IDAHO ENERGY LANDSCAPE

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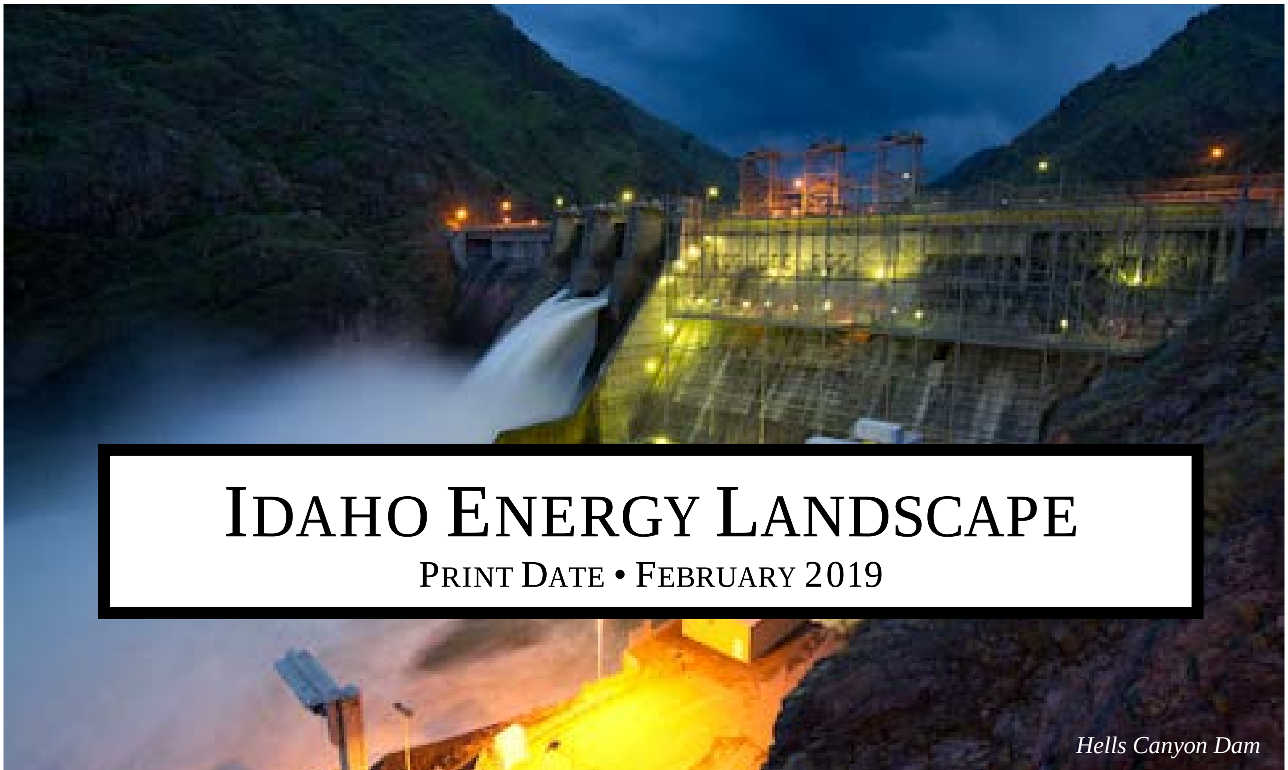
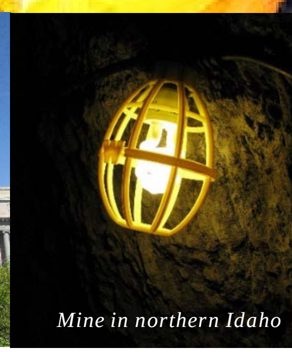


Hells Canyon Dam

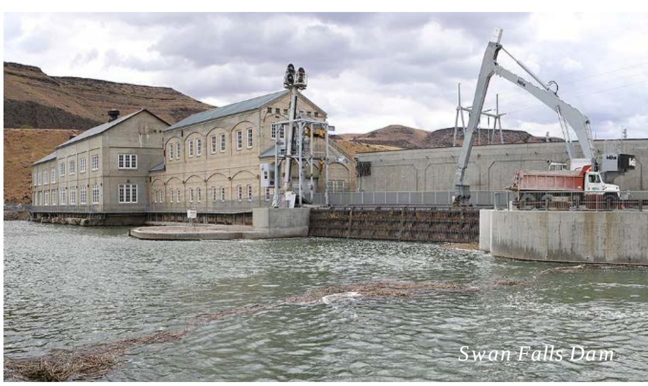
State Capitol



Mine in northern Idaho

Grand View Solar Farm

Idaho Governor's Office of Energy and Mineral Resources
304 N. 8th Street, Suite 250
P.O. Box 83720
Boise, Idaho 83720-0199



Swan Falls Dam

Fossil Gulch Wind Farm

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1. Idaho's Energy Landscape

1.1. ENERGY & THE ECONOMY

The health of Idaho's economy and the quality of the Idaho way of life depend upon access to affordable and reliable energy resources. Idaho's strong and diversified economy is fueled by energy-dependent sectors, including technology, manufacturing, agriculture, tourism, healthcare, construction, and professional services, all of which benefit from Idaho's low cost of energy.

Energy costs are affected by the economy, new technology, governmental regulation, and global market trends. For example, advancements in natural gas production technologies have increased the supply of domestically-produced natural gas. This has substantially lowered the cost to consumers and increased consumption by approximately 50 percent in the past decade. [1]

Historically, economic growth and energy consumption were strongly and positively correlated; however, technological changes and the increased utilization of energy efficiency have weakened this correlation. Idaho's gross domestic product grew 4.7 percent annually from 1997 to 2017, and Idaho's energy consumption (transportation, heat, light, and power) grew 1.1 percent annually from 1990 to 2016.[2] Today, thousands of people work in Idaho's energy sector, which pushes the boundaries of technology, launches start-ups, and fuels research, growth, and discovery.

1.1.1. Energy Costs

Low energy rates have consistently attracted energy-intensive industries to Idaho, including mining, pulp and paper, agriculture, food processing, and computer chip manufacturing. As a result, Idaho's energy expenditures equated to almost 8.3 percent of the state's Gross Domestic Product (GDP) in 2016, placing Idaho 13th among U.S. states for total energy costs to states.[3] The total energy costs per GDP illustrated in Figure 1.1 include the cost of gasoline to the state as well. Due to the rural nature of Idaho and the absence of a petroleum refinery in the state, Idahoans frequently spend more on transportation fuel than individuals who live in more densely populated regions of the country.

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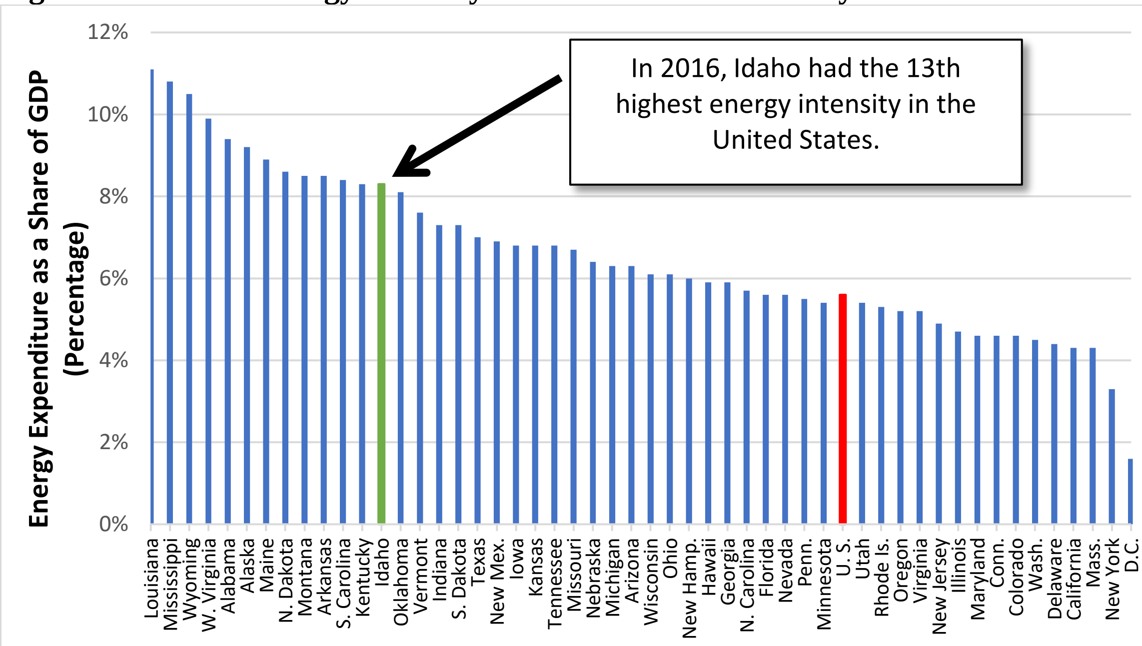
[1] U.S. Energy Information Administration. "Natural Gas" www.eia.gov/dnav/ng/hist/n3045us2a.htm
[2] Federal Reserve Bank of St. Louis. "FRED." https://fred.stlouisfed.org/series/IDNGSP and U.S. Energy Information Administration. "Total End-Use Energy Consumption Estimates, 1960-2016, Idaho." www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tx/use_tx_ID.html&sid=ID
[3] U.S. Energy Information Administration. "Total Energy Price and Expenditure Estimates, Ranked by State, 2016." https://www.eia.gov/state/seds/sep_sum/html/pdf/rank_pr.pdf

Figure 1.1 Idaho's Energy Intensity as a Share of the Economy[4]



Collectively, Idaho's residential, commercial, industrial, and transportation sectors spent almost $6 billion on energy in 2016.[5] When those dollars were adjusted specifically for residential and commercial use, the average Idahoan spent about $2,500 on direct energy products in 2016, as demonstrated in Table 1.1.[6] This number was based on Idaho's 2016 population estimate and didn't account for the cost of using propane and heating oil as part of a customer's energy mix.

Table 1.1 Average Energy Bill per Person, 2016[7]

Energy Source	Dollars Per Year	Percentage of Total Cost
Gasoline	$1,052	42%
Electricity	$1,107	44%
Natural Gas	$302	12%
Wood	$36	2%
Coal	$3	0%
Total	**$2,502**	**100%**

Note: The fuel used to heat or power a home or business varies significantly across Idaho; therefore, the estimated cost per person is an average of all energy types. Some people may use more or less of a specific energy source.

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[4] U.S. Energy Information Administration. "Total Energy Price and Expenditure Estimates, Ranked by State, 2016" https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_pr.html&sid=US

[5] U.S. Energy Information Administration. "Primary Energy, Electricity and Total Energy Expenditure Estimates, 2016." https://www.eia.gov/state/seds/sep_sum/html/pdf/sum_ex_tot.pdf

[6] U.S. Energy Information Administration. "Total Energy Price and Expenditure Estimates, Ranked by State, 2016." https://www.eia.gov/state/seds/sep_sum/html/pdf/rank_pr.pdf

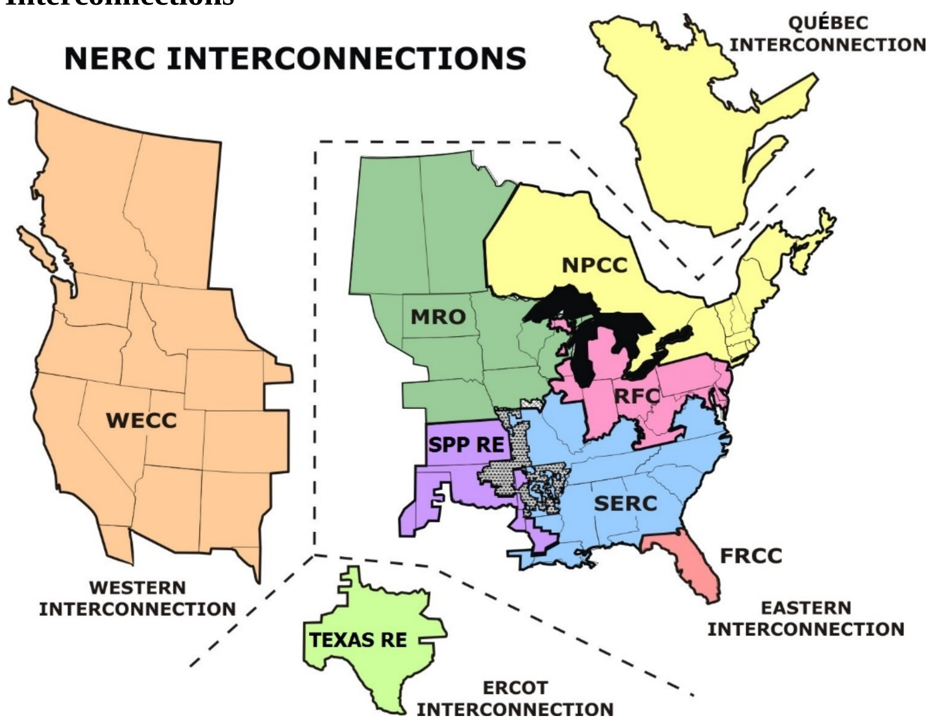
[7] U.S. Energy Information Administration. "Primary Energy, Electricity and Total Energy Expenditure Estimates, 2016." https://www.eia.gov/state/seds/sep_sum/html/pdf/sum_ex_tot.pdf; Idaho Department of Health and Welfare. "Idaho Vital Statistics: Population 2016." https://healthandwelfare.idaho.gov/Portals/0/Health/Statistics/2016-Reports/2016_Population.pdf

1.2 IDAHO UTILITIES AND ENERGY SYSTEMS

1.2.1. Electricity

The electrical transmission network in the United States and Canada is made up of four separate interconnections. The Western Interconnection links Idaho with the rest of the western United States and two Canadian provinces as shown in Figure 1.2. Existing coordination throughout the Western Interconnection on a local, sub-regional, and regional basis ensures a reliable and adequate integrated system of electricity for consumers. The Western Electricity Coordinating Council (WECC) is the regional entity that monitors and enforces compliance with reliability standards in Idaho and the rest of the Western Interconnection.[8]

Figure 1.2 North American Electric Reliability Corporation (NERC) Regional Electric Interconnections[9]



Idaho's electrical grid is served by three investor-owned utilities (IOUs), 11 municipal utilities, and 15 rural electric cooperatives. The three IOUs serve approximately 84 percent of the state's electricity needs, and municipal utilities and rural electric cooperatives serve the remaining 16 percent as illustrated by Figures 1.3 and 1.4.[10]

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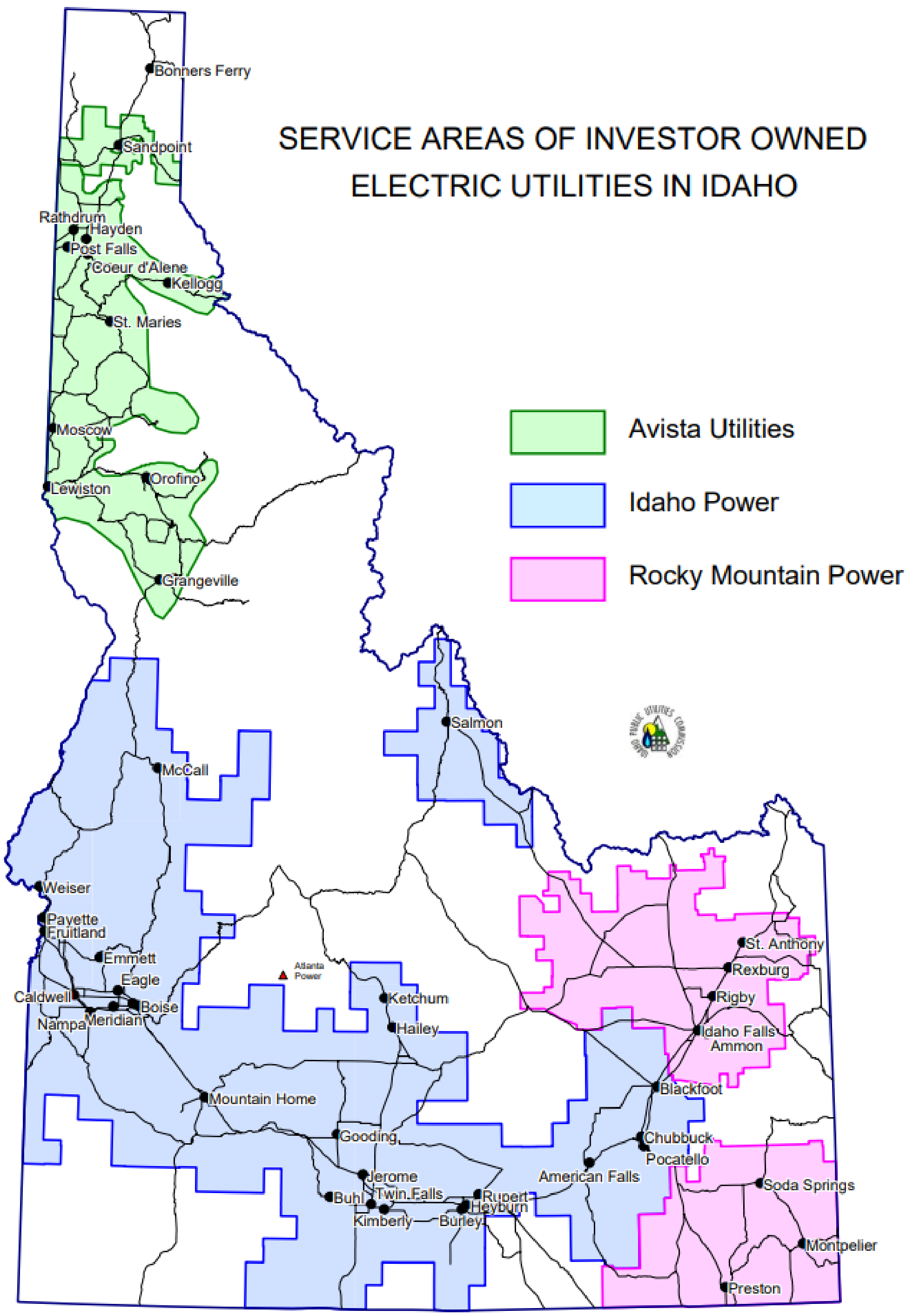
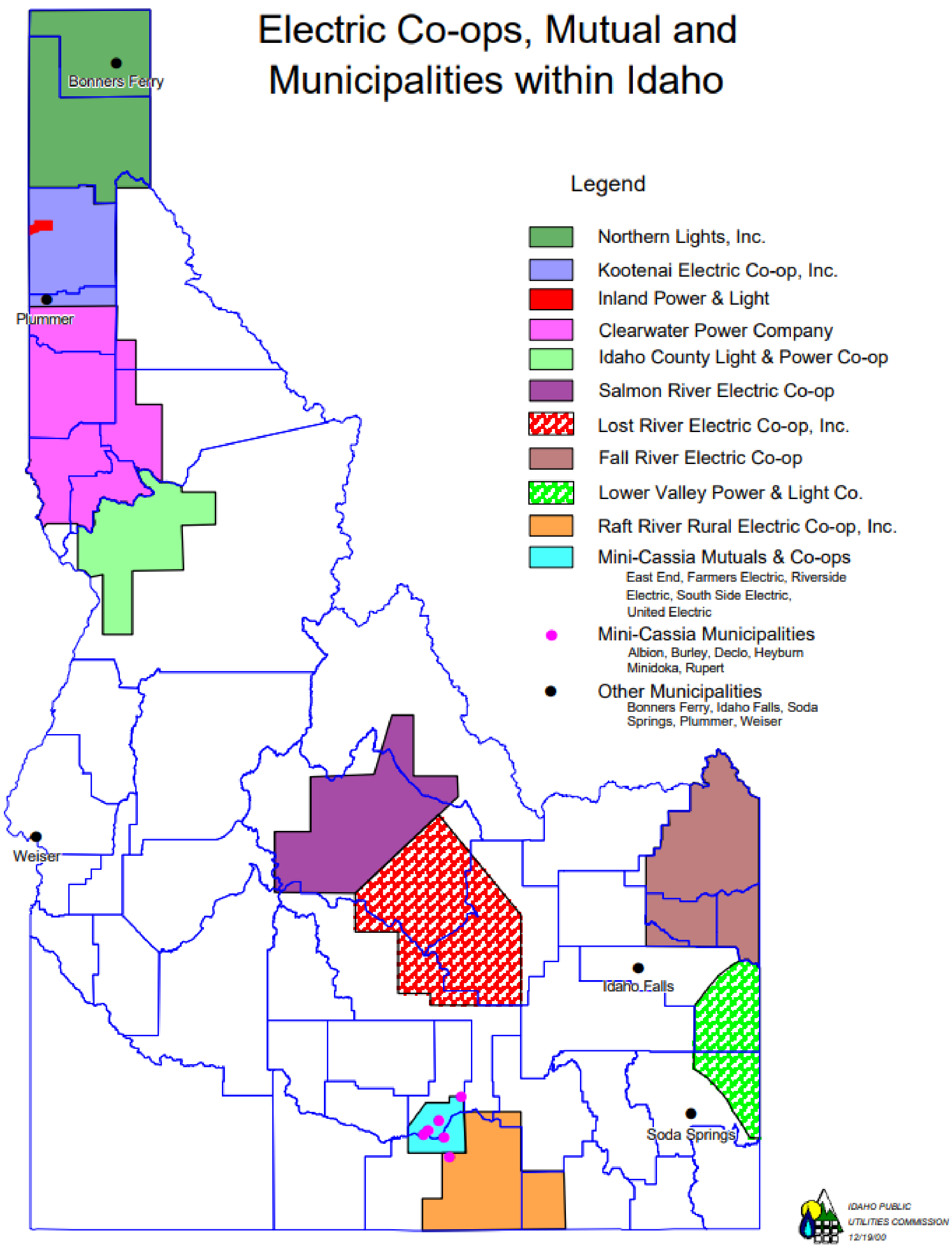
[8] Western Electricity Coordinating Council. "About WECC." https://www.wecc.org/Pages/AboutWECC.aspx
[9] North American Electric Reliability Corporation. http://www.nerc.com/AboutNERC/keyplayers/PublishingImages/NERC_Interconnections_Color_072512.jpg
[10] Idaho Consumer-Owned Utilities Association. "About ICUA." https://www.icua.coop/about-icua/

