

# INTRO TO PUMPED STORAGE HYDRO

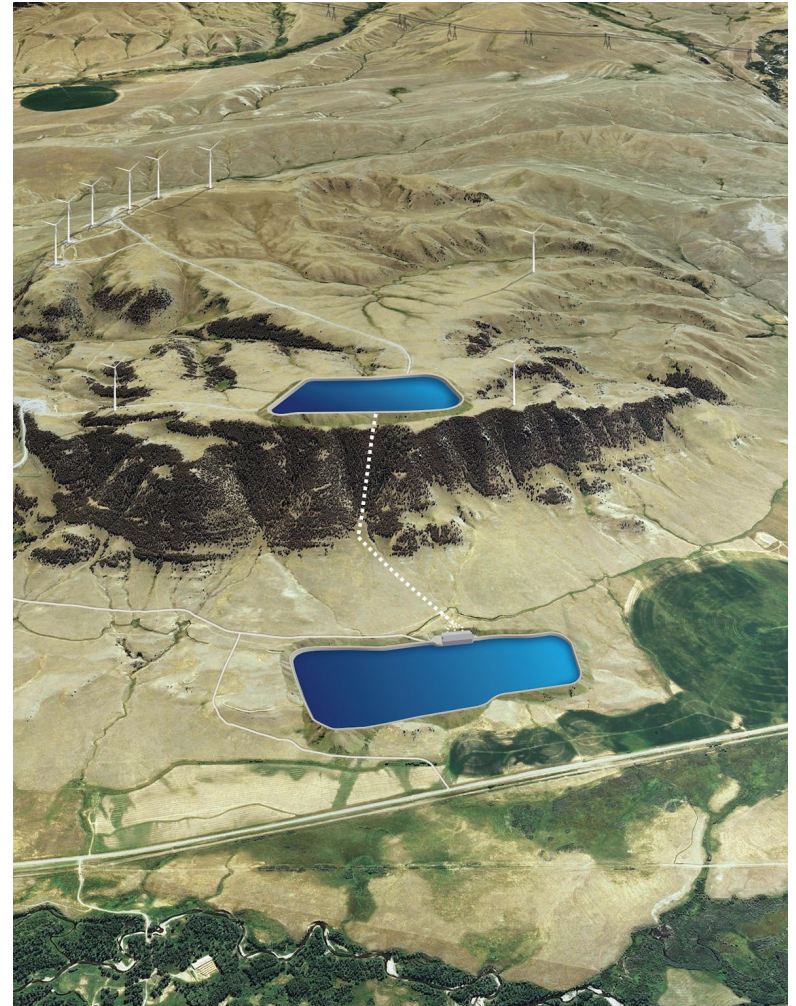
**ABSAROKA ENERGY**

Prepared for Department of Energy  
Tribal Division

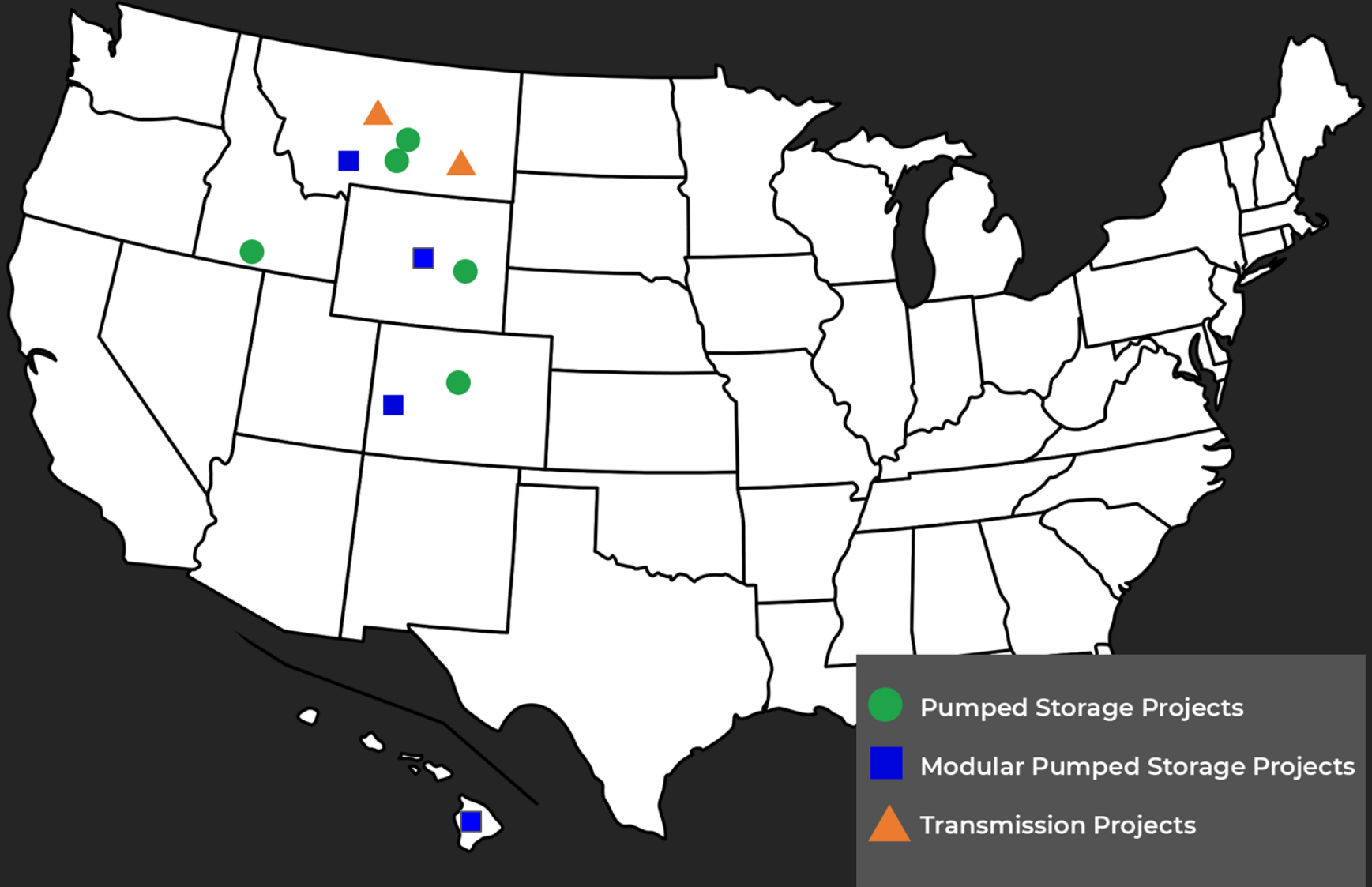


# ABSAROKA ENERGY

- Over 12 years of renewable energy development experience.
- Leading developer of pumped storage hydro in the United States.
- Developing projects that increase grid reliability and resiliency including:
