IDAHO'S ENERGY LANDSCAPE

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And

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1. Idaho's Energy Economy and Landscape

1.1. ENERGY & THE ECONOMY

Idaho has a strong and diversified economy. Technology, manufacturing, and agriculture remain top industries while tourism, healthcare, construction, energy, and professional services are growth sectors. Over 46,000 people work in Idaho's energy sector, and they are pushing technology boundaries, launching start-ups and fueling further research, growth and discovery. Idaho's low energy prices contribute to the growing economy.

As Idaho's economy grows, so will the demand for energy. Historically, economic growth and energy consumption were strongly and positively correlated. However, in Idaho, as with the entire nation, this correlation has been weakened due to technological changes, energy efficiency, and structural changes in the economy. The St. Louis Federal Reserve Bank reports that Idaho's gross domestic product grew 4.6% annually from 1997 to 2015,[1] while Idaho's energy consumption (transportation, heat, light, and power) grew 1.2% annually from 1990 to 2015.[2] The national gross domestic product only grew 2.2%,[3] while the national energy consumption only grew 0.6% annually over the same period.[4] Idaho's growing economy will likely result in increased energy use, and the health of Idaho's economy today depends on access to affordable and reliable energy resources.

In Idaho, transportation fuel and natural gas prices tend to follow global and national markets. Over the past two decades the price of transportation fuel has generally corresponded with the consumer price index, which measures changes in the price level of a market basket of consumer goods and service purchased by households.[5]

Advances in technology have opened new opportunities to develop natural gas and produced natural gas at a lower cost resulting in substantially increased U.S. proven reserves. Over the past ten years, natural gas has been the primary resource to supply the nation's growing electricity needs. In fact, natural gas consumption for power generation has increased nationally by approximately 50% in the last decade.[6] This trend is likely to continue as additional natural gas power generation replaces coal-fired power plants that lack necessary environmental controls to meet government regulation.

1.1.1. Energy Intensity

Idaho's historically low rates for electricity and natural gas have allowed it to attract and retain energy-intensive industries, including mining, pulp and paper, agriculture, food

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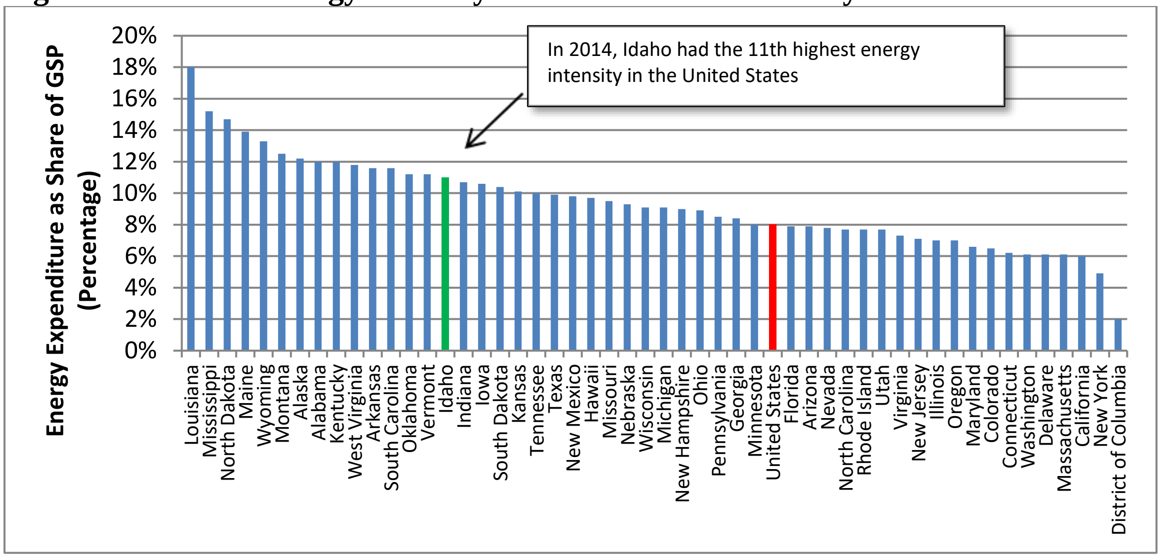
[1] Federal Reserve Bank of St. Louis. "FRED." https://fred.stlouisfed.org/series/IDNGSP
[2] U.S. Energy Information Administration. "Total End-Use Energy Consumption Estimates, 1960-2014, Idaho." www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tx/use_tx_ID.html&sid=ID
[3] Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/GDPCA
[4] U.S. Energy Information Administration. www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/tx/use_tx_US.html&sid=US
[5] U.S. Energy Information Administration. www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPM0_PTE_NUS_DPG&f=A and www.bls.gov/cpi/
[6] U.S. Energy Information Administration. www.eia.gov/dnav/ng/hist/n3045us2a.htm

processing, and computer chip manufacturing. As a result, Idaho's economy is more energy-intensive than many other states. Idaho's energy use per dollar of Gross State Product was 15th among U.S. states in 2014. Idaho's energy use per capita was 32nd highest in 2014, higher than neighboring states such as Washington, Oregon and Utah.[7]

Figure 1.1 Idaho's Energy Intensity as a Share of the Economy[8]



1.1.2. Household Energy Bills

Idaho's residential, commercial, industrial, and transportation sectors spent $7 billion on energy in 2014[9]; the average Idaho household spent about $5,100 on direct energy products in 2014.[10]

Figure 1.1 includes residential energy expenditures including an estimate of Idaho households' transportation fuel expenditures. As can be seen in Figure 1.1 energy expenditures consume almost 11% of median household income in Idaho. This figure places Idaho marginally above the U.S. average, despite Idaho's very low electricity and natural gas rates. This is because: (1) Idahoans drive more miles and purchase more gasoline than residents of more densely-populated states, and (2) Idaho's median household income of $47,334 in 2014 was lower than the U.S. average of $53,482.[11]

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[7] U.S. Energy Information Administration. "Energy Price and Expenditure Estimates." www.eia.gov/state/seds/sep_sum/html/pdf/rank_pr.pdf

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

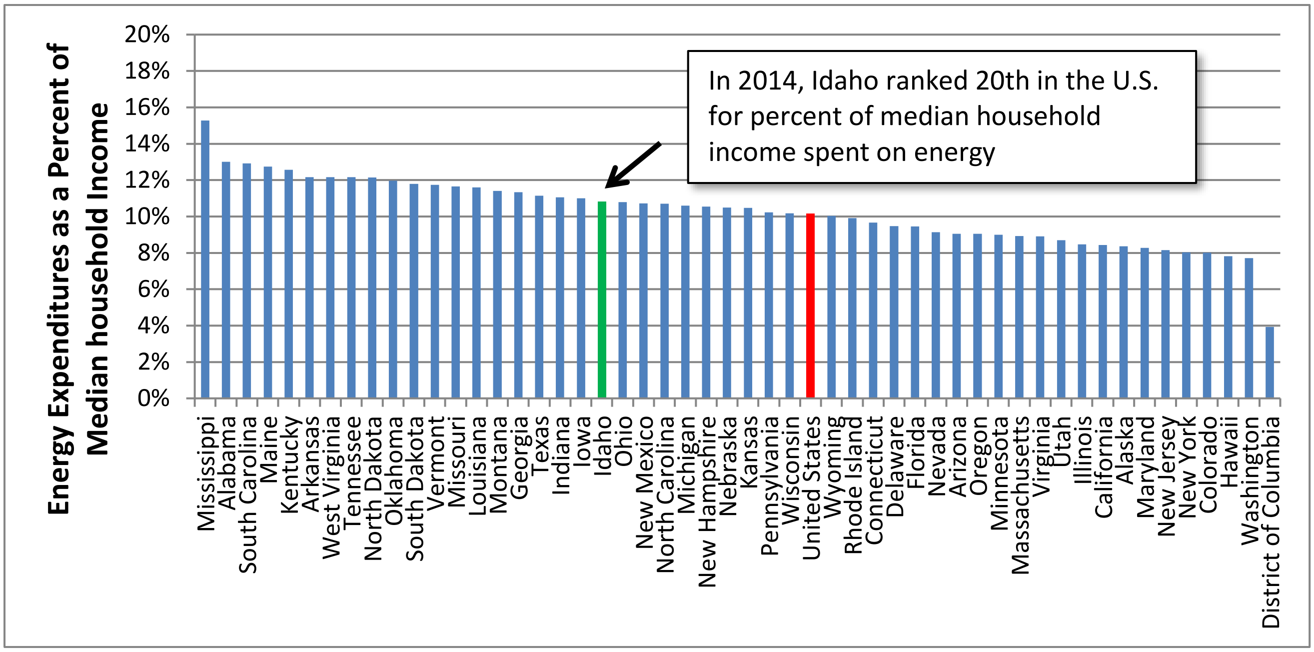
[9] U.S. Energy Information Administration. Expenditures – gasoline; www.eia.gov/state/seds/data.cfm?incfile=sep_prices/tra/pr_tra_ID.html, residential; www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_te.pdf, households; http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPANNHU&prodType=table

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

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

Thus, energy plays a significant role in Idahoans' household budgets, despite the low electricity rates that Idahoans continue to enjoy.

Figure 1.2 Idaho's Average Household Energy Burden Compared to Other States in 2014 (including Transportation Fuel)[12]



[12] United States Census Bureau. www.census.gov/search-results.html?q=median+household+income&page=1&stateGeo=none&searchtype=web
Source for Energy Prices and Expenditures and Gasoline Expenditures: www.eia.gov/state/data.cfm?sid=ID#ConsumptionExpenditures (Tables F30 and E13). www.census.gov/search-results.html?q=median+household+income&page=1&stateGeo=none&searchtype=web

Table 1.1 Average Household Energy Bill in Idaho, 2014[13]

Energy Source	Dollars Per Year	Share
Gasoline	$3,458	68%
Electricity	$1,154	23%
Natural Gas	$307	6%
Other Petroleum (Propane, Fuel Oil, Kerosene)	$157	3%
Wood	$45	1%
Coal	$0	0%
Total	5,120	100%

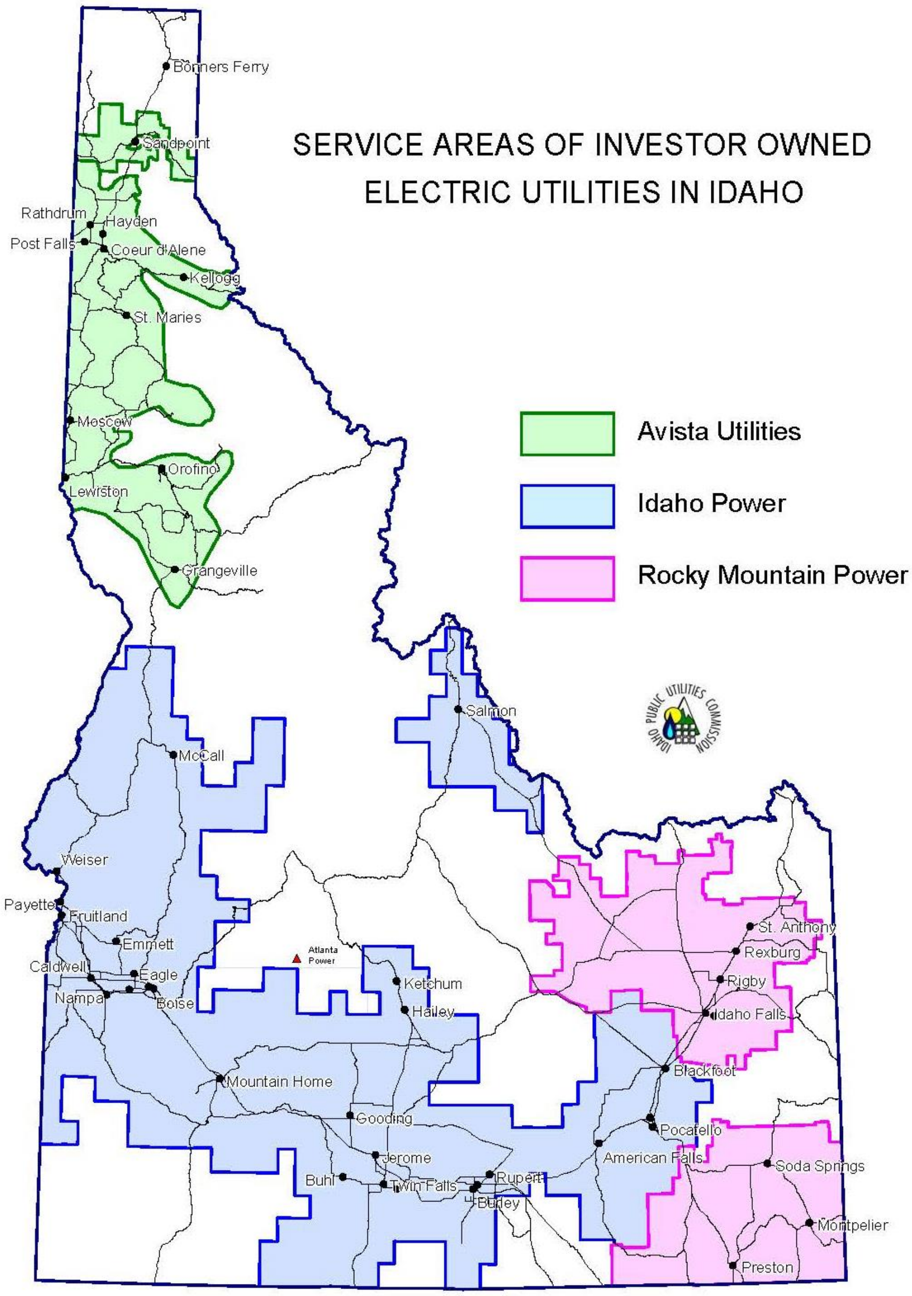
1.2. IDAHO UTILITIES AND ENERGY SYSTEMS

1.2.1. Electricity

Consumers in Idaho are served by three investor owned electric utilities (IOUs), eleven municipal utilities, and eighteen rural electric cooperatives. The three IOUs serve approximately 86% of the state's electricity needs. [14] The remaining 14% is served by municipal utilities and rural electric cooperatives. Figure 1.3 shows the service territories of the IOUs and Figure 1.4 shows the service territories of Idaho's municipal and cooperative utilities.

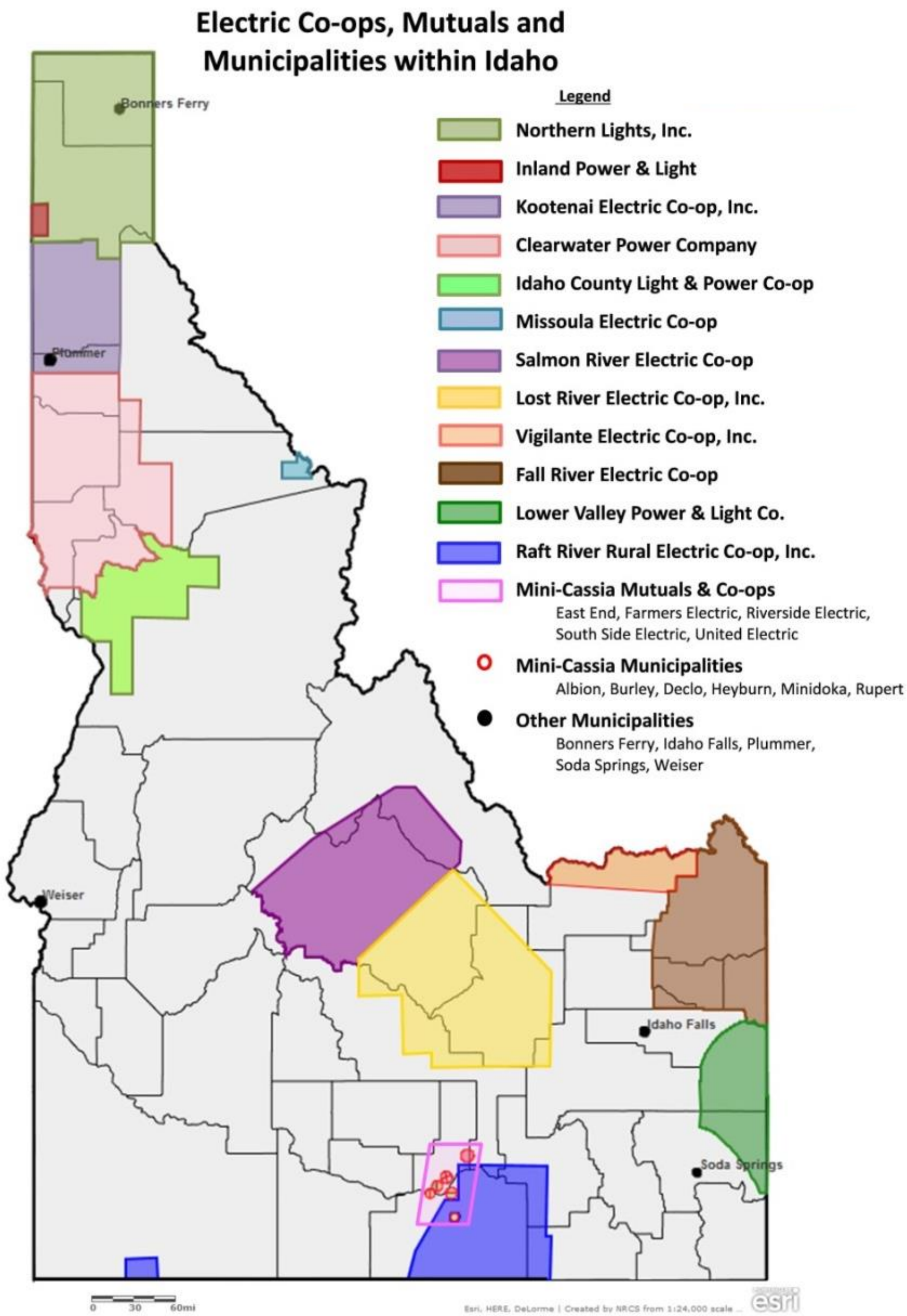
[13] U.S. Energy Information Administration EIA Tables, ET3, ET6, ET4 and ET5.
[14] U.S. Energy Information Administration. "State Electricity Profiles." www.eia.gov/electricity/state/Idaho

Figure 1.3 Service Territories of Idaho's Investor Owned Utilities[15]



[15] Idaho Public Utilities Commission.

