AI DATA CENTERS AND THEIR IMPACT ON THE ELECTRIC GRID

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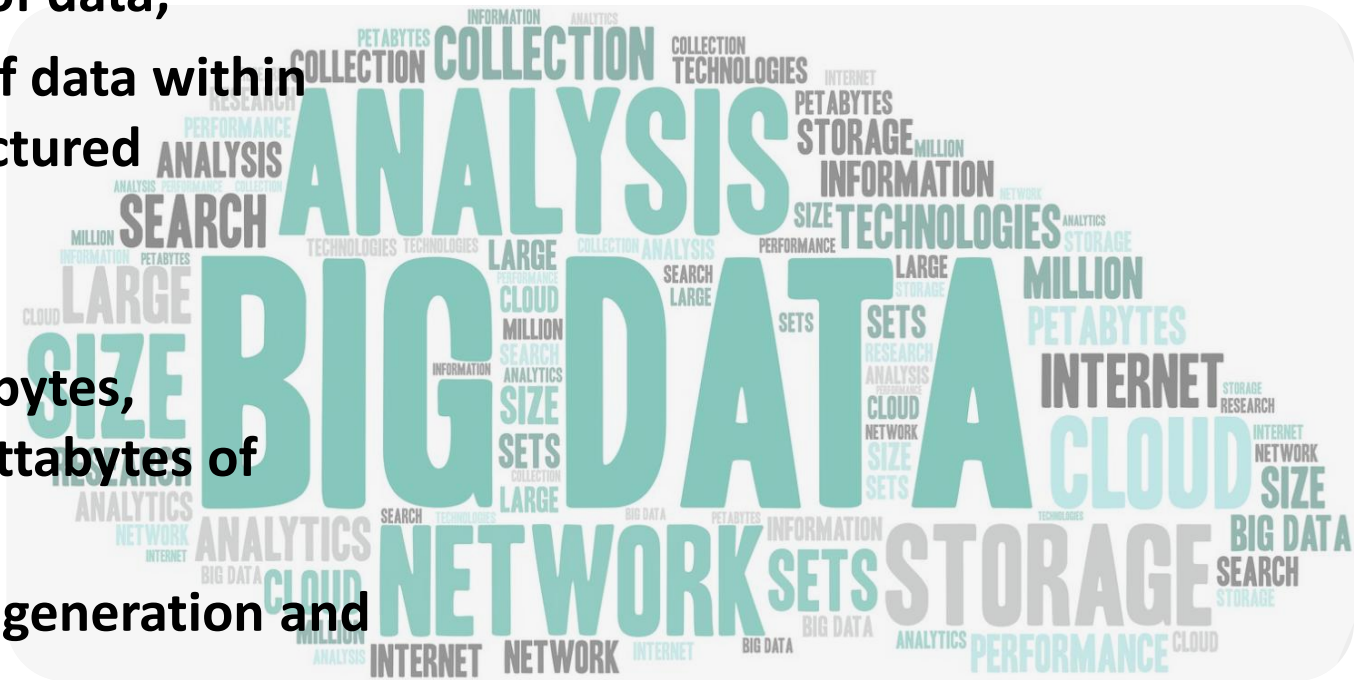
What is Big Data?

