Unalakleet Microgrid Optimization

US Department of Energy
Office of Indian Energy
Annual Program Review
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Unalakleet Native Corporation
"Where Southerly East Wind Blows"

UNALAKLEET VALLEY ELECTRIC COOPERATIVE EST. 1961

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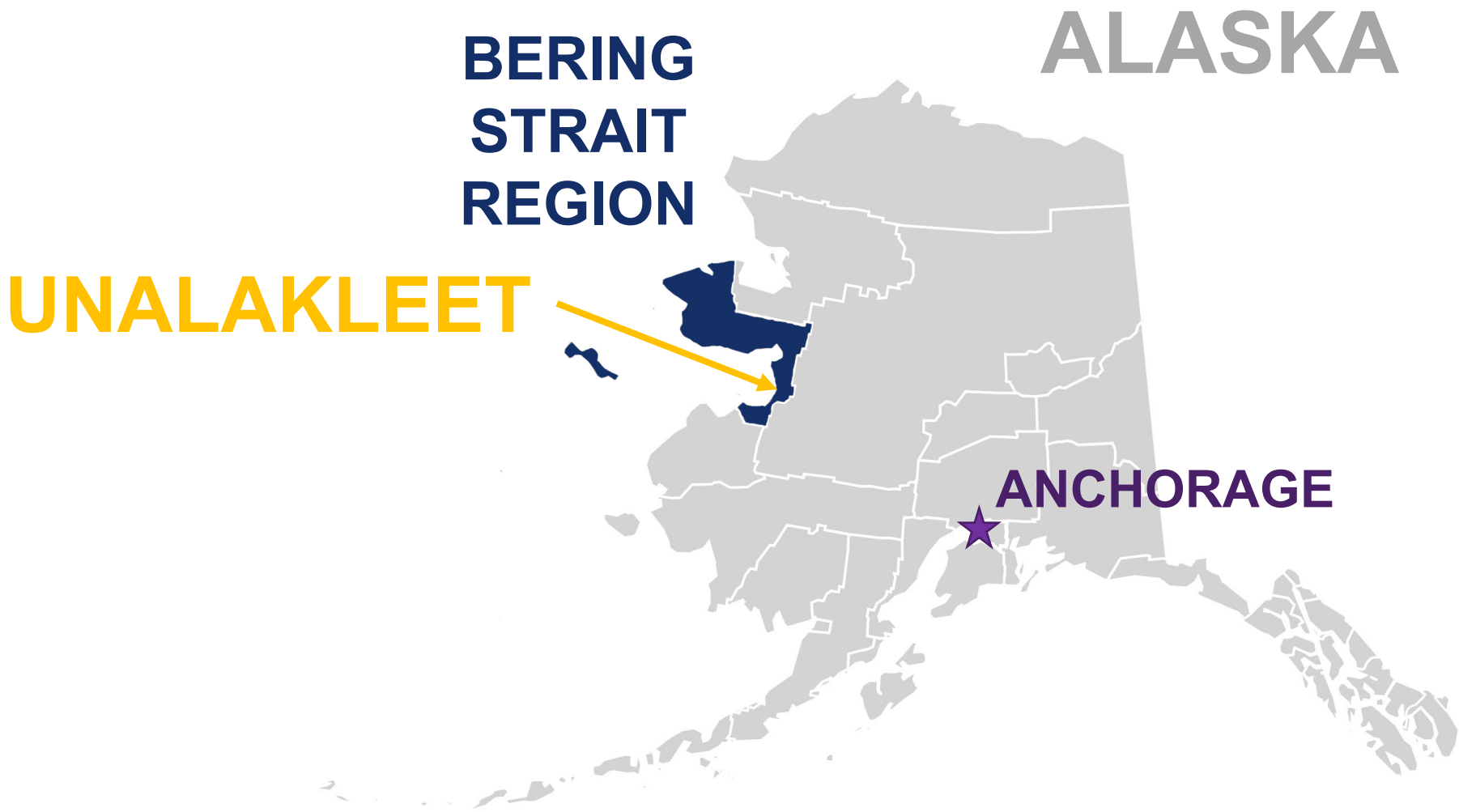
Unalakleet Location



Unalakleet Demographics

- 745 Residents
- 78% Alaska Native
  - Inupiat
  - Yupik
- 400 miles from road system
- 150 miles southeast of Nome

Project Partners

- Unalakleet Native Corporation
  - Primary Applicant
- Unalakleet Valley Electric Cooperative
  - Electric Service Provider

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Premise of Project

- UNC & UVEC goal to reduce diesel fuel consumption
  - 2009 - Install 100 kW wind turbines (x6)
  - 2010 - Install 300 kW electric boiler and recovered heat system
- Predicted Benefits
  - Displaced diesel fuel: 113,000 gal/year
  - Turbine production: 1,500,000 kWh/year
- Actual Benefits
  - Displaced diesel fuel: 50,000 – 70,000 gal/year
  - Turbine production: 750,000 – 1,000,000 kWh/year

