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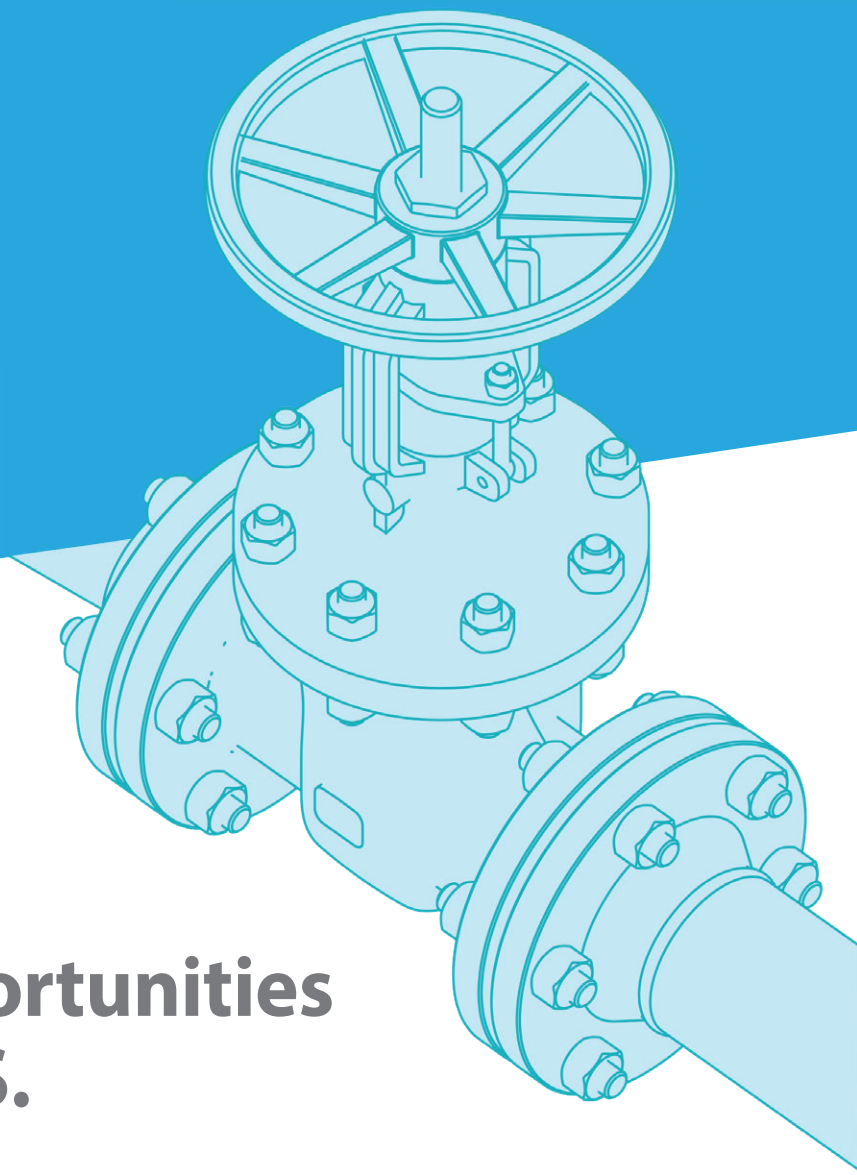

Irrigation Modernization Hydropower Opportunities in the Western U.S.

A vast, century-old network of earthen canals remains the most common way irrigation water is delivered to farms in the Western U.S. Many canals have reached the end of their useful life, requiring costly annual maintenance to remain in service and **OFTEN LOSING 15–30% OR MORE** of their water to seepage or evaporation, exacerbating drought challenges for both farmers and rivers. Modernizing irrigation canals by piping or lining can create opportunities to conserve water, save energy, and install conduit hydropower projects to generate renewable energy.

Earthen canal, North Side Canal Company, Jerome, Idaho. Photo by Jed Jorgensen.

CONDUIT HYDROPOWER AND IRRIGATION INFRASTRUCTURE

Conventional hydropower projects typically use dams in rivers to create energy opportunities. In contrast, conduit hydropower projects take advantage of water that has already been diverted from a river for another purpose, such as irrigation. As a result, conduit hydropower projects tend to have fewer environmental impacts and more simplified permitting processes. Conduit hydropower potential may exist anywhere there is surplus pressure or high velocities in a water system, creating revenue opportunities for farmers, irrigation districts, and other agricultural water providers.

