Media Backgrounder

What Hydropower Actually Does on the Grid

Overview

Hydropower supports Canada's electricity system in ways that go beyond generating electricity. This backgrounder explains how hydropower is planned and operated on the grid, including its roles in storage, flexibility, reliability, and system stability.

1. How Hydropower Is Used on the Grid

Hydropower in Canada is not operated as a short-term, weather-driven resource. Hydro operators with reservoir storage plan hydro production months to years in advance, using reservoir storage, inflow forecasts, and interprovincial and cross-border connections. Operators continually assess:

- How much water is in storage
- Expected precipitation and inflows
- Forecast electricity demand
- Expected surpluses or shortfalls

If a surplus is expected, utilities export power. If a shortfall is expected, they import electricity to preserve water in storage. This approach has been used for decades by hydro-dominated systems in British Columbia, Quebec, Manitoba, and Newfoundland and Labrador.

Exporting power in wet periods and repatriating it when domestic demand increases or conditions are drier is not a reliability failure. It is a core feature of how large hydro systems are designed and operated.

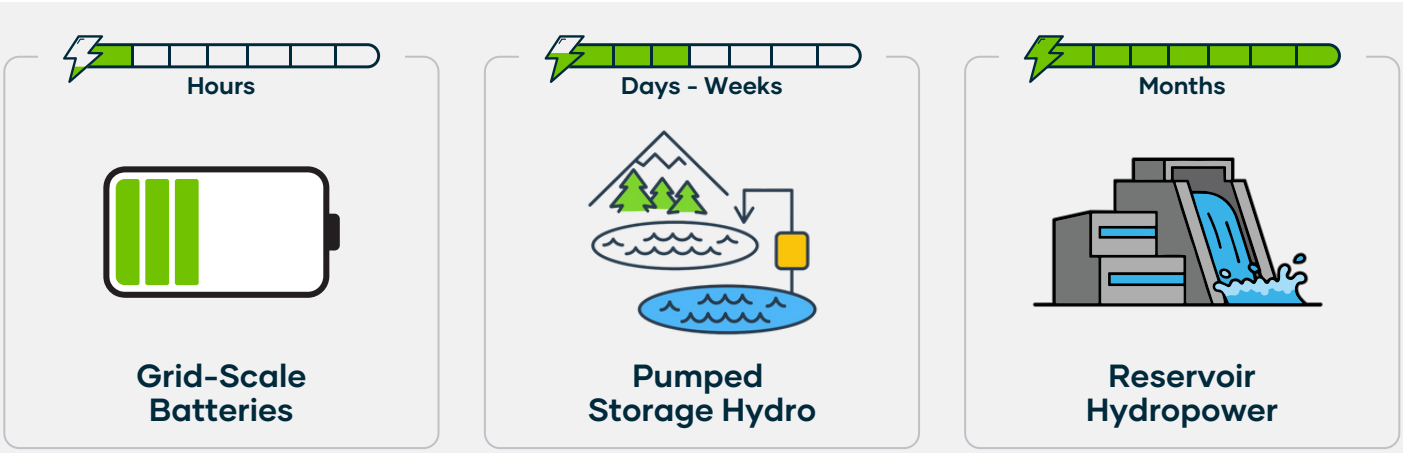
2. Why Storage Changes Everything

The defining characteristic of large hydropower systems is long-duration storage. Reservoirs store electricity in the form of water, which means operators can decide when electricity is generated, not just how it is generated. In some systems, stored water represents the equivalent of months of electricity production. This gives system operators a level of control that no other clean energy technology can match.

Long-duration storage allows operators to:

› shift production across days, weeks, and seasons
› hold back water when other resources are producing
› respond instantly to peak demand
› manage generation during dry periods

This is a fundamental distinction from weather-dependent renewables, which generate only when conditions allow, and from short-duration storage technologies, which operate over hours rather than weeks or months. Hydropower is not just a source of clean electricity; it is a system-level resource that provides flexibility, reliability, and strategic control over the grid.



For scale, the largest battery storage project currently under development in Canada has a capacity of approximately 1,560 MWh. By contrast, Hydro-Québec's reservoir system stores roughly 176 TWh of energy, or 176 million MWh. In practical terms, this means Hydro-Québec alone has over 113,000 times the storage capacity of the largest battery project in the country.

