U.S. Senate Committee on Energy & Natural Resources

Testimony of

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I. INTRODUCTION

Alaska is home to more than 200 villages that are inaccessible by road, and instead rely on their own "islanded" electric grids, most of which are still powered by diesel generators. Diesel power in these villages is at least three times more expensive than electricity in Anchorage, averaging more than 50 cents/kWh before state subsidies kick in. These remote communities are spread over a landmass that is the size of France, Spain and Portugal combined (or the 23 smallest US states combined). Many of these communities are far away from any local source of firewood and thus reliant on imported liquid fuel for heating. Heating oil today can cost these communities more than $8/gallon, roughly three times the cost in Anchorage. Rural Alaskans often spend more than 50% of their income on expensive electricity and heat generated from liquid fuel delivered by barge or airplane. Also lacking in these communities is the technical support and human capacity needed to keep the lights on and homes warm.

The six utilities that serve the state's most populous region between Fairbanks, Anchorage and the Kenai Peninsula are heavily reliant on natural gas to generate electricity; a mere 10% of the region's electricity is derived from hydropower. Two of these utilities own a major portion of the Beluga gas field near Anchorage, one that is expected to run dry in eighteen years. None of the six utilities have identified a source to replace the Beluga field and continue to keep their brand new gas generation units online. Furthermore, while the 550,000 people who live in this so-called "Railbelt" region represent 75% of Alaska's population, they do not represent a large market relative to the state's huge gas reserves. Without an export market, gas cannot be economically produced in Alaska. The result is a broad uncertainty over how much natural gas will cost in 20 years, a fuel that the majority of Alaska's citizens rely upon for electricity and heat.

Southeast Alaska has several large communities that today have adequate supplies of relatively inexpensive hydroelectric power. However, many of these same communities are struggling with relatively high heating oil prices. The natural tendency of consumers to switch over to less expensive hydroelectric heat is putting pressure on the existent hydro facilities. Meanwhile, smaller Southeast communities, not connected to a hydro facility, are confronted by the same high electric and heating costs that trouble rural Alaska.

It is estimated that Alaskans collectively spend more than $5 billion each year on electricity, heating, and transportation. A large percentage of buildings and homes in the state are not energy efficient. Yet, the state programs that have successfully cut home energy costs by an average of 30% no longer have funding. The entire state would benefit from more efficient buildings and more predictably priced, local, renewable energy. Inefficiencies are likely resulting in a 20% waste of the energy currently consumed in Alaska. That is $1 billion dollars of energy wasted every year at a time when the state's economy cannot afford to lose those dollars. Energy efficiency and renewable energy (together, often referred to as "clean energy") can help Alaska reduce that waste, create jobs, keep dollars circulating in the state, diversify the economy and lower greenhouse gas emissions.

Indeed, Alaska has the opportunity to become a world leader in clean energy technologies that can be applied in remote, small grid settings. Alaska now has 70 communities that have integrated wind or other renewable energy resources to their diesel grids. The success of those projects in reducing diesel dependency has caught the eye of similarly situated rural communities across the planet. With its remote locations and high energy costs, Alaska is also attracting the attention of technology developers from around the world. Alaska is a proven and safe locale for the piloting and testing of new equipment and systems that have the ability to make an immediate impact on the high cost of energy. These developers understand that the world has 1.5 billion people without any electricity and more than 700 million others who, like Alaska's remote villages, are dependent on diesel. As a result, Alaska is increasingly being recognized as a renewable energy laboratory – a recognition that, if supported and nurtured, could be leveraged to the great economic advantage of not only Alaskans, but to citizens of Maine and Hawaii, two states that are also home to "islanded microgrids". Alaska's work on microgrids can also benefit the many entities throughout the urban world that are working to make themselves more resilient through installations of local microgrids.

More than sixty years before the first barrel of oil flowed through the Trans-Alaskan Pipeline, a mining engineer in Juneau was generating hydropower from Annex Creek in 1915 – a facility that still provides Alaska's capital city with 10% of its electricity. Today, Kodiak, Alaska is the envy of the world as it generates 99.7% of its electricity from an integrated hydro-wind hybrid system that includes battery storage and a flywheel. The local Kodiak Electric Association turns on its diesel generators a few times a year, merely to "exercise" them. The Chaninik Wind Group in Alaska's Yukon-Kuskokwim delta is a coalition of five Alaskan villages creating economies of scale by working together in the design, construction, and maintenance of their wind-diesel hybrid systems. The Alaskan Village Electricity Coop, which operates utilities in 57 communities across the state, is now generating more than 6% of its total electricity from wind. And the Alaska Center for Energy and Power (ACEP) at the University-Fairbanks boasts some of the leading engineers and scientists working in the renewable energy field today. With state and federal support for public-private partnerships, Alaska is poised to embrace the worldwide movement toward clean energy. The hundreds of millions of dollars currently wasted on inefficiencies can be reclaimed and re-injected into the Alaskan economy. These partnerships have the potential to create new jobs retrofitting leaky buildings, spur the operation of new technologies and diversify the Alaskan economy. New and innovative Alaskan grown business sectors will be able to export their intellectual capital and serve similarly situated communities across the developing world.

In order to reach that objective, Alaska must not only focus on technology development, it must also focus on building the human capacity to fill the next generation of clean energy jobs. And it must create pathways for public-private partnerships to finance projects. The continued assistance of the federal governments in these areas is necessary if Alaska is to succeed.

This assistance should include:

1) Further research by DoE and the national laboratories to improve the reliability of hybrid renewable-diesel power systems. This includes current efforts such at the Alaska Microgrid Partnership and the Energy Transition Intiative (ETI);
2) Support for training and workforce development across the spectrum, from technicians in rural communities to university graduates;

3) Financial support to help communities understand their options and, in partnership with the public and private sector, develop solutions that lower energy dependence and power costs. This includes government secured loan guarantees that give the private sector the security to bundle isolated power system infrastructure projects, opening up capital markets and;
4) Capital investment subsidies that lower initial required lending levels to ones that are viable for both communities and private sector lenders.

II ENERGY EFFICIENCY: THE FIRST FUEL

REAP has been asked to testify about renewable energy infrastructure in Alaska. However, any discussion of energy production must begin with energy efficiency and conservation (EE&C). Although REAP encourages conservation, we put more emphasis on energy efficiency. Energy efficiency does not require any human behavioral change. Instead, technology simply allows the use of less energy to do the same amount of work. This can be in the form of more efficient lighting, boilers, appliances, automobiles, et cetera.

REAP considers energy efficiency to be a resource. It is the value of each KWh or Btu that does not have to be produced in the first place. Putting energy efficiency measures in place always costs less than generating heat or power, and can happen much faster than building a generation facility. Energy efficiency is our "first fuel" for another reason: by completing all possible energy efficiency measures first, a community or utility can often decrease the size of any necessary new generating unit, thereby saving dollars on expensive up-front capital expenditures. Overall, investment in EE&C is simply risk management: it creates more stable and resilient communities by keeping money that would otherwise be spent on wasted energy in our local economies.

Today, the 120 million buildings in the United States consume 42% of the nation's primary energy and 72% of its electricity. In Alaska, heating accounts for 40% of energy use in the state's commercial buildings. According to Deutsche Bank and The Rockefeller Institute, the US could save $1 trillion by investing in building energy retrofits over the next ten years.[1]

More efficient appliances are also a powerful way to save energy and keep dollars circulating in local economies. The ENERGY STAR program began under President George H.W. Bush in 1992 and has received strong bipartisan support ever since. ENERGY STAR is a voluntary program that typically recognizes the top 25% most-efficient equipment and buildings. The program has built 90% consumer brand recognition. It also spurs the manufacturing and purchasing of ENERGY STAR certified equipment and buildings. Since the program's inception, families and businesses have saved more than $400 billion cumulatively – $34 billion in 2015 alone. The ENERGY STAR program has achieved all of this on a budget of about $50 million a year; enough to purchase about half of a new F-35 fighter jet. REAP strongly supports the continuation of the ENERGY STAR program.

[1] http://www.greentechmedia.com/articles/read/efficiency-retrofits-could-save-u.s.-1t-in-energy/

In Alaska, the state has demonstrated that energy efficiency can save a tremendous amount of money. Since 2008, the weatherization and rebate programs administered by the Alaska Housing Finance Corporation (AHFC) have assisted more than 40,000 households in becoming more energy efficient through measures such as more efficient boilers, lighting and simple building envelope sealing. On average, after energy retrofitting, those residences are now saving 30% on their energy bills, mostly on the thermal side. Collectively, those households are saving the equivalent of more than 25 million gallons of heating oil every year. There are many more households in the state still to retrofit, but with the state's budget deficit, there is no more state grant money to catalyze those investments. REAP supports all public-private partnerships that can keep this fundamental infrastructure work going.

Alaska's public buildings also represent a tremendous energy efficiency resource and infrastructure improvement opportunity. According to a white paper on energy use in Alaska's public facilities published in 2012:

> [i]t is estimated that upwards of 5,000 publicly-owned buildings exist in Alaska. The estimated energy cost equates to approximately $641,245,000 to the public each year. At the average projected savings of $25,000/year/building, this would equal $125,000,000 in annual potential savings."[2] Since 2010, when the legislature mandated that the state DOT&PF work with other state agencies to retrofit 25% of all public facilities that are at least 10,000 square feet and larger (starting with the least energy efficient facilities) the state has accomplished energy savings performance projects in 69 facilities through the use of energy savings performance contracts, achieving a cumulative annual cost avoidance greater than $3.2 million.[3]

If the state were to prioritize funding for energy upgrades in existing infrastructure, it would protect that state's sunken investments and help those buildings realize their fully anticipated life and usefulness. In many cases, energy audits have already been done to public facilities that show tremendous potential savings.[4] However, developing these retrofit projects and securing financing, are often hurdles that local governments cannot overcome. Any federal assistance to help state and local governments develop energy efficiency projects, and then finance them through loan guarantees, would yield tremendous benefits for Alaskans; as well as citizens of the other 49 states and territories. These investments put people to work, spur manufacturing, and keep the benefits local.

Fortunately, a shift is beginning to take shape within Alaska's design community toward more efficient buildings, led by entities like the Cold Climate Housing Research Center (CCHRC) in Fairbanks. Since the cost of construction is only about 11% of the life-cycle cost of a building,

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[2] Armstrong, R.S. et al, White Paper on Energy Use in Alaska's Public Facilities, 10/19/2012

[3] Alaska DOT&PF: Sustainable Energy Act Annual Report to the Legislature, submitted Jan 2017

[4] See linked Potential Paybacks form Retrofitting Alaska's Public Buildings, 12/21/2014. Based on the 327 public facility audits by AHFC as well as the over 65 health clinics, washaterias, and water treatment facilities done by ANTHC.

while operations and maintenance (utilities) are approximately 50%, this shift can save hundreds of millions of dollars over the coming decades.

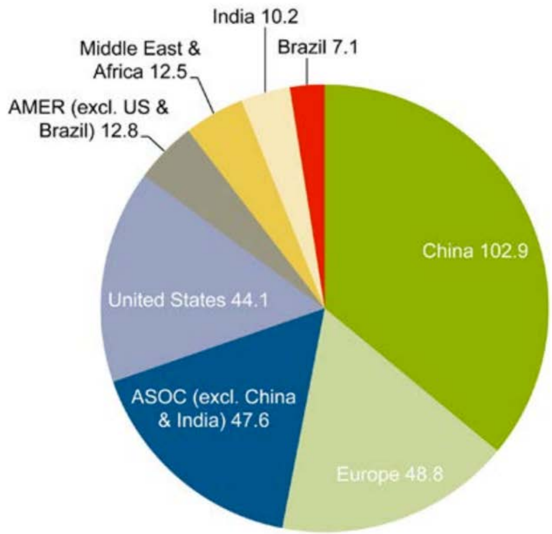
Today, REAP, AHFC, CCHRC and others are recommending that state policy makers adopt and enforce energy codes and minimum standards for all newly constructed residential buildings in Alaska, as well as for state funded buildings at the state, school district, borough and municipal levels; similar to the energy efficiency requirements now used by AHFC through its Building Energy Efficiency Standards (BEES).

