# 2020 BIENNIAL ENERGY REPORT

Submitted to the

**OREGON LEGISLATURE**

by the

**OREGON DEPARTMENT OF ENERGY**

November 2020

OREGON DEPARTMENT OF ENERGY

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## Published November 1, 2020

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# Executive Summary

In 2017, the Oregon Department of Energy, recognizing that the energy world has changed dramatically since the 1970s, introduced House Bill 2343 to the Legislature. The bill charged the department with developing a new Biennial Energy Report to inform local, state, regional, and federal energy policy development and energy planning and investments. The report – based on analysis of data and information collected and compiled by the Oregon Department of Energy – provides a comprehensive review of energy resources, policies, trends, and forecasts, and what they mean for Oregon.

## What You Can Expect to See in the 2020 Biennial Energy Report

The 2020 report takes a different approach than the inaugural 2018 Biennial Energy Report, which provided deep policy dives on a handful of important energy topics — including climate change, renewable energy, transportation, energy resilience, energy efficiency, and consumer protection. This 2020 report follows recommendations by energy stakeholders to provide shorter briefs on a wider array of energy topics — from energy in the agriculture sector to what's next for alternative fuels to the effects of the COVID-19 pandemic on energy, and more.

Many sections show that Oregon is on a path toward transitioning to a cleaner, low carbon future. Data and examples included in the report illustrate sustained investments in energy efficiency, affordability, renewable energy, and resource conservation. These efforts have positioned Oregon to successfully tackle today's energy challenges, which are driven by growing adoption from consumers for cleaner energy, economic innovation, and emerging technologies.

The report begins by looking at **Energy by the Numbers**—detailed information on Oregon's overall and sector-based energy use, energy production and generation, energy expenditures, and the strategies Oregon has employed to meet growing energy needs. New in 2020 is an energy flow diagram, illustrating energy production and imports to eventual end-use.

Next up is a **Timeline of Energy History in Oregon,** starting with the Missoula Floods that formed our state and ending with 2020's latest events — including the closure of Oregon's only coal power plant and new actions to tackle climate change.

The **Energy 101** section aims to help readers understand the first part of the energy story: how energy is produced, used, and transformed. Information is meant to provide a foundation for those new to energy and those who are already steeped in the sector.

The **Resource and Technology Reviews** section highlights 23 energy resources and technologies — they cover the spectrum of tradition to innovative, from renewable resources to emerging technologies like microgrids and power-to-gas. The topics covered are prevalent in Oregon or of interest to ODOE's various stakeholders. Many of the technologies offer opportunities to invest in Oregon's economy by creating energy-related jobs, including those focused on restoring our energy systems when disruptions occur.

The final section includes more detailed **Policy Briefs** that cover decarbonization, the transition of the electric grid, innovation in the natural gas system, cleaner transportation options, and the built environment and Oregon's communities. The primary purpose of the report — and these policy briefs — is to inform energy policy development, energy planning and energy investments, and to identify opportunities to further Oregon's energy policies.

The Biennial Energy Report wraps up with a new summary of the process used to develop the report and **closing thoughts** on what's next. ODOE will kick off discussions in 2021 and reach out to hear new voices on recommendations for energy policy in Oregon over the next two years — and beyond.

The Biennial Energy Report may be found in its entirety at

https://energyinfo.oregon.gov/ber

or

www.oregon.gov/energy/Data-and-Reports/Pages/Reports-to-the-Legislature.aspx

The Department of Energy welcomes your comments and questions. Please contact our agency at askenergy@oregon.gov.

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## Just about everything involves energy. It is a part of our daily lives, blending into the background of driving a car, turning on a computer, firing up a grill, or heating a home.

The 2018 *Biennial Energy Report* focused on foundational data and information about energy in Oregon. For 2020, ODOE asked stakeholders and the public what other context and information would be helpful and then leveraged ODOE expertise on a variety of topics including transportation, facility siting and permitting, nuclear safety and emergency preparedness, energy efficiency, renewable energy, electricity, and natural gas.

