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Thank you, Senator Murkowski, Senator Cantwell and the virtual members of the committee. I appreciate the opportunity to appear before you today. My name is Gwen Holdmann, I am the Director of the Alaska Center for Energy and Power at the University of Alaska Fairbanks. I was also recently appointed as the Director of the Office of Intellectual Property and Commercialization for UAF.

Senator Murkowski, I'd like to thank you personally for your national leadership not only on the productive use of our energy resources but for a host of other important issues facing our country. Your efforts are valued and appreciated. Senator Cantwell, welcome back to our state and thank you for the excellent work you and Senator Murkowski have accomplished by partnering on a bipartisan basis.

I appreciate the theme the two of you have selected for this Hearing – Innovation in Action, Microgrids and Hybrid Energy Systems – and I think it is very fitting we are hear in Cordova, which has been a leading community in terms of working toward solutions that will define our energy future, not just for microgrid communities like we find here in Cordova, but in ways that will also be relevant for the greater transformation of the national grid I expect we will see over the next several decades.

Of our roughly 150 communities in rural Alaska, there are about 70 projects that incorporate grid-scale renewables on community microgrids. Many are pushing penetration levels of variable renewables on a regular basis that would make most utility managers quite nervous. These are not demonstration projects. These are not pilot projects. Are they innovative? Yes. Do they work with local operators? Yes. Are they economically viable? Well, that might be a more complicated question to answer but the point is that these are examples of strategies Alaskans have adopted to provide reliable energy services in remote and harsh environments. In all, Alaska has about 12% of the microgrids in the world. Not islanded or remote systems, but microgrids in the broader sense of the definition. These have in very large part been funded by the State of Alaska, through programs like the Renewable Energy Fund and the Emerging Energy Technology Fund. Over the course of the past 2 decades, we have built up a substantial body of knowledge related to the design, construction, and operation of these systems.

When this committee last held a field hearing in Bethel, I mentioned that we are working on developing an Alaska Hub for Energy Innovation and Deployment (AHEID), where Alaska can serve as a 'living laboratory' to enable transformational change of the electric power market, with commonplace 100% renewable energy operation for microgrids - whether in U.S. markets or the developing world – using strategies that are cost effective from a holistic community perspective, addressing all energy requirements for the customers served, not only those that are electric. I am happy to report that we have made some very substantive progress in this area, and would like to present a few specific examples.

Example 1: The Office of Naval Research has recently invested in the AHEID program, funding an energy ecosystem in Alaska that incorporates not only research conducted through the Alaska Center for Energy and Power, but also the Alaska Network for Energy Education and Employment (ANEEE) managed by Renewable Energy Alaska Project (REAP) and Launch Alaska, a business accelerator specifically working on energy issues. Through this project, we will be able to work on technology development and research specifically identified as next-generation needs by Alaska communities and utilities, and by extension represent next-generation technologies with much broader applicability. For example, through this project we will be able to work with AVEC on developing a Grid-Bridging Storage Solution that they have identified as a top need and priority for their communities, as a way of economically incorporating higher penetration levels of renewable energy.

Example 2: I would like to mention the importance of our partnerships with DOE and our national laboratories, as assets to support our projects and help accelerate the development of energy solutions. Currently, ACEP is involved in four active projects that have both national lab and community involvement:

- the DOI-funded Remote Community Renewable Energy Project (Kokhanok, AK; NREL)
- the DOE Grid Modernization Program funds the Alaska Microgrid Partnership (Chiniki Wind Group, and other communities; NREL, PNNL, LBNL, Sandia; local industry and NGO partners)
- the DOE Office of Electricity funded Design Support Tool for Remote Off-grid Microgrids (Nome, Cordova, Kokhanok; LNBL, LANL, ANL, BNL; other national industry and community partners)
- the DOE OE Energy Storage Program funded Optimal Sizing of Energy Storage Project (Cordova Electric; Sandia)

All of the above, as well as several previous collaborations have been quite fruitful in moving the needle regarding reducing the cost of energy for remote communities, while increasing our understanding of detail and big picture issues that need to be addressed. I would like to specifically highlight the Cordova project given our venue. Through past projects with Cordova Electric, ACEP had identified several options for CEC to increase the utilization of their low-cost hydropower resource, while reducing the high-cost utilization of diesel generators. One of the identified options was to investigate an energy storage system to aid in this effort. In parallel, ACEP had identified a cross-cutting need for many of our remote communities to be aided in formalizing the process of *need-based* selection of energy storage systems. Both aspects were combined in a white paper pitching a study to the Clean Energy States Alliance and the DOE OE Energy Storage Program. As we knew from previous collaborations that necessary expertise resided at Sandia National Labs, it was also requested, that their Energy Storage Modeling Group were deployed in this project.