Today, the Alaska Legislature is on the brink of passing a bill to create a "Property Assessed Clean Energy" (PACE) program for the state's commercial buildings. This would allow local tax assessment districts to set up programs to lend money to business owners who wish to energy retrofit their buildings, and then pay the loan back through a voluntary special tax assessment on the building. This will give Alaska business owners another financing tool for energy efficiency. It will also allow those businesses to do energy efficiency now, without worrying about whether they will own the building long enough to see a return on investment. That is because the loan goes with the building, not the owner. If a building owner sells an improved building, the next owner continues to pay the special tax assessment. Mortgagors of those buildings must sign a waiver that allows the tax assessment district to take a superior position on the loan, but experience shows that those lenders are more than happy to see their collateral increase in value through energy efficiency improvements. Efforts across the country to apply the PACE concept to residential properties have failed because Fannie Mae and Freddie Mac have refused to take a similar inferior position on loans. Allowing such a position would produce a flood of homeowners from across the nation who would like to use a PACE-type program to finance energy efficiency improvements.

III RENEWABLE ENERGY WORLDWIDE

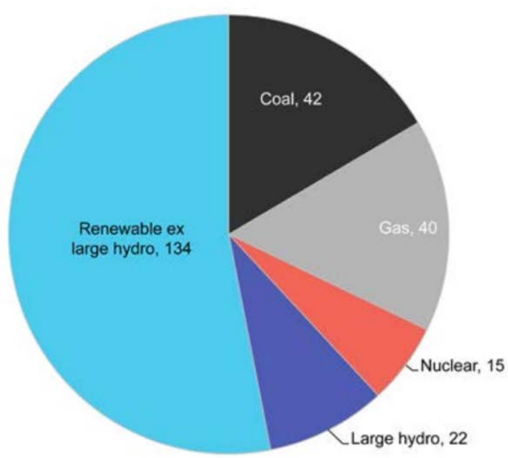
Renewable energy is one of the fastest growing industries in the world. In 2015, more than half of all new electric generation capacity added on the planet was renewable (and that does not include large hydro). As concerns about climate change increase, and technology costs continue to come down, investors are moving their money to what some are calling the next industrial revolution. The choice for the US is clear: continue to compete in the world market through policies and incentives that support renewables, or watch China and other nations fill the vacuum and corner the market on innovative technologies that will provide an enormous source of future revenues and employment.

Figure 1: Fig: Global New Investment in Renewable Energy by Region, 2015, $BN[5]



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

Figure 2: Net Power Generating Capacity added in 2015 by Main Technology, GW[6]



Source: Bloomberg New Energy Finance

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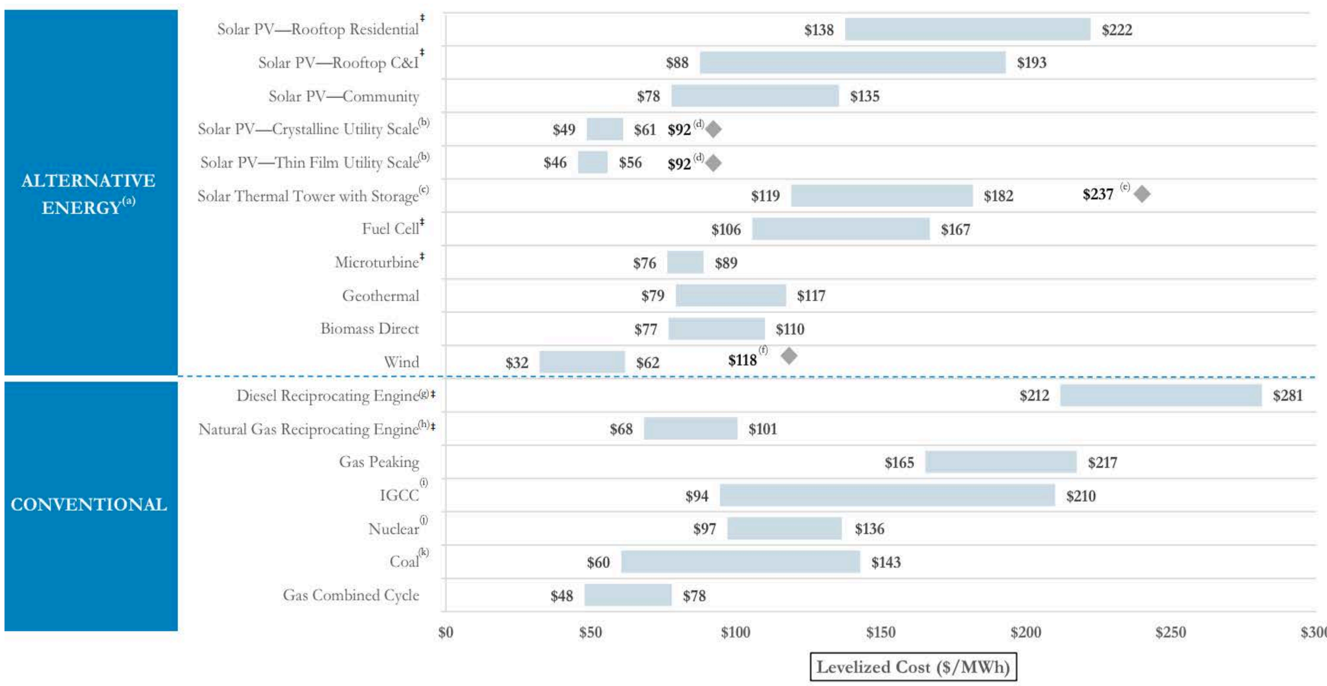
[5] See, http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf, pg. 22

[6] See http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf. Pg 31; For a general Renewable energy short-term forecast for U.S., see https://www.eia.gov/outlooks/steo/report/renew_co2.cfm

Drivers for Renewable Energy: Economics

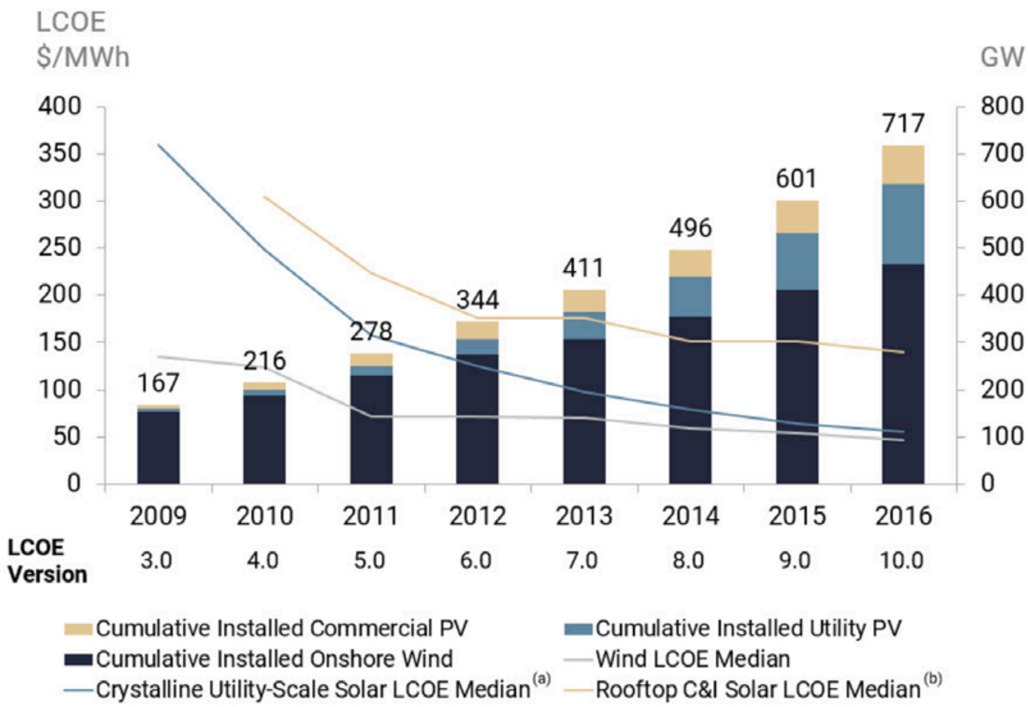
The economics of renewable energy continue to improve at a rapid rate, with both wind and solar prices already reaching price parity with conventional generation sources in some jurisdictions. As technology continues to improve and world demand increases, the price of renewable energy will continue to decrease. Meanwhile, fossil fuel prices remain volatile, and subject to a number of world market factors that the US has little control over.

Figure 3: Unsubsidized Levelized Cost of Energy Comparison, 2016[7]



[7] See https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf, pg. 2

Figure 4: Unsubsidized Levelized Cost of Energy—Wind/Solar PV (Historical)[8]

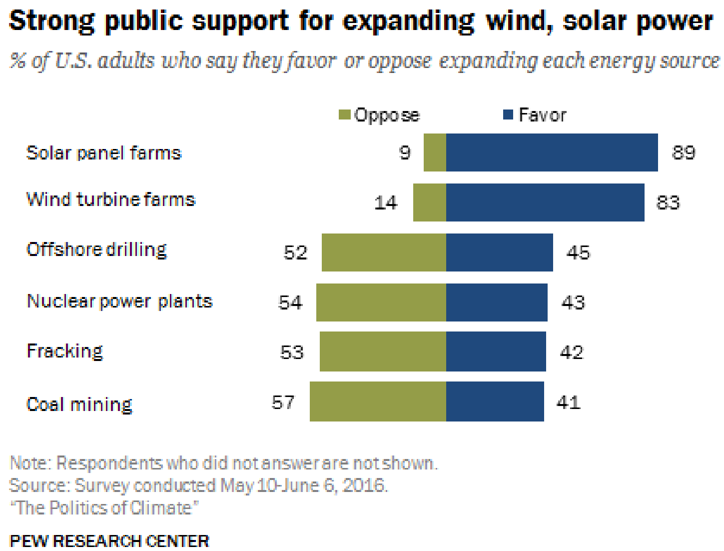


Drivers for Renewable Energy: Climate Change

The majority of Americans support renewable energy projects. A Pew Study published in 2016 found that 83% and 89% of Americans support expanding wind and solar power farms, respectively.[9] This is in contrast to other forms of energy, the study found, such as fossil fuels, which had up to 57% of adults opposed to it, as in the case of coal.

