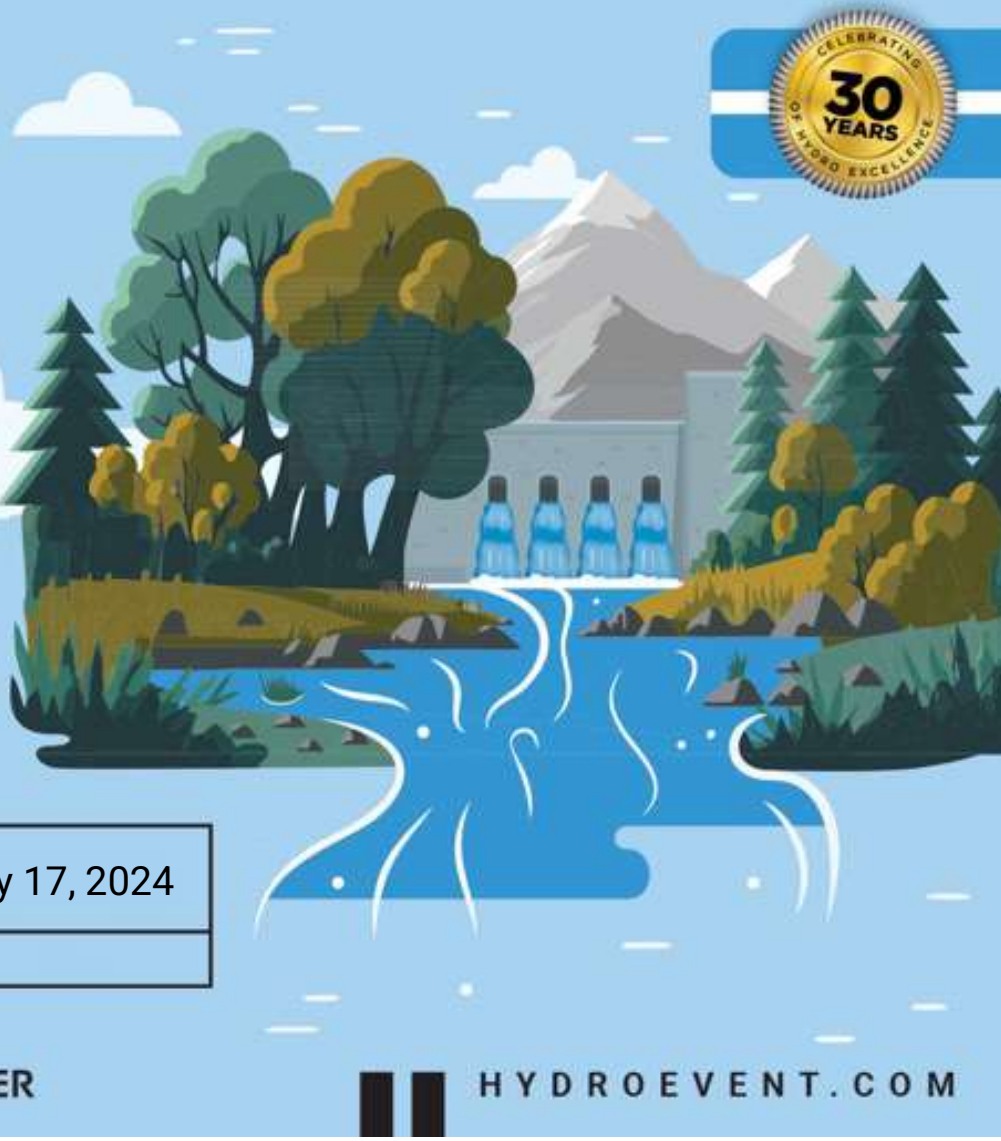
#HYDROVISION

CONNECTING THE

# GLOBAL

COMMUNITY OF HYDRO VISIONARIES



HYDROVISION INTERNATIONAL

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| Technical Case Studies of New Development | | July 17, 2024 |
| Benoit Otis, P.Eng. | | |

HOST UTILITY DENVER WATER

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#HYDROVISION

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# WELCOME

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# BENOIT OTIS, P.ENG.

