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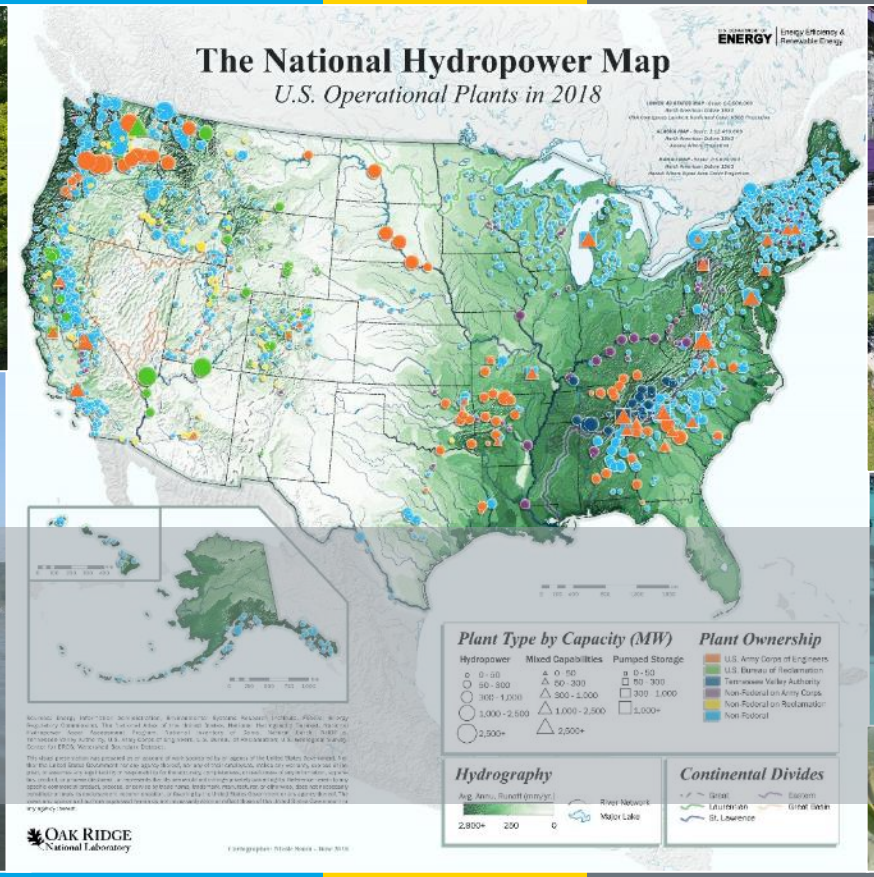

HydroSource

1.4.1.502

Hydropower Program

October 8, 2019

Brennan T. Smith

Oak Ridge National Laboratory

Project Overview

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Project Summary

HydroSource provides the comprehensive data and analyses that the hydropower community needs to sustain and manage its future.

- An authoritative synthesis of attributes, context, and production data for every US hydropower facility
- A geospatial catalog of US hydropower resource potential data for new stream-reach development and non-powered dams, with associated environmental and socio-economic attributes

Project Objective & Impact

- Streamline access to unbiased, consistent, accurate information about U.S. hydropower assets and hydropower development potential.
- Reduce the cost and effort required of hydropower stakeholders to investigate regional and national market potential, policy impacts, and environmental impacts for hydropower R&D activities.
- Enable each new analysis of U.S. hydropower to be more accurate, detailed, and useful by building upon publicly-available, peer-reviewed data resources and integrating the resulting insights and data into the HydroSource database.

Project Information

Project Principal Investigator

Brennan Smith (interim, ORNL)
Debjani Deb (as of 7/1/2019, ORNL)

WPTO Lead

Tim Welch / Mark Christian

Project Partners/Subs

Subcontracts:

- Kearns & West

Project Duration

- Project Start Date: October 2010
- Project End Date: 09/30/2021

Alignment with the Program

Hydropower Program Strategic Priorities

Environmental R&D and Hydrologic Systems Science

Big-Data Access and Analysis

- Technology R&D for Low-Impact Hydropower Growth
- R&D to Support Modernization, Upgrades and Security for Existing Hydropower Fleet
- Understand, Enable, and Improve Hydropower's Contributions to Grid Reliability, Resilience, and Integration

Alignment with the Hydro Program

Environmental R&D and Hydrologic Systems Science

- Develop better monitoring technologies to evaluate environmental impacts
- Develop technologies and strategies that avoid, minimize, or mitigate ecological impacts
- Support development of metrics for better evaluating environmental sustainability for new hydropower developments
- Assess potential impacts of long-term hydrologic variations to hydropower generation and flexibility
- Improve abilities to assess potential methane emissions from reservoirs
- Better identify opportunities and weigh potential trade-offs across multiple objectives at basin-scales

- The *Environmental Mitigation Prediction Tool* within HydroSource provides systematic insight into mitigation requirements for existing and proposed projects

- The *Stream Classification Tool* within HydroSource provides systematic ecological characterization of stream segments to support robust stakeholder discussions and analyses of hydropower environmental effects and benefits.