This section is intended to help the reader understand the first part of the energy story: how energy is produced, used, and transformed. This includes fundamental information for people new to energy or specific energy topics, along with those looking for data or a central place to help tell the story of how energy systems affect their work and interests. Energy policy is complex and, without being armed with technical information and understanding, it is sometimes difficult to be part of the conversations. The Energy 101 topics in this section are intended to help create a more diverse and inclusive conversation and to build our energy future together by bringing more stakeholders to the table. Narratives range from basic information about where our transportation and natural gas resources come from and how they get to consumers, to the role that codes, standards, and net-zero buildings play in reducing overall energy use. Several topics are directly linked to specific policy briefs included later in this report on complex concepts like resource adequacy and clean and zero-emission standards. This section also gives readers necessary background to understand the data and trends in Energy by the Numbers and cross-sectional discussions on climate, equity in renewable energy, and grid-interactive efficient buildings.

The second part of the story is how energy systems affect the lives of Oregonians. Information in this section includes an explanation of energy bills and how net metering works for technologies like rooftop solar. Readers can then learn more about the very real challenges of energy burden in our state, along with the growth and opportunities of clean energy jobs in Oregon. It is through foundational understanding of fundamental energy concepts that readers can make informed choices about the energy resources, uses, and investments that can change our work, lives, and communities.

## Energy 101: Resource Adequacy

We consume energy daily: when we charge our phones, flip a light switch, turn up the furnace to heat our homes, or fill up our car at the gas station. In terms of total end-use fuels consumed by Oregonians, 31 percent of the energy comes in the form of liquid transportation fuels (e.g., gasoline and diesel); 42 percent is electricity; and 26 percent is direct use of fuel oil or natural gas (e.g., for home heating or industrial processes).

### Storing End-Use Fuels: Gasoline, Natural Gas, and Electricity

Electricity must be generated and delivered across a large transmission and distribution system, just in time to meet consumer demand. This differs significantly from other end-use fuels (and differs from virtually all other commodities and consumer products) that can be produced at an operationally or economically optimal time, and then stored for consumption at a later point in time.

This section refers to "end-use fuels" because of the important differences between primary energy sources and the end-use fuels that consumers actually consume to power their everyday lives. For example, crude oil is a natural resource extracted from the earth. This primary energy source must be refined into gasoline before it can be used in a vehicle. That gasoline, once refined from the original energy source, can be (and is) stored in large volumes as the end-use fuel that Oregonians consume. Similarly, natural gas, once captured and processed for injection into storage tanks or pipelines, is the end-use fuel that Oregonians consume in their homes and businesses.

Electricity is quite different. The primary energy sources used to generate electricity vary considerably – from the gravitational potential energy stored in volumes of water at altitude, to the nuclear potential energy contained within uranium isotopes, to the thermal kinetic energy of solar energy. A wall outlet cannot use that water, uranium, or solar energy until it has been converted into electricity—the end-use fuel.

Think about gasoline. What does it look like? Chances are you are imagining a physical volume of a brownish-colored liquid. You can literally fill a jar on the table in front of you with gasoline or diesel fuel, the two liquid fuels that predominantly power our transportation systems. Liquids are easily stored in large volumes. Think about natural gas or propane. What does it look like? This one is a bit more challenging, but you might imagine filling a balloon in front of you with some volume of natural gas, or a propane tank attached to your grill. Pipeline networks and large tanks can store vast quantities of these gaseous end-use fuels.

