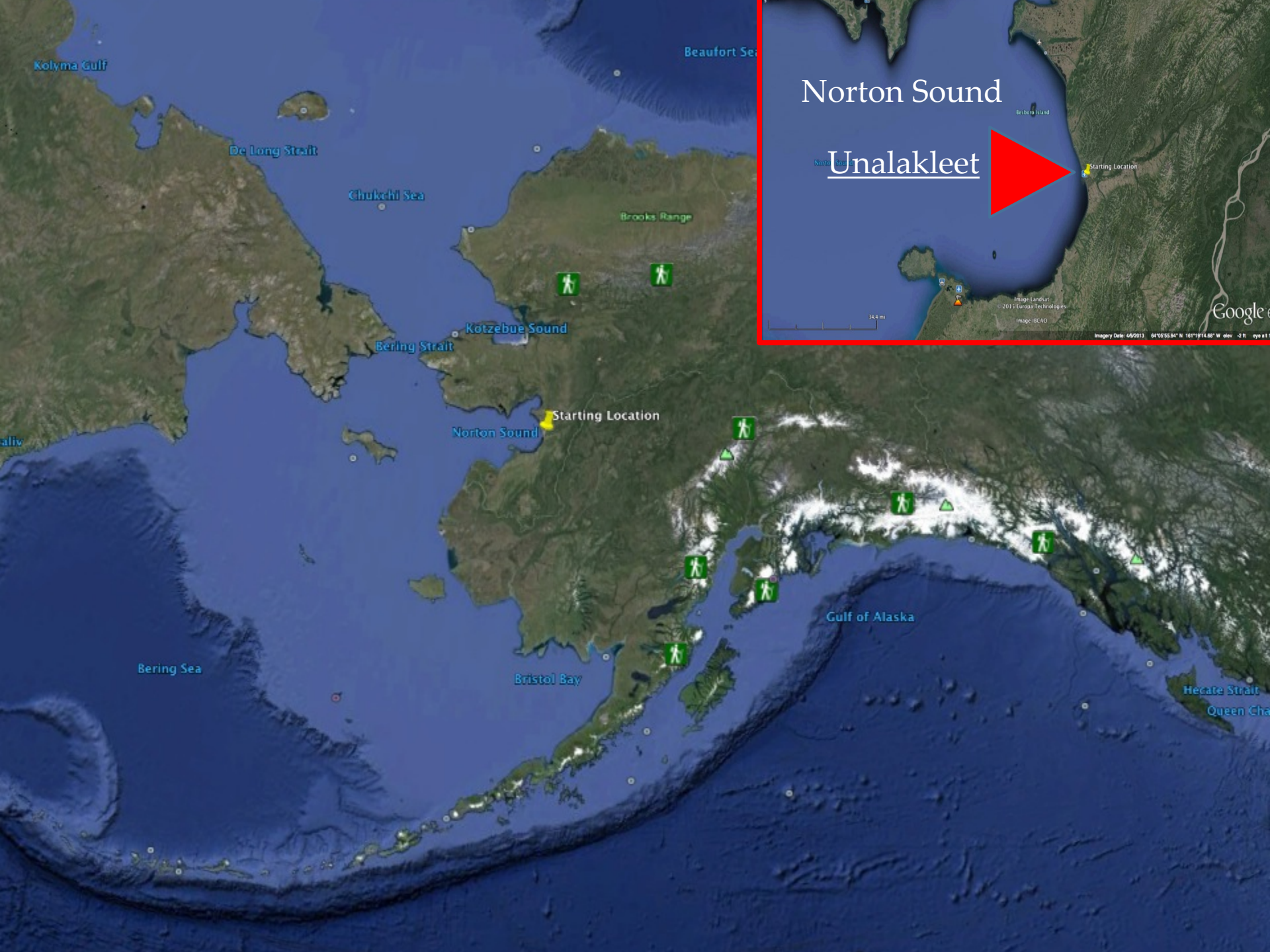
# Unalakleet Microgrid Optimization


Unalakleet Native Corporation

"Where Southerly East Wind Blows"

