The Future Role of Hydropower in the Northeastern US and Beyond

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John Simonelli, Managing Director, Flashover LLC

2023 ESIG Spring Workshop Tucson AZ
Session 4
March 28, 2023

HickoryLedge

Flashover LLC

Background

- A look at the future role of hydropower in the Northeastern US and beyond and how it can best support the reliable and economic evolution of decarbonization efforts
- Challenges driven by the integration of 10s of GWs of variable energy resources
- Work supported by DOE and NREL as part of the extensive activities of the DOE Water Power Technology Office

The Future Role of Hydropower in the Northeastern United States

May 2020–May 2022

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1 HickoryLedge LLC
2 Flashover LLC

NREL Technical Monitor: Greg Stark

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Subcontract Report
NREL/SR-5700-80168
April 2022

http://www.nrel.gov/docs/fy22osti/80168.pdf

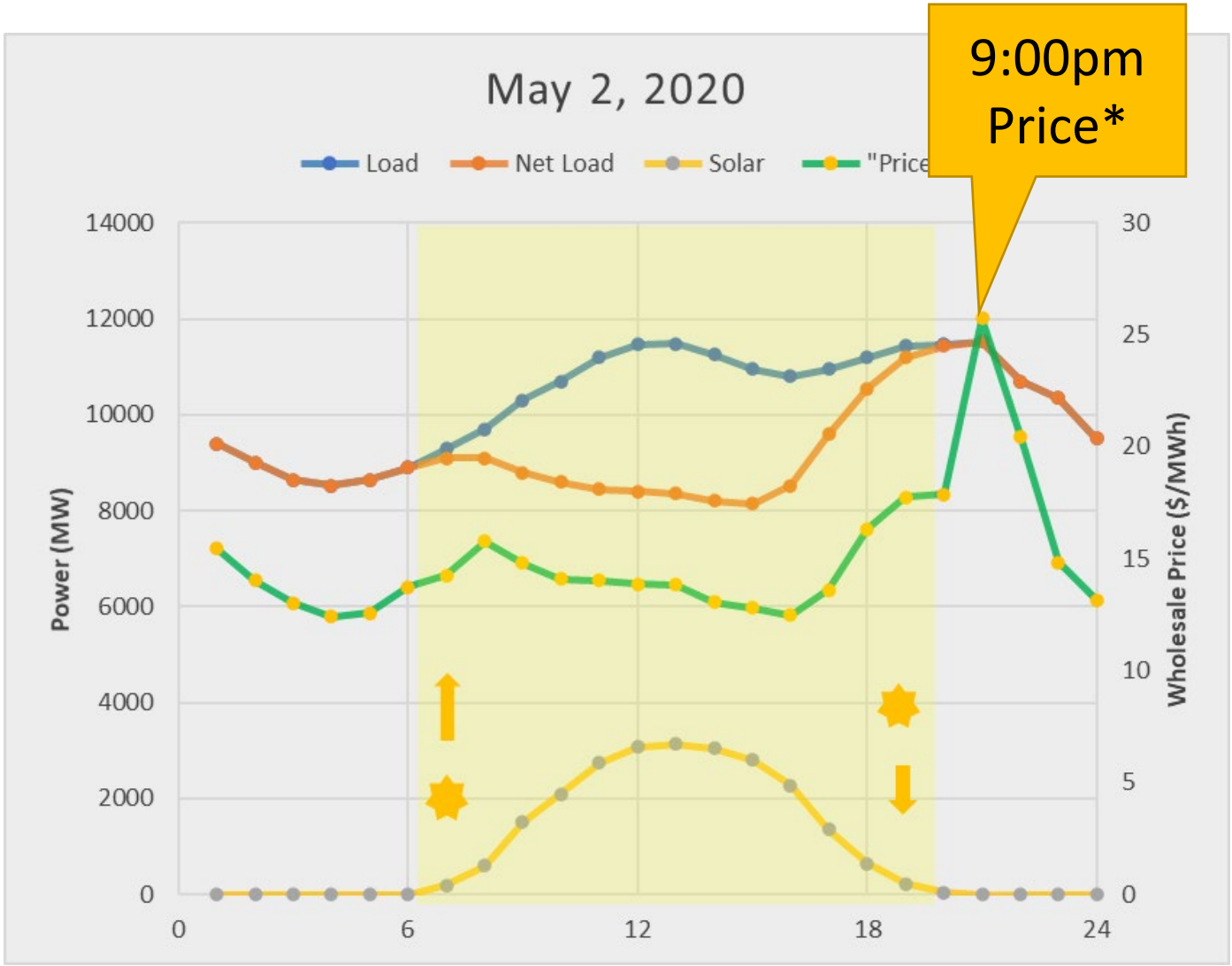
New England Region

- > 350 generators and 9,000 miles of HV lines ; interconnections to NY and Canada
- 31,500 megawatts (MW Capacity Obligation) of supply 767 MW of demand resources
- Population 14.8 million; All-time peak demand of 28,130 MW - 02/09/2006
- $3.0 billion energy market and $2.7 billion capacity market; 500 participants
- ISO-NE is the Independent System Operator for the Region; Under FERC jurisdiction
  - Neutral as to resource fuel type