The first phase of the project, determining the optimal size of an energy storage system, as well as its operational requirements, and placement options was completed recently, with the final report to be issued by the end of June. The work identified the potential to shift about 1 GWh of electric generation annually from diesel generation to hydropower generation, which constitutes a 10% reduction in diesel utilization. The collaboration between CEC, ACEP, and Sandia was very fruitful with CEC providing necessary data and meta-data about their system, ACEP handling data processing, and model development for optimal sizing of the energy storage system, and Sandia providing a high fidelity

dynamic grid model, which was utilized in testing transient response dynamics important in placement of energy storage systems in a grid.

Example 3: The Alaska Remote Energy Networks Academy (ARENA). Recently, there has been a much greater awareness of Alaska's technology leadership in this area. One example is that the Canadian Off Grid Utility Association (COGUA) held its first ever meeting outside of Canada here in Cordova last month. A big part of the reason was to share lessons learned and experiences related to remote communities across North America. We are trying to institutionalize knowledge transfer based on the Alaska experience through a newly developed ARENA program and network. In less than 2 weeks, we will be bringing native leaders, utility managers, and community champions from across the Arctic including Greenland, Russia, Canada and Alaska together to learn from practioners in Alaska. We will bring them to visit our research laboratory in Fairbanks and visit projects in Alaska's interior as well as Kotzebue and Nome. This program is based on a similarly structured program active in Iceland, the United Nations University Geothermal Training Program, which is designed to export knowledge on Iceland's Geothermal experience to areas of the developing world that are seeking to develop their own geothermal resources. This project is supported by the Arctic Council, with co-leadership from the US, Canada, Finland, Iceland and several Permanent Participants. We are using the word 'energy network' rather than 'microgrid' because we want to be sure to include all of the ways energy we use energy – specifically, not just a focus on electric power but also heat, and we hope, transportation as well. Our long-term goal is to promote knowledge sharing among people that are in the best position to influence the future trajectory of project development in their home countries and regions. We are planning to use Alaska as a living classroom to support ARENA, with our fellows touring projects relevant to their interests and interacting directly with utilities, developers, and the communities in which these projects are based to gather knowledge that can help them make good decisions about future energy development that can displace reliance on imported diesel fuel.

Example 4: Regional Collaborations. One of the things we have been working hard to foster is greater region collaborations, particularly with the greater Pacific NW. The microgrid remote energy systems of Alaska over great potential for regional collaboration. Entrepreneurs, research institutions, government laboratories, industry and project developers are exploring the opportunities for developing technologies that address the needs for reliable, affordable and sustainable energy solutions that meet the needs of community, industry, military bases and miscellaneous critical infrastructure applications. These engage accelerators like Launch Alaska, Cascadia, and Elemental Excelerator in Alaska, Washington, Hawaii, and beyond. Accessing funding available from federal, state and private sources through the Alaska Center for Microgrid Technologies Commercialization and the Alaska Hub for Energy Innovation and Deployment components, subsystems and systems teams are developing products and capabilities broadly relevant to the global energy market.

Recently, we held a competition funded the Economic Development Administration to provide technical support and testing services to companies working on microgrid-enabling technologies. I am happy to report that Uni-Energy Technologies, a flow battery manufactuer based in Muketeo, Washington was the grand prize winner and we will be testing their system in our laboratory later this year. Perhaps in the future, we may even see this system deployed right hear in Cordova to support this microgrid system.

Example 5: Hydrokinetics. Another example of strong regional partnerships is exemplified by our work on hydrokinetic energy. Hydrokinetic energy devices generate power from predictable and forecastable waves, tidal flows, ocean currents, thermal gradients and in-stream sources and could, with the right investments and policies, play a significant role in our nation's future energy portfolio. For example, the U.S. Department of Energy has estimated that approximately twenty percent of the future electricity requirements of the states of Washington, Oregon and California could be met by marine energy resources. Hawaii and Alaska alone could satisfy nearly all future power loads with marine energy technologies. In my opinion, this is a source of energy worthy of additional research, development and testing investments by the U.S. Federal Government.

Currently, the U.S. Department of Energy's Water Power Technologies Office supports cutting-edge private sector-led research, development and deployment of new innovative hydropower, pumped storage and marine energy technologies. Stable and growing federal support for these efforts will help our country meet increasing electricity needs and also gives confidence to investors and helps attract private capital.

The University of Alaska Fairbanks is a national leader in the development of new marine renewable energy technologies. UAF, along with its partners the University of Washington and Oregon State University, co-manages the Northwest National Marine Renewable Energy Center, a competitively designated U.S. Department of Energy (DOE) Center established in 2008 with the mission of advancing marine energy technologies. The Northwest Marine Energy Center's programmatic strength derives from our integrated research, development and testing activities, collaborating with private sector industry partners and the national laboratories. NNMREC serves as a "one stop shop" for technology developers; federal, state and local regulatory and resource agencies; and community stakeholders interested in marine energy.

