Event I: Balancing Data Center Energy Use & Climate Goals

Transition to the Future Grid in MA 2025

Joe Curtatone

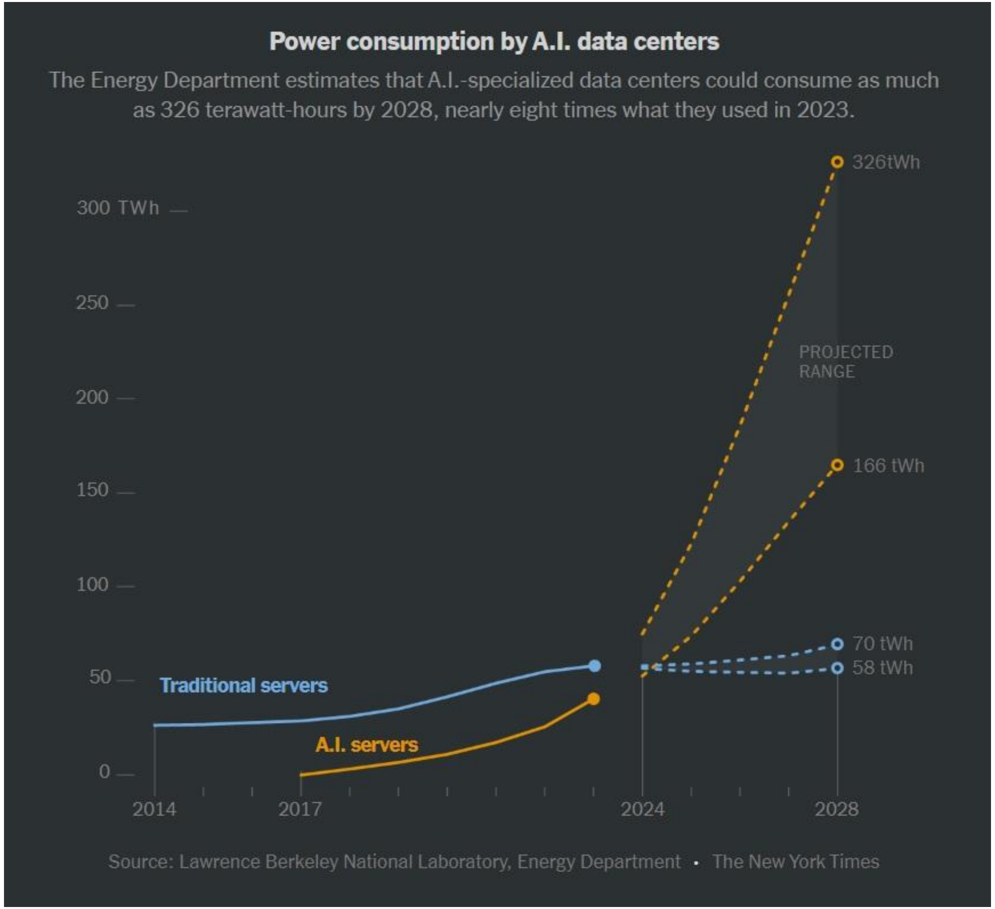
President,
ACT

Agenda

Networking with Coffee and Breakfast	8:30 – 9:00
Welcome, Joe Curtatone, President, ACT, Galen Nelson, Chief Climate Officer, MassCEC	9:00 – 9:15
MassCEC Grid Collaboration Lab & The Future Grid Event Series, Sarah Cullinan, Senior Program Director, Net Zero Grid, MassCEC	9:15 – 9:30
Panel 1: Understanding Data Center Loads and Defining the Challenge for MA	9:30 – 10:30
Vision: Audience perspectives on the future role of data centers in MA	10:30 - 10:50
Break	10:50 – 11:20
Panel 2: Emerging Technology Solutions & Opportunities	11:20 - 12:30
Lunch	12:30 - 1:20
MA EEA Perspective on Data Centers - Josh Ryor, Assistant Secretary MA EEA	1:20 - 1:40
Panel 3: Policy & People Perspective	1:40 - 2:40
Facilitated Small Table Discussions on Draft Recommendations	2:40 – 3:40
Wrap up	3:40 - 4:00
Happy Hour Networking	4:00 - 6:00

Galen Nelson

Chief Climate Officer,
MassCEC


Power consumption by A.I. data centers
The Energy Department estimates that A.I.-specialized data centers could consume as much as 326 terawatt-hours by 2028, nearly eight times what they used in 2023.
326tWh
300 TWh
250
200
150
100
50
0
PROJECTED RANGE
166 tWh
70 tWh
58 tWh
Traditional servers
A.I. servers
2014
2017
2024
2028
Source: Lawrence Berkeley National Laboratory, Energy Department • The New York Times

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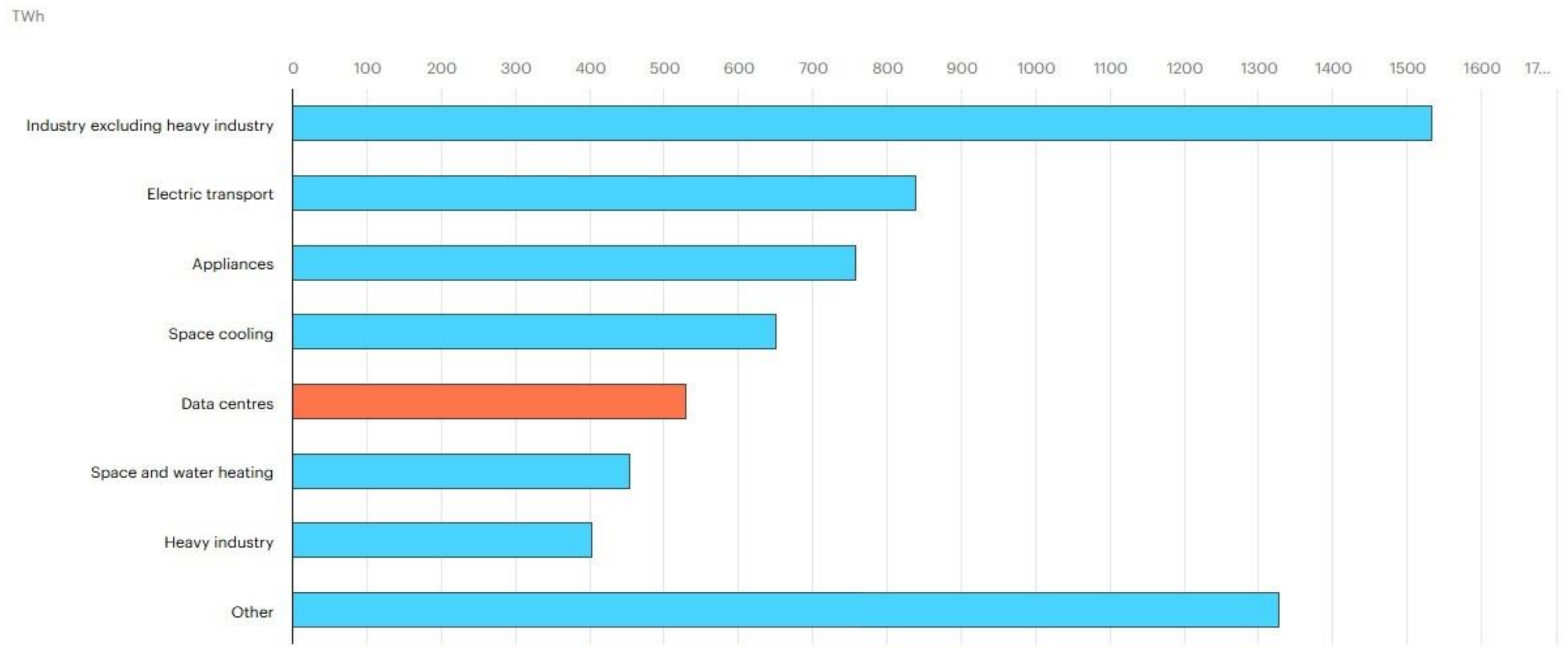
Increase in electricity demand by sector, Base Case, 2024-2030



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Sarah Cullinan - MassCEC Grid Collaboration Lab & Future Grid Event Series

Senior Program Director,
Net Zero Grid
MassCEC

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… so, what does that mean for Massachusetts?

Transition to the Future Grid in MA

2025 Event Series

May 21, 2025 | Balancing Data Center Energy Use with Climate Goals

June 26, 2025 | An Equitable Distributed Energy Future

October 2, 2025 | Grid-Edge Flexibility

Join ACT & MassCEC for the 2025 installment of our Transition to the Future Grid in MA Event Series, where we convene key stakeholders for critical conversations and hands-on collaboration to design **actionable steps toward modernizing our energy grid.**