Figure 1.4 Service Territories of Idaho's Municipal and Cooperative Utilities[16]

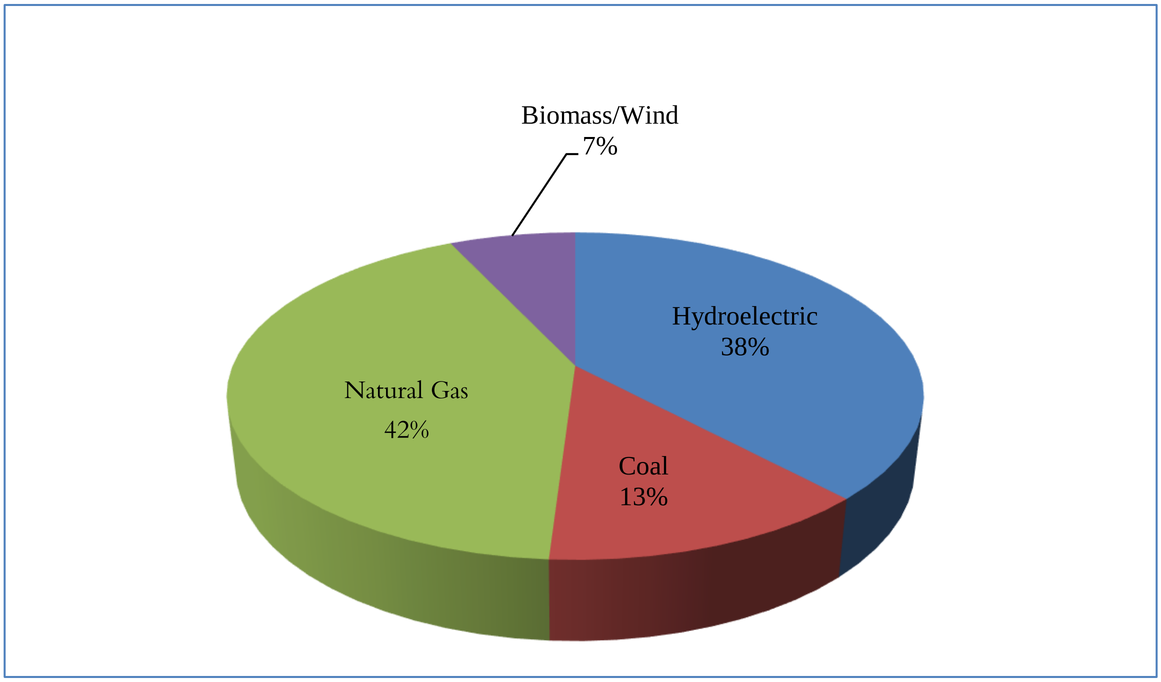


[16] Idaho Office of Energy and Mineral Resources.

1.2.1.1. Avista Corporation

Avista is an investor owned electric and natural gas utility headquartered in Spokane, Washington. Founded as the Washington Water Power Company in 1889, it changed its name to Avista Corporation in 1999. Currently, the Company 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. Electric customers receive 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 below.[17] About half of Avista's electricity capability comes from hydropower resources that provide a significant price benefit for its customers. Natural gas is delivered through 6,100 miles of distribution mains. Avista has both Company-owned and contract hydroelectric resources that are located in western Montana, eastern Washington, and northern Idaho; natural gas-fired baseload and capacity resources in Idaho, Oregon, and Washington, and an ownership share of a Montana coal plant.[18]

Figure 1.5 Avista Energy Fuel Mix (2016)



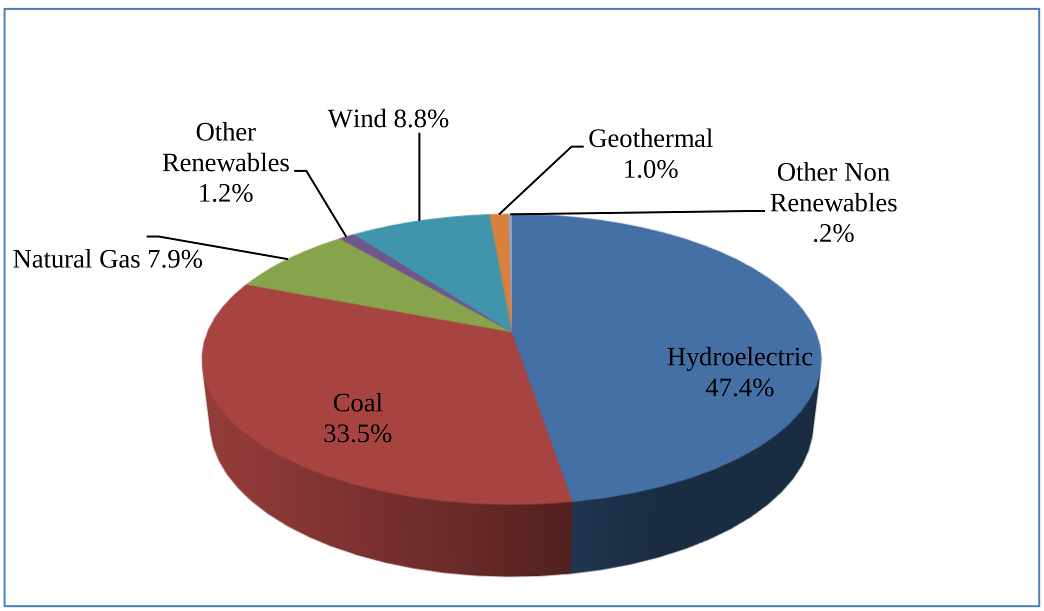
[17] Avista. "2015 Electric IRP." http://user-3golrxp.cld.bz/Avista-s-2015-Electric-IRP#52
[18] Ibid.

1.2.1.2. Idaho Power Company

Founded in 1916, the Idaho Power Company serves nearly 526,000 customers in southern Idaho and eastern Oregon across a 24,000 square mile service territory. Headquartered in Boise, Idaho, Idaho Power is the largest provider of electricity in the state. With 17 low-cost, emission-free hydroelectric projects at the core of its generation portfolio, it is one of the nation's few IOUs with a significant hydroelectric generating base. The heart of this system is the 1,167 MW, three-dam Hells Canyon Complex. Other resources include part ownership in baseload coal facilities located in Wyoming, Oregon, and Nevada. Idaho Power also has in its generation portfolio two natural gas-fired combustion turbine "peaker" plants and its newest resource, the natural gas-fired combined cycle Langley Gulch Power Plant. Idaho Power's resource portfolio fuel mix is shown below.[19]

Idaho Power has begun to reduce its reliance on coal-fired generation resources as evidenced by the 2020 retirement date of the Boardman, Oregon coal plant. As shown in Idaho Power 2015 Integrated Resource Plan's preferred portfolio, the North Valmy, Nevada coal plant may also be retired early in 2025. 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 130 PURPA projects, including 627 MW of wind generation and 290 MW of solar generation. All but 50 MW of the wind generation is online; the solar projects are all scheduled to be online in 2016.

Figure 1.6 Idaho Power Resource Portfolio Fuel Mix (2011-2015 Average)

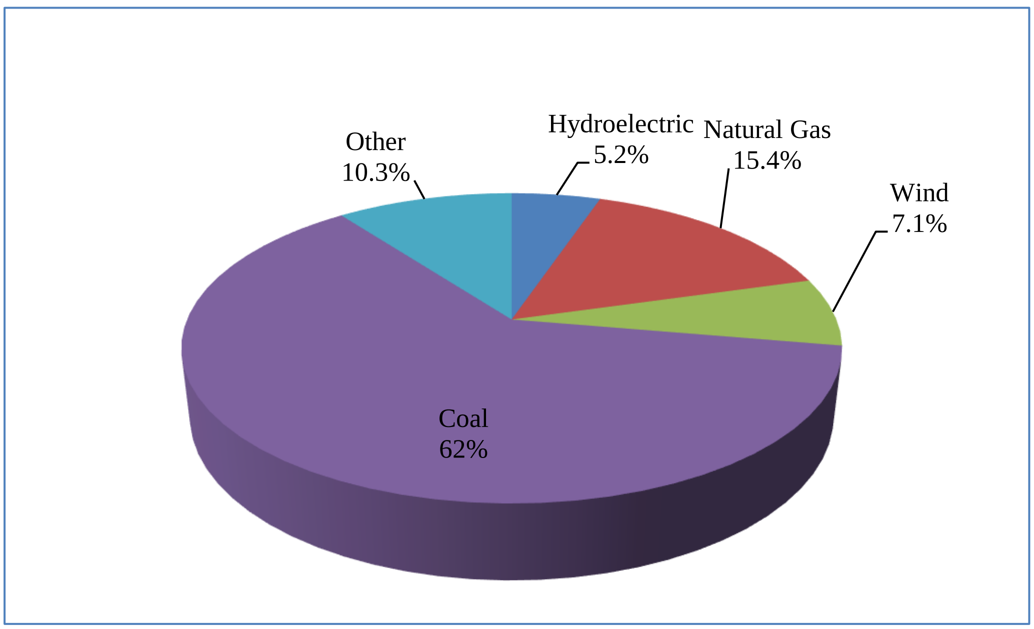


[19] Idaho Power Company. "Typical Resource Portfolio Fuel Mix." www.idahopower.com/AboutUs/EnergySources/FuelMix/typical_fuelMix.cfm

1.2.1.3. PacifiCorp / Rocky Mountain Power

PacifiCorp serves more than 1.8 million retail customers across 136,000 square miles of service territory in the six western states of California, Idaho, Oregon, Utah, Washington, and Wyoming. PacifiCorp was founded in 1910 as Pacific Power & Light changing its name to PacifiCorp in 1984. PacifiCorp began operating in Idaho in 1989 through its merger with the Utah Power & Light Company, which began serving customers in Idaho in 1912. The company was purchased by MidAmerican Energy Holdings Company in 2006, which later changed its name to Berkshire Hathaway Energy. PacifiCorp does business as Rocky Mountain Power (RMP) in Idaho, Utah, and Wyoming. RMP serves 76,749 customers in southeastern Idaho, which represents approximately four percent of PacifiCorp's total customer base. PacifiCorp owns 75 generating plants with 10,894 MW of net generation capacity, including coal, hydroelectric, natural gas, and wind resources. As a stand-alone utility, PacifiCorp is second only to MidAmerican Energy Company, a sister utility under Berkshire Hathaway Energy, in the ownership of wind generation. Wind, hydro, geothermal, and other non-carbon-emitting resources currently make up more than 29% of PacifiCorp's owned and contracted generating capacity, accounting for about 20% of total energy output. As of June 2016, PacifiCorp had 1,031 megawatts of owned wind generation capacity and long-term purchase agreements for more than 958 megawatts from wind projects owned by others.

Figure 1.7 PacifiCorp Energy Mix (2015 Report)



1.2.1.4. Idaho's Municipal and Cooperative Utilities and Bonneville Power Administration

There are 29 rural electric cooperatives and municipalities providing electric service in Idaho. These utilities serve more than 137,000 customers throughout Idaho, accounting for 14 percent of Idaho's load.[20] Most of these utilities collaborate under the Idaho Consumer Owned Utilities Association on issues of administrative, governmental, and regulatory significance. These municipal and cooperative utilities are customers of the Bonneville Power Administration (BPA); BPA provides 96% of the wholesale electric power requirements of these utilities.[21]

BPA is a federal power marketing agency in the United States Department of Energy. Although BPA is part of the U.S. Department of Energy, it is self-funding and covers its costs by selling its products and services. BPA markets the power from 31 federal hydroelectric dams in the Northwest, as well as additional power from nonfederal power plants and from the 1,200 MW Columbia Generating Station nuclear power plant in Richland, Washington. These resources, together with a handful of smaller resources, are referred to as the Federal Columbia River Power System (FCRPS). The dams are operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation. About 28 percent of the electric power used in the Northwest comes from BPA. BPA also operates and maintains about three-fourths of the high-voltage transmission in its service territory, which includes Idaho, Oregon, Washington, western Montana and small parts of eastern Montana, California, Nevada, Utah and Wyoming and covers over 300,000 square miles.[22] BPA also provides services to residential and small farm customers of IOUs within its service territories, and provides energy service to a handful of industrial customers known as direct-service industries, and to some irrigation customers of the U.S. Bureau of Reclamation, some of which are located in Idaho.[23]

BPA annually updates a Pacific Northwest Loads and Resources Study, commonly referred to as the "White Book." The 2015 White Book is a snapshot of conditions as of June 30, 2015, documenting the loads and resources for the federal system (including public power loads served by BPA) and the Pacific Northwest region for the 10-year study period OY 2017 through 2026. The 2015 White Book also updated the 2012 Needs Assessment analysis, and that data is used in BPA's 2016 Resource Program, which analyzes future resource needs for the federal system. The 2015 White Book shows that under critical water conditions, the Pacific Northwest region is projected to have small 120-MW capacity surpluses through OY 2018 and deficits of up to -5,107 MW over the study horizon. This was an increase in deficits over the 2014 study.

The 2015 Needs Assessment shows that under a variety of conditions BPA may need to supplement existing federal system generation in order to meet existing and projected

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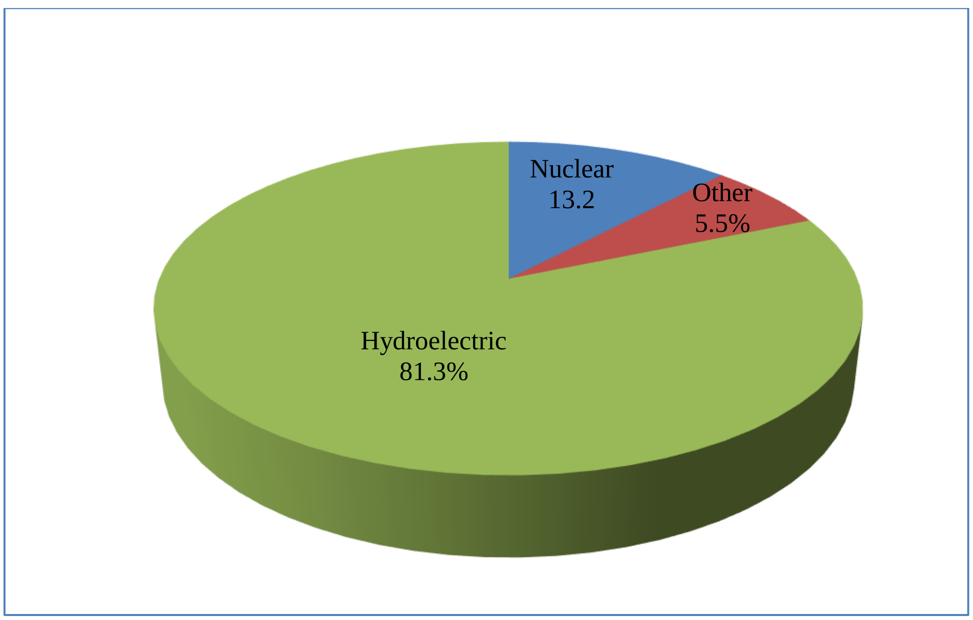
[20] U.S. Energy Information Administration. "Idaho Electricity Profile 2014." www.eia.gov/electricity/state/Idaho
[21] Idaho Consumer-Owned Utilities Association. "About ICUA." www.icua.coop/about-icua/
[22] Bonneville Power Administration. BPA Facts www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf
[23] Bonneville Power Administration. www.bpa.gov/news/pubs/GeneralPublications/gi-BPA-Facts.pdf

load obligations. The federal system is projected to have energy deficits under expected load growth, most notably in the winter and late summer.

