Micro-Hydropower

Hillsboro, Oregon Water Department Embraces Water-Energy Innovation

Sourcing, pumping, treating, and distributing clean drinking water to homes and businesses require a lot of energy, and that's something water departments all over the country are grappling with.

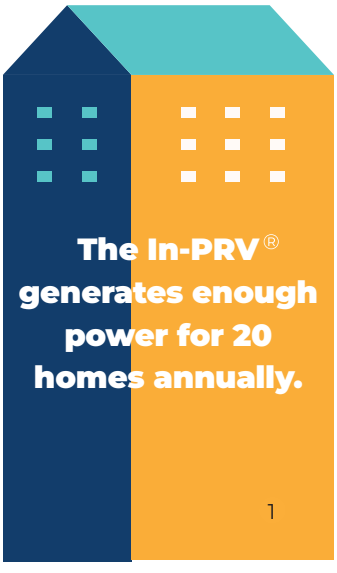
Electricity is a high cost for water utilities who often must use unsustainable sources such as coal and fossil fuels.

According to the US Environmental Protection Agency (EPA), "As much as 40 percent of operating costs for drinking water systems can be for energy. By incorporating energy efficiency practices into their water and wastewater plants, municipalities and utilities can save 15 to 30 percent, saving thousands of dollars with payback periods of only a few months to a few years."

At the Hillsboro Water Department in Hillsboro, Oregon, energy efficiency practices are key to helping Hillsboro meet its environmental stewardship goals and reduce reliance on fossil fuels. The project described in this article also presented a new opportunity. Hillsboro not only embraced the use of renewable energy sources, but became an energy producer.

The project uses water infrastructure to generate environmentally-friendly in-pipe (or conduit) hydropower. The Hillsboro In-Pipe Hydroelectric Project was commissioned in September 2020. The project features the first installation of the In-PRV®, a new micro-hydropower system from Portland-based InPipe Energy. The system transforms excess water transmission pressure into clean energy, while also performing essential pressure reduction for water delivery to homes and businesses.

The system has been operating successfully for over a year. It has exceeded its energy generation goals by producing 203,000 kWh of electricity in its first year. It's expected to continue generating at least 200,000 kWh of electricity per year (enough to power 20 homes), generating about million dollars' worth of electricity over the life of the system. The In-PRV was designed to last for 30 years with regular maintenance.



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Sustainable Hillsboro, Oregon

The City of Hillsboro 2035 Environmental Stewardship Goal Statement: Hillsboro is an environmentally sustainable community that takes proactive steps to protect natural assets, minimize greenhouse gas emissions, and recover, recycle, and renew resources. Residents, businesses, and community institutions understand the link between economic prosperity and environmental health and work collaboratively to maintain a thriving city for future generations.

Hillsboro's Commitment to Sustainability The Water–Energy Nexus

With a population of nearly 112,000 residents, the City of Hillsboro is a suburb of Portland, Oregon. It serves as both the county seat for Washington County and, more colloquially, as the hub of Oregon's "Silicon Forest." The city is home to Intel and hundreds of other related high-tech, bio-tech, clean-tech, and advanced manufacturing companies, as well as retail centers and fast-growing suburbs all served by Portland Metro's MAX light rail system. The city has a longstanding reputation as a forward-thinking community, committed to planning, sustainability, and investment in critical infrastructure to support the ever-growing industry and population.

Hillsboro's Significant Commitment to Sustainability Goals

Energy Efficiencies: 60% reduction in per-square-foot energy use.

Electric Vehicles: Replace passenger and non-passenger gas-powered vehicles with electric vehicles.

Carbon Credit: 100% power offset of city facilities by purchasing renewable energy.

Resource Management: More efficient use and management of water and energy.

At a time when budgets are lean and rate hikes are a hard-sell with customers still reeling from the losses of the pandemic, water utilities across the country are getting hit with a water-energy double whammy. Old, leaking pipelines are in dire need of repair or replacement and leaks continually add to the burden of energy required, as water is pumped and treated only to be released back into the ground - pushing the need for additional treatment and distribution capacity.

> **For water agencies, maintaining and repairing aging infrastructure is key to reducing the risk of water loss.**

Finding ways to lower operational costs for water companies is paramount.