New England's Duck

An example:

- High Solar Day May 2, 2020
- Significant BTM PV impact
- Midday price depression
- Evening price spike



*ISONE Day-Ahead LMP 5-22-20

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New England's Duck

An example:

- High Solar Day May 2, 2020
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- Midday price depression
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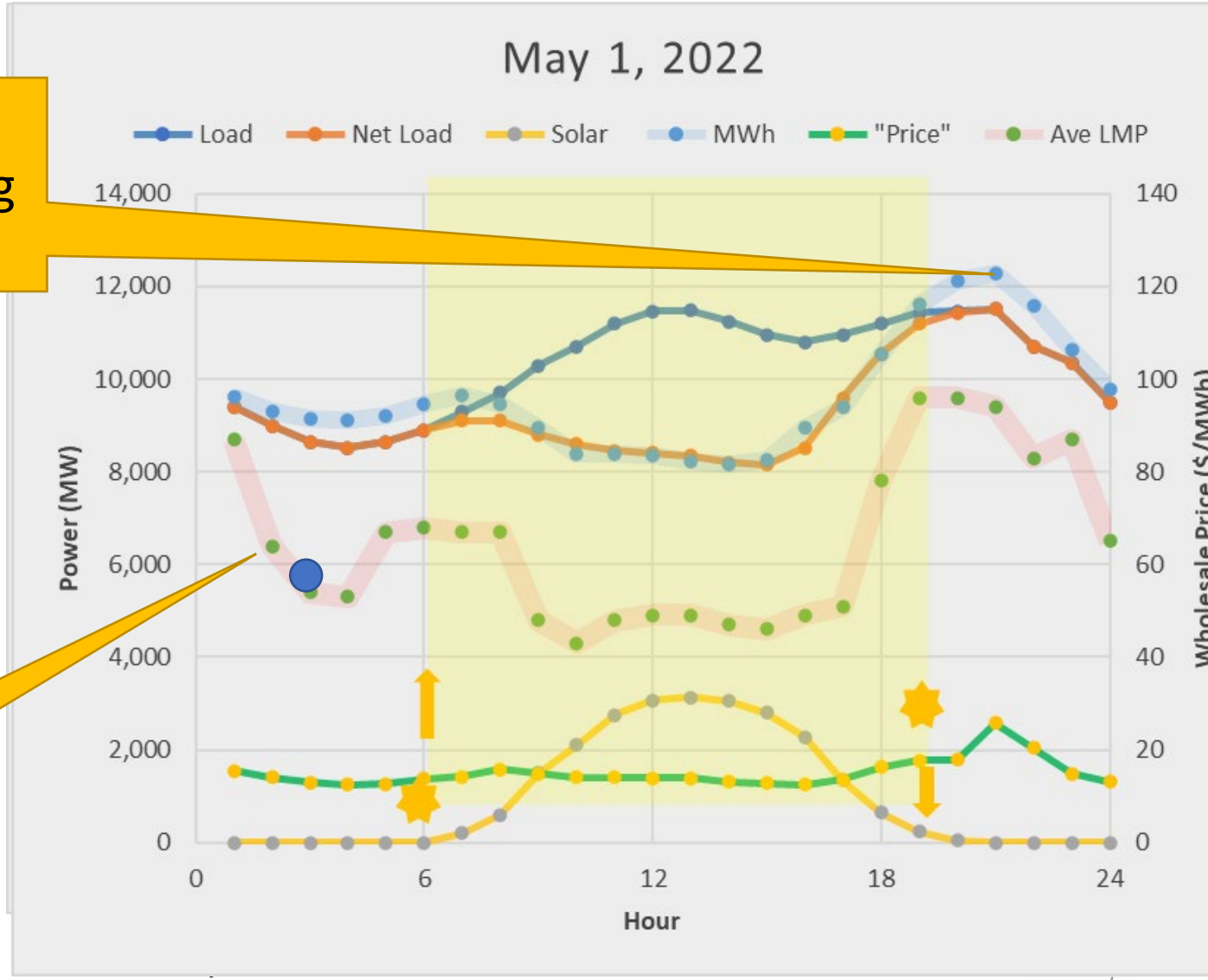
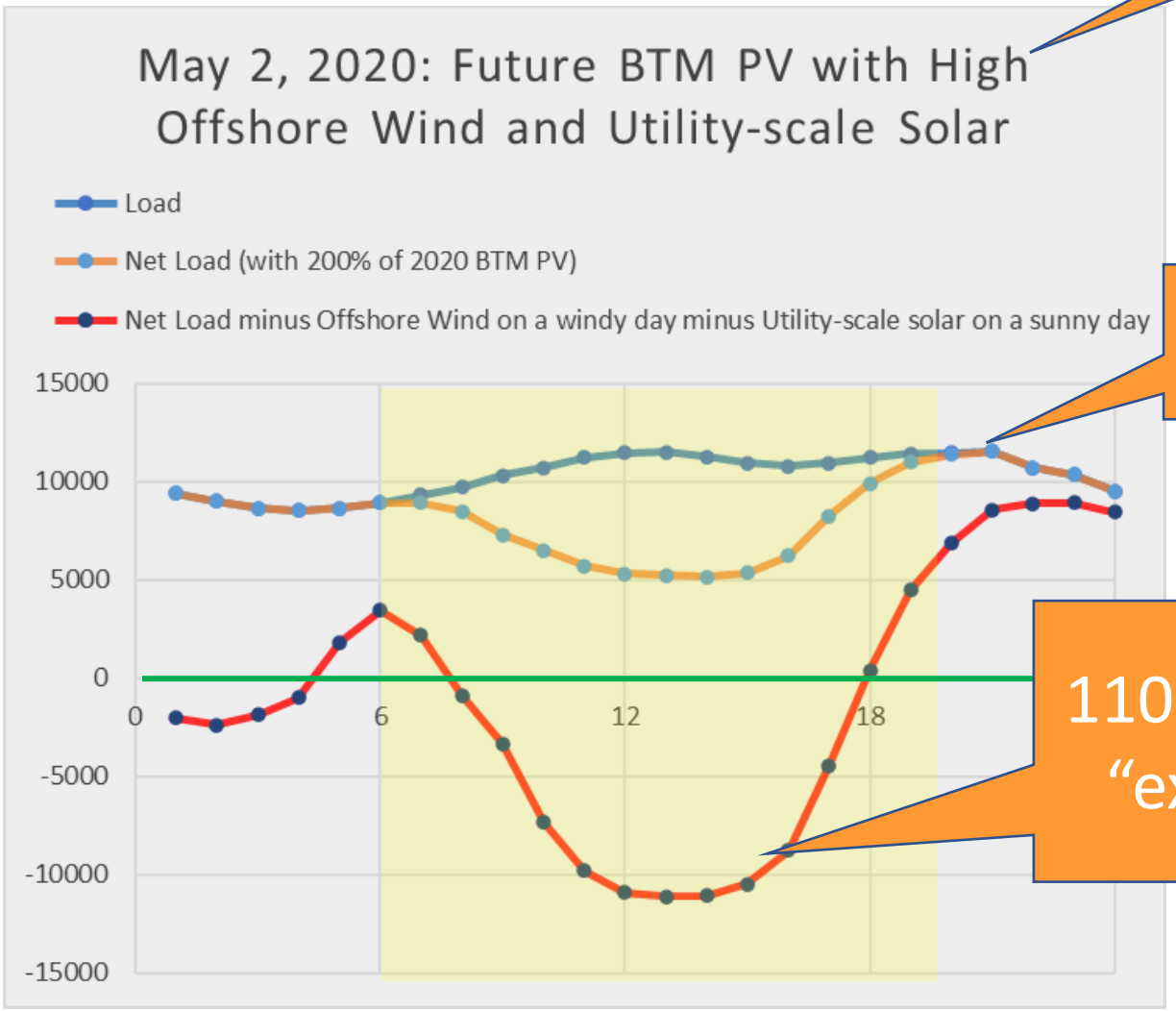
May 1, 2022: Net min similar; evening peak higher