2024 Future Grid Event Series Recommendations

Incentive-Based Regulation

Recommendations

Rec. 1: Grid metrics straw proposal

Rec. 2: Peak demand management targets

Fostering the Adoption of Gridtech

Recommendations

Rec. 3: Gridtech launch program

Rec. 4: Gridtech taxonomy & look-book

Engagement in Grid Planning

Recommendations

Rec. 5: Monitor & define engagement gaps

Rec. 6: Statewide energy literacy campaign

Understanding Data Center Loads and Defining the Challenge for MA

Christine Stevens
National Grid

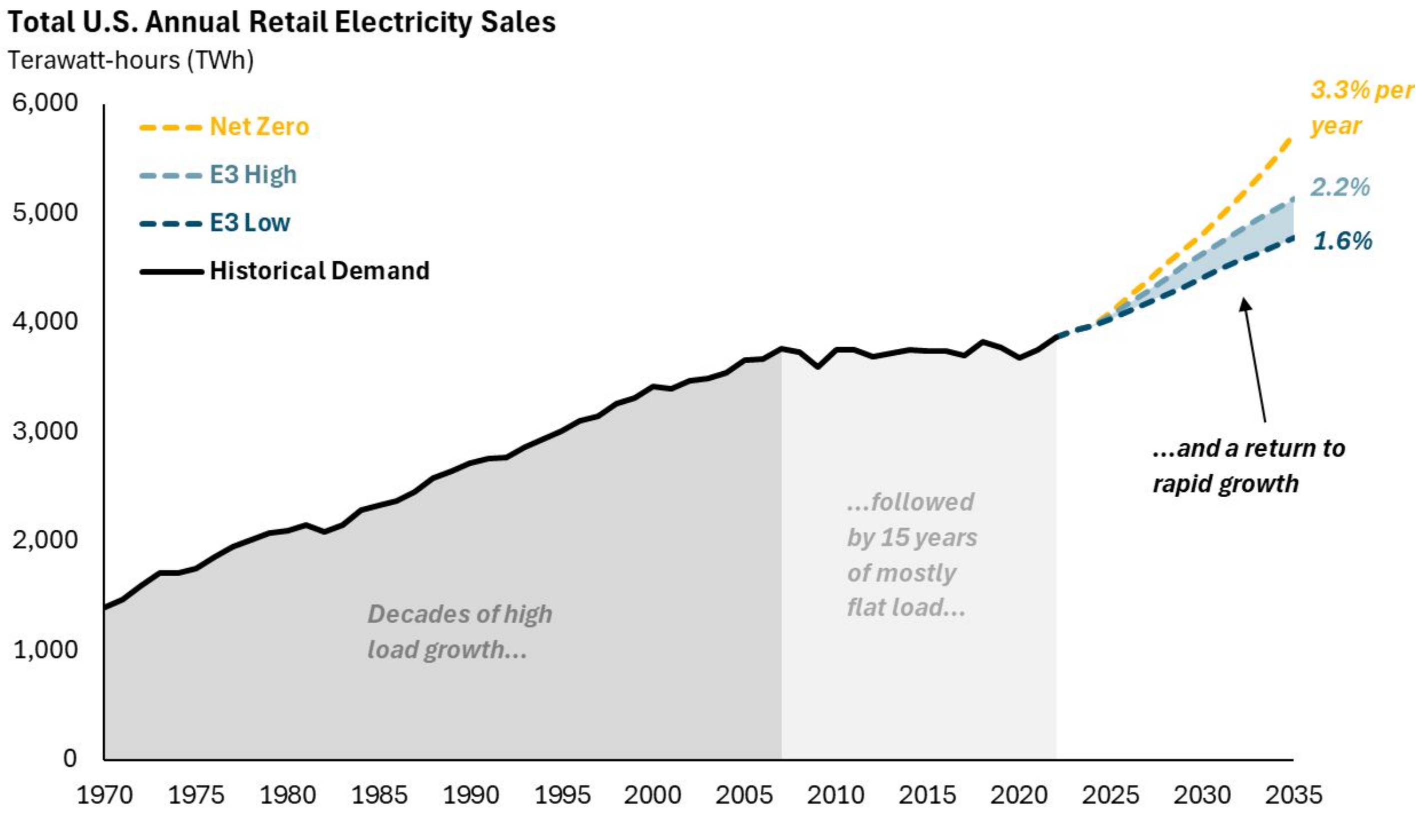
Patrick Donovan
Schneider Electric

Tory Clark
E3

Mike Jacobs
UCS

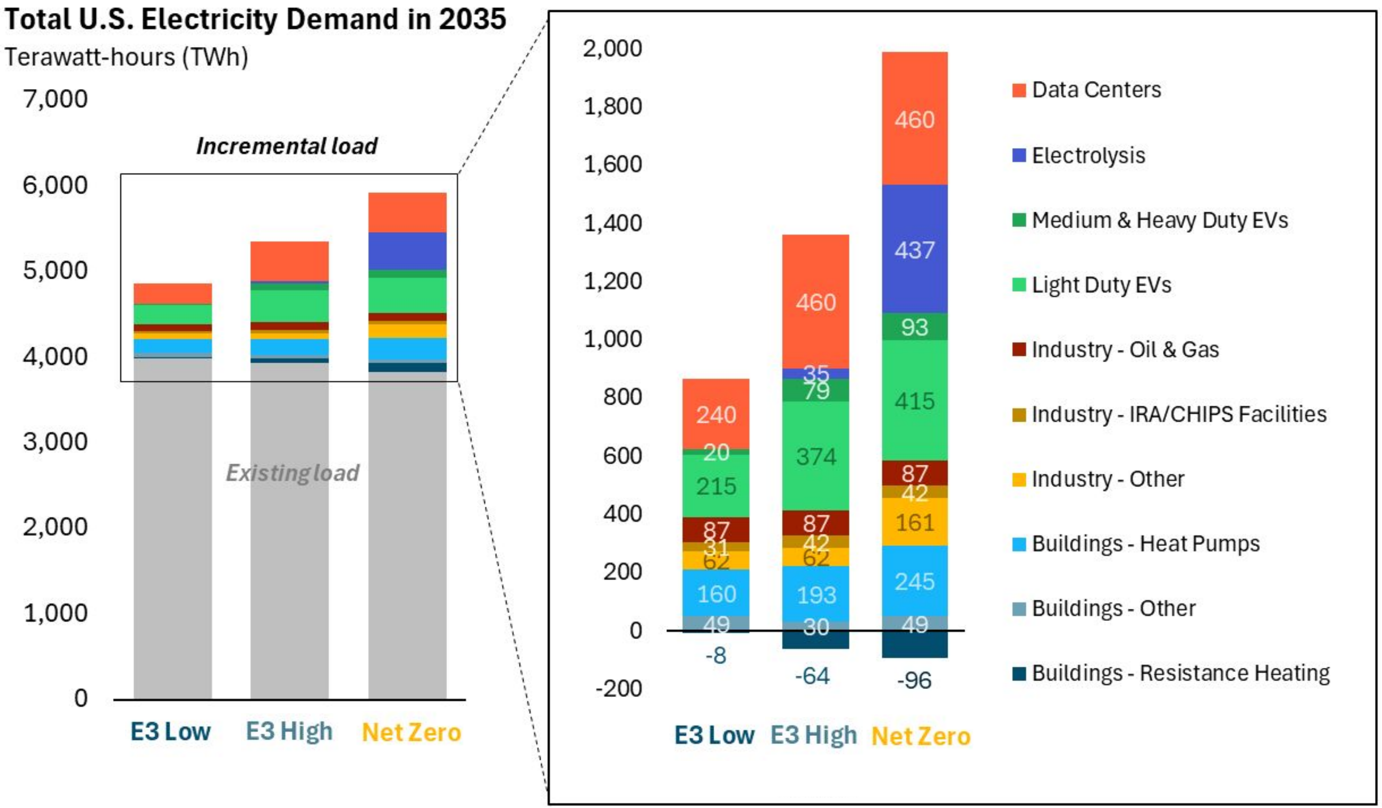
Alistair Pim
ACT
(MODERATOR)

Electric load growth is rapidly returning across the US after 15 years of flat load



 E3 load scenarios: https://www.utilitydive.com/news/federal-policy-rollbacks-electricity-demand-growth-data-center-EV/737456/

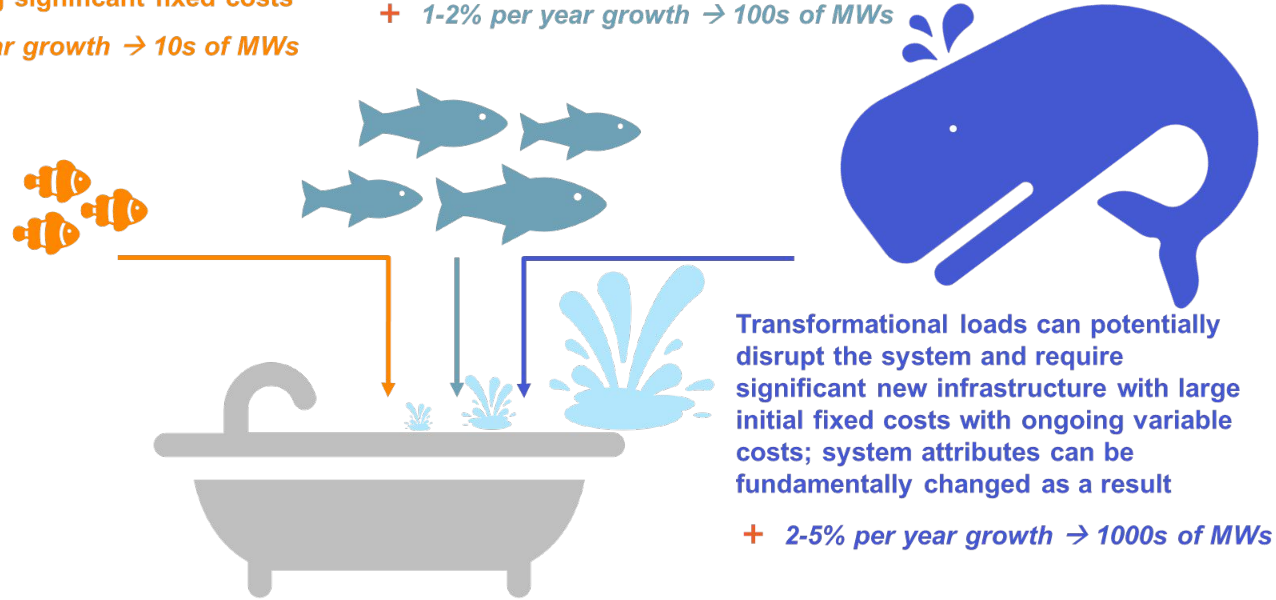
The next decade of load growth will be driven by EVs and data centers, but uncertainties remain



E3 load scenarios: https://www.utilitydive.com/news/federal-policy-rollbacks-electricity-demand-growth-data-center-EV/737456/

Additional Resources: Lessons Learned from Virginia

- **Virginia Data Center Grid Strain and Customer Impacts:** https://www.ethree.com/jlarc-load-growth/



Alison Magoon

Senior Program Manager, Net Zero Grid
MassCEC

Vision: Audience perspectives on the future role of data centers in MA

If we imagine data centers in Massachusetts in the future, what's important to you that MA gets right?

