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AI Talks: Data Centers + Digital Infrastructure

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Today's Agenda

- Data Center Basics and Current Trends
- Data Center Locations/Markets
- Data Center Costs
- AI Driven Growth
- Power
- Alternative Power Sources
- Where we are headed
- Legal Considerations
- What's needed to meet demand

Data Center Basics and Current Trends

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What is a Data Center?

- Facility housing computer systems and associated components and used by organizations to store, process, and distribute large amounts of data.
- Includes primary and redundant/backup power supplies, primary and redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression), and security devices.
- Often leased by megawatt of power needs v. square footage



What Data Centers Do



Backup and Disaster Recovery – backup/recovery solutions if there are hardware failures or unforeseen events that result in loss or damage of data



Cloud Computing – enable services like virtual machines, storage, and application to be remotely accessed



Business Applications – e-mail, customer relationship management, etc.



Analytics – real time analytics and critical operations

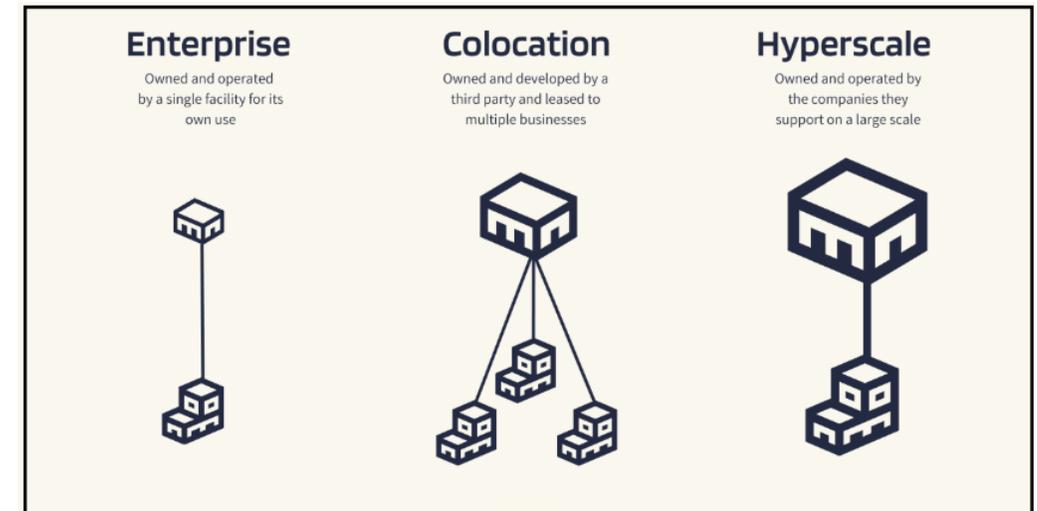


Business scalability and flexibility – allows businesses to adapt to demand changes

- **Storing and Managing Data** – safe and reliable storage space for business data and ensuring its available
 - Web content (websites, online applications),
 - Business data (customer records, employee information, etc.),
 - Email communication and records
 - Application and user data (social media platforms and software applications),
 - Big data and analytics (analytics, training machine learning models, research)
- **Network Infrastructure and Connectivity** – connects servers, storage, and end users to allow efficient communication and data transfer
- **Data Security and Protection** – implement firewalls, intrusion detection systems, and access controls

Typical Data Center Types

- **Enterprise**
 - Owner-operated to meet internal IT needs and requirements
- **Colocation**
 - Leased to 3rd parties (typically in multi-tenant data centers)
 - Owner provides rack space and tenants install own servers
 - Retail v. Wholesale:
 - Retail: Similar to hotel – no ability to design the room but have access to IT support “amenities”
 - Wholesale: tenant leasing large amounts of space/power can help design and construct
- **Hyperscale data centers**
 - Large facility/campuses hosting cloud providers and large companies’ internal compute and data processing needs
- **Edge data centers**
 - Computing resource close to end users or devices (i.e., closer to points of connectivity)
 - Low latency for real-time data processing



Tier Classification of Data Centers

- **24/7/365 operations are key**
- **Goal: zero downtime**
- “Uptime” means duration data center infrastructure is operational and available for service
- “Redundancy” means duplication of critical components to ensure continuous operation even if one part fails

Tier I

- Small businesses
- Basic capacity level
- Single path power and cooling
- No redundancy
- 99.671% uptime / year
- 28.8 max hours downtime / year

Tier II

- Small to medium businesses
- Single path power and cooling
- Some cooling and power redundancies
- 99.741% uptime / year
- 22 max hours of downtime / year

Tier III

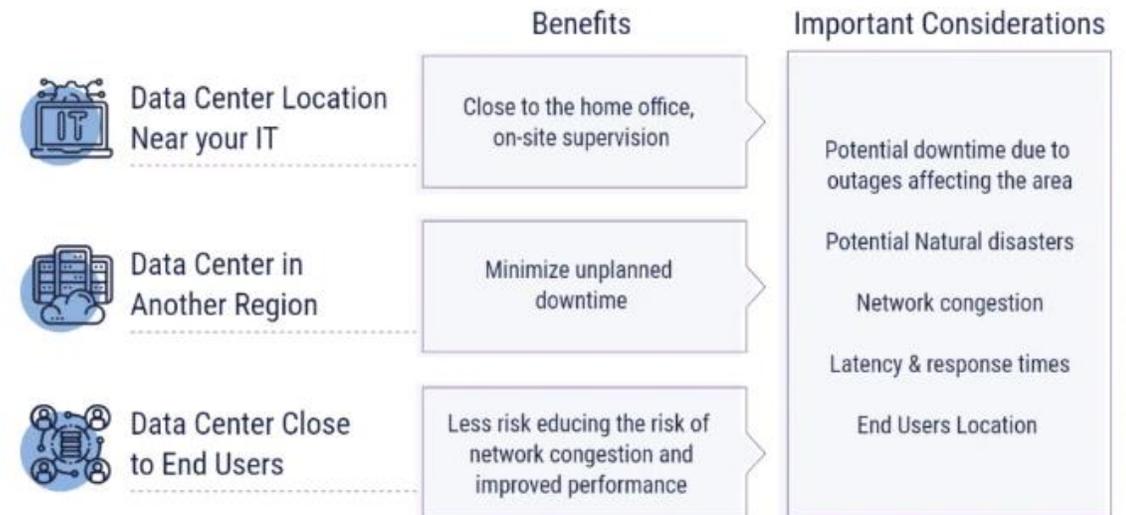
- Large and growing companies
- Multiple paths for power and cooling
- Fault tolerant (N+1)
- Sustain 72-hour outage
- 99.982% uptime / year
- 1.6 max hours downtime / year
- Most common

