



# Hydropower Market Report

1.4.1.501

**Hydropower Program**

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Oak Ridge National Laboratory

# Project Overview

## Project Summary

- The **Hydropower Market Report (HMR)** is a **data-driven summary of key trends** in the U.S. hydropower industry.
- It provides **up-to-date, comprehensive, objective** data to industry, policymakers, and other interested stakeholders on U.S. **hydropower development, operations, cost, and supply chain**.
- HMR aims to assemble datasets that are **representative of the entire fleet** and can be segmented by region or key plant attributes to provide more meaningful summary statistics.

## Project Objective & Impact

- To be a **reference publication** on U.S. hydropower development, performance, and supply chain trends for industry, federal partners, and Congress.
- To be a **useful primer** on the status of the U.S. hydropower fleet for a general audience interested in energy markets.
- Impact: The HMR project enables other research and innovations by **improving the available baseline data used to make decisions by industry and policymakers**.

## Project Information

Project Principal Investigator

Rocio Uria-Martinez (ORNL)

WPTO Lead

Hoyt Battey

Project Partners/Subs

Subcontracts:

- Industrial Info Resources (IIR)
- NERC (pc-GAR)
- Kearns & West

Project Duration

- Project Start Date: 10/01/2014
- Project End Date: TBD

## 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

## Big-Data Access and Analysis

- Help industry to manage large, disparate and dissimilar datasets relevant for performance, operations, costs, maintenance, permitting, and environmental mitigation
- Support comprehensive reviews of historical regulatory process drivers and outcomes
- Identify information-mechanisms that could increase coordination among permitting agencies
- Develop effective methods of communicating process complexities to non-technical stakeholders

- The HMR project **combines data from disparate sources** to build a comprehensive picture of trends in the hydropower industry.
  - Example: Hydropower price data sources:
    - Federal fleet: PMA tariffs and EIA Form 861
    - Non-federal fleet: FERC Form 1, PPA contract data, ISO/RTO prices
- The HMR extensively leverages ORNL's Existing Hydropower Assets (EHA) dataset in combination with other datasets to **analyze trends across different fleet segments** (e.g., size, ownership type, age).
- The HMR has **tracked the evolution of each new project** seeking permitting from FERC or Reclamation since 2014.
  - Resulting database allows computing process timelines and attrition rates

