COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

700 NE Multnomah Street, Suite 1200
Portland, Oregon 97232

(503) 238-0667
www.critfc.org

August 11, 2025

Via Electronic Filing

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street SE, Suite 100
Salem, OR 97301

Re: Docket No. UM 2377 – *CRITFC's Opening Testimony of Aja K. DeCoteau and Ben Burnett*

Dear Filing Center:

The Columbia River Inter-Tribal Fish Commission ("CRITFC") hereby submits Opening Testimony of Aja K. DeCoteau, CRITFC's Executive Director, and Ben Burnett, Senior Associate at PAE.

Please contact me if you have any questions.

Sincerely,

/s/ *Elijah Rempe Cetas*
Elijah Cetas, OSB No. 244043
Attorney for CRITFC
Columbia River Inter-Tribal Fish Commission
700 NE Multnomah St.
Suite 1200
Portland, OR 97232
503-789-2352
er.cetas@gmail.com

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF OREGON

UM 2377

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

DIRECT TESTIMONY
OF

AJA K. DeCOTEAU

AUGUST 11, 2025

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ATTACHED EXHIBITS

Exhibit CRITFC/101 – Witness Qualification Statement of Aja K. DeCoteau

I. Introduction

Q. Please state your name and business address.

A. My name is Aja K. DeCoteau. My business address is 700 NE Multnomah St., Suite 1200, Portland, Oregon 97232.

Q. By whom are you employed and in what capacity?

A. I am employed by the Columbia River Inter-Tribal Fish Commission ("CRITFC") and serve as its Executive Director.

Q. Please describe your education and background.

A. I am a citizen of the Yakama Nation and grew up on my reservation in Wapato, WA. I also have other tribal lineage with the Cayuse, Nez Perce and Turtle Mountain Chippewa. I have worked in tribal natural resource management for over two decades. My career started with the Yakama Nation in forestry, wildlife, and environmental management. For the past fifteen years, I have worked for the Columbia River Inter-Tribal Fish Commission, first as the Watershed Department Manager and now as the Executive Director.

I earned a Bachelor of Arts degree from Dartmouth College and a Master's degree in Environmental Management from Yale University's School of the Environment. I also sit on numerous boards including Earthjustice, American Rivers, the Native American Agriculture Fund, the Yale Center for Environmental Justice, Portland's Native American Youth and Family Center, and the Northwest

Power and Conservation Council's Independent Scientific Advisory Board's administrative oversight panel.

Q. What are your duties as Executive Director of CRITFC?

A. I am responsible for CRITFC's administrative operations and provide leadership and guidance to its 160 plus employees. I am also responsible for planning the organization's strategic objectives with guidance from CRITFC's Commissioners, a body of elected and appointed tribal leaders representing CRITFC's four member tribes. Key to our mission is the continued development of scientific knowledge, policy advocacy, and legal research to implement CRITFC's *Wy-Kan-Ush-Mi Wa-Kish-Wit*, the Spirit of the Salmon Restoration Plan, with its goal to put fish back in the rivers and protect the watersheds where they live. This plan incorporates policy, technical and community development recommendations for habitat improvements, hydrosystem operations, hatchery management, and most recently, climate mitigation planning and energy policy. A significant example of our work in the energy space is our 2022 *Tribal Energy Vision for the Columbia Basin*.[1]

Q. What issues will you be discussing in your testimony?

A. My testimony takes three parts. First, I will provide background on CRITFC's mission and our goals in energy advocacy. Second, I will

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[1] Columbia River Inter-Tribal Fish Commission, *Tribal Energy Vision for the Columbia River Basin* (2022), https://critfc.org/energy-vision/.

discuss our purpose in intervening in this proceeding and our perspective on these issues as regional managers and advocates for tribal fishers and the Treaty rights of our member tribes. Third, I will offer recommendations to the Commission to mitigate the foreseeable risks and impacts facing CRITFC tribes and tribal communities from large load customers.

CRITFC has also sponsored the testimony of Ben Burnett, a mechanical engineer from the sustainable design firm, PAE. He will describe the results of a study we commissioned on best-practices for energy efficiency in data center designs, and the opportunities in that space to reduce peak load and benefit the grid. Together, we hope our report and recommendations will support the Commission's efforts in this proceeding.

II. Overview of CRITFC and its Energy Vision

Q. Please describe CRITFC and its mission.

A. CRITFC is a political subdivision of the Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, and Confederated Tribes and Bands of the Yakama Nation. In 1855, each of CRITFC's member tribes entered into separate treaties with the United States ceding title to vast amounts of land in the Columbia Basin. Each treaty contained provisions securing the tribes' rights to hunt and gather in ceded lands and to continue to practice our time immemorial fisheries at all usual and accustomed places.[2]

The Columbia River treaty tribes founded CRITFC in 1977 to restore salmon and protect treaty rights.[3] CRITFC's mission is "to ensure a unified voice in the overall management of the fishery resources, and as managers, to protect reserved treaty rights through the exercise of the inherent sovereign powers of the tribes."[4]

Consistent with its mission, CRITFC works with its member tribes to realize the treaty promises made by the U.S. Government. CRITFC is recognized as a leading technical assistance agency for natural resources management in the Pacific Northwest. Our work includes providing legal and policy assistance to member tribes that supports the exercise of their treaty rights and the protection of fish and wildlife resources and their habitat in the Columbia Basin. In this role, CRITFC holds scientific, technical, legal, and policy expertise in areas of ecology, fisheries management, hydropower operations, climate change, and energy within the Columbia Basin.

Q. Please explain how CRITFC carries out its mission.

A. We are currently involved in numerous national and regional policy deliberations regarding the future of the Columbia River's hydropower operations and how its

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[2] Treaty with the Yakima Tribe, June 9, 1855, 12 Stat. 951; Treaty with the Tribes of Middle Oregon, June 25, 1855, 12 Stat. 963; Treaty with the Umatilla Tribe, June 9, 1855, 12 Stat. 945; Treaty with the Nez Perce Tribe, June 11, 1855, 12 Stat. 957.

[3] CRITFC's four member tribes are the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, and the Nez Perce Tribe.

[4] CRITFC Mission and Vision, https://critfc.org/about-us/mission-vision/ (last visited Aug. 10, 2025).

operations affect the treaty resources guaranteed to our members. Our employees are valued experts in these matters and are regularly called upon to review, analyze, and opine on how development in the Columbia Basin impacts resources dependent upon its natural environment.

CRITFC fulfills its mission through four principal initiatives:

1. Put Fish Back in the Rivers and Protect the Watersheds Where Fish Live
2. Protect Tribal Treaty Rights
3. Share Salmon Culture
4. Provide Fisher Services

I will briefly describe each initiative in turn.

1. Put Fish Back in the Rivers and Protect the Watersheds Where Fish Live

CRITFC provides our four member tribes and the region with invaluable biological research, fisheries management, hydrology, and other science to support the protection and restoration of salmon, lamprey, sturgeon, and other native fish in the *Nch'i - Wa'na* - the Columbia River. The vision of this goal is to reverse fish decline and rebuild populations to full productivity. This work is guided by the holistic principles outlined in *Wy-Kan-Ush-Mi Wa-Kish-Wit* that provide recommended restoration actions in every phase of salmon's lifecycle, from stream to ocean and back.[5]

[5] Columbia River Inter-Tribal Fish Commission, *Wy-Kan-Ush-Mi Wa-Kish-Wit* (Spirit of the Salmon), The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes (2014), https://plan.critfc.org/assets/wy-kan-update.pdf .

2. Protect Tribal Treaty Rights

We employ attorneys, policy analysts, and fisheries enforcement officers who work to protect tribal treaty rights on many fronts. All activities are done with careful coordination and under the direction of our member tribes. The Commission works closely with state and federal agencies to ensure fair harvests between tribal and non-tribal fisheries. We also provide comments and directly intervene in energy and land use proceedings that may impact treaty resources and tribal fishers in the Columbia Basin.

3. Share Salmon Culture

We use media and technology to share news, information, and tribal perspectives on a variety of issues. Common topics include salmon and lamprey restoration, the nature of treaty fishing rights, tribal culture, and traditional management. Our target audience ranges from policy makers to school children.[6]

4. Provide Fisher Services

We provide a variety of services directly to fishers from our member tribes. CRITFC operates and maintains 31 fishing access sites along the Columbia River for the exclusive or near-exclusive use of fishers from all four member tribes.[7] Our Salmon Marketing program provides fishers

[6] https://critfc.org/for-kids-home/for-kids/.
[7] https://critfc.org/for-tribal-fishers/in-lieutreaty-fishing-access-sites/.

with resources to help them carry on the tradition of making a living from the river, whether that be from commercial, over-the-bank, or value-added fish sales. We also provide public safety, emergency response services, social services, and food box distributions.

Q. You referred to the *Tribal Energy Vision for the Columbia Basin* earlier in your testimony, is CRITFC's work in energy matters a new initiative?

A. No. CRITFC's Member Tribes decided many years ago to become more active in regional energy matters. CRITFC regularly participates in the Northwest Power and Conservation Council (NPCC) Power Plans and assists our member tribes in Bonneville Power Administration (BPA) rate cases and federal court proceedings advocating for changes to the hydroelectric system to protect and restore impacted species.[8]

Following the 2001 energy crisis in the Northwest, CRITFC published its first *Energy Vision* in order to share the tribes' objectives and bring to light to the directs impacts to salmon that occurred when the hydropower system took emergency operations to meet peak loads.[9] Since then, our advocacy has remained consistent: invest in energy resilience and operate the Columbia River

[8] CRITFC has regularly intervened as co-petitioner in BPA rate cases and NPCC proceedings and our staff have provided direct testimony in support of such actions. *See, FY 2024-2025 Proposed Power and Transmission Rate Proceeding*, BPA Docket BP-24 (July, 2023); CRITFC's Recommendation for the 2025 Columbia River Basin Fish and Wildlife Program (May 2025) https://projects.nwcouncil.org/program/rec?id=843.

[9] CRITFC, Tribal Energy Vision for the Columbia Basin (2003) https://critfc.org/documents/tribal-energy-vision-for-the-columbia-river-2003/.

hydroelectric system in a manner that protects, mitigates and enhances impacted species and tribal Treaty rights.

Q. Please share CRITFC's view on the current transformation of the Northwest's energy system?

A. We believe the region's transition to carbon-free resources provides a previously unrealized opportunity to create benefits for both the energy system and our impacted tribal communities. CRITFC's member tribes envision a future where the region's electric power system supports healthy and harvestable fish and wildlife populations, protects tribal treaty and cultural resources, and delivers clean, reliable, and affordable electricity. Our *2022 Energy Vision* documents the strategies we believe necessary to achieve these goals.

The Pacific Northwest stands at a crossroads - facing challenges to the health of the planet and the future of iconic fish and wildlife. Addressing these challenges with realistic solutions is especially important to the tribal people that have been sustained by these resources since time immemorial. We envision a path that leads to affordable, carbon-free energy that harmonizes with the ecosystem. This future will prioritize energy efficiency, renewable and distributed resources, new storage technologies, reductions in peak loads, and other key strategies compatible with the needs of fish and wildlife and the protection of cultural resources. Importantly, these measures must also minimize impacts from renewable resource projects and the transmission lines needed to serve them.

III. CRITFC's Interest and Perspective in this Proceeding

Q. Please summarize why CRITFC decided to intervene in this docket.

A. We see this UM 2377 as an important opportunity to engage in conversation with the Commission, Staff, Portland General Electric ("PGE"), and other parties regarding the rights and interests of CRITFC's member tribes in the fair allocation of resources and costs associated with serving large load customer in Oregon. Our advocacy will offer a different perspective on PGE's proposed tariff measures and compliance with HB 2021 and the new POWER Act.[10] Through the testimony of Ben Burnett from PAE Engineers, we will share the results of an independent study we commissioned focusing on data center efficiency opportunities. Our recommendations reflect the vision, rights, and authorities of our Member Tribes as set forth in our *2022 Energy Vision*.[11]

There is no question that PGE's proposed large load customer tariff will affect tribal members and communities served by the utility. We maintain that decisions resulting from this docket and the Company's service to data centers and other new high-load customers may also result in PGE's increased dependence upon the region's hydroelectric system and market resources. We believe the potential impacts of new large loads will increase system costs and decrease reliability. We also see the data-center driven proliferation of new resource and transmission development within our ceded lands and traditional territories as having a

[10] HB 3546 (2025); Oregon Laws 2025, Chapter 323, Section 757, effective date June 16, 2025.
[11] *See* CRITFC Energy Vision, *supra* note 1.

potential direct impact to our member tribes and tribal fishers, who are already highly burdened, environmental justice communities.

Q. Please explain.

A. We call the Commission's attention to a recent forecast by the NPCC that shows regional utilities will need to acquire on average between 2,200 and 4,800 average megawatts of new capacity by 2030 to serve the expected growth in data centers and related facilities.[12] Recognizing that the Council's Ninth Power Plan remains in development, we believe this astonishing load forecast should give everyone in the region pause. Meeting this additional load would impose an immense and costly burden on the region's electric utilities responsible for grid safety and reliability. Without proportionate protective measures, such unprecedented growth will increase energy burdens for low-income and tribal customers, deepen reliance on hydroelectric ramping capacity, and further erode the Treaty rights of CRITFC's member tribes.

Q. How do you see the increase in data center demand impacting CRITFC's member tribes?

A. We believe the expected growth in data center electricity demand would have a direct and foreseeable impact on the speed and proliferation of new generation and transmission facility development in the region. Meeting significant new

[12] Northwest Power and Conservation Council, *Council releases initial 20-year forecast for Pacific Northwest electricity demand* (May 2, 2025) https://www.nwcouncil.org/news/2025/05/02/pacific-northwest-load-forecast-2025/.

loads will not only delay the pace of Oregon's clean energy goals,[13] but will also increase pressure on the load-balancing capacity of the hydroelectric system to integrate new resources and provide backup capacity for growing demand. Each of these pathways would detrimentally impact the Treaty rights of CRITFC's member tribes and the wellbeing of our tribal communities.

Q. Please describe how the region's transition to and reliance upon clean energy resources threatens the Treaty rights of CRITFC's members.

A. First, I feel it important to make clear that CRITFC supports the region's transition to clean energy. We have and will continue to advocate for urgent action to address climate change, which is a direct threat to salmon, water, and the web of life.[14] That being said, it is important to understand that CRITFC's Member Tribes are presently witnessing the further erosion of their Treaty rights caused by the electric system's transformation.

The *Treaties of 1855* guaranteed each Tribe the right to hunt, fish, gather traditional foods, and enjoy religious ceremonies and cultural freedoms within their ceded areas and traditional territories.[15] First among our foods is salmon. It is essential to recall that when the treaties were signed in 1855, *10 to 16 million salmon* returned to the Columbia annually.[16] From our perspective, the mainstay of our culture since time immemorial has been made a sacrifice to every

[13] The addition of new large load customers will delay the retirement of fossil fuel facilities needed to support grid safety and reliability.
[14] Energy Vision, *supra* note 1 at 6.
[15] *Id* at 21 (map of our member tribes' reservations and ceded lands).
[16] *See* U.S. Department of Interior, *Historic and Ongoing Impacts of Federal Dams on the Columbia River Basin Tribes,* at 9 (June 2024), https://www.doi.gov/media/document/tribal-circumstances-analysis.

hydroelectric project constructed in the Basin and to the grid's continued reliance on the hydroelectric system. We have given more than our share and certainly much more than we received in return.

Beyond our fisheries, we rely on our ceded lands and waters across our traditional territories for access to other First Foods, which are the heart of our culture and identity. First Foods are the basis for our subsistence, economic opportunity, and traditional ceremonies. They are how we teach our young people and continue our culture.

Tribal elders and leaders speak to and celebrate each traditional food offered and its importance to the natural world and the tribe. They also speak to the history of the people, our traditions, language, and the importance of salmon to each new generation. At every ceremony, the importance of salmon is highlighted, along with the oral history recounting the historic Columbia River and the seemingly infinite runs of fish using the river.

Many of these same ceded areas and traditional territories where we gather First Foods are now being developed for siting new solar, wind, and other renewable energy facilities. Each time such a facility or transmission project is developed within a tribal ceded area or traditional territory, tribal members lose access to their right to hunt, fish, gather and hold religious and cultural ceremonies on the affected properties.

Q. How would data centers affect the development of renewable energy projects within ceded or traditional territories?

A. As noted above, expert energy planners believe the region will need to add between 2200 and 4800 average megawatts of new generating resources by 2030 to support data center load. The potential magnitude of data center demand over such a short period would place tremendous pressure on PGE and other regional utilities to build out their generating and transmission facilities in order to maintain system and grid reliability. PGE and other Oregon utilities must also ensure that the resources they acquire or secure to serve data centers are HB2021 compliant - leading to more intense and sustained efforts to quickly develop carbon-free generators on available undeveloped property. The ceded and traditional areas of the Confederated Tribes of the Warm Springs Reservation, which is within PGE's service territory, as well as the territory of other CRITFC member tribes cover huge sections of Oregon, Washington, and Idaho. It is almost certain that the energy facility development required to serve data centers would be planned for these treaty-protected lands and impact the resources they support.

To give just one example, a project called the Cascade Renewable Transmission line is being proposed to connect BPA's substation in the Dalles to PGE's substation in Portland.[17] The company is planning to build this transmission line *through the middle of the Columbia River*, immediately adjacent to tribal fishing sites. The potential risks to our fishing families, salmon runs, and the Treaties from this project alone are extremely significant.

[17] Oregon Department of Energy, Energy Facilities & Safety, Facilities Under Review: Cascade Renewable Transmission System (last visited August 10, 2025), https://www.oregon.gov/energy/facilities-safety/facilities/Pages/CRT.aspx.

Q. Please explain how data center development would impact hydroelectric operations in the Columbia Basin?

A. The hydroelectric system under BPA's control is the largest and most flexible generation resource in the region. Without question, BPA's hydropower operations remain the backbone of the regional grid and it is frequently called on support reliability. This is particularly true during low water months (typically late summer through early winter) and when the region's grid is reacting to persistent high loads from seasonal patterns and extreme weather events.

This increased pressure on hydroelectric resources to support reliability creates systemic changes to hydropower operations that diminish and sometimes divert the water flows that anadromous species require to survive. These changes are hard to predict, and very much impacted by the overall resource adequacy and reliability of individual utilities and the regional market.

Q. How do Columbia Basin hydroelectric operations relate to PGE and the data centers it may serve?

A. We understand that in recent years PGE has acquired some 1,010 MW capacity from Mid-Columbia hydropower contracts with Douglas and Grant County public utility districts to meet its expected system demand.[18] We are concerned that PGE's reliance upon Mid-Columbia and BPA hydroelectric resources to meet its future load puts additional pressure on an already stressed hydroelectric system.

[18] *Portland General Electric Co., Annual Report to Investors (Form 10-K)*, 15 (filed Feb. 14, 2025), https://investors.portlandgeneral.com/static-files/dc0916fc-8a11-486e-862c-71076e9480b2.

History has shown that, without question, the system will protect grid reliability at the expense of natural resources dependent on river flows to survive.

CRITFC has witnessed many periods when the region's generation output falls precipitously due to weather conditions or mechanical failure. During such times, the hydroelectric system reacts first to protect grid reliability and the safety of migratory and resident resources becomes secondary, even when mandatory flow regimes are in place to protect endangered species.[19]

These events occurred dramatically in 2001, when BPA and federal hydro operators removed fish protections and radically altered flows to meet peak load demand. During spawning and rearing periods in 2001, more than 2.1 million salmon fry were killed when they were stranded in pools as flows dropped to save water for future peaks. In the Snake River system, operators allowed the river to reach zero flows, stranding migrating adults and requiring juveniles be trucked downstream. These operations cost utilities, customers, and fisheries managers alike.[20]

Today, we are very concerned that utilities and energy planners could overestimate the hydroelectric system's capacity to both protect endangered and treaty-reserved species *and* integrate new resources for large loads, while providing sufficient flows for backup capacity in the face of climate change, reduced snowpack, and increasing extreme weather events.

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[19] *See* Bonneville Power Administration, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, 2024 Water Management Plan at Appendix 1: Emergency Protocols (Jan. 16, 2024), https://pweb.crohms.org/tmt/documents/wmp/2024/.
[20] *See* CRITFC 2003 Energy Vision, *supra* note 9, at 13.

While these occurrences may be infrequent or short-lived, Mid-C operators or BPA's management of pool and instream flows for power production and load-following during these periods could cause irreversible damage to migrating species and resident fish populations.[21] Furthermore, growing peak loads during the lower instream flow summer months expected from climate change and as a result of data center demands will put even more pressure upon BPA – increasing both reliability risk and risk of salmon and lamprey extinction.

When we consider these foreseeable threats to grid reliability during key migratory periods within the life cycle of treaty-protected fish -- and then ratchet up those risks to account for the addition of up to 4,800 average megawatts of new data center load to an already pressured system and PGE's new reliance on more than 1,000 megawatts of Mid-Columbia output -- we become very concerned for the future of natural resources we depend upon to feed us physically and spiritually.