Conduit hydropower may be possible anywhere with surplus pressures or high water velocities.

COMMON SITES:

- Drop structures
- Regulation reservoir inlets
- Piped stretches where pressures rise
- Farm turnouts
- Canals with high water velocities

COMMON IRRIGATION HYDROPOWER OPPORTUNITIES AND HOW THEY WORK

Open canal, hydrokinetic systems

In open canals, electricity may be able to be generated in sections with adequate water velocities. Similar to wind turbines, hydrokinetic machines extract energy from the velocity of the water, slowing it slightly. Systems may be installed with multiple machines spaced in series down a canal, aggregating generated energy together.

Piped Systems

Piping canals largely eliminates water losses from seepage and evaporation and, in systems with enough elevation change, enables gravity to partially or fully pressurize the water supply. Where surplus pressure exists in a piped system, it may be necessary to install pressure reduction valves (PRVs) to regulate delivery pressures. A conduit hydropower turbine can perform the same function as a PRV while creating a potential new revenue stream for the system operator or farmer.

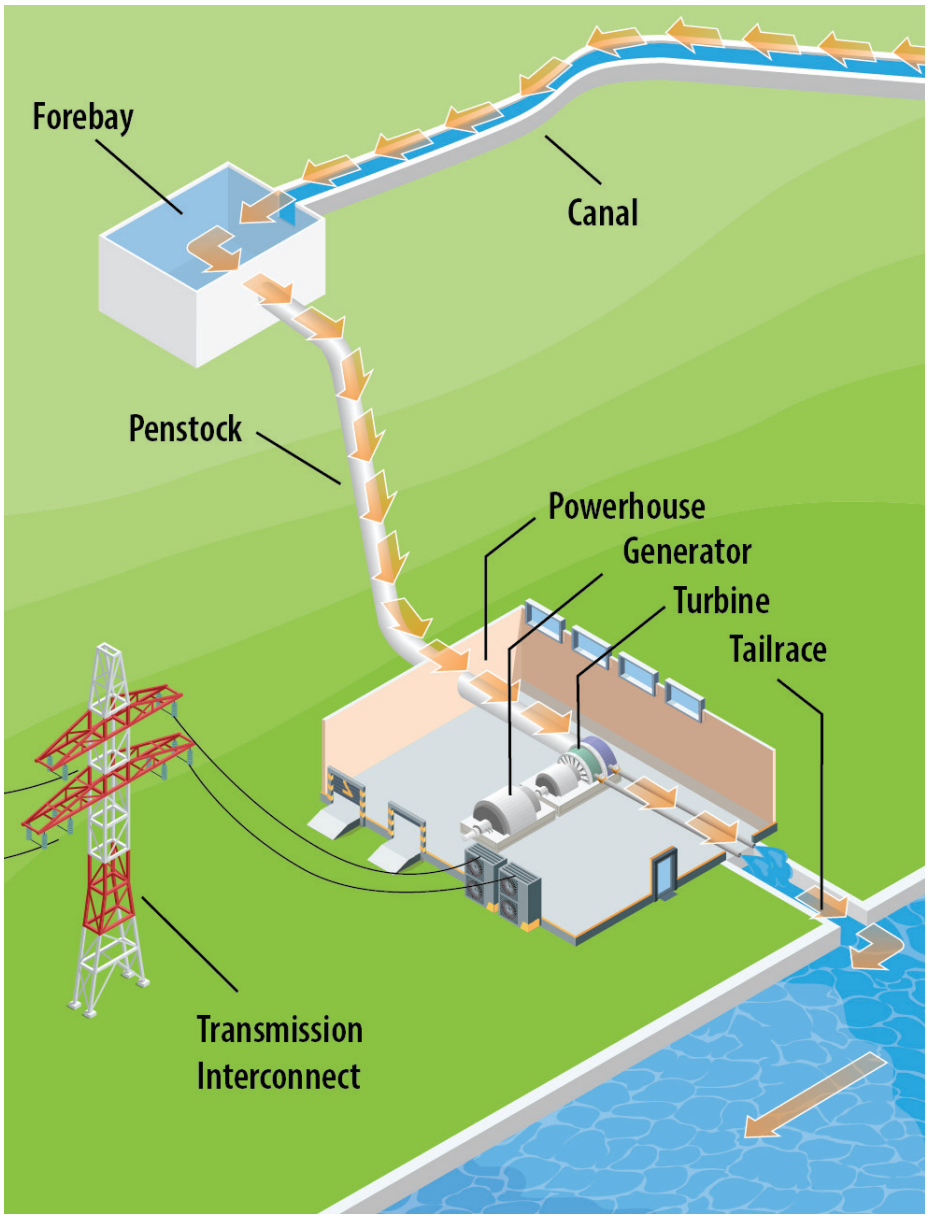

Illustration of drop structure hydropower.

Drop structure hydropower installation with eight Mavel siphon turbines. North Side Canal Company, Jerome, Idaho. Photo by Jed Jorgensen.

Farm turnouts where PRVs are installed.
Photo credit: Energy Trust of Oregon

Hydrokinetic turbines deployed in canals.
Photo credit: Emrgy

IMPORTANT CONSIDERATIONS

- Would farmers prefer pressurized water deliveries? Pressurized water can reduce on-farm pumping, saving farmers' money. Water delivery organizations should consider the relative value and benefits of the pressurized water when considering hydropower.
- Do you have other modernization goals or upcoming projects? Hydropower and hydrokinetic installations work best if planned in tandem with long-term goals, like piping or lining, to reduce costs and time and avoid future conflicts.
- Do you know your available flow and pressure (for piped systems) or velocity (for hydrokinetic)? Tools like IrrigationViz (https://irrigationviz.pnnl.gov/) can use these numbers to quantify high-level hydropower potential and water savings, giving you the resources to work with an engineer and determine viability.
- How close is your system to power lines? Distance to three-phase power lines and local utility requirements are critical to financial feasibility, so it is important to work with the local utility or an electrical engineer to estimate potential costs.

