

Achieving Economy-Wide Deep Decarbonization with Green Hydrogen

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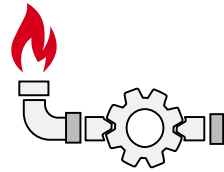
Our Mission in the Americas

We will provide profitable power generation and storage solutions to our customers, empowering them to affordably and reliably combat climate change and advance human prosperity.



Phase 1

The retirement and replacement of coal-fired power plants with:



Natural Gas



Renewables

Phase 2

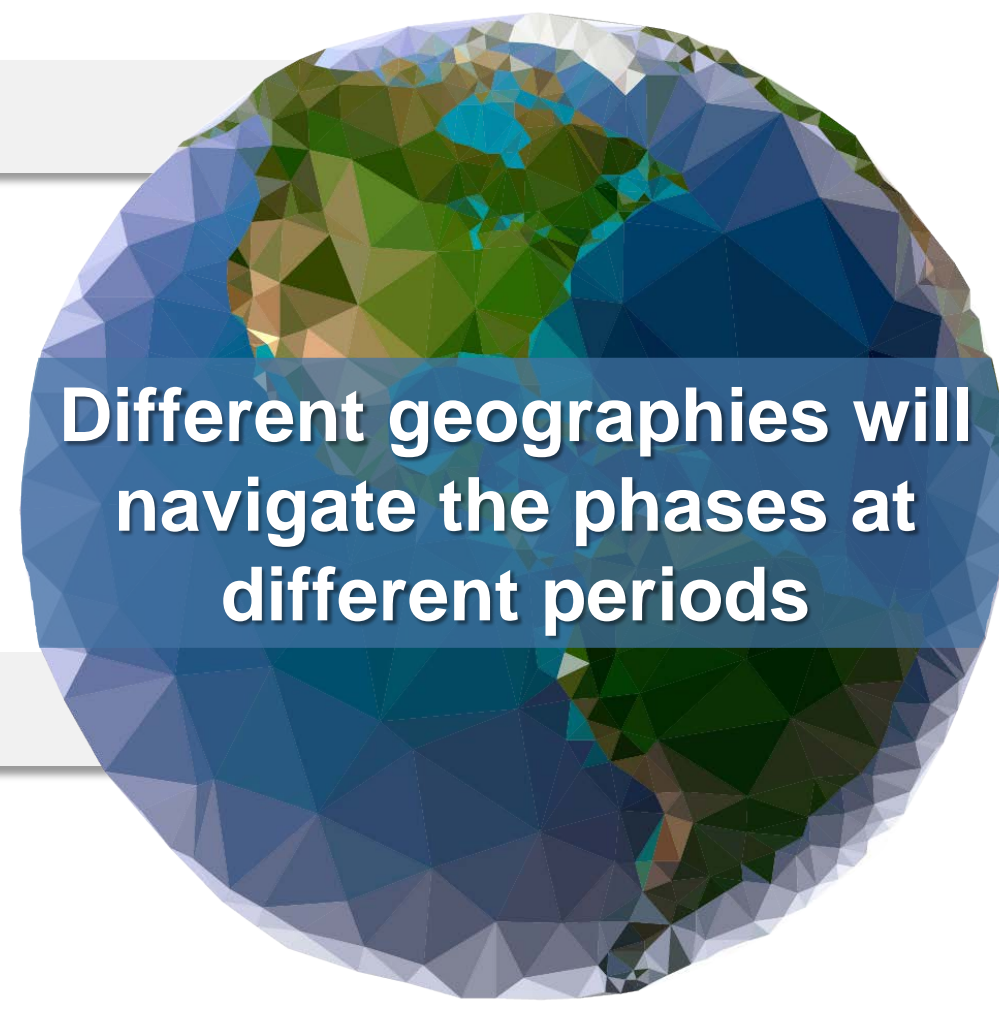
Tackle Long-term Intermittency, currently managed by natural gas power generation:



Energy Storage



Renewables



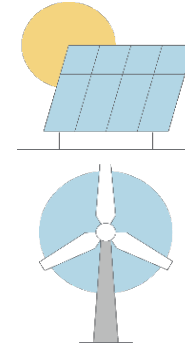
Different geographies will navigate the phases at different periods

Regulatory



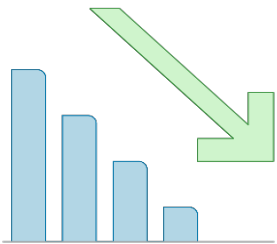
Does the regulatory and legislative environment exist to promote zero carbon targets?

