

**ALASKA STATE LEGISLATURE
SENATE SPECIAL COMMITTEE ON ENERGY**

January 29, 2009

10:06 a.m.

MEMBERS PRESENT

Senator Lesil McGuire, Chair
Senator Albert Kookesh
Senator Bert Stedman
Senator Bill Wielechowski

MEMBERS ABSENT

Senator Lyman Hoffman

OTHER LEGISLATORS PRESENT

Senator Charlie Huggins

COMMITTEE CALENDAR

Overview: Geothermal Energy in Alaska

Bob Swenson, Director, Alaska Division of Geological and Geophysical Surveys
Gwen Holdmann, Director, Alaska Center for Energy and Power
Chris Rose, Executive Director, Renewable Energy Alaska Project

PREVIOUS COMMITTEE ACTION

No action to report.

WITNESS REGISTER

BOB SWENSON, Director
Division of Geological and Geophysical Surveys
Department of Natural Resources (DNR)
Fairbanks AK

POSITION STATEMENT: Provided an overview of geothermal resources in Alaska.

GWEN HOLDMANN, Director
Alaska Center for Energy and Power (ACEP)
Fairbanks AK

POSITION STATEMENT: Provided information on the Chena Hot Springs geothermal project in Alaska.

CHRIS ROSE, Executive Director
Renewable Energy Alaska Project (REAP)
Anchorage AK

POSITION STATEMENT: Provided information and made suggestions on geothermal and other renewable energy policies.

ACTION NARRATIVE

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CHAIR LESIL MCGUIRE called the Senate Special Committee on Energy to order at 10:06. Present at the call to order were Senators Stedman, Wielechowski, Kookesh, and McGuire.

Overview: Geothermal Energy in Alaska

CHAIR MCGUIRE said the hearing will cover how geothermal energy fits into renewal energy as a whole, how other jurisdictions are looking at it, what the state is doing, and where the state needs improvements.

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Bob Swenson, Division of Geological and Geophysical Surveys

BOB SWENSON, Director, Division of Geological and Geophysical Surveys, Department of Natural Resources (DNR), Fairbanks, said geothermal heat is not new, but recently there has been a better understanding of how heat is generated and transmitted in the earth's core. He presented a slide show to the committee. The earth becomes incredibly hot with depth. Working with geothermal in the United States has been a challenge.

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MR. SWENSON said geothermal heat, where technically and economically accessible, is an excellent form of sustainable energy. Hydrothermal systems are the most common form of energy extraction from geothermal heat. It is rare to have the complex geologic parameters necessary for a viable geothermal resource. Certain settings are much more conducive. Alaska contains a number of potential sites, but there are many hurdles. New technologies are on the horizon but need extensive research.

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MR. SWENSON said temperatures in the earth are incredibly hot, but one can't just drill deeper to get it. The deepest well on

the planet is "essentially touching the surface of the earth," and none have reached the really hot regions. Knowing the heat is down there conjures up a number of different models to get it. He showed possibilities including "the motion of water heated up by this red, glowing source at depth." It is not that simple, he stated.

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MR. SWENSON said the four fundamental ingredients for geothermal energy include a geothermal gradient; porosity and permeability for the migration of fluids (an incredibly important part of the system); surface access; and sufficiently large hydrothermal systems. Alaska has many volcanoes. He showed an illustration of all volcanoes that have been active within the last 100,000 years. The next diagram showed large lineaments through the center of Alaska and a smaller one. "This is the Denali fault; this is what creates the Alaska Range." "...huge strike-slip faults that come in through the middle of the state and create all the deformation and a lot of the geology that we see -- big strike-slip systems where this rock is moving to the left in relationship to that rock. And so those are big crustal-scale faults. When we take a look at where the geothermal sources are in the interior part of Alaska, they're related to this system, because we have crustal-scale faulting; we actually have the possibility of allowing meteoric or surface waters to get at great depth and be heated up and [brought] back to the surface because of its buoyancy."

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MR. SWENSON said he will talk about all the different settings that are conducive to geothermal energy and which of those are in Alaska. He referred to a red line on a map that is related to what is seen along the Aleutian chain. The center of the Atlantic Ocean is a spreading center. That is where the two oceanic plates are pulling apart. It is important to note the Moho (Mohorovicic discontinuity) -- where rock changes from a competent rock to a mushy rock. It's where the heat changes the phase of the rock. The depth of that is important - "that tells you how deep the hot rock is in any given area." In a spreading center, the Moho comes to the surface because the plates are pulling apart and the molten rock is coming to the surface and creating new crust. Iceland is the only place that has an oceanic spreading center at the surface, making it geothermically conducive. "Anywhere you drill, you're going to be very, very close to a geothermal source."

