Brent J Sheets
Deputy Director
Alaska Center for Energy and Power
University of Alaska Fairbanks

Written Testimony before the
United States Senate Committee on Energy and Natural Resources

May 19, 2015

Madam Chair, Ranking Member Cantwell, and Committee Members, thank you for the opportunity to testify before you today. My name is Brent Sheets, I am the Deputy Director for the Alaska Center for Energy and Power. Our mission is to develop and disseminate practical, cost-effective, and innovative energy solutions for Alaska and beyond. The Alaska Center for Energy and Power is a statewide, university-led, applied research program based at the University of Alaska Fairbanks. We make every effort at being responsive to immediate and long term needs of residents, industries and agencies; and we focus on research related to community and industry-scale power generation that has the potential for providing reliable and affordable energy, especially in instances of islanded micro-grids. Those markets are found throughout rural Alaska where a regional transmission system does not exist, in developing nations, and increasingly in the lower-48 where some institutions are recognizing that the national transmission system is becoming increasingly unstable and are seeking energy security by developing microgrids that can be "islanded," that is isolated from the regional grid system, if that should become advantageous for continuing to operate their facility.

There are some cities in Alaska, namely Barrow, Anchorage, and several communities in the Kenai Peninsula, that have access to affordable natural gas, and many Southeast Alaska communities have affordable hydropower generated from small dams; but much of the rest of Alaska relies on expensive diesel fuel for generating electricity and home heating; fuel that is delivered once a year by barge during the summer months when the rivers are flowing. This is a costly way to provide power and heat to these communities, and the state of Alaska has invested millions of dollars seeking alternatives to the status quo. One form of state investment has been through grant programs administered by the Alaska Energy Authority, the Renewable Energy Fund and Emerging Energy Fund. Some of those outlays have been in support of advancing hydrokinetic, geothermal, and biomass technologies.

As a result of Alaska's investment in emerging energy technologies, and also the University's investment in establishing the Alaska Center for Energy and Power, Alaska has emerged as a leader in innovative microgrid power systems that incorporate renewable energy. The Alaska Center for Energy and Power works closely with the Alaska Energy Authority, various communities, utilities, and technology developers to demonstrate technology or control systems that enable renewable resources to displace some of the diesel currently used for power or heat generation.

We have also been fortunate to partner with the US Department of Energy and its labs in several technology areas, including wind, geothermal, hydrokinetic, and several other technologies not necessarily germane to our discussion today. We have also successfully competed for an award through the DOE EPSCoR program with a project entitled, "Sustainable Village Energy: Integration of Renewable and Diesel Systems to Improve Energy Self-Reliance for Remote Rural Alaska Communities" which we believe has benefited the state tremendously by adding to the body of knowledge and helping the state to develop additional expertise and capabilities.

Alaska also supports research to develop its unconventional fossil energy resources. In April 2013, the US Department of Energy entered into an MOU with the Alaska Department of Natural Resources concerning development of methane hydrates, a vast and important energy resource found on the North Slope of Alaska. Under the agreement, DOE's Office of Fossil Energy will be responsible for developing R&D opportunities in Alaska and providing scientific expertise and resources in support of projects. Alaska has set aside acreage for potential methane hydrates production testing, and will coordinate permitting and regulation where appropriate. The state further supports methane hydrate technology development by participating in periodic reviews of all scientific data and reports collected or created during the course of the MOU. Needless to say, Alaska strongly supports research into technology that will lead to the safe and commercial production of methane hydrates.

Because of my experience with a variety of energy technologies and resources in Alaska, I am here today to address several energy sources abundantly available in Alaska: hydrokinetic energy, low temperature geothermal, biomass, and methane hydrates.

Hydrokinetic

Many of Alaska's remote communities and technology developers are interested in river hydrokinetics because some studies suggest that power production during summer months in Alaskan rivers are capable of producing as much energy as tidal turbines (on an annualized basis) because of the periodic ebb and flow of tidal currents compared to the steady currents of rivers. But for the majority of villages in Alaska, river debris will be a major hazard for in-river turbines. Other considerations include sediment, river turbulence, ensuring that operation of turbines does not harm Alaska fisheries, and integration of hydrokinetic energy into the utility grid.