In the *Treaties of 1855*, CRITFC's members traded away much of their original homeland to protect their right to access and steward the traditional foods of *Nch'i-Wa'na*, the Big River. These species have already borne the weight of the region's hydroelectric system and many are now at risk of extinction. We are here to express our needs and concerns to the Commission and believe that Oregon and

[21] See e.g., Fish Passage Center, *Review of 2021 Flex Spill Operation* (August 12, 2021), at 2, 4,and 81. See also, *Hydropower peaking and stalled salmon migration are linked by altered reservoir hydraulics: A multidisciplinary synthesis and hypothesis,* Coutant, April 29, 2023, https://doi.org/10.1002/rra.4146.

the region can transition to a clean energy future without doing further damage to the resources the tribes depend upon.

IV. CRITFC's Recommendations

Q. Earlier in your testimony you referenced CRITFC's *2022 Energy Vision*. Can you provide the Commission a brief description of its recommended actions as they pertain to this proceeding?

A. Yes. As noted earlier in my testimony, the *2022 Energy Vision* responds to the region's history of hydroelectric operations and how its management has led to the near extinction of salmonid species that the Columbia River Tribes have relied for food and celebrated since time immemorial.

Q. Please go on.

A. The *Tribal Energy Vision* was produced by CRITFC in 2022 and marks its latest iteration – analyzing the current state of the Columbia River, hydroelectric operations, and the regional energy system to detail what is required to improve environmental conditions and protect its natural resources. It recommends that the region take steps to ensure that renewable resources in combination with increased storage, reductions in peak demand, and increased energy efficiency provide clean, adequate, reliable, and affordable electricity to support the restoration of healthy, harvestable salmon populations, and prevent future damage to salmon and steelhead and other tribal resources caused by the electrical system.[22]

Q. Why is the *Energy Vision* important to this proceeding?

A. CRITFC believes that the legislative objectives of HB2021 and the POWER Act profess outcomes shared by its *Energy Vision*: a future electrical grid built upon the highest possible deployment of energy efficiency and weatherization, distributed generation, renewable energy, and storage technologies. These strategies build resiliency while reducing overall system dependency on Columbia River hydropower. Finally, we also know that direct investments in energy efficiency, distributed generation, and demand response are critical for tribal communities, where families face both disproportionately high rates of poverty and energy burdens.[23]

Q. Please explain the importance of following the *Energy Vision's* guidance.

A. The true wealth of our region begins with the health of our rivers, fish, and the ecosystem they support, which is our culture, history, and future. Today, we know that many salmon species are near extinction – a condition exacerbated by climate change in the form of warmer temperatures, reduced snowpack, changes in river runoff timing, and reduced flows during critical salmonid migration periods. We also know that without careful consideration, the energy transition could make the

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[22] Columbia River Inter-Tribal Fish Commission, Tribal Energy Vision for the Columbia River Basin (2022), https://critfc.org/energy-vision/ .

[23] *See, e.g.*, Clean Energy Transition Institute, *Community-Defined Decarbonization: Reflecting Rural and Tribal Desires for an Equitable Clean Energy Transition in Washington* (September 2022), at 30, *available at* www.cleanenergytransition.org/programs/rural-community-decarbonization/community-defined-decarbonization.

grid even more dependent upon the Columbia River hydroelectric system to meet expected loads, thereby exacerbating the existing crisis for salmon and tribal communities.[24]

The *Energy Vision* does not suggest a *silver bullet* fix for today's grid, but instead observes the Seven Generations Principle – a worldview we hold that the decisions we make today we make for a more sustainable world that our descendants will inherit seven generations in the future. With this principle in mind, CRITFC supports the proposals in this proceeding to ensure data centers carry the full amount of their system costs, and do not over- or under-estimate their loads. Further, we urge the Commission to ensure that data centers in PGE's service territory deploy the most energy efficient, least impactful cooling technologies to reduce their demand and impacts to PGE's system and customers. For the same reason, we urge the Commission to ensure large load customers also contribute to PGE's provision of energy benefits for low-income and environmental justice communities – a crucial step to lessen their impact to Oregon's most marginalized communities and to the clean energy transition. Finally, we urge data transparency, so the Commission and stakeholders are able to fully consider the load and resource impacts of individual projects and ensure equitable outcomes, consistent with the policies of HB 2021 and the Power Act.

Q. Please say more about the rationale for these recommendations.

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24 *See, e.g.* Northwest Power and Conservation Council, Pacific Northwest Hydropower for the 21st Century Power Grid (January 2019), https://www.nwcouncil.org/energy/energy-topics/hydropower/ .

A. This past year, CRITFC has commissioned a report led by PAE Engineers, a firm specializing in energy innovation and sustainable design, to understand the potential for energy efficiency opportunities in data center projects. In this docket, CRITFC is sponsoring the testimony of Ben Burnett, PE, who will testify to these findings and the potential for very significant energy savings associated with energy efficient technologies. These savings could be especially important for reducing peak load, which is the most expensive to serve and poses the greatest to the hydrosystem and salmon protections.

Additionally, the report highlights the significant and somewhat complex relationship between data center energy use and water consumption. Many watersheds in Oregon and the Columbia Basin are already over-allocated, and data center operations may require significant water resources to maintain cooling capacity, which brings both local and watershed impacts. We understand that data about energy and water use may be difficult to find in the present, and the full scope of these impacts are not well understood. For this reason, we believe it is imperative that the Commission, the utility, tribes, and stakeholders have greater transparency and access to this critical information from data center developers.

Q. How can the Commission ensure through this docket and follow-up proceedings that data centers located within PGE's territory operate efficiently and with the least impact to PSE's system and the grid?

A. First, in line with Staff's proposals, we believe the Commission should ensure large load customers carry their full share of transmission and service costs to protect customers and communities and to minimize risks to the system.

Second, consistent with this approach, we recommend that PGE's data center tariff require any large load customer requesting service to demonstrate that it will develop its facility using the most energy efficient technology and methods available at the time of construction. This would help ensure that data centers bring the least possible impact to PGE's system and ensure broader grid reliability.

Third, we believe data centers must also offset their impacts through direct investment in low-income and environmental justice communities. We recommend that PGE's data center tariff include an additional charge and the revenues generated be used to fund energy efficiency, weatherization, and distributed generation resource development in environmental justice communities within its service territory, consistent with the intent of HB 2021 and the Power Act.

Fourth, we believe the Commission must consider the direct environmental and community impacts of projects in its future review of these large load connection agreements. For this to be possible, PGE and its data center customers must ensure sufficient transparency for the Commission and the public to understand and evaluate potential energy and water impacts.

Finally, as a matter of course, we request that PGE work with the Warm Springs tribal government to ensure that the utility's generating and transmission planning activities include the pre-decisional input of the Tribe, whose reservation and ceded lands lie within and connected to PGE's service territory.

Q. Does that conclude your testimony?

A. Yes.

WITNESS QUALIFICATION STATEMENT

NAME: Aja K. DeCoteau

EMPLOYER: Columbia River Inter-Tribal Fish Commission

TITLE: Executive Director

ADDRESS: 700 NE Multnomah St., Suite 1200, Portland, Oregon 97232

EDUCATION: Bachelor of Arts Degree, Dartmouth College; Masters of Environmental Management, Yale University's School of the Environment

EXPERIENCE: 15 years working for CRITFC; 4 years as Executive Director. I oversee CRITFC's administrative operations and policy, and provide leadership and guidance to its 160 plus employees. I am responsible for planning the organization's strategic objectives with guidance from CRITFC's Commissioners, a body of elected and appointed tribal leaders representing CRITFC's four member tribes. Key to our mission is the continued development of scientific knowledge, policy advocacy, and legal research to implement CRITFC's *Wy-Kan-Ush-Mi Wa-Kish-Wit*, the Spirit of the Salmon Restoration Plan, and *Tribal Energy Vision*. I oversaw development and implementation of the 2022 *Energy Vision.* I have participated in and overseen CRITFC's involvement in numerous BPA rate cases and NPCC planning processes. I testified before the Washington UTC in docket UE 210829 in 2024, and oversaw CRITFC's involvement in numerous Oregon PUC cases beginning in 2023, including LC 80, LC 82, UM 2273, UM 2345. I frequently participate in state, tribal, and federal governance forums, where I provide expert advice and testimony.

MEMBERSHIP: Board Member for Earthjustice, American Rivers, the Native American Agriculture Fund, the Yale Center for Environmental Justice, Portland's Native American Youth and Family Center, and the Northwest Power and Conservation Council's Independent Scientific Advisory Board's administrative oversight panel.

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BEN BURNETT

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I. INTRODUCTION & SUMMARY

Q. Please state your name and business address.

A. My name is Ben Burnett. My business address is 151 SW 1st Avenue, Portland, Oregon 97204.

Q. By whom are you employed and in what capacity?

A. I am employed by PAE, an engineering and building systems design firm based in Portland, Oregon. I serve as Building Performance Analyst, HVAC Design Engineer, and Project Manager in our Regenerative Design team. Specific to the referenced study, my role is Building Performance Analysis Lead.

Q. Can you briefly summarize your professional background and expertise in energy efficiency and sustainable building design?

A. I have 15 years of experience as a mechanical engineer applying advanced energy modeling to optimize system performance, resilience, and carbon reduction in some of the nation's most sustainable buildings.

I hold a Bachelor of Science degree in Physics from Oregon State University, and a Master of Science in Mechanical Engineering from Portland State University. From 2010 to 2013, I was a Process Engineer at Intel, supporting HVAC operations, design review, and commissioning with a focus on industrial exhaust, process cooling water, and cleanroom air systems. As a lead mechanical engineer at PAE, I manage teams of engineers and designers, specializing in systems analysis and design for energy efficient buildings in numerous industries and building sectors nationwide, including microgrids and district energy systems.

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to provide technical insight into how data center design choices impact regional energy demand, peak load, and water use—and to share findings from PAE's modeling work conducted on behalf of the Columbia River Inter-Tribal Fish Commission. I will explain how the adoption of best-practice system designs can substantially reduce energy use and peak electricity demand in Oregon. I offer context on energy efficiency data center design to support the Commission's consideration of cost allocation and alignment with Oregon's climate and equity goals.

Q. How did you and PAE become involved in this research for CRITFC?

A. PAE was engaged by CRITFC to analyze the energy and water implications of projected data center development in the Pacific Northwest, with a focus on identifying opportunities for demand reduction, energy efficiency, and sustainable resource use. CRITFC commissioned this research as part of its broader advocacy for equitable, climate-aligned utility planning that respects Tribal environmental values and Treaty-protected resources like Columbia Basin salmon, which can be impacted by increased load demands and water use from the data center market.

Q. What was the scope of PAE's assignment in this matter?

A. We were tasked with modeling multiple building system configurations commonly used in data center development, ranging from code-minimum to best-practice energy-efficient systems. The scope included analysis of annual electricity use, peak load impacts, and cooling-related water consumption under different scenarios. We also evaluated the regional implications of projected data center growth and developed new metrics to understand the impact of different designs on peak load. Ultimately, we concluded that implementing best-practice data center efficiency upgrades will lead to some of the largest peak power reductions and energy efficiency savings available in our region.

Q. Please summarize your testimony for the Commission.

A. First, I discuss the framework of our study, which is focused on the potential for energy savings from adoption of industry best-practices as opposed to code-minimum designs for data center energy efficiency. Our overall finding is that energy consumption can be reduced by 12% from building design alone – without reducing data center computing loads or taking into account grid-enhancing technology.

Second, I describe how we applied these results to data center load forecasts to estimate potential savings regionwide. We developed a new metric to model peak load savings, and found a potential 1,000MW difference in regional demand during peak hours, a 25% decrease in overall peak load growth estimates. These potential peak load savings are significant, and is an important consideration for PGE and the Commission to consider.

Finally, I conclude with an overview of the relationship between energy use and water withdrawal and consumption from data centers. Our findings demonstrate that more energy-efficient evaporative cooling systems also rely on higher associated water withdrawals and consumption than less efficient air-cooled systems. Analyzing the potential impact of these tradeoffs fell outside the scope of our study, and would require project- and site-specific information as impacts will be predominantly experienced locally.

Q. Do you take an opinion on any of the rate allocation methodologies proposed in this case?

A. No. PAE takes no position on the discussion about rate allocation, as this is outside our expertise. Our comments are limited to our analysis of forecasted data centers loads and the potential grid benefits from energy efficiency investments detailed in our report.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring Exhibits CRITFC/201 (Ben Burnett curriculum vitae), CRITFC/202 (Witness Qualification Statement), and CRITFC/203 (Energy and Water Use Impacts of Building System Design for Data Centers study performed by PAE).

II. BUILDING DESIGN AND ENERGY EFFICIENCY POTENTIAL

Q. You stated that the focus of the study was a comparison of "code-minimum" and "best-practices" in energy-efficient building systems. To begin, what does code-minimum mean?

A. The current governing standard for data center efficiency design in OR and WA is the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard 90.4. This standard is somewhat different from other building energy codes in that it is purely performance-based, whereas other codes have a prescriptive compliance path, meaning they require certain building standards but not power outcomes. For

ASHRAE 90.4, on the other hand, performance is based on Power Usage Effectiveness, or PUE, a metric of a data center's power use that is not tied to its Information Technology Energy (ITE) use – e.g. computing power – but on the energy consumption of the building itself. In other words, PUE shows the power used by all the other systems in a data center—for example, the cooling system—as a ratio to the server loads. As a result, there are multiple paths to code minimum performance.

In practice, code minimum systems are typically characterized by:

- Air-cooled, compressor-driven cooling systems, such as air-cooled chillers.
- Minimum-efficiency electrical transformation and distribution systems.

Q. What does "best-practice" mean in this context, and how did you identify this standard?

Best practice simply means the best, currently available technology for energy efficiency. We arrived at this standard by reviewing published studies of data center design and energy use.

In general, best practice systems are characterized by:

- Evaporatively cooled systems. The highest performing data centers rely on direct evaporative cooling and eliminate compressor-driven refrigeration equipment entirely.
- Higher efficiency electrical transformation and distribution systems.
- Cooling air and/or chilled water distribution systems that are further optimized to reduce fan/pump energy.

Q. How did PAE evaluate best-practice data center designs in your study?

A. PAE developed a data center energy model using a tool called Integrated Environmental Solutions' (IES) Virtual Environment (VE) software, and calibrated the code-minimum baseline in our model to meet ASHRAE 90.4-2022 compliance. We then applied best-practice design strategies to the energy model to evaluate and compare hourly energy demand over the course of a year.

Q. How do best practices compare with conventional data center design in terms of energy consumption?

A. We found that annual energy consumption was reduced by up to 12% compared to a code-minimum design.

Q. Can you describe how specific improvements—such as HVAC or electrical system designs and technologies—drive the most significant efficiency gains?

A. Yes, let's start with mechanical and HVAC designs. The following strategies had the most impactful results:

- Increasing temperature setpoints to reduce hours where supplemental mechanical cooling is required.
- Using direct evaporative cooling in lieu of active mechanical cooling.

For the electrical system:

- Reducing power transformation operations and selecting high-efficiency transformers and power distribution units.

- Selecting high-efficiency Uninterruptible Power Supply (UPS) equipment.

Altogether, these strategies were the most significant design tools we identified.

Q. Are these technologies currently available?

A. These technologies are currently available and cost-effective.

III. DATA CENTER DEMAND IMPACTS

Q. Your study looked at the differences between standard- and best-practices and their relative impact on overall load forecasts. Can you provide an overview of how typical data center operations may impact regional electricity demand?

A. Yes. Data centers are energy-intensive operations that run continuously—24 hours a day, 365 days a year. In addition to the energy used for computing, they require substantial and constant power for cooling systems and power distribution infrastructure. As a result, they place a large and relatively inflexible load on the electric grid. Unlike other commercial buildings, their energy use cannot be easily shifted or reduced during peak periods. When built at large-scale or concentrated in specific areas - as in Oregon - data centers can significantly increase both total electricity consumption, local demands, and peak demand. This growth can strain existing utility infrastructure and may require accelerated investment in transmission, generation, and demand management resources to maintain system reliability for all customers.

Q. What is the current data center market outlook for Oregon?

A. Our report shows that Oregon is one of the largest and fastest growing data center economies in both the country and the world. In Hillsboro alone, data center market inventory has grown over 600% since 2020.[1] According to Bonneville Power Administration (BPA) and Northwest Power and Conservation Council (NPCC) estimates, regional data center demand growth is projected to grow between two and six times larger than current levels, or an annual average between 2,200 MW to 4,800 MW increased load by 2030.[2]

Q. Based on the projected growth of this sector, what did you find are the overall potential energy savings from building efficiency measures?

Our modeling showed that if Oregon adopts an improved - yet achievable - energy efficiency requirement for data center building systems, the savings could potentially avoid adding 4 million megawatt-hours annually to the region's load by 2033. For comparison, these savings are equivalent to nearly half the current wind energy generation in the entire state.

Q. What do these savings amount to as a share of annual energy consumption, according to your modeling?

A. This is equivalent to nearly 15% of projected total demand from the data center sector. Importantly, these savings are achievable using currently available technologies.

Q. What is the associated reduction in peak demand from these energy savings?

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[1] CBRE Research, CBRE Data Center Solutions, H1 2024 (August 19, 2024) https://www.cbre.com/insights/reports/north-america-data-center-trends-h1-2024.

[2] Northwest Power and Conservation Council, *Council releases initial 20-year forecast for Pacific Northwest electricity demand* (May 2, 2025) https://www.nwcouncil.org/news/2025/05/02/pacific-northwest-load-forecast-2025/.

A. We estimate 1,000 MW of peak demand savings from industry adoption of best-practice designs.

We derived this figure by comparing the peak demand of code-minimum and best practice evaporatively cooled energy models and assuming all new data centers adopted the latter. The results were then applied to the data center load growth projection from Bonneville Power Administration as presented to the Northwest Power and Conservation Council on March 12, 2024 to arrive at an overall estimate.[3]

Q. What does 1,000 MW of savings look like as a share of the overall forecasted data center peak loads?

A. This estimate is based on the midpoint of the BPA/NPCC data center load growth forecasts, which estimate a potential 4,000 MW peak load increase. So, our findings estimate 1,000 MW of savings, which means roughly 25% of forecasted peak load growth could be avoided by adopting best practices.

For the grid, avoiding 25% of peak load growth would be a very significant outcome, especially for system costs, safety, capacity, and reliability, as peak loads are usually the highest cost resources in the system.

Q. Did the efficiency gains you modeled include contributions from demand response technologies, distributed resources, or any other grid-enhancing technologies?

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[3] *See* Northwest Power and Conservation Council, Presentation: *Data Center and Chip Fabrication Forecast*, slide 9 (March 12, 2024) https://www.nwcouncil.org/fs/18660/2024_03_p3.pdf.

A. No, the efficiency gains we identified were driven solely by the mechanical and electrical design and resulting performance of the modeled data centers.

Though outside the study, it is important to note that demand response, distributed resources, and other grid-enhancing technologies could be paired with best-practice efficient designs to reach additional annual and peak load savings.

Q. How could these findings be relevant to PGE?

A. While I am not an expert here and have not reviewed PGE's load forecasts in detail, I understand from the company's most recent Integrated Resource Plan (IRP) update that it expects significant demand growth from large load customers.[4] Reviewing Figure 13 of the IRP, which shows energy forecasts at five-year increments, I see potential load growth from industrial sources forecast to roughly 800 MWh between 2025 and 2040.[5] So, assuming all facilities adopted best-practices instead of operating at code-minimum, PGE could see a 12% reduction in this demand, or potentially 96 MWh energy savings.

This is a simple and rough estimate and does not include potential peak load savings, which would likely see a greater percentage decrease from best-practice efficiency designs. And of course, this is before taking into account the facilities' potential adoption of demand-response, on-site generation, or other grid-enhancing technologies.

IV. WATER USE AND COOLING SYSTEM

[4] Portland General Electric, 2023 Clean Energy Plan and Integrated Resource Plan Update, at 42 (June 18, 2025), https://edocs.puc.state.or.us/efdocs/HAD/lc80had337596113.pdf.
[5] *Id.*

Q. Your study also examined two cooling strategies – evaporative cooling and standard air-conditioned cooling – and the potential effect of both on energy and water demands. Can you summarize your findings?

A. Air-cooled systems are typical code-minimum designs. They use air to reject heat from the targeted space and use more power than equivalent evaporative cooling technologies. These systems do not directly withdraw or consume water.

Evaporative systems, on the other hand, are the highest efficiency design from a power consumption standpoint. As our study demonstrates, these systems use less power and reduce peak load demand. However, unlike air-based cooling technologies, evaporative cooling systems rely on the direct withdrawal and consumption of water, which is literally evaporated and cannot be returned to the water source.

Importantly, significant water withdrawals and/or consumption are associated with most power generation sources that provide electricity to regional data centers, so increased energy use by the data center leads to greater water use. This intersection of energy and water consumption touches on a complex area of analysis, requiring detailed comparisons of the power generation mix and associated water use as well as the specific location of the data center, its power sources, and the associated water withdrawal locations within the watershed. In general, power generation withdraws less water and consumes much less water than the equivalent amount of direct evaporative cooling in a data center. Specific PGE's resource mix, our median estimate showed 40% less water withdrawal and 90% less consumption due to power generation vs. direct evaporative cooling.