May 1, 2022: Prices ~3x compared to 2022



New England in the Years to Come

- Combined BTM Solar and Offshore Wind impact on Net Load
- Possible “what if” future duck curve challenge
  - Illustrative, not exhaustive
    - Expected wind & solar on light load day
  - What challenges does it present from operational perspective?
    - Over generation
    - Renewable curtailments
    - Congestion



11.4W new wind

Flat load

11000 MW “excess”

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DOE

- Potential for 350 GW
- 35 TWh
- ~14k sites
- 10hrs
- But not *huge* options in New England
- 1 future look added 6-7GW of PSH in a low carbon future

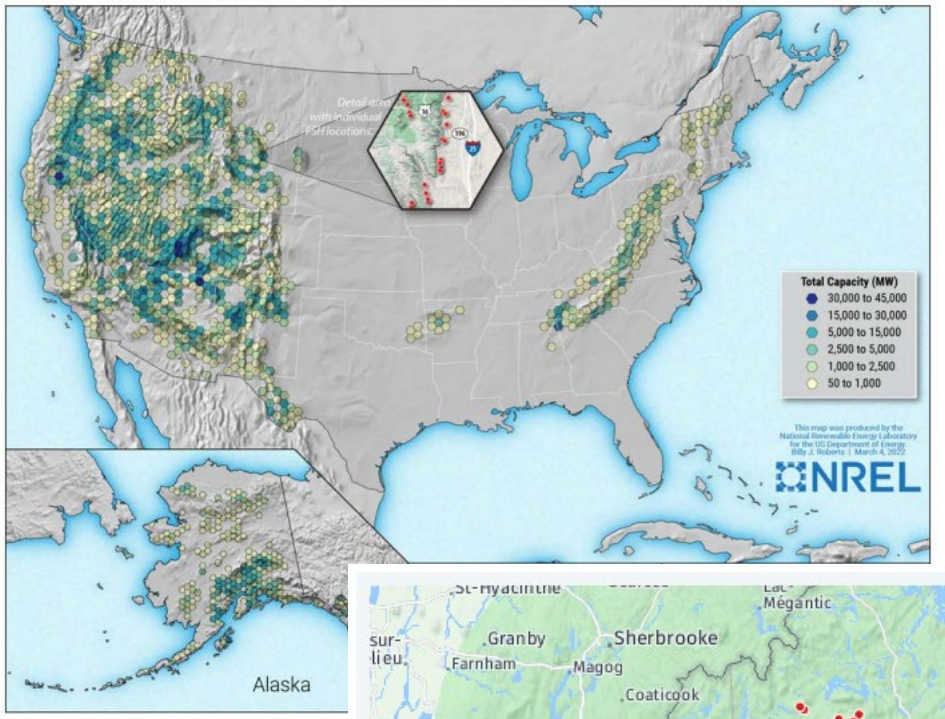


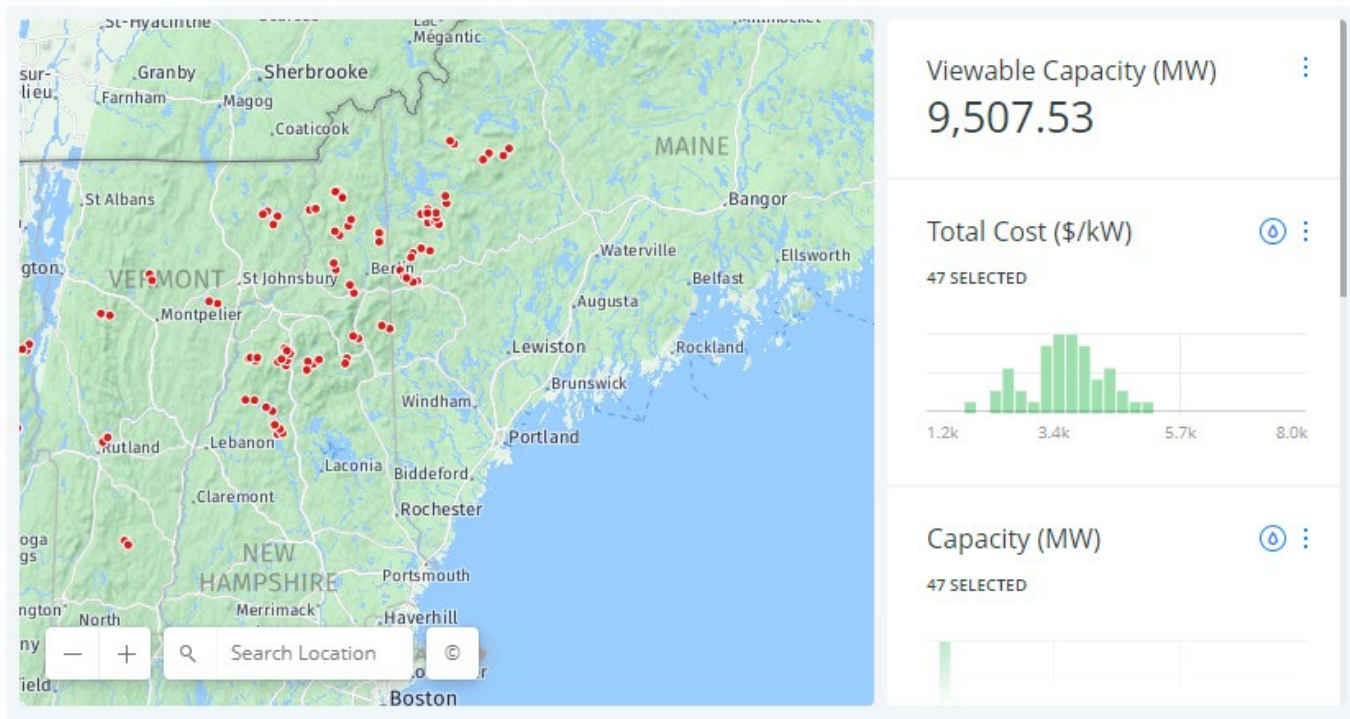
Figure ES-1: Spatial distributi

HydroWIRES
U.S. DEPARTMENT OF ENERGY

Closed-Loop Pumped Storage Hydropower Resource Assessment for the United States

Final Report on HydroWIRES Project D1: Improving Hydropower and PSH Representations in Capacity Expansion Models

May 2022



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It's not just MWs and MWhs

FKA "Ancillary Services"

- System needs critical Essential Reliability Services (ERS) to maintain reliability:
  - Keeping frequency healthy: inertia & frequency response
  - Keeping voltage healthy: voltage regulation and reactive power supply
  - Following the variations: Reserves and Ramping
  - Putting the system back together: black start & system restoration
  - Keeping protection working and inverters (wind, solar, BESS) stable: maintaining short circuit strength
- ERS can become scarce with increasing renewables/changing resource mix and retirements.
- Hydro can provide all ERS
- Some of these services are presently under-valued or lack market signals for investment: Many of these are arguably NETWORK functions

