

# Kokhanok Climate Adaptation Plan

**Developed for:** Kokhanok Village Council  
**Prepared with Support from:** DeerStone Consulting, LLC

December 2023



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## Executive Summary

The Kokhanok Climate Adaptation Plan is designed to enhance the resilience of Kokhanok, a remote Alaskan village on Lake Iliamna, as it faces growing threats from climate change. With rising temperatures, unpredictable weather patterns, reduced ice thickness, and declining subsistence resources, the community's traditional way of life, infrastructure, and food security are at risk. The purpose of this adaptation plan is to provide a comprehensive strategy to address these challenges while preserving the cultural heritage and traditional knowledge of Kokhanok.

Key climate risks identified include increased temperatures, which threaten subsistence practices like hunting and fishing, unpredictable weather and storm events, reduced ice thickness that impacts travel and subsistence activities, and the potential for more frequent wildfires. Additionally, the community faces challenges related to food insecurity, energy dependence on diesel fuel, and aging infrastructure that is vulnerable to extreme weather events.

To mitigate these risks, recommendations focus on several key adaptation projects. The Tribal Farm will enhance food security by providing locally grown, year-round food using adaptive agricultural practices, reducing dependence on imported foods while creating economic opportunities. The Road Resurfacing and Dust Control project will improve road safety and air quality by developing local gravel resources and applying dust control measures, reducing dust emissions and reliance on imported materials. Developing a new housing subdivision and weatherization upgrades for existing homes will increase housing and infrastructure resilience, while integrating renewable energy systems like solar and wind power will lower energy costs and reduce diesel dependency. Expanding renewable energy use, particularly solar, wind, and biomass, will further strengthen the community's energy security and resilience against power outages. Additionally, improving public health preparedness by strengthening healthcare infrastructure will ensure Kokhanok is better equipped to respond to future health crises.

Overall, the Kokhanok Climate Adaptation Plan outlines a path to resilience by addressing food security, energy independence, infrastructure improvement, and public health preparedness. With the support of identified funding sources from federal, state, and private organizations, Kokhanok will be able to implement these projects and build a sustainable future. The plan is a living document, designed to evolve as new challenges arise, ensuring that Kokhanok remains resilient in the face of climate change while preserving its cultural identity and traditions for future generations.

# Introduction, Outreach, and Methodologies

## Purpose and Scope of the Adaptation Plan

The purpose of the **Kokhanok Climate Adaptation Plan** is to enhance the resilience of the Kokhanok community in response to the growing challenges posed by climate change. As a remote village in Alaska, Kokhanok faces significant environmental changes, including rising temperatures, decreasing ice thickness, and unpredictable weather patterns, all of which threaten the community's traditional way of life, infrastructure, and food security. This adaptation plan provides a comprehensive framework to address these risks while preserving the cultural heritage and traditional knowledge that define Kokhanok.

The **scope** of the adaptation plan is broad, addressing multiple areas critical to the community's long-term sustainability. The plan outlines strategies for improving energy resilience, safeguarding food security, reducing wildfire risks, enhancing public health preparedness, and adapting key infrastructure to changing environmental conditions. It includes both immediate actions and long-term strategies to help Kokhanok thrive in the face of climate change.

This adaptation plan is not static; it is designed to be a **living document** that evolves as new challenges arise and as the community gains experience with implementing climate resilience strategies. Regular updates will be made based on ongoing community feedback, new scientific data, and shifting environmental conditions. The overarching goal of the plan is to empower Kokhanok to meet climate challenges head-on, ensuring a sustainable, resilient future for generations to come.

## Community Outreach, Planning, and In-Person Meetings

The development of the Kokhanok Climate Adaptation Plan was an inclusive and collaborative effort, anchored in key engagements with community leadership and residents. Throughout the planning process, outreach was focused on gathering insights from the community while ensuring that adaptation strategies reflected local priorities, cultural values, and traditional knowledge.

### Community Outreach and Engagement Process

To ensure the adaptation plan was aligned with the needs of the Kokhanok community, the planning process involved:

- **Targeted Engagement with Tribal Leadership:** The Kokhanok Village Council, led by the Tribal Administrator, played a critical role in guiding the planning process. Regular consultations with the Tribal Administrator ensured that the adaptation plan was culturally appropriate and aligned with community governance priorities.
- **Coordination Through Virtual and In-Person Meetings:** The planning process involved both virtual consultations and in-person community engagement to collect insights and feedback.
- **Workshops and Open Dialogues:** Residents had the opportunity to participate in key workshops where they shared personal experiences, identified risks, and brainstormed adaptation strategies.

- **Feedback Collection via Phone and Email:** Community members were encouraged to submit comments and suggestions throughout the process to ensure their voices were heard.

## **Key Meetings During the Planning Process**

### **1. November 2022: Virtual Meeting with Tribal Administrator**

- In this initial meeting, the DeerStone Consulting team met virtually with the Tribal Administrator to conduct a preliminary assessment of the community's climate-related challenges. This meeting focused on gathering leadership perspectives on priority areas such as the risks of increased temperatures, changing weather patterns, and food insecurity.
- The discussion also helped to outline the structure of the community outreach process and identify the most pressing concerns for Kokhanok's adaptation strategy. These included the impact of diesel dependency on the village's energy resilience and the need for long-term solutions for food security.

### **2. January 2023: In-Person Adaptation Strategy Development Workshop**

- This meeting took place in Kokhanok and involved a broad group of community members, including Elders, youth, hunters, and local leaders. The workshop focused on co-creating adaptation strategies that addressed the vulnerabilities identified in the earlier discussions.
- Residents participated in small group discussions around key themes such as wildfire prevention, energy security, and preserving traditional lifestyles. This in-person workshop provided the opportunity for community members to voice their concerns, share local knowledge, and collaboratively design solutions that would work for their unique context.
- Technical experts from DeerStone Consulting presented potential projects, such as microgrids, community farms, and energy efficiency upgrades, facilitating a dialogue around the feasibility and benefits of these options.

### **3. March 2023: Virtual Review Meeting with Tribal Administrator**

- In this final step of the planning process, the draft of the adaptation plan was reviewed virtually with the Tribal Administrator. This meeting provided the opportunity for final adjustments to the plan, ensuring that it accurately reflected the priorities and strategies developed during the January in-person meeting.
- The feedback focused on refining certain aspects of the project timelines and funding strategies. Following this virtual review, the Tribal Administrator gave approval for the adaptation plan, setting the stage for formal adoption and implementation by the Kokhanok Village Council.

## Methodology

The development of the Kokhanok Climate Adaptation Plan was a collaborative process that integrated both community input and scientific research to ensure it was comprehensive and locally relevant. A key component of this effort was the **integration of Indigenous Traditional Knowledge**. Community participation was actively encouraged through several meetings, including a major in-person workshop in January 2023, where residents discussed local vulnerabilities and proposed adaptation ideas. This ensured that the plan reflected the lived experiences of the community. The Kokhanok Tribal Council reviewed and approved the plan, ensuring it aligned with local governance structures and had full community support.

In addition to community contributions, the plan was informed by **scientific research and data**. The **Scenarios Network for Alaska and Arctic Planning (SNAP)**, based at the University of Alaska Fairbanks's International Arctic Research Center, provided climate modeling and environmental projections. These models helped the planning team better understand the relationships between climate, vegetation, and fire, and how these factors are likely to change over time.

The **Tribal Climate Change Adaptation Planning Toolkit (TCCAPT)**, developed by the Institute for Tribal Environmental Professionals (ITEP), provided a structured methodology for the planning process. This seven-step process guided the team through assessing climate risks, identifying vulnerabilities, and developing actionable adaptation strategies. The toolkit ensured that the plan was adaptable, allowing for adjustments as new data or climate conditions emerged.

The planning process also relied on broader **climate and economic projections**. For instance, the 2018 National Climate Assessment highlighted the significant financial risks Alaska faces due to climate change, estimating costs of \$3 to \$6 billion between 2008 and 2030. This economic data reinforced the need for proactive adaptation measures, underscoring the financial benefits of early planning to mitigate the impacts of climate change on the community.

## Planning & Resources Referenced

The development of the **Kokhanok Climate Adaptation Plan** was guided by a series of key documents that provided essential insights into the community's resilience strategies, energy needs, and infrastructure vulnerabilities. Each of these documents played a vital role in shaping the community's response to climate change and future planning efforts.

- **Kokhanok Tribal Resilience Program & Climate Adaptation Plan:** This foundational document outlined early efforts to build the community's climate resilience, providing the initial framework for the current plan.
- **Hard Copy Documents of Short and Long-Term Goals, Concerns, and Resolving Issues:** These documents captured ongoing community priorities and challenges, helping to align both immediate and long-term adaptation strategies with local needs.
- **Kokhanok Village Emergency Response Plan (ERP):** Adopted in 2022, the ERP identified key hazards and response strategies for emergencies, and its findings were integrated into the Climate Adaptation Plan.
- **Bristol Bay Native Corporation Wind and Hydroelectric Feasibility Study (2007):** This study informed the community's renewable energy planning, assessing the potential for wind and hydroelectric solutions to reduce Kokhanok's reliance on diesel.
- **Bristol Bay Regional Energy Plan (2013):** Provided a regional assessment of energy needs and supported Kokhanok's transition to renewable energy solutions.
- **Multi-Use Facility Feasibility Analysis (2014):** Highlighted the need for resilient, multi-purpose infrastructure that could serve multiple community functions, particularly in emergencies.
- **Lake and Peninsula Borough Capital Improvement Program (CIP) List (2024):** This list identified critical infrastructure needs, such as upgrades to the bulk fuel farm and emergency shelters, which were included in the adaptation plan.
- **Gray Stassel Engineering (GSE) Report (2024):** The GSE report assessed Kokhanok's power generation system, recommending improvements to diesel generators and microgrid upgrades, which support the community's goal of enhancing energy resilience and reducing diesel use.

## Community Information

Kokhanok is a small, remote community located on the southern shore of Iliamna Lake, about 200 air miles from Anchorage, Alaska. Home to 152 residents, primarily of Alutiiq and Yup'ik descent, the village maintains a strong connection to its traditional subsistence lifestyle. Hunting moose, caribou, and bear, fishing for salmon, and gathering berries are integral to daily life, sustaining the community and reinforcing their cultural ties to the land.

