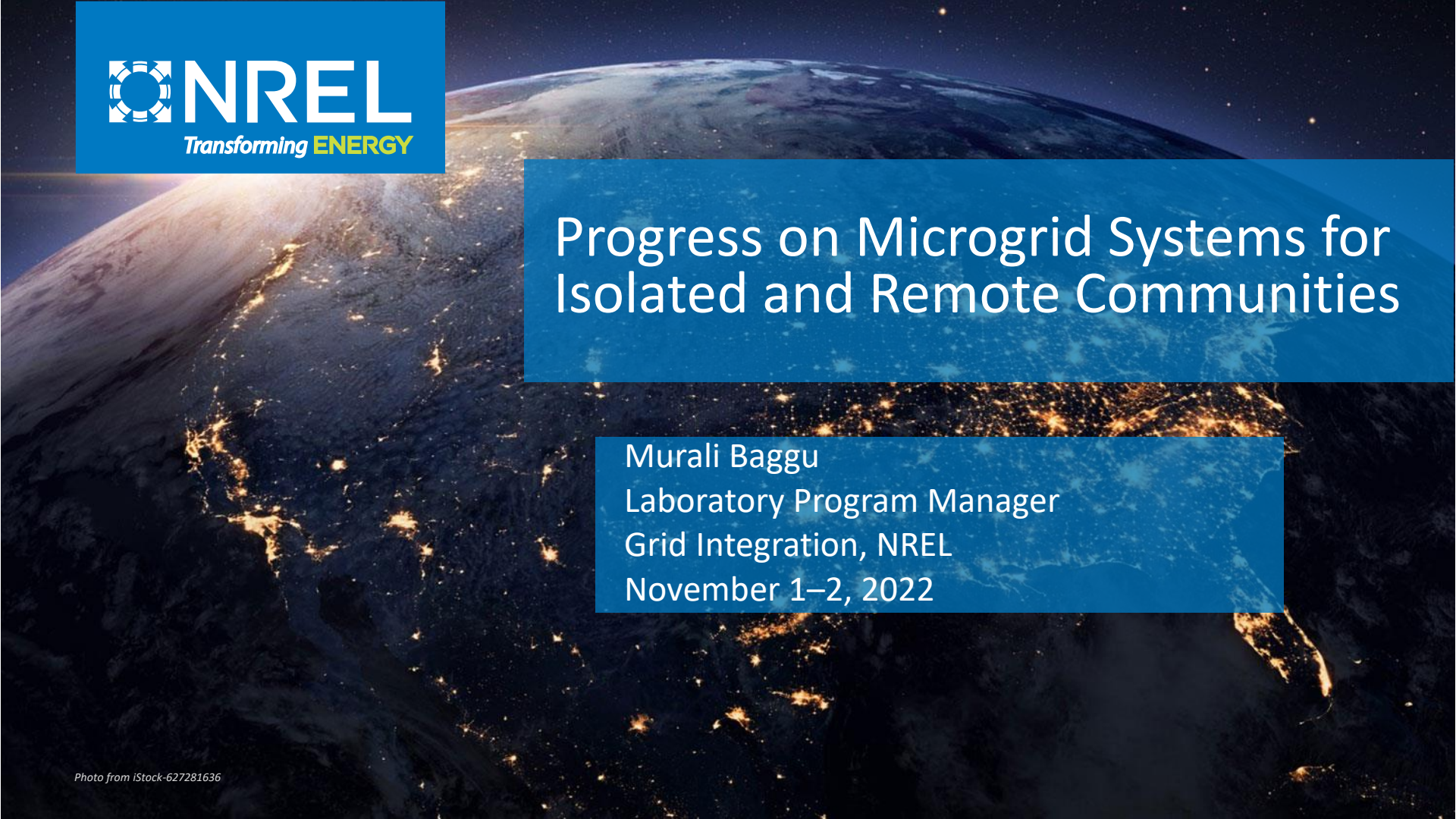

Progress on Microgrid Systems for Isolated and Remote Communities

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Laboratory Program Manager
Grid Integration, NREL
November 1–2, 2022

Photo from iStock-627281636

U.S. Microgrid Research Spans Remote Territories

The U.S. Energy Act of 2020 states that the Secretary of Energy "shall establish a program to promote the development of (A) integrated microgrid systems for isolated communities; and (B) microgrid systems to increase the resilience of critical infrastructure."