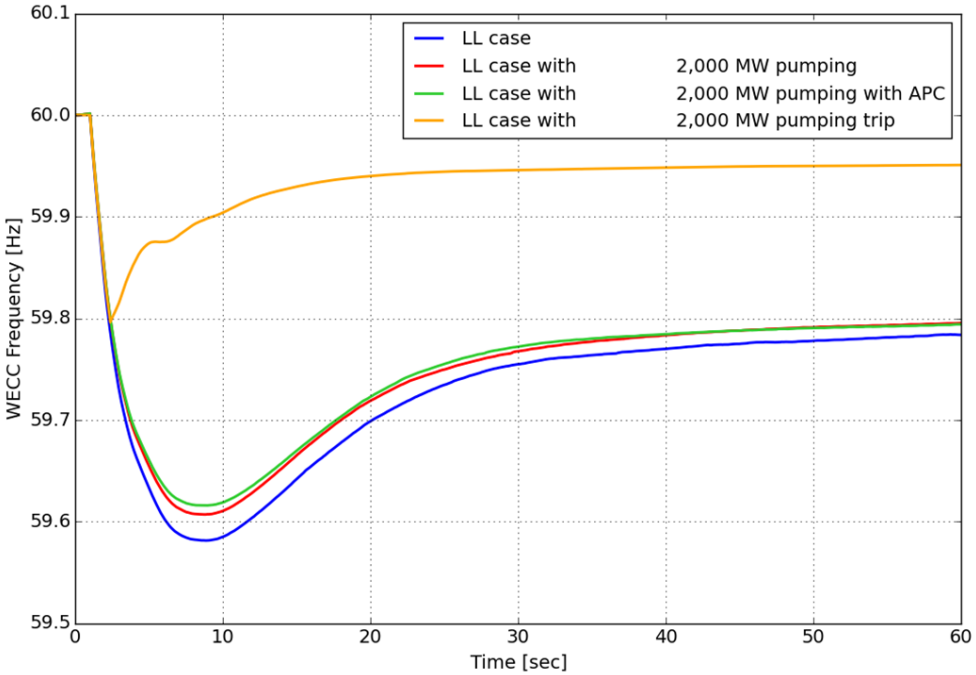
Dynamic Functions

- Frequency Response
  - Inertia
  - FFR
  - PFR
  - Reg
  - Tripping/E-Stop
- Power Control
  - Ramp Rate
  - Reversing Power (mode change)
  - Economic Dispatch
  - PSS/POD (P based)
- Reactive Control
  - Plant Volt/Var
  - No-load/stationary Q
  - PSS/POD (Q based)
- Transients
  - FRT.
  - Protection and Short circuit current
- Blackstart

Fast Stop/Trip (as FFR)

Size matters!

- Tripping of PSH in pump mode may qualify.
  - Details uncertain;
  - ERCOT has a separate category of FFR (extension of LAARs)
  - Distrust, costs associated with breaker actions.
- "Electronic" trip is accomplished by electronics, rather than breaker action.
  - Less stressful/lower variable costs for equipment.
  - More repeatable.
  - Lower penalties for false triggers.
  - An advantage for asset owner and ISO (my opinion)
- In future, "armed" tripping may be a big advantage;
  - For event A (at this minute of operation), Trip X MW
  - For event B (at this minute of operation), Trip Y MW
- Puts an operational tool in hands of ISO that has lower reliability (i.e. NERC) "friction" for implementation that breaker actuation.



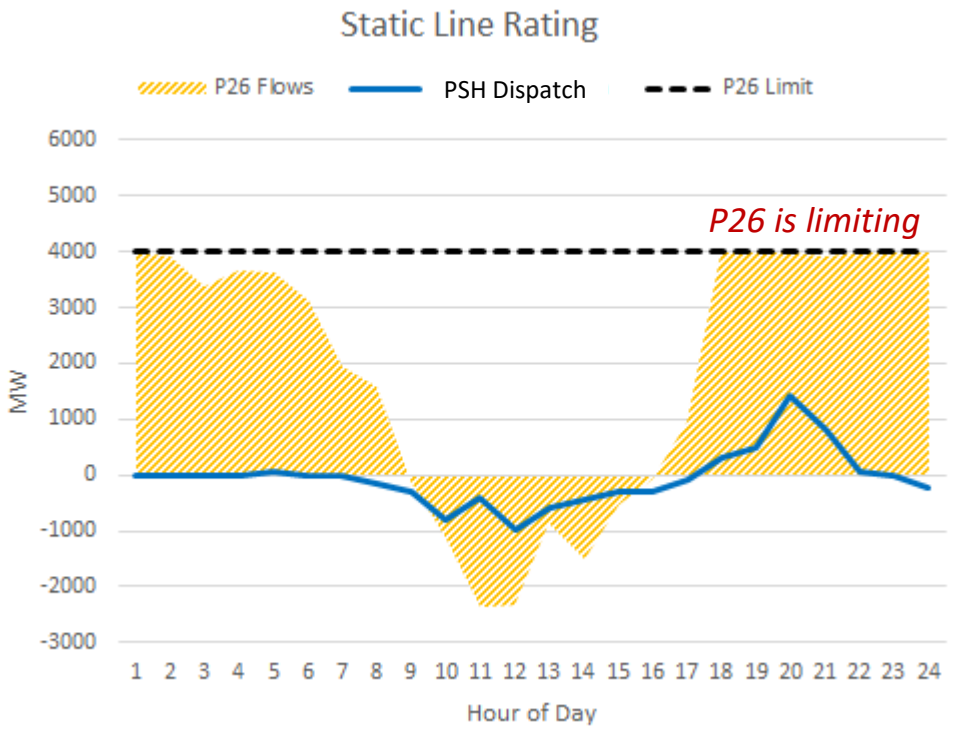
*ERS – Essential Reliability Services. Per NERC