Figure 1.3 Idaho's Investor-Owned Electric Utilities Service Territories[11]



[11] Idaho Public Utilities Commission. https://www.puc.idaho.gov/fileroom/maps/elec.pdf

Figure 1.4 Idaho's Municipal and Cooperative Utilities Service Territories[12]



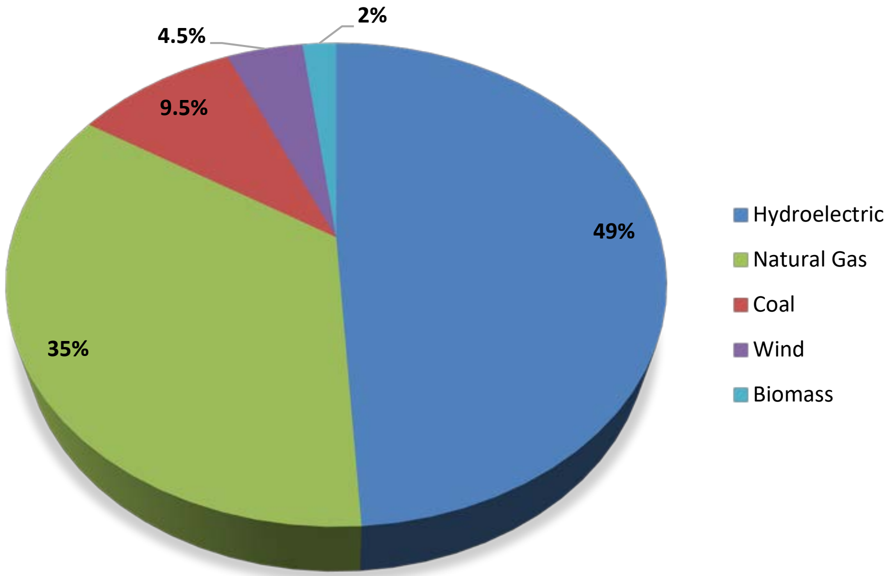
[12] Idaho Public Utilities Commission. https://www.puc.idaho.gov/fileroom/maps/elecoop.pdf

1.2.1.1. Avista Corporation

Avista is an investor-owned electric and natural gas utility headquartered in Spokane, Washington. Avista serves over 205,000 electric and natural gas customers in Idaho's northern and central regions. It is the second largest electricity and natural gas provider in Idaho, and the only investor-owned electric utility provider left in Idaho untied to the Western Regional Energy Imbalance Market (EIM) and California Independent System Operator (CAISO).

Avista generates electricity by utilizing a mix of hydroelectric, natural gas, coal, biomass, and wind generation delivered over 7,200 miles of electrical transmission lines, 19,000 miles of electrical distribution lines, and 7,800 miles of natural gas lines.[13] Avista's 2016 annual electrical energy fuel mix chart is shown in Figure 1.5 below. Hydroelectric generation accounts for nearly half of its electricity mix, which provides a significant price benefit for its customers. Natural gas generation comprises the next-largest source of generation. Avista's company-owned and contract hydroelectric resources are located in western Montana, eastern Washington, and northern Idaho; and its natural gas-fired baseload and capacity resources are located in Idaho, Oregon, and Washington. It also has an ownership share in the Colstrip coal-fired power plant in Montana.[14]

Figure 1.5 Avista Energy Production Mix (2016)[15]



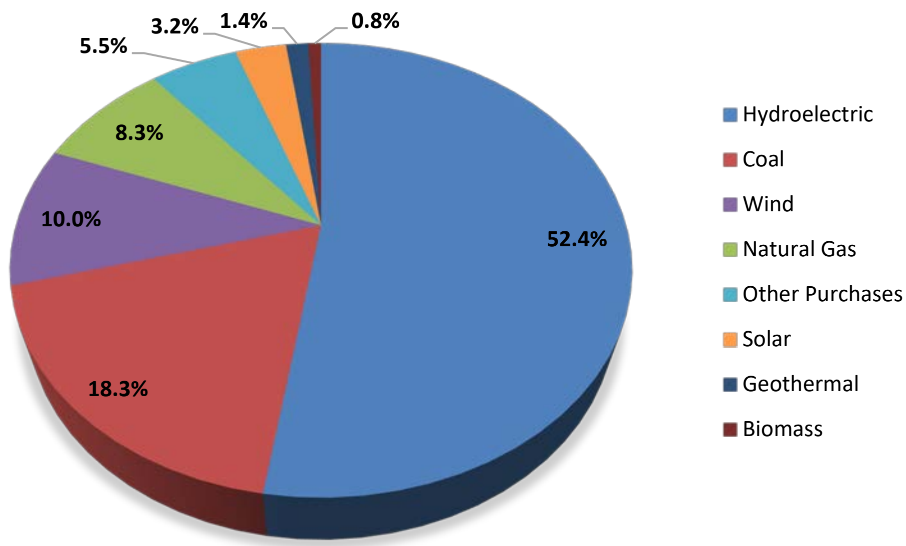
[13] Avista. "Quick Facts." https://www.myavista.com/about-us/our-company/quick-facts
[14] Avista. "2017 Electric IRP." https://www.myavista.com/about-us/our-company/integrated-resource-planning
[15] Avista. "About Our Energy Mix." https://www.myavista.com/about-us/our-company/about-our-energy-mix

1.2.1.2. Idaho Power Company

Founded in 1916, Idaho Power Company is the largest electricity provider in the State. Headquartered in Boise, it serves nearly 550,000 customers across a 24,000 square mile service territory in southern Idaho and eastern Oregon.[16] Electricity is supplied through nearly 5,000 miles of transmission line and more than 27,000 miles of distribution line. Idaho Power is one of the nation's few IOUs with a significant hydroelectric generating base, and it has 17 low-cost, emission-free hydroelectric projects at the core of its generation portfolio, including a 1,167 MW, three-dam complex in Hells Canyon.[17] In April 2018, Idaho Power signed an agreement to begin participating in EIM.

Idaho Power also generates electricity via two natural gas-fired combustion turbine "peaker" plants and the natural gas-fired combined cycle Langley Gulch Power Plant. Additionally, it has partial ownership in baseload coal facilities located in Wyoming, Oregon, and Nevada, the Bridger, Boardman and Valmy plants, respectively. Idaho Power's resource portfolio fuel mix is shown in Figure 1.6. In addition to its company-owned resources, Idaho Power's supply-side portfolio includes several long-term contracts with wind, solar, biomass, small hydro, and geothermal facilities. Among these are contracts with 134 PURPA projects, totaling 1,149 MW, of which 627 MW are wind generation and 316 MW are solar generation.[18]

Figure 1.6 Idaho Power Energy Production Mix (2017)[19]



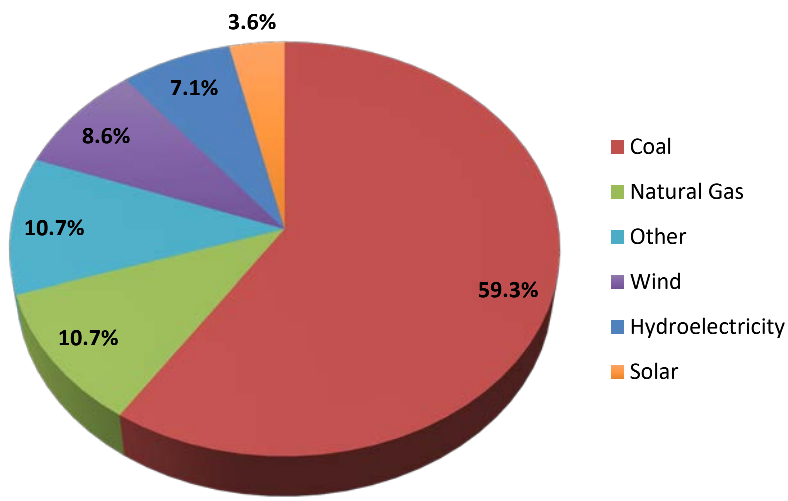
[16] Idaho Power Company. "Energy Sources." https://www.idahopower.com/energy/delivering-power/energy-sources/
[17] Idaho Power Company. "Power Plants." https://www.idahopower.com/energy/delivering-power/power-plants/
[18] Idaho Power Company. "2017 Integrated Resource Plan" https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf.
[19] Idaho Power Company. "Resource Portfolio Fuel Mix 2017." https://www.idahopower.com/energy/delivering-power/fuel-mix

1.2.1.3. PacifiCorp / Rocky Mountain Power

PacifiCorp serves more than 1.9 million retail customers across 141,390 square miles of service territory in California, Idaho, Oregon, Utah, Washington, and Wyoming.[20] PacifiCorp merged in 1989 with Utah Power & Light Company and was purchased by MidAmerican Energy Holdings Company in 2006, which later changed its name to Berkshire Hathaway Energy. In 2014, PacifiCorp and CAISO launched EIM. PacifiCorp operates under the name Rocky Mountain Power (RMP) in Idaho, Utah, and Wyoming, and serves 82,318 customers in southeastern Idaho, representing six-percent of PacifiCorp's retail sales.[21]

PacifiCorp owns 66 generating plants with 10,887 MW of net generation capacity, including coal, hydroelectric, natural gas, wind, and geothermal resources. Wind, hydro, geothermal, and other non-carbon-emitting resources currently make up 30 percent of RMP's owned and contracted generating capacity. PacifiCorp owns 1,032 MW of wind generation capacity and has long-term power purchase agreements for 1,301 MW from wind projects owned by others.[22] PacifiCorp's customers receive electricity through approximately 16,900 miles of transmission line, 64,000 miles of distribution line, 359 transmission substations and 821 distribution substations. [23] RMP's Energy Production Mix is shown in Figure 1.7.

Figure 1.7 Rocky Mountain Power Energy Production Mix (2017)[24]



[20] PacifiCorp. "Just the Facts." http://www.pacificorp.com/content/dam/pacificorp/doc/About_Us/Company_Overview/2018_Just-The-Facts_PacifiCorp.pdf
[21] Rocky Mountain Power. "Quick Facts." https://www.rockymountainpower.net/about/cf/qf.html
[22] PacifiCorp. "2017 IRP." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf
[23] PacifiCorp. "Quick Facts." http://www.pacificorp.com/about/co/cqf.html
[24] Rocky Mountain Power. "Power Content Label." https://www.rockymountainpower.net/content/dam/pacificorp/doc/CCCom_Update/2018/April_2018/17658-8_RMP_IDFuelMix_BillInsert_F.pdf

1.2.1.4. Idaho's Municipal and Cooperative Utilities

Twenty-six rural electric cooperatives and municipalities serve more than 137,000 customers throughout Idaho, accounting for about 16 percent of Idaho's electric consumers.[25] Twenty-three of these utilities are members of the Idaho Consumer Owned Utilities Association (ICUA) on issues of administrative, governmental, and regulatory significance.[26]

Municipal and cooperative utilities are not subject to regulation by the Idaho Public Utilities Commission.[27] Instead, Idaho's cooperative electric utilities provide competitively priced energy services to their members and are generally governed by an independently-elected Board of Directors. Idaho's several municipalities provide energy services to their communities and are generally governed by their respective city councils. Most of Idaho's cooperatives and municipalities purchase the bulk of their electricity – about 96 percent – from Bonneville Power Administration (BPA); however, many are beginning to acquire their own power generation resources and enter into power purchase agreements with other energy providers.[28] For example, Idaho Falls Power has five hydropower plants, a small amount of solar, and also purchases wind power from the Utah Associated Municipal Power Systems (UAMPS).[29]

1.2.1.5. Utah Associated Municipal Power Systems

Three of Idaho's municipal and cooperative utilities are members of UAMPS. UAMPS is a project-based joint action agency headquartered in Salt Lake City, comprised of 46 utilities in six western states. It provides comprehensive wholesale electric-energy services on a nonprofit basis to community-owned power systems throughout the Intermountain West. UAMPS conducts resource planning, evaluation of power resources or services for its members, and develops power-generating facility projects.[30]

1.2.2. Natural Gas

Two investor-owned natural gas utilities, Avista Utilities and Intermountain Gas Company provide the majority of natural gas service in Idaho. A third utility, Dominion Energy, provides service to a portion of Idaho customers in Franklin County located in the southeastern part of the state.[31] Figure 1.8 on the following page shows the major natural gas infrastructure in Idaho and Idaho utility service territories.

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[25] Idaho Public Utilities Commission. "Electric Co-op and Municipal Service Area Map." https://www.puc.idaho.gov/fileroom/maps/elecoop.pdf; and Idaho Consumer-Owned Utilities Association. "About ICUA." http://www.icua.coop/about-icua/

[26] Idaho Consumer-Owned Utilities Association. "About ICUA." www.icua.coop/about-icua/

[27] Idaho Public Utilities Commission. "About the Commission." https://www.puc.idaho.gov/about/about.html

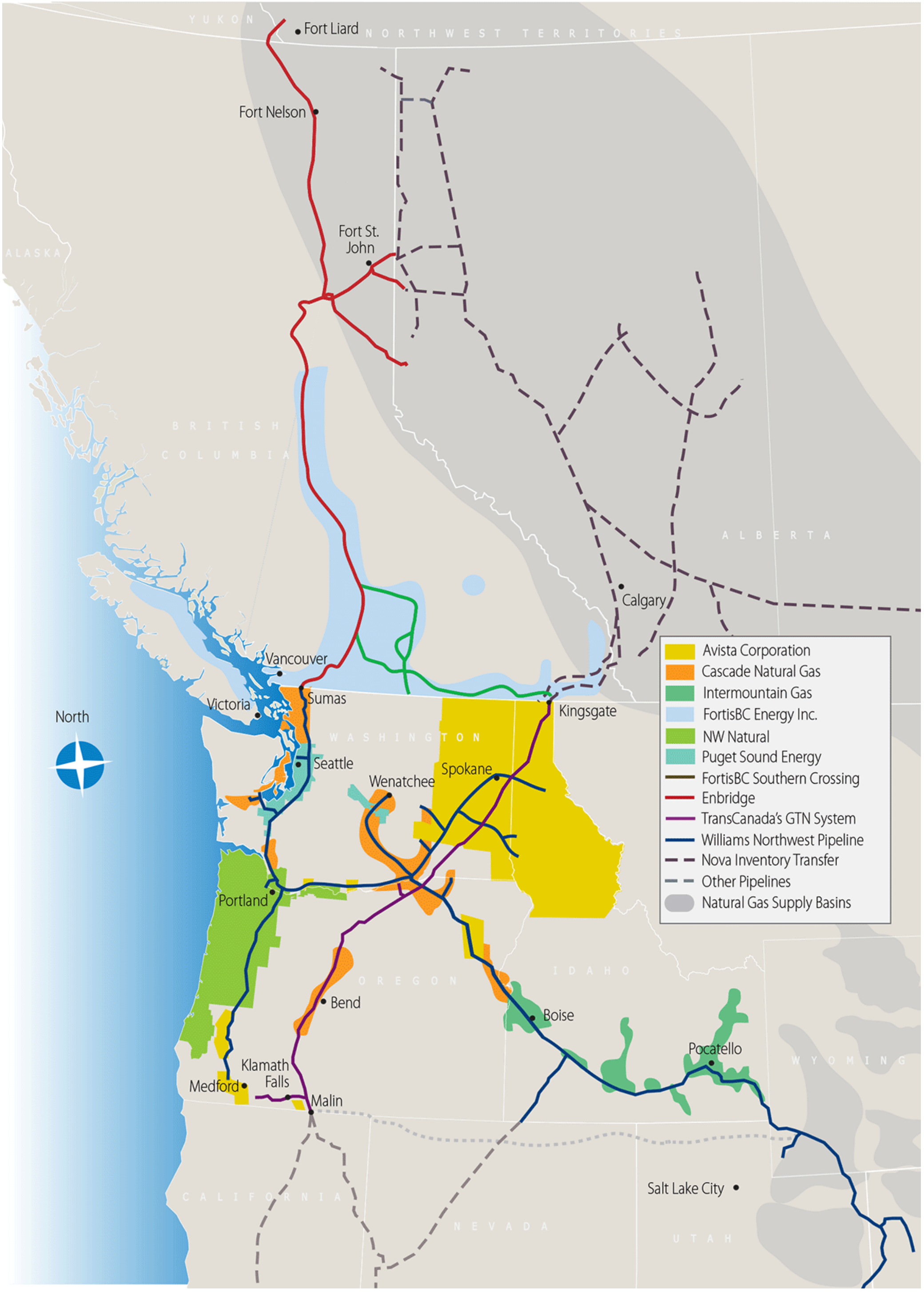
[28] Idaho Consumer-Owned Utilities Association. "About ICUA." http://www.icua.coop/about-icua/

[29] Idaho Falls Power. "Power Portfolio." https://www.idahofallsidaho.gov/248/Power-Portfolio

[30] UAMPS. "About Us." http://www.uamps.com/About-Us

[31] Dominion Energy "About Us – Western Gas Operations" https://www.dominionenergy.com/about-us/moving-energy/western-gas-operations

Figure 1.8 Western U.S. Interstate Natural Gas Pipeline System and Natural Gas Service Territories[32]



[32] Northwest Gas Association. "About Us." www.nwga.org/about-us/

1.2.2.1. Avista Utilities

Avista serves over 83,000 Idahoans in its Washington/northern Idaho natural gas service area, 90 percent of whom are residential customers.[33] Its North Division, which covers about 26,000 square miles primarily in eastern Washington and northern Idaho, is supplied by more than 40 points along interstate pipelines.