R&D Focus: Alaskan Microgrid Innovation

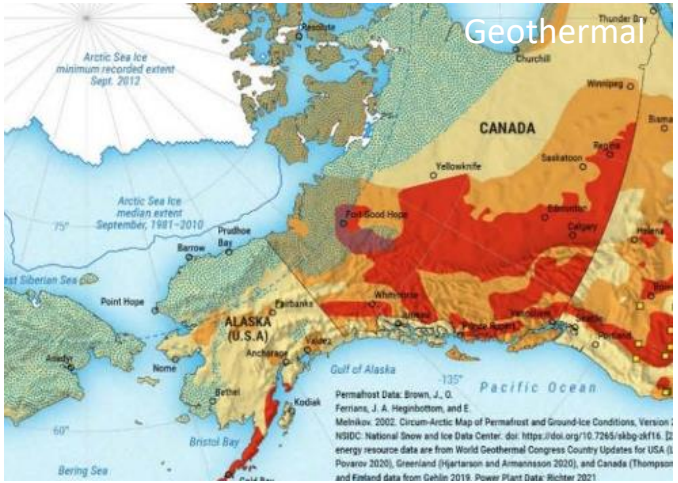
More than 50% of U.S. microgrids are located in Alaska, making it a hot spot for microgrid innovation, system designs, and demonstrations.

More than 200 isolated microgrid systems

Exposed to severe natural hazards

Heavily dependent on imported diesel

Alaska has a high diversity of energy resources.



Images from NREL

As well as high-intensity hazards that raise the importance of resilience.

Photo courtesy of FEMA

Photo courtesy of USGS

Photo courtesy of NOAA

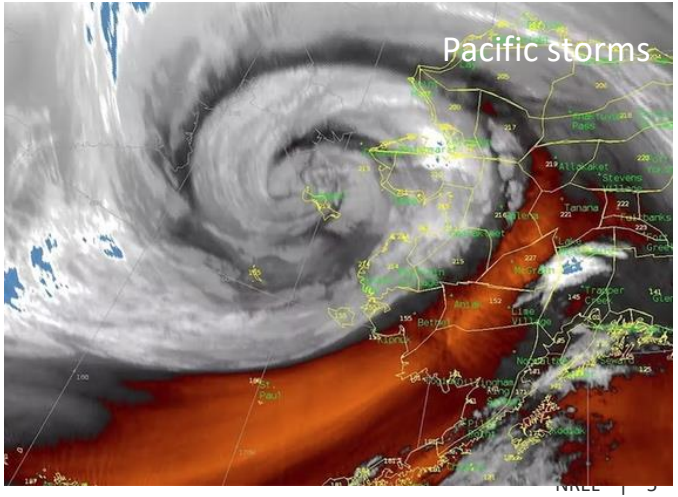


Photo courtesy of NWS

Project Example: Remote Microgrid Design in Cordova, Alaska

- The main industry is fishing, which causes large, seasonal load variations..
- The microgrid currently operates on two run-of-river hydro plants, plus diesel.
- There are approximately 2,000 permanent residents.

Project Example: Remote Microgrid Design in Cordova, Alaska

The U.S. Department of Energy (DOE) launched the Resilient Alaskan Distribution System Improvements Using Automation, Network Analysis, Control, and Energy Storage (RADIANCE) project for Cordova and other communities.

- Installed new 1-MWh battery energy storage system
- Upgrading grid's communications network to improve cybersecurity and reliability; installed underground lines
- Provided techno-economic analysis of storage and demand-response strategies
- Performing real-time simulation of microgrid on megawatt-scale Advanced Research on Integrated Energy Systems (ARIES) platform to model novel grid designs and controls.

Photo by NREL

Advanced Research on Integrated Energy Systems (ARIES)

- Power electronics grid interface
- Cyber-energy range
- Microgrid and advanced controls launchpad.

Photos by NREL

Project Example: Hydrokinetic-Based Electrification

Amid high-cost electricity, coastal Alaska has supreme hydrokinetic resources. The DOE project ORCA has been helping communities build on this opportunity.

- The Cook Inlet has 30% of all U.S. tidal power, enough to power 18 million homes.
- The inlet is adjacent to the state's largest population centers.
- Outside of the inlet, Alaska contains nearly 60% of total U.S. wave energy.