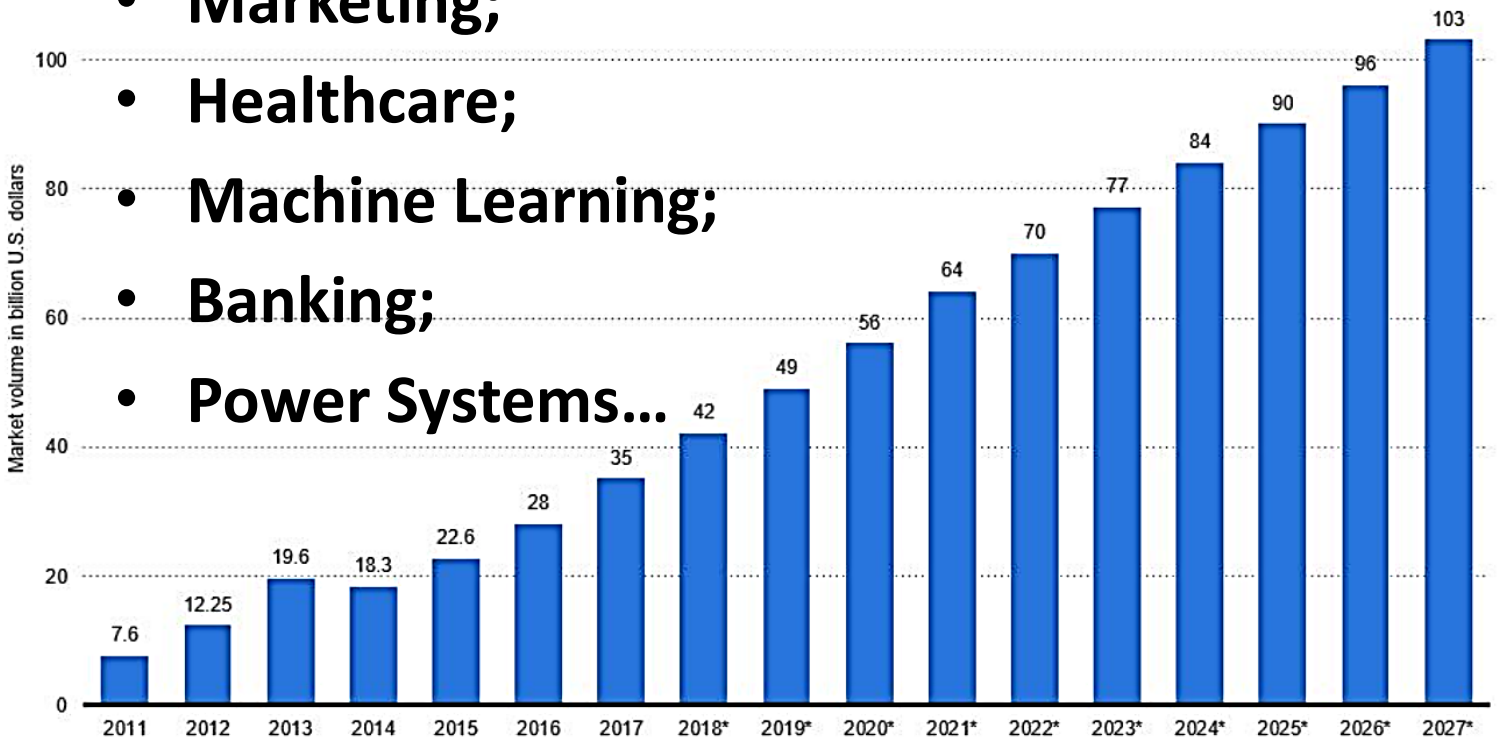
- Large collection of data;
- Different types of data within the same unstructured database;
- The 3 V's:
  - Volume (terabytes, petabytes, zettabytes of data)
  - Velocity (fast generation and application)
  - Variety (different types of data)



What is Big Data used for?

Big Data Market Size Revenue Forecast Worldwide From 2011 To 2027 (in billion U.S. dollars)