Kokhanok is governed by the **Kokhanok Village Tribal Council**, a federally recognized Tribal government, and is part of the **Lake and Peninsula Borough**. While unincorporated, the village is represented in the **Borough Assembly**, and local affairs are managed through the **Alaska Peninsula Corporation**, the local Native village corporation, in conjunction with the regional Native corporation, **Bristol Bay Native Corporation (BBNC)**. Together, these entities support Kokhanok's efforts to preserve its cultural heritage and adapt to the challenges of rural Alaskan life.

### Utilities

Kokhanok's utilities and infrastructure are vital to the community's ability to thrive in its remote location, with services largely managed by the Tribe to ensure sustainability and resilience.

**Electricity:** Power is provided by **Kokhanok Utilities**, a village-owned utility company. The community relies primarily on diesel generators, with two intermittent wind turbines contributing about 10% of Kokhanok's electricity needs. The **Power Cost Equalization (PCE)** program helps reduce electricity costs, ensuring more affordable energy for residents. During periods of strong wind, the village can occasionally operate entirely on wind power.

**Fuel:** Kokhanok maintains a fuel storage system with a capacity of 109,000 gallons of diesel and 24,000 gallons of gasoline, as well as three propane tanks with a combined capacity of 3,000 gallons. Fuel is delivered to the village by barge during ice-free months (spring through fall) or by plane. The community has experienced chronic fuel storage issues, often leading to fuel rationing during winter to keep generators running until the next fuel delivery arrives.

**Water and Wastewater:** Kokhanok operates a **pipled water system** and a **water treatment plant** that draws from a community well near Lake Iliamna. Homes outside the piped system are served by individual wells. The village also maintains a lagoon and a **sewer system**, which includes a combination of **Septic Tank Effluent Pumping (STEP)** and conventional sewer systems. Regular maintenance, such as septic tank pumping, is required to ensure the proper functioning of these systems.

**Landfill and Waste Management:** The Tribe manages a **Class III landfill**, where residents self-haul and sort their trash into burnable and non-burnable waste. The landfill plays an important role in the community's waste management strategy, ensuring proper disposal and minimizing environmental impact.

**Telecommunications:** **GCI** provides cell phone and internet services, supplemented by **HughesNet** for additional internet access. **Alaska Communications** offers landline service, which tends to be more reliable than cell coverage. Long-distance services are provided by **AT&T**, and texting is often more reliable than voice calls due to inconsistent cellular reception.



## Transportation:

Kokhanok is accessible by air and water, with a state-owned gravel airstrip (Kokhanok Airport) and a seaplane base used for transporting goods, mail, and passengers. Freight is brought in by plane or overland through Cook Inlet and Iliamna Lake during the ice-free months. Larger shipments, such as fuel and supplies, are typically delivered by barge, though barge services can be inconsistent, often requiring goods to be flown in, which increases shipping costs.

Local transportation within the village consists of cars, trucks, ATVs, snowmobiles, and small boats for water travel. The village has three primary gravel roads, maintained by the Tribe, which connect the airport, townsite, and landfill. These roads require regular maintenance due to the harsh weather conditions and heavy use by local vehicles. Seasonal wear from snow, ice, and rain also creates challenges in maintaining road quality, making ongoing upkeep essential for access to services and transportation within the village.

Overland travel to other communities is not possible by road; the nearest village, Igiugig, is accessible only by aircraft, boat, or snowmobile. Given these limitations, air and water transport are critical for moving goods and people in and out of Kokhanok, especially during the winter months when other transport options are limited.

## Employment

TABLE 1: DESCRIPTION OF EMPLOYMENT IN KOKHANOK.

Employers in Community	Number Amount
Kokhanok village council	11
Electric Utility	2
School	14
Clinic	2
Neilsen General Store	2
US Post Office	1
Commercial Fishing	22
Private Business / Other	3

## Climate Challenges and Vulnerabilities

### Overview of Climate Threats

Kokhanok, like many Alaskan communities, is on the front lines of climate change due to its high-latitude location. The community is already witnessing the impacts of rising temperatures, altered precipitation patterns, and changing seasonal dynamics, which affect the landscape and subsistence activities. Several key climate risks have been identified:

1. **Air Quality Degradation:** Rising wildfire risks and warming temperatures can lead to significant air quality issues, particularly during the summer months when smoke from regional wildfires may affect Kokhanok. In addition, gravel dust from unpaved roads contributes to poor air quality, further exacerbating health concerns. These air quality issues pose serious risks, especially for vulnerable populations such as Elders and children with respiratory conditions.

2. **Rising Temperatures:** Kokhanok is projected to experience a significant increase in temperatures, particularly in winter months. By the end of the century, average winter temperatures may rise by as much as 16°F, with annual temperatures projected to be near 11°F as seen in Figure 1. This warming trend is expected to shift winter temperatures to near or above freezing, fundamentally altering traditional activities such as winter travel and subsistence hunting, which rely on stable ice and cold weather. Warmer temperatures also present dangerous conditions for Elders and other sensitive populations, as Kokhanok's buildings do not have AC.
3. **Extreme Weather Events:** The community is already prone to severe storms due to its transitional climate, like much of Alaska. Storms from the Bering Sea and Gulf of Alaska often converge over the Iliamna Lake area, leading to violent wind events and hazardous conditions. These high winds are common, however, the increased frequency causes damage to homes, utilities, and vital infrastructure, while also disrupting air transportation—a critical link for supplies and medical evacuations.
4. **Increased Precipitation and Flooding:** Projections indicate that Kokhanok may see a significant increase in precipitation, especially in spring, with estimates showing a 47% rise as seen in Figure 2. This increased rainfall heightens the risk of flooding, which the community has already experienced in the past.
5. **Wildfire Risk:** Historically, the region surrounding Kokhanok had low flammability, but rising temperatures and drier conditions are increasing the risk of wildfires. Wildfires threaten subsistence resources, local wildlife, and infrastructure, and pose a growing danger to the community.
6. **Extreme Cold and Power Disruptions:** Extreme cold events, with temperatures dropping below -10°F, pose a threat during winter months, specifically with regards to electricity infrastructure. Power outages during these cold spells are very dangerous, increasing the risk of hypothermia and frostbite. Extreme cold is also especially impactful during winter hunting expeditions, impeding travel and causing unsafe outdoor conditions.
7. **Impact on Subsistence Resources:** Warmer summers and winters disrupts the habits of wildlife and vegetation patterns, directly affecting the community's subsistence practices. Extreme heat could degrade fish harvests and harm key subsistence species, while warmer winters reduce access to hunting areas.
8. **Invasive Species:** Warmer temperatures and changing ecosystems could increase the likelihood of invasive species encroaching into Kokhanok's environment, potentially disrupting local wildlife, vegetation, and subsistence resources.
9. **Water Supply and Contamination Risks:** With rising temperatures and increasing precipitation, there is a potential risk of water contamination due to flooding and fuel spills. Flooding can overwhelm existing water systems, while warmer temperatures may increase microbial activity that could affect water quality.

## Infrastructure Vulnerabilities Identified by the Community

In developing this Kokhanok Climate Adaptation Plan, the community identified critical infrastructure most at risk from the impacts of changing climate and weather patterns. When compiling this list, the community took into account factors such as building age, structural performance, energy use, layout, location, and overall importance to the community's daily operations and safety. The prioritized list below highlights the top infrastructure at risk and in need of climate adaptation and resilience improvements. Each of these locations plays a significant role in the village's ability to function and recover from extreme weather events, disruptions, or future climate-related risks.

**Bulk Fuel Farm:** As a vital source of energy for the community, the bulk fuel farm is vulnerable to damage from storms, flooding, and fuel spills. Upgrades are needed to ensure fuel storage remains safe, secure, and accessible, especially as the community transitions to more renewable energy sources.

**Cemetery:** Erosion, permafrost thaw, and changing soil conditions threaten the structural integrity of burial sites. The cemetery requires protection from flooding and other climate-related risks to preserve this important cultural site.

**Electric Utility:** The village's power system, including both diesel and renewable energy components, is at risk from storms, wind, and equipment failures. Ongoing upgrades to integrate more wind and solar power, along with improved battery storage, are necessary to reduce reliance on diesel and improve energy resilience.

**Emergency Shelters:** These shelters, including the Kokhanok School, are crucial for providing safe refuge during extreme weather events or power outages. Enhancing their energy efficiency, backup power systems, and structural integrity is essential to ensuring they can serve the community during emergencies.

**Garage:** The community's garage, which houses essential equipment for snow removal, road maintenance, and emergency response, is vulnerable to extreme weather and requires upgrades to ensure the protection of valuable equipment and tools.

**Firehall:** The firehall is a critical facility for housing firefighting equipment and supporting emergency response efforts. As wildfires and structural fires become more common due to climate change, ensuring the firehall is equipped with modern fire protection measures, backup power, and resilient building materials is a priority.

**Post Office:** The post office is a key service hub for the community, and disruptions to mail and package deliveries due to storms, road closures, or power outages can severely affect residents. Strengthening the post office's resilience is crucial for maintaining connectivity to the outside world.

**Telecommunications:** Reliable telecommunications infrastructure is essential for maintaining communication within the village and with outside services, especially during emergencies. Enhancing the resilience of communication towers and systems is critical as storms and other climate-related disruptions increase in frequency.

**Utility Maintenance Shop:** The maintenance shop, where repairs and upkeep of village utilities are managed, must be protected from extreme weather and power outages to ensure the village’s utilities remain operational.

**Housing:** Many homes in the village are aging and vulnerable to the impacts of extreme weather. Strengthening housing resilience through weatherization, energy efficiency upgrades, and renewable energy integration is necessary to protect residents and reduce energy costs.