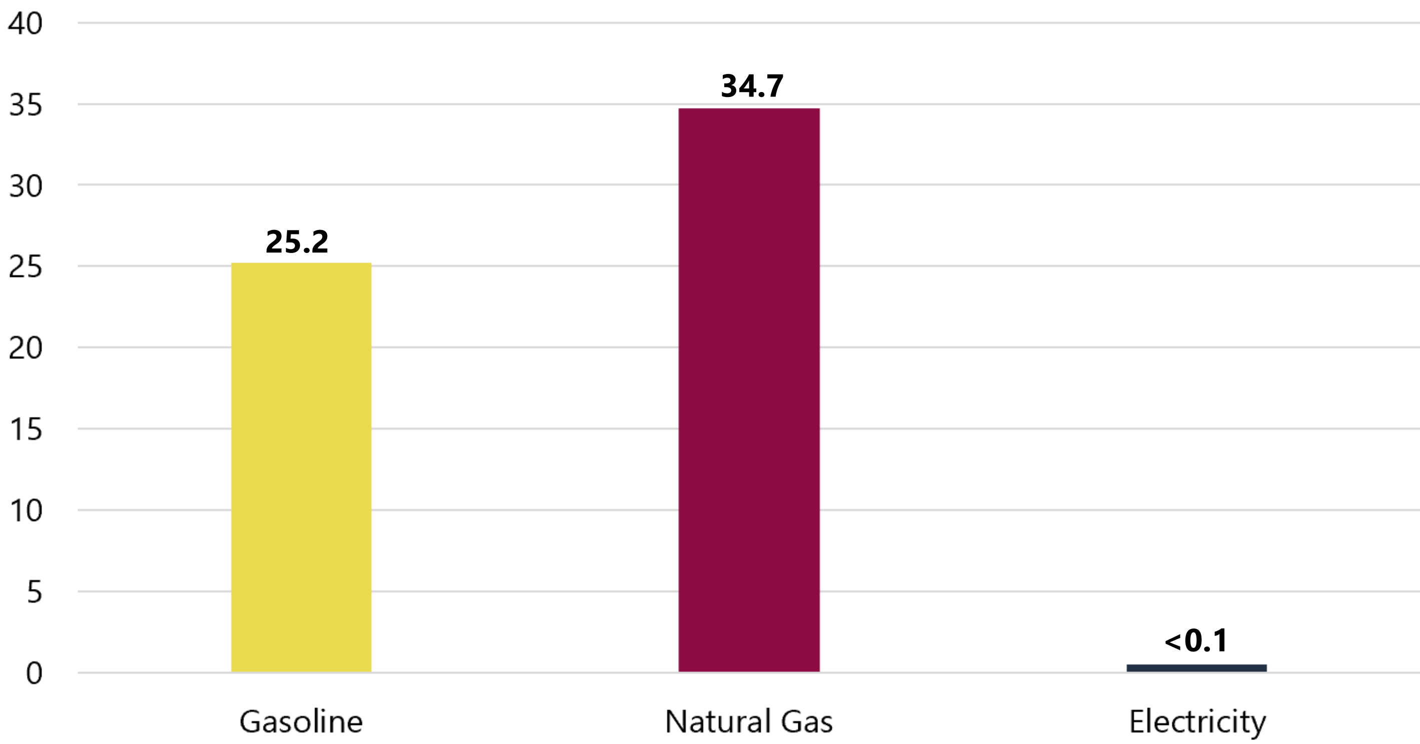
Now think about electricity. What does it look like exactly? Where might you store it? You might imagine a standard AA battery, which stores approximately 3 watt-hours (or 0.003 kWh) of energy.[1] The average residential customer in Oregon would need 9,000 AA batteries to power their house for a single day.[i] So while there are ways to store electricity, those storage systems have historically been limited in their ability to efficiently store energy over a long duration or in

[i] In 2018, the average residential customer of Oregon's investor-owned utilities consumed 10,151 kWh of electricity over the course of the entire year, or approximately 27.8 kWh per day. (OPUC Utility Statistics Book)

large volumes (e.g., batteries), and/or cost a lot of money per unit of energy stored (such as large capital projects like a pumped hydro facility that stores water for use at a later time). As a result, nearly all electricity is consumed at the same instant that it is generated at a power plant. This simple physical reality of electricity as an end-use fuel, compared to liquid and gaseous fuels, has had an enormous effect on the infrastructure required to meet end-use consumer demand.

The consumption of end-use fuels of all kinds varies throughout the day, across different seasons, and from year to year. This variability in consumption must be met by changes in the available supply of energy to meet those needs. The flexibility in the availability of supply to match real-time, end-use consumption is assisted by storage systems in the case of liquid or gaseous fuels. For example, a gas station has significant volumes of gasoline stored on site, ready and available for consumption when a car pulls up to the pump. Meanwhile, a network of large tanks and an extensive underground pipeline system filled with natural gas acts as a massive storage system that is connected homes or businesses, ready to supply end-use fuel on-demand for a stove, furnace, or other appliance. Distributed storage systems (i.e., systems that are typically distributed closer to the end-use consumer than the source of production of the fuel) can be sized and adjusted as needed to ensure that adequate supply exists to meet fluctuating demand at all times. In short, these storage systems provide a significant buffer to accommodate fluctuations in end-use demand and allow for a more optimized operation of upstream extraction, production, and delivery systems.