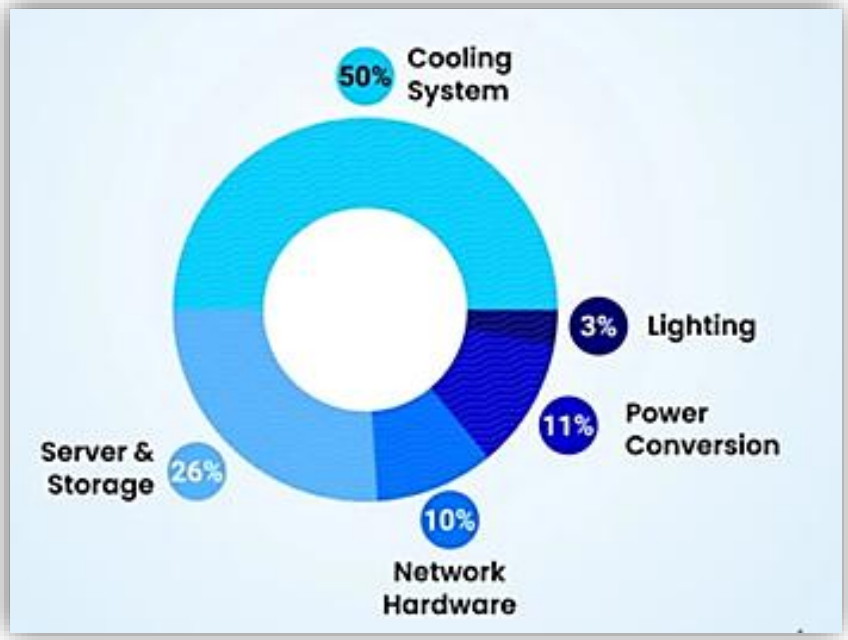
- **Product Decision Making;**
- **Marketing;**
- **Healthcare;**
- **Machine Learning;**
- **Banking;**
- **Power Systems…**



Forecast revenue Big Data Market Worldwide by Forbes

Increased Energy Consumption

- AI data centers consume significantly more power than traditional data centers.
- Major components: compute resources, storage, power & cooling systems…
- 40-50% of data center's total power usage is dedicated to cooling
- 24/7 Operations



AI and Power Supply

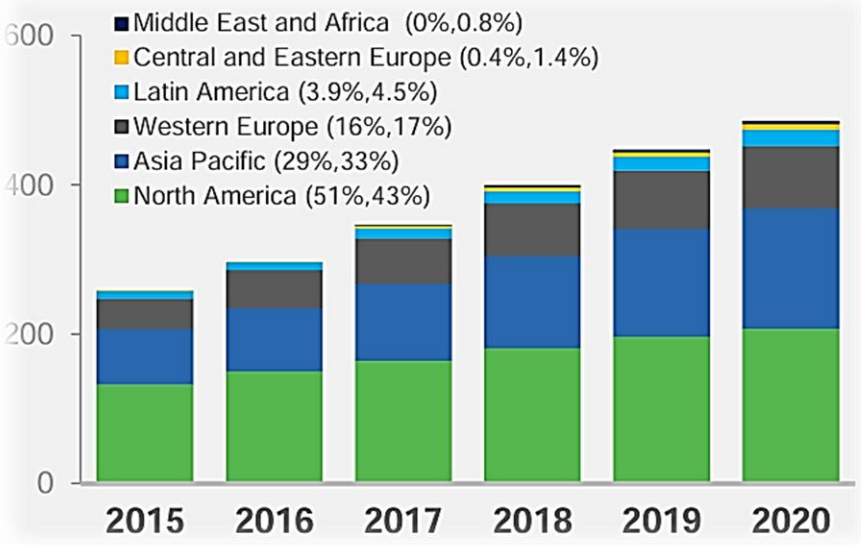
- The amount of energy that generative AI consumes can be staggering.
- Generative AI can quickly generate new content based on a variety of inputs.
- AI queries need ten times more energy than traditional internet searches.
- Example: a ChatGPT query (2.9 Wh) needs nearly 10 times as much energy than a Google search (0.3 Wh)

Fueling the Digital Revolution

- Data centers are used to house big data
- The power consumption varies
  - Small data centers (5000-20,000 sq.ft) consume 1-5 MW
  - Large or hyperscale data centers (100,000 - several million sq.ft) consume 20 MW to over 100 MW of power.
- For comparison: 1MW runs 650 – 1000 homes

Hyperscale data centers growth worldwide

Percentages within parentheses refer to relative share for 2015 and 2020



Cisco Global Cloud Index 2015–2020

Fueling the Digital Revolution in the US

- Data centers account for around 4.4% of electricity usage in 2023
- They are expected to consume 6.7 to 12% of the total US electricity by 2028 (DOE).
- Significant carbon and water footprints

Data Centers Locations

Deciding factors are:

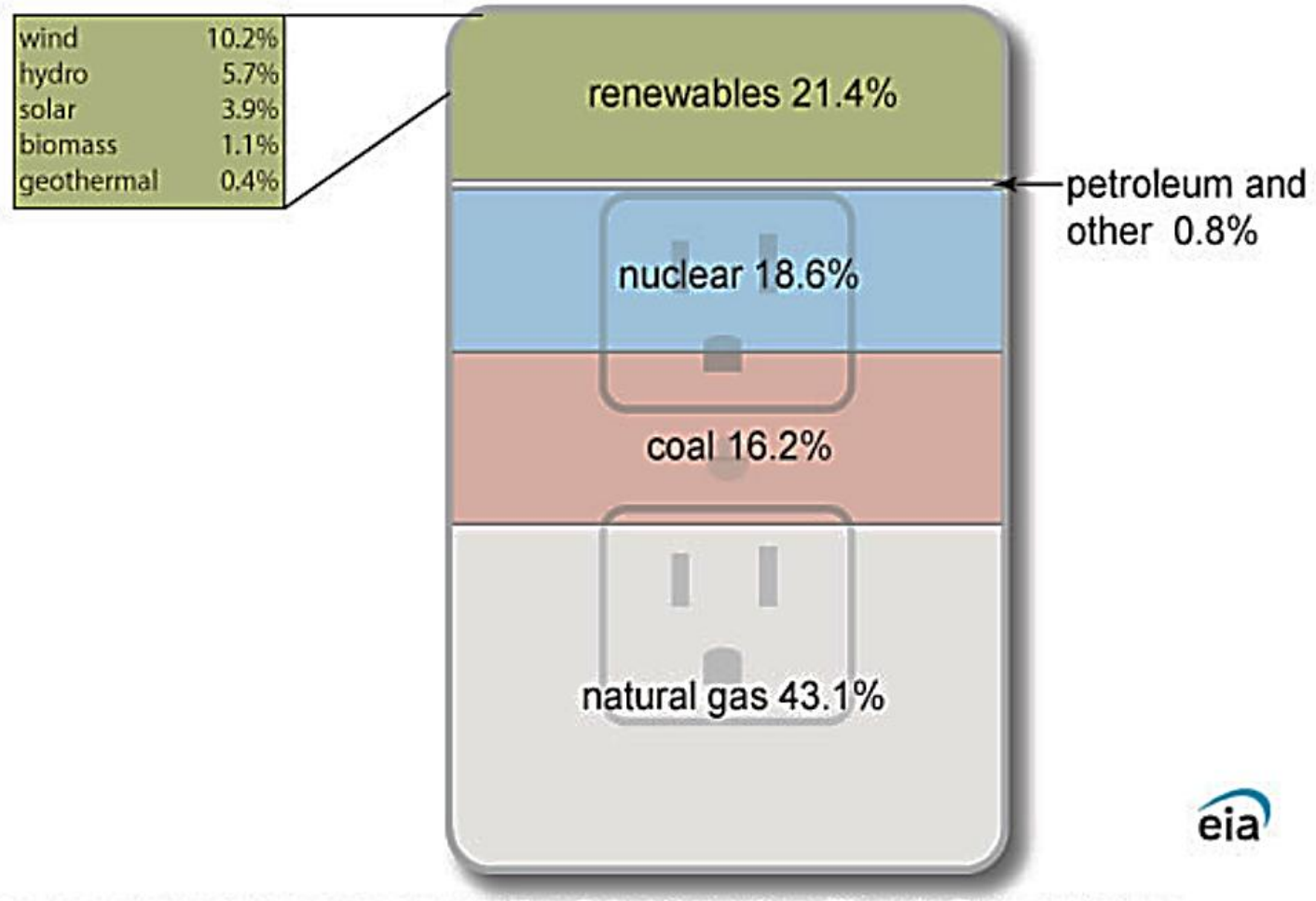
- **Power infrastructure;**
- **Water availability for cooling;**
- **Speed to market;**
- **Land costs;**
- **Tax incentives.**

- **Modular data center can be erected within 1 – 3 years, while renewables development faces 3-7 years**

