WBS # 1.2.3.604 – HIPPO-HS: A Tool for Planning and Assessing Hybrid Resources at System Level

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Project Overview

Project Summary

• This project will support vertically integrated utilities to reach their clean energy goal by investigating the benefits of operating the run-of-river (RoR) and battery storage as a hybrid generation resource. Working with our industrial partner, we are developing accurate representations of hydro generation resources, battery storage and the hybrid operation in real-world system-level day-ahead operation. The project will not only demonstrate the benefits of hybridization in lowering cost and improving system flexibility and utilization of clean energy, will but also provide a decision support tool directly to the industry for its day-ahead operation and resource planning activities.

Intended Outcomes

• High-Performance Power-grid Optimization – Hybrid System (HIPPO-HS) as decision support tool based on enhanced unit commitment (UC) model with industrial operation details for system-level day-ahead operation.
• Unit commitment model with the representation of RoR+battery storage hybrid.
• Battery storage siting and sizing tool for industry resource planning activities.
• Assessment of the benefits of RoR+battery storage hybrid in operating power system

Project Information

Principal Investigator(s)

• Feng Pan, PNNL

Project Partners/Subs

• Idaho Power Company (IPC)
  – Resource planning
  – Day-ahead operation
  – Operation Hydrology

Project Status

Ongoing

Project Duration

• Start: Oct 1, 2021
• End: Dec. 31, 2022

Total Costed (FY19–FY21)

$123,966
Project Objectives: Relevance

Relevance to Program Goals:

• The primary outcome envisioned in this project is for vertically integrated utilities
  – To adapt the developed models and algorithms to their day-ahead operation to
    achieve their clean energy goal.
  – To create a foundation for prudent investments in hybrid energy resources by
    utilities and private developers, using the siting and sizing algorithms.
  – With access to a market model for non-commercial use under a no-cost, non-
    exclusive research license, to enable researchers to explore other novel
    approaches to hybridization and the implied system value.

• Optimize hydropower operations and planning to best utilize hydropower’s
  capabilities to provide grid services through increasing fleet flexibility and
  value.
Approach:

• Integrate details of industry operation conditions and procedures into a centralized unit commitment optimization model.
• Model validation with industry partner to ensure HIPPO model matches current industry day-ahead operation.
• RoR+battery storage hybrid resource to convert must-take resource to dispatchable resource.
• Large scale mixed integer optimization models and bilevel optimization model.
• Fast algorithms and HPC based solution techniques provide an efficient computation engine.
Expected Outputs:

• Decision support tool for Idaho Power Company’s day-ahead operation and resource planning.
• Assessment of the benefits of RoR and battery storage hybrid as a guide for system level resource investment.
• Publication and conference presentation of developed methodologies.

Intended Outcomes:

• IPC will have an advanced day-ahead decision support tool to improve its operation cost and high utilization of clean resources.
• IPC will have a resource planning tool for assessing its battery investment.
• The assessment results can be used as foundation to provide IPC guidance to its battery storage investment.
**FY 2021**

- Develop unit commitment at the scale of Western Electricity Coordinating Council for large system study.
- Establish partnership with IPC.
- Industry data acquisition.
- Customize day-ahead unit commitment to IPC’s day-ahead operation.

**FY 2022**

- Model validation with IPC to ensure our model matches the current industry practice.
- Develop IPC model with RoR+battery storage hybrid.
- Develop battery siting and sizing model.
- Define scenarios and perform benefit assessment.

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**Regional System**

- Develop general Unit Commitment in WECC system

**Current System**

- Develop IPC unit commitment model reflecting its operation details

**Enhanced System**

- Develop IPC unit commitment model with hybrid RoR and battery storage

**Battery S2**

- Develop battery siting and sizing model
Project Budget

<table>
<thead>
<tr>
<th>FY21</th>
<th>Total Costs FY19-FY21</th>
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<tbody>
<tr>
<td>Costed</td>
<td>Total Costed</td>
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<tr>
<td>$123,966</td>
<td>$123,966</td>
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- The team spent less than the planned budget in FY21. There was a period during which the team was preparing the agreement between PNNL and Idaho Power before the technical work could proceed.
End-User Engagement and Dissemination

• Partnering with Idaho Power Company
  – IPC will be the early adopter of HIPPO-HS.
  – To reach its 100% clean energy goal, the objective is that HIPPO-HS can be used to
    – Investigate the benefits of RoR+battery storage hybrid in terms of cost, flexibility, and
      clean energy utilization.
    – Improve daily electricity operation with more accurate and faster unit commitment model.
  – With IPC as the project partner, we aim to provide HIPPO-HS as a decision support
    tool for its day-ahead operation and as a planning tool for its integrated resource
    planning activities.
  – The team is developing HIPPO-HS with IPCO. Through regular meeting, we model the details
    of IPC’s systems and validate HIPPO-HS with IPC’s operation model.

• Technology transfer
  – HIPPO-HS can be licensed from the existing HIPPO license.
  – Multiple phases starting with providing IPC the access to the HIPPO-HS
    web application
Performance: Accomplishments and Progress

- Demonstrate UC for WECC balancing area. Place collaboration agreement and NDA
- Develop IPC day-ahead UC model in HIPPO-HS and perform validation
- Web access for IPC to use HIPPO-HS
- Present benefits of RoR and battery storage to IPC

**FY 2021**
- Build UC for the WECC system and its balancing areas
- Understand IPC day-ahead planning operation and define data requirements
- Implement and validate IPC day-ahead UC problem

**10/2021 – 12/2022**
- Develop RoR and battery storage hybrid representation in IPC UC model
- Assess benefits of RoR and battery storage hybrid
Performance: Accomplishments and Progress

• Develop and implement a UC model for the WECC region
  – Curated WECC data for setting up unit commitment model.
  – Able to solve UC for balancing areas in WECC.

• Established collaboration with Idaho Power
  – Identified the areas for collaboration and signed NDA.

• Develop UC model for IPC
  – Learned Idaho Power’s day-ahead planning operation, defined the conditions for modeling UC for IPC, and identified data requirements.
  – Formulating and implementing IPC UC model in HIPPO-HS.
Future Work

• Formulate and implement UC to conform the IPC’s day-ahead operation. Add details on hydro storage, river connection and flow conditions to reflect hydro operation and compliance at IPC.

• Validate the HIPPO UC model to confirm the representation of IPC’s current operation.

• "Validate UC model to confirm representation of IPC's current operation"

• Formulate and implement RoR+battery storage hybrid model as the enhanced UC for IPC day-ahead planning.

• Formulate and implement battery siting and sizing model and solicit the battery investment options from IPC. Define future RoR+battery storage scenarios for IPC.

• Assess the benefits of RoR+battery storage hybrid and analyze the impacts in IPC’s day-ahead operation.
Q&A