Q. How significant are water impacts from data centers?

A. The study found that although evaporative cooling uses more water onsite as compared to air-cooled systems, at a state level the total increased water use is still relatively minimal compared to other industries, such as agriculture. Yet additional research is needed to understand the impacts of water use on a local, site-specific scale, where impacts will occur. Localized impacts, such as water withdrawal relative to local supply and the impacts of higher return water temperature, were not evaluated as part of this initial study.

As we developed our study, we realized that there is a relationship here that should be studied further. While we understand the Oregon Public Utility Commission does not directly regulate water usage by energy facilities, it is important for stakeholders and regulators to understand the relationship between energy savings and water use, and how different designs can have different local impacts.

V. CONCLUSIONS AND RECOMMENDATIONS

Q. Based on the findings in your report, what are the most significant conclusions?

A. Meaningful energy savings are achievable with existing best-practice technologies. These savings could amount to up to 12% of avoided annual MW load growth, or 4,000 annual MW hours across the region – almost half the total wind power in Oregon. Peak load savings from best-practices could be even greater, resulting in as much as 25% avoided peak load growth, or 1,000 MW less than forecasted regional peak demand – a significant figure. These benefits are possible from building design alone. Our estimates do not include any contributions from other energy saving strategies or grid-enhancing technologies, which could be used in addition to building design strategies.

Because PGE is seeing very high demand growth from data center customers, widespread adoption of best-practice efficient designs at data centers in the company's service territory could be a significant tool to reduce overall load demand and especially during peak periods. Briefly, any strategies that improves efficiency and reduce peak loads will support clean energy and equity laws in Oregon by reducing system cost and capacity requirements, and improving reliability.

Finally, there is a complicated but important relationship between data center design, energy use, and water withdrawal and consumption. These impacts - which are primarily local – deserve further investigation, but were outside the scope of our initial study.

Q. Does this conclude your testimony?

A. Yes.

Ben Burnett PE

Senior Associate

An innovative mechanical engineer, Ben has 14 years of experience working on some of the nation's most sustainable buildings. He has extensive experience as a lead mechanical engineer, efficiently organizing and managing PAE's engineers, designers, and BIM team. Ben's expertise extends to microgrids and energy efficient systems designs, where he applies advanced energy modeling to optimize system performance, resilience, and carbon reduction. By quantifying the energy impact of each design decision, Ben helps guide teams toward achieving ambitious sustainability and efficiency goals.

From 2010 to 2013, Ben was a Process Engineer at Intel, supporting HVAC operations, design review, and commissioning for the D1D and D1X development factories. His work there focused on industrial exhaust, process cooling water, and cleanroom air systems. This experience provided a strong foundation in precision systems and data-driven optimization that continues to inform his approach to high-performance building design.

EDUCATION

Portland State University, Master of Science, Mechanical Engineering

Oregon State University, Bachelor of Science, Physics

CREDENTIALS

Professional Engineer: OR

PREVIOUS WORK EXPERIENCE

Process Engineer, Intel
2010-2023

SELECT EXPERIENCE

Goldendale School District 404, Federal Emergency Management Agency (FEMA) Goldendale Microgrid Study, Goldendale, WA

City of Bellingham, District Energy Feasibility Study, Bellingham, WA

Rocky Mountain Institute Innovation Center, Basalt, CO | Living building Petal Certification, LEED Platinum, Net-Positive Energy, Passive House, Architecture 2030, All-Electric

Appalachian State University, Conservatory for Biodiversity Education and Research, Boone, NC | Pursuing Net-Zero Energy - includes a separate ground-source heat pump-based central plant system.

City of Beaverton, Public Safety Center, Beaverton, OR | Net-Zero Ready, Architecture 2030, Net-Zero Ready - includes a microgrid.

Schnitzer Property Sustainability Plan, Portland, OR

Washington University - St. Louis, Residential College Net-Zero Energy Feasibility Study, St. Louis, OR

WITNESS QUALIFICATION STATEMENT

NAME: Ben Burnett

EMPLOYER: PAE

TITLE: Senior Associate

ADDRESS: 151 SW First Ave, Unit 300, Portland, OR 97204

EDUCATION: Bachelor of Science, Physics, Oregon State University; Master of Science, Mechanical Engineering, Portland State University

EXPERIENCE: An innovative mechanical engineer, Ben has 14 years of experience working on some of the nation's most sustainable buildings. He has extensive experience as a lead mechanical engineer, efficiently organizing and managing PAE's engineers, designers, and BIM team. Ben's expertise extends to microgrids and energy efficient systems designs, where he applies advanced energy modeling to optimize system performance, resilience, and carbon reduction. By quantifying the energy impact of each design decision, Ben helps guide teams toward achieving ambitious sustainability and efficiency goals.

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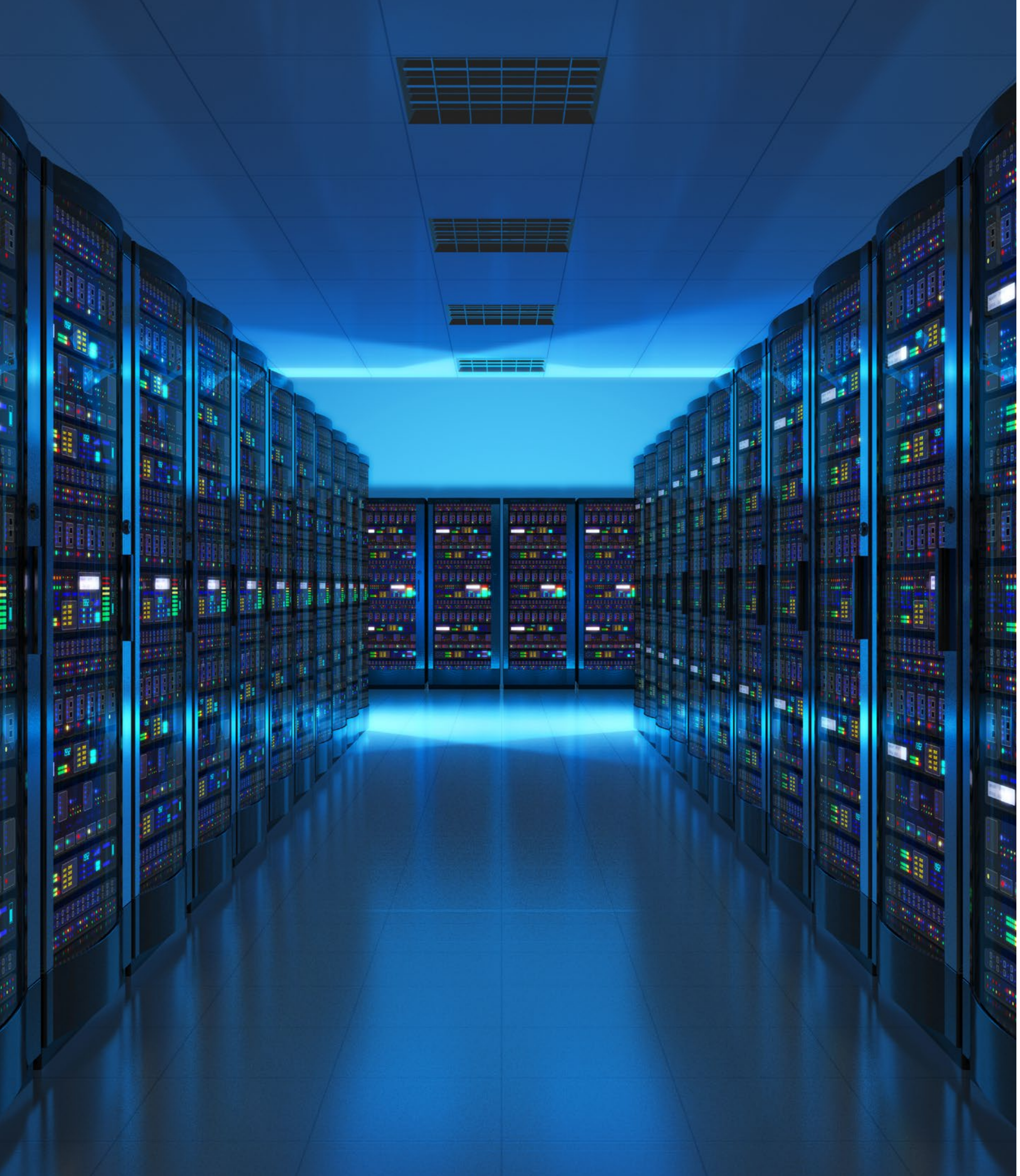
Ben was Building Performance Analyst Lead on the report for CRITFC titled, *Energy and Water Use Impacts of Building System Design for Data Centers* (February 14, 2025).

SELECT EXPERIENCE:

- Goldendale School District 404, Federal Emergency Management Agency (FEMA) Goldendale Microgrid Study, Goldendale, WA
- City of Bellingham, District Energy Feasibility Study, Bellingham, WA
- Rocky Mountain Institute Innovation Center, Basalt, CO | Living building Petal Certification, LEED Platinum, Net-Positive Energy, Passive House, Architecture 2030, All-Electric
- Appalachian State University, Conservatory for Biodiversity Education and Research, Boone, NC | Pursuing Net-Zero Energy - includes a separate ground- source heat pump-based central plant system.
- City of Beaverton, Public Safety Center, Beaverton, OR | Net-Zero Ready, Architecture 2030, Net-Zero Ready - includes a microgrid.



FEBRUARY 14, 2025

The Energy & Water Use Impacts of Building System Design for Data Centers

DESIGN CONSIDERATIONS FOR OREGON & WASHINGTON

STUDY PERFORMED BY:

PAE

ON BEHALF OF:

Confederated Tribes of the Umatilla Indian Reservation

Columbia River Inter-Tribal Fish Commission

The study used to inform this document was funded in part by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) for informative and exploratory purposes. The recommendations expressed herein may or may not represent CTUIR's current policy position. Any inquiries regarding CTUIR policy positions may be directed to Sterling Cosper, CTUIR Legislative Affairs Manager, 541-429-7392 or SterlingCosper@ctuir.org.

Executive Summary

Key Takeaways

Implementing data center energy efficiency and peak power reductions would provide some of the most significant energy savings available to the region.

STUDY OVERVIEW

Oregon and Washington are well suited for data centers, therefore the region has become a focus for this quickly growing sector. The energy and water impacts of this growth will depend on decisions implemented now to ensure this important market is leveraging the best solutions available to meet its increasing needs.

The focus of this study was on the building systems that support the core IT (server) loads of data centers. The study models were based on a simplified scenario comparing two systems in one climate zone to explore if the building systems had any impact. While these support loads can seem minimal in comparison to the server loads, the study results found building systems do have a measurable impact to the overall energy use of data centers and provide opportunity for innovation and improvement.

This study explored three key topics regarding building system selection:

- Impact on total annual building energy use
- Impact on peak power demand
- Impact on total annual water use

SUMMARY OF RESULTS

1. The study found notable differences in energy use of non-ITE loads as highlighted in their Power Usage Effectiveness (PUE) values for the following scenarios:
   - ASHRAE 90.4 baseline: 1.24 PUE
   - Best practices air cooled: 1.17 PUE
   - Best practices evaporative cooling: 1.10 PUE

2. The modeled scenarios found potential for total annual energy use savings of 2,000,000 MWh - 4,000,000 MWh by 2033 from the more efficient building system. These savings are equivalent to nearly half of all the wind power generated in Oregon in 2021[1] and resulted only from systems improvements without any reduction in data center quantity.

3. The models identified a potential 1,000 MW reduction in peak power demand between the system options. Peak demand is currently not considered in data center building standards, yet has important implications for regional energy systems.

   For the climate zone studied in this report, the "Peak-PUE" model results were:
   - ASHRAE 90.4 baseline: 1.59 Peak-PUE
   - Best practices air cooled: 1.52 Peak-PUE
   - Best practices evaporative cooling: 1.15 Peak-PUE

   It is recommended that a Peak-PUE metric be created and adopted to help ensure best practices regarding peak demand with system selections.

4. The interaction between water and energy use for the climate zone was modeled as a comparison between onsite direct water use and indirect water use for energy generation. The model found evaporative cooling results in a higher overall water use, even when reduced energy use is considered. Yet within the regional context, the total water use of evaporative cooling remains less than 0.1% of overall water use in the Washington and Oregon region while providing the previously noted improvements in data center energy use.

[1] https://www.nwcouncil.org/reports/columbia-river-history/megawatt/

REPORT DIRECTORY

PAE | ANALYSIS & ENGINEERING TEAM

Karina Hershberg
REGENERATIVE DESIGN | PROJECT MANAGER
karina.hershberg@pae-engineers.com

Ben Burnett
REGENERATIVE DESIGN | BUILDING PERFORMANCE ANALYSIS LEAD
ben.burnett@pae-engineers.com

Jonathan Roraff
REGENERATIVE DESIGN | BUILDING PERFORMANCE ANALYSIS

Paula Hopker
GRAPHIC DESIGN

Marc Brune
PRINCIPAL-IN-CHARGE
marc.brune@pae-engineers.com

CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

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How Data Centers Are Expanding

INTRODUCTION

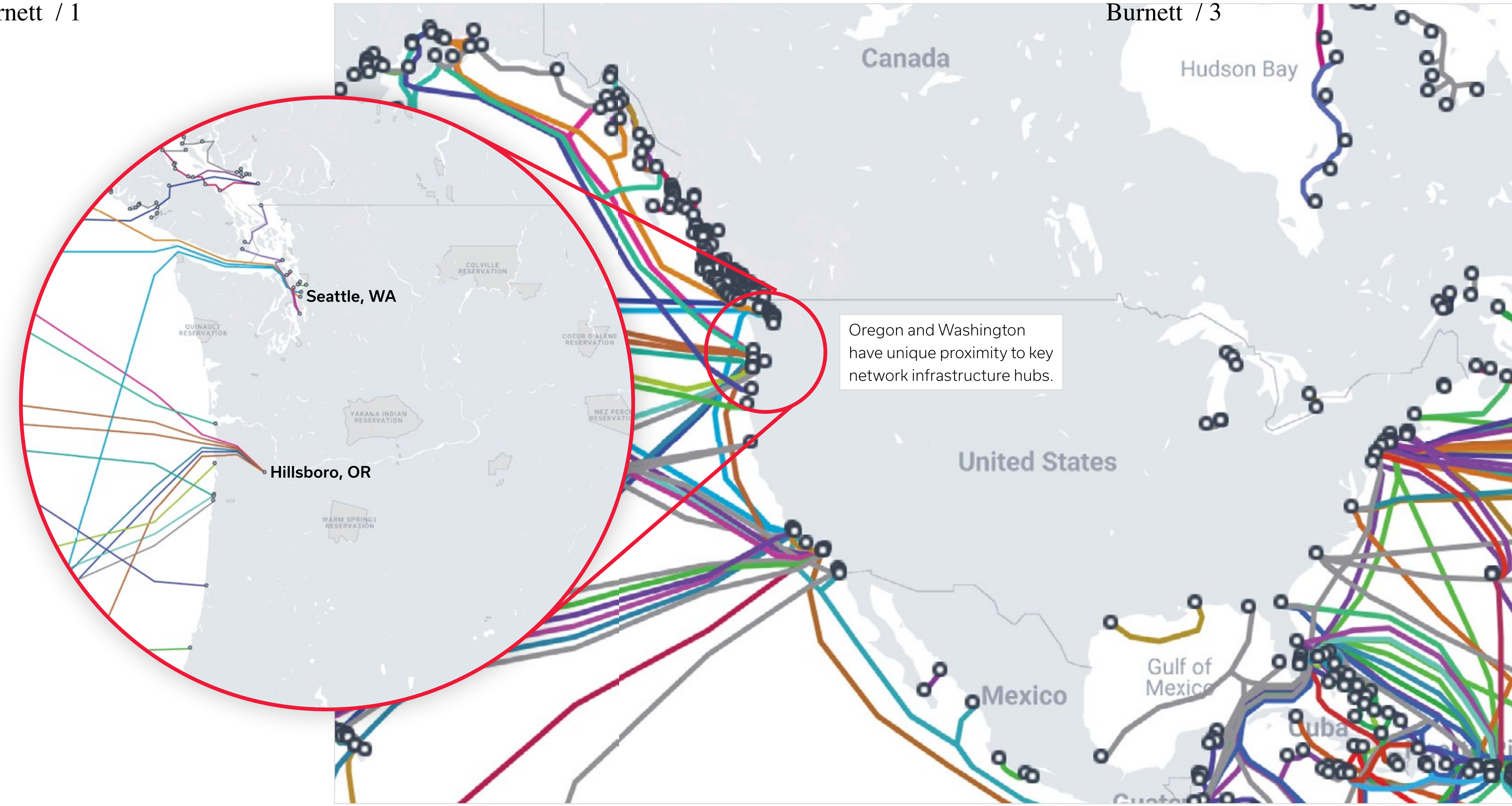
It has become well understood that the data center sector is expanding globally at a quickening rate. The impact of this growth is a topic of ongoing discussion as regions balance the requirements for increased data, energy, and water resources.

The focus of this report is on energy and water considerations specific to the northwest region of the United States, namely Oregon and Washington.

Oregon and Washington, like many regions of the US, are seeing an increased interest to expand their data center sector. Yet, while data centers are emerging in multiple locations around the country, Oregon and Washington offer unique benefits to the data center industry which make it a particularly intriguing option for this quickly growing market.

An ideal data center site has as many of the following attributes as possible, listed in general order of priority:

1. Reliable, available power
2. Proximity to network infrastructure
3. Sufficient land availability
4. Cool climate
5. Low risk of natural disasters
6. Security Considerations
7. Cost considerations, including
   - Land
   - Construction
   - Ongoing Operations
   - Electricity
   - Tax Breaks
   - Incentives



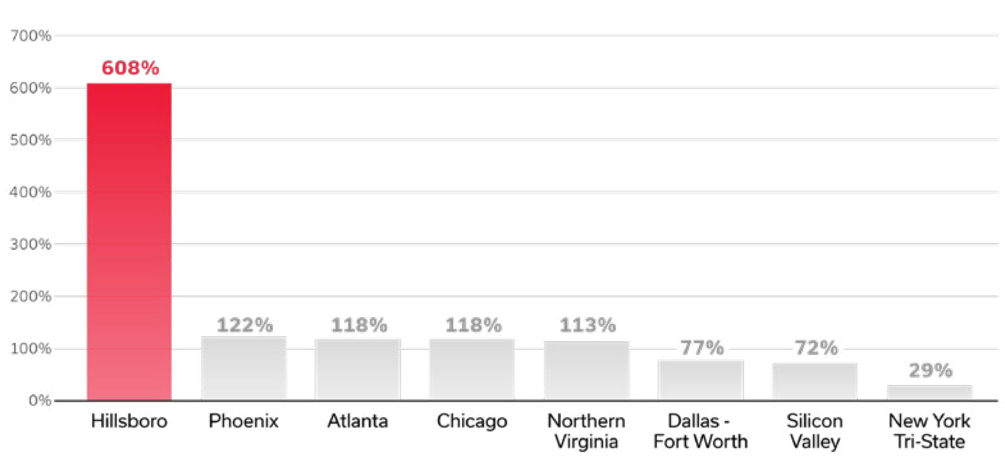
Source: https://www.submarinecablemap.com/

With Hillsboro, Oregon, already established as a primary data center market and eastern Oregon and Washington quickly growing in the secondary market, this has led the region to anticipate an increased interest in expansion from the data center market.

OREGON MARKET

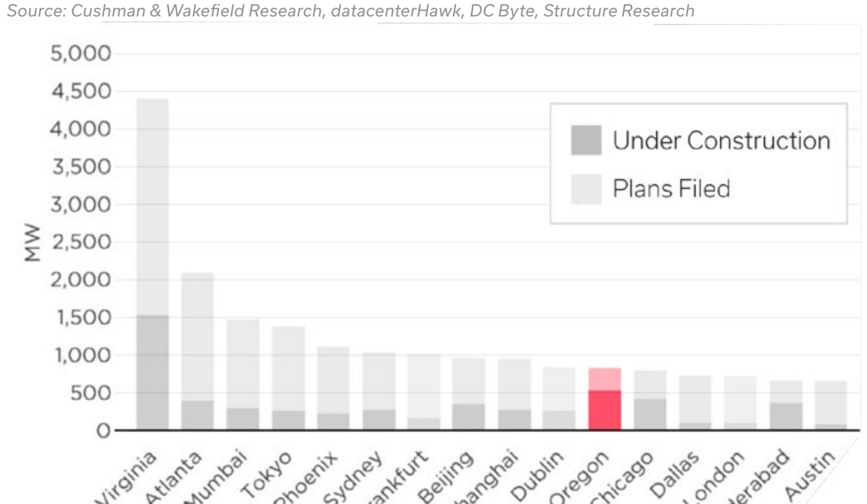
INVENTORY GROWTH OF PRIMARY DATA CENTER MARKETS SINCE 2020

Source: CBRE Research, CBRE Data Center Solutions, H1 2024



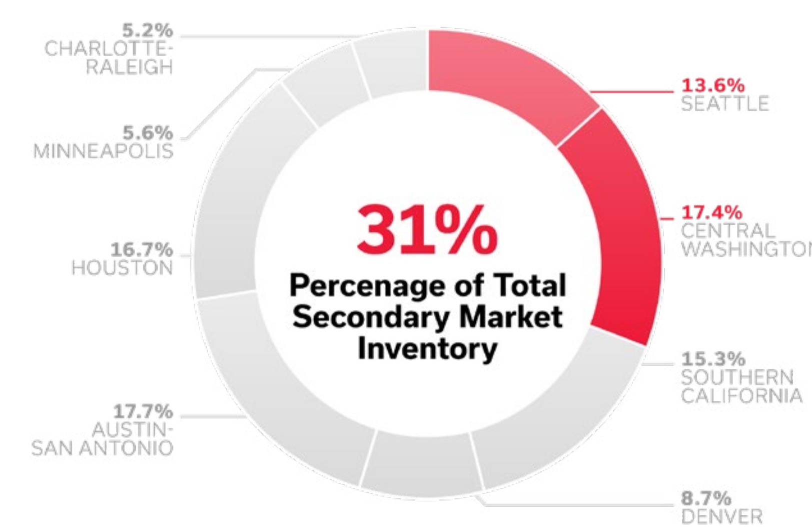
TOP MARKETS BY COMBINED IT LOAD UNDER CONSTRUCTION OR PLANS FILED

Source: Cushman & Wakefield Research, datacenterHawk, DC Byte, Structure Research



WASHINGTON MARKET

Source: CBRE Research, CBRE Data Center Solutions, H1 2024.