Alignment with the Hydro Program

Big-Data Access and Analysis

- Help industry to manage large, disparate and dissimilar datasets relevant for performance, operations, costs, maintenance, permitting, and environmental mitigation

- The *National Hydropower Plant Dataset (NHPD)* is available through HydroSource in GIS and tabular formats with corresponding metadata and source information, including facility-specific linkages to FERC eLibrary.
- The publicly-available NHPD is a subset of *Existing Hydropower Assets (EHA)* data series, updated annually by the HydroSource Team, is the starting point for hydropower analyses within the DOE Hydropower Program and multiple agencies.
- Multiple programmatic efforts base market assessments of new technology or policy applicability on the NHPD and the non-powered dam and new stream-reach potential datasets maintained by HydroSource.

Alignment with the Hydro Program

Technology R&D for Low-Impact Hydropower Growth

- Enable the design and development of new Standard Modular Hydropower (SMH) technologies for both existing water infrastructure and new stream-reach development. This new approach to systems design for hydropower projects incorporates ecological and social objectives for river systems earlier in design processes

- HydroSource provides data and public access to the *SMH Explorer*, enabling nationwide searches for sites suitable for SMH technology applications

- HydroSource *Existing Hydro Assets*, *Hydro Potential*, and *Environmental Attributes* data sets support market assessment of biological design evaluation tool applicability for hydraulic turbines.

Alignment with the Hydro Program

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R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet

- Create mechanisms to classify diverse hydropower plants by mechanical and cyber-physical systems, providing better characterization of the fleet and allowing identification of exemplary facilities / practices

- HydroSource *Existing Hydro Assets (EHA)* data provide the basis for Hydropower Fleet Intelligence analyses. HFI is focused on enabling data-driven asset management decisions at the unit level.
- In coordination with HFI, HydroSource also reconciles data from the hydroAMP, EUCG, and GADS industry data sets.
- HydroSource *Existing Hydro Assets* data have been used as the source of multiple analyses and reports of U.S. facility ages and status in discussions of infrastructure investment.

Project Budget

FY17	FY18	FY19 (Q1 & Q2 Only)	Total Project Budget FY17–FY19 Q1 & Q2 (October 2016 – March 2019)	
Costed	Costed	Costed	Total Costed	Total Authorized
$749K	$752K	$230K	$1,732K	$1,913K

- **HydroSource has stayed within budget during this peer review cycle**

Management and Technical Approach

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Energy & Water Data

- Monthly Generation - EIA
- Facility Data – USACE, USBR, TVA, FERC
- Bulk Power System Configuration
- Hydrography Data Sets - USGS
- *and others*
- National Inventory of Dams - USACE

Hydropower Potential Data

- New Stream-reach Dev. Potential (NSD)
- Non-Powered Dam Potential (NPD)

Environmental & Socioeconomic Data

- Species & Habitat Data Sets
- Conservation Lands
- *and others*
- Licensing Proceedings - FERC
- Impaired Streams – EPA & states

FY19 Task 1 ***Database & Archives***

Data curation

Project Team

- Principal & Co-Investigators
- Energy-Water-Env SMEs
- Data Scientists
- Communications Liaison
- IT Specialists

HydroSource Internal Product Development

- Existing Hydro Assets
- Stream Classification System
- Env. Mitigation Predictor

Within-Program Collaborations

- Hydro Market Report
- Hydro Fleet Intelligence
- Bio Design Market Eval
- SMH Explorer
- SWA 9505 Assessment
- and others

Analyses & Development

FY19 Task 2

SiteImprove Analytics

- **Web Portal**
- **Data Model**
- **Data Dictionary**
- **Presentations**

Hydropower Stakeholder Engagement

FY19 Task 3

Long-Term Data Integration

Internal & External Analysis Planning

End-User Engagement and Dissemination Strategy

- *NHAAP targeted internal DOE and agency-to-agency needs for analyses. In FY2017, the transition to HydroSource began a shift to hydropower community outreach that is ongoing.*
- *HydroSource will leverage ORNL/DOE/NASA data center and user community expertise with Kearns & West outreach expertise to center HydroSource as a powerful hydropower community-guided resource.*

