NREL Alaska Campus and Brief Project Overviews

NREL at-a-Glance

2,926

Workforce, including

219 postdoctoral researchers

60 graduate students

81 undergraduate students

World-class

facilities, renowned technology experts

More than 900

Partnerships

with industry, academia, and government

Campus

operates as a living laboratory

NREL Science Drives Innovation

Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

Grid Integration

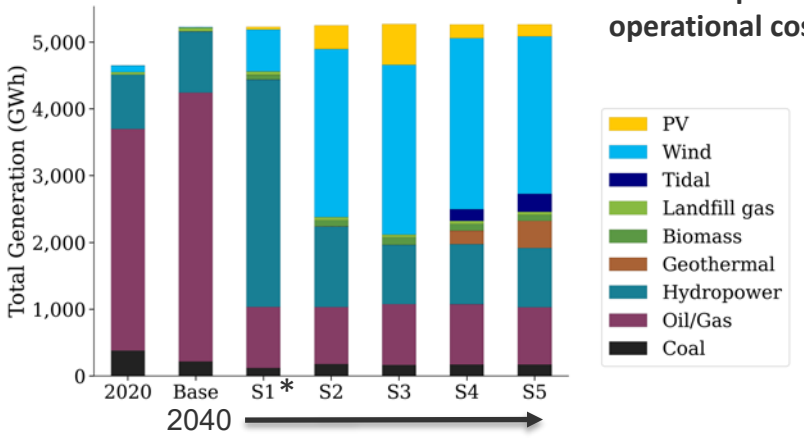
Hybrid Systems

Security and Resilience

Alaska Campus Research Focus Areas

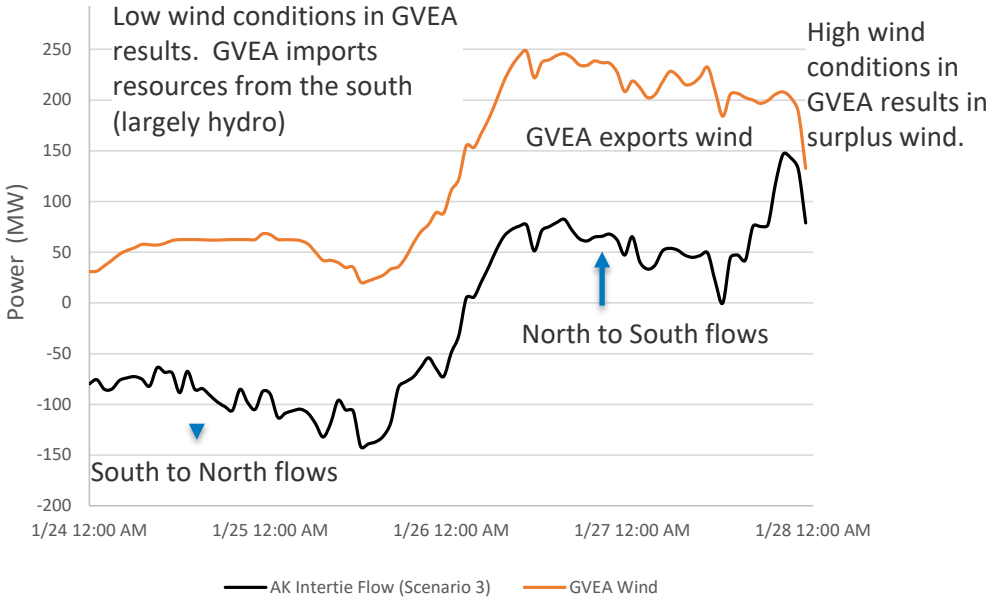
- Air and ground source heat pumps
- Biomass technologies
- Building envelopes and foundations
- Combustion safety
- Energy-water nexus
- HVAC optimization
- IAQ and moisture
- Net zero-ready buildings in cold climates
- Permafrost and building performance
- Renewable electricity to thermal storage
- Social Science Research
- Technoeconomic analyses
- Water and wastewater
- Weatherization

80% Renewable Portfolio Standard Assessment



*Scenarios 1-5 vary largely on new hydropower builds (e.g. Susitna-Watana) and the availability of new tidal and geothermal by 2040.

Flexible operation of the AK Intertie allows for efficient operation and reduces operational costs



- Multiple pathways exist for achieving an 80% RPS, and supply/demand balance can be maintained with appropriate system engineering.
- An 80% RPS achieves roughly $426-$506 million in fuel costs.
- Further analysis is currently underway to determine an optimal portfolio that minimizes overall costs

Stability Assessment for New Batteries in GVEA

ANALYTICAL FRAMEWORK

AC POWER FLOW
Evaluate the steady-state network loading and voltage profiles for the system operating in N-0 condition.

CONTINGENCY ANALYSIS
Evaluate the steady-state network loading and voltage profiles for the system operating in N-1 conditions.

SYSTEM STRENGTH ANALYSIS
Evaluate the short-circuit power profile in the network and identify critical conditions (emphasis on the system strength at the POI of the new IBR).