Access to funds for demonstration projects are vitally important to further the development of this technology. There have been several notable attempts to harness the kinetic energy found in the rivers of Alaska. In the summers of 2008 through 2010, a 5 kW turbine was deployed in the Yukon River near the community of Ruby. This project was sponsored by the Yukon River Watershed Tribal Council and funded with a grant from the Administration for Native Americans. In 2010, a 25 kW turbine was deployed in the Yukon River in Eagle by the Alaska Power and Telephone Company, primarily funded with a grant from the Denali Commission, but requiring considerable match component. Both demonstration projects were modestly successful generating power for a short period, but those early deployments also demonstrated that deploying such devices is not as simple as it might first appear.

There were some initial issues with the transmission and integration of the generated power into the utility systems. Some of these issues were easily solved, and others required additional investigation before a permanent solution could be identified. But there were other significant challenges that required more consideration. Working on the floating platform that suspends the turbine into the river proved challenging, and at times outright dangerous for the maintenance workers, thus making some solutions for addressing transmission and integration issues difficult to implement.

One of the most significant challenges illustrated by both Ruby and Eagle deployments was management of woody debris. Debris buildup on the various anchor lines and on the floating platforms proved so significant that in the course of one night, debris sometime gathered up in a significant enough amount to partially submerge the floating platform. In the case of Eagle, a 12 man crew was once required to work for a full day to clear debris. In addition, both surface and subsurface debris damaged turbines and platforms on multiple occasions. These are the sorts of things that technology developers do not think about until such problems are encountered in the "real world."

Subsequent testing of hydrokinetic devices avoided the problem by deploying in debris-free settings, namely in the Kvichak (Kwe-jack) River in Igiugig, Alaska. Two companies deployed turbines at that location during the summer of 2014, and those demonstration projects further illustrated the difficulty, expense, and unforeseen problems associated with deploying a system in a remote rural community, even in the absence of debris, and the problem of integrating with the local grid. Both devices were able to produce power for a brief period of time, and much was learned from these demonstrations projects and documented so that everyone in the industry can benefit from their experiences. Modeling and testing in flumes will take the industry only so far, but it is trial and error testing in the environment that will expose the weaknesses of this emerging technology.

At the Alaska Center for Energy and Power, our faculty and staff recognized that the major problems facing the hydrokinetic industry included river debris, meeting regulatory requirements to demonstrate no harm to fish, special needs for deploying and operating in remote areas, determining the optimal sites for turbine locations, and grid integration. Our experts developed methods to characterize river hydrokinetic potential, designed and deployed reliable anchoring methods and debris diversion technology, developed a test site on the Tanana River at Nenana, conducted fish population studies, and have tested the performance of "river in-stream energy conversion" technology. In the summer of 2014, the University's test site was used to evaluate the performance of Oceana Energy's turbine over a three-week period. The device was protected from debris using the University's debris diversion device. Oceana Energy will return to the test site in July of 2015 for extended river testing. They will also be working with ACEP's Power Systems Integration lab to address the challenges of integrating with a local grid system.

Because of its innovative work with respect to debris diversion technology, river hydrodynamics, fish populations and their interaction with turbines, and performance testing of river energy converters, the Alaska Hydrokinetic Energy Research Center, a component of the Alaska Center for Energy and Power, is attracting national and international attention. Two of our research faculty are hydrokinetic subject matter experts serving on the International Electrotechnical Commission establishing standards for assessing the hydrokinetic potential of wave, tidal, and river locations so that hydrokinetic energy converters will have consistent standards to enable comparisons between the various technologies. They also lead the US shadow committee representing US interests to the International Committee. Shadow committees are national committees consisting of subject matter experts and industry representatives who provide input to the national technical committees. Finally, AHERC is advising some companies on ways to improve designs to reduce their susceptibility to debris impacts.

During the summer of 2014 the Alaska Center for Energy and Power had a visitor from Chile tour our Tanana River Hydrokinetic Test Site, and we expect to be working more closely with a Chilean partnership in the coming months. We also hosted representatives from the Inter-American Development Bank to explore possible collaborative opportunities that could be facilitated by them in other Central and South American countries. And this summer, we will be hosting a delegation of engineers from a west African country who are interested in developing hydrokinetic technology for deployment in their region.

