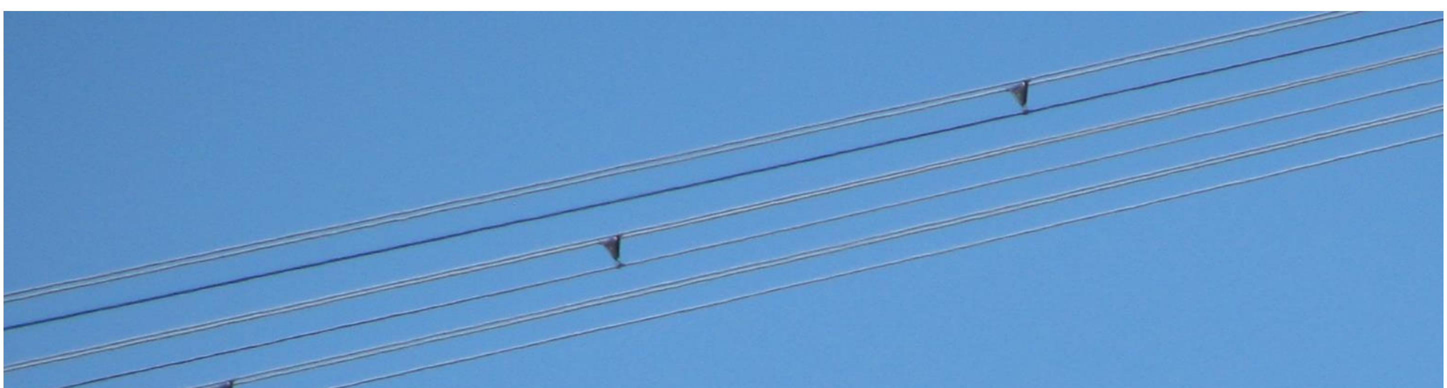



IDAHO ENERGY LANDSCAPE | PRINT DATE *MARCH 2018*



Idaho Governor's Office of Energy Resources

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1. Idaho's Energy Landscape

1.1. ENERGY & THE ECONOMY

The health of Idaho's economy and the continued feasibility 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, energy, and professional services all of which benefit from Idaho's relatively low cost of energy.

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 4.5 percent annually from 1997 to 2016, and Idaho's energy consumption (transportation, heat, light, and power) grew 1.1 percent annually from 1990 to 2015.[1] In addition, thousands of people work in Idaho's energy sector, which pushes the boundaries of technology, launches start-ups, and fuels research, growth, and discovery.

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 which dramatically lowered the cost to consumers and increased consumption by approximately 50 percent in the past decade. Natural gas plants are expected to continue to generate much of our nation's electricity supply. [2]

1.1.1. Energy Intensity

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 expenditure per dollar of Gross State Product was 12th among U.S. states in 2015. Idaho's energy expenditure per capita was 26th highest in 2015, higher than neighboring states such as Washington, Oregon and Utah.[3]

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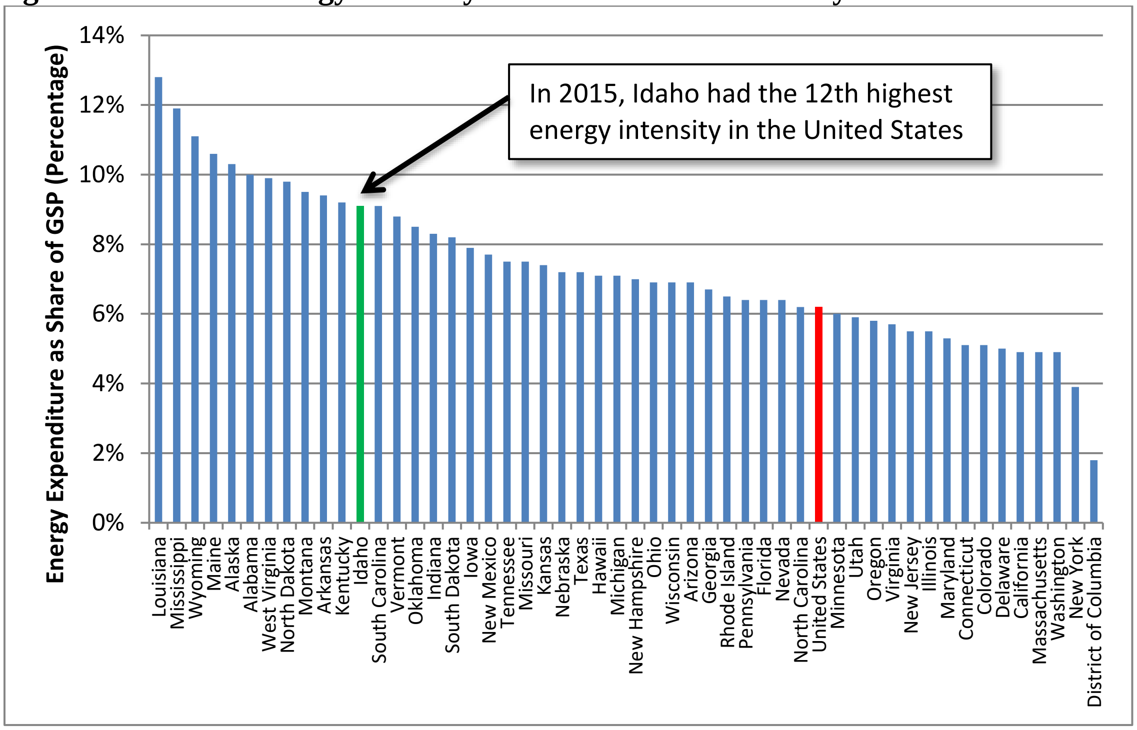
[1] Federal Reserve Bank of St. Louis. "FRED." https://fred.stlouisfed.org/series/IDNGSP and U.S. Energy Information Administration. "Total End-Use Energy Consumption Estimates, 1960-2014, Idaho." www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tx/use_tx_ID.html&sid=ID

[2] U.S. Energy Information Administration. www.eia.gov/dnav/ng/hist/n3045us2a.htm

[3] U.S. Energy Information Administration. "Energy Price and Expenditure Estimates." 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]



1.1.2. Household Energy Bills

Idaho's residential, commercial, industrial, and transportation sectors spent almost $6 billion on energy in 2015,[5] and the average Idaho household spent about $4,100 on direct energy products in 2015.[6]

While Idahoans enjoy low electricity and natural gas rates, Idaho's median household income of $48,000 in 2015 is significantly lower than the national average of $55,775 and Idahoans must frequently drive greater distances and spend more on transportation fuel because of the rural nature of Idaho.[7] Given these circumstances, energy expenditures consumed almost 8.5 percent of the average median household income in 2015 in Idaho, as illustrated in Figure 1.2.

[4] U.S. Energy Information Administration. www.eia.gov/state/seds/sep_sum/html/pdf/rank_pr.pdf

[5] U.S. Energy Information Administration. "Total Energy Consumption, Price, and Expenditure Estimates." www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_te.pdf

[6] U.S. Energy Information Administration. Expenditures – https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_ex_tra.html&sid=US, residential; https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_ex_res.html&sid=US households; http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPANNHU&prodType=table

[7] United States Census Bureau. www.census.gov/search-results.html?q=median+household+income&page=1&stateGeo=none&searchtype=web

Figure 1.2 Idaho's Average Household Energy Burden Compared to Other States in 2015 (including Transportation Fuel)[8]

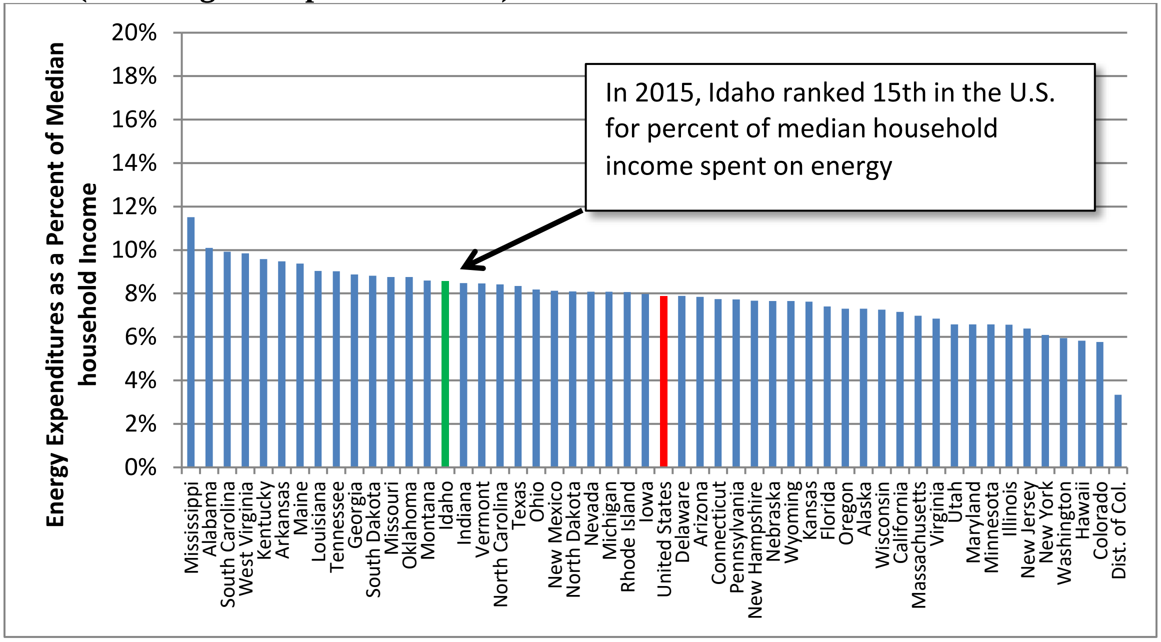


Table 1.1 Average Household Energy Bill in Idaho, 2015[9]

Energy Source	Dollars Per Year	Share
Gasoline	$2,580	62%
Electricity	$1,155	28%
Natural Gas	$291	7%
Other Petroleum (Propane, Fuel Oil, Kerosene)	$89	2%
Wood	$23	1%
Coal	$0	0%
Total	**$4,138**	**100%**

[8] United States Census Bureau. https://www.census.gov/library/publications/2016/acs/acsbr15-02.html
Source for Energy Prices and Expenditures and Gasoline Expenditures:
https://www.eia.gov/state/seds/sep_fuel/html/fuel_te.html
Source for Gasoline Expenditures:
https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_ex_tra.html&sid=

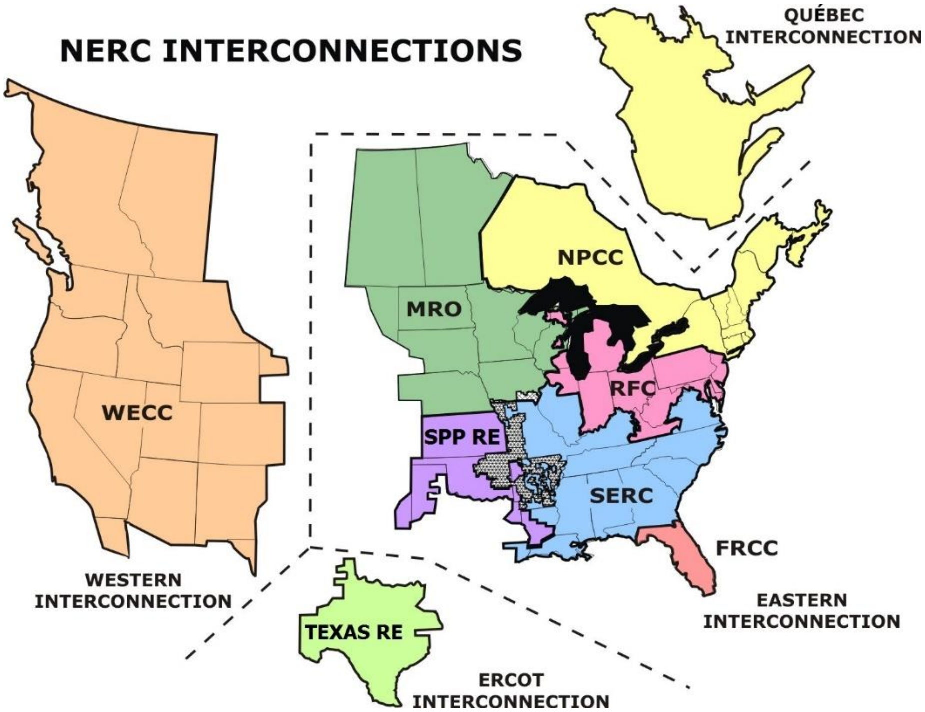
[9] U.S. Energy Information Administration. Expenditures – gasoline;
https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_ex_tra.html&sid=US, residential; https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_ex_res.html&sid=US households;
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPANNHU&prodType=table

1.2. IDAHO UTILITIES AND ENERGY SYSTEMS

1.2.1. Electricity

The electrical transmission network in the United States is made up of four separate interconnections. The Western Interconnection links Idaho with the rest of the western United States. 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 reliability standards in Idaho and the rest of the Western Interconnection.