Two ways to accomplish this are reducing water loss and reducing energy use. Concerning water loss, one can apply the well-worn phrase "an ounce of prevention is worth a pound of cure." While old pipelines can't be made new again without invasive and expensive investment, precise pressure management in existing pipelines is key to reducing wear and preventing or minimizing leaks. This is why Hillsboro, like most other water agencies, has traditionally used pressure reducing valves (PRV) to manage pressure in pipelines.

Widespread PRV use is why the concept of harnessing excess pressure to generate renewable energy is such an elegant solution for water agencies. This strategy helps mitigate two problems at once, and does so in a way that is practical and doesn't change how the system is operated. There is an additional benefit that is becoming more and more relevant — i.e., the need to find more creative solutions to address climate change. Like Hillsboro, cities and water agencies across the US are being called to take climate action. Water agencies have the means to be a greater part of climate change solutions.

By using this untapped source of energy - the excess pressure in pipelines - utilities can benefit from the opportunity to minimize risk for rate-payers while also making a huge impact on the reduction of carbon for the good of the planet.

Taking In-Pipe Hydropower to the Next Level

In the Pacific Northwest, while there is access to energy produced by traditional hydropower dams, fossil fuels are still used to meet energy needs. Hydropower, in general, provides a lower cost of energy than other renewables, but traditional dams come with a host of environmental concerns such as endangering salmon and wildlife habitat. **Finding new ways to tap into the economic benefits of hydropower without damaging the environment holds a great deal of promise, yet few companies have been able to deliver at a scale that makes it both practical and affordable for city governments and water agencies.**

The Evolution of Micro-Hydropower: A Turnkey Solution

A few years ago, the City of Portland installed a large-scale in-pipe hydropower system from Lucid Energy, which The Water Report covered in 2013 and 2015 (see Newton, TWRs #112 and #132). While Portland's pilot project generated a lot of interest in the concept of using water infrastructure to generate electricity, the system itself proved too large, expensive, and complicated to be widely used. That's why a new, smaller, turnkey micro-hydro system was developed through research conducted at Oregon State University. This system was commercialized by InPipe Energy, which was founded by former Lucid Energy CEO Gregg Semler. Semler and his team spent years learning from water agencies exactly what it would take to create a viable, cost-effective, in-pipe hydropower solution that would be practical, easy to install and maintain, and that would deliver both energy and pressure management in a way that doesn't challenge existing water operations.

THE CITY OF HILLSBORO
Oregon

Hillsboro has an extensive history of Council-sponsored programs that support sustainability. The In-PRV was a practical addition to the city's efforts.

The In-PRV presented an attractive and practical addition to further the city's sustainability goals. There are additional sites for more In-PRV installations. Furthermore, in the many places where a flow-based pressure system is being used to reduce pressure, this system presents a practical and cost-effective opportunity for most water systems. Water system operators are by nature cautious and conservative regarding anything that might impact or pose a risk to operations — be that water quality, system downtime, operational changes, or added maintenance.

InPipe Energy delivers a turnkey solution that serves the traditional function of a control valve, with the added benefit of energy generation. Many sustainability-oriented funding programs are available in Oregon, which helped make this project attractive (the funding opportunities are discussed later in this article).

The Hillsboro Water Department installed the first In-PRV in the country.

The In-PRV®

The In-PRV® (pressure recovery valve) is redundant to current operations. It is located in a bypass, making it easy to install onto an existing or new pipeline with minimal impact on water operations. The product combines smart control software with commercially-proven hardware that is reliable cost-effective and readily available.

Turning Pressure IN TO Energy

The City of Hillsboro receives a majority of its water from the Joint Water Commission (JWC) for which the city is the managing agency. The JWC owns a conventional water treatment plant next to Forest Grove, Oregon as well as many miles of large transmission mains. Water is pumped from the nearby Tualatin River to the treatment plant and then to a higher elevation reservoir, where it is then gravity fed via large transmission mains to each of the JWC partners and wholesale customers.

The transmission mains have system pressures of approximately 130 pounds per square inch (psi). Like a rock balanced at the top of a hill, water pressure at the high elevation of a reservoir is potential energy, but this pressure is far too high for direct delivery and safe usage by regular customers. Therefore, on its way down to the city, the water passes through Pressure Reducing Valves (PRV) to decrease the pressure to a level safer for consumer fixtures and appliances (80 psi or less).

