1.2.2.603/35977 – Enhancing the representation of conventional hydropower flexibility in production cost models

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Project Overview

Project Summary

- Resources adequacy studies look at needed investment in asset and technology to meet future electricity demand
- Hydropower is one of many resources involved in the process. Due to lack of data and limited computational resources, hydropower representation is simplified to a monthly representation for one average year.
- We leverage advances in large scale integrated hydrology modeling to provide higher temporal resolution hydropower datasets for a range of water year conditions

Intended Outcomes

- Open access hydropower datasets that i) cover multiple water year conditions and ii) are coincident in space and time across all dispatchable hydropower plants for input into production cost models in support of resources adequacy studies and long term planning
- Support western US resources adequacy studies
- Peer reviewed publications on novel approaches for representing hydropower operations – and hydroclimate research through hydropower operations- in power system studies

Project Information

Principal Investigator(s)

- Nathalie Voisin (PNNL), Thomas Veselka (ANL), Tim Magee (CADSWES), Larry Markel (ORNL)

Project Partners/Subs

- Mitch Clement, Edith Zagona (CADSWES)
- Quentin Ploussard (ANL)
- Kostas Oikonomou, Sean Turner (PNNL)
- Jinxiang Zhu, Hongyan Li (ABB Hitachi)
- Jamie Austin (PacifiCorp), Byron Woertz, Michael Bailey (WECC), Kevin Harris (consultant)

Project Status

Sunsetting

Project Duration

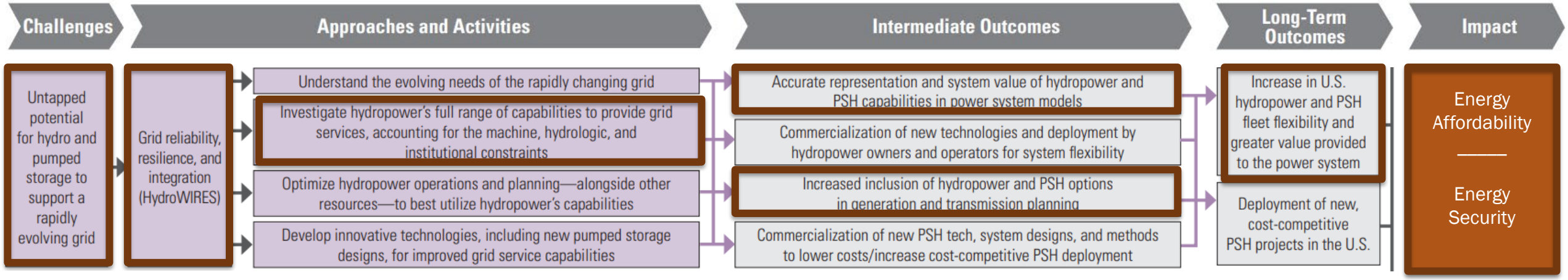
- October 2019
- September 2022

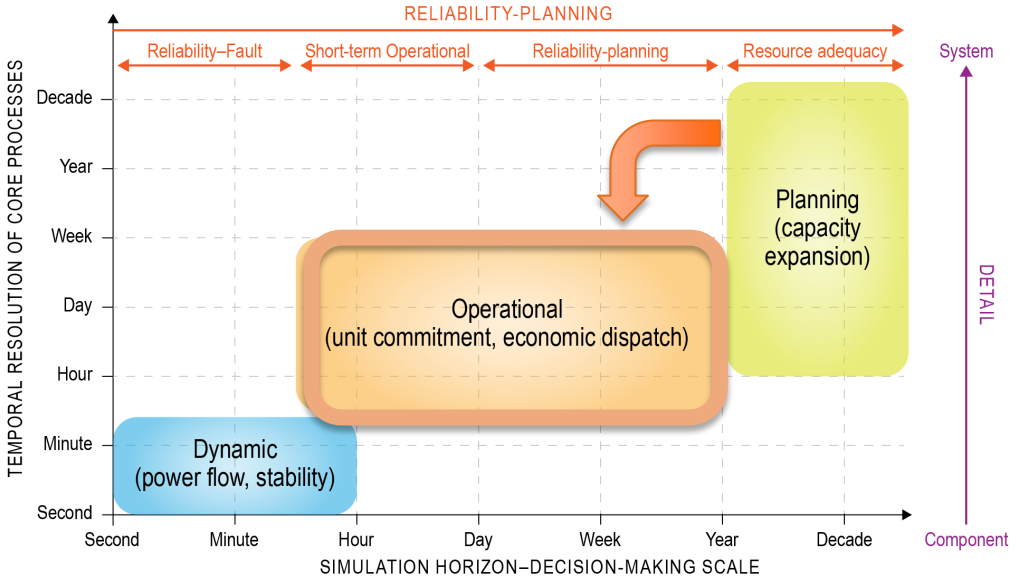
Total Costed (FY19–FY21)