Figure 1.3 North American Electric Reliability Corporation (NERC) Regional Electric Interconnections[10]



Idaho is served by three investor-owned electric utilities (IOUs), twelve municipal utilities, and sixteen rural electric cooperatives. The three IOUs serve approximately 87 percent of the state's electricity needs, and municipal utilities and rural electric cooperatives serve the remaining 13 percent as illustrated by Figures 1.4 and 1.5. [11]

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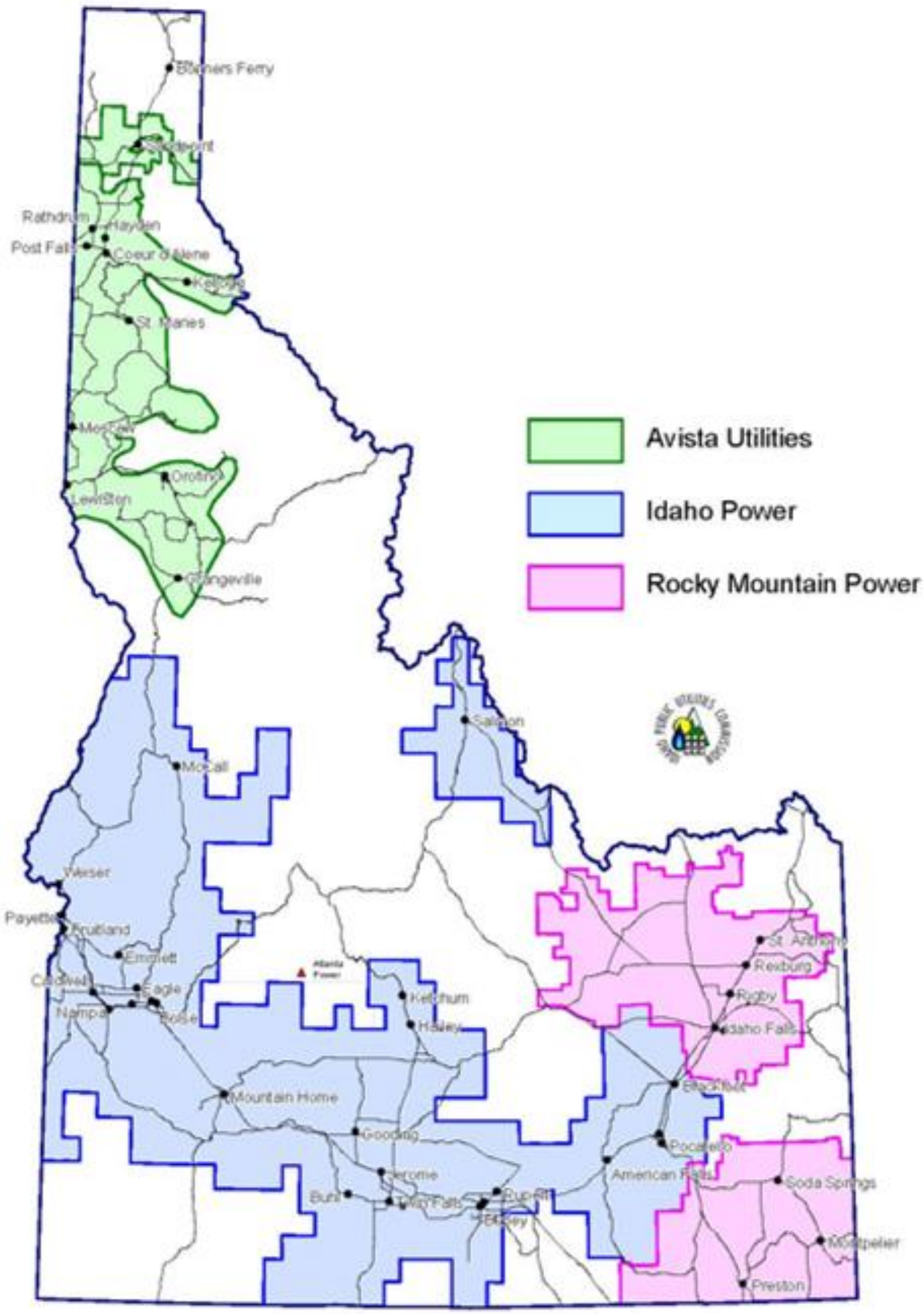
[10] North American Electric Reliability Corporation. http://www.nerc.com/AboutNERC/keyplayers/PublishingImages/NERC_Interconnections_Color_072512.jpg

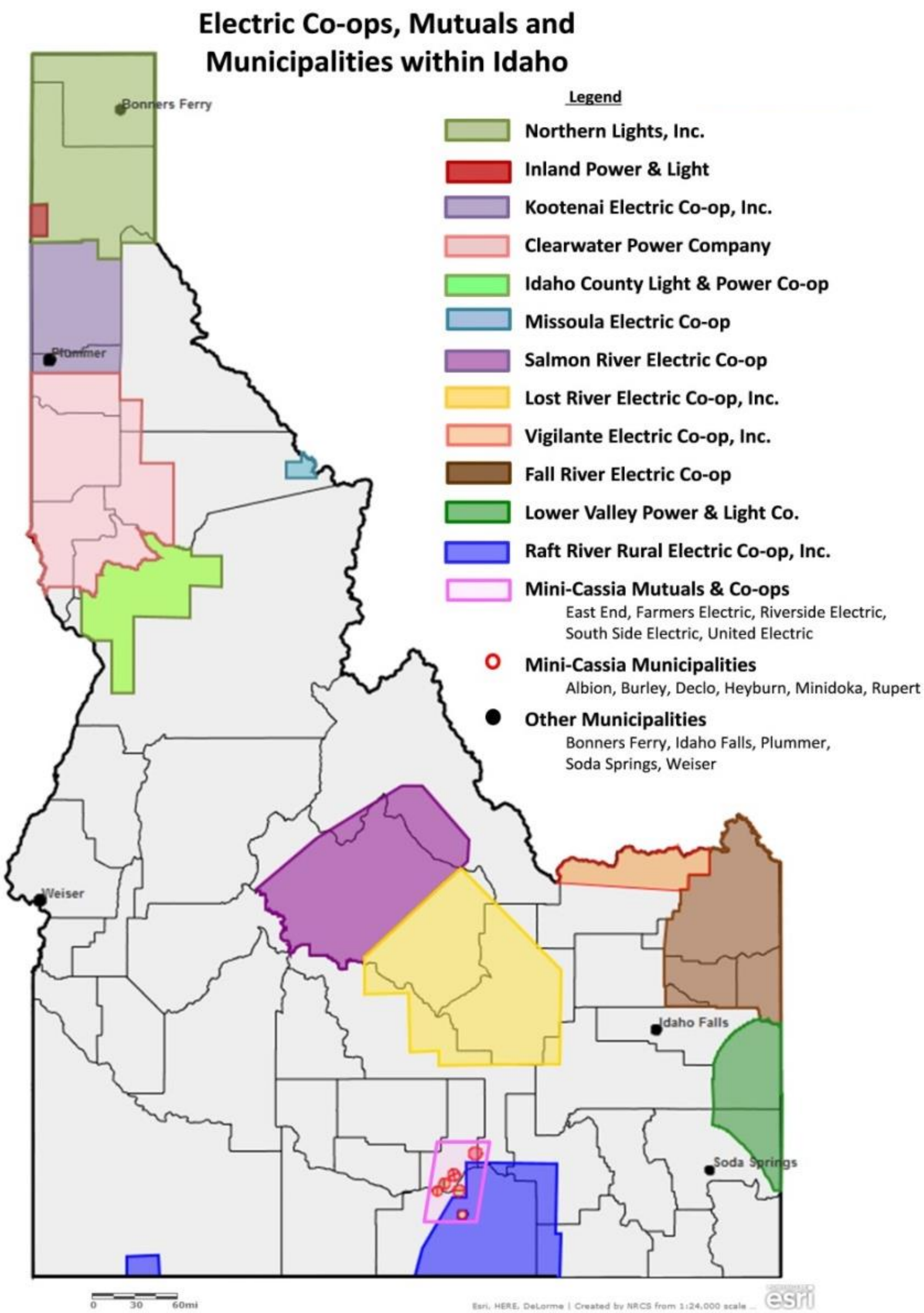
[11] U.S. Energy Information Administration. "State Electricity Profiles." www.eia.gov/electricity/state/Idaho

Figure 1.4 Transmission Territories of Idaho's Investor-Owned Utilities[12]



[12] Idaho Public Utilities Commission.

Figure 1.5 Service Territories of Idaho's Municipal and Cooperative Utilities[13]



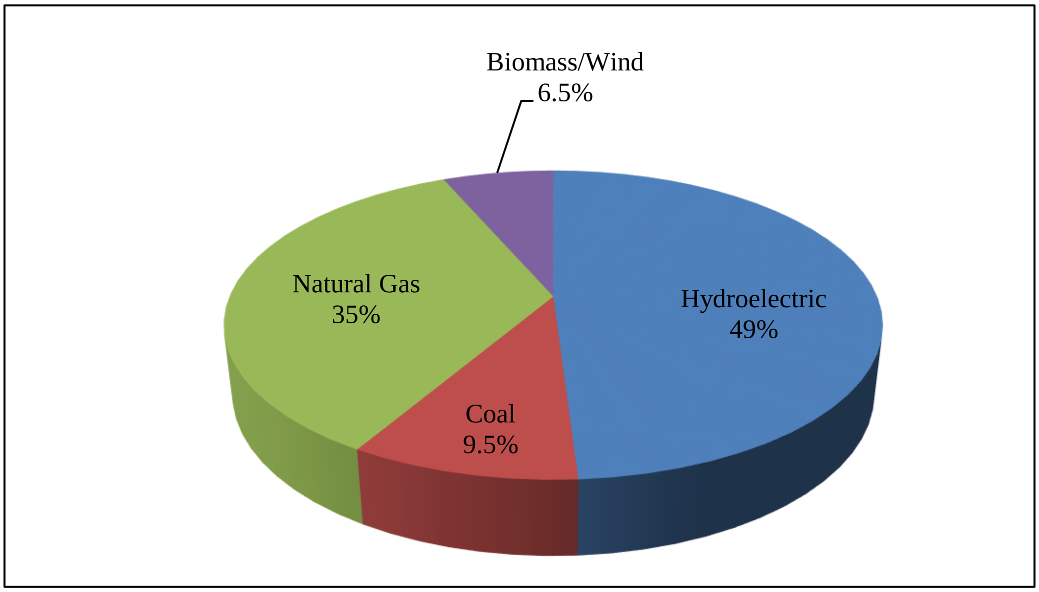
[13] Idaho Governor's Office of Energy and Mineral Resources.

1.2.1.1. Avista Corporation

Avista is an investor-owned electric and natural gas utility headquartered in Spokane, Washington, serves over 205,000 electric and natural gas customers in Idaho's northern and central regions, and is the second largest electricity and natural gas provider in Idaho.

