Unalakleet Microgrid Optimization

Unalakleet Native Corporation

"Where Southerly East Wind Blows"

US Department of Energy –
Office of Indian Energy
Annual Program Review
Denver, CO
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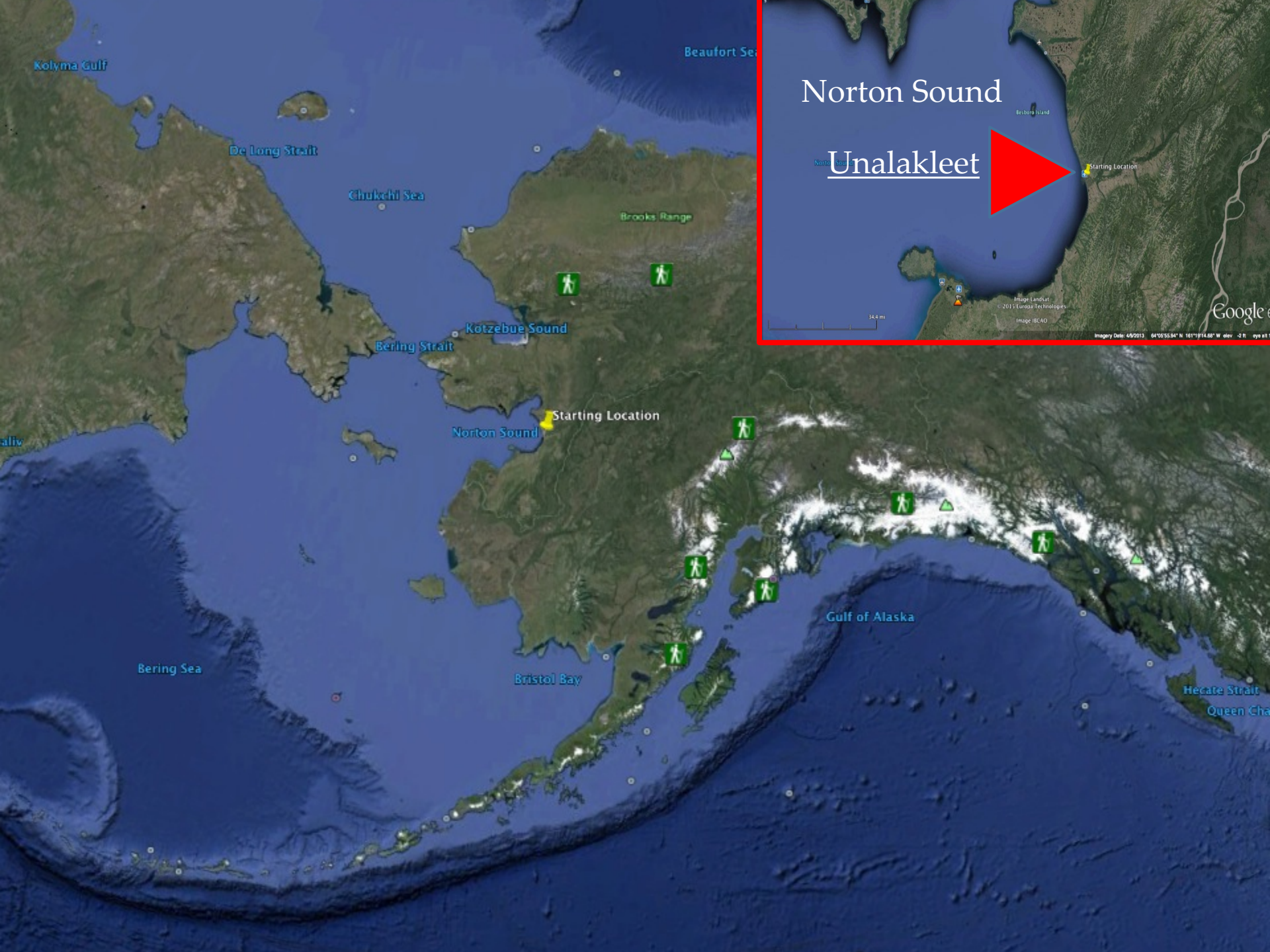
UNALAKLEET VALLEY ELECTRIC COOPERATIVE
EST. 1961


