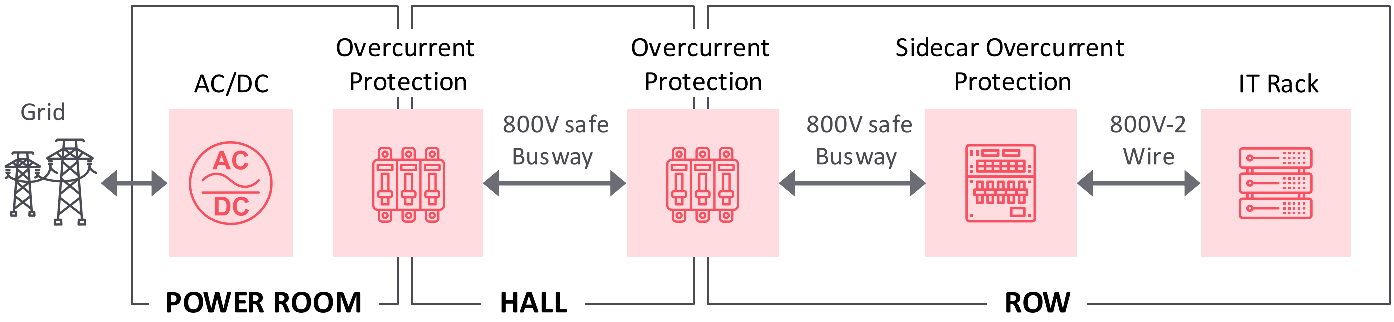
- Most data centers distribute power as AC, which is then converted to DC by individual PSUs inside servers
- Traditional 54 V in-rack power distribution, designed for kilowatt (KW)-scale racks

This process leads to significant energy losses during conversion and distribution

Players in the ecosystem

- **Silicon providers:** Infineon, MPS, Navitas, ROHM, STMicroelectronics, Texas Instruments
- **Power system components:** Delta, Flex Power, Lead Wealth, LiteOn, Megmeet
- **Data center power systems:** Eaton, Schneider Electric, Vertiv

Proposed HVDC system[17]



Centralized, HVDC distribution, specifically at 800V

- Supply power directly to server racks and convert it only at the point of use (the AI chip/GPU)
- Use fewer power conversion stages and allow upgrades to higher distribution voltages
- Make best use of the constrained space in a server rack

This reduces conversion stages, increases efficiency, and supports higher power densities.

Four interacting uncertainties:

- The energy efficiency of inference hardware,
- The mix of hardware types used (from ASICs to GPUs to CPUs),
- The scale and nature of user demand, and
- The characteristics of inference facilities

Implications for electricity utilities

The rapid growth of data centers is overwhelming aging power infrastructure, causing grid congestion and emergencies. Utilities must adopt grid technologies, demand response programs, and innovative pricing to manage the load-generation balance

Challenges faced by electricity utilities

1 Aging infrastructure

- ~70% of transmission lines in US for instance, is over 25 years old
- T&D networks are usually designed according to past demand patterns, but the growth of data centers is an exception