BREAK 10:50-11:20

Emerging Technology Solutions & Opportunities

Scott Clavenna
Latitude Media

Ayse Coskun
Boston University

Arin Kaye
EPRI

Tyler Norris
Duke University

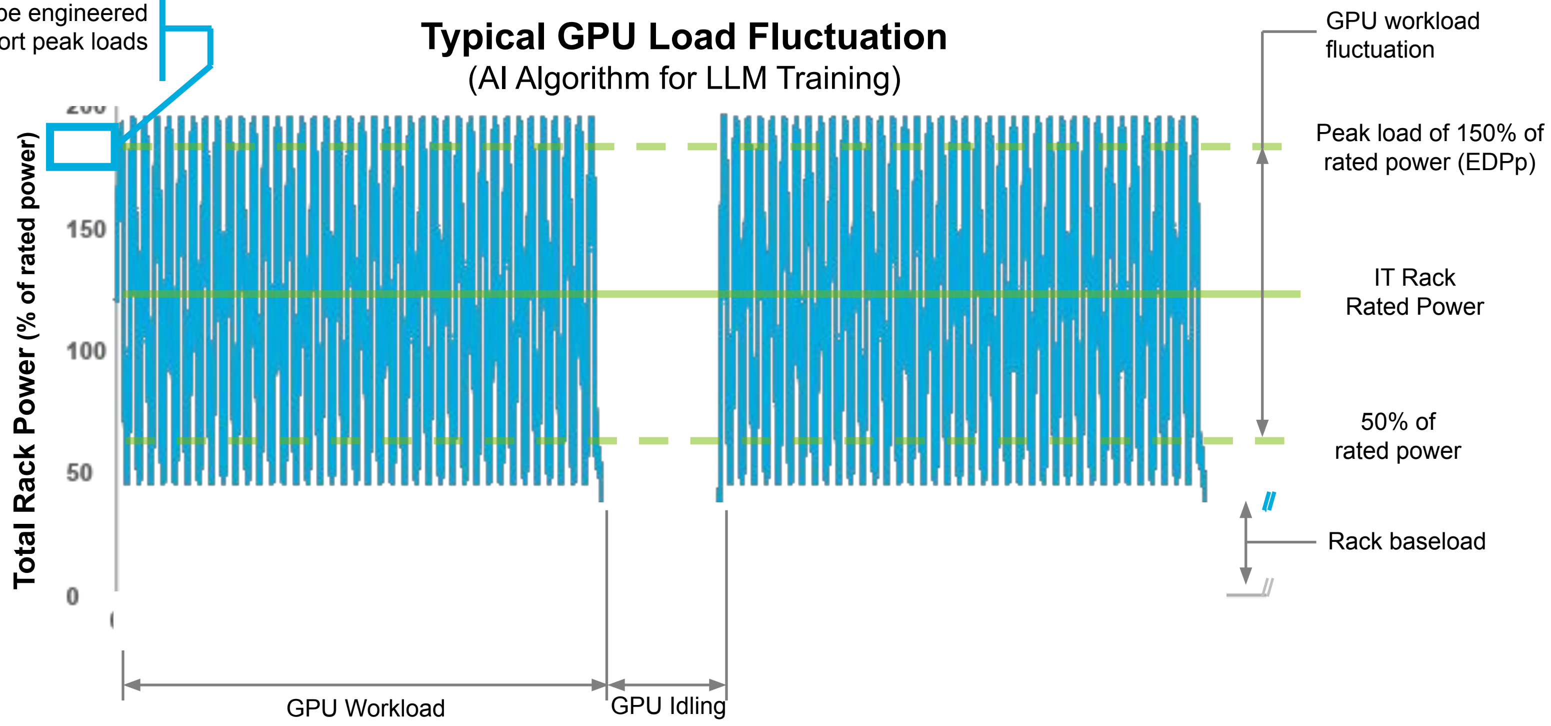
David Arsenault
Skeleton

Adam Wade
Foley Hoag
(Moderator)

Typical GPU load fluctuation - AI algorithm for LLM training

skeleton+

The electrical infrastructure of the Data Center must be engineered to support peak loads



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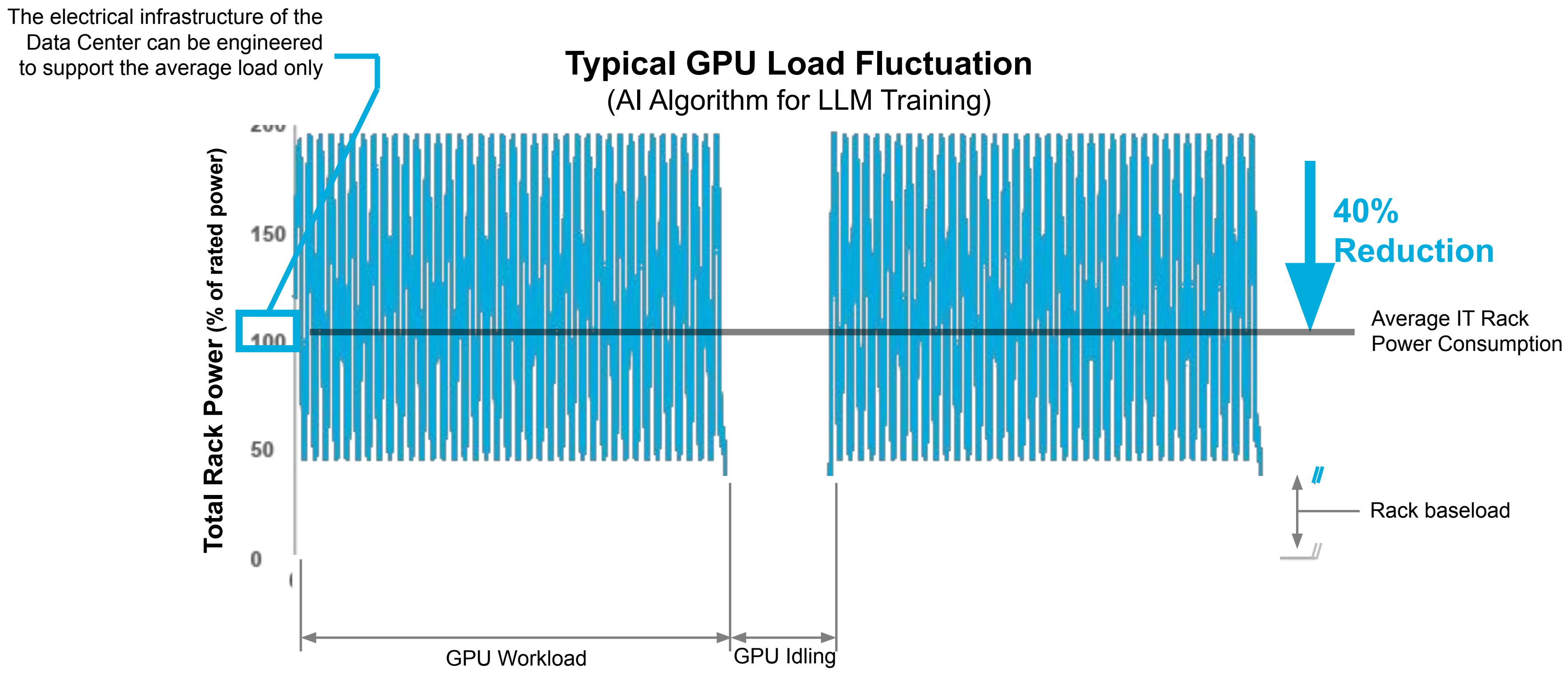


The Potential for Data Center Load Flexibility

Ayse Coskun
Chief Scientist

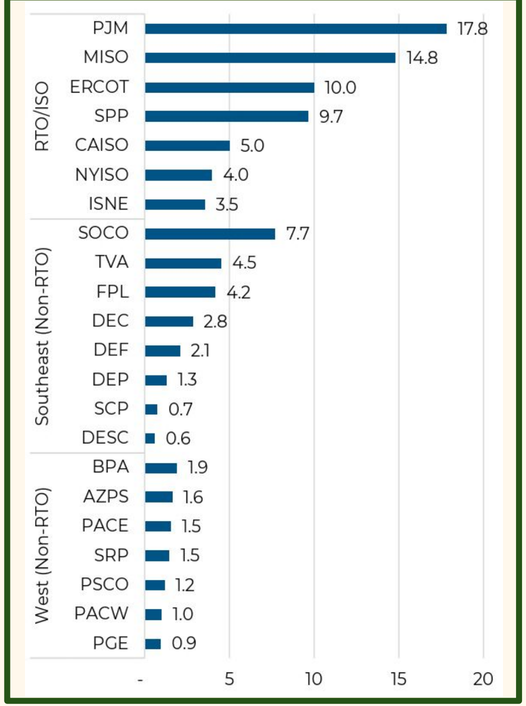
May 2025

emerald ai

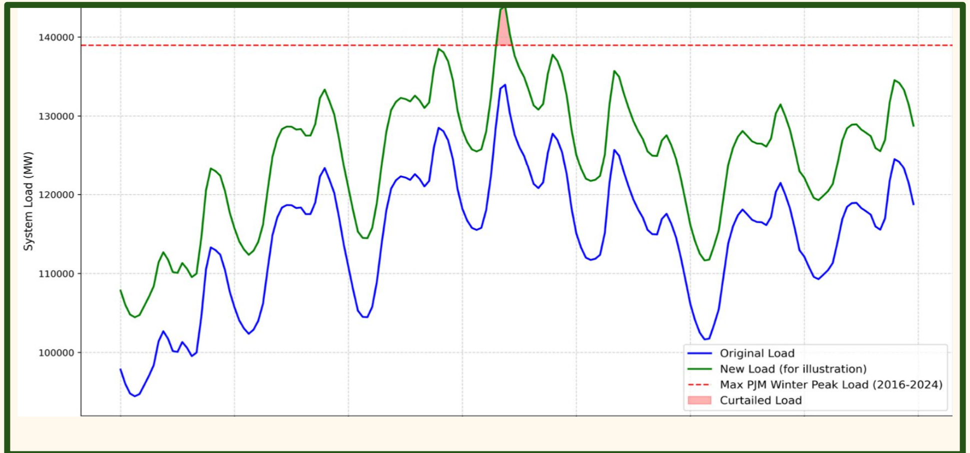
Load Flexibility Can Bring More Data Centers Online—*Now*

~100 GW of new data centers could be connected to US power grids today—without new grid or power plant infra—using just modest load flexibility.

