

# Energy Dashboard

## Overview

The Energy Dashboard, a part of the Energy Analytics Project, is a tool to help de-carbonize the energy sector by providing easy access to publicly available data.

## Presenter

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## Presentation Date

Nov 14, 2019

## Agenda

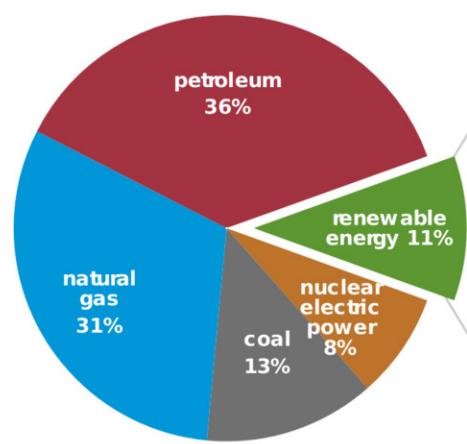
- [ ] USA Energy Overview
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## USA Energy Overview

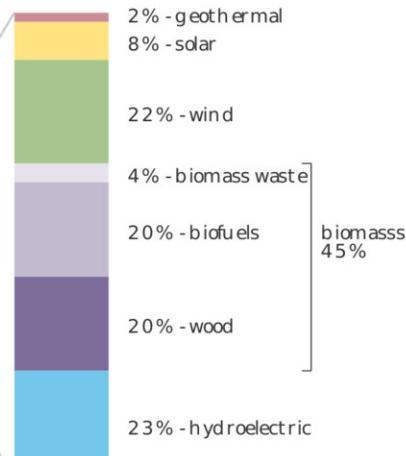
## Consumption by Source

### U.S. primary energy consumption by energy source

total = 101.3 quadrillion  
British thermal units (Btu)



total = 11.5 quadrillion Btu



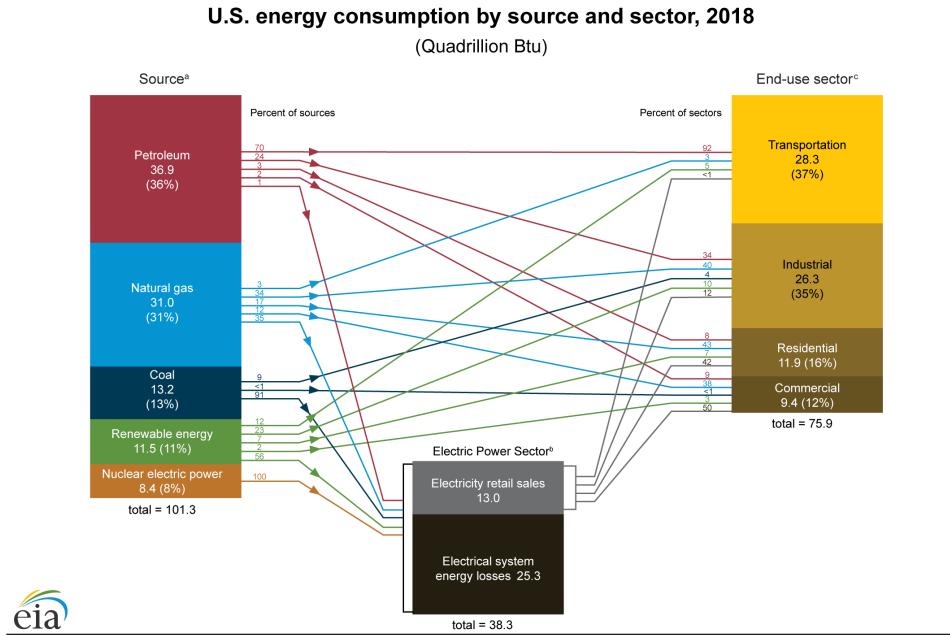
Note: Sum of components may not equal 100% because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 1C  
April 2019, preliminary data



Image courtesy of [EIA](https://www.eia.gov/energyexplained/us-energy-facts/) (<https://www.eia.gov/energyexplained/us-energy-facts/>).

## Consumption by Source and Sector



<sup>a</sup>Primary energy consumption. Each energy source is measured in different physical units and converted to common British thermal units (Btu). See U.S. Energy Information Administration (EIA), *Monthly Energy Review*, Appendix A. Noncombustible renewable energy sources are converted to Btu using the "Fossil Fuel Equivalency Approach"; see EIA's *Monthly Energy Review*, Appendix E.

<sup>b</sup> The electric power sector includes electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public. Energy consumed by these plants reflects the approximate heat rates for electricity. EIA's *Monthly Energy Review*, Appendix A. The total includes the heat content of electricity net imports, not shown separately. Electrical system energy losses are calculated as the primary energy consumed by the electric power sector minus the heat

content of electricity retail sales. See Note 1, "Electrical System Energy Losses," at the end of EIA's *Monthly Energy Review*, Section 2.

<sup>c</sup> End-use sector consumption of primary energy and electricity retail sales, excluding electrical system energy losses from electricity retail sales. Industrial and commercial sectors consumption includes primary energy consumption by combined-heat-and-power (CHP) and electricity-only plants contained within the sector.

Note: Sum of components may not equal total due to independent rounding. All source and end-use sector consumption data include other energy losses from energy use, transformation, and distribution not separately identified. See "Extended Chart Notes" on next page.

Sources: EIA, *Monthly Energy Review* (April 2019), Tables 1.3, 1.4a, 1.4b, and 2.1-2.6.

Image courtesy of [EIA \(<https://www.eia.gov/energyexplained/us-energy-facts/>\).](https://www.eia.gov/energyexplained/us-energy-facts/)

## The Grid

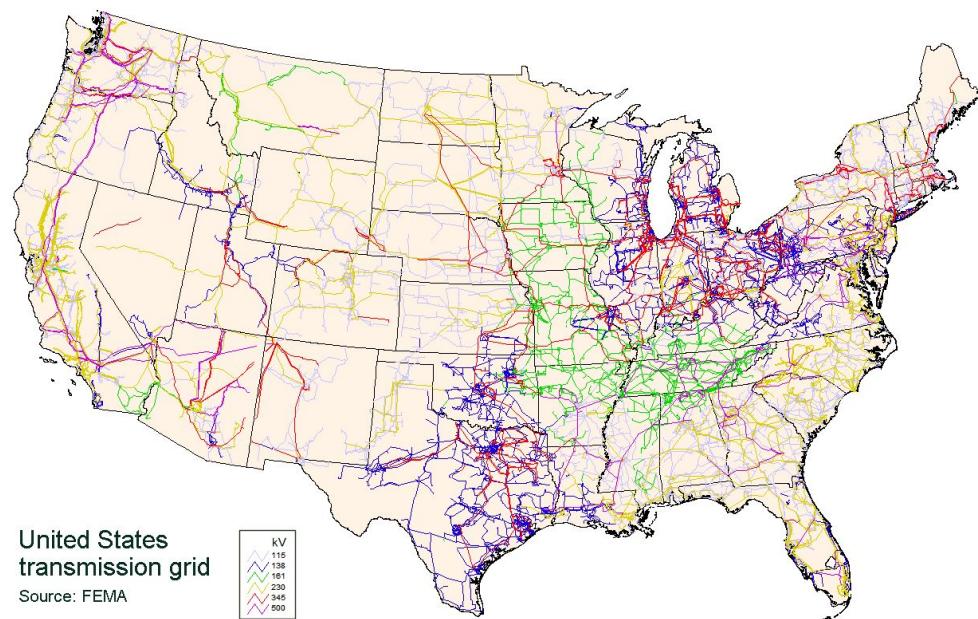
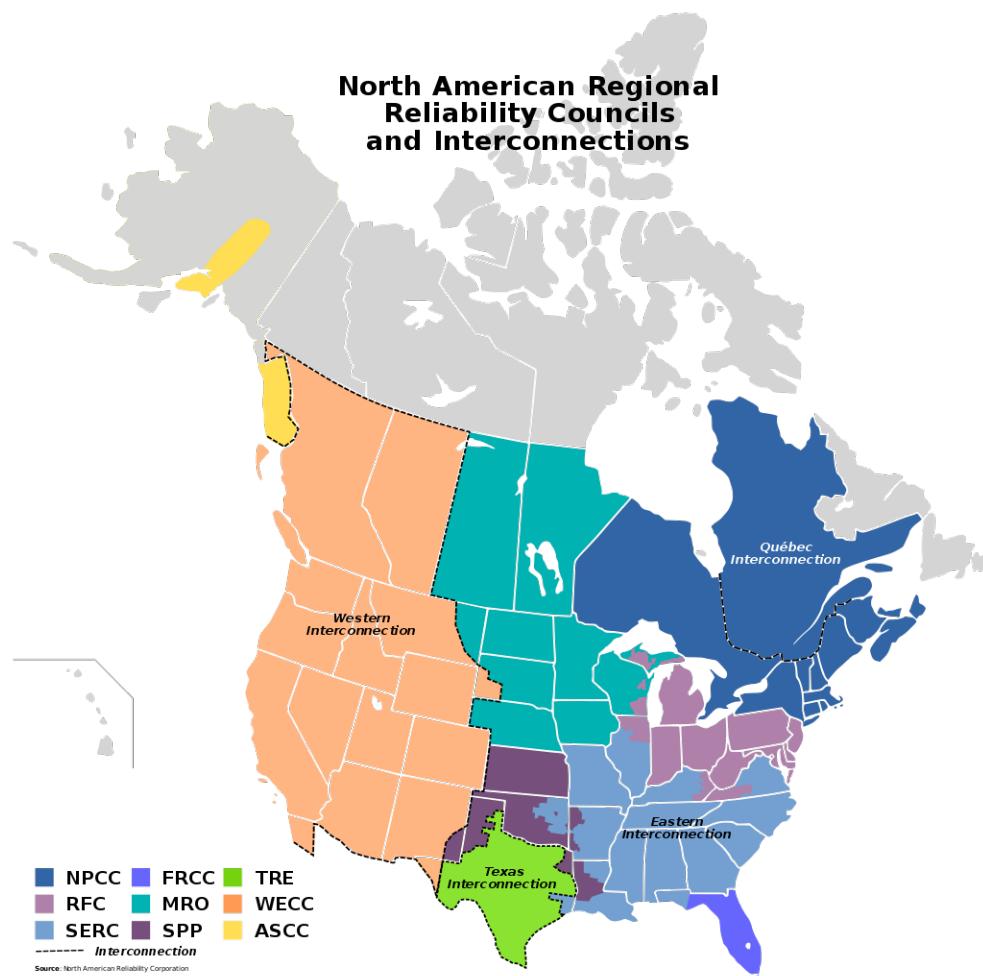


Image courtesy of [GENI](https://geni.org) (<https://geni.org>).

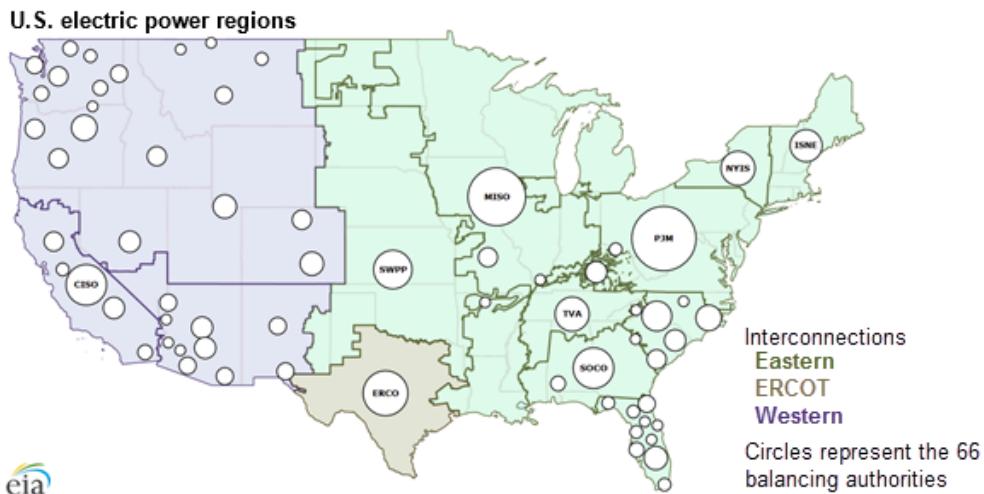
## Interconnections



The Western Interconnection is a wide area synchronous grid and one of the two major alternating current (AC) power grids in the continental U.S. power transmission grid. The other major wide area synchronous grid is the Eastern Interconnection. The three minor interconnections are the Québec Interconnection, the Texas Interconnection, and the Alaska Interconnection. [WIKIPEDIA \(https://en.wikipedia.org/wiki/Western\\_Interconnection\)](https://en.wikipedia.org/wiki/Western_Interconnection)

Image courtesy of [WIKIMEDIA \(https://wikimedia.org\)](https://wikimedia.org).

## Balancing Authority



A balancing authority ensures, in real time, that power system demand and supply are finely balanced. This balance is needed to maintain the safe and reliable operation of the power system. If demand and supply fall out of balance, local or even wide-area blackouts can result.[EIA](https://www.eia.gov/todayinenergy/detail.php?id=27152) (<https://www.eia.gov/todayinenergy/detail.php?id=27152>)

Image courtesy of [EIA](https://eia.gov) (<https://eia.gov>).

