Improving Hydropower Modeling for Power Systems Planning and Operational Studies

HydroWIRES — U.S. DEPARTMENT OF ENERGY

Hydropower modeling needs an upgrade. » *With industry input, we're modernizing it.* » *Better modeling will support a more resilient and reliable grid.*

Performance Example: Water Availability

Key Industry Comments:
- "It's a good idea to vary head parameter in dynamic models and observe the effect on studies"
- "For power system simulation programs, we should propose to build a new section … to specify seasonal water flow condition on rivers, head information and … to adjust steady state and dynamic model data accurately"

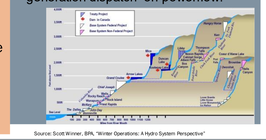
Source: Insight Climate News

Recommendations:
- To collect water data for different river basins for low and high -water conditions
- To establish water profiles for different water conditions for different river basins.
- Dependence among parameters (dynamic model)
- Many dynamic models do not allow to change water head
- To develop a tool that automatically impose water conditions on each river basins separately in steady state and dynamic models.

Performance Example: Interdependences and Constraints

Key Industry Comments:
- "Study engineers need to be educated on the river flow operations and the model data exchange between PCM and planning case need to be checked"
- "Not an urgent requirement for the transmission planners – need to educate the engineers to make sure errors are not made…"
- "It's more important in long term simulations and critical for run of river plants"

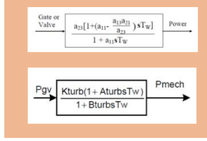
Recommendations:
- To collect rules on how water can be shifted from project to project including environmental rules
- To develop tool implementing coupling among plants and impose restriction on generation dispatch on powerflow.



Source: Scott Winner, BPA, "Winter Operations: A Hydro System Perspective"

Performance Example: Dynamic Models

Key Industry Comments:
- "Some of the models developed late 60s and early 70s"
- On some model water head cannot be changed"



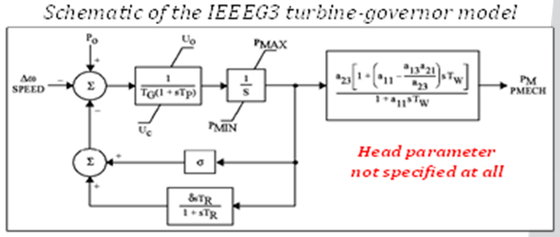
Recommendations:
- The models with linear water/turbine models have been superseded, and are now subsets of better models
  - ieeeg3 -> hygov4
  - gpwscc -> hyg3
  - g2wscc -> hyg3
  - pidgov -> hyg3*

*more discussion necessary

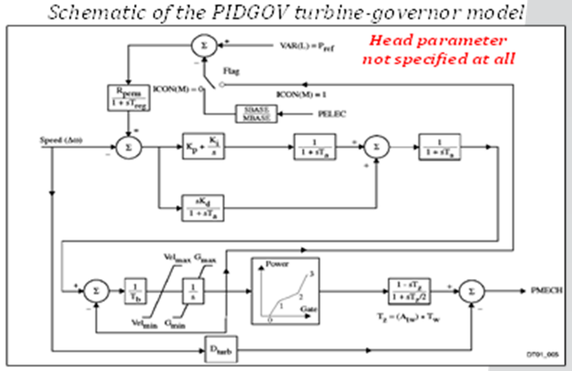
- Need to convert parameters from old to new, some studies are needed to check on effect
- About 200 models needs to be updated/substituted

Challenges in dynamic modeling

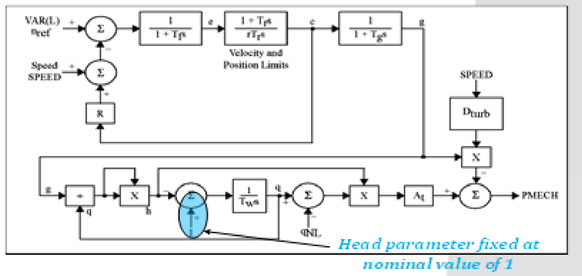
Schematic of the IEEEG3 turbine-governor model