- Professional Engineer, registered in BC, Alberta, Quebec (Canada)
- With Knight Piésold since 2008
- Area of expertise: civil and structural engineering for hydropower projects.
  - Concept design, detailed (final)
  - Water conveyance and penstock
  - Concrete and structural steel design for water control, intake, outlet, spillway, powerhouse structures
  - Infrastructure, road related to industrial projects
  - Value engineering and cost estimating
  - Construction supervision
- Currently involved with advancement of conventional hydro, pumped storage hydro, maintenance and rehabilitation of hydro sites

# KNIGHT PIÉSOLD – WHO WE ARE

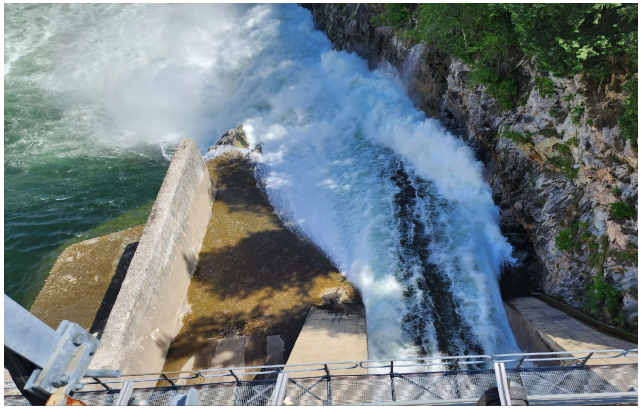
- Global consulting firm providing specialist engineering and environmental services in the mining, power, water resources, and infrastructure industries.
- Extensive involvement with run-of-river hydropower facilities and pumped storage hydro.
- some 40 IPP hydro projects at various stages of implementation in 15 countries.
- Operates from 28 offices across 16 countries, with North American offices in Denver, Elko, Tucson, Vancouver (BC) and North Bay (Ontario).

# PANELISTS

- Matthew Shapiro, CEO, rPlus Energies – private development company based in Salt Lake City, UT.
  - Financed or developed over 3,000 megawatts of operating renewable energy capacity across the U.S.
  - Portfolio of over 40 projects across the U.S. representing over 14 GW of renewable energy capacity

- Joel Herm, Current Hydro, CEO - private development company based in Rhinebeck, NY.
  - Develop projects at existing Non-Powered Dams (NPD) in the eastern U.S.
  - 20 MW New Cumberland planned to start construction in 2025.

# NEW DEVELOPMENT PIPELINE



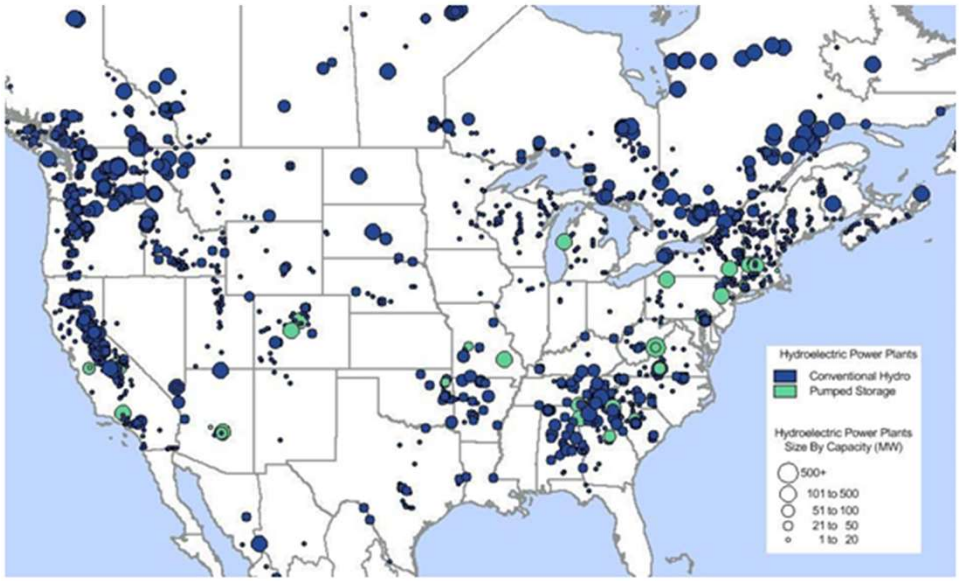
# WHY HYDROPOWER

- Energy transition to reduce greenhouse gas (GHG) emissions
- Replace generation deactivation (permitting, reduce emissions of nitrogen oxides, end of life, etc.)
- Intermittent renewables now cheaper than most fossil fuels like coal, diesel, etc.): wind, solar, run-of-river.
- Hydropower provides:
    1. Dispatchable power to address peak power demand requirements, integrate well with non-dispatchable power.
    2. Helps to maintain a balanced and reliable grid