## Power Flow

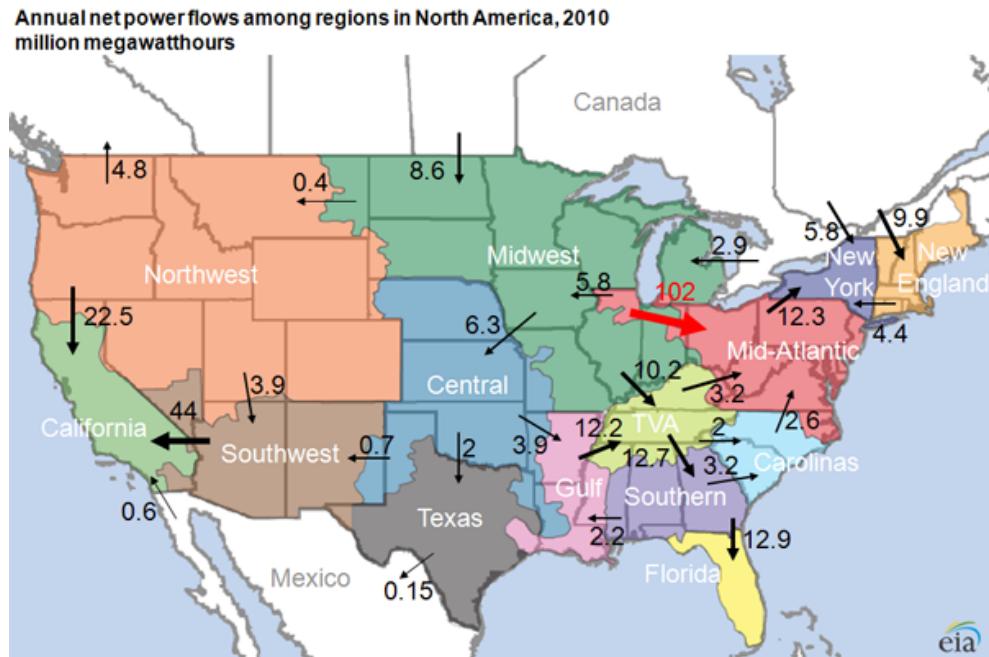
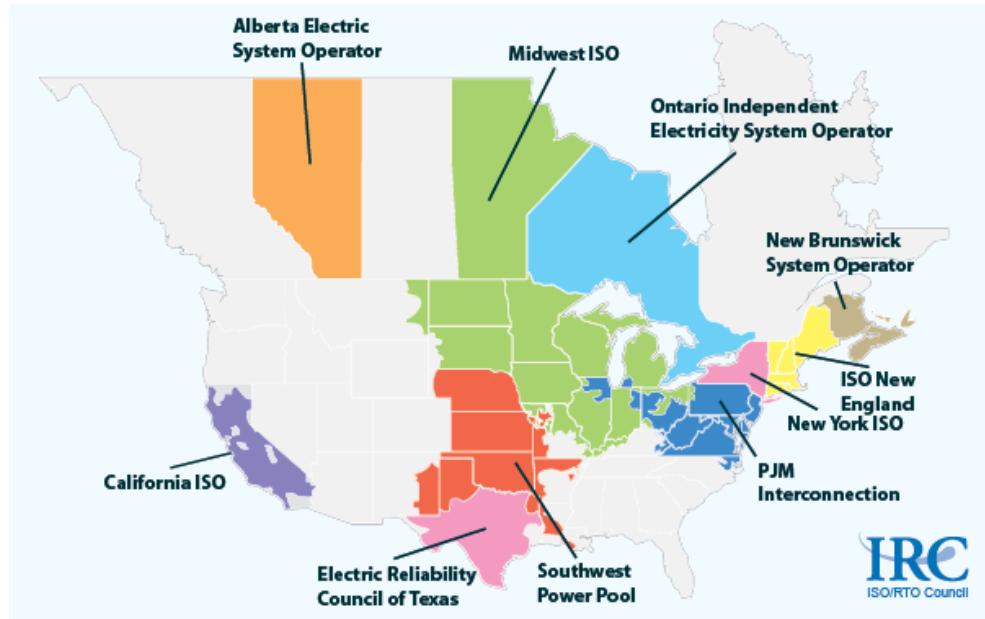


Image courtesy of EIA (<https://www.eia.gov>).

## Energy Grid



### RTO

Regional Transmission Organization

A *regional transmission organization (RTO)* in the United States is an electric power transmission system operator (TSO) that coordinates, controls, and monitors a multi-state electric grid.[wikipedia \(https://en.wikipedia.org/wiki/Regional\\_transmission\\_organization\\_\(North\\_America\)\)](https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America))

### ISO

Independent System Operator

An *independent system operator (ISO)* is similarly an organization formed at the recommendation of FERC. In the areas where an ISO is established, it coordinates, controls, and monitors the operation of the electrical power system, usually within a single US state, but sometimes encompassing multiple states.[wikipedia \(https://en.wikipedia.org/wiki/Regional\\_transmission\\_organization\\_\(North\\_America\)\)](https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America))

RTOs do the same thing (as ISOs) with an added component of greater responsibility for the transmission network, as established by the FERC. [wikipedia \(https://en.wikipedia.org/wiki/Regional\\_transmission\\_organization\\_\(North\\_America\)\)](https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America))

Photo courtesy of [wikimedia \(https://wikimedia.org\)](https://wikimedia.org).

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## USA Federal Agencies



Agency	Acronym
United States Department of Energy	DOE
Federal Energy Regulatory Commission	FERC
National Institute of Standards and Technology	NIST
Bureau of Ocean Energy Management	BOEM
Office of Surface Mining Reclamation and Enforcement	OSMRE
Bonneville Power Administration	BPA
U.S. Army Corps of Engineers	USACE
Pacific Northwest National Laboratory	PNNL

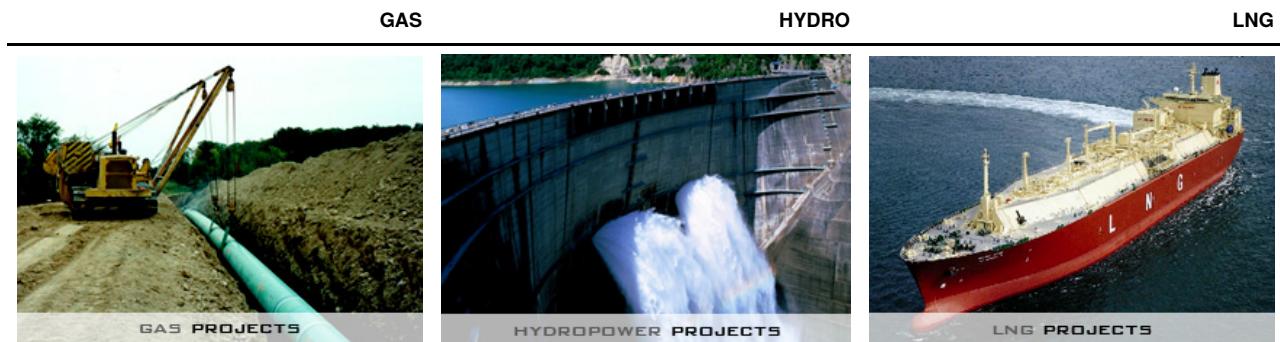
DOE : <http://www.energy.gov> (<http://www.energy.gov>)



The United States Department of Energy (DOE) is a cabinet-level department of the United States Government concerned with the United States' policies regarding energy and safety in handling nuclear material. Its responsibilities include the nation's nuclear weapons program, nuclear reactor production for the United States Navy, energy conservation, energy-related research, radioactive waste disposal, and domestic energy production. [wikipedia \(https://en.wikipedia.org/wiki/United\\_States\\_Department\\_of\\_Energy\)](https://en.wikipedia.org/wiki/United_States_Department_of_Energy)

Photo courtesy of [creativecommons \(https://creativecommons.org\)](https://creativecommons.org).

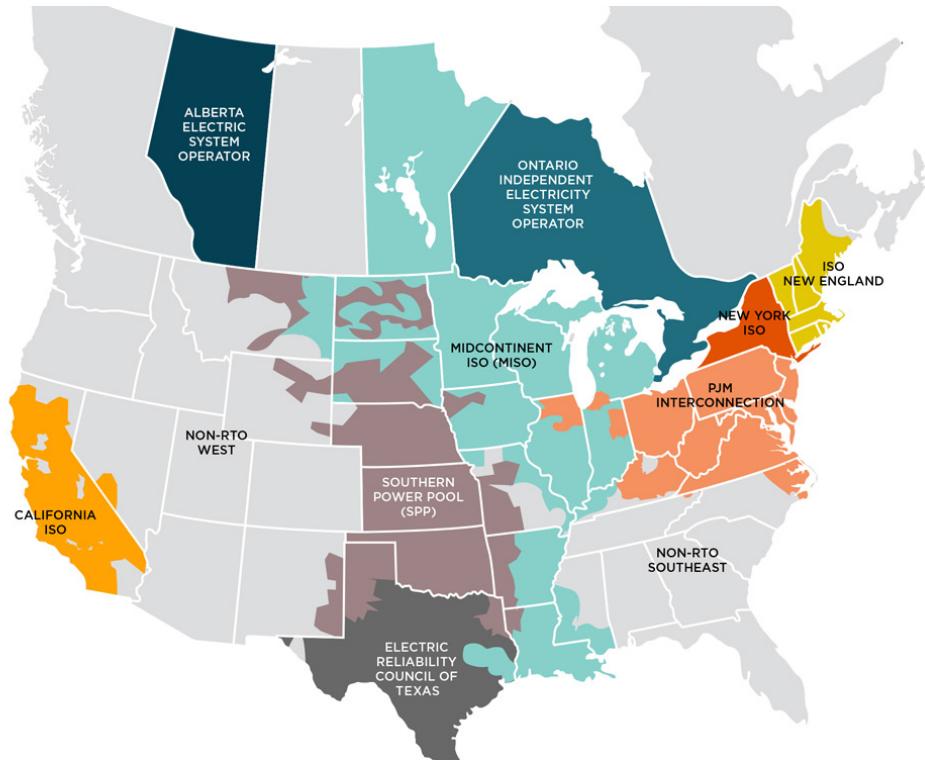
FERC : <https://www.ferc.gov> (<https://www.ferc.gov>)



The Federal Energy Regulatory Commission (FERC) is the United States federal agency that regulates the transmission and wholesale sale of electricity and natural gas in interstate commerce and regulates the transportation of oil by pipeline in interstate commerce. FERC also reviews proposals to build interstate natural gas pipelines, natural gas storage projects, and liquefied natural gas (LNG) terminals, in addition to licensing non-federal hydropower projects. [wikipedia \(https://en.wikipedia.org/wiki/Federal\\_Energy\\_Regulatory\\_Commission\)](https://en.wikipedia.org/wiki/Federal_Energy_Regulatory_Commission)

Photos Courtesy of [FERC \(https://www.ferc.gov\)](https://www.ferc.gov).

FERC : <https://www.ferc.gov> (<https://www.ferc.gov>)



NIST : <https://www.nist.gov> (<https://www.nist.gov>)



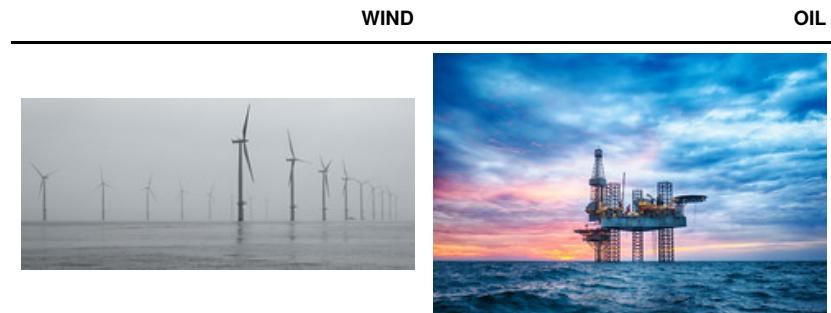
The National Institute of Standards and Technology (NIST) is a physical sciences laboratory, and a non-regulatory agency of the United States Department of Commerce. Its mission is to promote innovation and industrial competitiveness. NIST's activities are organized into laboratory programs that include nanoscale science and technology, engineering, information technology, neutron research, material measurement, and physical measurement.[wikipedia](https://en.wikipedia.org/wiki/National_Institute_of_Standards_and_Technology).([https://en.wikipedia.org/wiki/National\\_Institute\\_of\\_Standards\\_and\\_Technology](https://en.wikipedia.org/wiki/National_Institute_of_Standards_and_Technology))

<https://www.nist.gov/topics/energy> (<https://www.nist.gov/topics/energy>)

NIST develops the testing, measurements, and reference materials needed to ensure the quality of energy-related products and services and ensure fairness in the marketplace.[NIST](https://www.nist.gov/topics/energy).(<https://www.nist.gov/topics/energy>)

Photos Courtesy of [creativecommons](https://creativecommons.org).(<https://creativecommons.org>).