  - Pumped Storage Hydro
  - Modular Pumped Storage Hydro



# DEVELOPMENT LOCATIONS



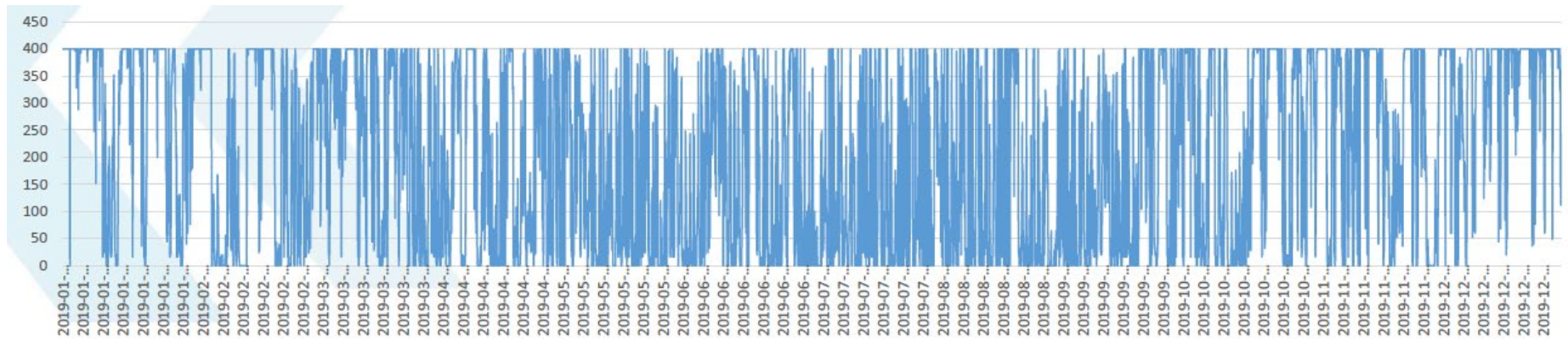


# RENEWABLES IN ACTION



# CHARACTERISTICS OF WIND

## FIRE ISLAND WIND ENERGY - ANCHORAGE, ALASKA



Typical 12-Month Wind Profile, Eastern Montana



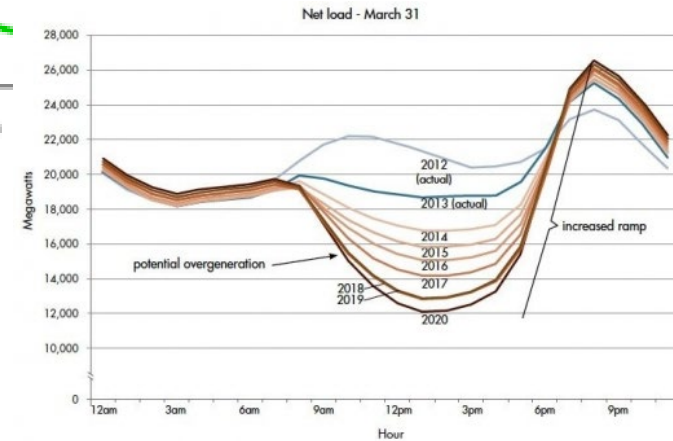
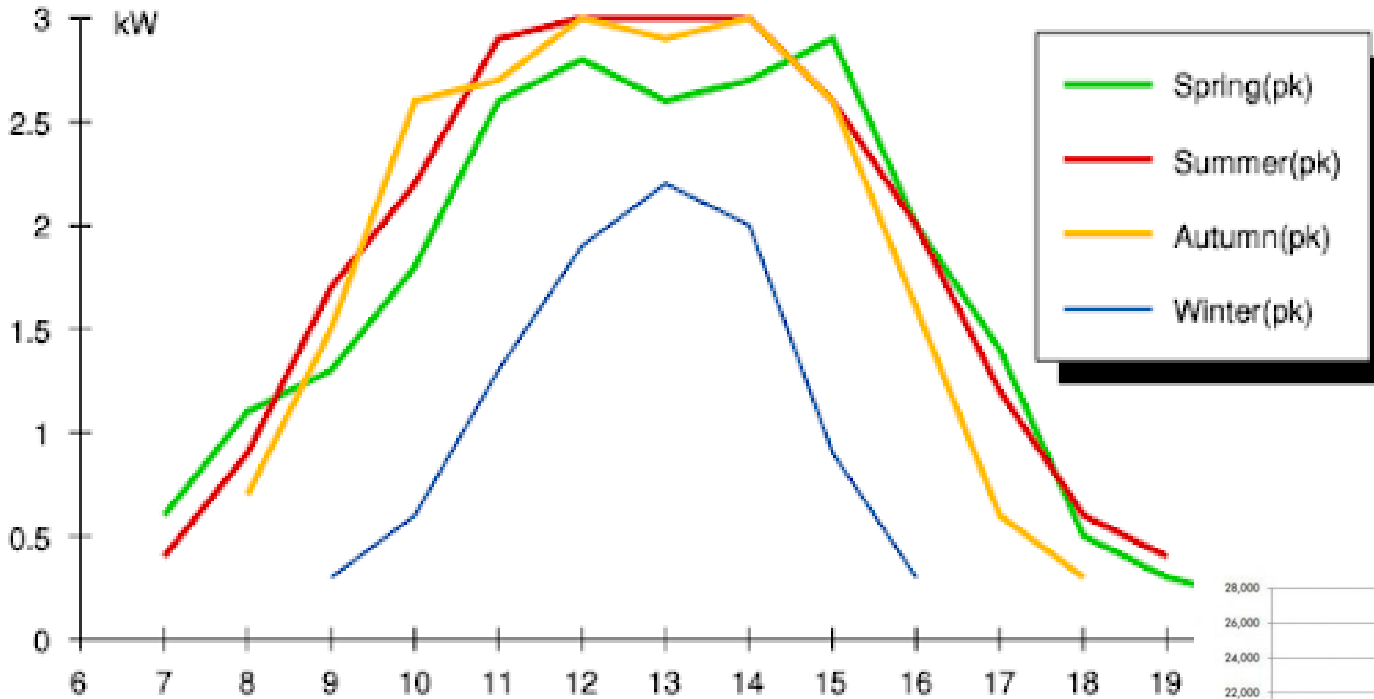
# CHARACTERISTICS OF SOLAR