New capacity with 0.5% Load Flexibility (GW)



How flexibility enables new loads to utilize the existing power system



Source: Norris et al., Duke University, 2025

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Unlocking the Value of Flexibility

1 Faster Time-to-Power

- Dominion Energy: 7+ year wait time
- Centerpoint Energy: 700% increase in data center queue
- **APS, ERCOT, others developing priority interconnection for flexible loads**

2 Increased Interconnection Capacity

- Utilities and transmission service providers limit load capacity based on worst-case load study results
- **Flexible loads can be interconnected at higher capacities (e.g., 400MW->500MW)**

3 Mandate Compliance

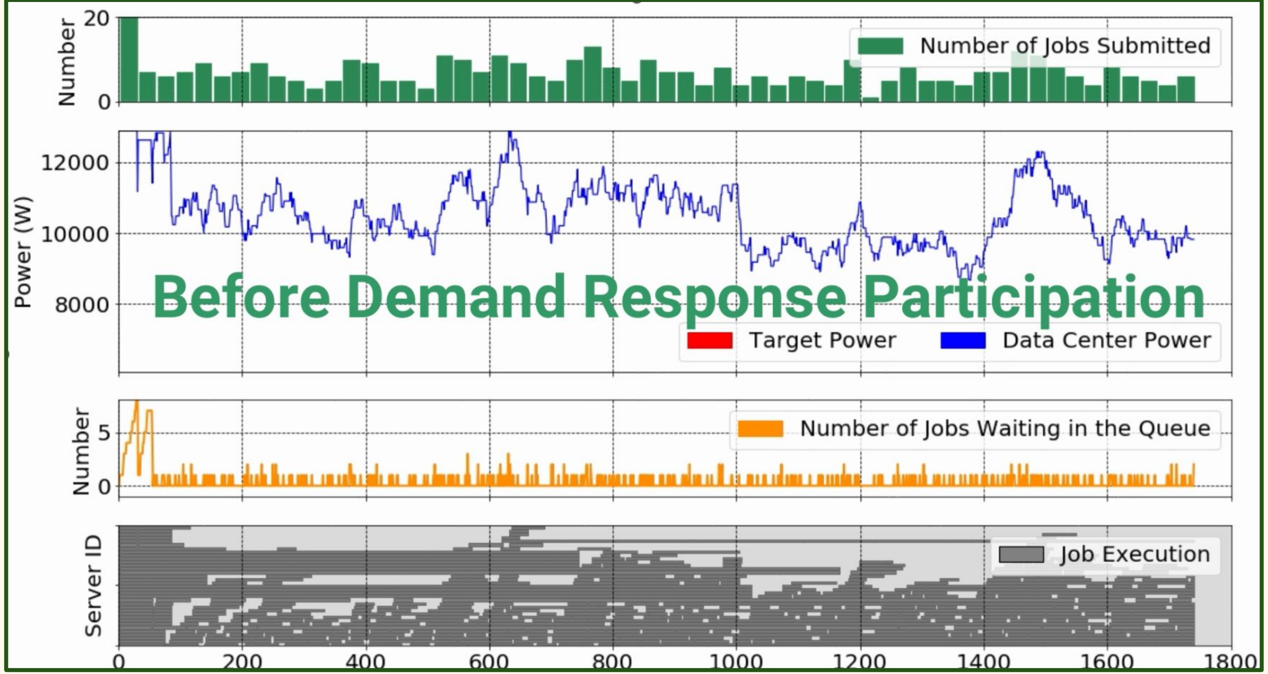
- Grid reliability and price affordability are suffering around the country.
- **Demand response mandates are coming: e.g., legislation already proposed in TX, VA.**

4 Flexibility Revenues

- As peak demand soars, regional power systems are looking for shock absorbers.
- **Skyrocketing flexibility revenues in 2025 could become material.**

Prototype at MGHPCC showing demand response participation…

12kW (36 servers) cluster BEFORE activating decision engine



Source: Coskun et al., 2022

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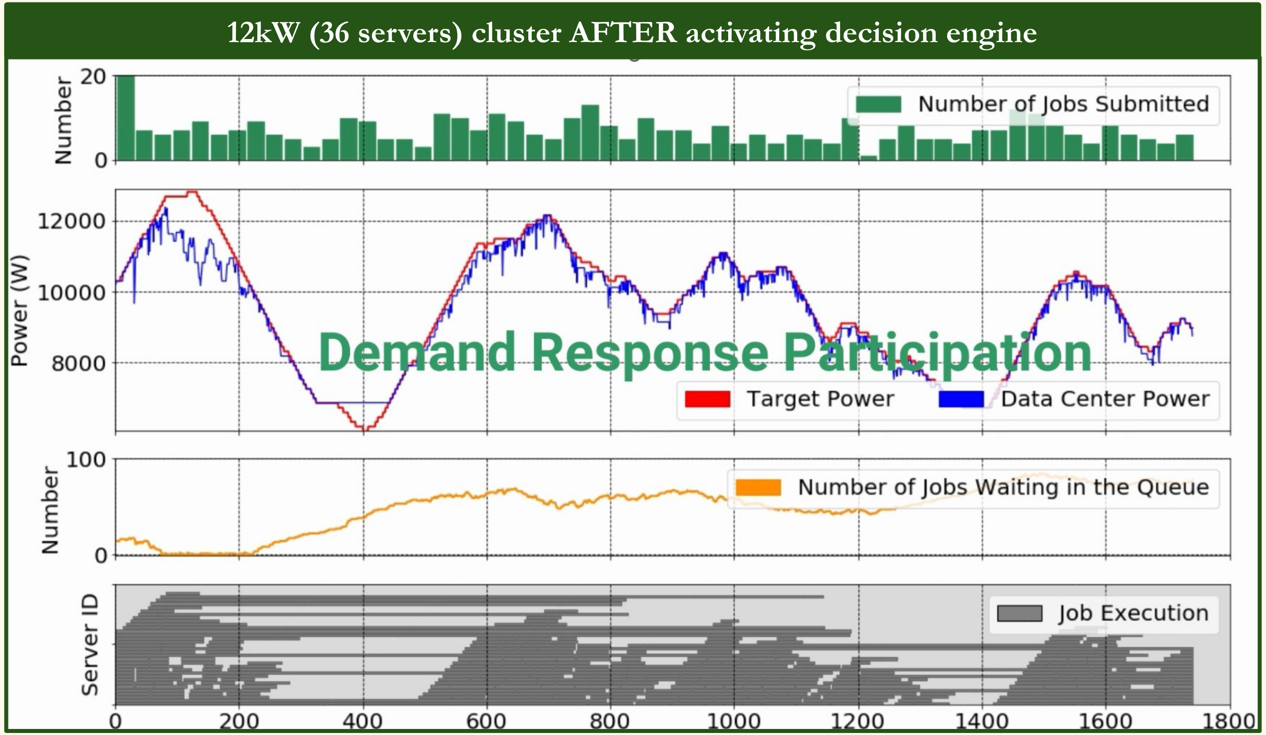
…meeting power grid AND compute user needs



Source: Coskun et al., 2022

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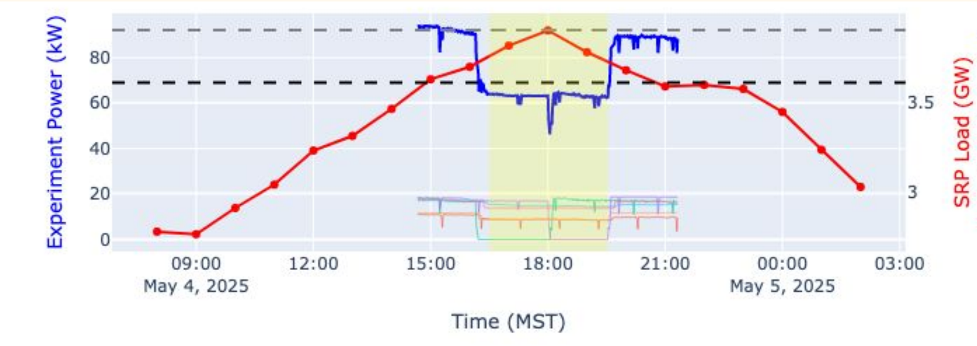
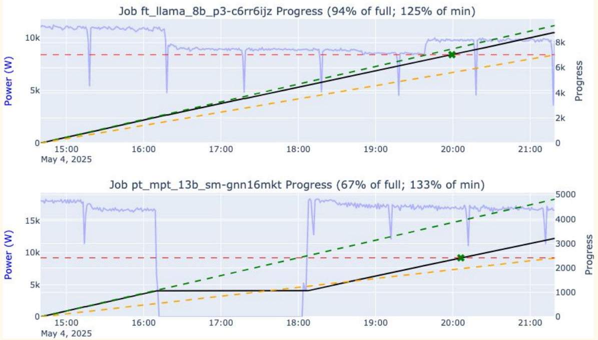
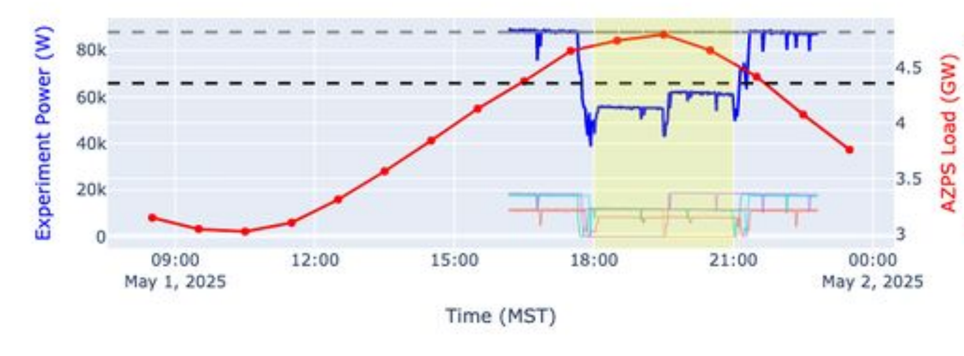
New demo at a Phoenix data center with AI loads