As part of this effort, UAF operates the Tanana River In-Stream Hydrokinetic Test Site (TRTS) in Nenana, Alaska. The TRTS mission is to help developers to demonstrate and/or improve their technology for this potentially significant global market. The Tanana River Test Site was established in 2010 for testing river energy converters and associated environmental monitoring tools and techniques as well as for demonstrating the effectiveness of infrastructure necessary for successful long term deployments of hydrokinetic energy converters in natural river conditions. The University and the State of Alaska have spent approximately $500,000 to date to develop the TRTS. The TRTS is the only permitted river test facility in the United States available to developers to demonstrate their innovative hydrokinetic technologies. Since its establishment, work at the site has contributed to the development of river resource and power assessment technical specifications as well as to the growing body of literature on in-river hydrokinetics. Despite the successful completion of numerous projects at the site, the budget crisis facing the State of Alaska means continued operation of the site and maintenance of the knowledge and skills to operate the site are in jeopardy. We are thus seeking outside sources of funding to ensure the continued operation of the TRTS.

At this point let me thank both of you for working together on legislation to reauthorize the U.S. Department of Energy's marine energy research, development and testing activities. This legislation was approved by both the Senate and the House of Representatives during the last Congress, but, as you are both painfully aware, a final conference agreement could not be reached in time to be signed into law before the end of 2016.

Senator Wyden recently reintroduced the Marine Energy Act. S. 1036 is bipartisan legislation that upon approval would reauthorize the Department of Energy's marine renewable energy research and development activities under the Water Power Technologies Office. The bill supports the development of marine energy testing facilities such as at the Tanana River Test Site or the tidal test facility being developed by the Pacific Northwest National Laboratories in Puget Sound. The legislation also authorizes funding to promote research, development and demonstration to support commercialization of this nascent renewable energy industry.

Reauthorization of the U.S. Department of Energy's marine energy research and development activities through S. 1036 is essential to providing the continued funding that this industry needs at this stage of its development. This is particularly true when you keep in mind that funding from the DOE Water Power Technologies Office is the one key mechanism to support U.S. technology developers competing against overseas companies that receive a suite of subsidies. The reality is that most marine energy companies are small businesses and not yet in a position to raise the private capital or receive the tax benefits enjoyed by more mature conventional and renewable energy technologies. This industry requires targeted investments like those that are included in S. 1036.

The legislation supports efforts in the private sector and National Labs to improve the performance, lower the costs and accelerate the deployment of innovative technologies capable of generating clean and affordable power from marine energy resources. The legislation also provides ongoing support for the National Marine Renewable Energy Centers. In total, the legislation authorizes an additional $300 million in federal funding over the next five fiscal years. A welcome investment!

Speaking of funding, let me pause and thank both of you for your excellent work on the Fiscal Year 2017 Omnibus Appropriations legislation. At $84 million, you have helped to set a new high water mark for hydropower and marine energy research, development and test funding at the Department of Energy. This is a great success!

However, the recently released budget proposal for Fiscal Year 2018 would endanger this progress. In fact, at just over $21 million, a substantial reduction from the current funding level of $84 million, would cripple the DOE Water Power Technologies Office and end any funding opportunities for companies to build pre-commercial prototypes or for the University of Alaska Fairbanks to build upon our success at the Tanana River Test Site testing those devices in a real world setting.

Continued investments by DOE in research ,development and technology advancement, along with expansion of full-scale technology testing centers, will accelerate deployment of advanced water power technologies and also give confidence to investors and help attract private capital. In addition, federal commitment to creating a robust U.S. marine energy industry will advance our national economic goals by creating high-quality employment in coastal communities, increasing long-term production in shipyards, expanding development of fleets of vessels for deployment and servicing, and strengthening the thousands of businesses that make up the U.S. industrial supply chain.

Just as other power generation technologies have historically enjoyed substantial and ongoing federal research and development support, similar investments are required to encourage private companies and universities to develop promising new water power technologies and to help them progress toward commercial viability. Strong funding in support of water power systems will reduce our nation's

dependence on foreign suppliers and create a significant opportunity to expand our economic competitiveness in this emerging clean energy sector.

Closing points

In closing, Alaskan communities live and breathe change while living in some of the most adverse conditions in the nation. This enterprising spirit establishes Alaskans as with finely honed early adopter skills, that coupled with the widespread experience in dealing with constrained resources and challenging operational conditions, can provide an excellent venue for hardening U.S. technologies prior to deployment in emerging markets. We have made great progress in this area, pulling together key stakeholders and a diverse group of partners, including National Labs, Manufacturers, Developers, the Utility Industry, Academia, and Native Alaskan organizations (technology end-users) to work together to develop the *Energy Systems of the Future*, based around microgrids and holistic 'energy networks', inclusive of technology advances, and improved understanding of the human dimension of implementing change.