Avista holds firm access rights to both Canadian and Rocky Mountain natural gas supplies through the Williams Northwest and GTN pipelines. Avista also holds rights to the Jackson Prairie and Plymouth storage facilities in Washington. According to Avista's latest Natural Gas Integrated Resource Plan the number of customers in Washington and Idaho is projected to increase at an average annual rate of 1.2 percent.[34]

1.2.2.2. Intermountain Gas Company

Intermountain Gas Company (IGC) was founded in Idaho in 1950, and in 2008 became a wholly-owned subsidiary of MDU Resources Group, headquartered in Bismarck, North Dakota. IGC distributes natural gas to approximately 365,000 residential, commercial, and industrial customers in 75 Idaho communities across 60,000 square miles in Southern Idaho through approximately 12,800 miles of pipeline. The 125 industrial and transport customers comprise 50 percent of the annual energy throughput while residential and commercial customers comprise 33 percent and 17 percent respectively.

Intermountain Gas holds firm capacity rights on William's Northwest Pipeline as well as three upstream pipelines to deliver gas to the distribution system. The upstream systems are; Gas Transmission Northwest, Foothills Pipeline and Nova Gas Transmission. IGC owns and operates the Nampa LNG storage facility and leases storage at the Jackson Prairie underground facility, the Plymouth LNG facility, and leases capacity from Dominion Energy's Clay Basin underground storage field. Residential, commercial, and industrial peak day load growth on IGC's system under design conditions is forecast to grow at an average annual rate of 2.68 percent over the five-year period of 2017-2021.[35]

1.2.2.3. Dominion Energy

Dominion Energy, formerly called Questar Gas, based in Salt Lake City, provides natural gas service to residential, commercial, and industrial customers in Utah, southwestern Wyoming and about 2,200 customers in Franklin County, Idaho.[36] The Idaho Public Utilities Commission has elected to allow the Utah Public Service Commission to regulate Dominion Energy's activities in its small Idaho service area.

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[33] Avista. "2018 Natural Gas Integrated Resource Plan." https://www.myavista.com/about-us/our-company/integrated-resource-planning

[34] Avista. "2018 Natural Gas Integrated Resource Plan." https://www.myavista.com/about-us/our-company/integrated-resource-planning

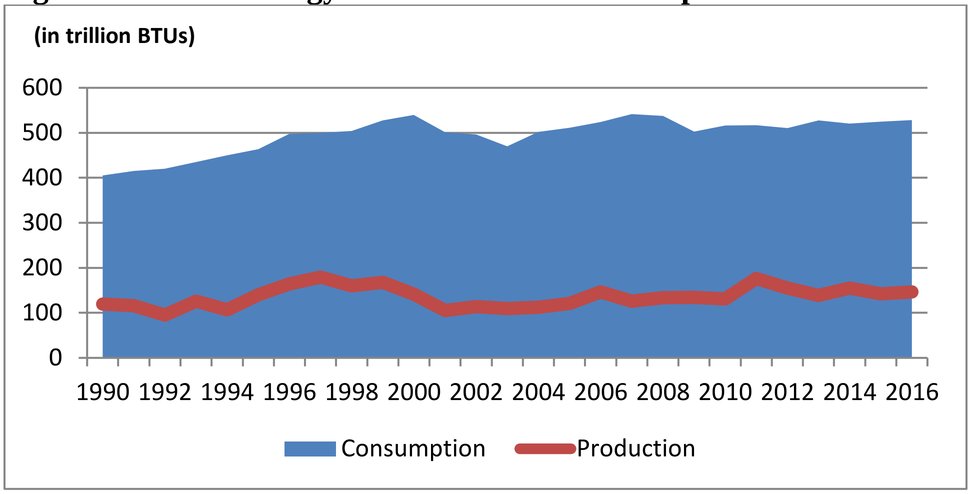
[35] Idaho Public Utilities Commission. "Intermountain Gas 2017 IRP." http://www.puc.idaho.gov/fileroom/cases/gas/INT/INTG1704/20170804APPLICATION%20SUMMARY.PDF

[36] Idaho Public Utilities Commission. "2018 Annual Report – Natural Gas." https://www.puc.idaho.gov/fileroom/annualreports/ar2018/Section%20III%20Natural%20Gas.pdf; Idaho Public Idaho Public Utilities Commission. "Merger Agreement." http://www.puc.idaho.gov/fileroom/cases/gas/QST/QSTG1601/ordnotc/20161019FINAL_ORDER_NO_33628.PDF

1.3. ENERGY CONSUMPTION, PRODUCTION, AND PRICES

Idaho produces approximately 28 percent of the total energy it consumes, including transportation and heating fuels along with electricity. This is demonstrated in Figure 1.9. The State's reliance upon imported energy requires a robust and well-maintained infrastructure of highways, railroads, pipelines, and transmission lines to facilitate economic development and maintain Idahoan's high quality of life.

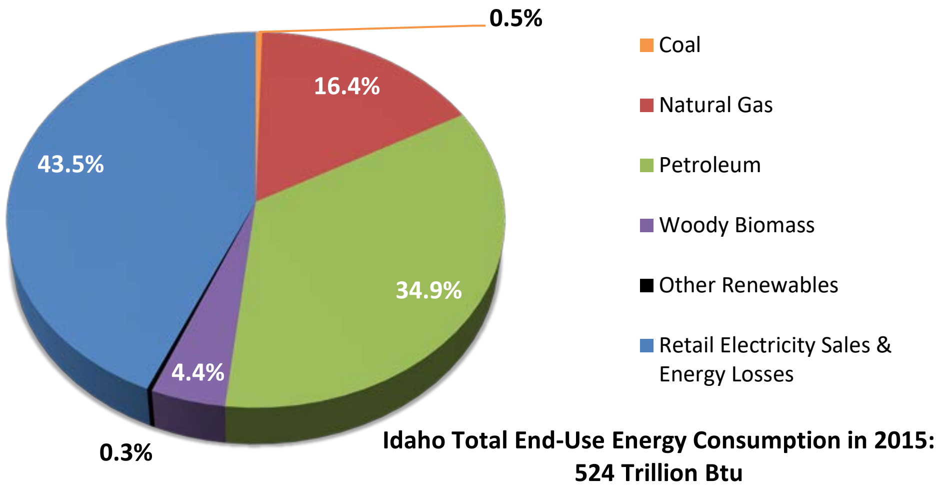
Figure 1.9 Idaho Energy Production and Consumption[37]



1.3.1. Sources of Idaho's Energy

As shown in Figure 1.10, petroleum – including those blended with ethanol – used primarily for transportation accounts for approximately 34 percent of Idaho's end-use energy consumption. Important energy commodities such as electricity sales and system losses account for 44 percent and natural gas accounts for 16 percent, while the remaining 6 percent is attributable to coal, biomass, and other renewable energy sources.

Figure 1.10 Sources of End Use Energy Consumed in Idaho in 2016[38]



[37] U.S. Energy Information Administration. https://www.eia.gov/state/seds/seds-data-complete.php?sid=ID#

[38] U.S. Energy Information Administration. https://www.eia.gov/state/seds/sep_use/notes/use_print.pdf

Figure 1.11 illustrates Idaho's dependence upon imported electricity to meet load demands. Idaho's utilities generate approximately 44 percent of the energy utilized in-state, and 24 percent is provided by non-utility cogeneration or independent power producers. The remaining 32 percent is comprised of market purchases and energy imports from out-of-state generating resources owned by Idaho utilities.

Figure 1.11 Idaho's 2016 Electricity Energy Sources[39]

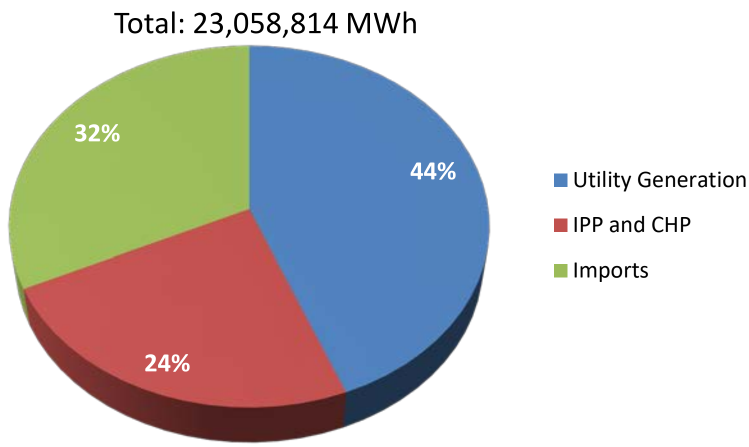
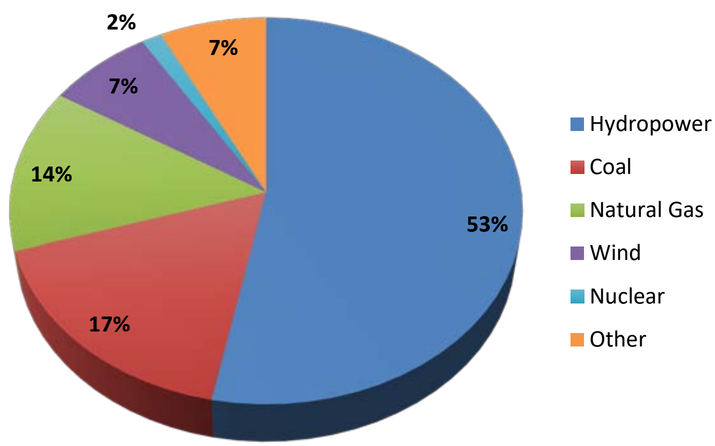


Figure 1.12 Idaho's 2017 Electricity Fuel Mix[40]



Note: The fuel mix in this figure is based on the percentage of Idaho load served by each utility and not by the generation source of the energy actually delivered to the customer. "Other" refers to solar, geothermal, biomass, and other sources.

As illustrated in Figure 1.12, hydroelectricity and coal are the dominant sources of Idaho's electricity, comprising approximately 53 and 17 percent, respectively. Natural gas makes up 14 percent, and non-hydro renewables, principally wind power, geothermal and biomass, accounting for approximately 14 percent. Idaho's municipal and

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[39] U.S. Energy Information Administration. www.eia.gov/electricity/state/idaho/index.cfm
[40] Investor-Owned Utilities information is from each investor-owned utility's FERC Form 1: https://www.ferc.gov/docs-filing/forms.asp and for percent of Idaho load served: https://www.eia.gov/electricity/data.php BPA: Source: https://www.bpa.gov/p/Generation/Fuel-Mix/FuelMix/BPA-Official-Fuel-Mix-2017.pdf

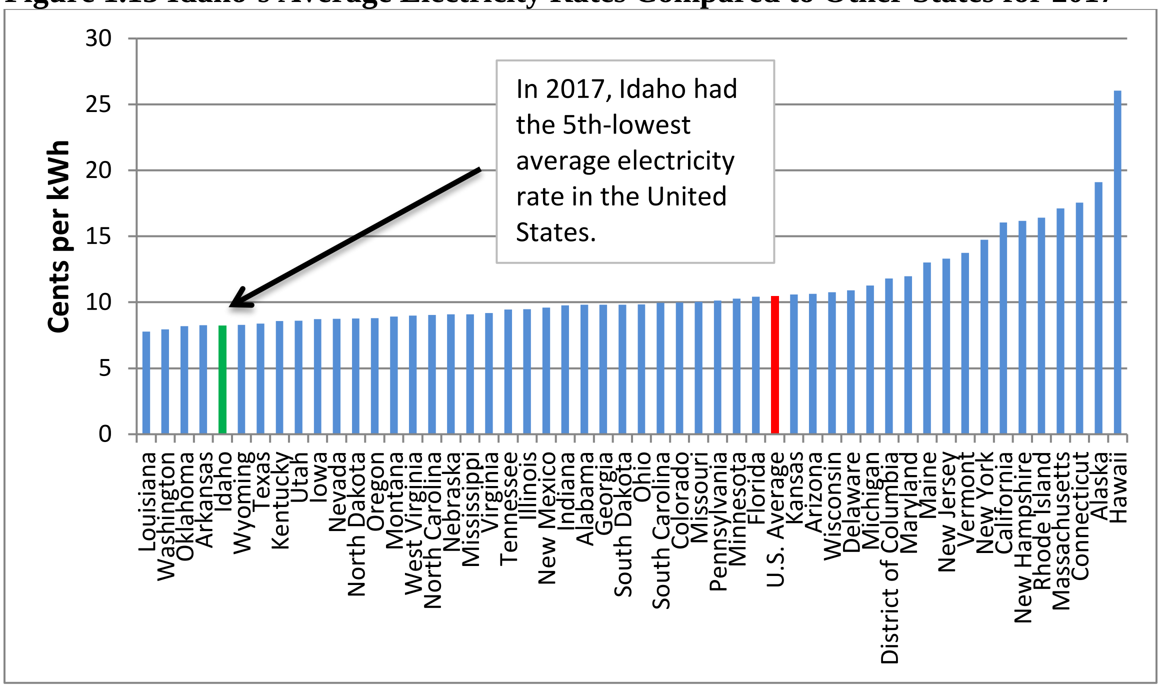
cooperative utilities also receive some output from the Columbia Generating Station nuclear plant in Washington.

While hydroelectric is typically the primary resource utilized for electricity generation in Idaho, its percentage depends upon the quality of the water year. Recent droughts reduced hydroelectric share to less than three-fifths in 2015. Natural gas and non-hydroelectric renewable sources almost entirely supplied the remaining two-fifths. All electricity sourced from coal-fired plants is generated in neighboring states.[41]

1.3.2. Energy Rates Compared to Other States

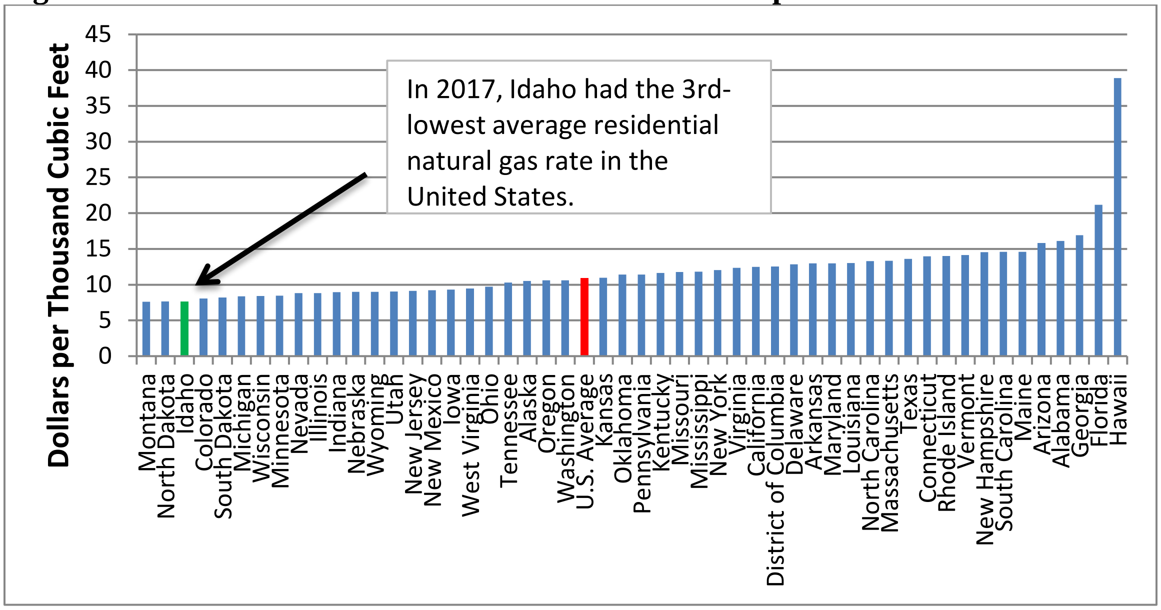
Low average rates for electricity and natural gas are the most important feature of Idaho's energy outlook. Large hydroelectric facilities on the Snake River and other tributaries of the Columbia River provide energy and the cost-effective flexibility required to meet the demand peaks of the region. Idaho's baseload resources, including hydro, thermal, and coal resources provide a constant source of reliable, relatively low-cost electricity to Idaho utilities. As a result, Idaho's average electricity rates were the 5th lowest among the fifty states in 2017, shown in Figure 1.13. Idaho's average residential natural gas rates also were among the lowest in U.S. in 2017, as shown in Figure 1.14.

Figure 1.13 Idaho's Average Electricity Rates Compared to Other States for 2017[42]



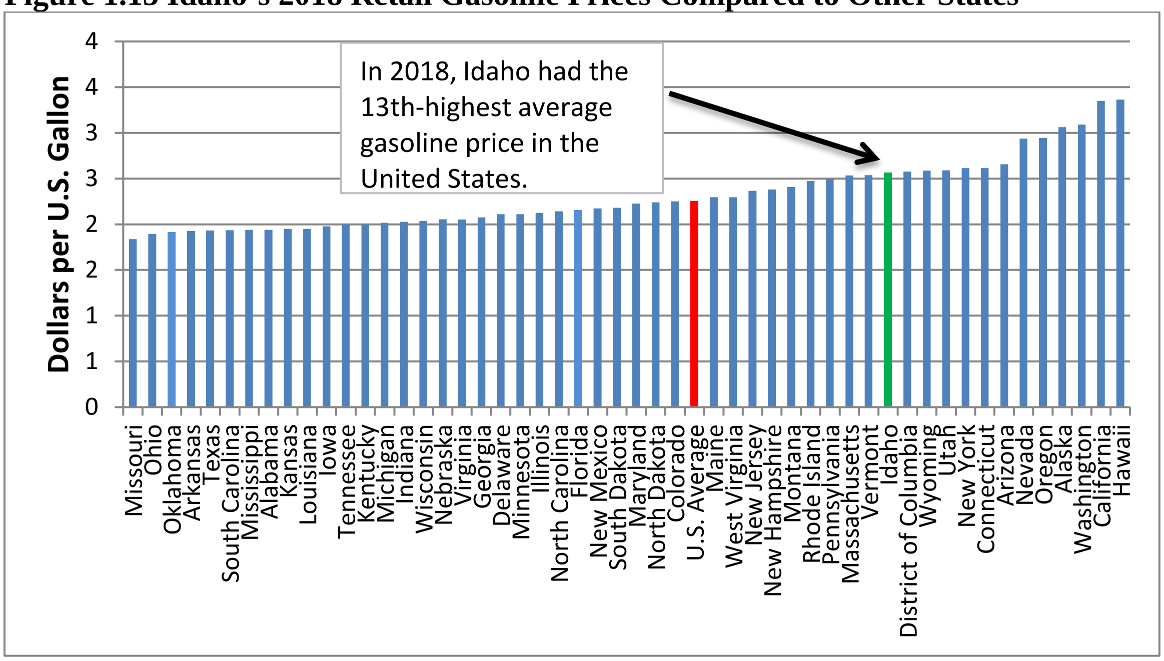
[41] U.S. Energy Information Administration, "Idaho State Profile." https://www.eia.gov/state/analysis.php?sid=ID
[42] U.S. Energy Information Administration. "Total Electricity Price." https://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf.