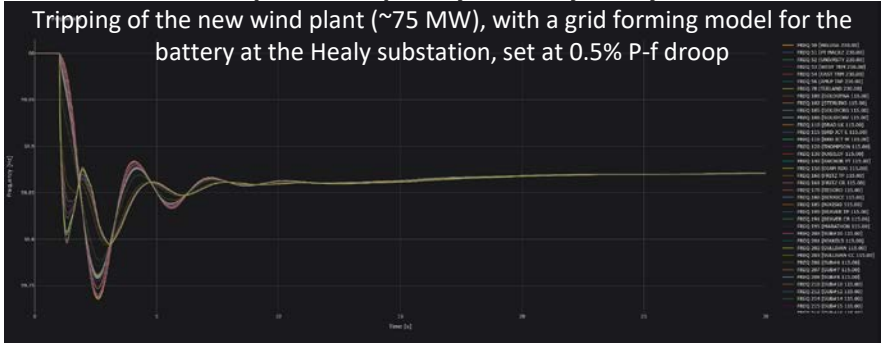
TRANSIENT STABILTIY ANALYSIS
Assess the capability of the system to overcome faults in the network while maintaining system synchronism and dynamic performance.

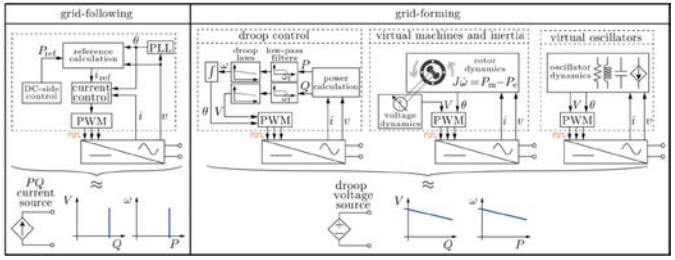
FREQUENCY STABILITY ANALYSIS
Assess the capability of maintaining system frequency within acceptable range facing sudden load/generation unbalance.

MAXIMUM TRANSFER CAPACITY
Evaluate the benefits and impacts of the integration of the BESS in the power transfer margins through the AK Intertie.

Example of frequency stability analysis:

Tripping of the new wind plant (~75 MW), with a grid forming model for the battery at the Healy substation, set at 0.5% P-f droop





KEY TAKE-AWAYS

01 Development of 90 MW wind power plant (WPP) in the GVEA system to increase the size of the largest single generation contingency in the system.

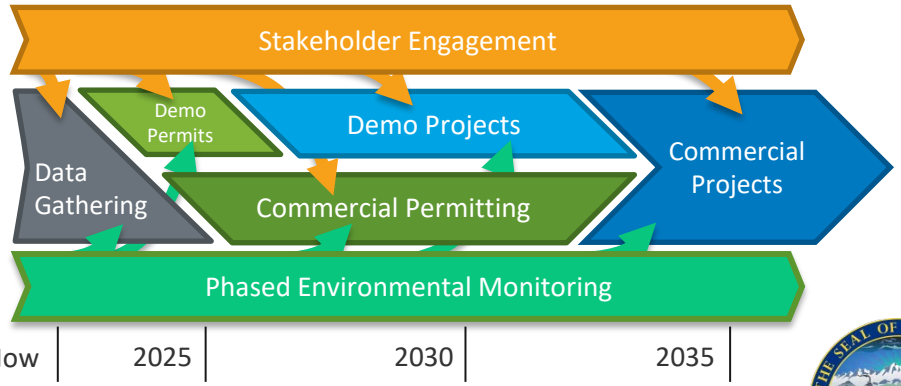
02 Dynamic performance following the 90 MW WPP trip constrained by stability limits on the AK Intertie.

03 Fast response of the battery power-frequency controls is key to ensure system stability. Virtual synchronous machine (VSM) grid forming control shows better dynamic performance for this application, with potential to replace event-driven control actions.

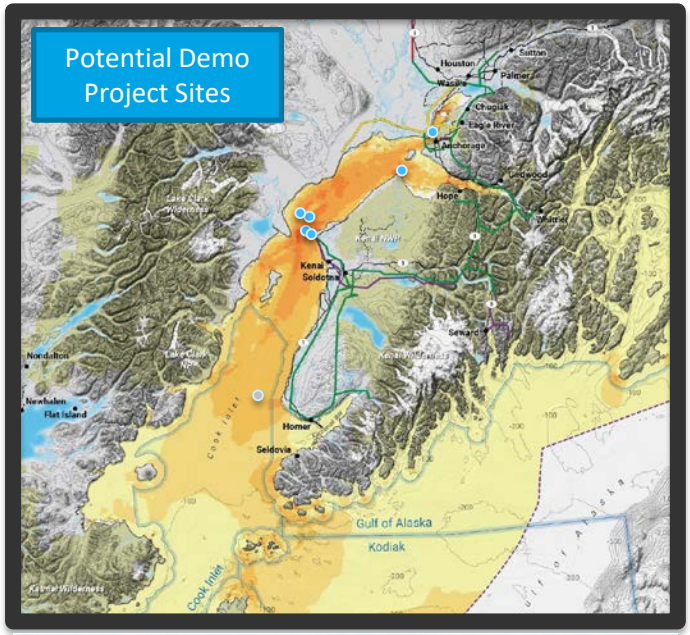
04 Different feasible alternatives to ensure system stability for the loss of infeed of the entire WPP have been identified, ranging from improved BESS controls to upgrades to the existing transmission infrastructure.

