RENEWABLE ENERGY ATLAS OF ALASKA





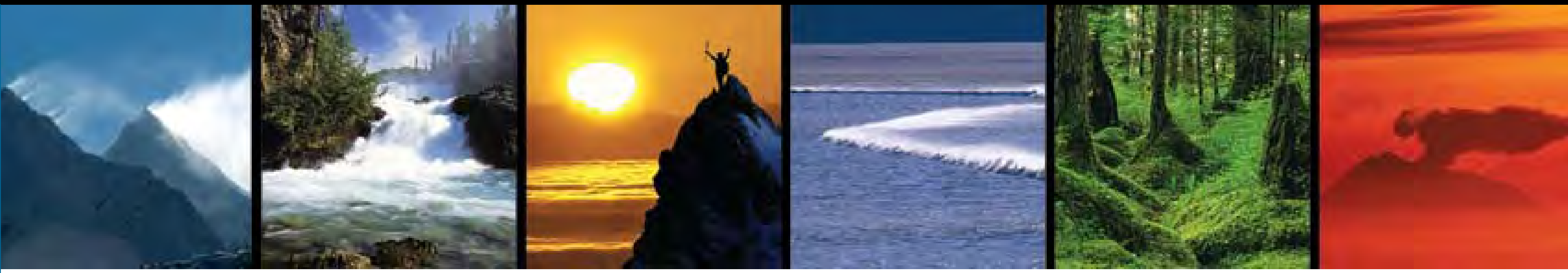

A Guide to Alaska's Clean, Local, and Inexhaustible Energy Resources

August 2011

Why Renewable Energy is Important

As concerns about rising fossil fuel prices, energy security, and climate change increase, renewable resources play a key role in providing local, clean, and inexhaustible energy to supply Alaska's growing demand for electricity, heat, and transportation fuel. Because there are limited or no fuel costs associated with generating electricity from renewable sources, more Alaskans are looking to resources like wind, geothermal, hydropower, tides, waves, solar, and biomass to hedge against the price volatility of natural gas and diesel.

Renewable resources, over the long term, can provide energy at a known cost that is far less susceptible to the uncertainties inherent in relying on fossil fuels. With some of the best renewable energy resources in the country, Alaska has an opportunity to be a leader in their development and bring new revenue streams into the state's economy.



The Renewable Energy Atlas of Alaska is designed as a resource for the public, policy makers, advocates, landowners, developers, utility companies and others interested in furthering the production of heat, electricity and fuels from wind, solar, biomass, geothermal, hydro, and ocean power resources. Produced with the use of GIS technology, this Atlas brings together renewable resource maps and data into a single comprehensive publicly available document. The maps contained in this Atlas do not eliminate the need for on-site resource assessment. However, they do provide an estimate of the available resources.

The Atlas is posted on the Alaska Energy Authority website, www.akenergyauthority.org, and Renewable Energy Alaska Project (REAP) website, www.realaska.org. The revised map data will be available by December 2011 in interactive format at the State of Alaska's energy inventory web site at www.akenergyinventory.org.

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Below, left to right: Marsh Creek LLC, Cordova Electric Cooperative, Alaska Energy Authority, Todd Paris/UAF, Alaska Energy Authority, Chena Hot Springs Resort.

Alaska's Energy Infrastructure

With 16% of the country's landmass and less than 0.3% of its population, Alaska's unique geography has driven development of its energy supply infrastructure—power plants, power lines, natural gas pipelines, bulk fuel "tank farms" and related facilities. Alaska has over 150 remote, stand-alone electrical grids serving villages as well as larger transmission grids in Southeast Alaska and the Railbelt. The Railbelt electrical grid follows the Alaska Railroad from Fairbanks through Anchorage to the Kenai Peninsula and provides 80% of the state's electrical energy.

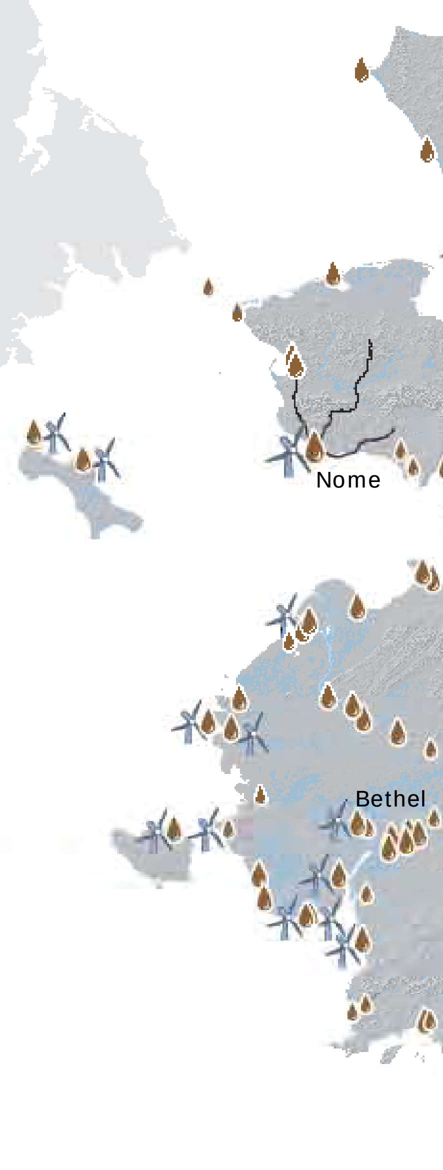
Powered by wood until 1927, Fairbanks switched to coal after the Railroad provided access to Nenana and Healy coalfields. Until recently, the Anchorage area has enjoyed relatively low-cost heating and power since expansion of the Eklutna hydro plant in 1955 and the development of major Cook Inlet oil and gas discoveries in the 1960s.

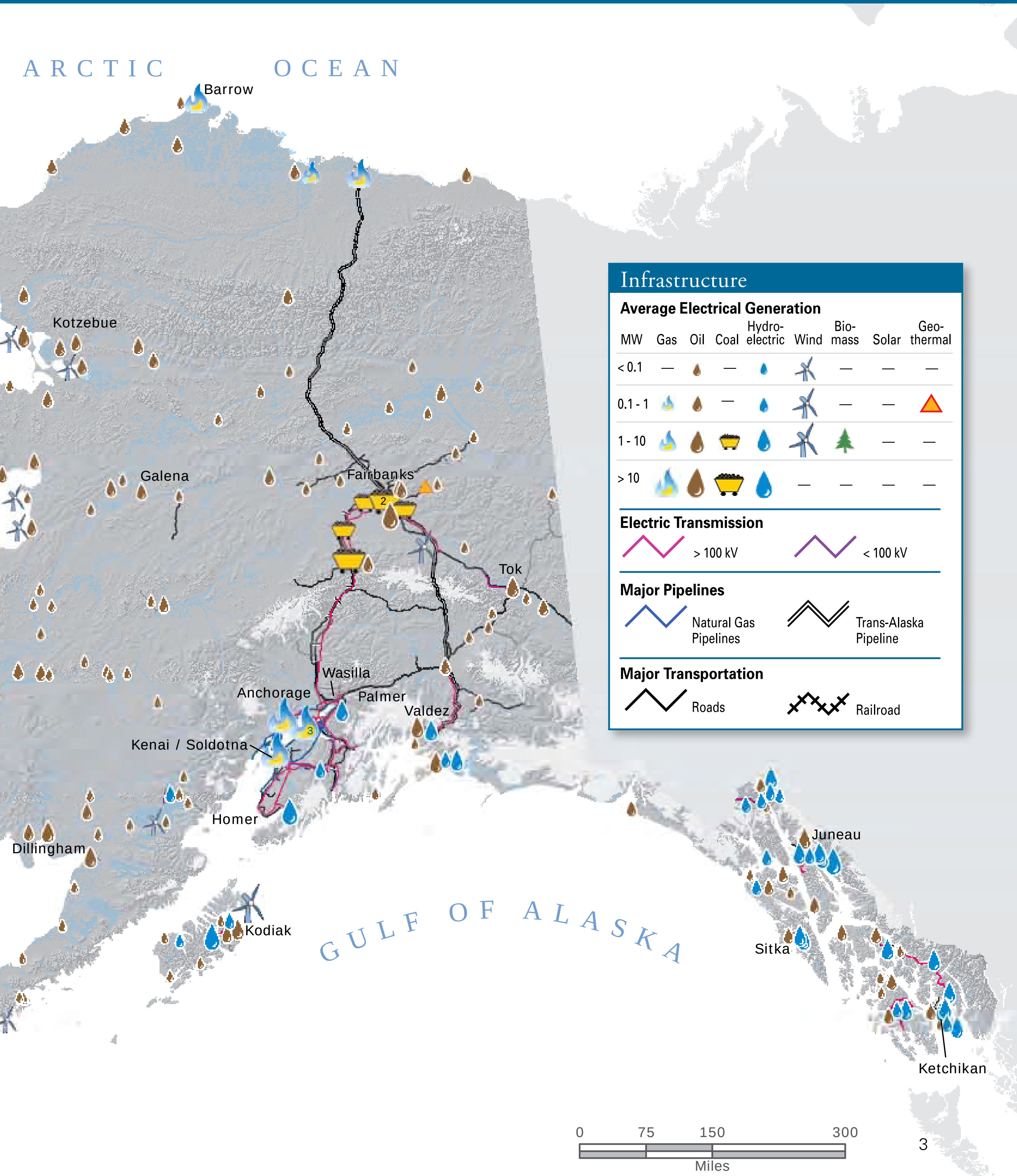
Completed in 1986, the state-owned Willow - Healy Intertie now provides a diversity of energy sources to the six Railbelt electrical utilities.

Approximately 70% of the Railbelt's electricity comes from natural gas generators. Major power generation facilities along the Railbelt include Chugach Electric Association's 430 MW natural gas-fired plant west of Anchorage at Beluga, Anchorage Municipal Light and Power's 266 MW natural gas-fired plant in Anchorage, Golden Valley Electric Association's 129 MW facility near Fairbanks fueled by naptha from the Trans-Alaska Pipeline, and the 126 MW state-owned Bradley Lake hydroelectric plant near Homer. In total, just over 1,400 MW of installed power generation capacity exists along the Railbelt to serve an average load of approximately 600 MW and a peak load of over 800 MW.

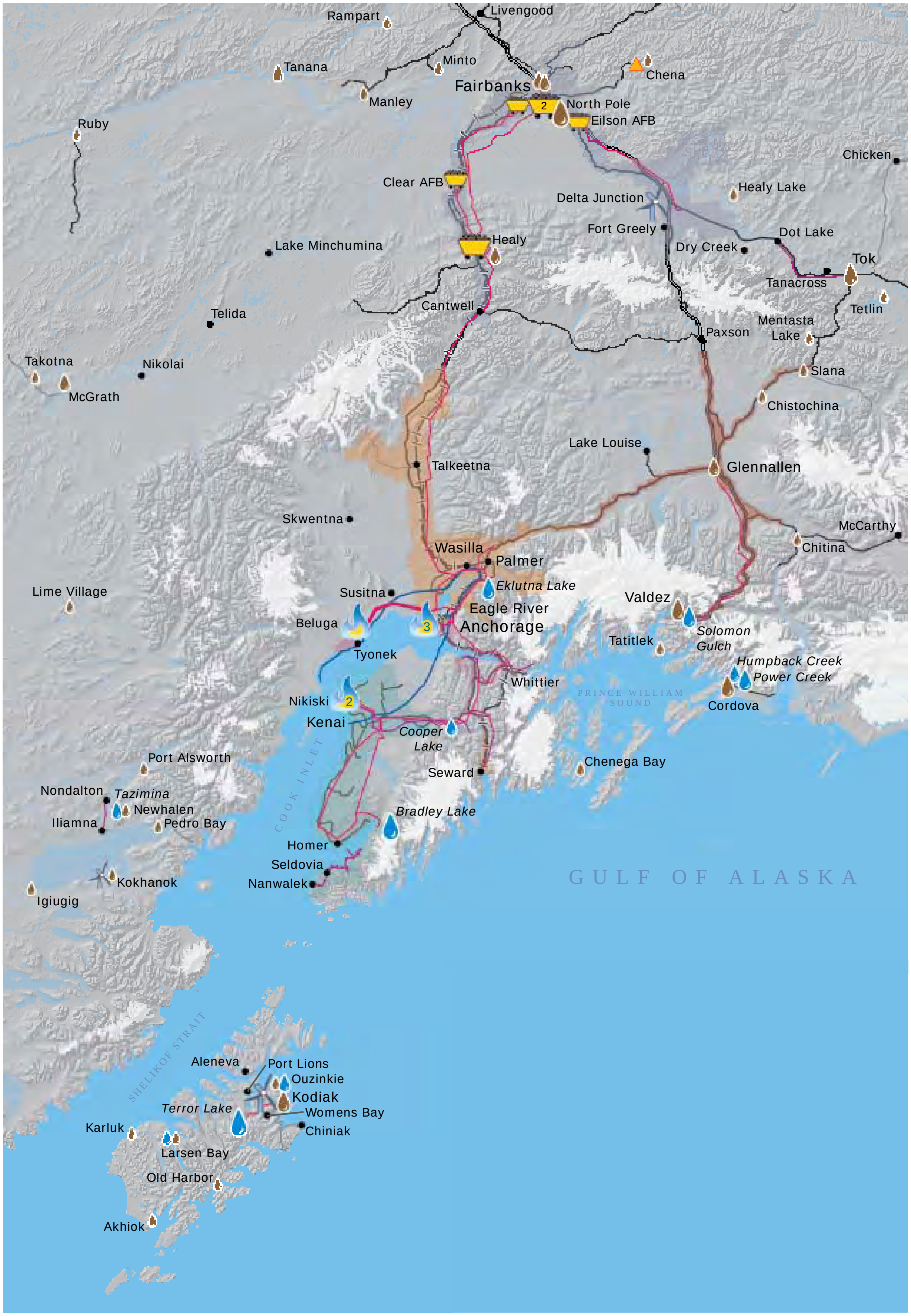
During the early 1980s, the state completed four hydropower projects to serve Ketchikan, Kodiak, Petersburg, Valdez, and Wrangell. With a total generating capacity of 76 MW, the "Four Dam Pool" projects displace the equivalent of approximately 20 million gallons of diesel fuel per year for power production. Other major hydro facilities supply the communities of Juneau and Sitka.