Other research centers are also interested in partnering with us, including Canada's leading research center for in-stream tidal energy, the Fundy Ocean Research Center for Energy. But it is our partnership with the Northwest National Marine Renewable Energy Center, NNMREC, that we are the most excited about. Created in 2008 through funding from the U.S. Department of Energy to Oregon State University and the University of Washington, NNMREC expanded in January 2015 to include the University of Alaska Fairbanks. NNMREC is now funded by a variety of federal agencies including the Bureau of Ocean Energy Management, the National Science Foundation, and the Department of Defense. Our network of industry partners includes many of the US leaders in tidal, riverine and wave energy: Ocean Renewable Power Corporation, Verdant Power, Columbia Power Technologies, M3, Oscilla Power, Resolute Marine, and Oceana Energy. Between the three universities, test sites are available for industry use to demonstrate full-scale wave energy devices, tidal devices, and river devices. Test sites are located off of the Oregon coast, in Puget Sound and Lake Washington, and in the Tanana River in Alaska. They are fully permitted for testing, supported by academia who are able to collect data and provide analysis that benefits the industry and regulators, and who have shown that testing at sites such as these is cost effective and more efficient than expecting each company to permit and develop their own proprietary test sites.

Taken together, these test sites represent the critical infrastructure that this country needs in order to provide the foundation for building the wave, tidal and river hydrokinetic industry. If we can successfully demonstrate this technology on a small scale, then it should be a relatively easy matter to scale it up so that it can also begin to provide renewable energy for larger populations as well. We hope to see deployment of river systems throughout remote Alaska during the summer months so that diesel generators can be turned off for a time, and we also expect larger versions of the same technology to be deployed in bays and oceans producing power for both coasts of the United States.

Tapping into the rivers to produce power has been a dream for many of Alaska's citizens over the years. That dream is closer to becoming a reality, in large part thanks to pioneering work made possible with research dollars to fund hydrokinetic power generation technology development and demonstration projects. Those research dollars have largely come from the federal government, and in the case of Alaska, from the state government as well. Several companies are partnering with Alaskan entities such as the one I represent, the University of Alaska Fairbanks' Alaska Center for Energy and Power, with National Marine Renewable Energy Demonstration Centers, and even a few regulatory agencies. Federal dollars are an enabler for developing this technology.

Geothermal

Alaska's potential for geothermal energy is high, but largely undeveloped. There are many locations with accessible geothermal energy in Alaska. The obvious ones are found in the Aleutians where proximity to volcanoes also provides some world-class geothermal opportunities. But there are also low-temperature geothermal resources in some areas of the Interior and Southeast Alaska where geothermic "hot spots" lie close to the surface and are easily accessed to draw up heat.

One site in the Interior of Alaska that has capitalized its low-temperature resource is Chena Hot Springs Resort. In 2006, Chena Hot Springs Resort installed a 400 kW geothermal power plant designed and manufactured by United Technologies Corporation. Chena Hot Springs was the first to develop commercial power from a resource of 165° F, about the temperature of a hot cup of coffee. This pushed the lower temperature limits down quite a bit, and was made possible by the cold water (and cold air during the winter months) that provided the necessary temperature differential between the hot and cold sides of the Organic Rankine Cycle generator. (The greater the temperature differential, the greater the efficiency of the generator.)

The Alaska Center for Energy and Power and its partners were funded by the Department of Energy to prove an inexpensive remote sensing technique capable of reducing the cost of geothermal exploration in remote areas, specifically Pilgrim Hot Springs which is approximately 60 miles from Nome. This was followed by a drilling program which resulted in slightly more than 60 shallow gradient holes of depths ranging from 80 to 500 feet, as well as three deeper confirmation holes that drilled to bedrock and were used to locate the source of the thermal fluids.

Today we know that the maximum downhole temperature at Pilgrim Hot Springs is 195° F, though the estimated reservoir temperature is considerably higher – likely approaching ~300 °F. This means the resource could be capable of sustaining approximately 2 MW of power generation, which could be used locally or delivered to Nome or a nearby mining operation via a transmission line. (Nome has an average electrical load of about 4 MW.) Because of the investment in this resource by DOE and additional financial support from multiple partners, including the Nome Joint Utility, Nome Chamber of Commerce, the Alaska Energy Authority, and the local native corporations to list but a few, there is now a private developer interested in potentially developing the resources and providing power to the community of Nome, thus reducing its dependence on diesel fuel.

Low temperature geothermal is often overlooked by developers in favor of traditional geothermal with its higher temperatures and higher pressures. But with additional research to help lower the cost of the technology, including exploration and drilling technologies, then the economics of remote mines or communities who rely on imported diesel fuel for power generation might be improved.

