COLUMBIA RIVER BASIN:
DAMS AND HYDROELECTRICITY

The power of falling water can be converted to hydroelectricity

A Powerful River

Major mountain ranges and large volumes of precipitation are the foundation for the Columbia River Basin. The large volumes of annual runoff, combined with changes in elevation—from the river’s headwaters at Canal Flats in BC’s Rocky Mountain Trench, to Astoria, Oregon, where the river flows into the Pacific—make the Columbia one of the most powerful rivers in North America. The entire Columbia River on both sides of the border is one of the most hydroelectrically developed river systems in the world, with more than 470 dams on the main stem and tributaries.
Two Countries: One River

Most dams on the Columbia River system were built between the 1940s and 1980s. They are part of a coordinated water management system guided by the 1964 Columbia River Treaty (CRT) between Canada and the United States. The CRT:

1. coordinates flood control
2. optimizes hydroelectricity generation on both sides of the border.

Managing the River

The Columbia River system includes creeks, glaciers, lakes, ponds, reservoirs, rivers, streams and wetlands. It connects hundreds of communities, seven states and two countries. Decisions about how much water flows, and when, can affect communities, upstream and downstream. Canada and the U.S. manage the trans-boundary Columbia River system by coordinating the storage and release of water that is stored in reservoirs behind dams built in accordance with the CRT.

In the past, this powerful river flooded many times over the years, impacting communities and people on both sides of the border. Today, the Columbia River system is managed to reduce the likelihood of major floods. In addition to flood control and hydroelectricity generation, both countries cooperate to manage the volume and timing of water flows for other uses, including fisheries, irrigation, recreation and transportation. However, these benefits and manage flows in the Columbia River, there were many negative impacts resulting from the creation of large reservoirs throughout the system.

Changing Water Levels

Deciding how to release and store water in the Canadian Columbia River system is a complex process. Decision-makers must balance obligations under the CRT (flood control and power generation) with regional and provincial concerns such as ecosystems, recreation and cultural values.

STORING AND RELEASING WATER
The ability to store water in reservoirs behind dams means water can be released when it’s needed for fisheries, flood control, hydroelectricity, irrigation, recreation and transportation. Releasing water to meet these needs influences water levels throughout the year and explains why water levels change frequently.

POWER AND WATER LEVELS
As the need for hydroelectricity increases during the winter months, water stored in reservoirs behind dams is released. This water flows downstream and generates hydroelectricity each time it passes through a generating station at a dam.

PEAK WATER FLOWS
The volume of water in the Columbia River varies seasonally, depending on the timing and volume of melting snowpack and precipitation. In Canada, the highest flows occur between May and August; the lowest between December and February. In the U.S., peak flows typically occur between April and June; the lowest also occur between December and February.

IT’S A CYCLE
In winter, reservoirs are drawn down and water is released to meet the need for hydroelectricity. By spring freshet, reservoir levels are much lower and the cycle begins again as melting snowpack refills the reservoirs.

Fish Passage

The completion of Grand Coulee Dam in Washington State in 1941 blocked salmon and other species from getting to the upper Columbia River. Fish passage exists on dams downstream from Grand Coulee, with the exception of Chief Joseph Dam, which is now the first barrier for fish heading upstream from the Pacific Ocean. Many dams in the U.S. have fish ladders that enable fish to swim upstream, plus screens or bypass systems, so fish swimming downstream avoid turbines. In Canada, Arrow Lakes Generating Station, Waneta Expansion and Brilliant Expansion will be able to accommodate upstream fish passage in the future.

Water level information
Fortis BC – fortisbc.com
BC Hydro – bchydro.com
How Does a Dam Generate Power?

1. Water flows into a generating station, also known as a powerhouse, where energy from the water is converted into hydroelectricity.
2. A tube, known as a penstock, carries water to the turbine.
3. The water spins large turbine blades.
4. The spinning turbine blades rotate a turbine shaft.
5. The shaft is connected to a generator that spins.
6. The generator rotates and converts mechanical energy into electrical energy.
7. Water flows back into the river and continues downstream, where it may repeat this cycle many times.