Tier IV

- Enterprises requiring utmost security
- Two independent utility paths
- Fully redundant (2N or 2N+1)
- Sustain 96-hour power outage
- 99.995% uptime / year
- 26.3 max **minutes** downtime / year

Key Data Center Location Characteristics

- **Power Cost, Reliability, and Availability**
 - Key driver of location decisions
 - Immediately available power separates players from posers
- **Connectivity Options**
 - Single fiber networks are vulnerable to outages and price insensitivity
- **Disaster Risks**
 - Biggest potential downtime risk if data center is inaccessible
- **Network Latency**
 - Distance data travels and associated network congestion
 - Not all compute needs require low-latency
- **Scalability**
 - Land and labor availability are paramount
 - 36MW in CA v. 3GW in VA or TX
- **Economic Incentives**
 - Tax exemptions on:
 - Electricity consumption
 - Data center equipment
 - Tax credits for projects located in underserved areas



Northern Virginia Data Centers

- Northern Virginia is world's largest data center market

- **Top 5 “States” in Terms of Data Center Capacity:**

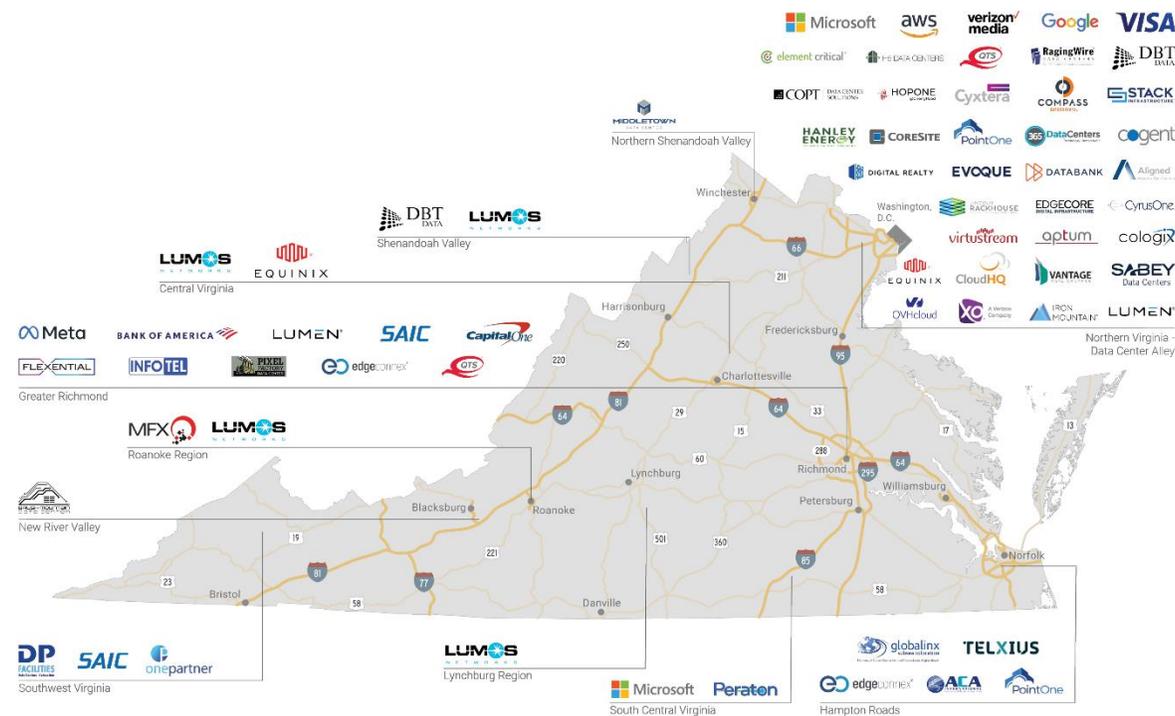
- Northern Virginia
- Oregon
- Texas
- Arizona
- California

- **Why Northern Virginia:**

- Attractive tax incentives
- Dense and expanding fiber infrastructure
- Large pool of skilled workers

- **Power demand from data centers in Virginia doubled between 2018 and 2022**

- Forecast to double again by 2028



<https://www.datacenterfrontier.com/site-selection/article/55126944/land-and-expand-virginia-data-centers>

