

# Load Shaping to Right-size Energy Storage



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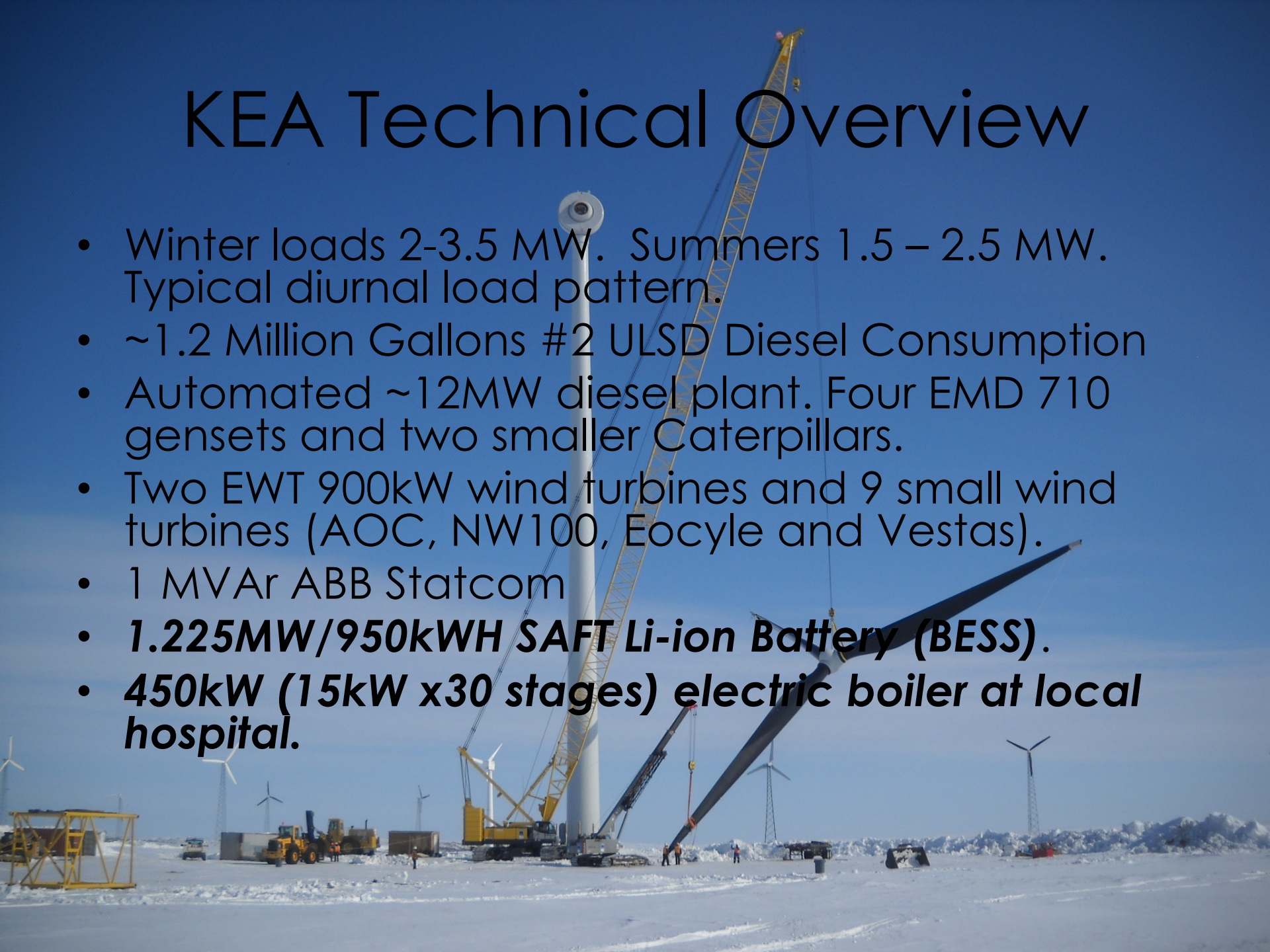
# About Kotzebue Electric Association