With some notable exceptions, most of the rest of Alaska's power and heating needs are fueled by diesel that is barged from Lower 48 suppliers or transported from petroleum refineries in Nikiski, North Pole, and Valdez. After freeze-up, many remote communities must rely on the fuel that is stored in tank farms, or pay a premium for fuel flown in by air tankers. Currently state and federal authorities are supporting a large program to fix leaky tanks, improve power generation and end use efficiency, and exploit local renewable energy sources such as wind, biomass, and hydro.



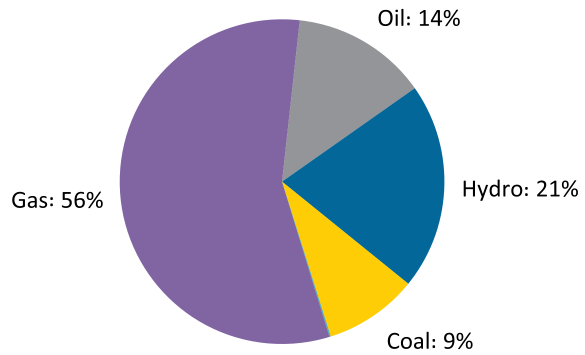

ARCTIC OCEAN
Barrow
Kotzebue
Galena
Fairbanks
Tok
Wasilla
Anchorage
Palmer
Valdez
Kenai / Soldotna
Homer
Dillingham
Kodiak
GULF OF ALASKA
Juneau
Sitka
Ketchikan
Infrastructure
Average Electrical Generation
MW
Gas
Oil
Coal
Hydro-electric
Wind
Bio-mass
Solar
Geo-thermal
< 0.1
0.1 - 1
1 - 10
> 10
Electric Transmission
> 100 kV
< 100 kV
Major Pipelines
Natural Gas Pipelines
Trans-Alaska Pipeline
Major Transportation
Roads
Railroad
0
75
150
300
Miles

Infrastructure: Fairbanks to Kodiak

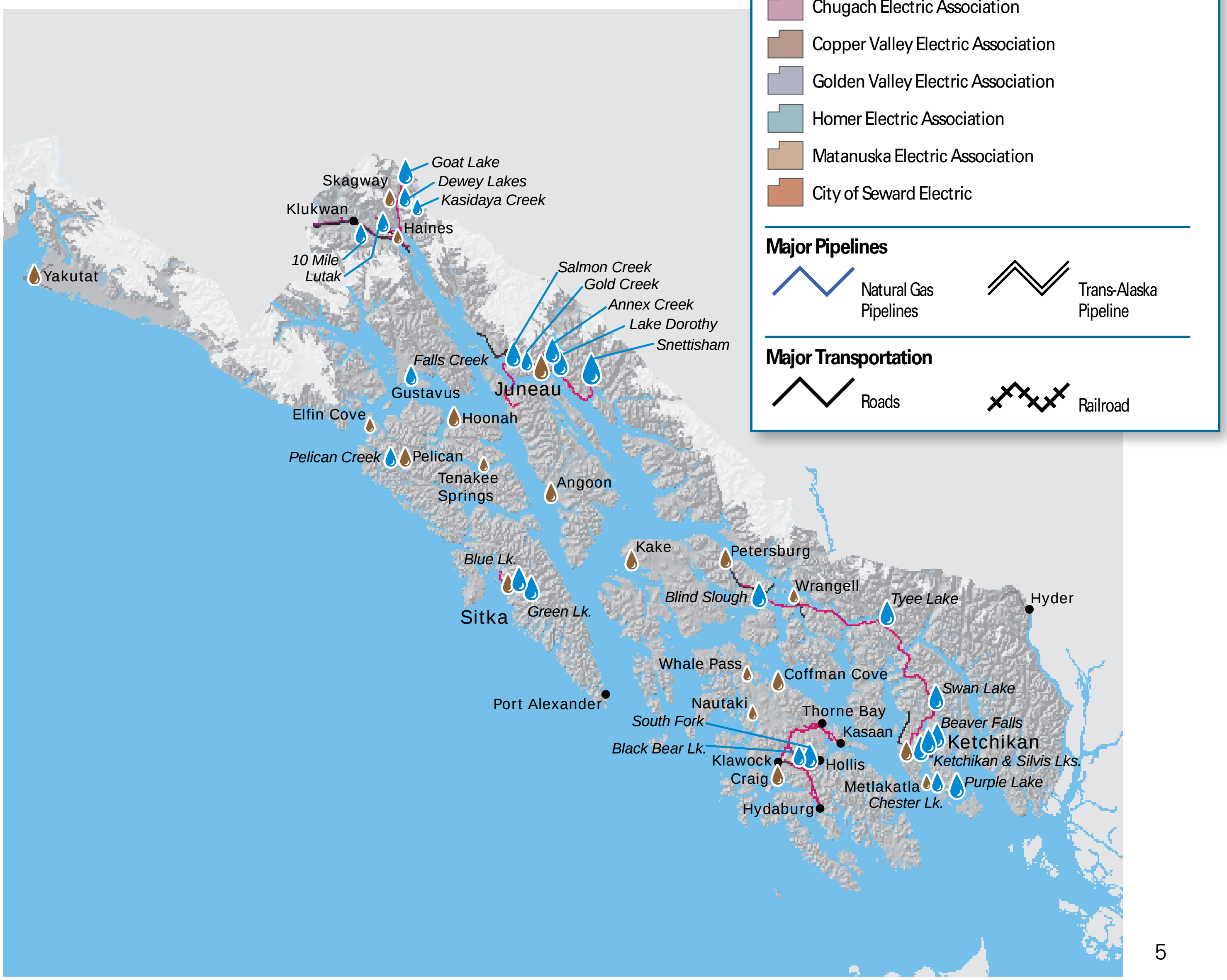


Infrastructure: Southeast Alaska

Average Statewide Electrical Generation in Alaska by Energy Source - 2003 - 2009



Wind, solar, and biomass account for 0.1% of Alaska's electrical generation.



Biomass

Alaska's primary biomass fuels are wood, sawmill wastes, fish byproducts, and municipal waste.

Wood remains an important renewable energy source for Alaskans with thousands of cords of wood - in the form of cordwood, chips and pellets - burned each year for space heating.

Closure of the major pulp mills in Sitka and Ketchikan in the 1990s ended large-scale, wood-fired power generation in Alaska. However, the price of oil has increased interest in using sawdust and wood wastes for small-scale power production as well as fuel for lumber drying and space heating.

In 2010, the Tok School installed a chip-fired boiler to heat the school that will displace approximately 65,000 gallons of fuel oil. Also in 2010, Sealaska Corporation installed the state's first large-scale pellet boiler at its corporate headquarters in Juneau. Additional wood-fired boilers have been installed in Craig, Kasilof, Dot Lake, Tanana, Coffman Cove, and Gulkana, and more than 40 projects in other communities are being considered.

The manufacture of wood pellets is of growing interest in Alaska. Both small and large-scale production facilities are operational in the state. The largest facility, Superior Pellets of North Pole, has estimated the plant is capable of producing an estimated 30,000 tons per year.

Alaska Energy Authority

Raw fish oil and fish oil biodiesel from the Unisea plant in Dutch Harbor.

Groundfish processors in Unalaska, Kodiak, and other locations produce approximately 8 million gallons of pollock oil every year as a byproduct of fishmeal plants. Much of the oil is used as boiler fuel for drying the fishmeal or exported to Pacific Rim markets for livestock and aquaculture feed supplements and other uses. In 2001, with assistance from the State of Alaska, processor UniSea Inc. conducted successful tests of raw fish oil/diesel blends in a 2.2 MW engine generator.

Local groups in Anchorage and other communities are converting waste fry oil into fuels for heating and transportation. Alaska Waste opened the first large-scale biodiesel plant in Alaska in 2010, producing up to 250,000 gallons annually from waste vegetable oil from local restaurants. Alaska Waste plans to use the biodiesel to fuel up to 20% of its vehicle fleet.

Alaskans generate approximately 650,000 tons of garbage per year. In North Pole, Chena Power is developing a 400 kW power plant that will burn 4,300 tons of waste paper and other biomass annually. The Municipality of Anchorage and its partners are moving forward on plans to convert methane gas from the city's landfill into electricity. The landfill gas project could produce up to 3 MW of power, yielding the equivalent energy of 2 million gallons of diesel per year, or enough to supply 3,000 homes along the Railbelt.

It is also possible that Alaska's agricultural lands may be used to produce energy crops, such as rapeseed, to produce biodiesel.


ARCTIC OCEAN
Barrow
Deadhorse
Kotzebue
Galena
Ft Wainwright
Fairbanks
North Pole
Salcha
Delta Junction
Tok
McGrath
Talkeetna
Red Devil
Chuathbaluk
Copper Center
Willow
Sutton
Wasilla
Palmer
Eagle River
Soldotna
Anchorage
Valdez
Nikiski
Kenai
Cordova
Whittier
Kasilof
Cooper Landing
Ninilchik
Anchor Pt
Seward
Dillingham
Homer
Naknek
Ekuk
Egegik
Larsen Bay
Kodiak
Alitak Bay
Chignik
GULF OF ALASKA
Yakutat
Haines
Excursion Inlet
Juneau
Gustavus
Hoonah
Tenakee
Pelican
Kake
Petersburg
Wrangell
Sitka
Naukati
Coffman Cove
Edna Bay
Klawock
Craig
Thorne Bay
Ketchikan
0
75
150
300
Miles
Biomass
Woody Biomass tons/acre
1 - 5
5 - 15
15 - 30
30 +
Sawmills
Communities with at least one sawmill
Fish Processors
Communities with at least one major fish processor
Landfills
Communities with at least one Class I landfill

Geothermal

Alaska has four distinct geothermal resource regions: 1) the Interior Hot Springs, which run east-west from the Yukon Territory of Canada to the Seward Peninsula, 2) the Southeast Hot Springs, 3) the Wrangell Mountains and 4) the "Ring of Fire" volcanoes, which include the Aleutians, the Alaska Peninsula, and Mt. Edgecumbe on Kruzof Island.