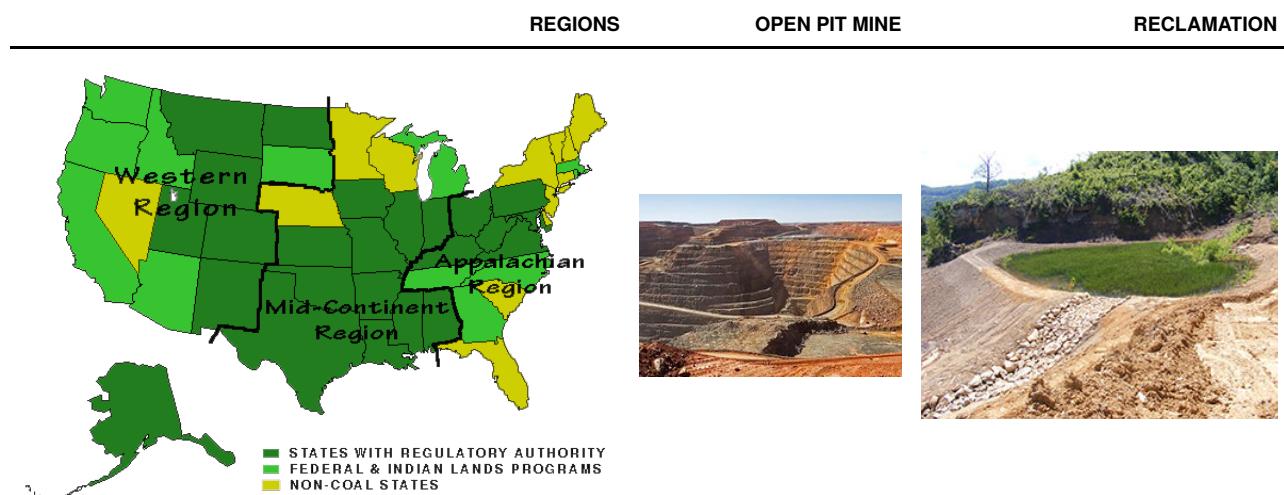
BOEM : <https://www.boem.gov/> (<https://www.boem.gov/>)



*The Mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.*[BOEM \(https://www.boem.gov/About-BOEM/\)](https://www.boem.gov/About-BOEM/)

Photos Courtesy of [creativecommons \(https://creativecommons.org\).](https://creativecommons.org/)

OSMRE : <https://www.osmre.gov/> (<https://www.osmre.gov/>)



*The Office of Surface Mining Reclamation and Enforcement (OSMRE) is a bureau within the United States Department of the Interior. OSMRE is responsible for establishing a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations, under which OSMRE is charged with balancing the nation's need for continued domestic coal production with protection of the environment.*[OSMRE \(https://www.osmre.gov/about.shtm\)](https://www.osmre.gov/about.shtm)

Photos courtesy of [OSMRE \(https://www.osmre.gov\).](https://www.osmre.gov/)

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)



*The Bonneville Power Administration is a nonprofit federal power marketing administration based in the Pacific Northwest. Although BPA is part of the U.S. Department of Energy, it is self-funding and covers its costs by selling its products and services. BPA markets wholesale electrical power from 31 federal hydroelectric projects in the Northwest, one nonfederal nuclear plant and several small nonfederal power plants. The dams are operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation. The nonfederal nuclear plant, Columbia Generating Station, is owned and operated by Energy Northwest, a joint operating agency of the state of Washington. BPA provides about 28 percent of the electric power used in the Northwest and its resources — primarily hydroelectric — make BPA power nearly carbon free.*

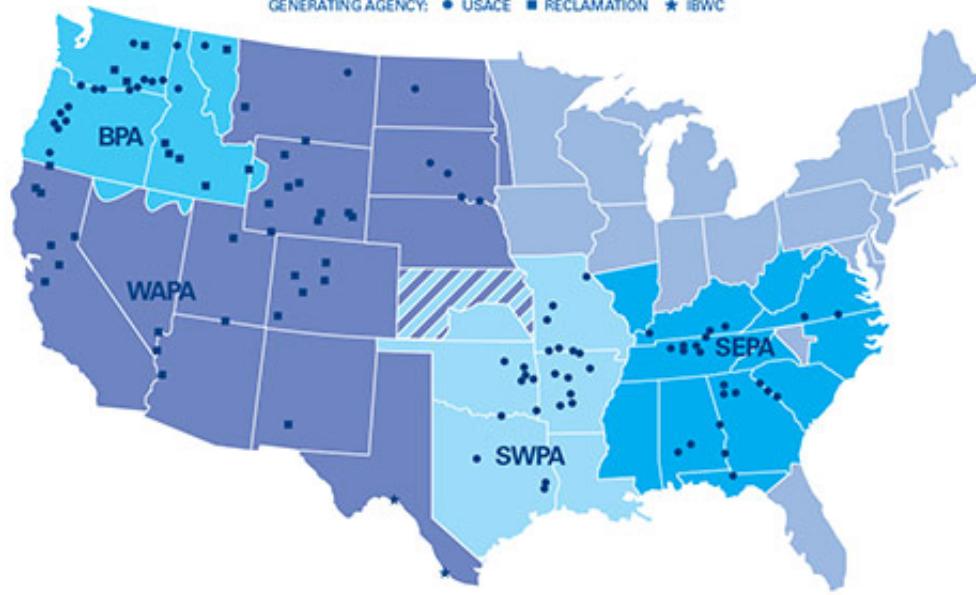
Photo courtesy [creativecommons](https://creativecommons.org) (<https://creativecommons.org>).

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)

**Federal Power Administrations**

**Federal Power Marketing Administrations**  
Territories and Facilities

GENERATING AGENCY: • USACE ■ RECLAMATION ★ IBWC



Photos courtesy of [BPA](https://www.bpa.gov) (<https://www.bpa.gov>).

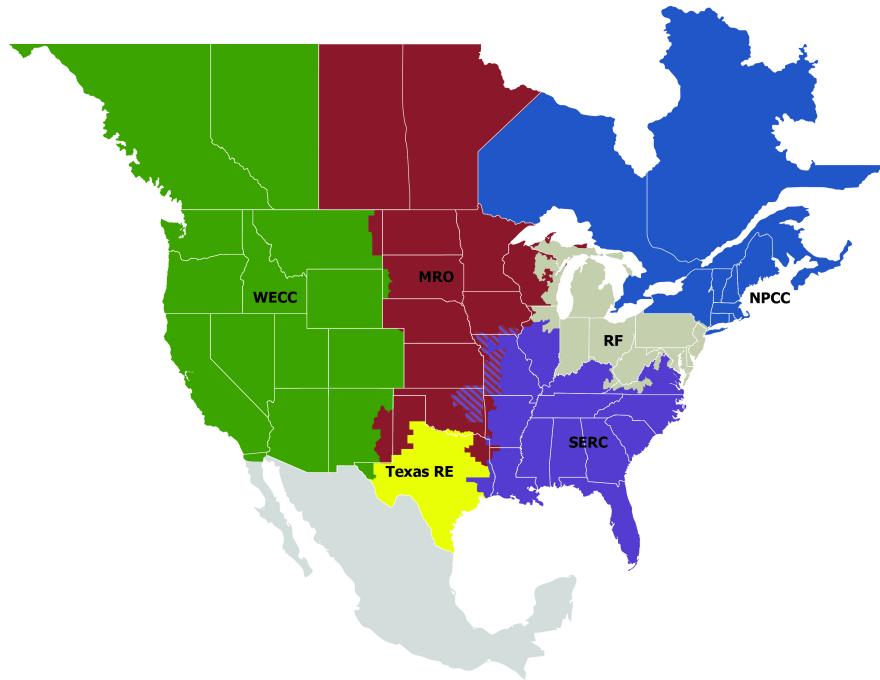
**USACE :** <https://www.usace.army.mil> (<https://www.usace.army.mil>)



*The U.S. Army Corps of Engineers is the largest operator of hydroelectric power plants in the U.S., and one of the largest in the world. The 75 Corps plants have a total installed capacity of 20,474 megawatts and produce nearly 100 billion kilowatt-hours a year. Nearly a third of the nation's total hydropower output, it's enough energy to serve about ten million households, or roughly ten cities the size of Seattle.*[USACE/HYDROPOWER](https://www.nwp.usace.army.mil/hydropower) (<https://www.nwp.usace.army.mil/hydropower>)

Photo courtesy of [USACE](https://www.usace.army.mil) (<https://www.usace.army.mil>).

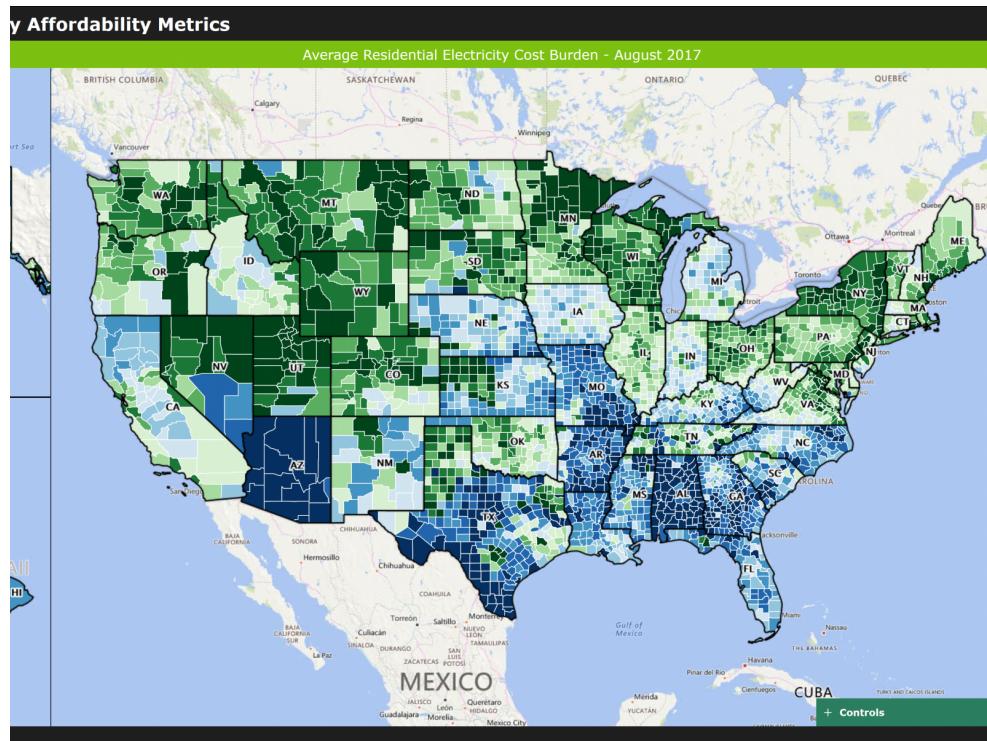
NERC : <https://www.nerc.com> (<https://www.nerc.com>)



The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the electric reliability organization (ERO) for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada. NERC's jurisdiction includes users, owners, and operators of the bulk power system, which serves more than 334 million people. [NERC \(<https://www.nerc.com/AboutNERC/Pages/default.aspx>\)](https://www.nerc.com/AboutNERC/Pages/default.aspx)

Image courtesy of [NERC \(<https://www.nerc.com/AboutNERC/keyplayers/Pages/default.aspx>\)](https://www.nerc.com/AboutNERC/keyplayers/Pages/default.aspx).

PNNL : <https://www.nerc.com> (<https://www.nerc.com>)



*Pacific Northwest National Laboratory plays a leading role in developing a power grid that enables real-time predictive operation to improve reliability and efficiency; incorporates advanced controls that engage new devices and enable new services at scale while ensuring resilience; and uses new approaches and technologies, such as energy storage, microgrids, and transactive energy, to provide flexibility in support of an array of energy futures.*[PNNL](https://www.pnnl.gov/electric-grid-modernization) (<https://www.pnnl.gov/electric-grid-modernization>)

## Federal Agencies (SUMMARY)

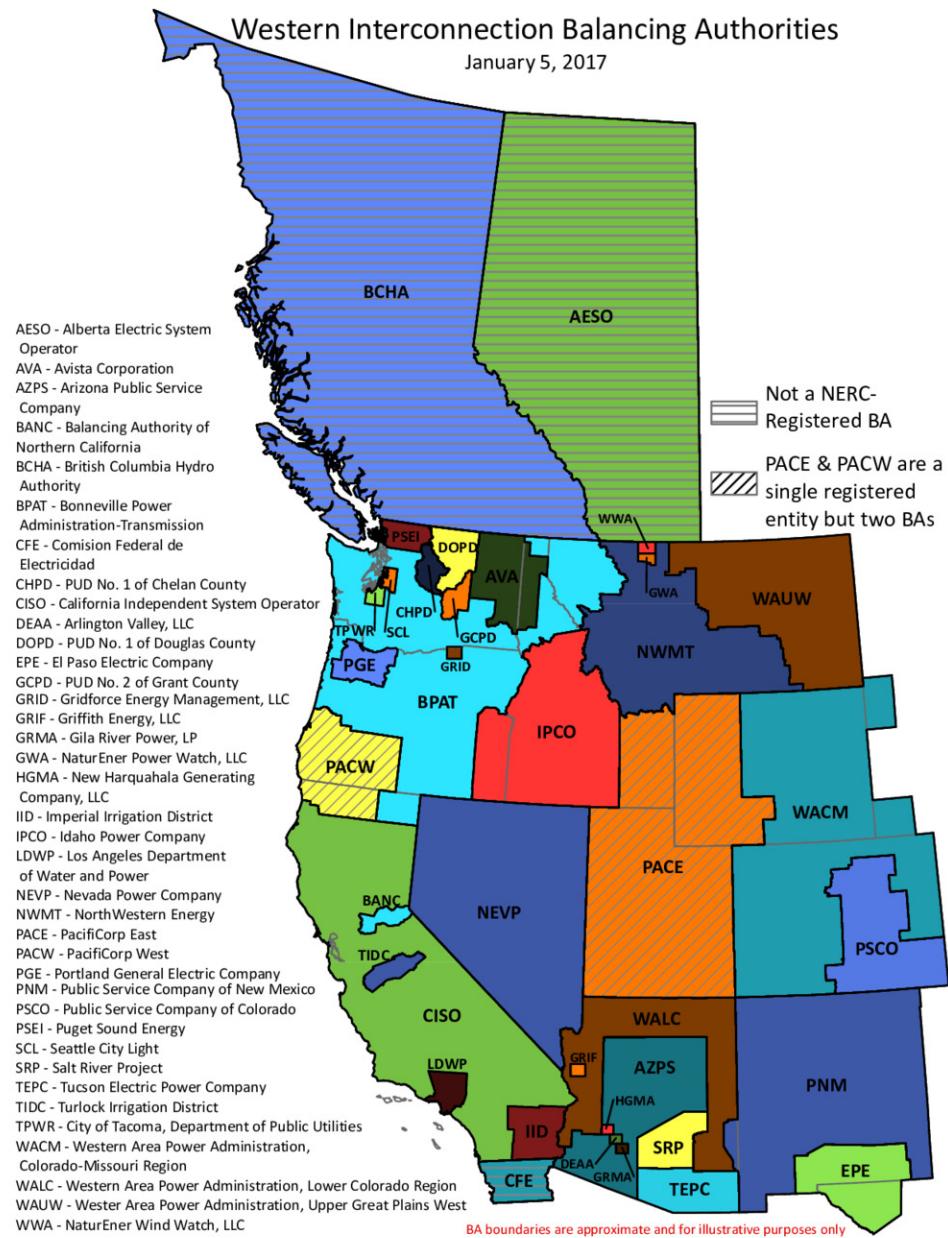
AGENCY	FOCUS
DOE	NUCLEAR
FERC	INTERSTATE TRANSMISSION/COMMERCE
NIST	STANDARDS & RESEARCH
BOEM	OFFSHORE ENERGY (DRILLING & WIND)
OSMRE	COAL
BPA	HYDRO & TRANSMISSION
USACE	HYDRO (in this context)
NERC	REGULATORY
PNNL	RESEARCH

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## Western USA Overview

## **WECC Balancing Authorities**



*The Western Electricity Coordinating Council (WECC) is a not-for-profit organization that works to effectively and efficiently mitigate risks to the reliability and security of the Western Interconnection's Bulk Power System. WECC operates under a Federal Energy Regulatory Commission (FERC) approved delegation agreement with the North American Electric Reliability Corporation (NERC) and in accordance with WECC's Bylaws. WECC (<https://www.wecc.org/WREGIS/Pages/Default.aspx>)*

Image courtesy of WECC.

