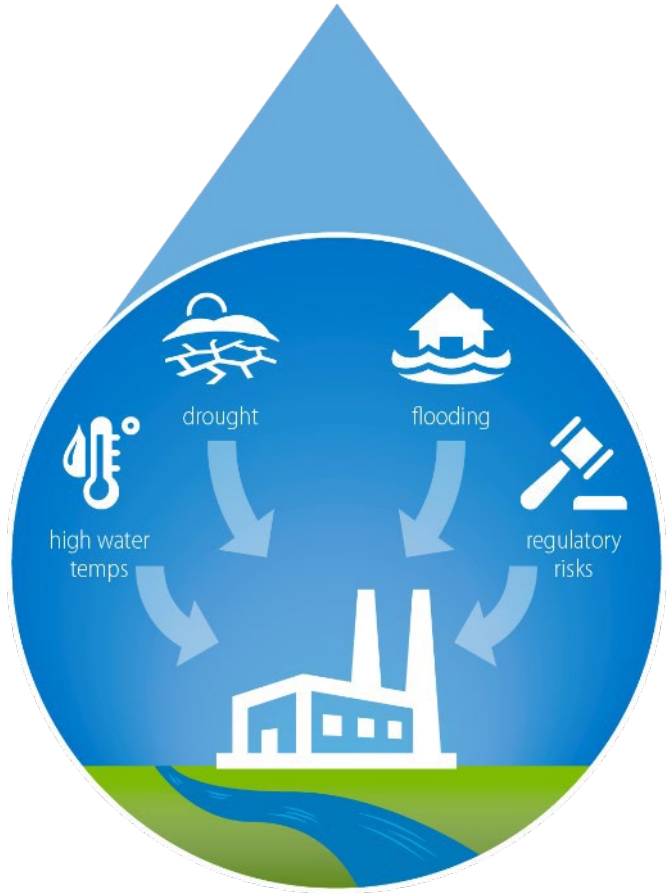
1.4.2.402 – *Water Risk for the Bulk Power System: Asset to Grid Impacts*



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Project Overview

Project Summary

Utilities and stakeholders need a standardized mechanism for evaluating how future climate and hydrologic conditions translate to water-related risks for power grid assets and systems to support planning decisions. Yet, no such mechanism exists. To address this need, our goals are to:

(1) Develop and execute a state-of-the-art multi-model framework to assess future climate-water impacts and risks to the grid, including sensitivities to varying hydrologic drivers and infrastructure scenarios.

(2) Create a standardized interactive visualization platform that enables stakeholders to evaluate climate-water impacts, risks, and adaptation measures for power systems.

Intended Outcomes: Key Deliverables and Products

- High-resolution climate-water risk modeling framework and assessments to support regional grid planning under stakeholder-informed climate-water-energy scenarios
- National visualization tool and data sets, informed by stakeholders, to support industry (Independent system operators (ISOs), regional transmission operators (RTOs), utilities), DOE, academia, and public understanding of climate impacts and water risk to power system planning and operations.

Project Information

Principal Investigator(s)

- Ariel Miara (NREL), Henriette Jager (ORNL), Nicole Jackson (SNL), Erik Shuster (NETL)

Project Partners/Subs

- CUNY Advanced Science Research Center: Charles Vorosmarty, Fabio Corsi
- Electric Power Research Institute: Nalini Rao