## Adaptation Risks & Strategies

### Wildfire and Structural Fires

#### **Risk: Increased Probability of Fires**

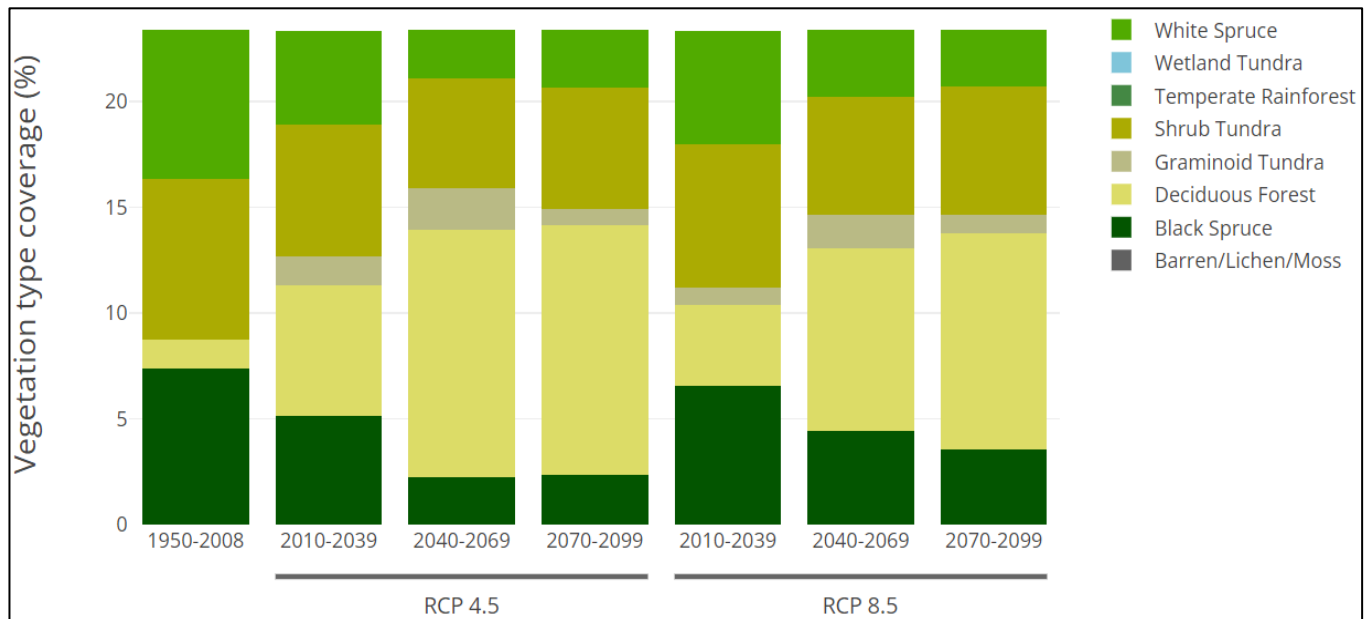
The risk of wildfires in Kokhanok has significantly increased due to climate warming. Warmer temperatures have led to the growth of woody shrubs and trees, including an increase in standing dead spruce trees caused by beetle infestations. These changes in vegetation are fueling more frequent and intense wildfires, while warmer, drier conditions are increasing the likelihood of fire starts and spread. As a result, the community faces growing threats to subsistence resources, infrastructure, air quality, housing, and human health.



**PICTURE 1: AERIAL, KOKHANOK 2023, SHOWING STANDING DEAD SPRUCE TREES**

Wildfire smoke is a significant concern, as it can reduce air quality, create health hazards—especially for Elders and children with respiratory issues—and even disrupt air travel in and out of the community. Furthermore, Kokhanok’s reliance on wooden structures increases the village’s vulnerability to structural fires. A recent house fire in the village highlights the need for improved fire response capabilities.

The community currently lacks a formal Volunteer Fire Department (VFD) and relies on community members, many of whom are gone periodically for subsistence hunting and fishing. While there are fire hydrants and firefighting equipment, including a Code Red trailer with a 300-gallon water tank and fire hoses, the community has expressed the need for more training, formal volunteer recruitment, and expanding the firebreaks upwards of 50-100 feet. Residents are interested in more formal training that could result in a certificate or credentials, allowing them to work in other locations outside Kokhanok. Without a fire truck or adequate fire-fighting training, Kokhanok remains at high risk in the event of a major fire emergency.



**FIGURE 1: HISTORICAL AND PREDICTED CHANGE IN VEGETATION TYPE IN KOKHANOK FROM 1950 TO 2099 FROM THE NORTHERN CLIMATE REPORT BASED ON TWO EMISSIONS SCENARIOS. THE REPRESENTATIVE CONCENTRATION PATHWAYS (RCPs) COMPARE DIFFERENT FUTURE GREENHOUSE GAS EMISSIONS SCENARIOS.**

### Proposed Strategy: Wildfire and Structural Fire Risk Reduction

#### Short-Term Strategies:

- **Repair and Maintain the Water Trailer:** Fix the community’s water trailer, which is essential for firefighting, by completing necessary mechanical work and ensuring the availability of spare parts for ongoing maintenance.
- **Prepare Existing Firefighting Equipment and Train Volunteers:** Ensure that all firefighting equipment is operational and that current volunteers are trained in its use. Specifically, volunteers need to learn how to operate the fire-fighting pump, which can pull water from standing sources (e.g., lakes, hydrants) to extinguish fires.
- **Purchase Personal Protective Equipment (PPE):** Procure and distribute adequate PPE, such as helmets, gloves, and fire-resistant clothing, so that volunteers are properly equipped and protected during firefighting efforts.
- **Secure Funding for Brush and Wood Clearing Jobs:** Obtain funding to offer local employment opportunities for residents to clear brush and cut wood around homes, reducing fuel sources for potential fires and creating a safer environment.

### Long-Term Strategies:

- **Develop a Comprehensive Fire Plan:** Create a Fire Plan that includes strategies for controlled burns, widening the fire break, and forest management and thinning. The harvested wood could be used in local biomass boilers, with extra wood donated to Elders. Potential outreach groups for assistance include the Alaska Wildland Fire Coordinating Group (AWFCG) and the US Fish and Wildlife Service (FWS).
- **Expand Firewise and Equipment Training:** Provide ongoing Firewise training and equipment maintenance education to ensure community members are well-prepared for fire emergencies and can properly maintain firefighting tools.
- **Install High-Efficiency Particulate Air (HEPA) Filters:** Purchase and install HEPA dust filters in key community buildings to improve indoor air quality during wildfire events, particularly in spaces where vulnerable residents, such as children and elders, may seek shelter.

“The community is like a match box waiting to be set on fire”

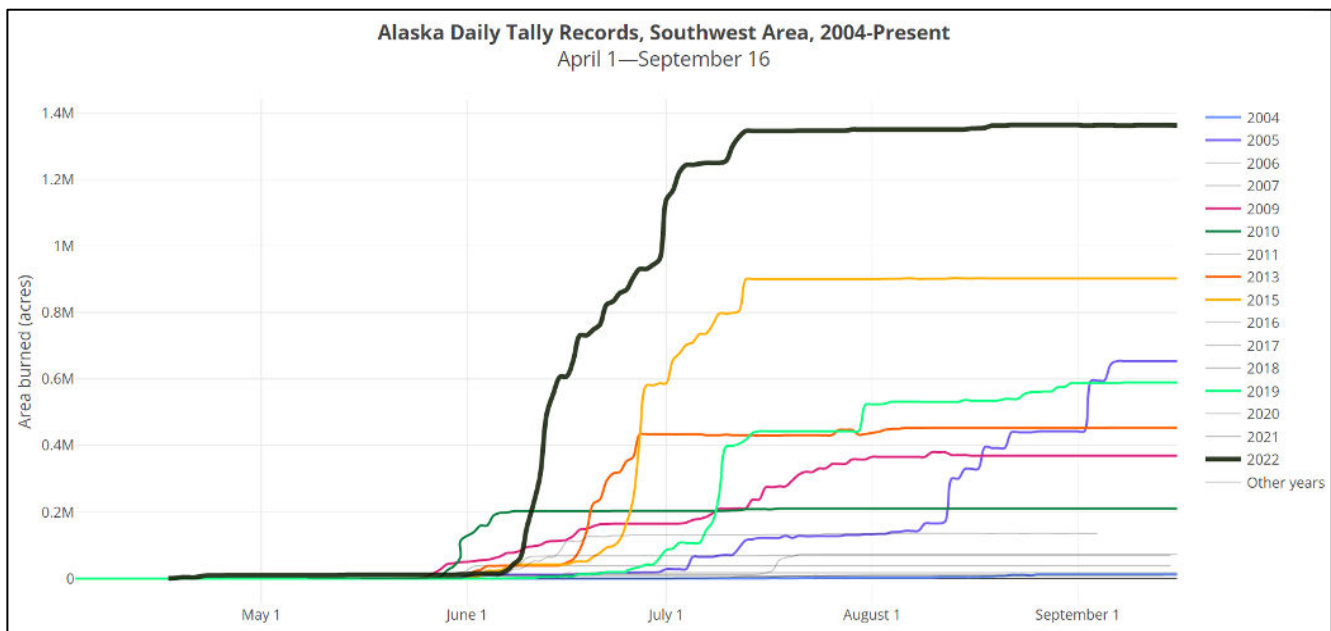


FIGURE 2: 2022 SOUTHWEST DAILY TALLY OF ACRES BURNED COMPARED TO HIGH FIRE YEARS (> 1 MILLION ACRES BURNED) SINCE DAILY TALLY RECORDS BEGAN IN 2004 (ALASKA FIRE SERVICE, 2022).

## Food Security

### Risk: Declining Subsistence Resources and Food Insecurity

For over 8,000 years, Yup'ik people have relied on a deep connection with the land and a culture of sharing, cooperation, and respect. Subsistence is not merely the act of harvesting resources but a way of life that transforms social and spiritual relationships with the environment. Kokhanok has long relied on subsistence activities such as hunting, fishing, and gathering to support its community and way of life. However, rapid climate change is increasingly threatening these practices, particularly in recent years. Rising land and water temperatures, changing wildlife migration patterns, and reduced ice thickness on Lake Iliamna are disrupting the availability of key subsistence resources such as fish, big game, and berries, impacting food security across the community.

“There has been a lack of blueberries in the past several years, the weather has been too hot and too wet for a good harvest”

- **Berry Harvests:** The summer of 2019 was the hottest in recent memory for many residents, which led to slow tundra growth and poor berry yields. The late start to the season meant that berries, particularly cloudberries, did not last long, and many residents had to travel further than usual to find sufficient quantities. For several years, there has been a noticeable decline in blueberries, attributed to hot and wet weather, which is unsuitable for their growth.
- **Big Game:** Kokhanok has also experienced a reduction in caribou and moose populations, a traditional staple of the local diet. Over the past three years, hunters have observed fewer caribou. This decline, combined with fewer reported sightings of moose, has resulted in “empty freezers” for many residents who rely on big game hunting. These patterns are likely due to changes in temperatures, which are known to impact the migration patterns of animals (Manning, 2008).<sup>1</sup>
- **Fishing:** Fishing conditions in Kokhanok have been impacted by warming water temperatures in Lake Iliamna, which have directly affected salmon populations. The combined effects of rising water temperatures and changing competition dynamics have led to a 60% reduction in adult salmon densities compared to the 1960s-1990s. Residents have emphasized that fish in the lake are maturing faster, leaving the lake after one year instead of two, leading to smaller fish and fewer viable harvests.
- **Water Levels:** Kokhanok residents have also noted that Lake Iliamna’s water levels are lower than in previous years. Historically, the lake’s water levels were observed where the water and vegetation meet, but now over 100 feet of lakebed rocks and gravel are exposed. The water level only reaches its historic norm during storm surges with strong east winds. The causes of these low lake levels are unclear, though residents hypothesize that reduced snowmelt and increased evaporation due to warmer air and water temperatures are to blame.