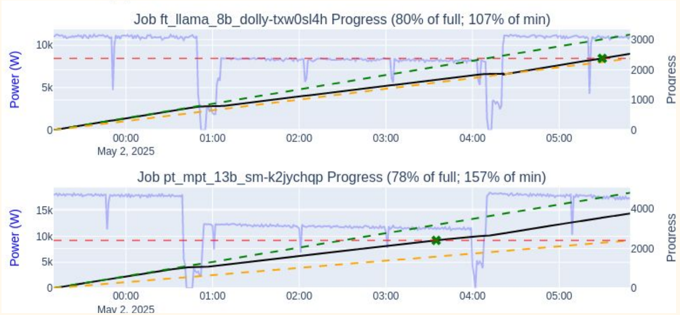
Salt River Project ("SRP"), May 4th, 2025





Arizona Public Service ("APS"), May 1st, 2025





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EPRI DCFlex

Innovative Product Offerings

Novel Utility Tariff Design to Meet Data Center Demand

Arin Kaye

Research Lead, EPRI

Balancing Data Center Energy Use with Climate Goals

May 21, 2025

Transformational Utility Programs

About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

Nonprofit
Chartered to serve the public benefit, with guidance from an independent advisory council.

Thought Leadership
Systematically and imaginatively looking ahead to identify issues, technology gaps, and broader needs that can be addressed by the electricity sector.

Independent
Objective, scientific research leading to progress in reliability, efficiency, affordability, health, safety, and the environment.

Scientific and Industry Expertise
Provide expertise in technical disciplines that bring answers and solutions to electricity generation, transmission, distribution, and end use.

Collaborative Value
Bring together our members and diverse scientific and technical sectors to shape and drive research and development in the electricity sector.

Demonstrate how data centers can support and stabilize the electric grid while improving interconnection and efficiency.

Drive a cultural, taxonomic, and operational shift, creating a blueprint for data center stakeholders, utilities, market operators, technology innovators, and policymakers to adopt.

Flexible Data Center Designs

Enabling future data centers to become grid resources through flexible & efficient designs and operational practices

Transformational Utility Programs

Explore market and program structures that advance data center flexibility

Grid Planning for Operational Flexibility

Equip the utility industry planning practices to embrace large flexible loads

Primer on Power Purchasing Mechanisms

Types of Electricity Supply Agreements

Power Purchase Agreements (PPA)

- **Physical PPA:** An agreement that specifies electricity generated by an EGU that is physically and directly connected to a specified delivery point where the off-taker obtains legal title to the energy (MWhs)
- **Virtual PPA:** An agreement that gives the off-taker rights to electricity that does not directly serve the customer

Energy Supply Agreements (ESAs)

- A bilateral contract between a project developer and an off-taker often implemented under a more general “umbrella” utility tariff
- Describes the type and source of energy (MWhs) to be supplied, delivery timing, associated pricing, how payment will be made, and other provisions
  - Customizable based on off-takers’ needs

Electric Utility Tariffs

- List of prices and related terms that govern how an electric utility provides its services and charges customers for their electricity consumption
- Regulated vertically integrated, investor-owned electric utilities (IOUs) typically are **required** to submit proposed tariffs to state public utility commissions (PUCs) and receive their approval to implement new tariffs

Innovative Products to Meet Data Center Demand

Power Purchase Agreements

- September 20, 2024 - Constellation & Microsoft: Crane Clean Energy Center
  - Generation Capacity: 835 MW
  - Source: Nuclear
  - Location: Pennsylvania
- February 4, 2025 - Enel & Meta: Rockhaven Wind Farm
  - Generation Capacity: 115 MW
  - Source: Wind
  - Location: Oklahoma

Utility Tariffs

- June 1, 2023 -Entergy Arkansas: Go-Zero
  - Generation Capacity: subscription dependent
  - Source: Renewables
  - Location: Arkansas
- March 11, 2025 - Nevada Energy & Google: Clean Transition Tariff
  - Generation Capacity: 115 MW (scalable)
  - Source: Advanced geothermal
  - Location: Nevada

Thank you!

Arin Kaye
Research Lead
akaye@epri.com

LUNCH 12:30-1:20

Josh Ryor

MA EEA Perspective on Data Centers

Assistant Secretary
MA EEA

Commonwealth of Massachusetts
Executive Office of
Energy and Environmental Affairs

Transition to the Future Grid in MA

Event I: Balancing Data Center Energy Use & Climate Goals

Josh Ryor
Assistant Secretary of Energy

May 21, 2025

Energy Affordability, Independence, and Innovation Act

Energy Affordability, Independence and Innovation Act

Governor Healey filed HD 4704 on May 13, 2025, to increase homegrown energy, avoid unnecessary spending, and save customers money. It does this by:

- Expanding and diversifying the energy supplies we can procure and providing more flexibility as to when and how we do it;
- Streamlining some programs and ending others that have achieved their goals and are no longer necessary;
- Reforming rates by changing how they are structured and assessed to reduce price and bill volatility;
- Providing more options for customers to control their own bills and lower costs;
- Leveraging lower cost and innovative financing to bring down bills and accelerate investments, without raising fees or taxes; and
- Providing greater oversight of utility spending, greater transparency into utility management, operations, and performance, and significantly reining in unscrupulous competitive suppliers – which costs us all when customers can't pay.

Many provisions proposed are complementary and are meant to work in concert to deliver the greatest costs savings for customers.

Energy Affordability, Independence and Innovation Act: Elements

- Get Costs Off Bills – Saves $6.9 Billion
- Create Accountability – Saves $2.5 Billion
- Bring More Energy into Massachusetts – Saves $200 Million
- Empower Customers to Lower Bills – Saves $900 Billion
- Power Innovation and Growth

Proposed provisions anticipated to result in more than $10 billion in savings over 10 years

Energy Affordability, Independence and Innovation Act: Key Sections

Get Costs Off Bills
Phase out alternative portfolio standard
Reduce net metering credit for large projects
Pay for programs like Mass Save differently
Reform existing rates and charges; set monthly cap on increases

Create Accountability
Provide more oversight of costly transmission projects
Restrict costs that utilities can recover from ratepayers
Authorize utility management audits
Require utilities to comprehensively plan and minimize grid costs

Power Innovation and Growth
Create clean energy ready zones to accelerate development
Share benefits of infrastructure investments with ratepayers and communities

Energy Affordability, Independence and Innovation Act: Key Sections

Bring More Energy into Massachusetts
Expand state energy procurement authority
Provide flexibility to set supply rates
Allow customers to connect faster to the grid
Reduce barriers to small nuclear technologies

Empower Customers to Lower Bills
Protect customers from predatory electricity marketing and pricing
Reduce upfront costs to building geothermal
Reform low- and moderate-income discount rates
Establish new financing tools for customers to efficiently heat and cool buildings
Make Mass Save more efficient and responsive

Sustainable and Affordable Data Center Development

Data Center Opportunities

- **Data centers present significant economic opportunities**
  - Jobs in the construction of new facilities
  - Ongoing company footprint
  - Increased sales and property tax revenue
- **Data center growth is aligned with other Healey-Driscoll policy priorities**
  - Massachusetts AI Hub
  - Climatech ecosystem
- **Data centers present other affordability and grid reliability challenges**

Data Center Activity in the Commonwealth

Sections 47 and 214 of the Mass Leads Act established sales tax exemptions for data centers on:

(A) data center equipment; (B) computer software for use in a data center; (C) electricity for use or consumption in the operation of a qualified data center; or (D) construction costs incurred for the construction, renovation or refurbishment of a qualified data center.