**Figure 1: Days of End-Use Fuel Storage in the U.S. Based on Average Daily U.S. Consumption by Fuel Type**[2]




*Derived from U.S. EIA data comparing average volumes of stored energy to average daily consumption for total gasoline (barrels consumed vs. weekly stocks); natural gas (mcf consumed vs. working natural gas in storage); and electricity (MWh of daily consumption vs. MWh of stored electricity).*

The basic fact that electricity cannot be easily stored in large volumes, however, has resulted in a vastly different organization of the systems to deliver fuel to consumers. The electric system is sized to be able to satisfy the largest requirements for electricity—called peak demands—at all times, even though consumers use less (oftentimes significantly less) during most hours of the year. This results in an electric generation and delivery system that is, by design, underutilized much of the time, especially when compared to other end-use fuels, such as natural gas[ii] and gasoline.[3] This might manifest as a power plant that only operates at full output 50 percent of the hours of the year, or a transmission line that operates at less than full capacity. The natural rhythms of society result in changes in our demand for electricity over different hours of the day and months of the year — so that excess capacity must essentially be on standby, ready when needed to meet demand when it spikes.

As a result, the concept of peak demand over various time durations (hourly, daily, monthly, annually) has more effect on the design and the cost of electric delivery systems than it does with other types of end-use fuel delivery infrastructure systems. For this reason, capacity planning takes on an outsized role in the electric sector. Capacity planning is the process that grid planners and utilities must undertake to ensure that adequate generating capacity is online and operational to serve peak demand in the future. Increasingly, grid planners and utilities also have to consider "net peaks" within a day. Net peaks refer to the difference between forecasted electric demand and the electricity produced by variable output renewables, most notably solar, and may require the grid to have more flexible resources.[4] Given the lead time required if it is determined that new generating capacity resources need to be developed (which can take several years or longer), this type of planning must attempt to forecast the future, taking into account potential variability in demand for power over different times of day and year or from year to year; changes to the supply of available power (e.g., a drought year may result in much less hydropower output than average); the impact of different weather patterns on consumption; and the near-term effects of longer-term factors, like climate change and an increasing electrification of end-uses (e.g., transportation electrification or conversion from a gas furnace to an electric heat pump).

These types of forecasts, involving a multitude of critical variables, are necessarily uncertain. The lack of end-use fuel storage in the electric system allows little room for error if utilities miss by forecasting less electric demand than what actually occurs. This creates a reasonable bias in favor of conservative forecasting to avoid having too little power available to serve demand in the years ahead. The alternative could be a system that fails to deliver enough electricity to customers and results in limited, or even widespread, blackouts.

### Resource Adequacy

Collectively, the electric industry applies the term Resource Adequacy to the evaluation of whether a particular utility, area of the grid, or region has adequate electric generating resources available to meet future demand for electricity at different times (e.g., times of day, seasons, or years) and under various conditions (e.g., temperature extremes or precipitation patterns), including an additional

[ii] Note that while peak demand also has a significant impact on the natural gas system, it is fundamentally different because of the ability to store the end-use fuel throughout the delivery system from the point of gas collection or extraction, through the transmission and distribution system, and up to the point of consumption by consumers.

reserve margin to account for demand excursions or unexpected outages. This is sometimes thought of as demonstrating the *long-term supply reliability* for the power system, as measured over a period of several years. RA standards, meanwhile, have been developed to ensure the uniformity of this evaluation process. In many states, standards are applied by an Independent System Operator (e.g., CAISO in California) with a wide geographic view of the electric grid across multiple utility service territories. Because of other constraints on the system, such as transmission congestion, some states evaluate RA on both a system-wide and a locational basis.

**Resource Adequacy** (or RA) is the term that grid planners and utilities use to refer to the evaluation of whether adequate generating capacity will be available to meet forecasted demand over the next several years (typically from one to five years).

