MICROREACTORS IN ALASKA

Use Case Analysis: Executive Summary

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Executive Summary

Alaska's energy landscape is made up of a dynamic patchwork of systems, from extremely small islanded micro-grids and remote mining operations to one larger interconnected system. Energy producers within each of these settings experience high costs for fuel and operations compared to U.S. averages.

The over 100 energy systems scattered across rural Alaska, in communities, at remote industry installations, and government sites are predominantly powered by diesel generation systems. The cost of producing power in remote areas is high, driven by fuel, infrastructure, transportation, maintenance, and administrative costs. The cost per kWh for energy production in remote areas can range widely, from $0.35 to $0.60 kWh, with an average of $0.52 per kWh.[1] A handful of hydroelectric and solar systems have been constructed, and wind diesel systems are growing in quantity annually. Heating needs are met with fuel oil primarily, with some communities supplementing with wood resources.

In urban Alaska, customers are served by an interconnected network of utilities and other energy producers, colloquially referred to as the Railbelt. Energy producers meet the demands of residential, commercial, and industrial users through a patchwork of energy sources, including natural gas, coal, diesel, hydroelectric, wind, solar, landfill gas, and Naphtha. Power costs on the Railbelt are significantly lower than the average for rural Alaska at $0.24 per kWh;[2] however, those costs remain significantly higher than the U.S. average of $0.13 per kWh.[3]

Power system size varies widely, with electric utilities hosting generation systems which range from 0.5 MW to 566 MW. Figure 1 maps the range of installed power capacity across the state.

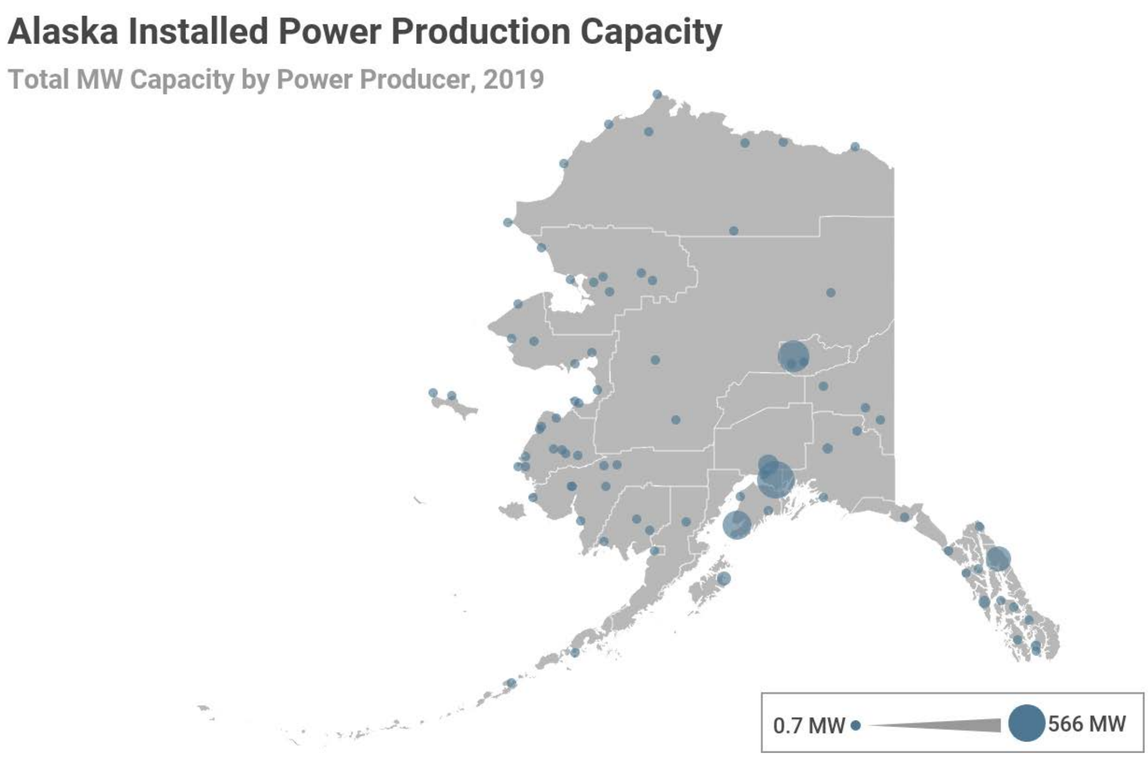

Figure 1: Alaska Energy System Size by Community.
Source: EIA, 2019.

Driven by the high costs and other factors impacting the energy systems across Alaska, the state's energy landscape has been the focus for alternative or early stage energy technologies. Alaska energy systems have served as a proving ground for a number of emerging energy technologies, to varying degrees of success.[4]

One emerging energy technology has been identified as a potential solution for Alaska energy systems of all sizes. Microreactors are under development by a number of companies, with small, remote energy systems in mind.[5] The reactors, which are in the early stages of development, include a number of characteristics which make them potentially well-suited to Alaska energy systems. These include:

- Minimal moving parts and maintenance requirements,
- Remote or autonomous operation,
- Load following characteristics, heat and power production capabilities,
- Infrequent refueling.