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SENATOR WIELECHOWSKI asked how deep a geothermal facility must go in Iceland and how that compares to Alaska.

MR. SWENSON said in Iceland it is very shallow -- at the surface even or to 2,000 feet. He will discuss Alaska's situation in great detail. Other good areas are called "hot spots." There are a number of them around the globe and he noted the Hawaiian hot spots that cause volcanic eruptions. There are also "oceanic arcs." The Philippines, for example, has that, and it is a relatively thin crust. Rift zones, where continents are getting pulled apart and the crust becomes thin have heat toward the surface. Nevada and Baja have rift zones. "Unfortunately, we don't have these in Alaska. What we have in Alaska is what you see here, and it doesn't mean we don't have geothermal resources." It has to be put into context of other areas.

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MR. SWENSON showed a map of heat flow in Alaska. It is related to the geothermal gradient and shows how fast heat is coming to the surface. The map shows slightly elevated heat flow across all of the state, which is good. "That makes us excited." However, the devil's in the details. He zoomed in on the map and looked at actual data points "that they're making this map on." He said, "That triangle, right there, constrains that whole area. There's only one data point in that whole area that tells you that. The hot springs are used in that, of course, however, again, I told you those big faults that run through the center part of the state, those hot springs are localized because of those big faults; that doesn't mean you have heat flow associated like that across the entire state or across the entire area. So, again, you have to put these things into context." He showed a map of the Aleutian Peninsula and of the wells drilled looking for oil and gas. The wells provide data showing temperature at depth, which will "help us constrain what our heat flow is, help us constrain what those gradients are."

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MR. SWENSON said the gradients show a tremendous amount of variability. He pointed to a gradient of 3.56° C per 100 meters and said it is a very common geothermal gradient. There is also a gradient of [2.2 ° C per 100 meters], which is relatively cold. Most of the wells in that area show a normal continental gradient because of the thick crust and the depth to the Moho. But right in a volcano, one gradient is 5.43° C, and that is relatively high. "So you can assume that these are actually getting closer to some type of heat source, obviously the intrusions that come up through the crust in the volcanic

areas." He showed those gradients on a plot. He added Chena and Makushin points on the graph. Makushin is in the Aleutian chain, and it is by far the best chance for geothermal power in the state. The shallower it is the less it will cost to produce electrical power. Drilling costs are in the packet. The average drilling cost in the Prudhoe Bay area is about \$1,800 per foot. A 10,000-foot well would cost \$18 million at a minimum. In a remote area, costs rise to \$3,500 per foot. [Geothermal] works well in Chena because it is shallow and hot enough to produce kilowatts. But finding heat near the surface is just part of the story. Porosity/permeability is another factor.

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MR. SWENSON showed a slide of a microscopic view of sandstone, and he pointed out the spaces between the grains, which define the porosity and is where the fluid will reside. The interconnection of the spaces defines the permeability. "That's how you can flow water through rock." It is very important. Each rock will have different porosity and permeability, so he showed a graph of Cook Inlet sandstones. "Tight sands" have low porosity and very low permeability, and they house a lot of resource, but it is incredibly hard to get at. He pointed on the graph where the hot rock will lie. He said to look at a place with natural fractures that will allow fluids to move through the rocks. The big faults in the state are very good. The fluid moves through and picks up the heat. There are "direct indicators" of a resource, like hydrocarbon. He showed an image of a natural oil seep in southern Alaska. It was the first oil field in the state. Another direct indicator would be a flat spot that denotes contact between gas and water. Those indicators tell explorers where to drill. He showed a hot spring that has gas bubbling out of it in the Port Moller area. The water coming out is about 160 degrees. There is a pile of clamshells that Native Alaskans had cooked on the heat.

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MR. SWENSON spoke of direct geothermal indicators. Geysers like the one he showed is one. The geologic survey is taking all the subsurface information that it can find that has temperature information with it. It is making geothermal gradients and looking for any anomalies - or hot rocks closer to the surface. Most of the North Slope has relatively constant gradients, but there are elevated temperatures that need to be analyzed.

MR. SWENSON showed a map of all the surface manifestations of the geothermal resources in the state, color-coded by temperature. Most have a low temperature. The higher

temperatures tend to be out in the Aleutian chain or in Southeast Alaska. How is this going to help people in rural Alaska? There are viable opportunities for geothermal. He plotted all Alaska villages with more than 100 people. "It's not going to impact a tremendous number of communities in Alaska, but there are opportunities."

