

Challenges of Integrating Renewables in Small Grids

Brian Miller, PE
Strategic Team Lead, Microgrids
Brian.Miller@NREL.gov

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Overview

1. Renewable power variability, prospecting, & forecasting
2. System engineering: technical challenges



Arctic Renewable Energy Atlas

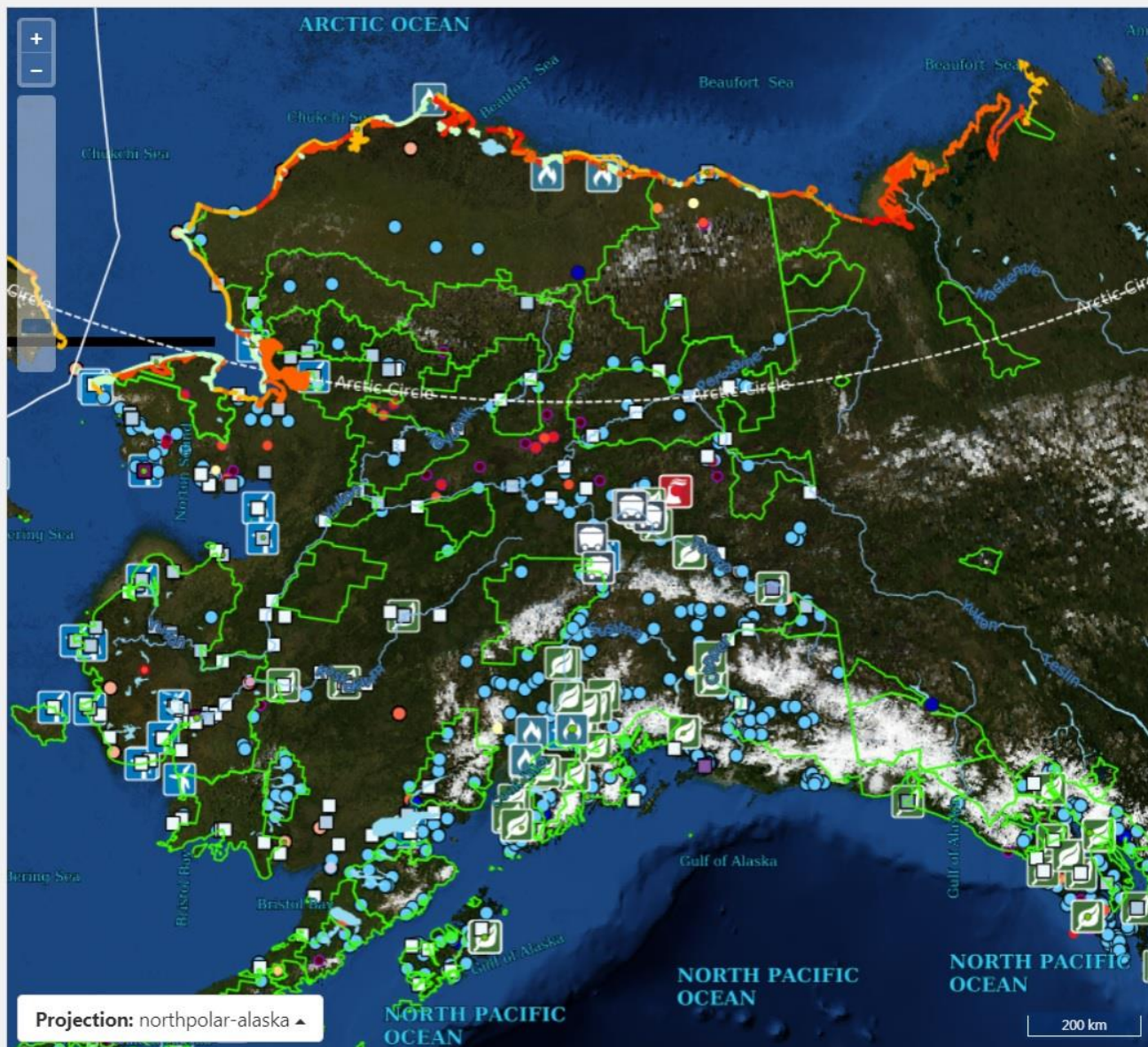
HOME MAP DATA RESOURCES COMMUNITY ENERGY STORIES



AREA Interactive Map
Arctic Renewable Energy Atlas

Layers

- Global
- ▾ Alaska
 - ▾ Reference
 - ▾ Infrastructure
 - Operating REF Projects
 - ▾ Generation and Transmission
 - AEDI Transmission Lines
 - Electric Service Areas
 - Power House Generators
 - ▾ Non-Renewable Infrastructure
 - Coal Plants
 - Natural Gas Plants
 - Petroleum Plants
 - TAPS Pipeline
 - ▾ Boundary
 - AK Energy Development Regions
 - WREZ Hubs
 - ▾ Admin
 - ▾ Tribal
 - Alaska Native Regional Corporations
 - Alaska Native Areas
 - ▾ Land Ownership
 - ▾ Environment
 - Areas of Critical Environmental Concern
 - National Parks
 - EPA Contaminated Lands
 - PM 2.5 (2006 Standard)
 - ▾ Resource
 - ▾ Biomass
 - Crop Residue
 - Biomethane