Project Status

Ongoing

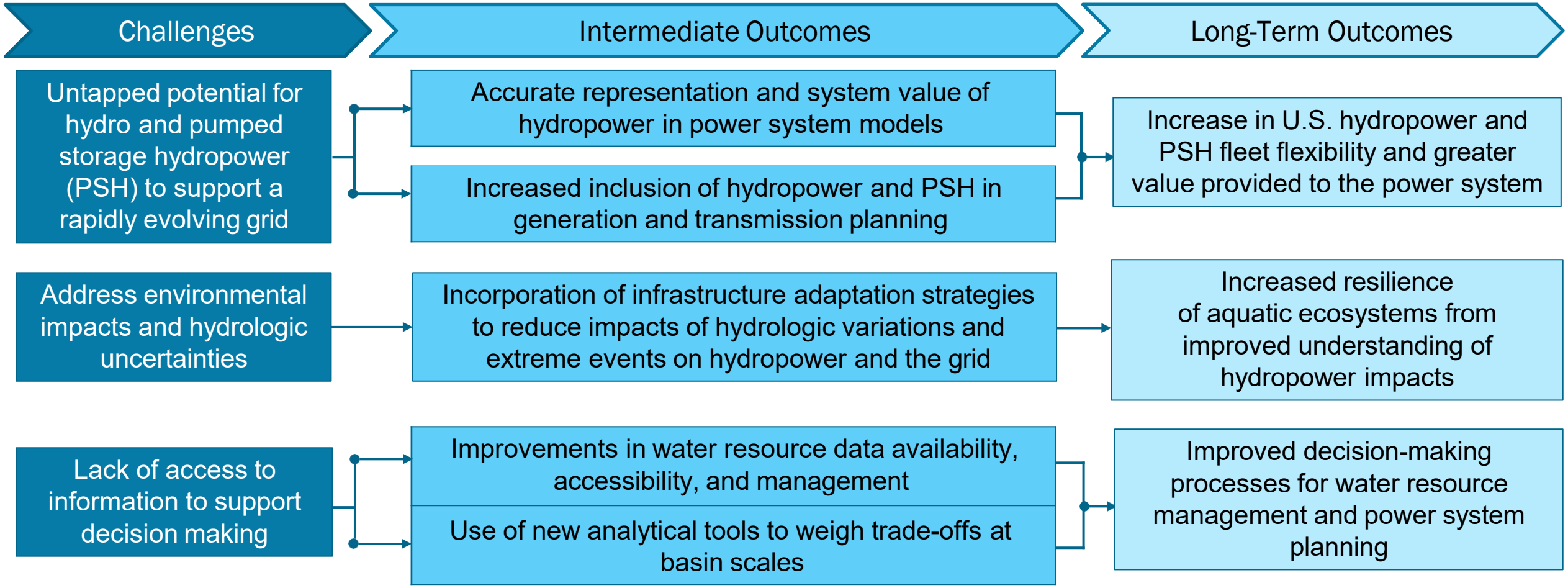
Project Duration

- Start date: June 2020
- End date: September 2023

Total Costed, All Labs (FY19–FY21)

$628K

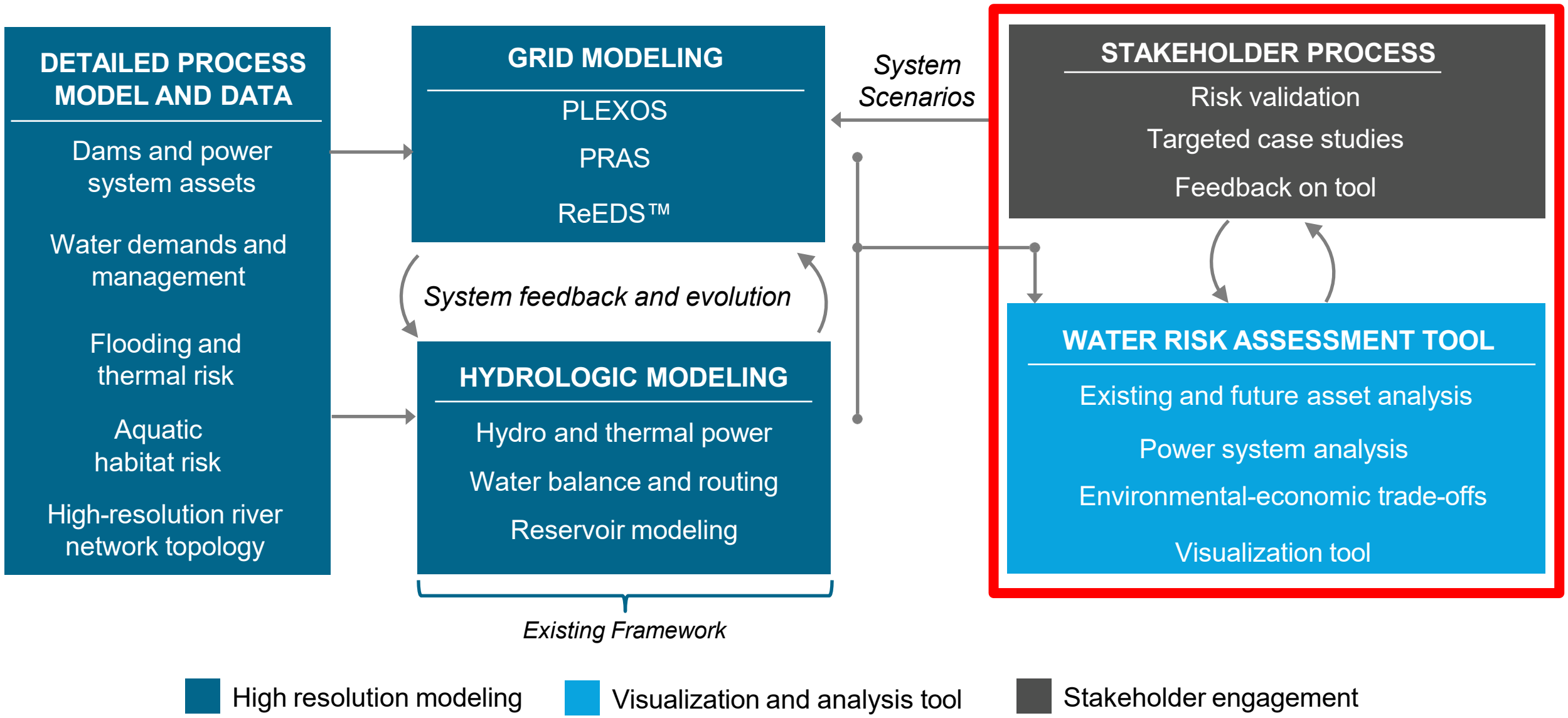
Project Objectives: Relevance to Program Goals