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MR. SWENSON said the types of geothermal systems are categorized by temperature, depth, and steam or fluid type (steam has the best BTU per unit of fluid). Most of what Alaska has is low temperature; however, there are things like Makushin, which is steam and hot water at relatively shallow depths. There's lots of research going on; a lot of the "frac technology" is actually being developed within the oil and gas industry. Geothermal surface manifestations are very odd; one doesn't always see geysers. Such things get put in national parks, like Yellowstone, where the geothermal potential is incredible. The same thing is going on in Alaska, like Katmai National Park.

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MR. SWENSON referred to geo-hazards, and said that most of Alaska's volcanoes have eruptive histories with some very violent eruptions, and that is a problem. He noted three that erupted this last summer, and Mt. Redoubt is on watch right now. He showed photos of Kasatochi prior to this summer's eruption and after the eruption. "It was a great bird rookery; it was a beautiful little island, but this is what it looks like now. So we have to be very, very careful about where we do site any types of geothermal facilities because of the geo-hazards associated with that." In summary, there is geothermal potential, but there is a lot of work to do and a lot of hurdles. It should make up part of Alaska's energy portfolio over the next 15 to 20 years.

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SENATOR STEDMAN suggested Mr. Swenson come back to the committee and discuss the regions in greater detail.

CHAIR MCGUIRE agreed, and she asked that he specify the areas in rural Alaska that could use geothermal energy.

SENATOR WIELECHOWSKI asked about Mt. Redoubt.

MR. SWENSON said currently there is a sustained group of tremors below the earth that are related to fluid movement. The fluid movement could just be hydrothermal fluid moving up from a magma

source. But experts say that an eruption is "pretty imminent." This type of fluid movement doesn't occur without something happening at the surface, and it is most likely within a few days. "Even from what they're seeing, they can't tell you how big of an eruption it's going to be." There was very little seismic activity prior to the Kasatochi eruption, and "it was a huge eruption." It could just blow out a bit of ash or "it could be something like 1982."

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SENATOR HUGGINS asked what the prevailing winds are.

MR. SWENSON recommended the website for the Alaska Volcano Observatory (AVO). Real-time data is presented there.

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The committee took an at-ease.

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Gwen Holdmann, Alaska Center for Energy and Power

GWEN HOLDMANN, Director, Alaska Center for Energy and Power (ACEP), Fairbanks, said ACEP is a program of the University of Alaska. The first geothermal power was produced in Italy in 1904 from a dry steam field and is similar to the "the Geysers" in California. Those are the two world-class geothermal resources and are the easiest resources for power generation. The dry steam coming out is used directly in a steam turbine cycle. The water-dominated systems, like in the Imperial Valley of California, were not brought on line until 1979. That is the technology used at Chena Hot Springs. She showed a graphic of how geothermal power is generated, "and the important thing here is to note that there is both production and injection wells." The wells produce a geothermal fluid to be used in some kind of power-generation schedule. Most of the time the fluid is reinjected in the ground to make sure the reservoir is developed sustainably. "You're mining heat out of the earth, and you want to be careful to do that in a sustainable way, and the injection part of this system is actually super, super critical ... in terms of maintaining heat and not overdeveloping the system."

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MS. HOLDMANN said steam power-plant technology is similar to plants that use things like coal or nuclear power as a heat source. The heat develops steam that drives the turbine. A binary power plant, developed in the late 1970s, is a little different, and that is the one used at Chena Hot Springs. The

water is not hot enough to boil, so steam can't be generated at atmospheric pressure. Instead, a fluid with a lower boiling point than water is boiled into a vapor to drive a turbine. A hydrocarbon or refrigerant is used.

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MS. HOLDMANN said geothermal energy is definitely on the rise world wide - "pretty dramatically." The United States is the only country where geothermal energy use has dropped, and that is because of problems developing the Geysers in California, which is the largest developed field in the world. There are problems. It is now injecting waste water from sewage plants to sustain the steam production.

MS. HOLDMANN noted the Chena Hot Springs site. Geothermal is one of the few sustainable energy sources that are truly dispatchable. It is there when you need it and can be used as a base load, in contrast to wind, solar, or hydro power, which have daily, hourly, or seasonal fluctuations. United Technologies built and designed the plant at Chena Hot Springs. It is the only [geothermal] power plant in Alaska. United Technologies is a Fortune 500 company and is very interested in Alaska, "and it's been interesting to see how they fit developing kind of cutting-edge emerging technologies into their business model." This is their number one product that it has developed over the past couple of years, and the company is very excited to talk about it being "Alaska tough" while marketing it.