- Located above the Arctic Circle in Northwest Arctic Borough
  - Hub community for 11 surrounding villages
- KEA operates a wind-diesel hybrid power system
  - Average load – 2000 kW; 3500 kW maximum
  - 6 diesels – 725 kW to 3080 kW
  - 11 wind turbines – 2,408 kW total
  - Eight 66kW PV arrays – 532 kW total
  - ~4.5 million kWh annual wind/PV production – 15 - 20% capacity factor
  - Average cost to members – 39 cents per kWh
  - 14 employees (5 office, 2 linemen and 7 operators)



# KEA Technical Overview

- Winter loads 2-3.5 MW. Summers 1.5 – 2.5 MW. Typical diurnal load pattern.
- ~1.2 Million Gallons #2 ULSD Diesel Consumption
- Automated ~12MW diesel plant. Four EMD 710 gensets and two smaller Caterpillars.
- Two EWT 900kW wind turbines and 9 small wind turbines (AOC, NW100, Eocyle and Vestas).
- 1 MVar ABB Statcom
- **1.225MW/950kWH SAFT Li-ion Battery (BESS).**
- **450kW (15kW x30 stages) electric boiler at local hospital.**



# The KEA energy storage journey...

- ~50kWh Ni-Cad bank at Wales, AK connected to DC-AC rotary converter (1998-2002)... Worked well and batts still good!
- ~1.8MWh zinc-bromide flow battery with 500kW inverter (2010-2013)
- 950kWh ***lithium-ion*** bank connected to 1.225MW inverter.... Voila!

# Wales Ni-Cd Bank (SAFT) coupled to DC-AC rotary converter.



# PremiumPower Flow Battery



# KEA BESS Sizing Approach

- What do we want the BESS to do?
  - Provide spinning reserve and peaking to the online diesel generation.
  - Capture excess renewable and diesel power generation.
  - Form the grid for diesel-off mode **if possible**.
- How much money do we have?
  - Inverter (power) capacity proportional to \$\$\$
  - Battery (energy) capacity proportional to \$\$\$
  - Inverter + Battery capacity = \$\$\$\$\$\$

# KEA Priority: Power!

- With the available project budget of \$1.5M, the KEA priority was to have the BESS provide enough power to:
  - Provide immediate power (spinning reserve) for the loss/trip of one EWT 900kW turbine for 1 hour. **FEWER PARTIAL OUTAGES!**
  - Provide peak shaving capacity for EMD genset during shoulder season loads (100-300kW needed for 3-6 hours per day).
  - Plant black-start capacity and for emergency situations.
- Energy storage needed for these modes: **~1MWh**
- Maximum renewable energy storage scenario: **~12MWh (summer-time, high winds)**