Direct Answer to Program Activity 4 Goal:

"Release a nationwide analysis and visualization platform that enables utilities and system operators to evaluate potential long-term water availability and climate change-related risks to existing and new hydropower assets at meaningful local or regional scales."

Technical Approach: Workflow

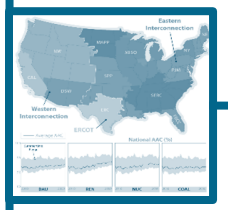


Project Objectives: Expected Outputs and Intended Outcomes

Expected Outputs

Climate-water impact and risk assessments

- Trade-offs in power system operations under climate-water risks
- Flooding and thermal risk assessments
- Asset-level hydro and thermal power generation
- Climate-water impact and adaption analyses
- Regional stakeholder-driven scenario analyses.



A nationwide analysis and visualization platform that is interactive, seamless, and hosts a large range of data sets and model results from the novel modeling framework and assessments

Intended Outcomes

Improve methods of capturing thermal plant and dam impacts on riverine ecosystems.

Improve the representation of hydropower in power system models.

Establish a transparent framework that evaluates how future climate and hydrologic conditions translate to water-related risks for power grid assets and systems.

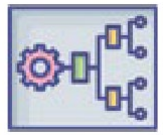
Enable quantitative insights to support planning decisions for utilities and system operators.

Enhance WPTO's understanding of hydropower's role and potential under future climate-water-energy scenarios.

Project Timeline

FY 2021

Integrate high-resolution data sets and powered/non-powered dam representation to modeling framework.



Develop visualization and analysis Prototype.

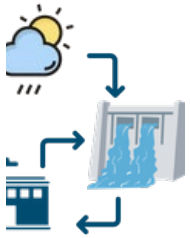
Kick off stakeholder engagement workshops for water risk and climate-energy scenario design

FY 2022

Visualization tool development go/no-go

Finalize methods for full suite of energy-water models and risk analyses

Analyze contemporary climate modeling results + showcase methods of improved representation of hydropower in power system models



Obtain stakeholder feedback on preliminary results and visualization tool

FY 2023

Release visualization tool and long-term support proposal

Complete modeling and risk analyses of future climate-energy-water systems
+
publish series of assessments

Conduct region-specific stakeholder discussions and analyses

End-User Engagement and Dissemination

Engagement activities:

- Q2 FY21: Water Risk Workshop
- Q4 FY21: Scenario Design Webinar
- FY22: 1-1 meetings on scenario design

Dissemination goals:

- Provide useful data and information through the visualization platform for:
  - ISOs, RTOs, utilities
  - Water resource planners
  - Public + academia
- Publish a series of energy-water modeling assessments
- Presentations of analysis findings and tool demos

Three key engagement areas

1. Feedback on research approach and results

Our goal: Ensure results are meaningful and relevant

Stakeholder opportunity: Learn and share input throughout the course of research

2. Co-developing energy-water scenarios

Our goal: Consider region-specific issues

Stakeholder opportunity: 1-1 meetings to inform the design of scenarios relevant to service territory and grid assets

