Northwest **Power** and
Conservation Council

January 6, 2025

MEMORANDUM

TO: **Council Members**

FROM: **Jennifer Light, Director of Power Planning**

SUBJECT: **Panel on Data Centers Efficiency and Flexibility Opportunities**

BACKGROUND:

Presenters: Christine Golightly, CRITFC and Karina Hershberg and Ben Burnett, PAE
Baskar Vairamohan, Electric Power Research Institute
Isaac Barrow, Portland General Electric
Jennifer Light, Kevin Smit, and Joe Walderman, Council staff

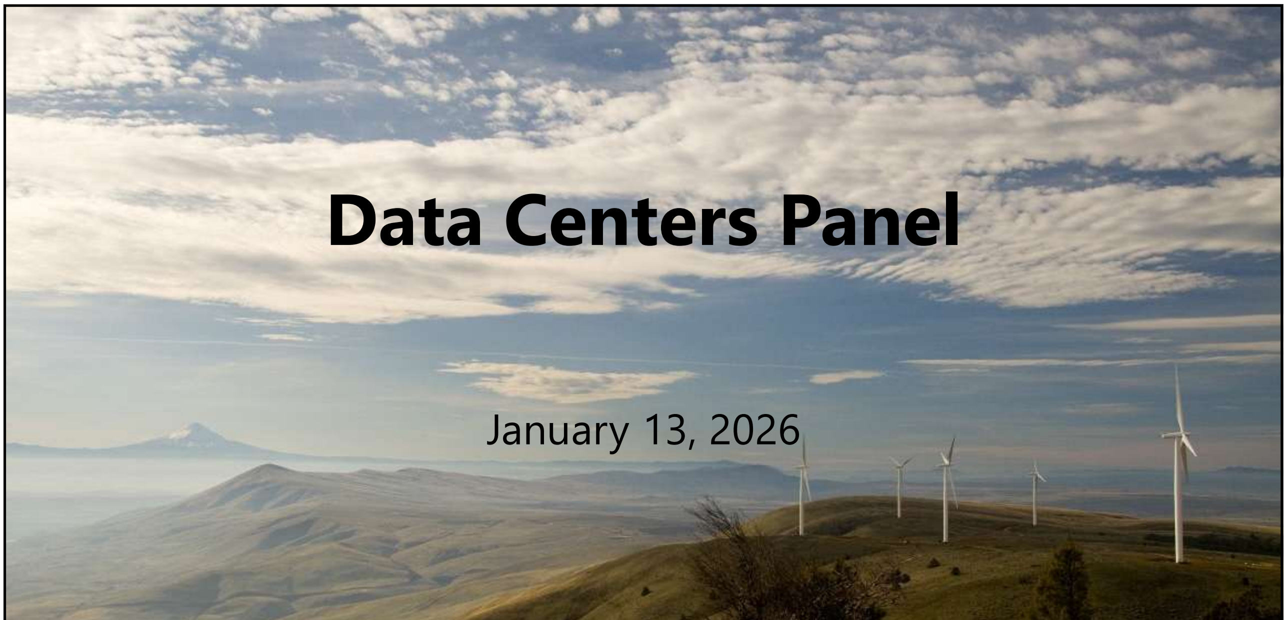
Summary: Data centers loads are forecasted to significantly increase, both in this region and across the U.S. The Council's Ninth Power Plan must address the resource needs to meet this, and other, load growth. This panel will pull together staff's analysis on this sector to date and highlight potential pathways the Power Plan can address this load. Presenters will specifically highlight energy efficiency and flexibility opportunities in this sector.

Relevance: The Council's power plan must include a general scheme for implementing conservation and developing resources in order to meet regional load growth. Data centers are a piece of that regional load growth, and therefore, must be considered in the Council's power plan.

Workplan: B. Development of Ninth Power Plan

More info: The following sources provide more information on topics that will be covered during the panel discussion.

- Load forecast for the Ninth Plan (presented on April 29, 2025)
- RTF Data Centers Market Characterization Study (presented on January 23, 2025 to the RTF)
- PAE Study: The Energy & Water Use Impacts of Building System Design for Data Centers
- EPRI Data Center Flexible Load Initiative



Data Centers Panel

January 13, 2026

Northwest **Power** and **Conservation** Council

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Agenda

- Introduction and Context Setting (10 min)
  - Forecasting data center loads
  - Developing recommendations for these loads
- Energy Efficiency Opportunities (55 min)
  - Staff's approach to data center efficiency in the Ninth Plan
  - Presentation from CRITFC and PAE on data center efficiency and water use
- Flexibility Opportunities (55 min)
  - EPRI presentation on DC Flex
  - Presentation from Portland General Electric on approach to flexibility in this sector

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Introduction

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Data Centers in the Ninth Plan

- Council is to develop a power plan for Bonneville and the region
  - Includes a general scheme for implementing conservation and developing resources
  - Must give due consideration for environmental quality, compatibility with the existing system, fish and wildlife, and other criteria
- The power plan has a regional focus, but with specific emphasis on Bonneville due to the provisions in the Act connecting their resource planning to the Council's power plans
- Data centers are a part of the regional load growth that the Council must account for in the plan, both in terms of resources to meet the load and supporting recommendations