Avista generates electricity by utilizing a mix of hydroelectric, natural gas, coal, biomass, and wind generation delivered over 2,100 miles of transmission line and 17,000 miles of distribution line. Avista's 2016 annual electrical energy fuel mix chart is shown in Figure 1.6 below.[14] 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 of a Montana coal plant.[15]

Figure 1.6 Avista Energy Fuel Mix (2016)[16]



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

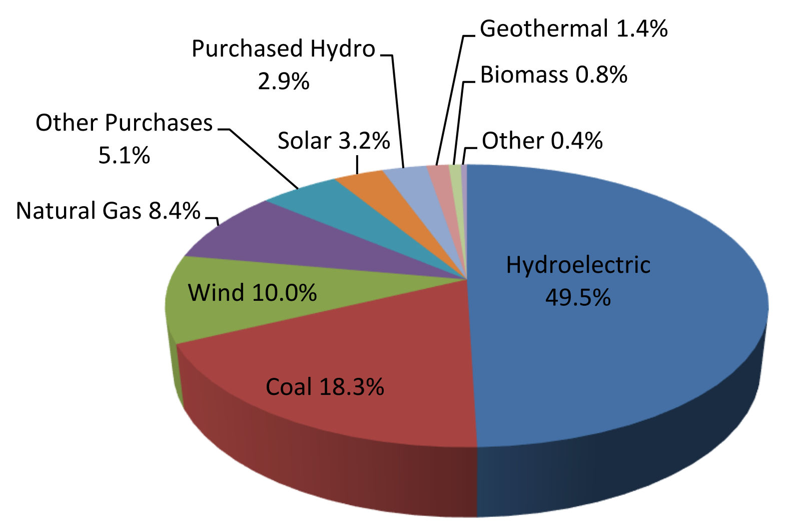
1.2.1.2. Idaho Power Company

Founded in 1916, the Idaho Power Company is the largest electricity provider in the State. Headquartered in Boise, it serves nearly 535,000 customers across a 24,000 square mile service territory in southern Idaho and eastern Oregon. 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.

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. It also has part ownership in baseload coal facilities located in Wyoming, Oregon, and Nevada. Idaho Power's resource portfolio fuel mix is shown in Figure 1.7. In addition to its company-owned resources, Idaho Power's supply-side portfolio includes several long-term contracts with wind, solar, biomass and geothermal facilities. Among these are contracts with 133 PURPA projects, totaling 1,115 MW, of which 613 MW are wind generation and 290 MW are solar generation.[17]

Idaho Power plans to reduce its reliance upon coal-fired generation as evidenced by the intended retirement of the Boardman, Oregon coal plant by year-end 2020, and the planned divestment of its interest in the North Valmy, Nevada coal plant starting with unit 1 by year-end of 2019 and unit 2 by year-end of 2025.

Figure 1.7 Idaho Power Resource Portfolio Fuel Mix (2017)[18]



[17] Idaho Power Company. "2017 Integrated Resource Plan" https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf.

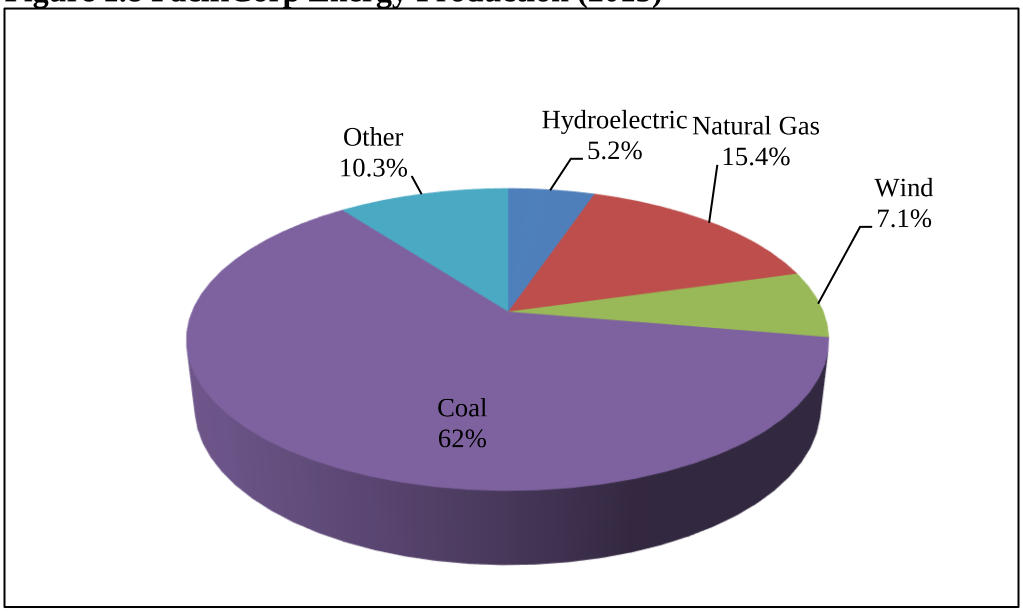
[18] Idaho Power Company. "Resource Portfolio Fuel Mix 2017." https://www.idahopower.com/energy/delivering-power/fuel-mix

1.2.1.3. PacifiCorp / Rocky Mountain Power

PacifiCorp serves more than 1.8 million retail customers across 143,000 square miles of service territory in California, Idaho, Oregon, Utah, Washington, and Wyoming.[19] The current company, owned by Berkshire Hathaway Energy, is the result of several mergers. PacifiCorp began operating in Idaho in 1989 through its merger with the Utah Power & Light Company, which began serving customers in Idaho in 1912. PacifiCorp was purchased by MidAmerican Energy Holdings Company in 2006, which later changed its name to Berkshire Hathaway Energy. PacifiCorp operates under the name Rocky Mountain Power (RMP) in Idaho, Utah, and Wyoming. RMP serves 76,268 customers in southeastern Idaho, which represents approximately four percent of PacifiCorp's total customer base.

PacifiCorp owns 72 generating plants with 10,894 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 19 percent of PacifiCorp's owned and contracted generating capacity, accounting for about 20 percent of total energy output. PacifiCorp had 1,032 MW of owned wind generation capacity and long-term purchase agreements for 1,301 MW from wind projects owned by others.[20] PacifiCorp's customers receive electricity through approximately 16,500 miles of transmission line, 63,000 miles of distribution line, and 900 substations.[21]

Figure 1.8 PacifiCorp Energy Production (2015)[22]



[19] PacifiCorp. "Company Quick Facts." http://www.pacificorp.com/about/co/cqf.html
[20] PacifiCorp 2017 IRP. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf
[21] PacifiCorp. "Quick Facts." http://www.pacificorp.com/about/co/cqf.html
[22] PacifiCorp. "Fact Sheets" http://www.pacificorp.com/content/dam/pacificorp/doc/About_Us/Company_Overview/PC-FactSheet-Final_Web.pdf

1.2.1.4. Idaho's Municipal and Cooperative Utilities

Twenty-eight rural electric cooperatives and municipalities serve more than 130,000 customers throughout Idaho, accounting for 13 percent of Idaho's electricity demand load.[23] Twenty-two of these utilities collaborate under the Idaho Consumer Owned Utilities Association (ICUA) on issues of administrative, governmental, and regulatory significance.[24]

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 also has several municipalities that 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 from Bonneville Power Administration (BPA), however many are beginning to acquire their own power resources and enter into power purchase agreements with other energy providers. 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).

1.2.1.5. Utah Associated Municipal Power Systems

Some 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 47 utilities in seven 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 development of projects including power generating facilities.[25]

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 about 2,000 customers in Franklin County.[26]

1.2.2.1. Avista Utilities

Avista serves over 79,000 Idahoans in its Washington/ Northern Idaho service area, 90 percent of whom are residential customers.[27] 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.

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[23] U.S. Energy Information Administration. "Idaho Electricity Profile." www.eia.gov/electricity/state/Idaho
[24] Idaho Consumer-Owned Utilities Association. "About ICUA." www.icua.coop/about-icua/
[25] UAMPS. "About Us." http://www.uamps.com/About-Us
[26] Idaho Public Utilities Commission. www.puc.idaho.gov/press/160419_Questar.pdf
[27] Avista. "2017 Integrated Resource Plan." http://www.puc.idaho.gov/fileroom/cases/gas/AVU/AVUG1603/20160901AVISTA%202016%20NATURAL%20GAS%20IRP.PDF

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 (IRP) the number of customers in Washington and Idaho is projected to increase at an average annual rate of 1 percent.[28]

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 holds firm capacity on William's Northwest Pipeline to distribute natural gas through approximately 12,000 miles of mainline and service lines to 74 Idaho communities across 60,000 square miles, and approximately 355,000 residential, commercial, and industrial customers.[29] Industrial customers are the largest users of natural gas. Total volume sales from the industrial sector comprise approximately 52 percent of IGC's annual energy throughput. Residential and commercial sectors comprise 32 and 16 percent, respectively.

In addition to owning firm capacity on interstate pipelines, IGC owns and operates the Nampa LNG storage facility and holds storage rights at the Jackson Prairie and Plymouth facilities. 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 2.69 percent over the five-year period of 2017-2021.[30]

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 northern, central and southwestern Utah, southwestern Wyoming and about 2,000 customers in Franklin County, Idaho.[31] The Idaho Public Utilities Commission (PUC) has elected to allow the Utah Public Service Commission to regulate Dominion Energy's activities in its small Idaho service area.

Figure 1.9 shows the major natural gas infrastructure in Idaho and Idaho utility service territories.

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[28] Avista. "2017 Integrated Resource Plan." http://www.puc.idaho.gov/fileroom/cases/gas/AVU/AVUG1603/20160901AVISTA%202016%20NATURAL%20GAS%20IRP.PDF

[29] Intermountain Gas Company. "About Us." www.intgas.com/utility-navigation/about-igc

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

[31] Idaho Public Utilities Commission. puc.idaho.gov/press/160419_Questar.pdf; Idaho Public Utilities Commission. http://www.puc.idaho.gov/fileroom/cases/gas/QST/QSTG1601/ordnotc/20161019FINAL_ORDER_NO_33628.PDF

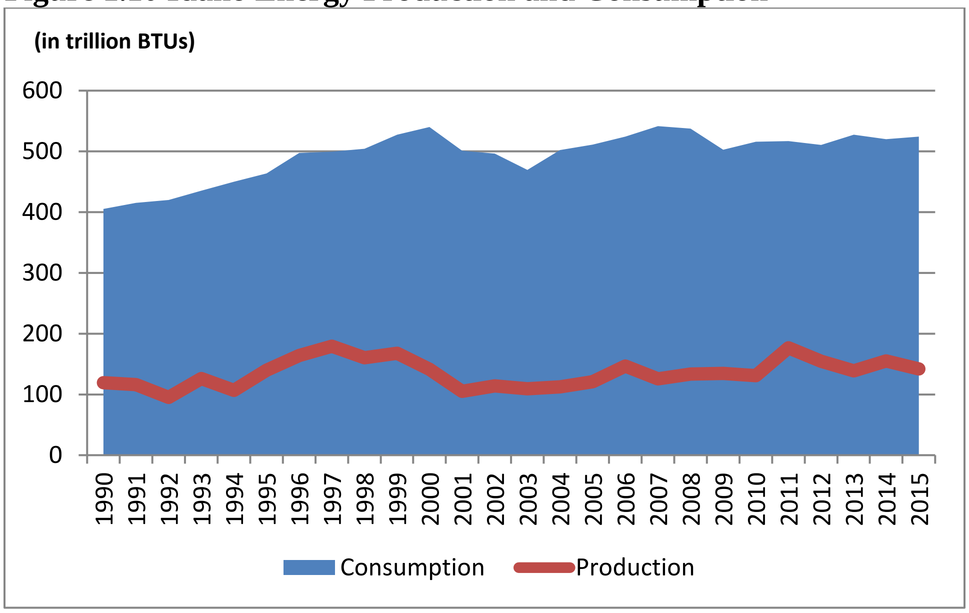
Figure 1.9 Western U.S. Interstate Natural Gas Pipeline System and Natural Gas Service Territories[32]

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

1.3. ENERGY CONSUMPTION, PRODUCTION, AND PRICES

The State produces approximately 27 percent of the total energy it consumes, as shown in Figure 1.10. 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 1.10 Idaho Energy Production and Consumption[33]