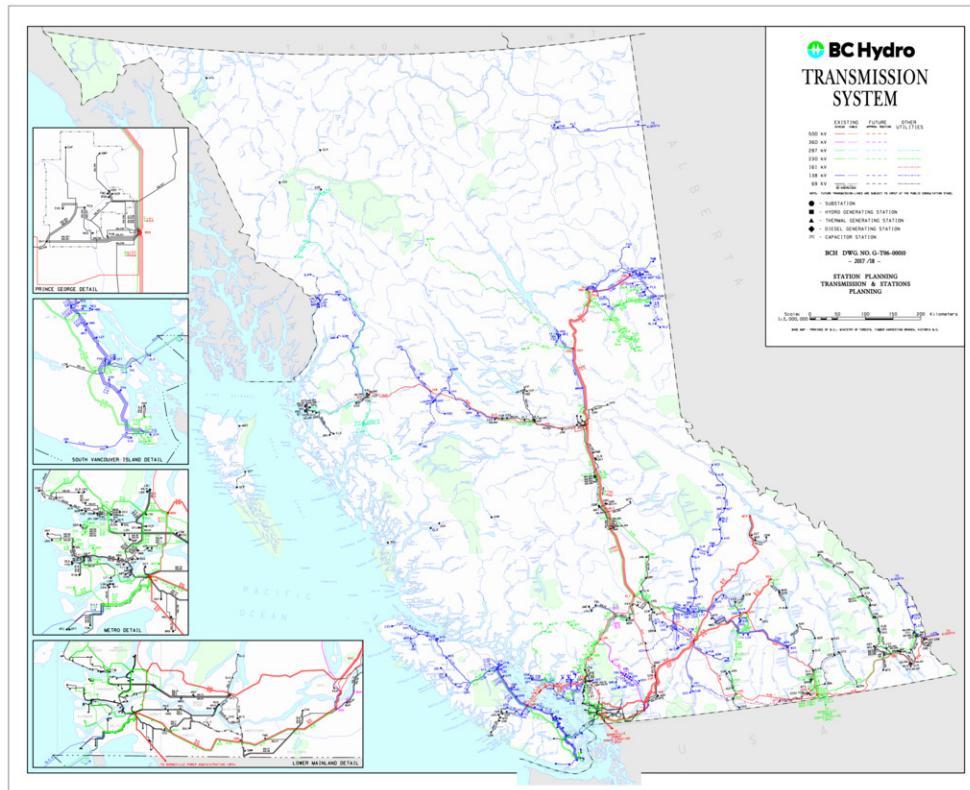
## Key West Coast Players

### Key Agencies

AGENCY	FUNCTION
British Columbia Hydro Authority (BCHA)	Balancing Authority
Western Electricity Coordinating Council (WECC)	Mitigate Risk, Reliability & Security
Bonneville Power Administration (BPA)	Hydro Producer, Transmission, Balancing Authority
Environmental Protection Agency (EPA)	Columbia River Basin
North West Power and Conservation Council (NWPCC)	Regional Oversight
California Independent Service Operator (CAISO)	Balancing Authority

## BCHA : <https://www.bchydro.com> (<https://www.bchydro.com>)

### Service Area



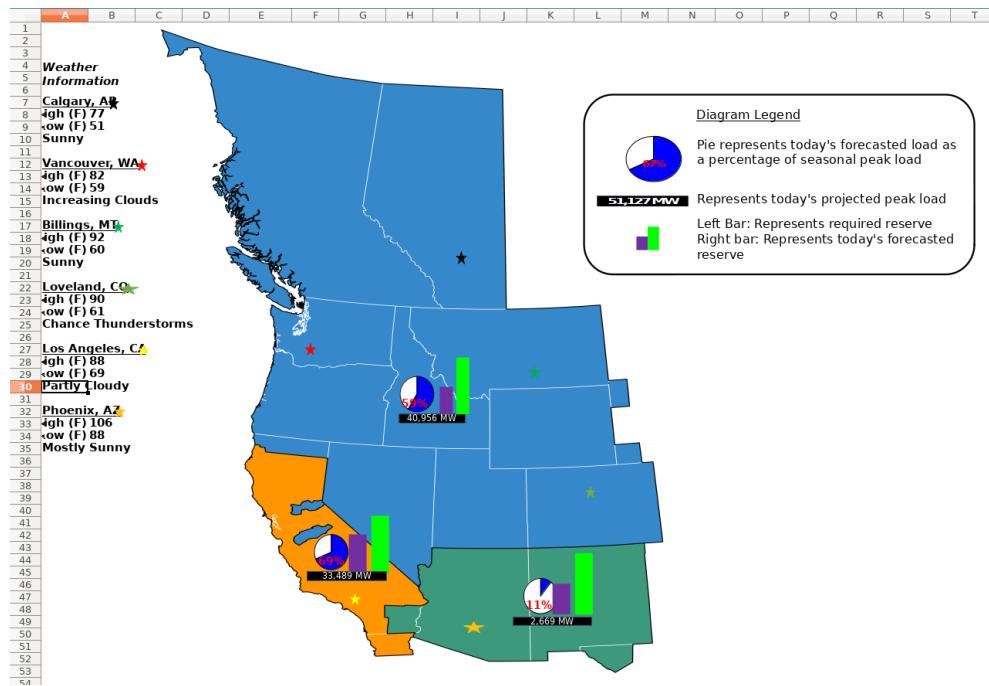
### Generating Capacity

HYDRO (#)	HYDRO (MW)	THERMAL (#)	THERMAL (MW)	TOTAL (MW)
31	11,932	3	177	12,109

[BCHydro-Annual-Service-Plan-Report-2018-2019](https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/accountability-reports/financial-reports/annual-reports/BCHydro-Annual-Service-Plan-Report-2018-2019.pdf) (<https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/accountability-reports/financial-reports/annual-reports/BCHydro-Annual-Service-Plan-Report-2018-2019.pdf>) EIA (<https://www.eia.gov/todayinenergy/detail.php?id=16891>)

BC Hydro is a Crown corporation, owned by the government and people of British Columbia. It's our job to safely provide our customers with reliable, affordable and clean electricity throughout the province. [BCHA](https://www.bchydro.com/toolbar/about.html) (<https://www.bchydro.com/toolbar/about.html>)

## WECC : <https://www.wecc.org> (<https://www.wecc.org>)



- Daily Status Reports
- Event Analysis

The principal goal of WECC is to promote the reliability of the bulk power system (BES) in North America. [WECC](https://www.wecc.org/EventAnalysisSituationalAwareness/Pages/default.aspx) (<https://www.wecc.org/EventAnalysisSituationalAwareness/Pages/default.aspx>)

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)

### Service Area

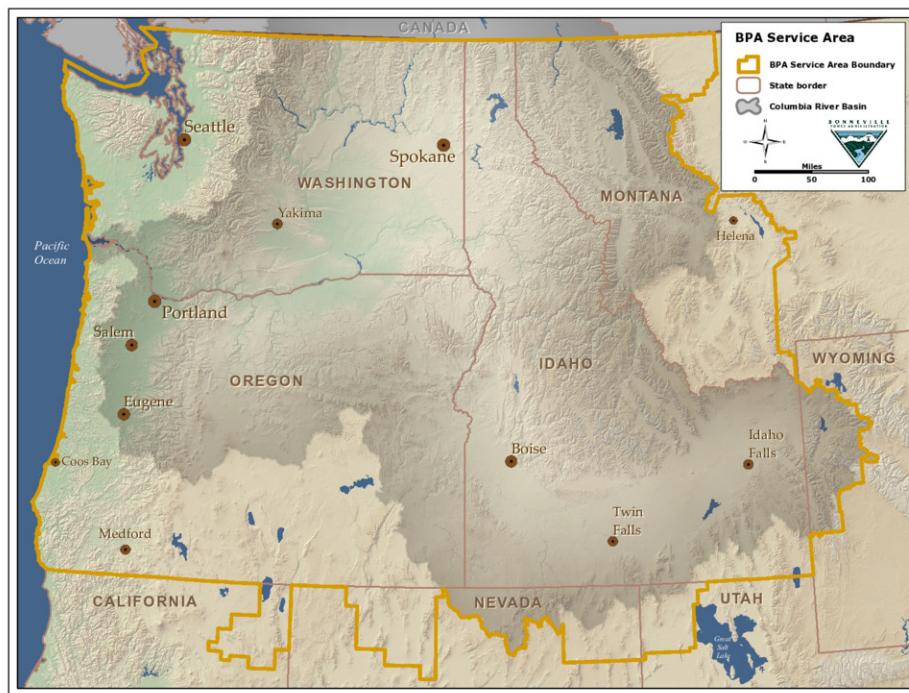
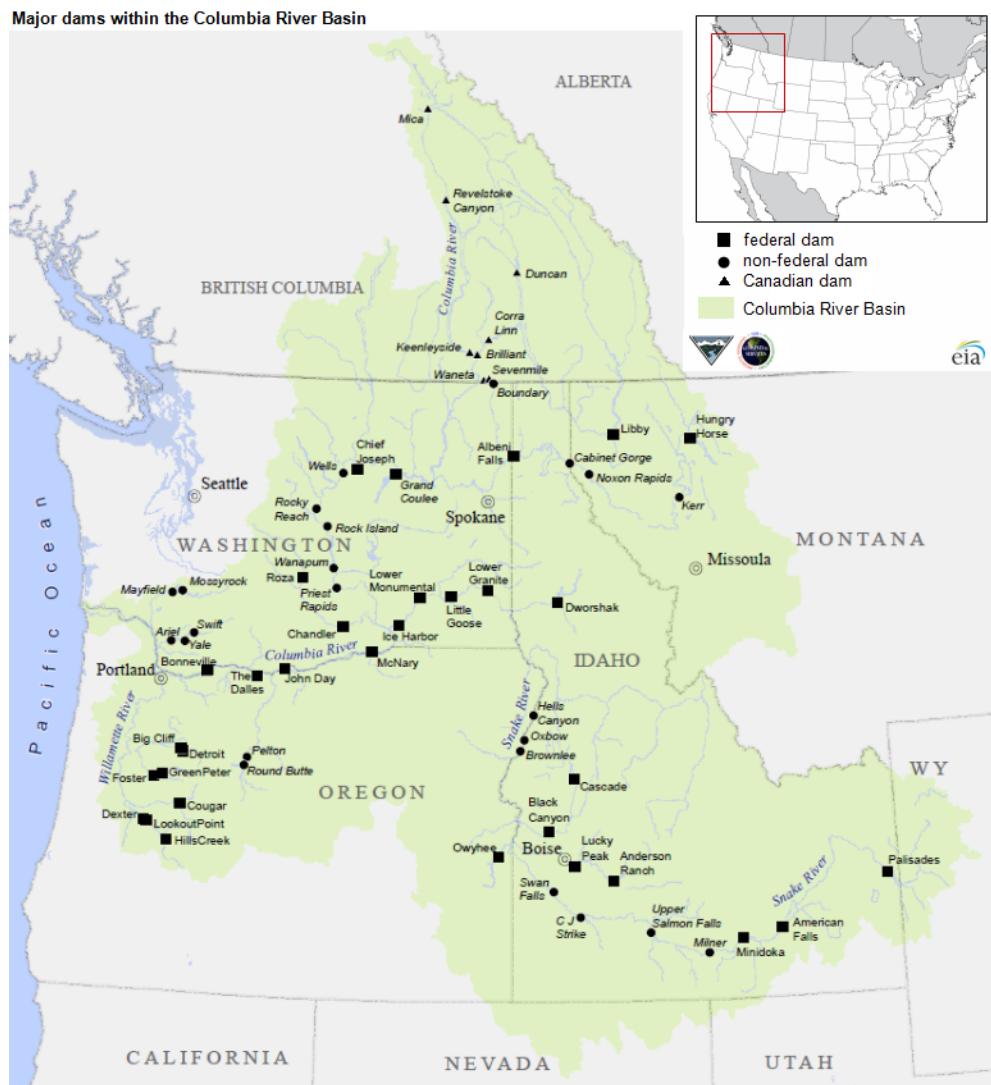


Image courtesy of [BPA](https://www.bpa.gov/news/pubs/map/BPA_ServiceArea.pdf) ([https://www.bpa.gov/news/pubs/map/BPA\\_ServiceArea.pdf](https://www.bpa.gov/news/pubs/map/BPA_ServiceArea.pdf))

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)



### **Generating Capacity**

Entire Columbia River Basin including Tributaries and 3 Dams in BC, Canada

HYDRO (#)	HYDRO (MW)	THERMAL (#)	THERMAL (MW)	TOTAL (MW)
32+	29,000	N/A	N/A	29,000

Hydroelectric power plants located in the Columbia River Basin account for a little more than one third of all the hydroelectric capacity in the United States. The Columbia River runs from the Canadian Rockies and flows 1,214 miles through Idaho, Oregon, and Washington, but the river basin also includes parts of Montana, Nevada, Wyoming, and Utah. Hydroelectric power plants located on the river and its tributaries account for 29 gigawatts (GW) of hydroelectric generating capacity and contributed 44% of the total hydroelectric generation in the nation in 2012. [EIA](https://www.eia.gov/todayinenergy/detail.php?id=16891) (<https://www.eia.gov/todayinenergy/detail.php?id=16891>)

Image courtesy of [EIA](https://www.eia.gov) (<https://www.eia.gov>).

