

Development of model specification for the generic WECC model of advanced pumped storage technologies

Jin Tan Power System Engineering Center National Renewable Energy Laboratory 09/20/2023

For WECC Model Validation Subcommittee Meeting

Project Team

- **Project Partners:**
- NREL (Jin Tan, Greg Stark)
- ANL (Vladimir Koritarov, Feng Qiu)
- OPAL-RT (Zerui Dong)
- GE (Jason MacDowell, Matt Pevarnik, Shuri etc.)
- SIEMENS*(James Feltes, Jayapalan Senthil)
- Pouyan Pourbeik

Advisor:

- WECC
- Auburn University (E Muljadi)

Background

As renewable energy's share in the grid increases, advanced PSH technologies have become attractive for accommodating more renewables by providing energy and ancillary services support. However, in the current U.S. market, most hydro projects are traditional PSH technology, and the lack of generic models for new advanced PSH technologies has created understanding gaps for investors and grid operators, hindering their implementation. Reliable and accurate models are urgently needed to fully comprehend the benefits of using advanced PSH.



 This project aims to develop a generic model specification for advanced pumped storage hydro technologies, including adjustable pumped storage hydro (A-PSH), ternary pumped storage (T-PSH), and quaternary pumped storage hydro (Q-PSH), for the Western Electricity Coordinating Council (WECC). These developed PSH models will enable the evaluation of how these advanced PSH technologies affect the transient dynamics and stability of transmission systems.

Work Effort

The project team aims to unify the top PSH modeling experts from national labs (NREL, ANL), PSH builder (GE), software vendors (GE, Siemens, OPAL-RT) in this field and develop the positive-sequence model and EMT models along with a detailed description and mathematical representation of different types of advanced PSH technologies. Leveraging NREL and ANL's past modeling work on advanced PSH, the project will refine the generic models and parameters based on the OEM's inputs. The accuracy and fidelity of the model specification will be validated with OEM's field-testing data if they are available, as it significantly impacts the quality of analysis and decision-making within power systems engineering and operations.

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Z. Dong, **J. Tan***, **E Muljadi**, R Nelms, A St-Hilaire, M Pevarnik, M Jacobson., "Developing of Quaternary Pumped Storage Hydropower for Dynamic Studies," IEEE Transactions on Sustainable Energy, 2020.

Z. Dong, **J. Tan***, **E. Muljadi**, R. Nelms, and M. Jacobson, "Impacts of Ternary-Pumped Storage Hydropower on US Western Interconnection with Extremely High Renewable Penetrations," in *IEEE Power & Energy Society General Meeting (PESGM)*, Atlanta, USA, August 2019.

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Thank You!

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