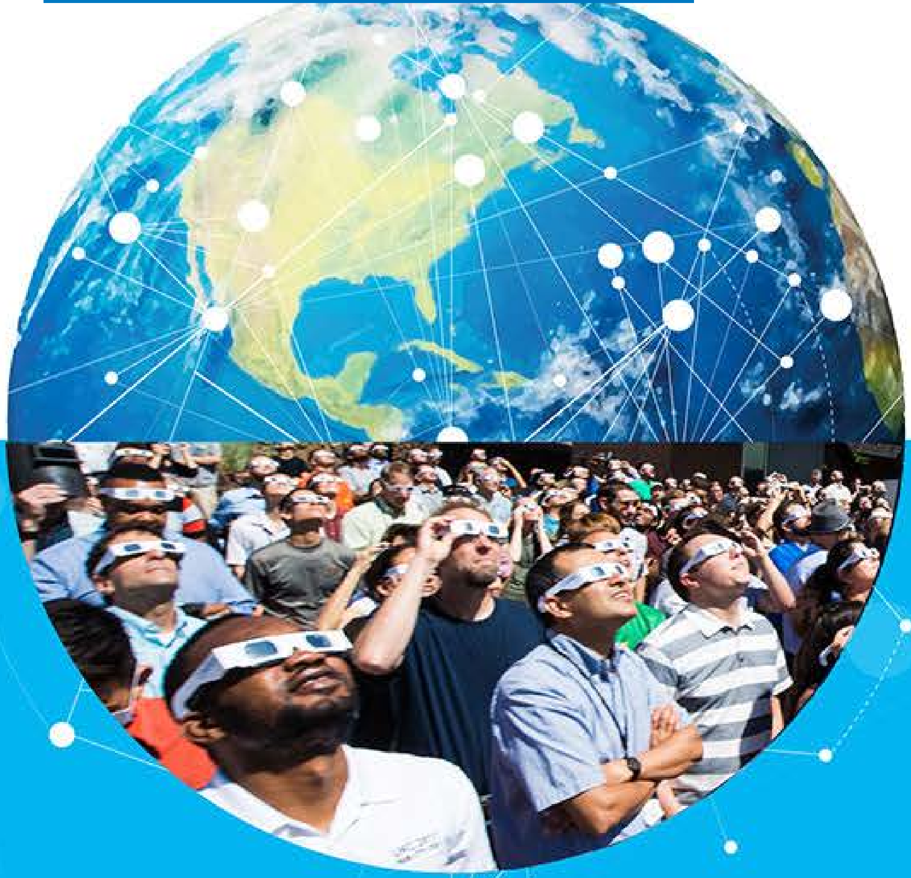


Small Hydropower Energy for USDA REAP

Elise DeGeorge
NREL
September 2024

Photo by Dennis Schroeder, NREL 46840

Agenda

1. Welcome & Intro to REAP (5 mins) - USDA
2. Hydropower (40 mins) - NREL
3. Hydropower Applications for REAP (15 mins) - NREL
4. Q&A (30 mins) - USDA/NREL

Welcome

USDA REAP and RAISE

RAISE Initiative

Rural and Agricultural Income & Savings from Renewable Energy (RAISE) initiative will provide savings and additional revenue sources for small agricultural businesses in rural America:

- Since 1981, the nation has lost nearly 545,000 farms and 155 million acres of former farmland.
- The nation has enjoyed record farm income in recent years, but the income has been concentrated among 7% of farms that cumulatively account for 89% of income.
- In the face of increased costs, competition for land use, and consolidation, small family farmers shouldn’t have to work twice as hard; we should find ways additional ways for them to generate revenue from the land.

Based on collaboration between the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA), this effort will:

- Advance opportunities for small and mid-sized farmers to earn savings and income from underutilized renewable energy projects.
- Pilot new and innovative business models for farmers, rural electric cooperatives, and developers that utilize distributed energy resources (DERs) to generate revenue for farmers.
- Lead to 400 individual farmers deploying small-scale wind projects within 5 years using Rural Energy for America Program (REAP).

Relevant Resources

New NREL/REAP website: https://www.nrel.gov/state-local-tribal/rural-energy-for-america-program.html

- Webinar slides and recordings will be made available on this site

[REAP Information and Application]()

[REAP State Rural Energy Coordinators]()

[REAP Frequently Asked Questions]()

Housekeeping Notes

- Please submit your questions using the Q&A function or in the chat. We will address questions during and after the presentation and will also follow up afterwards if needed.