2 Limited power supply

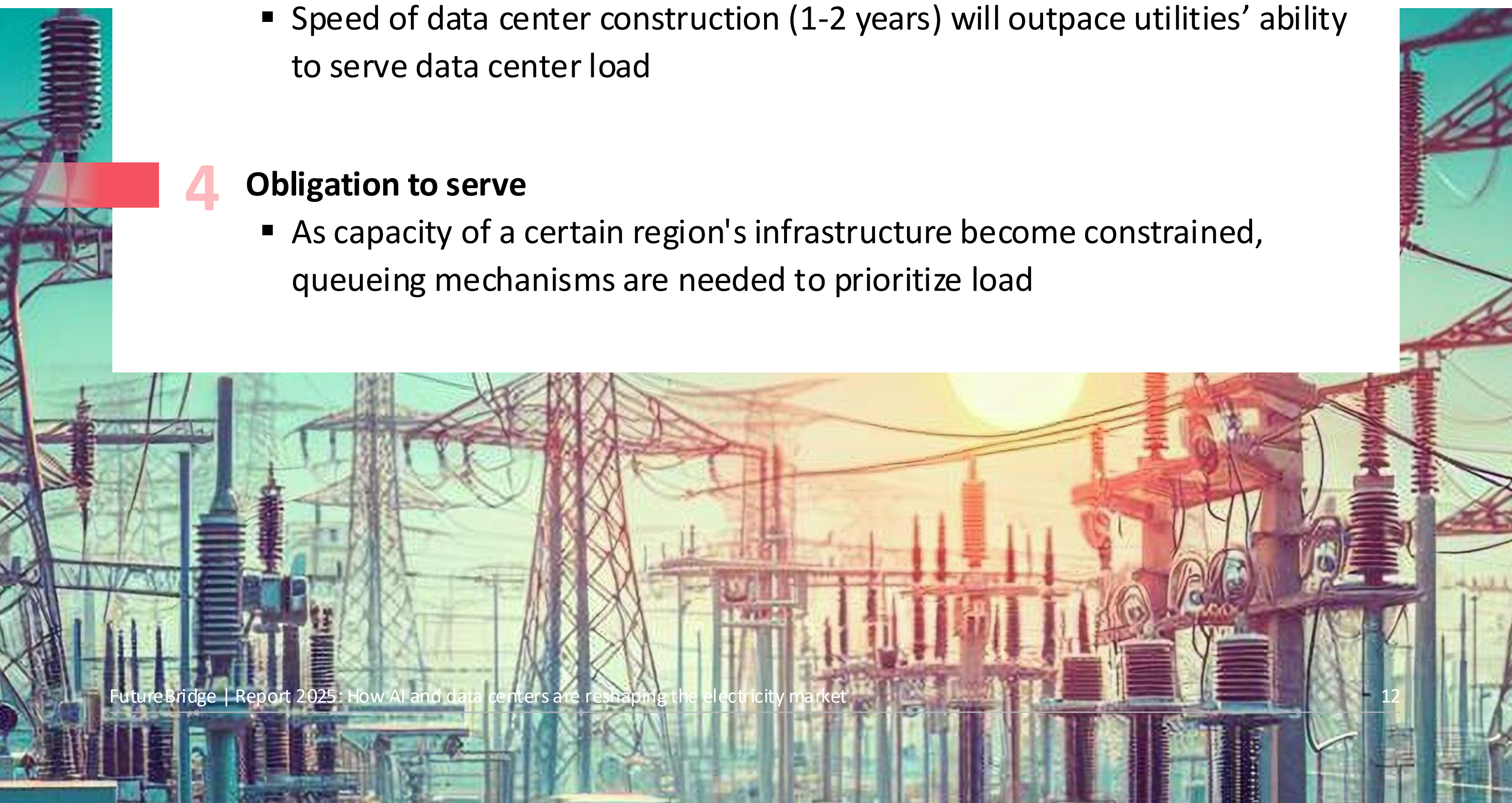
- **The decommissioning of fossil-fired** plants poses a potential power supply gap as new renewable energy sources aren't coming online fast enough

3 Data centers outpace utilities

- Speed of data center construction (1-2 years) will outpace utilities' ability to serve data center load

4 Obligation to serve

- As capacity of a certain region's infrastructure become constrained, queueing mechanisms are needed to prioritize load



Solutions to manage the increasing strain on utility power generation, transmission and distribution

Planning for rapid generation capacity addition

- Develop capacity addition plans in close collaboration with data centre developers
- Flexibilization of existing assets like gas turbines
- Strengthen the portfolio of ancillary support services through leveraging existing assets and new assets like long duration energy storage

Deploying Grid Enhancing Technologies (GET)

- GETs like Dynamic Line Ratings (DLR) and advanced conductors help unlock up to 40% additional capacity from existing infrastructure

Innovative pricing models

Data centers can be made participants to models like:

- Customized Rate Structures
- Clean Energy Tariffs

Flexibilization of grid operations

- AI and ML enhance demand response through real-time, automated load-generation management
- Adopt flexible generation like gas turbines with fast ramping capabilities and energy storage into the mix

Demand response programs

- Shift electricity usage during peak periods in response to time-based rates

Strategies being adopted by data center operators

The emerging scenario and associated requirements

Data centers are disrupting the electricity value chain due to their exponential growth and demand for sustainable energy