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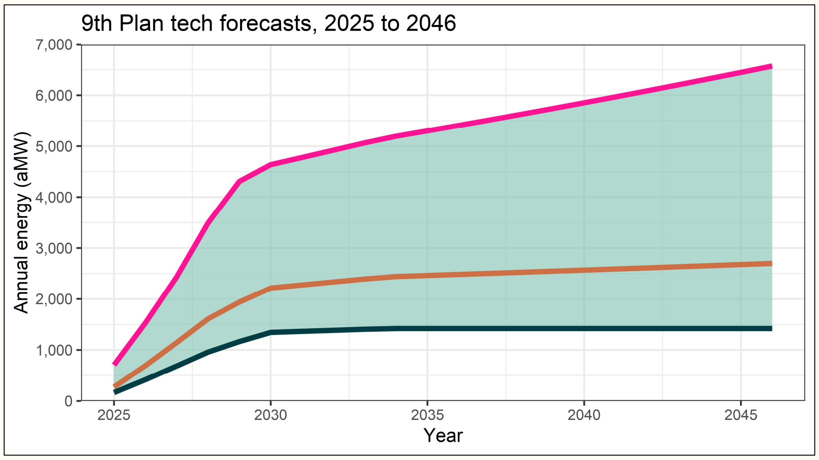
Data Center Load Forecast in Ninth Plan



The **high forecast** through 2030 reflects utility and BPA growth expectations

The **mid forecast** through 2030 is a continuation of recent trends

The **low forecast** through 2030 has a slowing of recent trends

Post 2030 growth at a fixed rate depending on forecast

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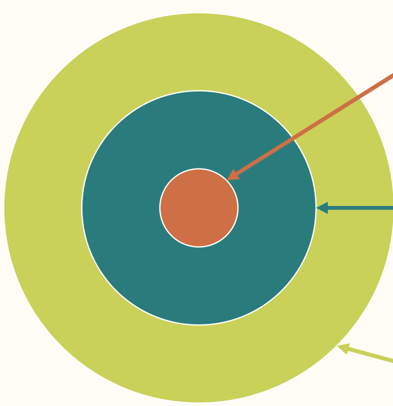
Recommendations in the Power Plan



Resource Recommendations to Bonneville: These include specific resources and in what amounts to meet or reduce Bonneville's obligation and have the strongest legal meaning.

Resource Recommendations to the Region: These include specific resources and in what amounts to meet regional needs. They guide decision making, but there is not the same legal connection as with the Bonneville resource recommendations.

Supporting Recommendations: These can cover a variety of issues and focus on addressing challenges the Council sees in implementing the resource recommendations. These too may guide decision making, but there is no legal hook for implementation.

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Data Centers and Bonneville

- These are considered New Large Single Loads under the Power Act and have different treatment by Bonneville
  - These loads are not eligible for preference rates (e.g. power sold at the Tier 1 or Tier 2 rate)
  - If requested, Bonneville will sell power to serve these loads at the New Resource rate
  - Timeline from the request to delivery of power is long, with up to three years for Bonneville to conduct a service study and potentially additional time for Bonneville to then acquire the resources to serve the load
- Given these considerations, it is anticipated that little (if any) of these loads will be placed on Bonneville to serve
- Therefore, these loads are not a big driver of resource need for meeting Bonneville's obligation

Data Centers and the Region

- Council will need to address data centers in the broader regional strategy, including providing recommendations on cost-effective resources to meet the load growth
- In addition, the Council can and does provide additional recommendations in support of the resource strategy
- Here are some examples from the 2021 Power Plan:

Siting considerations	Resource sharing	Transmission constraints
The Council recommends that the region be mindful of individual and cumulative impacts when siting new resources so that new renewable resource development is carried out in a manner that also protects the wildlife, fish, and cultural resources of the Pacific Northwest.	*In addition to these resources, the Council recommends Bonneville and the regional utilities, along with their associations and planning organizations, work together and with others in the Western electric grid to explore the potential costs and benefits of new market tools, such as capacity and reserves products, that contribute to system accessibility and efficiency.*	*The Council recommends that the region's transmission providers work with utilities, load-serving entities, NorthernGrid, and others to develop a comprehensive review of the existing state of the transmission system; research potential short-term and long-term solutions to alleviate new resource development barriers, while balancing existing long-term contracts and compensation to transmission providers; and explore the potential benefits of implementing a regional transmission operator in the Pacific Northwest.*

Possible Considerations for Ninth Plan

- Recommendations on ensuring energy efficiency and/or leveraging demand flexibility
  - These most directly relate to the resource strategy for and may also provide a potential path to connect to water use
  - ***We will touch on these topics today!***
- Other recommendations to ensure AEERPS while meeting load growth
  Examples:

Making accommodations for data centers that bring their own resources and/or meet reliability standards	Identifying siting considerations mindful of power system impacts and/or other land use considerations	Encouraging investment in power system enhancements, including transmission or development of emerging technologies

- Not recommending anything specific today, but we can think through options as we spend time with modeling results and work on drafting the plan

Energy Efficiency and Data Centers

RTF Data Center Market Characterization

- The RTF conducted a data center market characterization in 2024 (DNV)
- The purpose of the study was to provide the RTF and Council staff information on data center types and systems as well as EE and DR opportunities
- The PNW has over 23,000 embedded data centers (small) and about 300 custom (medium and large) data centers

Size	Type	Location
Small	Server Closet	Embedded in Building
	Server Room	
	Localized	
Medium	Mid-Tier	Embedded or Custom
Large	Enterprise	Custom Built - standalone
	Hyperscale	

https://www.visualcapitalist.com/mapped-u-s-states-with-the-most-data-centers-in-2025/