US Department of Energy –
Office of Indian Energy
Program Review
Denver, Colorado
November 2019

UNALAKLEET VALLEY ELECTRIC COOPERATIVE
EST. 1961


Norton Sound
Unalakleet
Starting Location
Kolyma Gulf
De Long Strait
Chukchi Sea
Brooks Range
Kotzebue Sound
Bering Strait
Starting Location
Norton Sound
Gulf of Alaska
Bering Sea
Bristol Bay
Hecate Strait

# Unalakleet Demographics


- 745 Residents
- 78% AK Native
- 400 miles from road system
- 150 miles southeast of Nome
- Unalakleet Native Corporation:  Land Owner
- Unalakleet Valley Electric Cooperative: Service Provider

Unalakleet Native Corporation

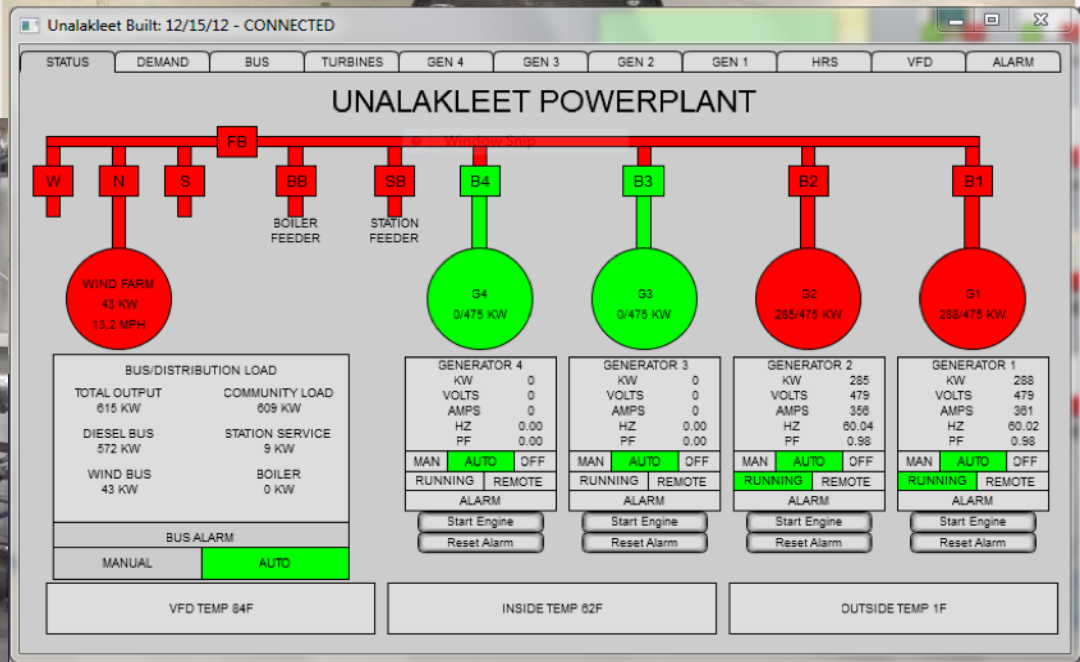
"Where Southerly East Wind Blows"

Unalakleet Native Corporation (UNC) operates a fuel station, grocery store, Deli restaurant, repair garage, and heating oil delivery business in Unalakleet, Alaska

The Company leases land, residential and commercial buildings in Unalakleet, and an office building in Anchorage. Most of UNC's operating activities are concentrated in Western Alaska.

# UVEC's System

- Electric loads: 400 – 1000 kW
- Four Cat 3456 475 kW gensets.
- Six 100 kW Northern Power Systems wind turbines.
- Recovered heat system.
- 300 kW Electric boiler – secondary load.