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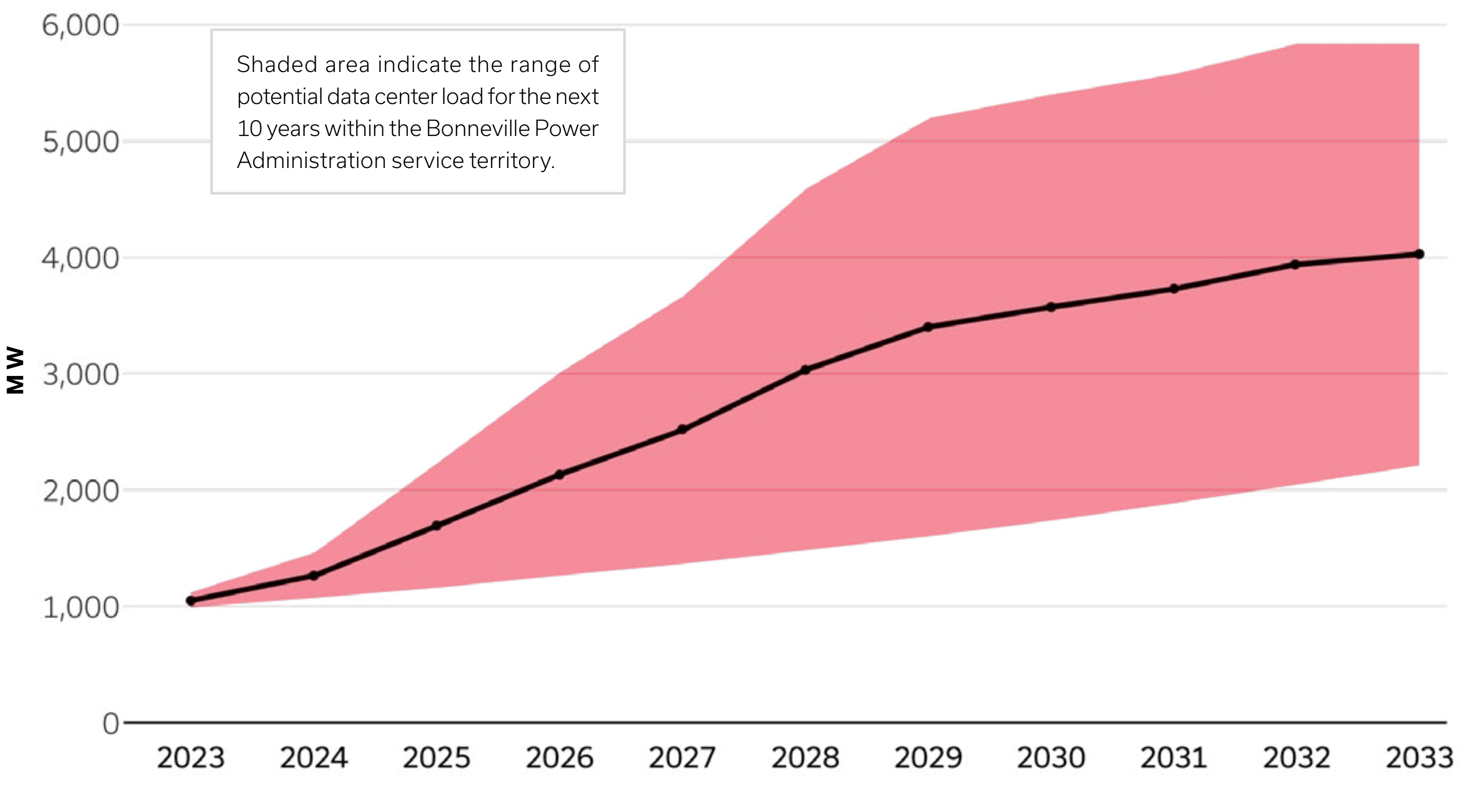
How Data Centers Are Expanding

LOOKING TO THE FUTURE

The Oregon and Washington region has started to evaluate the potential magnitude of impact in the coming years. If the market continues at the modeled rates, it is reasonable that an increase of 2x up to nearly 6x could occur within 10 years.

DATA CENTER LOAD GROWTH ASSUMPTION

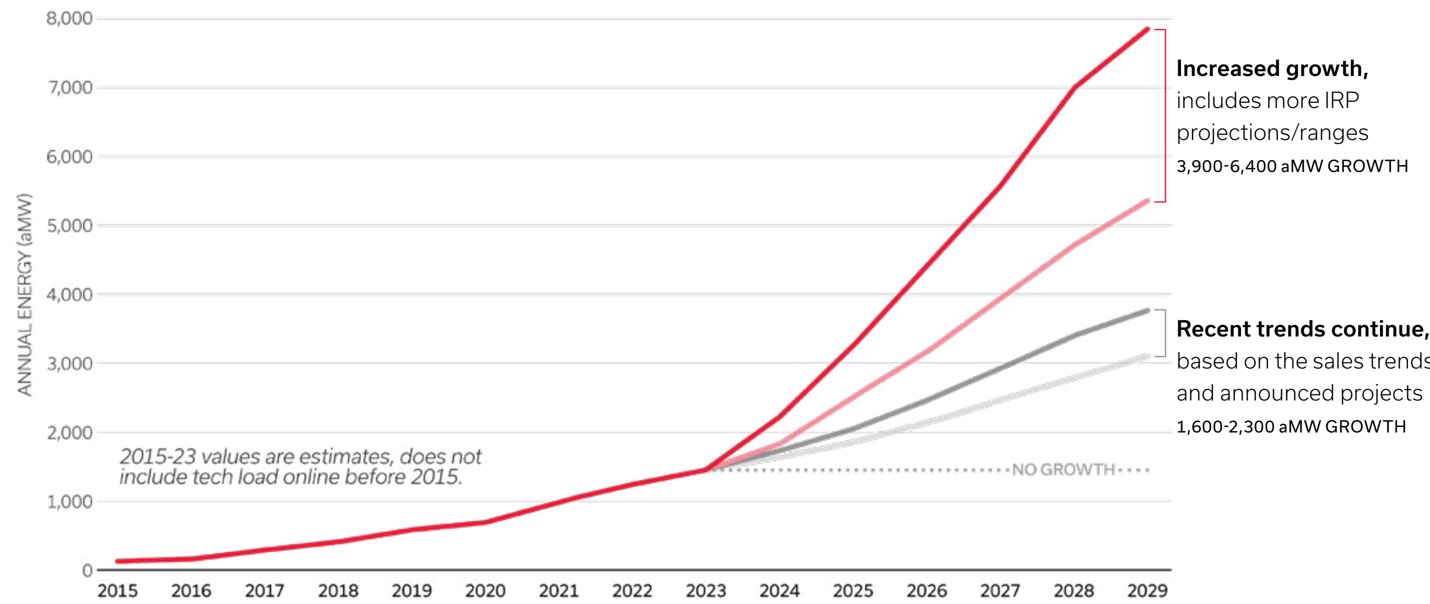
Source: BPA Loads Presentation NWPCC Power Committee Meeting March 12, 2024



Given the energy and water density of this market sector, this scale of increase has notable implications for the energy and water resources of the region. The intent of this study is to explore the options to influence these impacts with data-informed solutions for minimizing energy needs, balancing the interaction between water and energy use with different system options, and reducing the power demand during peak times.

DRAFT DATA CENTER AND CHIP FABRICATION FORECAST TO 2029

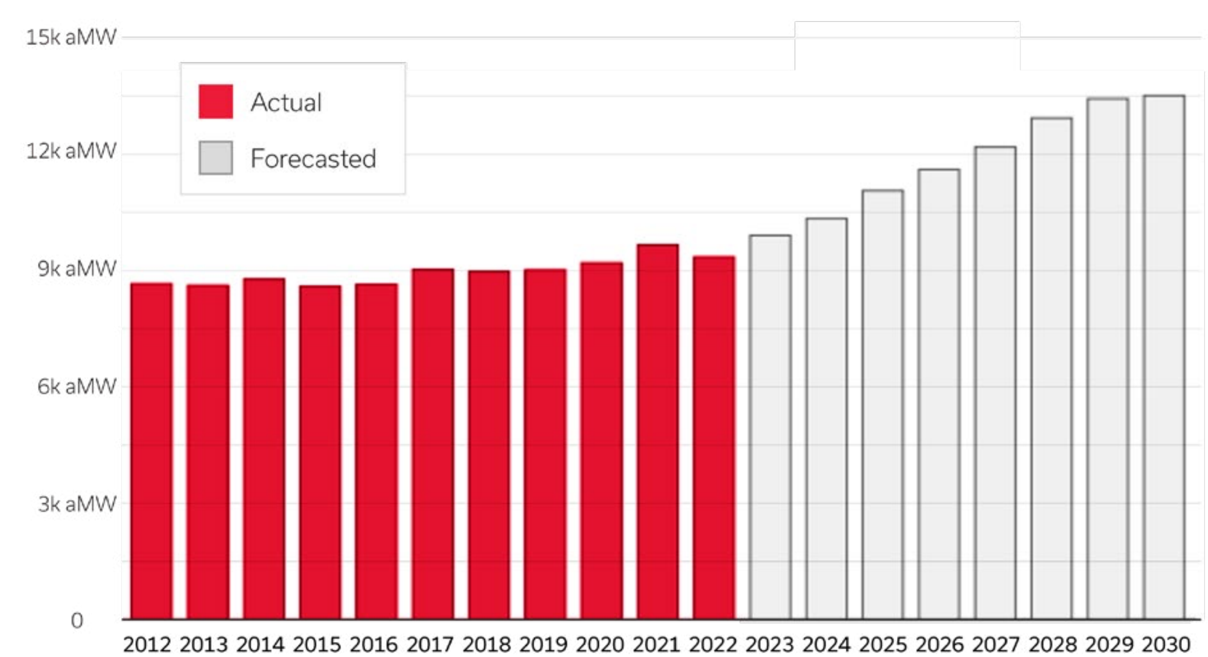
Source: Northwest Power and Conservation Council
Note: Forecast load growth is predominantly from data centers, although does include some semi-conductor facilities.



Not surprisingly, this projected growth is influencing the forecasts for the region's utilities regarding anticipated load growth and the need for additional generation and transmission capacity.

HISTORIC TOTAL RETAIL LOADS

Source: Bonneville Power Administration, 2024-2028 Strategic Plan



Annual Megawatt (aMW): A unit of energy output that measures the average amount of energy produced by a one megawatt capacity over a year.

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What Does PUE Really Mean?

MEASURING EFFICIENCY

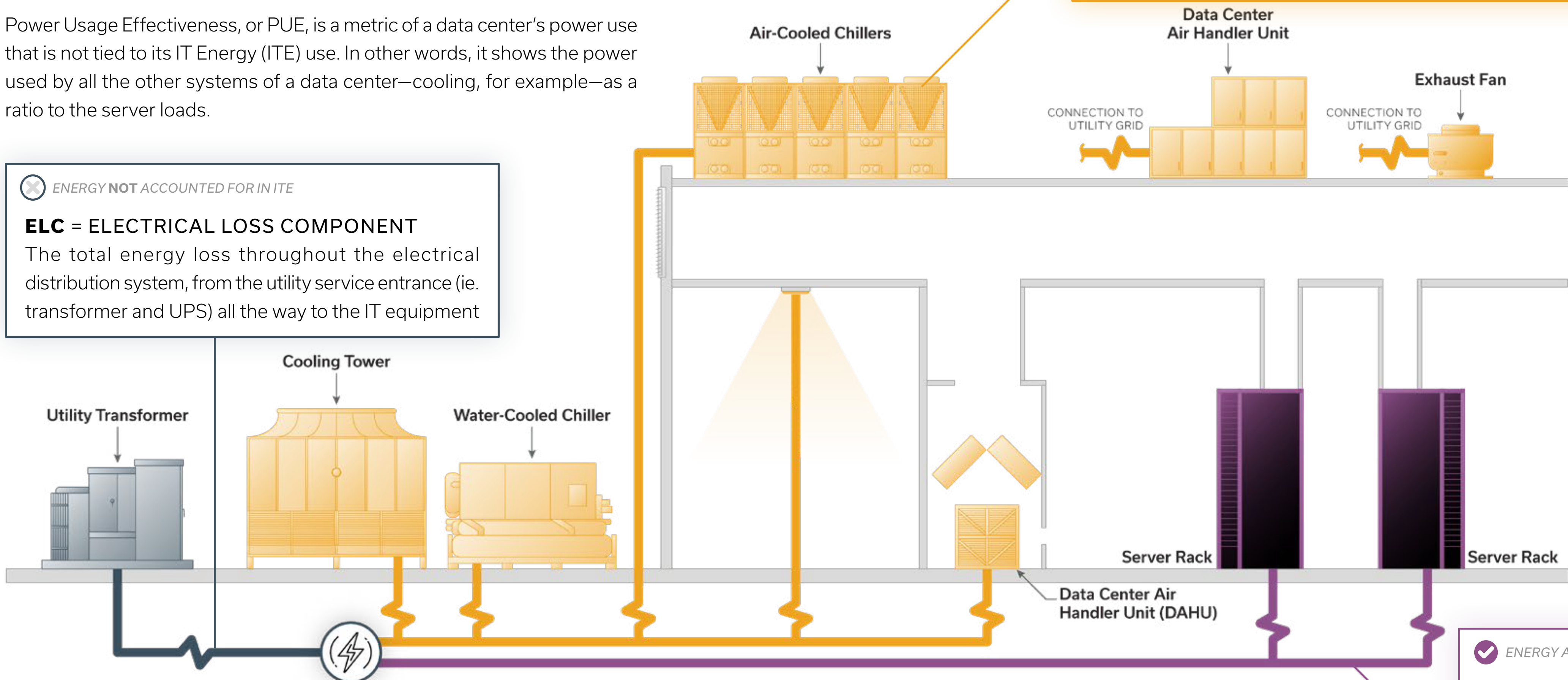
Power Usage Effectiveness, or PUE, is a metric of a data center's power use that is not tied to its IT Energy (ITE) use. In other words, it shows the power used by all the other systems of a data center—cooling, for example—as a ratio to the server loads.

ENERGY NOT ACCOUNTED FOR IN ITE

ELC = ELECTRICAL LOSS COMPONENT
The total energy loss throughout the electrical distribution system, from the utility service entrance (ie. transformer and UPS) all the way to the IT equipment

ENERGY NOT ACCOUNTED FOR IN ITE

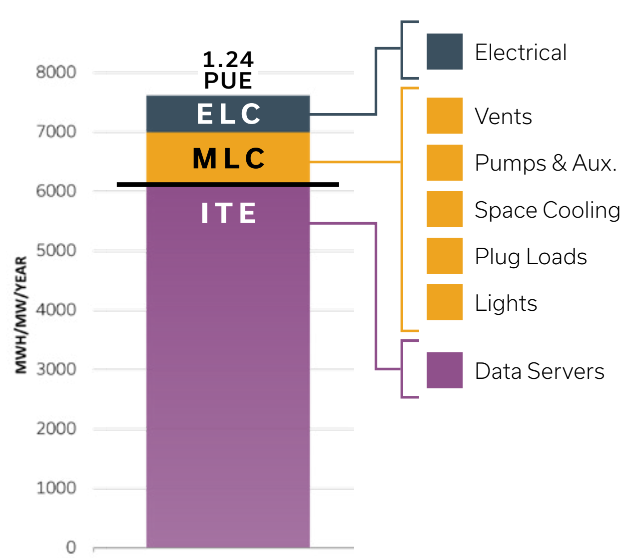
MLC = MECHANICAL LOSS COMPONENT
The power consumed by mechanical components like fans, pumps, and other equipment used to circulate coolant and reject heat, essentially representing the energy used to maintain the proper temperature within the data center



ENERGY ACCOUNTED FOR

ITE = IT ENERGY
Energy consumed directly by servers.

$$\text{PUE} = \frac{\text{TOTAL ENERGY (MLC + ELC + ITE)}}{\text{IT ENERGY (ITE)}}$$



90.4-2022 Baseline Data Center
AC CHILLERS

ASHRAE 90.4 Summary

Both Oregon and Washington have adopted ASHRAE 90.4 as the energy code standard for data centers. ASHRAE 90.4 defines a maximum PUE based on allowances for mechanical system loads and electrical efficiency.

CHAPTER 6 | MAXIMIZED ANNUALIZED MECHANICAL LOAD COMPONENT

Chapter 6 (Heating, Ventilation, and Air Conditioning) designates the Maximum Annualized Mechanical Load Component (Annualized MLC).

- MLC is defined as the total annual energy consumed by all mechanical equipment (e.g., fans, pumps, motors, drives, compressors, humidifiers, dehumidifiers, water filtration or treatment equipment).
- Mechanical equipment energy is calculated with Typical Meteorological Year Version 3 (TMY3) data with 8760 hourly data points or that is binned by dry bulb and wet bulb (or dew point) with a resolution ≤2°F (1°C).
- MLC is calculated as a weighted average of four runs at constant ITE loads of 25%, 50%, 75%, and 100% of the design ITE load.
- The MLC allowance is based on climate zone: Higher allowance in warmer climates, lower in cold climates. The allowance for both climate zones 4C and 5B (which cover all of Oregon and Washington) is 0.14.

CHAPTER 8 | MAXIMUM DESIGN ELECTRICAL LOSS COMPONENT

Chapter 8 (Power) defines the Maximum Design Electrical Loss Component (Design ELC). ELC applies only to electrical systems serving ITE loads.

- Design ELC is calculated based on the UPS segment loss and the ITE distribution segment losses, separately reported at each of four load levels: 100%, 75%, 50%, and 25% of the ITE design load. The electrical system must meet or exceed the ELC minimum requirements listed in Table 8.6 at each of the ITE design load levels.

CHAPTER 11 | ALTERNATIVE COMPLIANCE METHOD

Chapter 11 (Alternative Compliance Method) allows a 1:1 trade-off between MLC and ELC allowances, so a less efficient electrical system may be offset by a more efficient mechanical system, or vice-versa.

- Onsite Renewables may also be used to offset the overall PUE allowance and demonstrate compliance.

Table 8.6 Maximum Design ELC and ELC Segments (IT Design Load ≥ 100 kW)

	UPS Redundancy Configuration: Single-Feed UPS (*N*, *N+1*, etc.) or Active Dual-Feed UPS (*2N*, *2N+1*, etc.)[a]			
Calculation Percentage	100% of IT design load segment ELC	75% of IT design load segment ELC	50% of IT design load segment ELC	25% of IT design load segment ELC
Segments of ELC and Overall ELC	*Loss/efficiency*	*Loss/efficiency*	*Loss/efficiency*	*Loss/efficiency*
UPS Segment	5.5%/94.5%	5.5%/94.5%	6.0%/94.0%	7.0%/93.0%
ITE Distribution Segment	5.8%/94.2%	4.6%/95.4%	3.6%/96.4%	2.5%/97.5%
Electrical Loss/Efficiency Total	11.0%/89.0%	9.8%/90.2%	9.4%/90.6%	9.3%/90.7%
ELC	0.110	0.098	0.094	0.093

a. *Informative Note:* Example calculations are shown in Informative Appendix C.

Source: ©ASHRAE, www.ashrae.org. 2022 ASHRAE Standard-90.4.

Comparing Baseline with Best Practices

BASELINE

As described on the previous page, ASHRAE 90.4 sets the minimum performance for data centers in Oregon and Washington. 90.4 is fundamentally a performance standard and does not mandate the systems or design approach used to meet the efficiency target. For simplicity, two cold air distribution systems are considered for this study to demonstrate the different performance of compressor driven systems versus systems without compressors. The systems presented here are an air-cooled chiller system and a direct evaporative system.