Need For Storage



Does your power grid have enough intermittent renewable power that curtailments are becoming a problem?

H₂ Production & Storage



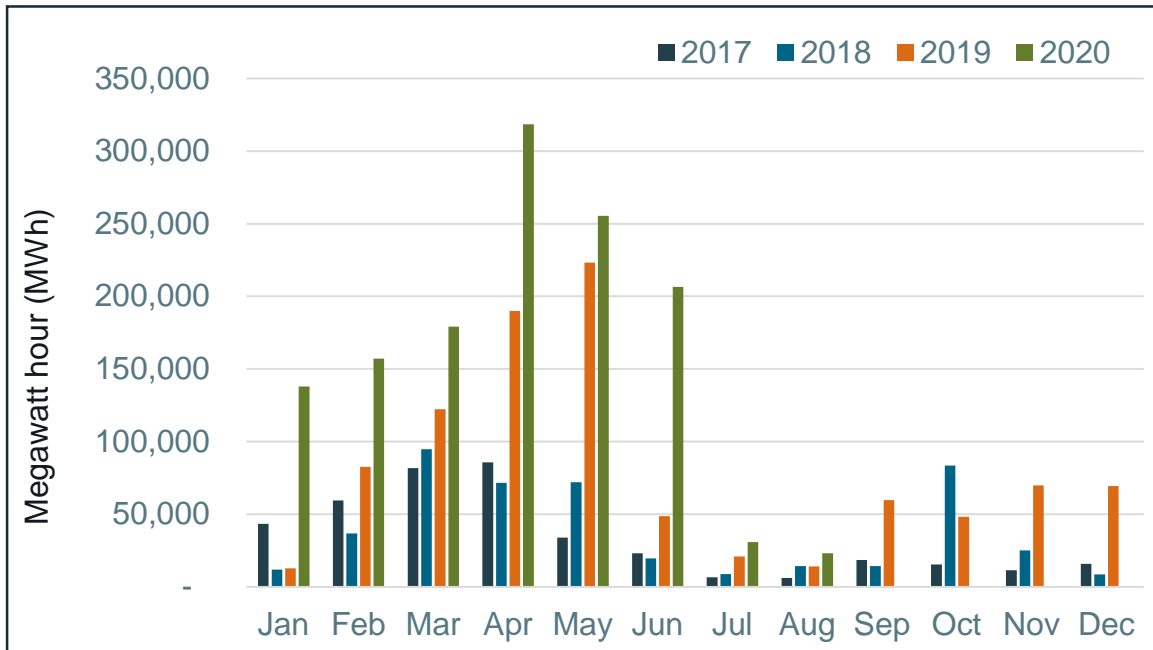
Is the cost of green hydrogen low enough to be the economic alternative for long duration storage?

Technology



Is there a reliable, affordable and scalable solution to convert hydrogen back to electricity?