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)

**BPA Transmission Lines and Facilities**

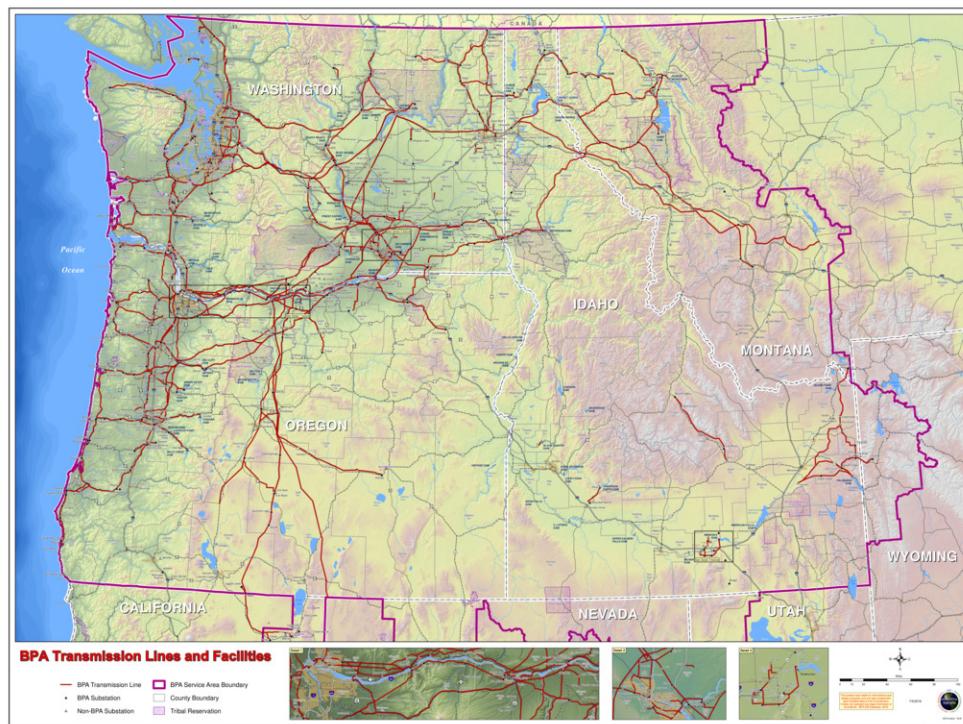
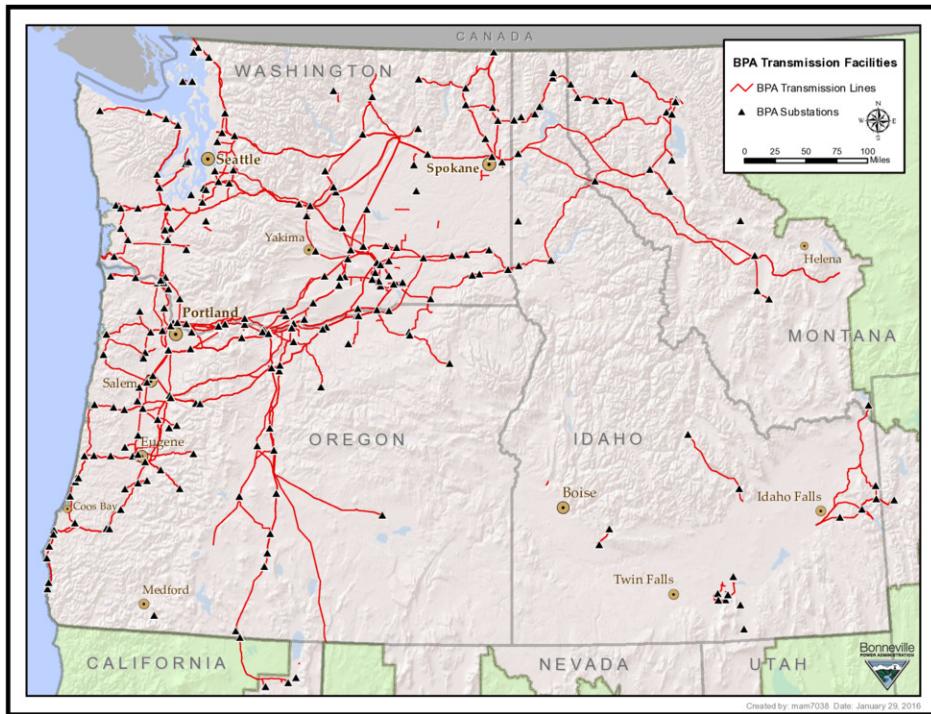


Image courtesy of [BPA](https://www.bpa.gov/news/pubs/map/BPA_TransmissionLines_and_Facilities.pdf) ([https://www.bpa.gov/news/pubs/map/BPA\\_TransmissionLines\\_and\\_Facilities.pdf](https://www.bpa.gov/news/pubs/map/BPA_TransmissionLines_and_Facilities.pdf))

BPA : <https://www.bpa.gov> (<https://www.bpa.gov>)

### BPA Transmission Lines and Facilities



BPA also operates and maintains about three-fourths of the high-voltage transmission in its service territory. BPA's territory includes Idaho, Oregon, Washington, western Montana and small parts of eastern Montana, California, Nevada, Utah and Wyoming. [BPA](https://www.bpa.gov/news/AboutUs/Pages/default.aspx) (<https://www.bpa.gov/news/AboutUs/Pages/default.aspx>)

Image courtesy of [BPA](https://www.bpa.gov/news/pubs/map/BPA_TLines_small.pdf) ([https://www.bpa.gov/news/pubs/map/BPA\\_TLines\\_small.pdf](https://www.bpa.gov/news/pubs/map/BPA_TLines_small.pdf))

EPA : <https://www.epa.gov> (<https://www.epa.gov>)

**Columbia River Basin Restoration Program**



- [Chemicals of Emerging Concern](https://www.epa.gov/columbiariver/chemicals-emerging-concern-columbia-river) (<https://www.epa.gov/columbiariver/chemicals-emerging-concern-columbia-river>)
- [Toxics](https://www.epa.gov/columbiariver/2009-state-river-report-toxics) (<https://www.epa.gov/columbiariver/2009-state-river-report-toxics>)
- [Cold Water Refuges](https://www.epa.gov/columbiariver/columbia-river-cold-water-refuges) (<https://www.epa.gov/columbiariver/columbia-river-cold-water-refuges>)

Congress amended the Clean Water Act in 2016 by adding Section 123, which required EPA to establish a Columbia River Basin Restoration Program. It was the first legislation to officially designate the national importance of restoring the Columbia River Basin, one of our nation's largest watersheds. The legislation focuses on the U.S. portion of the Basin, including the states of Oregon, Washington, Idaho, and Montana. [EPA](https://www.epa.gov/columbiariver/about-epas-work-columbia-river-basin) (<https://www.epa.gov/columbiariver/about-epas-work-columbia-river-basin>) Photo courtesy of EPA.

## Key West Coast Players

### Large Companies

COMPANY	WA	OR	CA
Pacificorp	X	X	O
Puget Sound Energy	X	O	O
Portland General Electric	O	X	O
Pacific Gas & Electric (PGE)	O	O	X

[source](https://www.bestenergynews.com/solar/utility_co/utility_companies.php) ([https://www.bestenergynews.com/solar/utility\\_co/utility\\_companies.php](https://www.bestenergynews.com/solar/utility_co/utility_companies.php))

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## Western USA Issues

- Transmission
- Capacity
- Storage
- Renewables
- News

See: <https://www.nwcouncil.org/sites/default/files/3transcript.pdf> (<https://www.nwcouncil.org/sites/default/files/3transcript.pdf>)

## ISSUE : Transmission

### Path66



- California Oregon Intertie (COI), identified as Path 66 by the WECC
  - 3 (500 KV) lines
- Transmission
  - 4,800 MW North to South
  - 3,675 MW South to North (why the difference?)|
- Risks
  - Fire
  - Snow/Ice (20 feet (6 m) of snow can accumulate near Grizzly Peak's 6,250 feet (1,905 m)-summit)

Data and image courtesy of [WIKIMEDIA \(\[https://en.wikipedia.org/wiki/Path\\\_66\]\(https://en.wikipedia.org/wiki/Path\_66\)\)](https://en.wikipedia.org/wiki/Path_66)

## ISSUE : Transmission

### What was Enron?

Enron Stock Price from August 23, 2000 to January 11, 2002



Enron Corporation was an American energy, commodities, and services company based in Houston, Texas. It was founded in 1985 as a merger between Houston Natural Gas and InterNorth, both relatively small regional companies.[wikipedia](https://en.wikipedia.org/wiki/Enron) (<https://en.wikipedia.org/wiki/Enron>)

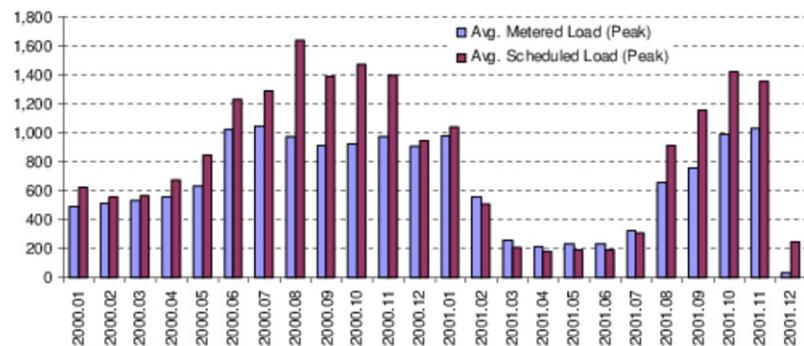
Image courtesy of [WIKIMEDIA](https://wikimedia.org) (<https://wikimedia.org>).

## ISSUE : Transmission

### Enron Scandal

Overscheduling by Enron dropped dramatically in late November and early December 2000, but resumed in August 2001 through November 2001.

**FIGURE 1. OVERSCHEDULING BY ENRON (PEAK HOURS)**



**FIGURE 2. OVERSCHEDULING BY ENRON (OFF- HOURS)**

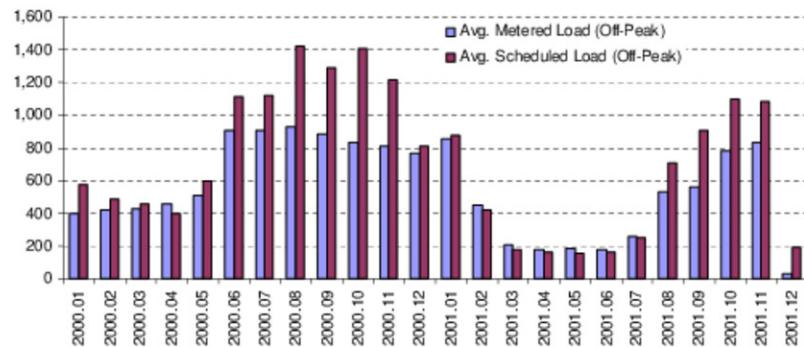


Image courtesy of [CAISO \(caiso.com/Documents/Analysis-TradingandSchedulingStrategiesDescribedinEnronMemos\\_DMA10\\_4\\_02\\_.pdf\)](http://caiso.com/Documents/Analysis-TradingandSchedulingStrategiesDescribedinEnronMemos_DMA10_4_02_.pdf)