3. Feedback and testing of visualization tool

Our goal: Ease of use for efficient data access and interactive analysis

Stakeholder opportunity: Access to data relevant for climate planning and scenarios

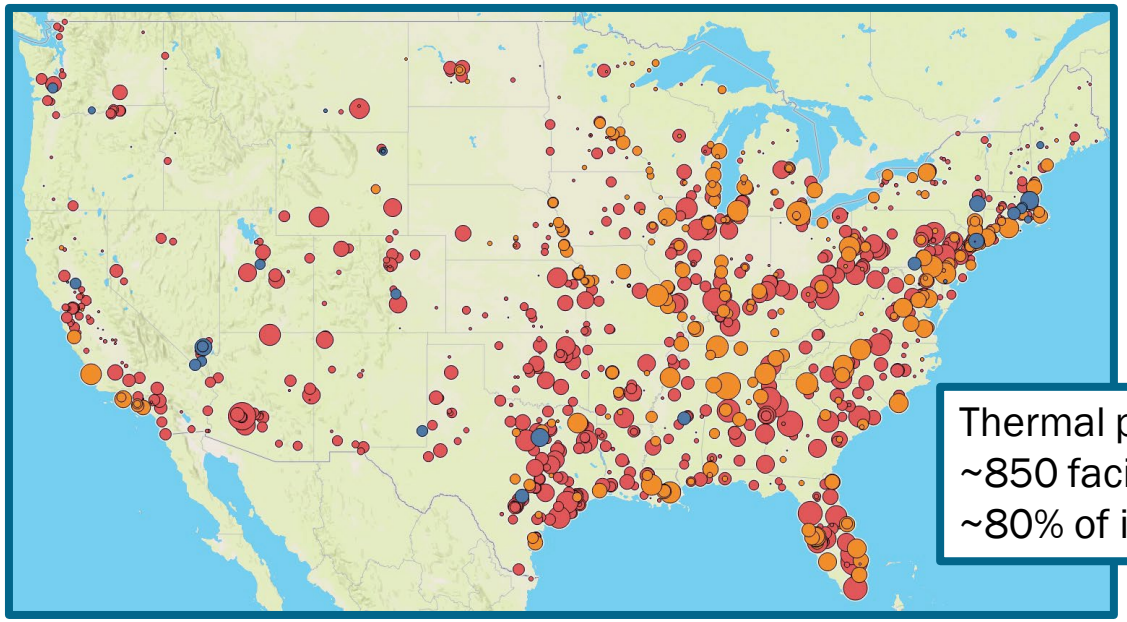
Performance, Accomplishments, and Progress: Energy-Water Modeling Assessments

Performance & Accomplishments:

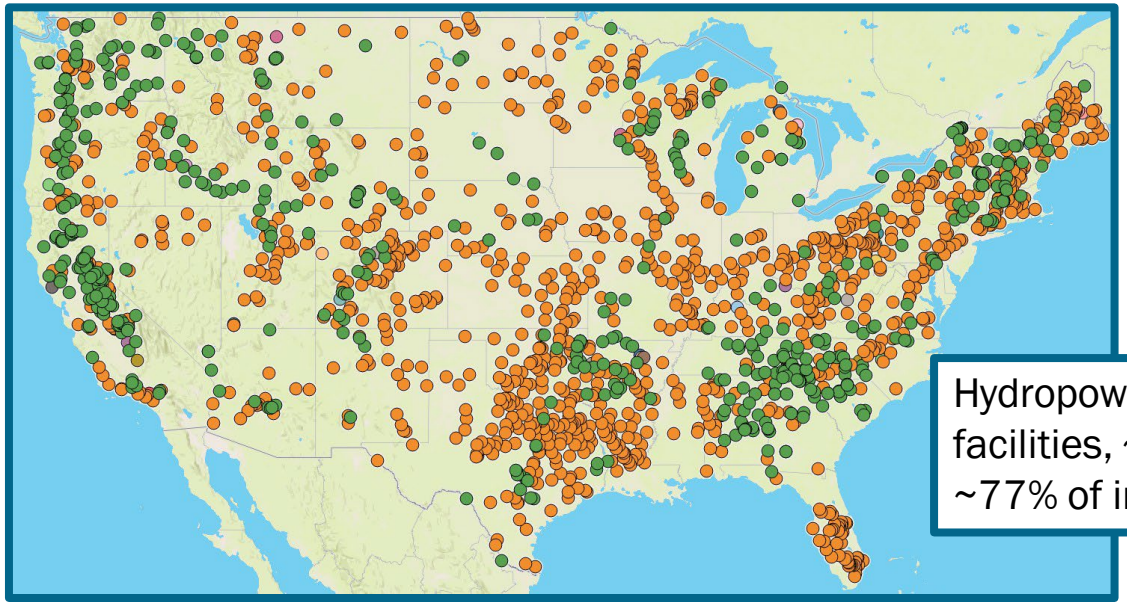
- High-spatial-resolution model development:
  - River network topology at 1-minute, 2x2 km
  - ~1,600 dams and ~850 thermal plants
  - Reservoir operations
  - Thermal plant water impacts
- Tested model framework
- Integrated weekly hydropower and daily thermal plant constraints to grid dispatch modeling.