GENERAL BEST PRACTICES

In order to reduce MLC, data centers are designed to maximize economizer, or free cooling operation. Specifically:

- Increasing temperature setpoints to reduce hours where supplemental mechanical cooling is needed and increase efficiency of mechanical cooling equipment when supplemental cooling is needed.
- Optimizing air paths to take advantage of passive airflow and reduce fan power.

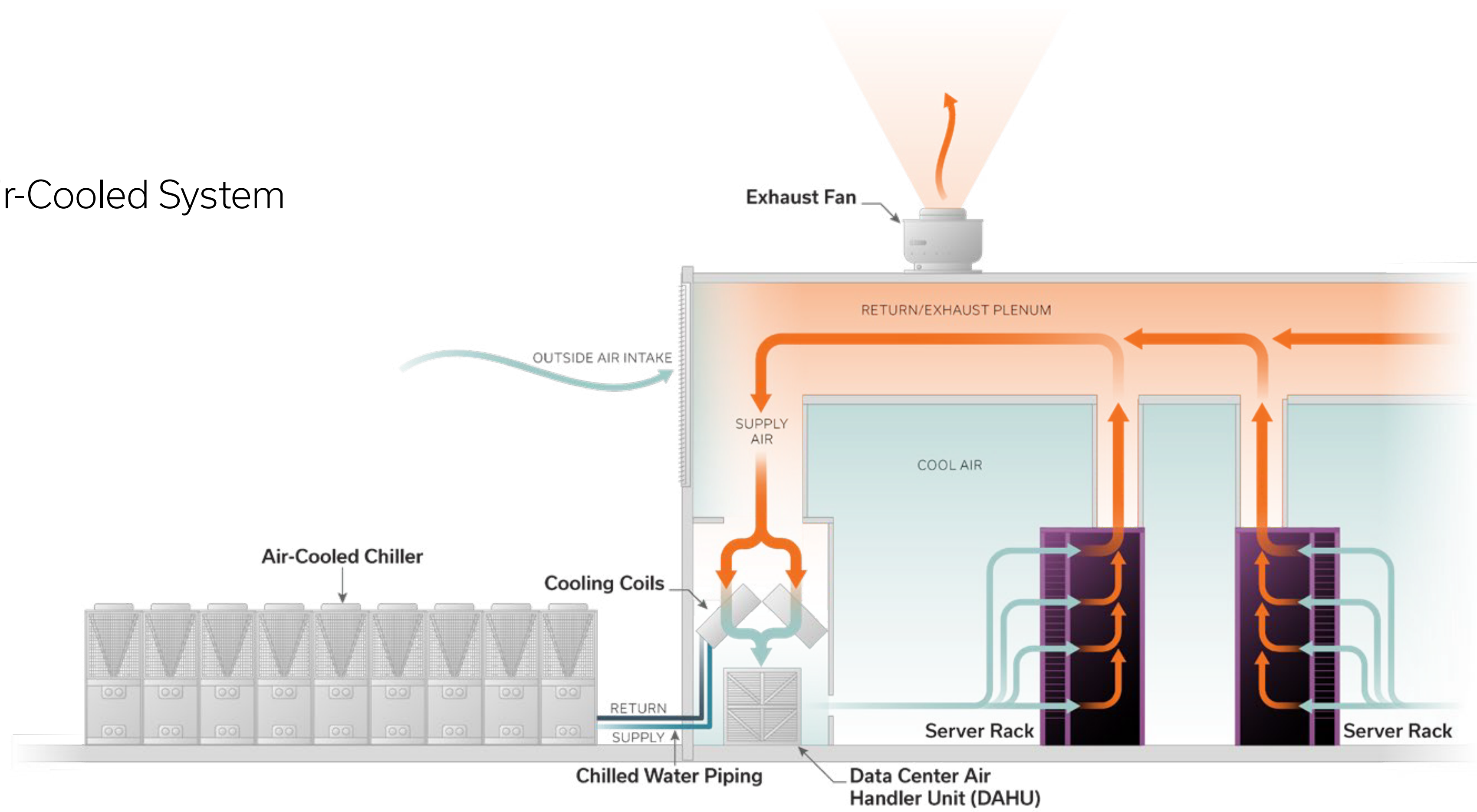
Strategies for reducing ELC revolve around design and selection of efficient electrical systems:

- Selecting high-efficiency UPS equipment.
- Reducing power transformation operations and selecting high-efficiency transformers and power distribution units.
- Minimizing conductor length and optimizing sizing to reduce distribution losses.

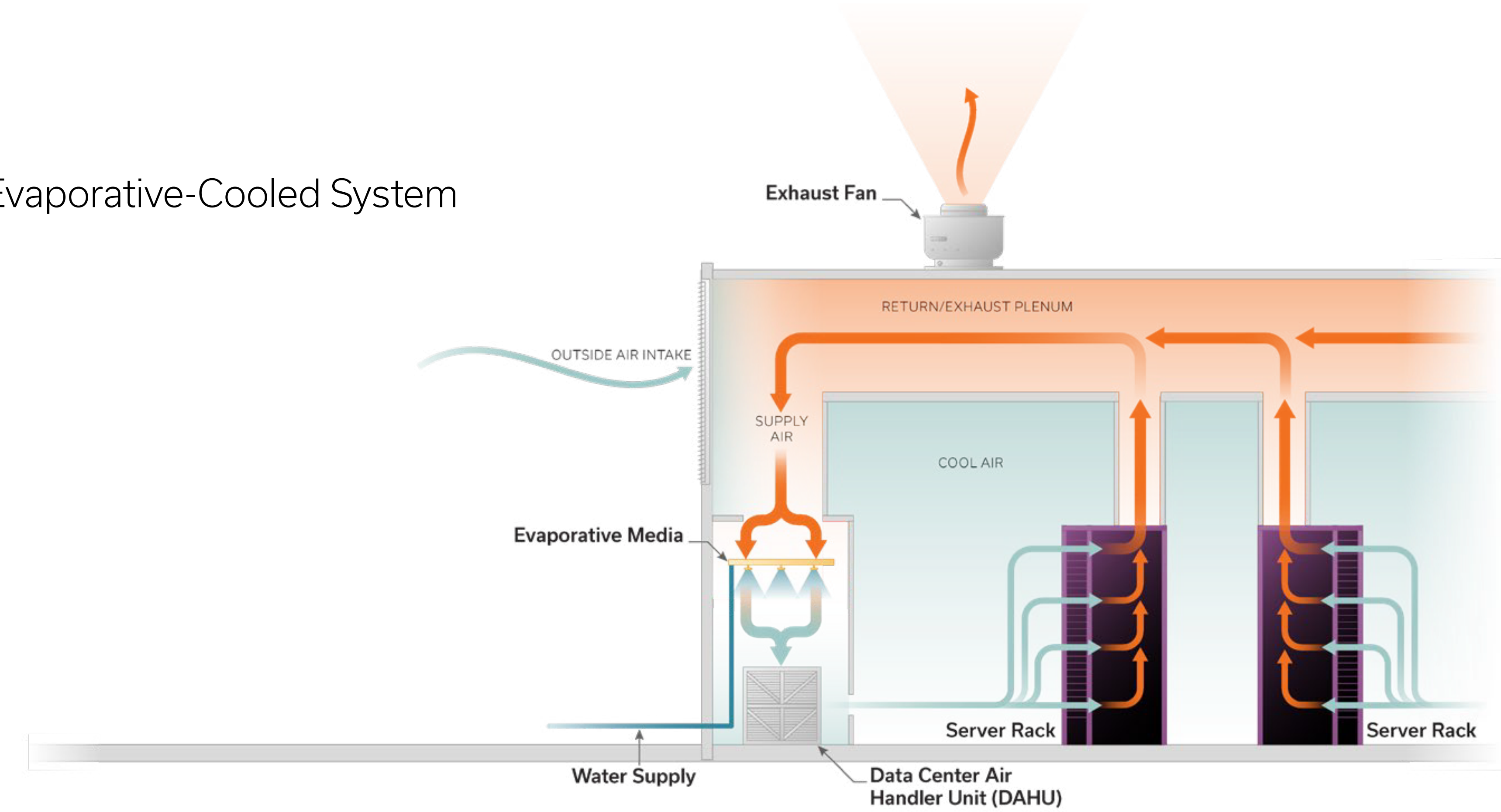
EVAPORATIVE COOLING SYSTEM

One strategy for efficient data centers in drier climates is to replace active mechanical cooling systems with direct evaporative cooling systems, which add moisture to the supply air stream to cool the air. Evaporative cooling systems substantially reduce peak and annual energy demand but require large quantities of water. Based on water availability and quality these systems are not always viable.

Air-Cooled System



Evaporative-Cooled System

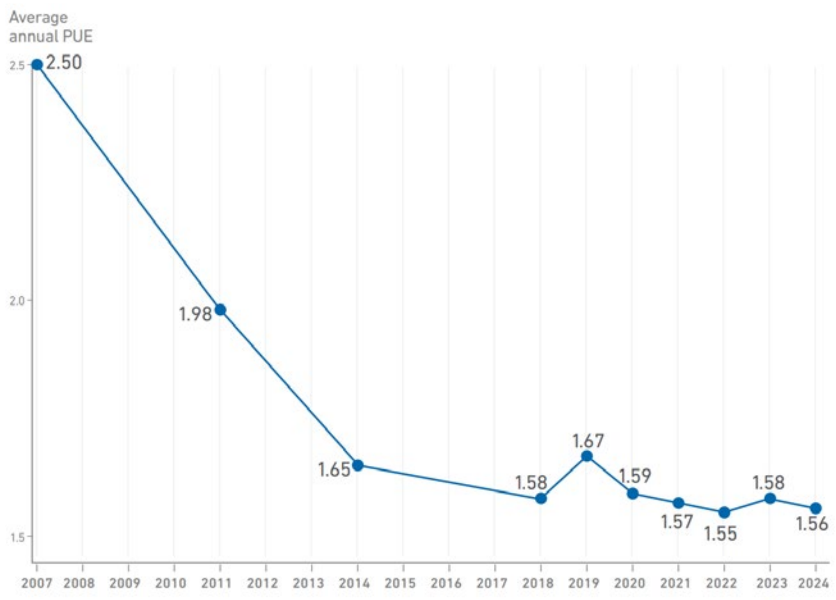


PUE Trends and Outlook

Data Centers: Market Context

PUE TRENDS

There is ongoing discussion within the data center industry on feasible PUE targets. Global PUE levels remain higher than the recommended ASHRAE minimums, yet this may be due to a lack of requirements rather than ability. Leaders in the data center sector have demonstrated that significant improvements over the ASHRAE 90.4 minimums are achievable with today's technologies.



Source: Uptime Institute Global Data Center Survey 2024

As an example, Google has an average reported PUE of 1.10 across its global portfolio of large facilities, including its Oregon location. This is even after using a more stringent reporting method. The more standard methodology would indicate an average PUE of 1.06.

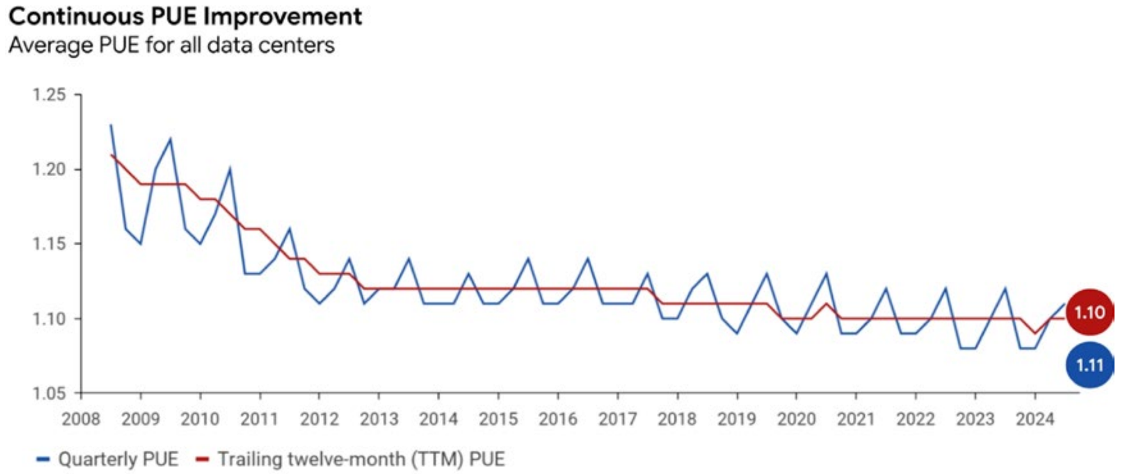


Figure 2: PUE data for all large-scale Google Data Centers

Source: https://www.google.com/about/datacenters/efficiency

FACILITY	QUARTERLY PUE	TRAILING 12-MONTH PUE
The Dalles, Oregon	1.10	1.10
The Dalles, Oregon 2ND FACILITY	1.06	1.07

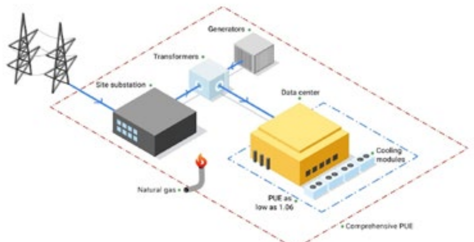


Figure 1: Google Data Center PUE measurement boundaries. The average PUE for all Google Data Centers is 1.10, although we could boast a PUE as low as 1.06 when using narrower boundaries.

Key Takeaways

Leaders in the data center industry have demonstrated that more efficient PUE numbers are achievable with current technology and system options.

Technology Outlook

WASTE HEAT AS A RESOURCE

Data centers generate significant amounts of heat through their processing loads. When considered at scale, there is intriguing potential for turning waste heat into a valuable resource by locating data centers adjacent to other building types, such as housing or hospitals, which have high space and hot water heating needs.

One example of this potential is NREL's High-Performance Computing (HPC) User Facility. Harnessing the heat output from the data center supports other facility energy needs with a process hot water PHW loop which supplies:

- Active chilled beams to heat the office space
- Air handlers to heat the conference and high bay spaces
- Snow melt loop in the courtyard of the ESIF's main entrance
- District heating loop

This is a topic that would benefit from additional study. The relatively low temperature of the waste heat may limit the potential benefits, yet it is still a topic worth more evaluation.

https://www.nrel.gov/computational-science/waste-heat-energy-reuse.html

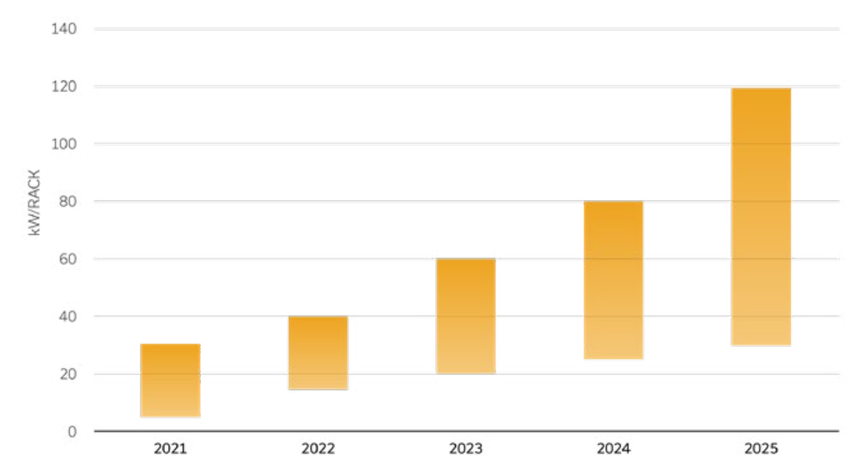
NEW SYSTEM TYPES

The power density for data center racks are expected to continue increasing over time. New technologies and building systems are being explored to support the increased needs.

System options, such as liquid cooled systems, are gaining adoption within the industry. Although not included in this report, an expanded comparison of system types could be explored in future studies.

AVERAGE SERVER RACK DENSITY RANGES | kW/RACK

Source: Cushman & Wakefield Research, Structure Research



Model Methodology and Results

Summary of Methodology

PAE developed a data center energy model in IES VE software to evaluate the expected energy performance and water consumption of a minimum code-compliant data center vs. current best practices for both air-cooled and evaporatively cooled systems. The model was patterned after an ASHRAE 90.4-2022 compliance model due to its wide adoption as a data center energy code throughout the U.S., including in Oregon and Washington. This provides a useful baseline for comparison with industry published PUE performance.

The following parameters were used as inputs in the model:

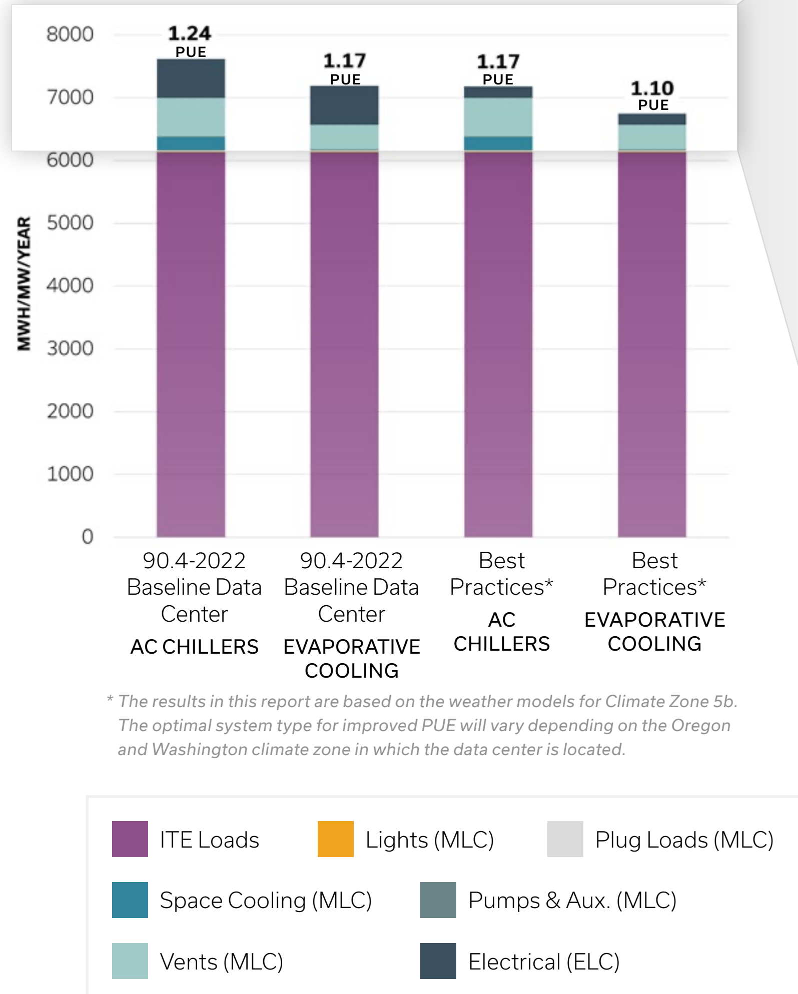
- **Weather File:** The Dalles Regional Airport TMYx.2009-2023, Climate Zone 5B
- **ITE Load:** 30MW
- **Supply Air Temperature/Economizer Setpoint:** 79°F

The model was simulated at 25%, 50%, 75%, and 100% of ITE loads. PUE is taken as the average of the sum of all runs. Peak PUE is taken at the peak hour of the 100% run.