Although historically the Idaho municipal and cooperative utilities have been able to rely on BPA for all power needs, the new BPA contracts, effective October 1, 2011, capped the amount of base system federal power available to all utilities. Each utility is faced with acquiring resources to meet future load growth. These resources may be developed or acquired independently or jointly with other utilities, including BPA (tier two power purchase). Each utility will follow its own approval process for evaluating resources and determining the appropriate power resource for their respective utility. These processes are public and involve a consideration of factors related to load forecasting, power availability/variability, costs, and transmission availability.

Some municipal and cooperative utilities are members of the Utah Associated Municipal Power Systems (UAMPS), a project-based joint action agency headquartered in Salt Lake City providing comprehensive wholesale electric-energy services, on a nonprofit basis, to community-owned power systems throughout the Intermountain West. UAMPS membership includes 47 utilities in seven western states. UAMPS conducts resource planning, evaluation of power resources or services for its members, and development of projects including power generating facilities.

Figure 1.8 BPA Resources (2015 Average)



1.2.2. Natural Gas

Idaho has two investor owned natural gas utilities, Avista Utilities and Intermountain Gas Company, which provide the majority of natural gas service in Idaho. Additionally, Questar Gas provides services to about 2,000 customers in Franklin County and some consumer owned utilities provide natural gas service.[24]

1.2.2.1. Avista Utilities

Avista manages its natural gas operations through two operating divisions, one of which serves Idaho. The North Division covers about 26,000 square miles, primarily in eastern Washington and serves northern Idaho. Over 840,000 people live in Avista's Washington/Idaho service area. Natural gas is received at more than 40 points along interstate pipelines and distributed to over 227,000 residential, commercial and industrial customers. Of the Avista North Division customers who purchase natural gas directly for delivery to their home or business ("non-transportation"), approximately 90% are residential.

Avista can access both Canadian and Rocky Mountain supplies via firm transportation capacity it holds on the Northwest and GTN pipelines. In addition, Avista hold rights to the Jackson Prairie and Plymouth storage facilities in Washington. Avista's latest natural gas integrated resource plan (IRP) indicates that the number of customers in Washington and Idaho is projected to increase at an average annual rate of 2.2% with demand growing at a compounded average annual rate of 1.0%.

1.2.2.2. Intermountain Gas Company (IGC)

IGC is a wholly-owned subsidiary of MDU Resources Group, headquartered in Bismarck, North Dakota who purchased IGC from its private owners in 2008. It is a local distribution company of natural gas and utilizes William's Northwest Pipeline to distribute clean, efficient energy through approximately 12,000 miles of mainline and service lines to 75 Idaho communities across 60,000 square miles. The company was incorporated in 1950 and began serving its first five customers on December 31, 1955. IGC has grown to serve approximately 335,000 customers which is comprised of 303,000 residential, 32,000 commercial and 122 industrial customers.[25] Industrial customers are the largest users of natural gas. Total volume sales from the industrial sector comprise approximately 52% of IGC's annual energy throughput. Residential and commercial sectors comprise 32 and 16% respectively.

In addition to owning firm capacity on interstate pipelines, IGC owns and operates the Nampa LNG storage facility and also owns 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 over the five-year period 2015-2019 to grow from 389 MDth/d to 426 MDth/d.; an average annual rate of 2.32%.[26]

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[24] Idaho Public Utilities Commission. www.puc.idaho.gov/press/160419_Questar.pdf
[25] Intermountain Gas Company. "About Us." www.intgas.com/utility-navigation/about-igc
[26] Idaho Public Utilities Commission. "Intermountain Gas 2014 IRP." www.puc.idaho.gov/fileroom/cases/gas/INT/INTG1501/20150113APPLICATION%20SUMMARY.PDF

1.2.2.3. Questar Gas

Questar Gas provides natural gas service to residential, commercial, and industrial customers in northern, central and southwestern Utah, southwestern Wyoming and southeastern Idaho. Questar Gas, based in Salt Lake City, provides natural gas service to about 2,000 customers in Franklin County in southeastern Idaho.[27] The Idaho Public Utilities Commission has elected to allow the Utah Public Service Commission to regulate Questar's activities in its small Idaho service area.

Figure 1.9 shows the major natural gas infrastructure in Idaho and Idaho utility service territories.[28]

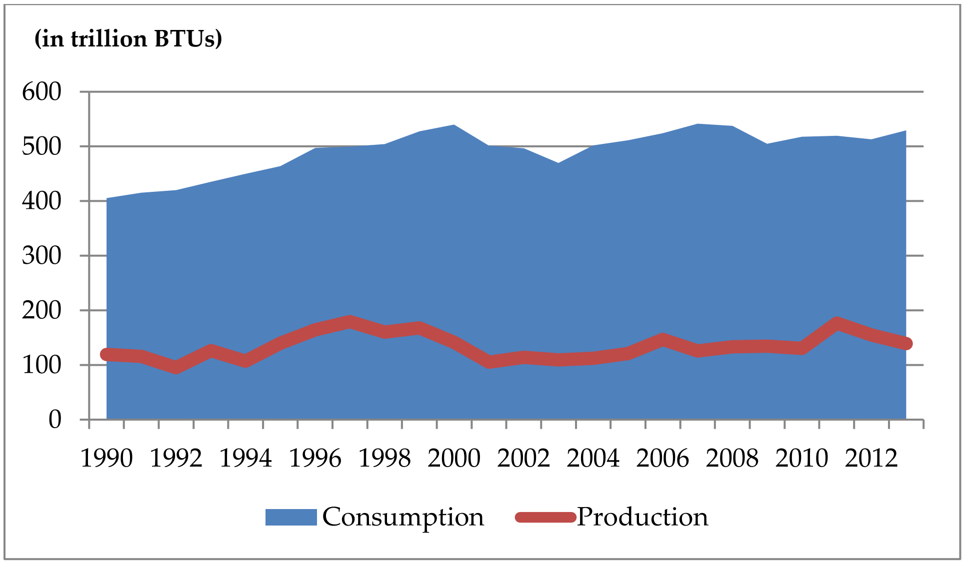
[27] Idaho Public Utilities Commission. puc.idaho.gov/press/160419_Questar.pdf
[28] Northwest Gas Association. "About Us." www.nwga.org/about-us/

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

1.3. HISTORICAL PERFORMANCE IN KEY AREAS

The state produces about 27% of the total energy it consumes, as shown in Figure 1.10.[29] The state's reliance on imported energy emphasizes the need to maintain and develop infrastructure like highways, railroads, pipelines, and transmission lines, in order to support economic development.

Figure 1.10 Idaho Energy Production and Consumption



1.3.1. Energy Rates Compared to Other States

The most important feature of Idaho's energy outlook is the very low average electricity and natural gas rates that Idahoans currently enjoy. Idaho's low electricity rates are largely the result of its hydro-thermal resource base. Baseload coal plants built in neighboring states in the 1970s and 1980s provide a constant source of reliable, relatively low-cost power to Idaho utilities. Large hydroelectric facilities on the Snake River and other tributaries of the Columbia River provide energy as well as flexible and very low-cost capacity for meeting peak demands. As a result, Idaho's average electricity rates were the 5th lowest among the fifty states in 2014 (see Figure 1.11).[30]

[29] U.S. Energy Information Administration. www.eia.gov/state/seds/seds-data-complete.cfm?sid=ID#Consumption
[30] U.S. Energy Information Administration. http://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf

Figure 1.11 Idaho's Average Electricity Rates Compared to Other States for 2014[31]

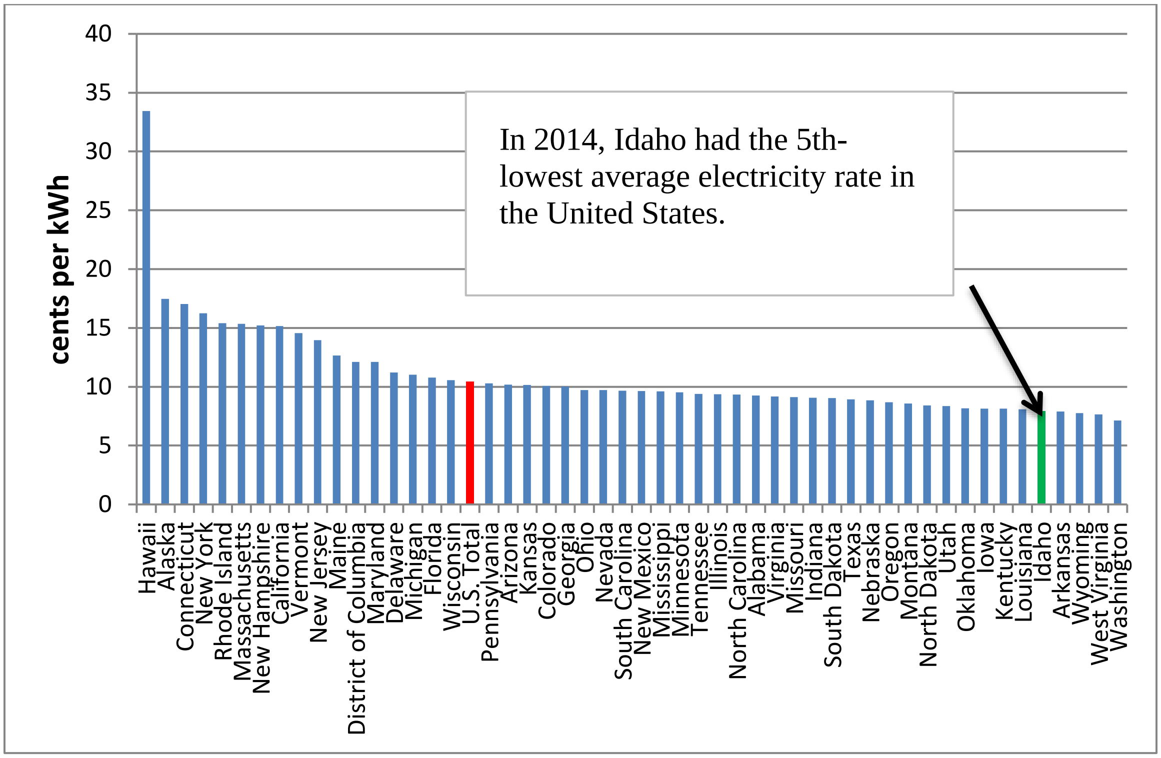
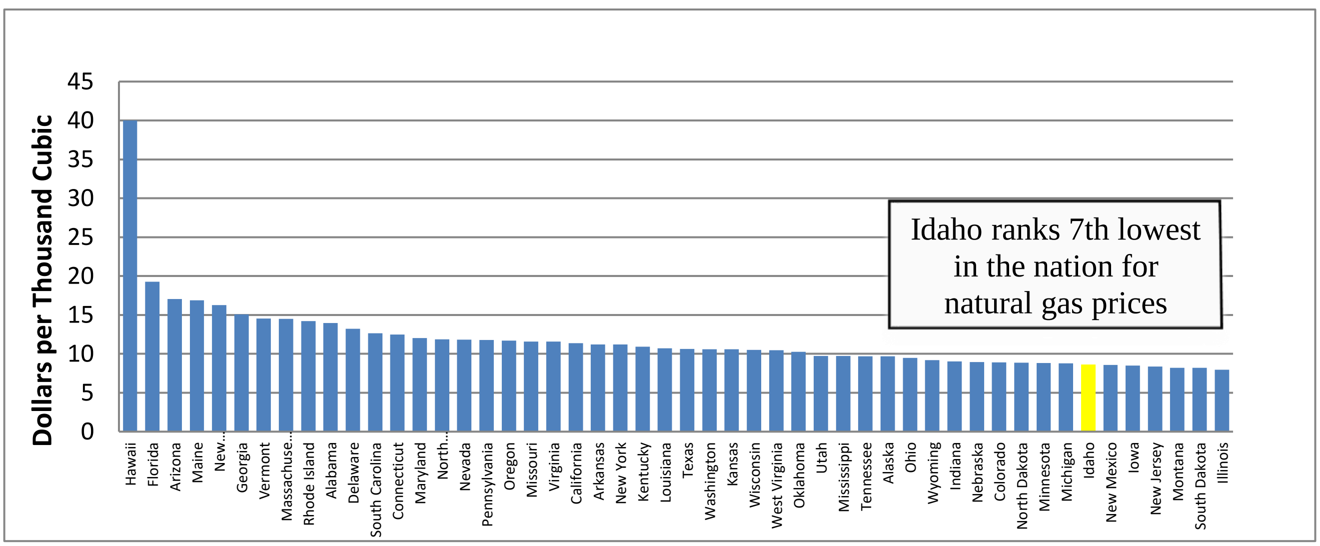


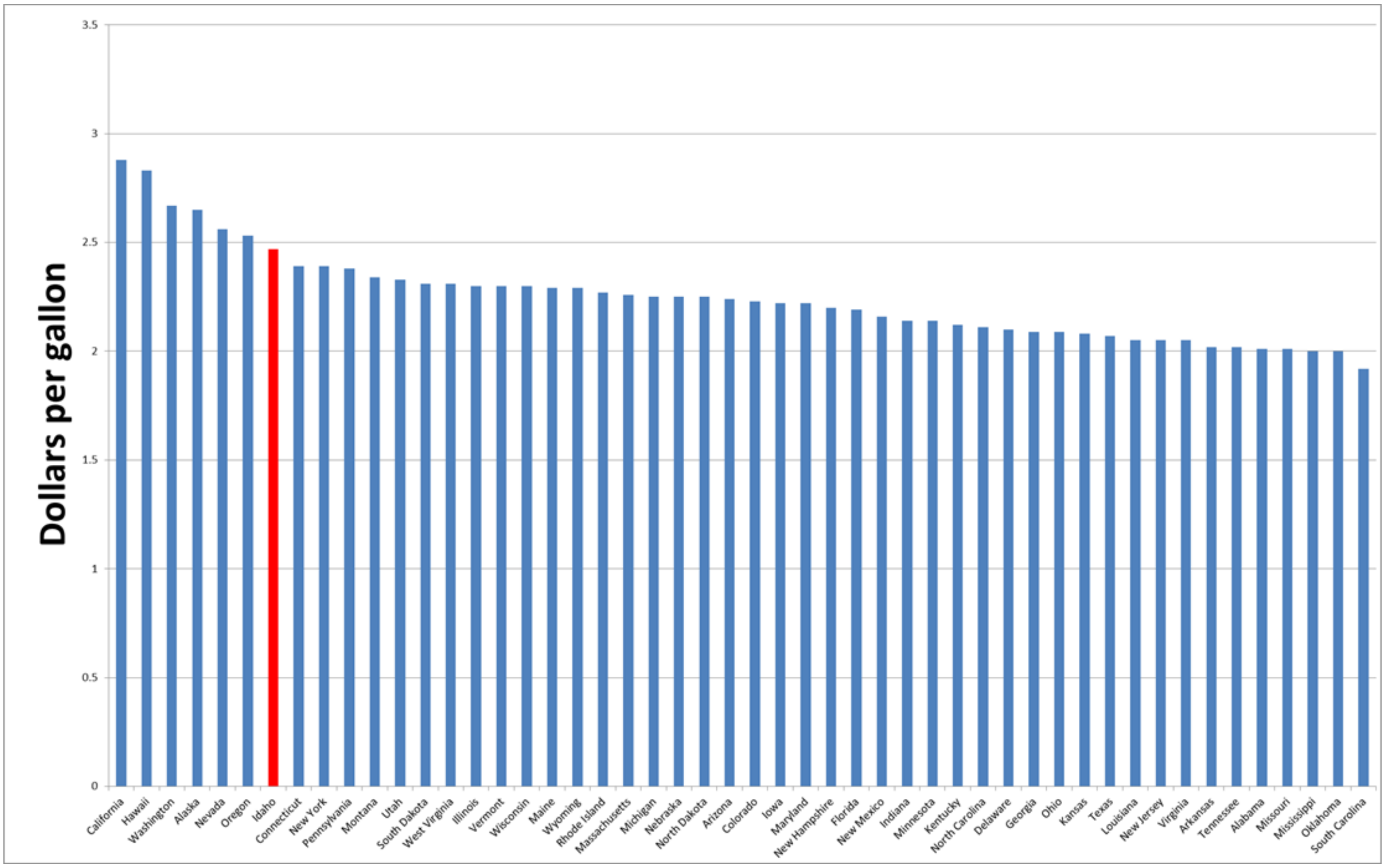
Figure 1.12 Idaho's Residential Natural Gas Prices Compared to Other States in 2015[32]



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

Idaho's average natural gas rates were among the lowest in U.S. states in 2015 as shown in Figure 1.12. [33] However, Idaho's prices for petroleum products are typically higher than the national average. Idaho relies principally on refineries in Montana, Utah and Washington for its supplies of gasoline, diesel, and other petroleum products. Idaho's average gasoline prices were among the highest of the U.S. states in 2016, as shown in Figure 1.13.[34]

Figure 1.13 Idaho's 2016 Retail Gasoline Prices Compared to Other States[35]



Note: The federal tax on gasoline in 2016 was 18.4 cents per gallon. The average state gasoline tax was 48.04 cents per gallon. Idaho's gasoline tax rate in 2016 was 50.4 cents per gallon.