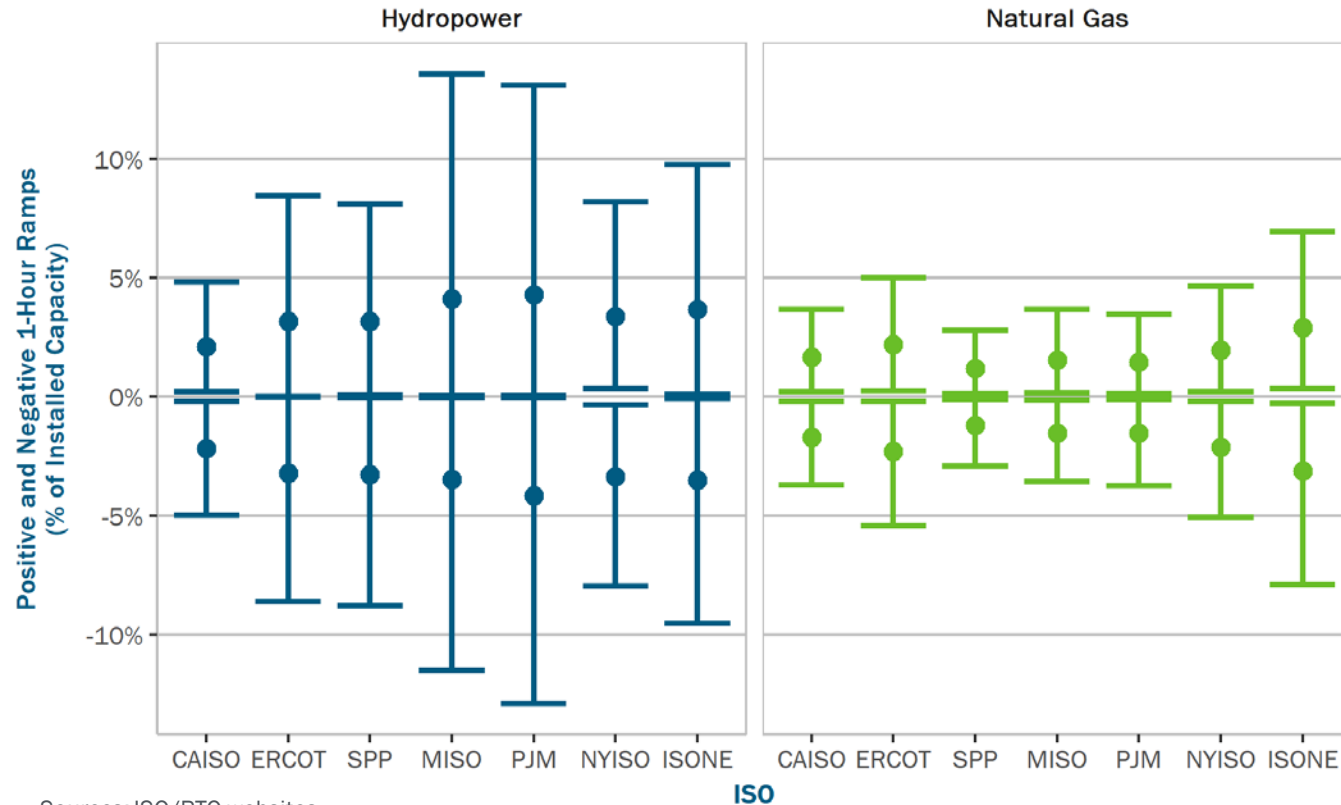


## Understand, Enable, and Improve Hydropower's Contributions to Grid Reliability, Resilience, and Integration

- Investigate the full range of hydropower's capabilities to provide grid services, as well as the machine, hydrologic, and institutional constraints to fully utilizing those capabilities.

The HMR project assembles and disseminates data on hydropower generation trends and hydropower's contributions to grid services (e.g., NERC pc-GAR data, ISO/RTO data).

Average and 10<sup>th</sup>–90<sup>th</sup> percentile interval for one-hour ramps per installed megawatt for hydropower and PSH vs. natural gas by ISO/RTO



Sources: ISO/RTO websites

# 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
\$234,399	\$466,016	\$172,967	\$873,382	\$1,032,746

Budget is higher in years in which a full report is published (FY18 in this cycle)

In “off-years”:

- Slide deck update for selected development and performance metrics
- Research to generate new datasets and cover new topics of interest for WPTO and/or industry

## FY17-FY19 Peer Review Cycle



## Development of New Content

- 1) Topic selection
- 2) Data collection
  - Public data sources (e.g., EIA, FERC)
  - Commercial databases (e.g., IIR, NERC pc-GAR)
  - Questionnaires/interviews to relevant stakeholders
- 3) Creation of scripts for data cleaning/wrangling
- 4) Combination/Merge of various datasets for richer insights
- 5) Data analysis and visualization
- 6) Technical memo/slide deck to WPTO [quarterly milestone]

## Report Production

- 1) Table of contents
- 2) Update existing datasets and visuals
- 3) Integrate new topics/datasets
- 4) Write and format report
- 5) External review
- 6) Publication and dissemination
- 7) Online stakeholder survey

**CRITICAL SUCCESS FACTORS TO  
DECIDE WHETHER NEW TOPICS ARE  
INCLUDED IN THE REPORT**

- Fleet coverage
- Data quality
- Frequency of data updates

# Management and Technical Approach

## QUARTERLY MILESTONES FY17-FY19Q2

### FY17

Q1: **International** hydropower statistics (new & refurbishments)