- **Web portal: http://hydrosource.ornl.gov**
  - "Contact Us" form enables public to provide specific feedback on portal or data
  - Increasing use of website analytics to know what data and resources are most popular and who is accessing them
- **Agency and institutional engagement**
  - Annual information exchange with federal hydropower agencies (Corps, USBR, TVA)
  - Data and tools demonstrations delivered at annual training events for USFWS, NOAA, NPS agencies
- **Industry/commercial engagement**
  - Develop standard presentations that can be delivered to utility and consultant staffs
- **Presentations**
  - Demonstrations of HydroSource Web Portal at Hydrovision, Water Power Week, and regional meetings

End-User Engagement and Dissemination Strategy

In early FY2018, ORNL commissioned Kearns & West to find out how and why HydroSource was being used. Here is a sample of what they found.

- **Hydropower owner/operators**

  *HydroSource helped our team assess **return on investment** for upgrading assets.*

- **Hydropower developers**

  *We were able to present **benchmark data** about comparable assets to our board.*

- **Non-governmental organizations**

  *HydroSource … eliminates the need to make estimates on hydropower generation in-house—**saving time**.*

- **Academic researchers**

  *HydroSource provided us with particularly **valuable, trusted, high-quality data.***

  *HydroSource data **saved us effort and time** and we were able to **avoid data duplication**.*

- **Government agencies**

  *HydroSource **provides the aggregated data that I need in one place**.*

  *Without HydroSource data, we wouldn't know about new hydropower projects and publications that we depend on to **do our job effectively.**.*

Technical Accomplishments: NHAAP & HydroSource

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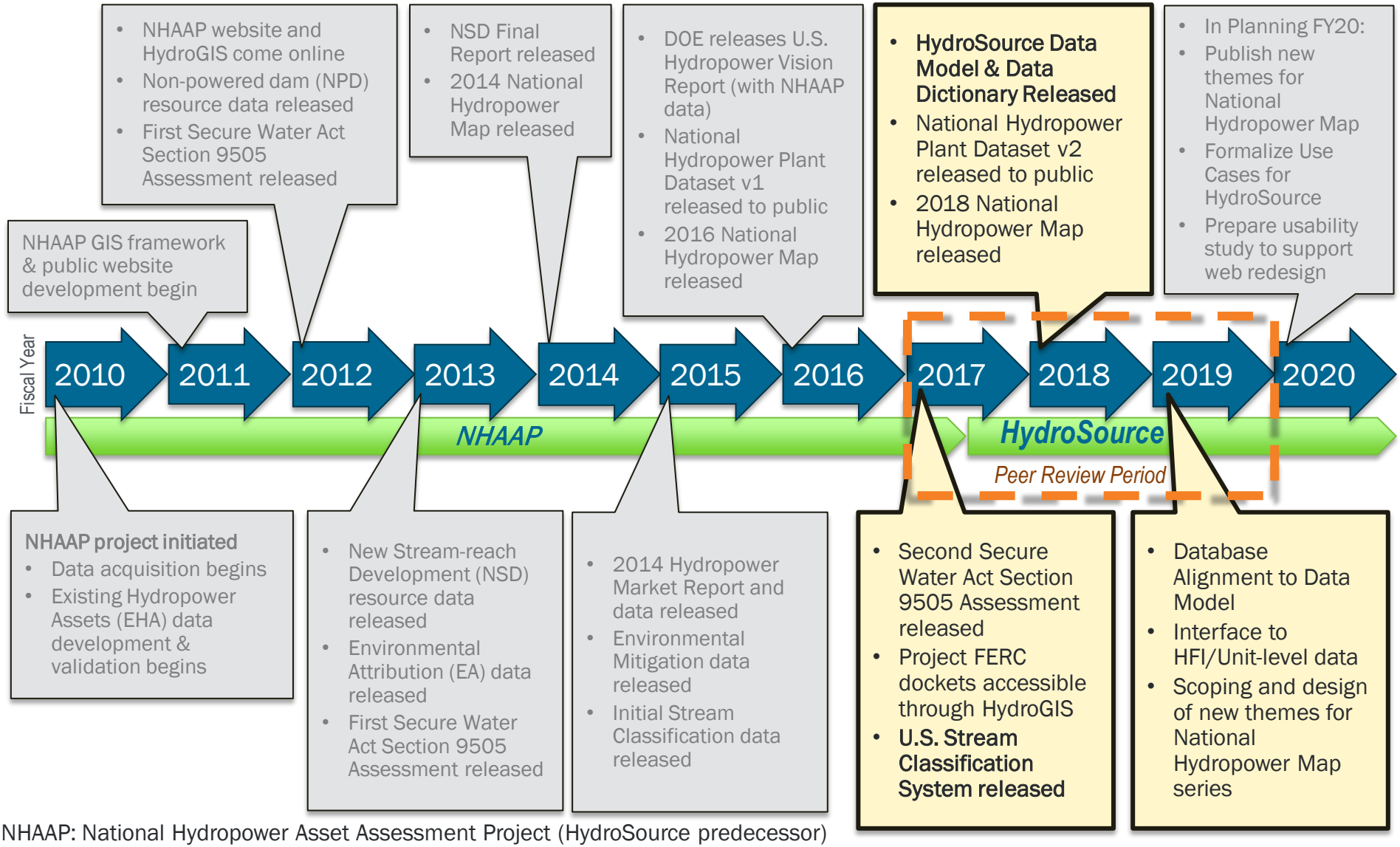