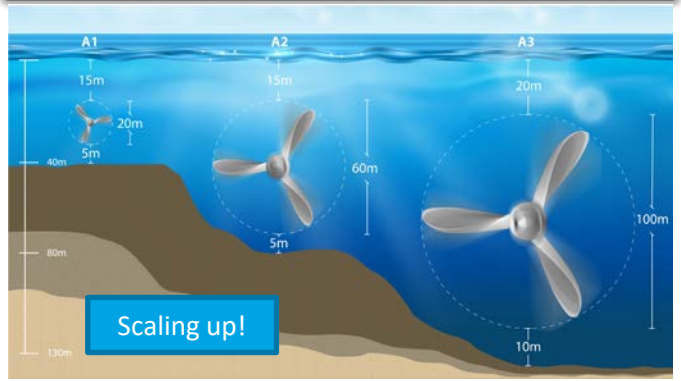
Cook Inlet Tidal Energy Roadmap

100MW by 2035

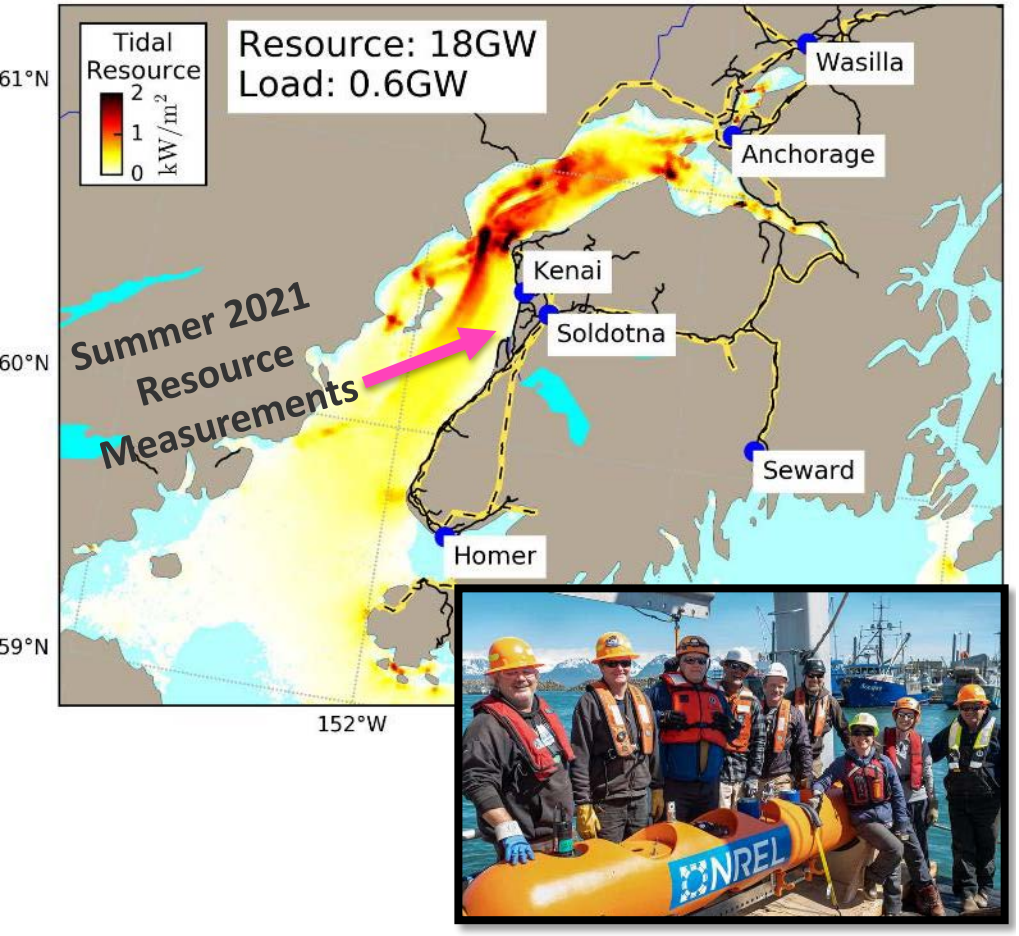


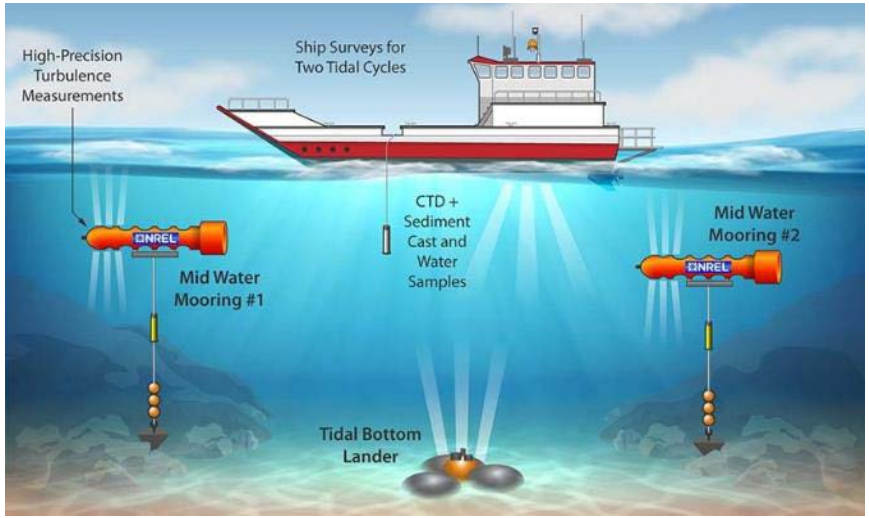
Cook Inlet Tidal Energy Working Group	
Project Plan	December 5
Data Needs and Gaps	January 23
Permitting and Regulatory	February 13
Tidal Energy around the globe	March 27
Resource Assessment	April 12
Cost Estimates	May 22