Power Supply for Data Center…

- Energy production needs to be decoupled from environmental impact and clean energy needs to be abundant and inexpensive!
- Uninterruptable power supply requirement
- Deliverability:
  - Microgrid (small to moderate size data centers)
  - Close proximity (co-location) to big power plant (hyper sized data centers)

Sources of US Generation in 2023



Data source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2024, preliminary data

Sources of US Generation in 2023

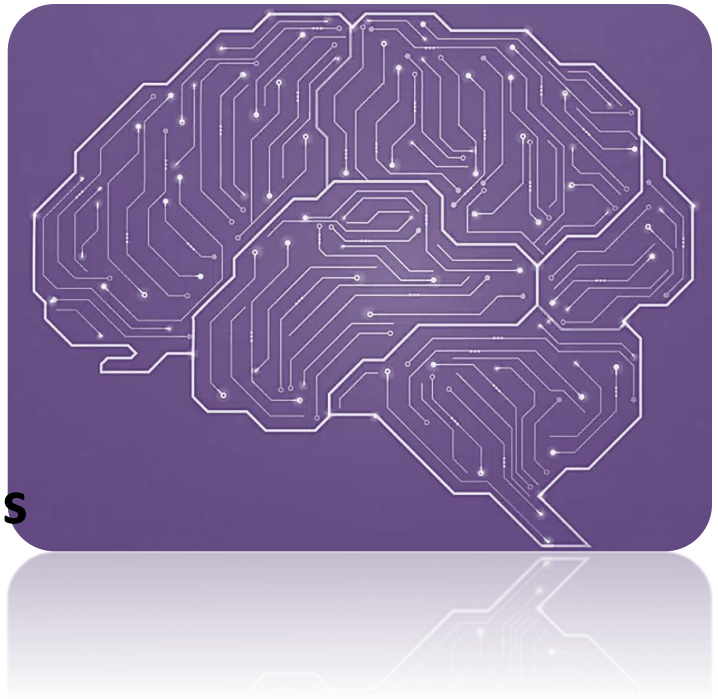
- 1 MW to 1,000s of MW utility-scale
- 1,189,492 MW of total generation capacity

Source	1990 (MW%)	2023 (MW%)
Coal	42	16.2
Natural Gas	17	43
Nuclear	20	20
Wind	1	10
Photovoltaic	0.1	3.9

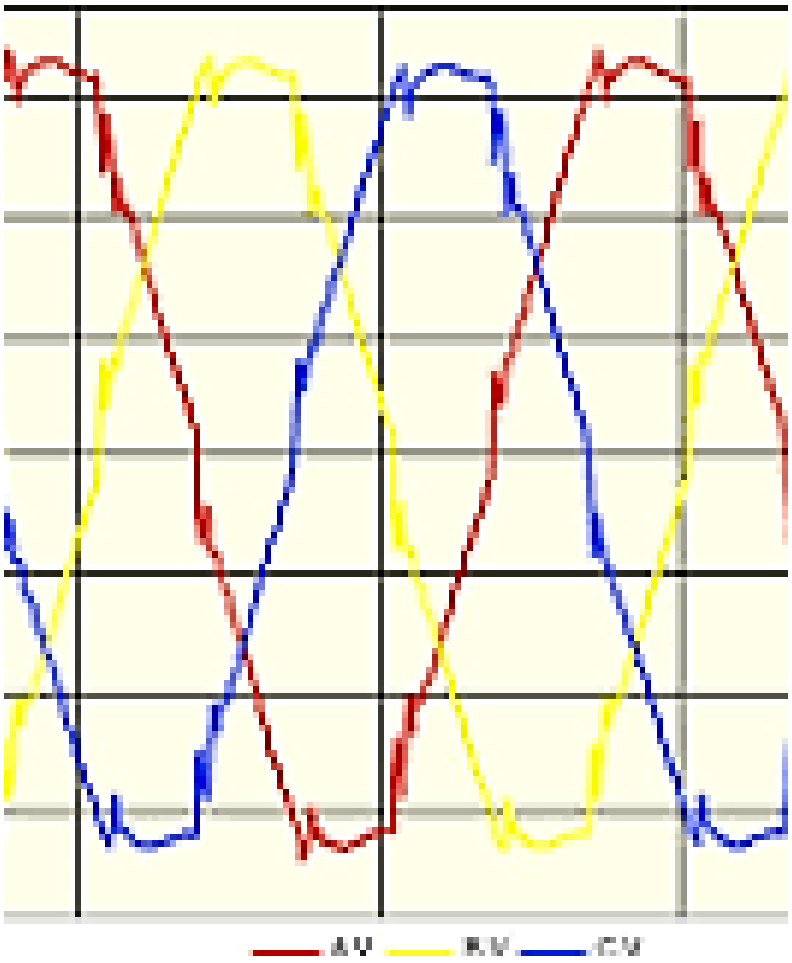
Source: US Energy Information Administration, Electric Power Monthly, 02/2023

