



Hawaii

State Profile and Energy Estimates

Profile Analysis [Print State Energy Profile](#) (overview, data, & analysis)

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Overview

Hawaii's islands stretch more than 1,500 miles across the central Pacific Ocean, from the Big Island of Hawaii in the southeast to the Kure Atoll in the northwest. The eight main islands, and the more than 100 uninhabited reefs, shoals, and atolls, are farther from a major landmass than any other island group on earth.¹ Located 1,800 miles north of the equator, Hawaii is tropical, but its climate is moderated by steady trade winds and the surrounding ocean. Extremes of heat, cold, and rainfall occur in the mountains, but weather at low altitudes is generally mild, with little variation year-round.^{2,3} Most of the state's population lives on Oahu. On all the Hawaiian islands, residents are clustered in the coastal areas.⁴

Isolated by the Pacific Ocean, Hawaii is the most petroleum-dependent state in the nation.

Hawaii's geographic isolation makes its energy infrastructure unique among the states. In recent years, more than one-tenth of the state's gross domestic product has been spent on energy, most of that for imported crude oil and petroleum products.^{5,6} More than four-fifths of Hawaii's energy comes from petroleum, making it the most petroleum-dependent state in the nation.^{7,8,9} The state of Hawaii and the U.S. Department of Energy entered a partnership in 2008 called the Hawaii Clean Energy Initiative (HCEI), aimed at reducing the state's dependence on petroleum and optimizing use of sustainable local energy sources.¹⁰ In 2015, Hawaii became the first state to set a goal of obtaining 100% of its electricity from sustainable renewable sources. The state plans to reach this goal by 2045.¹¹

Hawaii's largest industry is tourism. Major economic sectors also include the U.S. military and agriculture.^{13,13} Transportation accounts for about half of all energy consumed.¹⁴ Overall, Hawaii's economy is not energy intensive,¹⁵ and per capita energy consumption is among the lowest in the nation.¹⁶

Petroleum

Hawaii does not produce petroleum¹⁷ and has no proved petroleum reserves.¹⁸ The state has two crude oil refineries, located in the Honolulu port area on Oahu. Both can produce a broad range of refined petroleum products¹⁹ and have been supplying almost all of Hawaii's demand.²⁰ Refinery feedstock is most often light sweet crude oil imported from Pacific Rim producers,^{21,22} although crude oil is also imported from Africa and the Middle East.²³ Alaska used to be a major crude oil

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supplier to Hawaii, but its production has declined.^{24,25} Refined petroleum products, chiefly jet fuel and propane, are also imported from Asia, Canada, and the Caribbean.²⁶

Hawaii has no inter-island pipelines. Crude oil is offloaded to storage tanks in the Oahu refinery area through offshore mooring systems, and refined products are loaded at Honolulu harbor terminals onto fuel barges for distribution to other islands.²⁷ State petroleum consumption patterns are changing. Hawaii's electricity generators and its synthetic gas supplier are seeking economic alternatives to refined petroleum products, and the state is exploring options for maintaining needed product supplies if one or both Honolulu refineries should shut down.²⁸

The transportation sector consumes about six-tenths of all petroleum in Hawaii, followed by the electric power sector, which consumes nearly three-tenths.^{29,30} Jet fuel and motor gasoline each account for about two-fifths of transportation fuels consumed. Because of significant demand from military installations and commercial airlines, jet fuel makes up a larger share of total petroleum consumption in Hawaii than in any other state except Alaska.^{32,32} A major goal of the HCEI is to displace 70% of petroleum-based ground transportation fuels by 2030.^{33,34,35} All ethanol for blending with motor gasoline is shipped in, usually from the U.S. mainland or from Brazil.³⁶ Hawaii had hoped to spur creation of a local ethanol industry, using locally grown feedstocks, with a 2006 requirement that all motor gasoline be blended with 10% ethanol, but no ethanol refineries have been built in the state. As of 2016, Hawaii will eliminate the statewide ethanol blending requirement.³⁷

Natural gas

Hawaii produces no natural gas³⁸ and has no proved natural gas reserves.³⁹ Hawaii is one of two states producing synthetic natural gas called syngas; the other is North Dakota.⁴⁰ Syngas is produced in an Oahu processing plant using naphtha feedstock from a local refinery.^{41,42} The syngas is delivered by pipeline to parts of Oahu. Customers in rural areas of Oahu and on other islands, who are not connected to utility Hawaii Gas's distribution system, use propane. The natural gas utility is diversifying its supply with both liquefied natural gas (LNG) and renewables-based syngas.⁴³ As part of the state's shift to renewables, Hawaii is encouraging the development of synthetic gas production using local biomass as a feedstock.^{44,45}