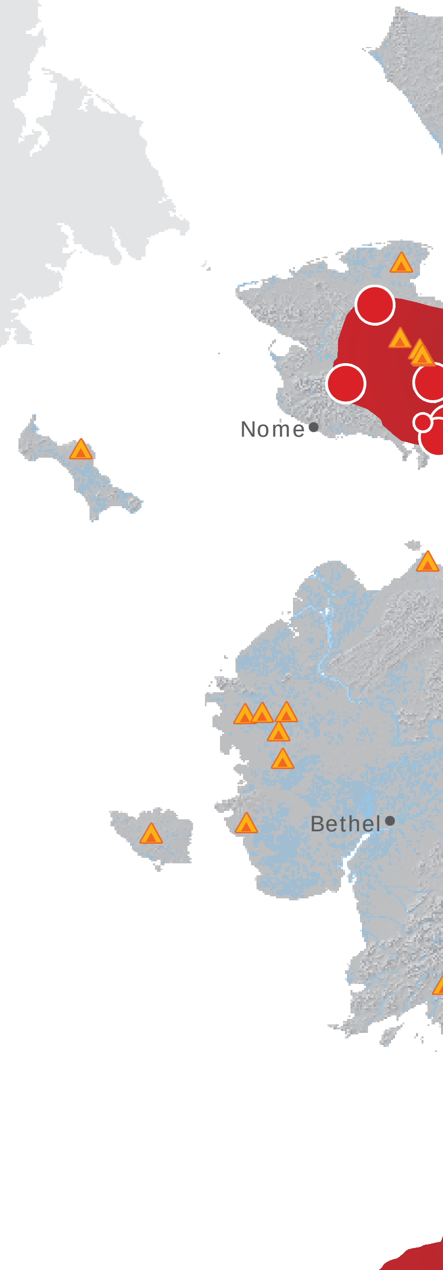
Interior and Southeast Alaska have low to moderate temperature geothermal systems with surface expressions as hot springs. The Wrangell Mountains have several active volcanoes and may have geothermal energy development potential. The Ring of Fire hosts several high-temperature hydrothermal systems, typically seen on the surface as hot springs, geysers, and fumarole fields.

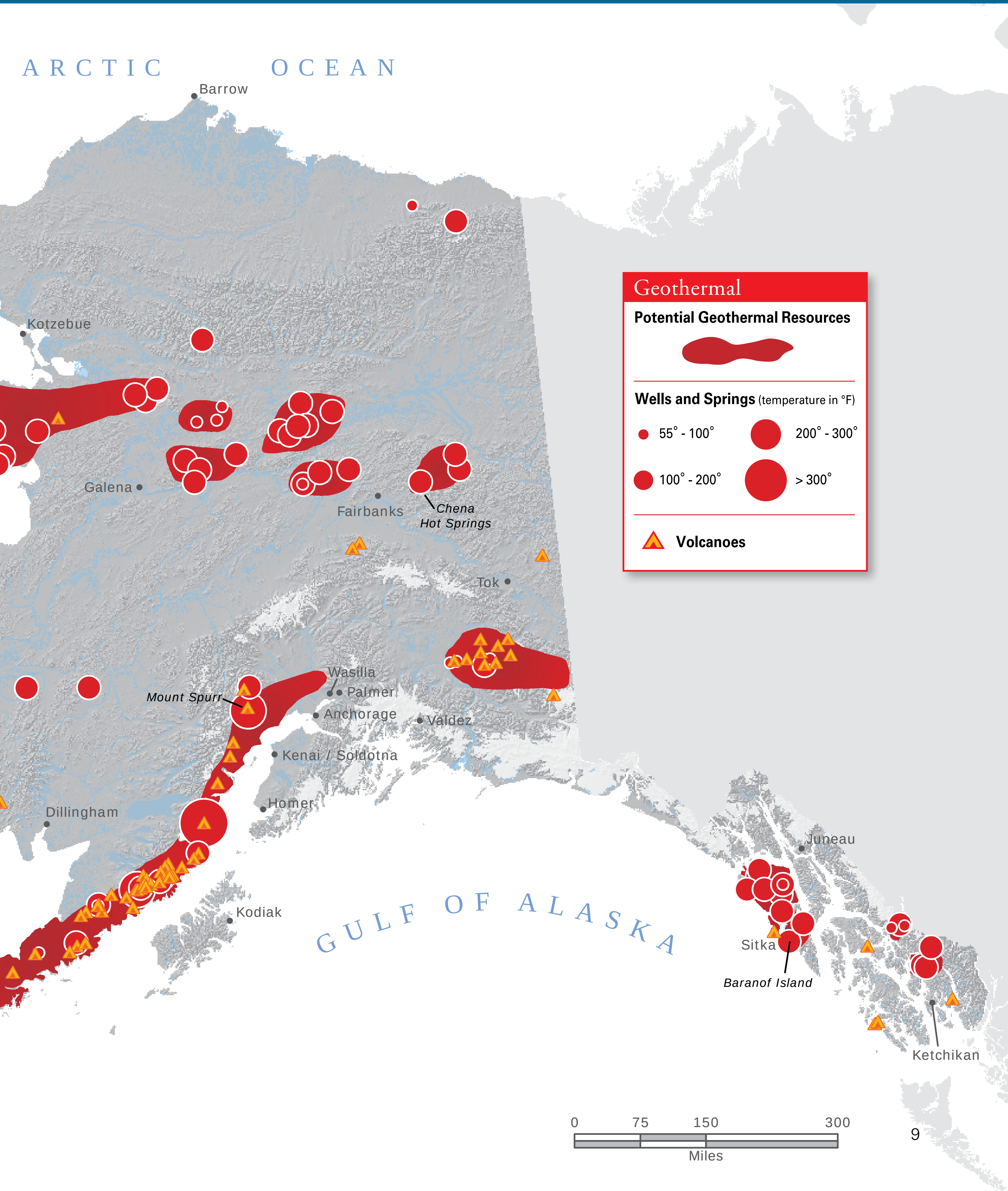
The use of geothermal resources falls into two categories: direct use and electricity production. Direct use includes non-electricity producing applications such as district heating, greenhouses, absorption chilling, and swimming pool heating.

Geothermal exploration is increasing statewide. Mt. Spurr, near Anchorage, is being investigated for large-scale development to diversify the Railbelt's energy supply. The State of Alaska awarded leases for geothermal exploration at Mt. Spurr to Ormat Technologies, Inc. in 2008. Ormat performed surface exploration and drilled two 1,000-foot deep temperature gradient wells in 2010, and plans more drilling in 2011. Akutan in the Aleutians is another site with geothermal potential. In 2010, the City of Akutan drilled two exploratory wells at Hot Springs Valley, encountering 359°F water at 585 feet. Drilling and exploration in the 1980s near Mt. Makushin indicated tens of megawatts could be generated from geothermal resources there.

In the Interior, Chena Hot Springs Resort serves as an example of diverse uses of geothermal energy - providing heat and power to its facilities, swimming pools, and greenhouses. The resort utilizes organic rankine cycle generators totaling 680kW that run on 165°F water, the lowest temperature energy source for an operating geothermal power plant in the world. The resort also installed a 16-ton absorption chiller in 2005 and uses geothermal power to chill an outdoor ice museum that is kept frozen year-round. The resort still relies on a diesel generator to meet a portion of its electric load.

Ground source heat pump (GSHP) systems are another use of geothermal energy. These electrically powered systems tap the relatively constant temperature of surrounding earth or water bodies to provide heating or cooling. More than a million such systems exist worldwide, including dozens in Alaska used for space heating in homes and commercial buildings. The Juneau airport and Auke Bay Laboratories Ted Stevens Marine Research Institute use GSHP systems. The Alaska Sealife Center in Seward is installing a system that taps heat from Resurrection Bay, and the City & Borough of Juneau use a GSHP system to help heat the Dimond Park Aquatic Center. Additionally, the Alaska Center for Energy & Power and Cold Climate Housing Research Center are preparing a statewide GSHP assessment in cooperation with Alaska Energy Authority and National Renewable Energy Laboratory. GSHP systems are most applicable in areas with low electric rates and high heating costs. Alaska's challenging geotechnical conditions such as permafrost are also a factor.




ARCTIC OCEAN
Barrow
Kotzebue
Galena
Fairbanks
Chena
Hot Springs
Tok
Wasilla
Palmer
Mount Spurr
Anchorage
Valdez
Kenai / Soldotna
Homer
Dillingham
Kodiak
GULF OF ALASKA
Juneau
Sitka
Baranof Island
Ketchikan
Geothermal
Potential Geothermal Resources
Wells and Springs (temperature in °F)
55° - 100°
200° - 300°
100° - 200°
> 300°
Volcanoes
0
75
150
300
Miles

Hydroelectric

Hydroelectric power, Alaska's largest source of renewable energy, supplies 21% of the state's electrical energy in an average water year. In 2010, 37 hydro projects provided power to Alaska utility customers, including the 120 MW state-owned Bradley Lake project near Homer, which supplies 8% of the Railbelt's electrical energy.

Most of the state's developed hydro resources are located near communities in Southcentral, the Alaska Peninsula, and Southeast – mountainous regions with moderate to high precipitation. Outside the Railbelt, major communities supplied with hydropower are Juneau, Ketchikan, Sitka, Wrangell, Petersburg, Kodiak, Valdez, Cordova, and Glennallen.

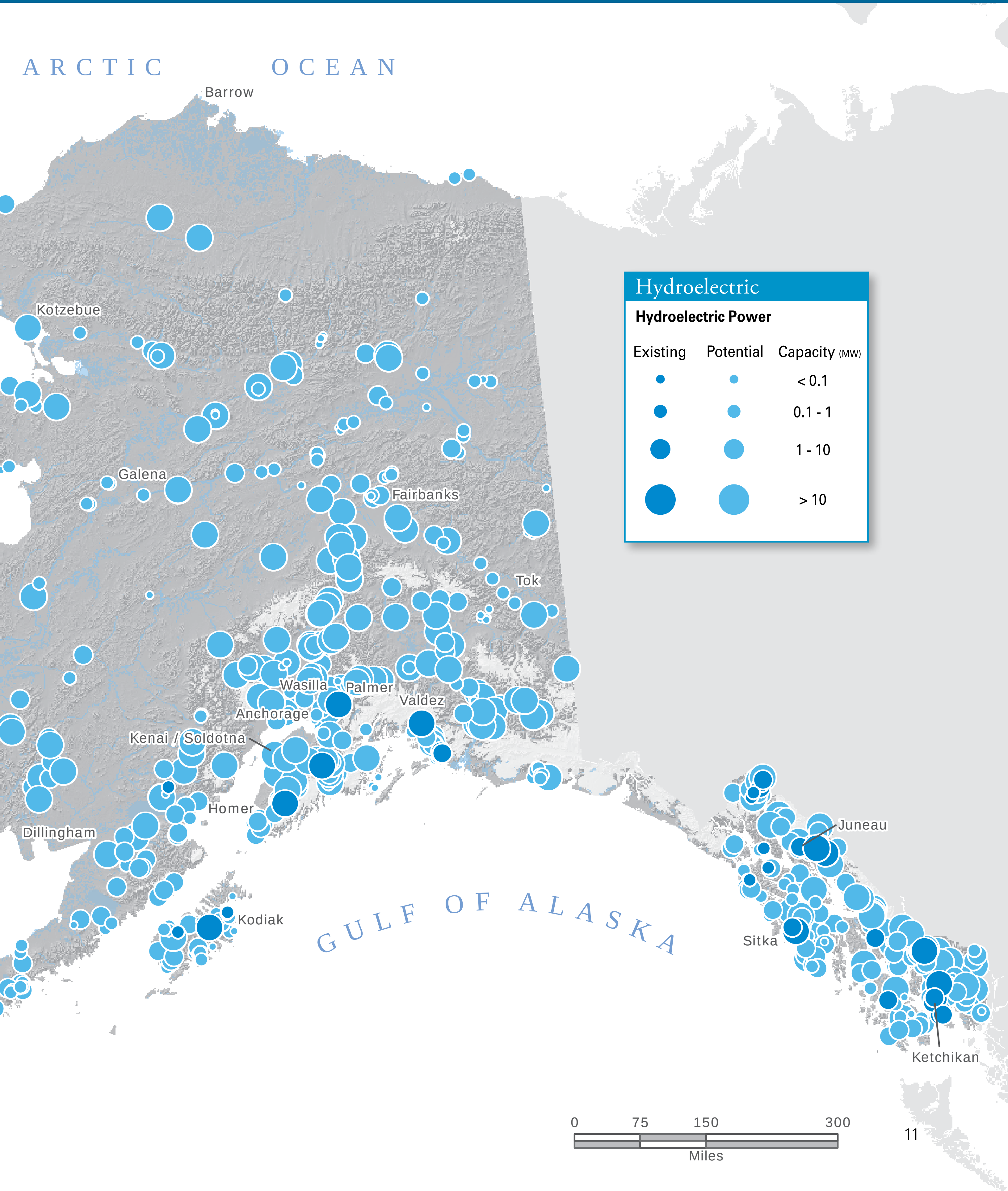
The 6 MW Blue Lake project near Sitka is an example of a project that stores energy by impounding water in a reservoir behind a dam. The dam is approximately 145 feet high with a spillway 342 feet above sea level. Plans are in the works to raise the dam 83 feet, add a third turbine and replace the two existing turbines. This will increase the average annual energy generation from Blue Lake to 33 GWh, a 50% increase over the existing project.

Other projects provide hydro storage without dam construction through the natural impoundment of an existing lake. The 31 MW Crater Lake project, part of the state-owned Snettisham project near Juneau, includes a "lake tap" near the bottom of the lake that supplies water to a powerhouse at sea level through a 1.5-mile long tunnel. Eklutna Lake, near Anchorage, is another example of a lake tap system.