# KEA 1.25MW/950kWh BESS (2015) SAFT Intensium Max 20M container



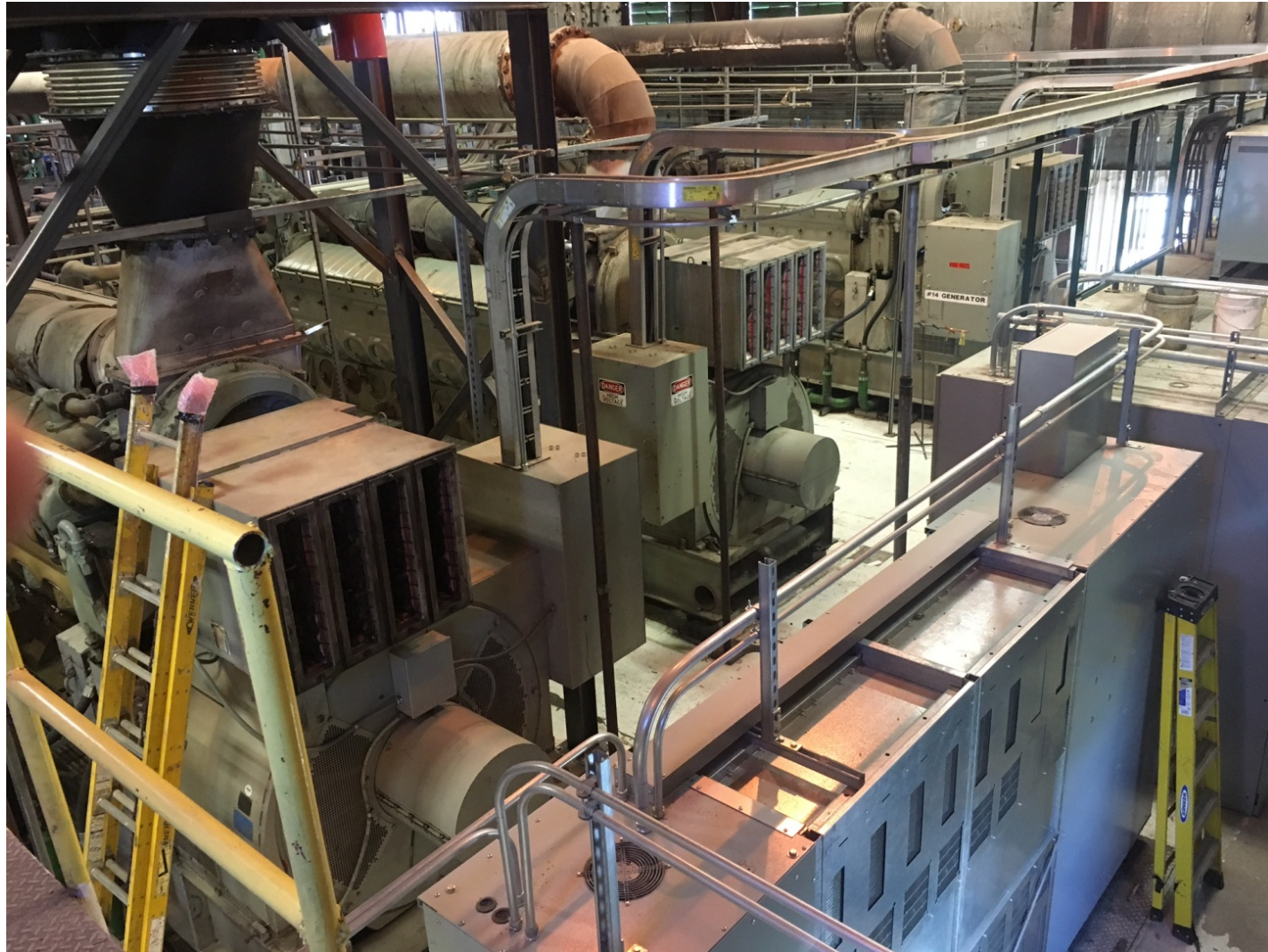
# SAFT Batt Container in Substation



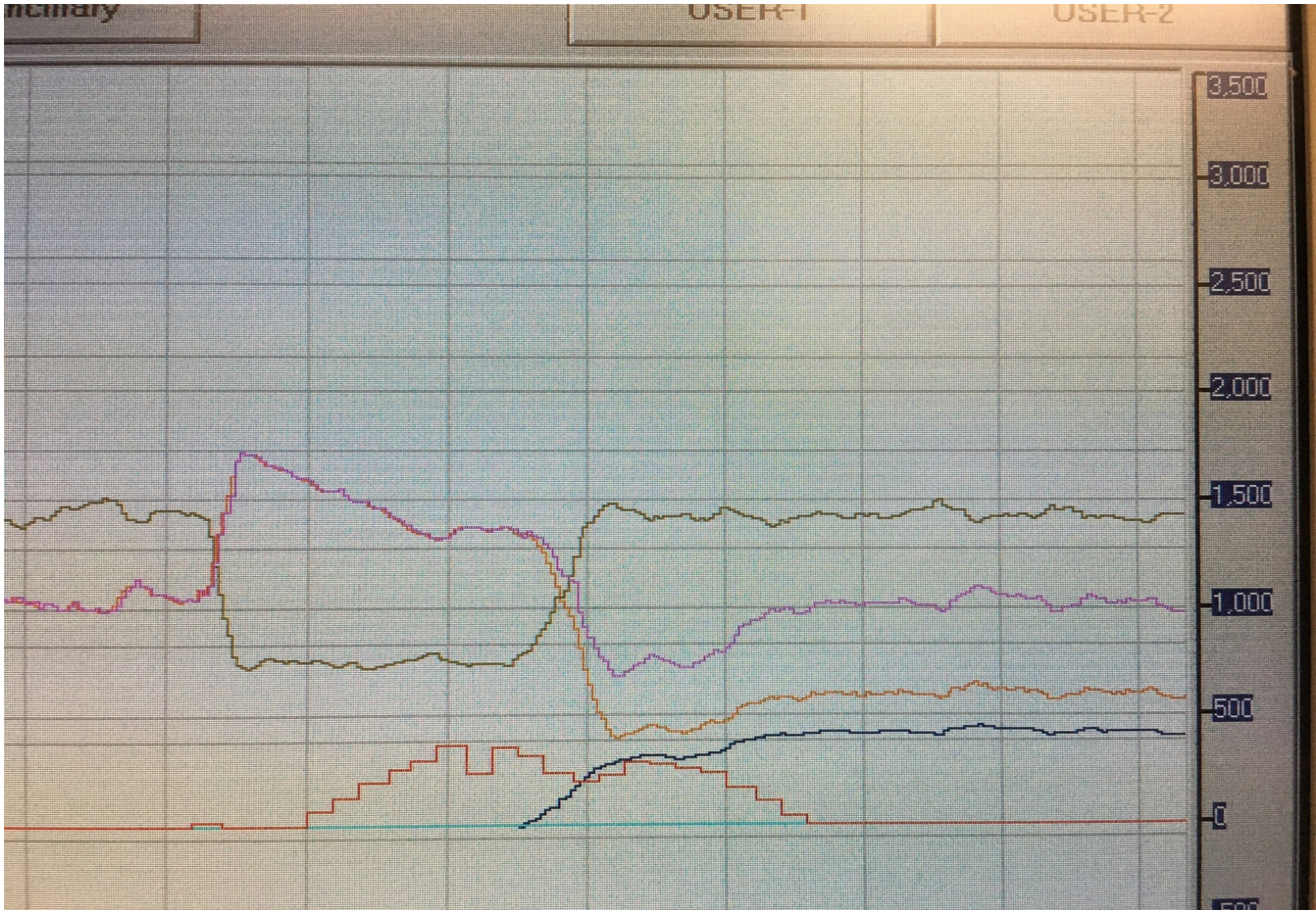
# ABB PCS100 1225kW Inverter



# ABB Inverter in EMD engine bay



# EWT Turbine Tripped OFF



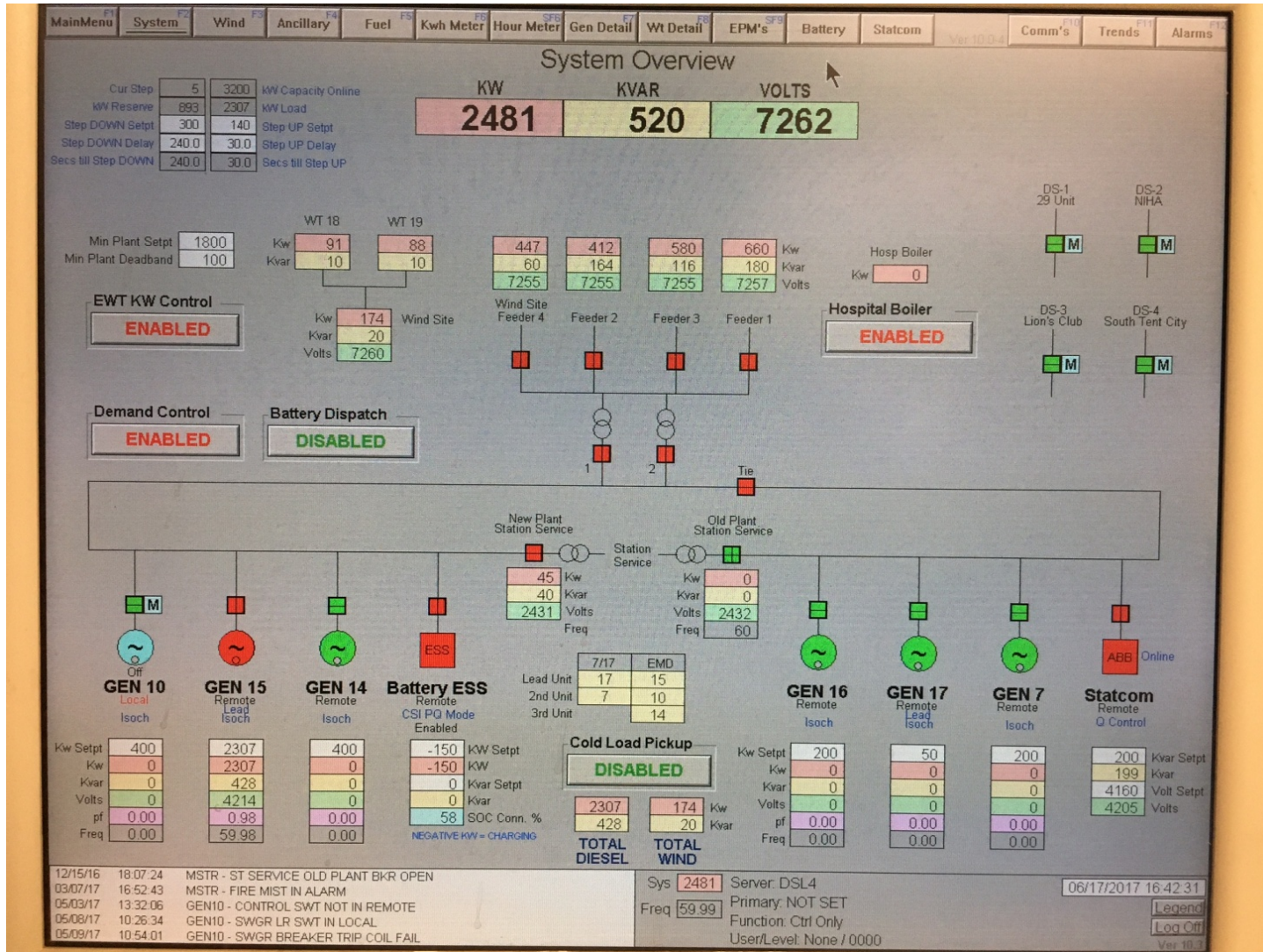
# Excess Renewable Energy Capture and Usage

- Ideal capacity for KEA BESS is ~8-12MWh to capture ALL excess renewable generation with 1MW diesel base load (needed for grid forming and heat generation).
- Large BESS not affordable **YET; *instead***, create *load to utilize excess renewable generation*:
  - Electric boilers.
  - Electric furnaces/heaters.
- Kotzebue heat needs are nearly year-round for space and hot water heating.
- Heating fuel costs ~\$5/gallon in Kotz!

# Load Shaping with Controllable Electric Loads

- **Excess** renewable power generation directed by KEA controlled electric boilers to boost temperature of hydronic thermal systems at local commercial facilities.
- Facility owner pays the cooperative for the BTU absorbed by facility each month. Cost per BTU keyed the cost of heating fuel with a discount.