Figure 1.14 Idaho's Residential Natural Gas Prices Compared to Other States[43]



Idaho relies principally upon refineries in Montana, Utah, and Washington for its supplies of gasoline, diesel, and other petroleum products. Due to the need to import these products, Idaho's prices for these products are typically higher than the national average.

Figure 1.15 Idaho's 2018 Retail Gasoline Prices Compared to Other States[44]



Note: The average combined (local, state and federal) gasoline tax was 52.61 cents per gallon. Idaho's combined gasoline tax rate in 2018 was 51.40 cents per gallon.[45]

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[43] U.S. Energy Information Administration. www.eia.gov/dnav/ng/NG_PRI_SUM_A_EPG0_PRS_DMCF_A.htm
[44] AAA, "Gas Prices." https://gasprices.aaa.com/
[45] American Petroleum Institute, http://www.api.org/~/media/Files/Statistics/Gasoline-Tax-Map.pdf

1.4. STATE, REGIONAL AND FEDERAL ENERGY COORDINATORS AND REGULATORS

Policies adopted in neighboring states, regionally or nationally may have an impact on the cost or future rates of energy for citizens located in Idaho. The agencies listed below are involved in coordinating or regulating various aspects of energy policy in Idaho.

1.4.1. Idaho Public Utilities Commission

The PUC regulates Idaho's investor-owned electric, natural gas, telecommunications, and water utilities to ensure adequate service at just, reasonable and sufficient rates. The PUC also has authority to promulgate administrative rules under the Idaho Administrative Procedures Act.[46]

The PUC consists of three commissioners, appointed by the governor and subject to Senate confirmation, who serve staggered, six-year terms. No more than two commissioners may be of the same political party. The PUC renders decisions based upon all of the evidence that is presented in the case record. PUC orders may be appealed directly to the Idaho Supreme Court.

The PUC holds formal hearings that resemble judicial proceedings in which parties to the case may present testimony and evidence and may conduct cross-examinations. All cases are a matter of public record. The PUC seeks to increase transparency of its operations and has made information about its functions and means by which citizens can get involved in rate cases available on its website. Information about the PUC's Consumer Assistance Section, which helps customers with billing and service-related questions, also is available on the website. [47]

To ensure its decisions are based upon the best information available, the PUC employs approximately 50 people, including engineers, accountants, economists, and investigators, to analyze each matter before the PUC and to issue a recommendation. In formal proceedings, the staff is a separate party to the case, and may present its own testimony, evidence, and expert witnesses. Staff recommendations are considered by the PUC along with those of other parties to each case, which may include utilities, the public, and agricultural, industrial, business, or consumer groups.

1.4.2. Idaho Oil and Gas Conservation Commission

The Idaho Oil and Gas Conservation Commission operates under the authority of section 47-314 of Idaho Code.[48] Administratively housed within the Idaho Department of Lands (IDL), the Commission regulates the exploration, drilling, and production of oil and gas resources in Idaho to ensure the conservation of the resources and the protection of surface and groundwater.[49]

IDL reviews applications for drilling, well treatment, pit construction, and other activities in conjunction with the Idaho Department of Water Resources and the Idaho Department

[46] Idaho Statutes § 61and § 62.
[47] Idaho Public Utilities Commission. "About the Commission." www.puc.idaho.gov
[48] Idaho Statute §47-314.
[49] Idaho Oil and Gas Conservation Commission. "About the Commission." https://ogcc.idaho.gov/

of Environmental Quality. The Director or her/his designee may hold administrative hearings on applications for activities that may affect other mineral interest owners. The Commission consists of the Director of IDL, as well as a Governor-appointed county commissioner from an oil and gas producing county and three Governor-appointed technical experts with degrees in geosciences or engineering and at least ten years of experience in the oil and gas industry.

1.4.3. Idaho Energy Resources Authority

The Idaho Energy Resources Authority (IERA) is an energy-related lending/financing entity authorized to issue revenue bonds to municipal and cooperative electric utilities. It was established by the Legislature in 2005 to promote transmission, generation, and renewable energy development in the state and the region.

The IERA provides a vehicle for Idaho utilities to jointly own and finance transmission and generation projects for the benefit of their ratepayers, which often was financially unfeasible for Idaho's municipal and cooperative electric utilities prior to 2005. The IERA can participate in planning, financing, constructing, developing, acquiring, maintaining, and operating electric generation and transmission facilities and their supporting infrastructure. While the IERA has bonding authority and other powers to promote specific projects, it has no appropriation, no full-time staff, and no ability to finance projects that are not backed by ratepayers.[50]

In 2010, the IERA undertook a structured transaction in conjunction with UAMPS to develop the Horse Butte Wind Project on behalf of UAMPS members, including the City of Idaho Falls and Lower Valley Energy (an electric cooperative that serves Caribou and Bonneville Counties). Participation by the IERA materially lowered the development costs of Horse Butte for the UAMPS participant members that now own the wind project.

In 2013, the IERA and the BPA signed a Master Memorandum of Intent to allow BPA to finance northwest transmission facilities through the issuance of IERA bonds. On September 21, 2017, IERA issued $200,765,000 of Transmission Facilities Revenue Bonds to BPA. The proceeds of the bond sale will be used to finance the acquisition of transmission facilities owned by the Northwest Infrastructure Finance Corporation VI.[51]

1.4.4. Idaho Department of Environmental Quality

DEQ is responsible for enforcing various state environmental regulations and administers a number of federal environmental protection laws including the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act.[52] DEQ has six regional offices across the state with staff who are knowledgeable about environmental issues in their particular regions.[53]

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[50] Idaho Energy Resources Authority. http://iera.info/purpose/
[51] Idaho Energy Resource Authority. http://iera.info/announcements/
[52] Idaho Department of Environmental Quality. http://www.deq.idaho.gov/about-deq/
[53] Idaho Department of Environmental Quality http://www.deq.idaho.gov/regional-offices-issues/

1.4.5. Idaho Department of Lands

The IDL leases and issues rights-of-way for energy projects on state endowment lands and provides regulatory oversight of forestry practices in the State and some regulation of Idaho's mining industry.[54] IDL has 16 regional offices throughout the state with staff that provide professional assistance to the citizens of Idaho.

1.4.6. Idaho Governor’s Office of Energy and Mineral Resources

The Idaho Governor’s Office of Energy and Mineral Resources (OEMR), reestablished by Executive Order 2016-03, coordinates energy and mineral planning and policy development in the State of Idaho.[55] OEMR works to ensure that Idaho energy and mineral resources are developed and utilized in an efficient, effective, and responsible manner, enhance the economy, and sustain the quality of life for its citizens.

OEMR serves as the clearinghouse and first point of contact for the State on energy matters. It oversees the Idaho Strategic Energy Alliance (ISEA), serves as a resource for policy makers, and coordinates efforts with federal and state agencies and local governments. OEMR also administers energy efficiency programs, including Government Leading by Example and the State Energy Loan Program. Information about Idaho’s energy and mineral landscape is available to the public on OEMR’s website.[56]

1.4.7. Idaho Strategic Energy Alliance

Governor C.L. “Butch” Otter established the ISEA in 2009 to enable the development of a sound energy portfolio that emphasizes the importance of diverse, effective, secure, and stable sources of energy. The portfolio includes energy resources available to the state and production methods that provide a high value to Idahoans, thereby ensuring the ongoing good stewardship of our environment. Through its Board of Directors and Taskforces, ISEA engages a wide variety of stakeholders to develop effective and long-lasting responses to existing and future energy challenges.[57]

1.4.8. Leadership in Nuclear Energy Commission 3.0

The Leadership in Nuclear Energy Commission (LINE) 3.0 was established by Executive Order 2017-11 and makes recommendations to the Governor on policies and actions of the State of Idaho to support and enhance the long-term viability and mission of Idaho National Laboratory (INL) and other nuclear industries in Idaho. Membership of the Commission includes cabinet officials, local government leaders, representatives from Idaho tribes, INL, Idaho universities, the nuclear industry, and a member of the public.

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[54] Idaho Department of Lands. https://www.idl.idaho.gov/land-board/about-idl/index.html; https://www.idl.idaho.gov/oil-gas/leasing/index.html

[55] Governor C.L. “Butch” Otter. “Executive Order 2016-03.” https://gov.idaho.gov/mediacenter/execorders/eo16/EO_2016-03.pdf

[56] Idaho Governor’s Office of Energy and Mineral Resources. https://oemr.idaho.gov/

[57] Idaho Governor’s Office of Energy and Mineral Resources. “Idaho Strategic Energy Alliance.” https://oemr.idaho.gov/isea/

1.4.9. Idaho State Department of Agriculture, Bureau of Weights and Measures

The Bureau of Weights and Measures is responsible for assuring the accuracy of commercial weighing and measuring devices such as petroleum meters, fuel pumps, and propane meters. The Bureau monitors gasoline octane levels and is responsible for Idaho's fuel quality and labeling.[58]

1.4.10. Bonneville Power Administration

BPA is one of four power marketing agencies under the U.S. Department of Energy (DOE) that supply power throughout their regions.[59] BPA is self-funded and serves the Northwest, supplying about 28 percent of regional power. BPA works with cooperatives, municipalities, IOUs, and directly provides power to some industrial and irrigation customers in a practice known as direct-service.[60]

BPA sources power from 31 federal hydroelectric dams that are operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation. These dams are referred to as the Federal Columbia River Power System. It also markets power generated from some non-federal plants in the Northwest, as well as additional power from the 1,200 MW Columbia Generating Station nuclear power plant in Richland, Washington. BPA's energy resources are shown in Figure 1.16. BPA operates and maintains approximately three-fourths of the high-voltage transmission lines that serve nearly 13.7 million people in its service territory, which covers over 300,000 square miles and includes Idaho, Oregon, Washington, parts of Montana, California, Nevada, Utah and Wyoming.[61]

BPA annually updates a Pacific Northwest Loads and Resources Study, commonly referred to as the "White Book," which documents regional retail loads and resource capabilities that serve the federal system and Pacific Northwest for 10 years. The most recent "White Book" details resource capabilities from 2019 through 2028. The study uses public resource planning reports submitted by individual utilities, the Northwest Power and Conservation Council and the Pacific Northwest Utilities Conference Committee.[62] According to the Federal System Analysis in the 2017 "White Book," the federal system is projected to have small annual energy surpluses for the first two years, and then large energy deficits over the remaining eight years. Energy deficits are expected to peak in the winter due to higher peak load obligations.[63]

While Idaho municipal and cooperative utilities historically relied upon BPA for most power needs, BPA capped the amount of base system federal power available to all

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[58] Idaho State Department of Agriculture. https://agri.idaho.gov/main/about/about-isda/ag-inspections/

[59] U.S. Energy Information Administration. "Federal Power Marketing Administrations operate across much of the United States." https://www.eia.gov/todayinenergy/detail.php?id=11651

[60] Bonneville Power Administration. "BPA facts." https://www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf

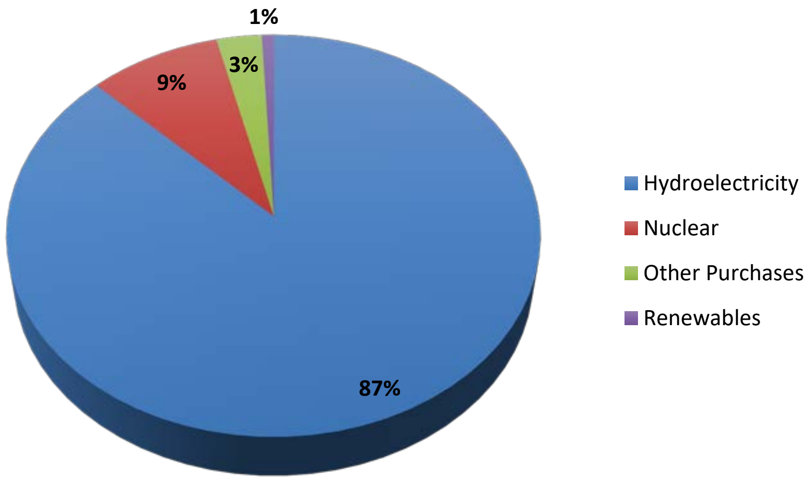
[61] Bonneville Power Administration. BPA Facts www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf

[62] Bonneville Power Administration. "2017 Pacific Northwest Loads and Resource Study." https://www.bpa.gov/p/Generation/White-Book/Pages/White-Book-2017.aspx

[63] Bonneville Power Administration. "2017 Pacific Northwest Loads and Resources Study. https://www.bpa.gov/p/Generation/White-Book/wb/2017-WBK-Loads-and-Resources-Summary-20171218.pdf

utilities beginning in 2011. Each utility is now faced with acquiring resources independently or jointly with other utilities to meet future demands.

Figure 1.16 BPA Resources (2017)[64]



1.4.11. Northwest Power and Conservation Council

The U.S. Congress created the Northwest Power and Conservation Council (Council) in 1980 through the Northwest Power Act, to better engage Idaho, Montana, Oregon, and Washington in future energy planning and the stewardship of the region's fish and wildlife resources.[65]

The Council is an independent entity, controlled by the states, without a vested interest in selling electricity. It forecasts future electricity load growth in the region and helps plan how to best meet future needs. The Council informs the public about regional energy issues and implements a program to conserve fish and wildlife in the Columbia River Basin system that are impacted by hydropower dams.[66]

The Council prepares and updates a least-cost Power Plan to advise BPA, which is updated at least every five years. Included are electricity demand forecasts, electricity and natural gas price forecasts, an assessment of cost-effective energy efficiency that can be acquired over the life of the plan, and a least-cost generating resources portfolio.[67]

Additionally, the Council updates the Columbia River Basin Fish and Wildlife Program every five years. The latest update was adopted in October 2014. The Seventh Power

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[64] Bonneville Power Administration. "Fuel Mix" https://www.bpa.gov/p/Generation/Fuel-Mix/Pages/Fuel-Mix.aspx
[65] Northwest Power and Conservation Council. "About." https://www.nwcouncil.org/about
[66] Northwest Power and Conservation Council. "2018 Overview." https://www.nwcouncil.org/sites/default/files/2018overview.pdf
[67] Northwest Power and Conservation Council. "Seventh Northwest Power Plan Summary Brochure." https://www.nwcouncil.org/sites/default/files/finalplanbrochure.pdf

Plan incorporated the full Fish and Wildlife Program in May 2016, and the Council will begin forming the next Fish and Wildlife Plan in summer 2019.[68]

1.4.12. U.S. Department of Energy

The DOE administers national energy, environmental, and nuclear policies through science and technology solutions.[69] DOE oversees the nation's nuclear infrastructure, and operates energy research facilities throughout the nation, including national laboratories like INL.

1.4.13. U.S. Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is an independent regulatory agency within the U.S. DOE. FERC has jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas transmission and related services, pricing, oil pipeline rates and gas pipeline certification.[70]

1.4.14. North American Electric Reliability Corporation

The North American Electric Reliability Corporation (NERC) is a non-profit subject to oversight by the FERC and governmental authorities in Canada whose mission is to ensure the reliability and security of the bulk power system in North America. NERC accomplishes this by developing and enforcing Reliability Standards and assessing seasonal and long-term reliability. [71] NERC has 4 interconnection regions and Idaho is located in the Western Interconnection.

1.4.15. Western Electricity Coordinating Council

The Western Electricity Coordinating Council (WECC) is the regional entity that monitors and enforces reliability standards in the Western Interconnection subject to oversight by NERC and FERC. These reliability standards apply to electric utilities and other entities that own or operate generation, transmission, or other facilities in the bulk electric system. WECC also promotes reliability in the Western Interconnection by serving as a central repository of data and other technical metrics about the grid.[72]

1.4.16. Peak Reliability

Peak Reliability (Peak) is a non-profit corporate entity formed in 2014 that assumed the role of a Reliability Coordinator in the Western Interconnection; a role that had previously been performed by WECC.[73] As a Reliability Coordinator, Peak coordinates with electric utilities and transmission operators to ensure the bulk electric system is operated within specified limits and that system conditions are stable across the area. Peak announced in August 2018 that it would begin winding down operations as a Reliability Coordinator, providing services until December 31, 2019. Over the past few

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[68] Northwest Power and Conservation Council. "Columbia River Basin Fish and Wildlife Program Amendment Process." https://www.nwcouncil.org/fw/program/2018-amendments

[69] U.S. Department of Energy "About Us" https://www.energy.gov/about-us

[70] Federal Energy Regulatory Commission. "About FERC." https://www.ferc.gov/about/about.asp

[71] North American Electric Reliability Corporation. "About NERC" https://www.nerc.com/AboutNERC/Pages/default.aspx

[72] Western Electricity Coordinating Council. "About WECC." https://www.wecc.biz/Pages/AboutWECC.aspx

[73] Peak Reliability. "Peak's History." https://www.peakrc.com/aboutus/Pages/History.aspx

years, several of the member organizations had announced plans to seek Reliability Coordinator services elsewhere.[74]

1.4.17. California Independent System Operator

CAISO is one of seven independent system operators (ISOs) in the country. ISOs operate transmission systems for regions of the country where they provide wholesale energy marketplaces. Buyers and sellers bid on energy generation in these marketplaces. ISOs are subject to the jurisdiction of the FERC.[75]

CAISO began developing Reliability Coordinator (RC) readiness efforts in January 2018 with a notice to Peak that the ISO would withdraw from the funding agreement supporting Peak's role as RC, effective in September 2019. In February 2018, the ISO applied to WECC requesting to start the RC certification process. The ISO plans to provide RC services for its own Balancing Authorities (BAs) area commencing in July 2019. Additionally, the ISO stated it would offer RC services to other BAs and Transmission Operators in the Western Interconnection.[76]

1.4.18. U.S. Nuclear Regulatory Commission

The U.S. Nuclear Regulatory Commission (NRC) is an independent federal agency that oversees licensing, safety, security, storage, and disposal of nuclear materials. The State works with NRC on small-scale nuclear projects at INL, and to ensure that materials transported through the State for disposal, and the materials present at INL adhere to appropriate safety guidelines.[77]

1.4.19. U.S. Department of the Interior

The U.S. Department of the Interior (DOI) manages public lands, territories, and tribal matters in the United States through its agencies, including the Bureau of Land Management (BLM), the Bureau of Reclamation (BOR), the National Park Service (NPS), and the Fish and Wildlife Service (FWS). Many energy projects have an effect on public lands or endangered species in some manner. The State and developers must work with DOI and its agencies to secure permitting approval under the National Environmental Policy Act and other federal laws for projects on federal land.[78]

Some examples of cooperative efforts include the following; the BOR oversees federal water resource management efforts, and oversees several dams in Idaho, including Anderson Ranch, Arrowrock, American Falls, and Palisades. The BLM administers several mineral leases throughout Idaho, and is the lead permitting agency for transmission line siting for the Gateway West and Boardman to Hemingway projects.