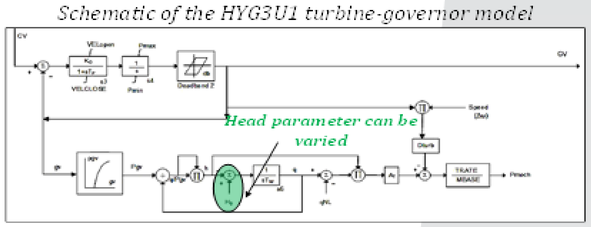
Schematic of the PIDGOV turbine-governor model



Schematic of the HYGOV turbine-governor model

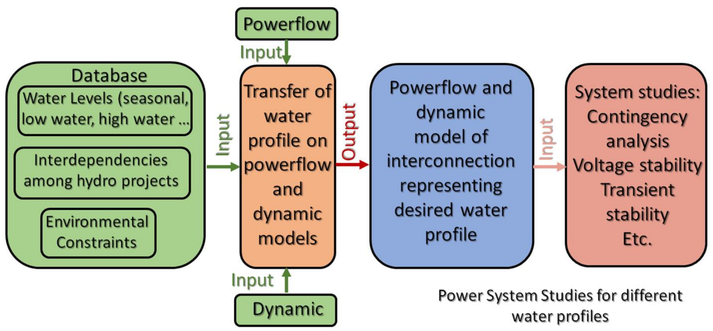


Schematic of the HYG3U1 turbine-governor model



Project Objectives

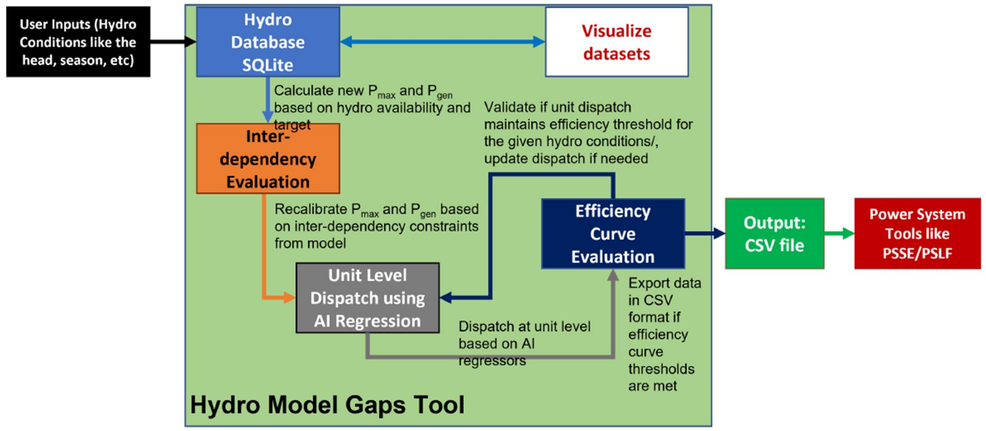
- Develop database/methods/tools that will update system models to account for dynamic water availability, interdependences between cascading systems, and rough zones in planning and operations models,
- Review, update, and develop dynamic models,
- Stakeholder engagement to collect and disseminate information and data, validation of methodologies, and testing of the tools



Approach

The Hydro Model Gaps Tool is developed as follows:

- The user interface or frontend is based on **React** (a JavaScript library)
- The REST API is based on **FastAPI** (a Python framework)
- The backend includes **unit-level dispatch models** using regression models and historical hydrology and electrical dispatch datasets, **database**, **efficiency** curves, **interdependency** validation, etc.



Intended Outcome

- Industry awareness of hydro generation misrepresentation
- Improvement of modeling practice
- Improvement of planning and operational studies
- Improved reliability of power system
- Accurate estimation of the role of hydro in the integration of other renewable resources.

Industry Stakeholders and Partners

WECC — John Undrill

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