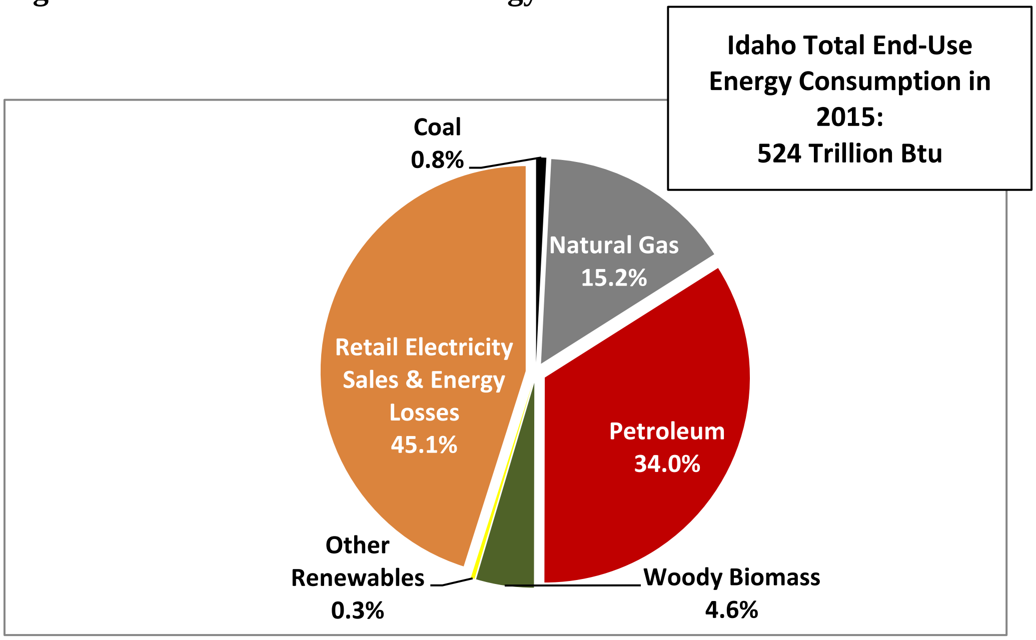


1.3.1. Sources of Idaho's Energy

As shown in Figure 1.11, petroleum- including those blended with ethanol- used primarily for transportation accounts for approximately 34 percent of Idaho's end-use energy consumption. Electricity sales and system losses (45 percent) and natural gas (15 percent) also are important energy commodities, while the remaining 6 percent is attributable to coal, biomass, and other renewable energy sources.

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

Figure 1.11 Sources of End Use Energy Consumed in Idaho in 2015[34]

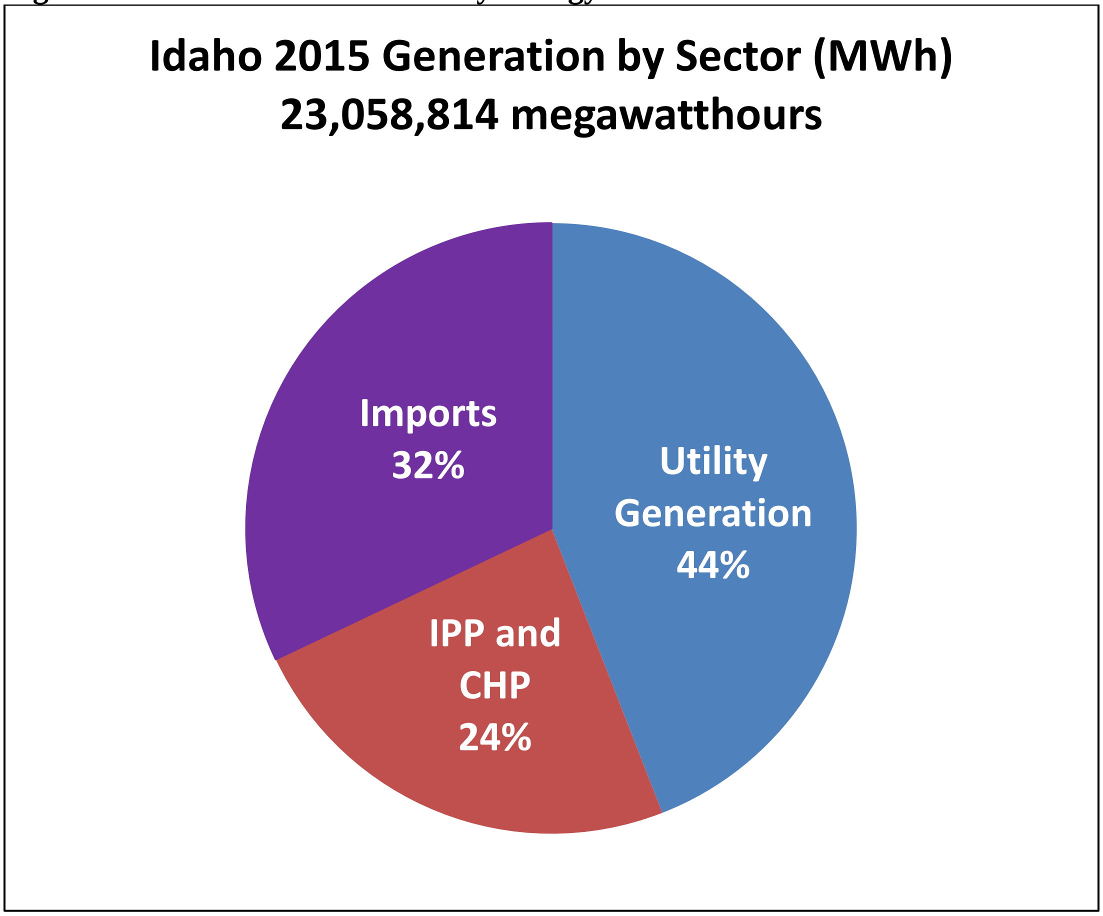


Note: "Other Renewables" includes geothermal, wind and solar.

Figure 1.12 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.

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

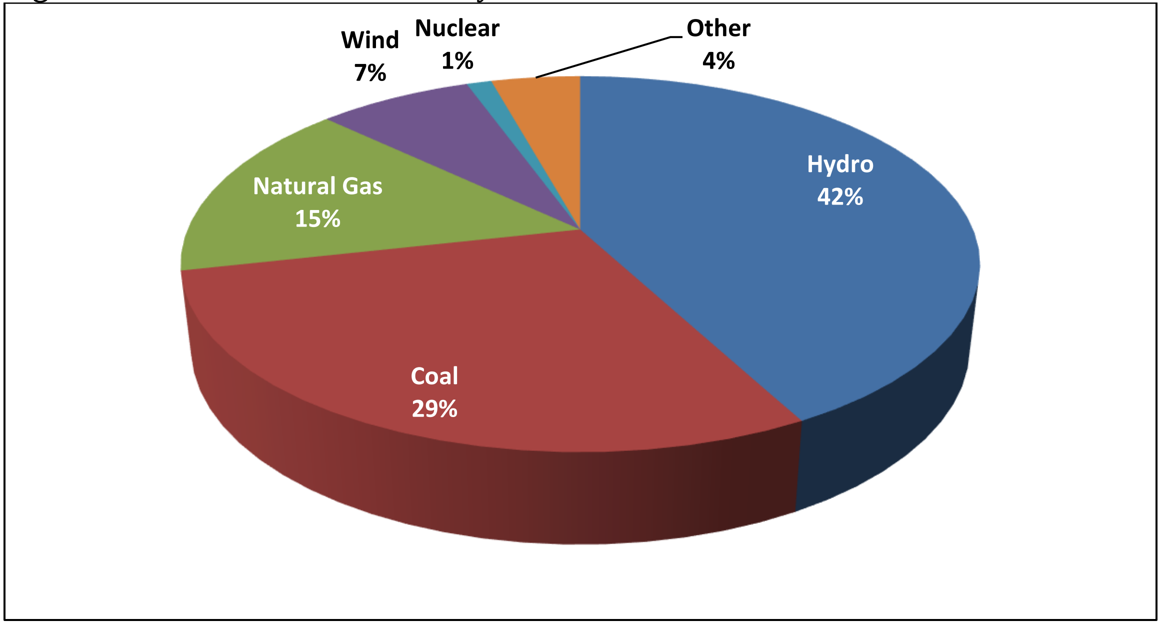
Figure 1.12 Idaho's 2015 Electricity Energy Sources[35]



As illustrated in Figure 1.13, hydroelectricity and coal are the dominant sources of Idaho's electricity, comprising approximately 42 and 29 percent, respectively. Natural gas comprises 15 percent, with non-hydro renewables, principally wind power, geothermal and biomass, accounting for approximately 11 percent. Idaho's municipal and cooperative utilities also receive some output of the Columbia Generating Station nuclear plant in Washington.

[35] U.S. Energy Information Administration. www.eia.gov/electricity/state/idaho/index.cfm

Figure 1.13 Idaho's 2015 Electricity Fuel Mix[36]



Note: that 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. Data based upon three IOUs and BPA 2015 resources apportioned by percent of Idaho load served and that none of these resources are specifically allocated to Idaho.

While hydroelectricity is typically the primary resource utilized for electricity generation in Idaho, its percentage in the total electricity fuel mix of the State depends upon the quality of the water year. Recent droughts reduced hydroelectricity's 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.[37]

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 hydro, thermal, and baseload coal resources located in neighboring states provide a constant source of reliable, relatively low-cost electricity to Idaho utilities. As a result, Idaho's average electricity rates were the 4th lowest among the fifty states in 2016, see Figure 1.14. Idaho's average residential natural gas rates also were among the lowest in U.S. in 2016, as shown in Figure 1.15.

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[36] 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: http://www.eia.gov/cneaf/electricity/page/eia861.html BPA: Source: https://www.bpa.gov/p/Generation/Fuel-Mix/FuelMix/BPA-Official-Fuel-Mix-2015.pdf

[37] U.S. Energy Information Administration, https://www.eia.gov/state/analysis.php?sid=ID

Figure 1.14 Idaho's Average Electricity Rates Compared to Other States for 2016[38]