Hawaii's first LNG shipment arrived in April 2014 in a standardized cryogenic container from a liquefaction plant in California. Standardized shipping containers can serve markets that do not have terminals for LNG tankers. The LNG was regasified and injected into the Hawaii Gas distribution system, becoming the first non-synthetic natural gas ever put into the system.⁴⁶ Hawaii Gas is receiving monthly shipments of containerized LNG⁴⁷ and is evaluating the feasibility of bulk imports by tanker, possibly using a floating regasification unit, starting in 2019.^{48,49} The electric power utility, Hawaiian Electric Co., is exploring the conversion of up to eight of its petroleum-fueled generating plants on five islands to use LNG, which would be delivered either in standardized containers or through tanker terminals if LNG consumption is large enough.^{50,51,52} The two utilities are also part of a public-private consortium considering a coordinated statewide approach to bulk LNG imports.⁵³

With its limited supply and limited distribution network, Hawaii has the lowest total natural gas consumption in the nation and the lowest per capita consumption.^{54,55} The commercial sector, which includes hotels and restaurants, consumes about two-thirds of all the synthetic natural gas produced in Hawaii.⁵⁶ The residential sector accounts for less than one-fifth of consumption, in part because very few Hawaiians rely on syngas as their primary fuel for home heating.⁵⁷

Until LNG was shipped to Hawaii in 2014, the state's only source of natural gas was synthetic natural gas produced from a naphtha feedstock.

Coal

Hawaii does not produce coal⁵⁸ and has no demonstrated coal reserves.⁵⁷ Coal use began in Hawaii in the 1980s and was seen then as a way to reduce the state's dependence on petroleum in both the industrial sector and the electric power sector.⁶⁰ Coal is shipped in by ocean freighter, usually from Indonesia, for Hawaii's single operating coal-fired electricity generating plant, a 180-megawatt facility on Oahu.^{61,62,63,64} Coal is transported by conveyor belt from a marine unloading terminal to the plant.⁶⁵ The plant is able to burn wastes such as wood chips, motor oils, and tires along with coal.^{66,67} A small amount of coal is shipped to Hawaii, typically from Colorado, for industrial uses, mainly to supplement agricultural waste burned to power sugarcane processing operations.^{68,69,70}

Electricity

Petroleum-fired power plants have supplied more than three-fourths of Hawaii's net electricity generation in the past 20 years.⁷¹ In 2014, for the first time, net generation from petroleum slipped below 70%, and renewable sources—mainly wind, biomass, and geothermal generators—supplied 13% of the state's electricity from utility-scale generators. Coal supplied most of the remaining electricity.⁷² Use of small-scale distributed renewables, like rooftop solar panels, has increased, and if net generation from distributed sources is included, Hawaii generated more than 21% of its electricity from renewable sources in 2014.⁷³

Hawaii's electric utility is exploring the feasibility of converting some or all of its petroleum-fired generating units to LNG, both to reduce costs and to comply with tightening federal emissions standards.⁷⁴ Hawaii's islands have six separate electricity grids that are not connected by undersea electric transmission cables. Each island must generate its own power. Hawaii is encouraging initiatives to interconnect the island grids to enable more efficient power generation and to support increased development of renewable energy resources.^{75,76,77,78}

The state's heavy dependence on imported petroleum and the isolated island grids result in Hawaii's having the highest retail electricity prices of any state in the nation.^{79,80} Hawaii's electricity demand is among the lowest in the nation, both in total amount consumed and in per capita consumption.^{81,82,83} About 3 in 10 households in Hawaii use electricity as their primary energy source for home heating, but, with the mild tropical climate, heating is rarely needed, and nearly two-thirds of households have no heating system at all.⁸⁵

Hawaii's dependence on petroleum and its isolated island grids result in the highest electricity prices in the nation.

Renewable energy

Hawaii's renewable portfolio standard (RPS), as amended by the legislature in 2009, requires 40% of electricity to be generated by renewable sources by 2030.⁸⁶ In June 2015, the legislature extended the RPS to 2045 and required 100% of electricity to come from renewable resources by that year, making Hawaii the first state in the nation to set a target of 100% renewable electricity.⁸⁷ State regulators also set separate energy efficiency portfolio standards, which are aimed at reducing anticipated electricity consumption 30% by 2030.⁸⁸ The overall state goal is 70% clean energy, counting both renewable sources and efficiency, by 2030, and 100%

Hawaii is the first state to set a goal of producing all its electricity from

clean energy by 2045.^{89,90} Technologies recognized in the RPS include: wind; solar thermal and photovoltaic (PV); geothermal; biogas including landfill methane; biomass including municipal solid wastes; hydroelectricity; seawater-chilled air conditioning; and wave, tidal, and ocean energy.^{91,92}

renewable sources.