[8] See, https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-100
[9] See, http://www.pewinternet.org/2016/10/04/public-opinion-on-renewables-and-other-energy-sources/

Figure 5: Pew Research, 2016[10]



This public approval can be linked in part to Americans' increasing concerns about climate change. As has been widely publicized, Alaska is at ground zero for climate change, and has been feeling its impacts for some time. With record-low Arctic Ocean ice coverage, thawing permafrost, ocean acidification and increasing incidence and severity of forest fires; Alaska's landscapes and ecosystems are changing.[11]

These changes are likely to be expensive for the state. According to the EPA:

> "[c]limate change leads to more permafrost thaw and disruptions to freeze-thaw cycles that can increase frost heaves and subsidence. This can potentially cause damage to transportation infrastructure in Alaska, including highways, railroads, and airstrips. Uneven sinking of the ground in response to permafrost thaw is likely to add significant costs to the maintenance and repair of transportation infrastructure and buildings. Many of Alaska's highways are built in permafrost areas and are subject to damage if the permafrost thaws. Additionally, warming leads to a shorter period when ice roads are usable and a shorter season during which oil and gas exploration on the tundra can occur."[12]

Drivers for Renewable Energy: National Security

Renewable energy is a national security issue. Increasing the production of domestic energy makes the nation less dependent of foreign energy sources, and the politics that go with that dependency. Despite being at the lowest levels since 1970, in 2015, U.S. net imports (imports minus exports) of petroleum from foreign countries was still equal to about 24% of

[10] http://www.pewinternet.org/2016/10/04/public-opinion-on-renewables-and-other-energy-sources/
[11] Sea Ice: https://www.nasa.gov/feature/goddard/2017/sea-ice-extent-sinks-to-record-lows-at-both-poles
[12] https://www.epa.gov/climate-impacts/climate-impacts-alaska

U.S. petroleum consumption.[13] Various estimates have been made on what the US spends every year on its military presence to continue to access to oil in the Middle East. The cost of military operations in the Persian Gulf in 2007 alone was estimated to be $500 Billion.[14] In addition, the US military has stated over and over that the instability caused by drought, refugees, war and other events attributable to climate change are a prime national security threat. In order to decrease its own dependency on liquid fuel at forward operating based, the military is also leading many efforts to deploy renewable energy in small microgrids.

Utilization of Renewable Energy resources reduces refueling trips to and from the battlefield and therefore the exposure of any given unit or individual. The U.S. Army has a stated goal of deploying 1 GW of renewable energy on Army installations by 2025. The U.S. Navy's aircraft carrier John C. Stennis leads a Strike Group known as the *Green Fleet* because it utilizes a newly developed biofuel and energy efficiencies aboard its ships. As of the 2013 the U.S. Air Force had 261 renewable energy projects located on 96 sites. The push toward renewable energy solutions within all three branches of the military stems from a life or death pragmatism: "There is no mission assurance without energy assurance."[15]

IV ALASKA'S RENEWABLE ENERGY OPPORTUNITIES

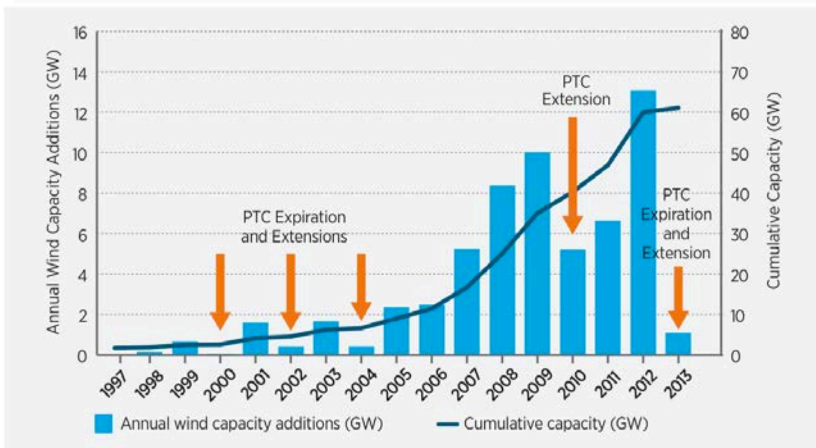
Wind

Wind energy now generates 4.7% of America's electricity."[16] In 2015, the U.S. Department of Energy (DoE) released *Wind Vision: A New Era for Wind Power in the United States.* The report shows that wind energy can supply the U.S. with 10% of the country's electricity by 2020, 20% by 2030, 35% by 2050, and provides a road map for how to get there. *Wind Vision* updates and expands on the DOE's 2008 report, *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to the U.S. Electricity Supply,* which galvanized the nation's rapid growth of wind. Indeed, wind turbine technician employment is on track to see an increase of 108% between 2014 and 2024.[17]

[13] See, https://www.eia.gov/tools/faqs/faq.php?id=32&t=6
[14] See, https://www.princeton.edu/oeme/articles/US-miiltary-cost-of-Persian-Gulf-force-projection.pdf
[15] Melinda Ballentine, Assistant Secretary of the Air Force, Installations and Energy
[16] http://www.awea.org/windvision
[17] See, http://www.aweablog.org/meet-americas-fastest-growing-profession-wind-technician citing U.S, citing Bureau of Labor Statistics: https://www.bls.gov/news.release/pdf/ecopro.pdf.

However, the effect of uncertain federal policy has a large impact the wind market in the United States, as shown in the figure below.

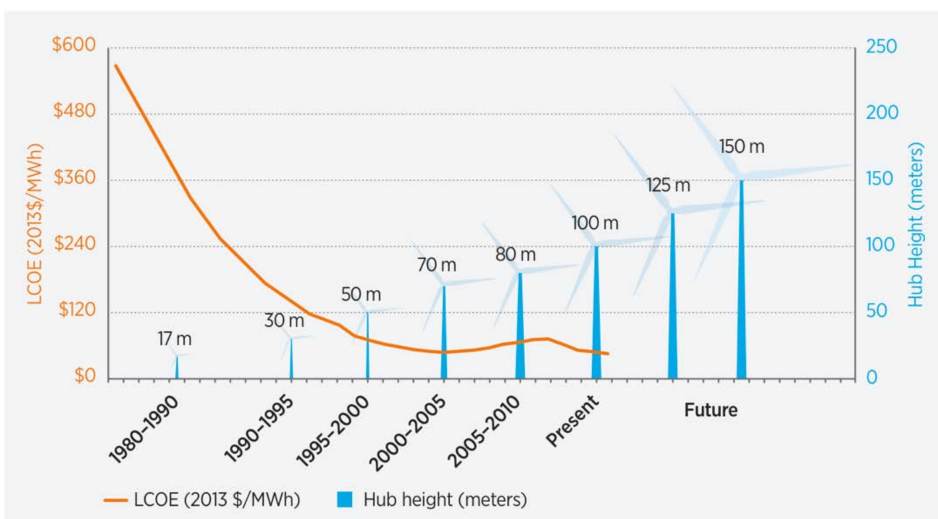
Figure 6:Historical Wind Deployment Variability and the Production Tax Credit[18]



On January 1, 2014, the PTC expired again and lapsed for more than 11 months. In early December 2014, the PTC was extended again, but was valid only through year-end 2014.

Economies of scale and technological advancements are increasingly driving down the cost wind energy. In 2016, the average power purchase agreement (PPA) for wind energy in the Midwestern US was around 2 cents/kWh.[19]

Figure 7: Wind Technology Scale-up Trends and the Levelized Cost of Electricity[20]



Note: LCOE is estimated in good to excellent wind resource sites (typically those with average wind speeds of 7.5 m/s or higher), excluding the federal production tax credit. Hub heights reflect typical turbine model size for the time period.

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[18] https://www.energy.gov/sites/prod/files/wv_executive_summary_overview_and_key_chapter_findings_final.pdf, pg. xxxvi

[19] See Berkley Labs report, http://newscenter.lbl.gov/2016/08/17/annual-wind-market-low-wind-energy-prices

[20] https://www.energy.gov/sites/prod/files/wv_executive_summary_overview_and_key_chapter_findings_final.pdf, pg. xxxviii

Wind is not only a consistent and predictably priced energy source, it is also a local economic engine. According to the US DoE:

> "[l]ocal economic impacts of wind power are derived from temporary and permanent employment in construction, engineering, transportation, manufacturing, and operations; local economic activity resulting from wind construction; and increased revenues from land lease payments and tax revenue. A study of economic development impacts for wind power installations between 2000 and 2008 found that total county personal income was 0.2% higher and employment 0.4% higher in counties with installed wind power, relative to those without wind power installations. Another study on four rural counties in west Texas found cumulative economic activity resulting from wind investments in local communities to be nearly $520,000 (2011$) per MW of installed capacity over the 20-year lifetime of the wind plant. In 2013, an estimated total of more than 50,000 onsite and supply chain jobs were supported nationally by wind investments."[21]

The *Wind Vision* report also notes that:

> "[i]ncreasing wind power can simultaneously deliver an array of benefits to the nation that address issues of national concern, including climate change, air quality, public health, economic development, energy diversity, and water security. For example, the 12.3 gigatonnes of CO2-equivalents avoided over the period 2013–2050 in the Central Study Scenario delivers $400 billion in savings for avoided global damages. This is equivalent to a benefit of 3.2¢/kWh of U.S. wind energy produced. The value of long-term social benefits such as these can be provided by wind energy and far exceeds the initial investment required."[22]

In Alaska, large wind on the Railbelt grid has so far been limited to installations at Delta, Healy and near Anchorage on Fire Island. Cook Inlet Regional Incorporated (CIRI) took advantage of the federal Investment Tax Credit (ITC) to build the first phase of Fire Island but structural and governance issues in the Railbelt have limited the ability of independent power producers (IPPs) like CIRI to sell more wind, or other renewable energy, into the grid. The six incumbent Railbelt utilities do not plan new generation additions together as a region. Without regional integrated resource planning in the Railbelt, more generation than is necessary for the region as a whole can be built, without resulting in any diversification of the generation mix. Each utility has the authority to charge tariffs for electrons that move through their respective service territories. These so-called "pancaking" transmission tariffs can ruin the economics of a good wind project quickly. The issue of what constitutes the target price for IPPs is also still unresolved. Defined in the federal Public Utility Regulatory Policy Act (PURPA) of 1978 as "avoided cost," this

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[21] See, https://www.energy.gov/sites/prod/files/wv_executive_summary_overview_and_key_chapter_findings_final.pdf, pg. xxxvii

[22] See, https://www.energy.gov/sites/prod/files/wv_executive_summary_overview_and_key_chapter_findings_final.pdf, pg. lvi

target price is currently being litigated in state court after new Regulatory Commission of Alaska regulations on the issue were promulgated in 2016. Finally, transmission bottlenecks both north and south of Anchorage limit the amount of electricity that can be moved in and out of the state's most populated area. Without the kind of transparent market rules that exist in other parts of the US, it will be difficult for wind and other renewable energy projects like geothermal to be built in the state's largest electricity market.

Outside of the Railbelt, today wind serves at least part of the electric load in more than 30 remote communities across the state. Most of these systems are so-called “wind-diesel hybrid” systems in remote, "islanded" communities that are not connected to a larger grid and rely on imported diesel fuel to generate electricity. Wind's contribution varies considerably in these communities, but many average 20%. However, through the use of advanced controls and energy storage, the goal for these systems is to provide more than 50% of a community's electricity.

Several efforts, including the Alaska Microgrid Partnership (AMP) supported by the US DoE, are working to create pathways for these communities to increase wind's contribution. The AMP is one of 11 regional projects currently under way through the DoE's Grid Modernization Laboratory Consortium (GMLC). The Alaska project seeks to develop more affordable, clean, reliable and scalable islanded power systems for remote Alaska communities, with a goal of reducing imported fuel consumption by at least 50% through a combination of advanced technologies. The Partnership includes four national labs (the National Renewable Energy Laboratory (NREL), Lawrence Berkeley National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratory) and a cross-section of Alaskan partners; including REAP, the Alaska Center for Energy and Power (ACEP) at the University of Alaska-Fairbanks, the Institute of Social and Economic Research (ISER) at the University of Alaska-Anchorage and Intelligent Energy Systems, an Anchorage-based small business.