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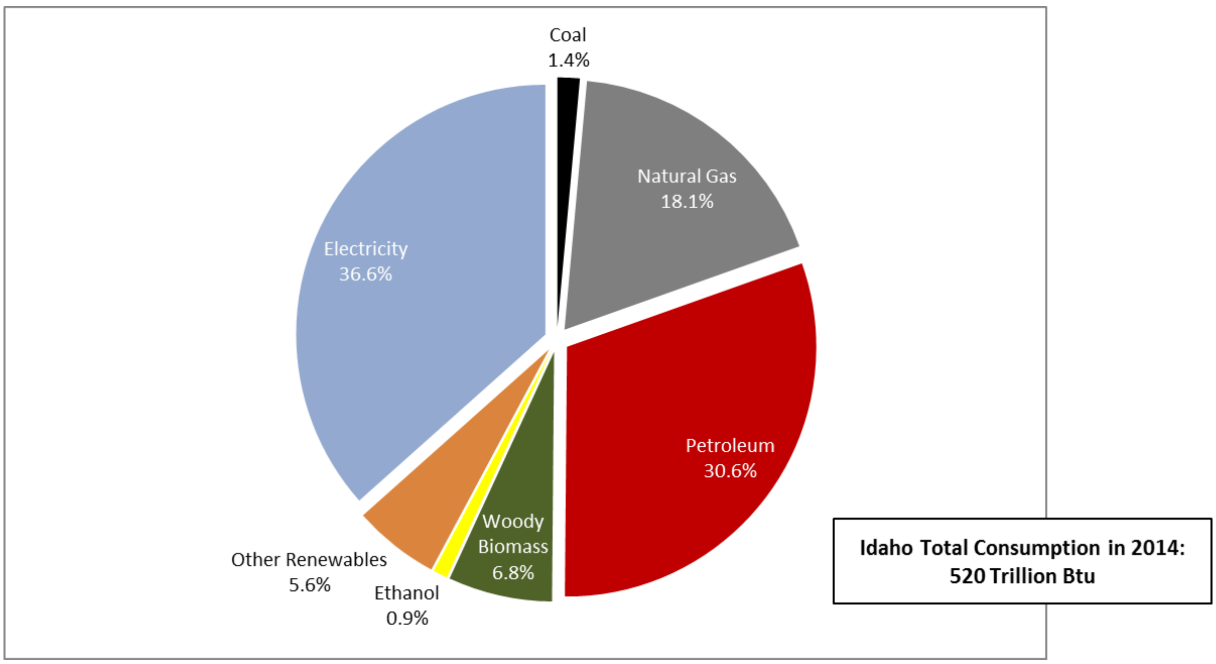
[33] U.S. Energy Information Administration. www.eia.gov/dnav/ng/NG_PRI_SUM_A_EPG0_PRS_DMCF_A.htm
[34] U.S. Energy Information Administration. "Retail Gasoline Prices." http://www.eia.gov/dnav/pet/pet_pri_allmg_a_EPM0_PTC_Dpgal_m.htm and American Petroleum Institute. "Fuel Tax Tables." http://www.api.org/~/media/Files/Statistics/State-Motor-Fuel-Taxes-Report-Jan-2017.pdf
[35] AAA. http://gasprices.aaa.com. and http://www.api.org/~/media/Files/Statistics/Gasoline-Tax-Map.pdf

1.3.2. Sources of Idaho's Energy

As shown in Figure 1.14, petroleum fuels, mostly used for transportation, account for approximately 30% of Idaho's end-use energy consumption. Electricity (36%) and natural gas (18%) are also important energy commodities, while the remaining approximately 16% is attributable to coal, biomass, ethanol, and other renewable energy sources. Energy demand in Idaho, and across the country, is placing upward pressure on energy rates as low-cost sources of energy are exhausted and energy suppliers must turn to higher-cost resources.

Figure 1.14 Sources of Energy Consumed in Idaho in 2014[36]

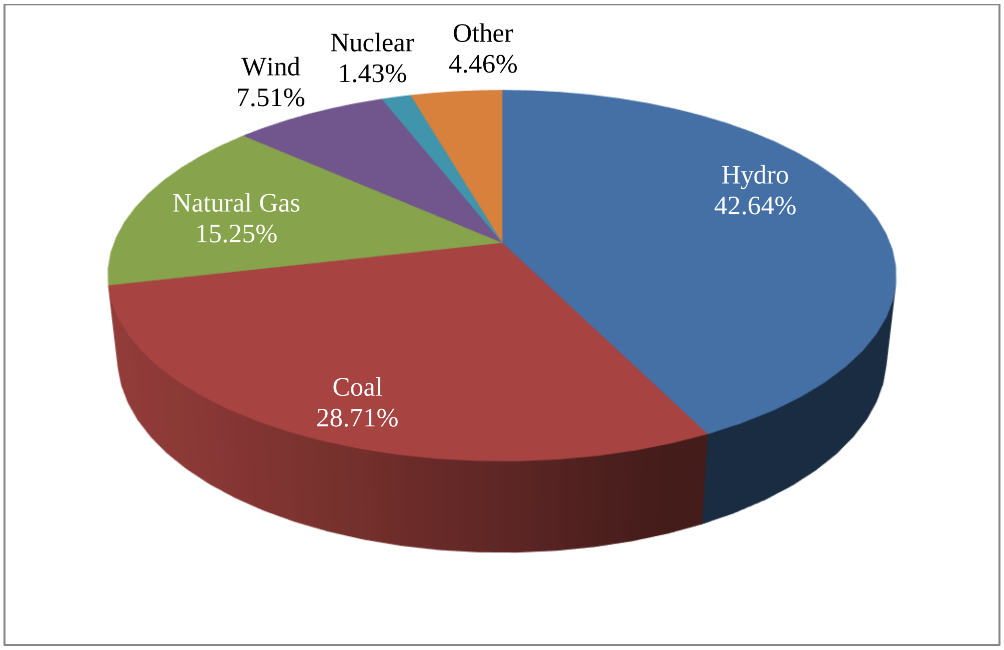


Note: "Other Renewables" includes geothermal (0.5%) and wind (0.8%)

Figure 1.15 depicts the fuel sources of Idaho's electricity in 2014. The figure shows that hydroelectricity and coal are the dominant sources of Idaho's electricity, comprising approximately 43% and 29%, respectively. Natural gas comprises 15%, with non-hydro renewables, principally wind power and biomass, accounting for approximately 12%. Idaho's municipal and cooperative utilities also receive some output of the Columbia Generating Station nuclear plant in Washington.

[36] U.S. Energy Information Administration. www.eia.gov/state/seds/data.cfm?incfile=sep_use/total/use_tot_IDcb.html

Figure 1.15 Idaho's 2014 Electricity Fuel Mix[37]



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 2014 resources apportioned by percent of Idaho load served and that none of these resources are specifically allocated to Idaho.

In Idaho, hydro is still the primary source of fuel for our electricity generation, followed by coal. This depends, of course, on the quality of the water year. As mentioned above, all of Idaho's coal-fired generation comes from neighboring states.

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[37] 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/power/BPA_Fuel_Mix/docs/BPA_Official_Fuel_Mix_2014.pdf

Figure 1.16 Idaho's 2014 Electricity Energy Sources[38]

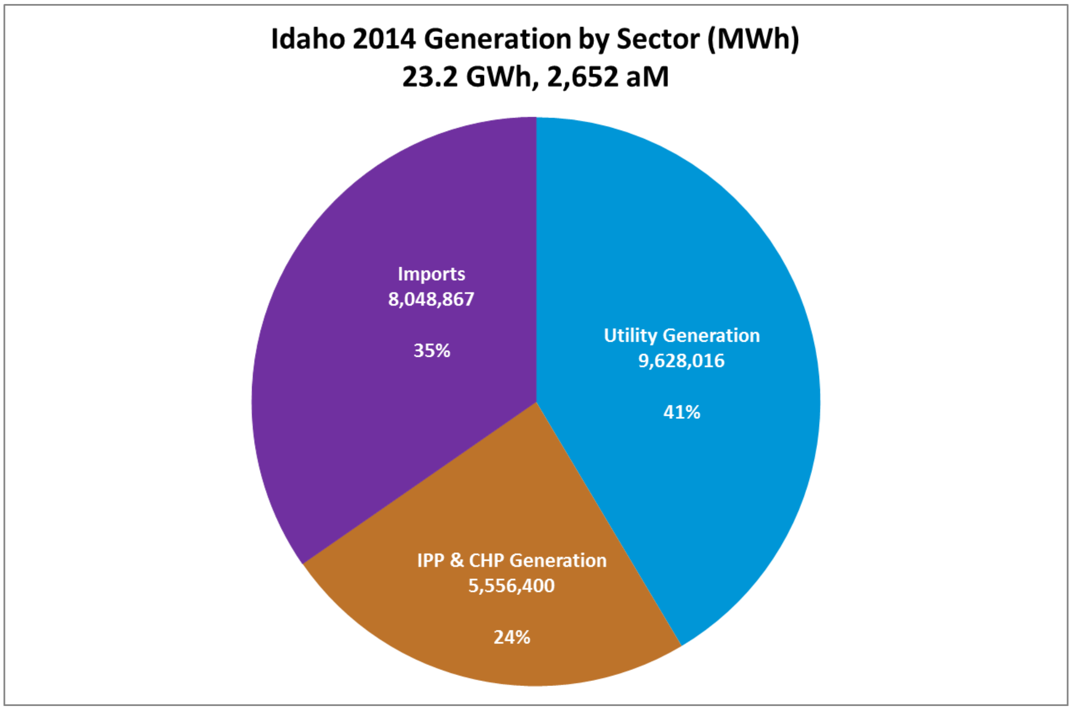

Figure 1.16 indicates that Idaho is dependent upon imported electricity to meet our loads. Our utilities generate in-state approximately 41% of the energy we utilize, with another 24% being provided by non-utility cogeneration or independent power producers. The remaining 35% is made up through energy imports which are comprised of generation from out-of-state resources owned by Idaho utilities as well as market purchases.

1.4. IDAHO ENERGY AGENCIES

Energy responsibilities are spread among many state and local agencies. Energy policy within the State is established by the Legislature, except in those areas preempted by federal statutes.

1.4.1. Idaho Public Utilities Commission

The Idaho Public Utilities Commission (PUC or Commission) regulates Idaho's investor owned electric, natural gas, telecommunications and water utilities in order to ensure adequate service at just, reasonable and sufficient rates. The PUC also has authority to promulgate administrative rules, and the PUC's official rules are published in Idaho Administrative Procedures Act.[39]

[38] U.S. Energy Information Administration. www.eia.gov/electricity/state/idaho/index.cfm
[39] Idaho Statutes § 61and § 62.

The PUC consists of three Commissioners who are appointed by the governor, subject to Senate confirmation, to staggered, six-year terms. No more than two commissioners may be of the same political party.

The PUC holds formal hearings on utility issues on a case-by-case basis. These hearings resemble judicial proceedings and are recorded as well as transcribed by a court reporter. Formal parties to the case under consideration present testimony and evidence, subject to cross-examination by attorneys representing the parties and the commissioners. To help ensure its decisions are fair and workable, the commission employs a staff of about 50 people, including engineers, accountants, economists, and investigators. The staff analyzes each matter before the Commission and issues a recommendation. In formal proceedings before the Commission, the staff acts as a separate party to the case, presenting its own testimony, evidence and expert witnesses. The Commission considers staff recommendations along with those of other participants in each case - including utilities, public, agricultural, industrial, business and consumer groups. The Commission renders a decision based on all the evidence that is presented in the case record. Commission Orders are appealed directly to the Idaho Supreme Court.

While the work of the Idaho Public Utilities Commission is primarily regulatory, it has been seeking to increase the "Energy IQ" of Idaho's citizens in a number of ways. The commission recently produced videos, available on their website, that give an overview of the role of the commission, how a rate case is decided and how citizens can be involved in rate cases[40]. Another video introduces citizens to the commission's Consumer Assistance section, which helps customers with billing and service-related questions.

1.4.2. Idaho Office of Energy and Mineral Resources

The Idaho Governor's Office of Energy and Mineral Resources (OEMR), established by Executive Order 2016-03, is responsible for coordinating energy and mineral planning and policy development in order to promote the efficient use of energy, developing Idaho's energy and mineral resources, and ensuring the availability of adequate energy and mineral supplies to sustain the State's economy and quality of life for our citizens. Information about Idaho's energy and mineral landscape is located on OEMR's website. OEMR oversees the Idaho Strategic Energy Alliance.

As the lead entity in Idaho for energy issues, OEMR coordinates energy planning and policy development for the state. The OEMR advises policy makers, cooperates with federal and state agencies, departments and divisions, and local governments on issues concerning the state's energy requirements, policies, supply, transmission, management, conservation, and efficiency efforts.

The OEMR is the clearinghouse and first point of contact for energy and mineral information for the state and seeks to increase understanding of energy and mineral resource issues throughout the state.

[40] Idaho Public Utilities Commission. www.puc.idaho.gov

1.4.3. Idaho Energy Resources Authority

The Legislature established the Idaho Energy Resources Authority (IERA) in 2005 with the purpose of promoting transmission, generation, and renewable energy development in the state and the region. The IERA is an energy-related lending/financing authority with the ability to issue revenue bonds. This legislation was proposed in response to the recognized inability of Idaho's municipal and cooperative electric utilities to adequately and reasonably finance transmission and generation projects required for the benefit and needs of their residents and members. The IERA can participate in planning, financing, constructing, developing, acquiring, maintaining and operating electric generation and transmission facilities and their supporting infrastructure. The IERA provides a vehicle for Idaho utilities to jointly own and finance transmission and generation projects for the benefit of their ratepayers. 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.[41]

In 2010 the IERA undertook a structured transaction in conjunction with the Utah Associated Municipal Power System (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 Bonneville Power Administration signed a Master Memorandum of Intent to allow BPA to finance northwest transmission facilities through the issuance of IERA bonds. The IERA anticipates completing a second bond financing for BPA in early 2017, although whether and when to proceed is solely at the discretion of BPA.

1.4.4. Idaho Oil and Gas Conservation Commission

The Idaho Oil and Gas Conservation Commission was created by section 47-317, Idaho Code.[42] The Idaho Department of Lands serves as the administrative arm of the Commission. The Commission is appointed by the Governor and consists of one member who is knowledgeable in oil and gas matters, one member who is knowledgeable in geological matters, one member who is knowledgeable in water matters, one member is a private landowner who owns mineral rights with the surface in a county with oil and gas activity, and one member is a private landowner who does not own mineral rights.

The Idaho Oil and Gas Conservation Commission regulates the exploration, drilling, and production of oil and gas resources in Idaho to ensure the conservation of oil and gas and the protection of surface and groundwater.[43] IDL reviews applications for drilling, well

[41] Idaho Energy Resources Authority. http://iera.info/purpose/
[42] Idaho Statute §47-317.
[43] Idaho Department of Lands. www.idl.idaho.gov/oil-gas/regulatory/index.html

treatment, pit construction, and other activities in conjunction with the Idaho Department of Water Resources and the Idaho Department of Environmental Quality. Applications for activities that may affect other mineral interest owners may be heard before the Director or his designee at an administrative hearing.

1.4.5. Idaho Strategic Energy Alliance

Governor C.L. "Butch" Otter established the Idaho Strategic Energy Alliance (ISEA) to help develop effective and long-lasting responses to existing and future energy challenges. Through its Board of Directors and Taskforces, ISEA allows a wide variety of stakeholders to play a role in developing options for Idaho's energy future. The purpose of ISEA is to enable the development of a sound energy portfolio for Idaho that includes diverse energy resources and production methods, that provides the highest value to our citizens, that ensures quality stewardship of our environment, and that functions as an effective, secure, and stable energy system for our state.

1.4.6. Leadership in Nuclear Energy Commission 2.0

The Leadership in Nuclear Energy Commission (LINE) 2.0 was created by Governor C.L. "Butch" Otter through Executive Order 2013-02.[44] LINE 2.0 is tasked with implementing and overseeing progress on recommendations from LINE 1.0. Governor Otter extended the work of LINE 1.0 in March 2013 after the Commission identified a robust and expansive nuclear industries sector in the state that is anchored by the Idaho National Laboratory.[45] The LINE Commissions were established with the recognition that developments in the nuclear energy sector will cause the State of Idaho to face important strategic choices in the future and that it is important that the state understand the options available.