NorthWind 100 Turbines
* 2009-Construction
* 2010-SLC, 300 kW electric boiler, connected to Diesel Heat Recovery System: City Loop, School Loop, Baler Loop
* Rated 600 kW

- Predicted annual production: 1,500,000 kWh/year
- Actuals range from 750,0000 to 1,000,000 kWh
- Predicted annual fuel savings: 113,000 gal/year
- Actuals range from 50,0000 to 70,000 gals

# What is the impact of wind energy on our rates?

- UVEC would have imported 70,000 more gallons of fuel.
- Our system efficiency would drop without wind.
- The added fuel cost would add to our FUEL SURCHARGE
  - 2014 Fuel Surcharge $0.2172 (Total Res. Rate $0.50)
  - 2019 Fuel Surcharge $0.1699 (Total Res. Rate $0.45)
  - With out Wind our 2019 Surcharge would be $0.2188
    - That's 29% higher, or $0.0489 per kWh.

**Wind production is valuable; however, we can do better, much better!**

**Actual wind production is ~40% LESS than Predicted, AND**
**High winds require UVEC to turn on a second generator for grid stability.**

Invest in proven technology to get us to "one-diesel" or "diesels off" mode.

**DOE OIE to the rescue…**


UNALAKLEET VALLEY ELECTRIC COOPERATIVE EST. 1961

ALASKA NATIVE TRIBAL HEALTH CONSORTIUM
Rural Energy Initiative

ies INTELLIGENT ENERGY SYSTEMS

TDX power
a tanadgusix company

Deerstone Consulting

KAWERAK, INC.

## Objective

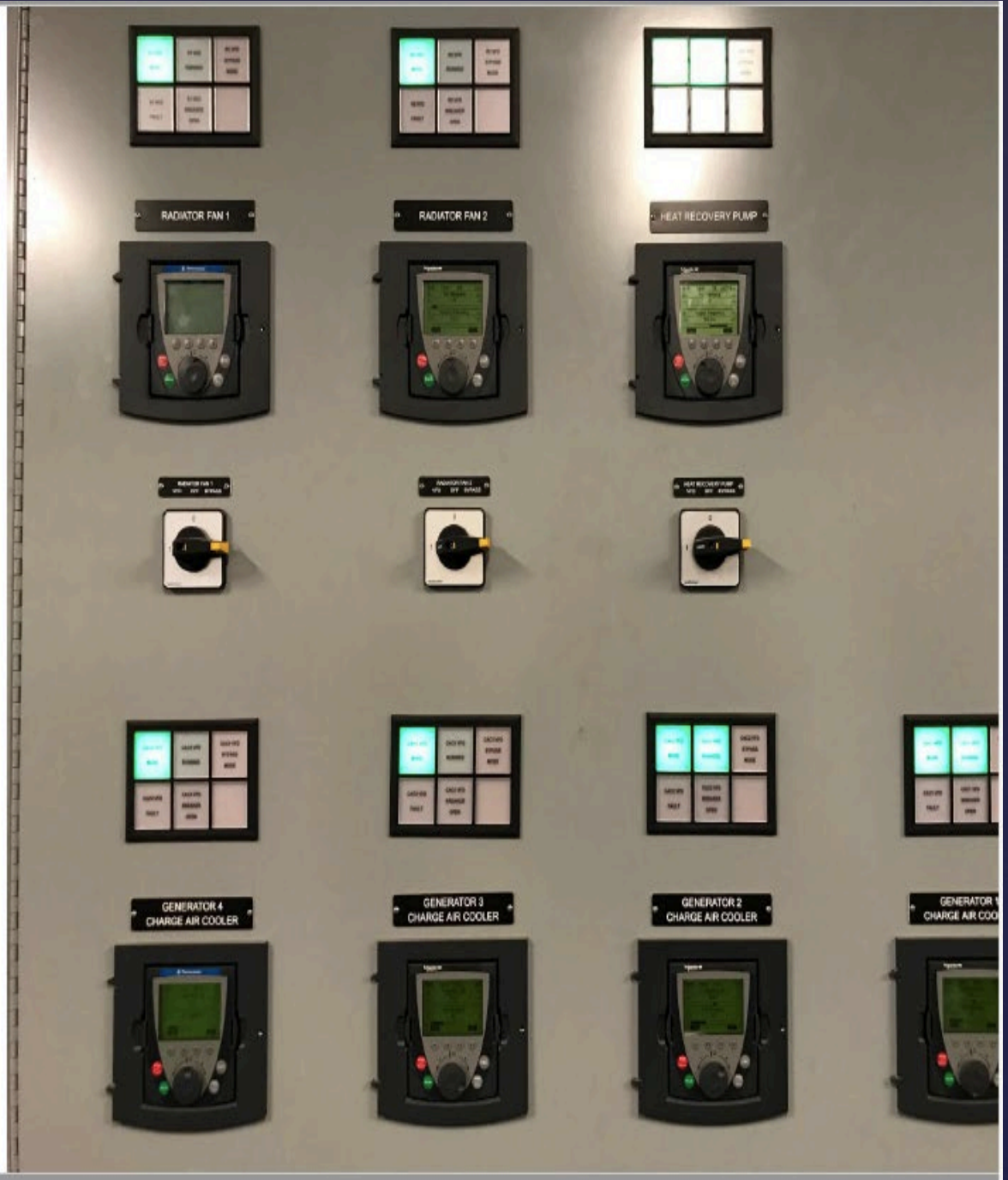
Optimize integration and performance of existing equipment in order to achieve single genset operation and pave the way for the incorporation of additional renewables and energy storage.