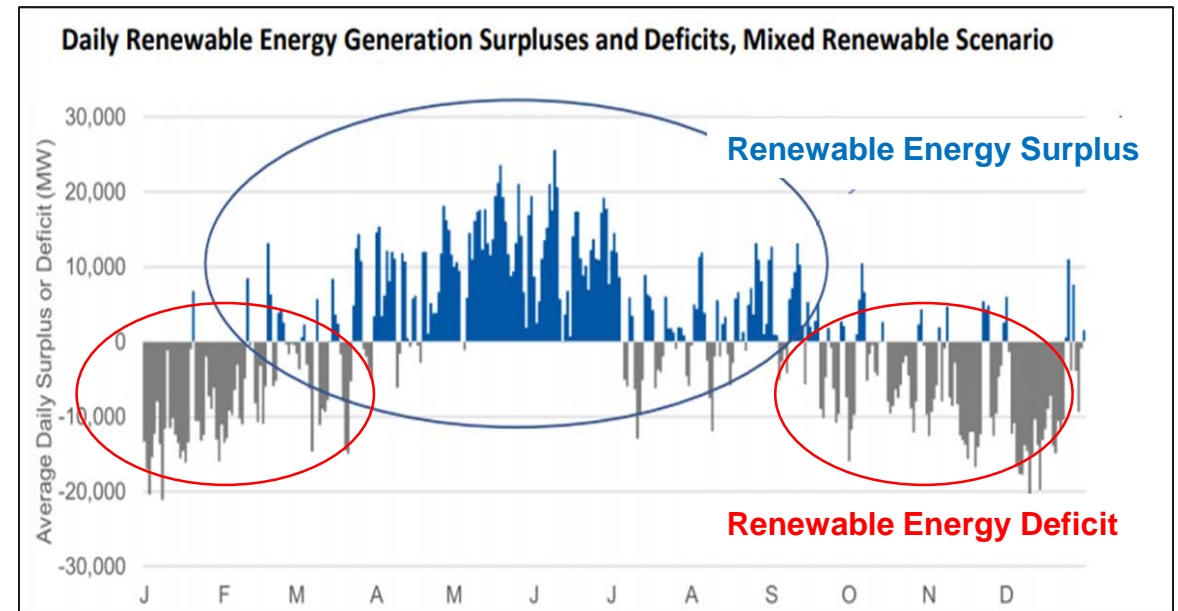
California wind and solar curtailments hit record high in April 2020



Source: CAISO
 Data compiled September 2020
<http://www.caiso.com/informed/Pages/ManagingOversupply.aspx>