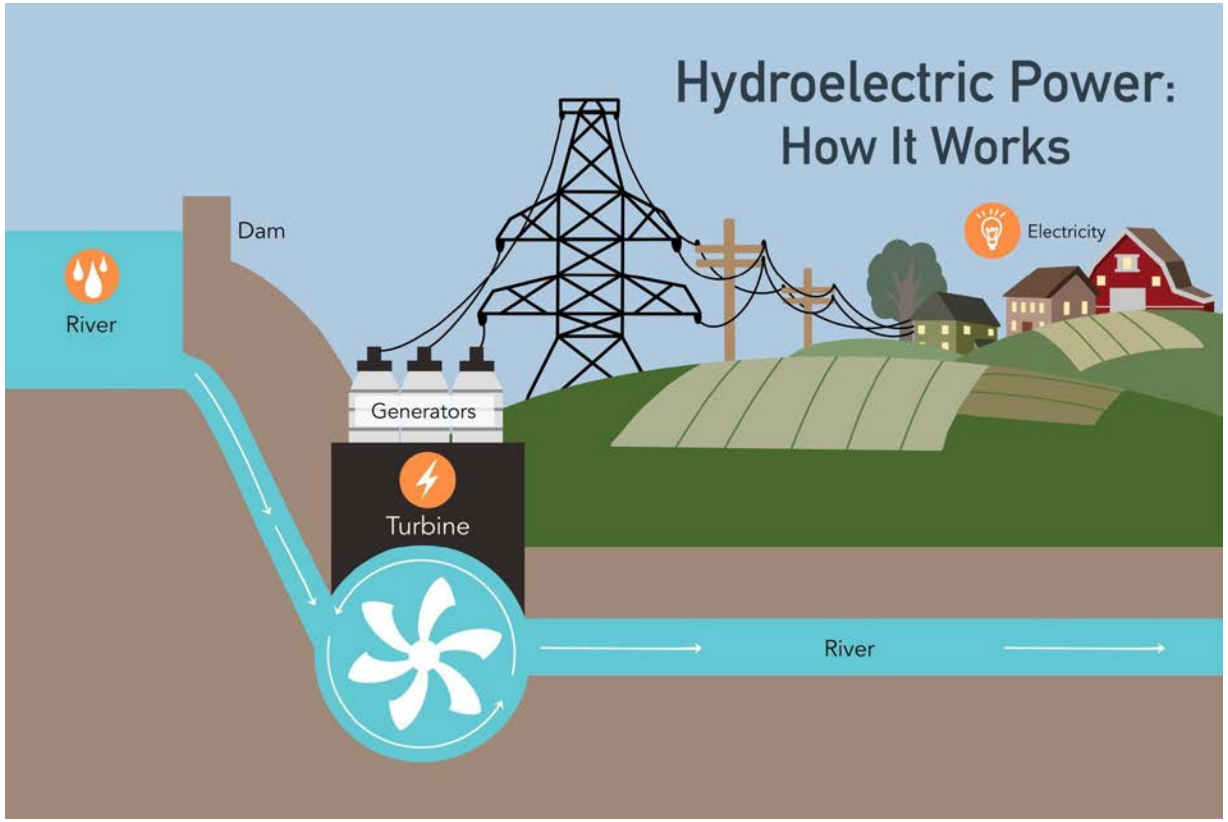
- The following information and best practices are recommendations based on NREL's experience in this area and are *not meant to supplant any REAP application requirements*.

- NREL staff cannot answer any application-specific questions. These should be directed to REAP program staff.