## Known Barriers and Concerns

- Electric boiler
- Wind curtailment
- Reactive power
- Data collection/access

# Assessment Focus Areas

- Power Line Capacity
- Capacitor Bank
- Secondary Load Controller/Electric Boiler
- SCADA – Data Collection and Analysis




# Budget & Project Outcomes

# Unalakleet Native Corporation

1847-1509

## UNALAKLEET MICROGRID OPTIMIZATION
## TRIBAL COMMUNITY RESILIENCE

### Budget

- Federal funds requested: $372,011
- Cost-share proposed: $372,011
- Total Project Costs: $744,022

### Project Outcomes

- Increase wind penetration by 63% (from 22.9% of total electric production up to 37.4%)
- Displace 43,933 gallons of diesel fuel each year equivalent to an annual savings of $131,799
- Decrease annual maintenance costs by an estimated $33,800
- Reduce annual emissions by 18 tons
- Stabilizes energy costs by further decoupling them from fluctuating fossil fuel prices.

*Maximizing power generated by local, renewable resources – one step closer to energy independence.*

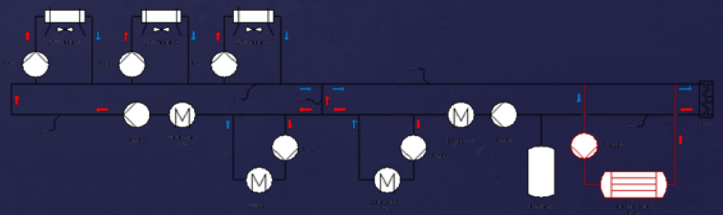
# Priorities

**1. <u>Upgrade power line & increase voltage</u>**, starting with transformer replacement, then conductor and structural improvements as long-term solution to mitigate reactive power issues.

Increase system voltage from 4160 V to 12,470 V
* Reduces voltage drop from 25% to 2%.
* Grid stability & Reactive load brought within reasonable parameters. Managed with BESS, capacitor bank, …

**<u>Re-plumb the electric boiler</u>**, moving it from the hot side of the secondary heating loop to the cold side to increase frequency regulation capacity and reduce wind production curtailment.

This is a related but non-grant funded initiative.