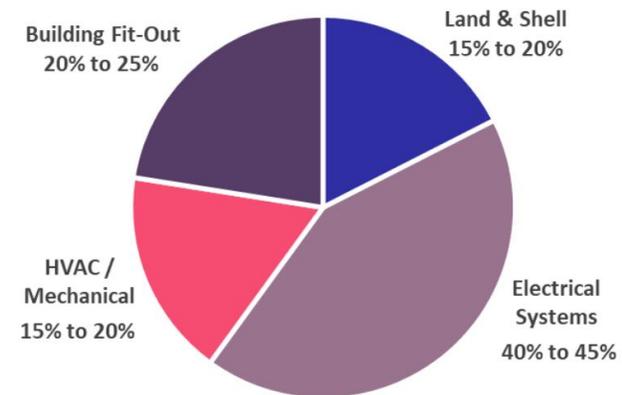
Emerging Data Center Markets

- **Salt Lake City**
 - Ideal climate, lower power costs (5-6 cents per kwh – national average is 6.6), fiber lines, educated technical workforce, low land cost and open space, minimal natural disasters
- **Kansas City**
 - Low land cost, lowest wholesale power cost in nation (\$30/MWh = 3 cents per kwh), fiber lines, Sprint, T-Mobile, and AT&T have major regional facilities, central U.S.
- **Indianapolis**
 - Generous tax incentives (sales and use-tax exemption on data center equipment for up to 50 years based on investment), access to renewable energy, educated technical workforce, predictable climate
- **Minneapolis**
 - Sales tax exemption for 20 years on equipment if building or refurbishing data centers, investment in broadband infrastructure, incentivized renewable energy, good climate
- **Nashville**
 - Low disaster risks, low land price, affordable power rates, network connectivity, educated workforce, (Amazon, Oracle, and Meta in the area), proximity to other major markets (Atlanta, Charlotte)
- **Denver**
 - Well-developed network infrastructure, (Microsoft, IBM, Amazon), low natural disaster profile, mild climate and low humidity)

Data Center Costs

Construction costs range between \$9 million and \$15 million per megawatt of commissioned IT load.

- **Land and Building Shell:** building shell, raised floor
- **Electrical Systems:** electrical backup generator, batteries, power distribution unit (PDU), uninterruptible power supply (UPS), switchgear / transformers
- **HVAC / Mechanical / Cooling Systems:** computer room air conditioner (CRAC), computer room air handler (CRAH), air cooled chillers, chilled water storage and pipes
- **Building Fit-Out:** lobby / entrance, meet-me room (MMR), shipping & receiving area



Annual Operating Expenses:

- **Power:** The largest operating item, ranging between 40% and 80% of total annual expenditures.
- **Staffing:** Security, operations and IT staff account for 15% of annual operating expenditures
- **Taxes:** Property taxes are estimated to be between 8.7% of total cost over 10 years and about 12% of annual operating spending.
- **Other:** administrative, maintenance, security, and landscaping.

AI Driven Growth

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AI-Driven Growth

- AI fueling a boom in data center development
 - Data centers are now critical infrastructure for the economy, innovation and national security
 - Hyperscale cloud and AI companies investing tens of billions in new facilities to train and deploy AI models.
 - Data Center demands fueling hardware innovation
 - Staggering numbers. Global price tag to scale AI data centers could hit over \$5.2 trillion by 2030.
 - 8 leading hyperscalers plan to increase data center and compute infrastructure capex 44% year-over-year to \$371 billion in 2025.

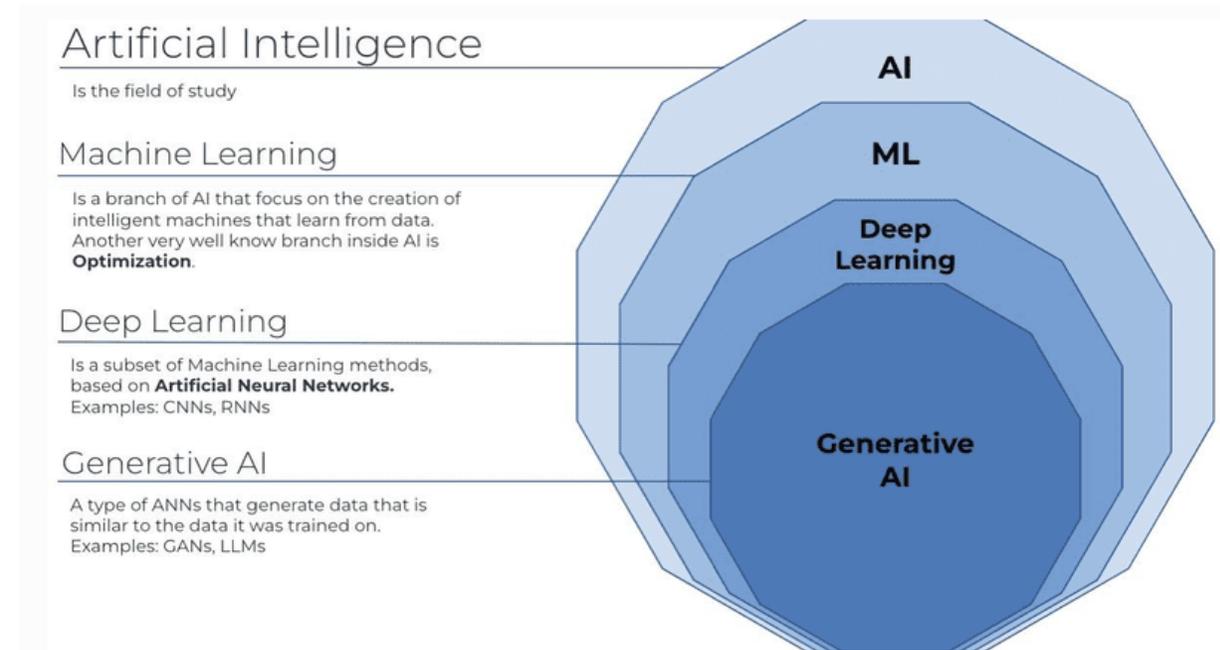
Generative v. Machine Learning AI

• Generative AI:

- Creates new content/data that mimic human creations
- Examples: ChatGPT, Deepfake Technology, art, and music
- Characteristics: low latency, thousands or millions of kw hours, sophisticated cooling (typically liquid), high performance storage for unstructured data (texts, images, videos), massive computational power

• Machine Learning AI:

- Large amounts of data fed into algorithms to analyze information and learn
- Focuses on understanding and predicting existing data
- Involves data collection, training, validation, and testing
- Examples: Predictive Finance Models, healthcare diagnosis
- Characteristics: higher latency, significant power (not as much as generative), traditional cooling (air), structured data stored in cloud or databases, not as much computational power



<https://fpt.ai/blogs/generative-ai-vs-machine-learning/>

AI Data Centers

- **Characteristics of AI Data Centers:**

- **Quick Computing**

- High Performance Computing (HPC) capabilities within AI accelerators
- AI Accelerators = hardware that makes AI and its applications possible

- **Advanced Storage**

- AI data center designs need storage that can accommodate fluctuations in data demands

- **Secure and Resilient Network**

- AI data centers require advanced network virtualization technology for better interconnection, scalability, and performance
- Must also address data privacy and security related to the large volume of data used to train generative AI

- **Power and Cooling Solutions**

- AI computational power and storage requires massive amounts of power and advanced cooling to avoid outages
- AI is predicted to drive a 165% increase in data center electricity demand by 2030



<https://www.bloomenergy.com/blog/ai-data-center/>

AI Data Centers

- **Characteristics of AI Data Centers:**

- **Scale and Footprint**

- Larger footprint to house computer clusters
- Training AI models requires thousands of GPUs for AI training.
- Engineered for maximum throughput
- Large campuses or data center parks

- **Use Case Differences**

- Purpose built for training AI models or serving AI Inference



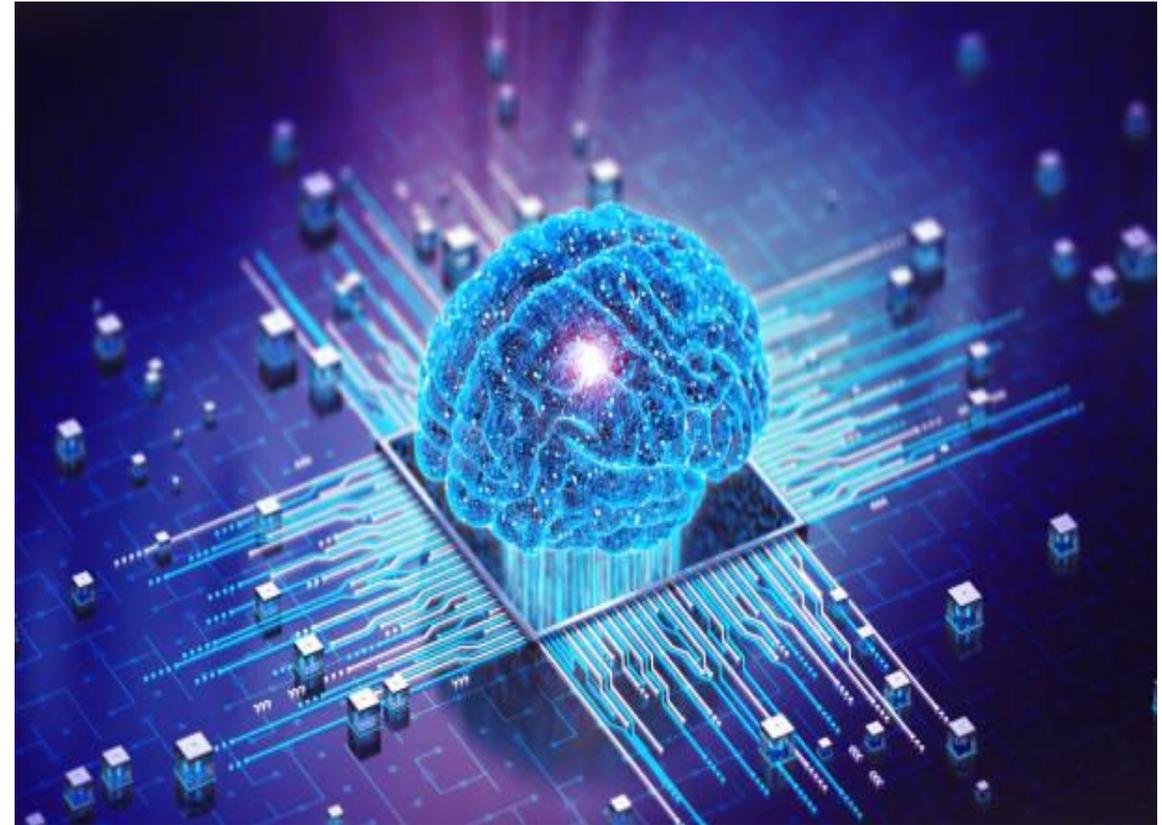
<https://www.bloomenergy.com/blog/ai-data-center/>

AI Data Center Design

- AI is influencing the data center design, with a greater focus on energy efficiency, high-density deployments, and advanced cooling technologies
- The need for specialized hardware like GPUs, TPUs, and FPGAs optimized for AI processing is also driving changes in data center architecture
- The demand for AI-specific hardware, particularly GPUs, is outpacing supply, leading to shortages and increased costs
- A combination of factors is causing the shortage, including high demand for AI and gaming, supply chain disruptions, and global economic and political issues
- Scaling up production of these chips is a complex and expensive process