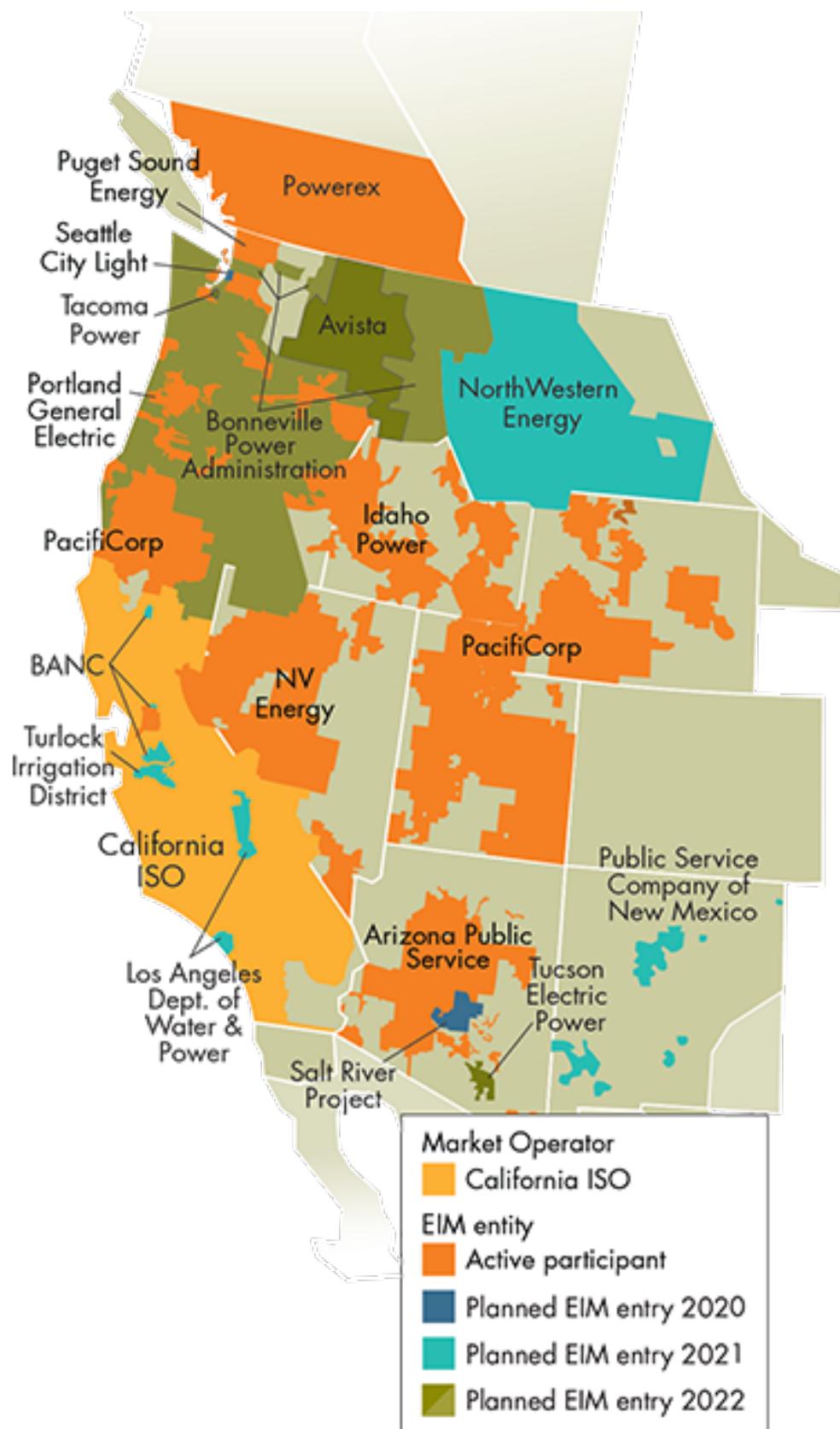
## ISSUE : Transmission

### Enron Strategies

- FatBoy (overscheduling)
- Export (to outside markets)
- Non-firm Export
- Death Star (Circular Schedules)
- Load Shift
- Get-Shorty (Sellback)
- Wheel-Out (Scheduling of Counterflows on Out-of-Service Lines)
- Scheduling Energy to Collect Congestion Charges

Source courtesy of [CAISO \(caiso.com/Documents/Analysis-  
TradingandSchedulingStrategiesDescribedinEnronMemos\\_DMA10\\_4\\_02\\_.pdf\)](http://caiso.com/Documents/Analysis-TradingandSchedulingStrategiesDescribedinEnronMemos_DMA10_4_02_.pdf)



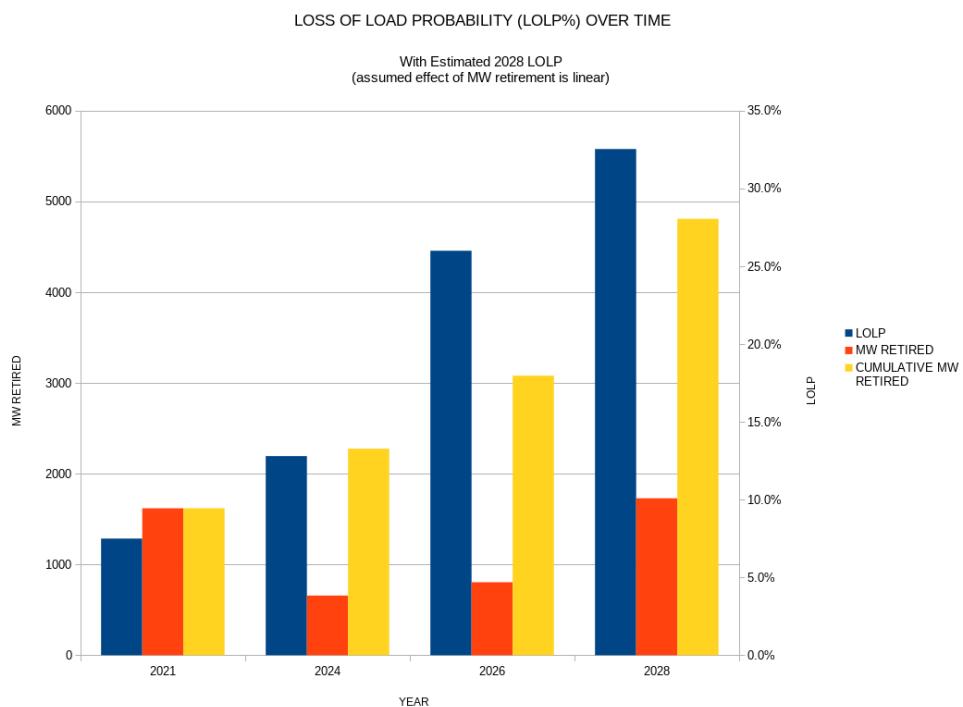
**ISSUE : Transmission + EIM**

## ISSUE: Transmission

### News

DATE	ACTORS	ARENA	DESCRIPTION
2019	Washington State & BC Hydro	Clean Grid	<a href="https://www.geekwire.com/2019/washington-state-b-c-launch-joint-clean-grid-initiative-align-renewable-energy-transition/">Fight Climate Crisis Together (https://www.geekwire.com/2019/washington-state-b-c-launch-joint-clean-grid-initiative-align-renewable-energy-transition/)</a>
2019	BPA & CAISO	EIM	<a href="https://www.bpa.gov/Projects/Initiatives/EIM/Pages/Energy-Imbalance-Market.aspx">BPA signs implementation agreement with CAISO to join EIM (https://www.bpa.gov/Projects/Initiatives/EIM/Pages/Energy-Imbalance-Market.aspx)</a>
2017	BC Hydro (Powerex) & CAISO	EIM	<a href="http://www.caiso.com/Documents/PowerexWillJoinWesternEnergyImbalanceMarket.pdf">Powerex joins EIM (www.caiso.com/Documents/PowerexWillJoinWesternEnergyImbalanceMarket.pdf)</a>

## ISSUE : Capacity

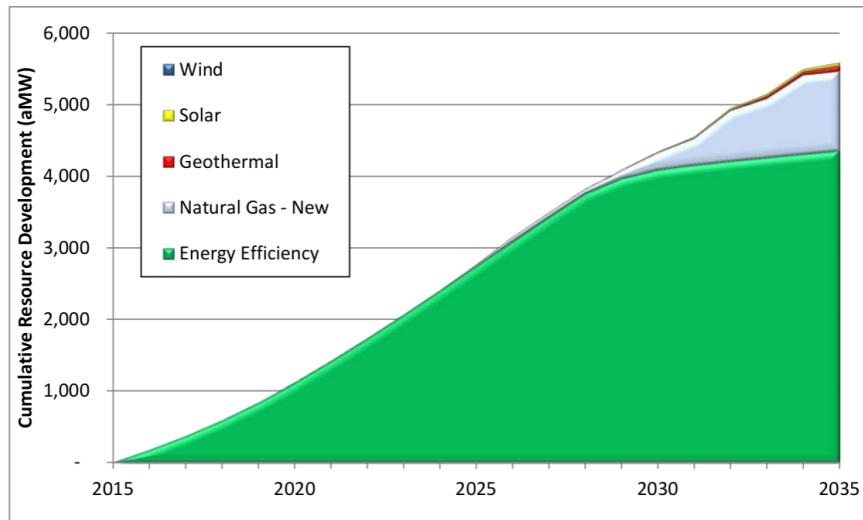


In 2011, the Northwest Power and Conservation Council adopted a resource adequacy standard to provide an early warning should resource development fail to keep pace with demand growth. The standard defines the regional power supply to be adequate when the likelihood of a shortfall or Loss-of-Load Probability (LOLP) is no more than 5 percent.[NWCOUNCIL \(https://www.nwcouncil.org/reports/pacific-northwest-power-supply-adequacy-assessment-2024\)](https://www.nwcouncil.org/reports/pacific-northwest-power-supply-adequacy-assessment-2024)

- Image generated by [Todd Greenwood-Geer \(http://zwrob.com\)](http://zwrob.com).
- Image data from Executive Summary [NWCOUNCIL Adequacy Assessment 2024 \(https://www.nwcouncil.org/reports/pacific-northwest-power-supply-adequacy-assessment-2024\)](https://www.nwcouncil.org/reports/pacific-northwest-power-supply-adequacy-assessment-2024).
- See also [NWCOUNCIL Adequacy Assessment 2024 Final \(https://www.nwcouncil.org/sites/default/files/2024%20RA%20Assessment%20Final-2019-10-31.pdf\)](https://www.nwcouncil.org/sites/default/files/2024%20RA%20Assessment%20Final-2019-10-31.pdf).

## ISSUE : Capacity

Figure 1 - 1: Seventh Plan Resource Portfolio<sup>1</sup>



After energy efficiency and demand response, new natural gas-fired generation is the most cost- effective resource option for the region in the near-term. Similarly, after energy efficiency, the increased use of existing natural gas generation offers the lowest cost option for reducing regional carbon emissions. Combined with investments in renewable generation, as required by state renewable portfolio standards, improved efficiency, demand response resources, and natural gas generation are the principal components of the plan's resource portfolio.[NWCOUNCIL 7th Power Plan \(\[https://www.nwcouncil.org/sites/default/files/7thplanfinal\\\_chap01\\\_execsummary\\\_6.pdf\]\(https://www.nwcouncil.org/sites/default/files/7thplanfinal\_chap01\_execsummary\_6.pdf\)\)](https://www.nwcouncil.org/sites/default/files/7thplanfinal_chap01_execsummary_6.pdf)

Image courtesy of [NWCOUNCIL 7th Power Plan \(\[https://www.nwcouncil.org/sites/default/files/7thplanfinal\\\_chap01\\\_execsummary\\\_6.pdf\]\(https://www.nwcouncil.org/sites/default/files/7thplanfinal\_chap01\_execsummary\_6.pdf\)\)](https://www.nwcouncil.org/sites/default/files/7thplanfinal_chap01_execsummary_6.pdf).

## ISSUE : Capacity

Energy Efficiency --> Lighting

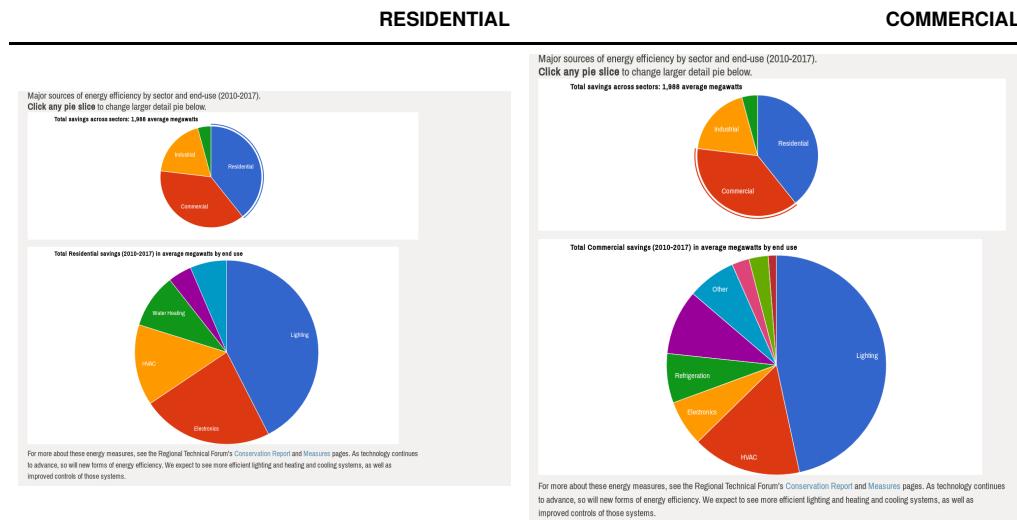
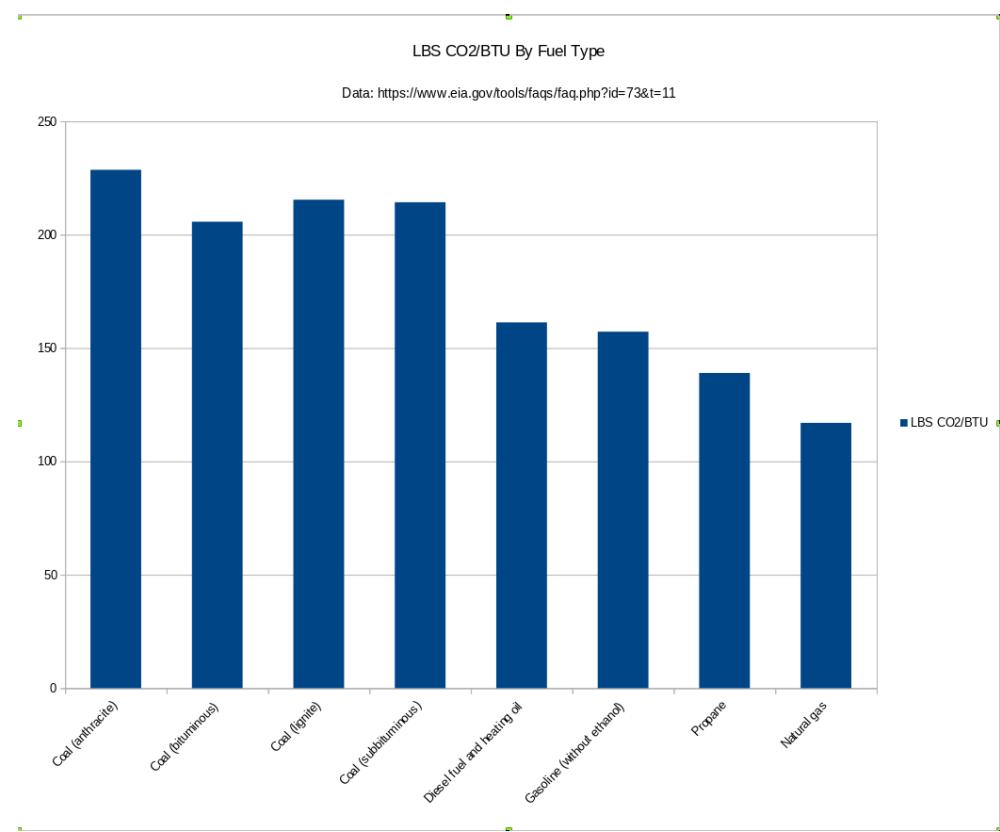


Image courtesy of [NWCOUNCIL](https://www.nwcouncil.org/energy/energy-topics/energy-efficiency) (<https://www.nwcouncil.org/energy/energy-topics/energy-efficiency>).