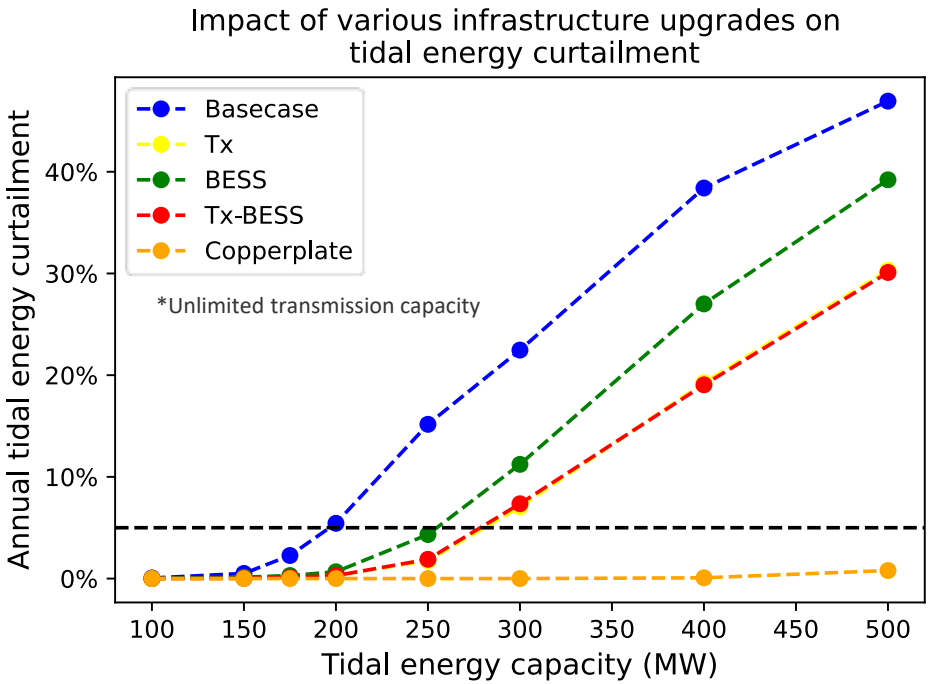
Cook Inlet Tidal Energy



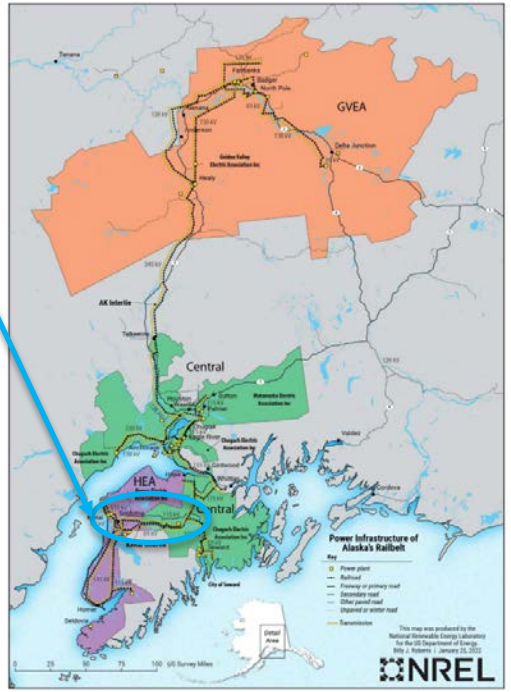


- Multi-GW resource—35% of nation's total
- Adjacent to transmission serving 70% of AK
- Space for multiple pilot projects
- E-fuel production by providing power to existing infrastructure
- Production cost modeling
  - How does tidal energy fit into existing grid?
  - What is 'added value' of tidal predictability?
- Resource data from models and measurements

Cook Inlet Tidal Energy: Grid Integration



Kenai Intertie (75 MW), which would transport the tidal energy, to the Anchorage region, presents a major bottleneck.

