Americas Market Dynamics

The future is natural gas, renewables, and storage in the Americas

Natural Gas Generation
Natural gas supplies baseload power as coal and nuclear are retired

9.1 GW /yr HDGT in Americas

Renewable Generation
Economics, subsidies, and policy drive renewable installations for the foreseeable future
US POWER SECTOR EMISSIONS

813 lb CO₂/MWh

A5 OF 2019 Q2

-9% since 2018 Quarter 2
-38% since 2005

“The switch from coal to natural gas, and a 75% increase in renewables generation, are the two largest factors contributing to the reduction in emissions intensity”
Gas, Wind, and Solar Costs Continue to Decline

LCOE is now $41/MWh for a 50/25/25 split of gas, wind & solar

Source: Lazard’s Levelized Cost of Energy Analysis v11.0; MHPS Market Analysis; *Estimated
Announced Retirements and Distressed Assets

- Western US has retired most of their coal plants
- Eastern and mid-continent US still has a lot of coal to retire
- 19.1 GW of announced retirements
- 73.3 GW of distressed assets

NOTE: Values shown here only accounts for announced retirements and assets identified as distressed
Curtailments and Negative Pricing Signal the Need for More Storage

CAISO wind and solar curtailments hit record high in May 2019

Source: CAISO
Data compiled June 6, 2019
Energy Storage Technologies

Flexible Technologies For Multiple Uses

- **Commercial & Industrial**
  - 500 kW – 3 MW

- **Renewables + Batteries**
  - > 5 MW

- **Utility Scale Energy Storage**
  - > 10 MW

- **Microgrids**
  - Fuel Cell + Solar Storage + …
  - > 500 kW

- **Gas Turbines + Batteries/ H₂**
  - > 20 MW
Li-Ion Limitations: Capturing Maximum surplus becomes Cost prohibitive

Accumulated surplus during the year equals 35.9 Million MWh, or roughly 14% of the California’s annual electric usage.

To contain that much energy at peak storage time:

- A peak storage system equivalent in instantaneous capacity larger than the generating capacity of the entire US electric grid
- Assuming $80/kwh (80% lower than where it is today) - the total cost of such a battery storage system would be $2.9 trillion
- California’s annual GDP is $2.7 trillion.

Source: Armond-Cohen (Clean Air Task Force) Testimony: Building Americas Clean Future
Advanced Clean Energy Storage (ACES) Project Delivers a Complete Solution

Electrolysis

Compressed Air

H₂

For CAES

Verticals (Users)

Power
LADWP / NV Energy
PacifiCorp

Pipeline Injection
BHE Kern River / Dominion

Industrial Gas
Trucks / Buses / Trains / Forklifts

One cavern can hold 5 million kg H₂

Large scale centralized storage for total grid stabilization
The Evolutionary Path to 65%+ Combine Cycle Efficiency

T-Point 1 1997 (G) / 2011 (J) COD

MHPS TOMONI Point 2020 COD

July 2019

*Actual Operating Hours (AOH) as of November 2019
Increased flexibility reduces fuel costs and avoids starts / stops when integrating with renewables

Normal operational range is from 100% to MECL (Minimum Emissions Compliant Load)

MECL is typically 50% GT Load

MHPS-TOMONI Very Low Load (VLL):

- Expanded range: emissions compliant continuous ramping ~ 40%-100% load
- Very low operational point @ ~20% GT load and emissions compliant

Operational Range

- Normal Operational Range
- Expanded Range
- Hold Load

MHPS Renewable Hydrogen Fueled Turbine

100% Hydrogen Fuel = Zero CO₂ Emissions

Powering the Next Generation, with Renewable Hydrogen

Extensive EXPERIENCE with hydrogen fuel mix

Over 3 MILLION hours of operation

100% renewable hydrogen by 2024
Thank You