Glossary

FRESHET
A sudden rise in a stream or river due to heavy rain or melting ice or snow.

GENERATING STATION
A building where electricity is generated. Also known as a powerhouse.

GENERATOR
A device that converts mechanical energy to electrical energy.

HYDROELECTRICITY
Electric power generated through use of the gravitational force of falling water.

KILOWATT HOUR (KWH)
Used to express power consumption. One kilowatt hour equals the amount of power a 1,000-watt appliance would use if kept running for an hour.

MEGAWATT (MW)
Used to express generating capacity. One megawatt equals one million watts.

SUBSTATION
A building where voltage is transformed from high to low, or the reverse.

TRANSFORMER
Transfers electrical energy from one circuit to another.

TRANSMISSION
The bulk transfer of electrical energy from generating stations to substations located near demand centres.

TURBINE
A mechanism in a generating station that rotates with the force of water and is attached to a generator that produces electricity.

WATER STORAGE DAM
A dam used to collect or store water for later use.
Columbia Basin Trust supports the ideas and efforts of the people in the Columbia Basin. We take our lead from residents and communities. The Trust is here to offer resources and support to all Basin residents. While our range of services, programs, initiatives and financial investments is extensive, our purpose is straightforward: we exist and act for the social, economic and environmental well-being of the Basin—now and for generations to come.

Columbia Basin Trust and Power Projects

Together with Columbia Power Corporation, we own and operate four power projects in the southwestern Basin: Arrow Lakes Generating Station, Brilliant Dam, Brilliant Expansion and Waneta Expansion which is also co-owned by Fortis Inc.
The Columbia River Basin

The Columbia River Basin is the sixth largest river basin by area in North America, and the fourth largest river in North America by volume, surpassed only by the Mississippi, Mackenzie and St. Lawrence. The Columbia River is a snow-charged river that relies on melting snow and precipitation, especially from the high-elevation reaches of the Upper Columbia in BC. It cuts through five mountain ranges in Canada and the U.S.—the Cascades, Monashees, Purcells, Selkirks and Rockies—and picks up water from 10 major tributaries, making the Columbia one of the most powerful rivers in North America.

U.S. DAMS AND GENERATING STATIONS

There are more than 400 dams on the Columbia River and its tributaries in the U.S. Some are small, with generating capacity of less than 1 MW, while others are large. Grand Coulee has a generating capacity of 6,620 MW. The map shows all dams on the main stem of the Columbia River and select other dams on major tributaries. Visit the Northwest Power and Conservation Council’s website, www.npacouncil.org/energy to learn more about hydropower generated in the Pacific Northwest.

CANADIAN DAMS AND GENERATING STATIONS

(Does not include Independent Power Producers)

<table>
<thead>
<tr>
<th>Name</th>
<th>Completed</th>
<th>Owner</th>
<th>Generating Capacity (MW)</th>
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<tr>
<td>Aberfeldie</td>
<td>1922</td>
<td>BC Hydro</td>
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<td>2007</td>
<td>Columbia Power/ Columbia Basin Trust</td>
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<td>Castlegar</td>
<td>1932</td>
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<td>Duncan*</td>
<td>1967</td>
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<td>1934</td>
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<tr>
<td>Waneta Expansion</td>
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<tr>
<td>Waneta</td>
<td>1971</td>
<td>BC Hydro</td>
<td>54</td>
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</table>

*Includes dams in BC that are part of the Columbia Basin Treaty

Legend

- Columbia River Treaty Dams
- Canadian Dams/Generating Stations
- Dams in the U.S.
- Direction of Water Flow
- Communities
- Columbia Basin Trust Region
- Columbia River Basin in Canada
- Columbia River Basin in the U.S.

NAD 83 Lambert Conformal Conic
Central Meridian: -117
Standard Parallel 1: 45
Standard Parallel 2: 70
Footprints on the map have been generalized for illustration purposes.

River Basin generates approximately 50% of the total hydroelectricity produced in BC, producing low-cost, zero-carbon electricity.