At just 30% renewable integration,
 Peak monthly curtailment exceeds 300,000 MWh

California surplus and deficit patterns under a 100% renewable energy scenario

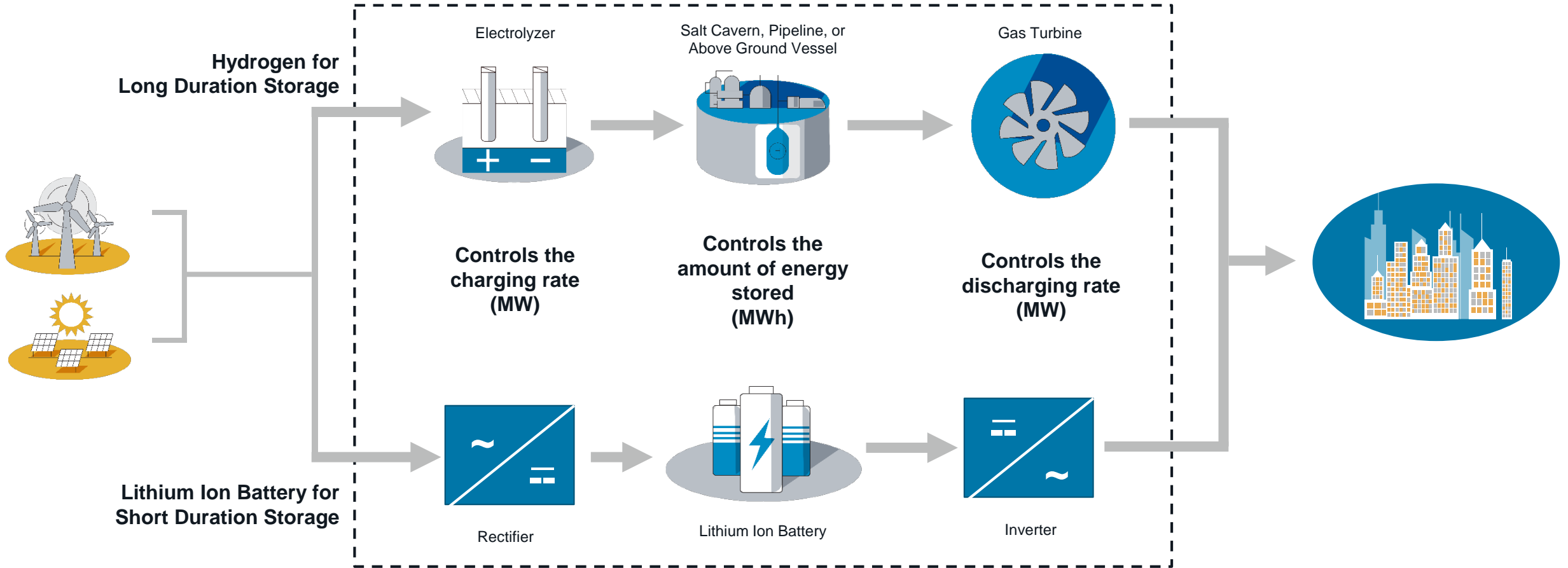


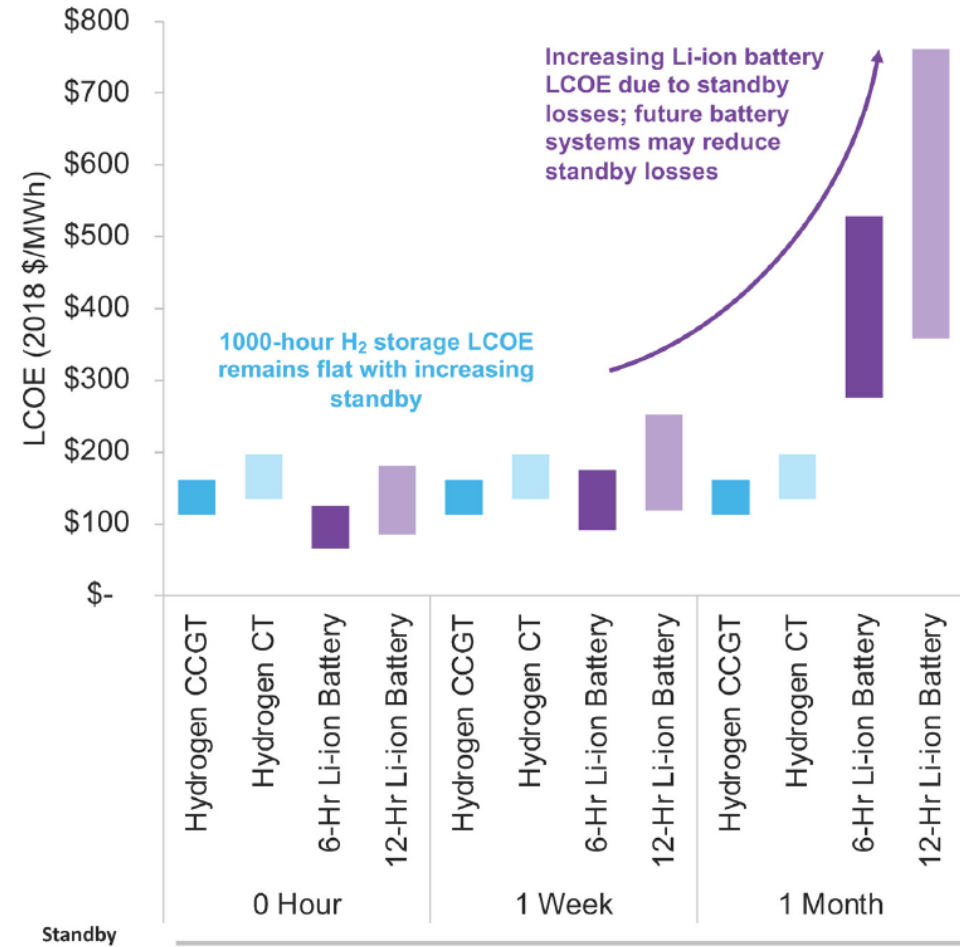