However, the critical variable which would accommodate remote Alaska energy systems is the capacity size, with microreactors estimated to range from 1MW to 20 MW electric(e).[6] The Nuclear Energy Institute (NEI) estimates that the first 50 microreactors deployed could produce energy at costs range as high as $0.40 per kWh in remote communities to $0.10 per kWh in Alaska's Railbelt.

Technology fit is determined by more than system size and costs. To examine the variables which could impact microreactor deployment in Alaska, this analysis grouped energy producers into five categories and developed case studies based off those groupings. The cases examined include:

- Small Rural Communities,
- Rural Hub Communities,
- Railbelt Energy Producers,
- Remote Mining Operations,
- Military Installations.

This analysis identifies and tests value propositions for each of the case studies using available data and information collected through interviews with energy operators and energy stakeholders across Alaska. The intent is to identify opportunities and barriers to implementing microreactors across five user groups present in Alaska. Some of these value propositions are discussed in Table 1 below.

The goal of this analysis was not to identify specific energy users or communities as potential microreactor users, but to put context behind some of the drivers of energy technology decisions and discuss how they might relate the reactors being developed. For that purpose, the case studies discussed here do not attempt to call out any one energy user or community and instead use hypothetical energy users to model energy needs and characteristics.

Value Proposition	Small Rural Community	Rural Hub Community	Railbelt Utility	Remote Mine	Defense Installation
Cost predictability/ containment	A major issue for diesel-dependent communities.	A major issue for diesel-dependent communities.	Some cost sensitivity but existing access to lower-cost fuels like natural gas.	A major issue, especially for non-grid connected mines using diesel generation.	Some cost sensitivity but less of a concern than other segments.
Low maintenance/ Remote operability	Potentially a major benefit but still discomfort with unknowns, since diesel systems are well-understood.	Potentially a major benefit but still discomfort with unknowns, since diesel systems are well-understood.	Less of an existing challenge but opportunities to reduce maintenance needs would be welcome.	Reducing on-site staff requirements to maintain powerhouses could be an advantage.	Less of an existing challenge but opportunities to reduce maintenance needs would be welcome.
Supply chain independence	Opportunity to reduce dependence on diesel fuel deliveries would be an advantage.	Opportunity to reduce dependence on diesel fuel deliveries would be an advantage.	More of a "nice to have" than a necessity.	Opportunity to reduce dependence on diesel fuel deliveries would be an advantage.	A major advantage; installations seek to be independent of an interruptible fuel source.
Decarbonization and air quality	An issue in some communities more than others, depending on priorities and local conditions.	An issue in some communities more than others, depending on priorities and local conditions.	Potentially an important issue in areas with air quality concerns and climate action plans in place.	Potentially valuable if carbon taxes are implemented in the future. Could also signal good corporate citizenship.	Advantageous to help meet defense targets for reducing carbon emissions.

Table 1: Alaska Customer Value Propositions and Barriers

Green=value proposition is a likely fit for the customer segment
yellow=uncertain

Barriers to adoption	Rural Village	Rural Hub	Railbelt Utility	Remote Mine	Defense Installation
Regulatory uncertainty/ risk	Limited ability to absorb new regulatory burdens, depending on specifics.	Limited ability to absorb new regulatory burdens, depending on specifics.	Greater ability to manage regulatory compliance.	Generally high ability to manage compliance, but may not wish to add to existing regulatory burdens.	Greater ability to manage regulatory compliance.
Public perception risk	A major potential challenge until technology is more widely understood.	A major potential challenge until technology is more widely understood.	Presents some risk but not certain currently.	A possible threat to pre-development projects during planning and permitting phase.	Less sensitivity than other segments given higher trust in reactors for military use.
Cost uncertainty	Access to capital limited, posing problems for upfront costs even if operating costs are low.	Access to capital limited, posing problems for upfront costs even if operating costs are low.	Greater ability to access capital and predict operating costs.	Strong access to capital for upfront costs, able to predict operating costs.	Likely able to absorb upfront costs through installation budgets.
Operational unknowns	Generally averse to being an early adopter until technology is better understood.	Generally averse to being an early adopter until technology is better understood.	Preference for known technologies but some willingness to adopt micro-reactors depending on costs/benefits.	Willing to be an early adopter if risks, costs, and benefits are well analyzed.	Willing to accept the operational unknowns of being an early adopter.

Table 1 Continued…

Green=not a major barrier to adoption

Yellow=mixed or uncertain

Red=likely to be a significant barrier to adoption

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Work Cited

[1] AEA. (2019). *Power Cost Equalization Program: Statistical Report.*

[2] RCA. (2020). Annual Reports for Golden Valley Electric Association, Anchorage Municipal Light and Power, Chugach Electric Association, Homer Electric Association, and Matanuska Electric Association.

[3] EIA. (2019). *Alaska State Energy Profile.* Retrieved from https://www.eia.gov/state/print.php?sid=AK

[4] Allen, R., Brutkoski, D., Farnsworth, D., Larsen, P. (2016). *Sustainable Energy Solutions for Rural Alaska.*

[5] IAEA. (2020). *Advances in Small Modular Reactor Technology Developments, A supplement to: IAEA Advanced Reactors Information System.*

[6] IAEA. (2020). *Advances in Small Modular Reactor Technology Developments, A supplement to: IAEA Advanced Reactors Information System.*