Dynamic Path Ratings

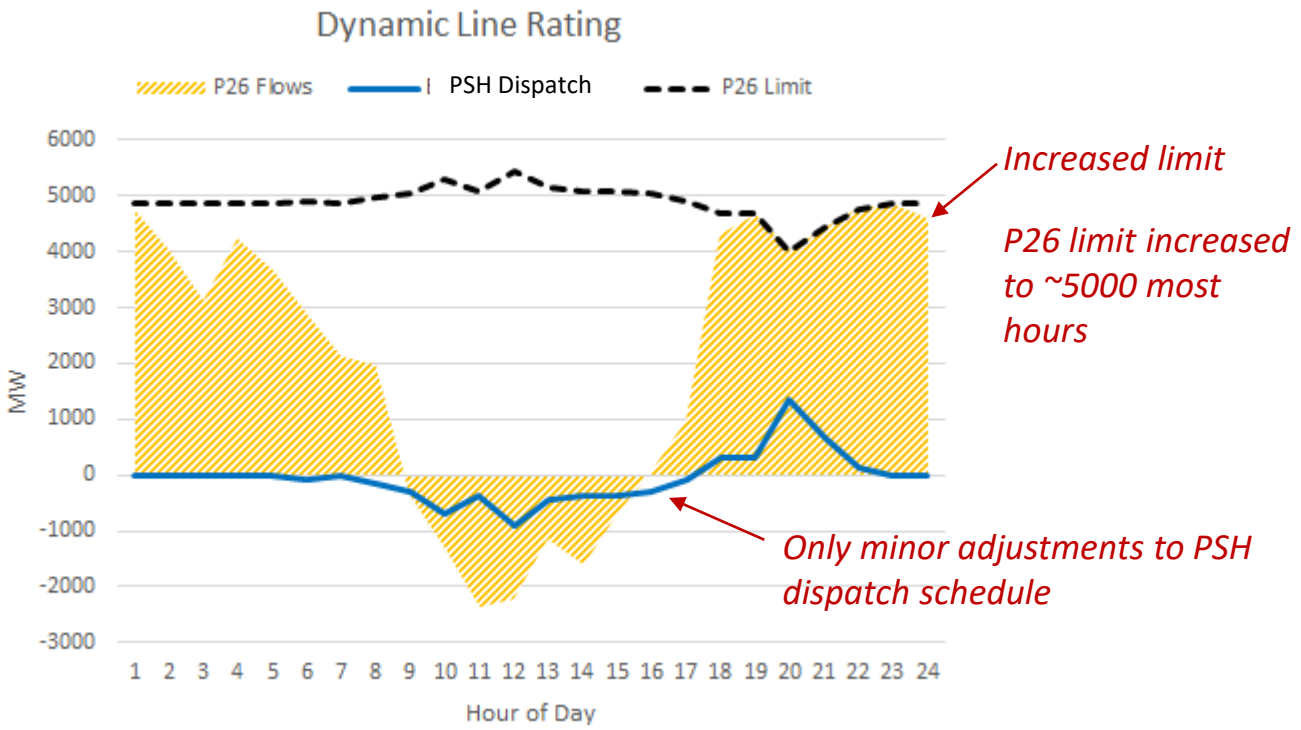
924MW… like getting most of a new 500kV transmission line

**based on CAISO 2019-2020 LTPP*

How CAISO Operates Today…



Novel transmission planning with PSH RAS…



June Results… increased Path 26 Limit 93% of hours, average of 924 MW

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Hydro's critically important (network?) services

Voltage control:

- Excitation systems are critical to maintaining a stable voltage profile across the system
  - Hydro (older) may benefit from upgrades to increase the speed of excitation and increase lead/lag reactive capability.
  - Voltage support is locational by nature.
    - Hydro often in remote location with acute needs.
  - Condenser mode increasingly valuable.
    - Historically some hydro units have been able to operate in this mode (not producing MW but providing leading and lagging reactive capability). Some modifications to hydro plants may be required. Wear and tear must be considered.
  - No market signals to invest in upgrades and limited market revenue stream.
    - Some wholesale markets provide small compensation. Incentives to upgrade equipment largely absent.