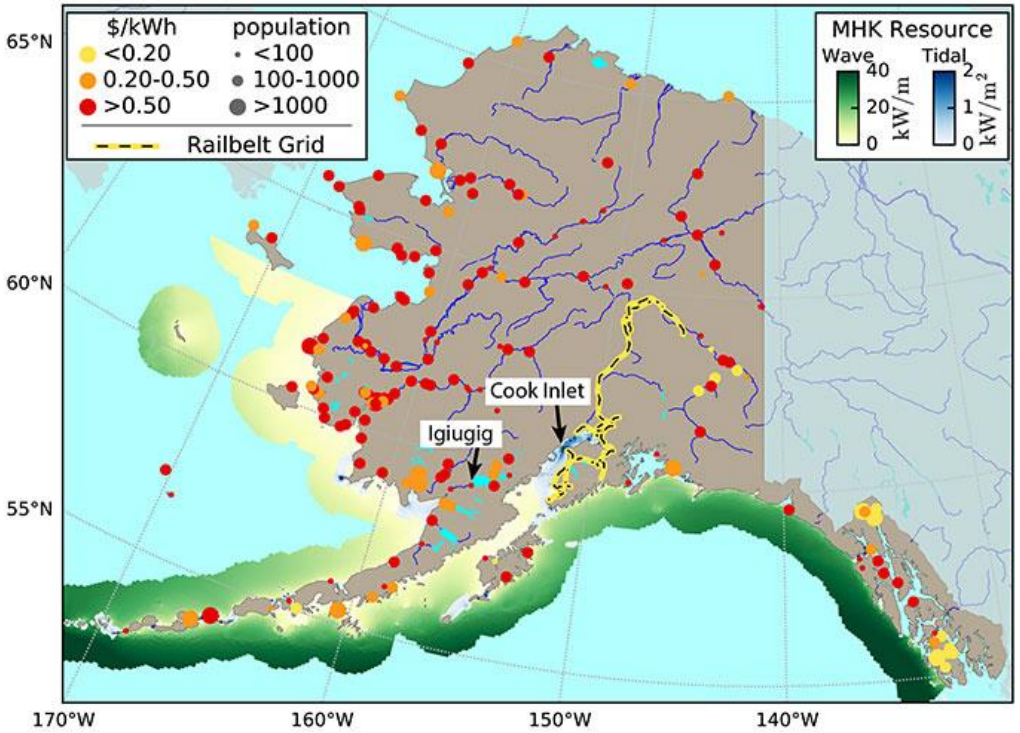


Image by NREL

Project Example: Hydrokinetic-Based Electrification

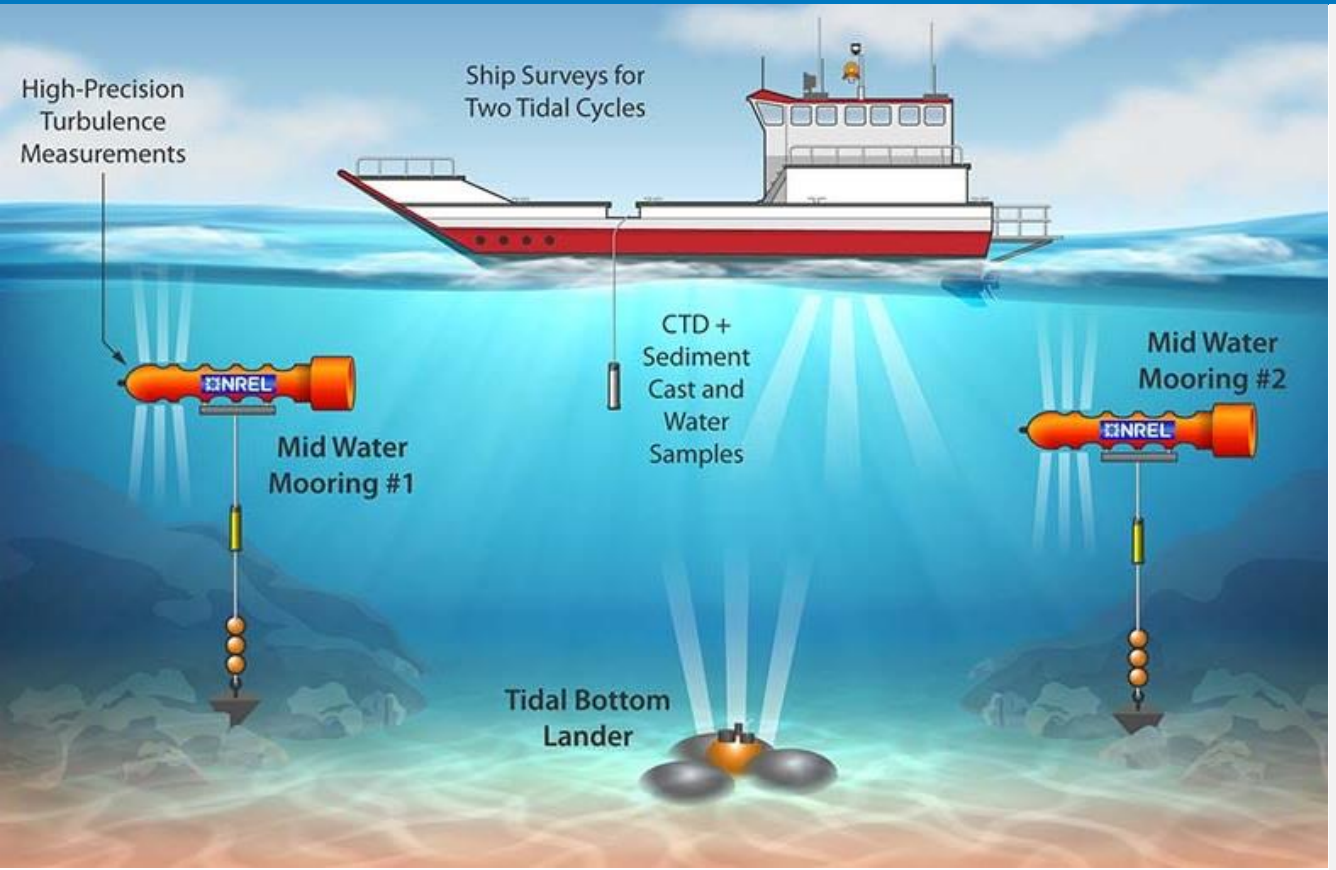


Image by NREL

- NREL deployed survey instruments in the Cook Inlet to gather high-detail data on resource potential and technical feasibility.
- Created a novel data-collection method to evade problems with sediment deposits

Project Example: Hydrokinetic-Based Electrification

Photo courtesy of ORPC

- A 35-kW river current device powers the village of Igiugig alongside wind and solar. It could reduce Igiugig's diesel use by 90%.
- There were no observed disruptions to the salmon population, part of the largest sockeye salmon run in the world.
- It provides reliable year-round baseload power.

Lessons Learned So Far About Remote Microgrids

Image courtesy of DOE

- Each system and community is different, as is their microgrid approach.
- However, results—and especially technology demonstrations—can provide useful examples for other sites.

Research Recommendations of the Arctic Lab Partnership

Microgrid design needs:

- Standardization around energy system designs and development
- Microgrid design that supports heating, cooling, and transportation, and with relatively high contributions from renewable energy.

Institutional support needs:

- Detailed information on community energy needs and local resources
- Supportive policy, funding, and collaborative development models
- Global knowledge exchange with islanded and isolated communities around the world
- Expanded research coordination.

Arctic Lab Partnership

5

Research Laboratories