Biomass

The heat requirement for Alaska far surpasses the electricity requirement, and while a majority of the state's communities use diesel fuel to meet their heat demand, woody biomass is often a more economical solution, especially in communities separated from the road/rail connected system. Diesel is imported into communities by barge and airplane, and is sold as heating fuel at between $3.50 and $12 per gallon. Conversely, in many communities, especially in the Interior region of Alaska, abundant woody biomass exists in the local forests. Permitted harvesting is available on land owned by state, tribe, community, and private entities with allowable harvest limits determined through resource assessments and harvest plans. Using this locally available fuel can be economically beneficial to a community by creating jobs where employment opportunities are limited, and retaining the monies spent on local fuels in the community and thereby increasing the economic sustainability of the community.

Alaska has demonstrated many successful applications of biomass energy for community heating, including completed installations in over 29 communities throughout three major geographical regions of the state (Southeast, Interior, and Western). Assessment of candidates occur annually through the Alaska Wood Energy Development Task Group's (AWEDTG) pre-feasibility grant applications. These applications rank the community's readiness and compatibility for community scale biomass energy installations using criteria including: wild fire threat, beetle-killed trees, diesel fuel cost and offset, building energy efficiency audits, and lastly the willingness of the community to engage in a labor-intensive employment to maintain and operate the biomass systems.

The 2013 funding of Alaska's State Wood Energy Team by the US Department of Agriculture has enabled a wider range of pre-feasibility assessments, including allowing commercial buildings to be assessed for the economic feasibility of biomass system installations. This opens the door to wider adoption of the locally available resource. Many successful candidates who complete the pre-feasibility applications of the AWEDTG either pursue the biomass heat installations on their own, or they use their assessment to apply for grant funding from other sources. The state-funded Renewable Energy Fund has funded approximately 50 biomass energy assessments, designs and construction projects since the inception of the grant program in 2008. Despite funding cuts in the Alaska state budget, biomass energy projects remain alive in the 2016 budget approved by the state legislature.

The biomass systems selected for installation in Alaska are selected for efficiency, reliability, and low emissions. Alaska, despite its remote location, is often affected by high-emissions from low quality biomass systems that burn inefficiently, lack emission controlling components, and are used in conjunction with wet, green wood. Many days throughout the winter months, some Alaska communities fail to meet EPA mandated $PM_{2.5}$ fine particulate air quality standards. Educating the public about proper wood drying and appliance maintenance is a large component of biomass energy in Alaska, and the Alaska Wood Energy Conference is one method of delivering valuable information for lowering the emissions and increasing the efficiency of these units.

"Biomass readiness" is incredibly important for Alaska, especially where many of the energy systems installed are found in very remote areas with limited air transport. These communities must maintain the operation of their energy systems usually troubleshooting without much guidance. To help the new generation of boiler operators, a biomass energy training workshop was held in the community of Tanana in 2015 in which participants from nine different communities were trained on the operation, maintenance and repair of the systems. This training is the first of many that prepares communities funded to receive new biomass system installations to become familiar with the system and meet other operators to share knowledge and troubleshooting. This first 3-day training was overwhelmingly successful, and we are encouraged by the participant's dedication to understanding their systems.

The Alaska Energy Authority recently received funding through the USDA to create a "Community Sustainability Handbook: Best Practices for a Biomass-Heated Greenhouse at your Alaska School." Several school districts in Alaska have used the savings realized from heating with wood to build greenhouses adjacent to their schools. Today the children at the Thorne Bay School and Tok Schools eat salad every day as part of their lunch, and soon the students at three other schools (Kasaan, Coffman Cove and Naukati) will have their greenhouses up and running. The students are also involved in growing the plants in the greenhouse. Other schools in Alaska would like to do the same. Additionally, this handbook could be used by Alaska tribes and other publicly managed facilities that have existing biomass heating systems. And of course the private sector could benefit as well.

Alaska does not have a large wood processing industry, and thus lacks inexpensive waste fuel that could be used for biomass energy. The harvesting of whole trees for use as biomass fuel is generally not cost-effective in other states, but due to the high cost of diesel fuel, the harvest of trees for biomass does make economic sense in some regions of Alaska. And, there is a constant threat of wildfire to communities with large, highly-flammable spruce forests. As a way to alleviate this fire threat, many communities including Tok, Alaska, (a road accessible community of 1,300 close to the Canadian border) cut a large fire protection perimeter around their community. The wood from Tok's mitigation effort is used to fuel the state's first biomass-fueled combined heat and power system at the Tok School. This unique system, and the only one of its kind in Alaska, produces 5.5 MMBTU and up to 52 kW per hour. In response to excess heat produced, the school installed a year-round greenhouse supplying fresh produce and an educational tool for the students. This system is uniquely suited to Tok where there is an abundant, and subsided, source of wood from Alaska's state forestry fire mitigation efforts.