MS. HOLDMANN said the University of Alaska is a big participant in the geothermal exploration programs and the greenhouse project. The power plant project was funded with a \$250,000 grant from the Alaska Energy Authority. The Denali Commission was involved. The Department of Energy funded the exploration program at Chena. The first well was drilled in 1998, and all of the buildings on the property are heated with geothermal water, which is 165° F. The temperature is low on the spectrum of geothermal heat. Yearly energy savings are about \$500,000 just in heating.

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MS. HOLDMANN said Chena Hot Springs also has greenhouses and gardens with crops grown year-round. The greenhouse project was completed in 2006, and it is 5,000 square feet. It requires 60 kilowatts for lighting. Without the geothermal plant, the project would not be possible, even with the geothermal heat. The Aurora Ice Museum was her favorite project that she was

involved in. It uses heat to drive a refrigeration cycle instead of electric power to drive a compressor. It is not new technology but it has never been applied to such a low-temperature resource. It is the only place in the world using geothermal heat for absorption refrigeration. She showed a photo of the equipment, which is only four feet wide and six feet high. It is state of the art. It can run off of any kind of heat source. "Waste heat at 165° F is available from every single diesel generator in rural Alaska, and we can be doing things like that." Kotzebue uses a similar kind of absorption chiller to make ice for the local fish industry.

MS. HOLDMANN said resource exploration is very important. The original reports on Chena all said that it could not be developed for power generation because of not enough heat. She said to keep that in mind. There may be a need to reevaluate existing resources in light of newer technologies. A big part of the Chena project was extensive resource exploration to make sure that the injection wells were sited properly and sustainably.

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MS. HOLDMANN said the power plant at Chena is comprised of two 200 kilowatt units. A third was installed. They are prototypes and the first ones in the world ever built by United Technology for the purpose of power generation. But several hundred units were sold "in the meantime." The plant in Chena was installed in 2006 using about 900 gallons per minute of the hot water. It is air and water cooled. Alaska has good cold water and air. The power is made from the difference between the hot and cold temperatures, or delta-T. "If you don't have that much on the high side, if you've got a really low cold temperature that you can reject heat to, then you can actually still produce quite a bit of power. And that's actually something that's pretty interesting to Alaska." Even though Chena doesn't have high temperatures, the cold can be used to an advantage. The plant has reduced the cost of power from about \$0.30 (using diesel) to about \$0.05. The project cost about \$2.2 million, and the savings are about \$500,000 per year. So payback will take about six years. There are additional revenue opportunities because of the draw to visitors to see the project.

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MS. HOLDMANN said a binary power plant is like a refrigeration cycle in reverse. Hot water comes in to the evaporator side and boils the refrigerant, which generates vapor. The vapor drives

the turbine. The spent vapor is recondensed back into a liquid in a condenser. It could be with cold air or cold water.

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SENATOR WIELECHOWSKI said 160°F will not boil water.

MS. HOLDMANN said the hot water is not boiling, so the heat is boiling a refrigerant that has a lower boiling point. It boils at about 20°F. It is a closed cycle, "so you would hope that you don't ever lose the refrigerant." It is simple technology. It will work off of any low-grade heat source: waste heat, biomass, and a number of different options.

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CHAIR MCGUIRE asked if anyone has considered replication of this plant in rural Alaska.

MS. HOLDMANN said there has been much discussion. Her program is assessing smaller units for waste heat recovery on diesel generators in rural Alaska. Chena Hot Springs and the university are involved in testing this equipment using biomass in North Pole as a demonstration project.

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CHAIR MCGUIRE said this committee will look at biomass next. She talked to people from Ocean Beauty Seafoods about its plant at Naknek. It is running off of diesel, and there was discussion about using fish wastes.

MS. HOLDMANN replied that that is a really great topic. Her program has done a lot of research in using fish byproducts for power generation and heating in rural communities. Fish oil can't be thought of as a fuel the way that hydrocarbons are; it has a shelf life so it needs to be thought of as food. Once it oxidizes it can destroy diesel engines. It needs to be stabilized as a fuel if it is not used "in the near term."