$627k

Project Objectives: Relevance

Relevance to Program Goals:





Focus on hydropower in operational models in support of resource adequacy and reliability studies

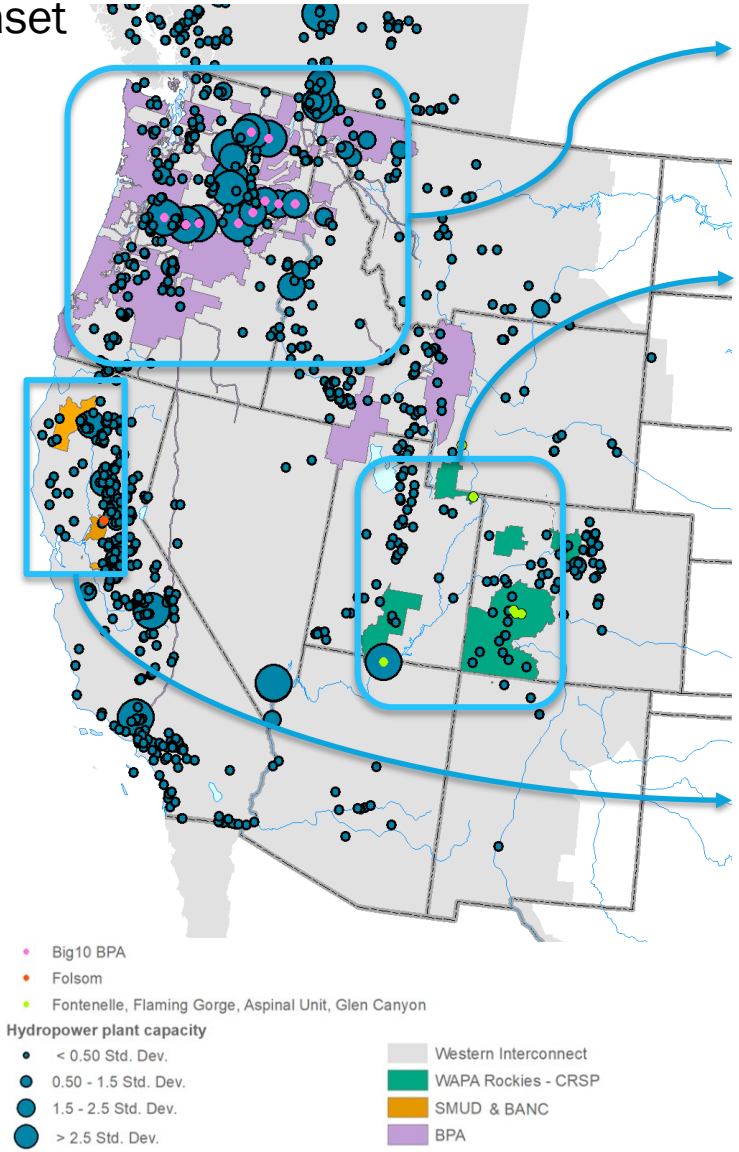
Ensuring that hydropower datasets - beyond EIA annual generation- are available for an entire interconnect results in:

- Robust reliability studies with different water conditions and realistic operations
- Robust evaluation of market and regulatory needs to incentivize hydropower operations that support reliability, economic and societal goals
- Fast adoption by the industry - software updates are also provided

Project Objectives: Approach

(1) WECC-scale hydropower dataset & GridView software weekly hydro logic

- Historical Observed Climate, Contemporary Land Use
- Hydrology Model
- River Routing + Existing Reservoir Operations and Water Demand
- Hydropower MONTHLY & WEEKLY Datasets at >300 individual plants - Statistical Tools -
- GridView weekly logic model update
- WECC 2028 ADS simulations Weekly vs Monthly under 3 water year conditions
- Engagement with WECC – start effort for WECC ADS 2032



(2) Case Study – BPA Big 10 – Benchmarking

WECC 2028 ADS hydro dispatch → → Feasibility Errors

(3) Case Study – WAPA – Are weekly datasets realistic from a hydropower operator perspective?