Hydropower Energy Fundamentals

Contents

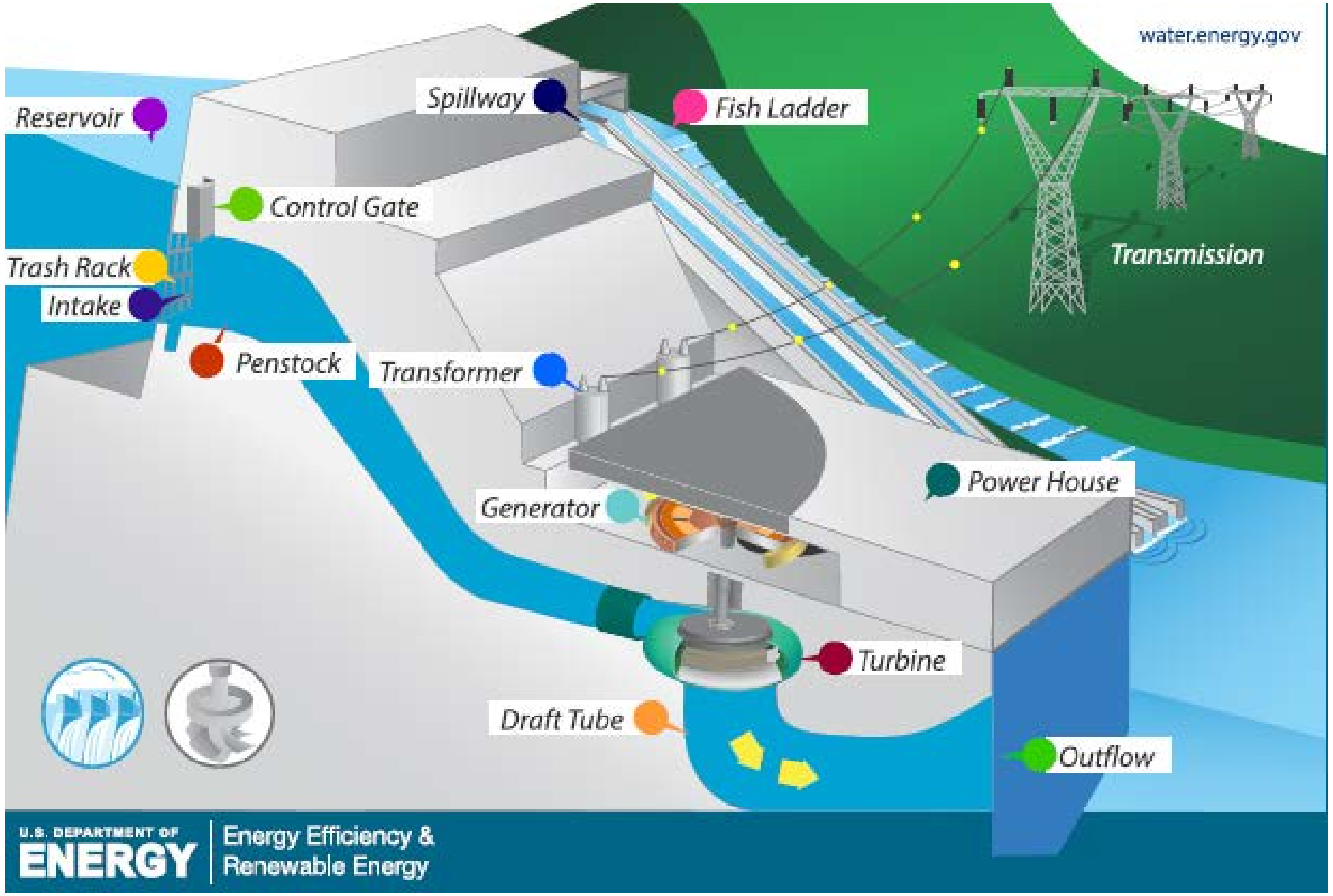
Hydroelectric vs Hydromechanical (Direct Drive) Systems



https://www.agriculturalmuseum.org/hydroelectric-power-how-it-works

https://ag.colorado.gov/conservation/acre3/agricultural-hydro

Hydropower Basics



Hydropower potential

- Head - the height distance between the intake and the turbine (ft)
- Flow – the amount of water (cfs)
- Hydro-efficiency – primarily +driven by the size and type of penstock
- Mechanical efficiency of the turbine
- Electrical efficiency of the motor