EE in Data Centers (9P)

- Embedded Data Centers
  - Potential estimates for ENRGY STAR servers for embedded and small data centers
  - Region currently has an estimated 406,000 servers in embedded data centers
  - 26 aMW of potential for upgrading to ENERGY STAR servers
- Large and Hyperscale Data Centers
  - The large and hyperscale data centers are being built with the latest technologies, so we assumed current practice
- Medium and Standalone Data Centers
  - The medium standalone data centers have some EE potential, especially for cooling and heat recovery.
  - However, we have very little reliable data on these facilities, so EE potential estimates are not possible at this point.
  - Some utilities (e.g., Energy Trust of Oregon) have programs that provide incentives for custom EE projects.
  - We are recommending that utilities continue to pursue these opportunities through their custom project approaches

Next Steps for EE and DR in the Ninth Plan

Target | Recommendations | MCS?

- Include the EE potential for embedded data centers in the targets if they are shown to be cost-effective
- Recommend that utilities pursue EE opportunities through custom projects
- Recommend that the region conduct some additional stock assessment research, especially on mid-sized data centers
- Consider setting efficiency standards through the Model Conservation Standards
- We will be discussing these (and other) possible topics with our advisory committee over the next 3-5 months

Data Center Energy Efficiency Speakers

- Presenters:
  - Christine Golightly, CRITFC
  - Karina Hershberg and Ben Burnett, PAE
- PAE conducted a study analyzing the energy and water use impacts of build system design for data centers, which provides useful insights to inform potential energy efficiency standards and other considerations

Data Center Flexibility

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Load Flexibility

- Data centers pose significant new load growth
- However, they may offer opportunities to flex certain workloads intermittently to help maintain a stable grid

9th Plan Considerations

- Pilots and demonstrations are developing but there is a lack of reliable cost and performance data
- Potential is not modeled explicitly as a resource but is important to think about in the context of the plan

Approaches to Data Center Load Flexibility		
Time Shifting Shifting non-time-critical data center workloads away from peak demand periods	**Generation and Storage** Supplying energy usage from onsite generation and storage to reduce demand	**Locational Shifting** Reallocating workloads to different data center locations where the grid is less strained

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Data Center Flexibility Speakers

Electric Power Research Institute (EPRI)	Portland General Electric
• Baskar Vairamohan • Technical Executive (EPRI DC Flex) • Providing background on load flex opportunities and sharing on EPRI's approach to bolstering and demonstrating data center load flexibility	• Isaac Barrow • Senior Manager for Data Centers and Growth • Sharing on the data centers that PGE serves, their approach to data center flexibility, and their partnership with GridCARE to enable large load interconnections

Northwest Power and Conservation Council 17 The 9th Northwest Regional Power Plan

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Wrap-Up & Further Discussion

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Energy Efficiency and Data Centers

PRESENTED BY: KARINA HERSHBERG
BEN BURNETT

JANUARY 13, 2026

PAE

pae-engineers.com

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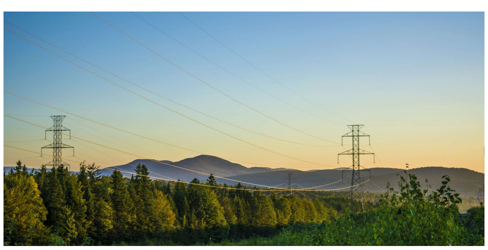
Data Center Energy Metrics



Power Usage Effectiveness (PUE)

MOST FREQUENTLY USED METRIC OF DC ENERGY EFFICIENCY

— **PUE = Total DC Energy Use/IT Equipment Energy Use**

— A PUE of 1.0 means all data center energy is from the IT /server equipment

— Current modern data centers reach PUEs of 1.2

Water Use Effectiveness (WUE)

— Measured in gallons (or liters) consumed per kWh of electricity

— Average is 0.5 gallons per kWh[1]

[1] *https://www.eesi.org/articles/view/data-centers-and-water-consumption*

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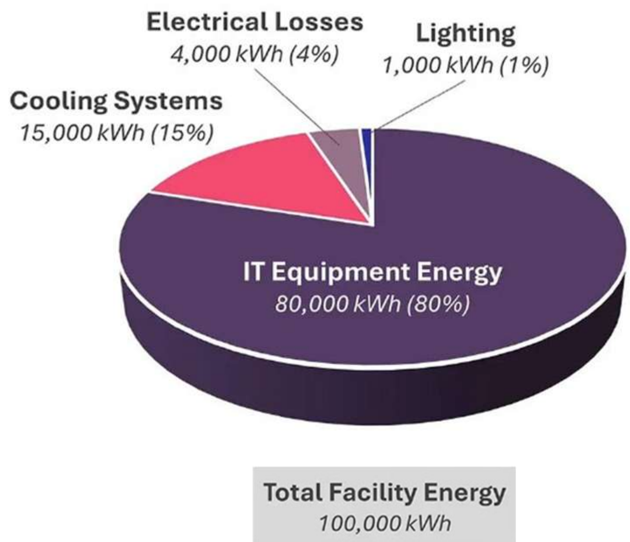
Data Center End-Use Energy Breakdown

(ILLUSTRATION ONLY)