1.5. ENERGY LANDSCAPE

1.5.1. Federal Coordinators and Regulators

Idaho utilities are interconnected with each other and with utilities across the West in a single power grid known as the Western Interconnection. Existing coordination throughout the Western Interconnection on a local, sub-regional, and regional basis ensures a reliable and adequate integrated system for providing electricity to consumers.[46]

In general, Idaho's electric utilities are subject to federal oversight, compliance monitoring, and enforcement by Western Electricity Coordinating Council (WECC). WECC is the largest geographically and most diverse of the eight Regional Entities that monitors and enforces reliability requirements under an agreement with the North

[44] Governor C.L. "Butch" Otter. "Executive Order 2013-02." https://gov.idaho.gov/mediacenter/execorders/eo13/eo_13_02.pdf
[45] Leadership in Nuclear Energy Commission. "Full Report." http://line.idaho.gov/wp-content/uploads/sites/12/2016/07/LINE-Full-Report.pdf
[46] U.S. Energy Information Administration. Electric Power Annual 2009 - Data Tables Format 1990 - 2009 : Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923))

American Electric Reliability Corporation (NERC). NERC is certified by the Federal Energy Regulatory Commission (FERC) to establish and enforce reliability standards for the bulk-power system of North America.[47] WECC's service territory extends from Canada to Mexico. It includes the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 Western states in between. In addition to its compliance role, WECC is responsible for coordinating and promoting bulk electric system reliability in the Western Interconnection and coordinating the operations and planning activities of its members.[48]

1.5.2. Northwest Power and Conservation Council

The Northwest Power and Conservation Council (Council) was created by Congress in 1980 when it passed the Pacific Northwest Electric Power Planning and Conservation Act (Act), giving the states of Idaho, Montana, Oregon, and Washington a greater voice in how to plan an energy future and protect fish and wildlife resources.

Congress concluded that an independent agency, controlled by the states and without a vested interest in selling electricity, should be responsible for forecasting the region's electricity load growth and helping determine which resources should be built.

The Act gives the Council three distinct responsibilities: 1) to assure the region has an adequate, efficient, economical and reliable electric power supply; 2) to prepare a program to protect, mitigate and enhance fish and wildlife of the Columbia River Basin that have been affected by the construction and operation of hydropower dams; and 3) to inform the public in the Pacific Northwest about energy issues and give them an opportunity to be involved in the Council's decision-making process.

The Council writes a 20-year, least-cost power plan for the Pacific Northwest and updates it at least every 5 years. The plan includes several key provisions, including an electricity demand forecast, 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 plan guides the Bonneville Power Administration's decision-making to meet its customers' electricity load requirements.

The Council also is to update the Columbia River Basin Fish and Wildlife Program every 5 years. The latest Fish and Wildlife Program was adopted by the Council in October 2014. The full Fish and Wildlife Program is incorporated into the 7th Power Plan that was finalized in May 2016.[49]

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[47] North American Electric Reliability Corporation. www.nerc.com/
[48] Western Electricity Coordinating Council. "About Us." www.wecc.biz/Pages/AboutWECC.aspx
[49] Northwest Power and Conservation Council. www.nwcouncil.org

Figure 1.17 North American Electric Reliability Corporation

IOUs are also regulated by FERC. FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. Its mission is to "assist consumers in obtaining reliable, efficient and sustainable energy services at a reasonable cost through appropriate regulatory and market means."[50] One of its primary responsibilities is to protect the reliability of the high-voltage interstate transmission system through mandatory reliability standards. FERC does not approve prices for the retail sale of energy or the physical construction of energy facilities; this is left to the state utility regulators. In addition, it does not regulate nuclear facilities or the Electric Reliability Council of Texas (ERCOT). Nuclear facilities are regulated by the Nuclear Regulatory Commission, [51] while ERCOT schedules and centrally dispatches the grid within a single control area that does not have major transmission interconnections and is not synchronously connected to any other interconnections.

1.5.3. Transmission Planning and Regionalization Efforts

Pursuant to recent rules adopted by FERC, Idaho's investor owned utilities are required to participate in local and sub-regional transmission planning and to coordinate with neighboring sub-regional planning groups and local stakeholders.[52] Two Pacific Northwest planning groups – Northern Tier Transmission Group (NTTG) and Columbia

[50] Federal Energy Regulatory Commission. "About Us." https://www.ferc.gov/about/about.asp
[51] Nuclear Regulatory Commission. "About Us." http://www.nrc.gov/about-nrc.html
[52] Federal Energy Regulatory Commission. FERC Order Nos. 890 and 1000.

Grid – now produce transmission expansion and economic study plans on a periodic basis.[53] These local, sub-regional, and regional planning processes are providing the opportunity to explore transmission project costs, benefits, and risks and their allocation to customer group beneficiaries, as well as to explore opportunities for project coordination at the sub-regional and regional levels in order to avoid costly duplication of facilities. The OEMR and the IPUC participate in the development of these planning processes.

Idaho's consumer-owned utilities have historically taken transmission service from BPA, despite their physical location on the grids of investor owned utilities. BPA has, in turn, relied upon a system of agreements with the investor owned utilities known as General Transfer Agreements (GTAs), which allow BPA to serve its customers without having to construct duplicate transmission facilities. The use of historic GTAs has been transitioned to standard Open Access Transmission Tariff (OATT) service, thus replacing the "one off" legacy agreements.

The 1992 passage of the Federal Energy Policy Act, which introduced competition to the wholesale side of the electricity business, ultimately resulted in the development of Independent System Operators (ISOs). ISOs provide open and non-discriminatory access to the wholesale transmission grid, supported by a competitive energy market and comprehensive infrastructure planning efforts. An ISO has no financial interest in any market segment and makes sure diverse resources have equal access to the transmission network and markets used to fine tune the flow of electricity. Two-thirds of the United States is served by these independent grid operators. In the West, an ISO exists within the state of California and is known as "CAISO".

In 2015, PacifiCorp entered into a memorandum of understanding with the CAISO to explore the potential development of a regional ISO to serve parts of Idaho, Utah, Wyoming, Oregon, Washington, and California.

At the same time, several utilities in the west are beginning to participate in a regional real-time market service, referred to as an Energy Imbalance Market (EIM). An EIM optimizes management of the transmission system to balance supply and demand across a larger footprint, covering multiple balancing authority areas. This service can occur outside of an area covered by an ISO and participants do not need to be a full participant in the ISO to join and EIM. 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.

PacifiCorp began participating in the EIM in November 1, 2014. Since then, several regional utilities have planned to join the EIM, and Idaho Power has recently signed an agreement to begin participating in the EIM in April of 2018.

[53] Idaho Power and PacifiCorp are members of NTTG, and Avista and BPA are members of ColumbiaGrid.

1.5.4. The Clean Power Plan

The Clean Power Plan is a rule promulgated by the United States Environmental Protection Agency (EPA) under Section 111(d) of the Clean Air Act.[54] The purpose of the rule is to regulate carbon dioxide (CO_2) emissions from large existing fossil fuel electric generating facilities, reducing them by 32 percent from 2005 emission levels by 2030.[55] Under the rule, EPA set mandatory CO_2 emission targets for each state.[56]

The rule required each state to submit a final plan, or an initial plan with a request for a two year extension, to the EPA by September 2016 describing how the particular state would reach its specific rate-based or mass-based target.[57] Upon submission, states were to begin implementing their plans to meet specific interim targets by 2022 and their final targets by 2030.[58] However, implementation of the Clean Power Plan was temporarily suspended by the Supreme Court of the United States (Supreme Court) in early 2016.[59]

The validity of the Clean Power Plan is being challenged in the United States Court of Appeals for the District of Columbia (D.C. Circuit).[60] Hundreds of parties are involved in the litigation effort including 28 states challenging the rule and 18 states intervening on behalf of the EPA.[61] The Supreme Court granted the challengers of the rule a stay of the Clean Power Plan in February 2016.[62] The stay will remain in place until the D.C. Circuit resolves the merits of the current litigation and the Supreme Court resolves any appeals.[63] A final decision on validity of the rule is expected in 2017 or 2018. Accordingly, implementation of the rule has been halted and, should the rule be upheld, the compliance timeline may be revised. Additionally, if the Clean Power Plan is upheld, Idaho will need to work with the states that host Idaho's coal generation in order to minimize the impacts on Idaho ratepayers.

1.5.5. PURPA

One of the vehicles for developing smaller-scale resources in Idaho has been the Public Utility Regulatory Policies Act (PURPA) of 1978. PURPA requires utilities to purchase energy from "qualifying facilities" (QFs) at the utility's avoided energy costs. The avoided cost rate is defined as the incremental costs to a utility for energy or capacity or both which but for the purchase from the qualifying facility such utility would generate itself or purchase from another source. The federal law places these facilities into two categories: qualifying small power production facilities and qualifying cogeneration facilities. A small power production facility is a generating facility of 80 MW or less whose primary energy source is renewable (hydro, wind or solar), biomass, waste, or

[54] Clean Power Plan, 80 C.F.R. § 64,661.2015.
[55] Ibid., 64,664-5.
[56] Ibid., 64,664.
[57] Ibid., 64,669.
[58] Ibid., 64,664.
[59] West Virginia v. EPA, 136 S. Ct. 1000 (2016) (mem.)
[60] See West Virginia v. EPA, No 15-1363 (D.C. Cir. argued Sep. 27, 2016).
[61] Ibid.
[62] West Virginia v. EPA, 136 S. Ct. 1000 (2016) (mem.)
[63] Ibid.

geothermal resources.[64] A cogeneration facility is a generating facility that sequentially produces electricity and another form of useful thermal energy (such as heat or steam) in a way 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. [65]

Determining avoided costs as well as other implementation details are conducted at the state level. The policies established by the Idaho PUC have been relatively favorable toward QFs, and as a result, Idaho experienced development of 200 MW of QF resources by the early 1990s, principally industrial co-generation and small hydro projects. While momentum slowed with the move toward competitive markets in the 1990s, a resurgence of interest in using PURPA to develop projects began with the new century. Many of the projects in the late 1990s and early 2000s were wind facilities sized to come in just under the 10 average MW maximum size eligible for their published available cost rates established by the Idaho PUC. However, in recent years, wind developers were disaggregating much larger projects into 10 MW sized units in order to qualify for the published PURPA rates. In order to address such disaggregation, in late 2010, the Public Utilities Commission reduced the eligibility size from 10 MW to 100 kW for intermittent resources (wind and solar). Larger projects are still eligible for PURPA contracts, with the rate determined on a case by case negotiation with the utility, with the prices based on the utility's Integrated Resource Plan.[66]

In the years following 2010, growth in Idaho PURPA project capacity increased significantly, as shown in Figure 1.18. The ability of Idaho utilities to absorb the amount of projects seeking contracts and to accurately predict avoided costs over a 20-year contract length for projects using IRP-based pricing increased future risk of adverse rate impacts. In 2015, the Idaho Public Utilities Commission reduced contract length for IRP-based PURPA contracts from 20 to 2 years to alleviate this risk.[67]

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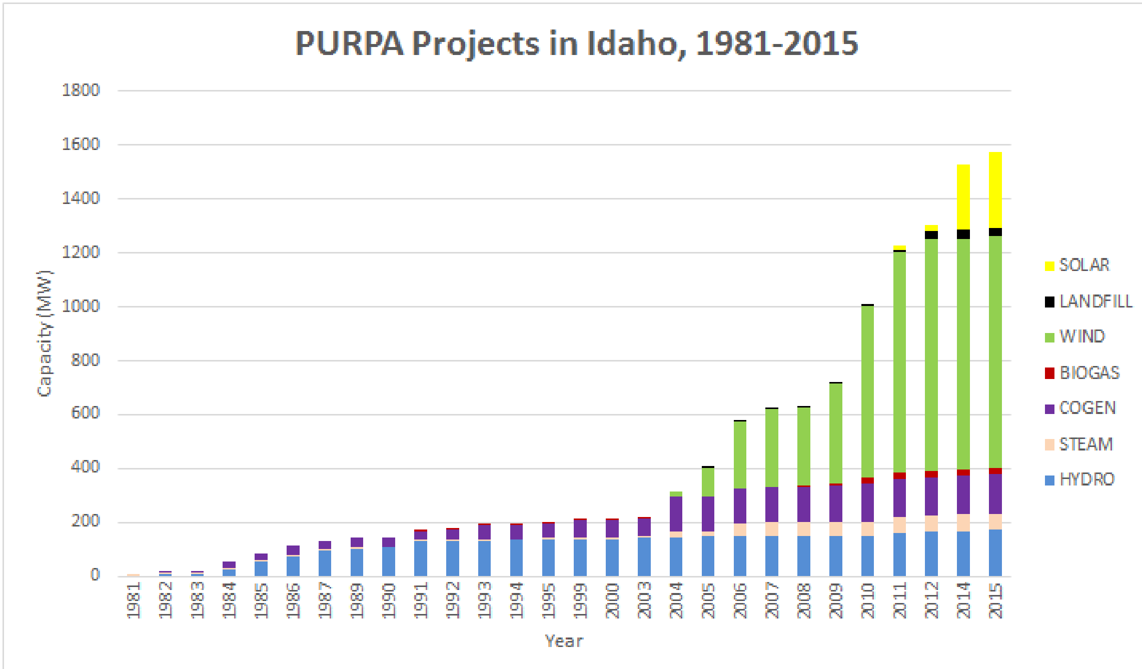
[64] Federal Energy Regulatory Commission. "What is a Qualifying Facility?" www.ferc.gov/industries/electric/gen-info/qual-fac/what-is.asp.
[65] U.S. Forest Service. "FSH 2709.15 - HYDROELECTRIC HANDBOOK." www.fs.fed.us/im/directives/fsh/2709.15/05.txt
[66] Idaho Public Utilities Commission. "CASE NO. GNR-E-10-04, ORDER NO. 32176." http://www.puc.idaho.gov/fileroom/cases/elec/GNR/GNRE1004/ordnotc/20110207FINAL_ORDER_NO_32176.PDF
[67] 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

Figure 1.18 PURPA Generation in Idaho, 1981-2015[68]



[68] Idaho Public Utilities Commission.

2. Idaho Resources

2.1. COAL

Idaho currently has no in-state production of coal. Idaho utilities have ownership shares in coal-fired power plants that supply approximately 35% of Idaho's electricity; however, all of these plants are located in neighboring states.[69] Coal is found in abundance in the United States, with the nation's largest coal exporter (Wyoming) and largest recoverable coal reserve (Montana) in close proximity to Idaho.

The New Source Review process of the Clean Air Act requires pre-construction review of environmental controls for building new coal-fired power plants or for any modifications of existing plants that would create a significant increase of a regulated pollutant. In addition, the attention being paid to global climate change has led to increasing calls for state and federal regulation of CO_2 and other greenhouse gas emissions. These regulations substantially impact generation costs, creating significant uncertainty regarding the viability of new coal based generation and the future of existing coal-fired generation. Additionally, neighboring states have incorporated renewable portfolio standards that place coal at an economic disadvantage.

"Clean coal technology" describes processes that sharply reduce air emissions and other pollutants from coal-burning power plants. This includes existing emission control system technologies such as wet scrubbers (for SOx removal), selective catalyst reduction (for NOx), fabric filters and electrostatic precipitators (for particulates), and powdered activated carbon injection (for mercury). A new generation of processes is being developed focusing on CO_2 reduction through improved efficiency, separation, and reuse or capture. Flue-gas separation uses a solvent to remove CO_2 which is subsequently stripped off with steam. Oxy-fuel combustion burns coal in pure or enriched oxygen creating a flue gas which is primarily CO_2 and water, avoiding the need to separate CO_2 from other flue gases. With coal gasification, coal is heated in the presence of steam and oxygen to produce a syngas primarily composed of carbon monoxide (CO), hydrogen (H2) which is combusted to make electricity and CO_2 which can be separated. When separated, CO_2 can be sold and reused (e.g. enhanced oil recovery) or captured and stored permanently in geologic formations (sequestration). The greatest challenge is bringing the cost of the technology down sufficiently.[70]

2.2. NATURAL GAS

Natural gas is an important fuel for Idaho's economic future: heating our homes, powering businesses, moving vehicles and serving as a key component in many of our most vital industrial processes. With the successful drilling in the Payette Basin, Idaho

[69] 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

[70] World Nuclear Association. "'Clean Coal' Technologies, Carbon Capture & Sequestration." www://world-nuclear.org/information-library/energy-and-the-environment/clean-coal-technologies.aspx

now has its first commercial production of natural gas and natural gas liquids. Despite being in its infancy, production of natural gas in Idaho is expected to increase in the future. Easy access to the regional Williams Pipeline helps to make this production economic.

With the growing demand for natural gas particularly in the residential and commercial sectors, there is the concern for potential price volatility. However, the forecast of natural gas production in the U.S. is projected to be sufficient to meet increases in demand for both domestic consumption and net exports through 2040, as the U.S. is now the world's largest natural gas producer. [71] [72]

Natural gas power plants provide significant operational benefits because the plants can adjust generation to follow changing electricity load including the real-time changes in the electric system from 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) have lower emissions than coal-fired generation and are the predominant thermal resources being considered by utilities in the US. Because SCCT and CCCT resources have a relatively low capital cost and natural gas prices are forecasted to remain low, natural gas resources are some of the least expensive thermal generation resources at the present time.