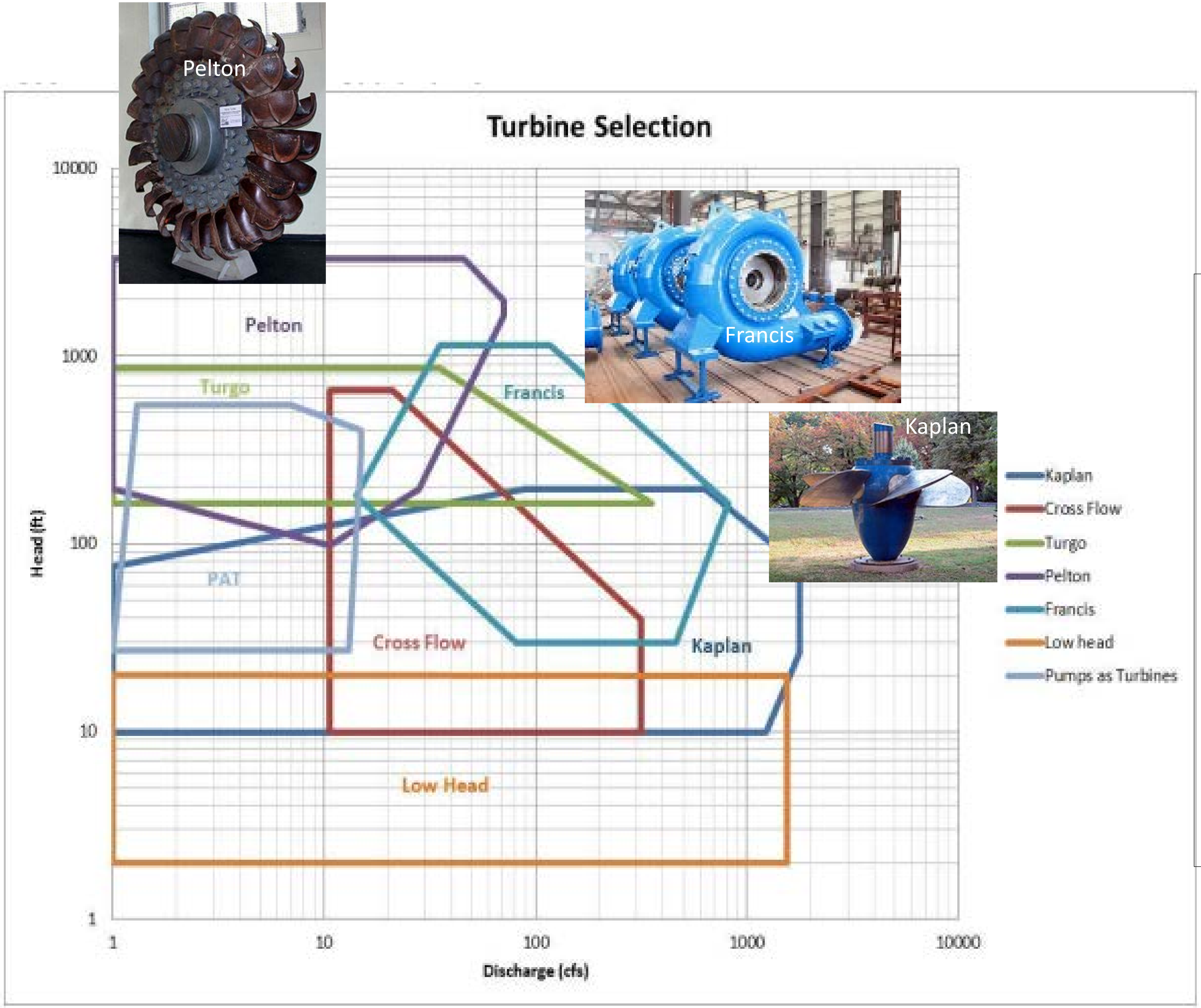


Figure 45: Turbine Selection Chart

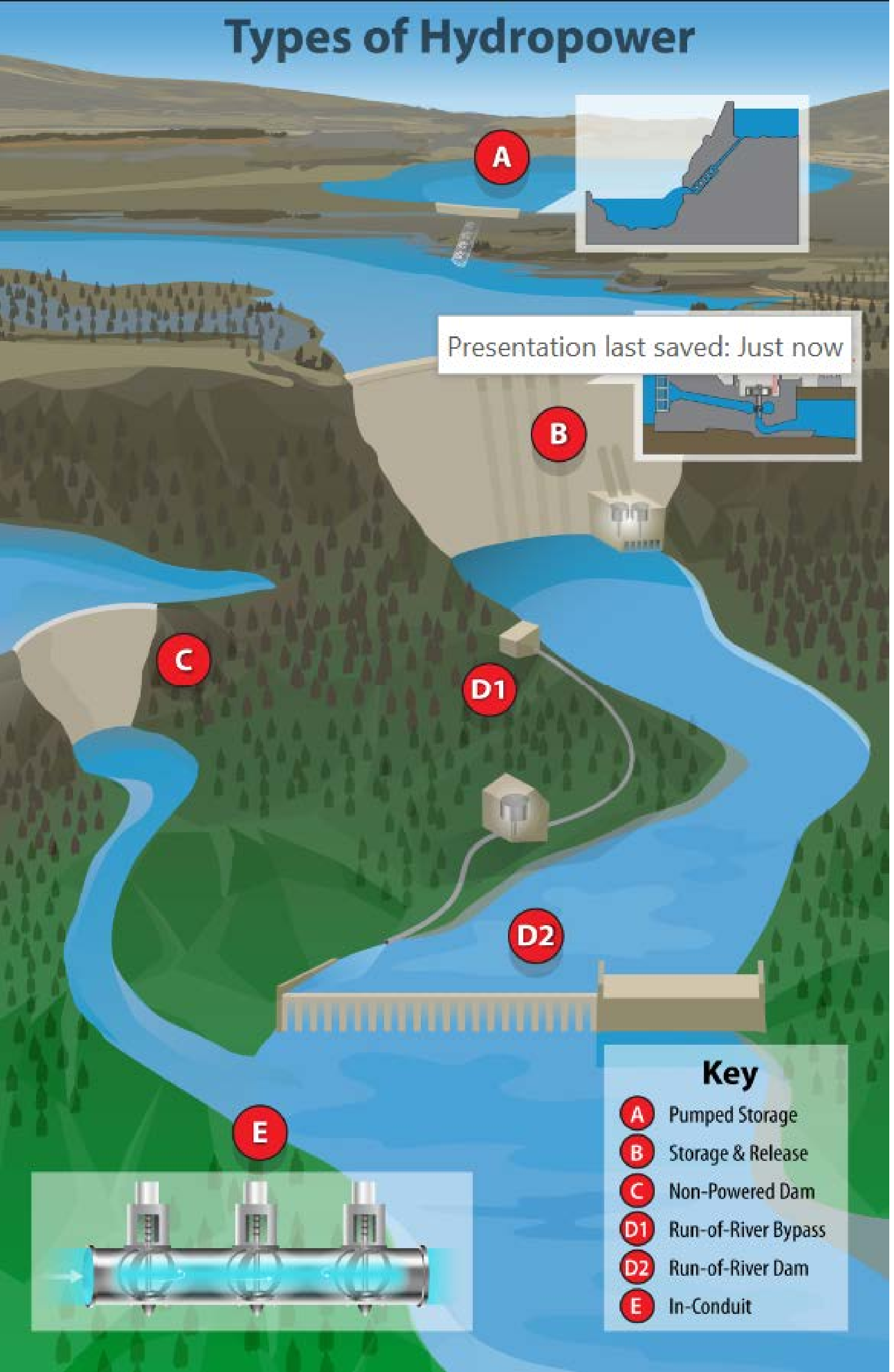
The type of hydropower turbine selected for a project is based on the head and flow:

Impulse turbine (high head, low flow)

- Pelton

Reaction turbine (low head, high flow)

- Francis (95% eff, most common)
- Kaplan



Types of Hydropower

Graphic created by NREL

Benefits and Disadvantages of Hydropower

Benefits

- Renewable
  - Snow and rainfall
- Carbon free (Once constructed)
  - Lowest CO_2 emissions compared to other energy sources