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<sup>1</sup> Manning, E. (2008). *Caribou and climate change: The Nelchina caribou herd, lichens, and fire*. Alaska Department of Fish and Game. [https://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view\\_article&articles\\_id=356#:~:text=Some%20scientists%20believe%20that%20climate,the%20more%20protected%20calving%20areas](https://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view_article&articles_id=356#:~:text=Some%20scientists%20believe%20that%20climate,the%20more%20protected%20calving%20areas)

## Other Sources of Food Insecurity

Community members emphasize Kokhanok's reliance on imported food as well. However, food prices are already high in rural Alaska and the community is concerned about further increases as well as potential disruptions to supply chains. The community is also reliant on a single generator for electricity. If the generator fails, freezers and refrigerators storing both subsistence and imported foods could lose power, leading to spoilage. This would further strain food supplies and potentially cause widespread shortages. These scenarios exacerbate food insecurity, especially for vulnerable populations like Elders, children, and low-income households

## Proposed Strategy: Enhancing Food Security and Local Food Systems

### Short-Term Strategies

- **Community Garden and/or Greenhouse:** The community has expressed interest in small-scale gardening projects to reduce reliance on expensive imported foods, as well as hydroponics. A greenhouse or gardening area near the firebreak has been proposed, so that it could be maintained and watered regularly.

### Long-Term Strategies

- **Community-Scale Bulk Food Storage:** Community members have expressed concern over the potential for spoiled food due to loss of power from the generator. They are interested in increasing smoking, drying, and preserving food on a wider scale.
- **Biomass-heated Greenhouse:** This has been considered as a more long-term strategy along with a traditional greenhouse. Community members suggest integrating it into the school, which would require training and education.
- **Youth and Elder Mentor Program:** A program designed for Elders to share wisdom and knowledge on traditional food and lifestyle practices.

## Loss of Traditional Lifestyle

### Risk: Decrease in Residents and Traditional Practices within the Community

Climate change poses a significant threat to many Alaskan communities, including Kokhanok. These changes, particularly the uncertainties surrounding subsistence foods and traditional practices, have been linked to mental health challenges, especially for Indigenous people who have a deep connection to their land. "This is especially true of Indigenous peoples, who have a deep connection to their home areas, often described as a sense of place. As the effects of climate change are felt in the landscape, many Alaska Natives feel a sense of personal loss as the familiar has become unpredictable and sometimes strange (Markon, 2018)."

Community leaders in Kokhanok are focused on retaining young people to pass on traditional knowledge, culture, and ways of life. Residents with a strong sense of community and connection to the region and tribe are needed for a sustainable, self-reliant Kokhanok. For many generations, many residents fished commercially in Bristol Bay. While fewer people participate now, some are still



determined to continue this tradition. Cultural knowledge has been passed down generation after generation. Though fewer residents participate in traditional dances or speak the Yup'ik language, community members have hope that future generations will embrace their ancestral traditions. Many believe that increasing outdoor activities for youth could help foster a stronger connection to the community.

### Proposed Strategy: Enhancing Community Opportunities

#### Short-Term Strategies:

- **Youth-Elder Programs:** Include support from Elders and community members in schools to teach aspects traditional lifestyle and culture.

#### Long-Term Strategies:

- **Economic Opportunity Expansion:** Retention of youth, creating opportunities for people to stay and grow in the community. Training for heavy equipment, geared towards youth that are graduating high school.
- **Infrastructure:** ANTHC will be building a better road to the water treatment plant, which can be further extended to allow access to the planned multipurpose building. Overall, this would reduce costs for the village.
- **Development of New Housing**

### Weather and Ice Thickness

#### Risk: Changes in Weather Patterns and Reduced Ice Thickness

Lake Iliamna has seen significant changes in ice formation due to rising temperatures. A study conducted by the USGS in 1973 provided baseline data on the region's soils, vegetation, and water bodies, indicating that the lake was historically partially or completely frozen each winter. However, over the years, the duration and extent of lake ice have decreased, with the lake now becoming ice-free about a month earlier than in the 1950s. Residents of Kokhanok, who rely on the lake ice for travel, subsistence ice fishing, and firewood collection, have observed that the ice is becoming less predictable and often unsafe for use. In the past decade, the lake has only frozen sufficiently for travel in two out of ten winters.

This change has severely impacted winter activities, including snowmachine travel across the lake to nearby communities like New Halen. Rivers and lakes, which once served as stable roadways, now freeze later, thaw earlier, and often exhibit dangerous thin ice or open water mid-winter, creating hazardous and life-threatening conditions for travel. More frequent overflow on river ice slows or reroutes travel, and more frequent occurrences of shelf ice forming along riverbanks can pose obstacles to snowmachine routes all winter long (Cold et al, 2018).

The shifting freeze-up patterns have also impacted moose hunting, as residents traditionally hunted when the lake was frozen. With the lake now freezing much later in the season, there is interest in advocating for adjustments to the state's moose hunting season to better align with the changing environmental conditions.

These changes in weather and ice formation are expected to worsen, with projections suggesting that lake ice may become increasingly sporadic or even disappear entirely by the end of the century. This poses long-term risks to the community’s subsistence activities, transportation, and overall way of life.

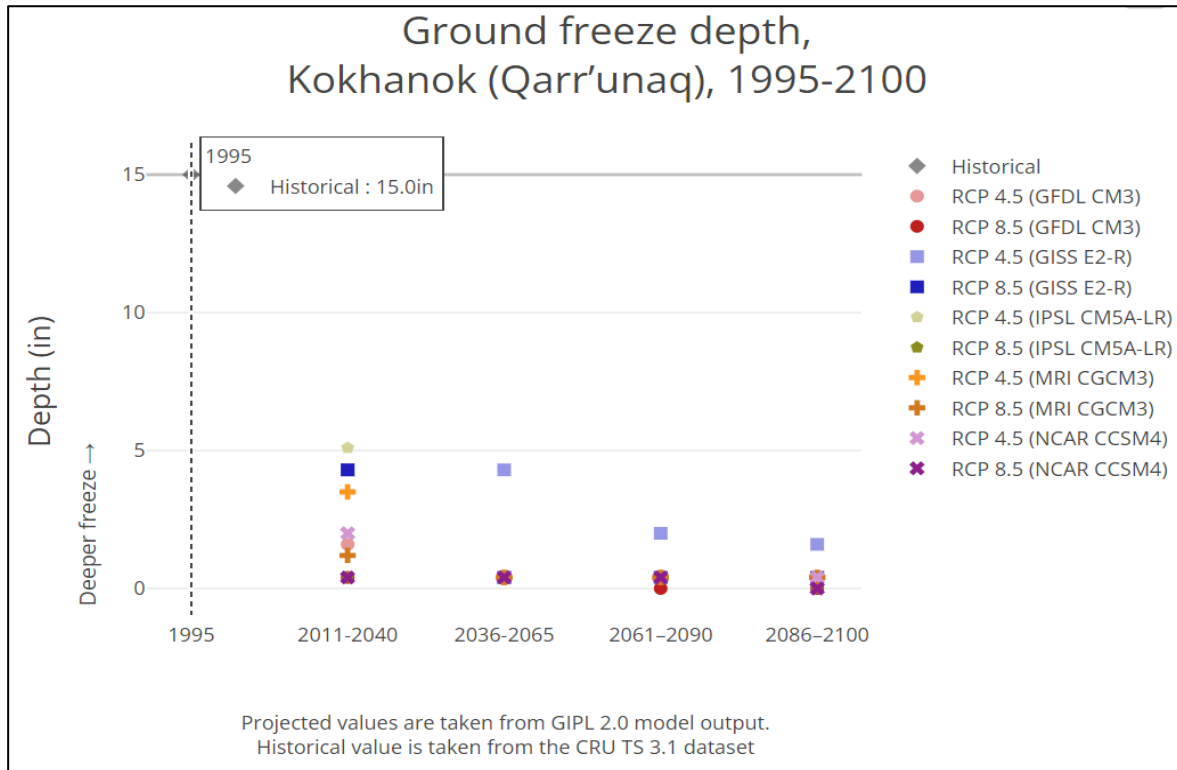


FIGURE 3: KOKHANOK CLIMATE PROJECTIONS FOR GROUND FREEZE DEPTH BY NORTHERN CLIMATE REPORT

### Proposed Strategy: Adapting to Changing Weather and Ice Conditions

#### Short-Term Strategies:

- **Communication:** Improved communication about local ice and water conditions.
- **Survival Gear:** Increasing use of survival suits, floatation devices, and personal locaters or messaging devices while traveling on the lake.
- **Education:** Teaching children in the Kokhanok community to be careful on and around the lake.

#### Long-Term Strategies:

- **Infrastructure:** Improve structural integrity for buildings of concern; install and connect the plumbing to the new duplex.
- **Training:** Search and rescue training and volunteer recruitment.
- **Advocating:** Work with legislature and local leaders to advocate for a change in hunting season to accommodate the later freeze.

## Pandemic and Public Health

### Risk: Public Health Concerns

Kokhanok continues to feel the effects of the COVID-19 pandemic, which has made community leaders more aware of the need for better preparedness for future pandemics. As the climate changes, the risk of widespread disease increases. The increased potential is documented in a study by the National Science Foundation, “The research shows that animal movements and interactions due to a warming climate might increase the number of viruses jumping between species.” As animals and insects rapidly adjust their migration patterns and habitats they begin interacting with new species for the first time, breeding new viruses. “The study suggests that climate change will become the biggest upstream risk factor for disease emergence -- exceeding higher-profile issues such as deforestation, wildlife trade and industrial agriculture (National Science Foundation, 2022) <sup>2</sup>. Consequently, planning for pandemic response has become an integral part of climate adaptation efforts.