## ISSUE : Capacity

### Is Propane/Natural Gas the Solution?



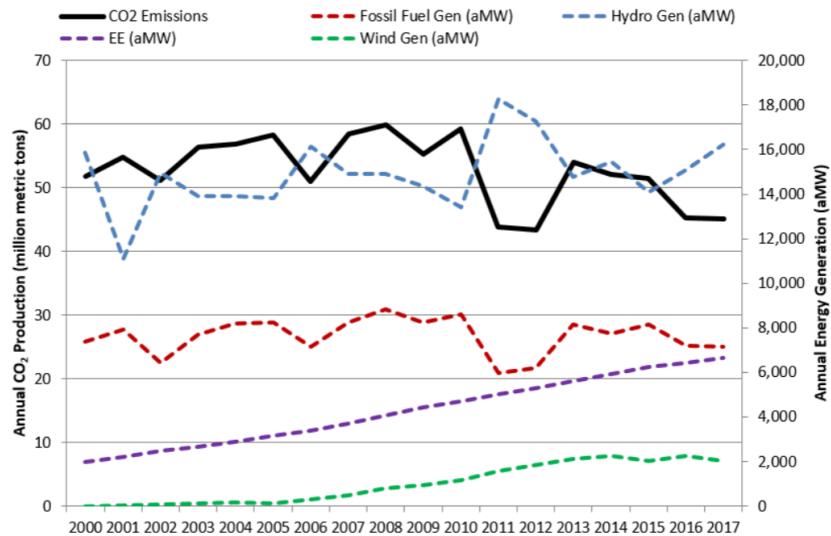
*Best case, Natural Gas emits 50% the CO2 per BTU as Coal Is that good enough?*

Data from [EIA](https://www.eia.gov/tools/faqs/faq.php?id=73&t=11) (<https://www.eia.gov/tools/faqs/faq.php?id=73&t=11>).

## ISSUE : capacity

### Look into the Midterm Assessment of the Seventh Power Plan

Figure 6 - 4: Annual Pacific Northwest Carbon Emissions from Electricity Generation



The region's carbon dioxide emissions from energy generation since the year 2000 have averaged just above 50 million metric tons, bouncing around and reaching as high as 60 million metric tons in 2008 and as low as 43 million metric tons in 2012 (see Figure 6-4). In the Pacific Northwest, carbon emissions are directly affected by the region's abundant hydropower resource. In a good hydro year, when the runoff is above average, the region's fossil fuels are dispatched less and emissions are lower. In a poor hydro year, when the runoff is below average, the region may rely more on fossil fuels and emissions are higher.[NWCOUNCIL Midterm Assessment of the Seventh Power Plan \(<https://www.nwcouncil.org/sites/default/files/7th%20Plan%20Midterm%20Assessment%20Final%20Cncl%20Doc%20%232019-3.pdf>\)](https://www.nwcouncil.org/sites/default/files/7th%20Plan%20Midterm%20Assessment%20Final%20Cncl%20Doc%20%232019-3.pdf)

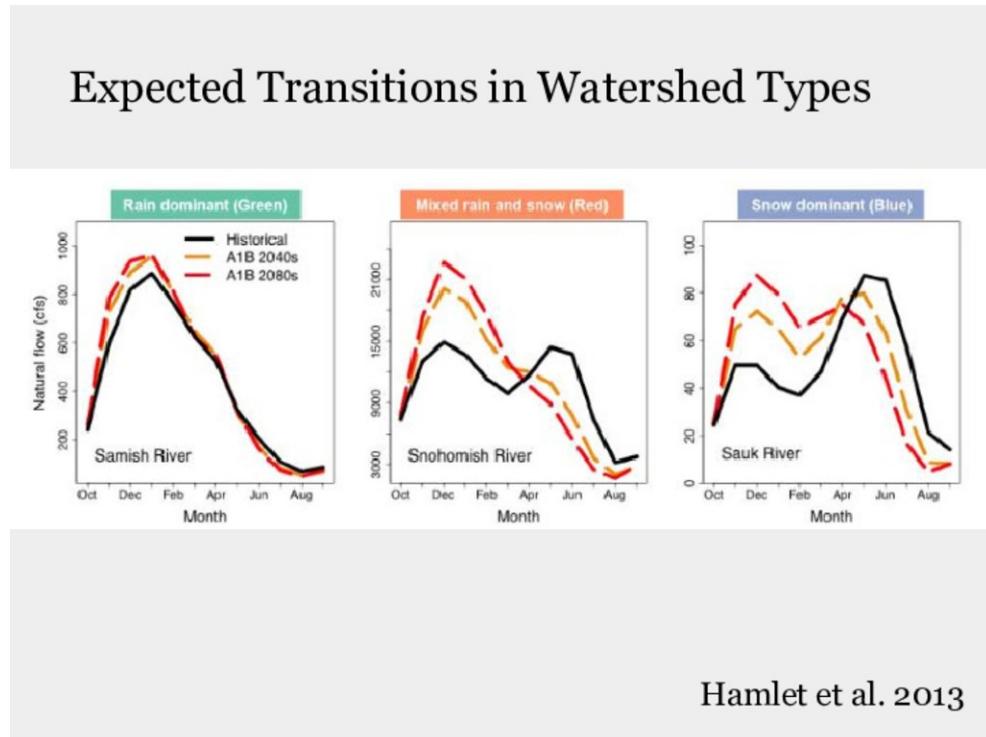
Image courtesy of [NWCOUNCIL Midterm Assessment of the Seventh Power Plan \(<https://www.nwcouncil.org/sites/default/files/7th%20Plan%20Midterm%20Assessment%20Final%20Cncl%20Doc%20%232019-3.pdf>\)](https://www.nwcouncil.org/sites/default/files/7th%20Plan%20Midterm%20Assessment%20Final%20Cncl%20Doc%20%232019-3.pdf).

## ISSUE : Storage

- Climate Heating
- Salmon
- Orcas
- Dams

## STORAGE

### Climate Heating



*Wetter Winters and Drier Summers (Probably)*[Dr. Nick Bond, Washington State Climatologist](https://environment.uw.edu/faculty/nicholas-bond/) (<https://environment.uw.edu/faculty/nicholas-bond/>)

Image courtesy of [BOND \(NWCOUNCIL BRIEFING\)](https://www.nwcouncil.org/sites/default/files/2019_1015_2.pdf) ([https://www.nwcouncil.org/sites/default/files/2019\\_1015\\_2.pdf](https://www.nwcouncil.org/sites/default/files/2019_1015_2.pdf)).

## STORAGE

### Salmon and Cold Water Refuges

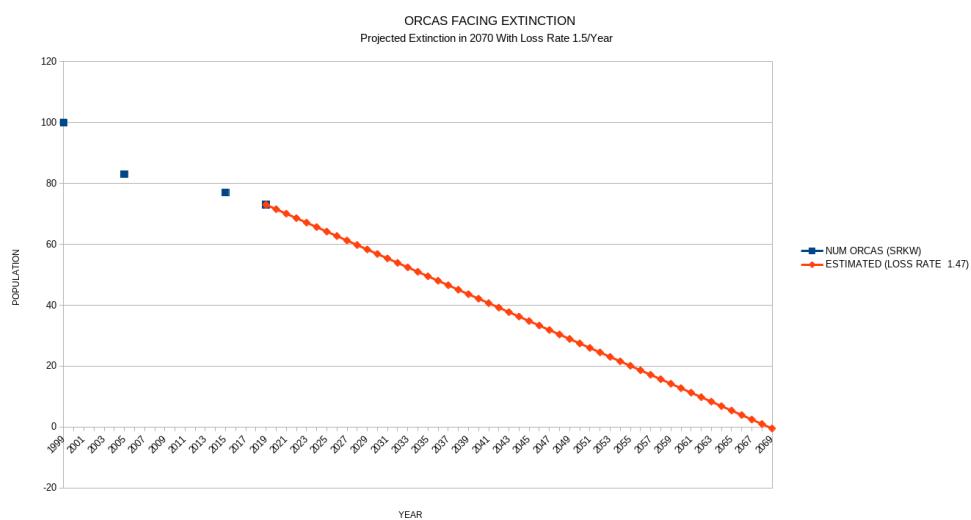


Identified 23 areas where cool tributaries enter the Columbia, 12 of which are critical b/c they account for ~80%? of cold water in system EPA concludes there are enough refuges now but will not be in the future [Chris Hladick, Regional Administrator, US EPA Region 10 \(my notes from NWCOUNCIL Meeting\)](#) (<http://zwrob.com/posts/nwpcc01/>)

Image courtesy of [BOND \(NWCOUNCIL BRIEFING\)](#) ([https://www.nwcouncil.org/sites/default/files/2019\\_1015\\_2.pdf](https://www.nwcouncil.org/sites/default/files/2019_1015_2.pdf)).

## STORAGE

Salmon -> Orcas



- Image courtesy of [WHALERESEARCH](https://www.whaleresearch.com/getfacts) (<https://www.whaleresearch.com/getfacts>).
- Graph based on data from [WHALERESEARCH](https://www.whaleresearch.com/getfacts) (<https://www.whaleresearch.com/getfacts>).

## STORAGE

### Dams and Spill

SPILLING DAM	2019-2021 Spill Operation Agreement
	<p><i>The agreement calls for flexible spill operations that meet three objectives: provide additional fish benefits by increasing spill; manage power system costs and preserve hydro system flexibility; and retain operational feasibility. Specifically, these operations involve increased spill during certain times of the day for fish migration and lesser amounts for the hours when hydropower production is needed most.</i> <a href="https://www.bpa.gov/news/newsroom/Pages/Flexible-spill-agreement-aims-to-benefit-salmon-and-hydropower.aspx">BPA (<a href="https://www.bpa.gov/news/newsroom/Pages/Flexible-spill-agreement-aims-to-benefit-salmon-and-hydropower.aspx">https://www.bpa.gov/news/newsroom/Pages/Flexible-spill-agreement-aims-to-benefit-salmon-and-hydropower.aspx</a>)</a></p>

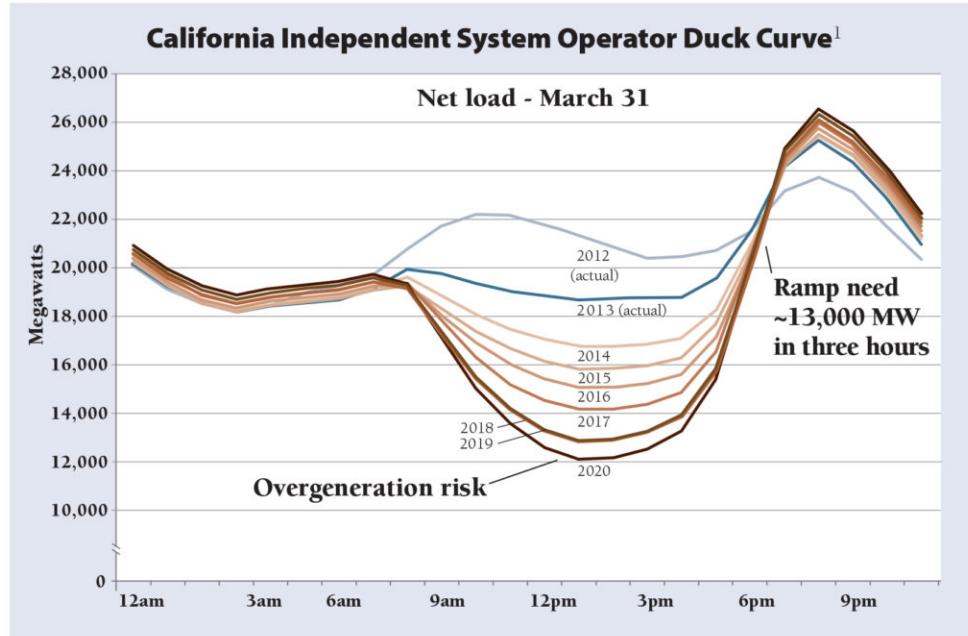
### History

- [2019 EPA Appeal \(<https://www.columbiariverkeeper.org/news/2019/8/going-court-salmon>\)](https://www.columbiariverkeeper.org/news/2019/8/going-court-salmon)
- [2019 WASHINGTON Case No. C17-289RSM \(<https://www.columbiariverkeeper.org/news/2019/8/ggoing-court-salmon>\)](https://www.columbiariverkeeper.org/news/2019/8/ggoing-court-salmon)
- [2018 BPA Spill Agreement \(\[https://www.bpa.gov/efw/FishWildlife/SpillOperationAgreement/doc/ECF-2298\\\_Spill-Notice-and-Agreement.pdf\]\(https://www.bpa.gov/efw/FishWildlife/SpillOperationAgreement/doc/ECF-2298\_Spill-Notice-and-Agreement.pdf\)\)](https://www.bpa.gov/efw/FishWildlife/SpillOperationAgreement/doc/ECF-2298_Spill-Notice-and-Agreement.pdf)
- [2018 OREGON \(OPB\) Case No. 3:01-cv-0640-SI \(<https://www.opb.org/news/article/court-orders-more-spill-over-columbia-river-dams-in-2018/>\)](https://www.opb.org/news/article/court-orders-more-spill-over-columbia-river-dams-in-2018/)
- [2017 OREGON \(OPB\) Case No. 3:01-cv-0640-SI \(<https://www.opb.org/news/article/plaintiffs-call-for-more-court-ordered-spill-at-columbia-river-dams/>\)](https://www.opb.org/news/article/plaintiffs-call-for-more-court-ordered-spill-at-columbia-river-dams/)
- [2017 OREGON Case No. 3:01-cv-0640-SI \(<http://earthjustice.org/sites/default/files/files/3-27-17%20Injunction%20NWF%20Columbia%20River%20salmon%20ruling.pdf>\)](http://earthjustice.org/sites/default/files/files/3-27-17%20Injunction%20NWF%20Columbia%20River%20salmon%20ruling.pdf)
- [2016 OREGON \(OPB\) EPA still violating ESA \(<https://www.opb.org/news/article/judge-rejects-latest-federal-plan-for-columbia-river-dams/>\)](https://www.opb.org/news/article/judge-rejects-latest-federal-plan-for-columbia-river-dams/)
- [2011 OREGON EPA violated ESA \(<https://nwenergy.org/uncategorized/federal-judge-rules-for-columbia-and-snake-river-salmon/>\)](https://nwenergy.org/uncategorized/federal-judge-rules-for-columbia-and-snake-river-salmon/)

Image courtesy of [BPA \(<https://www.bpa.gov>\)](https://www.bpa.gov).