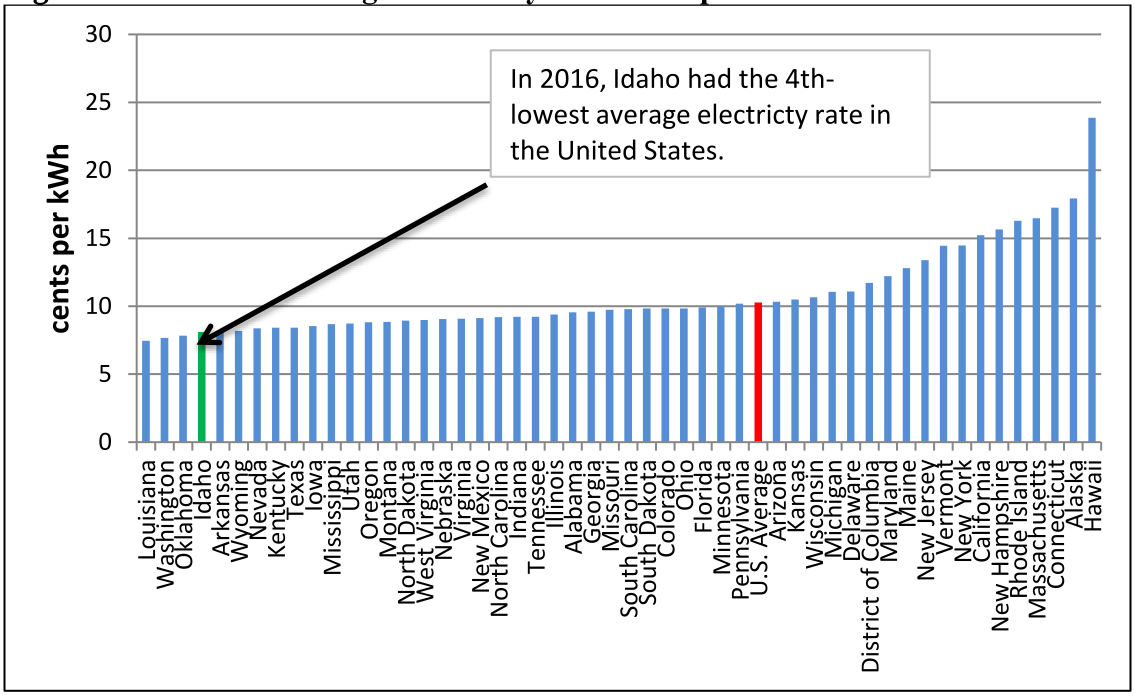
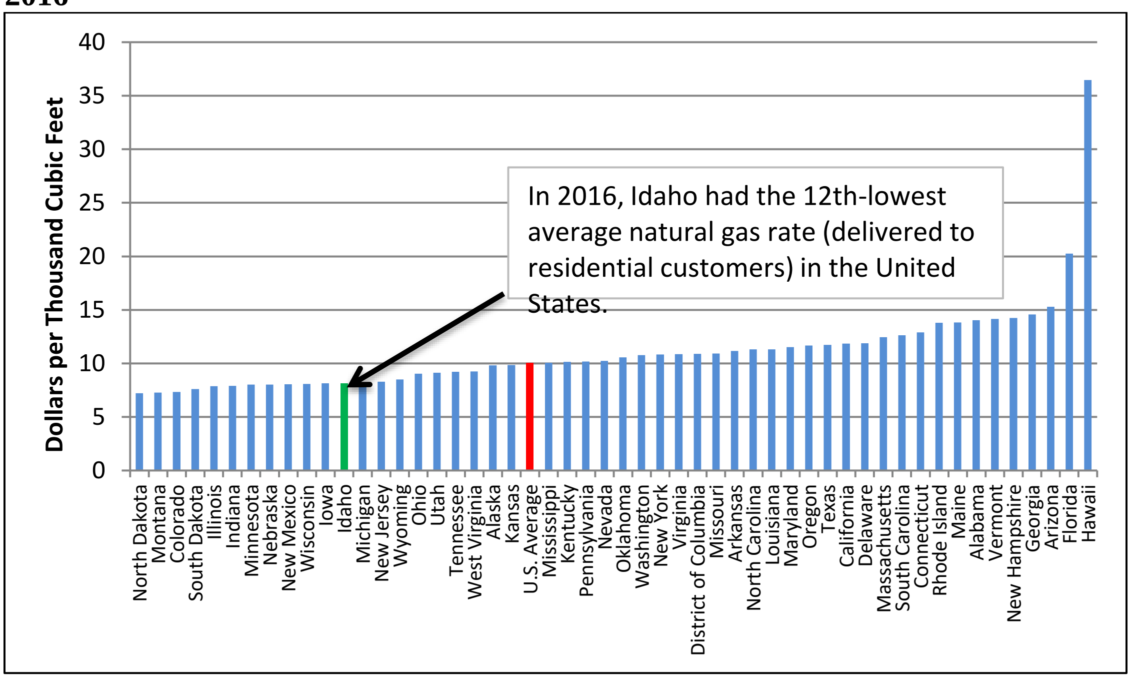


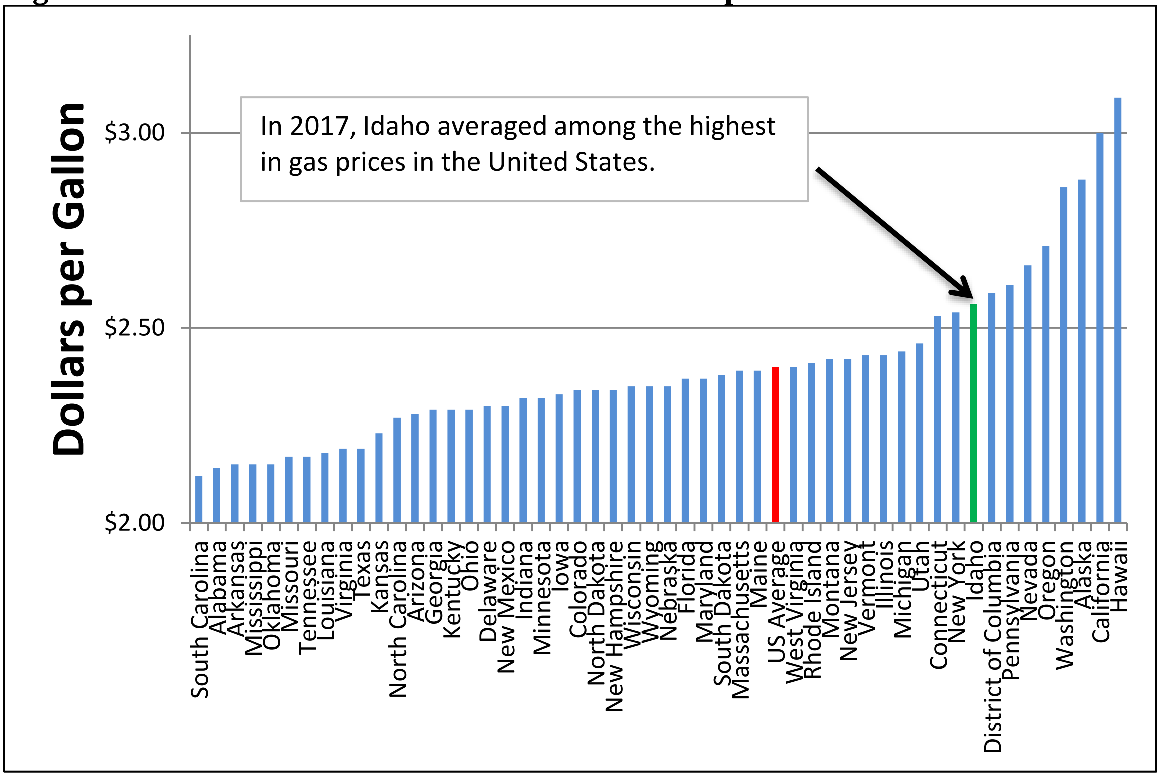
Figure 1.15 Idaho's Residential Natural Gas Prices Compared to Other States in 2016[39]



[38] U.S. Energy Information Administration. "Total Electricity Price." https://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf.
[39] U.S. Energy Information Administration. www.eia.gov/dnav/ng/NG_PRI_SUM_A_EPG0_PRS_DMCF_A.htm

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

Figure 1.16 Idaho's 2017 Retail Gasoline Prices Compared to Other States[40]



Note: The average combined (local, state and federal) gasoline tax was 51.73 cents per gallon. Idaho's combined gasoline tax rate in 2017 was 51.40 cents per gallon.[41]

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.[42]

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[40] AAA, http://newsroom.aaa.com/tag/aaa-fuel-gauge-report/
[41] American Petroleum Institute, http://www.api.org/~/media/Files/Statistics/Gasoline-Tax-Map.pdf
[42] Idaho Statutes § 61and § 62.

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 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.

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.

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 seeks to increase awareness, transparency, and accessibility 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. [43]

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.[44] Administratively housed under 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.[45]

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 of Environmental Quality (DEQ). The Director or her/his designee may hold administrative hearings on applications for activities that may affect other mineral interest owners.

The Director of the IDL, a 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 serve on the Commission.

[43] Idaho Public Utilities Commission. www.puc.idaho.gov
[44] Idaho Statute §47-314.
[45] Idaho Oil and Gas Conservation Commission. https://ogcc.idaho.gov/

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.[46]

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.[47]

1.4.4. Idaho Department of Environmental Quality

The 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.[48]

1.4.5. Idaho Department of Lands

The IDL leases and issues rights-of-way for energy projects on state endowment lands.[49]

1.4.6. Idaho Office of Energy and Mineral Resources

The Idaho Governor's Office of Energy and Mineral Resources (OEMR), established by Executive Order 2016-03, coordinates energy and mineral planning and policy development in the State of Idaho.[50] OEMR works to ensure that Idaho energy and

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[46] Idaho Energy Resources Authority. http://iera.info/purpose/
[47] Idaho Energy Resource Authority. http://iera.info/announcements/
[48] Idaho Department of Environmental Quality. http://www.deq.idaho.gov/about-deq/
[49] 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
[50] Governor C.L. "Butch" Otter. "Executive Order 2016-03." https://gov.idaho.gov/mediacenter/execorders/eo16/EO_2016-03.pdf

mineral resources are developed and utilized in an efficient, effective, and responsible manner; and that the State has sufficient energy resources to sustain a healthy economy.

As Idaho's lead entity for energy issues, 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.[51]

1.4.7. Idaho Strategic Energy Alliance

Governor C.L. "Butch" Otter created the ISEA to enable the development of a sound energy portfolio that includes diverse, effective, secure, and stable sources of energy and production methods that provide a high value to Idahoans, and that ensures 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.[52]

1.4.8. Leadership in Nuclear Energy Commission 3.0

Governor C.L. "Butch" Otter renewed the Leadership in Nuclear Energy Commission (LINE) 3.0 through Executive Order 2017-11 to oversee Idaho's robust and growing nuclear energy sector, anchored by the Idaho National Laboratory (INL).[53] Membership of the Commission includes cabinet officials, local government leaders, representatives from Idaho tribes, the INL and Idaho universities, the nuclear industry, and a member of the public. The LINE Commission will prepare the State to understand its options and to make strategic choices as Idaho's nuclear industry evolves.

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, gas pumps, and propane meters. The Bureau monitors gasoline octane levels and is responsible for Idaho's fuel quality and labeling.[54]

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. BPA serves the Northwest and supplies about 28 percent of regional power by working with utilities, IOUs, and by

[51] Idaho Governor's Office of Energy and Mineral Resources. https://oemr.idaho.gov/
[52] Idaho Governor's Office of Energy and Mineral Resources. "Idaho Strategic Energy Alliance." https://oemr.idaho.gov/isea/
[53] Governor C.L. "Butch" Otter. "Executive Order 2017-11." https://gov.idaho.gov/mediacenter/execorders/eo17/EO%202017-11%20LINE%203.0.pdf
[54] Idaho State Department of Agriculture. https://agri.idaho.gov/main/about/about-isda/ag-inspections/

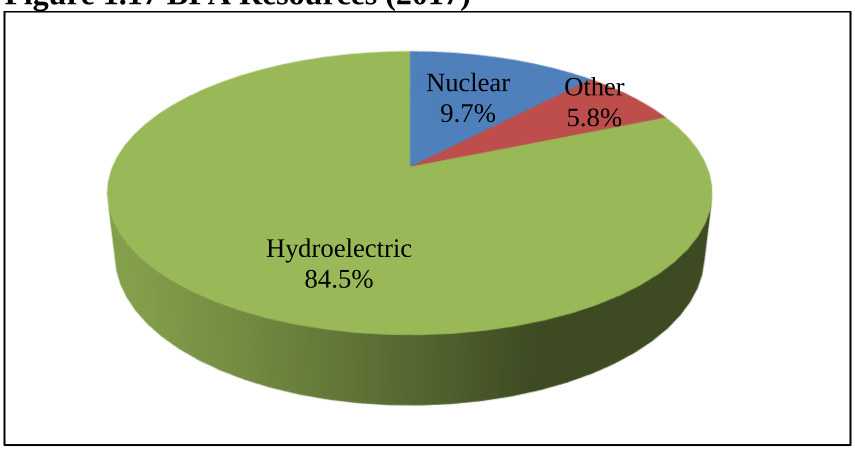
directly providing power to some industrial and irrigation customers in a practice known as direct-service.[55]

BPA sources power from 31 federal hydroelectric dams that are operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation, and are referred to as the Federal Columbia River Power System (FCRPS). 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 also operates and maintains approximately three-fourths of the high-voltage transmission lines that serve nearly 13.5 million people in its service territory, which covers over 300,000 square miles and includes Idaho, Oregon, Washington, western Montana and parts of eastern Montana, California, Nevada, Utah and Wyoming.[56]

BPA annually updates a Pacific Northwest Loads and Resources Study, commonly referred to as the "White Book," which documents federal system loads and resources including public power loads served by BPA and the Pacific Northwest for the period 2017 through 2026. According to the Federal System Analysis in the 2016 "White Book," energy deficits are expected in the federal system, most notably in the winter and late summer, and BPA may need to supplement existing federal system generation to meet projected load obligations.[57]

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 utilities beginning in 2011. Each utility is faced with acquiring resources independently or jointly with other utilities, including BPA (called a tier two power purchase) to meet future demands.

