Rain is most often associated with hydropower, but snowpack keeps hydro facilities going strong during drier months.
Photo by Freepik

Hydropower: From Snow to Storage

The annual water cycle plays a significant role in energy production

When you think of electricity being generated from hydroelectric dams, you might first picture rushing rivers that spin giant turbines. The story actually begins on snowcapped mountains.

Hydropower is the conversion of flowing water into electricity. It is considered a renewable energy source, which means its fuel is replenished by nature—more specifically, the water cycle.

The water that drives the Northwest's hydroelectric generators comes from rain and snow farther upstream that falls within the Columbia River Basin, which is a vast area that begins in the Rocky Mountains of British Columbia and flows down through most of Washington, Oregon, Idaho and western Montana.

Rain helps keep the rivers flowing in winter and spring, but the melting snow carries us through dry summer months. The amount of snow that accumulates high in the mountains is called snowpack, and it is vital to the energy needs of the Northwest.

Knowing how much water is held in the snowpack any given year is critical to ensure enough fuel is available to meet the region's demands. Hydropower operators daily monitor the snowpack, temperature, precipitation, storms and droughts, as well as wind and solar energy outputs. This information helps them plan for near- and long-term energy availability for the Northwest.

Monitoring snowpack and streamflow requires collaboration from multiple agencies and teams. The U.S. Department of Agriculture, Natural Resources Conservation Service and National Water and Climate Center monitor the snowpack at 300 mountain sites across Oregon and Washington. This data is available online in near real-time.

The Bonneville Power Administration funds dozens of streamflow gauges to help monitor river levels, and several

temperature and precipitation sensors in remote locations where snowpack is particularly important for hydropower generation.

Snowpack is monitored either by manually sampling the snow with an aluminum tube and weighing it or by automated remote stations equipped with a device called a snow pillow. A snow pillow looks like a trampoline hooked to sensors to weigh the snow.

The automated stations also measure other weather conditions such as temperature, wind speed, relative humidity and precipitation.

Forecasting the volume of streamflow from snowpack levels is critical and challenging. The depth of the snowpack varies year to year, as does the rate at which it melts. Warming winter temperatures mean more precipitation will fall as rain instead of snow, changing the snowpack and streamflow.

Summer flows depend on water in storage reservoirs. Following dry winters with little snowpack, it may be difficult to refill the reservoirs, and there may not always be enough water to meet all demands on the system.

The region's hydropower operators work together to make the best use of storage reservoirs and maximize the power output to maintain reliability across the Northwest.

Just as animals gather and store food in times of abundance for leaner months, hydropower operators store water during wet months to prepare for drier conditions. Squirrels may opt for underground storage, but hydropower operators store water above ground behind hydroelectric dams in large pools called reservoirs.

Not all dams have reservoirs, but hydropower system operators work together to make the best use of the available storage and release water to meet multiple needs year-round.

Reservoirs act like giant batteries that provide energy when needed. Hydropower operators release stored water in the reservoirs behind the dam to generate electricity. They adjust the amount of water flowing through turbines to match electricity use. Power forecasters determine how much electricity will be needed during a given time and communicate that to hydropower operators.

Recreation is one of many benefits created by reservoirs.

Photo by Jakob Owens

While operations change depending on conditions, reservoirs generally are drawn down in winter and early spring to provide power and make room for heavy spring runoff. As snowpack melts in April through August, water is stored to prevent flooding and keep communities safe.

Water stored in reservoirs can help hydropower operators support the seasonal needs of both young and adult salmon. In winter and spring, operators help ensure salmon spawning grounds have enough water for spawning and to keep their nests covered.

Releasing stored water helps other wildlife, such as lamprey eels, which are an important cultural resource for some Northwest tribes.

The consistent availability of hydropower helps support other, more variable types of renewable energy sources such as wind. Dams can quickly ramp up to provide more electricity when the wind drops and can scale back generation when the wind picks up again.

Reservoirs also allow barges to move up and down the river, carrying all sorts of materials—from grain to wood chips to garbage. Wheat is transported from Idaho and Washington to Oregon and even overseas. Barges on the Columbia River move almost half of all wheat from the United States.

The reservoirs created behind dams are also popular places for recreation.

Operating the Columbia River hydropower system to support all of these needs is quite the balancing act. The storage capacity of reservoirs is critical to its success. ■

Source: The Bonneville Power Administration