WAPA hydropower scheduler GTMax
Weekly hydro-economic surfaces
→ GridView weekly logic model → Delta in computational burden, system cost and revenues at WAPA hydropower plants

(4) Joint Case Study (HydroWIRES B2) – BANC – methods of hydropower schedule optimizations

Weekly datasets → GridView weekly logic model → Delta in revenues at BANC hydropower plants

FLASH & SIIP →

(5) WECC datasets fine tuning – use of EIA annual datasets and USGS daily flow for observation-based weekly datasets, updated software update

Project Objectives: Expected Outputs and Intended Outcomes

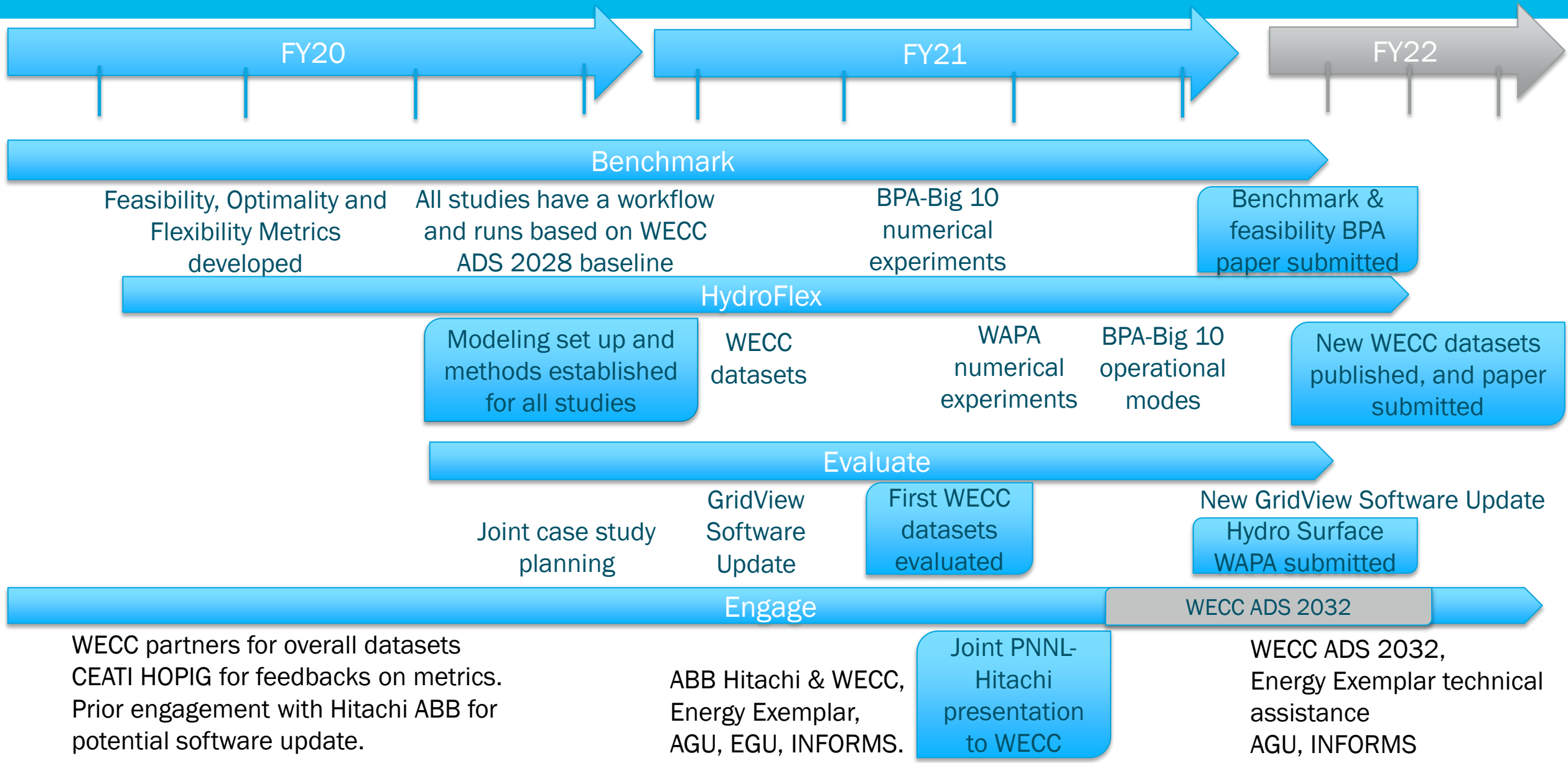
Outputs:

- Monthly and weekly hydropower datasets for 7 years of diverse water conditions based on simulations over the Western Interconnect (> 300 power plants)
- Monthly and weekly hydropower datasets for 20 years (2001-2020) based on observed water conditions and reservoir operations
- Hydrofxr statistical tool
- GridView software update for the weekly logic
- 3 peer reviewed publications
- A joint case study and associated report
- 9 presentations (AGU, EGU, INFORMS, invited academic webinars, industry forums)
- Staff training: 3 early career scientists

Outcomes:

- Support WECC ADS 2032 in developing new hydropower datasets
  (dataset already published)
- Support WECC ADS 2034 with an ensemble of strategic hydropower datasets
- Work with other commercial and open source production cost models developers for integration of the datasets
- Extension to other interconnections (MISO, PJM, SERC, NYISO, ..)

Project Timeline



Project Budget

FY20	FY21	Total Actual Costs FY19–FY21	FY22
Costed	Costed	Total Costed	Total Costed
$381K	$246K	$627K	$116K (projected)

Original budget of $693k –
- +$50k to PNNL for GridView software Update
- $50k to CADSWES in FY22Q1
- $26k to fine tune datasets and support 2 publications
- $19k to finish ANL-led publication

The closing of WECC activities was delayed for 2 quarters in FY21Q4 and FY22 Q1-Q2 while working on WECC ADS 2032 hydropower dataset.

- Presentation to WECC partners in July 2021 led to a quick-win project further customizing the datasets and software within WECC specifications (start from 2030 case instead of 2028, based on observed operations rather than simulations, represent evolving environmental regulation).
- Hydropower dataset was adopted in April 2022 for the WECC ADS 2032 case.

End-User Engagement and Dissemination

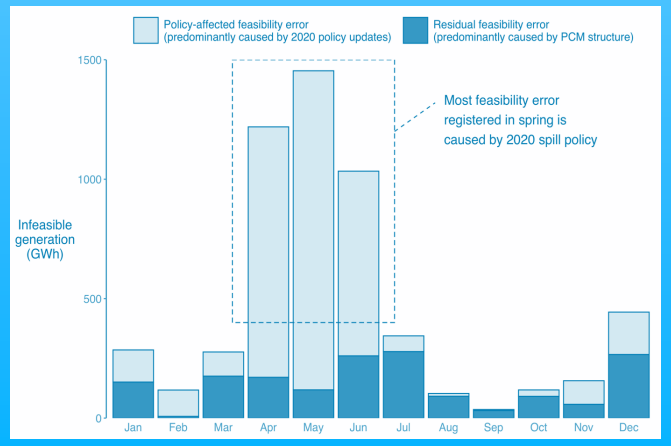
- **Available datasets for research and stakeholders:**
  - the main WECC-scale approach targets long term reliability studies (approach requires 6 months of flow to represent long term water management objectives). We have both EIA and USGS-based datasets for stakeholders more comfortable with recent past, as well as datasets based on climate and water demand datasets if using hydrologic simulations.
  - All datasets are publicly available, publications are open-access and tools are open-source (DOI, presentations, already supporting new projects).

