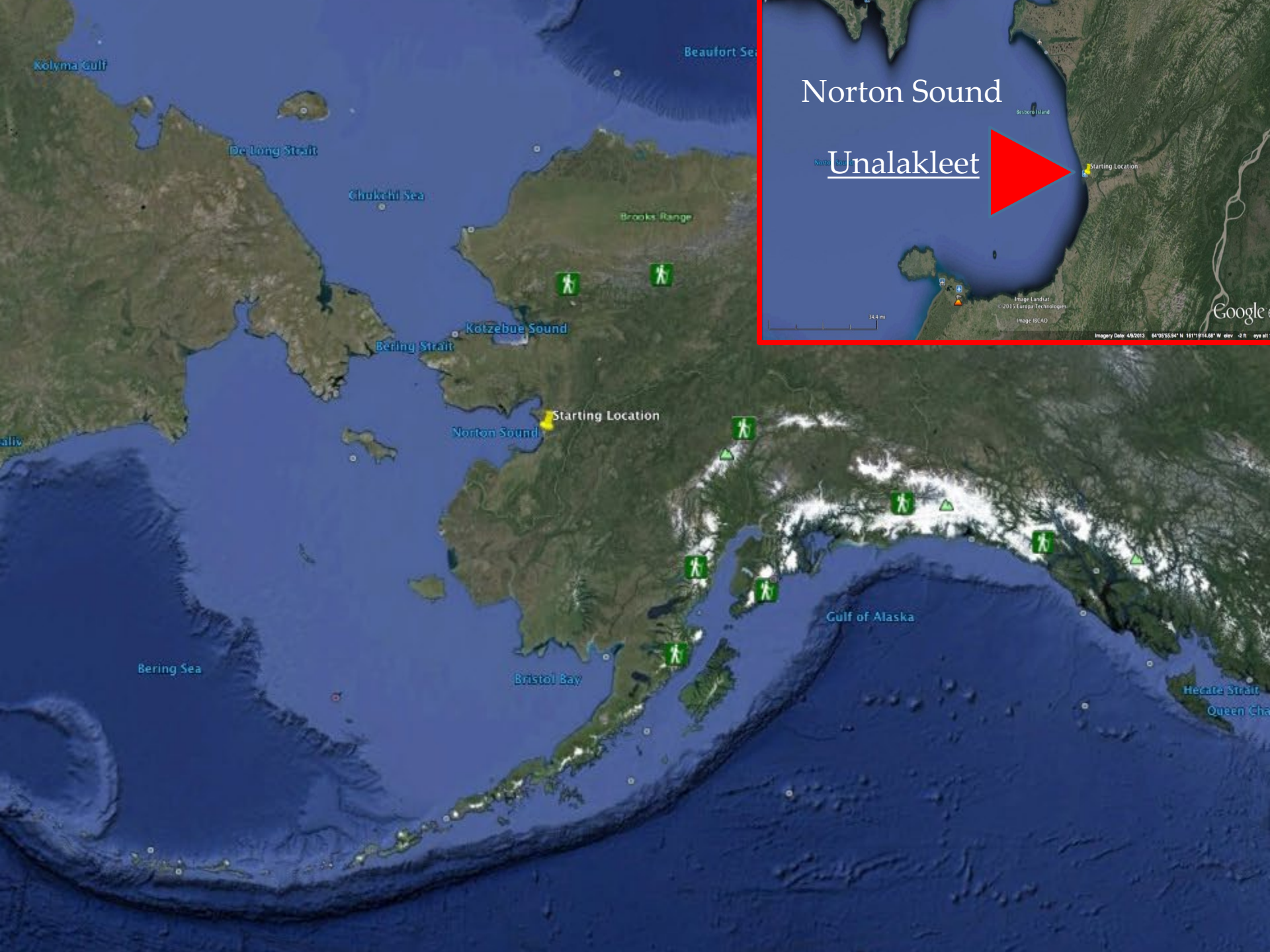


# Unalakleet Microgrid Optimization



US Department of Energy –  
Office of Indian Energy  
Program Review  
Virtual Presentation  
December 2020





Norton Sound

Unalakleet



34.4 mi

Google

Imagery Date: 4/9/2013 64°05'55.94" N 161°19'14.66" W elev -2 ft eye alt

# Unalakleet Demographics

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





## Unalakleet Native Corporation

"Where Southerly East Wind Blows"