WILLOW SOLAR FARM - ANCHORAGE, ALASKA



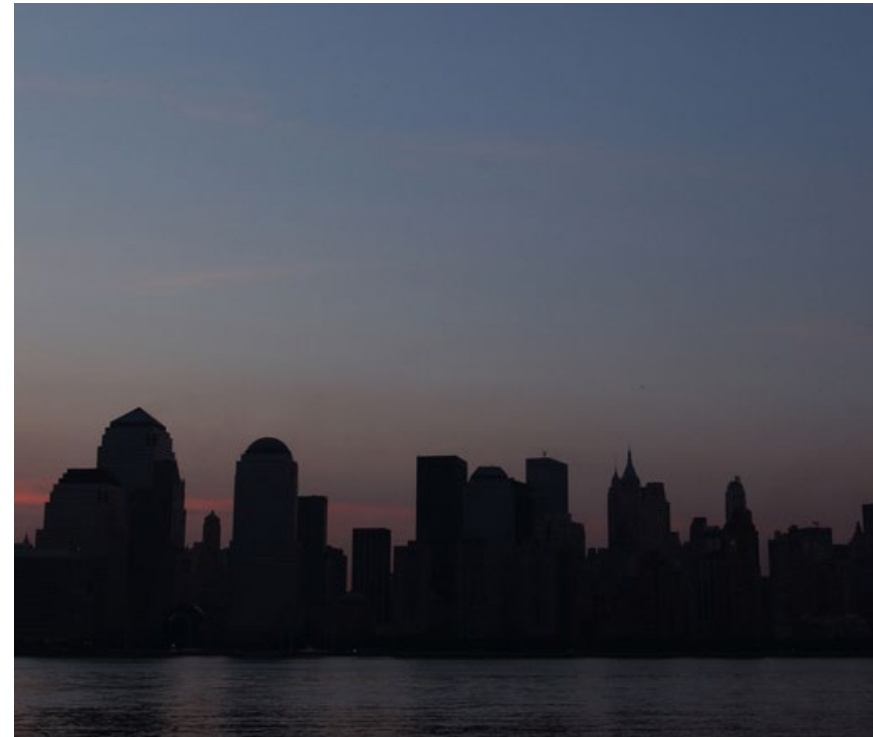
# TYPICAL DAILY SOLAR PRODUCTION

YUKON, CANADA



# GRID INSTABILITY IN ACTION

NEW YORK CITY BLACKOUT, 2003