Q2: Publication of HMR update slide deck

Q3: Findings from hydropower **PPA** and **asset sales** datasets

Q4: Findings on hydropower **cost and performance metrics**

### FY18

Q1: Policy and Market Drivers; rolling out strategy for 2017 HMR

Q2: Publication of 2017 HMR

Q3: **Relicensing** activity trends

Q4: Econometric analysis of **capacity factor** trends

### FY19

Q1: U.S. **refurbishment and upgrade** project pipeline

Q2: Publication of HMR update slide deck

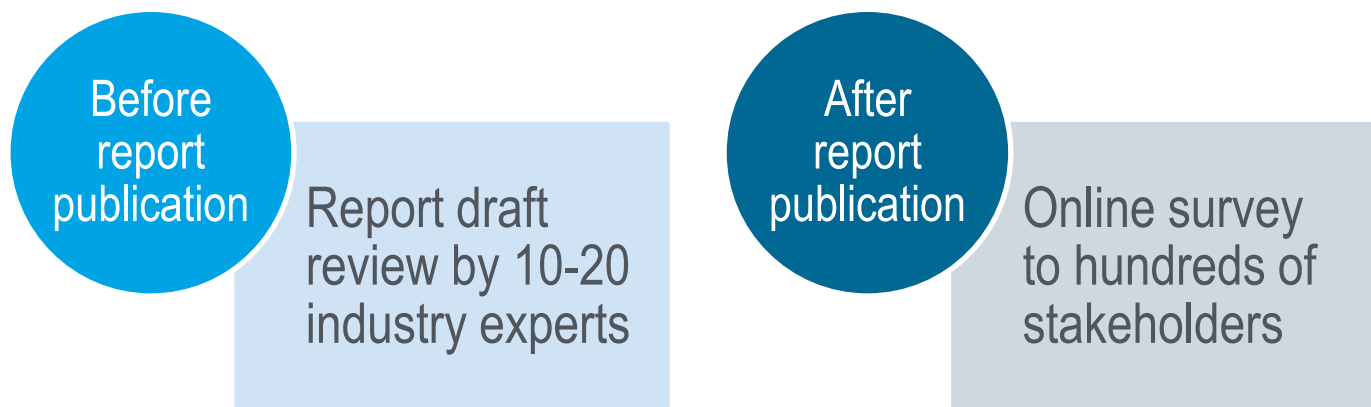
### Dominant activity type

DEVELOPMENT OF NEW CONTENT

REPORT PUBLICATION



- The HMR team seeks input from stakeholders at several stages of the report production