## ISSUE : Renewables

**Figure 1**



In utility-scale electricity generation, the duck curve is a graph of power production over the course of a day that shows the timing imbalance between peak demand and renewable energy production. [WIKIPEDIA](https://en.wikipedia.org/wiki/Duck_curve) ([https://en.wikipedia.org/wiki/Duck\\_curve](https://en.wikipedia.org/wiki/Duck_curve))

- CA has a ramp up of 13 MW in ~4-5 hours
- For scale, the National Electricity Market (NEM) in Australia has an installed capacity of 47,148 MW [AER](https://www.aer.gov.au/system/files/State%20of%20the%20energy%20market%2C%20May%202017%20%28A4%20format%29_1.pdf) ([https://www.aer.gov.au/system/files/State%20of%20the%20energy%20market%2C%20May%202017%20%28A4%20format%29\\_1.pdf](https://www.aer.gov.au/system/files/State%20of%20the%20energy%20market%2C%20May%202017%20%28A4%20format%29_1.pdf))
- So about 1/3 the entire NEM AU market ramps up in about 4 hours

Image courtesy of [RAPONLINE](https://www.raponline.org) (<https://www.raponline.org>).

## Agenda

- [X] USA Energy Overview
- [X] USA Federal Agencies
- [X] Western USA Overview
- [X] Western USA Issues
- [ ] CAISO Overview
- [ ] CAISO OASIS
- [ ] Energy Dashboard
- [ ] Questions

## Caiso Overview

### What is it?

- Independent System Operator (ISO)
- Balancing Authority (BA)
- Manages 80% of CA electricity flow
- "If it were a country, California would be the fifth-largest economy in the world (larger than the United Kingdom, France, or India)"[WIKIPEDIA](https://en.wikipedia.org/wiki/California) (<https://en.wikipedia.org/wiki/California>)
- 300 Million MWh / year

*The California Independent System Operator (CAISO) is a non-profit Independent System Operator (ISO) serving California.[1] It oversees the operation of California's bulk electric power system, transmission lines, and electricity market generated and transmitted by its member utilities. The primary stated mission of CAISO is to "operate the grid reliably and efficiently, provide fair and open transmission access, promote environmental stewardship, and facilitate effective markets and promote infrastructure development." [2] The CAISO is one of the largest ISOs in the world, delivering 300 million megawatt-hours of electricity each year and managing about 80% of California's electric flow.[WIKIPEDIA](https://en.wikipedia.org/wiki/California_Independent_System_Operator) ([https://en.wikipedia.org/wiki/California\\_Independent\\_System\\_Operator](https://en.wikipedia.org/wiki/California_Independent_System_Operator))*

## CAISO Overview

### CAISO Regions



Image courtesy of [OASIS](http://oasis.caiso.com/mrioasis/logon.do) (<http://oasis.caiso.com/mrioasis/logon.do>).

## CAISO Overview

### Network Model

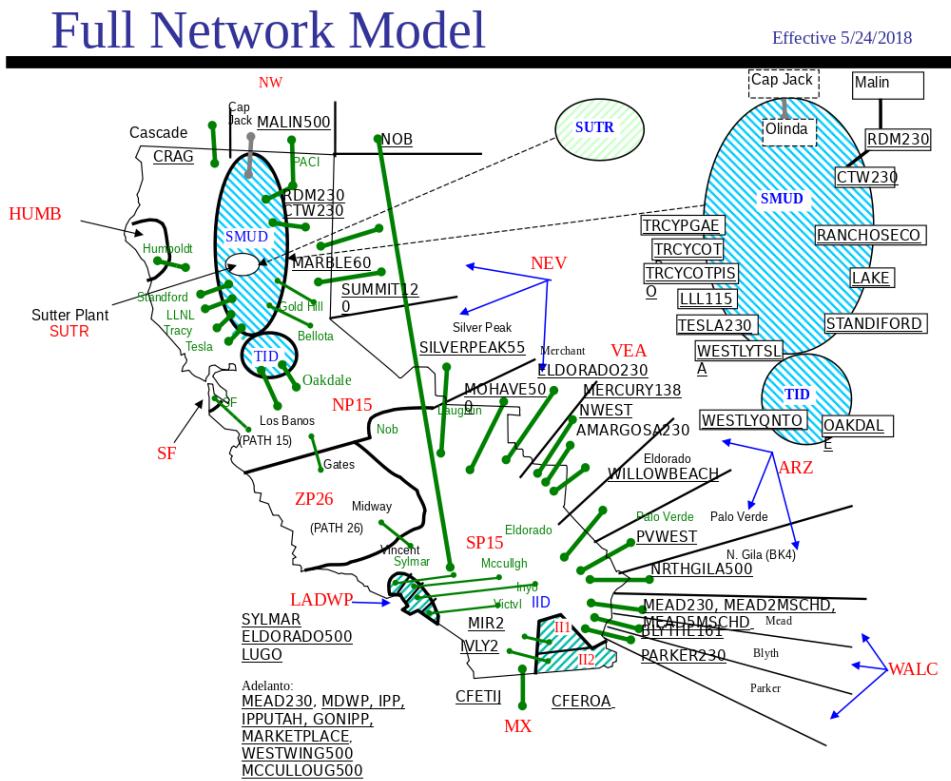


Image courtesy of [CAISO \(\[http://www.caiso.com/Documents/FullNetworkModel\\\_PricingNodeMapping\\\_Based\\\_FullNetworkModel\\\_ReleaseDB2019Q3.xls\]\(http://www.caiso.com/Documents/FullNetworkModel\_PricingNodeMapping\_Based\_FullNetworkModel\_ReleaseDB2019Q3.xls\)\).](http://www.caiso.com/Documents/FullNetworkModel_PricingNodeMapping_Based_FullNetworkModel_ReleaseDB2019Q3.xls)

## CAISO Overview

### Resources

- [CA Integrated Energy Policy Report \(<https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report>\)](https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report)
- [CA Draft 2019 Integrated Energy Policy Report \(<https://efiling.energy.ca.gov/getdocument.aspx?tn=230539>\)](https://efiling.energy.ca.gov/getdocument.aspx?tn=230539)

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## CAISO OASIS

### Data Portal

The screenshot shows two side-by-side views of the California ISO OASIS website.

**Left Side (Data Portal):**

- The header says "OASIS".
- The URL is [www.caiso.com/search/Results.aspx?k=specification&ks=interface+specification](http://www.caiso.com/search/Results.aspx?k=specification&ks=interface+specification).
- The main content area displays a map of California divided into three regions: NP15 (orange), ZP26 (blue), and SP15 (green).
- On the left, there's a sidebar with links for "Standards Information", "System Help", and "System Technical Information".

**Right Side (Specification):**

- The header says "SPECIFICATION".
- The URL is [www.caiso.com/search/Results.aspx?k=specification&ks=interface+specification](http://www.caiso.com/search/Results.aspx?k=specification&ks=interface+specification).
- The main content area shows a search bar with "interface specification" and a search icon.
- Below the search bar, there are filters for "Date posted" (One Year Ago to Today) and "Category" (Tariff (147), Technical Documentation (93), Agenda (81)).
- A list of results is shown, with the top item being "FRT | OASIS Interface Specification v5.1.8 Clean (Independent 2019...)".

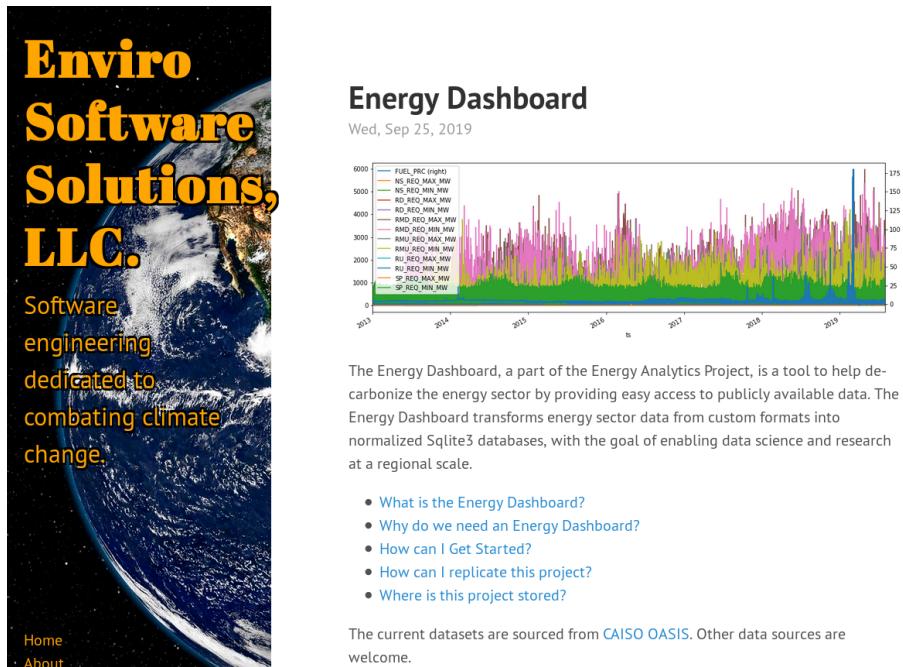
- <http://www.caiso.com/Documents>
- [http://www.caiso.com/Documents/OASIS-InterfaceSpecification\\_v5\\_1\\_6Clean\\_Independent2019Release.pdf](http://www.caiso.com/Documents/OASIS-InterfaceSpecification_v5_1_6Clean_Independent2019Release.pdf)

The Interface Specification is your portal to data.

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- [ ] Questions

## What is the Energy Dashboard?



The Energy Dashboard, a part of the Energy Analytics Project, is a tool to help decarbonize the energy sector by providing easy access to publicly available data. The Energy Dashboard transforms energy sector data from custom formats into normalized SQLite3 databases, with the goal of enabling data science and research at a regional scale.

- What is the Energy Dashboard?
- Why do we need an Energy Dashboard?
- How can I Get Started?
- How can I replicate this project?
- Where is this project stored?

The current datasets are sourced from CAISO OASIS. Other data sources are welcome.

- [http://envirosoftwaresolutions.com/posts/energy\\_dashboard/](http://envirosoftwaresolutions.com/posts/energy_dashboard/) ([http://envirosoftwaresolutions.com/posts/energy\\_dashboard/](http://envirosoftwaresolutions.com/posts/energy_dashboard/))

*The Energy Dashboard takes data from CAISO OASIS and publishes it to S3 buckets. [ED](#) ([http://envirosoftwaresolutions.com/posts/energy\\_dashboard/](http://envirosoftwaresolutions.com/posts/energy_dashboard/))*

Image courtesy of [ED](#) ([http://envirosoftwaresolutions.com/posts/energy\\_dashboard/](http://envirosoftwaresolutions.com/posts/energy_dashboard/)).

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- [X] Questions

## More Links

- [https://en.wikipedia.org/wiki/Regional\\_transmission\\_organization\\_\(North\\_America\)](https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America)
- <https://www.thebalance.com/who-regulates-energy-companies-in-the-united-states-1182615>
- [https://en.wikipedia.org/wiki/Regional\\_transmission\\_organization\\_\(North\\_America\)](https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America)
- <https://isorto.org/>
- [https://en.wikipedia.org/wiki/Columbia\\_River](https://en.wikipedia.org/wiki/Columbia_River)
- <https://www.eia.gov/todayinenergy/detail.php?id=16891>
- <http://www.cbr.washington.edu/hydro>
- <https://www.nwcouncil.org/reports/columbia-river-history/hydropower>
- [Orcas Briefing](https://www.nwcouncil.org/sites/default/files/2019_1015_1.pdf)
- [Marine Heat Waves Briefing](https://www.nwcouncil.org/sites/default/files/2019_1015_2.pdf)
- <https://www.nwcouncil.org/>
- <https://www.nwpp.org/>
- [Seventh Power Plan](https://www.nwcouncil.org/energy/7th-northwest-power-plan/about-seventh-power-plan)
- [Invenergy IPP](https://www.nwcouncil.org/sites/default/files/2019_1015_8.pdf)
- [Randy Hardy 2017](https://www.nwcouncil.org/sites/default/files/3transcript.pdf)
- [BPA](https://en.wikipedia.org/wiki/Bonneville_Power_Administration)
- <https://www.nrel.gov/news/program/2018/10-years-duck-curve.html>
- <https://www.nwcouncil.org/meeting/council-meeting-october-15-2019>
- <https://www.epa.gov/columbiariver/columbia-river-cold-water-refuges>
- [https://archive.fisheries.noaa.gov/wcr/fish\\_passage/fcrps\\_opinion/flexible-spill-operations.html](https://archive.fisheries.noaa.gov/wcr/fish_passage/fcrps_opinion/flexible-spill-operations.html)

normal