- Flexible
  - Can be ramped up or down quickly
- Low costs
  - US average is 3-5 cents per kWh
  - Low maintenance costs
- Other uses for reservoir
  - Irrigation
  - Tourism
  - And much more

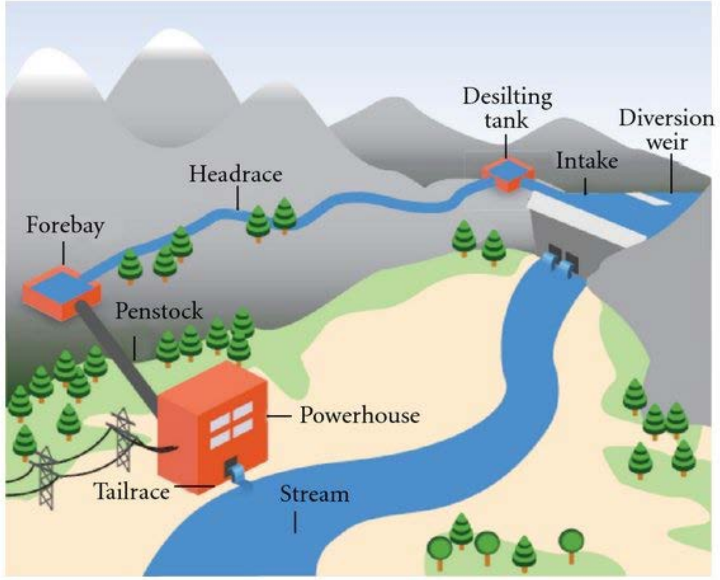
Disadvantages

- Environmental impacts of reservoirs
  - Fish passage
  - Ecosystem changes
  - Sedimentation
  - Methane gas
  - Fluctuating water levels
- High capital cost
- Reliant on water sources
  - Electricity generation and energy costs are related to available water
  - Droughts can affect this