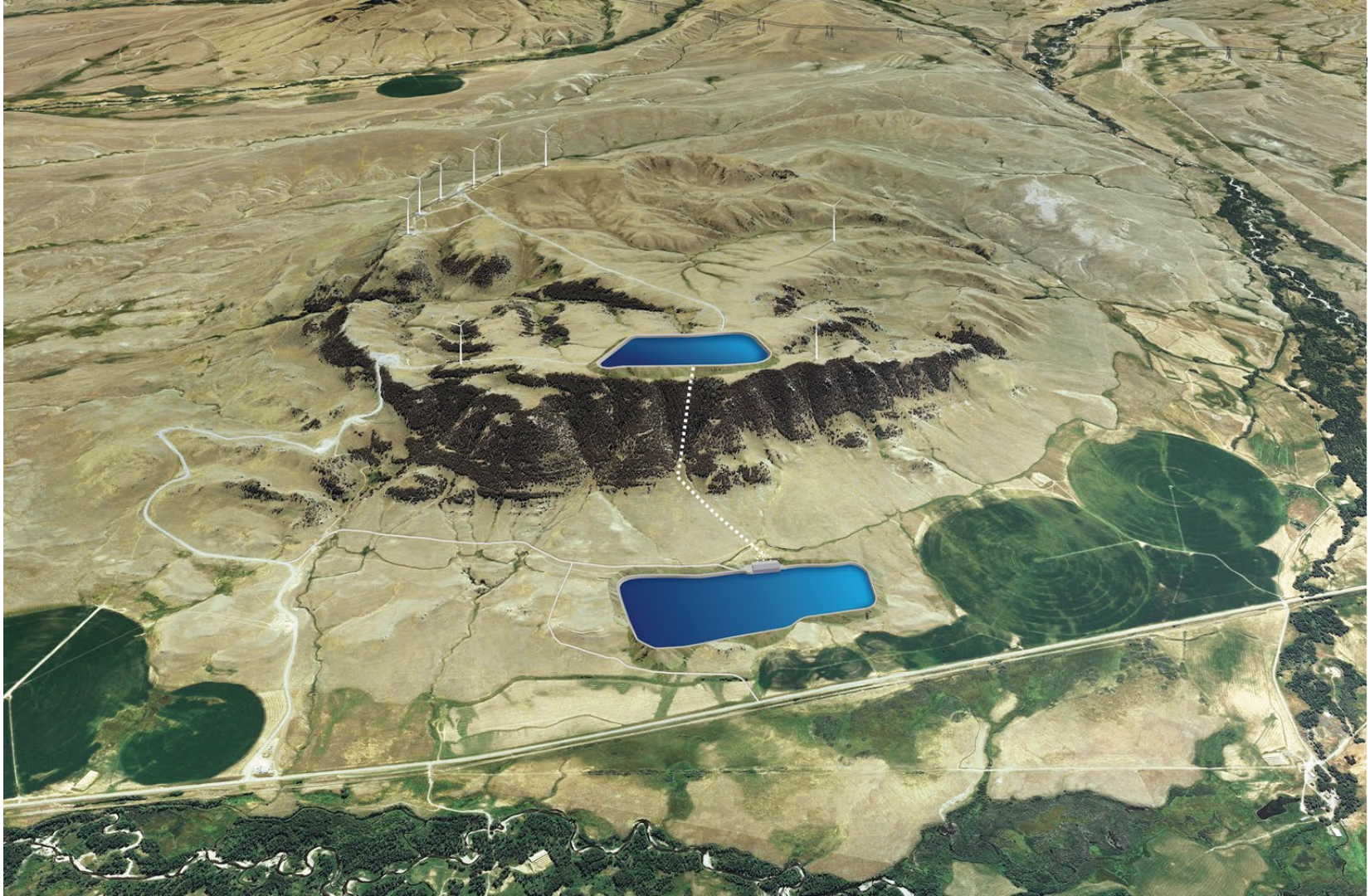






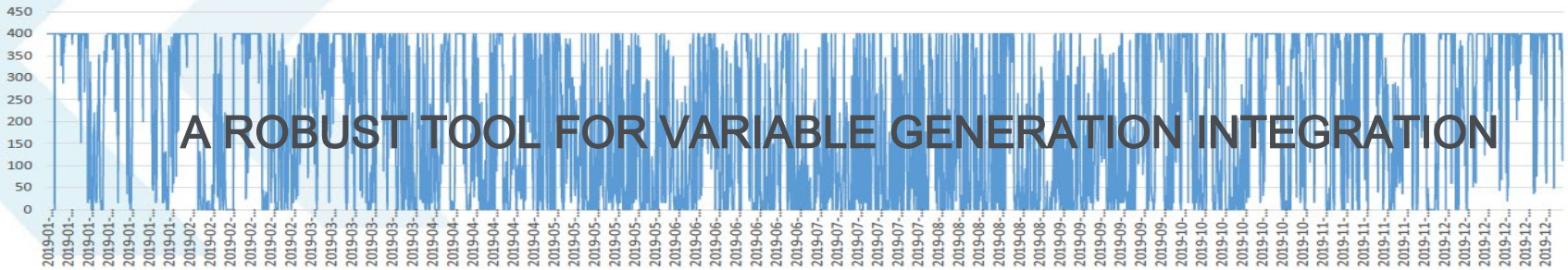
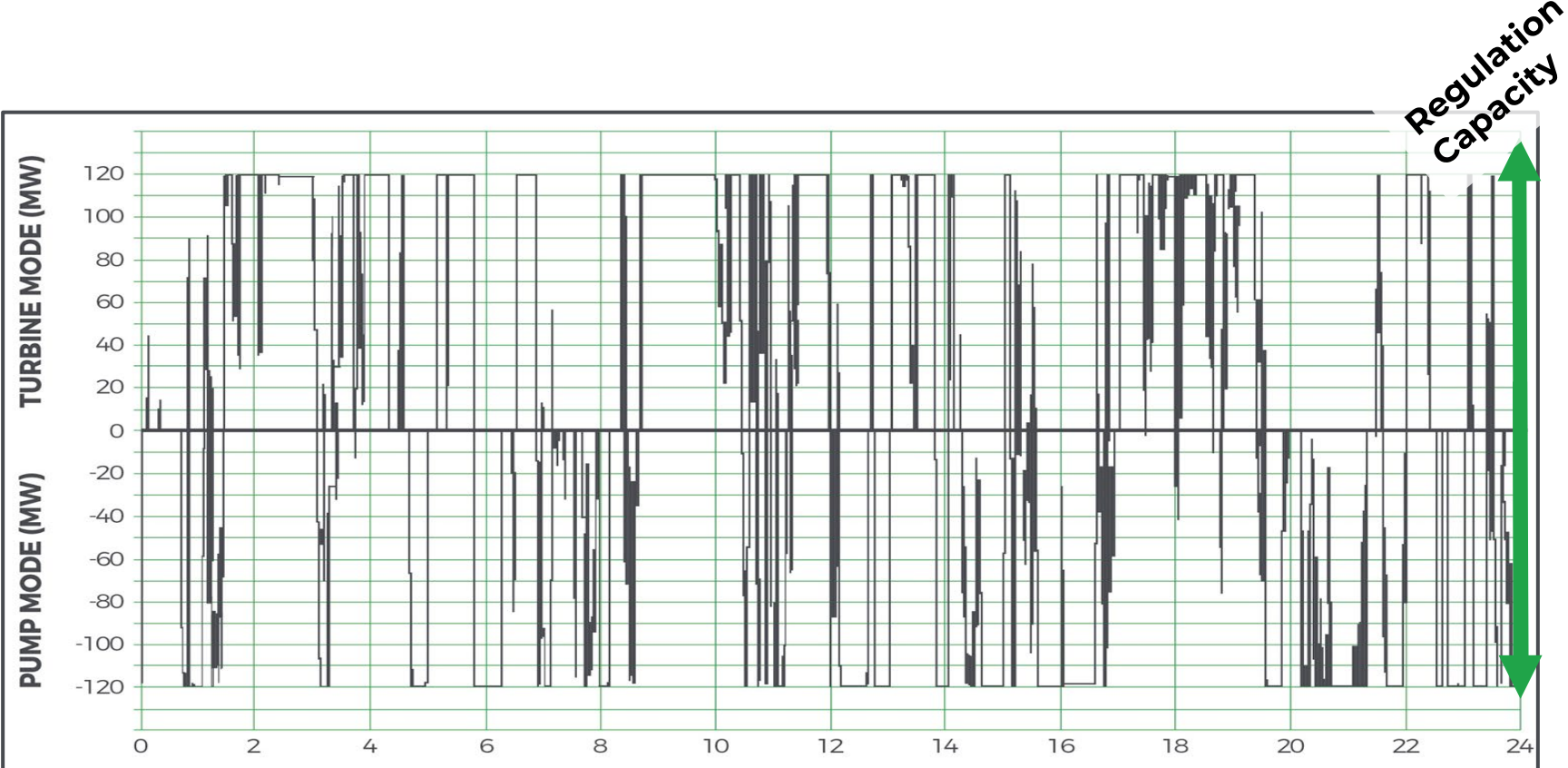
# STORAGE: THE KEY TO INTEGRATION