Typical control valves simply bleed off pressure as heat and that potential energy gets wasted. This is common practice and why every water agency reducing pressure with valves can harness this untapped energy. The In-PRV provides the same pressure reduction function as a traditional PRV, but converts the pressure drop into electricity that is fed back to Portland General Electric's power grid.

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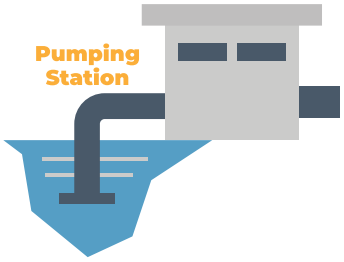
The installation site is in a small vault situated under a garden at the Gordon Faber Recreation Complex in Hillsboro. The only above-ground elements are in the colorful electrical control box that marks the project site. The In-PRV solution combines smart control software with integrated micro-hydro and control technologies that precisely control water pressure while producing renewable energy and providing critical operational data. The In-PRV is connected to a Supervisory Control and Data Acquisition (SCADA) control system and the hydroelectric generator is connected to an electrical panel and fed to the grid using the same standards established by the solar industry.

Hillsboro's New Power Generation Benefits Rate Payers

Providing Electricity for Use

The electricity (generated 24/7) is either used by the stadium complex or sold back to Portland General Electric. On site, it helps to power the lights, concessions, and Electric Vehicle (EV) charging stations at the sports complex (home to the Hillsboro Hops Minor League baseball team).

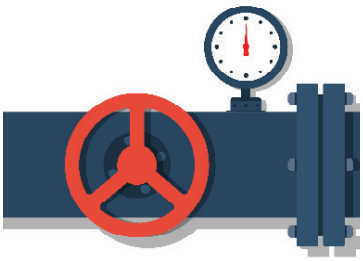


Offsetting Operational Costs for Energy

Because the city is a government agency, the value of any electricity sold to Portland General Electric is credited back to the Water Department. This helps offset operational costs for things like the pumping of water.

Meeting Climate and Sustainability Goals

The production of clean, carbon-free electricity is helping the City meet its sustainability and climate action goals. The system is eliminating approximately 162,000 pounds of carbon annually and approximately 6.3 million pounds of carbon over the life of the system (30 years). The nature of this unique form of renewable energy — and its vast potential for water agencies across the country — is also what helped garner significant grant funding for the project.



Extending the Useful Life of Pipelines

By precisely managing the water pressure and avoiding pressure spikes, the useful life of pipelines can be extended. This is especially true with older systems, that might not have full integrity like a new pipe, such as pipelines impacted by corrosion. As noted earlier, precise pressure management is essential in helping to prevent system wear and water loss.

Decreasing Risk

The In-PRV is installed in a bypass configuration, backing up the existing valve and enabling the system to be shut off if needed without impacting water operations. In the future, In-PRVs could be used in place of traditional control valves. The In-PRV is now a regular component of the city's water system and has performed flawlessly for nearly two years with no maintenance needed.