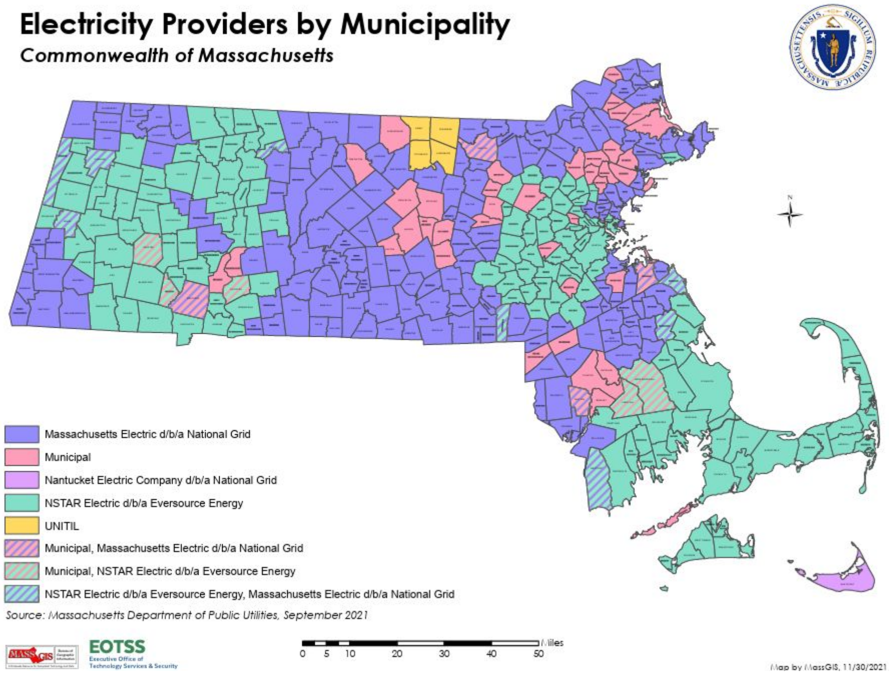
Electric Distribution Companies

~2 GW of data centers are in the interconnection queue of the state's investor-owned utilities, the overwhelming majority of which materialized after the passage of the Mass Leads Act.

Takeaway

The sales tax exception of both construction and electricity costs, in addition to data center hardware and software costs are rare.

These costs savings may be sufficient to overcome higher electricity, labor, and land costs in Massachusetts.



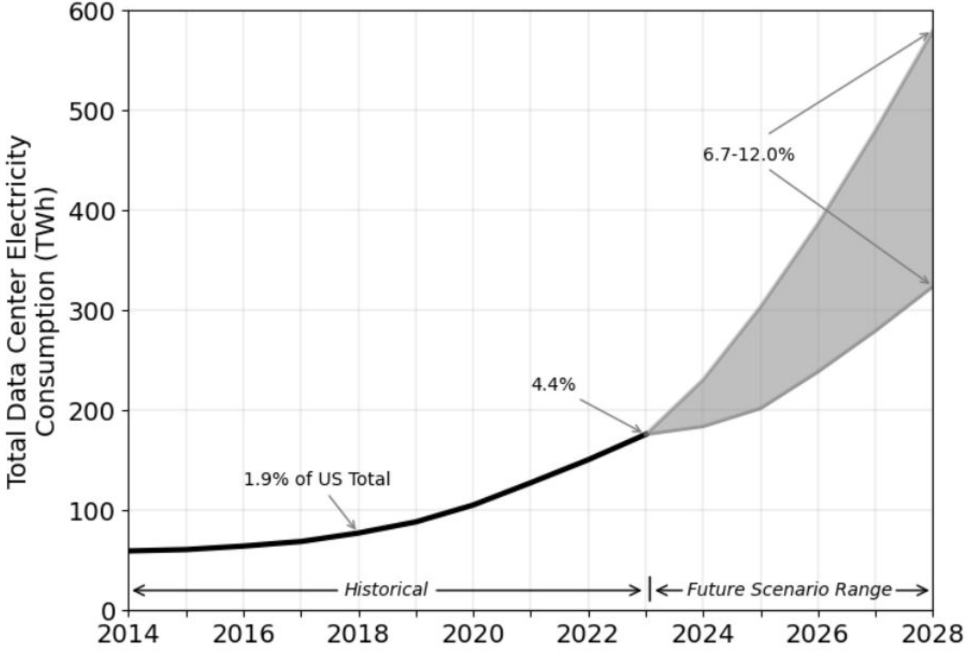
Scale and Speed of Data Center Development

Large Apartment Building (300 units)
0.1 to 0.3 kW peak demand per unit

Total: Up to 1 MW

Large Data Center
100-500 MW

U.S. Electricity Consumption



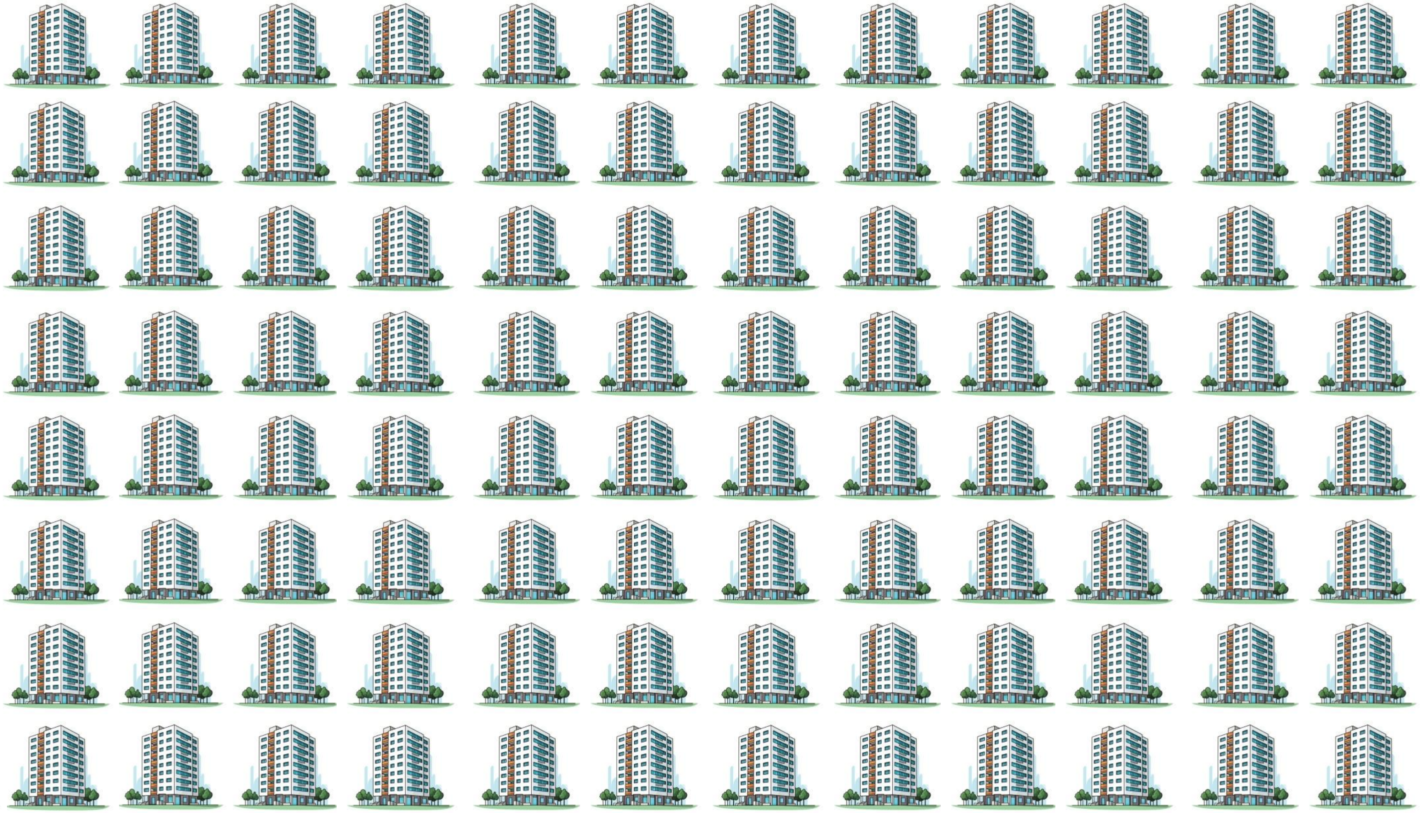
Sources:
https://www.aceee.org/files/proceedings/2006/data/papers/SS06_Panel1_Paper10.pdf
https://eta-publications.lbl.gov/sites/default/files/2024-12/lbnl-2024-united-states-data-center-energy-usage-report.pdf

Data Centers as New Housing

100 MW Data Center

Equals

100 Large Apartment Buildings



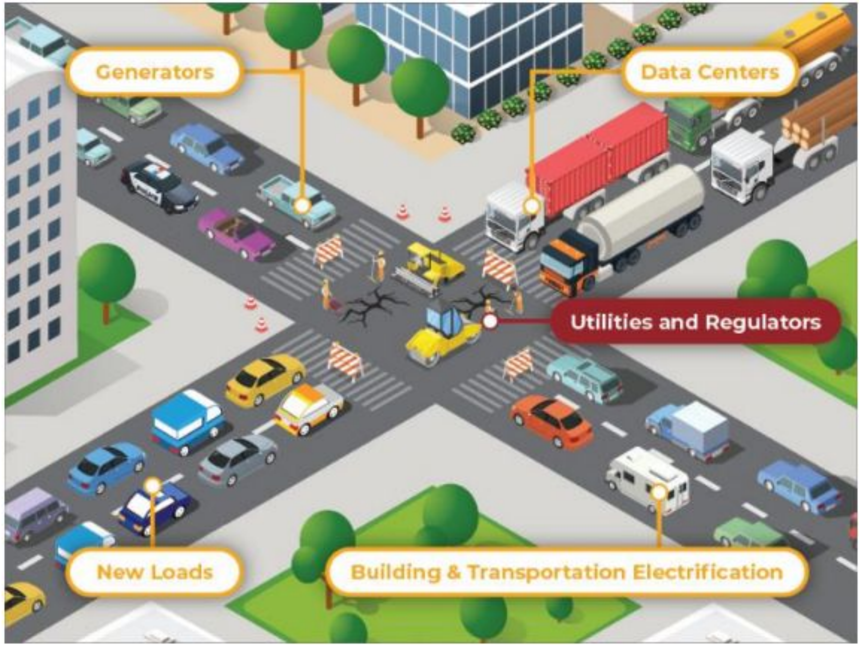
Potential Customer Impacts Associated with Data Center Growth

Cost

- Increased wholesale market costs from tightening of supply and demand
- Increased electric grid distribution and transmission infrastructure investments
- Infrastructure may be built, but not paid for, if data centers do not materialize
- Data centers collocated with existing generation forgoes paying grid infrastructure costs