Natural gas is the cleanest burning transportation fossil fuel. As a transportation fuel, natural gas is used as compressed natural gas (CNG) or as liquefied natural gas (LNG). Both compression and liquefaction are methods employed to increase the amount of natural gas 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, but this is a rapid and efficient process.[73]

There are only two public CNG vehicle refueling stations in Idaho, in Boise and Nampa. However, various municipal and commercial fleets have their own CNG refueling stations for their vehicles. Avista and Intermountain Gas have private refueling stations for their fleet service vehicles, as well.

Idaho is one of our nation's leaders in the introduction and deployment of LNG fueling for heavy-duty transportation vehicles. There are five public LNG fueling stations along

[71] Forbes. Article by Jude Clemente 8. Aug. 2016. "An Update on U.S. Natural Gas Production." www.forbes.com/sites/judeclemente/2016/08/24/an-update-on-u-s-natural-gas-production/#616e608524a9
[72] U.S. Energy Information Administration. "Market Trends: Natural Gas." www.eia.gov/forecasts/aeo/MT_naturalgas.cfm#natgas_prices
[73] Idaho Strategic Energy Alliance. "Transportation Task Force Report 2015." https://oemr.idaho.gov/wp-content/uploads/2016/06/2015_Transportation_TF_Report.pdf

the Idaho southern interstate corridors located in Nampa, Boise, Jerome, American Falls, and Idaho Falls.

2.3. PETROLEUM

The Rocky Mountain West, particularly Utah, Colorado, and Wyoming, contains enormous reserves of kerogen contained in sedimentary deposits, commonly referred to as “oil shale”. The U.S. Geological Survey estimates that there may be approximately 3 trillion barrels of oil equivalent in these deposits, and possibly 1.5 trillion barrels of recoverable oil equivalent.[74]

Idaho has a relatively small petroleum and transportation fuel market, limited pipeline infrastructure, and no refineries. The Tesoro pipeline connects Salt Lake City refineries with Pocatello, Burley and Boise before continuing to Pasco, Washington. The pipeline then continues from Pasco to Spokane, Washington, which enables it to deliver fuel to northern Idaho. Additional supplies originate at three refineries in the Billings, Montana area and are transported to Spokane via the Phillips 66 Pipeline. A small portion of Idaho’s supply originates at refineries in Northwestern Washington. This fuel is transported to Portland via the Olympic Pipeline, where it is loaded onto barges and transported up the Columbia River-Snake River System to Lewiston. See Figure 2.1.

While efficiencies of vehicles have been improving over the recent years, the continued increase of vehicle miles traveled has resulted in increases of fuel demand.[75] Pricing for diesel fuel has remained higher than gasoline prices due to the high demand in the United States, Europe, China, and India.[76]

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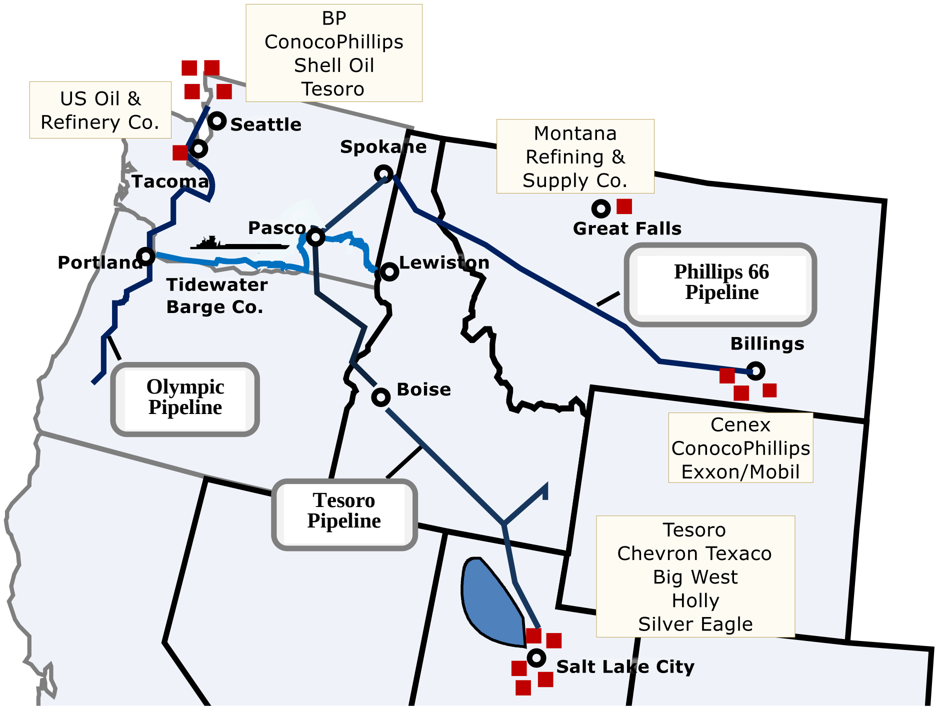
[74] Rocky Mountain Energy Forum. “Oil and Oil Shale.” www.rockymountainenergyforum.com/topics/oil
[75] U.S. Department of Transportation. “Travel Monitoring.” www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm
[76] U.S. Energy Information Administration. “Frequently Asked Questions.” http://www.eia.gov/tools/faqs/faq.cfm?id=9&t=9

Figure 2.1 Transportation Fuel Pipelines and Refineries Serving Idaho



2.4. PROPANE

Idaho citizens utilize propane to heat their homes and businesses throughout the state. While the price of propane remains relatively stable, there are two major contributors to the fluctuation in pricing for propane: supply and demand; and transportation costs. Propane consumption is highly seasonal, and is generally built up during the spring and summer when consumption is lowest, and demand increases in the fall and winter, when consumption is at its peak. Propane users who are furthest away from major supply sources generally pay a higher price for delivered propane. Residential propane prices in Idaho fluctuated between 1.96/gallon to $2.51/gallon in 2015.[77]

Propane can also be used in a number of transportation applications. The number of refueling opportunities for a propane vehicle has contributed to the increasing use of this fuel across the county and in Idaho. In Idaho, propane is available at some truck stops, propane infrastructure businesses, and U-Haul rental centers. However, fleets usually prefer to have on-site fueling. Propane infrastructure dealerships provide fleet owners with tanks and fuel at a cost significantly lower than those found at most public fueling facilities. For vehicles that travel a significant number of miles per year, the savings are large enough that the additional cost of a vehicle modified to use propane is returned within a few years of operation.

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[77] 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

2.5. HYDROELECTRICITY

Idaho's many rivers provide a tremendous source of renewable electricity. With more than 140 existing hydro plants having a combined generating capacity of approximately 2,700 MW, Idaho has some of the most valuable hydroelectric power resources in the country. Hydroelectricity is a unique renewable energy resource. It is a clean, inexpensive, dispatchable resource, and has greater flexibility than any other form of renewable electric generation because of its ability to match the fluctuating demands on the electric grid. It accommodates the highly-variable and intermittent contribution of wind and solar generation.

The largest hydroelectric projects that contribute to Idaho's electricity system are the 1,167 MW Hells Canyon Complex (consisting of the Hells Canyon, Oxbow and Brownlee dams) owned by 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 2014 hydroelectric generation was 9,154,000 MWh, providing about 60% of in-state electrical generation.[78]

There are limited opportunities for additional hydroelectric development in Idaho. However, the State of Idaho is studying the potential to develop the Galloway dam on the Weiser River in southwestern Idaho. The Galloway project is in the early stages of analysis and there are many operational, hydrologic, engineering, environmental, cultural, and financial issues to be considered. The Galloway project is not expected to significantly affect the energy situation in southern Idaho.

2.6. WIND

Idaho's wind generation grew from 75 MW[79] at the end of 2008 to a total nameplate capacity of more than 900 MW in 2014.[80] Wind mapping studies estimate that Idaho has approximately 25,000 MW of wind generation potential, the 13th highest potential in the U.S. The most readily available wind resources in Idaho are located in the Snake River Plain and the surrounding hills and ridges.[81] There has been high interest for wind development on the eastern end of the Snake River Plain.

Electricity produced from wind does not emit CO_2 or other emissions and can reduce the demand for fossil fuels. However, since wind generation is an intermittent resource and produces energy only when the wind blows, wind generators cannot be dispatched to meet load, and cannot be counted on to produce electricity at any particular capacity during times of high energy demand. The consequence is that dispatchable resources

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[78] U.S. Energy Information Administration. "Electricity." www.eia.gov/electricity/data.cfm#generation
[79] Idaho Strategic Energy Alliance. "Wind Task Force Initial Mandate Response 2009." https://oemr.idaho.gov/wp-content/uploads/2016/06/wind_packet.pdf
[80] American Wind Energy Association. "Idaho Wind Energy." http://awea.files.cms-plus.com/FileDownloads/pdfs/Idaho.pdf.
[81] Idaho Strategic Energy Alliance. "Wind Task Force Initial Mandate Response 2009." https://oemr.idaho.gov/wp-content/uploads/2016/06/wind_packet.pdf

(often natural gas-fired plants) must be ready to meet actual customer loads at times when wind generation is not available.

2.7. GEOTHERMAL

Geothermal energy extracts heat from the earth and is typically harvested by drilling wells into deep subsurface reservoirs and pumping hot water to the surface and used to generate electric power or to provide space heating. After the heat is extracted from the water, the water is injected back into the reservoir to be reheated. Idaho ranks high in its potential for geothermal resources. An estimated 17,000 GWh of geothermal power potential exists in Idaho.[82] Much of this geothermal energy potential exists in the southern portions of Idaho (Figure 2.2).[83]

Currently Idaho has one operating geothermal power plant at Raft River in Cassia County operated by U.S. Geothermal. This plant is designed to provide 13 MW of net capacity. The Raft River project could add two or more 13 MW power plant modules in the coming years depending on market conditions. A new geothermal 22 MW power plant was constructed at Neal Hot Springs by U.S. Geothermal just across the border in eastern Oregon, and the Bureau of Land Management recently approved the development of a 25 megawatt power plant in southern Idaho.

The benefits of geothermal energy include reliable baseload power generation, sustainable low operating costs, and near zero carbon emissions. An obstacle to geothermal power development is the risk associated with drilling expensive wells to prove a reservoir. Continued long-term federal tax incentives have been necessary to overcome these risks.

Direct-use is the oldest, most versatile and most prevalent form of geothermal energy.[84] Idaho has over 900 wells and springs with water temperatures greater than 90° F. Direct use of low temperature geothermal resources are also used in many parts of Idaho (Figure 2.2) for space heating, aquaculture, greenhouses, and recreation. District heating has a long and rich history in Idaho. In the late 1800’s the nation’s first district heating system was built in Boise, servicing over 200 buildings, a system is still in use today. In the 1980’s the Idaho State Capitol became the only geothermal heated capitol in the entire U.S., using district heating to supply heat to the Capitol Mall complex. More recently district heating has been successfully implemented for space heating at the Boise State University campus in the new College of Business and Economics building.

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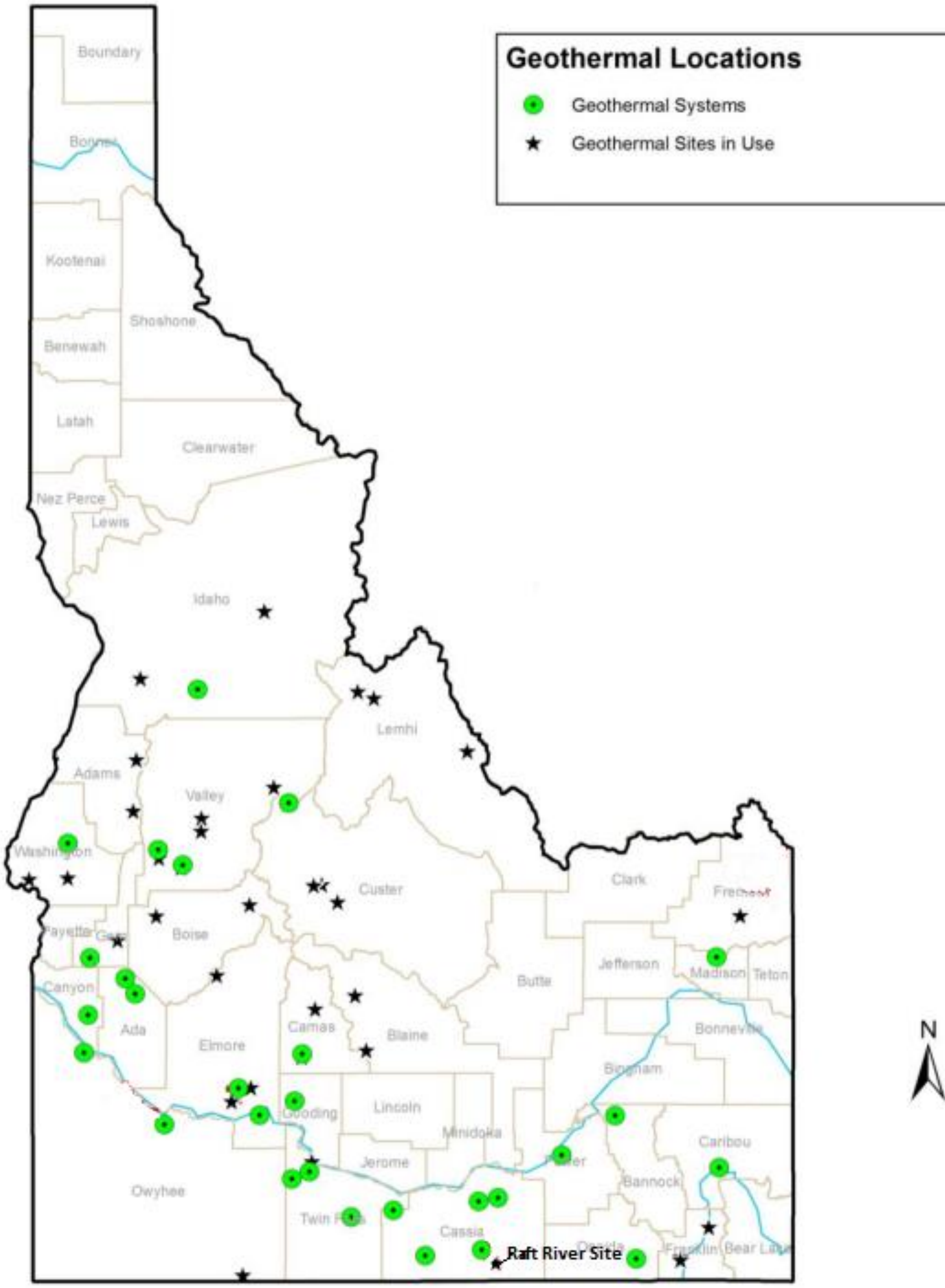
[82] Geothermal Energy Association. “Geothermal Energy Potential-State of Idaho.” http://geo-energy.org/pdf/Guides_2015/Idaho.pdf

[83] 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

[84] 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

Figure 2.2 Geothermal Locations in Idaho



2.8. BIOENERGY

Bioenergy is renewable energy derived from biological sources to be used for heat, electricity, or vehicle fuel. Bioenergy comes primarily from wood, wastes, ethanol from corn fermentation, and biodiesel from oil seeds and animal fats, although it can also come from agricultural wastes and dedicated energy crops, including switchgrass, miscanthus, and poplar used to make advanced biofuels.

Woody biomass has historically been used in Idaho's forested regions to generate both thermal and electrical energy. Future utilization of woody biomass will depend on unique circumstances where facility location (distance from feedstock) and availability of alternative energy supplies are limited. Woody biomass is currently being explored as an option to co-fire with, or potentially replace, coal at regional power plants. However, the role that woody biomass will play in future energy needs remains uncertain due to federal regulations, as EPA's Scientific Advisory Board has yet to define a framework to factor for carbon emissions associated with the entire lifecycle of biomass feedstocks.

The low energy content of biomass, compared to fossil fuels, requires a higher input of feedstock, which poses significant logistic and economic challenges. Even though bioenergy converted from waste incineration, anaerobic digestion, gasification, and pyrolysis currently play a small role in Idaho energy mix, these conversion technologies will likely need to see improvements in efficiency and/or reductions in cost in order to become utilized at a broader scale.

In 2014, there was 87 MW of installed capacity for biomass electricity that produced approximately 590,000 MWh, or 3.9 percent of Idaho's electricity production for that year.[85] As of 2016, Idaho has one operating ethanol plant capable of producing 60 million gallons per year.[86] There is no commercial production of biodiesel in Idaho.