Progress:

- Thermal stratification
- Flood risk analyses
- Execute final version of contemporary climate analysis (trade-offs in power grid operations)
- Assemble climate driver datasets for ensemble hydrologic modeling
- Finalize future energy infrastructure scenarios for capacity expansion (ReEDS) modeling.



Thermal power assets: ~850 facilities, ~610 GW, ~80% of infrastructure



Hydropower assets: ~300 facilities, ~61.5 GW, ~77% of infrastructure

Performance, Accomplishments, and Progress: Visualization Tool

Performance & Accomplishments

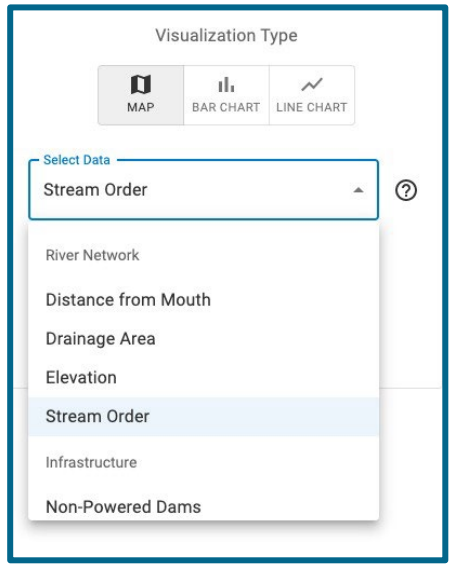
- Successfully completed prototype for a go/no-go milestone
- Demonstrated stable and efficient performance with a subset of model data sets and key user options
- Identified approaches to reduce risks associated with large data sets and a range of queries.

Progress:

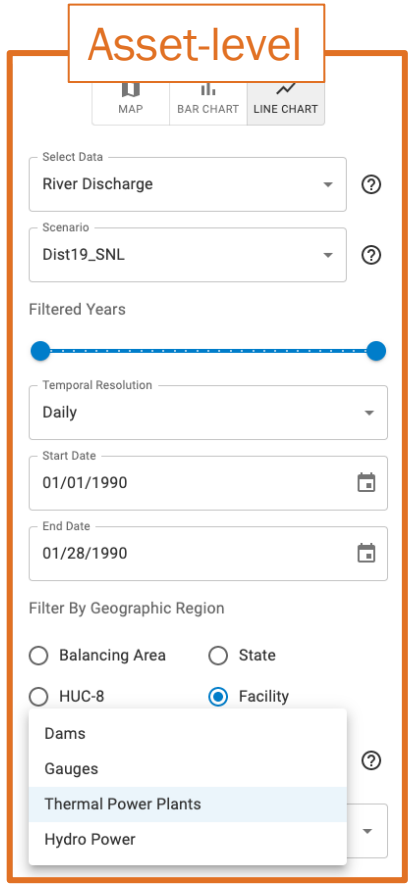
- Continue integrating datasets across models
- Enhance interface/visualization so users can efficiently interrogate the data sets based on “analysis storylines”
- Obtain stakeholder feedback.

