Battery Storage Optimizing Renewable Energy

Battery Sizing & Future KEA Expansion

KOTZEBUE ELECTRIC ASSOCIATION

- 31 miles above the Arctic Circle
- Population: 3,200
- Native Name: Qikiqtaġruk = almost an island
- Demographic: 70% Alaskan Native (Iñupiaq)
- Transportation: Ice bound 9 months of the year. Accessible by air only.
- Climate: Avg winter temperature -20F (alapaa! = it's cold!) Avg summer temperature 60F.
- Wind Speed: Avg 11.7 mph
- Shortest day in Dec is just over 2 hrs – June & July the sun does not set.


Airport Runway
Kotzebue Sound
The Lagoon


KOTZEBUE
NATIONAL
FOREST

History of Moving Away from Diesel

- 1998-2002 ~50kWh Ni-Cad bank at Wales, AK connected to DC-AC rotary converter + small wind turbines
- 1997-2006 First KEA installed 10 AOC (50kW) & 1 NPS 100kW Wind turbines in Kotzebue - *how to store excess wind energy*
- 2010-2013 ~1.8MWh zinc-bromide flow battery with 500kW inverter 950kWh
- 2012 Installed 2 x 900kW EWT wind turbines
- 2015 Installed SAFT Li-Ion BESS 900kW / 1.2 MWh (grid firming of renewables)
- 2018 Created a dump load boiler for hospital/Community Center
- 2020 Installed 532(AC) kW PV array
- 2023 Installed additional 540KW(AC) PV array making our solar farm the second largest in Alaska