2.9. SOLAR

Solar cells, also called photovoltaic (PV) cells, convert sunlight directly into electricity. Some utility companies are using PV technology for large-scale power generation. Solar energy is an intermittent resource, producing energy only when the sun is shining. Because it is intermittent, solar energy cannot be counted on to produce at any particular capacity during times of high energy demand.

Concentrating solar power (CSP) technologies use mirrors to reflect and concentrate sunlight onto receivers that collect the solar energy and convert it to heat. This thermal energy can then be used to produce electricity via a steam turbine or heat an engine that drives a generator.

Solar energy is currently used for specific applications such as water pumping, thermal heating, and electricity production in remote locations that would be difficult to serve

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

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

with energy from the electricity grid. Increasingly, solar is used in Idaho for grid inter-tied applications, offsetting facility energy use. Oak Ridge National Laboratory found that Idaho was one several states noted for having the strongest projections for plant installations and capacity.[87]

Idaho's first commercial solar farm was built south of Boise to create 40 megawatts of electricity.[88] Idaho Power filed applications in 2016 with the Idaho Public Utilities Commission for a 500-kilowatt community solar project.[89] The Idaho Public Utilities Commission has approved Idaho Power Company agreements for several hundred MW of solar power.

2.10. NUCLEAR

Nuclear power production accounts for nearly 19% of the nation's electricity provided by 99 nuclear reactors operating in 30 states.[90] Over the past two decades, the operational performance of these reactors has improved,[91] as demonstrated by an increase in operational capacity factor from approximately 53% in 1980 to over 90% today.[92] The US nuclear industry has also achieved gains in power plant utilization through improved maintenance, refueling, and safety systems at existing plants. However, reduced natural gas prices, and corresponding investment in natural gas power plants, have placed some new projects on hold.

Although Idaho does not have a commercial nuclear power plant, Idaho National Laboratory (INL), as the U.S. Department of Energy's lead laboratory for nuclear energy, has had a significant influence on every reactor designed in the United States. INL researchers are working on several initiatives that will help shape the future of nuclear energy worldwide.

There are several different types of nuclear power reactors, including light-water reactors, gas-cooled reactors, heavy-water reactors (reactors which use a "heavy" form of water – deuterium oxide – instead of typical "light" water) and breeder reactors. Each different type of reactor has certain s attributes and characteristics.

Advances in commercial nuclear technology are expected to include hybrid energy systems that couple nuclear reactors with renewable or fossil energy inputs to create

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[87] Oak Ridge National Laboratory. "Application of Spatial Data Modeling and Geographical Information Systems (GIS) for Identification of Potential Siting Options for Various Electrical Generation Sources." www.osti.gov/scitech/biblio/1032036/

[88] Idaho Statesman. "A new crop is now growing in Idaho: Solar energy." www.idahostatesman.com/news/business/article91855892.html

[89] Idaho Public Utilities Commission. "Idaho Power seeks to build community solar project and modify existing Green Energy Program." www.puc.idaho.gov/press/160711_IPCcommunitysolar.pdf

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

[91] Nuclear Energy Institute. "Safety and Security." www.nei.org/Issues-Policy/Safety-and-Security

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

synthetic fuels while improving transmission system stability, and development of dry-cooling technologies. Advanced simulations and computing approaches, coupled with advances in system diagnostics and control techniques, hold promise for enhancing operability, maintainability, and safety of existing and future nuclear systems. These advances may also be transferable to non-nuclear energy systems, offering greater economic competitiveness and breadth of deployability of renewable and fossil systems.

2.10.1. NuScale Small Modular Reactors

NuScale Power, LLC, is developing a new kind of nuclear power module in a small modular reactor (SMR) design. SMRs are a smaller, scalable version of widely-used pressurized water reactor technology. In 2014, NuScale Power finalized a cost-sharing agreement with DOE to develop SMR technology, under which the company will receive up to $217 million in matching funds over a five-year period. The company will use the funds to perform the engineering and testing needed to proceed through the Nuclear Regulatory Commission design certification process. NuScale is projected to submit the Design Certification Application to the NRC by the end of 2016.

As a hedge against carbon regulation, UAMPS is investigating development of a Small Modular Reactor project using NuScale technology. NuScale Power received an additional $16.7 million award by DOE for siting analysis for the UAMPS project, with the preferred site being identified on the Idaho National Laboratory property in eastern Idaho. Site analysis activities are underway with the expectation that the combined construction and operating license application will be submitted in 2019.

In 2016, the U.S. Department of Energy issued a Site Use Permit to UAMPS CFPP granting it access to the INL site for the purposes of identifying potential locations for the NuScale Power Plant and, if suitable, the long term use of a preferred site for such purposes. UAMPS CFPP is projecting the first NuScale Power Module could achieve commercial operation in 2024, with the full 12-module plant becoming operational in 2025. Advanced reactor deployment at INL will provide additional benefits to Idaho as more reactor developers and suppliers focused on supporting construction of new reactors at the INL site.

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 with a large demand for electricity and hot water or steam, such as large industrial users and campuses. Idaho has approximately 20 CHP systems being utilized by wood product facilities, dairies, universities and large industrial users.[93]

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

Advances in gas turbine technology and advanced computing and control technologies have opened the door for hybridization of other energy systems and resources. System hybridization involves coupling various energy resource inputs to generate one or more energy products. Early generation hybrid systems that are currently being deployed couple solar and natural gas; and planned systems couple solar, natural gas, and wind inputs for electricity generation. These systems show significant benefits in overall system efficiency and transmission stability under high intermittent generation scenarios. Future hybrid systems that are currently being researched 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) are not energy resources in the same sense as fossil fuels or hydroelectric power, but they do constitute another economically attractive resource that electric and natural gas utilities can call upon to meet their customers' energy needs.

- "Conservation" refers to consumer actions that reduce their use of energy-consuming devices. An example is a consumer remembering to turn off the lights when leaving a room.
- "Energy efficiency" refers to processes that provide the same energy service but consume less electricity. An example is switching from incandescent lights to LED light bulbs.
- "Demand response" refers to customers temporarily altering their energy-consuming behavior in response to signals from the utility or grid operator. An example is lighting fixtures that can be dimmed remotely by utility personnel during times of high electricity demand.

Collectively, these resources are referred to as "demand-side management" (DSM), although the terms "conservation" or "efficiency" are sometimes used to refer to all DSM measures.

Idaho utilities have been utilizing cost effective, sustainable energy efficiency programs. 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 energy savings, cost-effective energy measures provide economic benefits to Idaho utilities when they can earn a rate of return on this investment. Cost-effective energy efficiency saves money for Idaho businesses, families, and taxpayers.

Idaho investor owned electric utilities continue to place an emphasis on cost-effective conservation, energy efficiency and demand response, and the Idaho Public Utilities Commission has "steadfastly" directed Idaho utilities to pursue all cost-effective DSM programs.[94] Energy efficiency and conservation not only addresses current energy use, it is a reliable and cost effective resource to meet future energy demands. This new "supply" of energy comes in two forms, increasing energy savings from existing programs and new savings from new programs. Today, Idaho's utilities analyze new energy efficiency and conservation as a viable supply resource when factoring their total load and resource balance.

Energy efficiency benefits Idaho manufacturers, retailers, and food processors by directly lowering the costs of production and improving the cost competitiveness of the facilities and the resulting goods and services produced in Idaho. Energy efficiency in homes directly lowers the cost of living for Idaho residents. All three investor-owned electric utilities, as well as municipal and cooperative electric utilities in Idaho, offer energy efficiency programs to residential, commercial, industrial, and agricultural customers.

For publicly owned utilities, the Northwest Power Planning Council Seventh Power Plan identifies the cost effective potential for the region and Bonneville Power Administration has methods to encourage action and review results 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. Each investor owned utility serving Idaho calculates the level of cost effective efficiency potential in their IRP process and offers a suite of efficiency programs for all customers. The Idaho Public Utilities Commission has existing, robust methods to review these forecasts, and evaluate, measure, and verify these energy savings.

2.12.1. Northwest Power and Conservation Council

The Northwest Power and Conservation Council (Council) estimates of the amount of cost-effective energy efficiency that can be acquired in the four-state Pacific Northwest region. The Council's Seventh Power Plan concluded that "in more than 90 percent of future conditions, cost-effective efficiency met all electricity load growth through 2030 and in more than half of the futures met all load growth for the next 20 years."[95] The Council's most recent Resource Strategy recommends the region achieve approximately 4,300 aMW of energy efficiency over the next 20 years (2016-2035).[96]

2.12.2. Avista

Avista began offering energy efficiency programs to its customers in 1978, and in 1995 became the first utility in the nation to implement an energy conservation tariff. Avista has acquired 197 aMW of electricity savings since 1978, and of that total, the Company currently has 127 aMW of active demand side resources that reduce overall electric loads by nearly 11 percent. For its Idaho electric customers, this amounts to approximately 38

[94] 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

[95] The Northwest Power and Conservation Council. "Power Planning, Seventh Power Plan." www.nwcouncil.org/energy/powerplan

[96] Ibid.

aMW. Every two years, Avista hires an independent contractor to complete an assessment of the energy conservation potential in its service area for the coming 20-year period. This conservation potential assessment, or CPA, identifies potential energy savings based on economic and technical potential, which are then rationalized with its customers' likely participation rates to determine the overall achievable potential. For the 20-year planning horizon Avista's achievable potential is 124.5 aMW. The Company's 2015 IRP highlights planned annual investments in energy efficiency measures that are projected at $11.6 million in 2016, increasing each year to $26 million in 2026, and increasing each year to more than $31 million in 2035.

2.12.3. Idaho Power

Idaho Power published its 2015 Integrated Resource Plan in June 2015. The 2015 IRP portfolio development analyzed a planning period from 2015 – 2034 to determine resource adequacy. Idaho Power relies on third party analysis to estimate the amount of achievable, cost-effective energy efficiency potential across the planning period. The amount of cumulative energy savings determined to be available across the planning period was 301 aMW. Of this energy savings, approximately 95% is expected to occur in the Idaho service area. The estimated energy saving have an estimated benefit of over $1.5 million in 2015 dollars. Total peak summer capacity reduction available through the Company's demand response program portfolio is targeted at 390 MW across the planning period. New energy efficiency opportunities come from a combination of new measures and program expansions. The cost to acquire energy efficiency from a total resource cost perspective will vary between averages of 10.3 cents per kilowatt hour (kWh) to 3.3 cents per kWh with an overall portfolio levelized cost of 6.1 cents per kWh. This compares to energy from new generation from natural gas plants at 7.5 cents, wind at 13.5 cents, a natural gas simple cycle combustion turbine at 21.9 cents, and small modular nuclear at 34.3 cents.

In 2015, Idaho Power's portfolio of energy efficiency program energy savings were 162,533 megawatt hours (MWh), including the estimated savings from the Northwest Energy Efficiency Alliance (NEEA). This is enough energy to power more than 14,000 average homes a year. The company's energy efficiency portfolio was cost effective from both the total resource cost (TRC) test and the utility cost (UC) test perspectives. The portfolio cost of acquisition for these energy savings was 1.7 cents per kWh from a utility cost perspective and 3.9 cent per kWh from a total resource cost perspective. Additionally, Idaho Power successfully operated all three of its demand response programs in 2015. The total demand reduction achieved from the company's programs was 367 megawatts (MW) from an available capacity of 385 MW.

2.12.4. PacifiCorp

PacifiCorp is aggressively pursuing energy efficiency in several sectors. Their 2015 IRP Update estimates that energy efficiency will represent the largest "resource" added to their system on an average capacity basis through 2034. They estimate average annual energy efficiency measure additions will be equivalent to about 135 MW, totaling nearly 2,740 MW of capacity over the next twenty years. Rocky Mountain Power has historically focused its demand-side efforts on programs that reduce peak demand, rather than programs that reduce overall energy consumption. Rocky Mountain Power provides a wide range of energy efficiency programs including a bundle of programs at 1.0 cent per kWh to 15.0 cents, and higher. This compares to energy only cost per kWh from new generation from their natural gas plants that range from 4.8 and 13.4 cents, wind from 2.9 to 6.8 cents, solar from 6.9 to 9.2 cents, and nuclear from 7.4 to 11.2 cents.

2.12.5. Bonneville Power Administration

Bonneville Power Administration works with its public utility customers to fund and implement energy efficiency programs, as well as track savings produced through those programs; this organization supplies over 96% of the wholesale electric power that is utilized by municipal and cooperative utility members of the Idaho Consumer-Owned Utilities Association. These organizations typically do not engage in an IRP process.

Table 2.1 BPA Energy Efficiency Savings: Idaho Municipal and Cooperative Utilities[97]

Calendar Year	Classification	Savings (kWh)
2011	Cooperative	15,815,983
2011	Municipality	11,081,385
2012	Cooperative	10,437,027
2012	Municipality	10,047,426
2013	Cooperative	15,836,185
2013	Federal - US (FWS)	8,266,369
2013	Municipality	7,089,270
2014	Cooperative	11,002,034
2014	Municipality	5,284,074
2015	Cooperative	12,630,466
2015	Municipality	9,047,906
2016*	Cooperative	5,723,030
2016*	Municipality	7,486,227
* CY 2016 savings haven't all been reported yet. Reported through 9/30/16		

2.12.6. Distributed Energy Resources

Distributed energy resources, also called on-site generation, dispersed or decentralized generation, are defined as "the integrated or standalone use of small-scale (usually less than 60 MW), modular, electricity generation or energy storage resources used by utilities, utility customers, and/or third parties in applications that benefit the electric system, specific end-use customers, or both".[98] These electrical generating facilities are used on-site or are located close to energy consumers.

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[97] Bonneville Power Administration.

[98] Electric Power Research Institute, Inc. "Distributed Energy Resources: Current Landscape and a Roadmap for the Future." http://mn.gov/commerce/energyfacilities/documents/EQBFileRegister/04-87-CON-Monticello/2004%20EPRI%20DEG%20Roadmap%20for%20the%20Future%20Final.pdf

Distributed energy resources include micro-turbines, small natural gas-fueled generators, combined heat and power plants, electricity storage, biomass, wind, and a significant portion of DER is solar or photovoltaic installations. In some cases, a distributed generation unit can be used as an alternative to connecting a customer to the grid. Retail electric utilities as well as their customers can use distributed energy resources to avoid or defer investments at the local level.

Utilities face increasing challenges as distributed energy resources continue to become more popular and consumer demand changes. The intermittent nature of distributed resources brings with it the prospect of imbalances in transmission and distribution grids, requiring complex and expensive integration and power-balancing mechanisms.

3. Outlook

3.1. UTILITY INTEGRATED RESOURCE PLANS

Idaho's investor-owned utilities work with local stakeholders to develop integrated resource plans that are filed every two years with the IPUC. IRPs forecast the demand for energy over the next 20 years and evaluate a variety of different resources to meet demand, including adding 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 Investor Owned Utility IRPs are available at the IPUC website and on their respective websites:

- Avista: https://www.avistautilities.com/inside/resources/irp/pages/default.aspx
- Idaho Power: https://www.idahopower.com/AboutUs/PlanningForFuture/irp/default.cfm
- Rocky Mountain Power: https://www.rockymountainpower.net/about/irp.html
- IPUC: http://www.puc.idaho.gov

3.2. FUTURE PLANNED DEVELOPMENT

Table 3.1 includes planned generation projects listed by Idaho's three investor-owned utilities in their 2015 IRPs or IRP updates. The actual resources may be located outside of Idaho. Additional renewable generation may be developed by independent power producers under PURPA or developed as net metering projects. Major investor owned utility planned transmission projects are listed in Table 3.2. Additionally, BPA is planning to build the Hooper Springs transmission line in Southeast Idaho, Idaho Falls Power is continuing to work on a 161 kV transmission expansion to serve its customers, and LS Power is exploring development of the Southwest Intertie Project, northern section.

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

Year	Investment Type	Nameplate Capacity (MW)	Utility
2020	Natural gas-fired Peaker	102	Avista
2021-2025	Thermal Upgrades	38	Avista
2027	Natural gas-fired Peaker	102	Avista

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

Year	Investment Type	Capacity (kV)	Utility
2021	Oquirrh to Terminal	345	PacifiCorp
Pending	Wallula to McNary	230	PacifiCorp
2019-2024	Windstar to Populus (Gateway West)	500	PacifiCorp
2019-2024	Populus to Hemingway (Gateway West)	500	PacifiCorp, IPCo
2025	Boardman to Hemingway	500	PacifiCorp, BPA, IPCo
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 2015 IRPs or IRP Updates

3.3. "SMART GRID"

Emerging "smart grid" technologies could make it possible for consumers to help balance their supply and demand. By providing information and tools to consumers to adjust electricity use in response to available supplies and costs, the capacity and flexibility of the power system could be enhanced, and may have a significant impact on Idaho energy networks. Smart grid development also may facilitate the deployment of electric vehicles that could improve the use of available generating capacity 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. Energy storage technologies can provide the ability to meet electrical demand whenever it is needed and have the potential to extend and optimize the operating capabilities of the grid. These systems can also help make renewable energy, whose variable power output often cannot be controlled by grid operators, smooth and dispatchable (turned on and off). Energy storage also can play a key role in providing overall grid security and allow critical infrastructure such as hospitals, police stations and other key services to remain operational during emergency situations.