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[74] Peak Reliability. "About Us." https://www.peakrc.com/aboutus/Pages/default.aspx
[75] California ISO. "Reliability Coordinator (RC) Services California ISO Implementation Plan Overview." http://www.caiso.com/Documents/RCImplementationPlanOverview.pdf
[76] California ISO. "Reliability Coordinator (RC) Services California ISO Implementation Plan Overview." http://www.caiso.com/Documents/RCImplementationPlanOverview.pdf
[77] U.S. Nuclear Regulatory Commission. "The Commission." https://www.nrc.gov/about-nrc/organization/commfuncdesc.html
[78] U.S. Department of Interior. "Who We Are." https://www.doi.gov/whoweare

The State and developers also work closely with the FWS on issues pertaining to the impact of energy generation and transmission on endangered species and migratory birds.

1.4.20. U.S. Forest Service

The U.S. Forest Service (USFS), administered under the U.S. Department of Agriculture, is responsible for managing and protecting the nation's national forests and grasslands. The State and developers work with USFS on issues relating to transmission rights-of-way through national forests, issues pertaining to energy and mineral development on National Forest System lands and woody biomass as a source of energy.[79]

1.4.21. National Marine Fisheries Service

The National Marine Fisheries Service (NMFS), administered under the U.S. Department of Commerce through the National Oceanic and Atmospheric Association, oversees endangered anadromous fish species and ensures compliance with fisheries regulations. The State and Idaho utilities work closely with NMFS on fisheries issues, including those related to salmon, steelhead, and hydropower facilities in the Snake and Columbia River systems.[80]

1.4.22. U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) establishes minimum standards related to clean air, land and water in energy-generating processes including those involving nuclear, coal, and hydropower. EPA works closely with the state departments responsible for air and water quality, including DEQ, to develop and ensure compliance with environmental standards.[81]

1.5. REGIONAL AND NATIONAL ENERGY ISSUES

1.5.1. Transmission Planning

Pursuant to rules adopted by FERC, Idaho's IOUs are required to participate in local and sub-regional transmission planning and to coordinate with neighboring sub-regional planning groups and local stakeholders.[82] Two northwest planning groups, the Northern Tier Transmission Group (NTTG) and the Columbia Grid, produce transmission expansion and economic study plans on a periodic basis.[83] These local, sub-regional, and regional planning processes identify transmission project costs, benefits, and risks and their allocation to customer group beneficiaries They explore opportunities for project coordination at the sub-regional and regional levels to avoid costly duplication of facilities. OEMR and the PUC participate in the development of these plans.

1.5.2. Energy Imbalance Market

The Western Energy Imbalance Market (EIM) utilizes regional transmission systems to balance supply and demand across a larger geographical footprint in real time. EIM

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[79] U.S. Forest Service. "About the Agency." https://www.fs.fed.us/about-agency
[80] NOAA Fisheries "About Us" http://www.nmfs.noaa.gov/aboutus/our_mission.html
[81] U.S. Environmental Protection Agency "About EPA" https://www.epa.gov/aboutepa/our-mission-and-what-we-do
[82] Federal Energy Regulatory Commission. FERC Order Nos. 890 and 1000.
[83] Idaho Power and PacifiCorp are members of NTTG, and Avista and BPA are members of Columbia Grid.

manages transmission congestion and optimizes procurement of imbalance energy (positive or negative) through economic bids submitted by EIM Participating Resource Scheduling Coordinators in the fifteen-minute and five-minute markets.

EIM was first launched in 2014 as an agreement between PacifiCorp and CAISO. Since 2014, eight other utilities with service territories in the western U.S. and British Columbia, Canada have joined. Idaho Power joined EIM in April 2018. EIM also has six confirmed pending participants that will enter before 2021. EIM's daily operations are managed by CAISO.[84]

1.5.3. PURPA

The Public Utility Regulatory Policies Act of 1978 (PURPA), requires utilities to purchase energy from qualifying facilities (QFs) – such as wind, solar, geothermal, and biomass – at the cost that the utility would otherwise incur if it self-generated the electricity or obtained it from elsewhere. This calculation is called the avoided cost rate.[85]

PURPA categorizes QFs as either small power production facilities, or cogeneration facilities. To qualify for the required purchase at the avoided cost rate, a small power production facility must generate 80 MW or less, with a primary energy source that is renewable, biomass, waste, or geothermal resources.

To qualify under PURPA, a cogeneration facility must sequentially produce electricity and another form of useful thermal energy in a manner that is more efficient than the separate production of both forms of energy. For example, a large cogeneration facility may produce both electricity and provide steam for industrial uses.[86]

The policies of the PUC have been relatively favorable toward QFs, and as a result, 200 MW of QF resources were developed in Idaho by the early 1990s, consisting principally of industrial co-generation and small hydro projects. While momentum slowed with the move toward competitive markets in the 1990s, there has been a resurgence of interest in PURPA projects in recent decades. Many wind projects in the late 1990s and early 2000s were sized to meet the eligibility standard of 10 aMW for published avoided cost rates established by the PUC.

In recent years, wind developers disaggregated large-scale projects into 10 MW units in order to qualify for the published PURPA rates. In response, the PUC reduced the eligibility size from 10 MW to 100 kW for intermittent resources (wind and solar) in 2010. Larger projects are still eligible for PURPA contracts, but the rate is determined on a case-by-case negotiation.[87]

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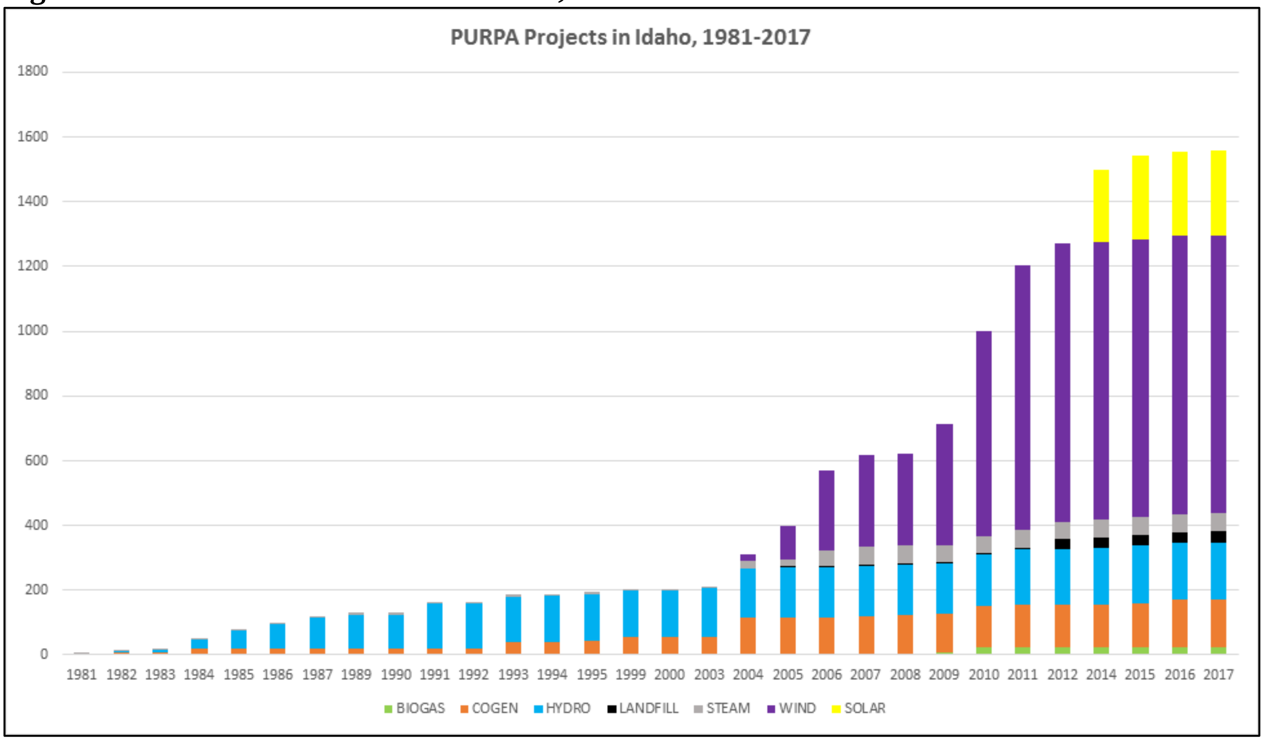
[84] Western Energy Imbalance Market. "About." https://www.westerneim.com/Pages/About/default.aspx
[85] Federal Energy Regulatory Commission. "What is a Qualifying Facility." https://www.ferc.gov/industries/electric/gen-info/qual-fac/what-is.asp
[86] Federal Energy Regulatory Commission. "What is a Qualifying Facility?" www.ferc.gov/industries/electric/gen-info/qual-fac/what-is.asp.
[87] Idaho Public Utilities Commission. "CASE NO. GNR-E-10-04, ORDER NO. 32176." http://www.puc.idaho.gov/fileroom/cases/elec/GNR/GNRE1004/ordnotc/20110207FINAL_ORDER_NO_32176.PDF

In the years following the 2010 PUC decision, the number of Idaho PURPA projects significantly increased, as shown in Figure 1.17. With the influx of projects and rapidly changing technologies, the ability of Idaho utilities to absorb the number of projects seeking contracts and to accurately predict avoided cost rates over a 20-year contract period was jeopardized. To account for the risk associated with the increase in projects and evolving technologies, the PUC reduced contract length in 2015 for IRP-based PURPA contracts from twenty years to two years to alleviate this risk.[88]

Figure 1.17 PURPA Generation in Idaho, 1981-2017[89]



[88] Idaho Public Utilities Commission. "CASE NO. IPC-E-15-01, AVU-E-15-01, PAC-E-15-03, ORDER NO. 33357." http://www.puc.idaho.gov/fileroom/cases/elec/IPC/IPCE1501/ordnotc/20150820FINAL_ORDER_NO_33357.PDF
[89] Idaho Public Utilities Commission. Graph created by Yao Yin, emailed to OEMR by Yao and Kevin Keyt.

2. Idaho Energy Sources

2.1. HYDROELECTRICITY

Hydroelectricity is a renewable resource, and Idaho has more than 140 existing generating plants with a combined capacity of 2,700 MW, which constitutes some of the most valuable hydroelectric infrastructure in the nation.[90] The flexible nature of hydroelectricity enables it to supply the fluctuating demands on the electric grid, and also allows it to accommodate and compliment the highly-variable and intermittent contributions of local wind and solar generation.

Some of the largest hydroelectric plants providing electricity to Idaho include the 1,167 MW Hells Canyon Complex (consisting of the Hells Canyon, Oxbow and Brownlee dams) owned by the Idaho Power Company; the 400 MW Dworshak Dam, operated by the U.S. Army Corps of Engineers; and the 260 MW Cabinet Gorge Project owned by Avista Corporation. In 2017, total hydroelectric generation was 10,670,409 MWh, providing about 60 percent of in-state electrical generation.[91]

2.2. NATURAL GAS

Natural gas is critical to Idaho's economic health. It heats homes, powers businesses, moves vehicles and serves as a key component in many industrial processes. More than half of Idaho households use natural gas as their primary energy source for heating their home.[92]

Natural gas power plants can adjust generation in real-time to adapt to load demands. Such responsiveness is critical to supplement the ebbs and flows of electricity generated by wind and solar projects. Advances in gas turbine design and natural gas-fired internal combustion engines have improved the operating flexibility of natural gas generation.

As a transportation fuel, natural gas is used as compressed natural gas (CNG) or as liquefied natural gas (LNG). Both compression and liquefaction are methods employed to increase the amount of natural gas storage on the vehicle and thus increase its driving range. Idaho has two public CNG vehicle refueling stations, one in Boise and another in Nampa. Some municipal and commercial fleets utilize natural gas and operate their own CNG refueling stations.[93]

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[90] U.S. Energy Information Administration, "Idaho Electricity Profile." www.eia.gov/electricity/state/Idaho.

[91] U.S. Energy Information Administration. "Idaho Electricity Profile." www.eia.gov/electricity/state/Idaho.

[92] U.S. Energy Information Administration "Idaho State Profile and Energy Estimates – Profile Analysis" https://www.eia.gov/state/analysis.php?sid=ID&CFID=19979425&CFTOKEN=6ac60633ec26f3b3-9C7FAA90-237D-DA68-24023FFD41A835EC&jsessionid=8430bccceb80dc2263757c222e31663d5a40#111

[93] Department of Energy. "Boise Buses Running Strong with Clean Cities." https://energy.gov/articles/boise-buses-running-strong-clean-cities; Intermountain Gas. "Natural Gas Vehicles." https://www.intgas.com/rates-services/naturalgas-vehicles

Natural gas reserves were detected in the Payette Basin of western Idaho in 2010.[94] These discoveries led to Idaho's first commercial production of natural gas and natural gas liquids in 2015.[95]

2.3. COAL

Idaho has no in-state utility-scale coal-fired power plants. However, Idaho utilities hold ownership shares in coal-fired power plants located in neighboring states that supply approximately 29 percent of Idaho's electricity.[96] In close proximity to Idaho, Wyoming is the nation's largest coal exporter and Montana has the largest recoverable coal reserve. Some industrial users in Idaho still utilize coal at their facilities for power and steam generation (cogeneration) purposes.

2.4. NUCLEAR

Nuclear energy is a carbon-free power source. While no commercial-scale nuclear power generation exists in Idaho, on a national scale, nuclear power generation from 98 operating reactors in 30 states accounts for 20 percent of the electricity produced in the United States.[97] Over the past two decades, improved maintenance, refueling, and safety systems have increased the operational performance of these reactors from approximately 53 percent in 1980 to over 90 percent today. [98]

Idaho National Laboratory (INL), located in southeastern Idaho, is the lead laboratory for nuclear energy research. INL has influenced every reactor designed in the United States and INL researchers are working on several initiatives that will help shape the future of nuclear energy worldwide.

2.4.1. NuScale Small Modular Reactors

NuScale Power, LLC, is developing a small modular nuclear reactor (SMR) that utilizes pressurized water reactor technology in a scalable form that could be used for multiple applications.[99] Utah Associated Municipal Power Systems (UAMPS) is interested in utilizing NuScale's SMR technologies. UAMPS and NuScale are working with INL to explore siting the first system at the laboratory. UAMPS is planning on commercial operation of the first NuScale Power Module at INL in 2026.

2.5. WIND

Wind is a renewable resource. Idaho's wind production grew from 207,000 MWh at the end of 2008 to a total of more than 2,400,000 MWh in 2016. This is equivalent to about

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94 Dunnahoe, Tayvis. "Idaho enters ranks of hydrocarbon producing states." Oil and Gas Journal (February 6, 2017).
95 U.S. Energy Information Administration. Natural Gas Gross Withdrawals and Production, Gross Withdrawals, Annual, 2012-2017.
96 U.S. Energy Information Administration. "Idaho State Profile and Energy Estimates." www.eia.gov/state/analysis.cfm?sid=ID&CFID=19979425&CFTOKEN=6ac60633ec26f3b3-9C7FAA90-237D-DA68-24023FFD41A835EC&jsessionid=8430bccceb80dc2263757c222e31663d5a40
97 Nuclear Energy Institute. "US Nuclear Power Plants." www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants
98 Nuclear Energy Institute. "Safety and Security." www.nei.org/Issues-Policy/Safety-and-Security and at "U.S. Nuclear Power Plants." www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants.
99 NuScale Power, LLC "About Us." http://www.nuscalepower.com/about-us/history.

15 percent of the electricity generated in Idaho during 2016.[100] Currently, Idaho has approximately 973 MW of installed wind capacity, but wind mapping studies estimate that Idaho has almost 212,000 MW of potential wind generation. Idaho's most promising wind resources are located in and around the Snake River Plain, particularly on its eastern end.[101] To supplement wind's intermittent nature, dispatchable resources, including hydropower and natural gas-fired generators, must be ready to meet and/or supplement load requirements when wind generation is not available.

2.6. GEOTHERMAL

Geothermal energy is a renewable resource. Unlike intermittent resources, geothermal energy provides reliable baseload power generation. An estimated 17,000 GWh of geothermal power potential exists in Idaho, much of it in the southern portions of the State as depicted in Figure 2.1.[102] Ormat manages Idaho's only operating commercial geothermal power plant, which is located at Raft River in Cassia County. The Raft River plant provides about 9 MW of net capacity.[103]

In addition to electric generation, direct-use of geothermal waters is the oldest, most versatile, and most prevalent utilization of geothermal energy.[104] Idaho has over 1,000 wells and 200 springs with water temperatures greater than 90°F, and these low-temperature geothermal resources are used for space heating, aquaculture, greenhouses, and recreation throughout the State.[105]

Geothermal heating of buildings has a long and rich history in Idaho. Boise is home to the nation's first geothermal district heating system, Warm Springs Heating District, which was built in the late 19th century and continues to service over 200 buildings. Boise has a total of four geothermal heating districts; the Idaho State Capitol building, and surrounding complex are located on a state operated district. The Idaho Statehouse is the only geothermally heated capitol building in the nation. District heating is also currently being used for space heating at nine of the Boise State University campus buildings.[106]

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[100] U.S. Energy Information Administration, "Net Generation for Wind, Annual." https://www.eia.gov/electricity/data/browser/#/topic/0?agg=1,0,2&fuel=008&geo=vvvvvvvvvvvvo&sec=o3g&linechart=ELEC.GEN.WND-US-99.A~ELEC.GEN.WND-IA-99.A~ELEC.GEN.WND-TX-99.A&columnchart=ELEC.GEN.WND-US-99.A~ELEC.GEN.WND-IA-99.A~ELEC.GEN.WND-TX-99.A&map=ELEC.GEN.WND-US-99.A&freq=A&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=.