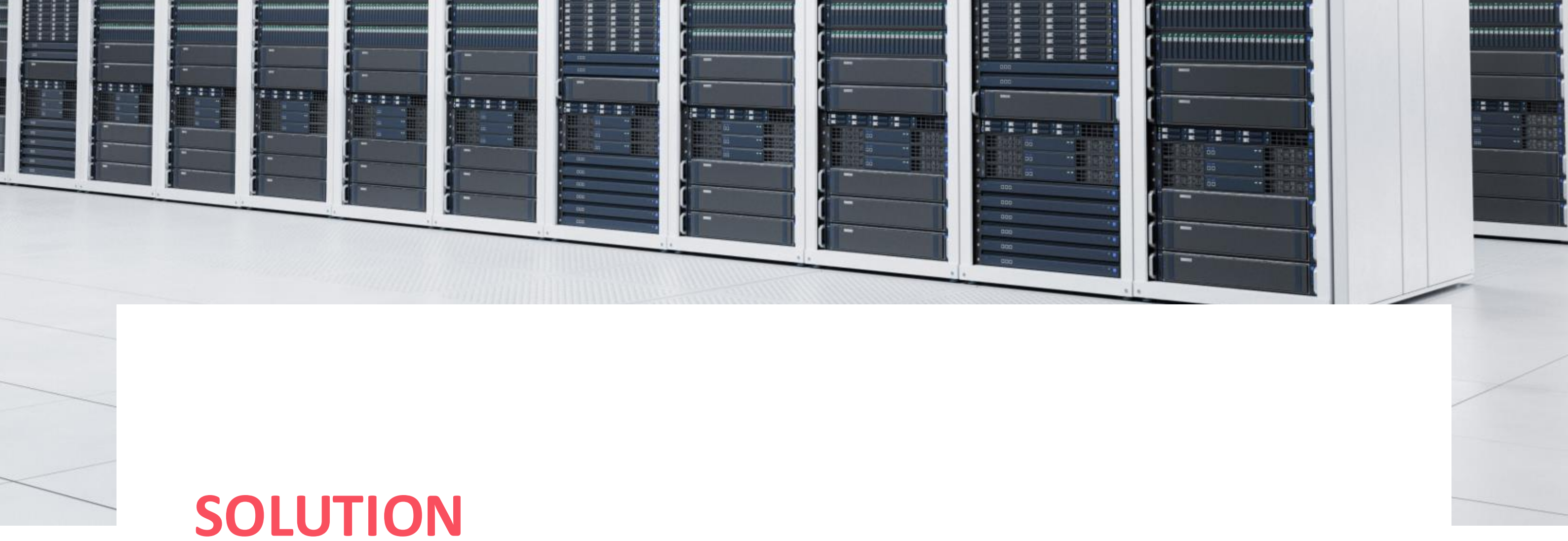
1 **A typical data center needs 5-150 MW 24/7 reliable, sustainable and affordable electricity. A typical breakdown of the energy is:**

- Servers / Key equipment: 50%-60%
- Cooling Systems: 30%-40%
- Power distribution losses: 10%-20%

2 **There are five major factors which determine the location of data centers:**

- Network latency
- Room for growth / modifications
- Deployment velocity
- Natural disaster risk
- ESG considerations

3 **At present, Virginia in US is one of the preferred location due to network latency advantage**



SOLUTION

Data centers are adopting a multi-pronged approach:

- "Behind the Meter" solutions are likely to grow 5-6 times than "Front of the Meter" solutions
- Preference for integrated solutions over specific solutions, including "Energy as a Service"
- Energy efficiency is likely to emerge as one of key differentiator for the solutions
- Components (servers, storage devices, and networking equipment) are designed to deliver maximum performance with minimal energy consumption, directly reducing the overall data center energy footprint
- Many data center ecosystem players along with semiconductor companies are trying to innovate solutions to reduce the overall demand by improving energy efficiency within the data center
- PPA agreement with utilities to ensure 24/7 electricity supply

Opportunities for OEMs and solution providers

1 Procurement solutions

PPA management

- Umbrella contract for power procurement
- RE procurement and certification services
- Digital mapping of sources across geographies and timelines
- Monitoring and tracking solutions for customers