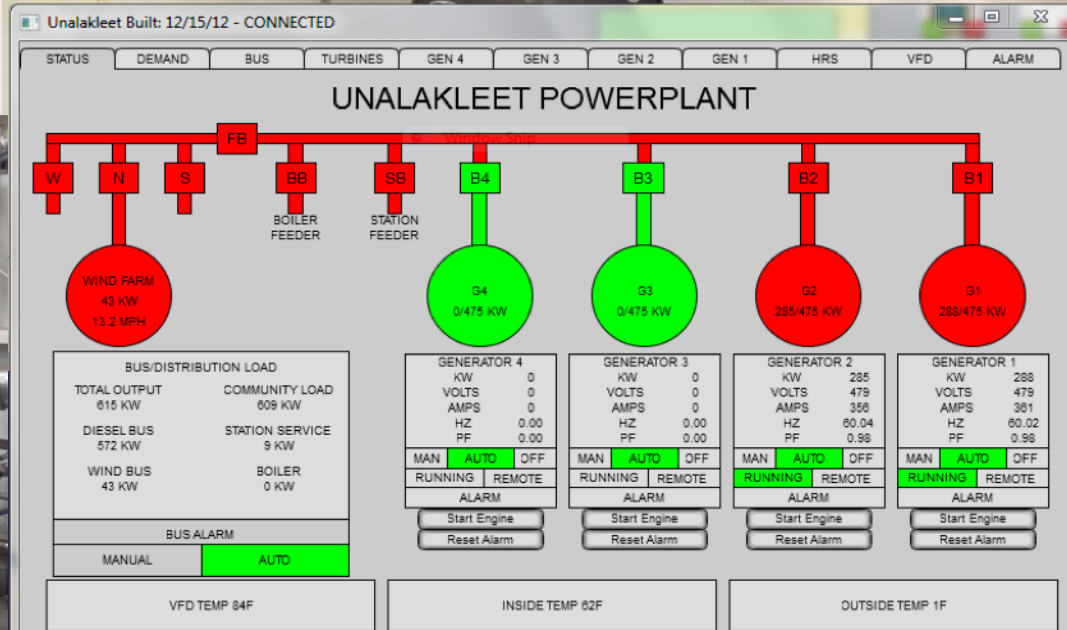
Unalakleet Native Corporation (UNC) operates a fuel station, grocery store, Deli restaurant, repair garage, and heating oil delivery business in Unalakleet, Alaska.

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.

Covid Impacts: Loss of food & fuel sales, tourism, increased costs, transportation difficulties

# 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 750,000 to 1,000,000 kWh

- Predicted annual fuel savings: 113,000 gal/year

- Actuals range from 50,000 to 70,000 gals - improved integration = more fuel savings



# 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.
  - Expected higher fuel prices in future – would have even more impact

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...