[101] National Renewable Energy Laboratory. "Wind Energy in Idaho." https://windexchange.energy.gov/states/id

[102] Geothermal Energy Association. "Geothermal Energy Potential-State of Idaho." http://geo-energy.org/pdf/Guides_2015/Idaho.pdf and Benjamin Matek, Geothermal Energy Association. "2016 Annual U.S. & Global Geothermal Power Production Report." http://geo-energy.org/reports/2016/2016%20Annual%20US%20Global%20Geothermal%20Power%20Production.pdf

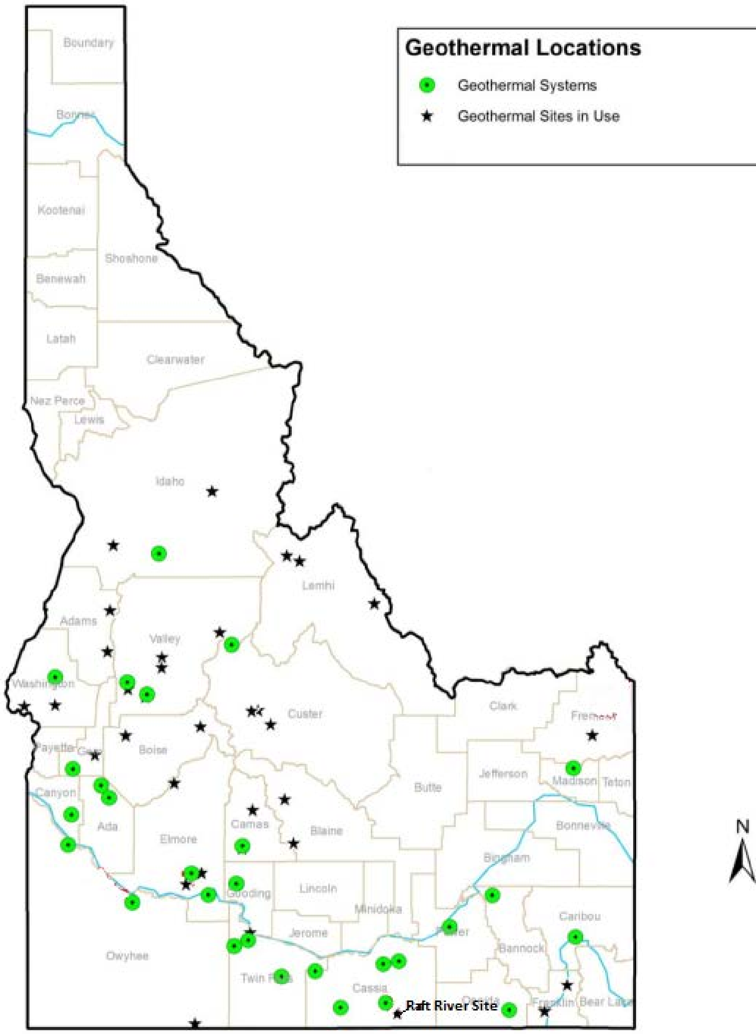
[103] Ormat. "Global Projects." https://www.ormat.com/en/projects/all/main/?Country=USA&Seg=0&Tech=0

[104] U.S. Department of Energy. "Low Temperature Deep Direct Use Program Draft White Paper." http://energy.gov/eere/geothermal/low-temperature-deep-direct-use-program-draft-white-paper

[105] Idaho Department of Water Resources. "Geothermal Resource Wells." https://idwr.idaho.gov/wells/geothermal-wells.html

[106] Boise State University. "Campus Sustainability: Geothermal Heating." https://sustainability.boisestate.edu/blog/2015/03/06/campus-sustainability-geothermal-heating/; Idaho Capitol Commission. "Facts about the Idaho Capitol Building." https://capitolcommission.idaho.gov/education/capitol_facts.html; City of Boise. "Geothermal Heating." https://publicworks.cityofboise.org/services/geothermal/

Figure 2.1 Geothermal Locations in Idaho[107]



2.7. BIOENERGY

Bioenergy is renewable and derived from biological sources for uses associated with heating, electricity, or vehicle fuel. Bioenergy is produced primarily from wood, wastes, ethanol from corn fermentation, and biodiesel from oil seeds and animal fats. It can be produced from agricultural wastes and dedicated energy crops that are used to make advanced biofuels, which include switchgrass, miscanthus, and poplar.

Idaho had 84 MW of installed capacity of biomass electricity generation in 2016 which produced approximately 531,573 MWh, or 3.4 percent of Idaho's electricity production

[107] Idaho Governor's Office of Energy and Mineral Resources

for that year.[108] As of 2018, Idaho has one operating ethanol plant capable of producing 60 million gallons per year.[109] There is no commercial production of biodiesel in Idaho.

2.8. SOLAR

Solar power is a renewable resource. Electricity is produced either through photovoltaic (PV) solar cells, or concentrated solar power (CSP). PV solar cells convert sunlight directly into electricity using solar plates stationed on an array angled towards the sun. CSP technologies reflect sunlight from mirrors and concentrate it onto receivers that convert the solar energy into heat. This thermal energy can then be used to produce electricity via a steam turbine, or to heat an engine that drives a generator.[110]

Solar energy can also be used for domestic applications which help to generate hot water and heat residential homes. There are two types of solar water heating systems, active and passive. Active solar water heating systems circulate liquid, either water or an anti-freezing heat-transfer fluid, through a series of pumps and controls located in pipes throughout a home. Passive solar water heating systems use the movement of hot water rising and cool water sinking to push water through a pipe system in the home without the use of pumps. Both types of systems need a storage tank for the water and solar panels to collect the needed heat.[111]

Utility-scale solar power generation in Idaho began in August 2016 and produced 0.2 percent of the total power generated in Idaho that year. Solar generation increased in 2017, producing about 3 percent of Idaho's in-state electrical generation.[112] The amount of solar generation is expected to increase.

2.9. PETROLEUM

There are no petroleum refineries located in Idaho. Since all of Idaho's refined petroleum products are imported and there is limited storage capacity, Idaho's transportation fuel prices are generally higher than the national average, as depicted in an earlier section in Figure 1.15. The state's petroleum pipeline infrastructure includes the Northwest Products Pipeline, which connects Salt Lake City refineries with Pocatello, Burley, and Boise, and continues to Spokane. This pipeline delivers refined petroleum products to southern Idaho. Three refineries near Billings, Montana also transport refined petroleum products to northern Idaho via the Yellowstone Pipeline. Refineries in northwestern Washington also contribute to Idaho's petroleum supply via a multi-stage route that includes the Olympic Pipeline and Columbia River barges that transport refined petroleum upriver from Portland to Lewiston. These routes are depicted in Figure 2.2.

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[108] U.S. Energy Information Administration. "Idaho Electricity Profile 2014, Table 5." www.eia.gov/electricity/state/Idaho/

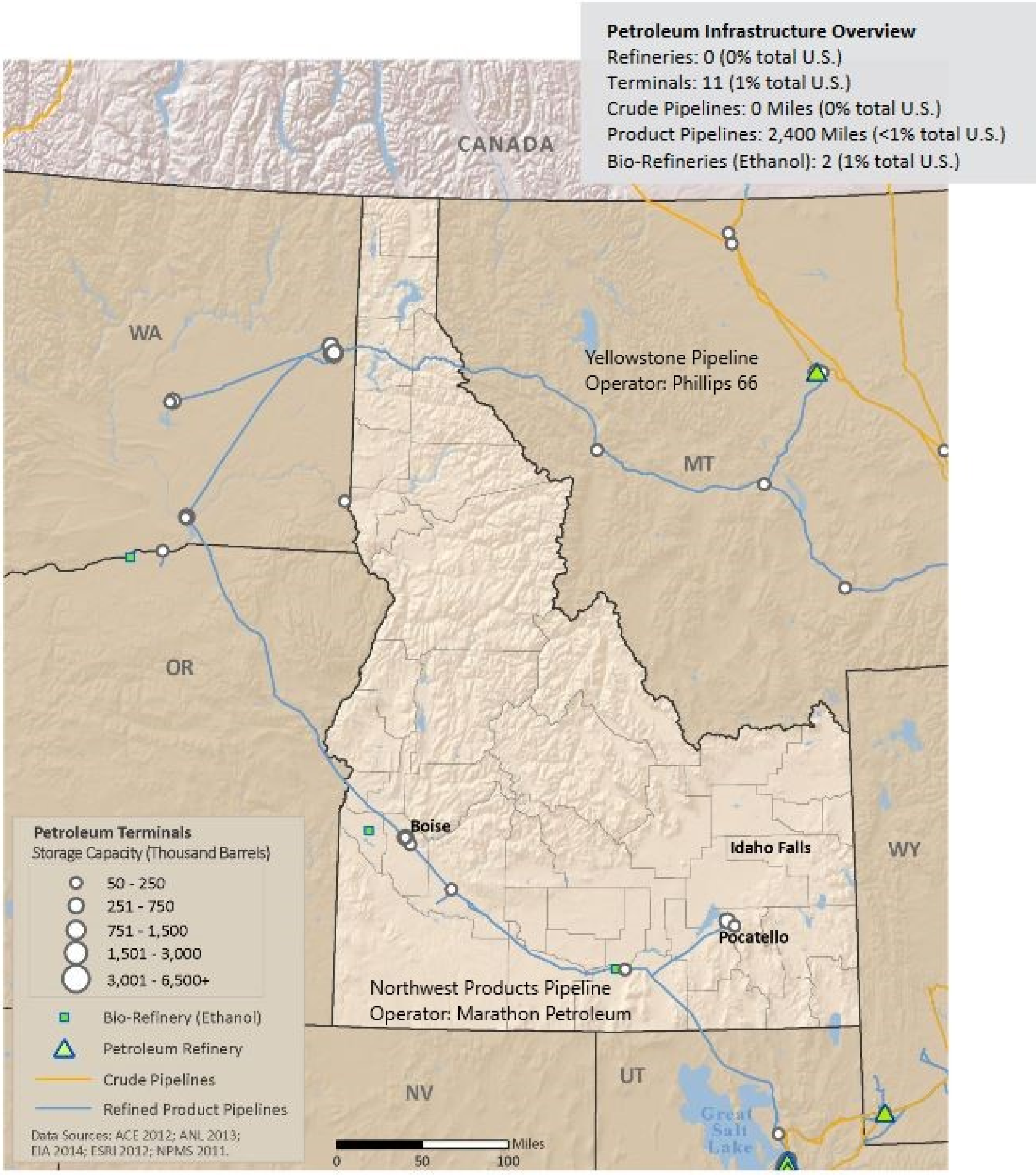
[109] Official Nebraska Government Website. "Ethanol Facilities Capacity by State and Plant." www.neo.ne.gov/statshtml/122.htm

[110] Department of Energy. "Solar Energy Technology Basics." https://energy.gov/eere/energybasics/articles/solar-energy-technology-basics

[111] Department of Energy. "Solar Water Heaters." https://energy.gov/energysaver/solar-water-heaters

[112] U.S. Energy Information Administration. "Net Generation by State by Type of Producer by Energy Source 2001-Present: Monthly Data" https://www.eia.gov/electricity/data/state/

Figure 2.2 Transportation Fuel Pipelines and Refineries Serving Idaho[113]



2.10. PROPANE

Propane is used to heat homes and businesses throughout the state of Idaho, particularly in rural areas. Residential propane prices in Idaho fluctuated between $2.32/gallon to $2.55/gallon in 2017. Propane consumption is highly seasonal, with peak consumption in fall and winter. Propane is also used as a transportation fuel.

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[113] U.S. Dept. of Energy. "State of Idaho Energy Sector Risk Profile." https://energy.gov/sites/prod/files/2016/09/f33/ID_Energy%20Sector%20Risk%20Profile.pdf

2.11. COMBINED HEAT AND POWER

Several Idaho facilities and industrial users have incorporated systems that generate on-site electricity and thermal energy in a process known as combined heat and power (CHP). CHP is typically deployed at sites, such as industrial operators and university or corporate campuses, which have high demand for electricity and hot water or steam. There are approximately 21 CHP systems in Idaho, and most are utilized by wood product facilities, dairies, universities, and large industrial users.[114]

2.12. CONSERVATION, ENERGY EFFICIENCY, DISTRIBUTED ENERGY RESOURCES, AND DEMAND RESPONSE

Conservation, energy efficiency, and demand response practices may not generate any new energy, but they do constitute another economically attractive resource that can be utilized to meet the energy needs of customers.

- "Conservation" refers to a consumer's personal actions that reduce their use of energy-consuming devices. For example, turning the lights off when leaving a room.[115]
- "Energy efficiency" refers to processes of utilizing technology that consumes a lower amount of electricity while providing sufficient service. For example, switching from incandescent lights bulbs to LED light bulbs.[116]
- "Demand response" refers to customers temporarily altering their energy-consuming behavior during times of higher demand for electricity, usually in response to signals from the utility or grid operator. For example, authorizing a utility to remotely control heating and ventilation systems during times of high electricity demand.[117]

Collectively, these resources are often referred to as "demand-side management" (DSM), by utilities and other companies in the power industry. Sometimes the terms "conservation" or "efficiency" are used to refer to all DSM measures.

Idaho utilities have utilized cost-effective, sustainable energy efficiency programs for over four decades in an effort to conserve both company and customer resources. Cost-effectiveness of an energy measure means that the lifecycle energy, capacity, transmission, distribution, and other quantifiable savings to Idaho citizens and businesses exceed the direct costs of the measure to the utility and participant. Cost-effective energy measures can provide economic benefits to Idaho utilities by increasing the capacity for energy within their system to meet future energy demands.

[114] U.S. Department of Energy. "Combined Heat and Power Installations in Idaho." https://doe.icfwebservices.com/chpdb/state/ID
[115] Energy Information Administration. "Use of Energy in the United States Explained." https://www.eia.gov/energyexplained/index.cfm?page=about_energy_efficiency
[116] Energy Information Administration. "Use of Energy in the United States Explained." https://www.eia.gov/energyexplained/index.cfm?page=about_energy_efficiency
[117] Energy Information Administration. "Demand response saves electricity during times of high demand." https://www.eia.gov/todayinenergy/detail.php?id=24872

The Idaho Public Utilities Commission (PUC) directs Idaho investor-owned electric utilities to continue to place an emphasis on cost-effective conservation, energy efficiency and demand response.[118] Each investor-owned utility (IOU) calculates the level of cost-effective efficiency potential in their integrated resource plan (IRP) process and offers a suite of efficiency programs for customers to achieve energy efficiency goals.

Idaho Power, Bonneville Power Administration and Avista belong to the Northwest Energy Efficiency Alliance (NEEA), which provides support to regional utilities and groups in the Northwest that implement energy efficiency and conservation programs. NEEA provides funding for initiatives such as the adoption of energy codes, and also provides a vehicle through which collective industry consensus can be achieved on market acceptance of energy efficient products, like LED light bulbs.[119]

2.12.1. Northwest Power and Conservation Council's Seventh Power Plan

The Northwest Power Planning Council's Seventh Power Plan identifies the potential of cost-effective energy measures for the region. It estimates that approximately 4,300 aMW of cost-effective energy efficiency can be developed in the Pacific Northwest region of Washington, Oregon, Idaho and Montana by 2035.[120] However, an important finding of the plan is that future electricity needs can no longer be adequately addressed by only evaluating average annual energy requirements. Planning for capacity to meet peak loads, and the flexibility to provide within hour load following and regulation services will also need to be considered.

2.12.2. Avista Energy Efficiency

Avista has acquired 219 aMW of electricity savings since it began offering energy efficiency measures to consumers in 1978. Of that total, the company currently has 145 aMW of active demand side resources for all of its customers. This reduced Avista's overall electric load by approximately 12.3 percent in 2016. This amounts to approximately 48 aMW in Idaho customer savings.[121]

Avista commissions a Conservation Potential Assessment (CPA) every two years to assess the energy conservation potential in its service area, and to utilize the findings in its 20-year conservation analysis. The CPA analyzes economic and technical potential, which are then rationalized with its customers' likely participation rate to determine the overall achievable conservation potential. In its most recent IRP, Avista indicates that it has an achievable potential of demand savings of up to 173.1 aMW.[122] The CPA process was used to develop Avista's IRP for 2017.

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[118] Idaho Public Utilities Commission. "CASE NO. IPC-E-1O-27, ORDER NO. 32245." www.puc.idaho.gov/fileroom/cases/elec/IPC/IPCE1027/ordnotc/20110517ORDER_NO_32245.PDF
[119] Northwest Energy Efficiency Alliance. "About NEEA." http://neea.org/about-neea
[120] The Northwest Power and Conservation Council. "Power Planning, Seventh Power Plan." www.nwcouncil.org/energy/powerplan
[121] Avista Corporation. "2017 Electric Integrated Resource Plan." file:///C:/Users/kpegan/Downloads/2017%20Electric%20IRP%20Final.pdf
[122] Avista. "2017 Electric IRP." https://www.myavista.com/about-us/our-company/integrated-resource-planning

2.12.3. Idaho Power Energy Efficiency

In its 2017 IRP, Idaho Power analyzed the amount of achievable, cost-effective energy efficiency potential for the period of 2017 – 2036. New energy efficiency opportunities are emerging on the market and Idaho Power predicts that the cost to acquire energy efficiency, from a total resource cost perspective, will vary between 6.7 cents per kWh for residential and irrigation use, to 3.9 cents per kWh for industrial and commercial use; with an overall portfolio levelized cost of 4.8 cents per kWh.[123]

In 2017, Idaho Power's energy efficiency programs had energy savings of 191,471 MWh; this is enough energy to power more than 17,000 average homes a year.[124] This is a 12-percent increase from the 2016 energy savings of 170,792 MWh. Additionally, Idaho Power successfully operated all three of its demand response programs in 2017. The total demand reduction achieved from the company's programs was 383 MW from an available capacity of 394 MW.[125]

2.12.4. Intermountain Gas Energy Efficiency

Intermountain Gas was granted authority by the Idaho Public Utilities Commission to implement an energy efficiency program effective October 1, 2017. The residential energy efficiency program was designed to acquire cost-effective demand side management (DSM) resources in the form of natural gas therm savings. The initial program includes rebates for residential customers that purchase and install qualifying high-efficient natural gas equipment in their homes. In addition, Intermountain is offering a rebate for the completion of new ENERGY STAR® qualified homes that have a Home Energy Rating Score (HERS) of 75 or less.[126]

Outlined in its 2017 IRP, Intermountain estimates achieving a savings of 65,000 therms during the first program year. The estimated annual therm savings are projected to grow to 374,292 by the fifth year of the program.[127]

2.12.5. PacifiCorp Energy Efficiency

PacifiCorp's 2017 Integrated Resource Plan Update includes updated cost and performance information for the Energy Vision 2020 projects, which include 1,311 MW of new wind, repowering 999 MW of existing wind capacity, and the new 140-mile, 500 kv Aeolus-to-Bridger/Anticline transmission line in Wyoming. Collectively, these resources contribute to meeting needs identified in PacifiCorp's long-range plan and are on track to be in service by the end of 2020. The Energy Vision 2020 projects continue to

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[123] Idaho Power Company. "2017 IRP: Looking Ahead." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf
[124] Idaho Power Company. "2017 IRP Appendix B: DSM Annual Report." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/AppendixB_DSM.pdf
[125] Idaho Power Company. "2017 IRP: Looking Ahead." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf
[126] Intermountain Gas. "Energy Efficiency Program." https://www.intgas.com/energy-efficiency/rebate-program
[127] Idaho Public Utilities Commission. "Intermountain Gas IRP." http://www.puc.idaho.gov/fileroom/cases/gas/INT/INTG0202/0423022002%20IRP.PDF

be a central feature of the company's least-cost, least-risk portfolio and will provide substantial benefits for customers.[128]

As a result of the Energy Vision 2020 projects, the IRP Update shows a reduced reliance on higher risk wholesale market purchases throughout the 20-year planning horizon. PacifiCorp will continue to plan to meet its customers' growing needs largely through the acquisition of cost-effective Energy Vision 2020 resources, energy efficiency resources, and short-term wholesale purchases over the next 10 years.[129]

2.12.6. Bonneville Power Administration Energy Efficiency

BPA works with its public utility customers to fund and implement energy efficiency programs. They have tracked savings produced through those programs over the last four decades, acquiring more than 1,700 aMW of energy saved.[130] While the municipal and cooperative utilities BPA supplies wholesale electric power to typically do not engage in IRP processes BPA set goals for achieving energy efficiency savings from 2016-2021 in its 2016 Energy Efficiency Action Plan, sets an Energy Efficiency Incentive budget every two-year rate period, and monitors cost-effective efforts of individual public utilities. BPA is pursuing efforts to achieve a goal of saving approximately 580 aMW from 2016 through 2021.[131] To accomplish this, BPA offers its municipal and cooperative customers an extensive energy efficiency program including many qualifying improvements and rebates that are passed on to the retail customer.