Figure 1.17 BPA Resources (2017)[58]



[55] Bonneville Power Administration. www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf
[56] Bonneville Power Administration. BPA Facts www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf
[57] Bonneville Power Administration. "2016 Pacific Northwest Loads and Resources Study. https://www.bpa.gov/power/pgp/whitebook/2016/2016-WBK-Loads-and-Resources-Summary-20161222.pdf
[58] Bonneville Power Administration. https://www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf

1.4.11. Northwest Power and Conservation Council

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

The Council is an independent agency, 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 also 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.

The Council also prepares and updates a Least Cost Power Plan to advise the BPA, and must update it at least every five years. Included in the Plan are electricity demand forecasts, electricity and natural gas price forecasts, an assessment of the amount of cost-effective energy efficiency that can be acquired over the life of the plan, and a least-cost generating resources portfolio.

The Council also updates the Columbia River Basin Fish and Wildlife Program every five years, the latest update was adopted in October 2014. The Seventh Power Plan incorporated the full Fish and Wildlife Program in May 2016, and the Council will begin the formulation of the next Fish and Wildlife Plan this summer.[59]

1.4.12. U.S. Department of Energy

The DOE administers U.S. energy policies, oversees the nation's nuclear infrastructure, and operates energy research facilities throughout the nation, including the INL.

1.4.13. U.S. Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is a quasi-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.[60]

1.4.14. North American Electric Reliability Corporation

The North American Electric Reliability Corporation (NERC) is an organization subject to oversight by the FERC and governmental authorities in Canada whose mission is to ensure the reliability of the bulk power system in North America.[61]

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

[59] Northwest Power and Conservation Council. www.nwcouncil.org
[60] Federal Energy Regulatory Commission. "About FERC." https://www.ferc.gov/about/about.asp
[61] North American Electric Reliability Corporation. http://www.nerc.com/Pages/default.aspx

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.[62]

1.4.16. Peak Reliability

Peak Reliability (Peak) is a non-profit corporate entity formed in 2014 to assume the role of a Reliability Coordinator in the Western Interconnection; a role that had previously been performed by WECC. 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 has authority to prevent or mitigate emergency operating situations and give orders to local utilities to take corrective action.[63]

1.4.17. 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 the INL, and to ensure that materials transported through the State for disposal, and the materials present at the INL adhere to appropriate safety guidelines.[64]

1.4.18. 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 impact public lands or endangered species in some manner and the State and developers must work with DOI and its agencies to secure proper permitting and approval under the National Environmental Policy Act (NEPA) and other federal laws.[65]

For example, 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. 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.

1.4.19. The U.S. Forest Service

The U.S. Forest Service (USFS), an agency of the U.S. Department of Agriculture, is responsible for managing the nation's national forests and grasslands. The State and developers work with USFS on issues relating to transmission rights-of-way through

[62] Western Electricity Coordinating Council. "About WECC." https://www.wecc.biz/Pages/AboutWECC.aspx
[63] Peak Reliability. https://www.peakrc.com/aboutus/Pages/default.aspx
[64] U.S. Nuclear Regulatory Commission. "The Commission." https://www.nrc.gov/about-nrc/organization/commfuncdesc.html
[65] U.S. Department of Interior. https://www.doi.gov/whoweare

national forests, issues pertaining to energy development on National Forest System lands and woody biomass as a source of energy.[66]

1.4.20. 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. 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.[67]

1.4.21. U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) establishes minimum standards related to clean air and clean 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 Idaho DEQ, to ensure state compliance with environmental standards.

1.5. REGIONAL AND NATIONAL ENERGY ISSUES

1.5.1. Transmission Planning

Pursuant to recent 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.[68] Two Northwest planning groups, the Northern Tier Transmission Group (NTTG) and the Columbia Grid, now produce transmission expansion and economic study plans on a periodic basis.[69] These local, sub-regional, and regional planning processes identify transmission project costs, benefits, and risks and their allocation to customer group beneficiaries, and 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

Several utilities in the west also are beginning to participate in a regional real-time market service, referred to as an Energy Imbalance Market (EIM), which utilizes regional transmission systems to balance supply and demand across a larger geographical footprint in real time. EIMs can cover areas served by multiple utilities, and members of the EIM do not need to be full participants in Independent System Operators (ISOs). The EIM 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.

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[66] U.S. Forest Service. "About the Agency." https://www.fs.fed.us/about-agency
[67] NOAA Fisheries. http://www.nmfs.noaa.gov/aboutus/our_mission.html
[68] Federal Energy Regulatory Commission. FERC Order Nos. 890 and 1000.
[69] Idaho Power and PacifiCorp are members of NTTG, and Avista and BPA are members of Columbia Grid.

PacifiCorp has participated in the region's EIM since November 1, 2014, and several regional utilities plan to join. Idaho Power signed a participation agreement to begin participating in April 2018.

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.

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 renewable primary energy source, biomass, waste, or geothermal resources.[70]

To qualify under PURPA, a cogeneration facility must sequentially produces electricity and another form of useful thermal energy in 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.[71]

Avoided cost rates and other implementation details are determined at the state level. 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.

However, 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.[72]

In the years following the 2010 PUC decision, the number of Idaho PURPA projects significantly increased, as shown in Figure 1.18. With the influx of projects and rapidly changing technologies, the ability of Idaho utilities to absorb the amount of projects seeking contracts and to accurately predict avoided cost rates over a 20-year contract

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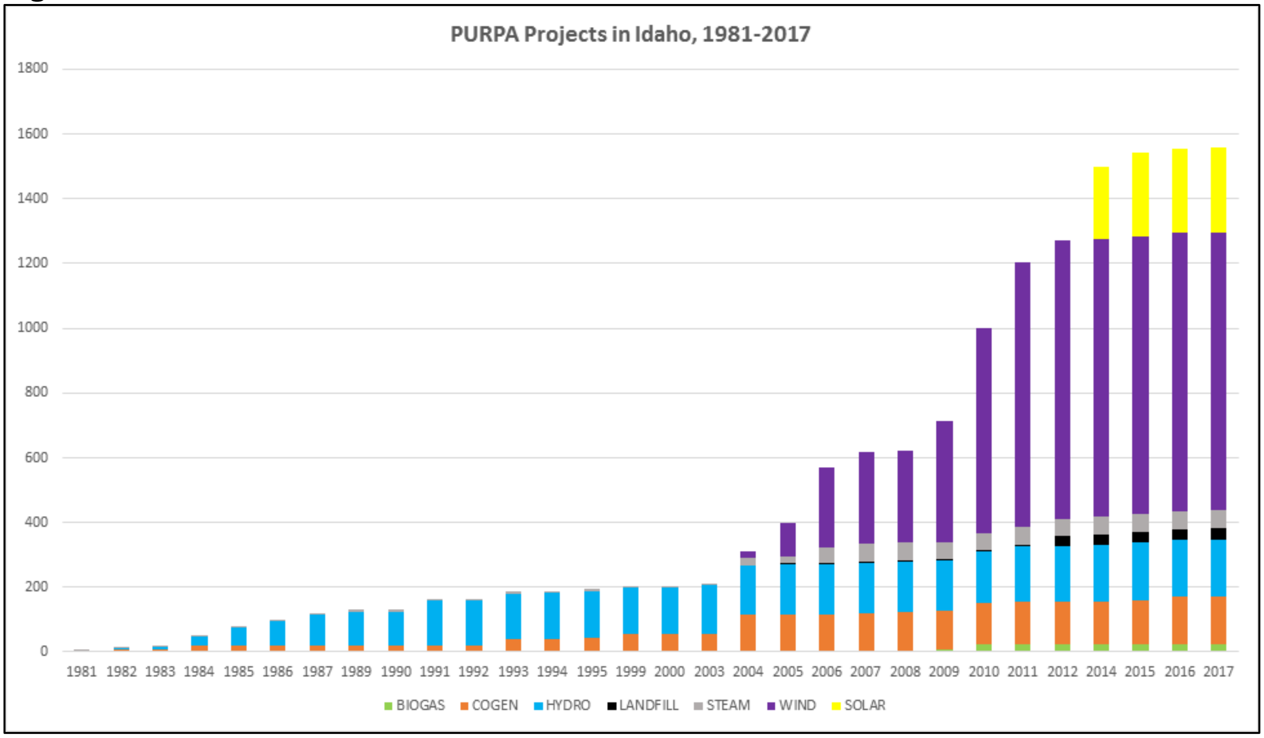
[70] Federal Energy Regulatory Commission. "What is a Qualifying Facility?" www.ferc.gov/industries/electric/gen-info/qual-fac/what-is.asp.
[71] U.S. Forest Service. "FSH 2709.15 - HYDROELECTRIC HANDBOOK." www.fs.fed.us/im/directives/fsh/2709.15/05.txt
[72] Idaho Public Utilities Commission. "CASE NO. GNR-E-10-04, ORDER NO. 32176." http://www.puc.idaho.gov/fileroom/cases/elec/GNR/GNRE1004/ordnotc/20110207FINAL_ORDER_NO_32176.PDF

period was jeopardized, and increased the risk of future adverse impacts on consumer rates. 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 20 years to 2 years to alleviate this risk.[73]

Figure 1.18 PURPA Generation in Idaho, 1981-2015[74]



[73] 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
[74] 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.[75] The flexible nature of hydroelectricity enables it to supply the fluctuating demands on the electric grid, and also allow 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 2016 hydroelectric generation was 8,756,622 MWh, providing about 56 percent of in-state electrical generation.[76]

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.

Natural gas reserves were detected in the Payette Basin of western Idaho, and related drilling commenced in Idaho's first commercial production of natural gas and natural gas liquids. While still in its infancy, production of natural gas in Idaho is expected to grow in the future.

Natural gas power plants are an efficient and effective means of electricity generation, as they can adjust generation in real-time to adapt to load demands. Such responsiveness is critical to supplement to the ebbs and flows of electricity generated by wind and solar projects. Advances in gas turbine design, as well as advances in natural gas-fired internal combustion engines, have been developed to improve the operating flexibility of natural gas generation.

Natural gas-fired simple-cycle (SCCT) and combined-cycle combustion turbines (CCCT) are favored by utilities due to their ability to emit fewer regulated pollutants and CO_2 gases than coal-fired generation. The low capital cost of construction, and the current low cost of natural gas eases operating expenses of natural gas plants has made electricity generated by natural gas plants some of the most affordable in the nation, and these facilities are the predominant thermal resource considered by domestic utilities.

Natural gas also is utilized for transportation, and is the cleanest burning fossil fuel for that purpose. As a transportation fuel, natural gas is used as compressed natural gas

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

(CNG) or as liquefied natural gas (LNG). Both compression and liquefaction are methods employed to increase the amount of natural gas that can be stored on the vehicle and thus increase its driving range. CNG is used directly in an internal combustion engine. LNG must first be vaporized before it can be burned in the internal combustion engine.[77] Idaho has two public CNG vehicle refueling stations, one in Boise and another in Nampa. Some municipal and commercial fleets also utilize natural gas and operate their own CNG refueling stations.[78]

2.3. COAL

Idaho currently has no in-state utility-scale coal 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.[79] Coal is found in abundance in the United States, with both the nation's largest coal exporter (Wyoming) and the largest recoverable coal reserve (Montana) in close proximity to Idaho. Some industrial users in Idaho still utilize coal at their facilities for power and steam generation (cogeneration) purposes.

2.4. NUCLEAR

The Idaho National Laboratory (INL), located in southeastern Idaho, is the lead laboratory for nuclear energy research. The 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.

While no commercial-scale nuclear power generation exists in Idaho, on a national scale, nuclear power generation from 99 operating reactors in 30 states accounts for nearly 20 percent of the electricity produced in the United States.[80] 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. [81]

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.[82] Utah Associated Municipal Power Systems (UAMPS) is interested in

[77] Idaho Strategic Energy Alliance. "Transportation Task Force Report 2015." https://oemr.idaho.gov/wp-content/uploads/2016/06/2015_Transportation_TF_Report.pdf

[78] 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

[79] 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

[80] Nuclear Energy Institute. "US Nuclear Power Plants." www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants

[81] 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.

[82] NuScale Power, LLC http://www.nuscalepower.com/about-us/history.

utilizing NuScale's SMR technologies. UAMPS and NuScale are working with the INL to explore siting of the system at the laboratory. UAMPS hopes to begin commercial operation of the first NuScale Power Module at the INL in 2026.