Table 1 below helps to illustrate the different timescales of power reliability, and distinguishes what is meant by RA as compared to other types of reliability:

**Table 1: Power System Reliability Over Different Timescales** [5]

| | | |
|---|---|---|
| **Short-term** ***(< 1 minute)*** | **System Stability** | Short-term reliability (e.g., frequency response) focused on grid stability over very short time intervals |
| **Medium-term** ***(Hourly or Daily)*** | **System Balancing** | Medium-term reliability focused on managing imbalances on the system like those that occur between a day-ahead forecast and real-time conditions |
| **Long-term** ***(1 to 5 years)*** | **Resource Adequacy** | Long-term reliability focused on seasonal or year-to-year mismatches between supply-and-demand |

Ultimately, when a utility, state, or region evaluates RA, they are asking themselves: what level of risk are we willing to accept that inadequate generating capacity will be available to meet future customer demand for electricity over the next several years? Because forecasting the future is necessarily uncertain, the evaluation of RA and development of new capacity resources ahead of expected need is an inexact process that requires balancing the risk of under-building resources and having a shortage of power available vs. the cost to consumers of potentially over-building to ensure that power is available when it is needed.

### *Evaluating and Maintaining Resource Adequacy*

There is currently no statewide organized program for the evaluation or maintenance of resource adequacy in Oregon. Discussions are currently underway to consider the development of a more formal approach (described below).

#### Evaluating Resource Adequacy

Many individual utilities independently evaluate their own adequacy to serve their customers. Meanwhile, the Northwest Power and Conservation Council (NWPCC) annually develops a long-term regional assessment of RA that evaluates the adequacy of the power supply in the Pacific Northwest, five years in the future.[6] The goal of the NWPCC's RA assessment is to "establish a resource adequacy framework for the Pacific Northwest to provide a clear, consistent, and unambiguous means of answering the question of whether the region has adequate deliverable resources to meet its load reliably and to develop an effective implementation framework."[7] The assessment includes existing resources, expected future energy efficiency savings, and only those planned resources that have already been sited and licensed.[8] This is intended to provide a signal to the region of the status of RA with adequate lead time for individual utilities or third-party developers to develop new capacity resources ahead of any forecasted shortfalls.

This is a *regional* assessment, the development of which is informed by contributions from utilities, state agencies, and other stakeholders from across the northwest.[9] [10] Due to differences in hourly, daily, and seasonal electricity consumption patterns across different regions, synergies can often be achieved by evaluating the electric system over a wider geographic footprint. For example, one area of the region may experience its annual peak demand for electricity during cold winter mornings, while another area's peak might occur during the summer months when air-conditioning or irrigation pump loads are highest.

#### Maintaining Resource Adequacy

Individual utilities and their regulators (the Oregon Public Utility Commission in the case of investor-owned utilities, or individual governing boards in the case of consumer-owned utilities) in the northwest evaluate RA to meet future demand in their territories. Utility-specific efforts will often incorporate the NWPCC's assessment as an input that reflects the broader regional availability of generating resources in the years ahead. This can be important for a utility that is weighing the risks of relying upon capacity available on the market to meet some share of its expected demand. Ultimately, however, individual utilities are responsible for maintaining resource adequacy to ensure that they can serve the demand of their customers.

### *Customer Choice and Resource Adequacy*

In recent years, there has been increasing interest in customer choice programs in the electric sector. Many of these efforts stem from the broader deregulation movement in the 1990s. In Oregon, certain commercial and industrial customers have had access since that time to choose their retail provider of electricity through participation in Long-Term Direct Access (LTDA) agreements, which allow independent power producers to register with the PUC as electricity service suppliers (or ESSs) to deliver retail service in lieu of a utility.[11] Meanwhile, in the last decade,[12] California has seen a surge in the number of municipal and county governments forming Community Choice Aggregation (CCA) programs to exercise choice over their community's retail electricity provider.[iii]

Whether participating in LTDA as a commercial or industrial customer, or forming a CCA, customers are often motivated by actual or perceived cost-savings or other benefits associated with the exercise of choosing their retail electricity provider. For example, the customer(s) may seek an electricity

[iii] California's CCA example is particularly relevant to this discussion given the challenges that state has faced in recent years specifically regarding the role of CCAs in contributing to the maintenance of Resource Adequacy. It is important to note, however, that Oregon law does not allow for the formation of CCAs.

resource mix that includes higher levels of renewable resources than the incumbent utility provides, or may seek to source power from more locally-sited projects.