NHAAP: National Hydropower Asset Assessment Project (HydroSource predecessor)

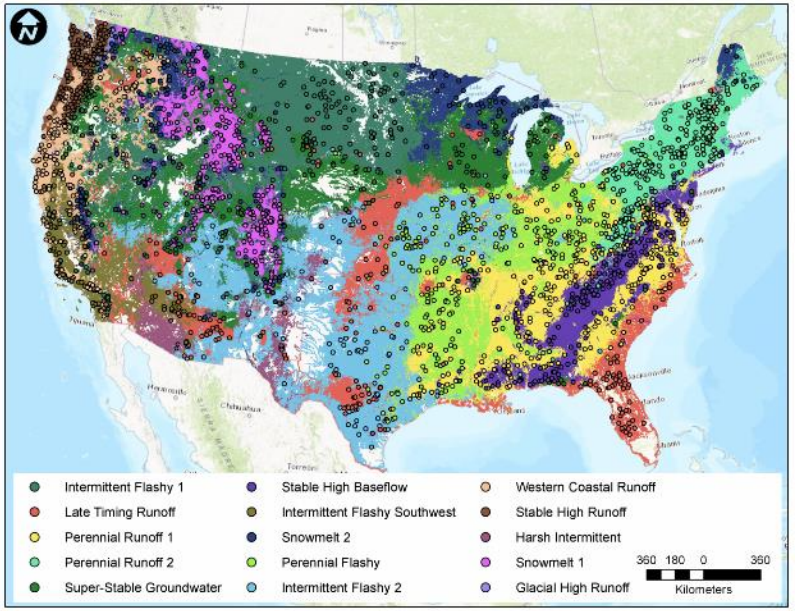
Technical Accomplishments: U.S. Stream Classification System

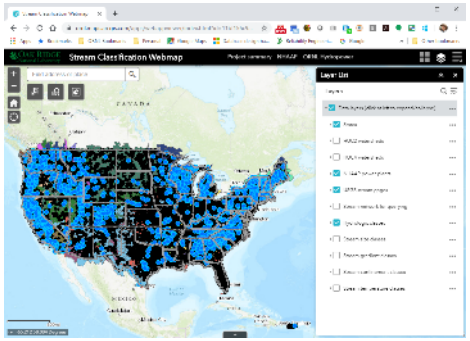
A classification of 2.6 million stream reaches of the Conterminous U.S. into a layered typology based on

- Hydrology
- Size
- Gradient (slope)
- Temperature
- Valley Confinement

Relevance to hydropower

- provides a systematic approach to establishing baseline (reference) conditions for environmental assessment and mitigation within licensing and other hydropower-related actions
- helps to organize complexity of myriad stream responses to disturbance and restoration of impaired streams
- a rigorous logical step towards templates for hydropower environmental assessment





Use cases for the HydroSource-hosted Stream Classification App

- Finding an appropriate reference stream for a hydropower site
- Characterizing and classifying the ecosystem in which a hydropower facility resides
- Inventorying hydrologic regimes, thermal regimes, size, gradient, and valley geomorphology of rivers within a region or basin.
- Searching for hydropower facilities with a similar context for environmental assessment and mitigation

~~Suggested~~ **Citation:** McManamay, R.A., C.R. DeRolph (2018) A stream classification system for the conterminous United States. *Scientific Data*.