Source: ACEEE 2025

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Current Energy Code

—

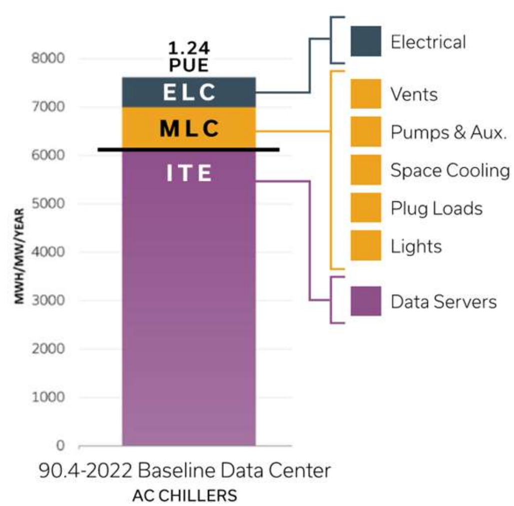
ASHRAE STANDARD 90.4

— Applies to all new Data Centers in OR and WA rated at greater than 10kW ITE load.

PERFORMANCE-BASED COMPLIANCE

— 90.4 Sets a PUE limit based on climate zone.
  - PUE separated into ELC, MLC (tradeable)
  - ELC – Electrical Loss Component
  - MLC – Mechanical Loss Component

— Performance is based on annual energy consumption, modeled or calculated in local weather conditions.



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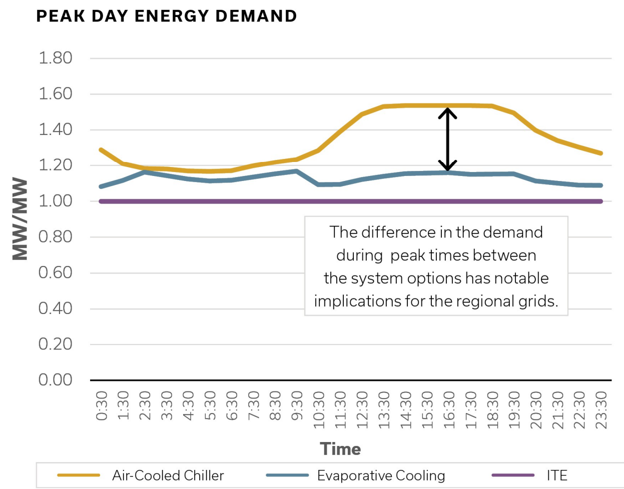
Peak Demand

— Peak demand is the primary driver for grid capacity.

— Data Centers with similar annual energy use can have significantly different peak demand.

– Dependent on mechanical/heat rejection system

— Current Energy Codes do not address peak demand.



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Water Consumption for Cooling in Data Centers

— Data center processors produce significant amounts of heat

— Some data centers consume water to cool the processor chips through:

– Direct evaporative cooling

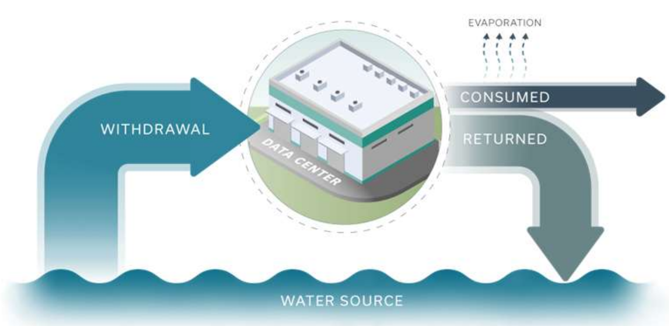
– Evaporative waterside economizers

– Water-cooled chiller systems

— Other water-cooling technologies not associated with high water consumption:

– Direct "on-chip" water cooling

– Immersion cooling



[withdrawal] - [returned] = [consumption]

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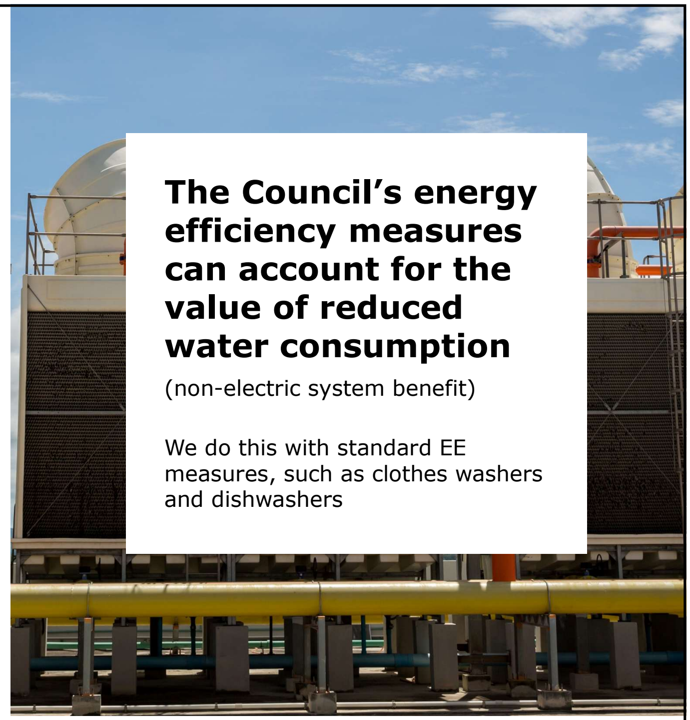
Water Consumption for Cooling In Data Centers

— **ADVANTAGES:**
— Energy use reduction: ~6%
— Peak energy demand reduction: ~20%

— **RISKS:**
— Water availability
— Complex, expensive treatment systems



The Council's energy efficiency measures can account for the value of reduced water consumption