- **Datasets and software's potential users:**
  - NERC (sub) regions and associated power councils
  - Market regions
  - Balancing authorities with multiple utilities, independent producers and over multiple disconnected watersheds
  - Utilities in the Northwest as they benefit from more accurate locational marginal prices in their long-term studies
  - Hydropower operators across the West in understanding evolving operational needs

Performance: Accomplishments and Progress

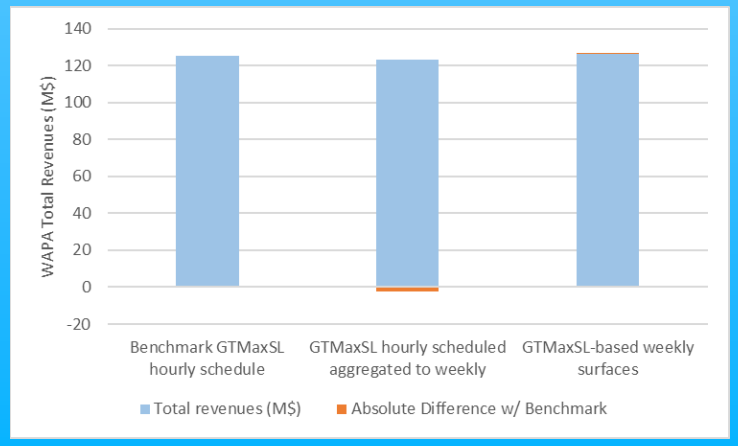
Benchmarks
(Magee et al. ERL 2022 – BPA Big 10 – in review)

- 9% of the annual hydropower generation infeasible during an average year,
- 2/3rd of it associated with contemporary environmental regulation
- Hydrologic simulations are needed to address changes in water management
- RiverWARE set up more aligned to explore grid-relevant operations



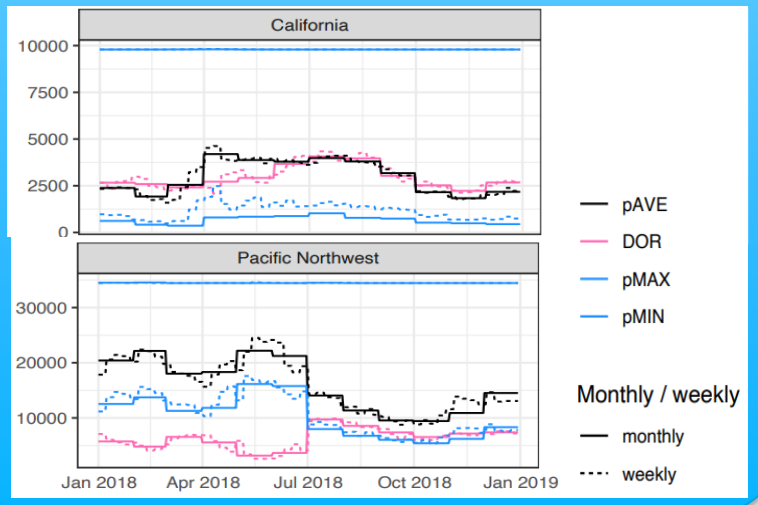
Potential adoption by utilities
(Ploussard et al. Applied Energy 2022 – in review)

- <3% differences in revenues when using the weekly surfaces instead of the hourly scheduler
- Weekly time steps for hydropower datasets are a reasonable tradeoffs for coordination with utilities



Adoption by WECC for reliability studies
(Voisin et al. ERL submitted)
(Voisin et al. 2022 – 2032 WECC ADS Hydropower Datasets)

- 3.2% lower CO2 emissions
- Substantial wind curtailment reduction
- Consistency between system operators and utilities planning



Future work (FY2022 and beyond)

Range of hydropower datasets for multiple science questions

This project's FY20-21	This project's FY22
20-year weekly dataset based on historical hydrologic simulations calibrated to EIA, easily extendable to climate change conditions, new water demand and reservoir operations	20-year weekly dataset based on observed operations and environmental regulation (EIA, USGS)
Statistical tool	Extended statistical tools
Gridview Weekly logic	Extended GridView weekly logic software

Open access datasets

Software already available to customers

- WECC ADS 2032 hydropower datasets (include environmental regulation) in support of industry
- EERE Technical Assistance FY22-23 Energy Exemplar for integration of hydropower datasets in PLEXOS
- Office of Electricity FY22-23 WECC long term support (input to ReEDS, and evaluation of ReEDS scenarios)
- Office of Science FY22-23 Evaluation of compounded drought and other extreme events on evolving power grid

Q&A