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MS. HOLDMANN said in 22,000 hours of operation in two years, there has been very little down time. It operates 95 percent of the time. Capacity is lower: the average output is 175 kilowatts when the boiler nameplate was 200 kilowatts, and that is because of an engineering issue with getting enough water to it. But it has still offset well over 200,000 gallons of diesel fuel and CO2. The Chena project has gotten a lot of attention because it was previously thought that binary power needed a temperature of at least 230° F. Chena has "blown that out of the water and

literally rewritten the textbooks to say that 165 is now the bar for that." It's gotten recognition. It got the top power-generating project of the year award in the renewable energy category by "PowerGen" magazine. It got an award from the Department of Energy. It is nice to see Alaska on the map for such a project.

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MS. HOLDMANN said there have been spinoff projects. She has been involved in trying to deploy this on oil and gas wells using heat that is also extracted. The wells on the North Slope are about 10,000 feet deep where it is about 165 degrees. That is enough to generate power. The oil and gas industry was approached about demonstrating this technology. There was hesitancy, so a private developer in Florida is going to do that as a pilot project. Regarding a proposed bill, she suggested thinking about this idea. She noted the biomass power plant being built in North Pole, and she said United Technologies is also building a 1-megawatt unit to test in Alaska and a 5-kilowatt unit for waste heat applications for rural Alaska.

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Wielechowski asked how many houses could use 1 megawatt, and if it is electricity and heat.

MS. HOLDMANN said a megawatt could serve a "hub" village. Kotzebue or Nome would have about 5 megawatts of generation. "We're not talking about heat here, and that's really unfortunate." Heat is a big issue and there is so much potential, but ground-source heat pumps need a hole drilled. In rural Alaska it is difficult to be cost effective. But in Juneau, there are two ground-source heat projects going in now using heat from the first couple hundred feet of the earth, "which is almost more stored in solar radiation from the summer." It is popular in the Lower 48 and applicable to a lot of Alaska, but not all of it.

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SENATOR WIELECHOWSKI asked how many more megawatts would be needed to provide electric heat to a hub village.

MS. HOLDMANN guessed that it would triple the need.

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MS. HOLDMANN said Disneyland is getting most of its power from the same plant that Chena Hot Springs is using - from a project in Utah.

MS. HOLDMANN said enhanced [or engineered] geothermal systems (EGS) create artificial geothermal systems. The U.S. Department of Energy is betting heavily on it. Almost all of the funding for geothermal is going into it. It involves waters percolating through rock toward heat and coming back up to the surface somehow. In several places in the world artificial systems are being created. "So you're creating production and injection wells and you're actually fracturing rock or finding natural areas of high permeability and porosity ... and you're actually pumping water into a reservoir and then reproducing it and mining this heat from the reservoir for power generation." It suddenly opens up a much broader area where geothermal is possible. "Right now we're depending on natural hydrothermal systems to basically mine this heat and bring water to the surface that we can use and power generation cycles; if we can create these kind of artificial cycles in different places, now we're looking at areas that have just higher elevated temperature gradients that we could be using for geothermal. And that suddenly opens up a much bigger part of the state for possible geothermal development." She calls it a "game changer" and a pretty big deal.

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SENATOR HUGGINS asked about subterranean combustion of coal in coalfield sites. "Injecting water on top of it."

MS. HOLDMANN said that has been discussed, especially with un-minable coal seams. The coal gets combusted in situ, and the gas is used for power generation. It is being done in a couple of pilot projects around the world.

MS. HOLDMANN said EGS increases the potential for geothermal energy "by an order of magnitude." MIT has done a lot of work estimating the economics, and it predicts a cost of 3.5 cents per kilowatt in the long term. It is not accurate for current projects. There are no commercially viable projects in the United States. There have been demonstration projects only. The ones done elsewhere are based on incentive programs that don't exist in this country. Alaska should look for potential areas where an EGS project could be done and evaluate a pilot project in a controlled setting with high resource potential. An EGS is being developed in the Cooper Basin in Australia, and there is the potential for 5 to 10 megawatts. That is like 5 to 10 nuclear power plants. There are six small ones in Europe that are operating and are connected to the grid. The reason why they work is based on policy and feed-in tariffs that give a good

price for that power. Those settings in Europe are similar to places in Interior Alaska; they are associated with granitic formations and elevated heat flow like at Chena, "but there's no surface expression - they're creating this artificial geothermal system."

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MS. HOLDMANN said ACEP proposed a pilot EGS project to the Department of Energy in January, 2008. It was in partnership with several national labs that had developed this concept, and the plan was to use supercritical CO2 instead of water. "So essentially liquefy CO2 and use that as the heat transmission fluid instead of water." CO2 has a much lower viscosity so it will move through tight formations more easily. It doesn't gunk up rock with mineralization, and it is more buoyant, so as it's heated up, it wants to come back up to the surface, which takes less energy to pump. This has never been done.