The limited healthcare facilities and resources in Kokhanok make the community particularly vulnerable during a pandemic or epidemic. Access to medical care is already scarce, and widespread disease could worsen financial and economic pressures, with job losses and rising living costs due to high shipping expenses and limited supplies. Vulnerable populations, including unvaccinated individuals, elders, children, and healthcare workers, face higher risks. Additionally, Kokhanok’s infrastructure could be strained if critical facilities like the health clinic or airport are rendered inaccessible during an outbreak, further jeopardizing access to essential services.

In addition to human health risks, there is concern about outbreaks of disease among animals that could affect subsistence hunting and fishing. Recent local observations, such as fish with unexplainable “white spots” that were rendered unusable, and declining caribou numbers—residents hypothesizing due to bacterial disease—have raised concerns about the health of subsistence resources. The temporary shutdown of caribou hunting due to declining herds, which could not be distinguished from those in western Alaska, has further highlighted the importance of monitoring animal health alongside human health in the face of emerging pandemics.

### Proposed Strategies: Strengthen Public Health Infrastructure and Education

#### Short-Term Strategies:

- Education and Communication: Ensure residents are aware of the recently adopted Emergency Response Plan and the community’s united actions for addressing widespread health concerns. This can be done by regularly referencing the ERP in community-wide events as well as through other communication channels such as social media, radio, flyers around the community, and more.
- Monitoring Environment Change: There is interest in active monitoring of environmental changes such as through the Leo Network – “Indigenous sentinels’ network” - actively documenting changes or concerns. Possibility for paid positions for active monitoring.

#### Long-Term Strategies:

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<sup>2</sup> National Science Foundation. (2022, May). *Study finds that climate change could spark the next pandemic.*

<https://beta.nsf.gov/news/study-finds-climate-change-could-spark-next>

- **Healthcare Facilities:** Maintain the clinic and health care tools

## Drought & Air Quality

### **Risk: Increased Drought Conditions and Impact on Water Resources and Air Quality**

Rising temperatures and changing precipitation patterns are leading to more frequent and severe droughts in Kokhanok. These prolonged periods of dry weather are causing significant challenges, including reduced water supplies, lower water levels in Lake Iliamna, and decreased groundwater availability. Drought conditions are impacting the community's subsistence lifestyle, disrupting wildlife habitats, affecting berry production, and threatening critical spawning areas for fish. Additionally, lower water levels in the river are restricting barge access, impeding the delivery of essential goods such as heating oil and diesel for electricity.

Dust from the gravel roads and runway is another issue linked to drought. The high levels of dust, worsened by dry conditions, are affecting air quality, particularly for vulnerable populations like children, elders, and those with respiratory issues. Although the village has a 1,000-gallon water tank to spray roads for dust control, this is a labor-intensive, temporary solution that requires frequent respraying during the summer heat.

Kokhanok residents have recently seen the effects of a 30-year drought starting to reverse, with lakes and tundra areas refilling. However, the community remains exposed to lingering issues such as fire risks, wildlife disruptions, and continued dust control challenges. Community members have proposed developing a gravel resource near the airport with the help of BBNC to help manage dust more effectively, potentially reducing costs and benefiting the local economy. This project would require further research to assess environmental and archaeological concerns, as well as equipment for gravel processing.

### **Proposed Strategy: Drought Mitigation and Air Quality Improvement**

#### **Short-Term Strategies:**

- **Maintenance:** The water truck is currently not operational; purchase parts so that the roads can be sprayed to keep the dust down.

#### **Long-Term Strategies:**

- **Development of Gravel Resources:** Resurface the roads with the appropriate gravel, followed by applying a dust control agent. Estimated miles to resurface the main road is about 2 miles long; with 6 miles to complete all roads in Kokhanok.
  - Community members suggested reaching out to ANTHC for help in developing a gravel resource locally, possibly near the airport. A project of this scale would likely require a feasibility study. This is municipal land held in trust by the state (DNR) and leased to DOT; BBNC holds subsurface rights. There is also potential for working with BBNC to purchase gravel for \$5 per cubic yard; the tribe could seek a waiver for in-kind donation from BBNC to acquire grant funding.

## Fuel Spills

### Risk: Leakage or into Surrounding Environment

Kokhanok relies heavily on fossil fuels for generating electricity and heating homes, making fuel a critical resource for maintaining daily life and safeguarding residents against changing weather conditions. However, fuel and hazardous material spills are an ongoing concern. These spills can occur during fuel transfers, leaks from holding tanks, or due to fires and floods. Fuel spills are most likely to happen near the shoreline of Lake Iliamna during barge landings or at key locations such as the bulk fuel farm, gas station, school, and homes.

If not properly contained and cleaned, fuel spills can pose significant risks to community health, pets, animals, and the local subsistence resources. Pollution from fuel spills can contaminate rivers, creeks, and Lake Iliamna, which serves as a vital drinking water source and supports subsistence fishing. Industrial pollution and fuel leaks from water vehicles or equipment staging areas can also threaten the water supply and subsistence foods.

The community lacks the capacity to manage large-scale fuel spills, increasing the risk of contamination. In the event of a major spill, the consequences could be severe, including the loss of the local fuel supply, which is essential for heating and electricity, especially during extreme weather. Community members identify a few contaminated sites in Kokhanok: one near the old powerhouse, one near the barge area, one from the 1960-1980s near the barge fuel farm, and a potential spill near the old Council building. The community is working with the Brownfields Program to get an assessment to clean up these spills. Currently, there is no active spill response team, but previously trained residents step in to contain spills until outside help arrives.

### Proposed Strategy: Enhance Community Preparedness and Begin Clean-Up

#### Short-Term Strategies:

- **Secure Clean-Up Funding:** Get a resolution from the council to start the clean-up process with BBNA. The DEC Brownfields Program works with local governments, tribes, and community stakeholders by providing information, funding, technical assistance, and other resources to facilitate the assessment, cleanup, and reuse of brownfields (ADEC, 2022)<sup>3</sup>.

#### Long Term Strategies:

- **HAZWOPER Training:** Much like responding to other climate risks and impacts, the community members are the first to respond. Formal training for a local team and equipment is paramount in ensuring a timely response. Perform drills regularly.

## Power Disruption

Power disruptions in Kokhanok can result from severe storms, faulty equipment, fuel shortages, or planned maintenance. Currently, power is generated by a combination of diesel and renewable

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<sup>3</sup> 2022. What does the dec brownfields program do? Alaska Department of Environmental Conservation (ADEC). <https://dec.alaska.gov/spar/csp/brownfields/about/>

sources, including two wind turbines, but the system remains vulnerable to outages. Overhead power lines are particularly at risk from windstorms and earthquakes, and power outages during the summer can lead to significant losses, such as spoiled food in freezers. In winter, outages pose a critical threat, especially to residents without secondary heat sources, as freezing pipes and health risks for those reliant on medical equipment can quickly arise.

The local clinic, without a backup generator, is vulnerable to losing essential medical supplies, such as refrigerated medications and vaccines. Additionally, power surges during outages frequently damage electronics and appliances, further burdening residents with high replacement costs due to shipping. The current microgrid, though operating, is not fully reliable due to issues with existing equipment, including a wind turbine that requires repair.

With the support of a new grant, Kokhanok is transitioning toward greater resilience through the installation of a **1 MW battery energy storage system (BESS)**, **100 kW of solar PV**, and a new **100 kW wind turbine**, all designed to displace **70% of the village's diesel use** in the first two years. This new system will reduce power outages, enhance energy reliability, and lower electricity costs, while also supporting the village's long-term energy independence.

## Proposed Strategies

### Short-Term Strategies:

- **Backup Generation Plan:** Ensure that the Kokhanok Power Association has a comprehensive plan for securing backup power and emergency assistance during outages.
- **Renewable Energy Expansion:** Begin planning and feasibility studies for integrating additional renewable energy sources, such as solar PV, wind, and battery storage, to reduce reliance on diesel.

### Long-Term Strategies:

- **Prepare Community Shelters:** Ensure that designated shelters, such as the Kokhanok School, are fully equipped for emergency power needs. The school, which serves as the primary shelter, is ADA accessible and equipped with an emergency generator, showers, kitchen facilities, and a bed capacity of 170.
- **Increase Renewable Energy Capacity:** Continue expanding the village's renewable energy capacity by incorporating more wind turbines, solar arrays, and battery storage, while also improving energy distribution systems.
- **Develop a Regional Utility Support Collaborative:** Work across the region to develop a sub-regional approach to managing the individually managed Tribal electric utilities. The utility collaborative would provide backbone support to each of the individually owned, operated and managed utilities.

### Specific Power Utility Upgrades Identified in 2023<sup>4</sup>

#### 1. Diesel-Electric Generation Equipment Improvements:

- **Gen #1:** Repair the engine and reprogram the system for wind-diesel hybrid operations.
- **Gen #2:** Major engine overhaul.
- **Gen #3:** Replace with a new 150 kW electronically governed genset.

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<sup>4</sup> Kokhanok Power Generation Assessment: Summary Letter Report - Final, Gray Stassel Engineering, January 2024.

- **Gen #4:** The engine is inoperable and not recommended for rebuild due to unreliability.
2. **Switchgear and Microgrid Upgrades:**
    - Complete integration of all generation components and repair the control system.
    - Ensure proper synchronization between generators and wind turbines.
  3. **Fuel System and Tank Farm:**
    - Confirm proper fuel usage (switch to ULSD from heating oil) and improve filtering for modern fuel injection systems.
    - Install new filters at the generator and tank farm to prevent engine damage from poor fuel quality.
  4. **Fire Detection and Suppression:**
    - Refill and recertify the clean agent fire suppression system in the power plant.
  5. **Engine Cooling and Heat Recovery:**
    - Install a new coolant system hand pump and pressure cap.
    - Replace old thermometers, gauges, and exhaust fans.
    - Repair radiator dampers and ensure the cooling system is fully functional for future diesel-off operations.

## Climate Migration and Housing

### Risk: Damage to Housing Structures

Climate change is having a significant impact on housing in Kokhanok, increasing risks related to extreme weather, temperature fluctuations, and environmental hazards. The community's wooden structures are vulnerable to wildfires, which are becoming more frequent and intense due to rising temperatures and drier conditions. Severe windstorms further threaten homes, as Kokhanok's exposed power lines and infrastructure are susceptible to damage.