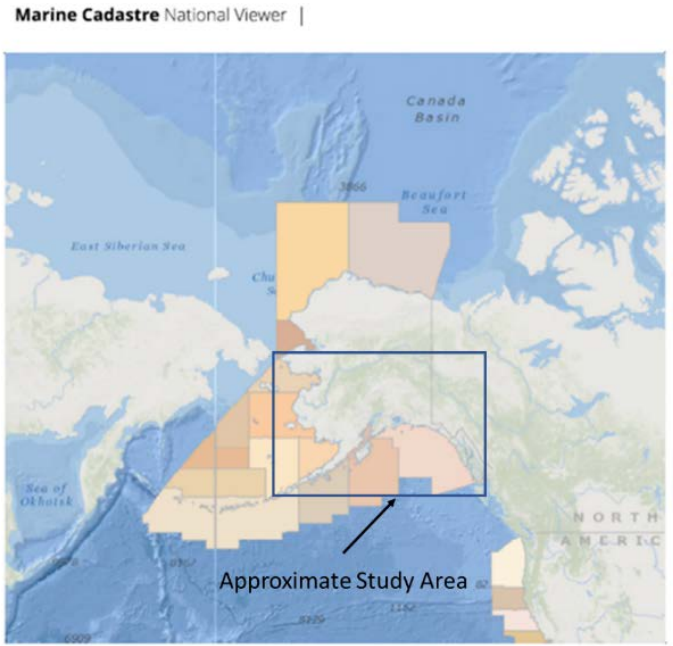


1. **Without major infrastructure investments, the Railbelt could support about 200MW installed tidal capacity without substantial curtailment.**
2. **Transmission and/or adding energy storage upgrades would increase limit to >275 MW.**
3. **Tidal energy reduces total Railbelt CO2 emissions by 8-37%, depending on infrastructure upgrades.**

BOEM: Opportunities in the U.S. **O**uter **C**ontinental **S**helf and State Waters

- **This is an investment in Alaska to describe the multi-billion-dollar marine energy and offshore wind potential in Alaska, particularly for the Railbelt.** *This is a 3-year project, FY22 through FY24.*

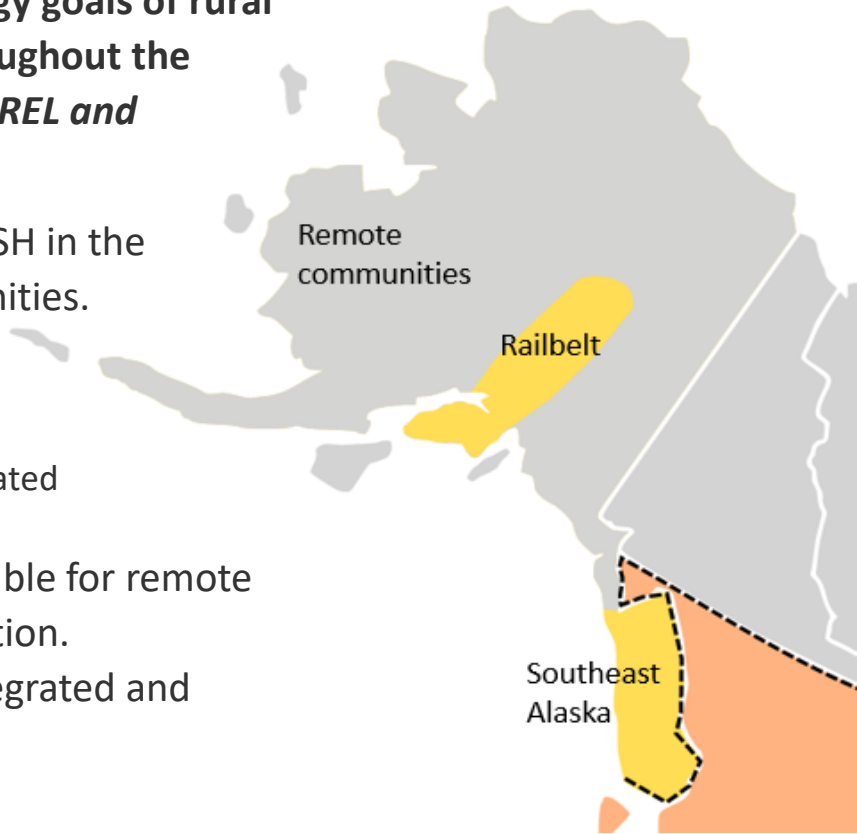
- **Primary focus**: identify best options for ocean-based renewable energy development for coastal communities
  - **Location:** the OCS off Alaska and in its state waters.
- **Geographic domain**: from Alaska coastline to the U.S. exclusive economic zone (EEZ), 200 nautical miles from shore.
- *Includes offshore wind, ocean wave, and tidal sources.*
- The study will also consider practical methods for delivering energy from these sources to the end users, including the potential for **green hydrogen fuel production**, distribution and end use adoption opportunities.