Barriers – Power Line Capacity & Reactive Power

- Reactive power
  - Reactive power consumption: 20 – 40 kVAr/turbine
  - Power factor: as low as 0.5 with high wind turbine production
  - Must run second genset to meet reactive power demand
  - Transmission line capacity constraints led to a demand for reactive power at the wind farm
- High voltage at wind farm
  - At peak output, voltage drop of 25%
- Line loss
  - At peak output, line loss >28%
- Wind curtailment

Barriers – SCADA, Genset Control & Trending

- System control
  - Woodward GCP genset controllers have limited control capabilities
  - PLC CPU and PLC software have limited control capabilities
- Data collection & historical data trending
  - Cannot evaluate alarms and power data when outage occurs
  - Multiple SCADA screens required to view power data for all equipment

Project Goals & Challenges

Objective

- Optimize integration and performance of existing equipment
- Achieve single genset operation
- Pave the way for the incorporation of additional renewables and energy storage

Project Summary – Current Status

Tasks

- ✓Upgrade SCADA system and historical data trending
- ✓Replace genset controllers
- ✓Modernize demand control logic for all assets
- ✓Replace 4,160 V power line with 12,470 V between power plant and wind turbines
- Replace and upsize transformers

Outcomes

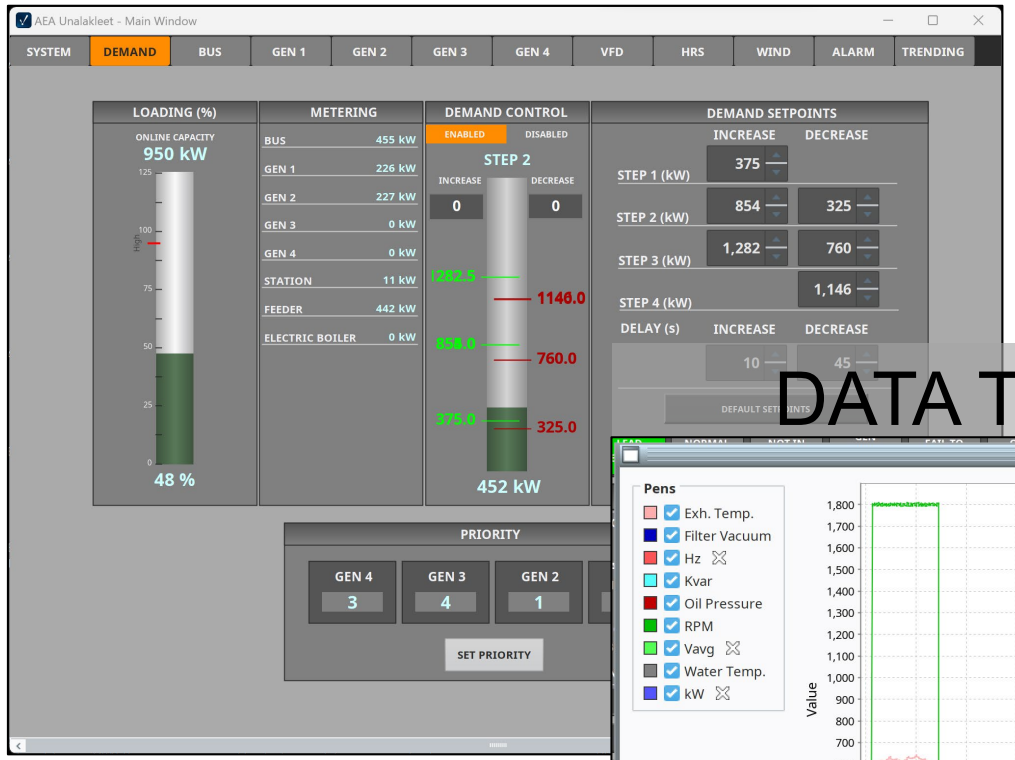
- ✓Enhance ability to operate and analyze power system data
- ✓Optimize control of gensets, wind turbines and electric boiler secondary load
- ✓Reduce reactive power consumption by wind turbines
- ✓Operate single genset or in diesels-off (with future storage) during high wind events
- ✓Reduce line capacity constraints
- ✓Reduce line loss and voltage drop

SCADA Upgrades – Complete

- Genset controllers to Woodward 3200XT (x4)
- PLC CPU & Programming
- SCADA to Ignition 8.1
  - Trending & alarm historian
- Panel-mount PC on switchgear
- Power meters to Shark 250s