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

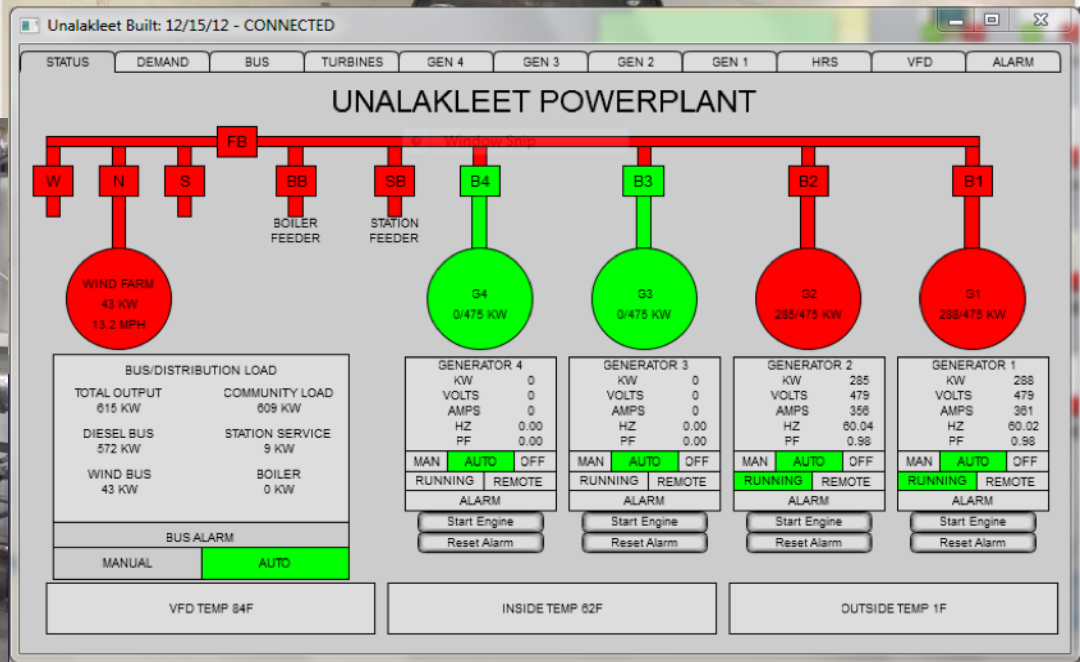
"Where Southerly East Wind Blows"

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
* Rated 600 kW
* Predicted annual production: 1,500,000 kWh/year
* Predicted annual fuel savings: 113,000 gal/year
* 2009-Construction
* 2010-SLC, 300 kW electric boiler, connected to Diesel Heat Recovery System: City Loop, School Loop, Baler Loop

	Diesel Generated (kWh)	Wind Generated (kWh)	Total Generated (kWh)	Sold or Consumed (kWh)	Fuel Cost ($/gallon)	Fuel Used (gallons)	Total Fuel Cost	Fuel Cost/kWh ($/kWh)	Residential Rate ($/kWh)
2017	3,627,128	708,028	4,341,703			237,769			
2016	3,483,268	992,979	4,516,645	4,241,686	$ 3.36	229,417	$ 770,841	$ 0.18	$ 0.42
2015	3,507,813	1,004,549	4,534,529	4,233,817	$ 3.78	237,209	$ 896,650	$ 0.21	$ 0.47
2014	3,430,435	1,216,441	4,409,211	4,217,000	$ 3.72	236,067	$ 878,169	$ 0.21	$ 0.42
2013	3,306,720	1,074,315	4,480,246	4,209,498	$ 3.67	226,047	$ 829,592	$ 0.20	$ 0.42
2012	3,631,262	1,160,819	4,474,519	4,173,309	$ 3.37	240,562	$ 810,694	$ 0.19	$ 0.41
Average	3,497,771	1,026,189	4,459,476	4,215,062	$ 3.58	234,512	$ 837,189	$ 0.20	$ 0.43

Under high wind conditions:

1. Voltage rises—Critical to have dump load.
   When Boiler goes offline, we have outages.
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.

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**
- **The added fuel cost would add to our FUEL SURCHARGE**
  - **2014 Fuel Surcharge $0.2172**
  - **2015 Fuel Surcharge $0.1693**
  - **With out Wind our Surcharge would be $0.2795**
    - **That's 65% higher, or $0.1102 per kWh.**

HOWEVER –

Actual wind production is ~40% LESS than Predicted

AND

High winds require UVEC to turn on a second generator for grid stability

Diesel prices. 75% of our generation is from Diesel. Invest in technology to get us to "one-diesel" or "diesels off" mode.