The AMP involves conducting analysis of potential technologies and associated systems that could meet a > 50% fuel reduction goal for two communities: (1) Shungnak in the NW Arctic and (2) Chefornak in the Yukon-Kuskokwim Delta. The team is currently conducting a business case—for consideration by project developers—and will be conducting actual testing of proposed technologies at ACEP later this year. A final task of the project involves upgrading the Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/) with the goal of disseminating community-level technical, financial, and human capacity to undertake new energy infrastructure projects across rural Alaska. All the project reports, data, and related materials will be made available through the Alaska Energy Data Gateway for other communities to learn from and potentially replicate.

REAP has also been working with the Alaska Energy Authority and NREL for years to share information about wind energy across Alaska. For the last three years, REAP and the Island Institute in Rockland, Maine have partnered to facilitate the Islanded Grid Resource Center (IGRC). The IGRC is a growing knowledge hub that allows small grid operators off the coast of New England and in Alaska to share information about their wind-diesel microgrid systems with operators in states like Hawaii, and territories such as Guam and American Samoa.

Alaska's clean energy efforts are further strengthened by DoE's Energy Transition Initiative

(ETI), a program that works with government entities and other stakeholders to establish a long-term energy vision and successfully implement energy efficiency and renewable energy solutions. ETI provides a proven framework of technical resources and action-oriented tools to help islands and remote communities move away from a set of "reports on the shelf" and toward and actual transition to a clean energy economy and clean energy goals. Increasingly, this program, like the IGRC, is connecting stakeholders in some of our nation's most remote areas - Alaska, Hawaii, and islands off the coast of Maine. ETI highlights the need for local capacity and the benefits in learning from one another in order to improve the cost-effectiveness of local clean energy investments.

Communities in the Channinik Wind Group near Bethel are oversizing their wind farms and using the excess electricity to heat individual homes. This application takes advantage of the fact that the wind blows more steadily in the winter, exactly the time to address the even larger community problem of affordable heat. The Alaska Native Tribal Health Consortium (ANTHC) has been installing wind systems in communities with new water and sewer systems to help offset the energy costs of operating those systems. In addition to the AVEC and Kodiak wind farms mentioned above, Kotzebue Electric Association and the nearby northwest arctic communities of Deering and Buckland, are using USDA and other federal funding to install both solar and energy storage onto their already existing wind-diesel grids.

These pioneering systems are in large part responsible for putting Alaska on the map as a world leader in renewable microgrid system architecture. Alaska's high energy prices demand solutions and the innovative projects that Alaskans are implementing are of the sort that hundreds of millions of people in other parts of the Arctic and the developing world are seeking. However, continued support from the DoE and national labs is necessary to continue to hone technical systems, increase human capacity and workforce development, and provide public-private financing solutions.

Solar

In 2016, solar power represented the largest new source of electricity generating capacity in the United States, for the first time beating out both natural gas and wind for new capacity additions. Solar represented 39% of all new capacity added, with natural gas at 29% and wind 26%. [23]

A prime driver for this growth is the speed at which solar prices are dropping. Indeed, prices dropped an amazing 29% in just one year, from Q4 2015 to Q4 2016. Overall, prices have dropped 67% since 2011, with utility-scale PPAs for solar now being signed in the $0.03 - $0.05/kWh range.[24]

[23] See, http://www.seia.org/research-resources/solar-industry-data
[24] See, http://www.seia.org/research-resources/solar-industry-data

Figure 8: Annual U.S. Solar PV Installations, 2000-2016[25]

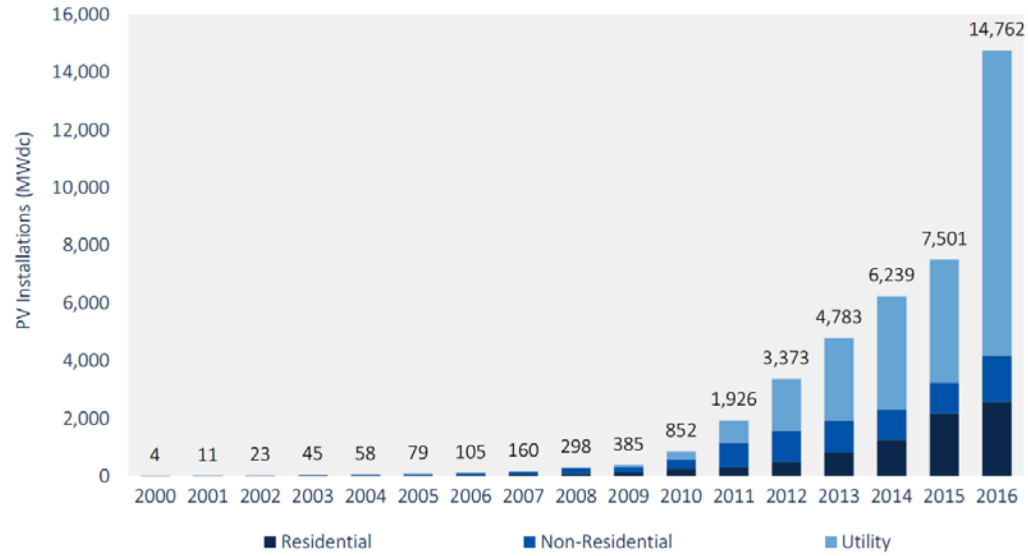
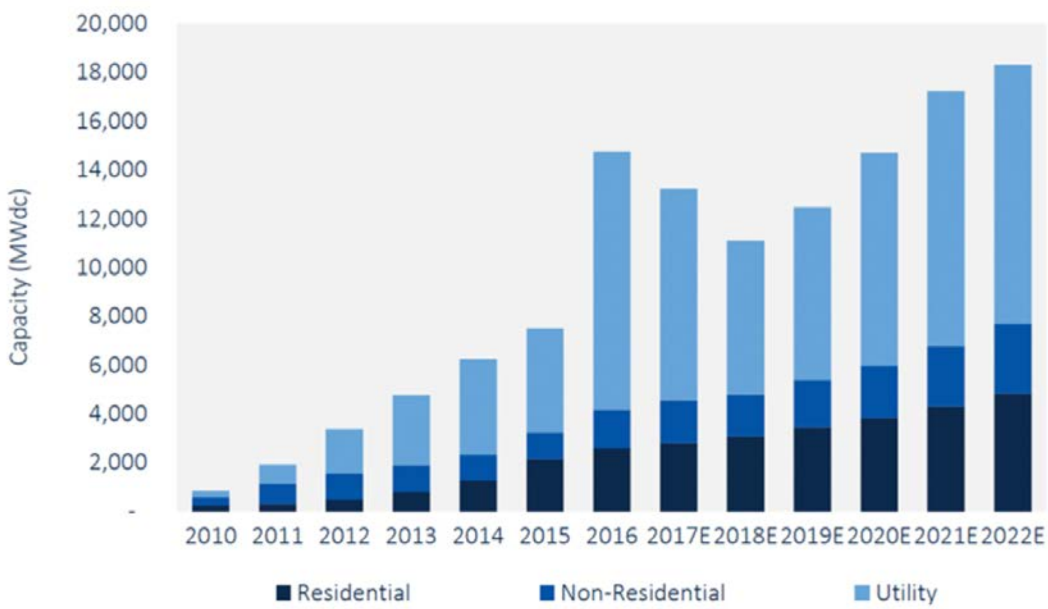


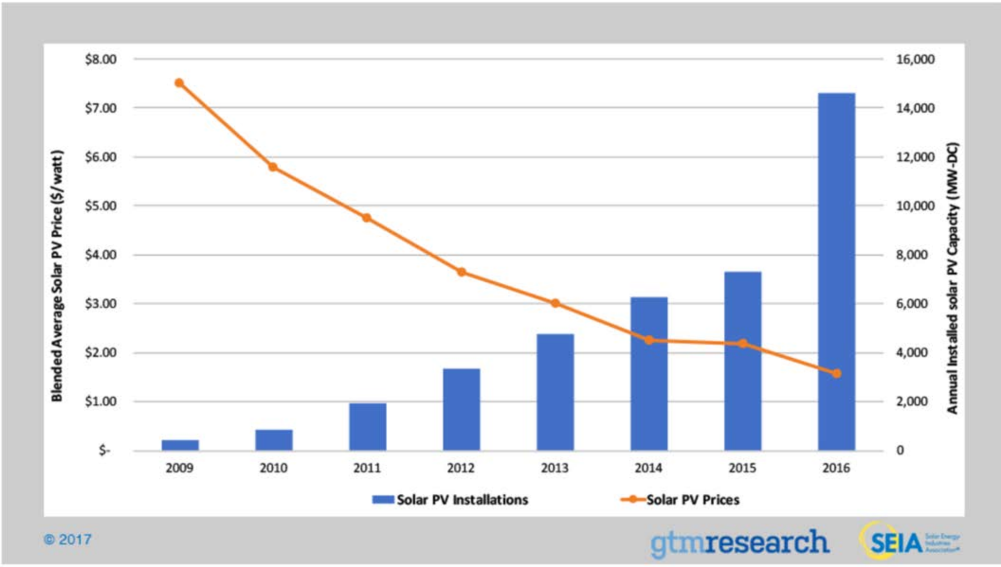
Figure 9: PV Installation Forecast, 2010-2022E[26]



[25]SEIA Solar Market Insight, Executive Summary, 2016, http://www.seia.org/sites/default/files/Dn4u8Zl5snSMI2016YIR.pdf, pg. 6

[26] SEIA Solar Market Insight, Executive Summary, 2016, http://www.seia.org/sites/default/files/Dn4u8Zl5snSMI2016YIR.pdf, pg. 18

Figure 10: Installed Solar compared to cost per watt[27]



In Alaska, besides an increasing number individuals and businesses using the federal Investment Tax Credit to put solar on their roofs; a number of small communities are also taking advantage of the sharp decline in solar prices over the last decade. Contrary to the perception of some, Alaska is not dark all the time. In fact, all places on the planet receive the same amount of sunlight each year. However, the farther one travels from the equator, the more lopsided the proportions of light and dark become. Most places in Alaska that experience a good amount of clear weather (including Southcentral and Interior Alaska where the vast majority of Alaskans live) have an excellent solar resource for about seven to eight months per year. The highpoint of solar production in many places is March and April, when the returning sun reflects off of ground snow and back onto the panels. For small utility systems that have deployed wind, solar can be a complementary resource that further decreases the amount of diesel that must be barged or flown in to generate electricity. The ability of a community to use solar electricity in the spring, summer and fall depends in part on how well it is integrated through advanced controls and energy storage. It also depends on finding new ways to use electricity in places that have not typically needed air conditioning (though this is changing) or a lot of lighting in the summer months. Potential additional uses include: value-added fish processing, ice making and electric vehicles.

Energy Storage

Advances in energy storage continue every year, both in performance and in price. In turn, these improvements are making variable renewable energy sources such as wind and solar more consistent and financially viable for Alaska's isolated grids. Kodiak Electric Association has already taken advantage of both 3 MW batteries (chemical energy storage) and a 2 MW flywheel (mechanical energy storage) to balance its load with its wind and hydro resources, allowing it to

[27] See, http://www.seia.org/research-resources/solar-industry-data

displace over 11 million gallons of diesel since 2009 when all systems were integrated. Several other utilities in remote communities across the state are also either already using energy storage, or planning to do so. Golden Valley Electric Association (GVEA) in Fairbanks has had a large battery for some time for use as backup in the event of a large power outage. GVEA is now looking at battery storage to help it balance the wind in its system, as are other Railbelt utilities near Anchorage.