Prolonged power outages, particularly in winter, pose additional risks. Homes without secondary heat sources are at risk of frozen pipes, which can cause extensive damage. The community's dependence on a diesel generators for electricity adds to the vulnerability, as power losses could result in residents losing access to essential heating and refrigeration.

In addition to these immediate threats, climate migration is emerging as a growing concern. As environmental conditions worsen, some residents may choose or be forced to relocate due to the increasing difficulty of maintaining homes and essential services. Changes in subsistence resources, unpredictable weather patterns, and the rising costs of living in an isolated area are contributing to a potential outmigration, particularly among younger generations seeking greater stability. If climate migration becomes more pronounced, the community could face depopulation, further straining local infrastructure and housing.

### Proposed Strategy: Invest in Resilient Housing and Community

#### Short-Term Strategies:

- **Storm Resilience:** Strengthen and reinforce existing homes and critical community buildings to better withstand extreme weather events, including severe wind and wildfires.
- **Heating Systems:** Install and update alternative heating systems, such as **electric thermal storage (ETS) units** and **heat pumps**, to provide efficient and reliable heating during winter and power outages.

#### Long-Term Strategies:

- **Housing Subdivision Development:** Develop new housing subdivisions that offer safe, climate-resilient homes designed to withstand extreme conditions. These new homes will use energy-efficient materials and integrate **renewable energy solutions**, such as solar panels and efficient heating systems. This development will address overcrowding, provide new options for young families, and encourage population stability.
  - **Integrate Renewable Energy Solutions:** Solar panels and efficient heating systems will reduce energy costs and improve sustainability.
  - **Support Population Stability:** Building climate-resilient homes will reduce outmigration by providing secure and affordable housing, helping to retain younger generations and support future community growth.
- **Rehabilitation of Existing Housing Stock:** Many of Kokhanok’s existing homes are aging and vulnerable to climate impacts, including severe storms and increasing energy costs. This strategy will focus on **weatherization** and **energy efficiency upgrades** to extend the lifespan of these homes while reducing costs for residents. Key actions include:
  - **Weatherization and Energy Efficiency:** Install insulation, repair roofs and windows, and integrate renewable energy sources, such as solar power, to reduce heating costs and energy consumption.
  - **Improve Living Conditions:** By improving the condition of older homes, the community can prevent the need for costly new construction and keep families in place while enhancing their quality of life.
- **Workforce and Community Development:** Provide incentives and opportunities for residents to stay in Kokhanok by focusing on workforce development, housing projects, and community-based initiatives. This will help mitigate climate migration and ensure that the community can grow sustainably in the face of climate-related challenges.

## Project Recommendations to Reduce Vulnerabilities

The following recommendations and solutions are meant as a supplement to the proposed strategies mentioned above and are the result of an inclusive, community-driven process that involved extensive input from Kokhanok residents through meetings, interviews, and the review of existing community planning documents. These projects reflect the community’s priorities, addressing the most pressing climate-related challenges identified by the people of Kokhanok. By focusing on areas such as infrastructure resilience, food security, public health, and cultural preservation, these strategies are designed to safeguard the village’s way of life while preparing for the future impacts of climate change.

Each recommendation is rooted in both traditional knowledge and modern adaptation practices, ensuring that the solutions are not only technically sound but also culturally relevant and reflective of Kokhanok’s unique needs. The community’s active involvement in identifying these priorities ensures that the proposed projects have broad support and are aligned with local values and goals.



These projects range from expanding renewable energy and securing local food systems to developing climate-resilient infrastructure and improving public health preparedness. Together, they form a comprehensive roadmap for Kokhanok’s long-term resilience, ensuring the community is equipped to face the challenges of climate change while protecting its environment, culture, and well-being.

## Tribal Farm, Cold Storage, and Biomass Greenhouse

The **Kokhanok Climate Adaptation Plan** outlines a series of key projects aimed at increasing the village’s resilience to climate change. These projects focus on enhancing food security, strengthening infrastructure, expanding renewable energy, and ensuring long-term community sustainability. At the heart of this plan are grant-ready solutions, specifically prioritized by the community, which will empower Kokhanok to proactively address climate risks while building a self-reliant and sustainable future.

The **Kokhanok Tribal Farm** is the community's highest priority project due to its direct impact on food security and economic resilience. As climate change threatens traditional subsistence resources, the farm will offer a sustainable, local food supply while reducing reliance on costly, imported foods. This initiative will significantly enhance food self-sufficiency while creating job opportunities and stimulating the local economy.

The project will focus on establishing essential infrastructure, including high tunnels (similar to Picture of Homer, Alaska High Tunnels), water systems, and food storage facilities, ensuring sustainable, year-round food production. By implementing adaptive agricultural practices such as permaculture and crop rotation, the farm will promote environmental sustainability and improve soil health. Additionally, the farm will serve as a driver of local economic growth by creating job opportunities, developing new markets, and fostering partnerships with schools, stores, and lodges. Through educational programs, the farm will empower the community to proactively address future climate challenges, making Kokhanok more resilient.

To further support food security, the development of **community-wide cold storage** and a **biomass-heated greenhouse** will help preserve subsistence foods and reduce spoilage. These facilities will ensure year-round access to locally grown food, significantly decreasing dependence on imported goods. A biomass-heated greenhouse will supply fresh produce even in colder months, providing a reliable, sustainable food source for Kokhanok. This holistic approach to food security, which combines innovative farming techniques with effective storage solutions, will protect the community from disruptions in supply chains while promoting local agriculture and economic development.



PICTURE 2: HOMER, ALASKA HIGH TUNNELS

- Establish a sustainable, year-round food supply through the Tribal Farm with high tunnels, water systems, and food storage facilities.
- Implement adaptive agricultural practices like permaculture and crop rotation to improve sustainability and soil health.
- Develop a biomass-heated greenhouse to supply locally grown food year-round, reducing reliance on imported foods.
- Establish community-wide cold storage facilities to preserve subsistence foods and ensure food security.
- Create job opportunities, new markets, and partnerships with local schools, stores, and lodges.
- Foster community education programs to prepare Kokhanok for future climate challenges.

The nearby village of Igiugig, located 40 miles from Kokhanok, successfully implemented a Greenhouse and Traditional Wild Foods Project to address food security challenges. By establishing a greenhouse, Igiugig improved access to fresh produce, reduced reliance on costly imported food, and created local employment and entrepreneurial opportunities for youth. The project also promoted the preservation of traditional food knowledge and strengthened community well-being. A similar approach in Kokhanok could enhance food sustainability, support local economic opportunities, and reinforce connections to traditional ways of life.

### Tribal Clean Gravel Quarry

Establishing a **local gravel source** is essential to Kokhanok’s long-term climate adaptation strategy, supporting both the **Kokhanok Road Resurfacing and Dust Control project** and critical infrastructure developments across the community. As climate change increases the frequency of extreme weather events and disrupts supply chains, local resilience becomes more important than ever. A local gravel source will provide a reliable, sustainable material supply for not only road improvements but also for new housing and community facilities, which will need durable foundations to withstand changing environmental conditions.

The local gravel quarry will directly contribute to Kokhanok’s ability to adapt its infrastructure to the challenges posed by climate change, such as increased storm intensity and fluctuating ground conditions. Road resurfacing with locally sourced gravel will strengthen the durability of village roads, making them more resilient to the impacts of severe weather and temperature fluctuations.

Additionally, site and pad preparation for new buildings—such as housing developments and community facilities—will benefit from this readily available resource, ensuring that these critical structures are built on solid, climate-resilient foundations.

By reducing reliance on expensive, imported gravel, Kokhanok will not



PICTURE 3: GRAVEL PAD FOR INFRASTRUCTURE IN RURAL ALASKA

only lower costs but also ensure the community can continue infrastructure projects even during times of supply chain disruptions. The application of dust control measures will further protect public health, improving air quality and reducing respiratory risks, which are increasingly exacerbated by climate-related changes like droughts. This project aligns with broader climate adaptation goals by addressing infrastructure vulnerabilities, enhancing health outcomes, and providing sustainable, local resources for long-term community growth.

- Develop a local gravel source to support climate-resilient road resurfacing and infrastructure projects, reducing the impact of extreme weather on village roads and buildings.
- Ensure a stable supply of gravel for new housing and community facilities, allowing for durable site and pad preparation that meets the demands of changing environmental conditions.
- Reduce reliance on external, imported materials, improving Kokhanok’s self-sufficiency in the face of climate-driven supply chain disruptions.
- Enhance air quality and protect public health through dust control measures, mitigating risks exacerbated by climate change.
- Strengthen Kokhanok’s overall climate adaptation efforts by building more resilient infrastructure and ensuring long-term sustainability.

## Housing Subdivision Development

The development of new housing subdivisions in Kokhanok is vital to address the growing need for safe, climate-resilient homes. As climate change intensifies, the frequency and severity of extreme weather events—including severe storms, wildfires, and fluctuating temperatures—pose significant risks to the community’s aging housing stock. In addition, overcrowding remains a persistent issue, with **16% of households** in the region experiencing overcrowding, nearly five times the national average, as highlighted in the 2017 Alaska Housing Assessment.

Increasing housing development is not only a response to these immediate physical risks but also a proactive measure to ensure long-term resilience. Climate-related challenges, such as extreme weather and the potential for population growth due to climate migration, are placing further pressure on the community’s existing housing. Developing new subdivisions with **climate-resilient designs** will provide homes that can withstand these extreme conditions, using **energy-efficient materials** and **renewable energy solutions** such as solar panels and efficient heating systems.

The integration of renewable energy is key to reducing Kokhanok’s reliance on diesel, which is both expensive and environmentally harmful. By investing in **sustainable energy solutions**, the community will achieve long-term economic savings, reduce greenhouse gas emissions, and increase energy security.

Beyond the physical need for improved housing, this development is essential for maintaining **population stability**. Many of the existing homes are in poor condition, making it difficult to retain younger generations. Providing modern, energy-efficient homes will help alleviate overcrowding, encourage families to stay, and ensure that Kokhanok remains a vibrant and sustainable community. These homes, built to align with Kokhanok’s goals for **sustainability** and **resilience**, will foster long-term growth and better prepare the community for the ongoing impacts of climate change.

- Build essential infrastructure, such as roads, water, sanitation systems, and reliable power grids, to support the new homes and ensure long-term resilience.
- Apply for federal, state, and private funding opportunities for housing development, renewable energy integration, and infrastructure improvements.
- Work with architects and engineers to design homes that can withstand extreme weather conditions, using durable, energy-efficient materials.