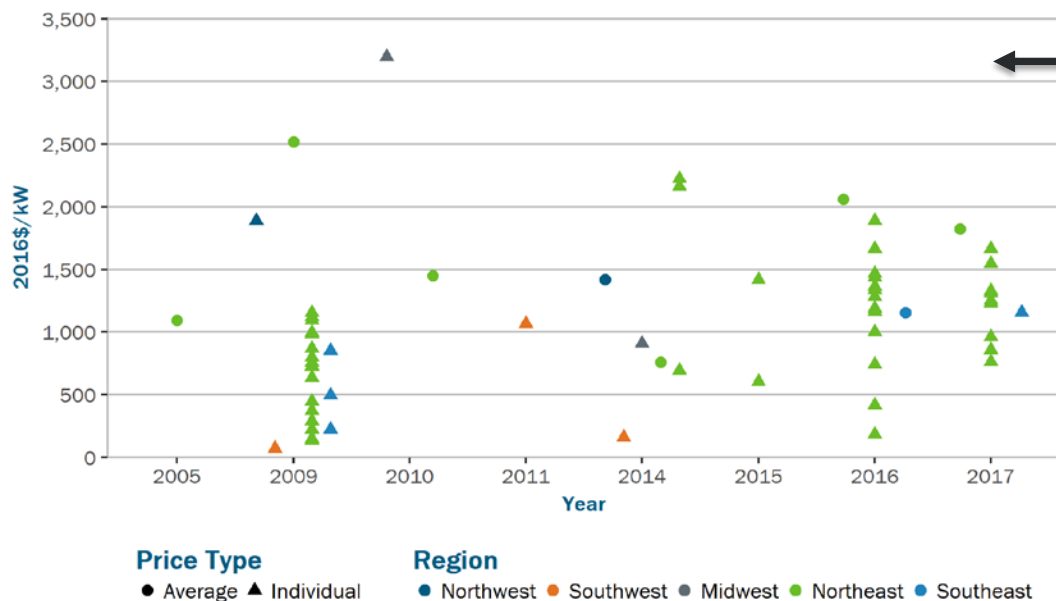


- Feedback from report review and online survey informs future work to ensure report and data are useful to target audience
- **Dissemination strategy:**
  - HMR products are available at HydroSource webpage and WPTO website
  - Printed copies of Executive Summary distributed at WPTO booth in key industry conferences
  - Engagement with other companies and associations that also release hydropower market data to ensure their awareness of HMR products
  - **Metrics tracked:** website pageviews, report downloads, citations in peer-reviewed publications, mentions in the press/social media, end-user queries.

# End-User Engagement and Dissemination Strategy

- The HMR aims to benefit the entire industry by improving available baseline data for U.S. hydropower
- How is the HMR data being used?

U.S. HYDROPOWER PLANT SALE PRICES BY YEAR AND REGION OF SALE



Sources: Web searches and SEC filings

**Use example #1:** Two consultants requested data on hydropower plant sale prices to complement internal analyses on the residual value of hydropower assets.

**Use example #2:** U.S. hydropower owner relied on 2017 HMR information and visuals as part of its comments to FERC under the “Grid Resilience in RTO and ISO” proceeding.

**Use example #3:** U.S. hydropower owner requested data on fleet and project development pipeline in one state in preparation for meeting with senator from that state.

# Technical Accomplishments: HMR Products

- All reports, update slide decks, and associated data are available at <https://hydrosource.ornl.gov/market-info-and-data/us-hydropower-market-and-trends>
- **743 pageviews** in first half of 2019
- **30 citations** (Google Scholar, 2014 HMR and 2017 HMR combined)
- New in 2019:
  - U.S. Hydropower Development Pipeline detailed dataset
  - U.S. Hydropower Retired Facilities dataset



# Technical Accomplishment: 2018 Hydropower Market Report

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

**1**

## **Trends in U.S. Hydropower Development Activity**

- 1.1 U.S. Hydropower Fleet
- 1.2 Capacity changes (2006-2016)
- 1.3 Hydropower Project Development Pipeline (as of December 31, 2017)
- 1.4 Investment in Refurbishments & Upgrades

**2**

## **U.S. Hydropower in the Global Context**

- 2.1 Description of the Existing Global Hydropower Fleet
- 2.2 International Trends in Hydropower Development
- 2.3 Investment in Refurbishments & Upgrades

**3**

## **U.S. Hydropower Price Trends**

- 3.1 Trends in Hydropower Energy Prices
- 3.2 Trends in Hydropower Asset Sale Prices

**4**

## **U.S. Hydropower Performance Metrics**

- 4.1 Capital Costs
- 4.2 Operation & Maintenance Costs
- 4.3 Energy Generation
- 4.4 Capacity Factors
- 4.5 Availability Factors
- 4.6 Hydropower Operation Flexibility