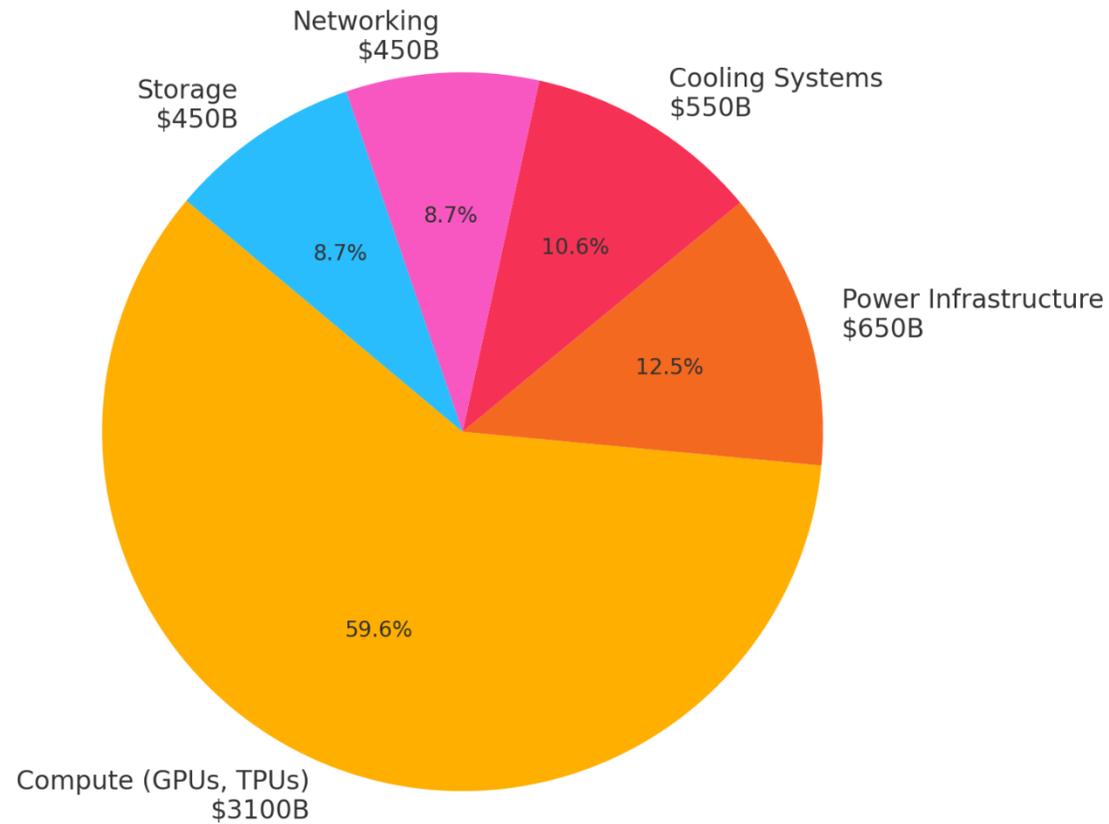
AI - Optimization and Automation

- AI can optimize resource allocation, dynamically distributing computing power, storage, and network resources based on workload demands
- AI powered predictive maintenance can anticipate equipment failures, minimizing downtime and extending the lifespan of critical infrastructure
- AI can automate tasks like network configuration, optimizing cooling systems, managing network traffic, and automating security protocols



AI-Driven Growth

Global AI Data Center Equipment Spending by Category (2025–2030)



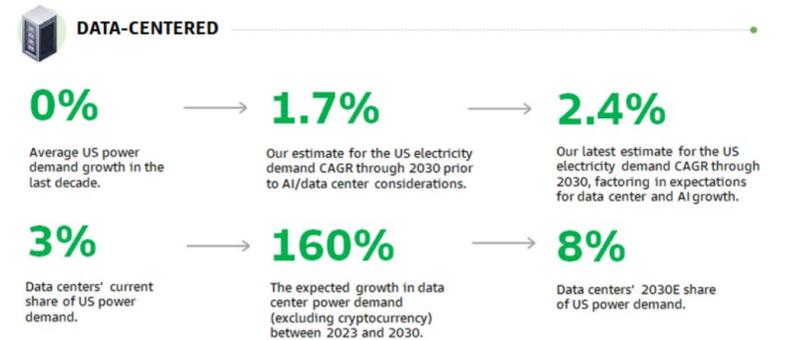
Power Requirements and Alternative Generation

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Power Requirements

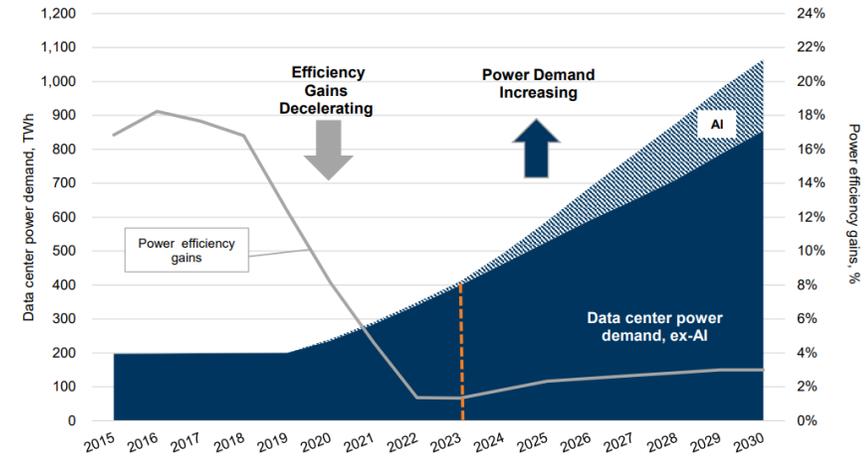
- Data centers consume 10 to 50 times more energy per square foot than a typical commercial office building
 - Traditional power ranges from 7kW to 10 kW per rack
 - Cloud providers require 10 kW to 40 kW per rack
 - AI workloads can exceed 60 kW to 100+ kW per rack.
 - Comparison: 100 MW = 80,000 homes
- According to DOE, data center power consumption rose from 58 TWh in 2014 to 176 TWh in 2023 (303% increase)
 - Six key markets—Northern Virginia, Silicon Valley, Phoenix, Atlanta, Chicago and Dallas—accounted for 72% of that increase.
- DOE projects power demand to increase to double or triple again by 2028