## Unalakleet Power line Upgrade

There are two important issues considered in the line voltage upgrade:

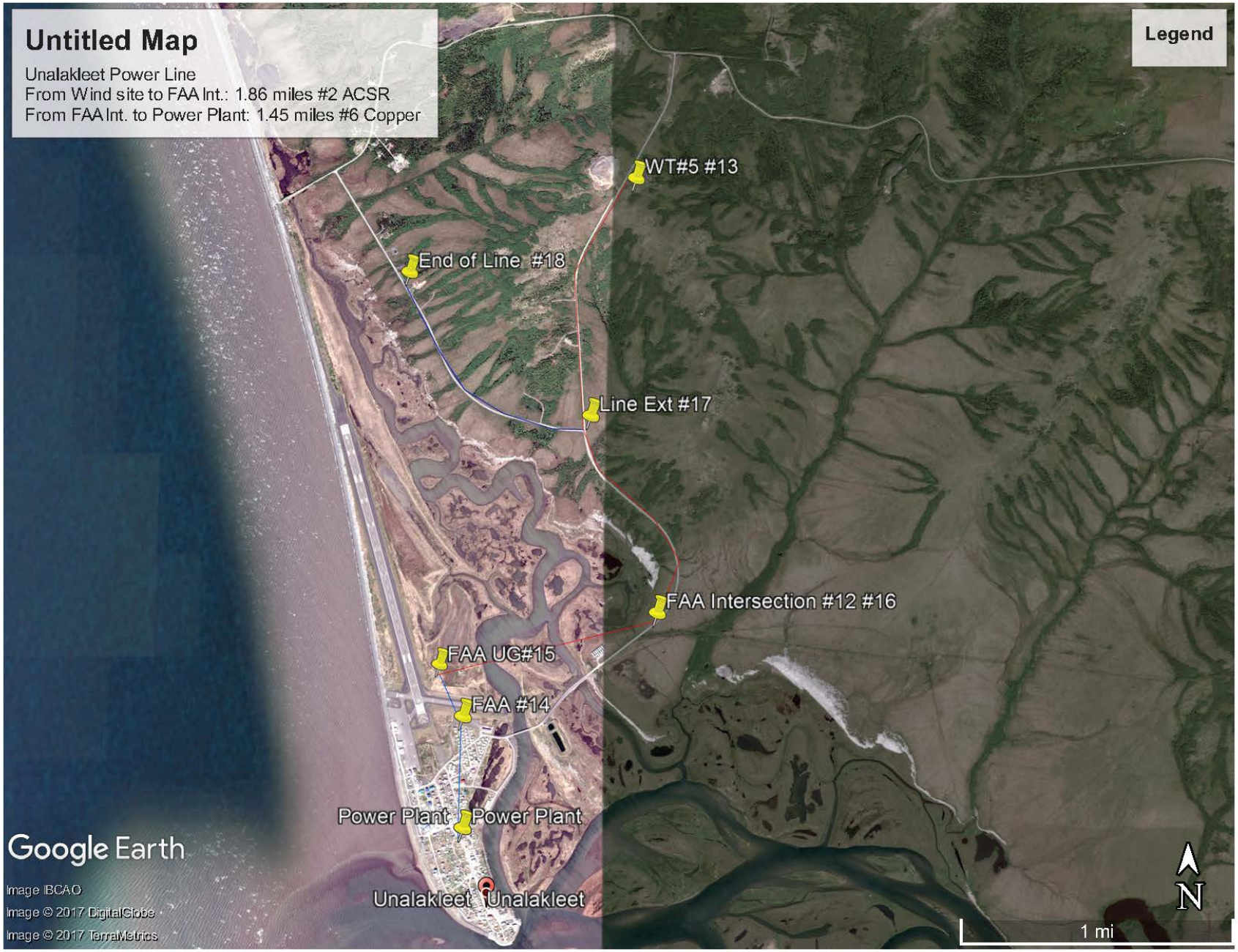
**1. Voltage Drop**

The existing line voltage of 4,160 volts is constraining the efficient operation of the wind turbine output when the six (6) wind turbines are at the maximum output of 600 kW. At peak output, the voltage drop from the wind turbines to town is nearly 25%.

So, when we upgrade the line line at 12,470 volts, at peak turbine output (of 600 kW), the voltage drop will be reduced to 2%.

**2. Line Losses**

Line losses are 28% for 4,160 volts during 500 kW of wind generation. When at 12,470 volts those line losses are only 3.73%.