**5**

## **Trends in U.S. Hydropower Supply Chain**

- 5.1 Hydropower Turbine Installations
- 5.2. Hydropower Turbine Imports/Exports

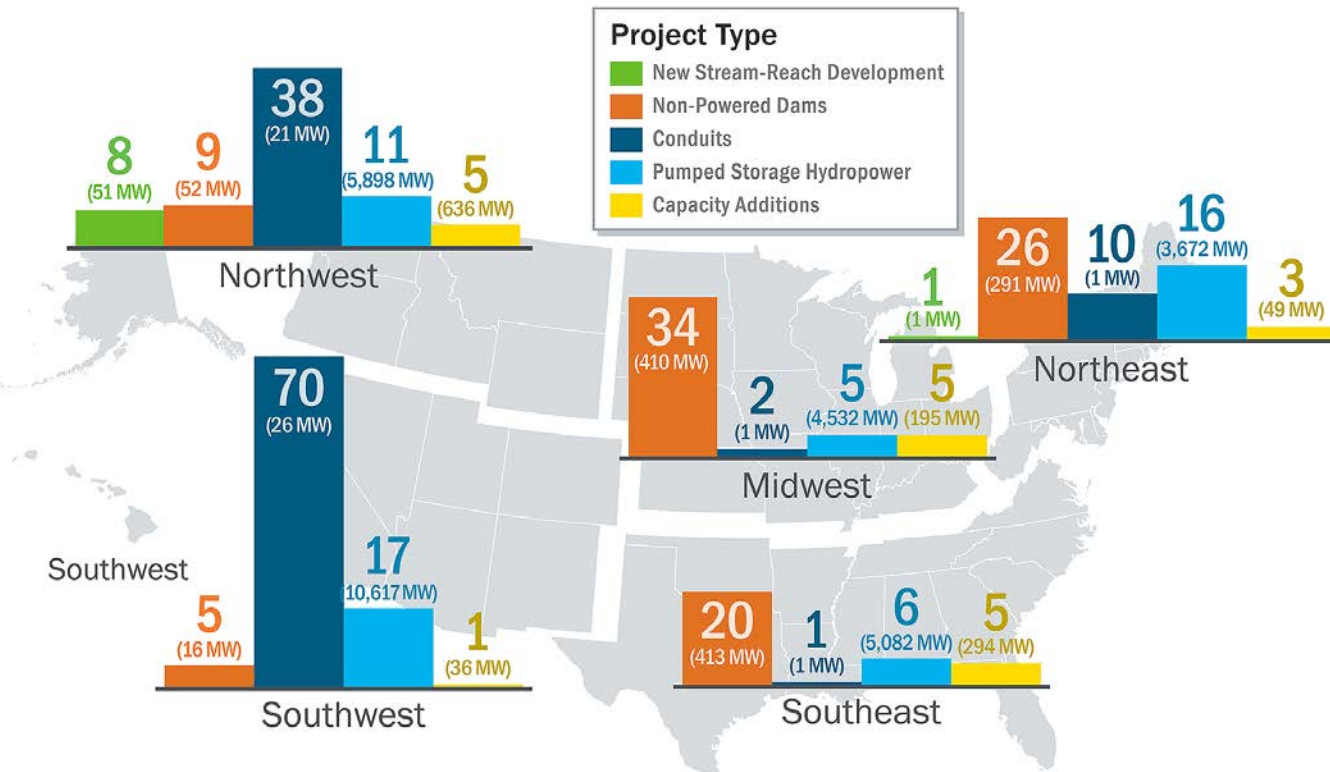
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## **Policy and Market Drivers**

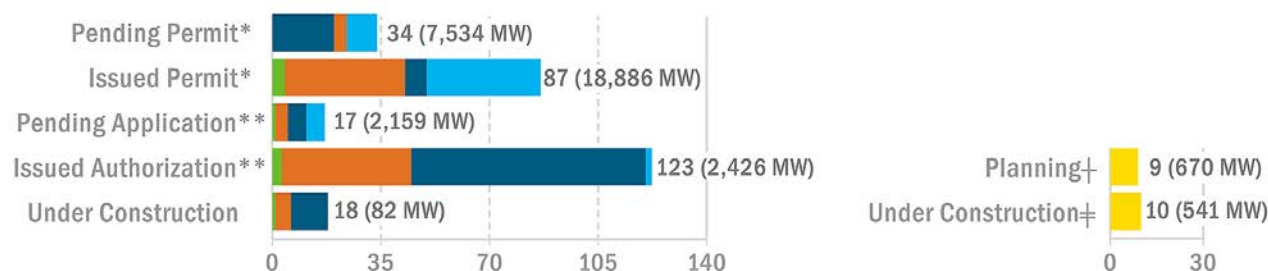
# Technical Accomplishment: U.S. Hydropower Development Pipeline Snapshot

## Project Type

- New Stream-Reach Development
- Non-Powered Dams
- Conduits
- Pumped Storage Hydropower
- Capacity Additions