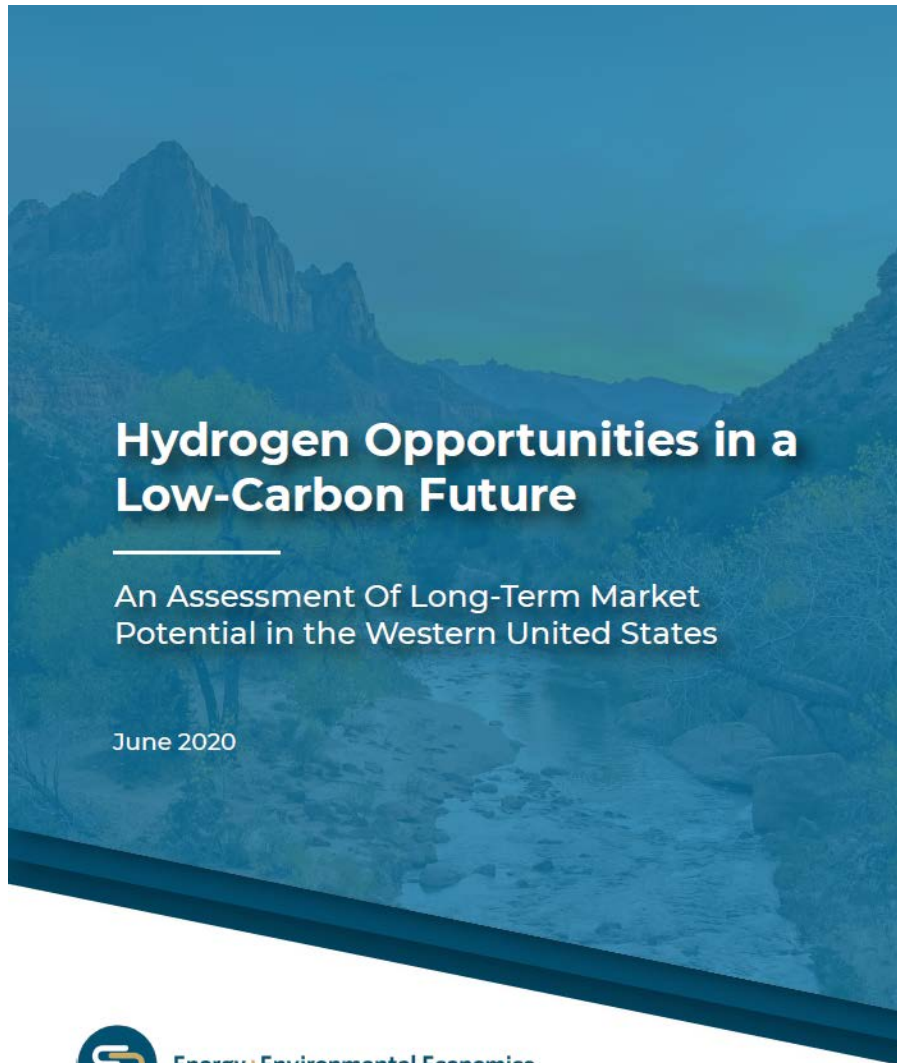
Source: Armonk Cohen Testimony

Seasonal surplus and deficits signal need for long-duration energy storage “beyond the duck curve”

To Store Energy via Hydrogen or to Store via Lithium?