Vision: To leverage the combined assets of science and technology leaders to address long-term challenges of resilience and security in Alaska and the Arctic.

Sample Tools for Microgrid Design and Analysis

REopt®: Renewable Energy Optimization Tool

Used to understand specific bill savings and resilience benefits that can be achieved with microgrid solutions.
https://reopt.nrel.gov

Microgrid Design Toolkit

Determines alternative microgrid designs, used to optimize topology, generation, and asset sizes over multiple measures of performance.
https://energy.sandia.gov/download-sandias-microgrid-design-toolkit-mdt/

Resilience Node Cluster Analysis Tool (ReNCAT)

Determines potential microgrid locations based on infrastructure data and density of critical services. Has been used to suggest microgrid portfolios for New Orleans and Puerto Rico.
https://www.osti.gov/servlets/purl/1880920

A suite of national laboratory-developed software is regularly used in remote microgrid research projects to realize optimal cost, technology, and reliability investments for microgrid deployments.

Sample Microgrid Institutional Support Programs

ARCTIC: Alaska Regional Collaboration for Technology Innovation & Commercialization

Leverages local know-how and capacity-building to demonstrate that 50% penetration of variable renewable energy on microgrids is technically and economically feasible, to enhance local sustainability, and to support the diversification of Alaska's ecosystem.

Alaska Microgrid Partnership

A laboratory consortium to develop more systemized, modular, and scalable concepts that could be widely implemented across communities with different energy needs and community readiness.