Figure 11: U.S. Annual Energy Storage Deployment Forecast, 2012-2021E (MW [28]

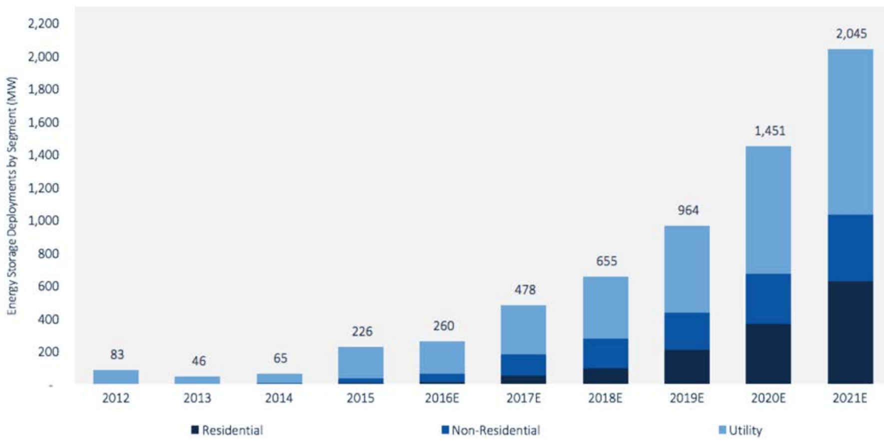
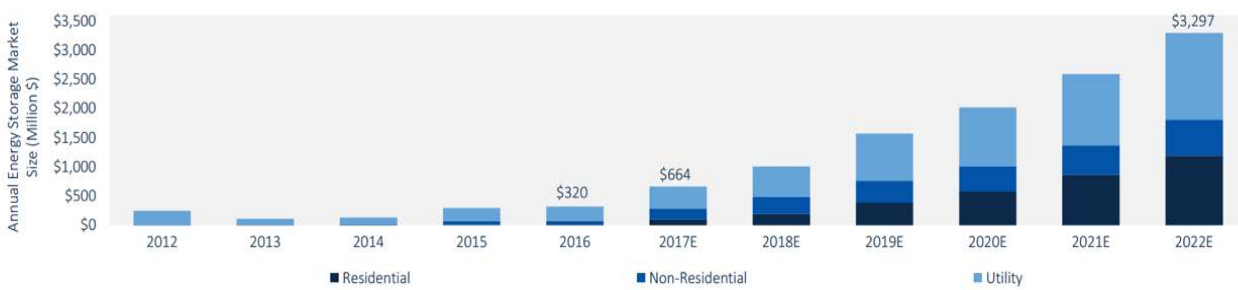


Figure 12: U.S. Annual Energy Storage Market Size, 2012-2022E (Million $)[29]



In general, energy storage system costs are being driven down across the board, even just over the course of 2016.[30] Production size and technological advancement are both moving the cost down, and are forecasted to continue to do so.[31]

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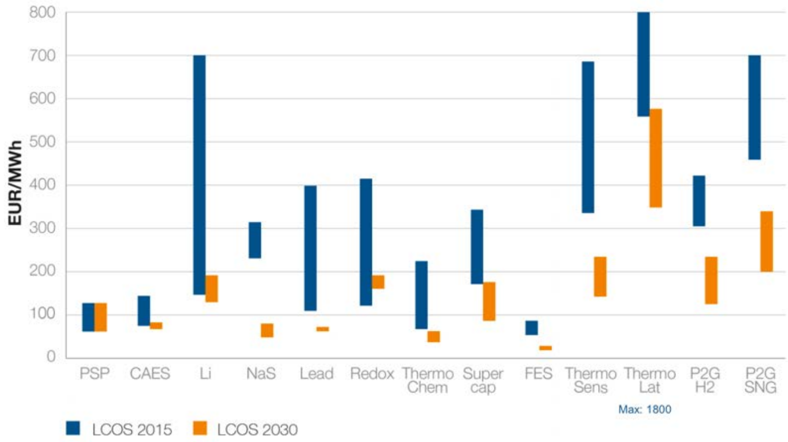
[28] https://www.greentechmedia.com/research/subscription/u.s.-energy-storage-monitor

[29] GTM Research. U.S. Energy Storage Monitor: 2016 Year in Review and Q1 2017 Executive Summary. pg 11

[30] http://energystorage.org/news/esa-news/energy-storage-falling-costs-major-gains

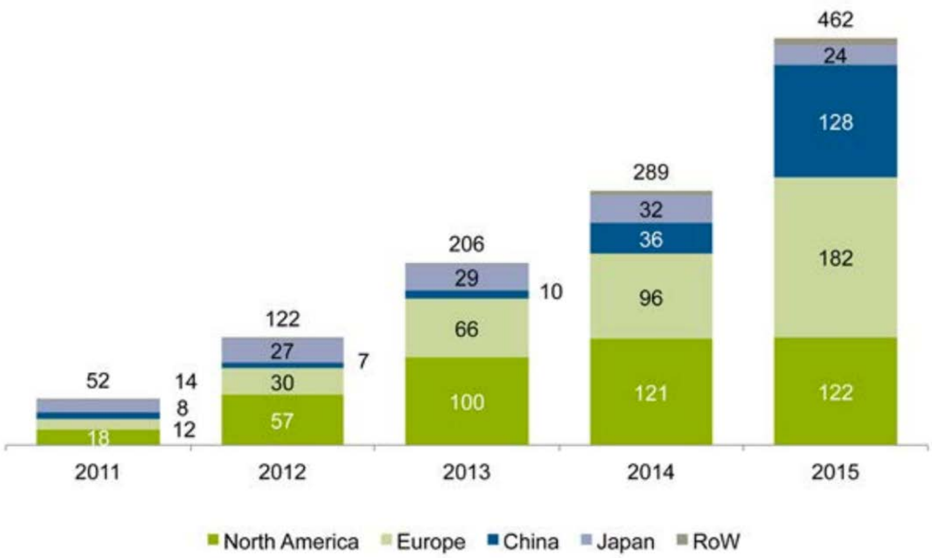
[31] All in Euro's but looks like a pretty great resource: https://www.worldenergy.org/wp-content/uploads/2016/01/World-Energy-Resources-E-storage-wind-and-solar-presentation-World-Energy-Council.pdf

Figure 13: Comparing general levelised cost of storage for 2015 and 2030 (€-2014) [32]



Electric cars are also poised to assist in the energy storage of renewable energies as their sales have continued to trend upward with no sign of slowing down, even during low oil prices. The improved batteries of vehicles, combined with smart grid management, can greatly assist in integrating variable energy through vehicle charging during peak production hours.

Figure 14: Total Electric Vehicle (BEV+PHEV) Sales, 2011-2015, Thousands[33]



[32] Interesting look at cost projection for current energy systems. See: https://www.worldenergy.org/wp-content/uploads/2016/01/World-Energy-Resources-E-storage-wind-and-solar-presentation-World-Energy-Council.pdf, pg. 16
[33] http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf, pg. 35

In Southeast Alaska towns like Juneau and Sitka electric vehicles (EVs) are already being heavily promoted. Those communities have a supply of clean hydroelectric power and a constrained road system (even though the mileage range of cars like the Chevy Bolt are increasingly greatly). Electric cars also align with the communities' focus on clean energy. Sitka is considering converting the city's municipal vehicle fleet to electric cars and the city has also established a public-private partnership that includes support for manufacturing facilities for the Nissan Leaf in Smyrna, Tennessee.

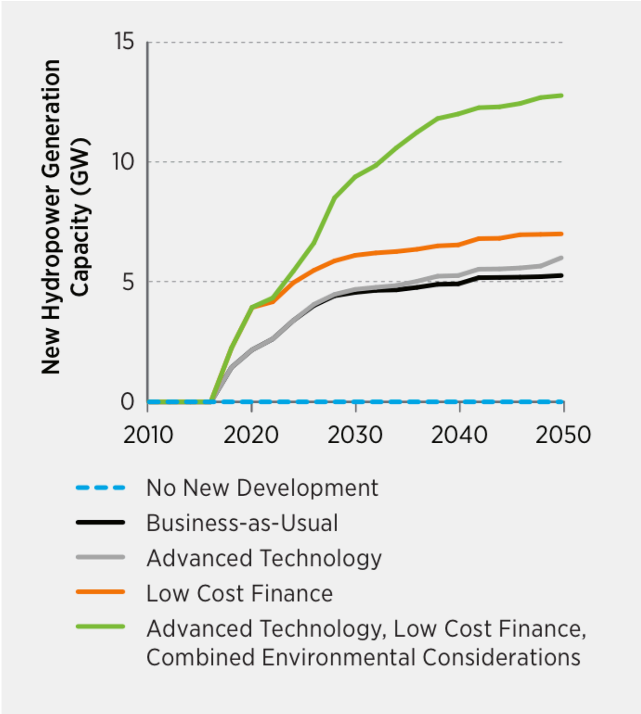
Juneau stands among the national leaders in EV adoption on a per capita basis despite the fact that it is still not possible to purchase a fully-electric vehicle in town. To support the adoption of EVs, a number of facilities owned by the state, city, university, utility, and private businesses now offer public charging stations. The Juneau Economic Development Council provided support for the effort that led to the installation of those public charging locations. Their continued work on electrifying Juneau's transportation sector includes supporting Tongass Rain Electric Cruise, a business intending to build the first marine tour vessel powered by lithium batteries, the first such design to be reviewed by the US Coast Guard. Juneau's electric utility also has the state's first electric vehicle incentive rate, offering customers a lower rate for shifting their charging into evening hours and providing an option to participate in that program through use of utility-owned charging stations. This allows customers to avoid some of the upfront cost of installing Level II chargers at home. To round out community efforts to support EV adoption, a local EV club and Facebook group page offer resources for current and prospective EV owners; including help coordinating Nissan service visits to Juneau (the community does not have a Nissan dealership or service center). Juneau anticipates continued acceleration in the rate of EV adoption throughout 2017.

The power systems integration laboratory at the Alaska Center for Energy and Power at the University of Alaska-Fairbanks is an ideal place for technology developers to test new energy storage technologies before they are deployed in the field.

Hydro

Alaska has already taken advantage of many hydroelectric sites, beginning over 100 years ago. The Railbelt generates more than 10% of its electric power through projects at Bradley, Cooper and Eklutna lakes, all projects that have minimal to no adverse impacts on fish. Such "lake-tap" projects also provide a significant amount of electricity in Southeast Alaska, particularly to Juneau, Ketchikan, Sitka and Wrangell. Other projects in Southeast are currently under consideration. In the Railbelt, Chugach Electric Association recently announced plans to investigate a 75 MW project near Seward at Snow River.

Figure 15:ReEDS Modeled Deployment of New Hydropower generation capacity, selected scenarios, 2017-2050 (GW) [34]



Biomass

A growing number of Alaskan communities in Southeast and Interior Alaska are using local wood to generate heat. These projects are often combined with green houses that increase a community's access to fresh food. As emerging technologies improve, there may also be an opportunity to convert low-value local wood to electricity, or to liquid fuels such as ethanol.