### How should retail choice customers contribute toward Resource Adequacy?

As described above, the maintenance of resource adequacy requires evaluation at both the regional and utility-specific levels. Utilities often need to engage in the inexact science of forecasting future customer demand to plan for new generating capacity. This becomes more challenging when customers "exit" the utility's service territory (e.g., pursuant to LTDA, CCAs, or another customer choice program) to be served by a third-party. Who, in those cases, is responsible for procuring adequate capacity to ensure that RA is maintained?

This issue has emerged as a critical one in California given the scale of CCA formation in the state in recent years—21 CCAs operating across the state now serve more than 10 million retail customers.[13] After wrestling with the issue for several years, the California PUC recently stepped in to establish a central buyer framework for RA that requires the state's largest IOUs to procure the necessary capacity to meet projected load within their service territory boundaries, whether or not that load is served by CCAs.[14]

RA also surfaced as an issue in Oregon in 2019 as part of a broader, holistic investigation begun by the OPUC in June 2019 exploring the costs and benefits of Oregon's LTDA programs. For more information on this and other related ongoing issues, see Oregon PUC Docket UM 2024.[15]

## What's Next for Resource Adequacy in Oregon

The electric system in the northwest has delivered incredibly reliable power to Oregonians for decades. This is in no small part due to the robustness of the Federal Columbia River Power System, which provides the foundation of the region's electric system. Increasing constraints on that hydropower system, widespread retirement of coal plants across the west, and increases in variable renewable energy generation have combined to create new concerns about maintaining RA in the years ahead. As intended, the NWPCC's regional assessment of RA has sent a signal that the region could be short of capacity by the mid-2020s. Being short of capacity could mean that the power system lacks the resources to meet demand at all times, which would increase the potential for rolling blackouts.[16]

### Hydropower: An outsized contribution to maintaining RA in the Pacific Northwest

The federal hydropower system has made a unique contribution to maintaining power system reliability in the northwest for much of the last century. Since the 1930s, the federal government has made substantial investments to develop the hydropower resources in the region, which now total over 22,000 MW of nameplate capacity, with the capability of providing 9,818 MW of sustained peak capacity in January (the region's highest electricity-use month) even during years with low water conditions. Non-federal hydropower resources, meanwhile, can provide an additional 11,336 MW of sustained peak capacity in January. Combined, these hydropower resources account for 54 percent of the region's total sustained peak capacity in January, and can account for an even greater share of the region's sustained peak capacity during non-critical water conditions.[17]

Northwest hydropower has provided the foundation of our electric system for decades and has historically provided a large share of the region's annual energy. In many respects, this has afforded the northwest electric sector with significant advantages not found elsewhere in the United States—in addition to often having an abundance of low cost, carbon-free energy to meet demand, the robustness of the hydropower system has been able to meet a significant amount of the region's capacity need. This has played a significant role in enabling the region (so far) to avoid the need for a more formalized approach to evaluating RA, such as those that exist in other regions.

As a result of the changes in the sector and continued, albeit modest, regional load growth, many of the state's largest utilities and BPA have recently joined together under the auspices of the Northwest Power Pool to explore the development of a formalized regional RA program, focused on short-term adequacy (from a period of days and weeks to months). The effort kicked off publicly in October 2019 when the NWPP convened a widely attended Northwest Resource Adequacy Symposium.[18] The future remains uncertain with respect to the successful launch of an NWPP-led regional RA program. It is expected that the effort will result in the release of a final proposed design of such a program in 2021, with implementation to occur over the following several years.[19]

Unlike the current process for evaluating regional RA in the northwest—where the NWPCC's assessment informs the region of the long-term status of RA (from a few years to 20 years into the future), but individual utilities procure resources to meet their own capacity needs—the type of program being developed by the NWPP is expected to formalize a short-term regional assessment of RA that would be contractually binding on individual participating utilities and electricity service providers. Those entities would voluntarily join the program, but then would have a contractual legal obligation to procure their apportioned share of capacity resources necessary, as assessed by the NWPP, to maintain overall regional RA in the short-term (from a period of days and weeks to months).[20]

There are also emerging discussions within Docket UM 2024 at the Oregon PUC about a proposed process to explore the development of an Oregon-specific RA program as a potential interim solution until the adoption of an organized, regional program.[21] [22] The NWPCC's regional assessment, in either case, would still provide complementary, valuable insight into the long-term adequacy of the power supply in the northwest.