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Hydro's critically importan

Conowingo (6/28/22):
"We had the capability to run condenser mode, but don't get paid for it and don't use it now"

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Beyond “our” community: Stanford “Uncommon Dialogue” (UCD)

- 90000+ dams under Federal jurisdiction, of which 2500 make electricity
- over 300 participants and has resulted in multiple agreements using a “coalition of the willing” model.
- Federal legislation includes ~ $5B for the “3Rs”
  - Rehabilitate for Safety
  - Retrofit for Power (and Environmental Improvements)
  - Remove for Conservation (and Climate, Safety)

Stanford Woods Institute for the Environment

Energy Futures Initiative

Steyer-Taylor Center for Energy Policy and Finance

American Rivers

National Hydropower Association

World Wildlife Fund

Eagle Creek Renewables

Union of Concerned Scientists

Low Impact Hydropower Institute

Great River Hydro

Rye Development

American Whitewater

Hydropower Reform Coalition

Natel Energy

Hydropower Foundation

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A wide array of viewpoints, parties, and observers

Dialogue Participants

4% Dam Safety

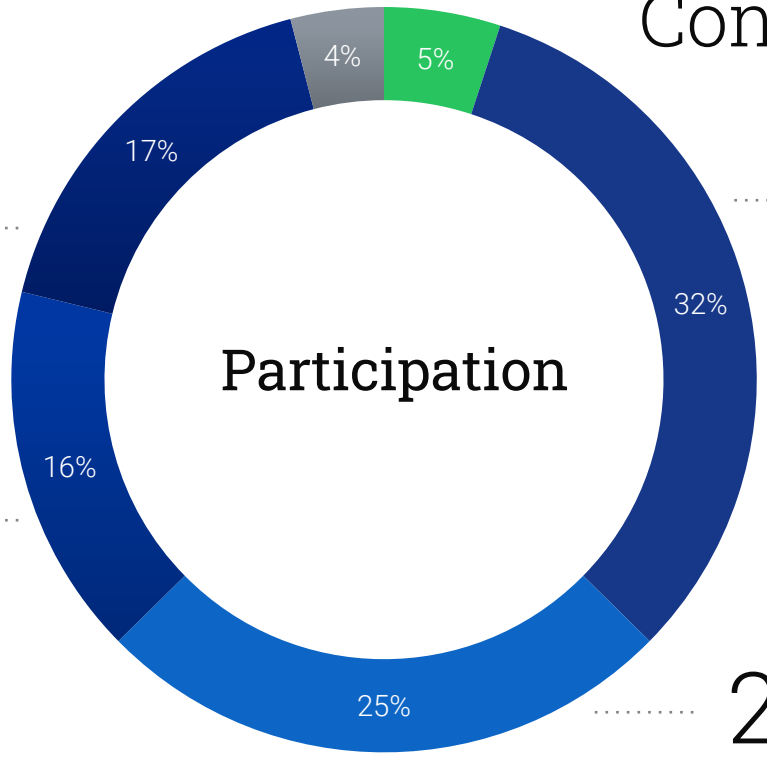
5% Convenors and Facilitators

17% Tribes

32% Observers

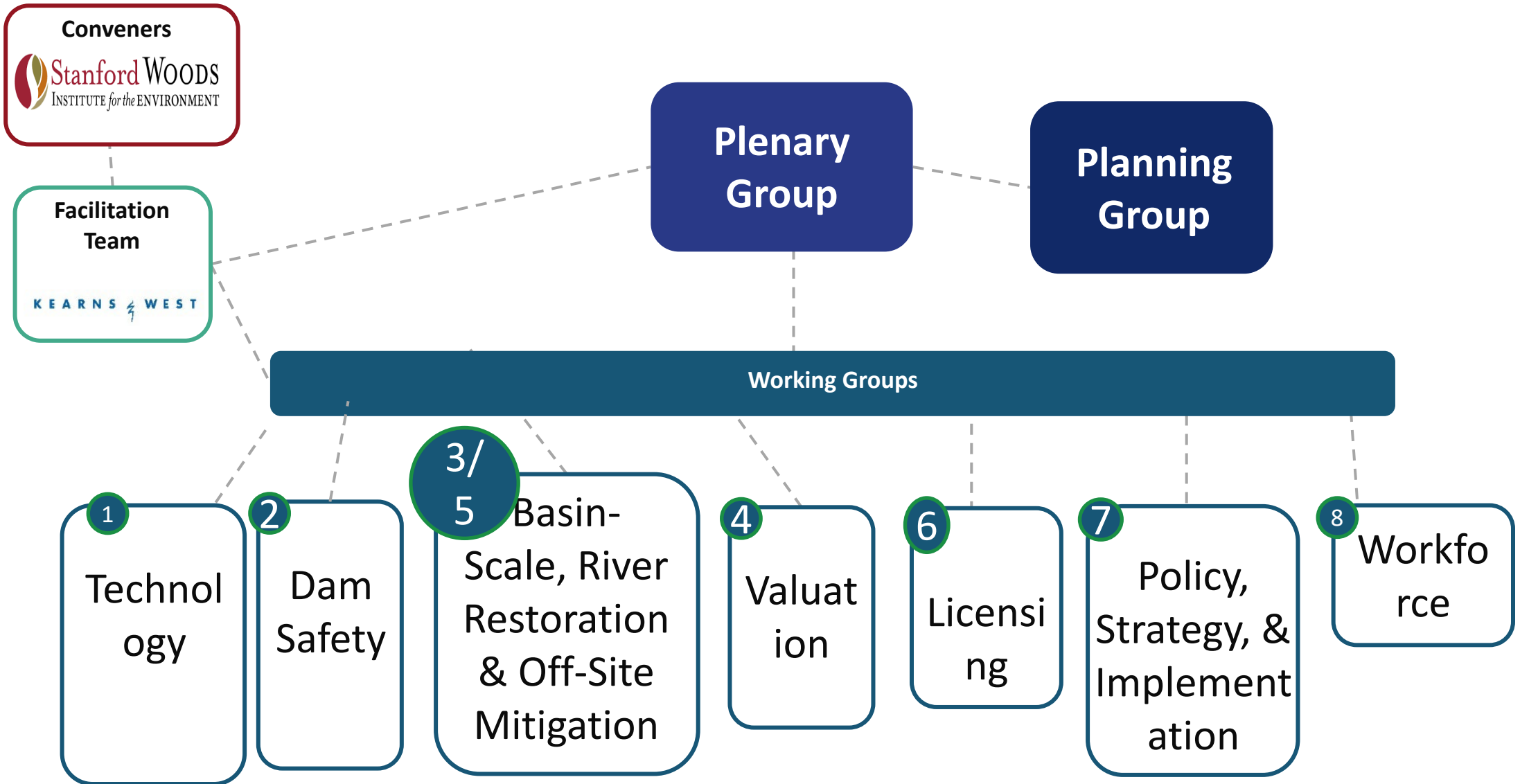
16% Environmental Nongovernmental Entities

