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"

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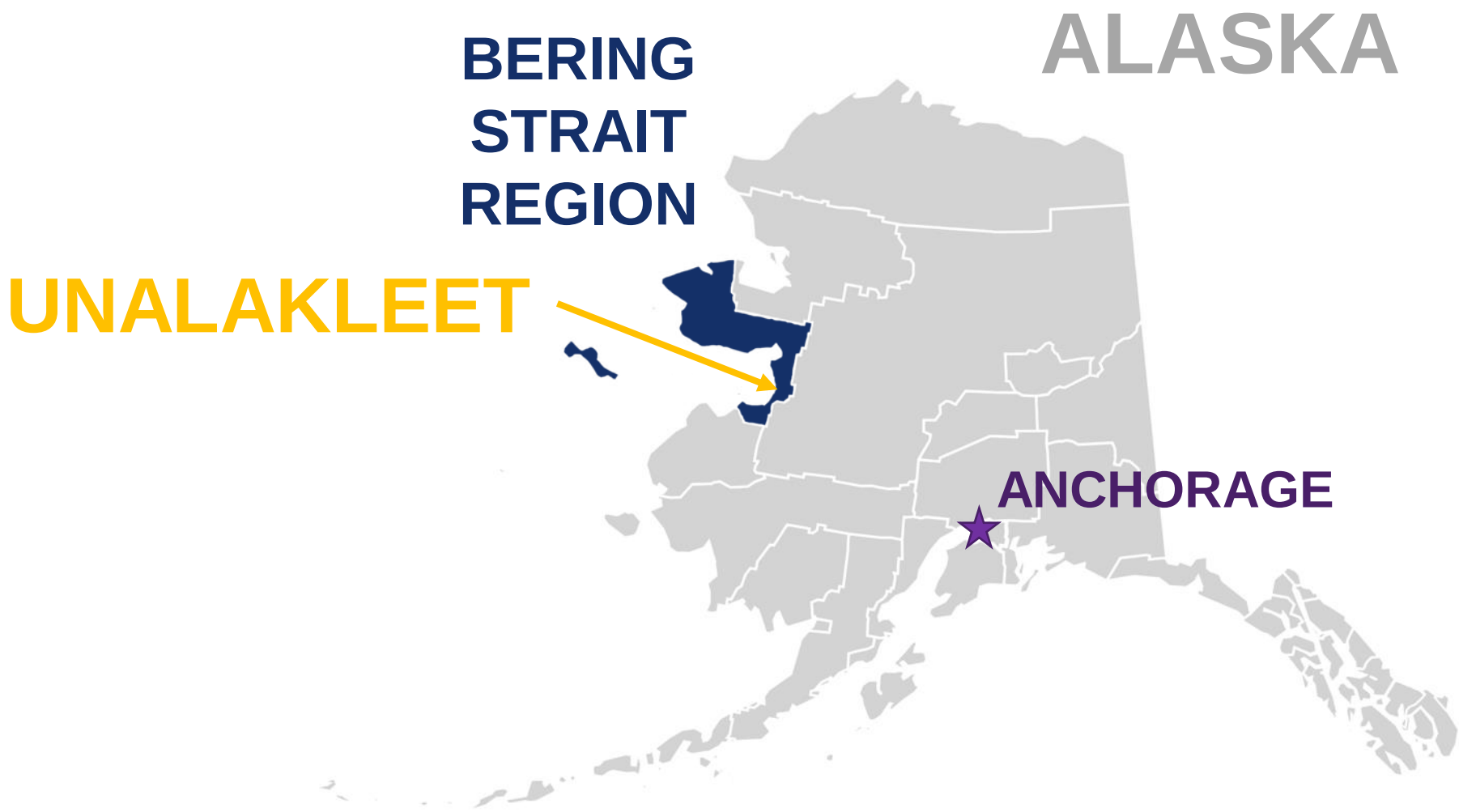
Unalakleet Location



Unalakleet Demographics

- 745 Residents
- 78% AK Native
- 400 miles from road system
- 150 miles southeast of Nome

Project Partners

- Unalakleet Native Corporation:
  Land Owner and
  Primary Applicant
- Unalakleet Valley Electric Cooperative:
  Electric Service Provider

Premise of Project

- UNC & UVEC goal to reduce diesel fuel consumption
  - Install 100 kW wind turbines (x6) in 2009
  - Install 300 kW electric boiler in 2010
- 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

Project Goals & Challenges

Objective

Optimize integration and performance of existing equipment in order to achieve single genset operation and pave the way for the incorporation of additional renewables and energy storage.

Known Barriers

- Wind curtailment
- Reactive power
- High voltage at wind farm
- Electric boiler control
- Data collection/access

UVEC Power System

- Electric Loads: 400 – 1,000 kW
- Four CAT 3456 475 kW gensets
- Six 100 kW Northern Power Systems wind turbines
- 300 kW electric boiler secondary load
- Recovered heat system


GENSET


RECOVERED HEAT
HEAT EXCHANGER


ELECTRIC BOILER


WIND TURBINE

Barriers – Power Line Capacity & Reactive Power

- Existing wind turbine line voltage 4,160 V
- At peak output, voltage drop of 25%
- At peak output, line loss >28%
- Transmission line capacity constraints have led to a demand for reactive power at the wind farm.
- 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

Barriers – SCADA, Genset Control & Trending

- SCADA system does not have data trending
  - Cannot evaluate alarms and power data when outage occurs
- Multiple SCADA screens required to view power data for all equipment
- Woodward GCP genset controllers have limited control capabilities
- PLC CPU and PLC software have limited control capabilities