(non-electric system benefit)

We do this with standard EE measures, such as clothes washers and dishwashers

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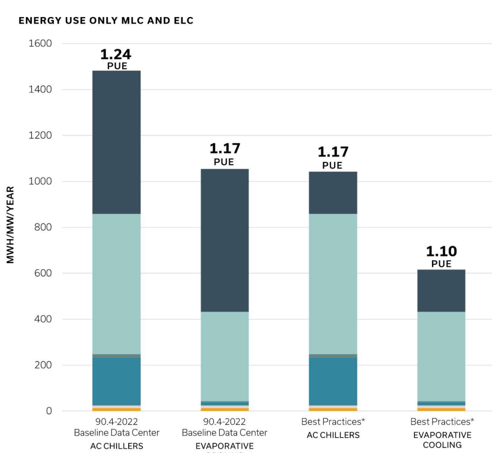
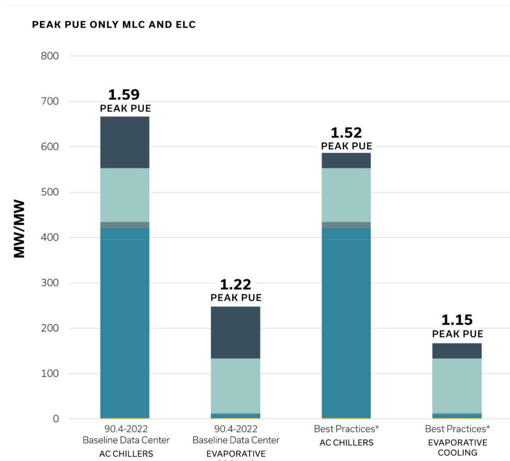
Water Consumption vs. Peak Demand & Energy Use





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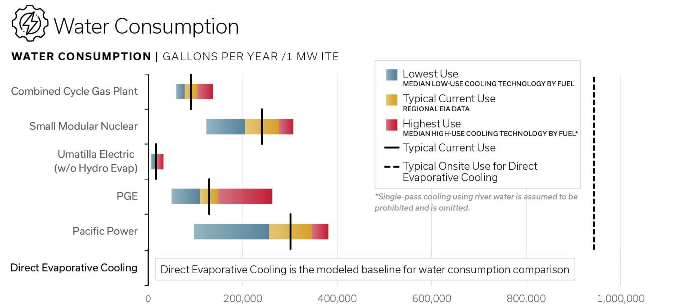
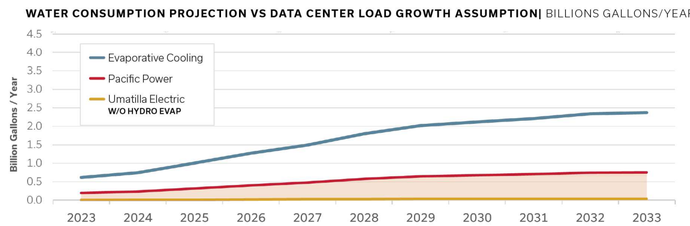
Direct Water Consumption vs. Energy Use

- Electricity production also consumes water
- This consumption is dependent on the cooling technology and fuel source
- Regardless of the electrical generation technology and/or fuel, consumption of water for evaporative cooling is 3x – 10x that of the equivalent additional cooling energy





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Recommendations

A REACH code for projects over a certain size that goes beyond the minimum requirements of ASHRAE 90.4 to ensure optimized systems for improved PUE.

Creation and adoption of a Peak-PUE metric to encourage selection of systems with reduced peak demand impacts.

Encouragement of innovation in the data center industry for creative water solutions to reduce the overall impact.

This could include support and adoption of future recommendations by the newly formed IAPMO WE-Stand Data Center Working Group.

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DCFlex

Data Center Flexible Load Initiative

Northwest Power and Conservation Council

January 13, 2026

Baskar Vairamohan
Technical Executive
EPRI

ABOUT US

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.

COLLABORATION

EPRI's collaborative platform is unrivaled. Our R&D:

- Leverages your research dollars
- Connects you to a global network of peers
- Accelerates deployment of technology
- Mitigates the risk and uncertainty of going it alone
- Positions you as a leader in addressing industrywide challenges

CREDIBILITY

EPRI's independent research is guided by our mission to benefit the public. We offer:

- Objective solutions
- A proven track record
- Scientifically based research you can trust

EXPERTISE

For nearly 50 years, EPRI has been applying R&D to help solve real challenges. With EPRI, you can:

- Reduce expenses and increase productivity
- Be more resilient today and better prepared for tomorrow
- Access an industry repository of collective experiences, technical expertise, and training resources
- Extend your staff and make your teams more robust and more confident
- Benchmark, learn and share best practices
- Increase your awareness of challenges that others are facing and alternate solutions to challenges you might be facing
- Save time and money troubleshooting problems EPRI and its stakeholders have seen before

