# Market Structure Innovations to Build More Long Duration Pumped Storage

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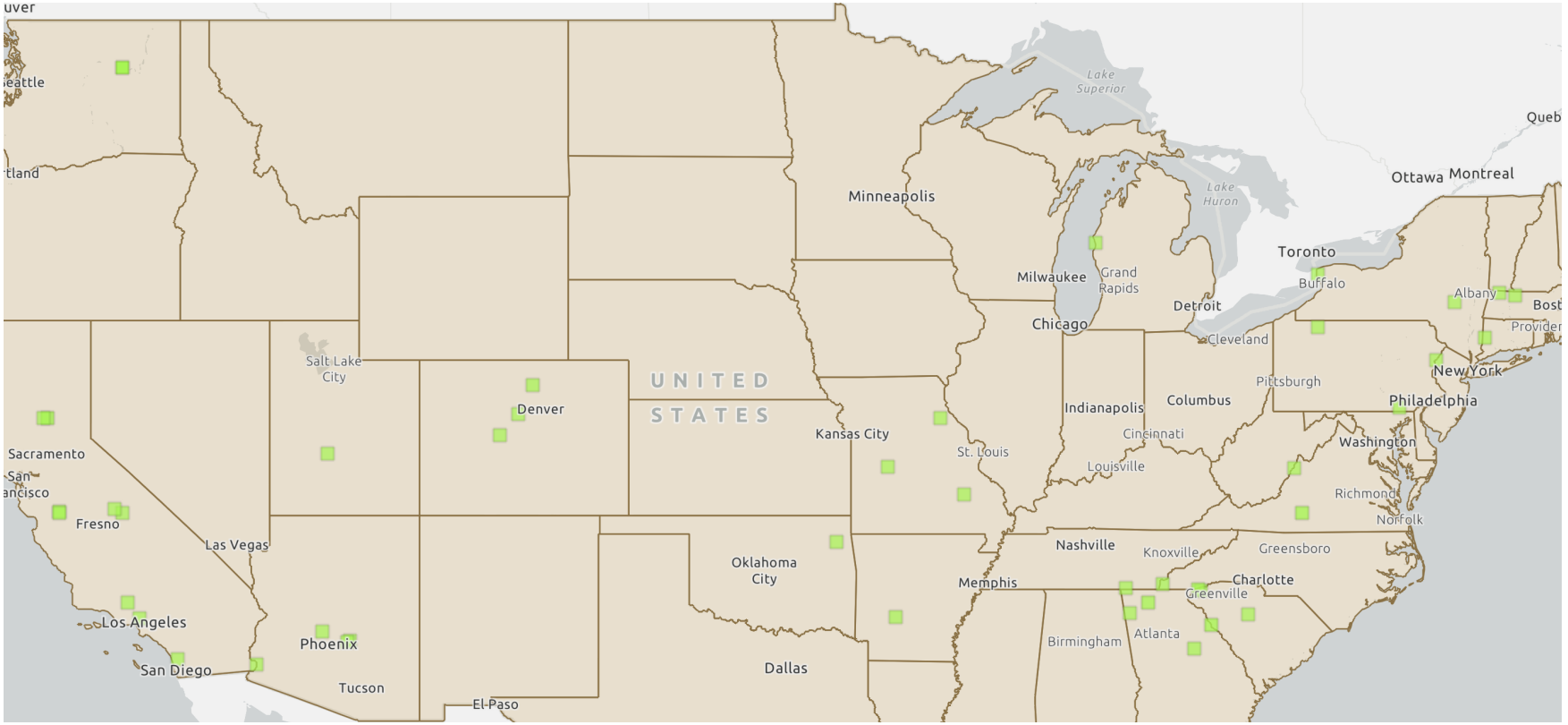



# The Largest Existing Source of LDES

- PSH is the nation's largest and most established form of long-duration energy storage (**43 plants**).
- **22 GW** operating today delivers **~90%** of U.S. utility-scale storage capability, due to its long duration discharge (8-20hrs).
- Firm, dispatchable operating fleet provides foundational reliability services and proven performance at scale.
- The **"Swiss army knife"** of the grid