ADVANTAGES OF CONDUIT HYDROPOWER DEVELOPMENT

- Uses existing water distribution infrastructure to generate power
- Creates opportunities to generate revenue as part of water system modernizations
- Reduces environmental impacts and permitting requirements compared to conventional hydropower
- Supports rural agricultural and electrical resilience

THREE SISTERS IRRIGATION DISTRICT

The Three Sisters Irrigation District (TSID) delivers water from Whychus Creek to 196 farms on more than 7,500 irrigated acres in Central Oregon's Deschutes Basin. Historically, TSID conveyed water through a system of 65 miles of earthen canals and laterals, and as much as 55% of the water was lost to seepage and evaporation. The high losses created significant challenges: Wychus Creek often ran dry due to district water diversions and farmers still didn't get the full quantity of water needed to produce crops.

In the late 1990's, TSID began modernizing their system. Over 26 years, the district fully piped its canals, eliminating water losses, enabling 32 cubic feet per second of water to be permanently restored in-stream in Whychus Creek, and dramatically improving water supply reliability. The new pipelines pressurized the district's water delivery system, eliminating the need for on-farm pumps and reducing energy costs for farmers.

The pressurized pipelines also created multiple opportunities for hydropower production. Between 2014-2022 the district installed three powerhouses at the inlets to re-regulation reservoirs. The Watson Reservoir hosts both a 700kW turbine and a set of four smaller hydropower units totaling an additional 200kW. The smaller units demonstrate different types of hydropower turbines that farmers with surplus pressure could consider for net-metered installations. Another 300kW unit is installed at the district's McKenzie Reservoir. Together, TSID's hydropower facilities collectively generate 1.2 MW of power and the revenues are utilized to repay loans that financed previous piping projects.

TSID manager Marc Thalacker in front of the district's 700kW Watson Hydropower Facility. Photo Credit: Energy Trust of Oregon.

DID YOU KNOW?

Oak Ridge National Laboratory reported that, as of October 2022, there is 622 MW of undeveloped hydropower potential in agricultural conduits with more than 70% located in Colorado, Washington, Nebraska, California, and Idaho

HYDROPOWER BENEFITS

- Renewable source of energy
- Affordable
- New revenue streams
- Improved energy reliability
- Opportunities to mitigate outages
- Lower carbon footprint

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WATER + POWER RESILIENCE