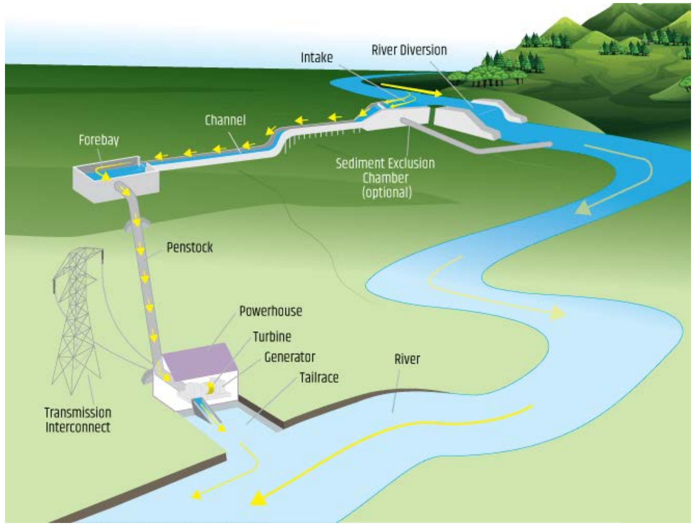
Small Hydropower - definitions

- Typically refers to projects under 10 MW that utilize existing dams, canals, or pipelines
- These projects also may involve simpler implementation:
  – No changes in diversions to existing natural waterways
  – No incremental environmental impact associated with addition of small hydro generation capacity
  – No environmental concerns associated with additions to existing non-powered dams

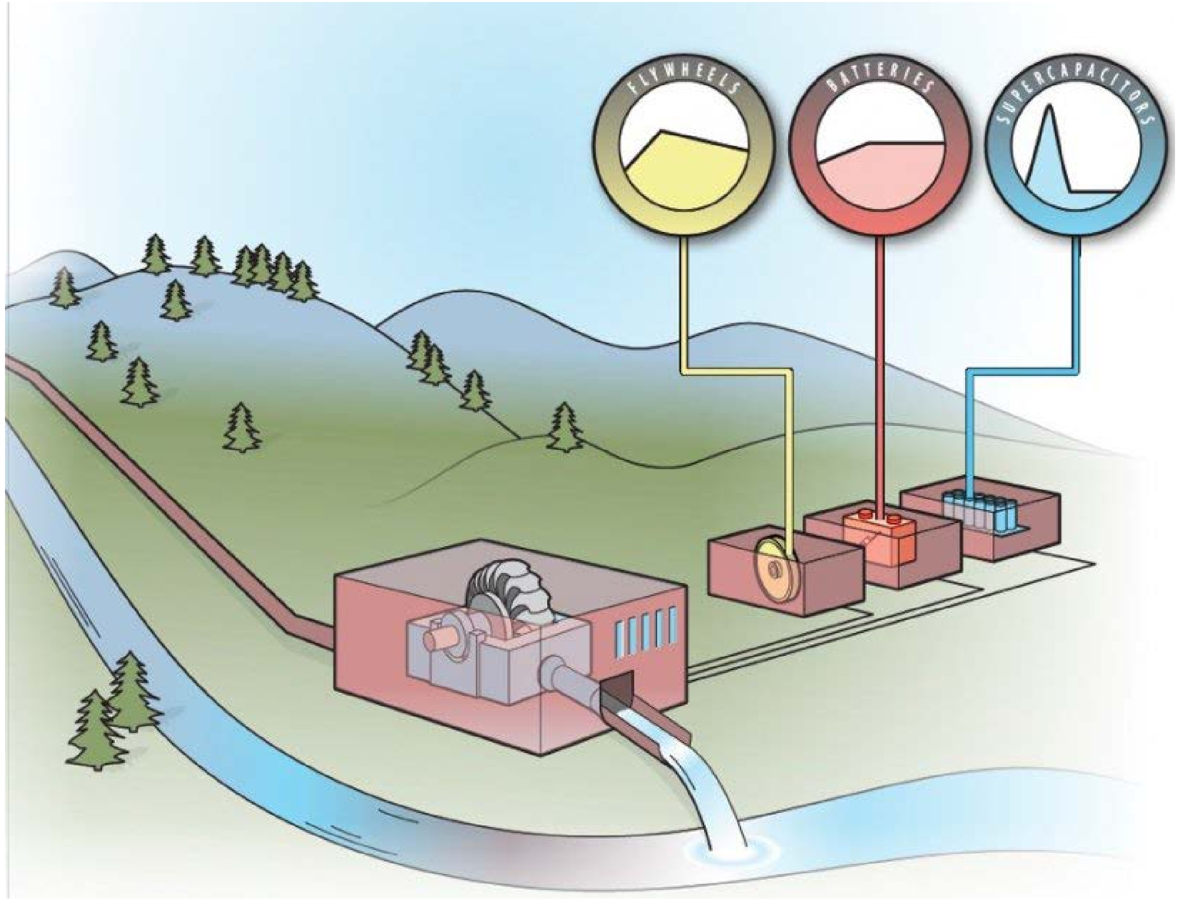
Likely Scenario for REAP Applications with and without Storage