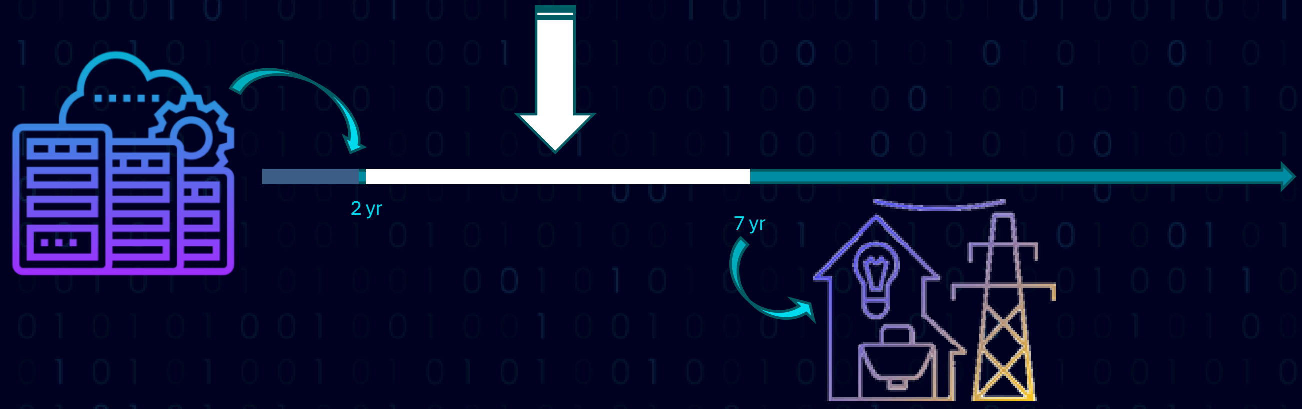
Who We Are

EPRI is a non-profit organization that performs research to advance safe, reliable, and environmentally responsible energy for the public benefit.

Our Members

EPRI members represent 90% of the electricity generated and delivered in the United States, with international participation extending to 45 countries.

The Challenge



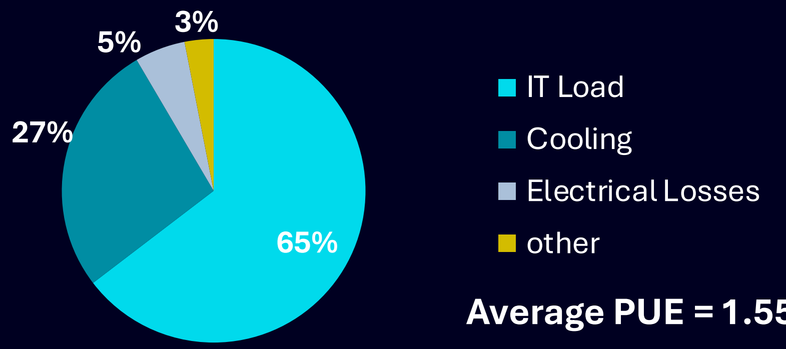
The Solution

Grid-integrated Flexible Data Centers

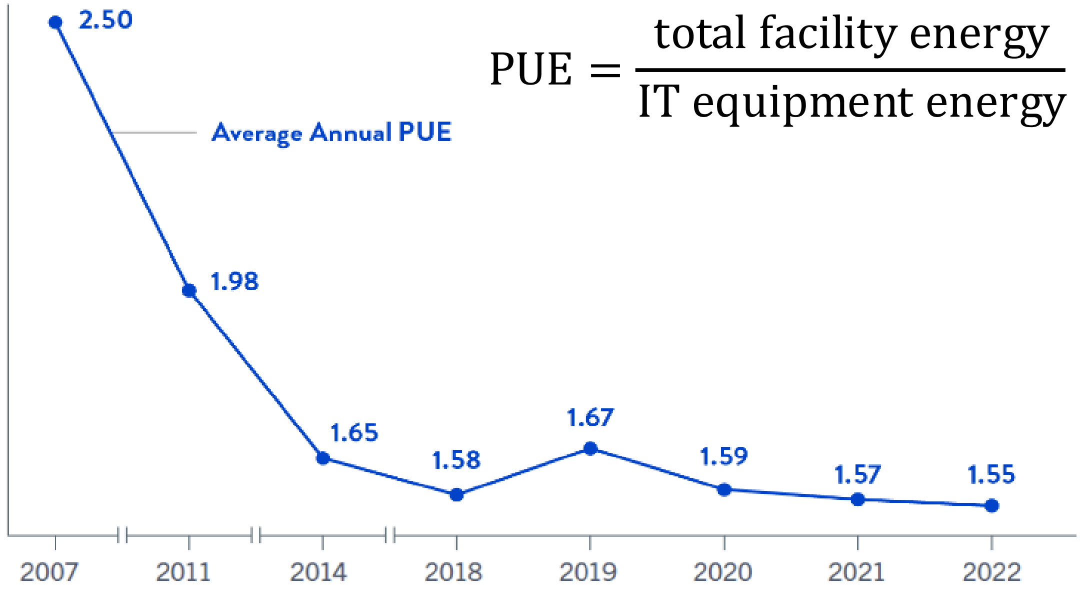
Data Center Power Use and Assets

- **IT load (Primary Load)**
  - servers, storage, networking
- **Cooling**
  - driven by 24x7x365 IT load
  - Chiller efficiency impacted by outdoor air
  - Limited humidification load
- **Power Conditioning**
  - Uninterruptible power supply (UPS) & battery loss
  - Backup generator may use block heater
- **Support**
  - Lighting, office equipment, space conditioning
- **Metric:** PUE (Power Usage Effectiveness)