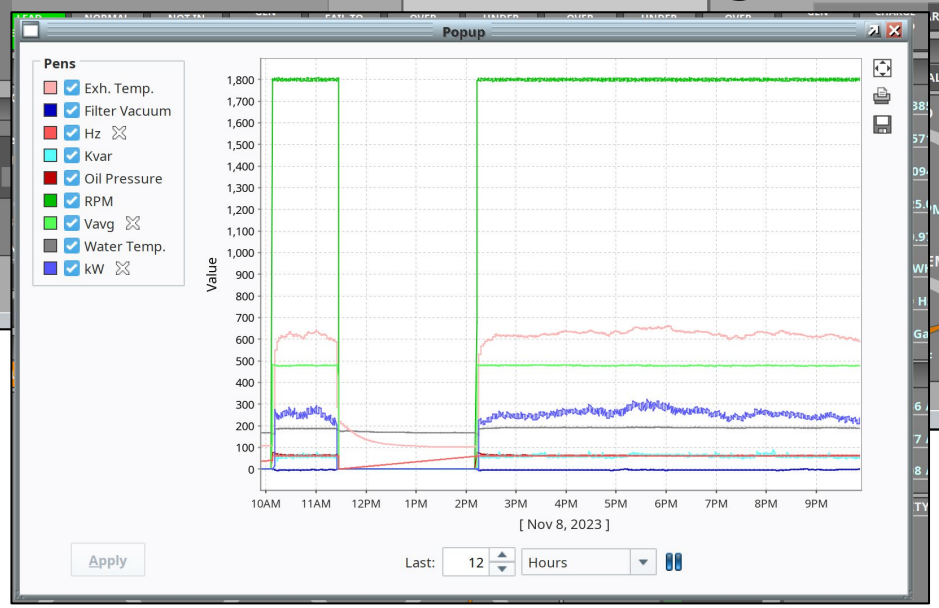
SCADA – Ignition 8.1

DEMAND CONRTOL



POWER DATA

DATA TRENDING



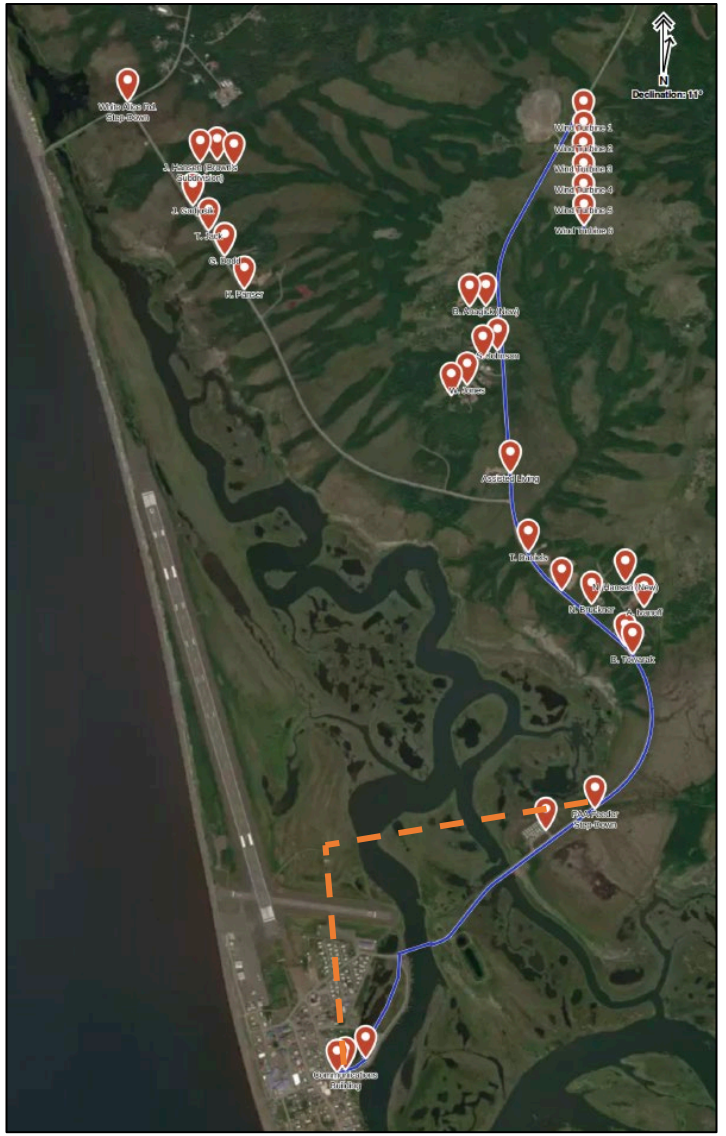
Wind Turbine Controls Upgrade – Complete

Northwind Reactive Power Settings

- Historically: Line voltage compensation mode
  - Increased voltage at turbines, turbines consume VArs
  - Decreased voltage at turbines, turbines generate VArs
  - Due to line voltage restriction, high voltage at turbines, turbines consume VArs
- Now: Power factor mode
  - Turbine generates or consumes VArs to achieve PF of unity
  - PF at power plant changed from ~0.5 to ~0.9 with no other system changes
- Future: Data Trending
  - Compare power system data, wind turbine production, and genset operation before and after high voltage line upgrade

High Voltage Line Upgrades – Nearly Complete

Distribution Resiliency Upgrades – Nearly Complete



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Questions?

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