3. Reliability and Variability: What the Data Shows

Hydropower output varies year to year because water inflows vary. Large hydro systems manage this variability through planning and storage. Production ranges discussed for different jurisdictions illustrate that variability is not uniform across systems:

› Studies for the 824 Muskrat Falls project indicate the 'firm' or minimum annual production for the project is 4.47 TWh compared to an average of 4.9 TWh.
› Newfoundland and Labrador (Hydro) shows minimum annual production approximately 20 per cent below long-term average for hydro generation on the Island of Newfoundland.
› Manitoba can experience higher variability (closer to 50 per cent), reflecting differences in storage carryover and system design.

Storage matters because it allows operators to match electricity production to immediate weather conditions. Operators can smooth variability over time and use imports and exports strategically to preserve storage and manage expected shortfalls.

This also differs from the operational profile of wind and solar, where output can fall dramatically for multiple consecutive days, requiring dispatchable resources to maintain reliability during those periods.

4. Supporting the Whole Electricity System

Hydropower contributes to system stability in addition to energy production. It provides grid services that support safe and stable operations, including:

- Inertia
- Reactive power and voltage control
- Rapid response capability (changing output to match system needs)

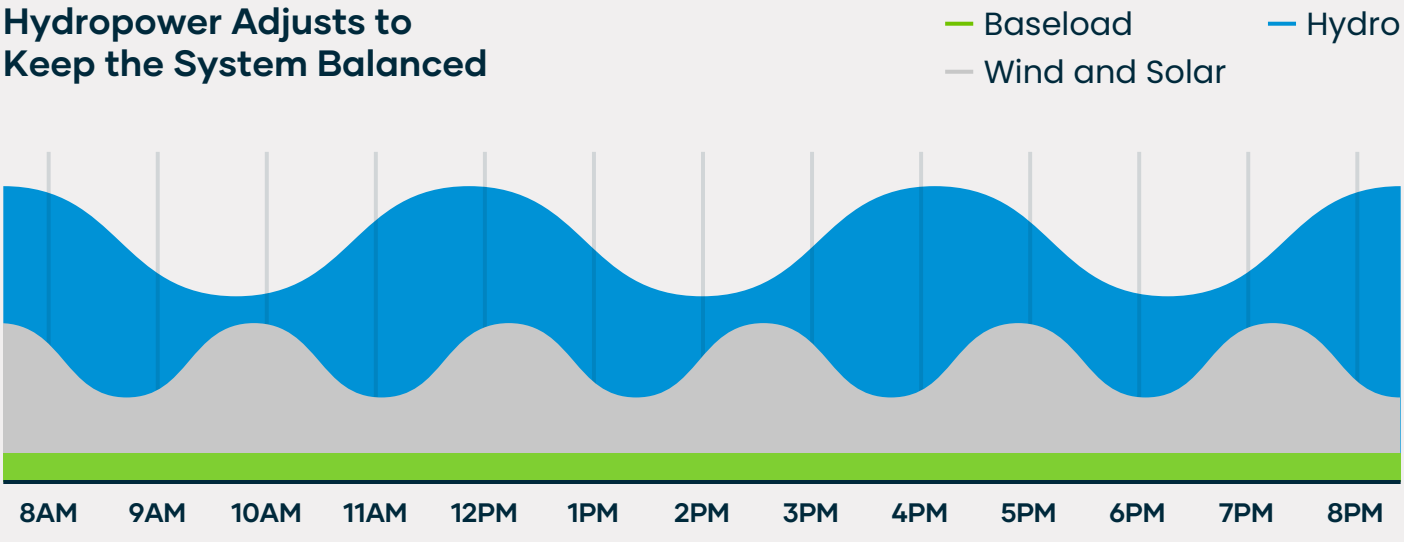
Hydropower is also used to support the integration of other clean energy resources:

- When wind or solar output is high, hydropower output can be reduced to conserve water
- When wind or solar output drops, hydropower output can increase to compensate

This flexibility helps maintain reliability while allowing variable renewables to be used where they are available.

Hydropower also plays a complementary role alongside nuclear generation. Because nuclear plants are designed to run continuously at full output, hydropower is often used to adjust to changing demand and system conditions around that steady baseload supply.

Hydropower Adjusts to Keep the System Balanced



Key Takeaways

› Hydropower is planned and operated over seasonal and multi-year timeframes
› Long-duration storage fundamentally distinguishes hydropower from wind, solar, and short-duration storage
› Storage and planning smooth year-to-year water variability
› Hydropower provides essential system stability services (inertia, reactive power, rapid response)
› Hydropower supports the integration of variable renewables and complements steady baseload resources

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