Comparison of Green Hydrogen Energy Storage Systems and Battery Energy Storage Systems





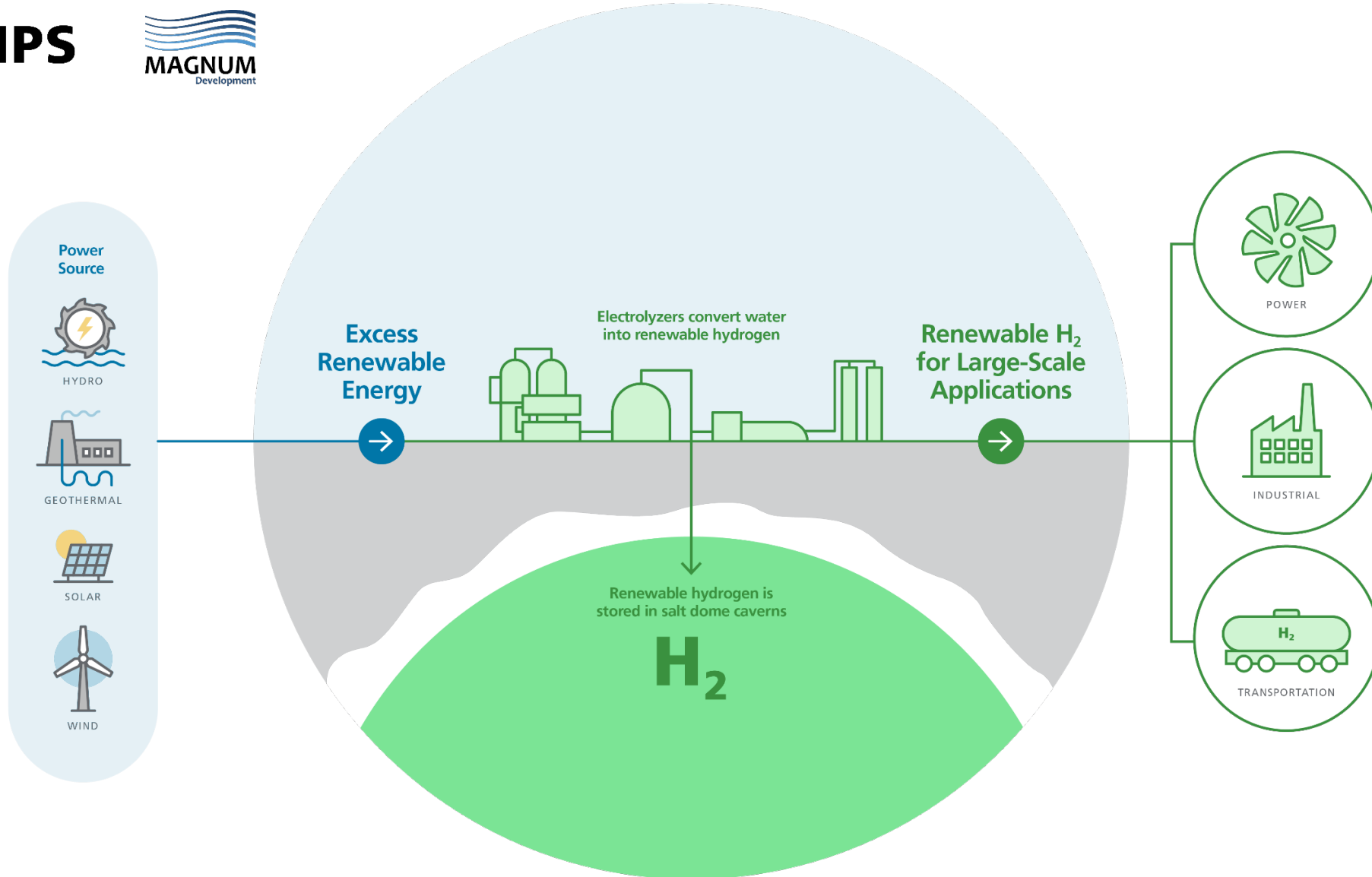
Lithium Ion Batteries Ideal for Short Duration / Intra-Day Storage
Hydrogen Ideal for Long Duration / Inter-Day Storage

- › March 10, 2020 - Mitsubishi Power (formerly MHPS) awarded contract for 2 hydrogen gas turbines
- › The **1st Advanced Class Gas Turbine project** specifically **designed for Green Hydrogen fuel**
- › **840MW of reliable energy** to Los Angeles and municipalities in other parts of California and Utah
- › **In 2025, 30% Green Hydrogen & 70% natural gas** fuel mix when plant operations begin
- › **By 2045, 100% Green Hydrogen** capable to support California carbon-free goals