In states that are experiencing tremendous growth in renewable energy resources such as solar and wind, there are significant developments concerning energy storage. These states see energy storage as a means to integrate the variable energy output of renewable generation resources into the utility grid. Additionally, the federal government has a number of programs promoting the adoption of more energy storage in the United States, particularly for resiliency purposes at military bases.

There are multiple ways of storing energy. Some examples of storage are batteries, that store energy chemically; some solar, that store energy thermally; capacitors, that store energy electrically; compressed air and pumped hydro, that store energy potentially; and flywheels, that store energy kinetically. Of note, the cost of energy storage infrastructure is not insignificant and utility-scale storage systems are only now being developed. Utility-scale storage technologies are the subject of considerable research and demonstration interest. Also, individual technology characteristics vary and may not be suitable for every application.

3.4.1. Chemical Storage

Batteries for grid scale energy storage are attracting significant interest across many regions in the US which has led to a gradual reduction in price. The response time and use of batteries for energy storage is usually for short- to mid-range time frames of seconds to a few hours. Due to differences in chemistries different battery types may be better suited for different grid services.

3.4.2. Thermal Storage

There are several thermal (heat) storage technologies that could provide energy storage at a utility level. Concentrated utility-scale solar power plants have the ability to store thermally and many use a special molten salt or other heat-retaining substance to store the sun’s energy as heat which can be released by generating steam that is run through turbines.

3.4.3. Potential Storage

Potential energy can be stored in either electrical or mechanical form. Capacitors and inductors can store energy electrically. The capacitor can store energy electrostatically between two conductors in a magnetic field created by current flowing in a superconducting coil.

Mechanical potential storage technologies include compressed air and pumped hydro. Compressed air storage uses excess energy (usually generated at night when demand is low) to run a compressor which pumps air at high pressure into an underground cavern or other confined space. When demand increases, the air is released, heated and expanded in an expansion turbine to drive an electrical generator. This same basic system can be applied in a pumped hydro storage system, where excess electricity is used to pump water from a lower to a higher reservoir and then, when more power is needed, let the water run back down through a turbine. Both pumped hydro and compressed air are best suited for response times of hours or longer.

3.4.4. Kinetic Storage

Another fairly well-known storage source is the flywheel. A flywheel energy storage system is a unique energy storage system where energy is maintained as rotational energy as the wheel or the rotors are accelerated with extreme speed to kinetically store energy for future use. This stored energy can then be easily extracted and used with the help of a generator which converts mechanical energy into electrical energy.

3.4.5. Energy Storage Approaches for the Electric Grid

There are numerous services that utility scale energy storage could potentially provide to the electrical grid[99]. Some of the following services require an organized energy market in order to perform transactions. However today, there is no organized energy market in the northwest so not all of the following services are feasible in Idaho.

- Electric Energy Time-shift (Arbitrage) – Involves purchasing inexpensive electrical energy during off-peak periods to charge the storage system then releasing the energy to be sold when costs are more favorable. Alternatively, the excess energy from variable output renewable energy generation can be stored and released later instead of having the generation curtailed because it is not needed.
- Electric Supply Capacity – Used to defer or reduce the need to buy new central station generation or the need to purchase energy in the wholesale electricity marketplace.
- Regulation – Used to reconcile momentary differences caused by fluctuations in generation and loads by damping out the difference.
- Spinning, Non-Spinning, and Supplemental Reserves – Act as reserve capacity that can be called upon when some portion of the normal electric supply resources become unavailable unexpectedly.
- Voltage Support – Help maintain voltage within specified limits either by strategically placing energy storage at central locations or near large loads.
- Black Start – Provide an active reserve of power and energy to energize transmission or distribution lines and provide station power to bring power plants on line after a failure of the grid.
- Load Following/Ramping Support for Renewables – Used for damping the variability of wind and photovoltaic systems.
- Frequency Response – Used for Frequency response which is very similar to regulation, described above, except it reacts to system needs in even shorter time periods of seconds to less than a minute when there is a sudden loss of a generation unit or a transmission line.
- Transmission Upgrade Deferral – Used to defer or avoid investment in transmission upgrades.
- Transmission Congestion Relief – Used to relieve transmission congestion that occurs when available, least-cost energy cannot be delivered to all or some loads because transmission facilities are not adequate to deliver that energy. Energy storage could be installed electrically downstream from the congested portion of the transmission system and discharged when congestion occurs.

[99] Sandia National Laboratories. "DOE/EPRI Electricity Storage Handbook." www.sandia.gov/ess/handbook.php

- Distribution Upgrade Deferral and Voltage Support – Used to defer or avoid investments needed to maintain adequate distribution capacity or to improve the voltage profile on a distribution line.
- Power Quality – Used to improve power quality at customer sites. Power quality includes improving variations in voltage and frequency, and reducing harmonics that can damage equipment.
- Power Reliability – Used to support customer loads when there is a total loss of power from the utility.
- Retail Energy Time-Shift – Similar to arbitrage, retail electric energy time-shift involves energy stored by the end user to reduce their overall costs for electricity. Customers charge the storage during off-peak, low-cost time periods then discharge the energy during on-peak, high-cost times.
- Demand Charge Management – Used by end users to reduce their overall costs for electrical service by reducing their demand during peak periods specified by the utility.

3.5. ELECTRIC VEHICLES

Electricity has been used as a transportation fuel since before the 20th century. However, electricity lost its preeminence once infrastructure was put in place to deliver inexpensive and abundant petroleum based fuels. Recent increases in gasoline prices, a desire to reduce foreign oil imports, advances in battery technology, and the environmental benefits of electric vehicles has increased the interest in electric vehicle (EV) ownership and has caused utilities to begin planning to produce and deliver energy for vehicle use.

In Idaho, EVs are fueled by electricity from a diversity of regional energy sources. Natural gas, hydro-electric power, and renewable resources provide significant reductions in pollutant emissions. Additionally, with the low electricity prices available in Idaho, the costs for charging an EV could be significantly less than the price of an equivalent amount of gasoline.[100]

Infrastructure is in-place to supply electricity to EVs, with EV owners having the ability to plug their cars into 120-volt outlets to recharge their batteries overnight. 240 volt charging stations can be installed at a reasonable price at residences or for fleet vehicles to provide quicker charging. Charging stations for public use can be installed in other places that are convenient for recharging vehicles.

As EV mileage range grows, so will the need for expanded EV charging infrastructure in Idaho. Many of the EVs currently registered in Idaho are limited to about 100 miles per charge, underscoring the need to add new charging opportunities, particularly DC “fast-charging” opportunities, on popular east-west and north-south travel routes in Idaho. The Idaho Transportation Department’s August 2016 “Idaho Alternative Fuels Corridors”

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

proposal to the U.S. Department of Transportation provides an excellent overview of how to most effectively "energize" Idaho's primary transportation routes.[101]

The Idaho National Laboratory is leading research into both EV charging technologies and the charging habits of EV owners. INL's extensive research can help inform decisions by state and local decision-makers, as well as those in the private sector, on how to most effectively deploy EV charging opportunities.

3.6. OTHER POTENTIAL ENERGY TECHNOLOGIES

Other technologies being examined include increased turbine efficiencies, hybrid systems and related technologies (such as rapid-start turbines), advanced nuclear reactor designs (including small modular reactors), advanced energy-related computer systems, sensors, controls and instrumentation, materials research, advanced biofuels, new and less expensive solar and photovoltaics.[102] The largest and least costly savings will likely come from energy efficiency improvements in buildings, appliances, transport, and industry as well as in power generation.

Some of the potential technologies being examined at the present time are summarized in the table below.

Table 3.3 Potential Energy Technologies

Supply Side	Demand Side
CCS fossil-fuel power generation	Energy efficiency in buildings, lighting, appliances
Nuclear power plants	Hybrid heat pumps
Onshore and offshore wind	Solar space and water heating
Biomass integrated-gasification combined-cycle and co-combustion	Energy efficiency in transport
Photovoltaic systems	Electric and plug-in vehicles
Concentrating solar power	H_2 fuel cell vehicles
Coal: integrated-gasification combined-cycle	CCS in industry, H_2, and fuel transformation
Coal: ultra-supercritical	Industrial motor systems
Second-generation biofuels	Smart grid and other demand response tools
Coal: integrated-gasification combined-cycle	
Unconventional fossil energy extraction	

[101] Idaho Transportation Department. "Idaho submits Alternative Fuels Corridor application to USDOT." http://apps.itd.idaho.gov/apps/MediaManagerMVC/transporter/2016/093016_Trans/093016_AltFuelsCorridors.html
[102] Idaho Strategic Energy Alliance. "Transportation Task Force Report 2015." https://oemr.idaho.gov/wp-content/uploads/2016/06/2015_Transportation_TF_Report.pdf

4. Energy Education

4.1. RESEARCH AT THE INL

Idaho National Laboratory is the state's second largest employer and the United States' lead national laboratory for nuclear energy. INL is a leading contributor to a variety of other clean energy technologies and is a tremendous resource for energy education and outreach.

DOE recently adopted the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative developed by the INL. GAIN focuses the resources of the national laboratories on developing private partnerships to accelerate the ability of innovative advanced reactor designs to succeed commercially. GAIN focuses on assisting new reactor technologies with a reactor test bed to overcome significant technical and regulatory development hurdles, especially with developing advanced fuels. GAIN also provides support for commercial and demonstration reactors at the INL in the same way INL supported siting the UAMPS reactor at the site.

INL, Boise State University, Idaho State University, University of Idaho, the University of Wyoming and private industry are partners in the **Center for Advanced Energy Studies** (CAES).[103] CAES serves as a public research center focused on collaboration that involves students in performing innovative, cost-effective, credible energy research leading to sustainable technology-based economic development.

CAES Energy Policy Institute (EPI) provides research on challenges such as the need for energy and environmental security and sustainable economic development.[104] EPI research focuses on both innovation and the more routine but critical mission of improving the design and implementation of energy policy. EPI seeks to inform and educate policymakers and other stakeholders to aid them in making decisions about energy. EPI does this through research publications (more than 35 to date), the development of decision support tools, policy roundtables, workshops, and the Western Energy Policy Research Conference. EPI has expertise in energy infrastructure siting and decision support tools, electricity transmission, nuclear energy, carbon capture and sequestration, and renewables.

In 2010, CAES launched an initiative to build the **Center for Energy Efficiency Research Institute** (CEERI) promoting efficient and effective use of energy resources through research, education and outreach. CEERI is developing energy efficiency concepts through research in applied technology and consumer behavior; providing specialized education for energy efficiency technicians, engineers and architects; evaluating existing energy-saving technologies; and creating 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 many partners including Boise State University, Idaho State University, the University of Idaho, Idaho Power, the Boise

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[103] Center for Advanced Energy Studies. "About Us." https://caesenergy.org/about-us/
[104] Center for Advanced Energy Studies. "About Us." http://epi.boisestate.edu/about-us/

Metro Chamber of Commerce, J.R. Simplot Company, Micron Technology, the National Resources Defense Council, the Idaho Office of Energy and Mineral Resources, and the Idaho National Laboratory.[105]

CEERI's goals include developing energy efficiency concepts through research in applied technology and consumer behavior; providing specialized education for energy efficiency technicians, engineers and architects; evaluating existing energy-saving technologies; and creating infrastructure for the accelerated transfer of ideas from the institute to the marketplace.

CAES' **Institute of Nuclear Science and Engineering** (INSE) was established in 2003. Under the INSE's administrative umbrella, the three public universities jointly focus on nuclear science and engineering education at the combined Idaho Falls campus. CAES researchers have access to a wide range of equipment including a high-end Microscopy and Characterization Suite and the Idaho State University Accelerator Center. INSE supports the goals and objectives of national and international nuclear energy programs. Together, the CAES partner universities make up one of the nation's largest nuclear science and engineering programs.

4.2. UNIVERSITIES, COLLEGES, AND TECHNICAL TRAINING

Idaho's three public research universities are all heavily engaged in educating tomorrow's energy workforce.

For example, within **Boise State University**, elective courses are offered in energy efficiency and renewable energy that are designed for the non-scientist. By providing students outside the science and engineering fields with a solid grounding in energy fundamentals, Boise State is helping to educate a savvy generation of energy consumers, policymakers, teachers and business leaders.

Understanding the performance of materials in existing energy systems and developing advanced materials for new energy applications are key factors in meeting future energy needs. 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.[106]

The Department of Biological and Agricultural Engineering at the **University of Idaho** houses the Biodiesel Fuel Education Program. The goal of the program is to provide unbiased, science-based information about biodiesel, and to assist in the development of educational tools for a national biodiesel outreach program. The program develops and

[105] CAES Energy Efficiency Research Institute. "CEERI." https://ceeri.boisestate.edu/
[106] Boise State University. "Micron School of Materials Science and Engineering." http://coen.boisestate.edu/mse/

distributes educational materials that support advances in biodiesel infrastructure, technology transfer, fuel quality, fuel safety, and increasing feedstock production.

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 its small cities and towns. The Institute contributes to the sustainability of this environment through the development of clean vehicles, alternative fuels, efficient traffic control systems, safe transportation systems, sound infrastructure, and the policies that support these systems.[107]

Idaho State University offers bachelor's and master's degree programs in Nuclear Science and Engineering that prepare students for advanced placement in the nuclear industry in commercial, research or development areas. The University's goal is to prepare graduates to excel in a wide range of careers in nuclear engineering associated with nuclear reactors, the nuclear fuel cycle, and other applications of nuclear technology.

The College of Technology at Idaho State University has established the **Energy Systems Technology and Education Center** (ESTEC) in Pocatello. 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.[108]

Educating tomorrow's energy workforce is also a major focus of Idaho's community colleges. At the **College of Southern Idaho** (CSI) in Twin Falls, instructors have been training the next-generation energy workforce with education and training in renewable energy since 1981. CSI's **Renewable Energy Training Center** provides a comprehensive curriculum designed to give students the skills necessary to work in any of the renewable energy fields.[109]

CSI received a $4.4 million federal grant in early 2011 from the U.S. Economic Development Administration to help build a nearly $7 million technology center in Twin Falls. The **Applied Technology and Innovation Center** provides a consolidated home for CSI's renewable energy programs. Completed in 2014, the 29,600-square-foot energy efficient center houses the college's expanding HVAC, environmental technology, wind

[107] University of Idaho. "National Institute for Advanced Transportation Technology." www.uidaho.edu/engr/research/niatt
[108] Idaho State University. "College of Technology." www2.isu.edu/estec/
[109] College of Southern Idaho. "Environmental Technology." http://agriculture.csi.edu/enviroTech/

energy and machine technology programs complete with classrooms, hands-on labs and administrative offices.[110]

Eastern Idaho Technical College (EITC) is also training the labor force that will build, operate and maintain the energy systems of the future. EITC launched its **Energy Systems Technology Program** in 2010. The College provides the first year of this two-year program at the Idaho Falls EITC campus, and 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.

Another educational option in Idaho is the **Northwest Lineman College** based in Meridian, which addresses the significant need in the industry to prepare lineman apprentices. The college educates students in construction, maintenance and operation of the electrical grid, provides lineman certification for individuals already working in the trade, and develops customized training services to 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.[111]

[110] Lochsa Engineering. "CSI Applied Technology & Innovation Center." www.lochsa.com/csi-applied-technology-innovation-center
[111] 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
Idaho Power Company	800-488-6151
Intermountain Gas	800-548-3679
Rocky Mountain Power	888-221-7070
Questar Gas	801-324-5111

Rural Electric Cooperatives

Bonneville Power Administration	800-282-3713
Clearwater Power	208-798-5204
East End Mutual Electric	208-436-9357
Fall River Rural Electric	208-652-7431
Farmer Electric	208-436-6384
Idaho County Light and Power	208-983-1610
Kootenai Electric Cooperative	208-765-1200
Lost River Electric Cooperative	208-588-3311
Lower Valley Power and Light	307-886-3175
Northern Lights Incorporated	208-263-5141
Raft River	208-645-2211
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	406-683-2327

Municipal Electric Utilities

Albion Light and Water Plant	208-673-5351
Bonners Ferry Light and Water	208-267-3105
Burley Municipal Distribution System	208-678-2538
Declo Municipal Electric Department	208-654-2124
Dubois Electric System	208-374-5241
Heyburn Electric Department	208-678-8158
Idaho Falls Power	208-529-1430
Minidoka Electric Department	208-531-4101
Plummer Electric Department	208-686-1422
Rupert Electric Department	208-436-9608
Soda Springs Electric Light and Power	208-547-2600
Weiser Water and Light Department	208-414-1965

Definitions

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: A power marketing and electric transmission agency of the U.S. government with headquarters in Portland, Oregon.

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

Gigawatt-hour: 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: 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.)*