INPRV®
PRESSURE RECOVERY VALVE

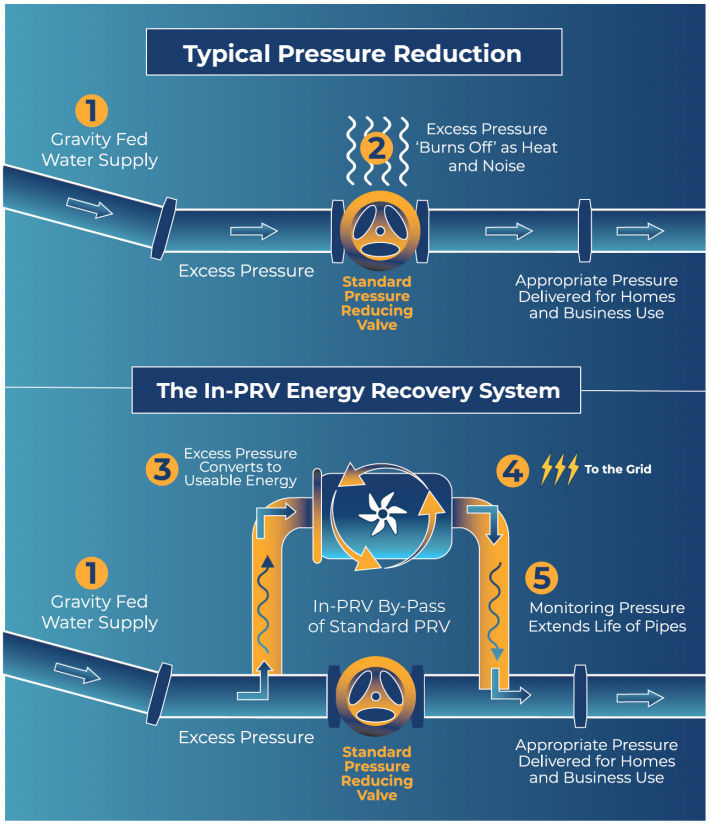
Applications of the In-PRV

The In-PRV can be installed wherever water systems use control valves to reduce pressure in 2 inch to 110 inch pipelines. However, the volumetric flow rate and the pressure drop need to be analyzed to validate that performance goals and capital costs provide a net benefit to the utility. In the Hillsboro installation there is up to 4.3 cubic feet per second (~1800 gallon per minute) of flow with a 30 psi pressure drop.

Typically the In-PRV is located in a bypass where there is a control valve, making it easy to integrate into existing or new pipelines with minimal impact on water operations. Sensors continuously monitor flow and pressure. As water flow is diverted through the In-PRV, a micro-turbine and generator combined with a sophisticated control valve precisely reduces pressure. The excess pressure is converted into electricity that can be used on-site or fed to the grid for net-metering. Grid connection and net metering requirements are similar to solar energy systems.

The system's precision pressure management eliminates chatter, vibration, and pressure pulses that can lead to leaks and water loss, helping extend the life of infrastructure. It provides redundancy for existing valves and gives water operators more precise control over the pressure in the pipeline during both high and low-flows — something older control valves don't provide. The In-PRV Dashboard provides real-time, continuous data on flow, upstream/downstream pressures, and energy production which can be integrated directly with most SCADA systems. The data can also be used for public education by presenting live data wherever desired, such as a web page or physical reader board.

An informational kiosk is now located at the stadium complex, across from the EV charging stations where school groups and sports fans can learn about this innovative form of renewable energy.



1. **Gravity is used to rapidly push Hillsboro's drinking water through large pipes from the treatment plant in Forest Grove to Hillsboro. That high pressure must then be reduced to make it appropriate for smaller water pipes in homes and businesses.**
2. **Normally, Hillsboro Water Department (HWD) uses pressure-reducing valves that simply "burn off" the pressure as heat that dissipates into the air.**
3. **The In-PRV pressure recovery valve is a micro-hydro turbine combined with pressure control that instead converts excess pressure into electricity that is fed to the power grid.**
4. **Sensors and software allow the HWD to monitor pressure, flow, and electricity production 24/7. Precise pressure management helps save water and extend the life of the pipeline.**
5. **This In-PRV system will generate up to 200,000 kWh of electricity per year to help power lights, concessions, and EV charging stations at the stadium.**

Developing a Renewable Energy Solution for Water Agencies

The Hillsboro Water Department and the City of Hillsboro were excited to pioneer this new system, not only for the benefits, but to serve as an example for other water agencies to follow. Water operators almost always need to know that a technology is tried-and-true before they invest time or resources. They need assurance that any new technology will only enhance - not disrupt - water operations. Some of the data that helped with this decision came from trusted institutions.

InPipe Energy spent four years following a nine-step product development process prescribed by the US Department of Energy and Isle Utilities, working with Oregon State University's Mechanical, Industrial, and Manufacturing Engineering department to develop, prototype, and validate the In-PRV. With the Hillsboro project, the In-PRV went from technology readiness level 6 (TRL 6) to TRL 8, the last and final step before full commercialization. (TRL of the US Department of Energy (DOE).

Isle Utilities completed a technology readiness assessment of the In-PRV and concluded, "InPipe's system is a straightforward approach to renewable energy from an untapped resource. It utilizes proven technologies such as hydroelectric turbines and induction type generators. At a time where conserving and generating clean energy are high priorities around the globe, InPipe Energy has introduced a simple and low-cost strategy to achieve both objectives."

During a recent presentation of this project to a group of engineers, one astute observer asked: Why doesn't the city just optimize pumping to minimize energy usage so as not to need the energy recapture? The answer: Water transmission and distribution often requires a specific hydraulic grade line to meet service needs. This may be due to meeting pressure at the endpoint such as filling a reservoir or to meet service requirements. This introduces necessary inefficiencies into optimizing pumping needs. But it does open the door for recapturing some of the wasted energy.