2.5. WIND

Wind is a renewable resource, and Idaho's wind production grew from 207,472 MWh at the end of 2008 to a total more than 2,578,415 MWh in 2016.[83] Wind mapping studies estimate that Idaho has approximately 25,000 MW of potential wind generation, the 13th highest in the nation. Idaho's most promising wind resources are located in and around the Snake River Plain, particularly on its eastern end.[84] 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. For electric generation, hot water is extracted from deeply drilled, subsurface reservoirs which then turn steam turbines. The cooled water is then injected back into the reservoir. 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.[85] (Figure 2.1). U.S. Geothermal currently operates Idaho's only operating commercial geothermal power plant is located in Cassia County, and it provides between 13-14.6 MW of net capacity. The Raft River area is one of the best-known, contiguous geothermal sites in the U.S. and additional power plants are under consideration. Risks associated with drilling expensive wells to access geothermal reservoirs have posed obstacles to the development of large-scale geothermal power generation.

In addition to electric generation, direct-use of geothermal waters is the oldest, most versatile, and most prevalent utilization of geothermal energy.[86] Idaho has over 900 wells and springs with water temperatures greater than 90° F, and these low-temperature

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[83] 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=.

[84] Idaho Strategic Energy Alliance. "Wind Task Force Initial Mandate Response 2009." https://oemr.idaho.gov/wp-content/uploads/2016/06/wind_packet.pdf

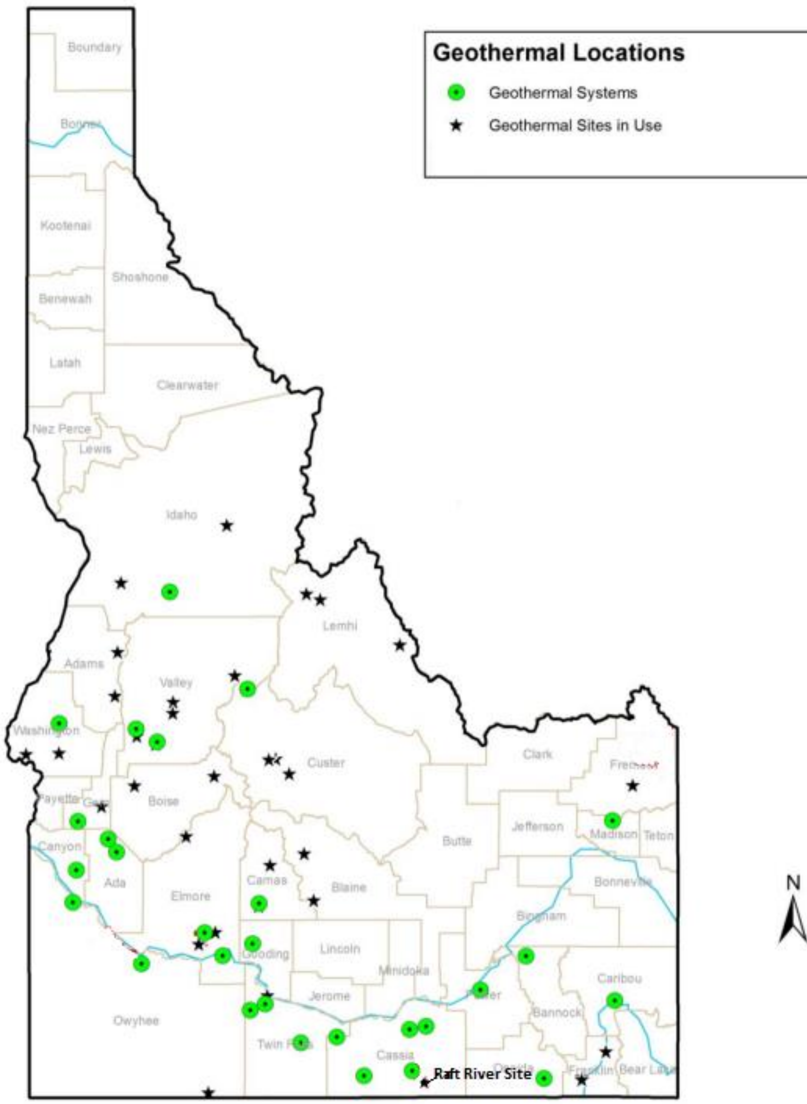
[85] Geothermal Energy Association. "Geothermal Energy Potential-State of Idaho." http://geo-energy.org/pdf/Guides_2015/Idaho.pdf and Benjamin Matek, Geothermal Energy Association. "2016 Annual U.S. & Global Geothermal Power Production Report." http://geo-energy.org/reports/2016/2016%20Annual%20US%20Global%20Geothermal%20Power%20Production.pdf

[86] 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

geothermal resources are used for space heating, aquaculture, greenhouses, and recreation throughout the State (Figure 2.1).

In particular, geothermal heating of buildings has a long and rich history in Idaho. For example, Boise is home to the nation's first geothermal district heating system, which was built in the late 19th century and continues to service over 200 buildings. In addition, the Idaho State Capitol building and surrounding complex is the only geothermally heated capitol in the entire nation. More recently, district heating has been utilized for space heating at Boise State University in the college of Business and Economics.

Figure 2.1 Geothermal Locations in Idaho[87]



87 Idaho Governor's Office of Energy and Mineral Resources

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 also can be produced from agricultural wastes and dedicated energy crops that are used to make advanced biofuels and include switchgrass, miscanthus, and poplar.

Idaho had 87 MW of installed capacity for biomass electricity in 2015 that produced approximately 601,000 MWh, or 3.8 percent of Idaho's electricity production for that year.[88] As of 2017, Idaho has one operating ethanol plant capable of producing 60 million gallons per year.[89] 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.[90]

Solar energy can also be used for hot water 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.[91]

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, and as of September, between 2 and 3 percent of Idaho's in-state electrical generation was solar power.[92] 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

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

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

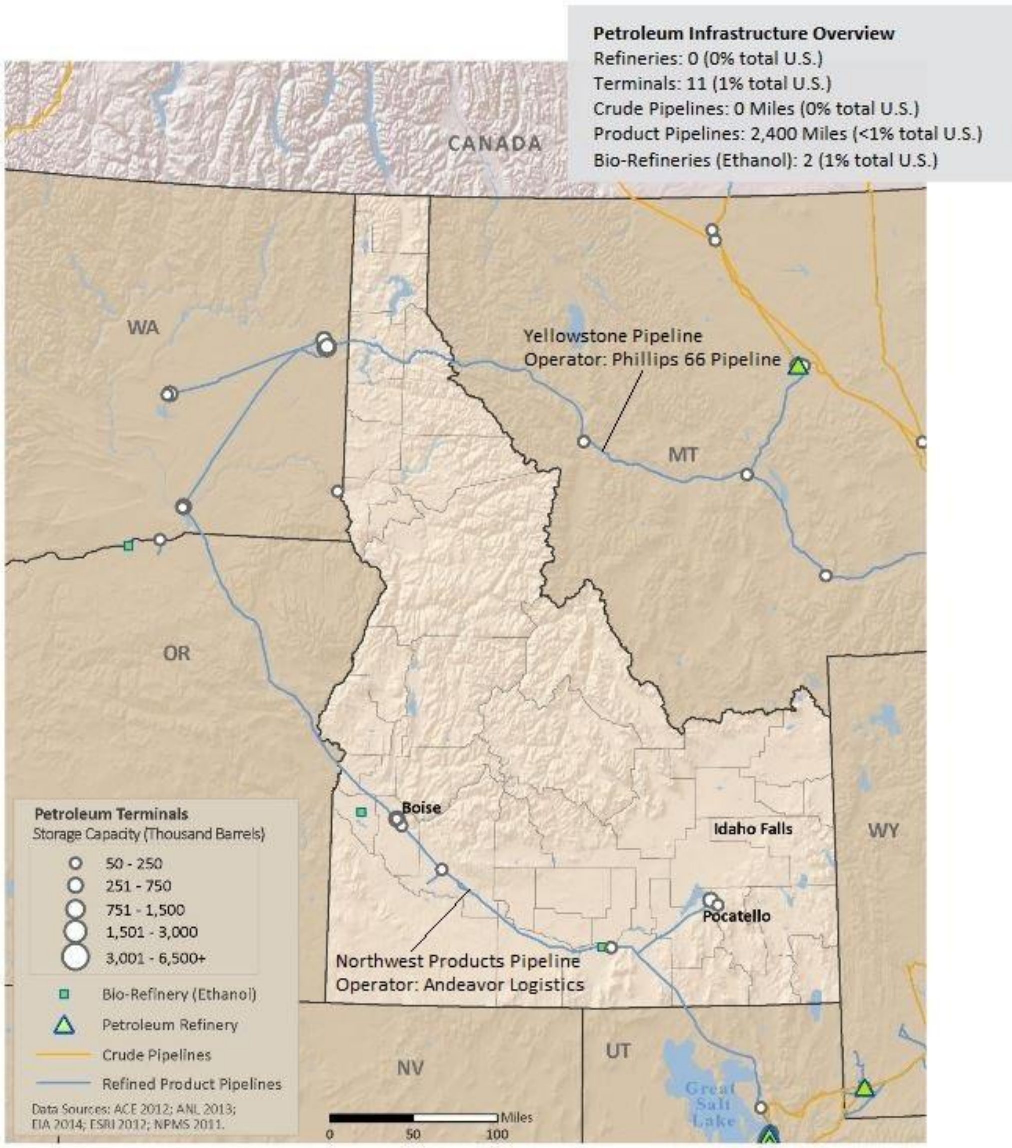
[90] Department of Energy. "Solar Energy Technology Basics." https://energy.gov/eere/energybasics/articles/solar-energy-technology-basics

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

[92] 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 1.16. The state's petroleum pipeline infrastructure includes the Northwest Products Pipeline, which connects Salt Lake City refineries with Pocatello, Burley and Boise. This pipeline delivers refined petroleum products to both southern and northern 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.

Figure 2.2 Transportation Fuel Pipelines and Refineries Serving Idaho[93]



[93] 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

2.10. PROPANE

Propane is utilized to heat homes and businesses throughout the state of Idaho, particularly in rural areas. Residential propane prices in Idaho fluctuated between $2.20/gallon to $2.98/gallon in 2017. Propane consumption is highly seasonal, with peak consumption in fall and winter. Propane is delivered to users, and those users located away from major supply sources generally incur greater expense for delivered propane.[94] Propane is also utilized as a transportation fuel.

2.11. CHP & HYBRID ENERGY SYSTEMS

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 22 CHP systems in Idaho, and most are utilized by wood product facilities, dairies, universities, and large industrial users.[95]

System hybridization involves coupling various energy resource inputs to generate one or more energy products, and advances in gas turbine technology and advanced computing and control technologies have opened the door for hybridization of energy systems and resources. Early generation hybrid systems in use couple solar and natural gas; and planned systems will couple solar, natural gas, and wind inputs for electricity generation. These systems can significantly benefit overall system efficiency and transmission stability under high intermittent generation scenarios. Future hybrid systems may combine fossil, renewable, and nuclear resources to produce both electricity and synthetic transportation fuels.

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

Conservation, energy efficiency, and demand response (DR) practices do not generate any new energy, but they do constitute another economically attractive energy resource that electric and natural gas utilities can call upon to meet the energy needs of their customers.

- "Conservation" refers to consumer's personal actions that consumers can take to reduce their use of energy-consuming devices. For example, turning the lights off when leaving a room.[96]
- "Energy efficiency" refers to processes of utilizing technology that consumes a lower amount of electricity while providing sufficient service. For example,

[94] U.S. Energy Information Administration. "Petroleum & Other Liquids." www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=W_EPLLPA_PRS_SID_DPG&f=W

[95] U.S. Department of Energy. "Combined Heat and Power Installations in Idaho." https://doe.icfwebservices.com/chpdb/state/ID

[96] Energy Information Administration. "Use of Energy in the United States Explained." https://www.eia.gov/energyexplained/index.cfm?page=about_energy_efficiency

switching from incandescent lights bulbs to LED light bulbs.[97]

- "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.[98]

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, water and other quantifiable savings accruing to Idaho citizens and businesses exceed the direct costs of the measure to the utility and participant. Beyond money-related energy savings, cost-effective energy measures can provide economic benefits to Idaho utilities by increasing the capacity for energy within their system, which can be used to meet future energy demands.