# GORDON BUTTE PSH





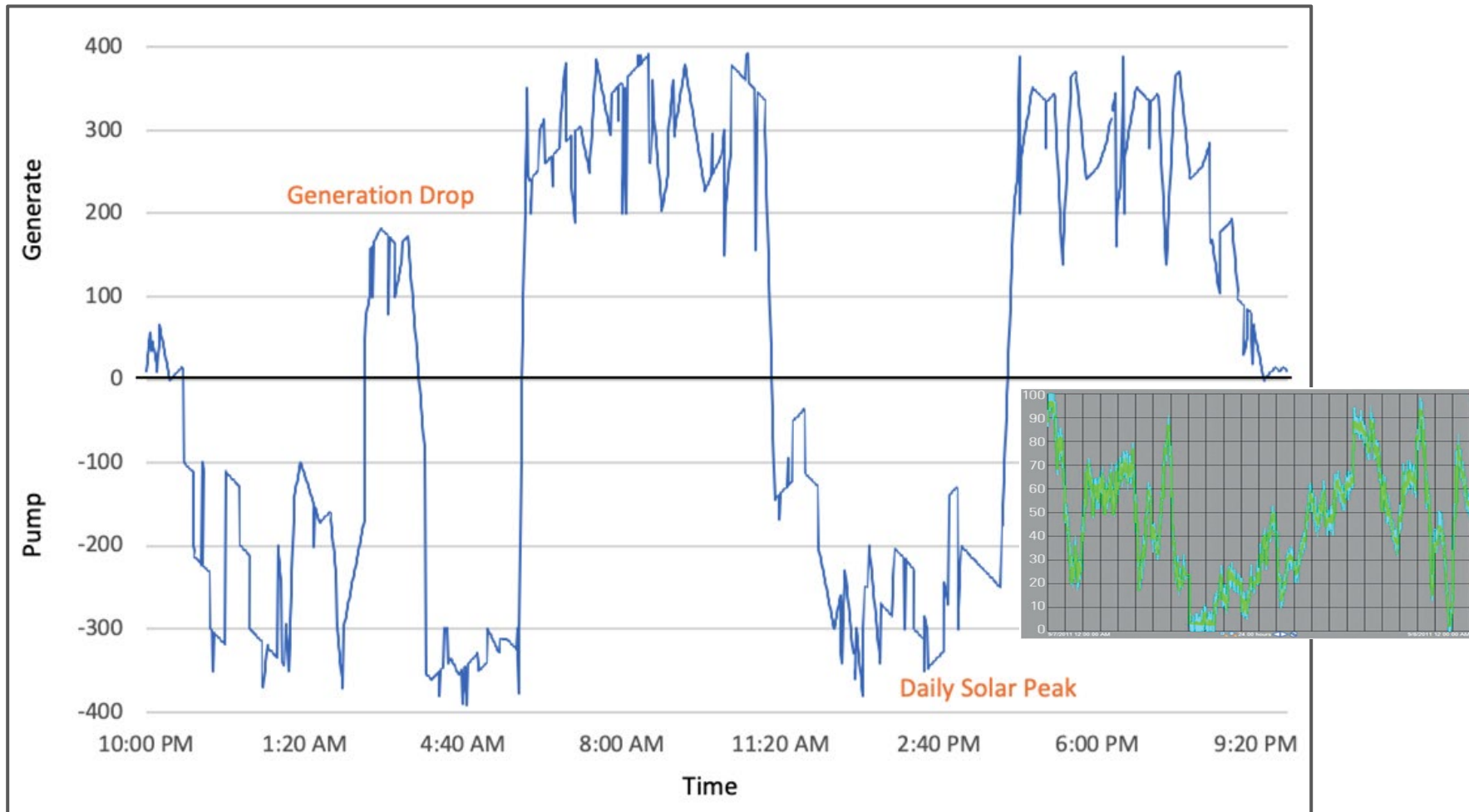
# ULTIMATE FLEXIBLE CAPACITY





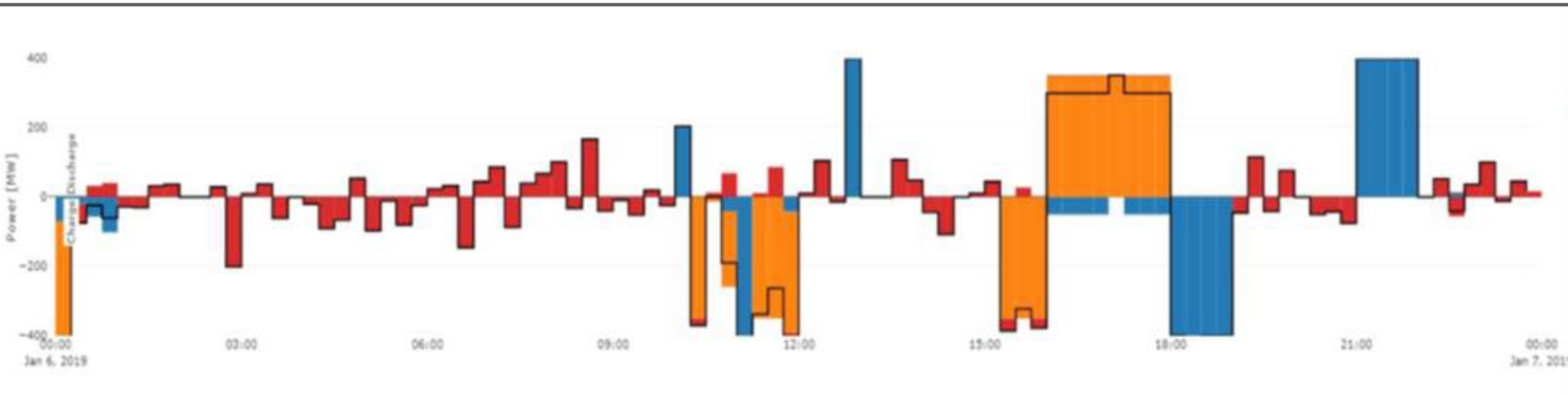
# DAILY OPERATION OF PSH

## GORDON BUTTE MODEL




# REAL-TIME PSH DISPATCH

SIMULATED 24 HOUR OPERATION OVER CRITICAL PEAK DAY, 2019



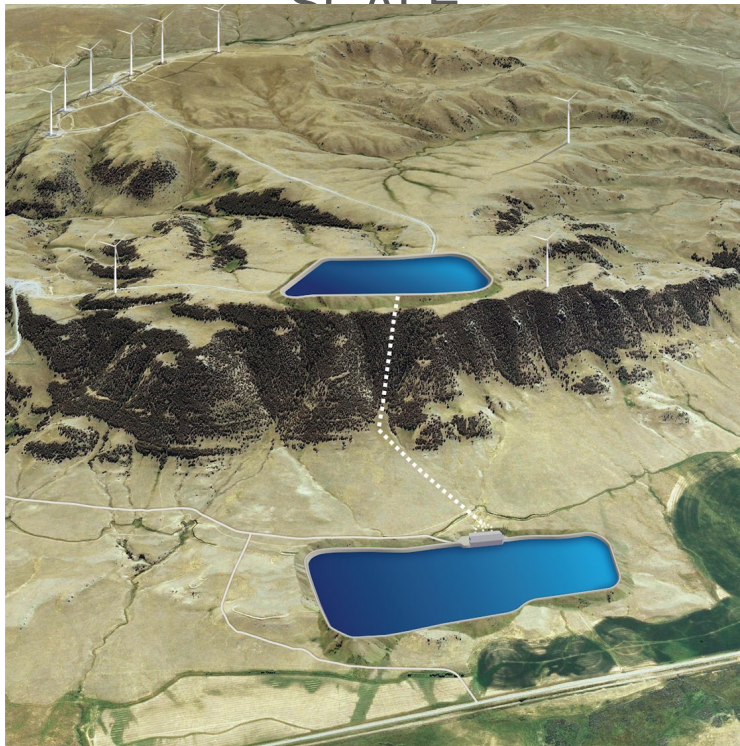
 = Reserve Regulation

 = Peak Shaving

 = Energy Arbitrage

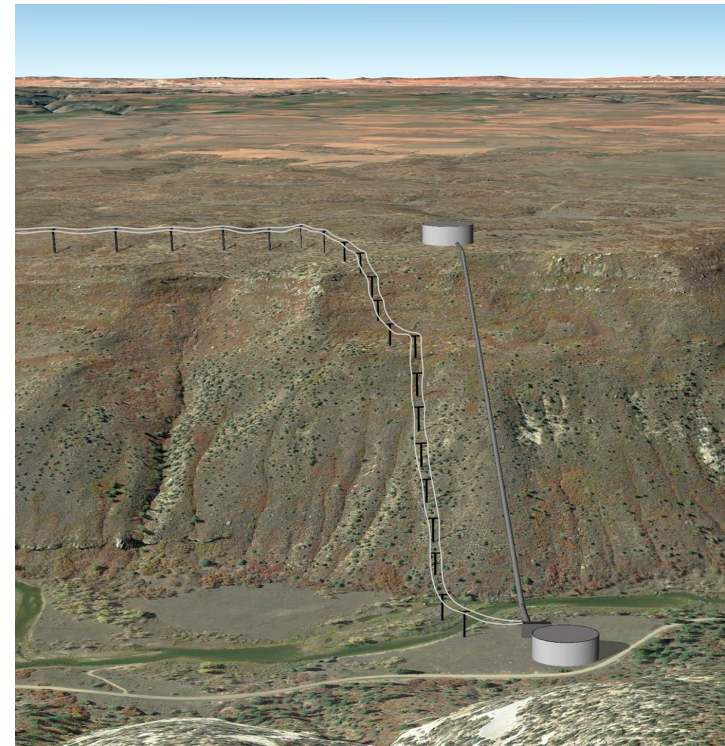
# ABSAROKA'S PSH OFFERINGS

CLOSED-LOOP UTILITY  
SCALE



OVER 50 MW

MODULAR PSH



1- 50 MW



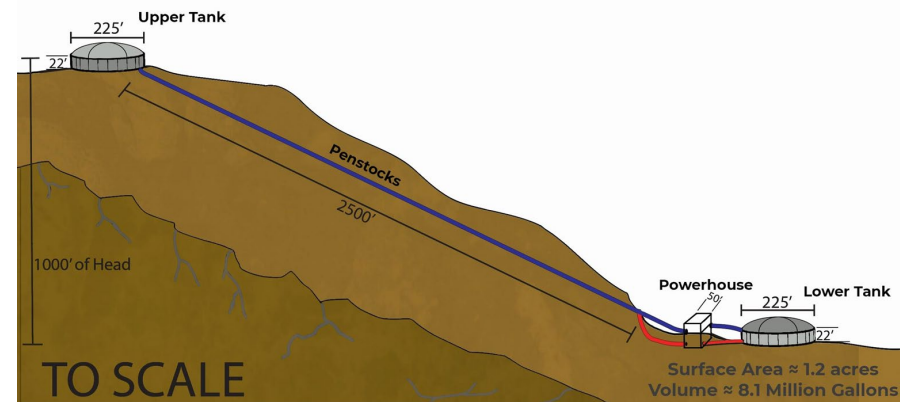
# CLOSED-LOOP UTILITY SCALE HIGHLIGHTS

- Installed Capacity: 400 MW
- Estimated storage: 3,400 MW/hours
- Equipment Units: 3 pairs
- Off-stream, closed-loop
- Not connected to surrounding fisheries or watersheds
- Evaporative makeup estimated at 5% - 10% annually



# MODULAR HIGHLIGHTS

- Scalable
- Minimal environmental impact
- Under 1 MW to 10 MW systems
- Off-the-shelf components to reduce costs
- Off-stream, closed-loop
- Not connected to surrounding fisheries or watersheds
- Esthetically integrates into the surrounding landscape
- Designed to minimize seepage and evaporative losses





# ALASKA PSH OPPORTUNITIES



# RAILBELT + PSH



- Operates like a giant water battery
- Reduces reliance on fossil fuels and protects against fuel pricing variation
- Provides enhanced grid stability and reliability to facilitate renewable expansion
- Offers cost savings by allowing the Railbelt to be operated more efficiently and by preventing the build out of gas turbines

