



A diesel fuel tank in Kodiak, Alaska. Credit: Dennis Schroeder/NREL

ARCTIC INITIATIVE | AUGUST 2023

Infrastructure Challenges in the Alaskan Arctic

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Infrastructure in northern Alaska requires special attention. Challenging weather conditions—including cold temperatures, remote conditions, limited transportation and logistical support, and inadequate technical capacity—result in higher costs and less reliability. These challenges are exacerbated by climate change. Permafrost thaw undermines the stability of foundations, causing building subsidence. Portions of roads are sinking, pipelines are being damaged, and utility poles are toppling over. In addition, climate change is accelerating the disappearance of sea ice, resulting

in storm-caused tidal surges that erode and flood the land, causing buildings to collapse and people to lose their homes.

Before discussing the current and future challenges caused by climate change, it is useful to briefly discuss the patterns of development in northern Alaska. Most of the population lives in small villages either on the coast or along small rivers. The largest “cities”—Nome, Kotzebue, and Barrow (Utqiagvik)—have populations of around 3,000 people.¹ Most of the villages are not connected by roads, and there is no interconnected electricity transmission, water, or sewerage system. Transportation between villages for both goods and people is by boat or plane—the latter can be quite expensive. Hence transporting materials and equipment for infrastructure assets can add significantly to the costs of the services that they provide. The absence of regional electric grids means that each village must rely on either mini-grids or self-generation, which are neither efficient nor cheap. The primary source of energy is diesel fuel. Except for larger coastal communities, diesel oil must be flown into villages, increasing fuel costs to more than double the cost of similar fuels in the lower 48 states.

Providing adequate water and sanitation services is a major challenge due to the inability to bury pipes. There is a wide range of sanitation services. Some villages have relatively modern systems, while others are dependent on primitive systems which haul away sewage in buckets. The cost of installing adequate water and sanitation services in northwest Alaska can be several times higher than installing similar systems in the southern part of the state.

What are the options for meeting the region’s infrastructure needs going forward? Let us start with energy systems. Are there alternatives to diesel oil? In the last two years, the global price of oil has risen, and this trend has driven diesel prices in the Arctic to new heights. Unfortunately, it has also driven transportation costs higher, meaning that moving the equipment to erect solar or wind generators is also costlier. Solar energy costs, which have plummeted in other parts of the globe, remain high in northern Alaska due to very low capacity factors, the absence of cost-effective storage, and high transportation costs. The prospects for wind energy are better. Wind speeds in most areas will result in higher capacity factors than solar facilities, and on a per kWh basis, transportation costs are lower. However, the economics of wind power favor larger units (2-12 Megawatts), and electricity demand in individual villages is too low to justify these larger units. Storage options and technologies that convert electricity to heat could make wind substantially more attractive.

1 Kotzebue. Northwest Arctic Borough. 2023. www.nwabor.org/village/kotzebue/

Sanitation and water systems suffer from many of the same problems as energy. Improving these systems will require more than just investing in innovative technologies. Access to capital to bring the more primitive systems up to basic standards is imperative, as is technical capacity to fix systems when they malfunction. One idea, suggested by residents around Norton Sound, is to create incentives for multiple villages to form community systems that will pool both capital and technical capacity. Building water and sanitation systems in regions where temperatures can routinely drop below -20°F will always be a challenge, given that the costs of these systems will be several times higher than a similar system in the rest of the United States.

Transportation systems are very susceptible to permafrost thaw. While it may be difficult to avoid many of the resultant problems, greater flexibility in accessing financial assistance from federal and state agencies would be helpful in repairing damaged roads, airports, and port facilities. Requirements that such repairs meet rigid federal safety standards make them unaffordable to small Alaskan communities. The U.S. Department of Transportation should weigh the benefits and costs of granting these communities the flexibility to repair their infrastructure to local standards.

The U.S. Army Corps of Engineers has studied the problem of coastal erosion and flooding in northwest Alaska several times, concluding that over 30 villages are at risk of serious damage to life and property. Indeed, several communities have already lost significant shoreline as well as buildings during fall and winter storms (when sea ice no longer is a protective barrier). There are two options to meet this growing problem. The first is to move the entire village and build new infrastructure systems, but the estimated costs are in the range of \$400 million per village.² The second is to help those who want to move to another community through assistance to both the individuals and the communities to which they intend to move. As climate-induced damage increases, these smaller villages, especially those along the coast, will suffer greater erosion and more out-migration—primarily to other communities in northwest Alaska. Working with these villages to identify how the federal and state governments might help is essential.

This brief was originally prepared for and presented at the Harvard/DHS Workshop on Impacts and Policy Challenges from Rapid Climate Change in Alaska, co-hosted by Harvard Kennedy School's Arctic Initiative and the Science and Technology Directorate of the U.S. Department of Homeland Security on May 8, 2023, in Cambridge, MA. It has been edited from its original form.

2 The White House. 2016. "President Obama Proposes New Funding to Build Resilience of Alaska's Communities and Combat Climate Change." <https://obamawhitehouse.archives.gov/the-press-office/2016/02/09/fact-sheet-president-obama-proposes-new-funding-build-resilience-alaskas>



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