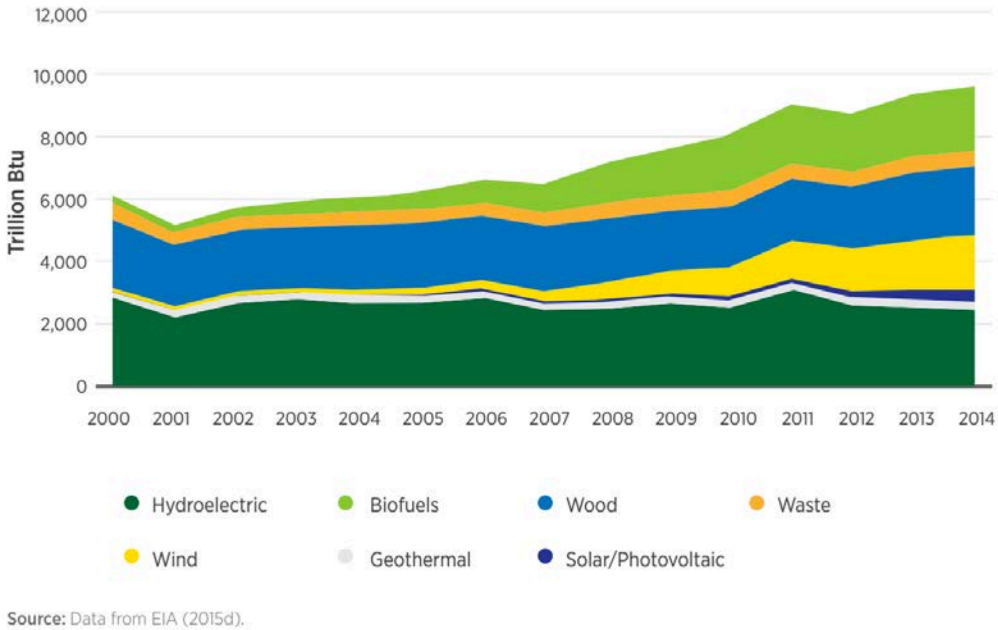
Groundfish processors across the state produce millions of gallons of fish oil every year as a byproduct of fishmeal plants. Since 2001, UniSea Inc. has been using approximately one million gallons of fish oil for power production, displacing the diesel it would otherwise use. The Alaska Energy Authority estimates that there are over 13 million gallons of fish oil thrown back into the ocean every year that are not being utilized.

Alaskans generate approximately 650,000 tons of garbage per year, and technologies to generate energy from such waste continue to improve each year. The Anchorage landfill has been capturing and using a significant amount of methane to generate 2.5 MW of electricity for over five years. As methane capture technologies improve, other, smaller communities may also be able to take advantage of this energy resource.

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

[34] https://energy.gov/sites/prod/files/2016/10/f33/Hydropower-Vision-Executive-Summary-10212016.pdf, pg. 16.

Figure 16: Primary Renewable Energy Consumption by Source (2001-2014)



Geothermal

Alaska has tremendous geothermal resources located in the Interior, the Southeast, the Wrangell Mountains and along the "Ring of Fire" volcanoes, which includes the Aleutian Islands and the Alaska Peninsula.

In the Interior, Chena Hot Springs Resort was the first place in the state to utilize geothermal energy for power generation. The resort installed a 400kW binary-cycle power generation unit produced by United Technologies Corporation (UTC), with assistance from state and federal agencies. The generator runs on 165°F water, the lowest temperature for an operating geothermal power plant in the world. In addition to the electric power plant, Chena uses its geothermal resources for outdoor baths, district heating, refrigeration, swimming pool heating, and to provide heat and carbon dioxide to its greenhouses.

Exploration for geothermal potential has also taken place at Mt. Makushin near Unalaska, and at Akutan, where the nearby Hot Springs Valley could produce up to 5 MW of electricity for the city and local fish processors. Perhaps the most interesting geothermal prospect is at Mt. Spurr, a volcano approximately 80 miles west of Anchorage. For several years, Ormat Technologies, Inc., a worldwide leader in geothermal power plants was exploring on a state land lease near the mountain. After it failed to find a sufficient resource in its first set of explorations, it quit operations after the State of Alaska decided it would cease cost sharing on drilling expenses. Mt. Spurr could still turn out to be a significant resource for Anchorage and the adjoining grid. Geothermal energy is ever-present base load power, and the Spurr resource has been estimated at upwards of 50 MW (approximately 8% of the entire grid-connected area's average annual load). If the resource can be located, it would be relatively easy to connect to the grid, which is approximately 35 miles away. Proximity to a large load, or to transmission, is an issue for most of Alaska's geothermal, and other “stranded” energy resources. If the transmission grid were extended to a future Mt. Spurr project, it could also pick up wind energy from the nearby "western forelands" of Cook Inlet, and/or a potential hydroelectric lake-tap project at Lake Chackachamna.

Tidal Power, Wave Power & In-River Hydrokinetic Power

Many people in Alaska are excited to harness that state's vast amounts of moving water. Since water is 842 times denser than air, a turbine set in the water has the potential to capture far more energy than if it were set up on land to capture the flow of the air. Cook Inlet, which laps the coastline of Anchorage, has the second highest tidal fluctuation in all of North America. The tides can be predicted centuries in advance, making it theoretically possible for multiple tidal energy generators set up along the coast to produce base load power. The state itself has more coastline to harvest wave power from than the rest of the United States combined. And Alaska's many large rivers provide an opportunity to capture the energy of moving water with devices that often look similar to those deployed to capture the energy of the tides.

Worldwide, most tidal, wave and hydrokinetic energy technologies would be considered "emerging" technologies (the exception are tidal "barrages" or impoundments, which have been used successfully for more than 50 years). Developers are, for the most part, still working to perfect the designs of their devices before beginning mass manufacturing. Many compare the place where these technologies are today with where wind power was 45 years ago. At that time, wind power was produced by 50 kW machines for over 90 cents/kWh. Today, wind is a very commercial power source, with much larger onshore turbines generating power that sells for less than 3 cents/kWh. Meanwhile, today Europeans are building offshore wind turbines that have 160 times the generating capacity of the small turbines of 45 years ago. Though today's low oil prices are making it difficult for tidal, wave and hydrokinetic power to commercialize quickly, most observers still don't believe it will take decades for those technologies to reach commercial maturity. Instead, international drivers such as climate change and national security will likely move those technologies along much faster.

Alaska's reputation as a natural energy technology laboratory has already attracted developers who are working to pilot tidal, wave and in-river hydrokinetic power devices. The Alaska Center for Energy and Power runs a hydrokinetic test center on the Tanana River near Nenana. Ocean Renewable Power Company (ORPC) based in Portland, Maine is investigating tidal power for both Anchorage in Cook Inlet and the tiny community of False Pass in the Aleutian Islands. ORPC has also successfully produced power in the Kvichak River in the village of Iguigig. In 2015, its devices sent power produced by the river's strong current back to the village while more than a million migrating salmon swam past it unharmed.

Resolute Marine Energy, based in Boston, Massachusetts, has been investigating the potential for wave energy near Yakutat for several years. Low oil prices are making it difficult for the company and many others in the industry to raise private capital to fund the pre-deployment technical surveys and other project planning initiatives required by state and federal regulators, or to fund important stakeholder outreach activities.

As noted, the state's vast renewable energy resources and high energy prices have made it a laboratory to optimize renewable energy technologies in small-grid hybrid applications. Those same conditions also make Alaskans ideal early adopters of tidal, wave and in-river hydrokinetic technologies that are likely to become mainstream in the coming decades.

V. OTHER NEEDS: HUMAN CAPACITY, FINANCING AND POLICY

Workforce and Training Investments

Cooperation and the development of highly specialized technologies has been part of the Alaskan legacy for more than 10,000 years. The first humans who trekked across the Bering Land Bridge were energy independent innovators destined to export their knowledge throughout the Americas. Then, as now, survival in Alaska is dependent upon access to natural resources, human capacity and applied technology. Alaska is uniquely positioned to capitalize on renewable energy but it must train Alaskans to operate, maintain and optimize the technologies described in this testimony. Why does this matter? Besides improving the lives of Alaskans, many of whom are already spending more than 50% of their take-home pay on energy, there is also a huge world market for efficient homes and locally produced renewable energy systems for remote communities that may never be connected to a grid. There are an estimated 1.5 billion people on the planet who today don't yet have any electricity, and all of them would like to have it. There are also more than 700 million people around the world who rely on diesel fuel to generate electricity. Most of those could use Alaska know-how to integrate local solar, wind and hydro resources into their grids. Alaskans could help people all over the world advance their local grids and reduce their reliance on fossil fuels.

In 2016, the global renewable energy industry experienced a 7% growth rate. The U.S. market now employs 3 million Americans and is valued at nearly $200 billion per year. Nationwide one out of every fifty new jobs added in the United States was created by the solar industry.[35] Alaska's solar industry is in its infancy and experienced a 94% growth from 2015 to 2016.[36] Wind employment in the U.S. increased by 34% in 2016. And yet, according to a survey taken by the DoE as part of the second Annual National Energy Employment Analysis: "73% of all employers surveyed found it "difficult or very difficult" to hire new employees with needed skills." It is imperative for both the nation and Alaska that we possess a workforce not playing catch up, but one reading itself to lead an industry that is so clearly the future of energy production.

Today a number of entities are working to train the technicians, operators and other specialists that will install, maintain and optimize new clean energy technologies in Alaska. The University of Alaska, vocational colleges, public utilities, government agencies and private entities are all exploring, training and innovating programs to further develop Alaska's workforce. But like so many things in Alaska, the state's vast geography and small population act as both catalyst and impediment to future development. Alaska's infrastructure includes cutting edge technologies and 19th century methodologies. Our workforce includes Native rural residents who live

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[35] Solar Foundation, 2016 National Solar Job Census, p.5
[36] Solar Foundation, 2016 National Solar Job Census, p.49

subsistence lifestyles and urban professionals from all over the world. Alaska's greatest research university is located in Fairbanks. Our financial center is in Anchorage. Our laws and budgets are made in Juneau. With these different centers located so far apart from each other, Alaska must make a concerted effort to build a vital clean energy business ecosystem.

REAP believes that a clean energy workforce development in Alaska hinges on a connected strategy to unite K-12 education, University and vocational program content and opportunities. Athough many important, discrete energy education and training programs exist in Alaska at all three levels, virtually all operate independently across a state with a landmass so large it would be the 19th biggest country. The state does not have a comprehensive energy education strategy, or a coherent plan to educate youth from kindergarten through job training. To define a workforce development strategy, REAP is bringing disparate energy education programs together under one umbrella network called the Alaska Network of Energy Education and Employment (ANEEE). Launched in 2017, the ANEEE network will collaboratively develop a strategic plan to unite existing programs and build on Alaska's strengths, while also reviewing approaches taken in other jurisdictions. ANEEE will both build energy literacy at all levels, and enable Alaskans to chart careers in clean energy from an early age. It's time to create a similar network for Alaska's energy education sector. Of paramount importance to Alaska's workforce future is greater coordination, communication and cooperation in creating shared efficiencies amongst Alaska's disparate energy stakeholders.

If Alaska wants to maintain its leadership in developing renewable energy technologies, there must also be a commitment to redouble investment in entities with a proven track record of training Alaskans to work in Alaska. Those include the Strategic Assistance Response Team (START) initiative which consists of technical experts from the DoE's Office of Indian Energy tasked with helping rural plant managers, leaders and tribal officials become more efficient in the planning, development and application of renewable energies; weatherization training done by the Alaska Housing Finance Corporation (AHFC) and the Alaskan Native Tribal Health Consortium (ANTHC); the Denali Commission's Alaskan Rural Maintenance Initiative (ARMI) program devoted to teaching rural leaders how to better implement renewable energy sources, maintain generators and repair equipment in order to conserve resources and secure a more reliable future for their communities; and the Alaska Vocational and Technical College (AVTEC), the state's single comprehensive vocational institution which has the herculean task of attracting, housing and educating Alaskans from throughout the entire state.