Typical Data Center Energy Use



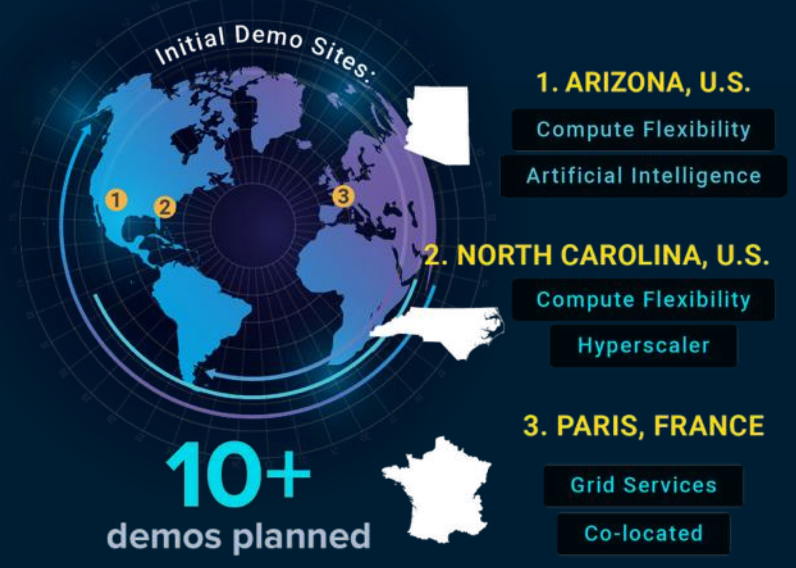
Average PUE = 1.55



$$\text{PUE} = \frac{\text{total facility energy}}{\text{IT equipment energy}}$$

Uptime Institute (2022)

DCFlex Optimize Data Center Operational Flexibility to Help Strengthen the Grid



DCFlex Workstreams

- 01 Flexible Data Center Design
- 02 Transformational Utility Programs
- 03 Grid Planning for Operational Flexibility
- 04 Data Center Informed Energy Supply

The DCFlex participant panel actively collaborates with regulators, academia, and industry stakeholders – both to share leading practices and insights, and to incorporate diverse perspectives that strengthen the initiative's direction and impact.

Learn More:
dcflex.epri.com

STARFLEX™ Deliver a tiered flexibility framework bridging data center capability to grid needs

DCFlex Participants

Developers
- Compass datacenters
- Digital Realty
- QTS

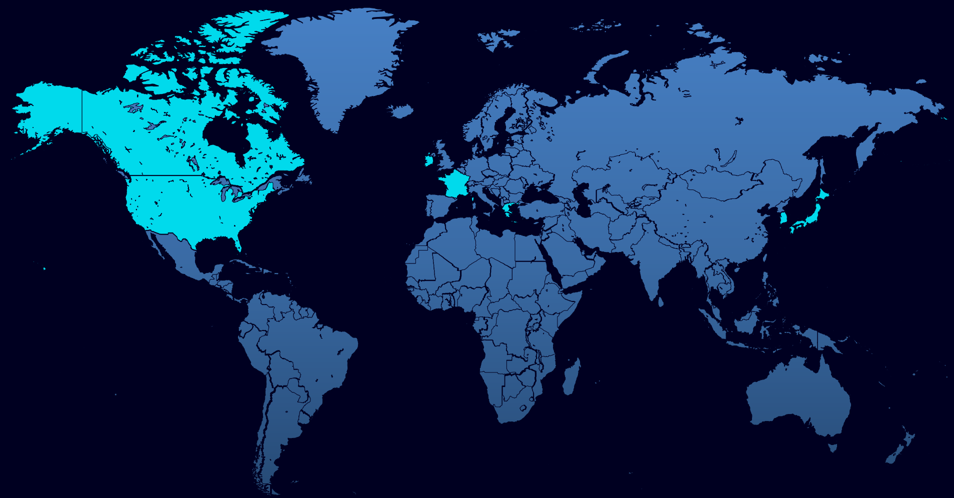
Hyperscalers
- Google
- Meta
- Microsoft

IPP's
- Calpine
- Constellation
- Jupiter Power
- nrg
- Vistra

ISO/RTO
- California ISO
- ercot
- ieso
- MISO
- pjm
- smart KPX
- SPP Southwest Power Pool

Other
- CRIEPI Central Research Institute of Electric Power Industry
- EY
- ING
- KPMG
- NESO National Energy System Operator
- Quanta
- wesco

Technology Providers
- Caterpillar
- Jenbacher
- INNIO
- NVIDIA
- Pado
- Schneider Electric



Utilities
- Alliant Energy
- aps
- AEH
- Bonneville Power Administration
- DTE
- Dominion Energy
- Duke Energy
- East Kentucky Power Cooperative
- ENOWA NEOM
- exelon
- Georgia Transmission
- KEPCO
- LES
- LCRA
- Nebraska Public Power District
- New York Power Authority
- Oglethorpe Power
- PGE
- ppl
- PSEG
- Rayburn Electric
- RTE
- SRP
- Southern Company
- TVA Tennessee Valley Authority
- United Power