Pumped Storage Hydropower in Alaska

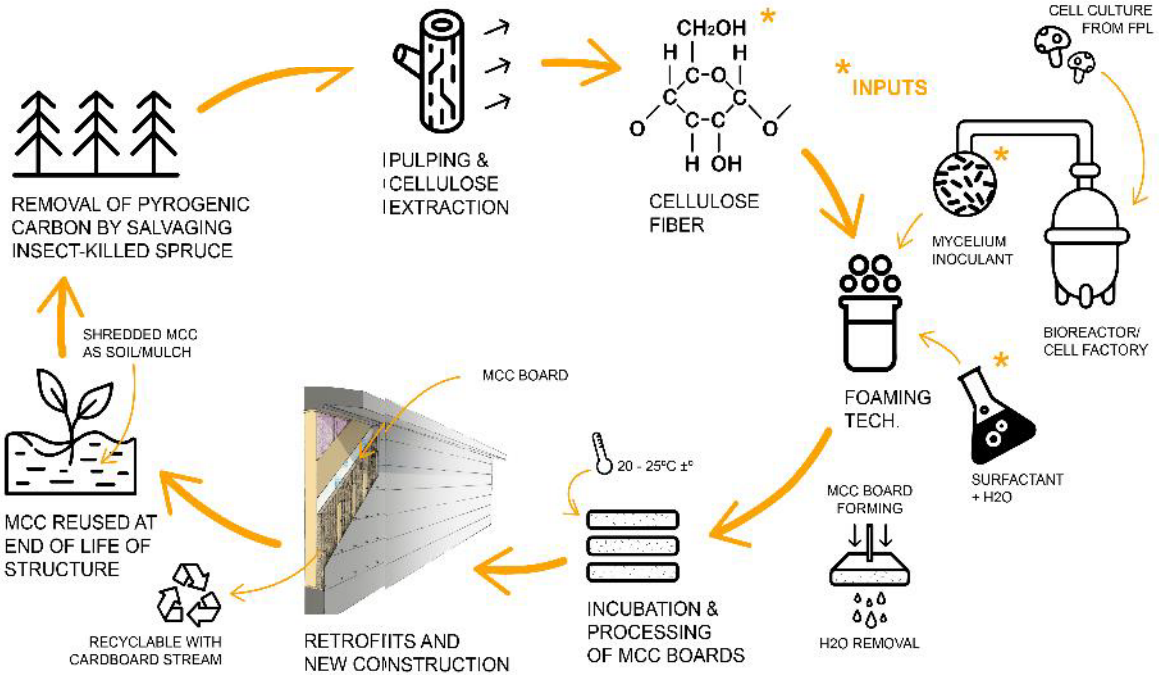
Multi-lab investment in Alaska to identify how PSH can support the state's renewable portfolio goals on the Railbelt and energy goals of rural Alaskan communities to foster energy independence throughout the state. *DOE Water Power Technology Office Funded with NREL and Argonne National Lab.*

- **Project focus**: investigate potential opportunities for PSH in the integrated Railbelt system and in remote rural communities.
  - Develop more clean renewable generation.
  - Develop energy storage to support renewables
    - long-duration storage is important in Alaska (integrated power systems and for remote communities)
  - Reduce cost of electricity and make it more equitable for remote communities that rely on expensive diesel generation.
  - Support the reliable and resilient operation of integrated and isolated power systems in Alaska.



U.S. Department of Energy Advanced Research Projects Agency-Energy

By creating an insulation product made of locally-produced cellulose from dead standing timber and mycelium, this project helps Alaskans reduce their heating bills and carbon footprint. ARPA-e award.



CELLULOSE-MYCELIUM COMPOSITES for CARBON-NEGATIVE BUILDINGS

National Renewable Energy Laboratory
University of Alaska Anchorage
VTT Technical Centre of Finland
Forest Products Lab
Cold Climate Housing Research Center, Inc.

PI: Robbin Garber-Slaght

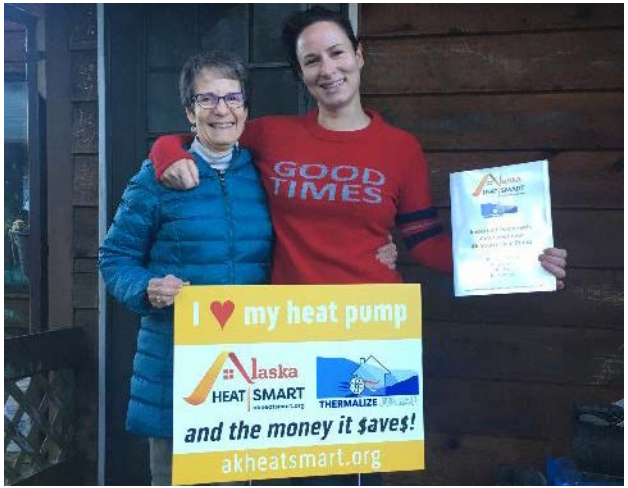
U.S. Department of Energy

NREL Alaska's partner Alaska Heat Smart received $2 million in HUD Healthy Homes funds to perform health and safety retrofits that enable heat pumps in low-income housing

- NREL Alaska team provides **grant management, workforce training, education & outreach**
- Builds off past work on *Thermalize Juneau* campaign in 2021, which promoted heat pumps and home energy retrofits in Juneau, Alaska as part of local action plan to reach 80% renewable energy by 2045
- NREL Alaska team performed a Community Survey, compiling results to-date, barriers to participation, and recommendations for inclusive community energy campaigns
- Results presented at Alaska Health Summit Jan. 18

Significance & Impact

Expanding Juneau's unique Thermalize campaign to reach low-income households reflects NREL's commitment to energy justice, and will help other communities implement more inclusive energy campaigns



Photos by Alaska Heat Smart

PI: Vanessa Stevens

Community-Wide Approach to Decarbonizing

"Thermalize" campaign designed to help Juneau, Alaska attain 80% renewable energy by 2040

Combines home energy retrofits with air source heat pumps to reduce household energy use and carbon emissions

Photo Courtesy Cold Climate Housing Research Center

Energy Transitions Initiative Partnership Project (ETIPP)

https://www.nrel.gov/state-local-tribal/etipp-technical-assistance.html

https://www.energy.gov/eere/energy-transitions-initiative-partnership-project-communities

The U.S. Department of Energy (DOE) Energy Transitions Initiative Partnership Project (ETIPP) helps remote, coastal, and island U.S. communities increase their energy resilience.