Collaboration programs are targeted at circulating lessons learned and providing a forum for information exchange, data sharing, and consensus building.

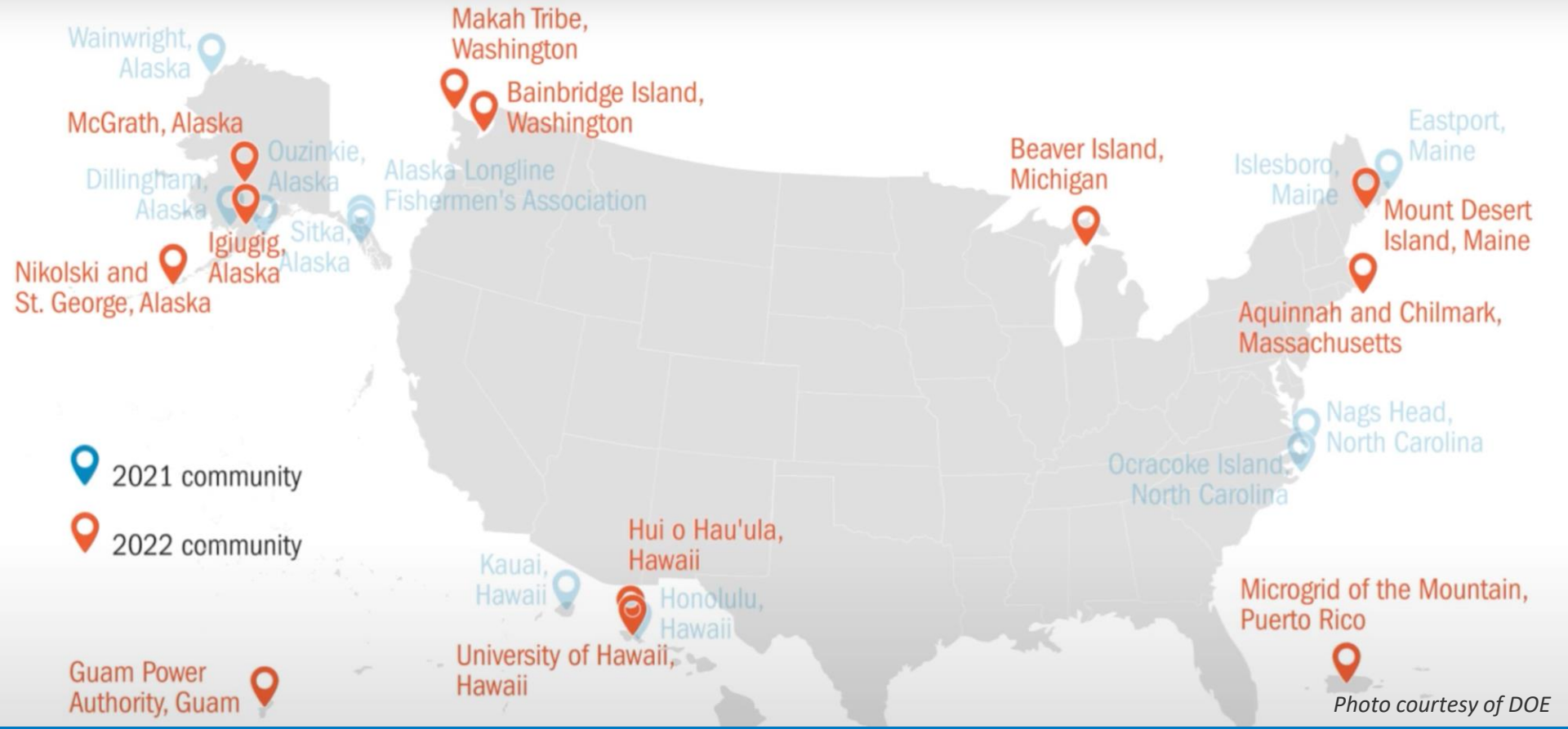


Photo courtesy of DOE

Energy Transitions Initiative Partnership Project (ETIPP)

A technical assistance program led by DOE to help remote and islanded communities transform their energy systems.

Image courtesy of DOE

ETIPP Example: Ocracoke, North Carolina

Identifying the cost-optimal approach for electrifying an island's ferry fleet.

ETIPP Example: Microgrid of the Mountain, Puerto Rico

Refining an intermunicipal microgrid plan and designing specifications for batteries and upgrades.