Reliability

- New England may not have adequate energy supply to meet increased demand (e.g., natural gas in the winter)
- The loss of large loads, like data centers, can impact the ability to maintain power on the grid



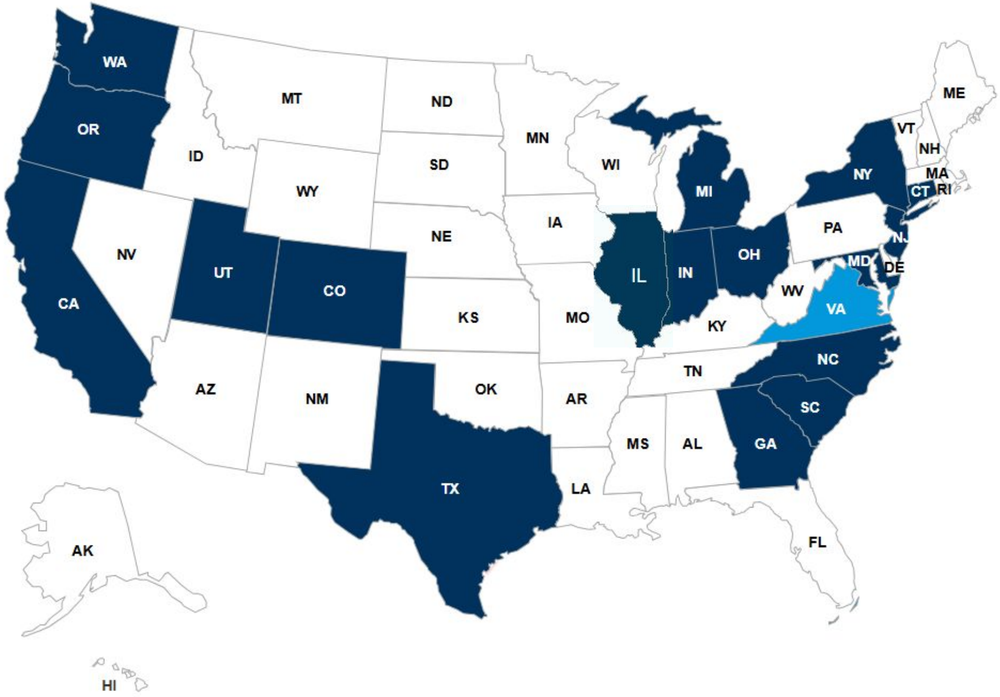
Emissions

- Grid fuel mixes are generally fossil fuel dominant, meaning increased load increases emissions
- Diesel generators are typically used by data centers for backup power

Examples of Consumer Cost & Reliability Impacts

- In the Mid-Atlantic, over $5 billion of transmission investment needs driven by data center load growth have been identified
- Generation capacity costs for the grid operator in the Mid-Atlantic and portions of the Midwest, PJM, increased from $2.2 billion to $14.7 billion in 2024 due to load growth driven by data centers, resource requirements, and updated market rules
  - This price increase contributed to some utility customers seeing rate increases up to 20%
  - In Chicago, average electric bills for residential customers are expected to rise by $10.50 a month by the middle of 2025
- Synapse Energy Economics estimates that an additional $160 billion in electric grid costs will be needed in PJM through 2040 to accommodate data center growth, which translates into a residential bill increase of around 10 percent for the average customer
- Large loads like data centers can be sensitive to disturbances on the grid
  - North American Electric Reliability Corporation is investigating these challenges
  - **Example:** July 2024 – 1,500 MW of data center load dropped off the grid at 60 different locations in Loudoun County, VA. Grid operators had to quickly scale back volume of energy going to network from power stations to avoid power surges/potential blackouts. This sudden change is not dissimilar from what triggered the recent blackouts in Spain.
- EEA estimates that the 2,000 MW of data centers currently proposed in Massachusetts could result in upwards of $1 billion in increased wholesale energy prices and incremental transmission investments paid by electric customers

Active Federal & State Legislative & Regulatory Efforts



The following states, indicated in dark blue on the map, in addition to the U.S. Senate, are actively exploring or have passed data center provisions:

California; Connecticut; Colorado; Georgia; Illinois; Indiana; Maryland; New Jersey; New York; North Carolina; Ohio; Oregon; South Carolina; Texas; Washington

Virginia, indicated in light blue on the map, has also explored similar provisions

Topics explored by these states and the U.S. Senate include, but are not limited to:

Cost responsibility and allocation; energy efficiency; load flexibility / demand response; bring your own energy; emissions limits / clean energy requirements; reporting requirements; study impacts of data centers

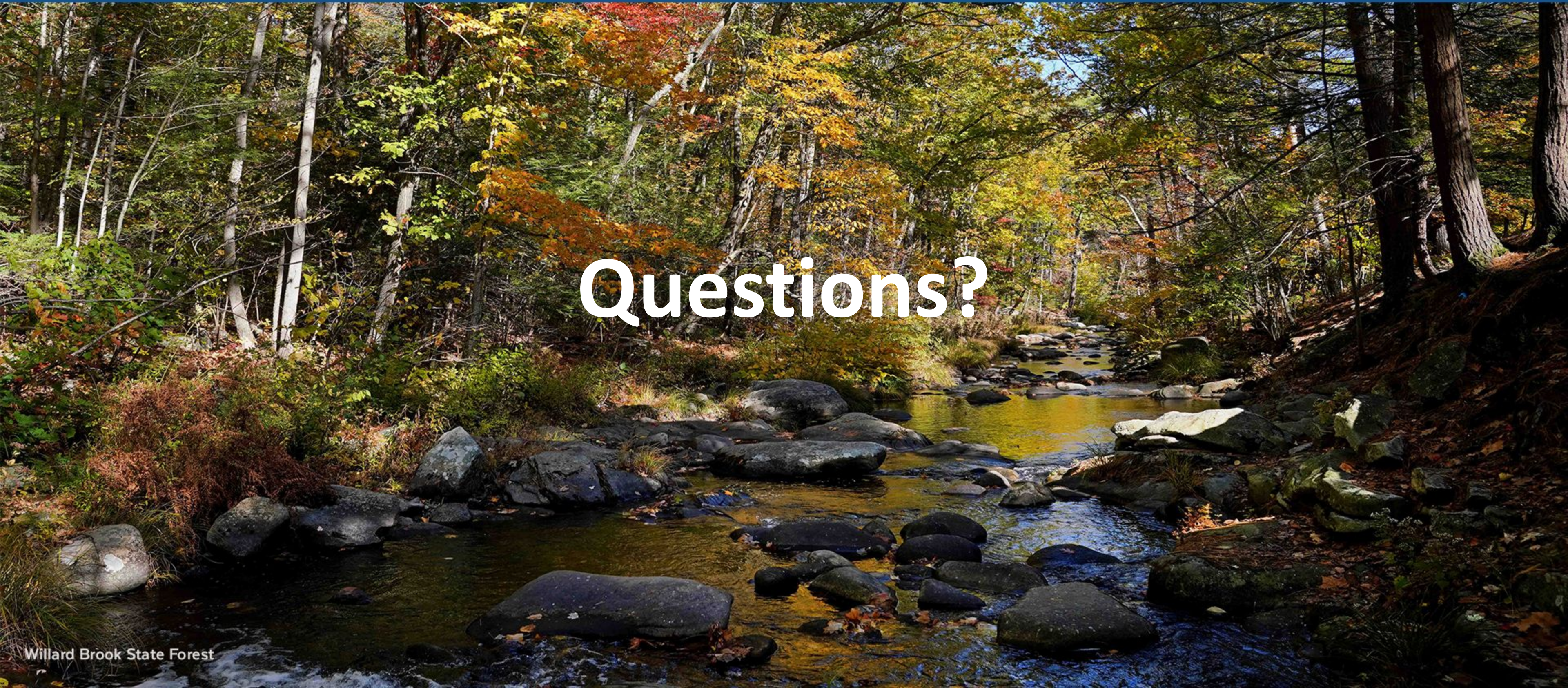
Mitigating Potential Cost, Reliability, & Emissions Impacts

- The Virginia Joint Legislative Audit and Review Commission highlighted the opportunity to balance the policy objective of sustained data center growth with other policy priorities (e.g., energy affordability, grid reliability, and emissions reductions) by requiring data centers that receive a tax exemption to meet additional requirements

- Requirements that would help mitigate the potential cost, reliability, and emissions implications of data center deployment include, but are not limited to:
  - Minimum energy efficiency standards
  - Criteria for deploying on-site renewables
  - Criteria for enrolling in demand response / flexibility programs
  - Criteria for the use of waste heat as part of a thermal loop
  - Minimum thresholds for meeting electricity consumption with new clean energy

- EEA is continuing is working with the legislature, industry, and ratepayer advocates to explore potential approaches to ensure that Massachusetts benefits from data centers opportunities, while mitigating the affordability and grid reliability challenges

Executive Office of Energy and Environmental Affairs



Policy & People Perspective

Ashley Gagnon
MA EEA

Aaron Lang
Foley Hoag

Francesca Dominic
Harvard University

Galen Nelson
MassCEC
(MODERATOR)

Data Centers and Air Pollution: Implications for MA

HARVARD T.H. CHAN | SCHOOL OF PUBLIC HEALTH

HDSI | Harvard Data Science Initiative

05.21.2025

Nationally, data centers are clustered in certain regions – the Mid-Atlantic and Northeast have the highest concentration