## Project Type by Development Stage: Number of Projects (MW)

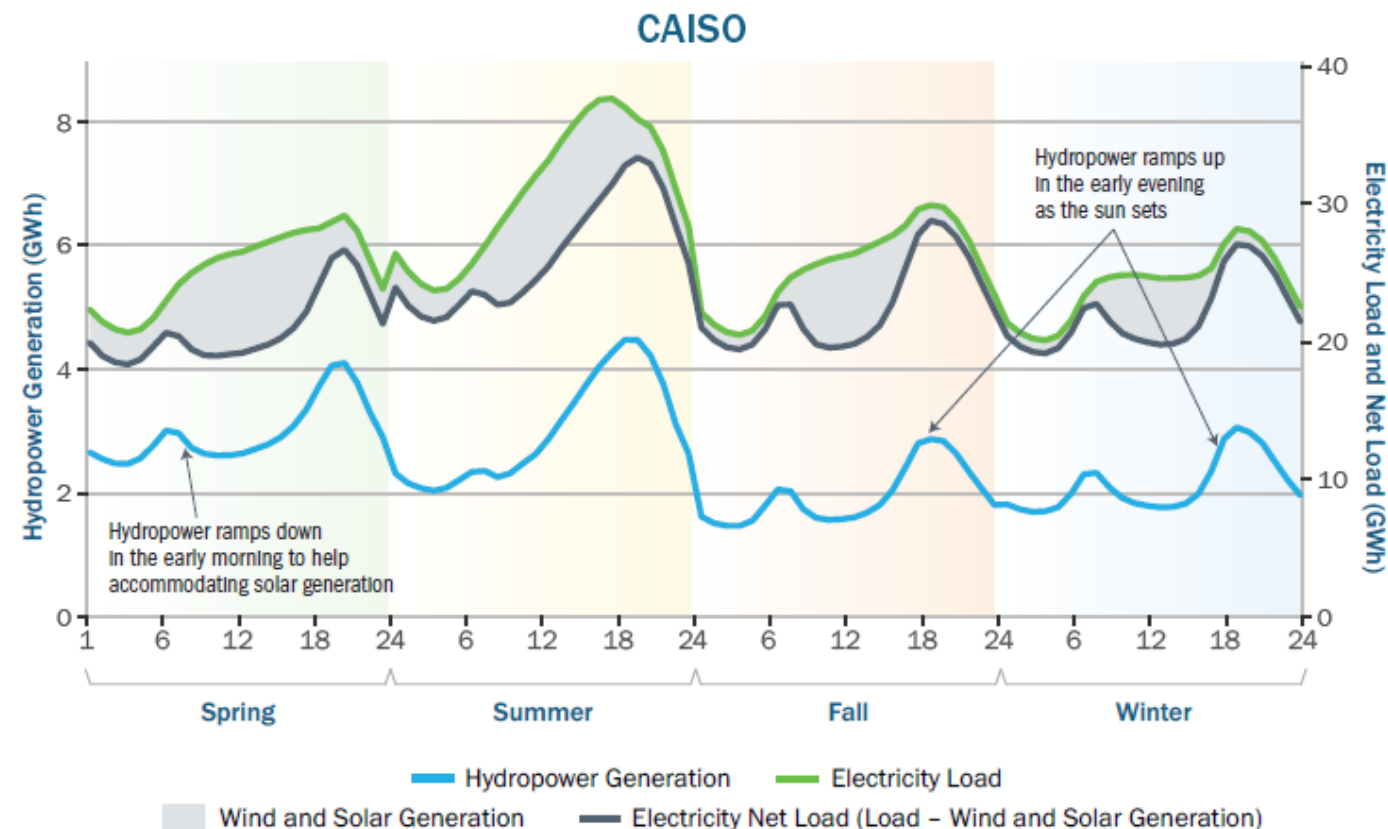


- **Infographic offers multidimensional summary of the development pipeline:**
  - Number and capacity of projects
  - Regional distribution
  - Project types
  - Project status
- **Combines data from multiple sources:**
  - FERC
  - Bureau of Reclamation
  - Industrial Info Resources
  - web searches
- **Includes new projects and R&U of existing plants**



# Technical Accomplishment: Documenting Load Following Role of US Hydropower Fleet in Every ISO/RTO

Average hourly hydropower and PSH generation, electricity load and electricity net load by season (2014–2017)



- The average daily shape of hydropower (including PSH) generation closely resembles the electricity load profile.
  - **Summer:** hydropower generation ramps up from early morning to late afternoon to meet cooling demand peaks.
  - **Fall/Winter:** hydropower generation displays two peaks (early morning & early evening) coinciding with demand peaks.
- The California market (CAISO) is the first one where high penetration of variable renewables (mostly solar) has notably changed the typical daily hydropower generation profile.