Image courtesy of DOE

ETIPP Example: O'ahu, Hawaii

Identifying optimal areas for developing microgrids to build a more resilient electric grid.

Opportunities for Remote Microgrid R&D Ahead

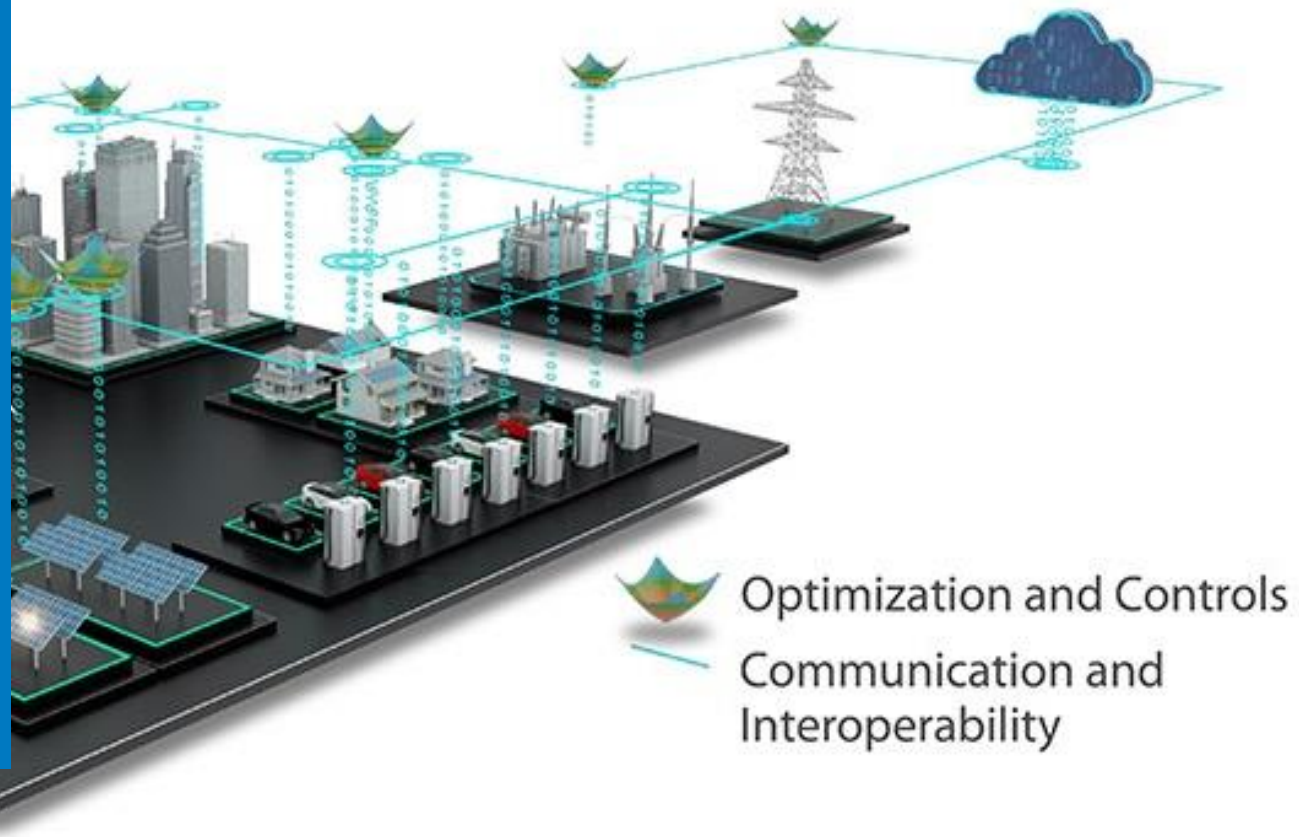
- U.S. Bipartisan Infrastructure Bill—$1 billion to energy systems in rural and remote communities.
- U.S. Inflation Reduction Act—Many incentives for renewable energy microgrid development.
- FERC Order 2222—Opens microgrids to participate in wholesale markets.

Photo by NREL

Historic Power Grid Transition in Puerto Rico

DOE's participation in Puerto Rico's grid recovery opens many possibilities for microgrid strategies.

Autonomous Energy Systems: A new generation of controls and algorithms that will unlock decentralized and dynamically resilient energy.



Strategic partnership between NREL and utilities, communities, and vendors

Thank you

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