# HYDROPOWER IN NORTH AMERICA

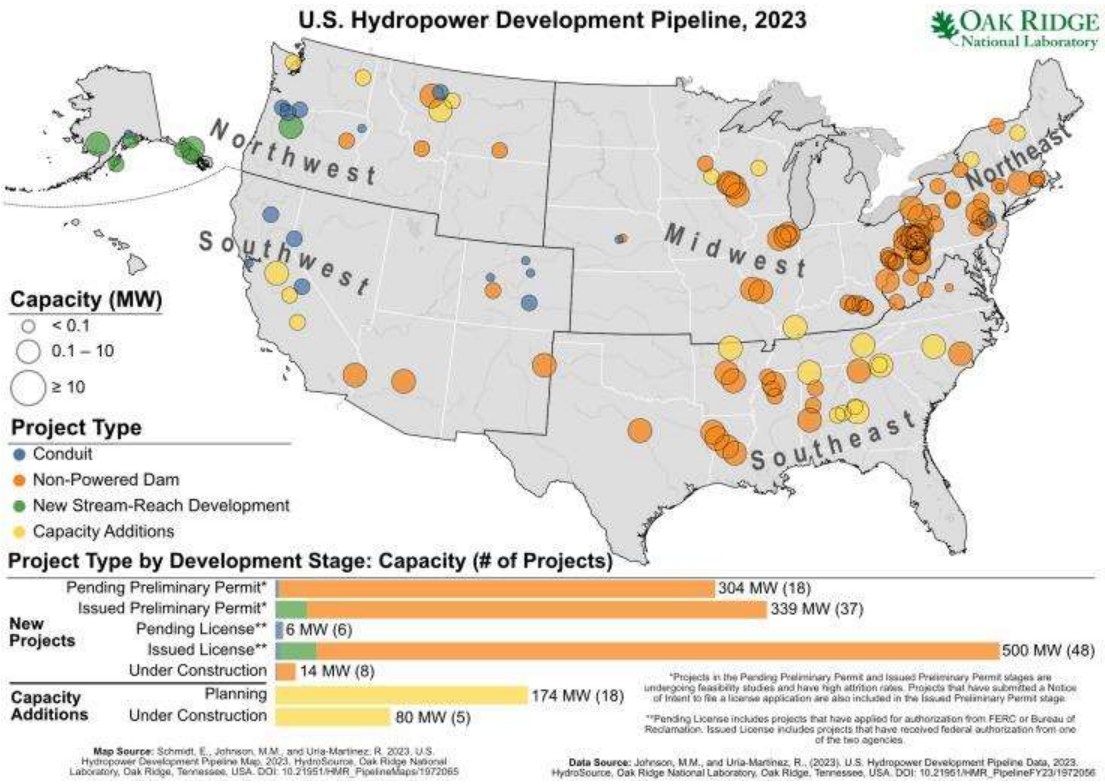
- Hydropower represents 6% of total U.S. utility-scale electricity generation and 30% of total utility-scale renewable electricity generation
  - Pumped storage hydropower remains the largest contributor to U.S. energy storage, representing roughly 96% of utility-scale energy storage capacity in the United States in 2022.
- Hydropower represents 60% of the total electricity generated in Canada
  - Pumped storage installed capacity 174 MW

Hydroelectric generators in and around the United States




Source: U.S. Energy Information Administration, derived from Energy Velocity

# DEVELOPMENT PIPELINE IN THE U.S.



# DEVELOPMENT – CONVENTIONAL HYDROPOWER

- Conventional hydropower projects contribute to the energy pool, may not be dispatchable
- Arrangements typically comprise:
  - Capacity addition projects – approx. 250 MW planned
  - Run-of-river plants
  - Adding power to non-powered dams (NPD)
  - Hydropower-battery pairings, battery to provide peaking power or ancillary services such as frequency regulation or black start .

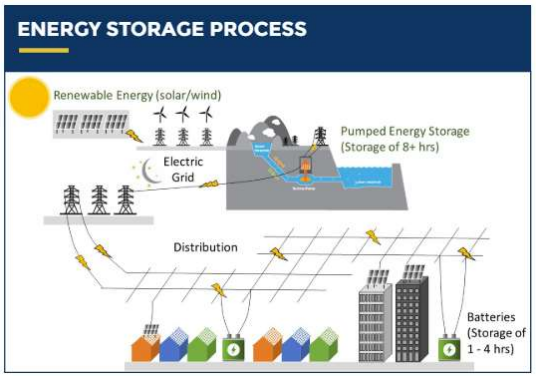
# DEVELOPMENT – CONVENTIONAL HYDROPOWER

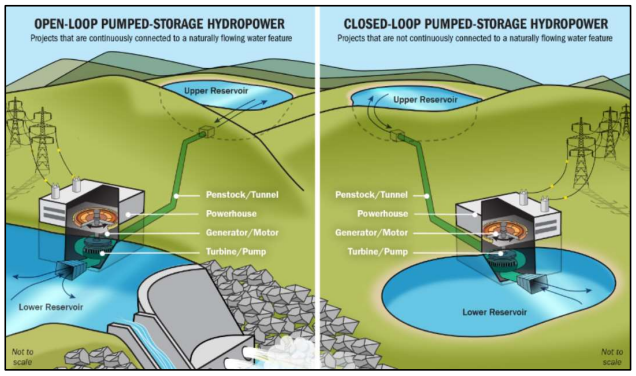
- Majority of US new conventional hydropower projects  up to 25 MW with majority of projects falling in the 10 MW range (exemption program FERC). Includes additions of hydropower to non-powered dams (NPDs).
  - Majority of projects are private development

- Canada, BC Hydro Call for Power: Energy call for private producers, projects between 40 and 200 MW, target approximately 3,000 GWh/year.

