ENERGY STUDIES INSTITUTE

Policy *Brief* 12

19 February 2016

Alaska's Remote Hybrid Energy Systems: Potential for International Collaboration

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SYNOPSIS

The stand-alone energy systems providing heat and power to the remotely-located communities and industrial sites of Alaska exemplify the microgrids required to address energy needs in remote settings around the world. These systems typically operate on imported fossil fuels, such as diesel, and sometimes integrate locally available renewable energy. Similarly, Southeast Asia has remote and rural communities that are looking for off-grid solutions, and there are those who have amassed significant levels of expertise supporting these tropical microgrid implementations, and are actively engaged in the development of solar and other renewable energy technologies. There are real and potentially significant opportunities to accelerate and expand the availability of affordable, sustainable and reliable microgrid-based energy systems, if these complementary interests and capabilities can be brought together and applied appropriately.

KEY POINTS

- Despite the fact that their applications are in radically different climates, the high degree of functional similarities between Alaskan and tropical microgrids offer the potential for advantageous collaboration synergies.
- The integration of locally available renewable energy resources into remotely located off-grid energy systems can help communities and operators alike improve energy security and affordability by reducing the dependence on imported fossil fuels.
- According to one estimate, the global market for microgrid systems in remote locations is expected to exceed US$10 billion by 2024.
- Both the Arctic and the Southeast Asian regions are undergoing energy transitions. There are untapped synergies for researchers working in these two regions, particularly in the areas of technological research and the study of energy governance.

INTRODUCTION

Alaska is home to more than 200 small community microgrids distributed across its geographically and environmentally diverse regions. Over the past decade, investment in renewable generation has increased dramatically to meet both a desire for greater energy independence and to reduce the cost of delivered power. It has been estimated that Alaska has approximately 12 per cent of all the microgrids worldwide that incorporate grid-scale levels of renewable generation, with more than one million hours experience every year operating these systems in some of the most challenging locations on the planet. This has led to the development of a niche industry in Alaska, with significant experience in the design, development and operation of these hybrid energy systems. Human activity is expected to increase in Alaska and the wider Arctic as this region becomes more accessible with climate change and technological innovation. To highlight a few key trends, maritime traffic is expected to grow; infrastructure and facilities will have to be built to monitor and mitigate the impact of climate change and human activity, and to support new economic activity; also a broad range of mitigation and resilience solutions will have to be put in place to support the remote communities and indigenous livelihoods. With growing human and economic activity comes rising energy demand and a key challenge is the implementation of sustainable energy options and practices.

There has also been growing interest in the energy transitions taking place in Southeast Asia. According to the *Southeast Asia Energy Outlook 2015* published by the International Energy Agency, more than 130 million people in this region, or one-fifth of the Southeast Asian population, still lacks access to electricity. The IEA report also pointed out that Southeast Asia's rapid economic development and demographic changes mean that energy systems need to be developed and deployed in a sustainable manner. Southeast Asia faces a range of challenges in providing energy access to those who currently lack it, limiting the rise of greenhouse-gas emissions, encouraging energy-efficient practices, and ensuring that energy demands are met in a secure and sustainable manner. There is also growing emphasis to improve electricity access in rural areas. Off-grid energy systems that include integrated renewable energy technologies are expected to feature prominently in enabling energy access in both remote and rural communities.

At the basic level, the energy challenges surrounding remote communities and industrial sites are common across the world, namely, to develop sustainable off-grid energy systems that are affordable, easy to manage and resilient. We believe there is significant opportunity for global collaboration to meet these shared requirements.

ANALYSIS

Microgrids in Alaska

A microgrid is a localized energy system that supplies power (and often heat) to a remote area which is not connected to a centralized powergrid (Figure 1).

Figure 1. Illustration of a Microgrid

Source: Alaska Center for Energy and Power

This system typically utilizes fossil fuels with diesel fuel being very common. Wherever there are locally available renewable energy resources, these may be integrated with the fossil fuel energy system. In Alaska, microgrids are associated with residential, commercial, and community facilities. The microgrids in the remote areas of Alaska are usually stand-alone systems, with no connection to a more extensive regional grid due to their physical remoteness.

These remote systems are predominantly reliant on imported fossil fuels (diesel fuel, coal), unless they are able to access a locally available energy resource. However, these fossil fuels can carry significant economic, social, and environmental costs in their transport, storage, and usage. And as Nome, located at Alaska's western coast, experienced in 2011 when powerful fall storms prevented the last fuel barge of the year from arriving, remote energy networks are susceptible to supply chain interruptions, sometimes with potentially dangerous consequences.

As a result, remote microgrid communities typically experience higher energy costs than their counterparts with a regional energy grid. According to an Alaska Energy Authority analysis of the 190 communities participating in the state's Power Cost Equalization programme during the most recent fiscal year (July 2014 to June 2015) the price of electricity for homes ranged from US$0.15/kWh (Anaktuvuk Pass) to US$1.88/kWh (Healy Lake), with an average of US$0.49/kWh. By comparison, a residential customer pays US$0.06/kWh in Seattle, with its abundant hydroelectric power and regional grid ties to wind and solar resources. In many cases, Alaska residents can face energy bills exceeding half of their income.