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MS. HOLDMANN said there is a high likelihood that the Arctic Ocean will be seasonally ice-free in the next several decades. The focus in the Aleutians has been on surface manifestations and resources that are close to population centers. Iceland has taken advantage of developing mineral processing industries around stranded and renewable energy resources, and this is something we should take another look at, because as Arctic shipping routes open up, Alaska becomes part of a major shipping route. There are issues with land ownership, but it is worth taking a look at.

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The committee took an at-ease.

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Chris Rose, Renewable Energy Alaska Project

CHRIS ROSE, Executive Director, Renewable Energy Alaska Project (REAP), Anchorage, noted that the previous speakers discussed the resource and the technology, and he will give a broad perspective of geothermal and policies of renewable resources. Making policy needs consensus, so REAP has been bringing stakeholders together, including small and large utilities, environmental consumer groups, Native organizations, government agencies, and businesses in support of increasing the production of renewable energy. "We really see ourselves as a development group to develop these resources." REAP has 21 board members and many contributing members. There are 60 members statewide. REAP

is advocating for and educating people about six main types of renewable energy: wind, geothermal, biomass, tidal/wave, hydro, and solar. As the cost of conventional fuels goes up, the stability of a nonfuel resource is showing its importance.

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MR. ROSE said there are upfront capital costs but no fuel costs. Once those capital costs are in, there will be no fuel costs and business can calculate the cost of power. That is very attractive to businesses. Iceland has been successful in attracting industry. Bauxite is being shipped from Australia to Iceland to make aluminum because they can get a 20-year fixed contract. Renewables are clean, and that plays into the carbon risk. There will be prices on carbon. Renewable fuel is a local resource, and it is inexhaustible. "We have been very blessed to have all these fossil resources that we've been developing." But looking at Chevron's data shows that it has used half of the conventional oil in the last 150 years. The extraction of it will peak and will drive the price up even higher. With renewable resources, "you can be assured that once you start investing in them, you're not going to run out of the wind; you're not going to run out of the water. These are inexhaustible resources." With geothermal, one needs to be a little more careful.

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MR. ROSE said, "We really see renewable energy as risk management." There are many risks, including price. He is expecting a huge increase in demand for energy resources on the planet, and he showed a graph of that increase. Currently the planet is using 400 quadrillion BTUs, and that is expected to double by 2050 and quadruple by 2100. Emerging economies like India, China, and Brazil want to use as much energy as we do, and that will cause a huge demand curve for energy. Oil is used for transportation, and 2/3 of the world's proven conventional oil reserves are in five countries in the Middle East. Saudi Arabia has about 25 percent of the easy, cheap oil. There is geopolitical risk and there is a finite supply of these proven conventional reserves.

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MR. ROSE said another part of the risk involves climate change, and that is why there will be a price on carbon. He finds it interesting how insurance companies are thinking about that. Swiss Re is the second largest insurance company in the world, and it stated: "For Swiss Re, climate change is more than a scientific issue. It is a financial issue." Swiss Re is a re-

insurance company that insures the State Farms and the All-States of the world, and it has to pay for the erratic climactic events around the world that are being associated with increased emissions of greenhouse gases. Swiss Re has had a greenhouse-reduction mismanagement unit for almost a decade, because it is hitting its pocket book. Big companies all around the world are saying that people have to do something. He showed photos of the melting polar ice cap.

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MR. ROSE said the U.S. Supreme Court ruled that the Environmental Protection Agency could regulate CO2 as a pollutant under the Clean Air Act. EPA has acknowledged that it may have to start looking at CO2 as a pollutant, and "we're certainly going to see that in this new administration." There are already many proposals in Congress - everything from a cap-and-trade to a carbon tax. Big utility companies have been looking at this for awhile and integrating the risk of carbon into their plans. The price of carbon under the Kyoto Protocol has been fluctuating over the past several years.

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MR. ROSE said there is a voluntary market for "green tags" or renewable energy certificates that has put a price on carbon. The renewable energy industry has been taking advantage of this for some time by acknowledging that there is an environmental benefit to producing renewable energy creating a market for the displacement of emissions. REAP helped small villages get money for their wind power. Those offsets are sold on the open market.