# DEVELOPMENT – PUMPED STORAGE HYDROPOWER

- Majority of new projects are pumped storage
- In the US, at least 96 PSH project are in development and expected to be licensed with approx. 72.7 GW capacity.
  - Average project size = 400 MW
  - Majority of PSH proposed is closed-loop
- In Canada, at least 7 PSH project are in development with approx. 3.2 GW capacity



# DEVELOPMENT – PUMPED STORAGE HYDROPOWER

- Pumped storage hydro in the US is used in majority to contribute to the energy pool, dispatchable capacity (during peak).

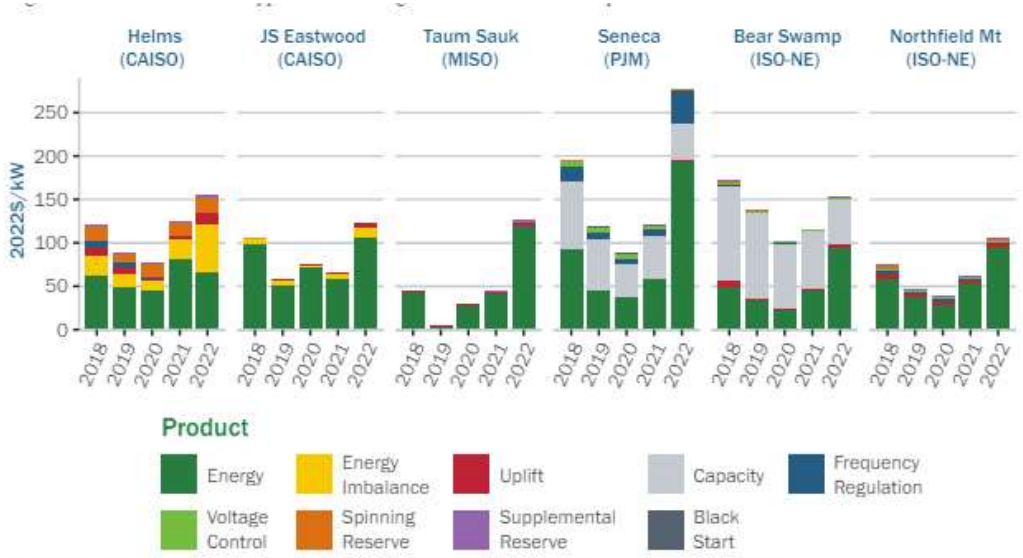



**Figure 30. Annual revenue streams from participation of PSH plants in ISO/RTO markets**

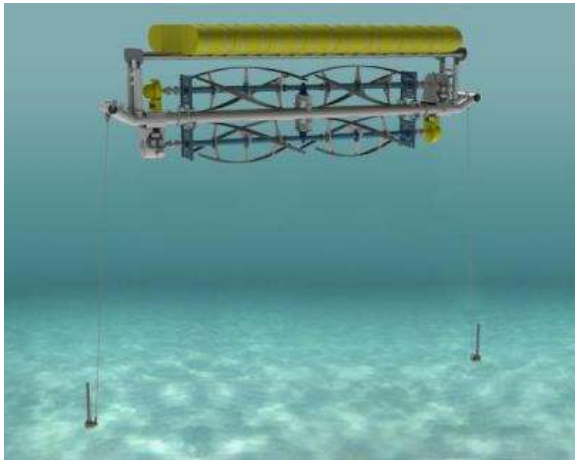
**Source:** FERC EQRs

# DEVELOPMENT – PUMPED STORAGE HYDRO

- Daily Storage 8-10 hours is most common (i.e. 400 MW Swan Lake PSH – 10 hours)
- Weekly Storage (Storage Cycles are also fairly common) (i.e. 1,333 MW Ingula PSH – 7-day cycle)
- Longer term / Seasonal storage is less common (i.e. 2,200 MW Snowy 2.0 PSH – 175 hours)

# DEVELOPMENT – MARINE ENERGY

- Technology in development
- Small projects in the eastern US. Less than 10 MW
  - Current, tides and wave energy
- No new development in Canada.



# Thank You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