# Technical Assistance Request in Action Led to Grant Proposal & Award





# Unalakleet Native Corporation

## UNALAKLEET MICROGRID OPTIMIZATION TRIBAL COMMUNITY RESILIENCE

1847-1509

### 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.*

# Assessment Focus Areas

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

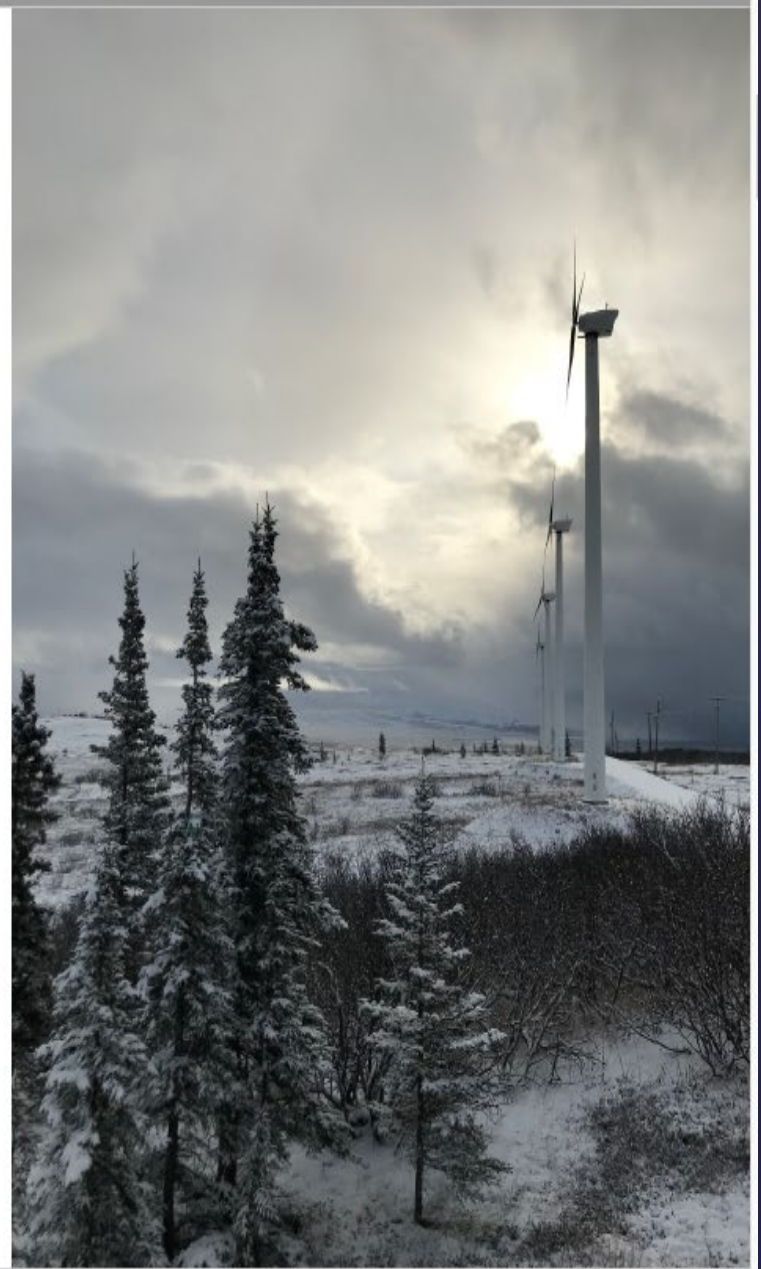


## Objective

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



# 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.

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

## Findings

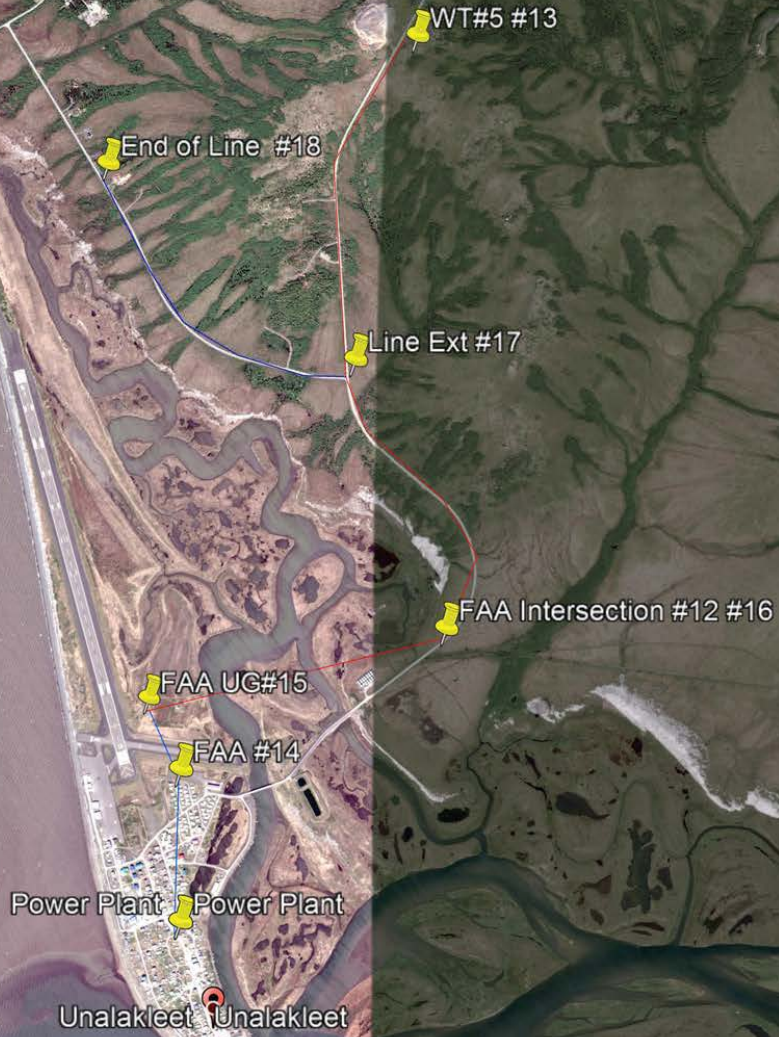
- Need to re-establish data collection and visualization.
- Need for clear sequence of how to extract data.



# 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



Google Earth

Image IBCAO  
Image © 2017 DigitalGlobe  
Image © 2017 TerraMetrics

1 mi

# 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 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%**.

**RESULT: POWER LINE UPGRADE WILL ALLOW FOR MORE WIND IN THE SYSTEM, REDUCE DIESEL GEN-SET RUN TIME, SAVE FUEL**

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



# Priorities

1. Upgrade power line & increase voltage, 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

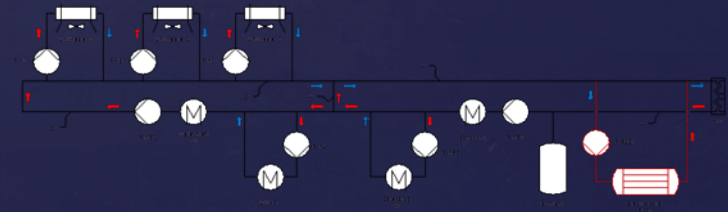
\* Reduces voltage drop from 25% to 2%.

- Grid stability & Reactive load brought within reasonable parameters. Managed with BESS, capacitor bank, ...
- Single gen-set operation



Re-plumb the electric boiler, 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.



# Priorities

## 2. Improve SCADA and related data management systems.

- 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 BESS, increased renewables, electric thermal storage → Post-DOE grant

# Progress to-date & Future plans

1. Notice to Proceed. UNC to UVEC (contractor)
2. Project manager selected
3. Engineer was collecting baseline data (Gen & Dist)
4. Inventory of existing infrastrure completed
5. Financing mostly secured.
6. Engineering STOPPED in Q2 2020 – Covid & health
7. Lost Transportation outlets
8. Developed Materials & Supplies List
9. Select new subcontractor to pick up where Engineer left off.
10. Permitting needs better addressed, routing identified



- 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
  - D. Define end-state of this project for additional system development

# Quyana – Thank You!

# Questions?



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