# MICROGRIDS + MODULAR PSH

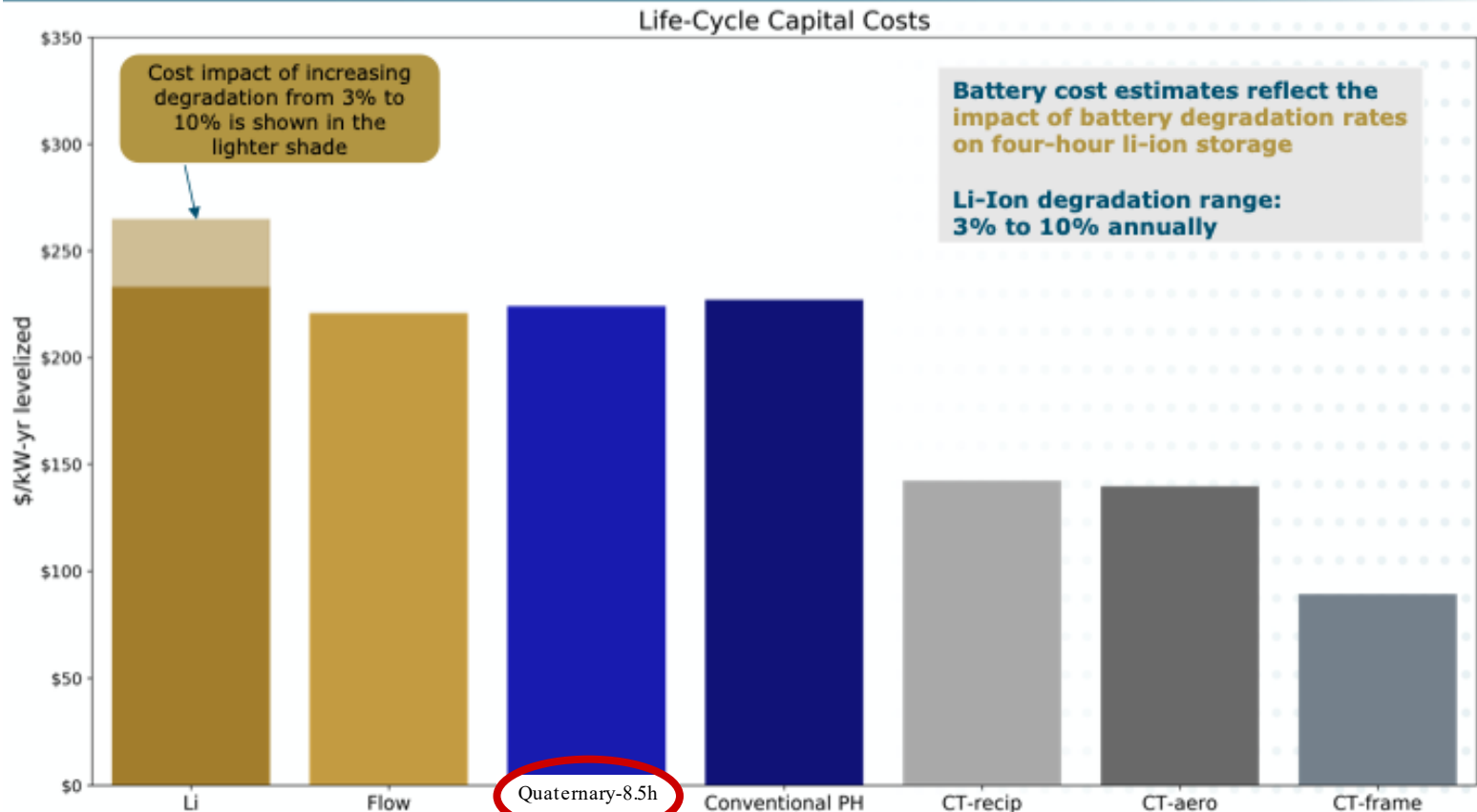


- Alaska has roughly 200 Microgrid communities
- Easily integrates into existing Microgrids, regardless of energy source or generation type
- Smaller scale system allows for lessened siting requirements
- Lower lifetime cost alternative to batteries

# PSH VS. BATTERIES



## Lithium-ion costs are sensitive to assumptions about cell degradation



Note: 1<sup>st</sup> year capital cost data are modelled as reported in the NorthWestern Energy Electricity Supply Resource Procurement Plan  
Energy+Environmental Economics

Chart compares the levelized cost of batteries with 4-hour (4h) storage duration to pumped hydro with an 8-hour (8h) storage duration