Data centers in the United States (2023)
Clustered by region

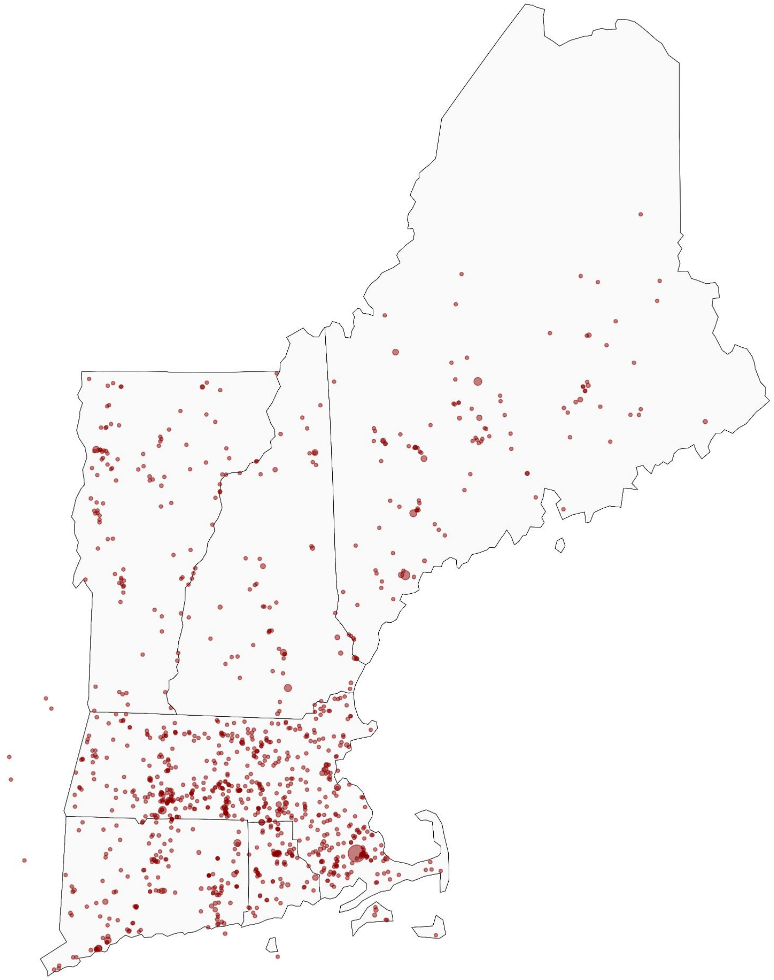
Source: Baxtel, Guidi analysis

Natural gas plants provide much of the electricity for MA's data centers

This energy comes from plants across New England and contributes to air pollution

Chart: Air pollution (PM2.5) from power plants supplying MA data centers (2023)

Each dot is a power plant emitting $PM_{2.5}$; size reflects PM2.5 in tons

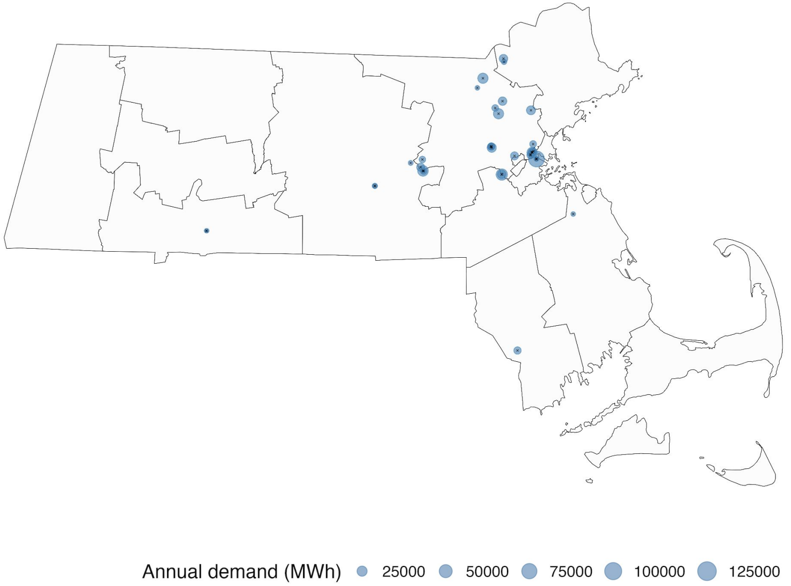


Source: Baxtel, ISO New England

MA data centers use 805 GWh of electricity from natural gas; although clustered around Boston, air pollution is in the SE

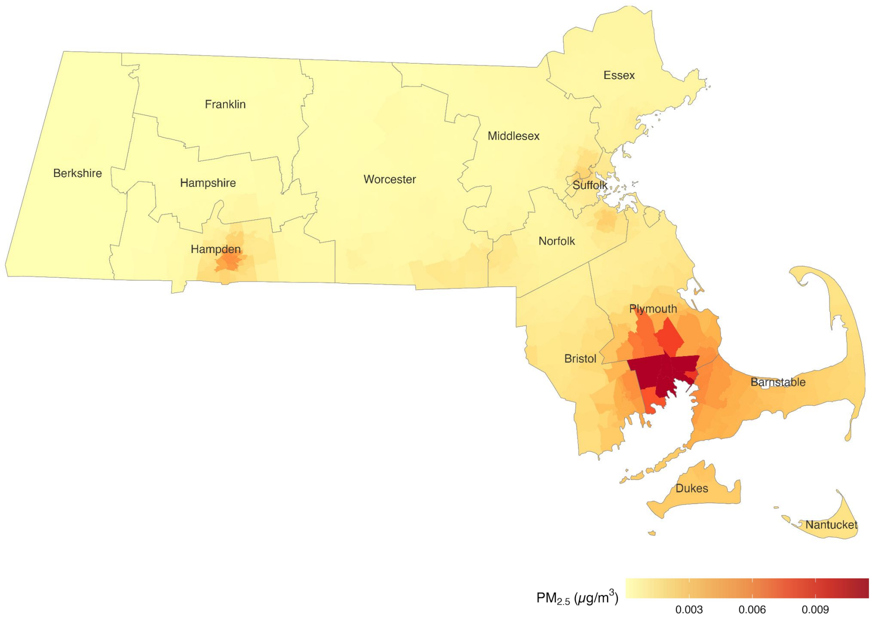
MA data centers and their electricity use (2023)

Each dot shows a data center; Size reflects its annual electricity demand (MWh)



Data centers' impact on air pollution (PM2.5) in MA (2023)

Each dot shows a data center; Size reflects its annual electricity demand (MWh)

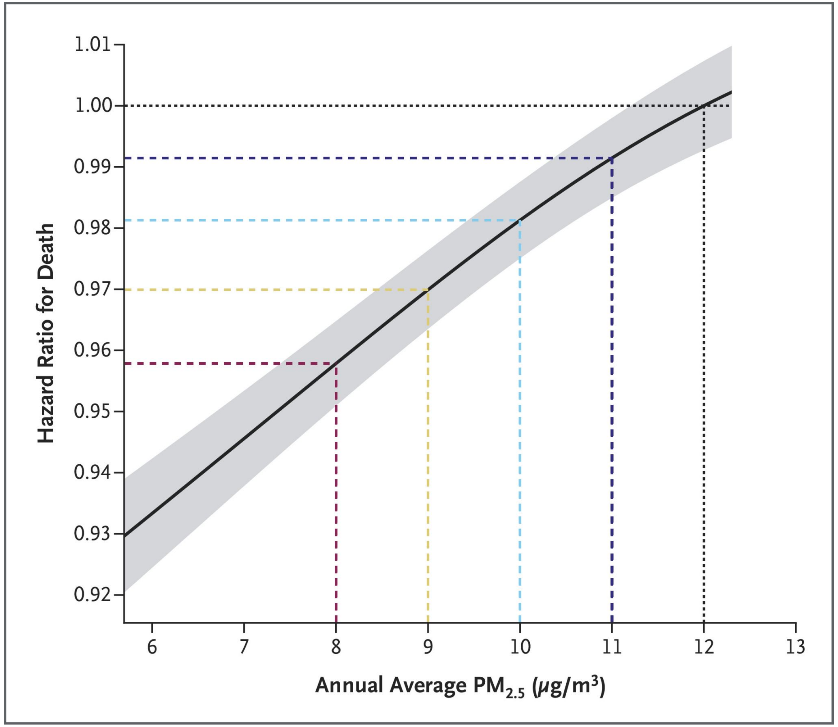


Source: ISO New England 2023; InMAP

More Pollution, Higher Risk:

No level of PM2.5 is safe

Breathing in air pollution — even at low levels — is linked to serious health problems like heart disease, asthma, and even early death



Graph: Exposure Response Curve

As air pollution increases, so does risk of death (hazard ratio)

Source: Josey, Kevin P., et al. "Air pollution and mortality at the intersection of race and social class." New England Journal of Medicine 388.15 (2023): 1396-1404.

Thank you.

Francesca Dominici
fdominic@hsph.harvard.edu

HARVARD T.H. CHAN | SCHOOL OF PUBLIC HEALTH

HDSI | Harvard Data Science Initiative

Table Discussions

Table Discussions Instructions

1. **Each table should identify:**
   a. A facilitator (if someone wasn't already assigned)
   b. A notetaker/email writer
   c. A timekeeper
2. **Responses to the questions should be emailed** to Alistair Pim at apim@joinact.org and grid@masscec.com
3. We will be happy receive additional comments after the event. Please email to the same email addresses.

Table Discussions Questions

1. What are data centers' benefits and burdens for Massachusetts and our communities? List them.
2. Using your list of **benefits**, for each one, how (with what tools – policy, regulation, or technology) can the State best capture that benefit?
3. Using your list of **burdens**, how (with what tools – policy, regulation, or technology) can the State manage/minimize that burden?
4. What are the **key outstanding questions** that MA needs to answer as we scope the role and development of data centers? How do those questions, or the priority order of those questions, differ between stakeholders?
5. What are the **first three policy, program, and/or regulatory initiatives** that MA should pursue or investigate further? How do those questions, or the priority order of those questions, differ between stakeholders?

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Wrap Up

Join us for Happy Hour Networking!

Huge thanks to Foley Hoag!