Hydropower Industry 25%



Inclusive planning, working group leadership, and facilitation ensure all parties are heard

Structure and Process



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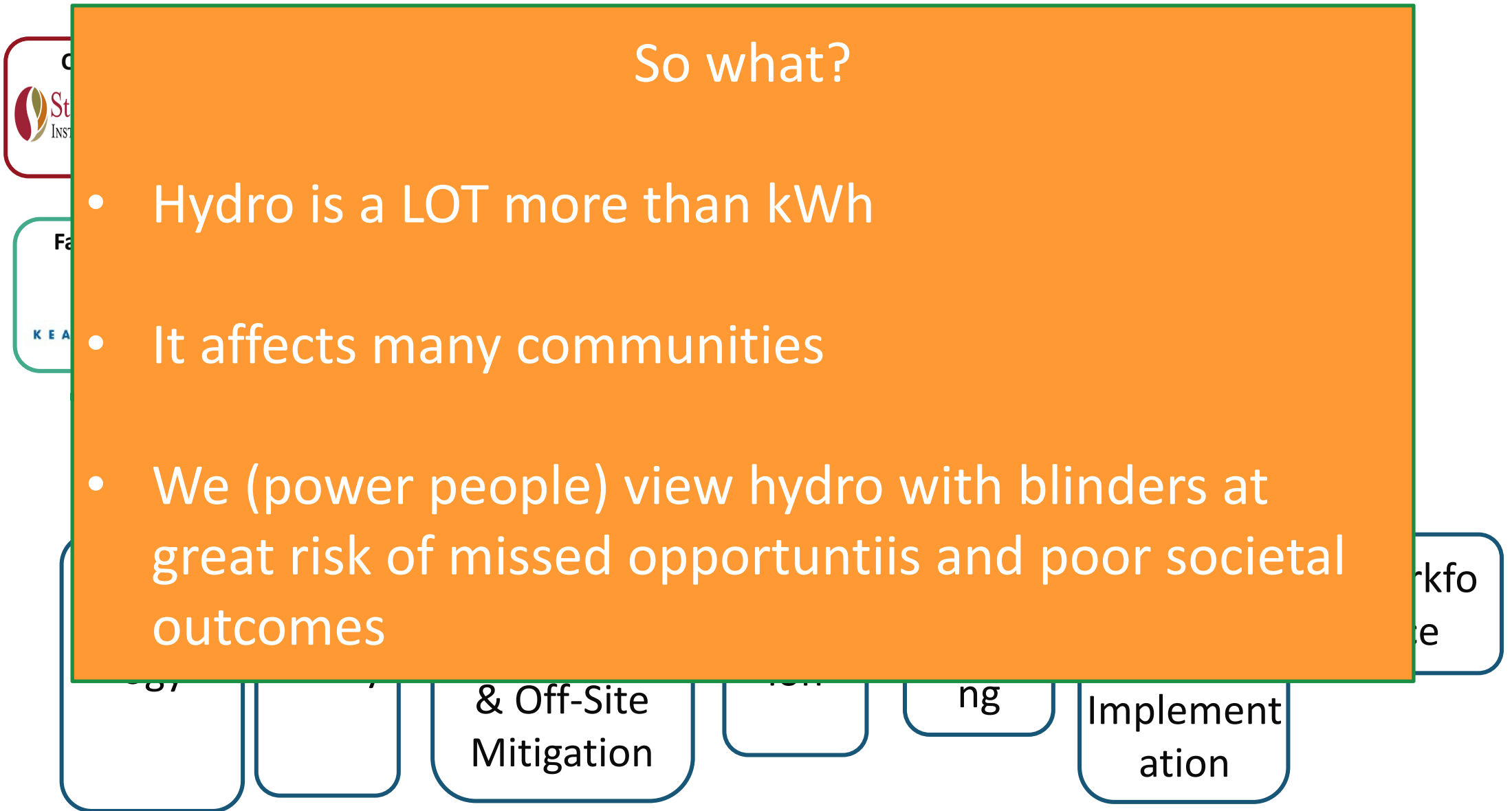

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Questions

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