Source: https://www.researchgate.net/publication/258404306_Hydropower_in_the_Context_of_Sustainable_Energy_Supply_A_Review_of_Technologies_and_Challenges?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoiX2RpcmVjdCJ9fQ



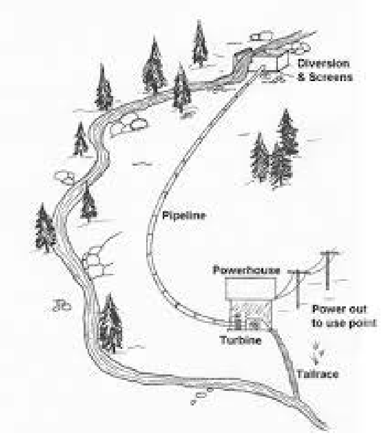
Source: Department of Energy

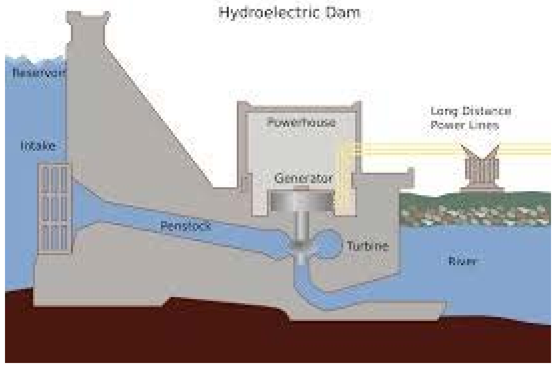


Source: Department of Energy

Run of River vs Conventional

Run of River	Conventional Hydropower
Streaming Hydro systems borrow a portion of the stream's water to produce power, returning it to the stream after the energy is extracted while not changing the natural course of the stream or store water for future use. • Little or no reservoir capacity to store water • Typically thought to have less environmental impact than conventional	Conventional hydropower refers to the use of dams or impoundments to store water in a reservoir; water released from the reservoir flows through a turbine to generate electricity





A new WPTO-funded virtual Renewable Energy Discovery (REDi) Island helps illustrate this. REDi Island an educational resource developed NREL and IKM 3D: Hydro Hollows: https://www.youtube.com/watch?v=FSeoBY92O08&list=PL3GM1pjrYAcirC10yXj2yQsNO-p-qKvlr&index=4

In-Conduit

Piped water with excess pressure can produce electricity using an in-conduit generator, rather than have the excess pressure relieved through a pressure-reducing valve.

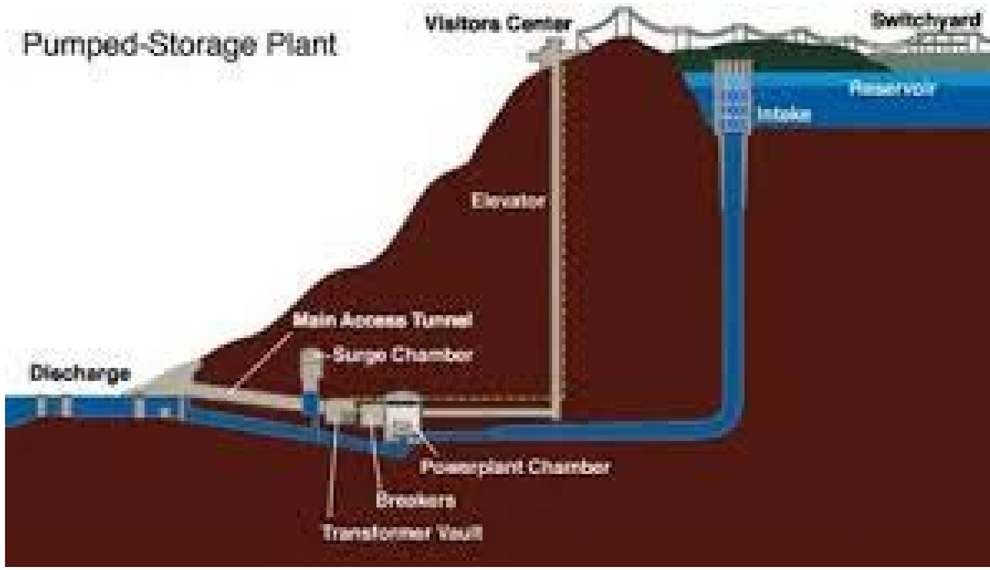
The in-conduit hydropower system places a turbine inside an existing pipeline or conduit does not require a dam nor a flowing river, with minimum capital cost and environmental impacts.