Some failures but many successes and learnings along the way

EWT 2 x 900kW Created Power Generation Stability

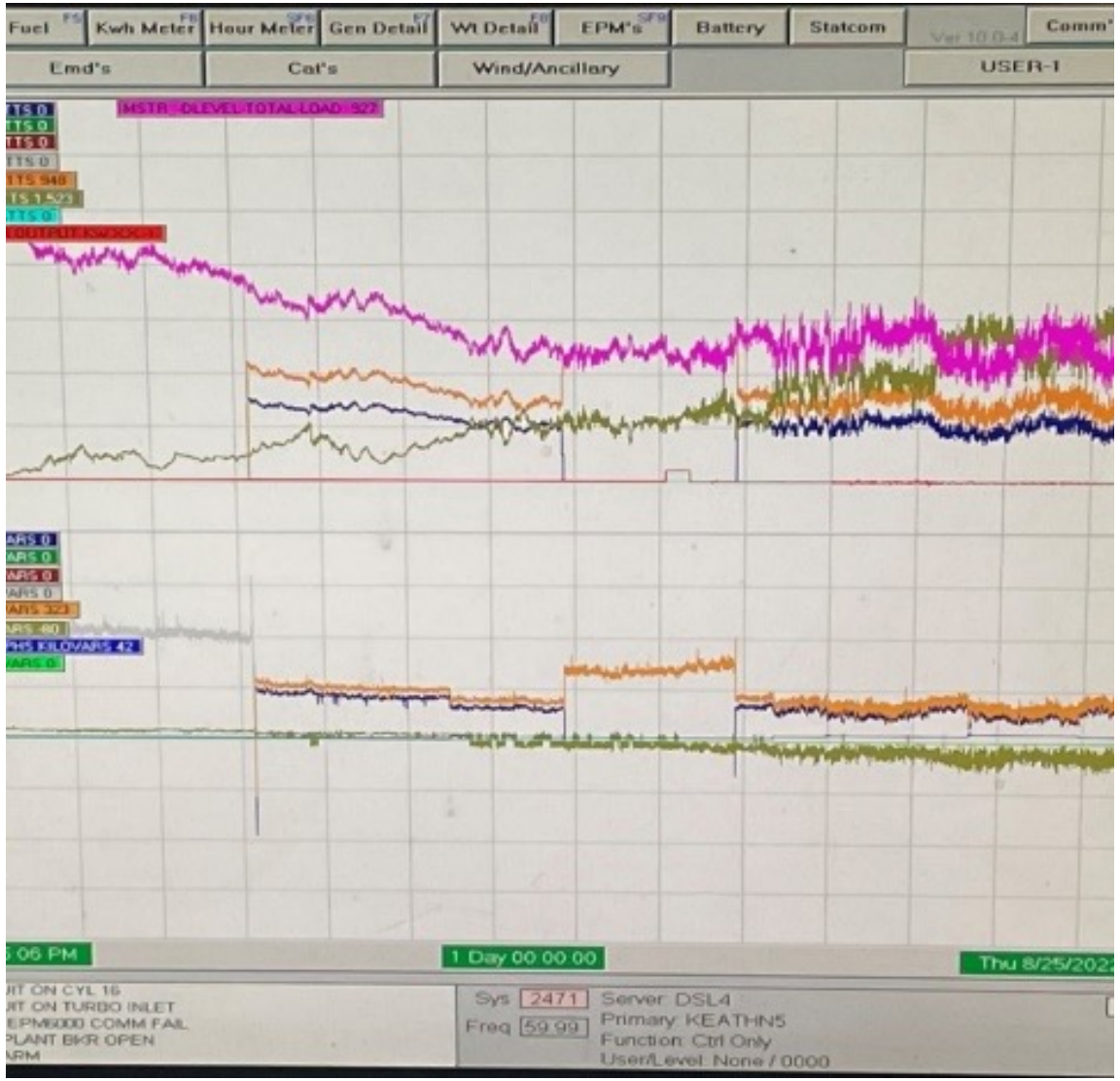
Current **Hybrid** Power Plant

- **Diesel Consumption: ~1.2 Million Gallons/year #2USLD (with a 5+ month reserve) Electricity Cost:**
- **.40c/kWh** for **electricity, $4-5 million per year for energy**
- **Winter Load (2 - 3.5 MW) and Summer Load (1.5 – 2.5 MW)**
- **Automated ~12MW Diesel Plant: 3 x 3 MW and 3 smaller units (1.4 MW, 1.1 MW & 725 kW)**
- **Wind Turbines: 2 x 900 kW (EWT) and 7 small turbines <100 kW (AOC, NW100, Eocyle & Vestas)**
- **Solar PV Array: 1072 kW (AC)**
- **Reactive Power: 1 MVAr ABB Statcom inverter**
- **Battery Storage: 950 kW/1.225 MWh SAFT Li-ion Battery (BESS)**
- **Electric Boiler: 450 kW (15 kW x 30 stages)for hot water and heat at local hospital from excess wind energy**

~4.5 million kWh annual wind/PV production – 20-25% capacity factor

Current Microgrid Performance

- **Fully automated system- PLC based**
- **2 x 900kW EWT Wind turbines + 1072kW PV + 1225kW Li-Ion BESS**
- **~25-30% Average Renewable Contribution per year (diesel displacement)**
- **Each turbine offsets 200,000 gallons of diesel per year**
- **BESS offsets 80-90,000 gallons due to charging & discharging wind & PV**
- **75% Renewable Contribution during weeks of winter storm**
- ***100% powered by renewables for 10 minutes (May 2022) – diesel forming grid***
- **Electricity rates have not increased in 8 years (despite fluctuations)**



What is grid firming?

Grid firming (also known as capacity firming or renewable firming) is the addition of another energy resource to a renewable power plant to balance the intermittent variation of renewable resources.

As the day starts, energy needs begin to ramp up...

...peaking in the late afternoon.

But with renewable energy's **intermittent nature**, we see a challenge for grid operators.

The sun provides energy when it's directly overhead— but not if it's cloudy...and none after it sets.

Similarly, the wind isn't always blowing hard enough for turbines to produce their rated capacity.

This creates a gap between

energy supply | · · · · | **and demand.**

NiCAD Bank & Premium Power Flow Battery

- NiCAD is still working, but Flow Batt did not

ABB PCS100 1225kW Inverter

SAFT 950kWh Battery Container in Substation

What is the Life Span of a Utility Scale Battery?

7 to 10 Years Depending on…….

- **Operating temperatures**
- **Discharge Rates**
- **Number of Partial Cycles Per Year**

Lithium Ion batteries typically provide about 7,000 cycles in a 7 to 10 year life cycle.

HOW LARGE OF A BATTERY DO YOU NEED?
It depends on…….

- **The current and planned mix of generation technologies**

- **Flexibility in existing generation sources**

- **Interconnections with neighboring power systems**

- **The hourly, daily, and seasonal profile of electricity demand**

- **The hourly, daily, and seasonal profile of current and planned VRE (Variable Renewable Energy)**


LISHEN
Power Your Life!
POWER CONVERSION SYSTEM
PCS
BESS1
HORIZON
POWER
energy for life
415 VOLTS
DANGER
MAX. GROSS
27,000 KG
59,525 LB
TARE
5,000 KG
11,025 LB
CU. CAP.
74.88 CU.M.
2,640 CU.FT.
LISHEN BATTERY ENERGY STORAGE SYSTEM
TIANJIN LISHEN BATTERY JOINT-STOCK CO., LTD.
CIMC

- Kotzebue Electric Association (KEA) will be increasing energy storage by purchasing an additional 4-megawatt (MW)/8-megawatt-hour (MWh) lithium-ion battery at an approximate cost of 6 million dollars.

- This additional capacity will allow the battery system to power all of Kotzebue for approximately 120 minutes

- The “grid-forming” ability of the battery allows KEA to shut off the diesel generators when sufficient renewable power is available

- **This project will procure and install a community scale (~4MW/~8MWh) battery energy storage and stability system at the KEA powerplant.**

- **KEA is prepared to procure, install, and commission a community-scale battery energy storage with stability system that will enable Kotzebue to run on 100% renewable power at times of sufficient wind and/or solar power availability.**

- **The battery will be located at the KEA powerplant site and replace the existing 1MW/1MWh BESS that is reaching end of life.**

- **The existing BESS has served KEA well and has proven the benefits of a BESS for a remote, islanded power system integrating high percentages of renewable power.**

Looking to Future Battery Expansion.....

Short Duration Batteries:

A **short duration battery** that is designed to provide power for a short period of time, typically **less than30 minutes**. These batteries are often used in applications where a **quick burst of energy** is required. Examples of short duration batteries are:

- **Lithium-ion**
- **Nickel-based**
- **Sodium based**
- **Lead Acid**

Long Duration Batteries:

Long duration batteries provide **power for longer periods of time, typically several hours or more**. These batteries are often used in applications where a steady supply of power is required over an extended periods in grid-scale storage systems.

- **Lithium-ion**
- **Flow Batteries**
- **Carbon Capture/Gravity**
- **Thermal Batteries**
- **Air Ion Batteries**
- **Hydrogen Energy Storage**