*NHA Hydro Facts Interactive Map: hydro.org/facts*

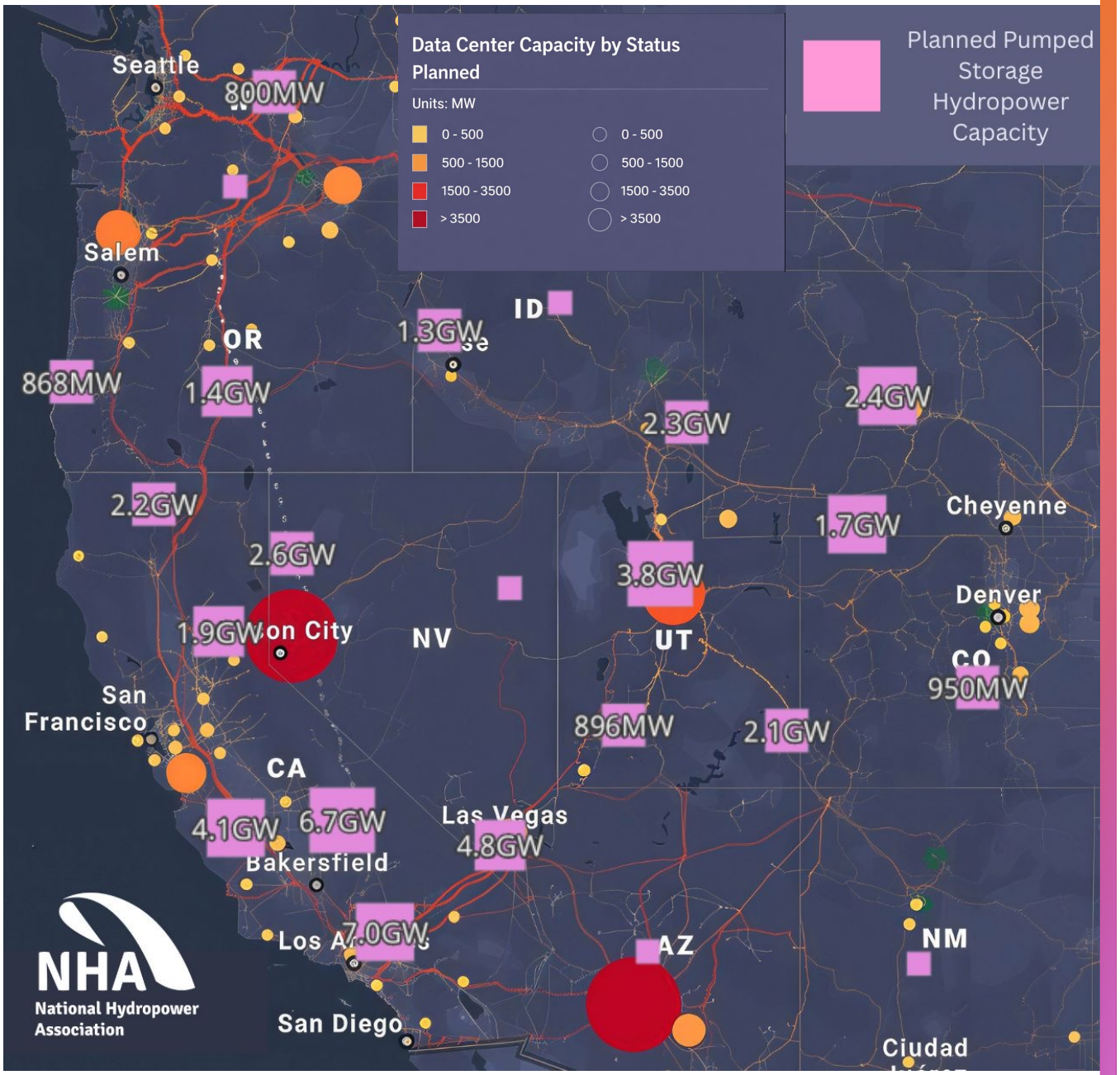
# A Pumped Storage Renaissance

- **60 GW** of PSH in the U.S. development pipeline
- **85%** located in Western Energy Coordinating Council (WECC) service territory.
- WECC electricity demand projected **+20.4%** (2025–2034), driven by data centers

**4** FERC Licensed Projects

**2** non-FERC projects underway

*NREL Speed to Power Map with overlay of pumped storage development pipeline*



# Grid-Forming Services and Solutions

- Grid-forming inertia, voltage support, and frequency response from synchronous spinning mass.
- Absorbs surplus baseload and variable generation for 8-20hr discharge
- Black start and restoration capabilities; can re-energize the grid after major outages.
- Help reduce transmission congestion and curtailment, thus lowering prices, by serving as both a load and a generator

*Half of all congestion costs occur in just 5% of hours*

*Oconee Nuclear Station built alongside Bad Creek and Jocassee Pumped Storage Facilities in 1974*

# Current Market Challenges

***In RTO/ISOs***

## 1. Capacity accreditation is increasingly unpredictable and does not serve LDES

- Some regions still rely on **4-hour capacity rules**
- **Effective Load Carrying Capability (ELCC) outcomes are highly model-dependent**, varying year to year and undermining investor confidence
- ELCC frameworks focus on **narrow peak risk windows**

## 2. Ancillary and flexibility services are often undervalued

- No priced market product for **inertial supply** despite Inverter Based Resources penetration
- **Black start** is compensated through out of market uplift
- **Reactive power and voltage compensation** is being actively contested

## 3. Arbitrage prices alone are insufficient as supply saturates

- Revenue **margins** are shrinking as batteries enter the market

# Current Market Challenges

***In State Procurement Markets***

**1. Most state storage procurements are still designed around 4-hour, diurnal peak needs, not multi-day reliability**

**2. Short-term capacity contracts do not provide revenue certainty for capital-intensive LDES assets**

**3. State RFPs and IRPs do not compensate the opportunity cost of holding stored energy for extreme events**

# Policy Solutions

## STATE

**1**. State Integrated Resource Plans (IRPs) and Resource Adequacy (RA) studies must align storage procurement targets with multi-hour and seasonal reliability needs

*California Public Utility Commission* – LDES Procurement Strategy

**2**. State Energy Offices must work with state resource agencies to streamline their contributions to FERC licensing process, reducing delay and financial risk

## FEDERAL

**1**. States should encourage FERC to initiate a targeted rulemaking directing RTOs and ISOs to remove barriers to long-duration storage participation in wholesale markets.

*Order 764* — adapted markets for variable renewables
*Order 841* — opened markets to storage

# Thank you!

# Consequences of Market Failures

1. Potential offtakers looking to enter PPAs are **unwilling** to sign 20-40-year contracts with *long-lead, capital intensive* projects if there is **little confidence** in future market conditions.

2. Merchant pumped storage developers struggle to secure the long-term revenue **certainty** needed to assure lenders that LDES **construction** can proceed.