DOE TA to the rescue…

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

UNALAKLEET VALLEY ELECTRIC COOPERATIVE EST. 1961

ALASKA NATIVE TRIBAL HEALTH CONSORTIUM
Rural Energy Initiative

ies INTELLIGENT ENERGY SYSTEMS

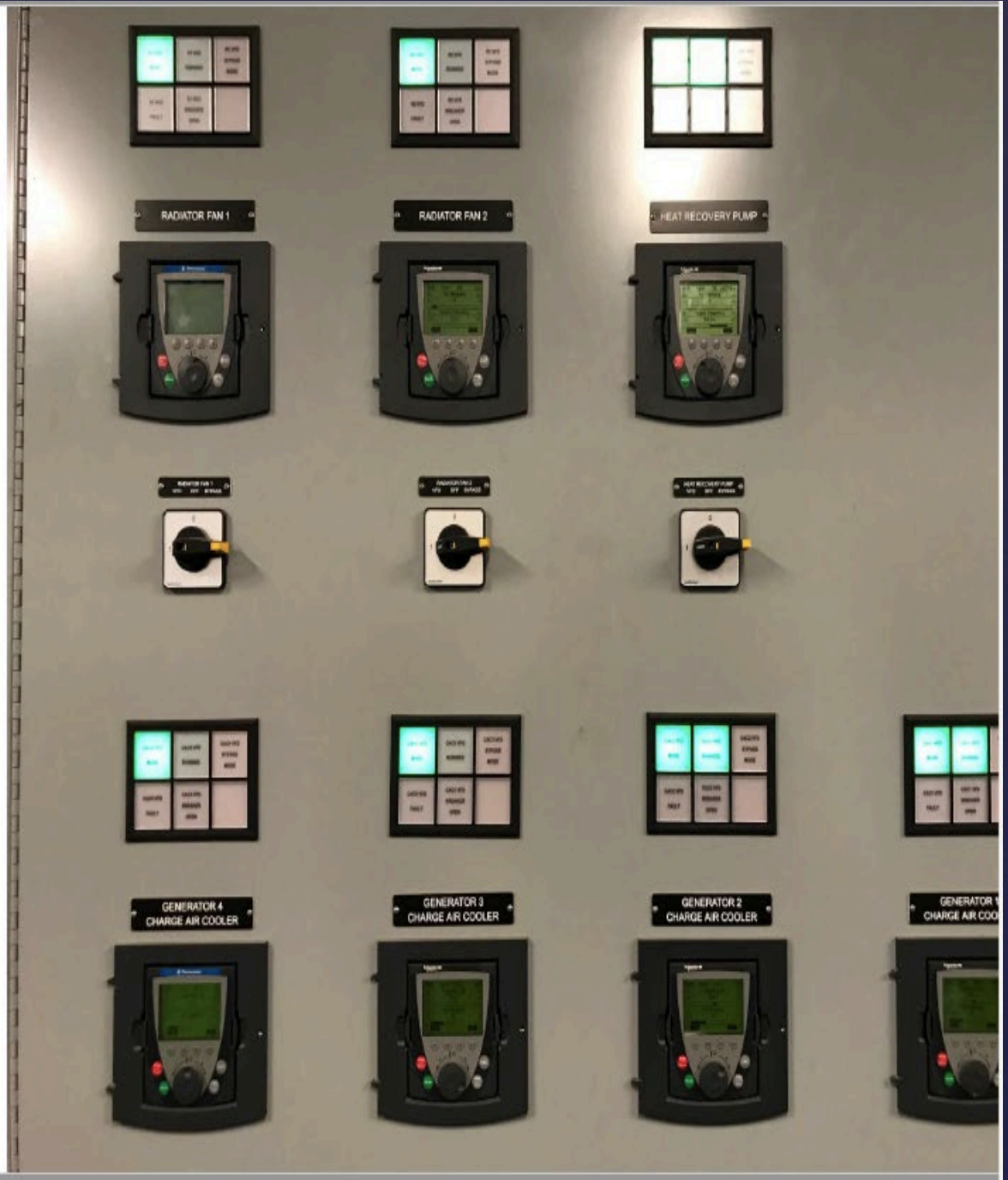
TDX power
a tanadgusix company

Deerstone Consulting

KAWERAK, INC.

Assessment Focus Areas

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



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.

A 300 kVAr power factor correction cabinet in the power plant has been out of operation for years.

Findings

- 9 out of 10 capacitors have failed.
- Per manufacturer:
  - Likely incurred thermal damage.
  - Recommend fitting with filters (inductors) when used with diesel gensets.

Capacitor Bank

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

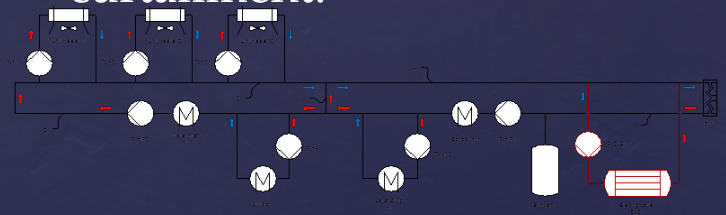
Findings

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

Prioritized Recommendations

Recognizing interrelatedness of issues, based upon least cost and highest immediate impact:

1. **<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.



Estimated Cost: $8,500

2. **<u>Improve SCADA and related data management systems</u>**.
   - New data server, extended memory.
   - Re-establish data collection and visualization.
   - Update control and SCADA schematics.
   - Collect data, use to conduct root cause analysis of outages.

Estimated Cost: $100,000-$200,000

Prioritized Recommendations

Recognizing interrelatedness of issues, based upon least cost and highest immediate impact:

3. Pending additional data collection to confirm harmonics and power quality issues, **install a new filtered capacitor bank**, to meet current reactive power needs.

Estimates Cost: $20,000 - $50,000

4. Pending full engineering study, **upgrade power line**, starting with transformer replacement, then conductor and structural improvements as long term solution to mitigate reactive power issues.

Estimate Cost: $350,000-$400,000

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.

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?

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