In contrast to projects providing storage, smaller "run-of-river" projects use more modest structures to divert a portion of the natural river flow through penstocks to turbines to make power. An example is the 824 kW Tazimina project near Iliamna where water is diverted into an intake, 250 feet upstream from a 100-foot waterfall, through a steel penstock to an underground powerhouse, and then released back into the river near the base of the falls.

Two major hydroelectric projects, first proposed in the 1980s for the Railbelt, have again been under recent consideration. The Alaska Energy Authority (AEA) is considering development of a 600 MW storage hydroelectric project on the Susitna River. First studied in the 1970s and later in the 1980s, the Susitna Project at the Watana site is a single 700-foot dam that could provide up to half of the current electrical generation needs of the Alaskan Railbelt. It would be located approximately halfway between Anchorage and Fairbanks, at a site about 90 miles upstream of Talkeetna.

The 300 MW Lake Chakachamna project, located 85 miles west of Anchorage, is also a potential power source for the Railbelt. The project would be a lake tap. It would use a 10-mile long tunnel to a powerhouse that would be connected to the grid near Beluga. In November 2010, AEA issued a preliminary decision document that recommended further development work should be limited to the Susitna project due to the Chakachamna project's significant licensing and operational risks.


ARCTIC OCEAN
Barrow
Kotzebue
Galena
Fairbanks
Tok
Wasilla
Palmer
Valdez
Anchorage
Kenai / Soldotna
Homer
Dillingham
Kodiak
GULF OF ALASKA
Juneau
Sitka
Ketchikan
Hydroelectric
Hydroelectric Power
Existing
Potential
Capacity (MW)
< 0.1
0.1 - 1
1 - 10
> 10
0
75
150
300
Miles

Ocean and River Hydrokinetic

Alaska has thousands of miles of coastline, providing a vast resource potential for tidal and wave energy development. Alaskan rivers can also be a potential resource, using river in-stream and tidal energy technologies that could supply some of Alaska's energy needs.

Tidal and river in-stream energy can be extracted using hydrokinetic devices. These devices are placed directly in the river or tidal current and powered by the kinetic energy of the moving water. The available power is a function of the speed of the water current. In contrast, traditional hydropower uses a diversion structure such as a dam to supply a combination of hydraulic head and water volume to a turbine to generate power. Hydrokinetic devices require a minimum current and water depth to operate. Typical speeds of 2-4 knots are the minimum required, while speeds of 5-7 knots provide for optimum operation. Ideal locations for hydrokinetic devices provide significant flow throughout the year and are not susceptible to serious flood events, turbulence, debris or extended periods of low water level.

Tidal energy is a concentrated form of the gravitational energy exerted by the moon and, to a lesser extent, the sun. Cook Inlet, with North America's second largest tidal range, has attracted interest as an energy source for the Railbelt. To quantify this, Alaska Energy Authority is partnering with the National Oceanic and Atmospheric Administration (NOAA) to create a model of Cook Inlet's tidal energy potential. Results should be available in 2013. In addition, Ocean Renewable Power Company, LLC obtained a FERC permit in 2008 to begin development of a demonstration tidal project in Cook Inlet.

Wave energy is the result of wind acting on the ocean surface. Alaska has one of the best wave resources in the world, with parts of the Aleutian Islands coast averaging more than 50 kW per meter of wave front. The challenge is lack of energy demand near the resource. Much of Alaska's wave energy is dissipated on remote, undeveloped shorelines. Other substantial wave energy areas include the southern side of the Alaska Peninsula and coastlines of Kodiak and Southeast Alaska. The best prospect for wave energy development in Alaska may be Yakutat, also known as the surfing capital of Alaska. Wave energy devices of varying designs have been tested around the world, including in Scotland and Portugal.

Many rural Alaskan communities situated along navigable waterways have the potential to host river in-stream hydrokinetic installations. The University of Alaska is completing a statewide assessment of in-stream hydrokinetic potential in rural Alaska, and systems have been tested on the Yukon near Ruby and Eagle.

While there are obvious opportunities, significant environmental and technical challenges remain for commercial deployment of wave, tidal, or in-river devices. These technologies are evolving rapidly and are being demonstrated at sites around the world.


ARCTIC OCEAN
Barrow
Kotzebue
Koyokuk
Nulato
Galena
Kaltag
Fairbanks
Whitestone
Grayling
Anvik
Tok
Holy Cross
Crooked Creek
Red Devil
Stony River
Sleetmute
Aniak
Napaimute
Talkeetna
Cairn Point
Knik Arm
Fire Island
Upper Cook Inlet
Palmer
Wasilla
Anchorage
Pt Possession
North Foreland
The Forelands
Kenai / Soldotna
East of Kalgin Island
Harriet Point
Cape Ninilchik
Homer
Bainbridge Passage
Gakona
Copper Center
Chitina
Valdez
Million Dollar Bridge
Dillingham
Clarks Point
Chugach Passage
Cape Current Narrows
Whale Passage
Kodiak
GULF OF ALASKA
North Inian Pass
North Passage (Icy Strait)
Juneau
South Passage (Icy Strait)
South Inian Pass
Kootzhanoo Inlet
Sergius Narrows
Turn Point
Sitka
South Ledge
Spike Rock
Tonowek Narrows
Ketchikan
Tlevak Narrows
0 75 150 300
Miles
Ocean and River Hydrokinetic
Tidal Power Potential
MW
1.3 - 25
100 - 220
25 - 100
Wave Power Potential
kW/m
26 - 30
40 - 50
30 - 40
50 - 56
In-River Power Potential
W/m²
50 - 220
600 - 900
220 - 450
1500 - 1700

Solar

Alaska's high latitude presents the challenge of having minimal solar energy during the long winter months when energy demand is greatest. But solar energy fulfills an important role in small, off-grid power generation and low-power applications such as communications at remote sites.

In Alaska, careful building design and construction can minimize the use of heating fuel. "Passive solar" design includes proper southern orientation and the use of south-facing windows that transfer the sun's energy into the house through the natural processes of conduction, convection, and radiation. Passive solar design employs windows, thermal mass, and proper insulation to enable the building itself to function as a solar collector.

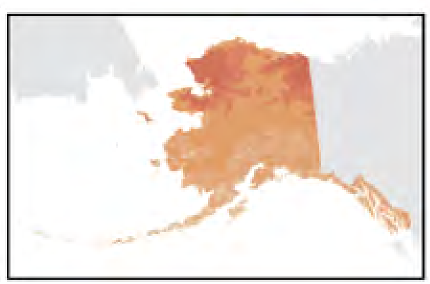
"Solar thermal" heating systems use pumps or fans to move energy to a point of use, such as a domestic hot water tank. A typical home demands a large amount of fuel year-round for domestic hot water, so using the sun to heat water for even seven or eight months a year saves significant amounts of energy. A larger role for solar thermal hot water systems is emerging as advances in heating systems allow solar-heated fluid to supply in-floor systems currently heated by conventional fuel boilers. Solar thermal heating demonstration projects are completed or underway in Nome, Kotzebue and in McKinley Village, and will provide performance and economic data.

During long summer days, photovoltaic (PV) panels can be the ideal power source for remote fish camps, lodges and cabins in stand-alone systems where power demands are relatively low. But the use of PV technology for utility-scale power generation in Alaska is generally not cost effective under current conditions.

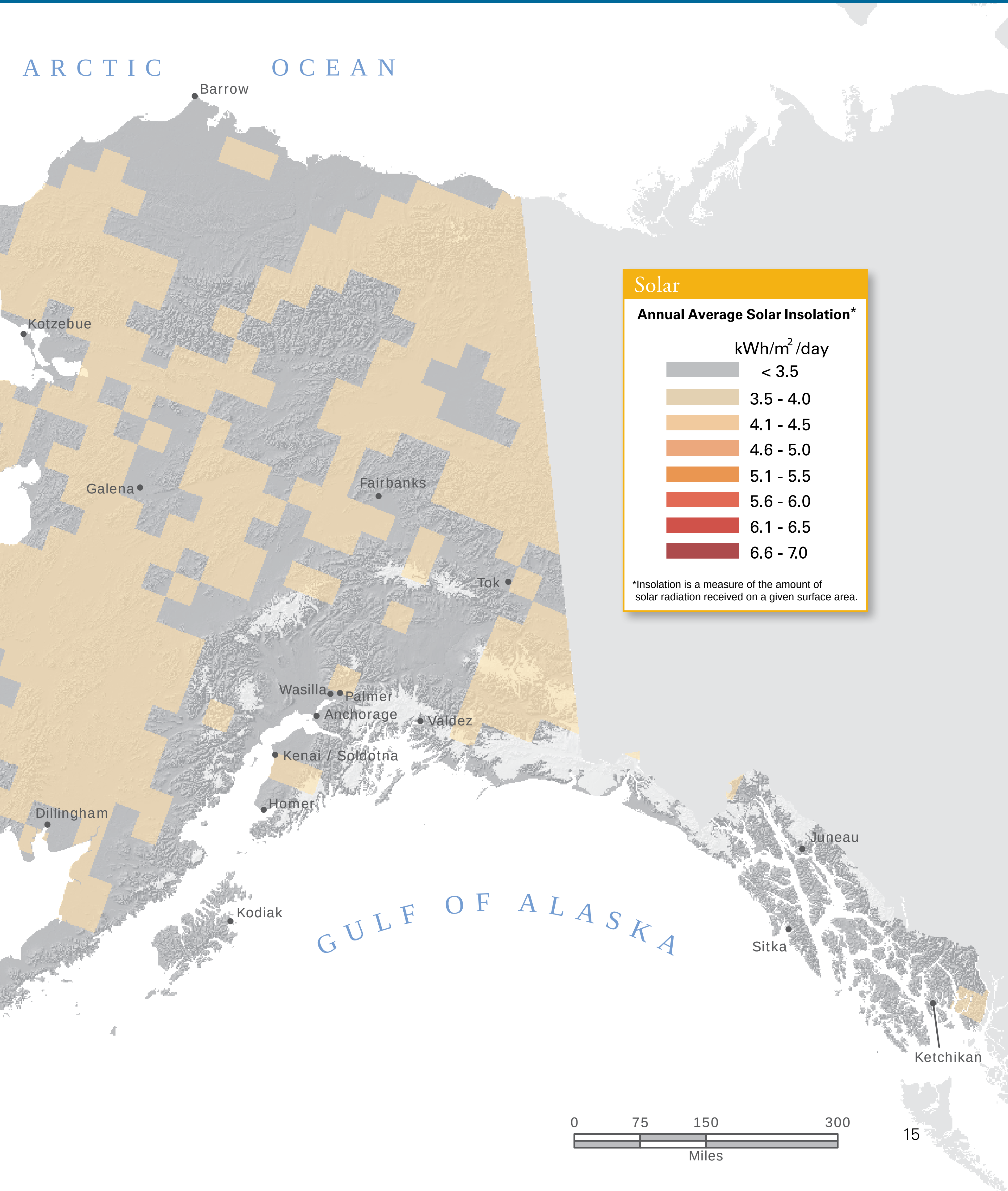
Even though the longest day is in June, the greatest amount of solar energy can be harnessed in April when panels receive direct sunlight in addition to snow-reflected light. Coupled with cool temperatures that reduce electrical resistance in the panels, PV systems can actually exceed their rated output at this time of year.

Currently PV is one of the most expensive electricity options for Alaska. However, the price of solar panels has dropped significantly over the past five years and there is an industry-wide effort toward similar cost reductions for balance-of-system components.

