U.S. Department of Energy Team 15

Hydropower Collegiate Competition

Team Members & Roles: Caiden Moreno and Ryan Garcia (Team Leads), Isaac Pricher and John Morenzi (Prototype Leads), Srikar Darapu (Prototype Worker), Vincent Van Asdale (Design Analyst), Colin Young (Design Lead), Yuri Steslboim (Siting Lead), and Alex Baca (Community Connections Lead). **Mentors:** Samuel Doyle (Industry Mentor), Sandra Cordoba **Faculty Advisor:** Jose Garcia Bravo

PURDUE UNIVERSITY

Polytechnic Institute

OBJECTIVE

Purdue HCC team, Purdam, looks forward to sharing the insights and advice received from a variety of hydropower professionals at different levels, roles, and regions within the industry. Our team was fortunate enough to interview four professionals within the industry on a topic that we deemed as the most demanding. From the range of topics given, Purdam decided to focus strictly on challenges presented in the hydropower workforce. The hydropower workforce today faces several challenges, including an aging workforce, limited awareness among younger generations, and the need for interdisciplinary skills. As the industry evolves with modern technologies and sustainability goals, there is a growing demand for new talent that can drive innovation while maintaining the reliability of existing infrastructure. The insights gathered from our interviews allowed us to address these challenges by forming potential solutions and tangible outreach activities centered around one of our potential solutions.

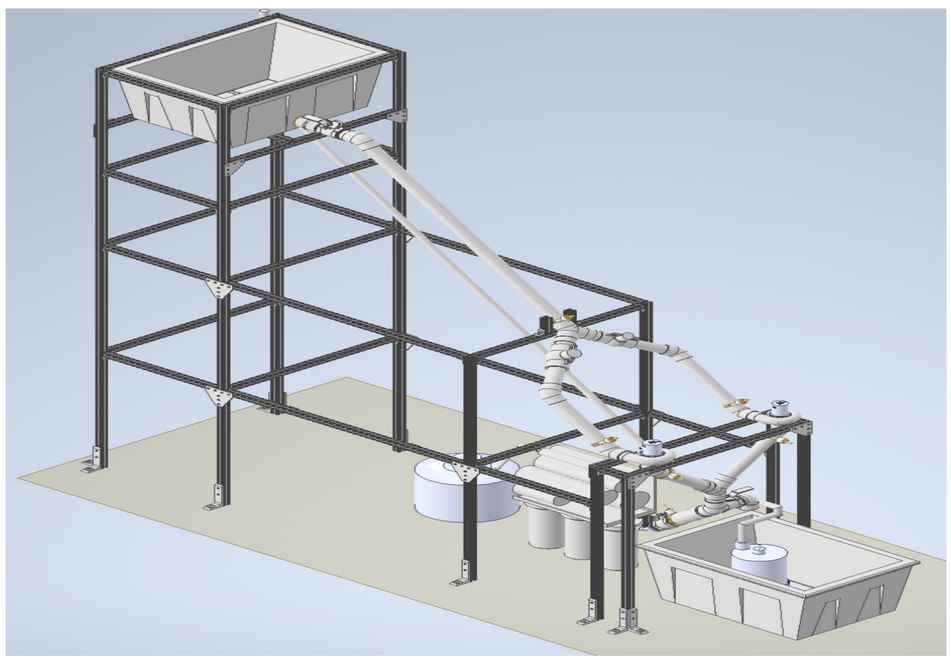
CUSTOMER PROBLEM AND BACKGROUND

The United States currently has over 90,000 total dams, with only 3% producing hydroelectric power. This leaves approximately 87,000 dams available for our team to choose from. With renewable energy becoming an increasingly important factor in the energy landscape of the United States, this massive number of non-powered dams (NPDs) creates great opportunities to expand renewable energy and decarbonize the energy sector. This paper reviews our complete process for siting down-selection, determining feasibility, and designing a concept for an NPD to hydroelectric dam conversion with co-developments. Our approach combines analytical rigor with practical design configurations to approach the conversion of an NPD to hydropower and seeks to contribute meaningfully to sustainable and efficient hydropower development.

CONCEPTS AND EXPERIMENTATION

This report covers the Purdue HCC Team's comprehensive siting and design process for the retrofitting of a non-powered dam to produce hydropower. A rigorous multi-phase down-selection process was conducted using the NPD Hydro software and custom qualitative and quantitative metrics. Prettyboy Dam in Maryland was ultimately selected due to its favorable head height, accessibility, as well as proximity to urban load centers. After selection, a detailed feasibility assessment was conducted, covering economic viability, flow dynamics, environmental impact, infrastructure compatibility, and regulatory considerations. This assessment confirmed that the site is suitable to create a 1.2 MW hydroelectric facility with integrated reverse-osmosis water purification. The final design includes two Francis turbines, fish passage, brine mitigation, and maintains the dam's original purpose of water supply and flood control.

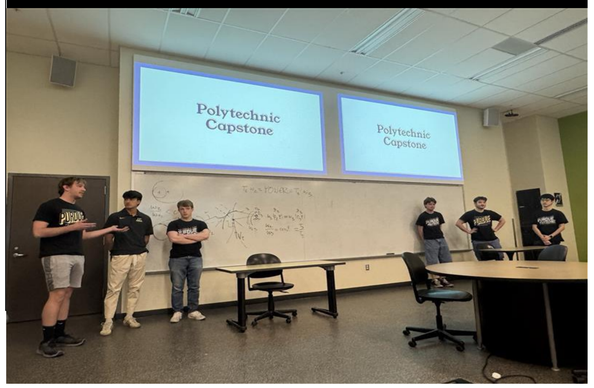
REQUIREMENTS AND FINAL DESIGN



https://americanmadechallenges.org/challenges/hydropower-collegiate-competition/docs/Hydropower-Collegiate-Competition-Rules.pdf

This project aims to implement novel methods for electricity generation using hydropower while addressing the environmental implications of the system. The methods to deploy include multistory reservoirs to separate the streams for power generation from those dedicated to the transfer of species and the regeneration of hydrostatic power using pump-turbine coupling devices. For this year's (HCC 2025), we will enhance the design of the hydropower systems by optimizing the performance of the systems based on the temporal electricity demand. Such an investigation requires modeling and testing hydraulic devices, optimization of the system components, data, and cost analysis.

Community Outreach



CONCLUSION AND RECOMMENDATIONS

In summation, the team will create a functional scale model of the retrofit designed for the Prettyboy Dam, which will be showcased as a part of the Hydropower Collegiate Competition. The team has created an extensive risk matrix and has developed mitigation plans for each risk identified. This will ensure the safe and proper construction of the prototype. With the construction complete, the team plans to conduct various tests to ensure the functionality of the prototype as well as to demonstrate the working principles that the design sought to capture. With this "build & test" plan, the team is confident that a quality model will be produced. Our down-selection process is a multi-step process that looks at a variety of qualitative and quantitative factors to narrow down to our eventual selected dam. To develop an initial subset of 100 dams, we used the Non-powered Dam Hydro software. This NPD Hydro software allows the user to filter through a large database of NPDs using user-set criteria to generate a ranked list of dams based on said criteria. The criteria we used fell under four categories: community, environmental, grid, and industry. All categories except for industry, which was weighed lower because its criteria shared the same criteria as the other categories, were weighed equally to ensure a more holistic approach and to provide us with a broader initial set of NPDs to choose from.