- Identify suitable land for development that is safe from flooding, permafrost thaw, and other climate-related risks. Ensure proper land surveys and environmental assessments are conducted.
- Ensure that the subdivision design allows for future expansion as the population grows or if climate migration increases.
- Provide training for local workers in housing construction, renewable energy installation, and infrastructure development to ensure jobs and skills stay within the community.

## Rehabilitation of Existing Housing Stock

Many of Kokhanok’s homes are aging, energy inefficient, and increasingly vulnerable to the impacts of climate change, including severe storms, extreme cold, and rising energy costs. According to the 2017 Alaska Housing Assessment by the Alaska Housing Finance Corporation (AHFC), homes in the region



PICTURE 4: HOUSE IN KOKHANOK, AK

have some of the highest energy costs in the state, with heating representing a significant portion of household expenses. On average, homes in rural Alaska consume three to four times more energy per square foot than the national average, making energy efficiency improvements a critical priority.

Kokhanok’s reliance on diesel fuel for heat not only drives up energy costs but also leaves homes vulnerable to disruptions in fuel delivery, particularly in winter when fuel shortages or transportation delays can have serious consequences. In light of these challenges, a focused effort to rehabilitate existing housing stock by weatherizing homes and upgrading

energy systems is essential to reducing energy costs, improving living conditions, and enhancing the community's resilience to climate change.

This rehabilitation effort will involve upgrading insulation, repairing roofs and windows, and integrating renewable energy sources like solar power where feasible. By improving energy efficiency, Kokhanok can reduce the high costs associated with heating and ensure that homes are more comfortable and reliable throughout the year.

- **Weatherize Homes:** Installing insulation, sealing windows and doors, and upgrading heating systems will significantly reduce heat loss and energy consumption, offering residents financial relief and better comfort.
- **Address Structural Repairs:** Repairing roofs, windows, and other structural components will improve the ability of homes to withstand severe weather events and prevent further damage caused by climate change impacts.
- **Integrate Renewable Energy:** Introducing solar panels and other renewable energy solutions can reduce dependence on diesel fuel and lower long-term energy costs, providing both economic and environmental benefits.

- **Reduce Energy Costs:** The AHFC report highlights the high cost of heating homes in the region, where energy inefficiency leads to skyrocketing utility bills. By focusing on energy efficiency upgrades, Kokhanok can significantly reduce these costs, freeing up household income for other needs.

## Expansion of Biomass Heating

**Biomass Heating** is recommended for Kokhanok as it will reduce dependence on diesel fuel by expanding the use of locally sourced biomass for heating public buildings and homes. This is an environmentally sustainable option that aligns with the community’s goals for reducing energy costs and improving energy resilience. By utilizing locally harvested wood, Kokhanok can create a more reliable and sustainable energy source while reducing greenhouse gas emissions.



PICTURE 5: GARN BIOMASS BOILER (KOYUKUK, AK)

- Expand biomass heating systems for additional facilities such as the school and clinic.
- Train residents to manage biomass operations and harvest local wood sustainably.
- Create local economic opportunities through wood harvesting.

## Expansion of Renewable Energy

Expanding Kokhanok’s renewable energy capacity is vital for ensuring long-term sustainability and energy independence. **Renewable Energy** solutions will focus on increasing the use of solar panels, wind turbines, and battery energy storage systems (BESS) to reduce reliance on diesel generators. By generating more clean energy and storing excess power, Kokhanok will be better prepared for power outages, extreme weather, and rising energy costs.

- Prepare the community for power disruptions and extreme weather events by building a resilient energy infrastructure.
- Explore partnerships and secure funding through grants to support renewable energy development and sustainability.
- Identify additional opportunities to maximize renewable energy and avoid diesel fuel usage.

## Wildfire and Structural Fire Risk Reduction

**Wildfire and Structural Fire Risk** in Kokhanok has significantly increased due to warming temperatures, resulting in changes in vegetation, such as the growth of woody shrubs, dead spruce trees from beetle infestations, and drier conditions that elevate the likelihood of fires. The following recommendations aim to reduce these risks, protect community infrastructure, improve air quality, and ensure a more effective response to fire emergencies.

### Short-Term Recommendations:

- **Repair and Maintain the Water Trailer:** The community’s water trailer is essential for firefighting. Immediate repairs and ongoing maintenance should be prioritized, with spare parts readily available to ensure it remains operational during emergencies.
- **Prepare Firefighting Equipment and Train Volunteers:** Ensure that existing firefighting equipment is in working condition and that volunteers are trained to use it. Specific attention should be given to operating the firefighting pump, which can pull water from standing sources

like lakes and hydrants. Volunteers should also receive personal protective equipment (PPE), including helmets, gloves, and fire-resistant clothing.

- **Recruit and Train a Formal Volunteer Fire Department (VFD):** Recruit local volunteers and offer formal firefighting training, which could also result in certificates or credentials. This would enhance firefighting capabilities and provide economic opportunities for residents who may want to work as firefighters in other locations.
- **Expand Firebreaks:** Clear brush and widen firebreaks to 50-100 feet around homes and key community structures. This will reduce fuel sources and help contain potential wildfires. Residents can be employed in these clearing efforts, creating local job opportunities.
- **Secure Funding for Equipment and Training:** Pursue funding to support brush clearing jobs, firefighting training, and the purchase of firefighting equipment and PPE. Local, state, and federal programs can be accessed to support these efforts.

#### **Long-Term Recommendations:**

- **Develop a Comprehensive Community Fire Plan:** A Community Wildfire Protection Plan (CWPP) should be created to address fire prevention, response strategies, controlled burns, and forest management. The plan should also include measures for maintaining firebreaks and managing forested areas around the village. Harvested wood can be used in local biomass boilers or distributed to Elders.
- **Establish Ongoing Firewise and Equipment Training:** Continue to offer Firewise programs to educate residents on fire prevention techniques, safe vegetation management, and firefighting skills. Provide regular equipment maintenance training to ensure tools are kept in good working condition.
- **Improve Air Quality Through HEPA Filters:** Install High-Efficiency Particulate Air (HEPA) filters in key community buildings to reduce the impact of wildfire smoke on indoor air quality. This will protect vulnerable residents, including Elders and children, during fire events.

## Traditional Knowledge and Cultural Preservation

Preserving traditional lifestyles and cultural heritage is essential for maintaining the well-being and identity of the Kokhanok community. The impact of climate change threatens not only the environment but also the cultural practices that are deeply rooted in the natural landscape. As subsistence activities like hunting, fishing, and gathering become more difficult due to climate disruptions, there is an urgent need to safeguard traditional knowledge and pass it on to future generations. Strengthening the connection between youth and elders is critical to maintaining cultural continuity, promoting mental health, and fostering resilience in the face of change. A community-driven effort to create spaces for cultural education and activities will ensure that Kokhanok's traditions endure despite external challenges.

- Develop youth and elder mentorship programs focused on traditional knowledge sharing and subsistence training.
- Establish a cultural center for education, subsistence activities, and community services.



PICTURE 6: YOUTH PARTICIPATING IN THE FALL 2024 QUNSHA (DENA'INAQ) QANGANAQ (YUGTUN) ARCTIC GROUND SQUIRREL (ENGLISH) CAMP

For example, highlighting the traditional knowledge and cultural preservation in Kokhanok, the Qunsha (Dena'inaq) / Qanganaq (Yugtun) Arctic Ground Squirrel Camp held in the fall of 2024 brought the community together for a unique gathering. Participants learned to craft snares, identify signs of the Arctic ground squirrel, and explored medicinal plants, storytelling (sukdu), and music. Led by a dedicated team of language teachers—Michelle Ravenmoon, Merna Wharton, Bianca Jensen, and Kirk Gallarardo—the camp served as an enriching experience, connecting the community to its cultural roots through language and traditional practices.

## Structural Integrity and Search & Rescue for Melting Permafrost and Reduced Ice Thickness

Kokhanok relies heavily on **Lake Iliamna** for winter travel and subsistence activities like ice fishing. However, rising temperatures have led to **reduced ice thickness**, making winter travel across the lake increasingly unsafe. Residents depend on the frozen lake for transportation, but thinner, unstable ice poses significant risks to those using snowmobiles or other vehicles to cross. This not only threatens individual safety but also impacts access to subsistence resources and other essential activities.

To address these challenges, Kokhanok must implement **monitoring programs** to track ice thickness and provide real-time information to residents. Additionally, **training local volunteers** in search and rescue techniques will be crucial to ensure the community can respond effectively to emergencies related to unsafe ice conditions. Project recommendations include:

- Establish a program to monitor ice thickness on Lake Iliamna, providing residents with regular updates on ice conditions to help them make informed decisions about winter travel and subsistence activities.
- Train local volunteers in search and rescue techniques specifically focused on emergencies related to unsafe ice conditions. This will ensure rapid response capabilities in case of accidents on the lake during winter travel.

## Pandemic Preparedness and Public Health

The COVID-19 pandemic highlighted the vulnerability of remote communities like Kokhanok to health crises. Limited access to healthcare services, isolation, and dependence on outside supplies make Kokhanok particularly susceptible to future pandemics. Improving public health infrastructure and preparedness is crucial to ensure that the community is equipped to manage health emergencies. This includes providing adequate emergency shelter options, enhancing telecommunication systems for remote healthcare, and expanding housing to accommodate quarantine needs during future outbreaks. By focusing on these improvements, Kokhanok will be better positioned to protect its residents from widespread health threats while maintaining the capacity to address both physical and mental health needs.

- Ensure that emergency shelters are available and equipped for health emergencies.
- Improve telecommunications infrastructure to support remote healthcare services.
- Expand housing availability to allow proper quarantining during pandemics.



PICTURE 7: TELEHEALTH AT THE ALASKA NATIVE TRIBAL HEALTH CONSORTIUM

## Fuel Spill Response and Hazardous Waste Training

Kokhanok relies heavily on fossil fuels for heating, electricity, and transportation, making the community particularly vulnerable to fuel spills and hazardous waste contamination. Given that nearly all residents are involved in moving, handling, or storing fuel—whether for personal use, heating homes, or supplying fuel to local generators—there is an elevated risk of accidental spills. In the event of a spill, the consequences could be severe, threatening water sources, subsistence resources, and the environment.

To address these risks, it is essential to implement a comprehensive fuel spill prevention and response plan. This plan should include regular inspections and maintenance of the community’s fueling infrastructure, including the tribally led fueling station, bulk fuel storage tanks, and the various methods used to transport fuel between locations (from delivery to end use). Regular inspection and maintenance of fuel tanks, pipes, and delivery systems will reduce the risk of leaks and spills.