2.12.7. Distributed Energy Resources

Distributed energy resources (DER), also called on-site generation, dispersed or decentralized generation, are small power sources that can be combined to provide power to satisfy demand.[132] Such sources can include micro-turbines, small natural gas-fueled generators, combined heat and power plants, battery storage, biomass, wind and solar thermal or photovoltaic installations. Use of DERs is becoming more common due to potential for more affordable renewable energy, and an increased desire for grid resiliency, especially during disasters. The intermittent nature of DERs remains a challenge for utilities, and complex and expensive integration upgrades and power-balancing mechanisms will be required as use of DER increases.[133]

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[128] PacifiCorp. "2017 IRP Update." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017%20IRP%20Update/2017_IRP_Update.pdf

[129] PacifiCorp. "2017 IRP Update". http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017%20IRP%20Update/2017_IRP_Update.pdf

[130] Bonneville Power Administration. "2016-2021 EE Action Plan." https://www.bpa.gov/EE/Policy/EEPlan/Documents/2016-2021_BPA_EE_Action_Plan.pdf

[131] Bonneville Power Administration. "2016-2021 EE Action Plan." https://www.bpa.gov/EE/Policy/EEPlan/Documents/2016-2021_BPA_EE_Action_Plan.pdf

[132] Electric Power Research Institute. "Distributed Energy Resources." http://www2.epri.com/Our-Work/Pages/Distributed-Electricity-Resources.aspx

[133] North American Electric Reliability Corporation. "Distributed Energy Resources: Connection Modeling and Reliability Considerations." https://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/Distributed_Energy_Resources_Report.pdf

3. Outlook

3.1. UTILITY INTEGRATED RESOURCE PLANS

Idaho's investor-owned utilities (IOUs) work with local stakeholders to develop Integrated Resource Plans (IRPs) that must be filed with the Idaho Public Utilities Commission (PUC) every two years. IRPs forecast energy demands over 20 years and evaluate a variety of different resources to meet demand, including the addition of generation resources and demand-side measures such as conservation and energy efficiency programs. IRPs typically select a "preferred resource strategy" based on evaluation criteria including cost, risk, reliability and environmental concerns. Idaho IOU IRPs are available to the public on the PUC's website and via the utilities websites listed below:

- Avista: https://www.myavista.com/about-us/our-company/integrated-resource-planning
- Idaho Power: https://www.idahopower.com/energy/planning/integrated-resource-plan/
- Rocky Mountain Power: https://www.rockymountainpower.net/about/irp.html
- PUC: http://www.puc.idaho.gov
- Intermountain Gas: http://www.puc.idaho.gov/fileroom/cases/gas/INT/INTG0202/0423022002%20IRP.PDF

3.2. FUTURE PLANNED DEVELOPMENT

Table 3.1 shows planned generation projects listed by Idaho's three electric IOUs in their 2017 IRPs or IRP updates. The resources listed below may be physically located outside of Idaho. Additional renewable generation may be developed by independent power producers under Public Utility Regulatory Policies Act (PURPA) or developed as net metering projects. IOU planned transmission projects are listed in Table 3.2.

Other organizations are continuing plans on transmission projects around Idaho. Bonneville Power Administration's (BPA) Hooper Springs transmission line began construction in southeast Idaho in Spring 2018.[134] Idaho Falls Power, a municipal electric utility serving the city of Idaho Falls, continues to work on the 161 kV North Loop transmission expansion proposal, while LS Power, a commercial energy developer, is exploring development of the Southwest Intertie Project, Northern Section through southern Idaho.

[134] Bonneville Power Administration. "BPA Hooper Springs EA" https://www.bpa.gov/efw/Analysis/NEPADocuments/nepa/HooperSprings/Hooper_4F_FEIS_FINAL_EIS-PDF.pdf.

Table 3.1 Planned Investments in Electric Generating Facilities by Idaho Investor-Owned Utilities, 2018-2027[135]

Year	Investment Type	Nameplate Capacity (MW)	Utility
2018	Solar Select	15	Avista
2026	Natural Gas-Fired Peaker	192	Avista
2026-2029	Thermal Upgrades	34	Avista
2027	Natural Gas-Fired Peaker	96	Avista
2020	New Wind	1311	PacifiCorp
2020	Upgraded Wind	999	PacifiCorp

Table 3.2 Major Planned Transmission Projects by Idaho Investor-Owned Utilities, 2018-2027[136]

Year	Investment Type	Capacity (kV)	Utility
2021	Oquirrh to Terminal	345	PacifiCorp
2018	Wallula to McNary	230	PacifiCorp
2019-2024	Windstar to Aeolus (Gateway West)	230	PacifiCorp
2020	Aeolus to Bridger/Anticline (Gateway West)	500	PacifiCorp
2020-2024	Bridger/Anticline-Populus (Gateway West)	500	PacifiCorp
TBD[137]	Populus to Hemingway (Gateway West)	500	PacifiCorp, Idaho Power
2025 or beyond	Boardman to Hemingway	500	PacifiCorp, BPA, Idaho Power
2020-2024	Aeolus to Mona	500	PacifiCorp
Note: Tables 3.1 & 3.2 report the generation and transmission facilities included in the preferred resource strategy from each utility based upon their 2017 IRPs or IRP Updates			

3.3. "SMART GRID"

Technologies that not only allow for two-way communication between a utility and its customers but sensing capabilities along transmission lines that respond to needed load in

[135] Avista: Idaho Public Utilities Commission. http://www.puc.idaho.gov/fileroom/cases/elec/AVU/AVUE1708/20170831AVISTA%202017%20IRP.PDF; PacifiCorp: "2017 IRP." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf

[136] Avista: Idaho Public Utilities Commission. http://www.puc.idaho.gov/fileroom/cases/elec/AVU/AVUE1708/20170831AVISTA%202017%20IRP.PDF; PacifiCorp: "2017 IRP." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf; Idaho Power: Idaho Public Utilities Commission. http://www.puc.idaho.gov/fileroom/cases/elec/IPC/IPCE1711/20170630INTEGRATED%20RESOURCE%20PLAN.PDF

[137] Idaho Power and PacifiCorp continue to coordinate the timing of next steps to best meet customer and system needs.

real time describes “smart grid” technologies. Emerging “smart grid” technologies could make it possible for consumers to individually balance their energy supply and demand. Allowing consumers to adjust electricity use in response to available supplies and costs could enhance the capacity and flexibility of the power system and may have a significant impact on Idaho energy networks. Smart grid development may facilitate the deployment of electric vehicles and help reduce carbon emissions in the transportation sector. The development of new energy storage technologies will impact both the feasibility of fuel-switching in the transportation sector (gas to electric) as well as grid stability through grid-scale energy storage.[138]

3.4. ENERGY STORAGE TECHNOLOGIES AND APPROACHES

Energy storage is the capture of energy produced at one time for use at a later time. These technologies could extend and optimize the operating capabilities of the grid. Energy is stored in numerous ways, including: battery storage; solar, which stores energy thermally; capacitors, which store energy electrically; compressed air and pumped hydro, which store energy potential; and flywheels, which store energy kinetically.[139]

Energy storage also can play a key role in providing overall grid security and resilience, while allowing critical infrastructure such as hospitals, police stations and other key services to remain operational during emergency situations. The federal government has a number of programs promoting the adoption of more energy storage in the United States, particularly for resiliency purposes at military bases. The cost of energy storage infrastructure is a significant hurdle; however, more affordable utility-scale storage systems are currently under development.[140]

3.4.1. Battery Storage

Batteries for grid scale energy storage are attracting significant interest across the nation which has resulted in a gradual reduction of price. Batteries for energy storage usually have a short to mid-range response time (seconds to a few hours). There are two types of batteries used for energy storage, solid state and flow batteries. Solid state batteries utilize different solid chemistrical compounds for varying grid service applications, the most common chemical pairing is lithium-ion. Flow batteries use different chemical compounds that are dissolved in liquid and are forced through a membrane within the battery to create a reaction that produces electricity. Research studies are being conducted on both types of batteries to discover more effective ways to use battery storage.[141]

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[138] U.S. Department of Energy: Office of Electrical Delivery and Energy Reliability. “Smart Grid.” https://www.smartgrid.gov/the_smart_grid/smart_grid.html

[139] Energy Storage Association. “Energy Storage Technologies.” http://energystorage.org/energy-storage/energy-storage-technologies

[140] U.S. Department of Energy: Office of Electricity. “Energy Storage.” https://www.energy.gov/oe/activities/technology-development/energy-storage

[141] Energy Storage Association. “Energy Storage Technologies.” http://energystorage.org/energy-storage/energy-storage-technologies

3.4.2. Thermal Storage

Thermal storage traps energy temporarily in the form of heat or cold which allows the energy to be turned into electricity later. An example of this on a utility scale includes solar thermal power plants that use molten salt or other heat-retaining substance to store the sun's energy, which can be utilized later in steam generating processes.[142]

3.4.3. Potential Storage

Potential mechanical storage technologies include Compressed Air Energy Storage, which runs a compressor with excess energy (usually generated at night when demand is low) that pumps air at high pressure into an underground cavern or other confined space. The air is then released, heated and expanded to drive generator turbine at times when energy demand is high.[143]

Similar systems are applied in a pumped water storage system, where water is pumped with excess electricity from a lower to a higher reservoir to be released through turbines when energy demand is high. Both pumped water and compressed air systems are best suited for response times of hours or longer.[144] Emerging potential electrical storage technologies are currently under development.[145]

3.4.4. Kinetic Storage

The flywheel is an energy storage mechanism in which rotational energy is stabilized and maintained through movement of an accelerating wheel that can then store the energy kinetically for future use. A generator is then applied to easily convert the stored energy from mechanical to electrical energy.[146]

3.5. ELECTRIC VEHICLES

Electric vehicles (EV) are vehicles that run off of batteries charged by electricity rather than fossil fuels and a combustion engine. The rate of electric vehicle ownership is rising due to affordability and advances in battery technology performance. The costs of charging an EV in Idaho are reflective of Idaho's affordable electricity rates and can cost significantly less than the price of an equivalent amount of gasoline.[147] However, the typical range of many EVs is limited to 100 miles per charge, which is challenging for Idahoans given the state's rural geography.

EV owners have a variety of charging options to recharge their battery that require differing types of infrastructure. For example, EVs can be charged overnight via common

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[142] Energy Storage Association. "Thermal Energy Storage." http://energystorage.org/energy-storage/storage-technology-comparisons/thermal2
[143] Energy Storage Association. "Compressed Air Energy Storage." http://energystorage.org/compressed-air-energy-storage-caes
[144] U.S. Department of Energy: Office of Energy Efficiency and Renewable Energy. "Pumped-Storage Hydropower." https://www.energy.gov/eere/water/pumped-storage-hydropower
[145] U.S. Environmental Protection Agency. "Electricity Storage." https://www.epa.gov/energy/electricity-storage
[146] Energy Storage Association. "Flywheel Energy Storage.: http://energystorage.org/energy-storage/storage-technology-comparisons/thermal
[147] Idaho Strategic Energy Alliance. "Transportation Task Force Report 2015." https://oemr.idaho.gov/wp-content/uploads/2016/06/2015_Transportation_TF_Report.pdf

120-volt outlets, also called Level 1 chargers. Level 2 charging stations have a 240-volt capacity, which can be installed at residences, businesses or fleet locations to charge at a faster rate (about 3-5 hours for a full charge).[148] Direct charge or DC "fast-chargers" require a specialized, 480-volt outlet and can provide a full charge after 20-30 minutes. Level 1 and 2 chargers are likely to be more frequently used day-to-day, but DC fast chargers are the most popular options for long range road trips.[149]

Idaho National Laboratory (INL) leads research into EV charging technologies and the charging habits of EV owners, hoping to discover safer, faster, and more efficient means of dispatching energy on smart grids, charging and utilizing battery technologies.[150] Effective charging will enhance EV owner security, while increasing domestic energy independence. INL's extensive research can help inform decisions on how to most effectively deploy EV charging opportunities.

[148] Department of Energy. "Electric Vehicles: Charging at Home." https://www.energy.gov/eere/electricvehicles/charging-home
[149] Department of Energy. "Electric Vehicles: Vehicle Charging." https://energy.gov/eere/electricvehicles/vehicle-charging
[150] Idaho National Laboratory. "Electric Vehicle Infrastructure Laboratory." https://www.inl.gov/wp-content/uploads/2015/12/EVI_Info_interior.pdf

4. Energy Research and Education Entities in Idaho

4.1. RESEARCH AT INL

Idaho National Laboratory (INL) is one of the state's largest employers, and the U.S. Department of Energy's (DOE) lead nuclear energy laboratory. INL also is a leading contributor to a variety of non-nuclear clean energy technologies and is a prominent resource for energy education and outreach. INL is home to the Advanced Test Reactor and supports research for cybersecurity and protecting critical infrastructure.[151]

DOE adopted INL's Gateway for Accelerated Innovation in Nuclear (GAIN) initiative across the Department, which facilitates public-private partnerships between national labs and private entities to support the commercial success of innovative advanced reactor designs. Through the GAIN program, new reactor technologies can access a reactor test bed to better overcome the technical and regulatory development hurdles associated with the development of advanced fuels. GAIN also provides support for commercial and demonstration reactors at INL, including the siting of small modular reactors.[152]

INL will soon open two new state-owned modern facilities dedicated to cybersecurity (Cybercore Integration Center) and nuclear modeling and simulation (Collaborative Computing Center). These facilities will significantly enhance the cutting-edge research being done by INL in collaboration with three of Idaho's universities.

4.2. CENTER FOR ADVANCED ENERGY STUDIES

The Center for Advanced Energy Studies (CAES) is a research, education, and innovation consortium that brings together Idaho National Laboratory, Boise State University, Idaho State University, the University of Idaho, and the University of Wyoming. Headquartered in Idaho Falls, with complimentary capabilities and research programs at each of the participating universities, CAES works to solve regional energy challenges that have national impact. CAES utilizes the expertise, facilities, and capabilities from all five member-organizations allowing for a collaborative approach to solve challenges in the following focus areas: nuclear energy; advanced manufacturing; cybersecurity; energy-water nexus; clean energy; energy policy; and computing, data, and visualization. CAES headquarters is a state-owned, energy-efficient facility located near Idaho National Laboratory and University Place campus in Idaho Falls.

4.3. UNIVERSITIES, COLLEGES, AND TECHNICAL TRAINING

Many of Idaho's higher education institutions are engaged in educating tomorrow's energy workforce.

For example, elective courses are offered in energy efficiency and renewable energy at **Boise State University**. The courses provide non-science or engineering students with a solid grounding in energy fundamentals, which is helping Boise State educate a

[151] Idaho National Laboratory "Research Areas." https://www.inl.gov/research-programs/
[152] Gateway for Accelerated Innovation in Nuclear "What is GAIN?" https://gain.inl.gov/SitePages/What%20is%20GAIN.aspx

knowledgeable generation of energy consumers, policymakers, teachers and business leaders.

The **Micron School of Materials Science and Engineering (MSE)** at Boise State University is home to one of the most productive materials science and engineering programs in the Pacific Northwest. MSE is currently investigating a broad range of materials issues in areas such as nuclear fuels, biomaterials, glasses, semiconductors, electronic memories, computational modeling and magnetic materials.[153]

The Department of Biological and Agricultural Engineering at the **University of Idaho** houses the Biodiesel Fuel Education Program which provides unbiased, science-based information about biodiesel, and assists in the development of educational tools for a national biodiesel outreach program. The program develops and distributes educational materials that support advances in biodiesel infrastructure, technology transfer, fuel quality, fuel safety, and increasing feedstock production.[154]

The **National Institute for Advanced Transportation Technology** at the University of Idaho is a center for transportation research, education and technology transfer. It is committed to preserving and protecting the environments of the Pacific Northwest. The Institute contributes to the sustainability of the environment through the development of clean vehicles, alternative fuels, efficient traffic control systems, safe transportation systems, sound infrastructure, and the policies that support these systems.[155]

Idaho State University offers bachelor's and master's degree programs in Nuclear Science and Engineering and prepares graduates to excel in a wide range of careers associated with nuclear reactors, the nuclear fuel cycle, and other applications of nuclear technology.[156]

Idaho State University established the **Energy Systems Technology and Education Center** (ESTEC) in its College of Technology. ESTEC integrates the education and training required for graduates to maintain existing plants. They also learn to install and test components in new plants in various key areas of technology, including electrical engineering, instrumentation and control, mechanical engineering, wind engineering, instrumentation and automation, nuclear operations and renewable energy.[157]

Idaho's community colleges also emphasize the importance of educating the energy workforce of the future. Instructors at the **College of Southern Idaho (CSI)** in Twin Falls have trained the next-generation energy workforce in renewable energy since 1981 through its **Renewable Energy Training Center**[158]

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[153] Boise State University. "Micron School of Materials Science and Engineering." http://coen.boisestate.edu/mse/
[154] University of Idaho. "Biodiesel Education." http://biodieseleducation.org/
[155] University of Idaho. "National Institute for Advanced Transportation Technology." www.uidaho.edu/engr/research/niatt
[156] Idaho State University. "Programs of Study." http://coursecat.isu.edu/programsofstudy/
[157] Idaho State University. "College of Technology." www2.isu.edu/estec/
[158] College of Southern Idaho. "Environmental Technology." http://agriculture.csi.edu/enviroTech/

CSI received a $4.4 million Economic Development Administration federal grant in 2011 to help build a nearly $7 million **Applied Technology and Innovation Center** in Twin Falls. Completed in 2014, the 29,600 square foot energy efficient center houses the college's expanding HVAC, environmental technology, wind energy and machine technology programs complete with classrooms, hands-on labs and administrative offices.[159]

College of Eastern Idaho (CEI) launched its **Energy Systems Technology Program** in 2010; it provides the first year of this two-year program at the CEI campus. After first-year completion, qualified students enter the second year of the ESTEC program at **Idaho State University**. The program equips students to become energy systems maintenance technicians with mechanical, electrical, and instrumentation and control skills.[160]

The **College of Western Idaho** (CWI) is looking to the future of managing a diverse energy sector with its advanced mechatronics engineering technology program. This one-to-two-year program teaches students about electricity, robotics, wireless communication, renewable energy, instrumentation and computerized control systems.[161]

The **Northwest Lineman College,** based in Meridian, trains lineman apprentices and educates students in construction, maintenance, and operation of the electrical grid. It also provides lineman certification for individuals already working in the trade and develops customized training services for power and construction companies worldwide. Founded in 1993, the college educates more trade professionals in the Power Delivery Industry than any other educational institution in the United States, training 4,000 individuals annually.[162]

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[159] Lochsa Engineering. "CSI Applied Technology & Innovation Center." www.lochsa.com/csi-applied-technology-innovation-center

[160] College of Eastern Idaho. "Energy Systems Technician." http://www.eitc.edu/programs-of-study/trades-industry/energy-systems-technician; Idaho State University. "Energy Systems Technology and Education Center." https://www.isu.edu/estec/

[161] College of Western Idaho. "All Programs and Classes." https://cwidaho.cc/program

[162] Northwest Lineman College. "Northwest Lineman College." https://lineman.edu/

Appendix A: List of Idaho Electric and Natural Gas Utilities

Investor-Owned Utilities

Avista Utilities	800-227-9187
Dominion Energy	800-323-5517
Idaho Power Company	800-488-6151
Intermountain Gas	800-548-3679
Rocky Mountain Power	888-221-7070

Rural Electric Cooperatives

Bonneville Power Administration	800-282-3713
Clearwater Power	888-743-1501
East End Mutual Electric	208-436-9357
Fall River Rural Electric	800-632-5726
Farmer Electric	208-436-6384
Idaho County Light and Power	877-212-0424
Inland Power and Light	800-747-7151
Kootenai Electric Cooperative	800-240-0459
Lost River Electric Cooperative	208-588-3311
Lower Valley Energy	800-882-5875
Northern Lights Incorporated	800-326-9594
Missoula Electric Cooperative	800-352-5200
Raft River Electric	800-342-7732
Riverside Electric Cooperative	208-436-3855
Salmon River Cooperative	208-879-2283
South Side Electric	208-654-2313
United Electric Co-Op Inc.	208-679-2222
Vigilante Electric Cooperative	800-221-8271

Municipal Electric Utilities

Albion Light and Water Plant	208-673-5352
Bonners Ferry Light and Water	800-626-4950
Burley Electric Department	208-678-2538
Declo Municipal Electric Department	208-654-2124
Heyburn Electric Department	208-679-8158
Idaho Falls Power	208-612-8430
Minidoka Electric Department	208-531-4101
Plummer Electric Department	208-686-1641
Rupert Electric Department	208-431-6598
Soda Springs Electric Light and Power	208-547-2600
City of Weiser Electric Department	208-414-1964

Definitions

Average Megawatt (aMW): An average megawatt is the amount of electricity produced by the continuous production of one megawatt over a period of one year. The term, sometimes also called average annual megawatt, defines power production in megawatt increments over time. Because there are 8,760 hours in a year, an average megawatt is equal to 8,760 megawatt-hours.