The PUC directs Idaho investor-owned electric utilities to continue to place an emphasis on cost-effective conservation, energy efficiency and demand response.[99] 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. The PUC has robust methods to review these forecasts, and evaluate, measure, and verify these energy savings.

Idaho Power, Bonneville Power Administration (BPA) 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 on market acceptance of energy efficient products, like LED light bulbs, can be achieved.[100]

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

The Northwest Power Planning Council's (Council) 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

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[97] Energy Information Administration. "Use of Energy in the United States Explained." https://www.eia.gov/energyexplained/index.cfm?page=about_energy_efficiency

[98] Energy Information Administration. "Demand response saves electricity during times of high demand." https://www.eia.gov/todayinenergy/detail.php?id=24872

[99] 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

[100] Northwest Energy Efficiency Alliance. "About NEEA." http://neea.org/about-neea

region of Washington, Oregon, Idaho and Montana by 2035.[101] 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. Requirements for within hour flexibility reserves have increased because the growing amount of variable generation in the region.

2.12.2. Avista

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.

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 also 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.[102] This CPA was used to develop Avista's IRP for 2017.

2.12.3. Idaho Power

In its 2017 IRP, Idaho Power analyzed from 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.[103]

In 2016, Idaho Power's energy efficiency programs had energy savings of 170,792 MWh; this is enough energy to power more than 14,000 average homes a year.[104] Energy efficient efforts so far will create an average annual energy savings of 273 aMW by 2036 of which approximately 95 percent is expected to occur in Idaho Power's Idaho service area. Additionally, Idaho Power successfully operated all three of its demand response

[101] The Northwest Power and Conservation Council. "Power Planning, Seventh Power Plan." www.nwcouncil.org/energy/powerplan
[102] Avista Corporation. "2017 Electric Integrated Resource Plan." https://www.myavista.com/about-us/our-company/integrated-resource-planning
[103] Idaho Power Company. "2017 Integrated Resource Plan: Looking Ahead." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf
[104] Idaho Power Company. "2017 Integrated Resource Plan Appendix B: DSM Annual Report." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/AppendixB_DSM.pdf

programs in 2016. The total demand reduction achieved from the company's programs was 378 MW from an available capacity of 392 MW.[105]

2.12.4. Intermountain Gas

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.[106]

As outlined in its 2017 IRP, Intermountain estimates achievable therm saving of 65,000 during the first program year. The estimated annual therm savings are projected to grow to 374,292 by the fifth year of the program.

2.12.5. PacifiCorp

PacifiCorp is aggressively pursuing energy efficiency across all of its service territories. Their 2017 IRP estimates that energy efficiency will represent the largest resource added to its system on an average capacity basis through 2036, at 2,077 MW. The estimated accumulation of energy efficiency additions is predicted to meet 88 percent of the forecasted load growth from 2017 through 2026. The 2017 IRP also estimates that the company will develop 365 MW of load control resource capacity over the next twenty years.[107]

2.12.6. Bonneville Power Administration

BPA works with its public utility customers to fund and implement energy efficiency programs, and tracks savings produced through those programs over the last four decades.[108] This organization supplies over 96 percent of the wholesale electric power that is utilized by municipal and cooperative utility members, many of which are members of the Idaho Consumer-Owned Utilities Association (ICUA).[109] While these organizations 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, and monitors cost-effective efforts of individual public utilities. 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.

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[105] Idaho Power Company. "2017 Integrated Resource Plan: Looking Ahead." https://docs.idahopower.com/pdfs/AboutUs/PlanningForFuture/irp/IRP.pdf

[106] Intermountain Gas. "Energy Efficiency Program." https://www.intgas.com/energy-efficiency/rebate-program

[107] PacifiCorp. "2017 IRP." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf

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

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

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.[110] 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 for several reasons including 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 technologies advances.

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

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. 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:

- 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

3.2. FUTURE PLANNED DEVELOPMENT

Table 3.1 shows planned generation projects listed by Idaho's three IOUs in their 2017 IRPs or IRP updates. The actual resources 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. Major IOU planned transmission projects are listed in Table 3.2.

Bonneville Power Administration's (BPA) Hooper Springs transmission line will commence construction in southeast Idaho beginning in Spring 2018.[111] Idaho Falls Power continues to work on the 161 kV North Loop transmission expansion proposal, while LS Power is exploring development of the Southwest Intertie Project, Northern Section through southern Idaho.

[111] 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[112]

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	1100	PacifiCorp
2020	Upgraded Wind	905	PacifiCorp

Table 3.2 Major Planned Transmission Projects by Idaho Investor-Owned Utilities, 2018-2027[113]

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
2020-2024	Populus to Hemingway (Gateway West)	500	PacifiCorp, Idaho Power
2024 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

[112] 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

[113] Avisa: 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

3.3. "SMART GRID"

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 also may facilitate the deployment of electric vehicles and help reduce carbon emissions in the transportation sector; and 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.

3.4. ENERGY STORAGE TECHNOLOGIES AND APPROACHES

Energy storage is the capture of energy produced at one time for use at a later time and such 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.

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 also 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.

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). Batteries utilize different chemistries for varying grid service applications.

3.4.2. Thermal Storage

Several thermal (heat) storage technologies provide energy storage at a utility level, including utility-scale concentrated solar power plants that have the ability to store energy thermally. These plants use molten salt or other heat-retaining substance to store the sun's energy, which can be utilized later in steam generating processes.

3.4.3. Potential Storage

Potential energy can be stored in either electrical or mechanical form. For example, a capacitor can store energy electrostatically between two conductors in a magnetic field created by current flowing in a superconducting coil. Potential mechanical storage technologies include compressed air which runs a compressor with excess energy (usually generated at night when demand is low) to pump 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.

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.

3.4.4. Kinetic Storage

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

3.5. ELECTRIC VEHICLES

The rate of electric vehicle (EV) ownership is rising rapidly due to affordability of battery technologies, significant advances in the technology performance, a desire to achieve domestic energy independence, and to reduce environmental impacts. 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.[114] 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 that require differing types of infrastructure. For example, EVs can be charged overnight via common 120-volt outlets, also called Level 1 chargers. Level 2 charging stations have a 240-volt capacity, which can be affordably installed at residences, businesses or fleet locations to charge at a faster rate (about 3-5 hours for a full charge).[115] Direct charge or DC "fast-chargers" require a specialized, 480-volt outlet and can provide a full charge after 20-30 minutes. DC fast chargers are the most popular on-the-go option for charging.[116]

The 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.[117] 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.

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[114] Idaho Strategic Energy Alliance. "Transportation Task Force Report 2015." https://oemr.idaho.gov/wp-content/uploads/2016/06/2015_Transportation_TF_Report.pdf
[115] Department of Energy. "Electric Vehicles: Charging at Home." https://www.energy.gov/eere/electricvehicles/charging-home
[116] Department of Energy. "Electric Vehicles: Vehicle Charging." https://energy.gov/eere/electricvehicles/vehicle-charging
[117] 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 THE INL

The 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 tremendous resource for energy education and outreach.

DOE recently 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 better enable 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 significant technical and regulatory development hurdles associated with the development of advanced fuels. GAIN also provides support for commercial and demonstration reactors at the INL, including the siting of the UAMPS reactor.

4.2. CENTER FOR ADVANCED ENERGY STUDIES

INL, Boise State University, Idaho State University, the University of Idaho, the University of Wyoming, and private industry are partners in the **Center for Advanced Energy Studies** (CAES).[118] CAES serves as a public, collaborative research center focused on student-led innovative, cost-effective, credible energy research that can result in sustainable technology-based economic development.

CAES Energy Policy Institute (EPI) provides expertise in energy infrastructure siting, transmission, nuclear energy, carbon capture and sequestration, and renewables and it seeks to inform and educate policymakers and other stakeholders. Its mission supports research into innovation and means by which design and implementation of energy policy can be improved. EPI issues publications (more than 35 to date), develops decision support tools, and holds policy roundtables, workshops, and the Western Energy Policy Research Conference support its mission.[119]

CAES launched an initiative to build the **Center for Energy Efficiency Research Institute** (CEERI) in 2010 to promote efficient and effective use of energy resources through research, education and outreach. CEERI conducts research in applied technology and consumer behavior; provides specialized education for energy efficiency technicians, engineers and architects; evaluates existing energy-saving technologies; and creates infrastructure for the accelerated transfer of ideas from the institute to the marketplace. The institute, based at Boise State University, draws on the strengths of its

[118] Center for Advanced Energy Studies. "About Us." https://caesenergy.org/about-us/
[119] Center for Advanced Energy Studies. "Energy Policy." https://caesenergy.org/research/core-capabilities/energy-policy/

partners including Idaho State University, the University of Idaho, the University of Wyoming, and the INL.[120]

CAES' **Institute of Nuclear Science and Engineering** (INSE) supports the goals and objectives of national and international nuclear energy programs and enables the three Idaho public universities to jointly focus on nuclear science and engineering education. CAES researchers access a wide range of equipment at the combined Idaho Falls campus, including a high-end Microscopy and Characterization Suite and the Idaho State University Accelerator Center. Together, the CAES partner universities are one of the nation's largest nuclear science and engineering programs.[121]

4.3. UNIVERSITIES, COLLEGES, AND TECHNICAL TRAINING

Many of Idaho's higher education institutions, including the three public research universities, heavily engage in educating tomorrow's energy workforce.

For example, elective courses for the non-scientist are offered in energy efficiency and renewable energy at **Boise State University**. By providing non-science or engineering students with a solid grounding in energy fundamentals, Boise State helps educate a savvy 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 and materials, biomaterials, glasses, semiconductors, electronic memories, computational modeling and magnetic materials.[122]

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.[123]

The **National Institute for Advanced Transportation Technology** at the University of Idaho is a center of excellence for transportation research, education and technology transfer. It is committed to preserving and protecting the natural and pristine environments of the Pacific Northwest and the Institute contributes to the sustainability of the environment through the development of clean vehicles, alternative fuels, efficient

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[120] CAES Energy Efficiency Research Institute. "CEERI." https://ceeri.boisestate.edu/
[121] Center for Advanced Energy Studies. "Nuclear Science and Engineering." https://caesenergy.org/research/core-capabilities/nuclear-science-engineering/
[122] Boise State University. "Micron School of Materials Science and Engineering." http://coen.boisestate.edu/mse/
[123] University of Idaho. "Biodiesel Education." http://biodieseleducation.org/

traffic control systems, safe transportation systems, sound infrastructure, and the policies that support these systems.[124]

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.

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.[125]

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**[126]

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.[127]

College of Eastern Idaho (CEI) also trains the labor force that will build, operate, and maintain the energy systems of the future. CEI launched its **Energy Systems Technology Program** in 2010, and it provides the first year of this two-year program at the CEI campus. The students are qualified to 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.[128]

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-

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[124] University of Idaho. "National Institute for Advanced Transportation Technology." www.uidaho.edu/engr/research/niatt
[125] Idaho State University. "College of Technology." www2.isu.edu/estec/
[126] College of Southern Idaho. "Environmental Technology." http://agriculture.csi.edu/enviroTech/
[127] Lochsa Engineering. "CSI Applied Technology & Innovation Center." www.lochsa.com/csi-applied-technology-innovation-center
[128] 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/

to-two-year program teaches students about electricity, robotics, wireless communication, renewable energy, instrumentation and computerized control systems.[129]

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.[130]

[129] College of Western Idaho. “All Programs and Classes.” https://cwidaho.cc/program
[130] 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	208-743-1501
East End Mutual Electric	208-436-9357
Fall River Rural Electric	208-632-5726
Farmer Electric	208-436-6384
Idaho County Light and Power	877-212-0424
Inland Power and Light	509-747-7151
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	406-541-4433
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	208-673-5351
Bonners Ferry Light and Water	208-267-3105
Burley Electric Department	208-678-2538
Declo Municipal Electric Department	208-654-2124
Dubois Electric System	208-374-5241
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	208-434-2320
Soda Springs Electric Light and Power	208-547-2600
Weiser Water and Light 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 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 the obligation to provide service to all customers in a defined service territory, an IOU is given a territorial 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.)*