December Average Insolation



June Average Insolation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Anchorage
Valdez
Kenai / Soldotna
Homer
Dillingham
Kodiak
GULF OF ALASKA
Juneau
Sitka
Ketchikan
Solar
Annual Average Solar Insolation*
kWh/m² /day
< 3.5
3.5 - 4.0
4.1 - 4.5
4.6 - 5.0
5.1 - 5.5
5.6 - 6.0
6.1 - 6.5
6.6 - 7.0
*Insolation is a measure of the amount of solar radiation received on a given surface area.
0
75
150
300
Miles

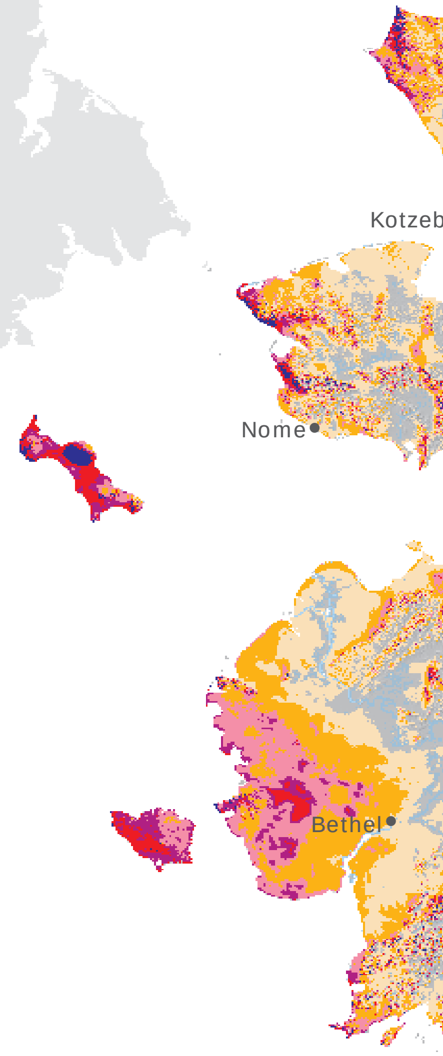
Wind

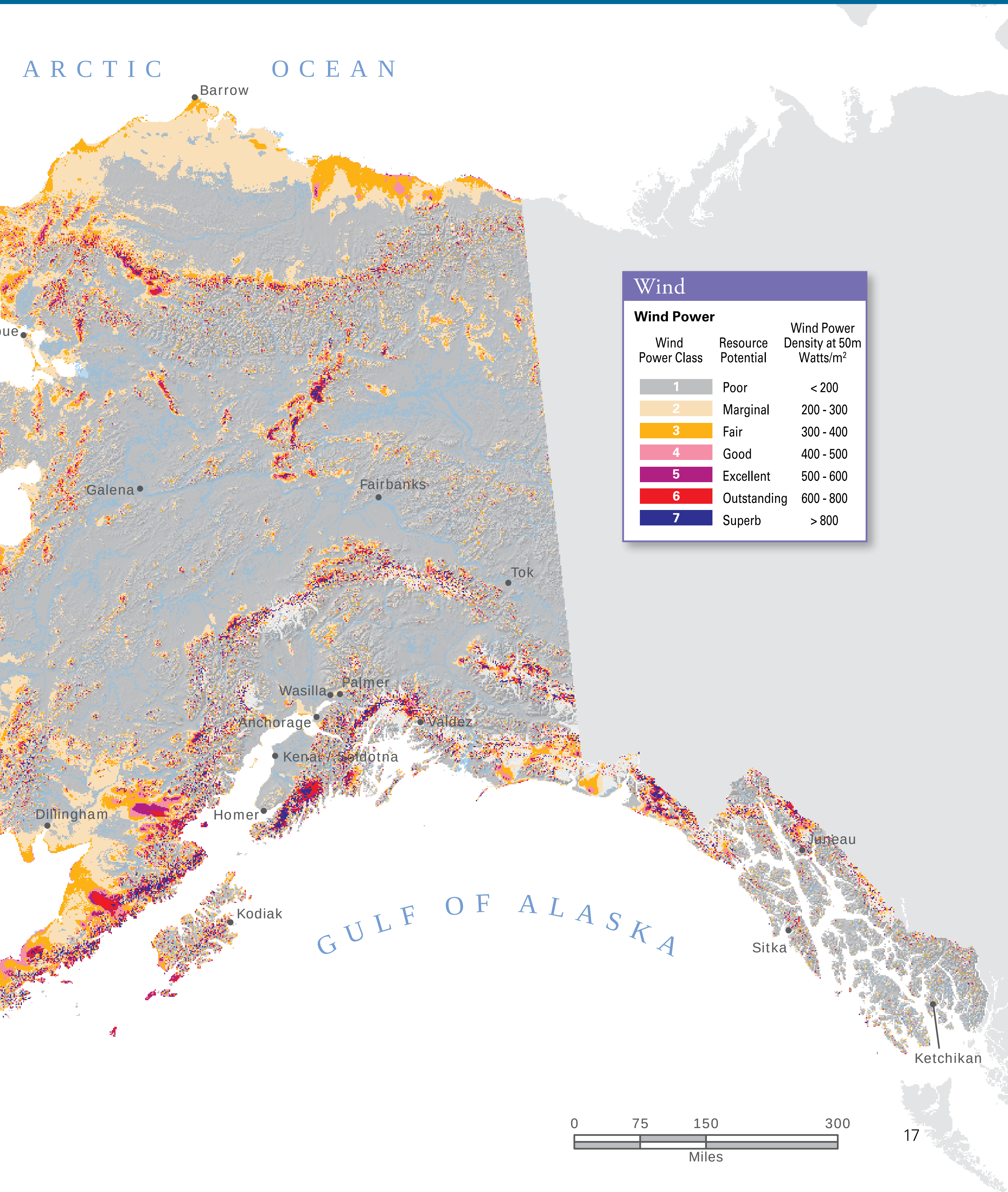
Alaska has abundant wind resources available for energy development. Costs associated with fossil fuel-based generation and improvements in wind power technology make this clean, renewable energy source attractive to many communities and individuals. The wind map on these pages provides an initial indication of the potential for wind energy development. The colors represent the estimated Wind Power Class in each area with Class 1 being the weakest and Class 7 the strongest. The quality of a wind resource is key to determining the feasibility of a wind project. But other important factors to consider include the size of a community's electrical load, the price of displaced fuel such as diesel, turbine foundation costs, the length of transmission lines, and other site-specific variables.

Alaska's best wind resources are largely located in the western and coastal portions of the state. In parts of SW Alaska, turbines may actually need to be sited away from the strongest winds to avoid extreme gusts and turbulence. In the Interior, average wind speeds tend to be much lower. But localized areas, such as near Healy and Delta Junction, can have strong wind resources. The quality of the wind resource is very site specific so it is critical to measure the wind resource before starting development. Site-specific wind resource data from around the state has been collected through the Alaska Energy Authority's anemometer loan program and is available on AEA's web page—www.akenergyauthority.org.

Wind power technologies in use in Alaska range from small systems at off-grid homes and remote camps, to medium-sized machines displacing diesel fuel in isolated village wind-diesel hybrid power systems, to large industrial turbines generating energy on the Railbelt and in towns such as Kodiak. On the Railbelt, several utilities are examining wind power as a way to diversify their energy sources and hedge against rising fossil fuel prices. In addition to a privately-owned 1 MW wind farm near Delta Junction, efforts are underway to develop a 53 MW project located on Fire Island just west of Anchorage. Fairbanks-based Golden Valley Electric Association is also looking at developing the 24 MW Eva Creek Wind project located north of Healy. Together these two projects could provide approximately 5% of the Railbelt's electricity.

Rural Alaska, which depends largely on expensive diesel fuel for power, has seen rapid growth in the use of wind energy with several community-scale wind systems installed in recent years and several more under construction. In 2009, Kodiak Electric Association installed the first megawatt-scale turbines in the state. The three GE 1.5 MW turbines are supplying 9% of the community's electricity, and cut the utility's diesel fuel use in half, saving 930,000 gallons in the first year of operation. Alaska Village Electric Cooperative, which serves 53 villages in Interior and Western Alaska, now has wind-diesel hybrid systems installed in 9 villages. In Nome, an 18-turbine 1.17 MW wind farm funded by a private for-profit corporation was installed in 2009. Unalakleet Village Electric Cooperative also added a 600 kW wind farm in 2009.




ARCTIC OCEAN
Barrow
Galena
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Valdez
Kenai / Soldotna
Dillingham
Homer
Kodiak
GULF OF ALASKA
Juneau
Sitka
Ketchikan
Wind
Wind Power
Wind Power Class
Resource Potential
Wind Power Density at 50m Watts/m2
1 Poor < 200
2 Marginal 200 - 300
3 Fair 300 - 400
4 Good 400 - 500
5 Excellent 500 - 600
6 Outstanding 600 - 800
7 Superb > 800
0 75 150 300
Miles

Renewable Energy Fund

Alaska's Renewable Energy Grant Fund was created by the Legislature in 2008 with the intent to appropriate $50 million a year for five years to develop renewable energy projects across the state, with an emphasis on projects in areas with the highest energy costs.

The Fund has been a major stimulus for renewable energy projects in Alaska. In the first three funding rounds, the Legislature appropriated $150 million for 133 qualifying projects. These projects cover a wide range of technologies and geographic areas, from wind turbines in Quinhagak to a hydroelectric project in Gustavus to a ground source heat pump system at the Juneau airport. Heat recovery systems in North Pole and McGrath have also been funded.

The program is helping communities stabilize energy prices by reducing their dependence on costly diesel fuel for power generation and space heating. In the 2009-10 time period, projects supported by the Renewable Energy Fund displaced the equivalent of 1.69 million gallons of diesel with a value of $3.37 million. As more wind, biomass, hydro, geothermal and heat recovery projects that have been funded are constructed and come on line, that figure is expected to top six million gallons of diesel equivalent displaced per year by 2013.

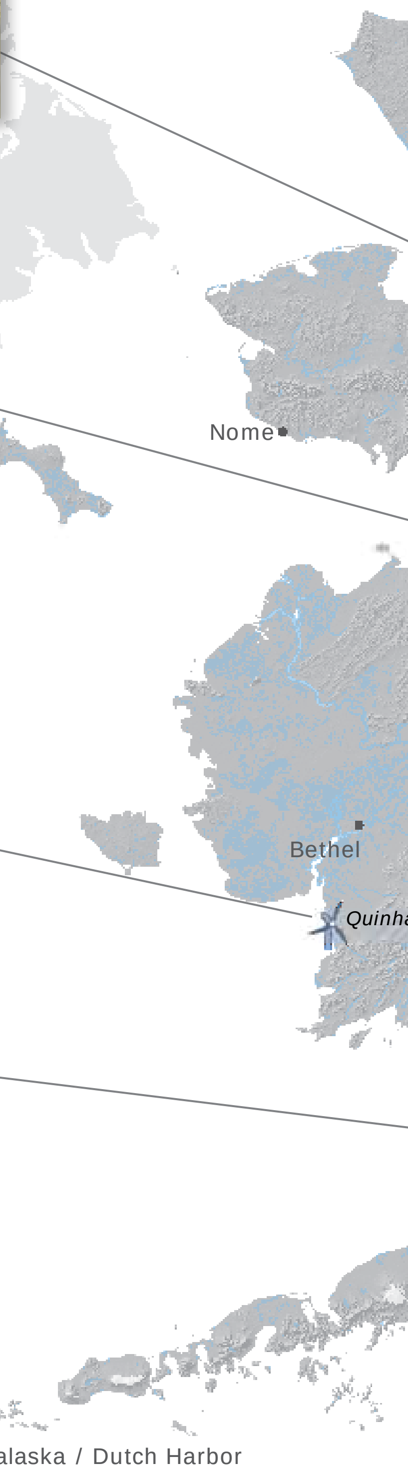
Kodiak is an example of a community where wind power is being used to displace large amounts of diesel. The local utility, Kodiak Electric Association (KEA), received $4 million from the Fund to help install three 1.5 MW wind turbines on Pillar Mountain in July 2009. In its first year of operation, the turbines cut diesel use in half, saving approximately 930,000 gallons - a value of more than $2.3 million based on $2.50 a gallon diesel. The wind turbines and an existing hydro project at Terror Lake now allow Kodiak to generate nearly 90% of its electricity from renewable sources.

In Southeast Alaska, the small community of Gustavus, aided by a $750,000 grant from the Fund, installed an 800 kW run-of-the-river hydroelectric project to displace diesel. In 2010, the hydropower plant generated 99% of the community's electrical power, eliminating the need to burn more than 126,000 gallons of diesel, a one-year savings of $380,000 based on $3 a gallon diesel.

To qualify for funding, project developers must submit applications to the Alaska Energy Authority, which ranks them based on a variety of criteria including economic and technical feasibility, local support, matching funding and the community's cost of energy. These rankings are then submitted to the Legislature, which approves the projects and appropriates the funding.