THE US POWER DEMAND SURGE in numbers

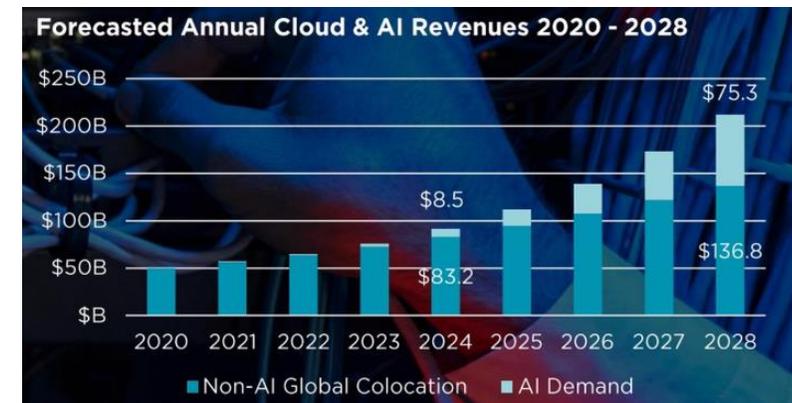


AI Power Requirements

- AI data centers require significantly more power than traditional data centers
- On average, **a *ChatGPT* query needs nearly 10 times as much electricity to process as a Google search . . .**
- Worldwide data center demand expected to more than double by 2030 to around 945 tera-watt hours (largely due to AI)
 - 945 TWh is slightly more than the entire energy consumption of Japan today



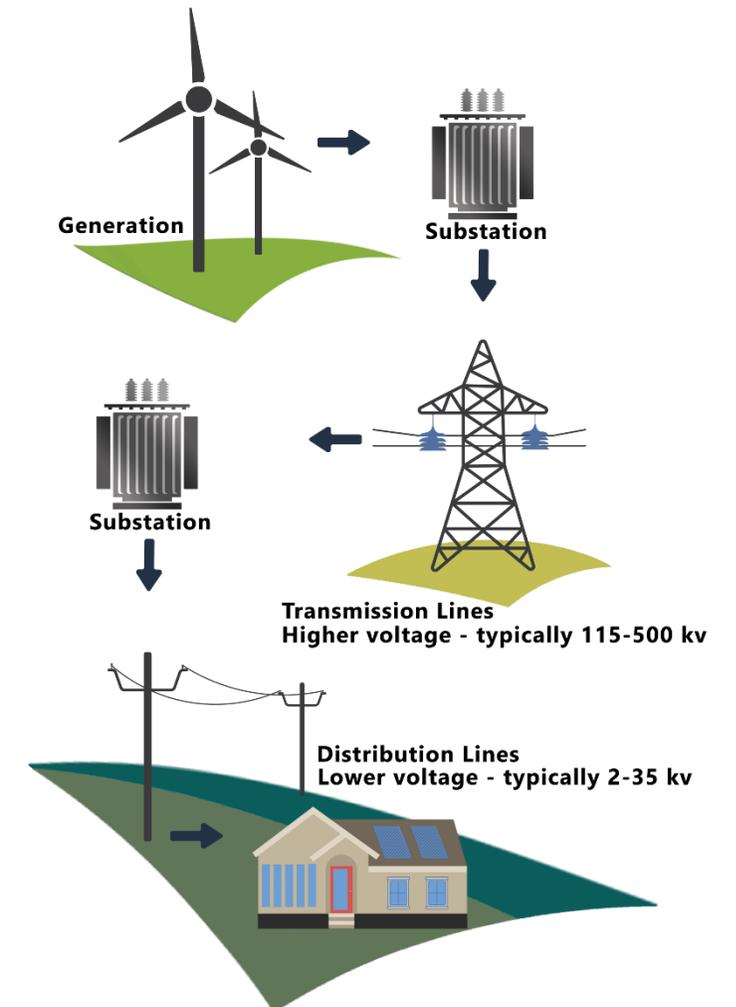
Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research



Power Lives on Three Levels:

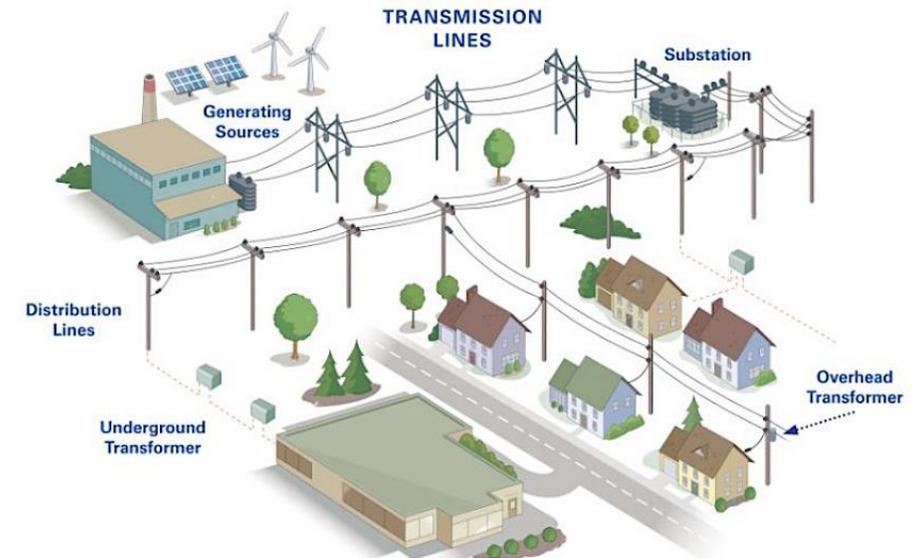


- **Generation:** the process of generating electric power from sources of primary energy.
 - Petroleum, coal, natural gas, nuclear, wind, hydropower, solar, biomass and geothermal
- **Transmission:** the process of moving large amounts of electricity from power plants to substations over long distances at high voltages.
 - 500 kv lines = Hot lanes
 - Need switching stations to pull down power (10-15 acres)
 - 230 kv lines = interstate highway
- **Distribution:** a network of cables used to connect high-voltage power to consumers at the required voltage.
 - Exit ramps