Hawaii has substantial renewable resources throughout the island chain.⁹³ Utility-scale wind potential is found both onshore⁹⁴ and offshore.⁹⁵ The state's six commercial wind farms are on Oahu, Maui, and the Big Island of Hawaii.⁹⁶ Smaller wind projects power a water treatment plant⁹⁷ and an irrigation system⁹⁸ on the Big Island. A 400-megawatt wind project has been proposed for federal waters off Oahu.⁹⁹

Hawaii has significant solar resources¹⁰⁰ and is generating increasing amounts of electricity from distributed solar PV installations on all the inhabited islands.^{101,102} Hawaii's capital, Honolulu, has more solar capacity installed per capita than any other U.S. city, and the state is a leader in solar installations per capita.¹⁰³ At the end of 2014, Hawaii had 381 megawatts of small-scale solar capacity installed on more than 51,000 residential and commercial properties and 33 megawatts installed at nine utility-scale facilities on Oahu, Kauai, and Lanai. Solar power provided 29% of Hawaii's renewable electricity generation. Hawaii has used net metering and tax incentives to encourage installation of more distributed solar facilities, and state regulators and grid operators are balancing increasing numbers of solar connection requests with grid stability requirements.¹⁰⁴

With the islands' small grids, some larger projects using variable wind and solar technologies are incorporating energy storage or continuous voltage regulation to smooth out variability.^{105,106,107} The 6-megawatt Port Allen project on Kauai includes a 3-megawatt battery energy storage system.¹⁰⁸ Government agencies and private sector firms are developing energy storage technologies, including batteries and hydrogen fuel cells, to support increased renewable energy penetration.^{109,110} Since 2010, state building codes require all water heaters in new single-family homes to be solar-powered.¹¹¹ One small solar thermal power plant on the Big Island closed in 2014.^{112,113} Solar thermal technologies for seawater desalination are also in development.^{114,115}

Biomass, mainly agricultural wastes such as bagasse from sugarcane, has long been used in Hawaii to generate heat and electricity. The state's agricultural sector is shrinking, and more biomass is coming from municipal solid waste.¹¹⁶ The H-POWER plant provides 10% of Oahu's electricity from municipal solid waste,¹¹⁷ and the plant is being expanded from 46 to 73 megawatts.¹¹⁸ A former coal-fired plant north of Hilo on the Big Island is being refurbished to run on local plant biomass, and other biomass electricity generators are operating or being developed on Oahu, Kauai, and Maui.^{5,120} Hawaii also aims to substitute sustainably produced biofuels for some petroleum-based fuels at utility generating plants.¹²¹ The 110-megawatt Campbell Industrial Park Generating Station, believed to be the world's largest commercial electricity generator fueled exclusively with sustainable biofuel, was brought into service on Oahu in 2010.^{122,123} The HCEI says more use of biomass and biofuels can also help boost the state's agricultural sector.¹²⁴

In 2014, Hawaii was one of seven states with operating commercial-scale geothermal power production.¹²⁵ Its single geothermal generating plant is located on the Kilauea Volcano on the Big Island and supplied about one-fourth of the island's electricity in 2014. State utilities are seeking more projects to tap the earth's heat on the Big Island, Maui, and Oahu.^{127,127}

Hawaii does not have rivers appropriate for hydroelectric dams. A handful of small hydroelectric turbines use run-of-river flow at sites on Maui and the Big Island, and studies have identified nearly 50 sites for additional small-scale projects. Kauai's electric cooperative is exploring raising the island's hydropower generation from 8% to 20% of consumption.^{128,129} The state is also looking to the surrounding ocean for renewable energy.^{130,131} The U.S. Navy has been testing wave energy technologies to supply power to its island bases.^{132,133} Studies indicate wave energy could provide anywhere from about one-

third to all of the electricity Hawaiians use, depending on technological advances.^{134,135,136} Ocean thermal energy technology, which generates electricity through temperature differences between warm, shallow waters and cool, deep waters, is being explored.¹³⁷ District cooling, drawing up cold deep sea water to chill air-conditioning units, is being commercially developed in Honolulu.¹³⁸

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