OPPORTUNITIES FOR ADDITIONAL STUDY

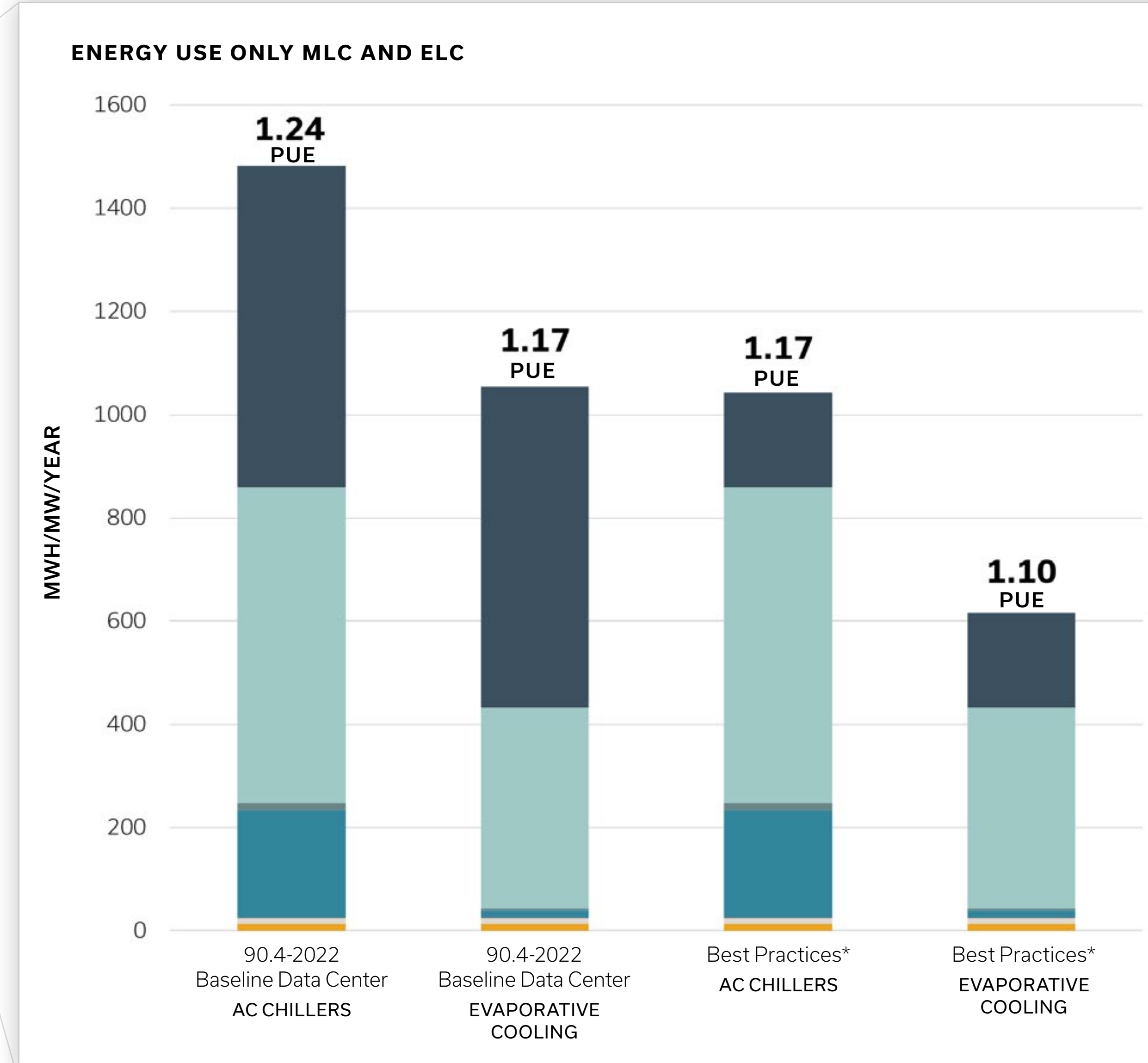
The models were based on a simplified scenario comparing two systems in one climate zone to explore if the building systems had any impact. The results indicate building systems do have a measurable impact, yet impacts of specific systems may vary depending on location. Additional study on these variables could provide beneficial information on the potential impact.

PUE RESULTS | ENERGY USE WITH ITE, MLC, AND ELC



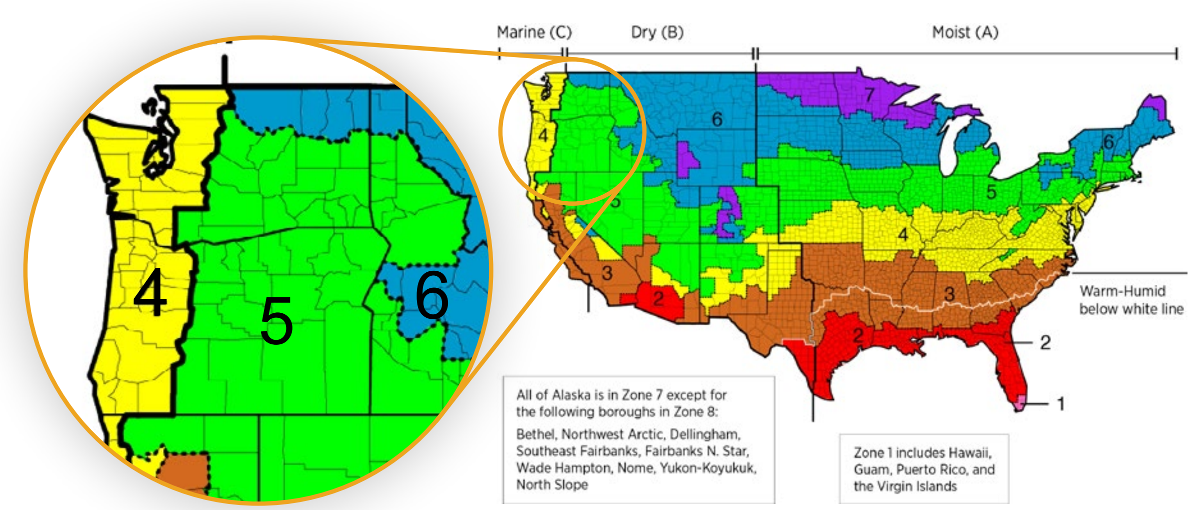
** The results in this report are based on the weather models for Climate Zone 5b. The optimal system type for improved PUE will vary depending on the Oregon and Washington climate zone in which the data center is located.*

ENERGY USE ONLY MLC AND ELC



CLIMATE ZONE CONSIDERATIONS

The majority of Washington and Oregon are located in climate zones 4C (Mixed mild/Marine) and 5B (Cool/Dry). The modeled weather file from The Dalles, in Zone 5B, can be considered generally representative of the areas of eastern Oregon and Washington where many data centers are located, such as central Oregon and the greater Columbia River Gorge. The milder 4C climates are expected to show less dramatic energy savings from evaporative cooling systems. Peak power results are expected to be more widely applicable, as the peak conditions of hot, dry summer days are similar to the modeled weather in most areas of Zone 4C, with the exception of the true marine climates near the western coast.



PUE Scale Implications and Key Takeaways

UNDERSTANDING SCALE

The region's current total electricity use currently is roughly 58,000,000 MWh in Oregon and 92,000,000 MWh in Washington, for a total of nearly 150,000,000 MWh for the region. Accordingly, the near-term impact of data centers based on the midpoint projection is a 3% increase in total electricity load. This could increase to over 10% based on the growth projections.

Although the building system impacts seem minimal compared to the overall energy use, the savings are significant when considered in other contexts.

This scale speaks to the importance of ensuring best practices are adopted for all projects in the region to help minimize the overall long term impact.

SOURCES:
—https://www.oregon.gov/energy/Data-and-Reports/Documents/2022-BER-Energy-by-the-Numbers.pdf
—https://closup.umich.edu/sites/closup/files/2024-03/closup-wp-61-State%20of-Washington-Renewable-Energy-Policy-Analysis-Report.pdf
—https://www.oregon.gov/energy/energy-oregon/pages/electricity-mix-in-oregon.aspx
—https://www.energy.gov/sites/prod/files/2016/09/f33/WA_Energy%20Sector%20Risk%20Profile.pdf

Key Takeaways

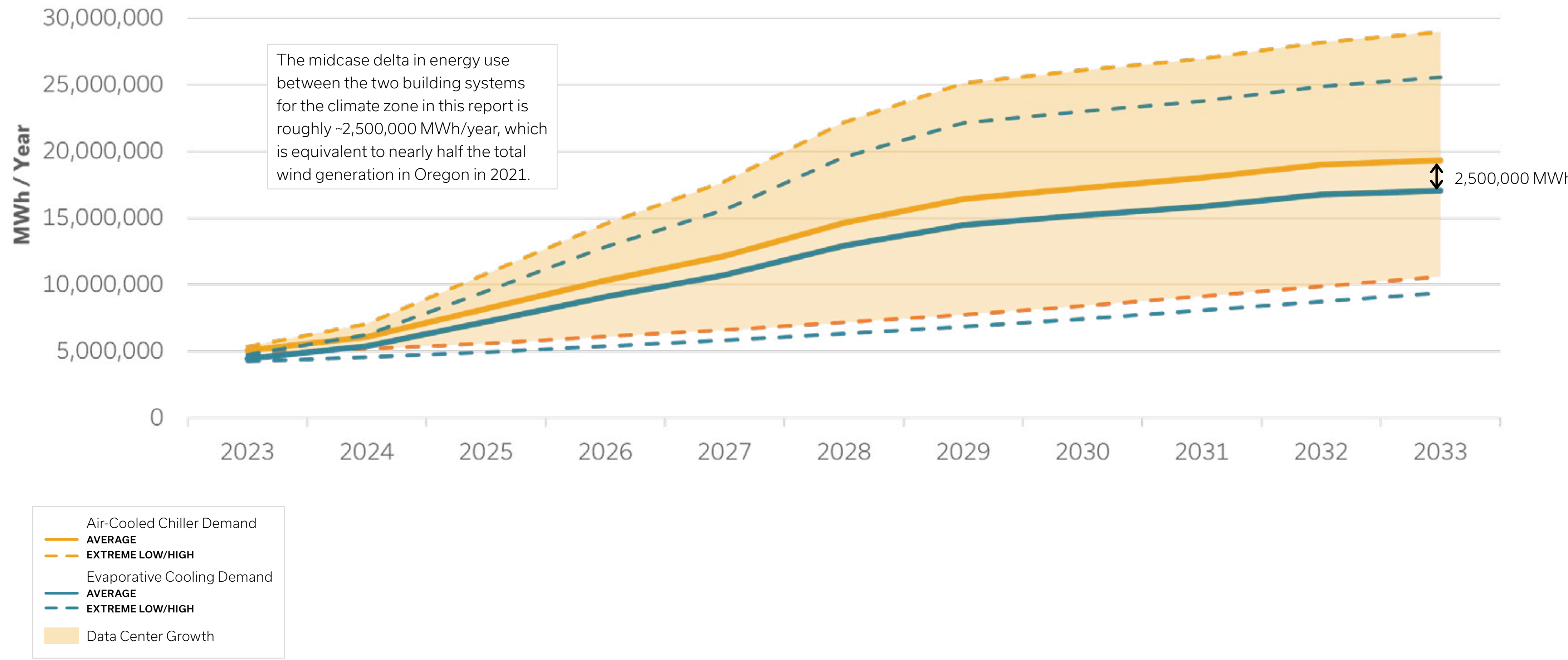
The PUE model results (page 8) show approximately the following improvements in total annual energy use:

- 6% reduction between minimum code compliant design and best practices when compared with the same mechanical systems
- 6% reduction between air-cooled chillers and direct evaporative cooling
- 12% cumulative reduction between a minimum code design and a best practices evaporatively cooled design

While these savings are incremental when compared to the overall ITE load, they still represent a potential savings of up to 850 MWh per MW of ITE load per year. When scaled to a regional level and contextualized with overall power consumption, this is a meaningful improvement.

REGIONAL IMPACT OF BUILDING SYSTEM SCENARIOS | ENERGY

Data Source: Regional growth projection is based on the Northwest Power and Conservation Council draft report Data Center and Chip Fabrication Forecast. Impact of the building systems scenario is based on the building system model results and the draft forecast.



Considering the Impacts of Peak Demand

There are multiple dimensions to consider when evaluating the system impact of data centers. Total energy use, which is a critical consideration, has historically received most of the attention.

But as Oregon and Washington grids come under additional stress in response to climate change, there is an additional consideration of increased loads during peak times. This becomes particularly important in summer when higher outside temperatures require increased cooling needs in all building types, but especially for data centers. This cumulative impact on the region's grids cannot be ignored.

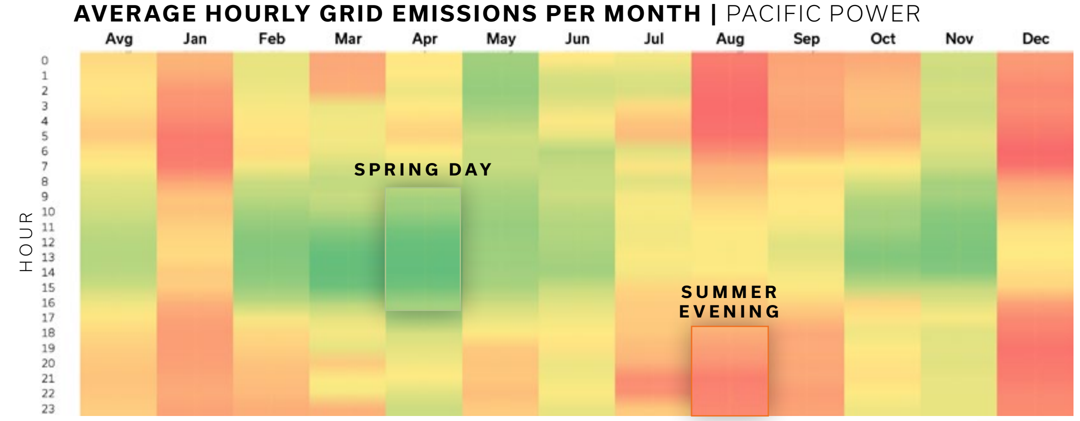
So while the total load increase to the region remains a key consideration, considerations around peak are of equal importance and yet have historically received less attention in data center forecasts and building codes.

As the results of the study presented here indicate, peaks are a key factor and should be considered in decisions around system requirements and codes. It is worth having the industry consider the addition of a metric for peak-demand evaluation in future versions of ASHRAE 90.4.

Looking at the Regional Data

In addition to the cost consideration of building a system to meet peak demand, there are environmental considerations as well. Increased coincident load often means increased use of higher emission resources. As a result, the emissions associated with peak times, such as summer afternoons and evenings, are often higher than the other times of year. Therefore reducing peak demand not only limits the stress on the grid systems but also helps reduce the overall operating emissions.

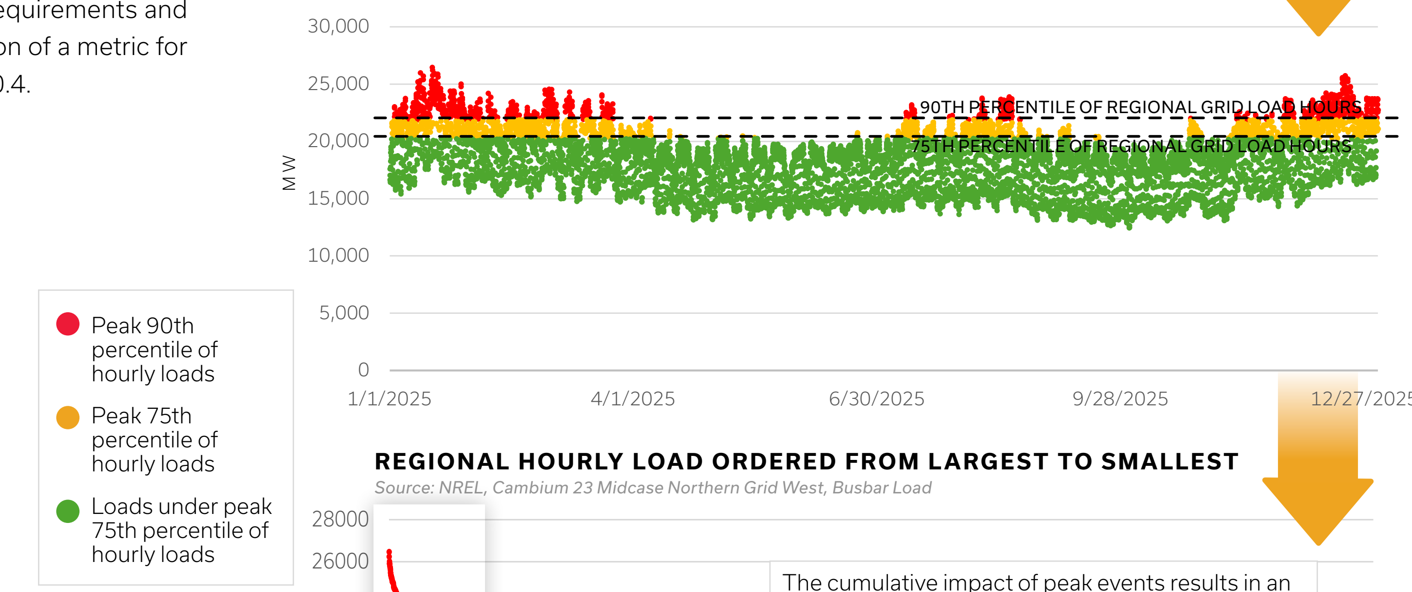
AVERAGE HOURLY GRID EMISSIONS PER MONTH | PACIFIC POWER



Grid emissions in Oregon and Washington are higher during summer evenings as compared to spring days.

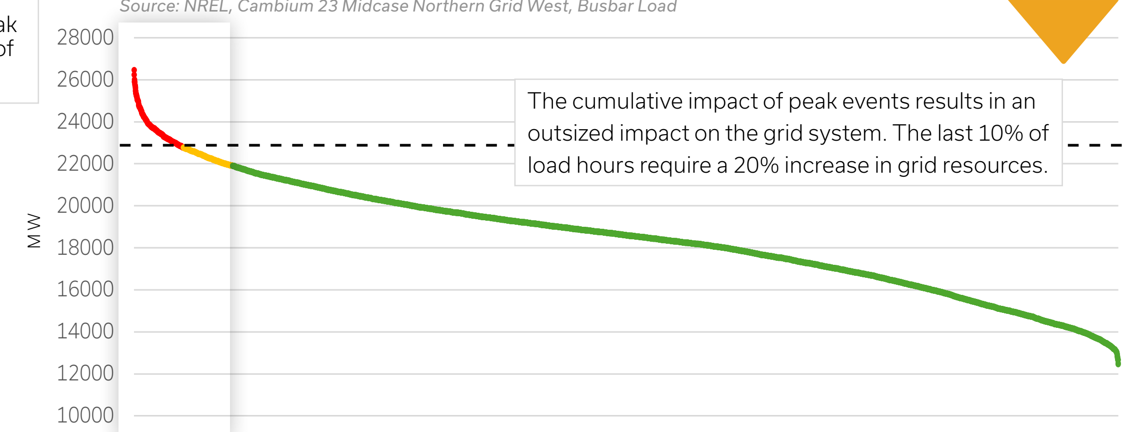
TOTAL HOURLY LOADS IN THE NW GRID REGION

Source: NREL, Cambium 23 Midcase Northern Grid West, Busbar Load



REGIONAL HOURLY LOAD ORDERED FROM LARGEST TO SMALLEST

Source: NREL, Cambium 23 Midcase Northern Grid West, Busbar Load

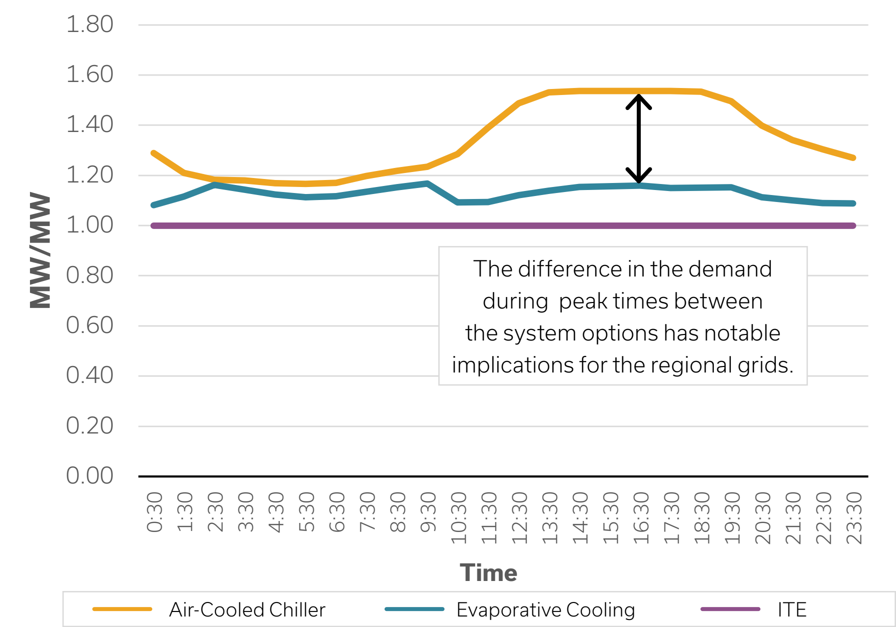


Difference in Peak Demand by System

SINGLE DATA CENTER

The difference in the demand during peak times between the system options has notable implications for the regional grids.

PEAK DAY ENERGY DEMAND

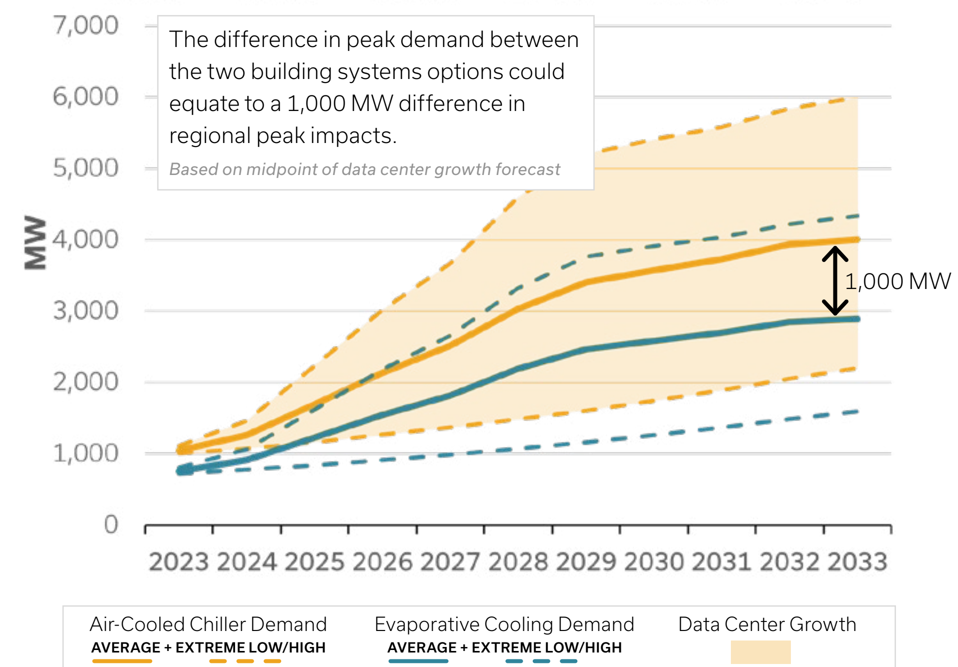


REGIONAL OUTLOOK

The difference in the demand during peak times between the system options has notable implications for the regional grids.