MR. ROSE showed a photo of a hydrogen filling station in Reykjavik, and said, "I think this is the biggest risk we've got. This is an exploding business. This is a \$55 billion a year market right now, expected to quadruple in the next six years. This is a very big business opportunity, and because we have so many renewable resources here in Alaska, we have a great chance to get in on it." He showed a list of some companies - all foreign companies - that are really into the clean energy market and are making "lots and lots of money doing it." Mid-America Energy, owned by Warren Buffet, is investing heavily in wind energy in the Midwest. Companies that are in fossil industries are investing heavily in wind. It is the fastest growing energy sector in the world. Wind was 35 percent of all new electric generation in the United States last year.

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MR. ROSE showed a photo of the Geysers, the largest developed geothermal resource in the world. It has been near Calistoga, California for the past 30 years. It provides 1,000 megawatts of power for a million people. Geothermal power is being generated at 22 different sites. A lesson was learned because water was not re-injected and the resource became depleted. Production declined, and now treated wastewater is being pumped back into the ground. Especially in an arid climate, water must be reinjected after it has been used to generate power. Geothermal is available almost 100 percent of the time - the most available of any resource. He showed a map of tectonic plate boundaries around the world and a map of where developed sites are. Most of the geothermal activity is in the west - close to the plate boundaries. Sites are found in the Philippines, New Zealand, Iceland, South and Central America, and the American west.

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MR. ROSE showed a photo from Iceland. There is a power plant called Nesjaviller, about 20 miles from Reykjavik, and it makes electricity and then pumps hot water in a pipe above ground to Reykjavik. It pumps hot water 20 miles in a cold climate and loses 2 to 3° F over that difference. Half of the water that heats a population of 180,000 people goes to Reykjavik this way. The other half comes from wells that are drilled right in town. Alaska is not on top of such a zone and can't do that. He showed a photo of six huge storage tanks that store the water. It is then gravity fed to the rest of the city. There are 808 miles of distribution in the city and 50 bore holes. A person in Reykjavik will encounter little shacks with steam coming out, perhaps in a bank parking lot. That is the well house for collecting warm water. Mr. Rose noted that the town is extremely expensive, but heating costs are extremely cheap. Iceland has a "total well concept."

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MR. ROSE said that same water will be used many, many times. When the water is the hottest, it is used to generate electricity, then the water is used to heat homes and buildings, then it is used for outdoor swimming pools, and then it is used in the streets to melt snow, and then the water is dumped at a "beach" in the summer for recreation. A lot of the water is used for fish farming, industry, and greenhouses. Using the heat of the water is called "direct-use" of geothermal. "There's a guy in Idaho who's raising alligators and there's snow-capped mountains in the background."

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MR. ROSE said the Federal Production Tax Credit is by far the most important federal policy to support renewable energy development in the United States. It was passed in the 1990s to level the playing field between the subsidies that have been given to the oil, gas, coal, and nuclear industries over many decades. It is a production credit similar to the legislature's bill. It is not an upfront subsidy or grant, it incentivizes people to go out and produce the power, and then for every kilowatt produced, "you give them something, and in this case, you get a tax credit. This is very good for people who have tax appetites; it doesn't really help the co-ops, for instance, in Alaska because they don't pay taxes." But it has been an important policy. It is 1.9 cents per kilowatt and that adds up to millions of dollars for big wind farms, for example. Congress has been authorizing this only one to two years at a time, so it creates a "stop-start" industry. There is no long-term certainty. A company building a \$500 million wind turbine factory would want some certainty in this policy.

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MR. ROSE said Europe has 20 years or more of certainty, which gives investors a lot more confidence. It is the same thing when dealing with Alaska's gas line. Congress supports a longer term tax credit, but since everyone wants it, it is used as a "sweetener" in a lot of deals made in Congress. It is a ten-year tax credit, so the Congress that reauthorizes is "on the hook for all the payments to go out for that next ten years. So once you're in the ground before the deadline, it's a ten-year credit." It was recently reauthorized again, and it included wind for one year and geothermal for two years. "So there's not even consistency between technologies."

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SENATOR HUGGINS asked what the annual price tag is.

MR. ROSE said he could get that data. As a result of the start-stop activity, the states tend to lead the way on policy. There are two kinds of policies. One is a renewable portfolio standard, which is a mandate. He said 26 states have mandates and 4 more have goals. Most of these were done legislatively and a few were based on initiatives. California has the most aggressive mandate: 20 percent [renewable energy] by 2010.

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CHAIR MCGUIRE asked how to distinguish between goals and mandates.

