Energy Generation

GALENA, ALASKA FLOOD RECOVERY

Learning Objective: Analyze the decision-making process utilized in Galena post-disaster to institute a sustainable and efficient energy generation project during the community's recovery period from a devastating flood.

Keywords: Recovery, Flood, Local Government, Tribal Government, Rural Community, Infrastructure Systems, Sustainability, Resilience

PART ONE

Background

During the spring break up[1] in May of 2013, flood waters carrying massive ice chunks from the Yukon River inundated nearly 90% of the homes, businesses, and government facilities in the small town of Galena, Alaska. An ice jam downriver caused floodwaters to rise and back up overbank in Galena. House-sized chunks of ice mowed down the native birch trees and ripped homes off of pilings. Most areas received between seven and nine feet of water. The event forced nearly all of the 472 residents to evacuate by air to Fairbanks and Anchorage as waters quickly rose and local roads became impassable.

Figure 1. Fuel and supplies are brought into Galena by plane.

Galena has experienced several major flooding events, with the Old Town neighborhood receiving the worst of the damage due to its location between the Yukon River and the levee constructed to protect the air strip. Community members have long recognized the town's vulnerability and were adamant in their desire to incorporate resiliency into all re-building and recovery efforts. For instance, after a major flood in 1971, the community rebuilt critical facilities, city offices, the health clinic, and many homes at a less vulnerable site 1.5 miles further from the river, locally called New Town.

The sustainability and growth of Galena depends on addressing critical energy challenges which include the need to find alternative, lower-cost sources of fuel. When the U.S. Air Force left Galena, it also left the air base to the community, along with approximately 1.5 million gallons of fuel for power generation. However, that supply has been dwindling and aging. Fuel is resupplied by barging diesel fuel up the Yukon River in the summer, resulting in energy costs of 67 cents/kilowatt hour (kWh) for the residents of Galena.

This situation forced a discussion about expensive fossil fuel reliance and a transition to a local, renewable energy source. Galena residents emphasized this desire for a long-term, sustainable energy solution for the community in recovery coordination meetings with local and state leadership. Galena residents identified "Improving energy generation and efficiency" as one of their top five priority goals for the flood recovery process.

Public support for increased energy efficiency was one of the main driving forces for leaders to study the possibility of replacing damaged energy systems with a community biomass power plant project, which was already in the planning stages prior to the flood. Community leaders set to work identifying partners that could help with determining the feasibility of building a biomass power plant, as well as other energy system improvements.

[1] The period of time in spring when the ice on the river physically breaks and the surface becomes free flowing again. Seasonal snow melt adds to the Yukon River's water level, and shifting pieces of ice pile up to create ice jams that break unpredictably.

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Challenges

Galena is geographically isolated from larger towns, cities, and traditional power grid systems due to its location in remote Alaska. Therefore, the Galena community and its critical infrastructure (such as medical facilities and community centers) are vulnerable to power outages. Fuel deliveries must be transported via boat in the summer or plane in the winter. Fluctuations in global fuel prices can significantly increase the already expensive delivery costs.

Snow and freezing temperatures typically begin in late September, so the recovery timeline needed to be expedited to get critical facilities back up before the fall. Galena residents, volunteers and contractors worked hard throughout the summer to repair and rebuild as many homes and facilities as quickly as possible. Destroyed homes and critical infrastructure – including septic and sewer systems – were the highest priority to complete before the Yukon froze.

The expedited rebuilding process involved significant logistical challenges. With no road or rail system connecting Galena to other communities in Alaska, people and goods – including emergency supplies and building materials – must be brought in via barge or plane. Timelines were highly dependent on weather conditions, supply availability, and higher prices, which impacted the timely arrival of critical personnel and materials recovery projects were depending on.

Galena also has two governing bodies – the Louden Tribal Council and the City Council. The population is a mix of Alaskan Native and non-native residents. In many communities throughout Alaska, tribal communities retain traditional claims to land and resources. In Galena, this traditional system of resource management posed a challenge to the biomass project because land titles for accessible forested areas were held by a disparate group of tribal members. Biomass power plants require a readily available supply of fuel from material that comes from plants and animals, such as wood, agricultural waste, garbage, or animal manure. A non-profit organization, Sustainable Energy for Galena Alaska (SEGA), was established specifically to negotiate access to tribal lands to harvest timber for the biomass energy plant.