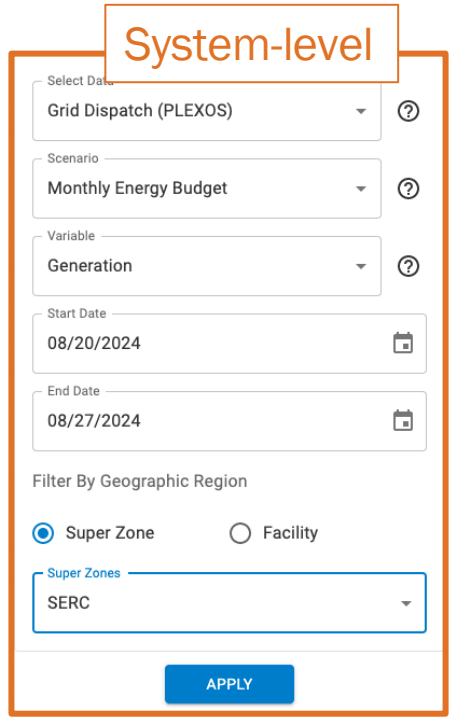
A consolidated area for all controls and placing all data in an organized workflow

Evaluate climate-water trends at grid assets and impacts on available capacity and grid operations

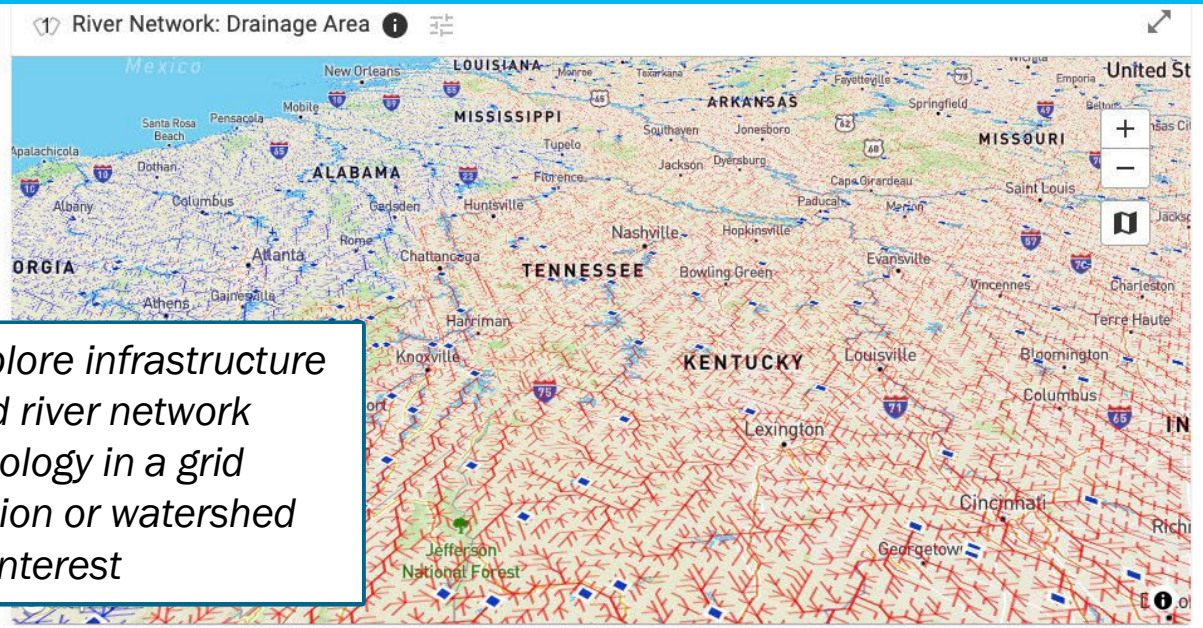


Explore river network topology

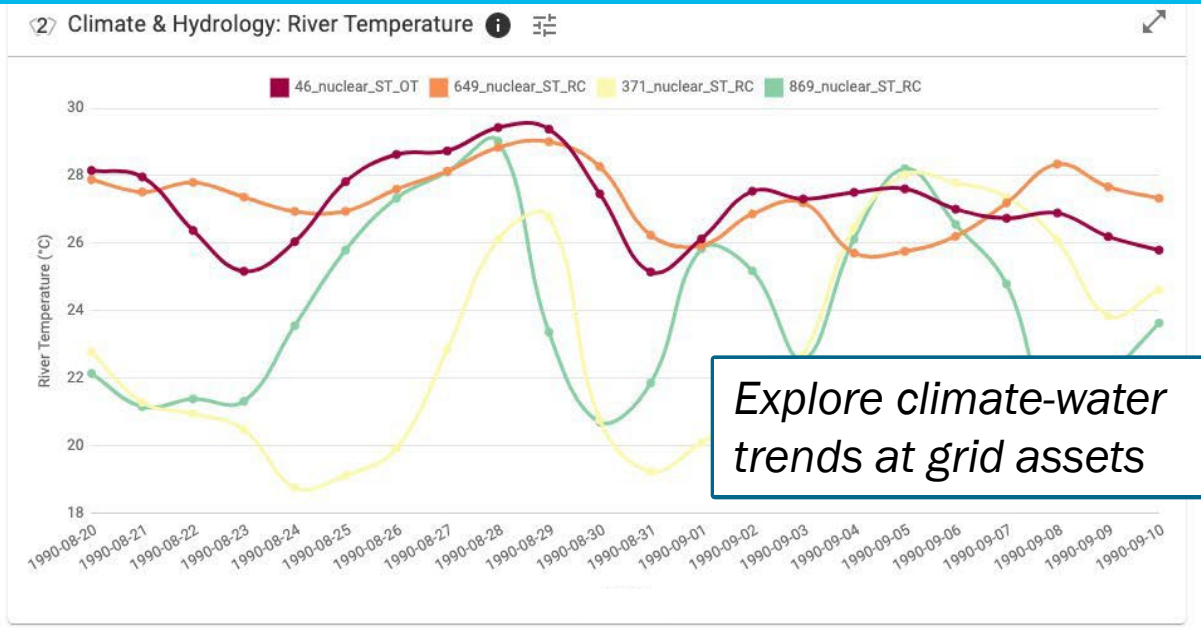




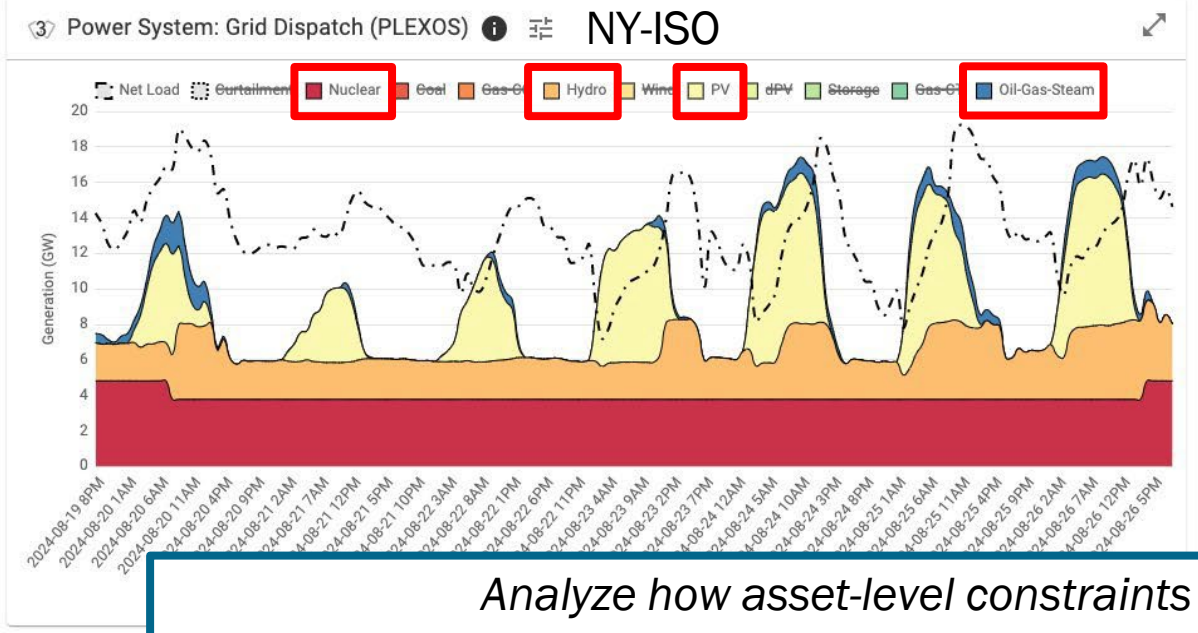
Performance, Accomplishments, and Progress: Visualization Tool