The Alaska Center for Energy and Power has also recently kicked off the Arctic Remote Energy Networks Academy (ARENA), an effort to make Alaska the world center in microgrid training. The first cohort of 20 students comes from Greenland, Canada, Russia and Alaska.

Gone are the days when Alaska can afford to rely on a skilled workforce that is not Alaskan grown. Expanding a dedicated clean energy workforce through a greater investment in education and training opportunities must be a part of Alaska's future.

Financing

Alaska has become a world leader in microgrid technology, in large part because the state provided significant support to the industry through the Renewable Energy Fund (REF). The State Legislature created the Fund in 2008 to provide grants for renewable energy projects, with an emphasis on projects serving communities with the highest cost of energy. This led to funding more than 150 grants between 2008 and 2015, most of which were for remote, rural communities dependent on diesel for electric generation. The State Legislature appropriated more than $259 million to the Fund during that time, which leveraged another $200 million in private sector and federal funding. The 60 projects that have so far been constructed in part with REF funding are now displacing the equivalent of an estimated 30 million gallons of diesel fuel every year. At a minimum of $2/gallon, the State's investments are saving Alaskans at least $60 million year. As those projects continue to be optimized, that figure will grow larger.

Alaska's budget deficits have ended appropriations to the state's Renewable Energy Fund, at least for now. However, there are still at least 130 remote Alaskan communities that are still not utilizing any form of renewable energy. Groups like REAP are looking for ways to catalyze future private investment in renewable energy projects in Alaska. One direction is to funnel any future state grant money toward essential reconnaissance and feasibility studies that the private sector will not lend money for. These types of studies must be done to identify both good projects, and ideas that are not yet ready for further investment. A complementary concept is a state "green bank." The Connecticut Green Bank was formed in 2011 and has been extremely successful in taking a relatively small amount of state money and leveraging it with the private sector interest and investment. The Green Bank does this by educating the private banking community on ways to structure clean energy loans in ways that are advantageous for both the borrower and the lender. The result has been a huge increase in clean energy investment in Connecticut. In its first five years, the Green Bank put together $1 billion in clean energy investments.

Federal support for clean energy can play an important role in making these investments work. Whether it's grants that can supplement loans, or federal loan gauruntees, the ability of a Green Bank or similar state investment institution to put together financing for renewable energy projects is enhanced when multiple entities work together to structure loans, and share risks.

As an appendix to this testimony, I have attached information on performance and savings from Alaska's Renewable Energy Fund, an example of a project success story and a spreadsheet listing a number of renewable energy projects that have already been vetted by the Alaska Energy Authority and approved for funding that are still waiting to move forward because no state grant funding or other financing has yet been found.

Policy

REAP understands that Congressional agreements have already been reached on phasing out important federal tax credits that support renewable energy, including the production and investment tax credits. At the very least, those phase-out agreements should not be modified or shortened. If the United States of America would like to be a producer of renewable technologies that the entire planet will increasingly demand, the Congress should consider maintaining a level playing field for clean energy technologies vis-a-vis the generous federal support that continues to be afforded to the fossil fuel industry. China and Europe are well on their way to world market dominance in most clean energy sectors, but if the US decided to compete, Americans still have an opportunity to benefit from the millions of jobs and trillions in revenues that world leaders in the clean energy industry will undoubtedly enjoy in the future.

The US can also support emerging energy technologies that will play a crucial role in our future by increasing the amount of resources it directs to national laboratories, state research institutions and federal programs like APRA-E. Without research, development and deployment strategies, new technologies like tidal, wave and in-river hydrokinetics that could play such a crucial role in Alaska will languish. For example, the federal government could consider devoting much <u>more</u> of the DoE's Water Power Program budget to the direct support of marine renewable energy projects in rural areas.

VI. CONCLUSION

Alaska is at a crossroads. The State Legislature is now in the process of restructuring the state's finances. While there has been talk about "diversifying Alaska's economy" for decades, there has never been a more important time to actually do it. What many are calling a "clean energy revolution" is sweeping the planet. The same kind of technology advances that now allow average citizens to hold the computing power of a 1960s supercomputer in the palm of their hand will continue to drive down the price of technologies like wind, solar, energy storage, tidal power and electric vehicles. The economics of clean energy will continue to get better. In addition, concerns about climate change and national security are only going to increase. Cleaner forms of energy are better for our children and grandchildren, and local forms of energy can make America less dependent on the politics of foreign oil.

Alaska is in an excellent position to capitalize on the fact that the energy challenges of its remote communities (imported, expensive liquid fuel) can lead to a huge opportunity to create a new sector of the state's economy based on Alaskan expertise that knows how to deploy energy efficiency and renewable energy technologies.

For this to become a reality, a constructive relationship amongst the private sector, the state government and the federal government must continue to be strengthened. Federal support for programs like the State of Alaska's Emerging Energy Technology Fund (EETF) would help the state promote energy solutions that help Alaskans in high cost areas, and commercialize technologies that will be sought after around the world. On this 150th anniversary of Alaska joining the United States, there is no better time to increase the strategic partnerships between the federal and state governments, and to recognize the common benefit that each will share if both governments make a concerted effort to increase support of renewable energy development in the north.

REAP thanks the Committee again for the opportunity to testify, and submit this written testimony. I would also like to thank my colleagues at REAP, Henry Hundt, Chris McConnell and Shaina Kilcoyne, for helping me prepare this written testimony.

PERFORMANCE & SAVINGS

- The present value of the capital expenditures used to build the 66 projects that were operational by the third quarter of 2016 is $562 million and the present value of benefits is $1,413 million. Based on the present value of capital cost and future estimated benefits, these projects have an overall benefit-cost ratio of 2.51.
- For every dollar invested, these projects have an estimated return of $2.51. It is important to note that the REF invested $158 million of total project costs in these 66 projects. The balance was invested from other sources.
- The technology with the largest number of generating projects continues to be wind, at 27 percent. This share has declined each year since 2013 when wind projects represented 40 percent of all REF projects.
- Biomass projects continue to come online and currently account for 20 percent of all active projects. Heat recovery projects make up an additional 20 percent of operational projects; these projects take heat from diesel powerhouse engines that would otherwise be wasted and put that heat to use in buildings and water systems, displacing thousands of gallons of costly heating fuel.
- The large majority of both capital cost and future benefit are from hydroelectric and wind projects. This is because of a handful of relatively large hydro and wind projects in more populated parts of the state including the Railbelt, Kodiak and Sitka.
- Three additional projects have come online in the fourth quarter of 2016 and will be included in the May 2017 update of this report.
- See pages 6 and 7 for information about where these $1.4 billion of benefits accrue.

REF CURRENTLY OPERATING PROJECTS - 2016 Q3

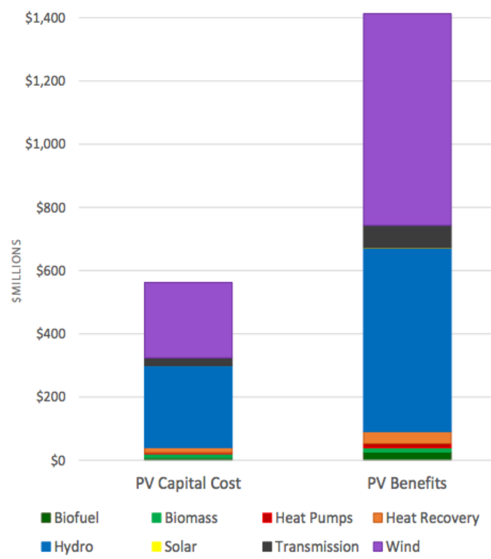

Figure 5 shows the present value (PV) of the 66 projects that are operational at end of Q3 2016.

GRANT AND FUNDING SUMMARY

	Round I	Round II	Round III	Round IV	Round V	Round VI	Round VII	Round VIII	Round IX	Totals
Applications Received	115	118	123	108	97	85	86	67	52	851
Applications Funded	80	30	25	74	19	23	26	10	-	287
Grants Currently in Place	9	4	8	19	8	16	21	9	-	94
Amount Requested[1] ($M)	$453.8	$293.4	$223.5	$123.1	$132.9	$122.6	$ 93.0	$ 43.8	$ 50.0	$ 1,536.1
AEA Recommended ($M)	$100.0	$ 36.8	$ 65.8	$ 36.6	$ 43.2	$ 56.8	$ 59.1	$ 20.6	$36.1	$ 455.0
Appropriated ($M)	$100.0	$ 25.0	$ 25.0	$ 26.6[2]	$ 25.9	$ 25.0	$ 20.0[3]	$ 9.5[4]	-	$ 257.1
Match Budgeted ($M)[5]	$ 10.1	$ 7.0	$ 8.6	$ 58.4	$ 5.7	$ 32.8	$ 8.1	$ 0.2	-	$ 130.8

NOTES:

1. Total grant amount requested by all applicants.
2. $26.6 million was appropriated for round IV, and an additional $10 million was re-appropriated from previous rounds for use in round IV.
3. $20 million was appropriated for round VII, and an additional $2.8 million was re-appropriated from previous rounds for use in round VII.
4. $9.5 million was re-appropriated from the Mt. Spurr geothermal project (FSSLA 2011 CH5, P137) for round VIII, and an additional $2.0 million was re-appropriated from previous rounds for use in round VIII.
5. Represents only amounts recorded in active and completed grants, does not capture all funding needed to construct the project.

RENEWABLE ENERGY FUND SUCCESS STORY

ALLISON CREEK HYDROELECTRIC PROJECT
The project has a capacity of 6.5 MW and will displace 15 gigawatt-hours of diesel-generated electricity annually

REF AWARDS | $10.3 million
DIRECT STATE APROPRIATION | $10 million
MATCHING FUNDS | $34.7 million
TOTAL PROJECT COST | $55 million
EXPECTED PROJECT LIFE | 50 years

Developing a hydro project in the Allison Creek drainage was a concept considered for many decades. In 2016, modern equipment, efficient contracting and construction and funding from the REF program. coupled with the dedication of Copper Valley Electric Association (CVEA), converged to make the Allison Creek Hydroelectric Project a reality.

The project serves more than 8,000 members of the CVEA cooperative in 15 communities in Southcentral Alaska. Like most rural areas, the high and variable cost of fuel is a burden. The Allison Creek project reduces dependence on fossil fuels and provides electric cost-stability and certainty in the region.

The Allison Creek project will provide an additional 15 GWh of hydro power on an annual basis. However, should demand in the area grow, the project has the potential to generate about 23 GWh annually. Total estimated fuel savings from the Allison Creek hydro is 725,000 gallons annually at present day demand.

The Allison Creek Project is a run of river (ROR) hydro project that is operated in conjunction with the existing Solomon Gulch storage hydro project to displace diesel generation to meet the demands of the service area.

The Allison Creek hydro project involved construction of a diversion structure at an elevation of 1,300 feet which diverts up to 80 cubic feet per second (cfs) of water from the creek into a 40 inch buried steel penstock to generate 6.5 megawatts of power via a single twin jet Pelton turbine.

Major features of the infrastructure include:

A 16 foot high diversion structure above a glacial moraine foundation spanning approximately 95 feet across Allison Creek.

A 7,900 foot long steel penstock ranging in size from 40 inch diameter at the intake to 36 inch diameter at the powerhouse.

A 700 foot long 16 foot diameter tunnel housing the 36 inch diameter penstock.

A 65 foot x 65 foot powerhouse with a floor slab to peak roof height of 48 feet, pitched to guide snow away from parking and the entrance to the building. The building also supports a large crane for handling the generation equipment.

A single twin jet 6.5 MW Canyon Pelton turbine and a tailrace located above the anadromous salmon reach of lower Allison Creek.