A small wood-to-electricity gasification unit (GEK 10 kW) has been installed in the Matanuska Experiment Farm, part of the University of Alaska Fairbanks. This system will be used by UAF engineers to determine the best use of this batch-load system using Alaska's resources. A small 10kW electricity generator could be used in some communities to offset a portion of their electricity generation from diesel. The money saved from offsetting diesel would stay in the remote community, enhancing the local economy and providing funding for employment.

Despite small steps towards using biomass to generate electricity, heat still remains the highest use of energy in Alaska, and biomass energy is best used to attempt to meet the thermal energy demands of residents and communities. And, the labor-intensive nature of woody biomass ensures that employment opportunities will always exist, and keep local money in the community. Alaska supports research that could lead to lower energy costs for its citizens, and we believe that more research in to lower the costs associated with biomass systems would be helpful, especially to the degree of lowering heating costs.

<u>Hydrates</u>

So far my testimony has been centered on renewable energy sources, which are important for a variety of reasons, but from my Alaska-centered perspective, investment in this technology is desirable in order for the technology to mature to the point where it becomes a reliable and affordable option for our communities that struggle with the high cost of energy. Use of local resources also puts local people to work, and enables cash to circulate inside of the community. And while renewable energy sources hold much promise for the country, and for the residents of Alaska, we cannot overlook the abundant fossil energy resources found only in Alaska, either.

A significant amount of our nation's conventional oil and gas resources remain on Alaska's North Slope and in offshore waters. This region contains more oil than any comparable region in the Arctic, including Russia, with approximately 40 billion barrels of technically recoverable oil and more than 250 trillion cubic feet of conventional gas, according to the EIA database. These numbers are likely dwarfed by Alaska's unconventional resources, such as shale oil, heavy and viscous oil, and methane hydrates.

While we are currently in a time of renewed oil and natural gas production within the borders of the United States, and American consumers are seeing some relief at the gas pumps, we cannot forget that the time to be investing in future fuel supplies is now so that they will be technically recoverable when the pendulum begins to swing toward high-priced energy again.

Continuing investment research is needed in order to enable the safe and economic production from methane hydrates. There have been some field tests funded by the US Department of Energy, and its federal, private, and international partners, that validated hydrate system concepts, and shown we can indeed detect, characterize, drill and produce hydrates from some types of hydrate reservoirs using carefully tailored applications of existing technology.

Despite these recent accomplishments, there are still challenges. One of the chief unknowns is whether the resource can be produced in a manner that meets environmental and commercial expectations. This will require a long term production test. The most obvious candidate for such a test is the North Slope of Alaska where there is existing infrastructure available to support such a demonstration project. As noted earlier, DOE entered into an MOU with the state of Alaska to cooperate on hydrates development, and since 2013, the state has set aside acreage for the purpose of conducting a hydrates production test on the North Slope.

Methane hydrate research is an obvious demonstration of the importance of government involvement in early, high risk research that has the potential to yield substantial benefits to the public. This large, untapped, energy resource has the potential to become the next "game-changer" similar to shale gas production which was transformed from uneconomic to viable based demonstration projects initiated by the newly formed Department of Energy in the 1970's. The state of Alaska is very supportive of continued methane hydrate research and urges this committee to support this vitally important research.

Conclusion

Speaking for the Alaska Center for Energy and Power, we support the efforts by this Committee to expand the portfolio of energy options available to our nation. For our communities, we believe that renewable resources, over the long term, can provide energy at costs that are less susceptible to the uncertainties inherent in relying solely on fossil fuels provided to our communities at considerable expense because of the remoteness of their locations. For our nation, Alaska has many unconventional fossil resources just waiting for the technology to produce them, methane hydrates is chief among them.

Demonstration projects for hydrokinetic energy, low temperature geothermal, biomass energy and methane hydrates hold the potential of developing advances in technology leading to lower energy costs. Alaska has world-class energy resources, renewable and non-renewable, but we lack the technology to economically utilize them. Let's change that.

Thank you again for the opportunity to testify before this committee. I would be happy to answer any questions you may have.