Untitled Map
Unalakleet Power Line
From Wind site to FAA Int.: 1.86 miles #2 ACSR
From FAA Int. to Power Plant: 1.45 miles #6 Copper
Legend
WT#5 #13
End of Line #18
Line Ext #17
FAA Intersection #12 #16
FAA UG#15
FAA #14
Power Plant
Power Plant
Unalakleet
Unalakleet
Google Earth
Image IBCAO
Image © 2017 DigitalGlobe
Image © 2017 TerraMetrics
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# Priorities

**2. <u>Improve SCADA and related data management systems</u>.**

- New data server, extended memory.
- Re-establish data collection and visualization.
- Consolidate Wind & Diesel SCADAs.
- Update control and SCADA schematics.
- Collect data, use to conduct root cause analysis of outages.

A. Replace PLC
B. Replace generator controls
C. Expand functionality to incorporate BESSm increased renewables, electric thermal storage

## Progress

A preliminary survey has been done and the upgrade project looks economical since more than 60% of the line is already insulated for 12,470 volts and built with new poles. The rest of the line needs to be upgraded because of old poles and old conductor. Step-up transformers at the wind site, transformers serving some customers along the line, and step-down transformers in town need to be procured and installed.

## Expectations

With a 12,470 volts line upgrade , the plant generators will not have to deal with the existing voltage variations, they will only have to deal with the load reactive that can be easily achieved with a 500 kW BESS, a battery energy storage system, or using a 12,470 volt switched capacitors bank that can be relatively inexpensive. A BESS is highly recommended since it can lead to 100% diesels off for low load periods.

# Progress to-date & Future plans

1. **Notice to Proceed. UNC to UVEC (contractor)**
2. **Project manager selected**
3. **Engineer is collecting baseline data (Gen, T & D)**
4. **Inventory of existing infrastructure completed**
5. **Financing in early stage. UVEC to contribute cash & in-kind for cost-share.**
6. **Engineering & Procurement continuing into Q1 2020**
7. **Construction to begin Q2 & Q3 2020.**

Kanagyagat Road Powerline Construction completed in 2019. Related but non-grant funded grid resiliency initiative to build 1.5 miles of new line:

A. 3-phase, 15 kV standards
B. Eliminates dependence on waterfront feeder. Inland routing (away from coastal erosion)
C. Balancing loads for subdivisions & relocation of community

# Future Upgrades

Once priorities 1-4 plus reprogramming for improved diesel dispatch and energy efficiency are in place:

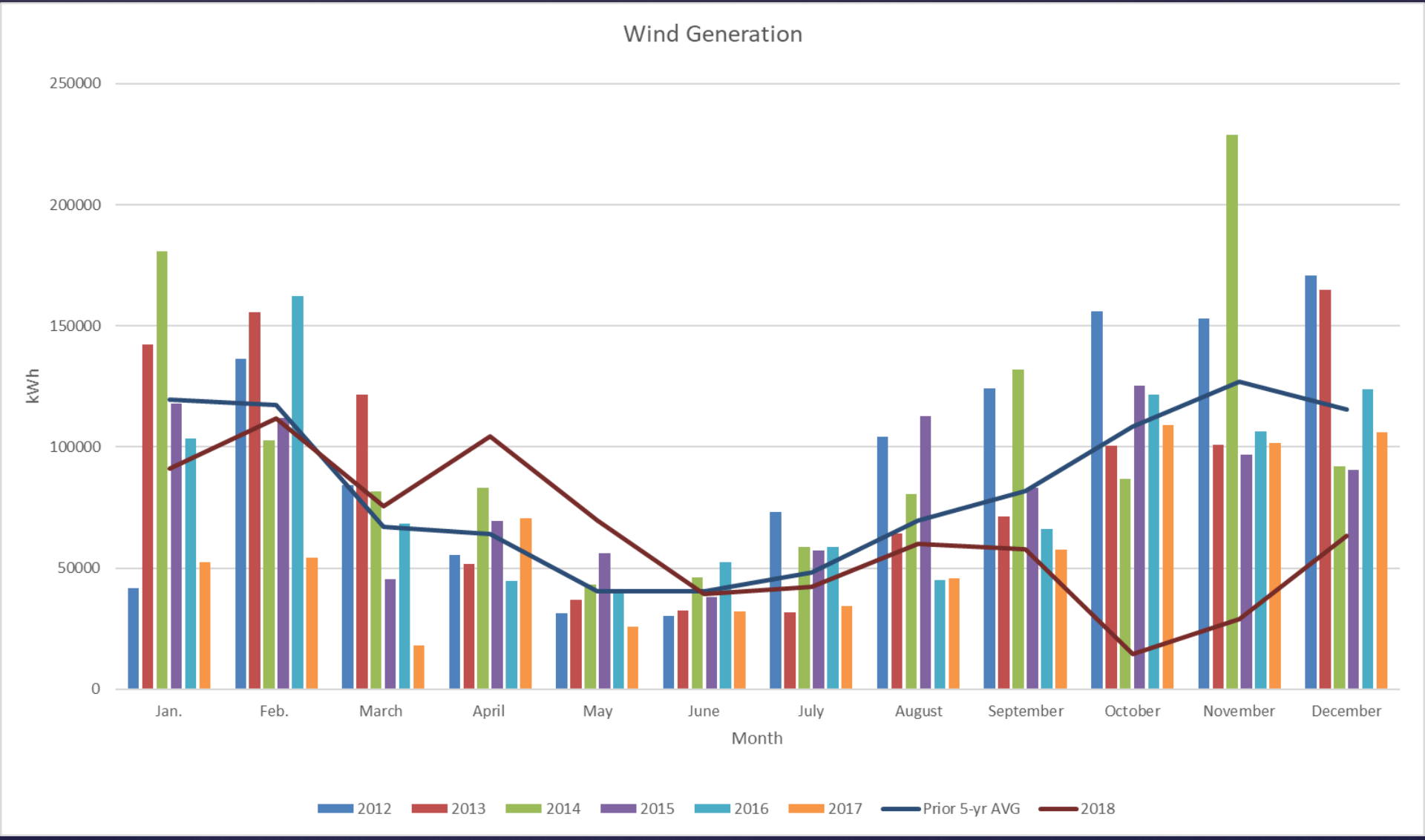
- Smaller sized and/or variable speed diesel generator to take advantage of times when this could supply whole village load.
- Incorporation of additional wind, solar and/or other renewables.
- Additional electric boilers and/or electric thermal storage to meet other heat loads.
- Incorporation of energy storage.
- Adoption of advancing technology such as electric vehicles and electric heat pumps

# Quyana – Thank You!  Questions?

Reese Huhta, General Manager
Unalakleet Valley Electric Cooperative
Email: uvec@gci.net  Phone: 907.624.3474

Michelle Harvey, Operations Manager
Unalakleet Native Corporation
Phone: 907.624.3411

# The End


Wind Generation
250000
200000
150000
100000
50000
0
kWh
Jan.
Feb.
March
April
May
June
July
August
September
October
November
December
Month
2012
2013
2014
2015
2016
2017
Prior 5-yr AVG
2018

# Power Line Capacity


Transmission line capacity constraints have led to a demand for reactive power at the wind farm. Higher turbine production often requires a second genset come online.

## Findings

At a typical level of wind production (300 kW),

- Paladin analysis indicates transmission line loss > 12%.
- Voltage drop at plant > 10%.
- Power loss over time = annual power output of an entire 100 kW turbine.

Under high wind conditions:

1. Voltage control—Critical to have dump load.
2. PF—set at 0.85 at WTG to stabilize grid voltage,
   but requires 2 diesels to provide VAR support.

UVEC MANUALLY CURTAILS TURBINES TO AVOID OVERTEMPERATURE/OVERFREQUENCY EVENTS

UVEC MISSES OUT ON WIND ENERGY!
Yet, grid reliability is preserved.

SCADA equipment has aged and the link between the operator workstation and the plant data server has failed.

## Findings

- Need to re-establish data collection and visualization.
- Need for clear sequence of how to extract data.