Technical Accomplishments: THe HydroSource Data Model

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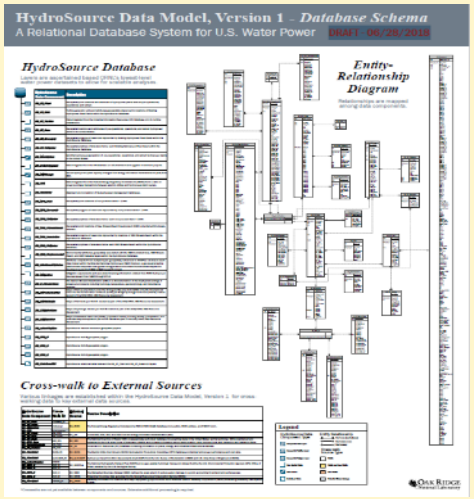
The HydroSource Data Model provides key technical resources for users and for long-term usability.



The Data Model tells users how the data sets within HydroSource may be linked together within GIS and database software to support queries and visualizations.

New data must be integrated into the data model if they are to be useful to those beyond their initial creators.

The Data Dictionary tells users how to interpret and use the individual pieces of information within each data set.

- *Consistent with individual meta data*
- *Prevents misinterpretation and misguided assumptions*
- *Easily citable*
- *Draft available on HydroSource landing page*

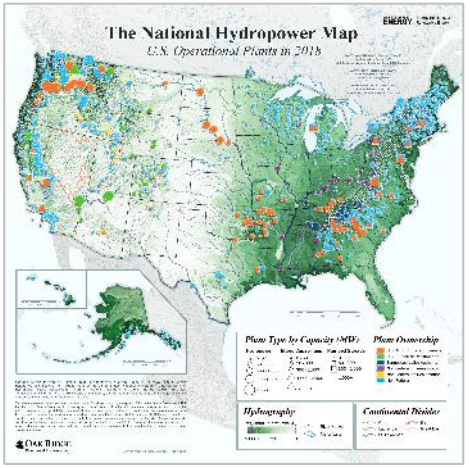
HSDM: HS_DG: Summary of existing fleet (EF) data components

Data_Component	Alias	Type	Description
HS_EF_Plant	EF plant	Geospatial point layer	Geospatial point locations and attributes of hydropower plants that are preoperational, operational, and retired
HS_EF_Unit	EF unit	Geospatial point layer	Turbine-generator units and attributes geospatially referenced to locations of existing hydropower fleet plants within the HydroSource Database
HS_EF_Turbine	EF turbine	Nonspatial table	Data integrated from the Industrial Information Resources (IIR) Database on US turbine installations
HS_EF_Dam	EF dam	Geospatial point layer	Geospatial locations and attributes of preoperational, operational, and retired hydropower dams in the United States
HS_EF_Reservoir	EF reservoir	Geospatial polygon layer	Geospatial polygons of reservoirs impounded by existing hydropower fleet dams within the HydroSource Database
HS_EF_Tailwater	EF tailwater	Geospatial polyline layer	Geospatial polylines of tailwaters below each existing hydropower fleet asset within the HydroSource Database
HS_FleetIntel	Hydro fleet intelligence	Nonspatial table	Alignment and correlation of fleetwide asset management databases

Data Dictionary excerpt

ORNL's HydroSource team used these linkages and definitions in their production of the 2014, 2016, and 2018 National Hydropower Map series.

The Data Model and Dictionary will enable ORNL and those beyond ORNL to build queries and visualizations on top of the National Hydropower Map (and other products), with transparency and traceability.



Progress Since Project Summary Submittal

- Increasing the depth, breadth, and specificity of the draft Data Model and Dictionary
- Preparation of updates to the Existing Hydropower Assets data set
- Responses to multiple industry, lab, and program requests for data and answers to queries
- Initial scoping of potential new themes within the National Hydropower Map series
  - Regulatory status/dates, critical species overlap, dispatch flexibility, …
- New Principal Investigator directing HydroSource FY20 planning
  - Dr. Debjani Singh, specializing in data science for interactions of water-energy-climate at diverse spatial and temporal scales

Future Work

- **Connect, inform, empower, and assist the hydropower community to make better use of HydroSource**
  - Formal usability study and use cases to guide outreach and the redesign of web interface
  - Presentations to regional meetings, agency staffs, industry groups, and utility/consultant staffs
- **Enhance HydroSource online functionality and usability**
- **Integrate and link new and updated data into HydroSource**
- **New Thematic Series within the National Hydropower Map**
  - "Test drive" themes and maps with hydropower stakeholders and finalize priorities