PEAK POWER DEMAND PROJECTION VS DATA CENTER LOAD GROWTH ASSUMPTION

Data Source: Northwest Power and Conservation Council | System Type Analysis: PAE



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A Metric for Peak Demand

INTRODUCING PEAK PUE

As outlined in the "Considering the Impacts of Peak Demand" section, peak demand is potentially as much a consideration for the regional energy impacts of data centers as the total annual energy use. Yet this factor has generally been invisible in the system evaluations which typically focus only on total annual energy use.

This report proposes the creation of a new metric to include visibility and consideration of peak demand factors in data center system decisions.

The proposed metric is a "Peak PUE" calculation. The current PUE metric is the PUE of the total annual energy use. As the name implies, Peak-PUE uses the same methodology from ASHRAE 90.4 for PUE but applies it only to the peak temperature hour* of the year.

The result is a paired set of metrics that provide more nuanced information for comparing different system options.

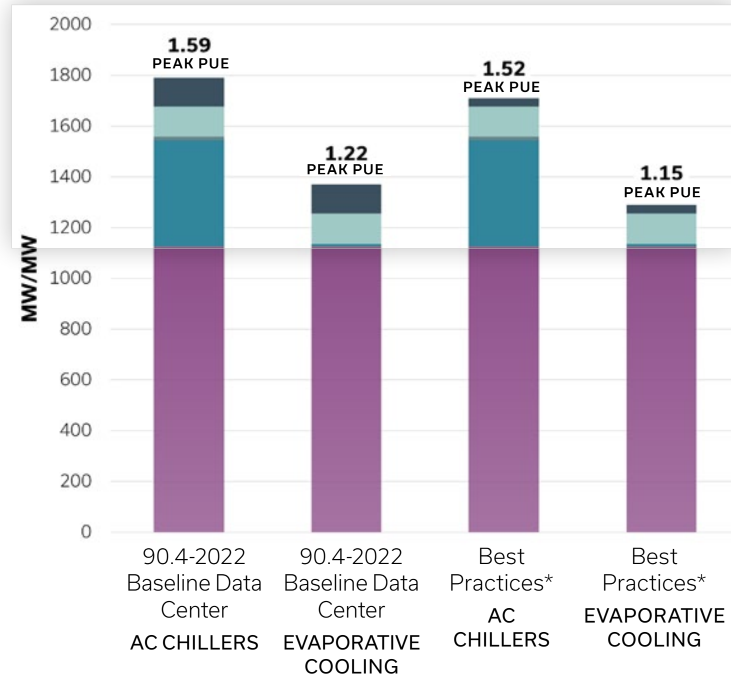
** The analysis shown here is based on the peak temperature hour of the year, but this could be modified to a bin temperature approach which would calculate peaks based on the top bin of annual temperatures within a two degree spread based on the requirement of ASHRAE 90.4.*

Recommendations

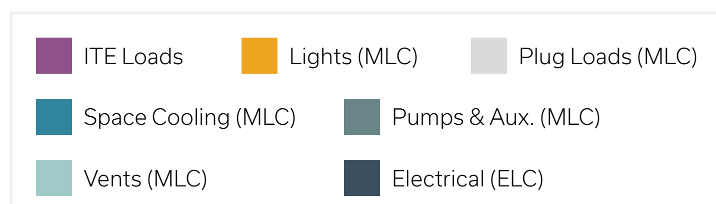
Further exploration and development of a peak-demand metric in ASHRAE 90.4 for data center system evaluation.

Note: As part of the standard adoption, parameters for a maximum allowable Peak-PUE will also need to be established.

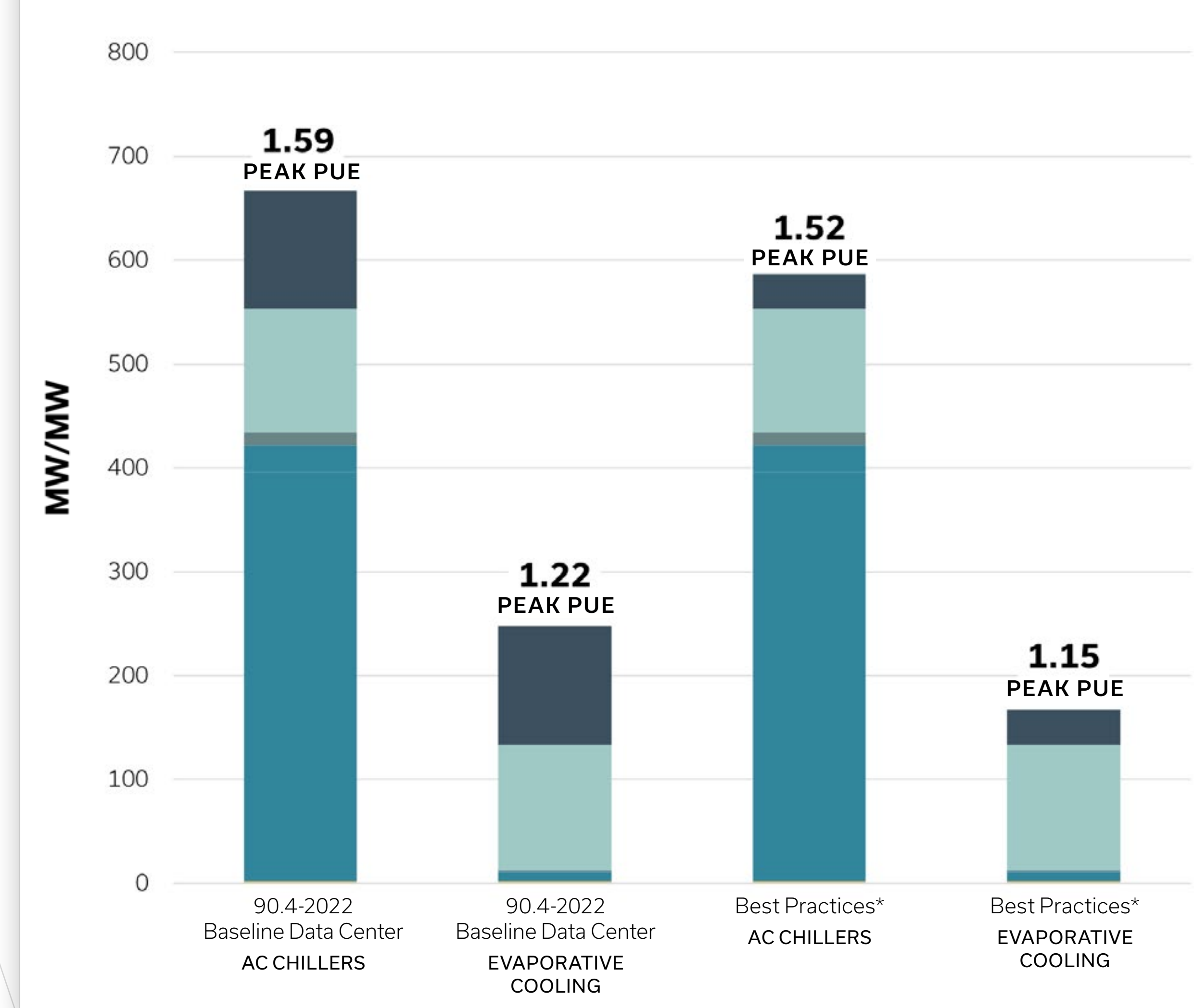
PEAK PUE WITH ITE, MLC, AND ELC



** The results in this report are based on the weather models for Climate Zone 5b. The optimal system type for improved PUE will vary depending on the Oregon and Washington climate zone in which the data center is located.*



PEAK PUE ONLY MLC AND ELC



Water vs. Energy

A BALANCE OF RESOURCES

There can be an interesting dynamic between energy and water use with data centers. Decreasing use of one resource often requires an increase in the other. Yet the total impact of these onsite trades needs consideration beyond the footprint of the building.

It becomes more complicated when considering the water use associated with power generation. Most traditional power generation sources — natural gas, hydro, coal, nuclear, etc — also require water in their generation facilities. Therefore decreasing water use onsite may not decrease overall water use if it results in an increase in energy. It may simply have moved the water use "upstream" to the power generation facility.

This section of the report explores this dynamic between energy and water, both direct use at the site and the larger boundary of the energy source.

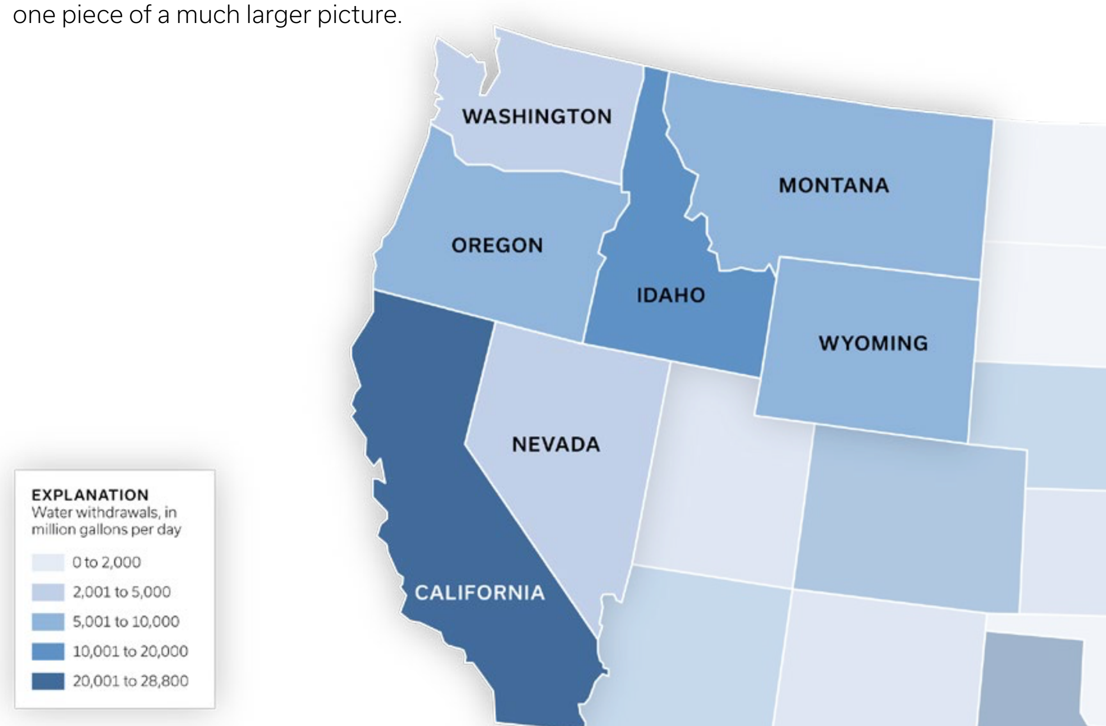
Understanding Scale

When evaluating the balance between energy and water use for the data center sector, it can be helpful to understand the magnitude of their impact to the region in the context of existing industries.

The state of Oregon withdrawals roughly 1,800-3,600 billion gallons of water per year. About 80% of that withdrawal is for use by the state's vital agriculture industry*, equaling about 2,000 billion gallons per year.

When this is compared to the projected data center growth for both Oregon and Washington, even with the higher water use associated evaporative cooling, data centers will equate to less than 0.2% of the overall water use of just the state of Oregon.

Water is a precious resource and efforts to minimize it's use should always be pursued. It is an area of great opportunity for innovation and advancement in the data center industry. But in terms of potential water stresses for the Oregon and Washington region, it is only one piece of a much larger picture.



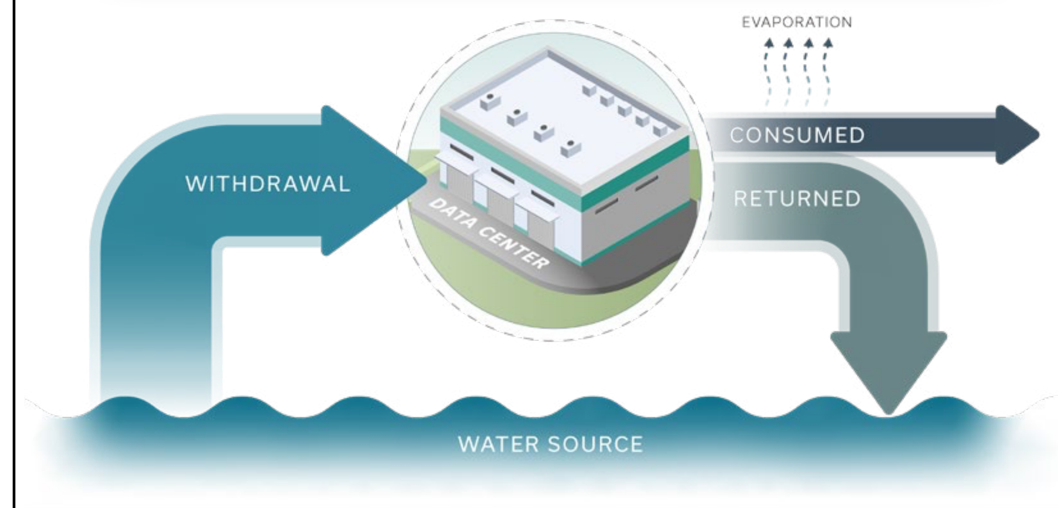
Source: https://www.usgs.gov/mission-areas/water-resources/science/total-water-use?qt-science_center_objects=0#qt-science_center_objects

TOTAL OREGON WATER WITHDRAWAL

	MINIMUM	MAXIMUM
Total Withdrawal BILLION GALS/YR	1,825	3,650
2033 Projected Data Center Withdrawal with Evaporative Cooling BILLION GALS/YR	4	4
Data Center Compared to Total BILLION GALS/YR	0.2%	0.1%

** Source: https://oeconline.org/wp-content/uploads/2014/12/Making-Water-Work_web.pdf*

[withdrawal] - [returned] = [consumption]



WATER WITHDRAWAL

A key factor in understanding the impact of water use is the relationship between withdrawal and consumption. Withdrawal refers to the volume of water extracted from the main source (river, aquifer, etc).

WATER CONSUMPTION

Depending on the use case, a portion of this withdrawal may be returned directly to the source. The remainder goes elsewhere, whether to municipal systems, evaporation to air, or other. This delta is what is considered to be "consumed".

WATER WITHDRAWAL VS CONSUMPTION

Withdrawn, returned, and consumed water all have impacts when considered in the context of overall regional impact. Withdrawal, even when returned, is a change to the system which could carry impacts to the local ecology and water resources. Returned water is measured by volume and doesn't necessarily capture other changes such as temperature when the water is returned to the source. Consumed water may eventually reenter the local systems, such as evaporation into rain, but even this is a change to what the unaltered flows might be.

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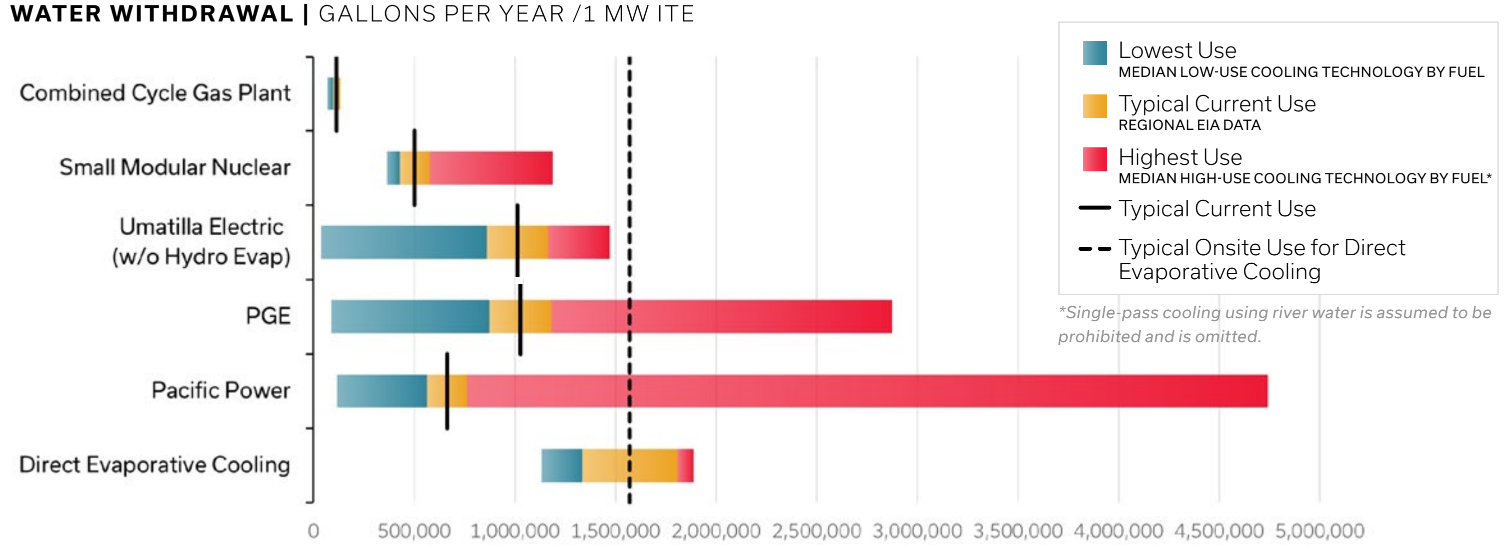
Water vs. Energy