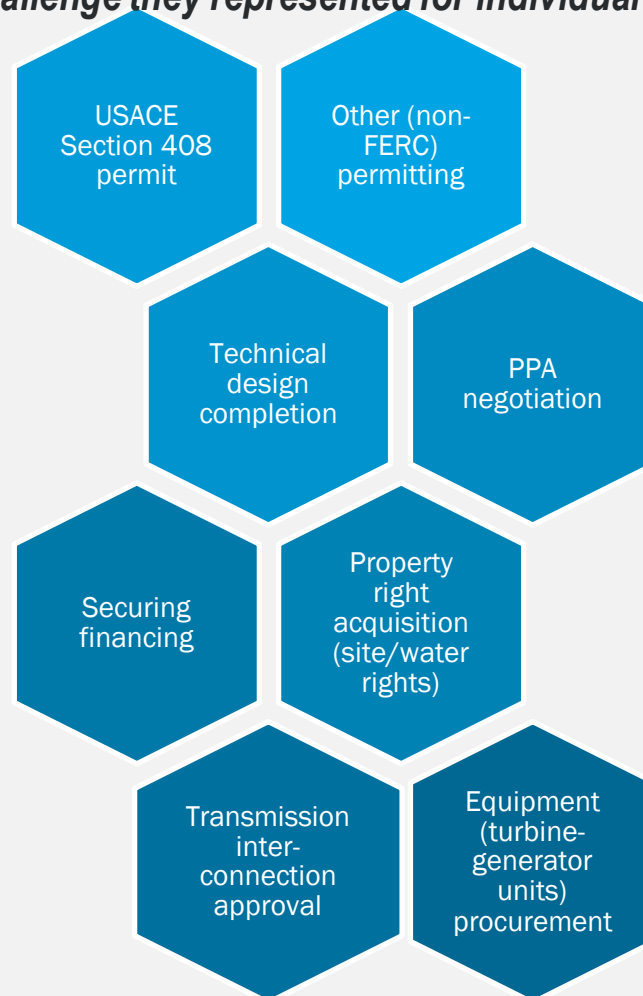
Sources: ISO/RTO websites

Note: Plots for other ISO/RTOs are included in the 2017 Hydropower Market Report full document.

# Progress Since Project Summary Submittal

- Submitted questionnaire to 50 U.S. hydropower developers to identify challenges and best practices in the post-licensing stage of U.S. hydropower projects
  - Motivated by finding of frequent project delays and cancellations after license issuance
  - Survey asks for details on PPA off-taker types, financing sources, applicable federal/state incentives
- Information from the questionnaire combined with FERC docket data to produce summary document for publication in trade magazine:
  - Average timeline from FERC license to construction
  - Attrition rates
  - Reasons for delays and cancellations

*Question 1 asks respondents to categorize the following activities as low/medium/high in terms of the challenge they represented for individual projects*



- **FY20 work will be geared towards publication of a new full version of the HMR in July 2020.**
- **Key WPTO R&D themes of *flexibility, integration, and storage* will be a focus throughout the report.**
  - Relevant findings from HydroWIRES publications will be referenced/leveraged as appropriate
- **New content:**
  - International comparison of hydropower & PSH permitting/financing/value propositions
  - Relicensing trends
  - Hydropower revenue trends and participation in ancillary service markets
  - Expanded analysis of hydropower PPA trends
  - Case studies:
    - Changes in hydropower operations after joining ISO/RTO, Western EIM
    - Strategies to maximize operational flexibility of multipurpose dams