Technology Innovation Project

Project Brief

TIP 422: HDC - Turbine Optimization Model (TOM) development for capital investment decision-making for FCRPS hydroelectric plants

Context

The Shuffled Complex Evolutionary - Turbine Optimization Model (SCE-TOM) is a modeling methodology that can evaluate optimal turbine design for economics and operations. The SCE-TOM was developed by the **Hydroelectric Design Center (HDC)** in 2015 to aid in calculating economic benefits of turbine replacements and uprates across the United State Army Corps of Engineers (USACE) fleet. The two primary incentives for the developing this software were to standardize the turbine dispatch across the units when comparing across alternatives and to utilize the breadth of the entire turbine efficiency hill curves (powerhills).

Together with other BPA tools, SCE-TOM has been used to evaluate: the timing the major powertrain investments in Federal Columbia River Power System (FCRPS) projects; the optimal mix of Kaplan turbines versus propeller turbines; and the determination of the optimal number of units to replace. This methodology can be applied to any FCRPS plant, but the models have only been built for a handful of plants. Due to the time and computing power required to build these model, especially for the larger plants, this analysis can become the critical path if it occurs parallel with scoping and design for a major capital improvement. This tends to crunch the time available for using the model to perform analysis and guide the design.

Description

This TI project develops SCE-TOM models for application at five additional FCRPS plants with upcoming major capital decisions. Developing the models ahead of the design and scoping phase will ensure that more time can be spent performing analysis and informing the direction of the capital investment decision.

There are five tasks associated with model development for each powerhouse in this project:

Task 1: Acquire Current Turbine Efficiency Curves and Generator Limits
Task 2: Acquire Historical Hourly Hydrologic Data
Task 3: Create Powerhills
Task 4: Model Validation
Task 5: Run Simulations
Task 6: Generate Final Report for each plant

Why It Matters

The SCE-TOM models will be complete and ready for use for capital planning prior to the need for investment which should decrease the cost and schedule of the project scoping studies. It is estimated that the Corps will save 4 to 12 months and $100k to $300k in direct design costs per powertrain investment project. Once developed, these models are easily updated and can be used for any future powertrain investment. They are expected to be used throughout the 2020s. Additionally, there are thirteen capital investments in the Asset Plan for which these models would likely be used.

Goals and Objectives

The goal of this project is the development of the Shuffled Complex Evolutionary - Turbine Optimization Model (SCE-TOM) for five FCRPS hydropower plants. SCE-TOM will be used in combination with other BPA economic planning tools to determine the feasibility and the most efficient timing for generator rewinds and turbine replacements at these facilities, including the optimal number of units to replace.

Deliverables

1) An SCE-TOM energy model will be created using the current generator and turbine characteristics of the The Dalles powerhouse. The final product will be a series of powerhills representing optimal generation of the powerhouse at different levels of unit availability. These series of powerhills will ultimately be combined with an Availability Workbench Reliability Model (AWB).
2) The USACE Hydropower Analysis Center (HAC) will also create a final report which describes the generalized modeling and validation procedures.
3) Delivery of similar model for powerhouses at Bonneville, Albany Falls, Detroit, and Big Cliff dams but only developing current conditions.

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Project Start Date: May, 2020

Project End Date: September, 2021

Links

USACE Hydroelectric Design Center
https://www.nwp.usace.army.mil/about/hdc/

Participating Organizations

United States Army Corps of Engineers (USACE)

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