ARCTIC OCEAN
Barrow
North Slope
Northwest Arctic
Kotzebue Heat Recovery
Ambler
Heat Recovery
NW Arctic
Borough Wind
Ft Yukon District
Wood Heat
Yukon-Koyukuk / Upper Tanana
raits
eak Transmission
Galena
Tanana Biomass
Fairbanks
Shaktoolik Wind
Unalakleet Wind
Chena Power
Biomass/ORC
North Pole
Heat Recovery
Delta Junction Wind
Delta Junction
Wood Chip Heating
McGrath
Heat Recovery
Tok Gateway School
Wood Heating
McKinley Village
Solar
Yerrick Creek
Hydroelectric
Gulkana Central
Wood Heating
Chistochina Central
Wood Heating
Railbelt
on-Kuskokwim
Copper River / Chugach
Wasilla
Palmer
hel Wind
iak Wind
k Wind
Anchorage
Landfill Gas
Valdez
Kenai / Soldotna
Cordova Wood
Processing Plant
Humpback Creek
Hydroelectric
Bristol Bay
Kvichak River
RISEC
Dillingham
Homer
Cordova
Heat Recovery
Alaska Sealife Ctr.
Seawater Heat Pump
Haines Central
Wood Heating
Juneau Airport GSHP
Juneau Aquatic Ctr. GSHP
Falls Creek
Hydroelectric
Southeast
Pilot Point Wind
Pillar Mtn. Wind
Kodiak
Kodiak
GULF OF ALASKA
Sitka
Wrangell Excess
Hydro to Heat
N. Prince of Wales
Intertie
Thorne Bay School
Wood Boiler
Ketchikan
Reynolds Creek
Hydroelectric
nd Point Wind
Projects Completed/
Under Development
Biomass
Geothermal
Heat Recovery
Hydro
Ocean / River
Solar / Thermal
Transmission
Wind
0
75
150
300
Miles

Renewable Energy Fund Project Highlights



North Pole Biomass-Fired Power

RE Fund Grant	$2,000,000
Total Project Cost	$4,007,900
Est Fuel Displaced/yr	210,000 gal

Unalakleet Wind

RE Fund Grant	$4,000,000
Total Project Cost	$6,000,000
Est Fuel Displaced/yr	90,000 gal

Quinhagak Wind Farm

RE Fund Grant	$3,882,243
Total Project Cost	$4,313,603
Est Fuel Displaced/yr	48,300 gal

Pillar Mountain Wind, Kodiak

RE Fund Grant	$4,000,000
Total Project Cost	$21,400,000
Est Fuel Displaced/yr	930,000 gal

North Pole Heat Recovery

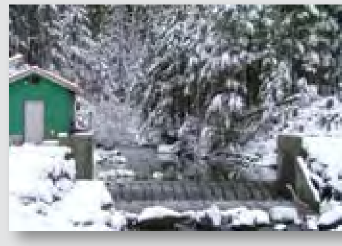
RE Fund Grant	$840,000
Total Project Cost	$1,050,000
Est Fuel Displaced/yr	99,000 gal

Gulkana Community Wood-Fired Boiler

RE Fund Grant	$500,000
Total Project Cost	$500,000
Est Fuel Displaced/yr	14,600 gal

Tok School Wood-Fired Boiler

RE Fund Grant	$3,245,349
Total Project Cost	$3,805,349
Est Fuel Displaced/yr	50,400 gal



Falls Creek Hydro, Gustavus

RE Fund Grant	$750,000
Total Project Cost	$10,153,000
Est Fuel Displaced/yr	126,000 gal

Juneau Airport Ground Source Heat Pump

RE Fund Grant	$513,000
Total Project Cost	$1,076,000
Est Fuel Displaced/yr	29,500 gal

Cordova Firewood Processor

RE Fund Grant	$147, 720
Total Project Cost	$628,825
Est Fuel Displaced/yr	88,700 gal

Humpback Creek Hydroelectric, Cordova

RE Fund Grant	$8,000,000
Total Project Cost	$21,300,000
Est Fuel Displaced/yr	275,800 gal

North Prince of Wales Intertie, Coffman Cove & Naukati

RE Fund Grant	$3,752,181
Total Project Cost	$6,155,019
Est Fuel Displaced/yr	111,000 gal

Renewable Energy Policies

State and federal policies that encourage renewable energy projects play an important role in their development.

At the federal level, the production tax credit (PTC) is the primary incentive tool. The PTC was passed by Congress to even the playing field between the renewable energy industry and the heavily subsidized fossil fuel and nuclear industries. The PTC currently allows the owners of qualifying renewable energy projects to take 2.2 cents off their tax bill for every kilowatt-hour of renewable energy generated during the first ten years of the project. Though the tax credit is an important part of renewable energy project financing, its weakness has been its short-term duration. Congress has typically reauthorized the tax credit for only one or two years at a time, making it difficult for investors to plan development of renewable energy resources far into the future. The current PTC expires December 31, 2012 for wind projects, and December 31, 2013 for other renewable energy projects. Alternatively, wind and solar projects can choose to take advantage of a 30% federal investment tax credit (ITC) or grant for facilities placed in service by 2013 if construction begins before December 31, 2011.

Historically, individual state policies have been the primary drivers of renewable energy development in the United States. The four primary policies used across the country are net metering, renewable portfolio standards, renewable energy funds, and feed-in tariffs.

Net Metering

State net metering rules provide an incentive for individuals and businesses to invest in their own small renewable energy systems by allowing them to sell excess power they produce back into the grid. More than 40 states, including Alaska, as well as the District of Columbia and the U.S. Virgin Islands, now offer some form of net metering. Different rules in each state determine the maximum amount of power an individual can sell back to the utility, the price at which the utility must purchase the power, and the length of time an individual producer can "bank" the power they produce before a "net" bill must be calculated.

Rich Seifert

This home near Fairbanks uses a combination of photovoltaic cells for power, an active solar water heater, and passive solar design.

Alaska Energy Authority

Renewable energy creates jobs for Alaskans.

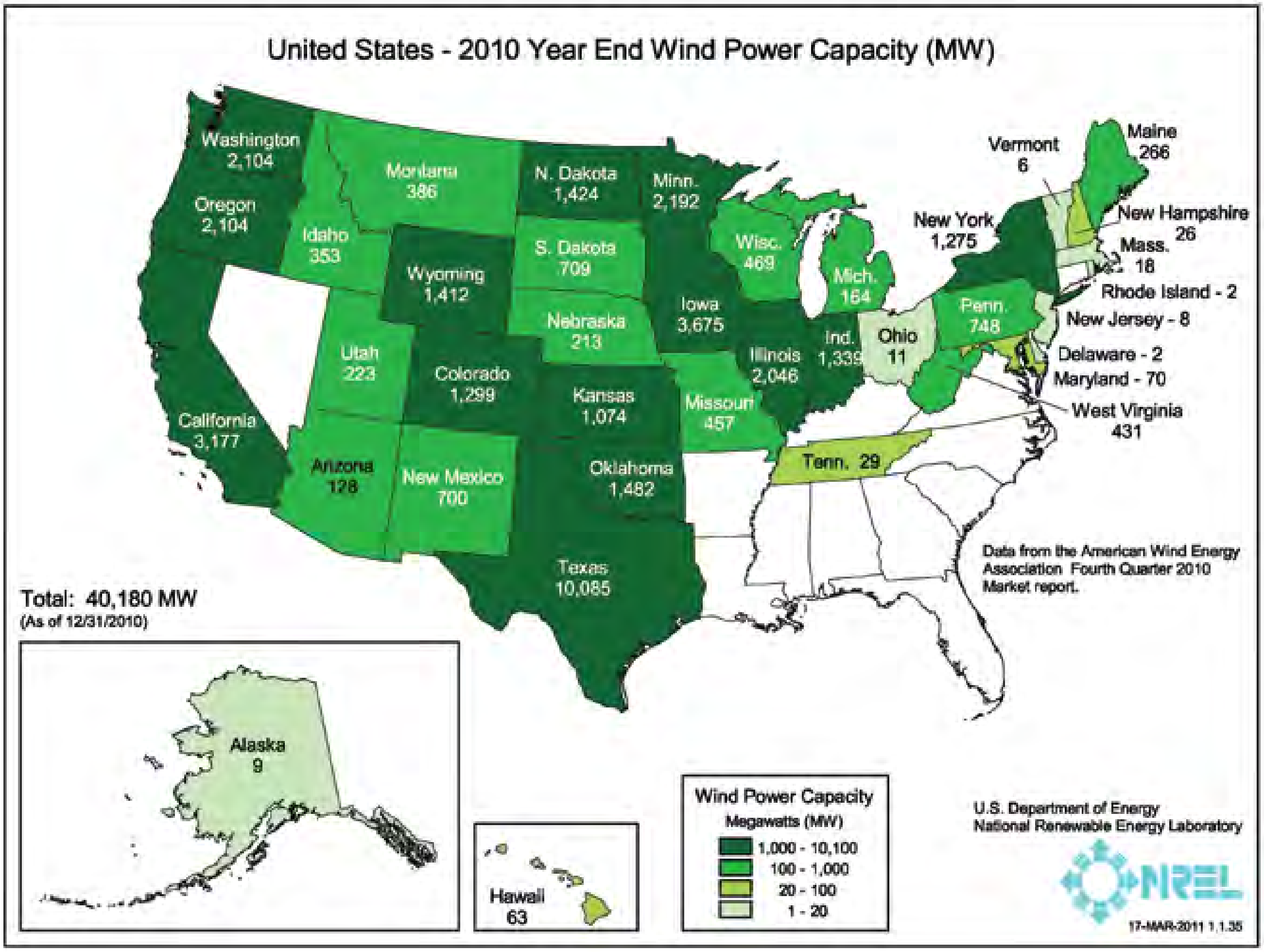
Alaska's net metering regulations, passed in 2010, apply to renewable energy systems of 25 kW or less, and require large utilities to purchase power from customers, up to 1.5% of the utility's average load. In addition, some utilities have their own incentive programs that allow individuals to sell power back to the utilities.

Fairbanks' Golden Valley Electric Association (GVEA) has developed a Sustainable Natural Alternative Power (SNAP) program. SNAP allows customers who wish to support renewable energy development to do so by contributing to a fund that is held in escrow by the utility company. Individuals in the GVEA service area who want to produce up to 25 kW of renewable electricity for the grid are paid from the escrow fund in proportion to the amount of power they produce, plus the utilities avoided fuel cost.

Renewable Portfolio Standards

Twenty-nine states and the District of Columbia now have a policy known as a renewable portfolio standard (RPS), and an additional 8 states, including Alaska, have set a less binding renewable energy goal. Alaska's goal, adopted in 2010, is to generate 50% of the state's electricity from renewable sources by 2025.

An RPS is a state law that requires utility companies to generate a specified percentage of their electricity from renewable resources by a certain date. For example, Nevada law mandates investor-owned utilities in that state produce 25% of their electricity



National Renewable Energy Laboratory

In 2010, the U.S. generated just over 2% of its electricity from wind, and was second only to China in the amount of total installed wind generation. Denmark already generates more than 20% of its electricity from wind, followed by Portugal at 18% and Spain at 16%.

from renewables by the year 2025. The percentage and end date vary widely from state to state. Utilities are typically given interim milestones, and must pay a fine if they do not reach those milestones. Most states allow utilities to purchase renewable energy credits (RECs) to meet the RPS standard and avoid paying fines. The RPS approach makes different entities and renewable energy resources compete to meet the standard. In addition, bills have been proposed in Congress to create a mandatory national Renewable Electricity Standard (RES).

Renewable Energy Funds / System Benefit Charges

More than 20 states, including Alaska, have renewable energy funds (sometimes called clean energy funds), most of which are supported by small, mill-rated surcharges on energy sold to consumers. These surcharges are sometimes referred to as system benefit charges. Renewable energy funds provide support for the development of renewable energy by helping to remove market barriers, lowering financing costs, developing infrastructure, and educating the public. For example, the system benefit charges in Oregon are deposited into an independent trust that funds eligible efficiency, wind, solar electric, biomass, small-scale hydro, tidal, geothermal, and fuel cell projects. These projects are supported by grants, loans, rebates, equity investments, and other financing mechanisms used by the fund.

Terms of the various funds vary from state to state. Some states have scheduled funds to last only five years. Other states have open-ended funds. Longer-term funds provide greater stability for renewable energy developers.

Renewable Energy Policies

REAP

Kodiak Electric Association installed three 1.5 MW wind turbines on Pillar Mountain in July 2009. In the first year of operation, the turbines displaced the equivalent of 930,000 gallons of diesel, saving the utility more than $2.3 million based on a diesel price of $2.50/gallon.

In the states that have both an RPS and a renewable energy fund, the two policies work together to stimulate the renewable energy market. RPS standards "pull" renewable energy technologies into a state by providing a long-term market that reduces investment risk and provides a level playing field for developers. On the other hand, renewable energy funds "push" clean energy technologies by lowering market barriers through direct investment incentives and supporting the infrastructure needed to develop renewable energy. For example, in California, the fund is used to buy down the above-market costs of renewable energy. Additionally, the development that takes place as a result of renewable energy funds helps states meet their RPS requirements.

Renewable Energy Credits (RECs)

Utilities recognized years ago that there was a market demand for clean, renewable energy when customers agreed to pay more for resources like wind. Today, rather than charging a premium for renewable source power, most utilities sell the social and environmental attributes of renewable energy separately from the actual electrons in the form of certificates. Also known as "green tags," renewable energy certificates (RECs) are essentially the bragging rights created when renewable energy is produced. Each REC represents the production of one megawatt hour of renewable energy and the displacement of approximately 1,400 pounds of CO_2 emissions. Buyers of RECs include utilities trying to meet state RPS requirements, as well as a growing number of federal agencies and corporations committed to supporting increased renewable energy production. For example, the Fortune 500 company Whole Foods is buying RECs from wind farms to offset 100% of the electricity used in all of its facilities in the United States and Canada.