Intermountain Power Project: Meeting California's 100% Carbon-Free Goals



Advanced Clean Energy Storage: Green Hydrogen Production and Utility Scale Storage



'Largest' renewable energy storage project set for Utah

By Nick Parkinson | 3 June 2019

Mitsubishi Hitachi Power Systems (MHPS) and Magnum Development have announced plans for the 'world's largest renewable energy storage project', to be located in Utah, US.



ACES & IPA
UT

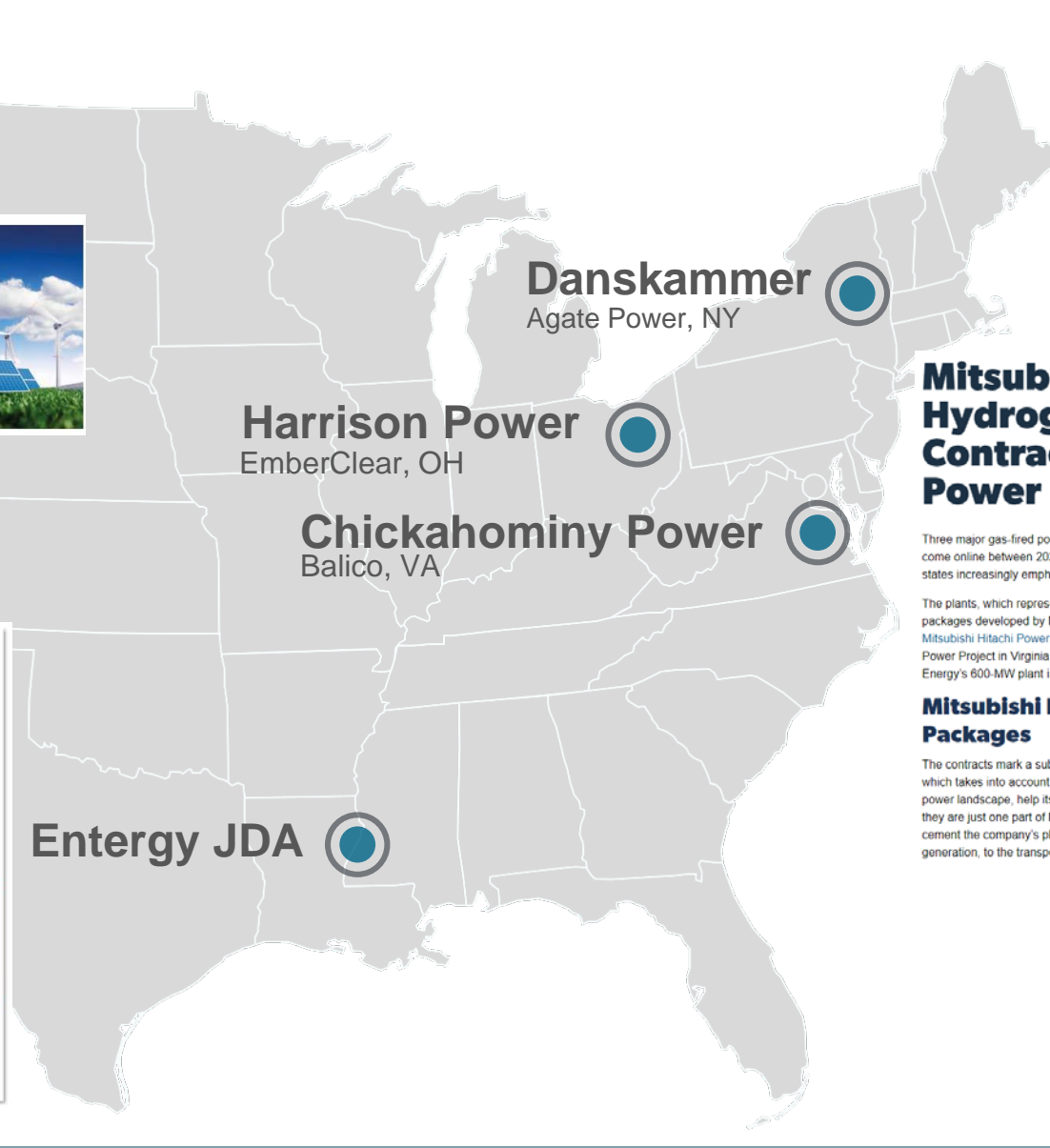
Entergy Moves Heavily on Hydrogen for Gas Turbines, Nuclear

