national**grid** ventures

Pumped storage: long-duration bulk storage

Rye Development



400-MW "closed-loop" **Swan Lake Pumped Storage Project** in southern Oregon



1200-MW "closed-loop" **Goldendale Energy Storage Project** in eastern Washington

national**grid** Ventures Rye Development

Pumped storage is a "sure thing"

- Pumped storage is the only proven, costeffective storage at scale
- Consists of pumping or generating by moving energy in the form of water through a powerhouse between an upper and lower reservoir
- Pumped storage is prolific in the US there are 39 pumped storage plants in operation with a total installed capacity of about 22,000 MW; however, over 2 decades since last built in US
- Globally, there is nearly 131,000 MW of pumped storage capacity currently in operation; currently building all over world but US
- Batteries still very expensive, uncertainty viability in replacing thermal plants, don't last nearly as long and come with mining/toxic waste issues



Other

1.7%



Lower Reservoir

0.1%

0.8%

Over 6 GWs of spinning mass/inertia slated for retirement & very difficult (if not impossible) to build new gas-fired plants



CA 100% modeling selects mostly solar and ventures storage to meet decarbonization goals

- 100%+ RPS achieved by 2050 in both scenarios
- RESOLVE utilizes a Planning Reserve Margin constraint but does not examine resource adequacy in detail



Pumped storage strategically located in grid for new carbon-free flexible capacity

national**grid** Ventures Rye Development



- Viable, constructible "closed-loop" projects interconnecting into
 existing high-voltage
 transmission that leverages major
 import/export path to California
 (i.e. AC & DC Interties)
- Proven storage solution strategically located in grid to support regional decarbonization goals affordably and reliably
- Projects support continued history of beneficial regional bulk power exchanges between California and the Pacific Northwest evolving from seasonal to daily
- Hundreds of millions of dollars in annual potential cost-saving/ revenue regionally to grid based on E3 modeling; over 6000 jobs during multi-year construction period

Barriers to building new pumped storage

- Carbon-free flexibility/storage will be critical for higher penetrations of renewables and reliability
- However, benefits of storage difficult to value in fragmented, deregulated markets and IRP processes (i.e. the Balkans)
- Also, IRPs do not expressly model or address market prices that can result from a tight capacity market (WUTC's concern on PSE's 2017 IRP in acknowledgement letter)
 - Game of "capacity chicken" going on in PNW with building new capacity
 - Everybody knows there is a potential problem but nobody wants to own it
- Bottom-line, need adequate economic modeling tools at the granular level necessary to show full value of storage both as generation and transmission for regulatory approval/cost-recovery to procure/commercialize
- Lastly, regulators need to encourage/incentivize utilities for building new carbon-free flexible capacity/storage in a orderly, planned fashion taking into execution/resourcing/capital deployment on a reasonable guidepath to decarbonize