Avoided cost: The cost to produce or otherwise procure electric power that an electric utility does not incur because it purchases this increment of power from a qualifying facility (QF). It may include a capacity payment and/or an energy payment component.

Baseload: The minimum amount of electric power or natural gas delivered or required over a given period of time at a steady rate. The minimum continuous load or demand in a power system over a given period of time.

Baseload plant: A plant that is normally operated to take all or part of the minimum continuous load of a system and that consequently produces electricity at an essentially constant rate. These plants are operated to maximize system mechanical and thermal efficiency and minimize system operating costs. Traditionally, coal, nuclear plants and some high efficiency natural gas plants have been considered baseload plants. Baseload plants are also required to firm intermittent energy resources such as wind or solar.

Biomass: Plant materials and animal waste used as a feedstock for energy production.

Bonneville Power Administration (BPA): A power marketing and electric transmission agency of the U.S. government with headquarters in Portland, Oregon.

British Thermal Units (BTUs): British Thermal Unit is a traditional unit of energy equal to about 1,055 joules. Production of 1 kWh of electricity generated in a thermal power plant requires about 10,000 BTUs. 1 gallon gasoline ≈ 125,000 BTUs.

Capacity (electric): The maximum power that can be produced by a generating resource at specified times under specified conditions.

Capacity factor: A capacity factor is the ratio of the average power output from an electric power plant compared with its maximum output. Capacity factors vary greatly depending on the type of fuel that is used and the design of the plant. Baseload power plants are operated continuously at high output and have high capacity factors (reaching 100 percent). Geothermal, nuclear, coal plants, large hydroelectric and bioenergy plants that burn solid material are usually operated as baseload plants. Many renewable energy sources such as solar, wind and small hydroelectric power have lower capacity factors because their fuel (wind, sunlight or water) is not continuously available.

Capacity (gas): The maximum amount of natural gas that can be produced, transported, stored, distributed or utilized in a given period of time under design conditions.

Capacity, peaking: The capacity of facilities or equipment normally used to supply incremental gas or electricity under extreme demand conditions. Peaking capacity is generally available for a limited number of days at a maximum rate.

Carbon capture and sequestration: An approach to mitigate climate change by capturing carbon dioxide from large point sources such as power plants and storing it instead of releasing it into the atmosphere. Technology for sequestration is commercially available and is used at many locations at a modest scale primarily for oil and gas recovery. However, technology needed for capturing carbon dioxide from large point sources has yet to be developed. Although carbon dioxide has been injected into geological formations for various purposes (such as enhanced oil recovery), long-term storage on a large scale has yet to be demonstrated. To date, no large-scale power plant operates with a full carbon capture and storage system.

Carbon dioxide (CO_2): A gaseous substance at standard conditions composed of one carbon atom and two oxygen atoms produced when any carbon-based fuels are combusted. It is considered by many scientists a major contributor to global climate change. Plants use carbon dioxide for photosynthesis and for plant growth and development. The atmosphere contains about 0.039 percent CO_2.

Coal gasification: A process by which synthetic gases are made from coal by reacting coal, steam and oxygen under pressure and elevated temperature. These gases can be used in processes to produce electricity or to make a variety of carbon-based products, including methane (natural gas), gasoline, diesel fuel and fertilizer.

Cogeneration: Also known as “combined heat and power” (CHP) or cogen. The simultaneous production of heat (usually in the form of hot water and/or steam) and power utilizing one primary fuel. Cogeneration is often used to produce power as a secondary use of the waste steam/heat from a primary industrial process.

Commercial: A sector of customers or service defined as non-manufacturing business establishments, including hotels, motels, restaurants, wholesale businesses, retail stores and health, social and educational institutions. A utility may classify the commercial sector as all consumers whose demand or annual use exceeds some specified limit. The limit may be set by the utility based on the rate schedule of the utility.

Commission: State public utility commission(s); the Federal Energy Regulatory Commission.

Concentrating solar power (CSP): A process that uses lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated light is then used as a heat source for a conventional power plant or is concentrated onto photovoltaic surfaces.

Conservation: Demand-side management (DSM) strategy for reducing generation capacity requirements by implementing programs to encourage customers to reduce their energy consumption. Program examples include incentives/savings for the installation of energy efficient appliances, lighting and electrical machinery, and weatherization materials.

Control area: A geographical area in which a utility is responsible for balancing generation and load. A control area approximates the service area of a utility.

Cooperative electric utility (Co-op): Private, not-for-profit electric utility legally established to be owned by and operated for the benefit of those using its service. It will generate, transmit and/or distribute supplies of electric energy to cooperative members. Such ventures are generally exempt from federal income tax laws. Many were initially financed by the Rural Electrification Administration, U.S. Department of Agriculture.

Demand: The amount of power consumers require at a particular time. Demand is synonymous with load. It is also the amount of power that flows over a transmission line at a particular time. System demand is measured in megawatts.

Demand-side management (DSM): The term for all activities or programs undertaken by an electric system to influence the amount and timing of electricity use. Included in DSM are the planning, implementation and monitoring of utility activities that are designed to influence customer use of electricity in ways that will produce desired changes in a utility's load shape such as, among other things, direct load control, interruptible load and conservation.

Dispatch: The monitoring and regulation of an electrical or natural gas system to provide coordinated operation; the sequence in which generating resources are called upon to generate power to serve fluctuating load; the physical inclusion of a generator's output onto the transmission grid by an authorized scheduling utility.

Distribution (electrical): The system of lines, transformers and switches that connect the high-voltage bulk transmission network and low-voltage customer load. The transport of electricity to ultimate use points such as homes and businesses. The portion of an electric system that is dedicated to delivering electric energy to an end user at relatively low voltages.

Distribution (gas): Mains, service connections and equipment that carry or control the supply of natural gas from the point of local supply to and including the sales meters.

Distributed generation: Electric power produced other than at a central station generating unit, such as that using fuel cell technology or on-site small-scale generating equipment.

Electric utility: A corporation, person, agency, authority or other legal entity that owns and/or operates facilities for the generation, transmission, distribution or sale of electric energy primarily for use by the public. Facilities that qualify as co-generators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities.

Electricity generation: The process of producing electric energy by transforming other forms of energy such as steam, heat or falling water. Also, the amount of electric energy produced, expressed in kilowatt-hours or megawatt-hours.

Electricity transmission congestion: Transmission congestion results when transmission lines reach their maximum capacity, so no additional power transactions can take place, regardless of power needs. Attempting to operate a transmission system beyond its rated capacity is likely to result in line faults and electrical fires, so this can never occur. The only ways the congestion can be alleviated are to tune the system to increase its capacity, add new transmission infrastructure, or decrease end-user demand for electricity.

Federal Energy Regulatory Commission (FERC): A quasi-independent regulatory agency within the U.S. Department of Energy having jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas transmission and related services, pricing, oil pipeline rates and gas pipeline certification.

Forecasting: The process of estimating or calculating electricity load or resource production requirements at some point in the future.

Fuel-switching: Substituting one fuel for another based on price and availability. Large industries often have the capability of using either oil or natural gas to fuel their operation and of making the switch on short notice.

Generator nameplate capacity (installed): The maximum rated output of a generator or other electric power production equipment under specific conditions designated by the manufacturer. Installed generator nameplate capacity is commonly expressed in megawatts (MW) and is usually indicated on a nameplate physically attached to the generator.

Geothermal power: Power generated from heat energy derived from hot rock, hot water or steam below the earth's surface.

Gigawatt (GW): A gigawatt (GW) is equal to one billion (10^9) watts.

Gigawatt-hour (GWh): A gigawatt-hour (GWh) is a unit of electrical energy that equals one thousand megawatts of power used for one hour. One gigawatt-hour is equal to 1,000 megawatt-hours.

Greenhouse gases (GHG): Gases found within the earth's atmosphere including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) that trap energy from the sun and warm the earth. Some greenhouse gases are emitted from the earth's natural processes; others from human activities, primarily the combustion of fossil fuels.

Grid: The layout of the electrical transmission system or a synchronized transmission network.

Head: The vertical height of the water in a reservoir above the turbine. In general, the higher the head, the greater the capability to generate electricity due to increased water pressure.

High-voltage lines: Wires composed of conductive materials that are used for the bulk transfer of electrical energy from generating power plants to substations located near to population (load) centers. Transmission lines, when interconnected with each other, become high voltage transmission networks. In the U.S., these are typically referred to as "power grids" or sometimes simply as "the grid". Electricity is transmitted at high voltages (110 kV or above) to reduce the energy lost in long distance transmission. Power is usually transmitted through overhead power lines. Underground power transmission has a significantly higher cost.

Hydroelectric plant: A plant in which the power turbine generators are driven by falling water.

Independent power producers: A non-utility power generating entity, defined by the 1978 Public Utility Regulatory Policies Act, that typically sells the power it generates to electric utilities at wholesale prices. *(See also Exempt Wholesale Generator.)*

Industrial customer: The industrial customer is generally defined as manufacturing, construction, mining, agriculture, fishing and forestry establishments. The utility may classify industrial service using the Standard Industrial Classification codes or based on demand or annual usage exceeding some specified limit. The limit may be set by the utility based on the rate schedule of the utility.

Integrated Resource Plan (IRP): A plan that utilities produce periodically for regulators and customers to share their vision of how to meet the growing need for energy. These plans contain a preferred portfolio of resource types and an action plan for acquiring specific resources to meet the needs of customers including conservation measures. Specific resources will be acquired as individual projects or purchases and, when appropriate, through a formal request for proposals (RFP) process.

Interconnection: A link between power systems enabling them to draw on one another's reserves in times of need to take advantage of energy cost differentials resulting from such facts as load diversity, seasonal conditions, time-zone differences and shared investments in larger generating units.

Interstate pipeline: A natural gas pipeline company that is engaged in the transportation of natural gas across state boundaries and is therefore subject to FERC jurisdiction and/or FERC regulation under the Natural Gas Act.

Investor-owned utility (IOU): A utility that is a privately owned, often publicly traded corporation whose operations are regulated by federal and state entities.

Kilowatt (kW): A unit of electrical power or capacity equal to one thousand watts.

Kilowatt-hour (kWh): A unit of electrical energy that is equivalent to one kilowatt of power used for one hour. One kilowatt-hour is equal to 1,000 watt-hours. An average household will use between 800 and 1,300 kWhs per month, depending upon geographical area.

Load: The amount of electric power delivered or required at any specific point or points on a system. The requirement originates at the energy-consuming equipment of the consumers. The load of an electric utility system is affected by many factors and changes on a daily, seasonal and annual basis, typically following a general pattern. Electric system load is usually measured in megawatts (MW). It is synonymous with demand.

Local distribution company (LDC): A company that obtains the major portion of its revenues from the operations of a retail distribution system for the delivery of electricity or gas for ultimate consumption.

Megawatt (MW): A unit of electrical power equal to 1 million watts or 1,000 kilowatts. Plant power output is typically measured in megawatts. (*See also capacity (electric)*.)

Megawatt-hour (MWh): One million watt-hours of electric energy. A unit of electrical energy that equals one megawatt of power used for one hour.

Metering: Use of devices that measure and register the amount and/or direction of energy quantities relative to time.

Municipal utility: A utility owned and operated by a municipality or group of municipalities.

National Association of Regulatory Utility Commissioners (NARUC): A professional trade association, headquartered in Washington, D.C., composed of members of state and federal regulatory bodies that have regulatory authority over utilities.

NERC (North American Electric Reliability Corporation): An organization subject to oversight by the Federal Energy Regulatory Commission and governmental authorities in Canada whose mission is to ensure the reliability of the bulk power system in North America. To achieve that, NERC develops and enforces reliability standards; assesses power adequacy annually via 10 year and seasonal forecasts; monitors the bulk power system; evaluates users, owners and operators for preparedness; and educates, trains and certifies electric industry personnel.

Net metering: A method of crediting customers for electricity that they generate on site in excess of their own electricity consumption.

Network: An interconnected system of electrical transmission lines, transformers, switches and other equipment connected together in such a way as to provide reliable transmission of electrical power from multiple generators to multiple load centers.

Nuclear power plant: A facility in which nuclear fission produces heat that is used to generate electricity.

Obligation to serve: In exchange for the regulated monopoly status of a utility for a designated service territory with the opportunity to earn an adequate rate of return, comes the obligation to provide electrical service to all customers who seek that service at fair, just, and reasonable prices. This has been part of what the utility commits to under the "regulatory compact" and also includes the requirement to provide a substantial operating reserve capacity in the electrical system. *(See also Regulatory compact.)*

Off peak: The period during a day, week, month or year when the load being delivered by a natural gas or electric system is not at or near the maximum volume delivered by that system for a similar period of time (night vs. day, Sunday vs. Tuesday).

On peak: The period during a day, week, month or year when the load is at or near the maximum volume.

Open access: The term applied to the evolving access to the transmission system for all generators and wholesale customers. This is also the use of a utility's transmission and distribution facilities on a common-carrier basis at cost-based rates.

Peak demand: The maximum load during a specified period of time.

Peak load plant or peaker unit: A plant usually housing low-efficiency, quick response steam units, gas turbines, diesels or pumped-storage hydroelectric equipment normally used during the maximum load periods. Peakers are characterized by quick start times and generally high operating costs, but low capital costs.

Photovoltaic (solar) conversion: The process of converting the sun's light energy directly into electric energy through the use of photovoltaic cells.

Pipeline system: A collection of pipeline facilities used to transport natural gas from source of supply to burner tip, including gathering, transmission or distribution lines, treating or processing plants, compressor stations and related facilities.

Power plant: A plant that converts mechanical energy into electric energy. The power is produced from raw material such as gas, coal, nuclear or other fuel technologies.

Qualifying facility (QF): A designation created by PURPA for non-utility power producers that meet certain operating, efficiency and fuel-use standards set by FERC. To be recognized as a qualifying facility under PURPA, the facility must be a small power production facility whose primary energy source is renewable or a cogeneration facility that must produce electric energy and another form of useful thermal energy, such as steam or heat, in a way that is more efficient than the separate production of both forms of energy. It must also meet certain ownership, operating and efficiency criteria established by FERC.

Regional transmission organization/group (RTO/RTG): A proposal advanced by FERC to establish regional groups to expedite the coordination of wholesale wheeling. The group is voluntary in each region and may include transmission system owners, wholesale purchasers and independent power generators.

Regulatory compact: A traditional covenant between customers in a state and investor-owned utilities (IOUs) in exchange for providing service to all customers in a defined service territory. IOU is given a service area monopoly on service and allowed to earn a limited return set by state regulators. The commission enforces the terms of the regulatory compact. *(See also Obligation to serve.)*

Reliability: The ability to meet demand without interruption. The degree of reliability may be measured by the frequency, duration and magnitude of adverse effects on consumer service.

Renewable resource: An energy source that is continuously or cyclically renewed by nature, including solar, wind, hydroelectric, geothermal, biomass or similar sources of energy.

Reserve capacity: Capacity in excess of that required to carry peak load, available to meet unanticipated demands for power or to generate power in the event of loss of generation.

Residential consumer: A consumer residing at a dwelling served by the company and using services for domestic purposes. This does not include consumers residing in temporary accommodations, such as hotels, camps, lodges and clubs.

Retail: Sales covering electrical energy supplied for end-use residential, commercial and industrial end-use purposes. Agriculture and street lighting are also included in this category. Power sold at retail is not resold by the purchaser to another customer.

Rural electric cooperative: *See Cooperative electric utility.*

Service area: The territory in which a utility system is required or has the right to supply service to ultimate customers.

Smart grid: Smart grid is a concept. At the moment that concept is undeveloped. The basic concept of smart grid is to add monitoring, analysis, control and communication capabilities to the national electrical delivery system to maximize the throughput of the system. In theory, the smart grid concept might allow utilities to move electricity around the system as efficiently and economically as possible. It might also allow the homeowner and business to use electricity as economically as possible. Consumers will have the choice and flexibility to manage electrical use while minimizing bills. Smart grid hopes to build on many of the technologies already used by electric utilities. It also adds communication and control capabilities with the idea of optimizing the operation of the entire electrical grid. To reduce this concept to a single sentence, one might describe smart grid as overlaying a communication network on top of the power grid.

Solar generation: The use of radiation from the sun to substitute for electric power or natural gas heating.

Substation: Equipment that switches, changes or regulates electric voltage. An electric power station that serves as a control and transfer point on an electrical transmission system. Substations route and control electrical power flow, transformer voltage levels and serve as delivery points to industrial customers.

Tariff: A document filed by a regulated entity with either a federal or state commission, listing the rates the regulated entity will charge to provide service to its customers as well as the terms and conditions that it will follow in providing service.

Thermal generation: The production of electricity from plants that convert heat energy into electrical energy. The heat in thermal plants can be produced from a number of sources such as coal, oil or natural gas.

Transmission: The network of high-voltage lines, transformers and switches used to move electrical power from generators to the distribution system (loads). This network is also utilized to interconnect different utility systems and independent power producers together into a synchronized network.

Transmission grid: An interconnected system of electric transmission lines and associated equipment for the transfer of electric energy in bulk between points of supply and points of demand.

Turbine: The part of a generating unit usually consisting of a series of curved vanes or blades on a central spindle that is spun by the force of water, steam or heat to drive an electric generator. Turbines convert the kinetic energy of such fluids to mechanical energy through the principles of impulse and reaction or a measure of the two.

Volt: A unit of measurement of electromotive force or electrical potential. It is equivalent to the force required to produce a current of one ampere through a resistance of one ohm. Typical transmission level voltages are 115 kV, 230 kV and 500 kV.

Watt: A measure of real power production or usage equal to one joule per second.

Watt-hour (Wh): An electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour.

Western Electricity Coordinating Council (WECC): A group of utilities banded together to promote reliability by coordinating the power supply and transmission in the West.

Wheeling: The use of the transmission facilities of one system to transmit power for another system. Wheeling can apply to either wholesale or retail service. *(See also Retail wheeling.)*