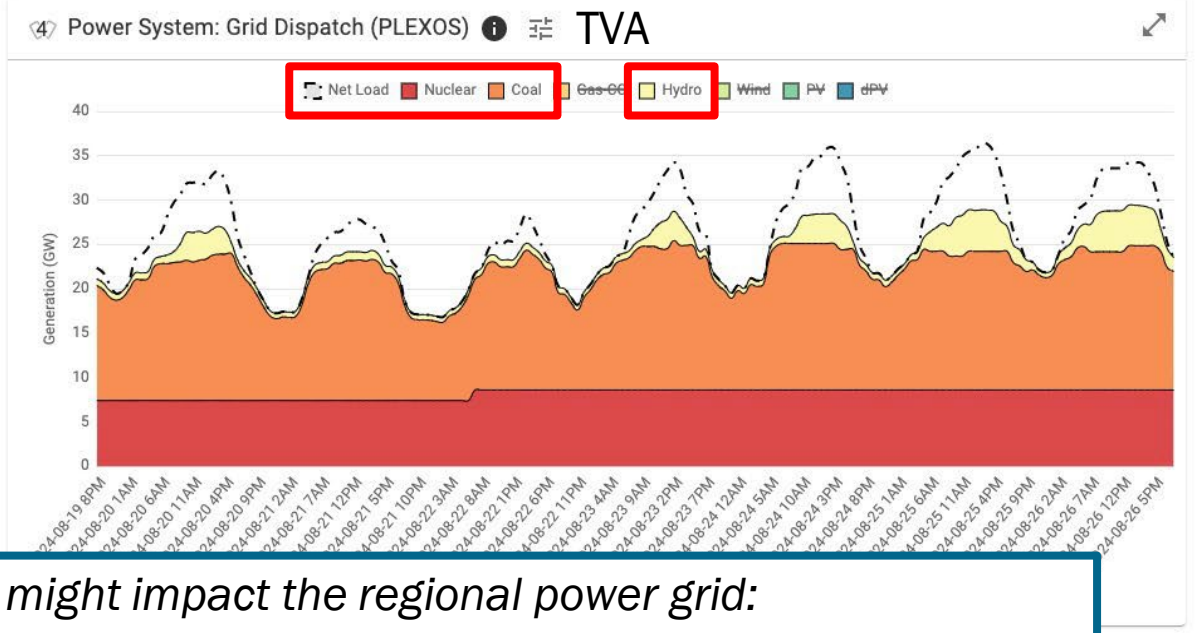


Explore infrastructure and river network topology in a grid region or watershed of interest



Explore climate-water trends at grid assets





Analyze how asset-level constraints might impact the regional power grid:
Regional or scenario comparison + trade-offs across technologies

Future Work

FY 2022

Modeling and analysis – finalize methods and execute model framework under contemporary climate

- Incorporate thermal stratification in hydro modeling for thermal and ecological risk analyses
- Preliminary flood risk analysis

•Analysis on trade-offs in power system operations under contemporary climate

Visualization tool and stakeholder engagement:

- Continue integrating datasets across models
- Demonstrate an updated version of the water risk visualization tool in a webinar, including a larger set of modeling results, to DOE and industry stakeholders (FY22 Q4/FY23 Q1)

FY 2023

Modeling and analyses with stakeholder engagement

- Ensemble modeling under stakeholder-informed electricity infrastructure scenarios (Q1)
- Analyze asset-level climate-water impacts on hydro and thermal assets (Q1)
- Regional/national climate-water impacts and adaptation analyses for energy-water system planning in coordination with stakeholders (Q1-3)

Visualization tool with stakeholder engagement

- Solicit feedback from test users (DOE labs + industry) in to help prioritize development (Q1)
- Initial tool release in Q2
- Continue integrating datasets and enhance user interface based on “analysis storylines” (Q1-3)

Project Budget

Lab	FY 2019 Costs	FY 2020 Costs	FY 2021 Costs	Total Actual Costs FY 2019–FY 2021
NREL	NA	NA	$161K	$161K
NREL (sub to CUNY)	NA	NA	$120K	$120K
NREL (sub to EPRI)	NA	NA	$100K	$100K
ORNL	NA	NA	$148K	$148K
SNL	NA	NA	$99K	$99K
NETL	NA	NA	$0K	$0K
Total	NA	NA	$628K	$628K

- Minor overall difference from FY 2021 planned costs ($617K), no change in scope required
  - $124K (20%) of in-kind cost-share from CUNY, EPRI, and stakeholders for FY 2021.

Q&A