The Alaska Center for Energy and Power (ACEP) established the Global Applications Program (GAP) to assess the global opportunities for trade surrounding the use of energy systems in islanded grids. The goal of the program is to develop a robust Alaska knowledge economy that can be exported globally and help facilitate the development of solutions and strategies for removing barriers to affordable, cost-stable, reliable, and secure energy.

Overview

Because Alaska’s remote energy applications, characterized as islanded microgrids, are predominantly reliant on diesel-powered electricity generation, they are adversely impacted by volatile fuel costs and supply interruptions. Communities, utilities, and industries operating these systems need, and are actively seeking, energy solutions that are affordable, cost-stable, reliable, and secure.

What is a microgrid?

Microgrids are electricity distribution systems containing localized loads and energy resources that can be operated in a controlled, coordinated way either while connected to the main power network (macrogird) or while islanded (intentionally or unintentionally disconnected from a macrogird for a short time period). In Alaska, microgrids do not typically have the ability to be connected to a macrogird and thus are not designed to be operated connected to or synchronous with a macrogird.

International Ranking System

GAP’s first task was to identify those countries with whom Alaska has the greatest potential to work collaboratively on islanded microgrid solutions. This was done by creating an international ranking system, using a spreadsheet matrix to facilitate the analysis. The GAP matrix used to assign scores to 100 countries and territories was based on attributes related to economic, energy, demographic, and political criteria. These criteria were designed to find where similarities to rural Alaska exist and where interest in microgrid research may be particularly relevant.

Methodology

In order to cast a broad global net and review nations as efficiently as possible, GAP researchers made two design decisions up front. First, they chose countries strategically using
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International studies of emerging energy markets, stakeholder reviews, and regional locations. Second, they analyzed data via a sequence of filters (see Figure 1), generally reviewing a large number of locations and then concentrating on those that best met the criteria (see Figure 2).

A weighted scoring system made it possible to advance countries through these filters. For each criterion, scores were applied based on the response to that particular topic. A country’s scores were then totaled at the end of each round of review; those scoring high enough were moved forward for further analysis. Figure 1 demonstrates how these filters functioned, and Figure 2 explains the specific criteria that were evaluated in each phase.

**Figure 1: GAP Filters**

- **Phase One:** 100 Countries
  - Relation to “Ideal Market”
- **Phase Two:** 50 Countries
  - Geopolitical Context
- **Phase Three:** 30 Countries
  - Economic Environment

**Figure 2: GAP Criteria**

- Phase One
  - Emerging economy
  - Population density
  - GDP per capita
  - National electrification rate
  - Rural electrification rate
  - Electricity growth rate
  - Residential cost of power
  - Electricity from fossil fuels
  - Cost of diesel
  - Non-integrated grids > 5 MW

- Phase Two
  - Government stability
  - Travel security
  - Business environment — legal & regulatory
  - Renewable energy goals and standards
  - International aid for energy development
  - Vulnerability to climate change
  - Existing contacts

**Five Highest-Scoring Nations**

**South Africa**

The highest scoring nation from the international ranking system was South Africa. As a member of BRICS,* South Africa has been identified as one of the fastest growing economies globally. South Africa’s domestic energy profile includes the ninth largest coal reserve worldwide as well as tremendous potential for solar (most areas average more than 2,500 hours of sunshine per year) and wind energy, particularly along the southwest coast. Moreover, South Africa has done extensive research to advance synthetic

*BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China and South Africa. BRICS members are all developing or newly industrialized countries.

New solar thermal panels on housing in Langa township, South Africa
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fuels, operating the largest coal-to-chemicals plant in the world and one of the largest gas-to-liquids facilities. South Africa is also exploring means to integrate renewable technologies with its mining sector, which in remote locations often operates using diesel generators.

**Vanuatu**
The Republic of Vanuatu is an archipelago of 82 volcanic islands in the South Pacific. Vanuatu is classified as a Small Island Developing State (SIDS). SIDS are characterized by development challenges, such as small-but-growing populations, remoteness, fragile environments, limited resources, and vulnerability to external shocks. As in Alaska, these issues are exacerbated by the high cost of communication, energy, and transportation. Vanuatu is working with the international community to reduce its reliance on imported fuels in order to support its tourism, fishing, and agricultural industries.

**Chile**
No Arctic nations made the top five; however, the sub-Antarctic nation of Chile has a region with environmental conditions analogous to Alaska, namely Patagonia. Chile has an extensive history with large-scale hydro projects, and hydro currently accounts for 35 percent of the country’s electricity production. In addition, the country has created economic incentives to encourage more small-scale applications of hydropower, including emerging technologies such as hydrokinetics. Furthermore, as a tectonically active region, Chile has vast geothermal energy potential, which has yet to be developed.

**Senegal**
Senegal was one of the countries not originally anticipated to score high in the analysis. The country, which declared independence from France in 1960, has been hailed as a democratic leader in West Africa. Its energy sector, not counting biomass, is more than 90 percent dependent on foreign imports, with 35 percent of its foreign exchange earnings used for oil imports alone. As the push to electrify rural communities continues, the nation has instituted regulatory and policy measures to promote the use of local energy sources. Through public-private partnerships, communities far from the national grid are accessing electricity through small modular hybrid systems, which incorporate solar, wind, diesel, and battery storage combinations. More detailed studies in Senegal have provided better understanding of its energy sector and identified organizations and institutions that are tremendous resources for investigating emerging energy markets. The map below comes from an example of such a resource, the International Renewable Energy Agency (IRENA) and its Renewable Readiness Assessment Program.

**Mongolia**
Mongolia is located on a mountainous plateau in Central Asia. In rural areas, low population densities coupled with vast distances have caused those not tied to the national grid to rely on intermittent diesel or coal powerhouses to supply electricity. However, Mongolia does have other options available to meet rural needs, including areas of good-to-excellent wind resources in the central and eastern regions. In addition, many locations are geologically similar to the Central Alaska Hot Springs Belt, and pioneering work is proceeding in small-scale geothermal power. Currently, there are existing partnerships between Alaska and Mongolia that offer venues through which information can be shared, including the Alaska National Guard-Mongolia State Partnership Program and the UAF College of Engineering and Mines affiliation with the newly formed American University of Mongolia.

**Next Steps**
The results from the initial GAP analysis highlighted many potential opportunities for improving the ranking system. The primary challenge in the current system is the inability to highlight regional differences within a country. For instance, using data about the U.S. as a whole in the matrix would not reveal the unique energy context that is found in rural Alaska. Accordingly, nations such as Canada and Australia, with whom we have known commonalities, did not score high because of the broad nature of the matrix evaluation method.
Developing Partnerships

The GAP program was initiated in order to develop collaborative relationships, so it is important to identify opportunities to work with other countries on shared energy challenges. Accordingly, researchers are actively exploring means through which global partnerships can be developed with universities, utilities and industries in the top-scoring countries by participating in international conferences and inviting international fellows to engage in project work in Alaska.

Conclusions

In summary, while GAP is designed to look outward for opportunity, the motivation for this action is to address in-state needs, such mitigating barriers to system integration in rural Alaska and developing a robust Alaska knowledge economy. Alaska is a state rich in locally available resources — advancing the technologies and expertise to maximize this abundance can serve communities and industries both domestically and abroad.

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