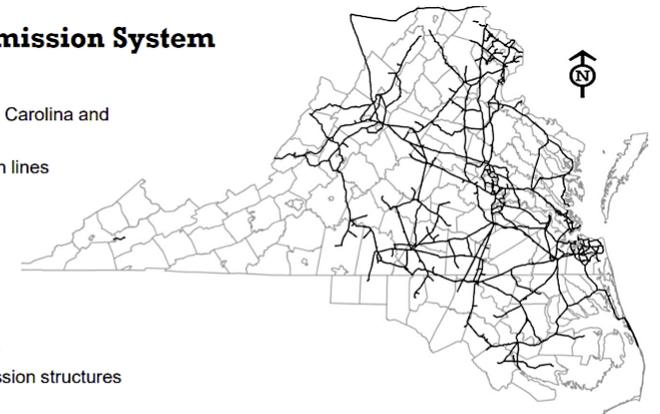
The Power Transmission Problem: a VA Case Study

- Data center power demand in Dominion's service territory grew at a nearly 24% compound annual growth rate (CAGR) from 2017-2023; forecast for a 10% CAGR going forward constrained by infrastructure
- JLARC projects need to increase both in-state and out-of-state generation capacity by 150% (each) by 2040
 - Ex: new natural gas utility plant every 18 months
- Virginia needs 40% more transmission capacity by 2040
- Challenges:
 - Outdated and insufficient transmission power lines must be rebuilt
 - Can't meet redundancy and reliability standards without new lines
 - Delays in planning and permitting new lines and supply chain bottlenecks
 - Community resistance to new generation and transmission facilities
 - Can't build new energy sources fast enough to meet demand
- New hookups backlogged 7-10+ years



Electric Transmission System at a Glance

- Operates in Virginia, North Carolina and West Virginia
- 6,600 miles of transmission lines
 - 500 kV – 1,299 miles
 - 230 kV – 2,871 miles
 - 138 kV – 63 miles
 - 115 kV – 2,293 miles
 - 69 kV – 78 miles
- More than 800 substations
- More than 45,000 transmission structures



Electric Transmission is responsible for delivering electricity to Electric Distribution and large industrial customers.

Virginia is Not Alone

- On 7/24/25, the California Public Utilities Commission (CPUC) issued an interim rule allowing PG&E to charge data centers for the cost of extending transmission lines
 - Traditionally, all ratepayers contribute to transmission line costs
 - Intent is to speed connection times
 - Requires data center customers to prefund up to 100% of construction costs
 - Final rule pending cost allocation guidance
 - Other states have considered similar programs

Data Centers and America's AI Action Plan

- Executive Order issued 7/23/25 to promote AI in the US
- Includes focus on data center development (100+ MW and \$500M) and energy infrastructure
 - Expedited environmental reviews and exemptions
 - Promotes use of federal lands and Brownfield/Superfund sites for data centers – fiber network availability is unclear
 - Does not address state or local permitting or regulatory requirements, which directly affect speed to market and availability

Alternative Power Sources / Self-Generation

- **Growing effort to develop proprietary or “behind the meter” solutions for bridging and/or permanent power:**

- **Large Nuclear Reactors**

- MSFT and Three Mile Island
- Colocate data centers with nuclear plants

- **On-site Small Modular Reactors (SMRs)**

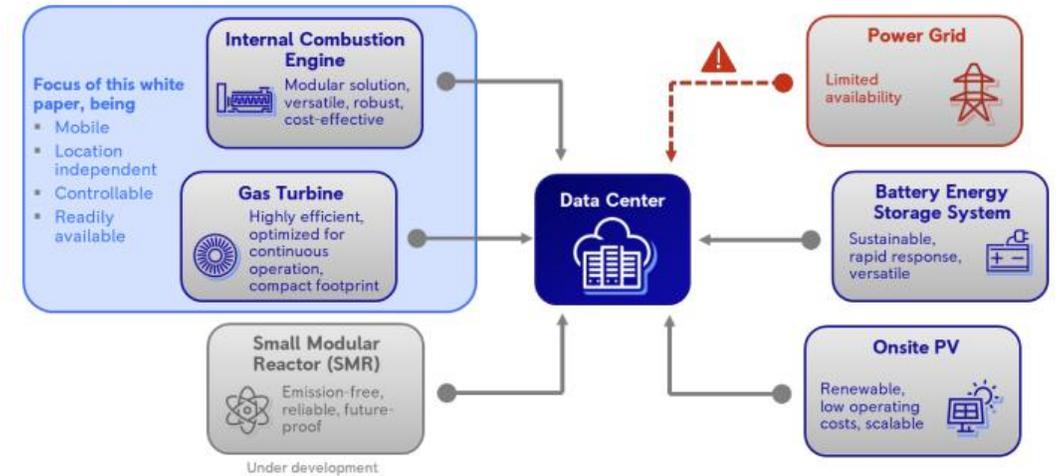
- Shows promise but still untested
- Likely to face regulatory hurdles and local opposition