Equipping the community with the skills needed to respond effectively to fuel spills through HAZWOPER (Hazardous Waste Operations and Emergency Response) training will further enhance Kokhanok’s preparedness. This training will enable community members to contain and manage spills swiftly and



safely. Additionally, conducting regular spill response drills and upgrading aging fuel infrastructure, such as bulk fuel farm tanks, will be critical in preventing incidents and ensuring rapid action when needed. Key strategies include:

- **Regular Inspection and Maintenance:** Implement a program to routinely inspect and maintain the tribally led fueling station, bulk fuel farm tanks, and delivery systems to prevent leaks and ensure safety.
- **HAZWOPER Training:** Provide HAZWOPER training for all community members involved in handling or transporting fuel. This will ensure residents are equipped to respond quickly and effectively to fuel spills.
- **Fuel Spill Response Drills:** Conduct regular spill response drills to practice containment and cleanup procedures, ensuring the community is prepared for real-world incidents.
- **Infrastructure Upgrades:** Upgrade bulk fuel farm tanks, fuel lines, and storage facilities to modern standards, reducing the likelihood of spills and improving environmental safety.
- **Fuel Handling Safety Education:** Organize community training workshops to teach residents proper fuel handling techniques, including the use of certified fuel containers, safe refueling practices, and recognizing signs of potential leaks.
- **Community-Wide Fuel Safety Protocols:** Develop and distribute a set of community-wide fuel safety protocols outlining best practices for moving, storing, and handling fuel.

## Funding Opportunities

The table below provides a limited list of funding opportunities currently available to support the projects outlined in the Kokhanok Climate Adaptation Plan. However, it is important to note that grant funding opportunities are continually evolving, with new programs and sources emerging regularly. To stay informed about the latest funding options, we recommend regularly checking **Grants.gov**, which serves as a central resource for federal funding opportunities.

Additionally, signing up for listservs and newsletters from key funders such as federal agencies, nonprofit organizations, and private foundations can help ensure that the Kokhanok Village Council stays updated on relevant opportunities. By actively monitoring these resources, the community can continue securing the financial support needed to implement its climate resilience initiatives.

FUNDING OPPORTUNITY	ELIGIBLE PROJECTS
<p><b>Department of Energy’s Office of Energy Efficiency and Renewable Energy (EERE) Tribal Energy Program</b>            Various grants available for energy efficiency and renewable energy projects:  <a href="https://www.nrel.gov/docs/fy13osti/54396.pdf">https://www.nrel.gov/docs/fy13osti/54396.pdf</a>  <a href="http://www.energy.gov/indianenergy/office-indian-energy-policy-and-programs">http://www.energy.gov/indianenergy/office-indian-energy-policy-and-programs</a></p>	<p>Biomass, energy efficiency, geothermal, hydropower, solar photovoltaics, solar water heat, wind, and other renewable energy projects.</p>
<p><b>Department of Energy Office of Indian Energy (DOE-OIE)</b>            Federal agencies provide grant, loan, and technical assistance programs to support Tribal energy projects:  <a href="https://www.energy.gov/indianenergy/current-funding-opportunities">https://www.energy.gov/indianenergy/current-funding-opportunities</a></p>	<p>Weatherization, technical assistance, economic development, community facilities, community water, energy audits, renewable energy development, and energy efficiency.</p>
<p><b>Department of Energy (DOE) – Other</b>            Grants available for energy efficiency, renewable energy, technical assistance, pilot projects, and Tribal government energy projects:  <a href="https://www.energy.gov/energy-economy/funding-financing">https://www.energy.gov/energy-economy/funding-financing</a></p>	<p>Weatherization, biomass, energy efficiency, geothermal, hydropower, solar photovoltaics, solar water heat, wind, other renewable energy projects, and education &amp; outreach.</p>
<p><b>Denali Commission Grants</b>            Improve the effectiveness and efficiency of government services, to develop a well-trained labor force employed in a diversified and sustainable economy, and to build and ensure the operation and maintenance of Alaska’s basic infrastructure:  <a href="https://www.denali.gov/grants/">https://www.denali.gov/grants/</a>  <a href="https://www.denali.gov/funding-requests/">https://www.denali.gov/funding-requests/</a></p>	<p>Energy reliability, bulk fuel safety, infrastructure protection, transportation, sanitation, health facilities, housing, broadband, and economic development.</p>
<p><b>Alaska Energy Authority (AEA)</b>            Supports the State’s communities and energy infrastructure by administering grant funding programs and a loan program:  <a href="http://www.akenergyauthority.org/What-We-Do/Grants-Loans">http://www.akenergyauthority.org/What-We-Do/Grants-Loans</a>            AEA Renewable Energy Grant Fund:  <a href="http://www.akenergyauthority.org/What-We-Do/Grants-Loans/Renewable-Energy-Fund">http://www.akenergyauthority.org/What-We-Do/Grants-Loans/Renewable-Energy-Fund</a></p>	<p>Solar water heat, photovoltaics, landfill gas, wind, biomass, hydroelectric, geothermal electric, fuel cells, geothermal heat pumps, combined heat and power/cogeneration, hydrothermal, waste heat, transmission or</p>

	distribution infrastructure, anaerobic digestion, tidal energy, wave energy, fuel cells using renewable fuels, and geothermal direct-use.
<b>Alaska Housing Finance Corporation (AHFC)</b> Financing for permanent energy-efficient improvements to public buildings owned by regional educational attendance areas, by the University of Alaska, by the state or by municipalities in the state: Alaska Energy Efficiency Revolving Loan Program: <a href="https://www.ahfc.us/efficiency/non-residential-buildings/energy-efficiency-revolving-loan-fund-aeerlp/">https://www.ahfc.us/efficiency/non-residential-buildings/energy-efficiency-revolving-loan-fund-aeerlp/</a>	Borrowers obtain an Investment Grade Audit as the basis for making cost-effective energy improvements, selecting from the list of energy efficiency measures identified.
<b>USDA Rural Development</b> High Energy Cost Grant: <a href="https://www.rd.usda.gov/factsheet/high-energy-cost-grants">https://www.rd.usda.gov/factsheet/high-energy-cost-grants</a>	Funds may be used to acquire, construct, extend, upgrade, or otherwise improve energy generation, transmission, or distribution facilities and to establish fuel transport systems that are less expensive than road and rail.
<b>Rasmuson Foundation</b> Capital projects and technology upgrades for eligible Alaska organizations: Tier 1 Grants: <a href="https://www.rasmuson.org/grants/tier-1-grants/">https://www.rasmuson.org/grants/tier-1-grants/</a>	Capital projects, technology updates, capacity building, program expansion and creative works, including building construction/renovation/restoration, technology upgrades in community facilities, and capacity building grant support.
<b>Housing and Urban Development (HUD)</b> <a href="http://portal.hud.gov/hudportal/HUD?src=/topics/grants">http://portal.hud.gov/hudportal/HUD?src=/topics/grants</a>	Energy efficiency and housing weatherization.
<b>Bureau of Indian Affairs (BIA)</b> Energy and Mineral Development Program Grant (EMDP): <a href="https://www.bia.gov/service/grants/emdp/what-energy-and-mineral-development-program-emdp-grant">https://www.bia.gov/service/grants/emdp/what-energy-and-mineral-development-program-emdp-grant</a>	Resource assessment, exploration studies, feasibility studies, market studies, engineering studies, economic evaluation, and defining potential targets for development.
<b>Bureau of Indian Affairs</b> Tribal Energy Development Capacity Grant (TEDC): <a href="https://www.bia.gov/service/grants/tedc">https://www.bia.gov/service/grants/tedc</a>	Developing the legal infrastructure to create any type of Tribal energy business. Establishing an energy-focused corporation under Tribal or state incorporation codes. Establishing an energy-related Tribal business charter under federal law.
<b>Bureau of Indian Education</b> <a href="http://bie.edu/Programs/index.htm">http://bie.edu/Programs/index.htm</a>	School energy programs.
<b>The Honnold Foundation</b> Grid Alternatives Tribal Program: <a href="https://www.honnoldfoundation.org/">https://www.honnoldfoundation.org/</a>	Unrestricted grant funding to organizations or projects that use solar energy to increase social and economic equity and reduce environmental impact.

<p><b>USDA Rural Development</b>  Many various grants. Listed below.  <a href="http://www.rd.usda.gov/ak">www.rd.usda.gov/ak</a></p>	<p>Diverse eligible activities.</p>
<p><b>Bipartisan Infrastructure Law – Clean Energy &amp; Power</b></p> <ol style="list-style-type: none"> <li>1. Delivering Clean Power (\$21.3 billion)</li> <li>2. Clean Energy Demonstrations (\$21.5 billion)</li> <li>3. Energy Efficiency &amp; Weatherization (\$6.5 billion)</li> <li>4. Funding for Clean Energy Manufacturing &amp; Workforce Development (\$8.6 billion)</li> </ol> <p><a href="https://www.whitehouse.gov/build/guidebook/">https://www.whitehouse.gov/build/guidebook/</a>  <a href="https://www.whitehouse.gov/wp-content/uploads/2022/05/BUILDING-A-BETTER-AMERICA-V2.pdf#page=152">https://www.whitehouse.gov/wp-content/uploads/2022/05/BUILDING-A-BETTER-AMERICA-V2.pdf#page=152</a></p>	<p>Delivering clean energy, clean energy demonstrations, energy efficiency, clean energy manufacturing and workforce.</p> <p>May be limited in ability to fund upgrades and improvements to existing diesel electric utility systems. This gap may better fit into an EPA Implementation grant.</p>
<p><b>Bipartisan Infrastructure Law - Electric Vehicles, Buses and Ferries</b></p> <ol style="list-style-type: none"> <li>1. National Electric Vehicle Infrastructure Formula Program (\$5 billion)</li> <li>2. Discretionary Grant Program for Charging and Fueling Infrastructure (\$2.5 billion)</li> <li>3. Clean School Bus Program (\$5 billion)</li> <li>4. Low- and No-Emission Transit Bus Program (\$5.6 billion)</li> <li>5. Electric or Low Emitting Ferry Program (\$250 million)</li> </ol>	<p>Building a network of electric vehicle chargers and supporting the transition to electrification across all types of vehicles is critical to reduce emissions and help to combat the climate crisis.</p>

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