Entergy Corp., an integrated energy company with a 30-GW power generating fleet, took a bold step toward decarbonization on Sept. 23, announcing it would join forces with Mitsubishi Power to integrate green hydrogen into utility businesses in Arkansas, Louisiana, Mississippi, and Texas.

Entergy will focus on developing hydrogen-capable combined cycle gas turbine (CCGT) facilities and related infrastructure to enable hydrogen production, storage, and transportation. Entergy and Mitsubishi Power also said they would create "nuclear-supplied electrolysis facilities with energy storage," as well as develop utility-scale battery storage systems.

Some of these solutions will integrate Mitsubishi Power's freshly announced standardized hydrogen packages, Hydaptive and Hystore. The Hystore package is inspired by Mitsubishi Power's ongoing projects to outfit the 840-MW Intermountain Power Project (IPP) in Millard County, Utah, with hydrogen-capable turbines, as well as the company's massive Advanced Clean Energy Storage (ACES) project, a project that promises to store up to 1 GW of renewable energy as hydrogen gas (and is strategically located near the new IPP facility). The Hydaptive package is focused on site integration, spanning the electrolyzers to the gas turbines.

Earlier this month, Mitsubishi Power announced it bagged lucrative contracts for Hydaptive with three major gas-fired power projects—a total of 2.1 GW—in eastern competitive markets that are slated to come online between 2023 and 2025. The plants, which represent a total investment of \$3 billion, include Balico's 1,600-MW Chickahominy Power Project in Virginia, EmberClear's 1,084-MW Harrison Power Project in Cadiz, Ohio, and Danskammer Energy's 600-MW plant in Newburgh, New York.



Mitsubishi Power Snags Hydrogen Integration Contracts for 2 GW of New Gas Power

Three major gas-fired power projects—a total of 2.1 GW—in Eastern competitive markets that are slated to come online between 2023 and 2025 have chosen hydrogen pathways to ensure their long-term viability as states increasingly emphasize energy system decarbonization.

The plants, which represent a total investment of \$3 billion, will adopt integrated green hydrogen solution packages developed by Mitsubishi Power, a Japanese power equipment giant known until Sept. 1 as Mitsubishi Hitachi Power Systems (MHPS). The gas-fired projects include Balico's 1,600-MW Chickahominy Power Project in Virginia; EmberClear's 1,084-MW Harrison Power Project in Cadiz, Ohio; and Danskammer Energy's 600-MW plant in Newburgh, New York.

Mitsubishi Power Launches Hystore, Hydaptive Packages

The contracts mark a substantial boost for Mitsubishi Power's foundational "Change in Power" campaign, which takes into account a recently rejiggered business strategy to respond to rapid changes across the power landscape, help its customers combat climate change, and generally "advance human prosperity." But they are just one part of Mitsubishi Power's larger global strategy to leverage hydrogen's potential and cement the company's place in a hydrogen economy, with impacts that could extend far beyond power generation, to the transportation and manufacturing industries, for example.

100% Hydrogen Fuel =
Zero CO₂ Emissions

Based on Proven and
Commercially Deployed Technologies

Over
3.5 MILLION
hours of H₂ turbine operation

First H₂ pipelines
1930's

Large-scale electrolysis
systems since
1940's

First H₂ storage in salt caverns
1980's



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