Electricity Feed Laws and Advanced Renewable Tariffs

Electricity feed laws and advanced renewable tariffs (ARTs) are used in a number of countries and are considered by many to be the world's most successful policy mechanism for stimulating rapid renewable energy development. They give renewable energy producers guaranteed access to the electric grid at a price set by the regulatory authority, giving producers the contractual certainty needed to finance renewable energy projects.

Alaska Volcano Observatory

Steam vent on Kiska Volcano in the Aleutian Islands. Several communities in the Aleutians are considering developing their geothermal resources.

They also enable homeowners, farmers, cooperatives, and others to participate on an equal footing with large commercial developers of renewable energy. Currently, more than 16 countries in the European Union use some form of feed law.

ARTs are the modern version of Feed Laws. They differ from the simpler feed laws in several important ways. Tariffs are differentiated by technology, project size, or, in the case of wind energy, by the productivity of the resource. Tariffs for new projects are also subject to periodic review to determine if the program is sufficiently robust.

In 2009, the Canadian province of Ontario enacted North America's first comprehensive program of Advanced Renewable Tariffs. The program offers 20- to 40-year contracts to producers of wind, hydro, biomass, landfill gas, and solar photovoltaic energy at a variety of prices ranging from 10 cents/kWh to 80 cents/kWh for small residential solar photovoltaic systems. The contracts are available to homeowners, businesses, and commercial energy producers, and differentiate between small and large energy producers. Additional financial incentives are offered for projects developed by First Nations, farmers, cooperatives, and community groups.

Vermont has adopted a modest version of an Advanced Renewable Tariff. The program is capped at 50 MW and offers 20-year contracts for renewable energy producers with prices varying from 12 cents/kWh for landfill gas to 30 cents/kWh for solar photovoltaic. The town of Gainesville, Florida also generated widespread publicity in 2009 for adopting a feed-in-tariff to spur installation of solar photovoltaic systems. The tariff incentivizes solar installations at homes and businesses with 20-year contracts that pay 24-32 cents/kWh depending on the size and configuration of the system. The program limits total installations to 4 MW a year and reserves a percentage each year for small residential systems of 10 kW or less. Legislation for feed-in tariffs is currently being considered in several other states.

Alaska

2008 was a landmark year for renewable energy and energy efficiency in Alaska. The Cold Climate Housing Research Center published a report outlining recommended state programs, initiatives, and goals to reduce end-use energy demand and save up to $840 million over the next 5 years, and the State

Chris Rose, REAP

Hydrogen filling station in Reykjavik, Iceland. Iceland gets 99% of its electricity and over 90% of heat for buildings from its geothermal and hydroelectric resources. The government's goal is to be the first nation in the world to replace its use of fossil fuels in autos and boats with hydrogen fuel.

Legislature appropriated $360 million for home weatherization and rebate programs. 2008 also saw the passage of H.B. 152, which established the Renewable Energy Grant Program administered by the Alaska Energy Authority (See more details under the Renewable Energy Fund on pages 18-21).

In 2010, the Alaska State Legislature passed two bills - S.B. 220 and H.B. 306 - that will help secure a more sustainable energy future for Alaska. H.B. 306 established goals to produce 50% of the state's electricity from renewable resources by 2025 and reduce energy use on a per capita basis by 15% by 2020. Among other provisions, S.B. 220 mandated that 25% of the state's public buildings be energy retrofitted by 2020 and created a $250 million revolving loan fund to help finance that work.

The bill also established the Emerging Energy Technology Fund (EETF). This Fund is aimed at supporting the development of new technologies that are not a priority for funding under the Renewable Energy Grant Fund. Administered by the Alaska Energy Authority, with financial support from both the Legislature and the Denali Commission, the EETF gives grants to projects that use technologies not yet tested in Alaska and/or technologies that are still being developed but could be commercially viable within five years. The first round of applications to the new program were submitted for review in March 2011.

Glossary

Absorption Chiller - A device that uses heat energy rather than mechanical energy to cool an interior space through the evaporation of a volatile fluid.

Active Solar - A solar water or space-heating system that use pumps or fans to circulate the heat transfer medium (water, air or heat-transfer fluid like diluted antifreeze) from the solar collectors to a storage tank subsystem or conditioned space.

Alternative Fuels - A term for "non-conventional" transportation fuels derived from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol, or biodiesel).

Anemometer - An instrument for measuring the velocity of wind; a wind gauge.

ASTM - Abbreviation for the American Society for Testing and Materials, which is responsible for the issue of many standard methods used in the energy industry.

Availability - It refers to the number of hours that a power plant is available to produce power divided by the total hours in a set time period, usually a year.

Avoided Cost - The incremental cost to an electric power producer to generate or purchase a unit of electricity or capacity or both.

Biodiesel - A domestic, renewable fuel for diesel engines derived from natural oils like fish and vegetable oil; produced by a chemical process that removes the glycerin from the oil and meets a national specification (ASTM D 6751).

Biomass - Organic matter that is available on a renewable basis, including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, and aquatic plants.

Bioenergy – Electrical, mechanical, or thermal energy or fuels derived from biomass.

Capacity Factor - The ratio of the average power output of a generating unit to the capacity rating of the unit over a specified period of time, usually a year.

Co-firing - Using more than one fuel source to produce electricity in a power plant. Common combinations include biomass and coal, biomass and natural gas, or natural gas and coal.

Cogeneration - The generation of electricity and the concurrent use of rejected thermal energy from the conversion system as an auxiliary energy source.

Conduction - The transfer of heat through a material by the transfer of kinetic energy from particle to particle; the flow of heat between two materials of different temperatures that are in direct physical contact.

Convection - The transfer of heat by means of air or fluid movement.

Dam - A structure for impeding and controlling the flow of water in a water course that increases the water elevation to create hydraulic head. The reservoir creates, in effect, stored energy.

District Heating System - Local system that provides thermal energy through steam or hot water piped to buildings within a specific geographic area. Used for space heating, water heating, cooling, and industrial processes. A common application of geothermal resources.

Distributed Generation - Localized or on-site power generation, which can be used to reduce the load on a transmission system by generating electricity close to areas of customer need.

Distribution Line - One or more circuits of an electrical distribution system on the same line or poles or supporting structures, usually operating at a lower voltage than a transmission line.

Domestic Hot Water - Water heated for residential washing, bathing, etc.

Electrical Energy - The amount of work accomplished by electrical power, usually measured in kilowatt-hours (kWh). One kWh is 1,000 Watts and is equal to 3,413 Btu.

Energy - The capability of doing work; different forms of energy can be converted to other forms, but the total amount of energy remains the same.

Energy Crop - A plant grown with the express purpose to be used in biomass electricity or thermal generation.

Energy Storage - The process of converting energy from one form to another for later use. Storage devices and systems include batteries, conventional and pumped storage hydroelectric, flywheels, compressed gas, hydrogen, and thermal mass.

Ethanol - A colorless liquid that is the product of fermentation used in alcoholic beverages, in industrial processes, and as a fuel.

Feedstock - A raw material that can be converted to one or more products.

Fossil Fuels - Fuels formed in the ground from the remains of dead plants and animals, including oil, natural gas, and coal. It takes millions of years to form fossil fuels.

Fuel - Any material burned to make energy.

Fuel Oil - Any liquid petroleum product burned for the generation of heat in a furnace or firebox, or for the generation of power in an engine. Domestic (residential) heating fuels are classed as Nos. 1, 2, 3; Industrial fuels as Nos. 4, 5, and 6.

Generator - A device for converting mechanical energy to electrical energy.

Geothermal Energy - Energy produced by the internal heat of the earth; geothermal heat sources include: hydrothermal convective systems; pressurized water reservoirs; hot dry rocks; thermal gradients; and magma. Geothermal energy can be used directly for heating and cooling or to produce electric power.

Head – A measure of fluid pressure, commonly used in water pumping and hydro power to express height that a pump must lift water, or the distance water falls. Total head accounts for friction and other head losses.

Heat Pump - An electricity powered device that extracts available heat from one area (the heat source) and transfers it to another (the heat sink) to either heat or cool an interior space or to extract heat energy from a fluid.

Hybrid System - An energy system that includes two different types of technologies that produce the same type of energy; for example, a wind turbine and a diesel system combined to meet electric power demand.

Hydroelectric Power Plant - A power plant that produces electricity by the force of water moving through a hydro turbine that spins a generator.

Hydrogen - A chemical element that can be used as a fuel since it has a very high energy content. Although it is often thought of as a fuel, hydrogen is better classified as an energy storage medium because it requires energy, typically from electricity or natural gas, to produce it.

Insolation - A measure of the amount of solar radiation energy received on a given surface area.

Landfill Gas - Naturally occurring methane produced in landfills that can be burned in a boiler to produce heat or in a gas turbine or engine-generator to produce electricity.

Large-scale or Utility-scale - A power generating facility designed to output enough electricity for purchase by a utility.

Load - Amount of electricity required to meet customer demand at any given time.

Meteorological (Met) Tower - A structure instrumented with anemometers, wind vanes, and other sensors to measure the wind resource at a site.

Ocean Energy Systems - Energy conversion technologies that harness the energy in tides, waves, and thermal gradients in the oceans.

Ocean Thermal Energy Conversion (OTEC) - The process or technologies for producing energy by harnessing the temperature differences between ocean surface waters and that of ocean depths.

Organic Rankine cycle (ORC) – A closed system that uses an organic working fluid instead of water to spin a turbine, and therefore can operate at lower temperatures and pressures than a conventional steam process.

Panel (Solar) - A term applied to individual solar collectors, and typically to solar photovoltaic collectors or modules.

Passive Solar Design - Construction of a building to maximize solar heat gain in the winter and minimize it in the summer without the use of fans or pumps, thereby reducing the use of mechanical heating and cooling systems.

Peak load – The amount of electricity required to meet customer demand at its highest.

Penstock - A component of a hydropower plant; a pipe that delivers water to the turbine.

Photovoltaics (PV) - Devices that convert sunlight directly into electricity using semiconductor materials. Most commonly found on a fixed or movable panel; also called solar panels.

Power - Energy that is capable of doing work; the time rate at which work is performed, measured in horsepower, Watts, or Btu per hour.

Production Tax Credit (PTC) – An incentive that allows the owner of a qualifying energy project to reduce their taxes by a specified amount. The federal PTC for wind, geothermal, and closed-loop biomass is 1.9 cents per kWh.

Radiation - The transfer of heat through matter or space by means of electromagnetic waves.

Railbelt - The portion of Alaska near the Alaska Railroad, including Fairbanks, Anchorage, and the Kenai Peninsula.

Renewable Resource - Energy sources which are continuously replenished by natural processes, such as wind, solar, biomass, hydroelectric, wave, tidal, and geothermal.

Run-of-River Hydroelectric - A type of hydroelectric facility that uses a portion of the river flow with minimal impoundment of the water.

Small-scale or Residential-scale - A generating facility designed to output enough electricity to offset the needs of a residence, farm or small group of farms, generally 250 kW or smaller.

Solar Energy - Electromagnetic energy transmitted from the sun (solar radiation). The amount that reaches the earth is equal to one billionth of total solar energy generated, or the equivalent of about 420 trillion kilowatt-hours.

Solar Radiation - A general term for the visible and near visible (ultraviolet and near-infrared) electromagnetic radiation that is emitted by the sun. It has a spectral, or wavelength, distribution that corresponds to different energy levels; short wavelength radiation has a higher energy than long-wavelength radiation.

Tidal Power - The power available from either the rise and fall or flow associated with ocean tides.

Transmission Grid - The network of power lines and associated equipment required to deliver electricity from generating facilities to consumers through electric lines at high voltage, typically 69kV and above.

Turbine - A device for converting the flow of a fluid (air, steam, water, or hot gases) into mechanical motion.

Wave Energy - Energy derived from the motion of ocean waves.

Wind Energy - Energy derived from the movement of the wind across a landscape caused by the heating of the atmosphere, earth, and oceans by the sun.

Wind Turbine - A device that converts energy in the wind to electrical energy, typically having two or three blades.

Windmill - A device that converts energy in the wind to mechanical energy that is used to grind grain or pump water.

Wind Power Class - A class based on wind power density ranging from 1 (worst) to 7 (best).

Wind Power Density - The amount of power per unit area of a free windstream.

Wind Resource Assessment - The process of characterizing the wind resource and its energy potential, for a specific site or geographical area.