## REFERENCES


[1] ("AA Battery Capacity" table showing the average 1.5 Volt AA battery has an energy capacity of approximately 2,000 mAh, or approximately 3 wH) Witman, S., "The Best Rechargeable AA and AAA Batteries," The New York Times, November 2019. https://www.nytimes.com/wirecutter/reviews/best-rechargeable-batteries/
[2] ODOE Internal Analysis
[3] 2018 BER at Page 1-57.
[4] "What the duck curve tells us about managing a green grid," California Independent System Operator., 2016. Page 1. https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf
[5] Lew, D., "Long-Term Reliability: Resource Adequacy," WIEB/WIRAB Tutorial, Presentation given on April 15, 2020. Slide 6, https://westernenergyboard.org/wp-content/uploads/2020/04/04-15-2020-WIRAB-Webinar-Series-Webinar1-Longterm-Reliability-Resource-Adequacy.pdf
[6] "Pacific Northwest Power Supply Adequacy Assessment for 2024," Northwest Power and Conservation Council, October 2019. https://www.nwcouncil.org/sites/default/files/2024%20RA%20Assessment%20Final-2019-10-31.pdf
[7] "Seventh Power Plan," Northwest Power and Conservation Council, Chapter 11: System Needs Assessment, February 2016. Page 11-8. https://www.nwcouncil.org/sites/default/files/7thplanfinal_chap11_systemneedsassess_1.pdf
[8] "Pacific Northwest Power Supply Adequacy Assessment for 2024," Northwest Power and Conservation Council, October 2019. Page 6. https://www.nwcouncil.org/sites/default/files/2024 RA Assessment Final-2019-10-31.pdf
[9] "Resource Adequacy Advisory Committee," Northwest Power and Conservation Council. https://www.nwcouncil.org/energy/energy-advisory-committees/resource-adequacy-advisory-committee (See, description of the Committee's role in advising the Power Council)
[10] "Resource Adequacy Advisory Committee: Steering Committee Members," Northwest Power and Conservation Council, June 2020. https://nwcouncil.app.box.com/s/1b1r6a33j060ids9uor02jh5mhiat655
[11] Wong, P., "Here's What Senate Bill 1149 Does," Medford Mail Tribune, April 1999. https://mailtribune.com/business/here-s-what-senate-bill-1149-does
[12] Vestel, L.B., "2010-2020: A Decade of CCA in California," California Community Choice Association, May 2020. https://cal-cca.org/celebrating-10-years-of-cca-in-california/
[13] "About CalCCA: History," California Community Choice Association. https://cal-cca.org/about/
[14] "Decision on the Central Procurement of the Resource Adequacy Program," California Public Utilities Commission, Decision (D.) 20-06-002. June 2020. https://www.cpuc.ca.gov/RA/
[15] UM 2024, Oregon Public Utility Commission. On-going docket. https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21962
[16] Northwest Adequacy Assessment for 2024 at Executive Summary, Page 5. (Showing a significantly higher Loss of Load Probability expected by the mid-2020s)
[17] "BPA Facts," Bonneville Power Administration, April 2019. Page 2. https://www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf
[18] "Dynamics of Today's Energy System: A Resource Adequacy Symposium," Northwest Power Pool, October 2019. https://www.nwpp.org/private-media/documents/2019.10.02_Resource_Adequacy_Symposium_ALL_SLIDES.pdf
[19] "Resource Adequacy Program – Conceptual Design," Northwest Power Pool, July 2020. Figure 1, page 5. https://www.nwpp.org/private-media/documents/2020-07-31_RAPDP_PublicCD_v2.pdf
[20] See, RA Program – Conceptual Design at Section 4. Legal and Regulatory Considerations, page 30-32.

[21] "Notice of Revised Commission Workshop and Agenda Morning and Afternoon Sessions," Oregon Public Utility Commission, Docket UM 2024, August 2020. https://edocs.puc.state.or.us/efdocs/HCB/um2024hcb121851.pdf

[22] "Portland General Electric Company Response to Notice of Commission and Agenda Morning and Afternoon Sessions," Portland General Electric, Docket UM 2024, August 2020. Page 2. https://edocs.puc.state.or.us/efdocs/HAC/um2024hac112047.pdf