Variable Renewable Resource Data

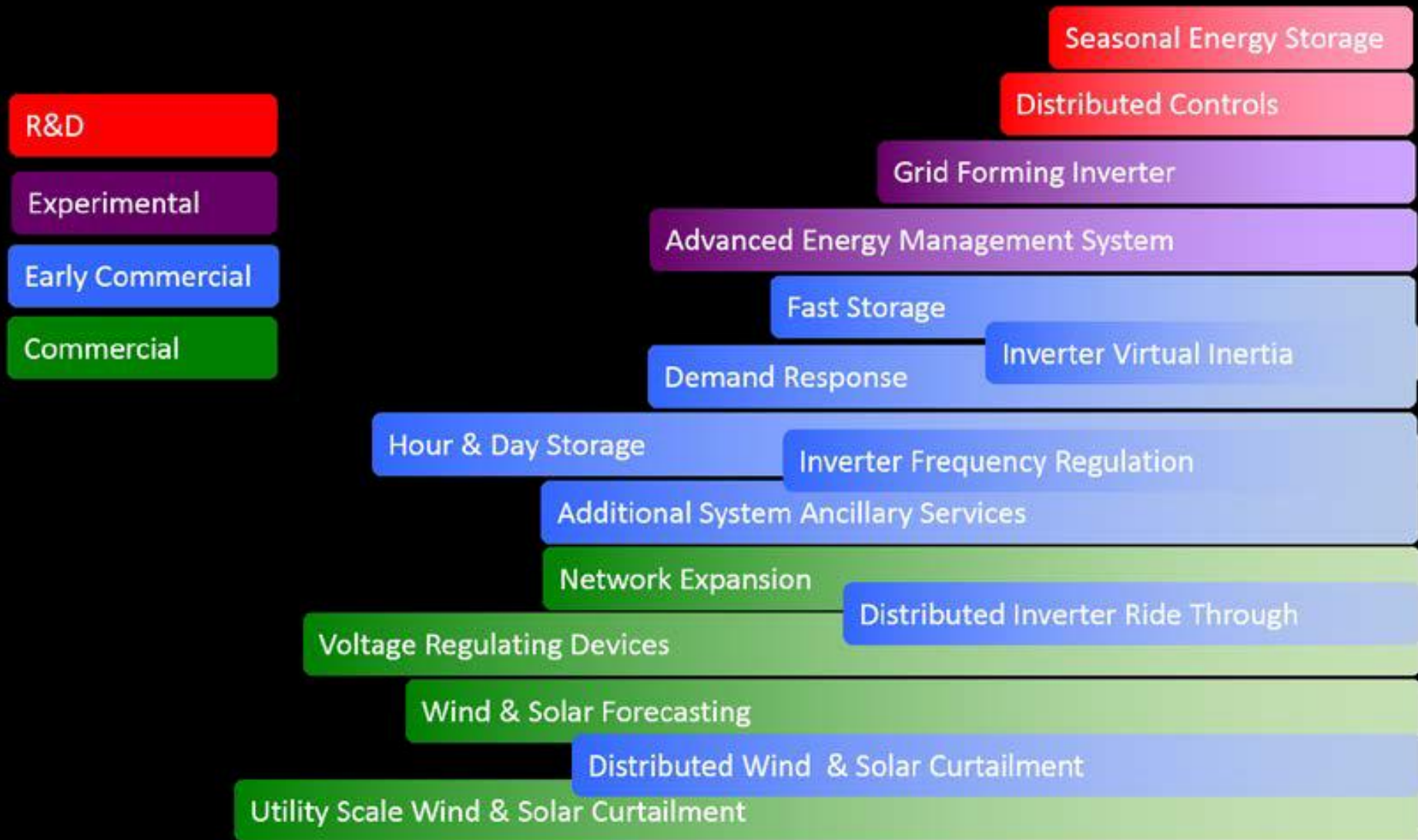
- Resource variability
 - Seasonal variation → annual energy production
 - Capacity factor → overbuilding
 - Managing real-time variability
 - » Over frequency curtailment (Tokelau)
 - » Under frequency load shedding (Maui)
 - » Energy storage
- Heat load following vs electrical load following
 - Diesel cogeneration; biomass; geothermal
- Underdeveloped hydro; small pumped storage (El-Hierro)

Variable Renewable Resource Data



- Underdeveloped hydro; small pumped storage (El-Hierro)

Renewable Integration Mitigation Measures



Technical Challenges and Solutions

- Grid forming inverters
 - Energy storage
- Wind generators: controls for synthetic inertia
- Black start
 - Close-couple energy storage with diesel plant
- Protection schemes
 - Short circuit studies
 - Fault clearing (El-Hierro)
- Autonomous Energy Grids
 - Self-Reconfiguring Power Systems



Thank You!

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Brian.Miller@NREL.gov

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