PART TWO

Actions

As part of the long-term recovery mission, FEMA requested technical assistance from the National Renewable Energy Laboratory (NREL) to conduct energy audits and identify opportunities to improve the energy systems in Galena. NREL participated in an Energy Summit, held in October of 2013, with other key partners to discuss the community's priorities for its energy systems and learn about ways to leverage the recovery process to achieve its energy goals. The opportunities identified at the summit included upgrades to the heat distribution system, evaluation of electric distribution system to better quantify use and reduce losses, improve the powerhouse (power plant and control station), and various energy efficiency measures.

Key Partners

- Galena Community Leadership
- State Leadership
- FEMA
- Economic Development Administration (Economic RSF lead)
- Alaska Energy Authority (AEA)
- National Renewable Energy Lab (NREL)
- Sustainable Energy for Galena Alaska (SEGA)

Some of the proposed transmission/distribution upgrades included implementing smart meters, identifying and reducing losses from unmetered loads and idle and over-sized transformers, voltage conversion of overhead lines between New Town and the Base (or removal of transformers), and quantifying and reporting service station losses.

Recommendations for energy efficiency upgrades included expanding energy audits to the remaining large public and commercial buildings, implementing recommended measures from existing and new audits, replacement of remaining streetlights, and expanding and improving the city's water and sewer pipe network. Finally, recommendations for powerhouse and heating system improvements included incorporating a biomass boiler system into the Galena Base Steam Plant, powerhouse operator training, new diesel generators to replace the old, inefficient generators damaged during the flood, new switch gear, new heat recovery equipment, and a behavior change campaign.

Following the summit, the community developed a plan for energy projects, including a biomass plant – an idea that had been discussed prior to the flood. Biomass is any organic matter used as a combustion fuel to generate electricity. In Galena's case, the proposal was for a wood-fueled central boiler, which would power the central steam plant within the levee, an area that had been undamaged by the flood. Steam heat produced by the system would be transmitted through the existing utility corridor (known as the utilidor) system to key facilities on the Air Force Base land, which today holds the Galena Interior Learning Academy (GILA).

The Energy Summit provided a laundry list of energy priorities, tasks, and opportunities. A general axiom of energy development, especially when addressing existing infrastructure, is to begin with efficiency improvements, since they typically incur the least cost with the best payback. Targeting efficiency first improves other capital projects, such as installing biomass plants and solar photovoltaics (PV). NREL conducted energy audits to identify potential energy efficiency measures that could be implemented throughout the rebuilding process, with a focus on the Galena power plant and power generation options. The NREL findings contributed significantly to the community's plans for the biomass-fueled power generation system.

The City of Galena has been pursuing energy and water conservation projects for several years to reduce cost and increase resilience to future natural disasters. Numerous feasibility studies have been conducted on behalf of the City. In order to fill the gaps on the audits that had already been conducted, a team led by NREL (and attended by an AEA representative with local and state knowledge) conducted assessments with City of Galena and tribal personnel.

Figure 2. NREL Energy Assessor Ian Metzger in Galena. Photo credit: Jimmy Salasovich, NREL.

The NREL team conducted an ASHRAE Level II energy audit, site survey, and initial analysis with spot measurements and short-term monitoring for lighting, temperature, humidity, boiler combustion efficiency, electrical power, and available solar resources. Additionally, the team reviewed historical energy data and previous audits to determine where opportunities exist. The team audited nine separate buildings.

Case Comparison

Energy Generation in the U.S. Virgin Islands after the 2017 Hurricanes

Like Galena, the U.S. Virgin Islands are also geographically isolated from a traditional power grid system and must achieve energy independence to ensure electricity is available to all residents.

In 2017, the U.S. Virgin Islands were devastated by hHurricanes Irma and Maria, and the existing power grid was heavily damaged. Both Galena and the U.S. Virgin Islands received assistance from FEMA and NREL to conduct assessments and restore power systems, but each location developed a different plan for energy recovery.