In more than 70 of the 200+ microgrids in Alaska, renewable energy of some type is integrated into the grids, offsetting some of the imported fuel required in these communities. For example, Kodiak Electric Association has almost completely eliminated diesel fuel from their operations under normal, non-emergency, conditions. Their system integrates 33 MW of hydroelectric power, 9 MW of wind power, 3 MW of battery electrical storage and 2 MW of flywheel electrical storage to meet the electrical needs of their residents, port, local industry (which includes eight seafood processors) businesses and a US Coast Guard base.

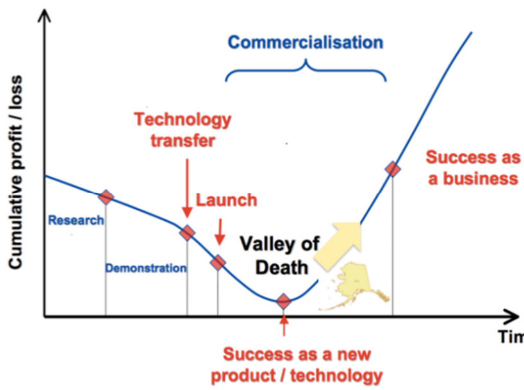
In Alaska's Northwest Arctic Borough, communities close to the Arctic Circle have recently integrated solar photovoltaic panels with the existing diesel generators providing power to their water treatment plants. In some cases, it has been possible to run completely on solar power. Chena Hot Springs, a resort situated about 60 miles (97 km) from Fairbanks and without access to any utility grid, is home to the world's lowest temperature geothermal power plant. Using 165°F (74°C) water pumped from wells drilled in the ground, it generates 300 kW of electrical power. The thermal waters are also used to provide heat for all of the buildings, including a year-round greenhouse; two thermal pools; and, via an absorption refrigeration cycle, cooling for a 10,000 square foot (92 square metres) ice museum on the premises.

Alaska has 14 microgrid hydropower projects serving local communities, primarily in the southeast region of the state, ranging in size, from 10 kW to more than 10 MW. Cordova is one of these, using energy from two run-of-the-river (no water is impounded behind a dam) hydroelectric sites with a total capacity of 7.2 MW to provide 60 to 80 per cent of their power demand. The balance of the load is provided via diesel generators (total capacity 11.2 MW) and a 280 kW Organic Rankine Cycle generator driven by heat recovered from the generator cooling system.

A Context to Accelerate Commercialization

Alaska has emerged as a location for helping energy technologies progress toward commercial viability, leveraging the expertise developed there by necessity. The US Department of Commerce recently awarded a grant to the Alaska Center for Energy and Power (ACEP) and the University of Alaska's Business Enterprise Institute to establish the *Alaska Center for Microgrid Technologies Commercialization* as a means of helping new technologies bridge the "valley of death" (Figure 2) and in some cases accelerate break-even achievement, and readying them for market across the globe in developing areas, isolated industrial sites, austere outposts, and as resiliency enablers for urban areas.

Figure 2. Alaska Helping Commercialization



Source: European Union Environmental Technology Verification Working Group (adapted by George Roe)

Alaska's suitability for service in this regard is rooted in the fact that its applications are typically small in size, which reduces the scope of capital and installation. It also shares similar attributes in multiple communities, thus enabling the development and evaluation of replication and scaling. In addition, Alaskans have strong skills for adapting and tailoring equipment, which helps to accelerate experience-based product improvement.

Finally, there is a certain degree of street credibility that goes with the moniker "as proven in Alaska".

As part of the programme, ACEP is developing a *Microgrid Technologies Guidance Document* that captures key requirements, functional attributes and technology development needs related to Alaska's microgrid applications. It will serve as a resource for companies seeking to develop system elements for microgrids in Alaska. The first release of the document is planned for March 2016. This could potentially, in the future, be expanded in collaboration with domain experts from Southeast Asia to include criteria and considerations germane to tropical microgrid implementations. ACEP is also coordinating a competition that will provide microgrid technology developers the opportunity to compete for free technical consultation and hardware-in-the-loop testing of their prototype hardware and control system strategies. In the future, companies with experience in the tropics, such as Southeast Asia, could potentially participate in this or similar commercialization accelerator programmes.

Market Potential for Microgrid Systems

In their 2015 *Market Data: Remote Microgrids and Nanogrids* publication, Navigant Consulting, Inc., a widely respected consultant and advisory firm in the United States, forecast the global market for microgrid systems in remote locations to exceed US$10 billion by 2024. The standalone energy systems used in Alaska's many remotely situated villages and isolated industrial sites may be applicable to locations elsewhere in the world. Similarly, energy research taking place in other regions, including Southeast Asia, may potentially provide scientific and social insights and technologies that could be relevant to Alaska and the wider Arctic.

A potential way forward may be to develop a collection of globally relevant use cases, identify the areas of greatest synergy and priority, and then establish Pacific-bridging partnerships to establish scalable, replicable hybrid energy solutions. Organizations such as the Islanded Grid Resource Center (islandedgrid.org) provide a context for this knowledge sharing engagement, and microgrid analysis tools such as HOMER™ (www.homerenergy.com) can be effective as a means of evaluating system technology elements and integration options.

WHAT TO LOOK OUT FOR

- The growing trend towards the establishment of microgrids in remote communities around the world, which will provide greater international research synergies and potential commercial opportunities.
- Innovative public-private collaboration and finance models that facilitate enhancements such as adding renewable energy and electrical storage to community-based microgrid systems without requiring government grants or subsidies.
- Growing collaboration between researchers in the Arctic and Asia in the study of energy transitions. This will include collaboration on technological innovation and in exchanging knowledge on energy governance issues.

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