Further Challenges

- Existing and future power capacity issues
- Uncertainties associated with load forecast
  - Speed of deployment
  - Secretive nature of business
- Data centers ride-through capabilities
- Regulatory challenges (co-location challenges, power planning and operations, power quality,…)

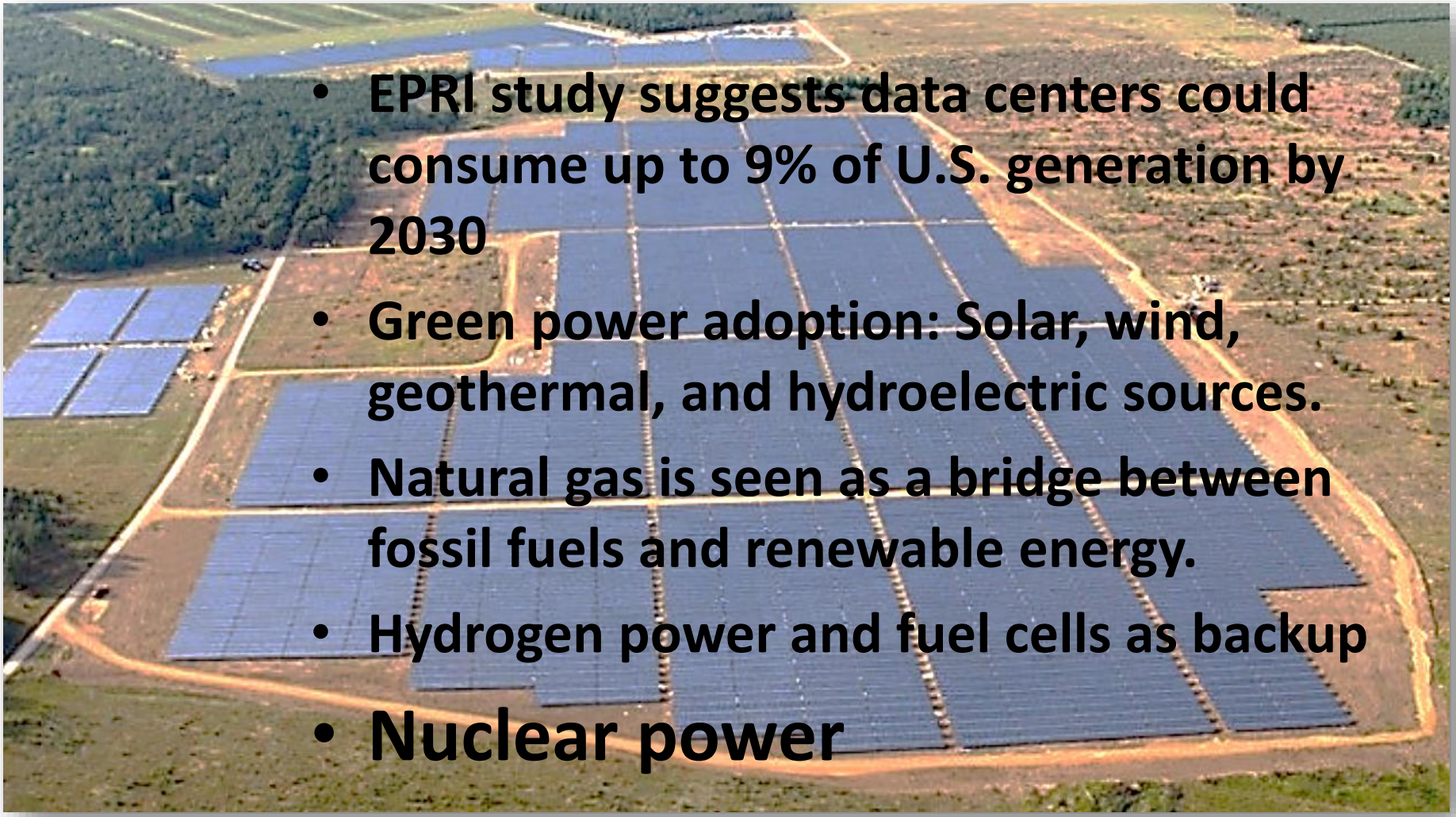


Grid Stability Issues



- High power draw can lead to fluctuations and instability in power networks.
- An exclusive Bloomberg analysis shows that more than three-quarters of highly-distorted power readings across the country are within 50 miles of significant data center activity.
- Total Harmonic Distortion way above permitted 8% in some measurements

Trends in Powering Data Centers



- EPRI study suggests data centers could consume up to 9% of U.S. generation by 2030
- Green power adoption: Solar, wind, geothermal, and hydroelectric sources.
- Natural gas is seen as a bridge between fossil fuels and renewable energy.
- Hydrogen power and fuel cells as backup
- **Nuclear power**

Nuke News!

- The Nuclear Regulatory Commission has approved small modular nuclear reactor (SMR) design in the US!
- Small modular reactors (SMRs) typically have a power output ranging from 20 to 300 megawatts (MW).
- April 2023, Green Energy Partners, a property and project development company, purchased 641 acres for a project that includes using four to six SMRs to power 20 to 30 data centers, generate hydrogen fuel and provide backup power for Virginia's grid.
- October 2023, Standard Power announced plans to use NuScale's SMRs to build two nuclear power plants in Ohio and Pennsylvania to provide nearly 2 GW of power to nearby data centers by 2029.

Potential Utility Impacts

- Uncertainty in terms of load forecasting
- Self-generation would reduce the need to connect to the existing infrastructure