Prototype Partners

INPIPE® ENERGY | isle | U.S. DEPARTMENT OF ENERGY | Oregon State University

Funding for Installation and Expansion

Because of the attractive economics and renewable energy potential for micro-hydropower generation, significant funding from Portland General Electric and The Energy Trust of Oregon was available to subsidize the project costs. The Hillsboro project received almost 80% of the capital cost from these sources.

A joint press release with all three organizations announced the project in October 2020: “The City of Hillsboro’s innovative new project is a great example of how we can support on-demand, cost-effective renewable energy generation right here in our community,” said Maria Pope, president and CEO of Portland General Electric. “From the In-Pipe Hydroelectric Project to sourcing their power from 100% clean wind, Hillsboro is a leader in sustainability. Thanks to PGE’s Green Future customers’ support for local renewable energy projects, we were able to help fund this work, along with Energy Trust and InPipe Energy. Only by working together will we build a clean energy future.”

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>
> *— Maria Pope, President/CEO Portland General Electric*

“The City of Hillsboro is tapping into a new, local source of renewable energy that communities across the region can deploy, and we support these projects through funding to offset costs,” said Dave Moldal, senior program manager at Energy Trust of Oregon. “The relationships that Hillsboro, PGE, Energy Trust and InPipe Energy have developed provide a successful model for how we can come together to implement new, innovative sources of clean energy for Oregon.”

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One thing to note, most states have organizations with a similar charter to The Energy Trust of Oregon. The Energy Trust should not be looked at solely as a potential source of funding. It has subject matter experts in every arena of power usage. The Energy Trust can assist with validating a pro forma for a proposed project as well as lead efforts to assist with energy projects. If any readers in Oregon are considering pursuing an energy project, the Energy Trust of Oregon should be one of the first stops.

InPipe Energy

Since the completion of the Hillsboro project, InPipe Energy has installed a second In-PRV at Skagit PUD in Washington in June 2021. The company recently secured "Series A" funding from FullCycle Capital, which will allow expansion to help water agencies fund their projects.

> **Energy and water are the two most important resources on the planet, and helping water agencies become more sustainable is critical in our battle against climate change.**
>
> **That's why we designed our product as a turnkey solution, so that it can be installed quickly, easily, and cost-effectively throughout water systems with smaller-diameter pipelines and wherever pressure must be reduced."**
>
> *— Gregg Semler, Founder & CEO, InPipe Energy*

By making it more cost-effective up front, water agencies can immediately start reaping the benefits of renewable energy generation to help them offset their operational costs and meet their climate and sustainability goals. Alternative funding sources make it easy for decision makers because of the decreased direct impacts on rate payers.

The In-PRV can also be used in other types of pressurized pipelines, such as in industrial and agriculture applications, providing a way to harvest even more electricity from moving water and building resilience.

Impact

The opportunity for this technology is immense. According to a Climate Impact Report by Boundless Impact Research and Analytics, a 100 kW In-PRV can save 550 tons of CO2 per year and has a three- to four-times higher return on carbon offset compared to solar or small wind systems (InPipe Energy Impact Profile, Boundless Impact Research and Analytics, January 2021). Considering full deployment of InPipe Energy's In-PRV technology at the global scale, Boundless Impact estimates that 1.75 gigatons of CO2 equivalent could be saved per year - that's equivalent to 4,300 billion driven miles in an average passenger car.

There are more than two million traditional control valves in use across the US alone. And embedded in that pressure reduction is a significant, untapped opportunity for water agencies to capture this excess pressure and produce renewable energy to improve resilience. InPipe Energy estimates that $230 billion in new revenue would be available for US water agencies to improve aging infrastructure, offset energy costs and benefit ratepayers over the next 30 years by adding this technology to their pressure management systems. As a water utility, infrastructure must be cost-effective for rate payers.

This means sustainable, long-term investments must look forward 50 years instead of 20 years. The City of Hillsboro has plans for additional InPipe installations. Hopefully, this easy win will be utilized by water utilities across the country.

This is an enormous opportunity for water agencies to improve resiliency.

Credit and special thanks to "The Water Report" #213.