# BESS and Boiler in SCADA HMI

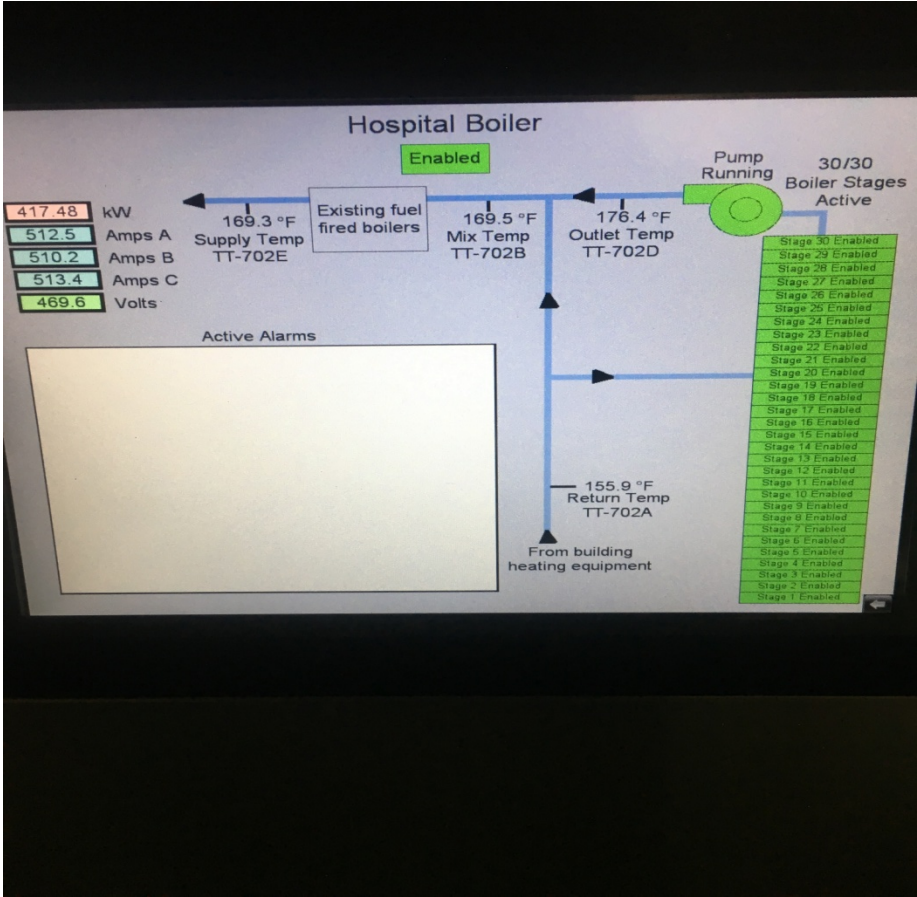




# 450kW Electric Boiler at Kotzebue Hospital (hospital owned, KEA controlled)



# Thermal energy storage at hospital 450kW. (~750,000kWh annual consumption)



All stages of boiler active. Hospital oil boilers not running.

# Planned Thermal Energy Storage

- 108kW at NPS Northwest Arctic Heritage Center (Summer 2021).
- 100kW at 29-Unit apartment building (2021).
- Additional ~500kW being explored for other Kotzebue commercial building and possibly residences.
- Total electric thermal storage planned is ~1200kW

# Conclusion...

- KEA using Lithium-ion BESS for **power and grid support** functions.
- Thermal storage used to capture excess renewable power for community heating and cooperative revenue as an alternative to battery storage.
- NEXT STEPS:
  - **Increase renewable generation and BESS capacity to be able to operate diesel-off.**
  - **Keep an eye out for reliable, and cost effective LONG TERM battery storage.**
  - **HYDROGEN?**