NREL also assisted the U.S. Virgin Islands by conducting an assessment of the current power grid's resiliency and capacity. Just as in Galena, the goal was to provide recommendations for restoration of power systems and improve resiliency to future disasters. In addition, NREL recommended options for integrating sustainable and energy-efficient renewable energy systems in both Galena and the U.S. Virgin Islands.

However, while the Galena community chose to pursue renewable energy options, operations in the U.S. Virgin Islands have focused primarily on restoring the energy grid to its prior state while utilizing stronger and more disaster-resistant building materials to prevent future damages. The most critical transmission lines in the U.S. Virgin Islands will be buried to prevent widespread power outages in the future, a more difficult course of action in Galena due to the presence of permafrost.

Though the U.S. Virgin Islands have huge potential for renewable energy generation and microgrid solutions, the immediate post-disaster focus has been on rebuilding the existing system rather than working toward the energy independence so highly valued by the Galena community.

Results

The community and FEMA successfully collaborated to convert this challenge into an opportunity and found a path forward to both comply with federal requirements and create a legacy that reduces Galena's ongoing energy needs.

The audits identified opportunities in the areas of HVAC, lighting and plug loads, water use, building envelopes, and renewable energy. These opportunities are summarized in Table 1 below.

Table 1. NREL Energy Recommendations

Heating and Ventilation	Lighting and Plug Loads
• Install variable frequency drives on pumps • Locate and repair failed steam condensate traps • Convert air-handling unit 1 from constant volume to variable volume with variable frequency drives • Install cogged v-belts on fan drives • Replace fan motors in fan coil units and unit heaters with electronically commutated motors • Consider premium efficiency motors on HVAC equipment • Set back space temperature set points for unit heaters	• Replace 40-W T-12 lamps with 28-W T-8 lamps or LED equivalents • Incrementally replace 32-W T-8 lamps with 28-W T-8 lamps • Replace incandescent lamps with LEDs or compact fluorescent lamps • Replace exterior lighting with LEDs • Install schedule-timer plug strips on printers, water coolers, and coffee makers • Replace high-bay metal halide lamps with high-intensity discharge T-5 lamps • Replace high-bay incandescent lamps with LEDs • Install switches for uncontrolled lighting circuits

Building Envelope	Renewable Energy
• Air seal exterior doors to prevent infiltration • Implement a policy to identify and close windows during heating season • Consider installing high-efficiency windows • Consider adding insulation • Consider replacing existing doors with higher efficiency models	• Consider installing a roof-mounted PV system for summer electricity production • Continue progress on biomass system and improve heat distribution **Water** • Consider low-flow water fixtures and low-flow faucet aerators, low-flow shower heads, and high-efficiency washing machines

Additionally, the NREL audit team created a table showing potential costs and savings associated with the recommended measures. The audit results included anticipated simple paybacks for decision- making. It is estimated that if all 41 measures the team identified were implemented, the total installation cost would be just over $620,000 and the annual savings would be over $165,000, taking just under four years to payback the investment[2].

The biomass plant is now operational, and many of the buildings on the old Air Force Base land are now heated by biomass, as planned. This project has increased the resiliency, sustainability, and energy conservation of the Galena community for many years to come.

Lessons Learned

- The flooding event, though destructive, presented a unique opportunity for the Galena community to pursue this previously discussed sustainable energy project. The biomass plant project contributed to the short-term recovery of the Galena community by upgrading the existing power system, and involving residents in the decision-making process. The high level of community involvement and input was ultimately what made this project a success.
- More significantly the biomass project is a step towards long-term resiliency for the town of Galena. Transitioning to a sustainable fuel source decreases Galena’s dependence on expensive and intermittent deliveries which are vulnerable to supply chain disruptions. Galena can now also serve as a model for renewable and sustainable energy generation in a rural location, and can participate in peer-to-peer knowledge sharing with other tribal communities in remote locations in Alaska wishing to pursue alternative energy projects.
- Galena’s recovery was locally-driven by strong local leadership, with support from federal and state agency partners committed to collaborating with community members and honoring Galena’s recovery goals.

Additional Resources

- NREL Experts Assist Before and After a Disaster
- U.S. Energy Information Administration: Biomass Explained

[2] Internal-only document. *Energy Efficiency and Renewable Energy Site Assessment.* Galena, Alaska. I. Metzger, J. Salasovich, and E. Hotchkiss, May 2014.