Project Summary – Current Status

Tasks

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

Outcomes

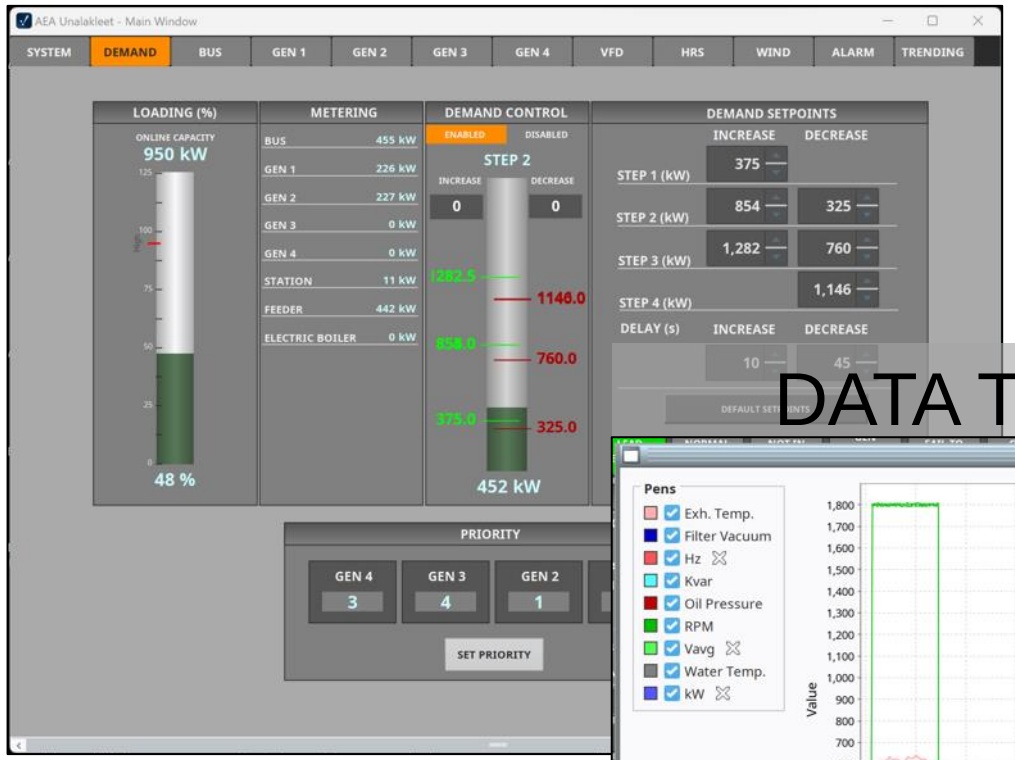
- ✓Enhance ability to operate and analyze power system data
- ✓Optimize control of gensets, wind turbines and electric boiler secondary load
- ✓Reduce reactive power consumption by wind turbines
- ✓Operate single genset or in diesels-off (with future storage) during high wind events
- Reduce line capacity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

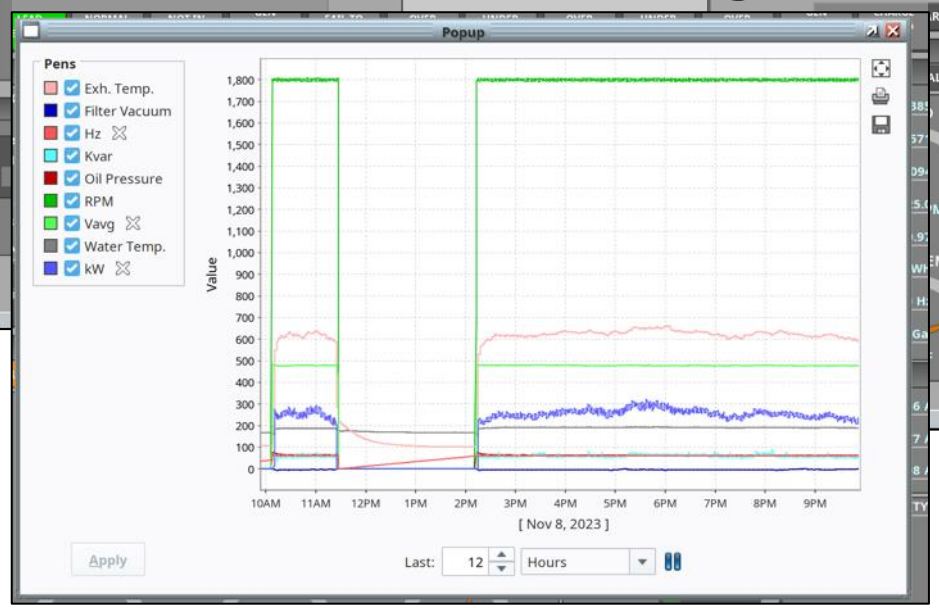
SCADA – Ignition 8.1

DEMAND CONRTOL



POWER DATA

DATA TRENDING



Wind Turbine Controls Upgrade – In Progress

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 genset operation, etc. before and after high voltage line upgrade

High Voltage Line Upgrades – In Progress

- ✓Long lead time materials ordered
  - ✓Power poles on-site
  - Transformers ETA Feb. 2024
- Permitting for bridge work
  - ✓DOT permit in place
  - Joint use agreement required to install water piping and power lines
- Overhead power line
  - Scheduled Jan. 2024

- Barge materials to Unalakleet
  - Spring barge after sea ice clears
- Underground power line & transformers
  - Scheduled Jul. 2024
- Completion & Inspection
  - Scheduled Aug. 2024

Questions?

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