A 3.8 mile long 34.5 kV transmission line to the Copper Valley switching station near the Petro Star facility along Dayville Road.

Figure 17: Renewable Energy Fund Recommended Projects[37]

REF ROUND X RECOMMENDED PROJECTS RANK LIST

Blue cells indicate a standard electric generation application

Orange cells indicate a heat project application

Recommended Projects											Project Cost			Recommendation			
Count	Energy Region	ID	Project Name	Applicant	Energy Source	B/C Ratio	Impacted Pop.	Household Energy Cost	Tech/ Econ Score	State-wide Rank	Project Cost Through Construction	Applicant Grant Requested	Applicant Match Offered	Recommended Phase(s)	AEA Recommd	Recommended Funding	Cumulative Funding
1	Copper River/Chugach	1226	Fivemile Creek Hydroelectric Project	Chitina Electric Inc. (CEI)	Hydro	1.71	116	$12,269	75.67	1	$6,589,090	$3,400,000	$2,600,000	Constr	Full	$3,400,000	$3,400,000
2	Aleutians	1237	Sand Point High Penetration Wind System	Sand Point Generating, TDX	Wind	2.19**	946	$10,793	83.33	2	$1,067,309	$649,030	$423,275	Design, Constr	Full	$649,030	$4,049,030
3	**Bering Straits**	**1234**	**Wales Water System Heat Recovery**	**City of Wales**	**Heat Recovery**	**1.44**	**146**	**$17,269**	**72.50**	**3**	**$653,277**	**$650,047**	**$4,566**	**Design, Constr**	**Full**	**$650,047**	**$4,699,077**
4	Aleutians	1245	Adak Hydro Power Generator	TDX Adak Generating, TDX	Hydro	1.75	247	$14,961	59.50	4	$1,750,000	$294,102	$126,044	Feas	Partial	$19,600	$4,718,677
5	**Bering Straits**	**1238**	**Koyuk Water System Heat Recovery**	**City of Koyuk**	**Heat Recovery**	**1.06**	**321**	**$18,742**	**61.50**	**8**	**$695,269**	**$688,386**	**$6,884**	**Design**	**Partial**	**$90,922**	**$4,809,599**
6	**Bering Straits**	**1223**	**Shishmaref Wind Feasibility & Conceptual Design**	**Alaska Village Electric Coop**	**Wind**	**0.55***	**607**	**$15,812**	**52.50**	**18**	**$2,529,400**	**$152,000**	**$8,000**	**Feas**	**Full SP**	**$152,000**	**$4,961,599**
7	***Y-K/Upper Tanana***	***1233***	***Grayling Water System Heat Recovery***	***City of Grayling***	***Heat Recovery***	***0.99****	***191***	***$12,652***	***54.50***	***21***	***$431,982***	***$427,705***	***$4,277***	***Design***	***Partial***	***$38,401***	***$5,000,000***
7	***Y-K/Upper Tanana***	***1233***	***Grayling Water System Heat Recovery***	***City of Grayling***	***Heat Recovery***	***0.99****	***191***	***$12,652***	***54.50***	***21***	***$431,982***	***$427,705***	***$4,277***	***Design***	***Partial***	***$11,599***	***$5,011,599***
8	Railbelt	1242	Heat Pump System for City of Seward	City of Seward	Heat Pump	1.97	2,768	$9,005	83.17	5	$955,458	$725,000	$125,000	Design, Constr	Full	$725,000	$5,736,599
9	Southeast	1244	IPEC Gunnuk Creek Hydro Rehab in Kake	Inside Passage Electric Coop	Hydro	2.23	1,915	$10,561	73.00	6	$5,715,000	$3,920,000	$1,545,000	Constr	Full SP	$3,920,000	$9,656,599
10	Lower Yukon-Kuskokwim	1224	Mountain Village-St. Mary's Wind Intertie	Alaska Village Electric Coop	Trans, Wind	1.00	1,524	$12,362	66.00	7	$6,196,000	$3,196,000	$3,000,000	Design, Constr	Full SP	$3,196,000	$12,852,599
11	Southeast	1250	Elfin Cove Hydroelectric Permitting	Elfin Cove Utility Commission	Hydro	1.22	16	$12,008	67.33	9	$3,705,000	$88,000	$22,000	Design	Full	$88,000	$12,940,599
12	Northwest Arctic	1216	Shungnak Wind-Diesel Conceptual Design	Native Village of Shungnak	Wind	1.04	460	$17,752	50.00	10	$5,598,500	$135,000	$36,000	Feas	Full SP	$135,000	$13,075,599
13	Lower Yukon-Kuskokwim	1222	Bethel Power Plant Heat Recovery Module	Alaska Village Electric Coop	Heat Recovery	2.16	6,241	$10,766	71.67	11	$8,233,369	$2,555,489	$280,943	Constr	Full SP	$2,555,489	$15,631,088
14	Bristol Bay	1247	Chignik Hydroelectric Dam Project	City of Chignik	Hydro	1.86	96	$8,746	73.67	12	$7,763,426	$1,025,175	$60,251	Design	Full	$1,025,175	$16,656,263
15	Kodiak	1221	Old Harbor Hydro Geotech & Final Design	Alaska Village Electric Coop	Hydro	1.38	213	$12,098	68.50	13	$9,317,500	$1,092,500	$57,500	Design	Partial	$792,500	$17,448,763
16	Kodiak	1202	Upper Hidden Basin Geotech Investigation	Kodiak Electric Association	Hydro, Storage	4.24	8,465	$7,047	79.00	14	$79,247,000	$750,000	$750,000	Feas	Full	$750,000	$18,198,763
17	Southeast	1249	Indian River Hydroelectric Project - Construction	Tenakee Springs Electric	Hydro	0.94*	128	$11,498	56.33	15	$5,473,280	$809,000	$1,115,280	Constr	Full	$809,000	$19,007,763
18	Northwest Arctic	1212	Cosmos Hills Hydro Design & Permitting	NANA Regional Corporation	Hydro	1.08	734	$15,410	40.50	16	$50,797,871	$341,335	$37,200	Design	Full	$341,335	$19,349,098
19	Lower Yukon-Kuskokwim	1214	Eek Water System Heat Recovery	City of Eek	Heat Recovery	1.01	349	$12,572	59.50	17	$311,394	$308,311	$3,083	Design	Partial	$50,000	$19,399,098
20	Southeast	1211	Sitka Wastewater Plant Effluent Heat Pump	City and Borough of Sitka	Heat Pump	1.13	9,061	$6,991	72.50	19	$826,067	$667,000	$113,000	Design, Constr	Full	$667,000	$20,066,098
21	**Y-K/Upper Tanana**	**1207**	**Yerrick Creek Hydro Construction**	**Upper Tanana Energy**	**Hydro**	**1.23**	**1,539**	**$7,963**	**57.17**	**20**	**$20,744,264**	**$4,000,000**	**$15,000,000**	**Constr**	**Full SP**	**$3,925,000**	**$23,991,098**
22	Southeast	1205	Neck Lake Hydropower Project: Phases II-III	Alaska Power Company	Hydro	1.21	39	$9,630	63.17	22	$3,616,475	$395,200	$98,800	Feas, Design	Full	$395,200	$24,386,298
23	Lower Yukon-Kuskokwim	1235	Scammon Bay Hydroelectric Project	City of Scammon Bay	Hydro	1.25	528	$12,698	49.67	23	$4,280,056	$305,000	$3,050	Feas	Partial	$90,000	$24,476,298
24	**Y-K/Upper Tanana**	**1215**	**Huslia Water & Clinic Biomass Boiler**	**City of Huslia**	**Biomass**	**0.72***	**338**	**$13,795**	**44.67**	**24**	**$496,526**	**$491,610**	**$4,916**	**Design**	**Partial**	**$53,116**	**$24,529,414**
25	Aleutians	1219	False Pass Hydro Feasibility & Conceptual Design	City of False Pass	Hydro	1.87	34	$8,145	73.67	25	$4,380,000	$187,000	$33,000	Feas	Full	$187,000	$24,716,414
26	Aleutians	1246	St. Paul Island 80% Renewable Energy Feasibility	TDX Power, Inc.	Other, Wind	1.66	406	$8,560	48.83	26	$5,731,500	$265,200	$66,300	Recon, Feas	Full	$265,200	$24,981,614
27	Northwest Arctic	1213	Ambler Washeteria and City Office Biomass Heating	City of Ambler	Biomass	1.06	274	$11,345	49.17	27	$484,691	$429,892	$54,799	Design, Constr	Full SP	$429,892	$25,411,506
28	North Slope	1232	Atqasuk Transmission Line Design and Permitting	North Slope Borough	Trans, Other	2.02	4,698	$3,417	78.00	28	$32,840,509	$2,017,818	$201,782	Design	Full	$2,017,818	$27,429,324
29	Southeast	1218	Saxman Low-Rent Multifamily Air Source Heat Pump	Tlingit-Haida RHA	Heat Pump	0.97*	8,304	$6,794	60.83	29	$438,341	$296,038	$213,193	Design, Constr	Full	$296,038	$27,725,362
30	Aleutians	1201	Unalaska Water Treatment Inline Micro Turbines	City of Unalaska	Hydro	1.24	4,689	$7,677	58.00	30	$1,340,000	$1,100,000	$240,000	Feas, Design	Partial	$144,000	$27,869,362
31	Southeast	1208	Ketchikan High School Biomass Boiler	Ketchikan Gateway Borough	Biomass	1.33	8,304	$6,794	82.67	31	$1,365,890	$1,251,000	$0	Constr	Full	$1,251,000	$29,120,362
32	Southeast	1217	Klawock School Biomass Fuel Boiler Project	Klawock City School District	Biomass	1.38	802	$7,488	59.67	32	$858,556	$833,556	$25,000	Design	Partial	$111,986	$29,232,348
33	Copper River/Chugach	1248	Crater Lake Power and Water Project	Cordova Electric Cooperative	Hydro, Storage	0.97*	2,286	$11,122	45.17	33	$17,306,696	$1,227,000	$426,680	Design	Full SP	$1,227,000	$30,459,348
34	Railbelt	1210	Chugach Electric Solar Project	Chugach Electric Association	Solar	0.36*	172,380	$3,751	59.67	34	$1,814,049	$100,000	$100,000	Feas	Partial	$50,000	$30,509,348
35	Railbelt	1225	Grant Lake Hydroelectric Project	Kenai Hydro LLC	Hydro	1.10	49,918	$6,643	56.67	35	$58,536,366	$4,000,000	$875,528	Design	Full	$4,000,000	$34,509,348
36	Kodiak	1239	Ouzinkie Hydroelectric Power Project	City of Ouzinkie	Hydro	0.73*	171	$7,460	40.67	36	$4,603,385	$397,427	$4,014	Design, Constr	Full SP	$397,427	$34,906,775
37	North Slope	1231	Kaktovik Wind Diesel Design	North Slope Borough	Wind	0.79*	251	$6,295	38.17	38	$7,606,795	$440,000	$44,000	Design	Full	$440,000	$35,346,775
38	Southeast	1209	Ketchikan Schools Recreation Heating Plant	Ketchikan Gateway Borough	Biomass	N/A*	8,304	$6,794	62.00	39	$2,600,000	$220,000	$0	Feas	Partial	$40,000	$35,386,775
	Sub Totals, All Recommended Projects										$347,155,275	$40,258,526	$27,715,642			$35,386,775	

[37] See, http://www.akenergyauthority.org/Portals/0/DNNGalleryPro/uploads/2017/1/27/REF%20Round%20X%20Status%20Report.pdf, pg. 10-11