Current Progress

57+

Committed Members & Growing

F — Flex Taxonomy, Tiered Framework, Flex-enabling Technology

L — Load Forecasting Framework, Profile Library, Case Studies

P — Policy & Regulatory Digest

D — Demonstration Cohort 1&2

Grid Flexibility Needs and Data Center Characteristics

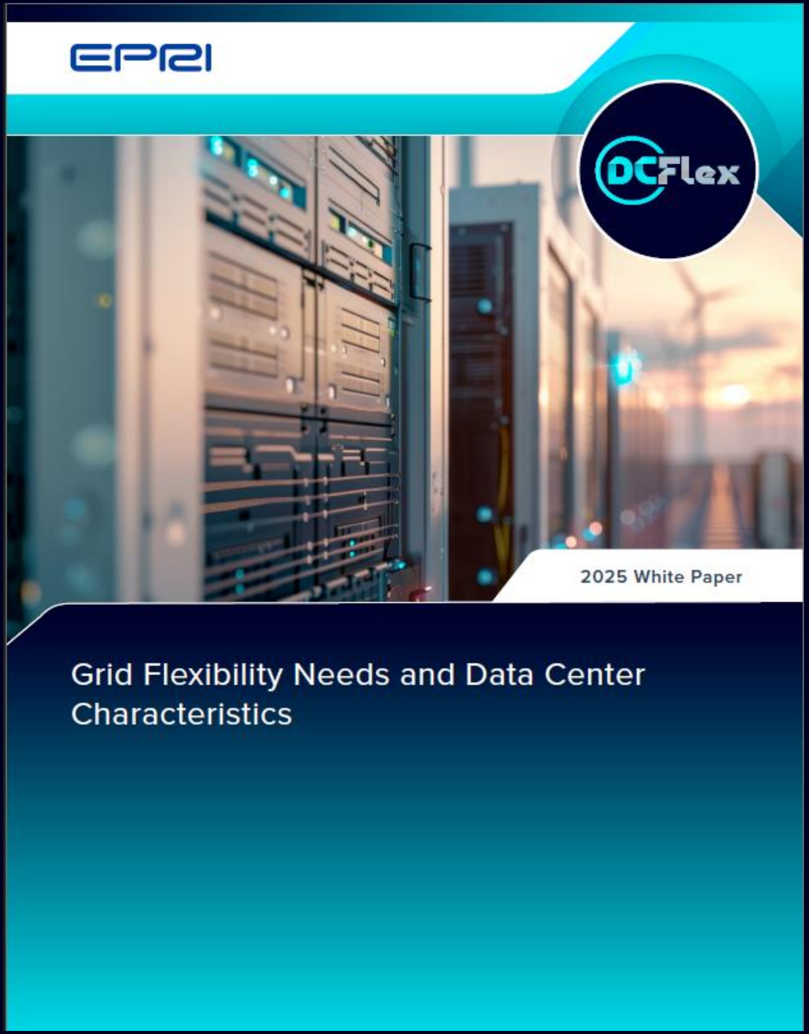
Published June 4, 2025

Goal: Outline framework to understand flexibility in context of data center integration

- Set common understanding of flexibility between power providers and the data center stakeholders.
  + Defines flexibility
  + Explains the grid need for flexibility over different time scales
  + Explores how data centers can provide this flexibility
  + Offers a framework for discussing and ultimately operationalizing flexibility

Link

- Publicly available white paper can be downloaded here: https://www.epri.com/research/products/000000003002031504



Evolving Power System: Critical Need for Flexibility

The Grid is Changing – Flexibility is No Longer Optional

- Increasing Electrification & Variable Renewables demand a more adaptable grid
- Traditional flexibility sources (dispatchable generation, new infrastructure) are facing constraints
- Large data centers represent a *significant* and growing load – and a potential flexibility resource

Why Flexibility Matters: 5 Key Benefits

Flexibility: The Key to a Modern, Resilient Grid

Cost Savings
Avoids price spikes & optimizes energy use

Reliability
Rapidly balances supply & demand

Network Efficiency
Reduces congestion & improves asset utilization

Environmental Impact
Optimizes plant dispatch & integrates renewables

Faster Grid Access
Accelerates connection for new projects

Understanding Flexibility: A Common Framework

A Shared Language for Collaboration

- A structured approach to identify grid requirements, how to meet them, and how to incentivize participation

Flexibility Need	Service	Product	Program
Manage net load variability and uncertainty	Capacity markets	Capacity obligation	Critical Peak Power
	Day-ahead energy market	Day-ahead energy	Distributed energy resources (DER) programs
	Intraday balancing markets	Real-time energy	Demand response programs
Frequency control	Ancillary services markets	Automatic frequency restoration reserve	Interruptible load

DCFlex demonstrations

Cohort 1

ARIZONA, U.S.
Compute Flexibility
Artificial Intelligence

NORTH CAROLINA, U.S.
Compute Flexibility
Hyperscaler

PARIS, FRANCE
Grid Services
Co-Located

Cohort 2

VIRGINIA, U.S.
Compute Flexibility
AI & Geospatial Load Shifting

ILLINOIS, U.S.
Compute Flexibility
Artificial Intelligence

ARIZONA, U.S.
HVO Backup Solution

OKLAHOMA, U.S.
Compute Flexibility

ORACLE · Rte · COMPASS datacenters · GRDA · Dominion Energy · NVIDIA · Schneider Electric · SRP Delivering More Than Power · pjm · comed AN EXELON COMPANY · Data4 · emeraldai · DUKE ENERGY · aps · Constellation · Google

Closing Thoughts…

Key Takeaways

- Data centers are no longer just large loads — they are **strategic grid assets**
- Flexibility is now **essential** to reliability, affordability, and clean energy integration
- DCFlex provides an **objective, scientific, and actionable framework** to unlock this value

What Comes Next

- Scale demonstrations into **repeatable grid services**
- Inform **planning, interconnection, and regulatory models**
- Enable utilities and regions to integrate data center growth **faster and more reliably**

Thank you!

Questions

EPRI

TOGETHER...SHAPING THE FUTURE OF ENERGY®