ETIPP is working with 9 communities in Alaska across Cohorts 1 and 2. Cohort 3 selections will be announced late Summer ‘23!

ETIPP Partner Network

Proven framework fosters high-impact, replicable community energy transitions.

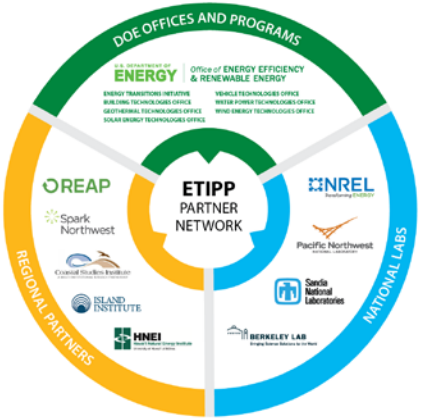
Community priorities

Partnership

Deep energy-sector experience +
Specialized local expertise

Resilient energy systems

LEARNINGS



ETIPP connects communities with energy experts to advance development of resilient energy systems.

Sample ETIPP projects in Alaska

Wainwright, AK (C1)

Energy analysis of EEMs for repurposed building. TEA of RE and ES on-site systems.

Igiugig, AK (C2)

SEP Implementation

McGrath, AK (C2)

Resource Assessment, Community Education, CEP Development

Nikolski, AK (C2)

Resource Assessment, CEP Development, Microgrid Integration

St. George, AK (C2)

Resource Assessment, CEP Development, Microgrid Integration

Igiugig, Alaska Technical Support

- Long term energy planning
- Economic Analysis
- River resource measurements

- This resource supports the community of Igiugig in developing an actionable long-term energy plan with lessons that are translatable to other communities throughout the State.

Technical Assistance to Alaskan Tribes

Pilgrim Hot Springs

Historic Building Energy Efficiency Upgrades and Rehabilitation Plan

Chilkat Indian Village

Energy Efficiency and Safety Surveys

Village of Solomon

Tribally Adopted Building Efficiency Standard

Metlakatla Indian Community

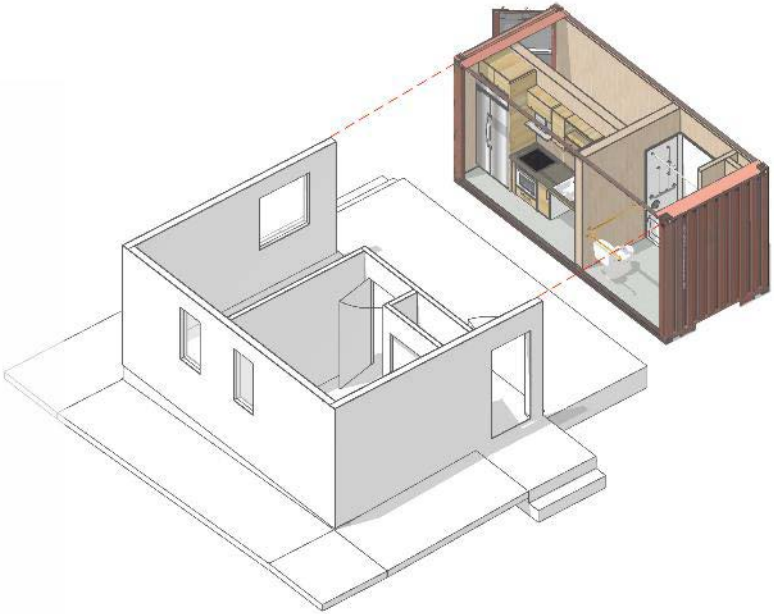
Strategic Energy Plan Updates

Organized Village of Kasaan

Energy Audits and Biomass Feasibility Study

The U.S. Department of Energy (DOE) Office of Indian Energy provides federally recognized Indian tribes, including Alaska Native villages, tribal energy development organizations, and other organized tribal groups and communities, with technical assistance to advance tribal energy projects.