UNITS

Ampere - A unit of measure for an electrical current; the amount of current that flows in a circuit at an electromotive force of one Volt and at a resistance of one Ohm. Abbreviated as amp.

Amp-Hours - A measure of the flow of current (in amperes) over one hour.

Barrel (Petroleum) - Equivalent to 42 U.S. gallons (306 pounds of oil, or 5.78 million Btu).

British Thermal Unit (Btu) - The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; equal to 252 calories.

Cord (of Wood) - A stack of wood 4 feet by 4 feet by 8 feet.

Gigawatt (GW) - A unit of power equal to 1 billion watts, 1 million kilowatts, or 1,000 megawatts.

Gigawatt-hour (GWh) - One million kilowatt-hours or 1 billion watt-hours.

Hertz - A measure of the number of cycles or wavelengths of electrical energy per second; U.S. electricity supply has a standard frequency of 60 hertz.

Horsepower (hp) - A measure of time rate of mechanical energy output; usually applied to electric motors as the maximum output; 1 electrical hp is equal to 0.746 kilowatts or 2,545 Btu per hour.

Kilowatt (kW) - A standard unit of electrical power equal to one thousand watts, or to the energy consumption at a rate of 1000 Joules per second.

Kilowatt-hour (kWh) - A common measurement of electricity equivalent to one kilowatt of power generated or consumed over the period of one hour; equivalent to 3,412 Btu.

Megawatt (MW) - One thousand kilowatts or 1 million watts; standard measure of electric power plant generating capacity.

Megawatt-hour (MWh) - One thousand kilowatt-hours or 1 million watt-hours.

Mill - A common monetary measure equal to one-thousandth of a dollar or a tenth of a cent.

Quad - One quadrillion Btu.

Therm - A unit of heat containing 100,000 British thermal units (Btu).

Terawatt (TW) - A unit of electrical power equal to one trillion watts or one million megawatts.

Tonne - A unit of mass equal to 1,000 kilograms or 2,204.6 pounds, also known as a metric ton.

Volt (V) - A unit of electrical force equal to that amount of electromotive force that will cause a steady current of one ampere to flow through a resistance of one ohm.

Voltage - The amount of electromotive force, measured in volts, that exists between two points.

Watt (W) - Instantaneous measure of power, equivalent to one ampere under an electrical pressure of one volt. One watt equals 1/746 horsepower, or one joule per second. It is the product of Voltage and Current (amperage).

Watt-hour - A unit of electricity consumption of one Watt over the period of one hour.

Watts per Square Meter (W/m^2) - Unit used to measure wind power density, measured in Watts per square meter of blade swept area.

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Average oil, gas, and hydro electrical generation data augmented via personal communication with AEA staff and the operating utilities.

(6) Pie chart from: U.S. Energy Information Administration www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html Retrieved: March 25, 2011. Source tables summarized by ISER and AEA include 1990 - 2009 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923) and 1990 – 2009 Retail Sales of Electricity by State by Sector by Provider (EIA-861).

(7) Existing Utility Hydroelectric sites: Alaska Energy Authority hydroelectric database. Spatial location and attribute data updated by HDR Alaska Inc. in 2006 and AEA in 2011.

(8) Wind Sites*: Average wind generation from the Statistical Report of the Power Cost Equalization Program, FY2010 and augmented by AEA. Includes projects currently under commissioning and expected to be in operation by the end of 2011. http://www.akenergyauthority.org/PDF%20files/FY10PCEreport.pdf

(9) Electrical Interties: Interties aggregated from data provided by Alaska Electric Light & Power Company, Alaska Power & Telephone Company, Alaska Village Electric Cooperative, Chugach Electric Association, City of Sitka Electric Department, Copper Valley Electric Association, Four Dam Pool Association, Golden Valley Electric Association, Homer Electric Association, Naknek Electric Association, Nushagak Cooperative, and AEA.

(10) Natural Gas Pipelines: ENSTAR Natural Gas Company.

(11) Electric Service Areas: Chugach Electric Association.

(12) Trans-Alaska Pipeline: Alaska Department of Natural Resources. www.asgdc.alaska.gov

(13) Roads: Alaska Department of Natural Resources & Alaska Department of Transportation. www.asgdc.alaska.gov

Biomass
(14) USDA Forest Service Forest Inventory and Analysis, Remote Sensing Applications Center 2008 based on J.A. Blackard, et.al. Mapping U.S. forest biomass using nationwide forest inventory data and moderate resolution information. Remote Sensing of Environment 112:1658-1677 fsgeodata.fs.fed.us/rastergateway/biomass/

(15) Shore-based Seafood Processors*: Alaska Department of Fish and Game. 2010 Commercial Operators Annual Report, data compiled by the Alaska Fisheries Information Network (AKFIN). www.akfin.org

(16) Class I Landfills*: Alaska Department of Environmental Conservation.

(17) Sawmills*: Alaska Wood Products Manufacturers Directory, September 2004. Juneau Economic Development Council Wood Products Development Service. Dataset augmented via personal communication with Dan Parrent, USFS. http://jedc.org/wood.shtml

Geothermal
(18) Volcanoes: Alaska Volcano Observatory. The locations depicted represent volcanoes without regard to recency of activity. www.avo.alaska.edu/pdfs/AKvolclatlong.zip

(19) Wells and Springs by Temperature and Potential Geothermal Resources: Geothermal Resources of Alaska, Motyka, R.J., Moorman, M.A., and Liss, S.A., 1983, Geothermal Resources of Alaska: Miscellaneous Publication MP 8, Alaska, Department of Natural Resources, Division of Geological & Geophysical Surveys, Fairbanks, Alaska – USA www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=671

(20) Wells and Springs by Temperature: Kolker, Amanda, Stelling, Pete, and Cummming, William. Geothermal Exploration at Akutan, Alaska: Favorable Indications for a High-EnthalpyHydrothermal Resource Near a Remote Market. Geothermal Resources Council (GRC) Annual Meeting, October 24-27, 2010. Sacramento, CA. www.geothermal. org/2010AMBrochure1001.pdf

Hydroelectric
(21) Existing and Potential Hydroelectric sites: Alaska Energy Authority hydroelectric database. Spatial location and attribute data updated by HDR Alaska Inc. in 2006 and AEA, 2011.

Ocean & River Hydrokinetic
(22) Tidal Electric Generation Potential: Brian Polagye, 2007. Tidal resource was quantified for 35 transects across tidal channels, perpendicular to the flow. The analysis used NOAA time series of currents and tidal range, as well as bathymetric data. Due to map scale each study site is depicted as a point location rather than a linear transect.

(23) Wave Power Potential: Mirko Previsic (re vision consulting LLC), 2007.

(24) In-Stream Hydrokinetic: Jacobson, Paul T., Ravens, Thomas, Cunningham, Keith. Assessment of U.S. In-Stream Hydrokinetic Energy Resources. Electric Power Research Institute Presentation. February 8, 2011. Power density estimates based on the cross-section average velocity at the open-water average flow rate at the given site. Open-water power density at the fast flowing portions of the river are several times greater than levels reported here.

Solar
(25) Solar Insolation: U.S. Department of Energy, National Renewable Energy Laboratory, 1999. Data layer provides annual average daily total solar resource averaged over surface cells of approximately 40 km by 40 km in size. www.nrel.gov/gis/data_analysis.html

Wind
(26) Wind Power: AWS Truepower, LLC Wind Resource Maps of Alaska using the MesoMap® system and historical weather data prepared for the Alaska Energy Authority, September, 2010. Although it is believed to represent an accurate overall picture of the wind energy resource, estimates at any location should be confirmed by measurement. All datasets were clipped to the coastline.

*For data sources with descriptive point locations, the spatial positions were derived by matching the descriptive location to the community location in (1), or were geocoded using the U.S. Geological Survey Geographic Names Information System database.

For More Information

Alaska

Alaska Energy Authority
www.akenergyauthority.org
Renewable energy resource maps, reports, programs, planning, and financing information.

Alaska Energy Efficiency Website
http://akenergyefficiency.org
State-run clearinghouse for information on energy efficiency in Alaska.

Alaska Housing Finance Corporation
www.ahfc.state.ak.us
Residential and community building energy efficiency programs, energy resources library, programs, and financing information.

Denali Commission
www.denali.gov
Independent federal agency created by Congress to provide basic facilities to remote Alaskan communities.

Renewable Energy Alaska Project
www.realaska.org
Alaska utilities, businesses, conservation and consumer groups, and Alaska Native groups with an interest in developing renewable energy resources.

University of Alaska Fairbanks Arctic Energy Technology Development Laboratory
www.uaf.edu/aetdl
Promotes research, development and deployment (RD&D) of energy technologies in Arctic regions.

University of Alaska Fairbanks Cooperative Extension Service
www.uaf.edu/coop-ext/faculty/seifert/energy.html
Provides housing technology information to Alaskan home owners and builders.

Nationwide and Regional

National Renewable Energy Laboratory
www.nrel.gov
USDOE's premier laboratory for renewable energy research and development.

US Department of Energy
www.energy.gov
USDOE home page provides information on federal programs relating to energy.

Western Governors' Association
www.westgov.org
Maintains an advisory committee on clean and diversified energy .

Policies Supporting Renewable Energy

Database of State Incentives for Renewables & Efficiency
www.dsireusa.org
Information on tax incentives, rebate programs, portfolio standards, green power programs, and other state-level policies.

National Association of State Energy Officials
www.naseo.org
Represents governor-designated officials from each state.

Biomass

National Biodiesel Board
www.biodiesel.org
National trade association represents the biodiesel industry.

Biomass Program
www1.eere.energy.gov/biomass
USDOE's biomass energy program.

Pacific Regional Biomass Energy Partnership
www.pacificbiomass.org
Promotes bioenergy development in Alaska, Hawaii, Idaho, Montana, Oregon, and Washington.

Geothermal

Geothermal Resources Council
www.geothermal.org
International association for geothermal education including industry, researchers, and government.

Geothermal Technologies Program
www1.eere.energy.gov/geothermal
USDOE's geothermal energy program.

Ocean

Electric Power Research Institute: Ocean Energy Program
www.epri.com/oceanenergy/
Tidal and wave energy webpage for independent, nonprofit energy research center.

Ocean Renewable Energy Coalition
www.oceanrenewable.com
National trade association for marine and hydrokinetic energy technologies.

Solar

Alaska Sun
www.alaskasun.org
Alaskans supporting solar energy with link to Solar Design Manual for Alaska.

American Solar Energy Society
www.ases.org
A national association dedicated to advancing the use of solar energy.

Solar Energy Technologies Program
www1.eere.energy.gov/solar
USDOE's solar energy technology website.

Wind

Wind Powering America
www.windpoweringamerica.gov
USDOE's wind energy deployment program.

National Wind Technology Center
www.nrel.gov/wind
USDOE's wind energy research and development facility.

American Wind Energy Association
www.awea.org
National trade association promoting the development of wind power.

Acknowledgments and Thanks

Text, editing, and maps by Alaska Energy Authority (Peter Crimp, David Lockard, Emily Binnian, Barbara Triplett, Devany Plentovich, Rich Stromberg, James Jensen, Doug Ott, Audrey Alstrom, Amber Converse, and Lauren Fritz) and Renewable Energy Alaska Project staff (Chris Rose, Hannah Gustafson, Stephanie Nowers, and Erin Shew). Thanks to the Western Resource Advocates and Northwest Sustainable Energy for Economic Development (NWSEED) for consultation and textual material. Thanks to Rich Seifert, UAF Cooperative Extension Service for solar energy material and to Paul Gipe who provided information on feed laws for the policy section.

Thanks to Alaska Electric Light and Power Company, Alaska Power and Telephone Company, Alaska Village Electric Cooperative, Chugach Electric Association, Homer Electric Association, City of Sitka Electric Department, Copper Valley Electric Association, Enstar Natural Gas Company, Four Dam Pool Association, Naknek Electric Association, and Nushagak Cooperative for power and natural gas system information for the infrastructure section.

Special thanks to Alaska Power Association, Rural CAP, Institute of the North – Arctic Energy Summit, Municipal Light and Power, Chugach Electric Association, Alaska Village Electric Coop, TDX Power, Sierra Club, Kotzebue Electric Association, and Homer Electric Association for covering the printing costs of previous editions of this publication.

Maps and design by Resource Data, Inc. (Dan Rathert and Matt Johnson).

Cost Block Information:
The Renewable Energy Atlas of Alaska was produced by the Alaska Energy Authority. It was printed by Northern Printing Inc. in Anchorage at a cost of $1.48 each.

RENEWABLE ENERGY ATLAS OF ALASKA

A Guide to Alaska's Clean, Local, and Inexhaustible Energy Resources

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