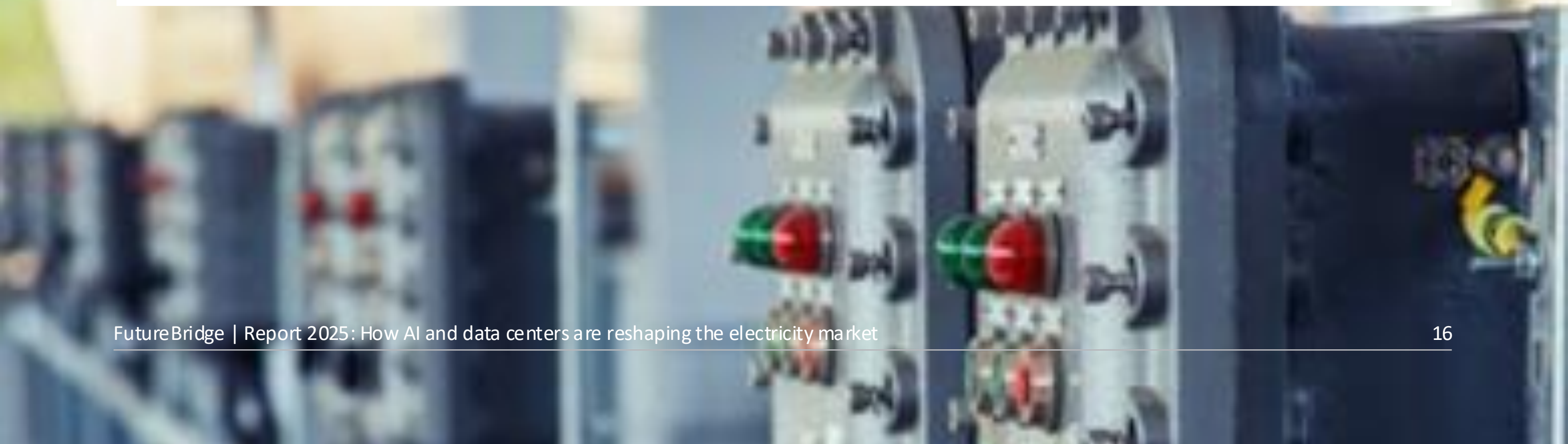
2 Integrated solutions for data centers

BTM Electrical systems

- Power distribution, conversion systems
- Transformers, circuit breakers, switchgears, solar inverters etc.
- HVDC architecture

Microgrids with integration of

- Renewable energy, BESS
- Gas turbines, others



Power backup

- UPS solutions, BESS
- Hydrogen fuel cells
- Gas turbines with flexibilization and multi-fuel capability for H_2, NH_3 etc.

Customized solutions

- Racks, power, cooling and management systems
- Prefabricated modular solutions for power and integrated IT
- Digital management systems for assets, monitoring
- Power consulting services
- CO_2 capture

Cooling solutions

- End-to-end cooling portfolio
- High-efficiency motors and variable speed drives (VSDs)
- Ultra-low harmonic (ULH) drives

3 Grid technology

- Hardware like cables, transformers, switchgears, STATCOMs
- Enabling FACTS, DERMs
- Digital tools enabling network modelling, monitoring, business models like VPPs and market operations

OEMs are developing digital solutions, including AI and ML into energy management systems to predict usage patterns, optimize resource allocation, and enable real-time adjustments

Questions leaders are also asking

When will grid expansions catch up with the 24×7×365 energy demands of Gen AI operators and hyperscale data centers?

Large Scale data center projects are being announced — but can utilities scale capacity in time?

Can billions in CAPEX for grid upgrades be safeguarded against stranded assets and underutilized lines?

Demand is rising, but are investments being prioritized for the right nodes?

Will hyperscalers bypass the grid with behind-the-meter (BTM) solutions if deployment delays persist?

Utilities risk losing their most valuable clients — how do we prevent disintermediation?

Is slow permitting and regulatory approval quietly eroding trust with Gen AI clients?

Competitors and private players are moving faster — can utilities stay embedded in the value chain?

How do we fast-track deployment without compromising reliability and compliance?

Shortcuts may meet timelines, but can they sustain resilience under unpredictable AI-driven loads

Talk to our Energy industry experts

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Glossary of terms

Telco Edge:	Deployment of small closets/rooms to micro data centers and network infrastructure by communications companies as points of presence throughout their network
Commercial Edge:	Network closets, server rooms, and micro-data centers deployed to support modern digital, infrastructure, and software delivery services to edge locations for commercial (focused on customer and business operations) and industrial (focused on supply chain and channel operations)
Small and Medium Businesses (SMB):	SMB deployments in their own internal facilities
Enterprise Branch:	Classic remote and branch office (ROBO) deployments for large enterprises in their own internal facilities (network closets, server rooms)
Internal:	Data centers run by enterprises, internally, for their own use
Communications Service Providers (Comms SPs):	Data centers run by telecommunications/cable companies to support internal services required to enable provision of communications technology services to their customers
Colocation – Sm/Med Scale:	Data centers built by local colocation companies typically providing retail leasing at smaller scale
Colocation – Large Scale:	Data centers built by major colocation companies providing wholesale and retail colocation leasing, typically deploying large and mega datacenters
Hyperscale:	Data centers built by companies that deploy internet services and platforms at massive scale

Meet the minds behind the insights

With over 100 years of combined global experience, our Energy team delivers cutting-edge solutions to global clients across emerging domains such as **Energy Transition, Decarbonization** and **Green Fuels.**

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With **23+ years of experience**, Mukesh guides global energy clients through transition, innovation, and growth strategies across emerging domains.

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