Energy+ Environmental Economics, Inc. (E3) is an independent consulting firm specializing in modeling and analysis of electric markets and systems. Absaroka hired E3 to perform the “Analysis of the Capabilities and Lifecycle Costs of Storage/Capacity Resources.”



# IN SUMMARY

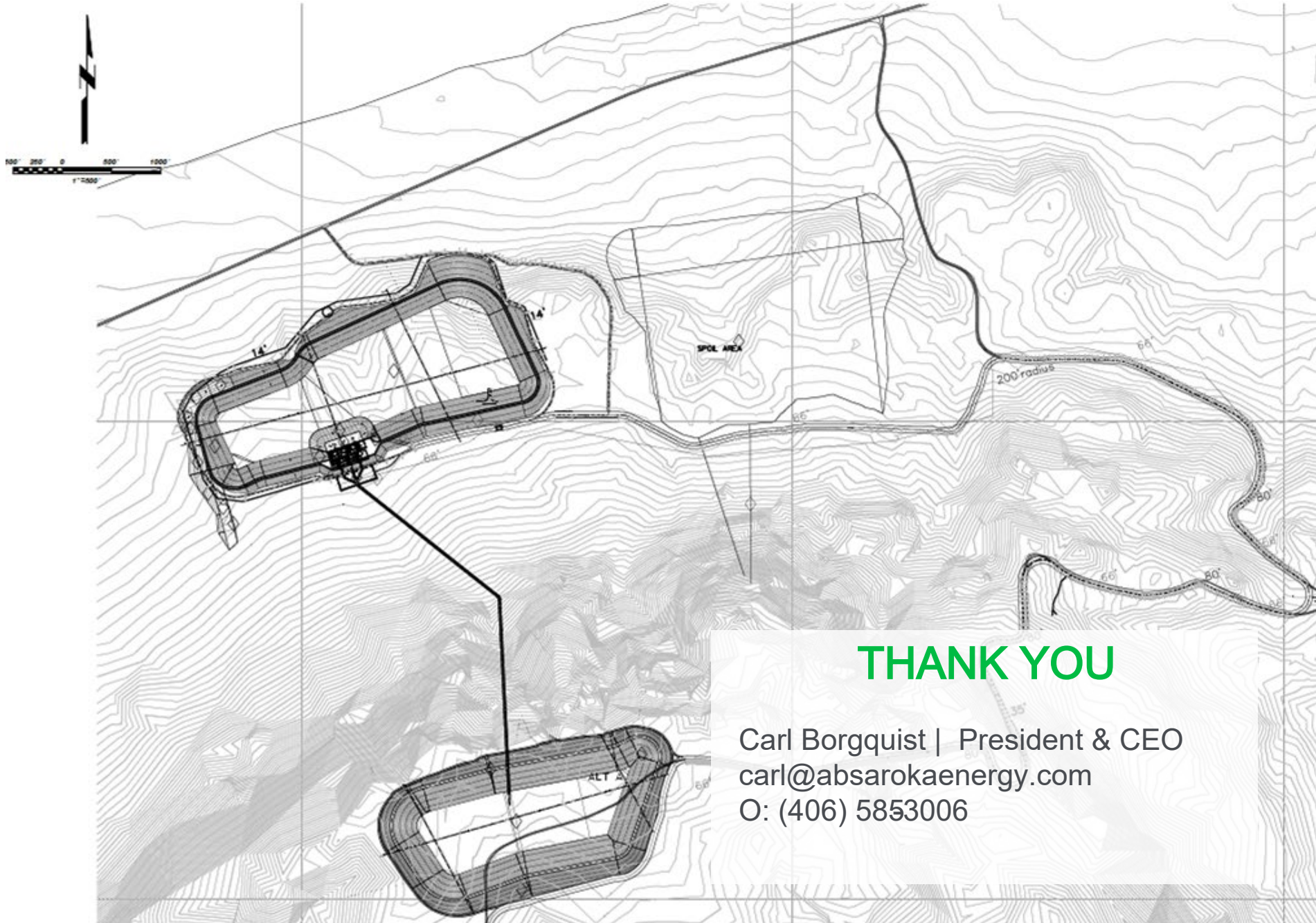
Pumped Storage Hydro offers many possibilities and benefits to Alaska.

- Low environmental impact
- Enhances stability of the Railbelt and Microgrids
- Lowers cost for consumers
- Integrates well with traditional and renewable technologies





# QUESTIONS & DISCUSSION



# THANK YOU

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