SUSTAINABLE WATER TREATMENT PLANT: DENVER WATER

Denver, Colorado

Aerial View of Denver Water's sustainable Northwater Treatment Plant under construction

PROJECT DESCRIPTION

Denver Water is a water utility serving approximately 1.5 million customers throughout the Denver Metro area. In 2015, Denver Water launched its North System Renewal Program, which includes the new Northwater Treatment Plant (NTP) and improvements at the Moffat Treatment Plant. The NTP is a new, state-of-the-art, 75-million gallon per day (MGD) surface water treatment plant with ability to expand to 150-MGD capacity in the future. The plant is designed to supplement, then replace, Moffat, which was built in the 1930s and is approaching the end of its useful life.

Sustainability was one of the key project objectives identified for NTP's design. Through years of planning and preliminary design, the sustainability project objective was realized via incorporation of alternative energy and reduced building footprints. The plant features a hydro turbine to capitalize on influent pressure from water entering the treatment plant, which provides sufficient energy to offset the NTP's power demands throughout most of the year.

In addition, the plant design includes land set aside for a future solar farm, should Denver Water choose to expand its alternate energy production. And the NTP will be Denver Water's first plant capable of remote operation, allowing for a reduction in on-site staff and further reducing site energy demands and vehicular traffic. The project is currently at 50% construction completion and is expected to be operational in 2024.

It is estimated that the hydro turbine will produce 2,660 MWH/year. The resulting annual offset of greenhouse gas (GHG) emissions from electricity generation equals 1,485 tons of CO_2 (*based on Xcel Energy's factor of 1,117 lbs CO_2/MWH).* It should be noted that the design accommodates future install of a second hydro turbine, should plant demands increase.

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MAKING THE PROJECT HAPPEN

While the NTP Project was always envisioned to be a sustainable facility that would include one or more alternative energy sources, the real impetus for the level of sustainability attained was a value engineering exercise. At approximately 20% design completion, a cost estimate prepared by the Construction Manager at Risk (CMAR) revealed the construction cost of the project was over budget. In response, Denver Water's project executives challenged the team to value engineer to reduce construction costs as well as to take the plant "off the grid" (i.e. produce all energy on-site) to produce a more sustainable life-cycle cost. Through intensive workshops and redesign efforts, the plant footprint and enclosed areas were downsized to reduce both construction cost and heating/cooling loads. Multiple alternatives for energy production were explored, including hydro, solar, and wind energy. While it was ultimately deemed feasible to take the plant off the grid, the cost of needed battery storage was prohibitive, and seasonal fluctuations in power demand made connecting to the power grid a more beneficial and sustainable solution that would also allow for excess generated power to be fed to the grid. The plant remains capable of modifications to go off the grid, should battery costs improve in future.

The four critical components for implementing renewable energy projects that support Denver Water's sustainability goals in reducing GHG emissions include:

1. Having executive vision and support
   - Executive leaders who want to push the limits of what is financially and realistically feasible to achieve an environmental benefit for Denver Water and the community.
2. Demonstrating leadership and teamwork
   - A project management team that supports the organizational vision and goals while managing and directing a diverse group of resources.
   - Collaborative space to brainstorm with team members and a culture that encourages out-of-the-box thinking.
   - Frequent status meetings to drive progress and resolve questions.
3. Validating assumptions
   - Rightsizing project to meet current and future program goals.
4. Implementing the plan
   - Address current needs while remaining flexible for future growth.

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FINANCES

Bonds were issued to fund the cost of the project. No outside grants or other cost-sharing measures were used. Specific to the hydro turbine, the approximate installed cost is $3 million. A cost-benefit analysis was performed based on installing two hydro turbines. The payback period was determined to be 30 years based on annual electrical cost offset of approximately $200k. It should be noted this analysis does not account for or recognize the other GHG reducing components of the NTP such as remote operation, reduced building footprint, and use of locally sourced materials, among others.

IMPLEMENTATION

Denver Water expressed a desire to split the design and construction of the NTP project among as many local firms as possible. This approach allowed the best consultants to be selected for each specific discipline or area of expertise, while also contributing to the local economy by keeping work within the region. This approach proved beneficial in multiple ways, including budget control, improved design efficiency, and a high level of competitiveness and accountability across the project team. That team is comprised of more than 50 consulting firms and more than 100 contractors and suppliers. Internally, multiple departments were engaged including Water Resource Strategy, Engineering, Operations and Maintenance, IT, Finance, and Administrative Services. Managing interactions between the project team and multiple internal departments with occasionally competing interests was a major focus throughout all phases of the project, which drove the team to be more cognizant of the clients' needs.

Installing the hydro turbine necessitated a permit from the Federal Energy Regulatory Commission (FERC). Fortunately, legal precedent allowed the project to apply for an exemption meeting the "Qualifying Conduit Hydropower Facility Criteria." This exemption was approved in 2019. No major challenges were encountered; however, it should be noted that permitting through FERC for facilities not meeting the criteria for an exemption can be a long and onerous process.

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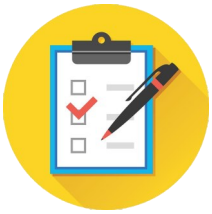
CHALLENGES

One challenge was properly sizing the hydro turbine based on unknown load capacity with the NTP plant, since it will be operating in a complementary way with Denver Water's other treatment plants to satisfy customer water demands on any given day. There have been challenges with the hydro turbine manufacturer as well. These included multiple technical details such as resolving downstream characteristics (which include raw water supply to not only the NTP, but also to Moffat and two other municipalities' treatment plants), and concerns over touchpoints between the hydro turbine and other major electrical gear on site (standby generator, switchgear, etc.). Additionally, there were contractual concerns due to the manufacturer's location overseas and a potential for shipping delays or total loss of the equipment en route.



ADVICE AND LESSONS LEARNED

The advice from Denver Water on constructing a sustainable water treatment plant is to get the whole team thinking about a green approach from the start. Though the GHG reduction component of the NTP is relatively small, it drove the team's thinking and approach to the entire design. Once the project team and associated contractors embraced the drive for a greener, more sustainable plant, it became a part of every design decision. The hydro turbine and sustainability aspects have already won the NTP Project an Envision Gold award, and the benefits of the design have improved not only capital costs, but also the life-cycle cost of the plant. This is a benefit to Denver Water and its customers.

LEARN MORE

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