MR. ROSE said it varies from state to state. A goal has no teeth. The states with mandates can have weak enforcement for utilities that don't meet the standards of the mandate. California is driving a lot of technology development because it is the sixth biggest economy in the world, and it is requiring that 20 percent of all its electricity comes from renewable sources by next year. The state laws have driven a lot of policy changes. Some states collect surcharges on electric bills to fund energy efficiency and renewable energy projects.

MR. ROSE said feed-in tariffs have been very successful in driving geothermal, solar, and wind development in places like Europe. A feed-in tariff is when a government mandates a certain above-market price be paid for renewable energy technology or resources. It will be a different price for different resources. Most places are incentivizing solar energy the most. It is the most expensive to begin with. In Germany, anyone who puts solar electricity back into the grids gets about \$0.50 per kilowatt hour. "So everybody and their brother is putting up solar panels." It has resulted in a lot of installations that are distributing all around, which is important if there is a power outage. It has driven the manufacturing of solar panels in Germany. Half of the solar panels in the world go to Germany. Germany has less solar insolation than Alaska. The utility company has to pay those rates to people who put power into the system, and it can spread that excess to all of the consumers. So even though there is a huge premium being paid, the average extra amount that the average German pays is about 0.5 cents per kilowatt hour. It raises their total utility bill by 3 percent. These policies work well because they are usually 20-year contracts. Sometimes there is a de-escalating tariff, giving an incentive for efficiency in power generation. It is very useful. Denmark has 20 percent of its energy coming from wind because of a similar policy. Germany has 5 percent of its energy coming from solar. Spain gets 9 percent from wind. Feed-in tariff ideas began in the United States, but it fizzled in the early 1980s. Germany picked up the model and refined it. There is \$2.5 billion extra in Germany that goes out to these resources, and the program creates 170,000 jobs. Ontario is the first place in North America to really get into feed-in tariffs.

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MR. ROSE said Ontario instituted the feed-in program in 2006 with a 20-year contract to incentivize smaller systems - 10 megawatt and smaller. Generators pay all interconnections and licensing fees, and the price paid for wind, small hydro and

biomass begin at 11 cents per kilowatt hour, and it is 42 cents for solar photovoltaic projects.

MR. ROSE said the fastest and the "biggest bang for our buck" comes from energy efficiency and just using less. He noted an excellent report with nine recommendations from the Cold Climate Housing and Research Center. The cheapest energy is not using energy at all.

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MR. ROSE said the Renewable Energy Fund is not set up to put money into pilot or demonstration projects. "We really need to have some kind of an emerging energy technology development fund for Alaska." It could be for fossil and renewable projects. The money could be leveraged with federal dollars to put into pilot projects. In the Lower 48, no one would want to figure out how to make electricity out of wood, yet Alaska villages could use that. The same goes for battery storage for small utilities. Alaska has 90 percent of the country's potential and 50 percent of the nation's tidal power potential. Alaska is in a great position to be a leader in that. There are 2 billion people on the planet with no electricity at all. Bush Alaska is a laboratory where we can perfect these kinds of systems that can be marketed around the world. Icelanders are going around the world and helping with geothermal plants. "We could be helping people do these small distributed generation systems around the world." Also, Alaska has such high costs for energy we could be saving people money.

CHAIR MCGUIRE said absolutely.

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MR. ROSE said the long-term forecast for a barrel of oil is \$110. Alaska can't have a vibrant economy without energy. Alaska has money and resources, and it should become a world leader. "These are 20 to 100-year decisions." There is aging infrastructure and demand for energy, so these decisions need to be made in the next five years. Iceland's vision is a good example. Icelanders are excited and proud of being on the cutting edge. They are attracting a lot of development.

CHAIR MCGUIRE said Mr. Rose has been very patient with people in the legislature who have taken a lot of time to catch up to this vision. The committee looks forward to working with the witnesses, and it should start crafting energy policy this year. She saw an attitudinal commitment to innovation and to exporting ideas that make the world a better place. There are four areas.

One is research and development and money that could have come out of the Alaska Science and Technology fund. Secondly there are proven technologies and ideas that state funds can support. Thirdly is the transmission aspect, and fourthly is the consumer role. There seem to be arbitrary numbers given to certain projects that may or may not make them feasible.

MR. ROSE said he is looking forward to working with the committee.

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SENATOR WIELECHOWSKI said this is an opportunity for the state and this committee to really put together a plan. "I'm excited about it."

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There being no further business to come before the committee, the meeting was adjourned at 11:46 a.m.