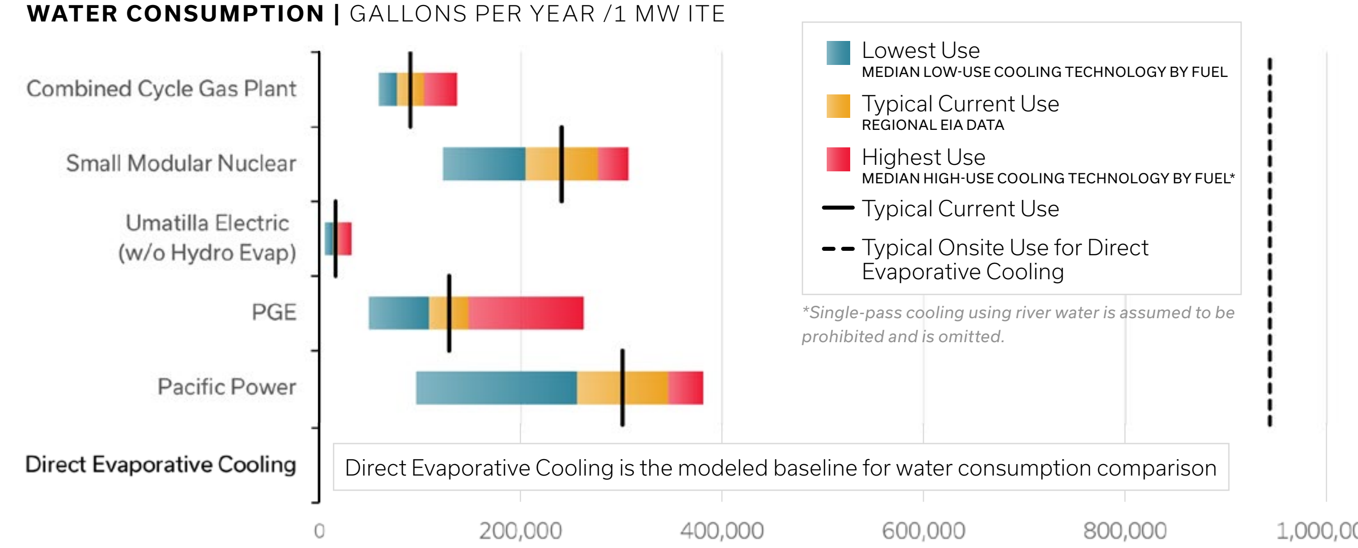
Water Withdrawal

WATER WITHDRAWAL | GALLONS PER YEAR /1 MW ITE

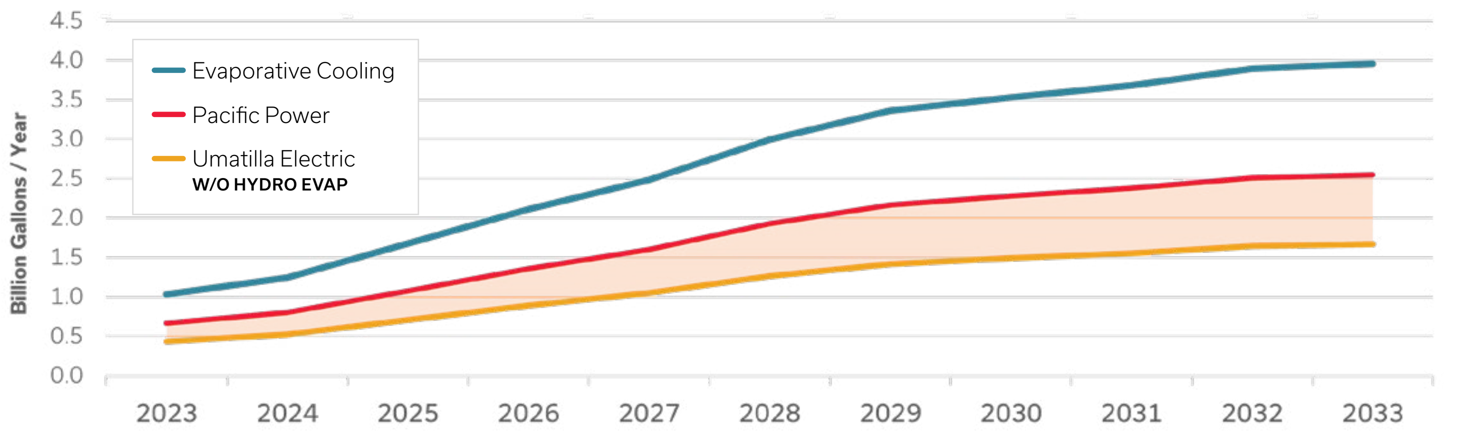


Water Consumption

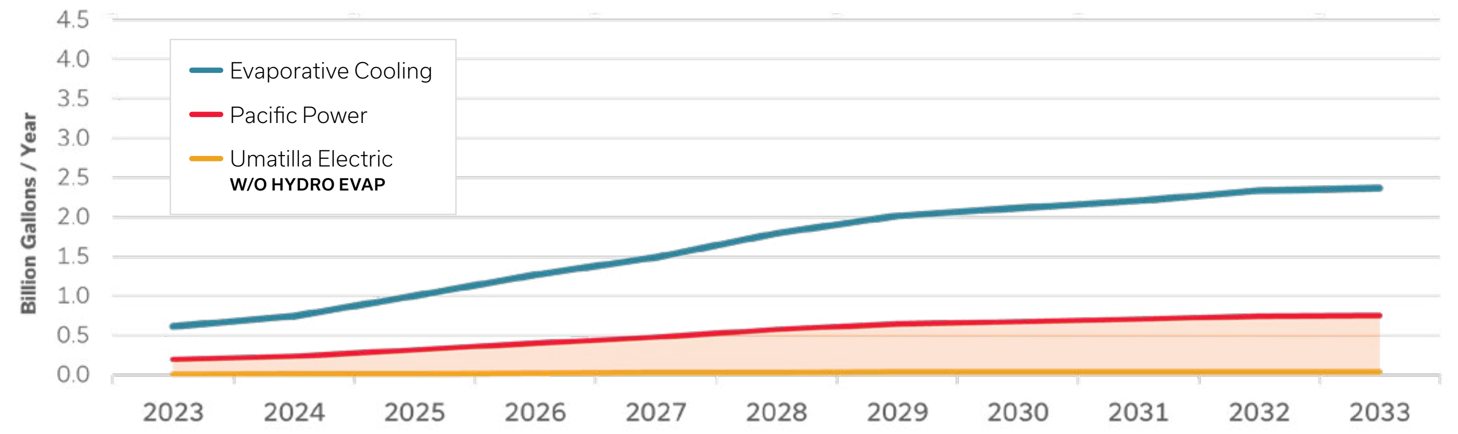
WATER CONSUMPTION | GALLONS PER YEAR /1 MW ITE



WATER WITHDRAWAL PROJECTION VS DATA CENTER LOAD GROWTH ASSUMPTION| BILLIONS GALLONS/YEAR



WATER CONSUMPTION PROJECTION VS DATA CENTER LOAD GROWTH ASSUMPTION| BILLIONS GALLONS/YEAR



METHODOLOGY

Water withdrawal and consumption factors vary greatly both across and within different fuel sources. With fossil fuels in particular, the cooling technology used at a given plant is more predictive of water use than the fuel type.

Typical water factors for fuel sources were taken from 2023 EIA Form 923 data, filtered for generation plants in OR, WA, and CA. To provide an estimate of the likely water factor ranges for new generation plants, median factors for the highest and lowest water use cooling technologies for a given fuel were taken from NREL Technical Report TP-6A20-50900, "A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies".

In order to estimate water use for regional utilities, the fuel source values were applied to the fuel source mix of the utility as reported by the Washington Department of Commerce or Oregon Department of Environmental Quality.

Key Findings

Water use of direct evaporative cooling was compared against equivalent cooling energy water use for three existing utilities and individual fuel technologies. PGE and Pacific Power were selected to represent large scale regional utilities. Umatilla Electric can be considered a proxy for hydroelectric-heavy local utilities as well as Bonneville Power Administration generally. Combined cycle natural gas and small modular nuclear technologies are shown as they are believed to be the most likely technologies for rapid deployment of new electricity generation.

Evaporative cooling is shown to withdraw 50% - 150% more water than existing utilities. Consumption results show that evaporative cooling consumes between 3 times and 50 times the water of current utility generation. While these results are more dramatic, this water use should be weighed against the benefits of reduced energy consumption (and associated greenhouse gas emissions) as well as reduced peak demand.

RECOMMENDATIONS

Review future recommendations of the newly formed APMO WE-Stand Data Center Working Group for industry guidance on water efficiency for data centers.

Summary of Key Findings

Summary of Results

1. The study found notable differences in energy use of non-ITE loads as highlighted in their Power Usage Effectiveness (PUE) values for the following scenarios:
   - ASHRAE 90.4 baseline: 1.24 PUE
   - Best practices air cooled: 1.17 PUE
   - Best practices evaporative cooling: 1.10 PUE

2. The modeled scenarios found potential for total annual energy use savings of 2,000,000 MWh - 4,000,000 MWh by 2033 from the more efficient building system. These savings are equivalent to nearly half of all the wind power generated in Oregon in 2021[1] and resulted only from systems improvements without any reduction in data center quantity.

3. The models identified a potential 1,000 MW reduction in peak power demand between the system options. Peak demand is currently not considered in data center building standards, yet has important implications for regional energy systems.

   For the climate zone studied in this report, the "Peak-PUE" model results were:
   - ASHRAE 90.4 baseline: 1.59 Peak-PUE
   - Best practices air cooled: 1.52 Peak-PUE
   - Best practices evaporative cooling: 1.15 Peak-PUE

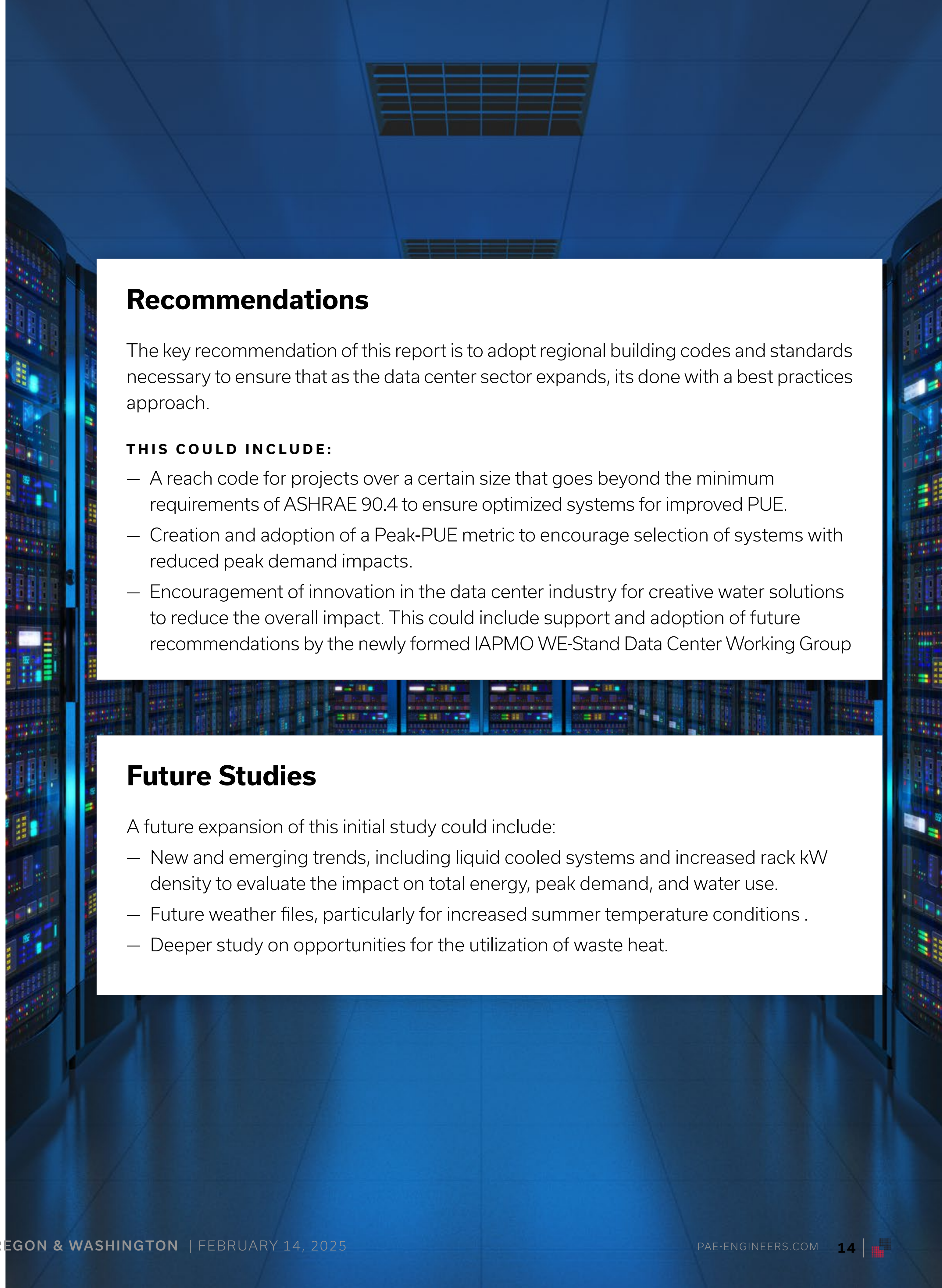
   It is recommended that a Peak-PUE metric be created and adopted to help ensure best practices regarding peak demand with system selections.

4. The interaction between water and energy use for the climate zone was modeled as a comparison between onsite direct water use and indirect water use for energy generation. The model found evaporative cooling results in a higher overall water use, even when reduced energy use is considered. Yet within the regional context, the total water use of evaporative cooling remains less than 0.1% of overall water use in the Washington and Oregon region provides the previously noted improvements in data center energy use.

[1] https://www.nwcouncil.org/reports/columbia-river-history/megawatt/

Key Findings

Implementing data center energy efficiency and peak power reductions would provide some of the most significant energy savings available to the region.



Recommendations

The key recommendation of this report is to adopt regional building codes and standards necessary to ensure that as the data center sector expands, its done with a best practices approach.

THIS COULD INCLUDE:

- 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

Future Studies

A future expansion of this initial study could include:

- New and emerging trends, including liquid cooled systems and increased rack kW density to evaluate the impact on total energy, peak demand, and water use.
- Future weather files, particularly for increased summer temperature conditions .
- Deeper study on opportunities for the utilization of waste heat.

Water Consumption

Table 1. Water Consumption Factors for Renewable Technologies (gal/MWh)

Fuel Type	Cooling	Technology	Median	Min	Max	*n*	Sources
PV	N/A	Utility Scale PV	26	0	33	3	[10, 34, 35]
Wind	N/A	Wind Turbine	0	0	1	2	[11, 36]
CSP	Tower	Trough	865	725	1,057	17	[10, 34, 37-46]
		Power Tower	786	740	860	4	[34, 39-41]
		Fresnel	1,000	1,000	1,000	1	[47]
	Dry	Trough	78	43	79	10	[38, 42-44]
		Power Tower	26	26	26	1	[48]
	Hybrid	Trough	338	105	345	3	[42, 47]
		Power Tower	170	90	250	2	[47]
	N/A	Stirling	5	4	6	2	[34, 49]
Biopower	Tower	Steam	553	480	965	4	[49-51]
		Biogas	235	235	235	1	[52]
	Once-through	Steam	300	300	300	1	[50]
	Pond	Steam	390	300	480	1	[50]
	Dry	Biogas	35	35	35	1	[51]
Geothermal[1]	Tower	Dry Steam	1,796	1,796	1,796	1	[10]
		Flash (freshwater)	10	5	19	3	[19, 20, 49]
		Flash (geothermal fluid)	2,583	2,067	3,100	2	[53]
		Binary	3,600	1,700	3,963	3	[10, 54, 55]
		EGS	4,784	2,885	5,147	4	[10, 51, 54, 55]
	Dry	Flash	0	0	0	1	[51]
		Binary	135	0	270	2	[19, 51]
		EGS	850	300	1,778	2	[19, 51]
	Hybrid	Binary	221	74	368	1	[56]
		EGS	1,406	813	1,999	2	[51, 56]
Hydropower	N/A	Aggregated in-stream and reservoir	4,491	1,425	18,000	3	[22, 23]

Used Data   Hydro Reference

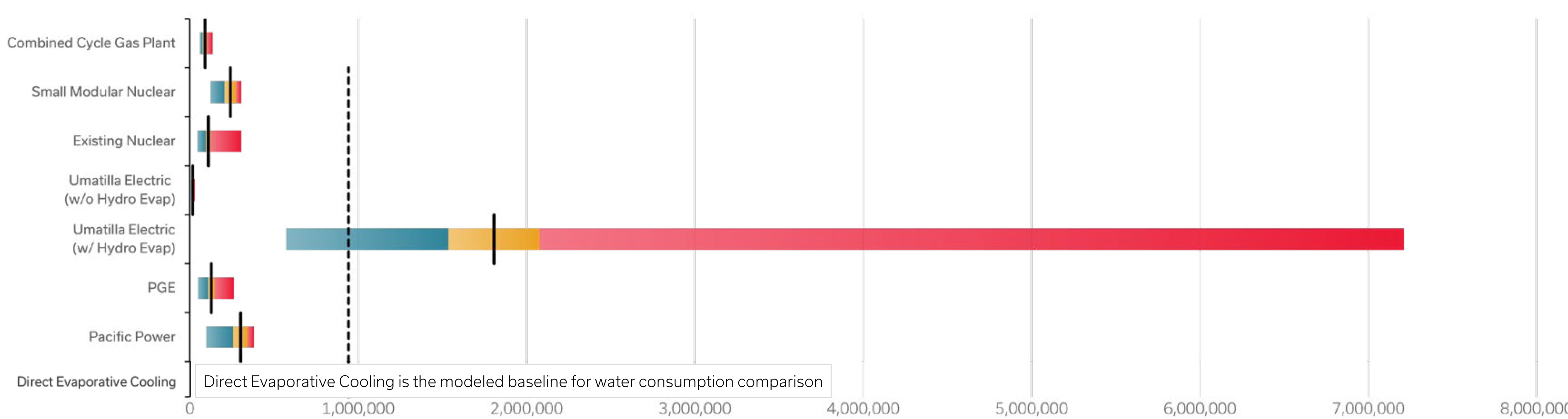
1 Most geothermal facilities can use geothermal fluids or freshwater for cooling.

Table 2. Water Consumption Factors for Non-renewable Technologies (gal/MWh)

Fuel Type	Cooling	Technology	Median	Min	Max	*n*	Sources
Nuclear	Tower	Generic	672	581	845	6	[10, 14, 27, 50, 57]
	Once-through	Generic	269	100	400	4	[27, 50, 57, 58]
	Pond	Generic	610	560	720	2	[27, 50]
Natural Gas	Tower	Combined Cycle	198	130	300	5	[13, 34, 50, 57, 59]
		Steam	826	662	1,170	4	[10, 14, 49, 60]
		Combined Cycle with CCS	378	378	378	1	[59]
	Once-through	Combined Cycle	100	20	100	3	[50, 57, 60]
		Steam	240	95	291	2	[10, 49]
	Pond	Combined Cycle	240	240	240	1	[57]
	Dry	Combined Cycle	2	0	4	2	[50, 57]
	Inlet	Steam	340	80	600	1	[49]
Coal	Tower	Generic	687	480	1,100	5	[10, 14, 27, 50, 58]
		Subcritical	471	394	664	6	[13, 57, 59, 61]
		Supercritical	493	458	594	6	[13, 57, 59, 61]
		IGCC	372	318	439	7	[13, 59]
		Subcritical with CCS	942	942	942	1	[59]
		Supercritical with CCS	846	846	846	1	[59]
		IGCC with CCS	540	522	558	3	[59]
	Once-through	Generic	250	100	317	4	[10, 27, 50, 58]
		Subcritical	113	71	138	3	[57]
		Supercritical	103	64	124	3	[57]
	Pond	Generic	545	300	700	2	[27, 50]
		Subcritical	779	737	804	3	[57]
		Supercritical	42	4	64	3	[57]

Used Data   Hydro Reference

WATER CONSUMPTION - COMPLETE | GALLONS PER YEAR /1 MW ITE



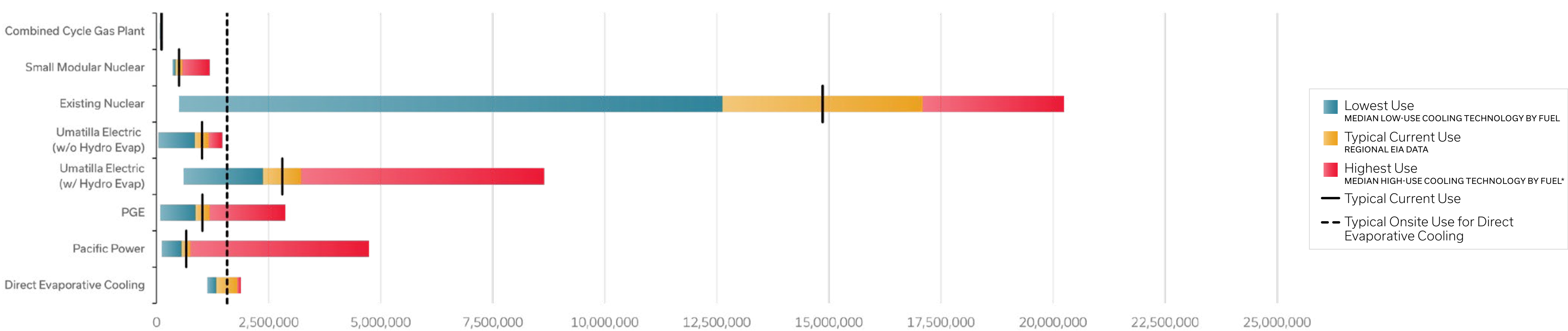
Water Withdrawal

Table 3. Water Withdrawal Factors for Electricity Generating Technologies (gal/MWh)

Fuel Type	Cooling	Technology	Median	Min	Max	*n*	Sources
Nuclear	Tower	Generic	1,101	800	2,600	3	[27, 50, 57]
	Once-through	Generic	44,350	25,000	60,000	4	[27, 50, 57, 58]
	Pond	Generic	7,050	500	13,000	2	[27, 50]
Natural Gas	Tower	Combined Cycle	253	150	283	6	[12, 13, 50, 57, 59]
		Steam	1,203	950	1,460	2	[49, 60]
		Combined Cycle with CCS	496	487	506	2	[12, 59]
	Once-through	Combined Cycle	11,380	7,500	20,000	2	[50, 57]
		Steam	35,000	10,000	60,000	1	[49]
	Pond	Combined Cycle	5,950	5,950	5,950	1	[57]
	Dry	Combined Cycle	2	0	4	2	[50, 57]
	Inlet	Steam	425	100	750	1	[49]
Coal	Tower	Generic	1,005	500	1,200	4	[27, 35, 50, 58]
		Subcritical	531	463	678	7	[12, 13, 57, 59, 61]
		Supercritical	609	582	669	7	[12, 13, 57, 59, 61]
		IGCC	390	358	605	11	[12, 13, 35, 59]
		Subcritical with CCS	1,277	1,224	1,329	2	[12, 59]
		Supercritical with CCS	1,123	1,098	1,148	2	[12, 59]
		IGCC with CCS	586	479	678	6	[12, 59]
	Once-through	Generic	36,350	20,000	50,000	4	[11, 27, 50, 58]
		Subcritical	27,088	27,046	27,113	3	[57]
		Supercritical	22,590	22,551	22,611	3	[57]
	Pond	Generic	12,225	300	24,000	2	[27, 50]
		Subcritical	17,914	17,859	17,927	3	[57]
		Supercritical	15,046	14,996	15,057	3	[57]
Biopower	Tower	Steam	878	500	1,460	2	[49]
	Once-through	Steam	35,000	20,000	50,000	1	[50]
	Pond	Steam	450	300	600	1	[50]

Used Data | Hydro Reference

WATER WITHDRAWAL - COMPLETE | GALLONS PER YEAR /1 MW ITE



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