- **On-site Natural Gas Engines**

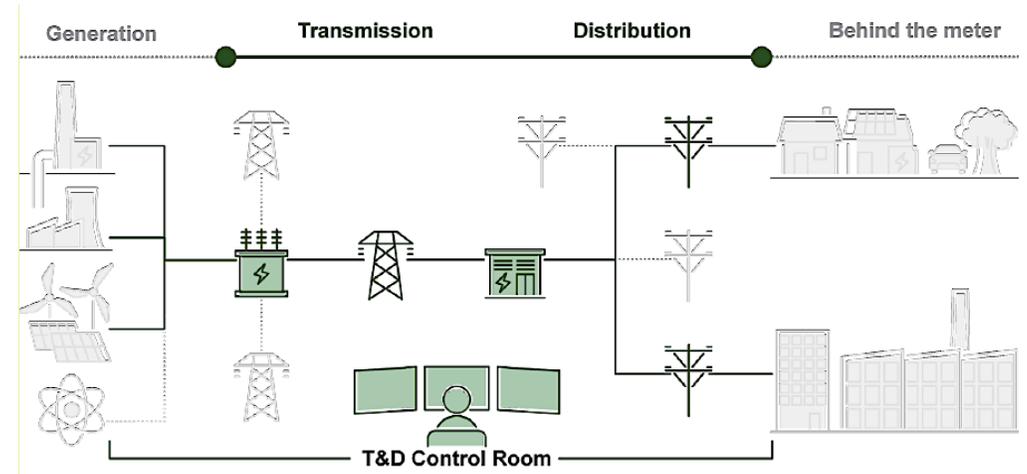
- Gas lines often collocated with other utilities
- Lower greenhouse gas emissions than diesel counterpart
- Supply and delivery are extremely reliable
- Can be mobile or permanent, providing flexibility
- Eventually will suffer from transmission limitations
- Localized opposition still an issue

- Virginia example:

- 8 natural gas turbines at 16 MW each (128 MW total)
- Placed on trailers and mobile
- Cost = \$50M
- Third-party operates and coordinates daily power needs
- Tenant paid to install to get to market faster



<https://www.mtu-solutions.com/au/en/technical-articles/2025/enabling-data-center-operators-to-bridge-the-grid-capacity-gap-with-self-generation-solutions.html>



<http://www.virginiaplaces.org/energy/electricitytransmission.html>

Alternative Power Sources / Self-Generation

- State regulations often don't anticipate self-generation
- Per Va. Code § 56-265.1, electric generation facilities are public utilities unless:
 - Generating/distributing electricity exclusively for own consumption, or
 - Furnishing electricity (plus HVAC) to tenants of a building, provided:
 - Generated from a central plant on the premises;
 - Building(s) served are on a single tract of land not separated by a public road; and
 - Electric charges are part of base rent and not separately metered
- Unless exempt, generation facility requires state regulatory approval

Alternative Power Sources / Self-Generation

- Phased development/financing may not fit regulations
- Ideas to avoid state regulation for multi-building campus:
 - Land Condominium: generation facility owned by condo association for the exclusive benefit of its members
 - Single landowner with ground leases to data center pad sites
 - Mobile generation facilities relocated as buildings phase
- Local zoning laws still apply
- Utilities increasingly want to be part of the self-gen solution

Legal Considerations Moving Forward

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Where We are Headed

- **It's the new gold rush: God's not making any more land**
- Proliferation of new real estate market entrants:
 - Land speculators
 - Office/industrial developers pivoting
 - Private equity/investors
 - Demand is driving land prices up (\$4.5M+ per acre)
- Customer demands disconnected from supply – we need it yesterday
- Power availability is key: “will serve” is different from “can serve”
- Public utilities trying to separate real from fake through major upfront investments
- Very little negotiation with utilities over price, terms, timing, or amount of available power
 - Ex: assignment of ESA/PPA for multi-phase projects
- Localized opposition grows each year, lengthening construction cycles (5+ years)

Legal Considerations

- Land Use & Zoning
 - Zoning challenges or special use permits (e.g. noise, water, substations)
 - Pushback or even local moratoria on new data centers
 - Conditioned approvals tied to environmental/community offsets
 - Protracted timeline for obtaining approvals
- Energy Procurement & Utility Regulation
 - Access to utility-scale power and interconnection rights
 - Direct Power Purchase Agreements – Negotiation
 - Avoiding utility regulation for onsite generation
 - Risk of curtailment during grid emergencies
- Environmental & Climate Compliance
 - Increased scrutiny on water use
 - Environmental laws – NEPA or state environmental reviews
 - Clean Air Act (air permits)
- Tax Incentives
 - Some states with incentives (e.g. VA)
 - Clawbacks for failing to meet incentives
 - Risk of changes to incentives
- Interconnection & Telecom Regulations
 - FCC and state telecom rules

Legal Considerations

- **Data Privacy & AI Regulation**
 - Cybersecurity
 - Particularly sensitive for certain users (e.g. finance, health, government)
 - Evolving laws related to location and segregation of data (GDPR, HIPAA, etc.)
- **Contractual Liability – Increased Legal Risk**
 - Indemnity Clauses (e.g. for downtime, power failures)
 - Limitation of liability (consequential losses tied to disruptions)
 - Insurance requirements (e.g. for catastrophic power loss, cyber incidents)
 - Force majeure clauses – supply chain delays
- **Intellectual Property**
 - Access restrictions to the data
 - NDA terms
 - Protecting proprietary information (e.g. facility design, operations)
- **National Security & Export Controls**
 - Government scrutiny under CFIUS
 - Evolving laws with AI infrastructure now classified as critical to national security
 - Compliance with US laws if data center hosts foreign tenants

Trends in Data Center Agreements

- **Hyperscaler-Dominated Deals**
- **High Demand+Limited Supply = Commitments before construction**
- **Pricing and cost pass-throughs**
- **Sustainability – Renewable Energy Commitments**
- **Customized Agreements – Tailored to address unique requirements**
- **Making agreements financeable**
 - Strong tenant credit and guarantees
 - Long lease term and limited termination
 - Unconditional rent
 - Significant power commitments
 - High service availability
 - Defined remedies
 - Lender step-in rights



What's needed to meet demand

- Land with access to adequate and sustainable power and fiber
 - Power - Behind the meter (renewables, nuclear, gas)
- Innovation in AI hardware to produce higher performance and lower power consumption
- Breakthroughs in AI chips, cooling systems and power management
- Rapid expansion outpacing availability of skilled tradespeople

Questions?

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