Unalakleet Semi-Modular Demonstration Home



- Storage containers outfitted with kitchen-bathroom built in lab
- “Plugs into” newly framed home built on-site by local crew
- Modeled to reduce energy costs by 80%
- Semi-modular approach reduces construction costs by 40%
- Climate resilient homes for rapidly changing Arctic

Unalakleet Semi-Modular Construction

Harvest to Home Program

Photo from Dave Loeks, HTH Homes

NREL is working with the Kuskokwim Corporation to design a system of milling locally harvested lumber into energy-efficient housing for the region

Harvest to Home Production for the Middle Kuskokwim Region

Photos from Lindsay Flett

U.S. Department of Housing and Urban Development

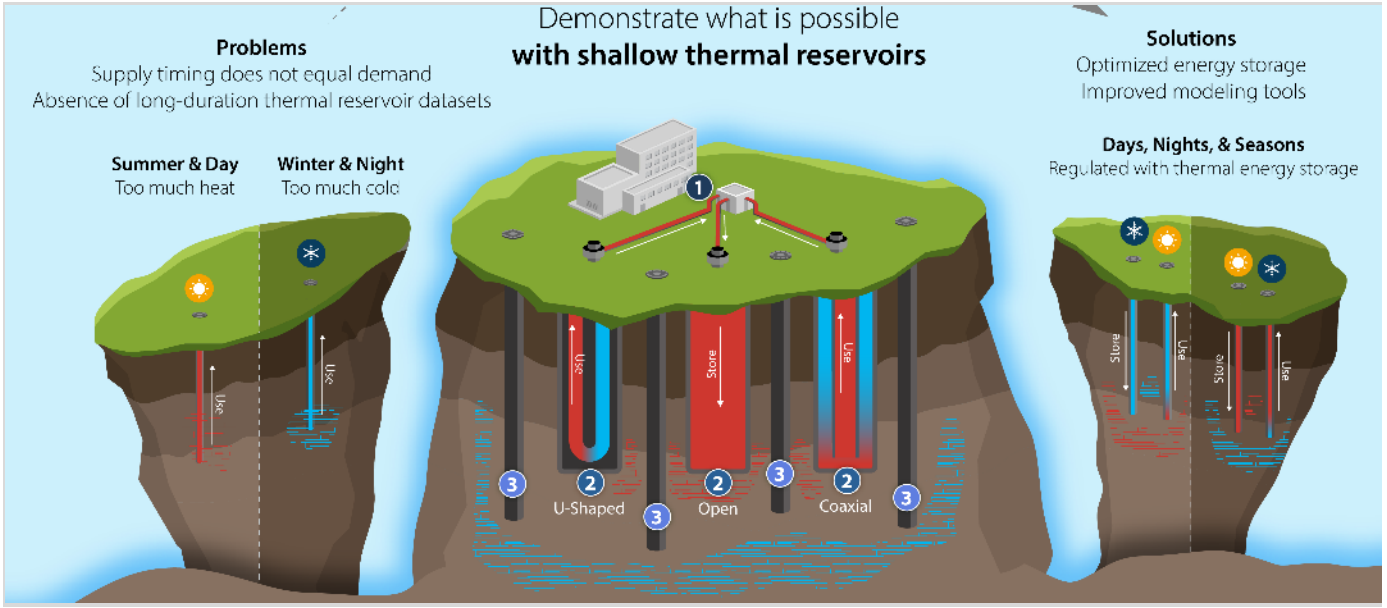
Healthy Homes Projects Across Alaska

- Gakona, Galena, Buckland, Unalakleet, Maniilaq, TNHA/Utqiaġvik
- Local capacity-building effort hires and trains crews to perform surveys and retrofit work
- Provides holistic approach to energy efficiency that incorporates local culture, economic development, and quality of life

U.S. Department of Defense

U.S. Army Corps of Engineers

- Geothermal heating strategies for cold climates
- Improving grid resilience
- Demonstration and de-risking of technology
- Net-zero target



U.S. Department of Defense

NREL Alaska team is helping DOD in AK meet requirements to be climate change ready: Joint Base Elmendorf-Richardson, Clear Space Force Station, Eielson Air Force Base, Fort Wainwright and Fort Greely.

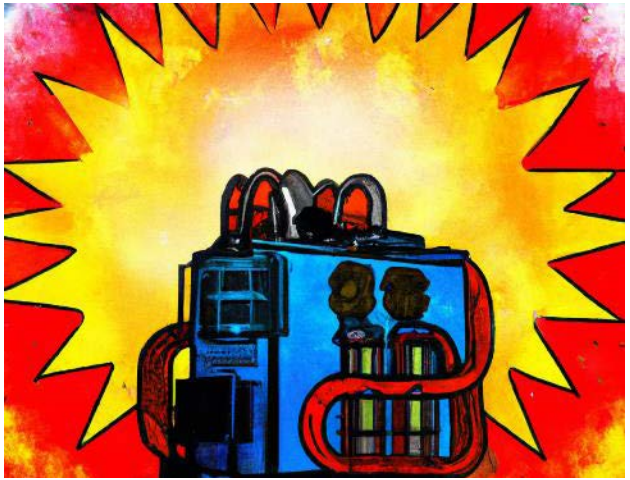
Alaska Army National Guard

1. Preliminary microgrid designs for Guard installations
2. Building energy assessments for improved efficiency
3. Assessment of energy use for new technologies

U.S. Department of Defense

Ft. Wainwright Environmental Security Technology Certification Program (ESTCP)

- Assessment of energy use and feasibility for new cold-climate technologies
- Suggestions for replacement of coal-fired CHP
- Evaluation of geothermal heat pumps



NREL/PR-5700-86355

Photo Courtesy Cold Climate Housing Research Center