- Co-location of data centers with the generators – impact on the rest of the users in terms of power availability and energy cost
- Possibly flexible load options, including demand response
- Regulatory measures that may attract or deter investments

Utility News

- **PG&E has hit a "Goldilocks" growth zone—not too slow, not too fast—where steady demand from data centers could begin lowering customer bills by 2027.** (Utility Dive)
- With 10 GW of data center load now in its queue, PG&E expects steady, diversified demand will offset costs. Every 1 GW of additional load growth will decrease customer bills by 1% to 2%, CEO Patti Poppe said.
- **Google will reduce AI data center load during grid stress events under new agreements with Indiana Michigan Power and Tennessee Power Authority.** (Reuters)
- These deals represent Google's first formal agreements re: demand-response programs with utilities—but as AI demands spike, power flexibility from Big Tech could become as valuable as a new peaker.

Utility News Cont…

- **China has created a new state-owned company to further nuclear fusion.** (Ignition)
- China Fusion Energy Co. will focus on building a fusion plant with a budget of 15B yuan ($2.1B) from the state.
- **Worth noting:** The US is home to the most fusion companies, but total funding stateside is much smaller. The Milestone-Based Fusion Development Program has a total authorized budget of $415M through 2027.

- **Oak Ridge has developed a medium-voltage circuit breaker that can interrupt direct current faults in under 50 microseconds—fast enough to finally make grid-scale DC distribution practical and safe.** (Newswise)
- The company is currently scaling up to 10,000 volts, filling a major protection gap as utilities eye DC for **data centers**, electrified transport, and next-gen grid design.

Questions?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