Alternately, with a pump-turbine, an in-conduit system can function both as a buck (as a generator) to reduce the rate of the water flow or as a boost (as a pump) to increase the rate of the flow within the pipe.

The boost mode is applicable in places where the water delivery must supply residential or commercial complex in a hilly real estate and the main pump has a limited capacity to provide desired output pressure, thus, without resizing the main pump, the in-conduit hydropower in boost mode can be installed to add pressure needed to deliver water to the customers.

Pumped Storage Hydropower

- When energy is needed on the grid, the system sends water from a higher elevation reservoir to a lower elevation one through a series of pipes—turning electricity-generating turbines along the way. When there is low energy demand on the grid, water is pumped back up to the upper reservoir for later use.
- A new WPTO-funded virtual Renewable Energy Discovery (REDi) Island helps illustrate this. REDi Island an educational resource developed NREL and IKM 3D: https://www.youtube.com/watch?v=WnndzmuhCsE&list=PL3GM1pjrYAcirC10yXj2yQsNO-p-qKvlr&index=17
- Scalable to also serve as a battery in smaller systems, e.g. A CO hydropower developer has designed one that can be scaled down to the size of an irrigation pump



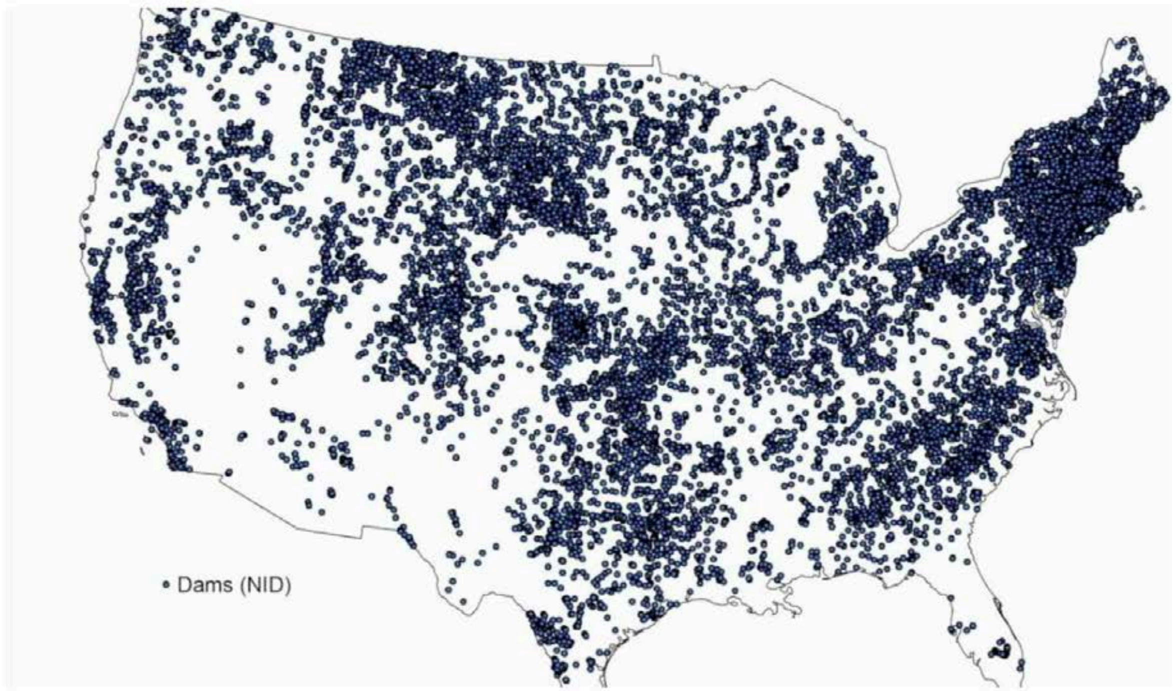
Siting and Regulatory

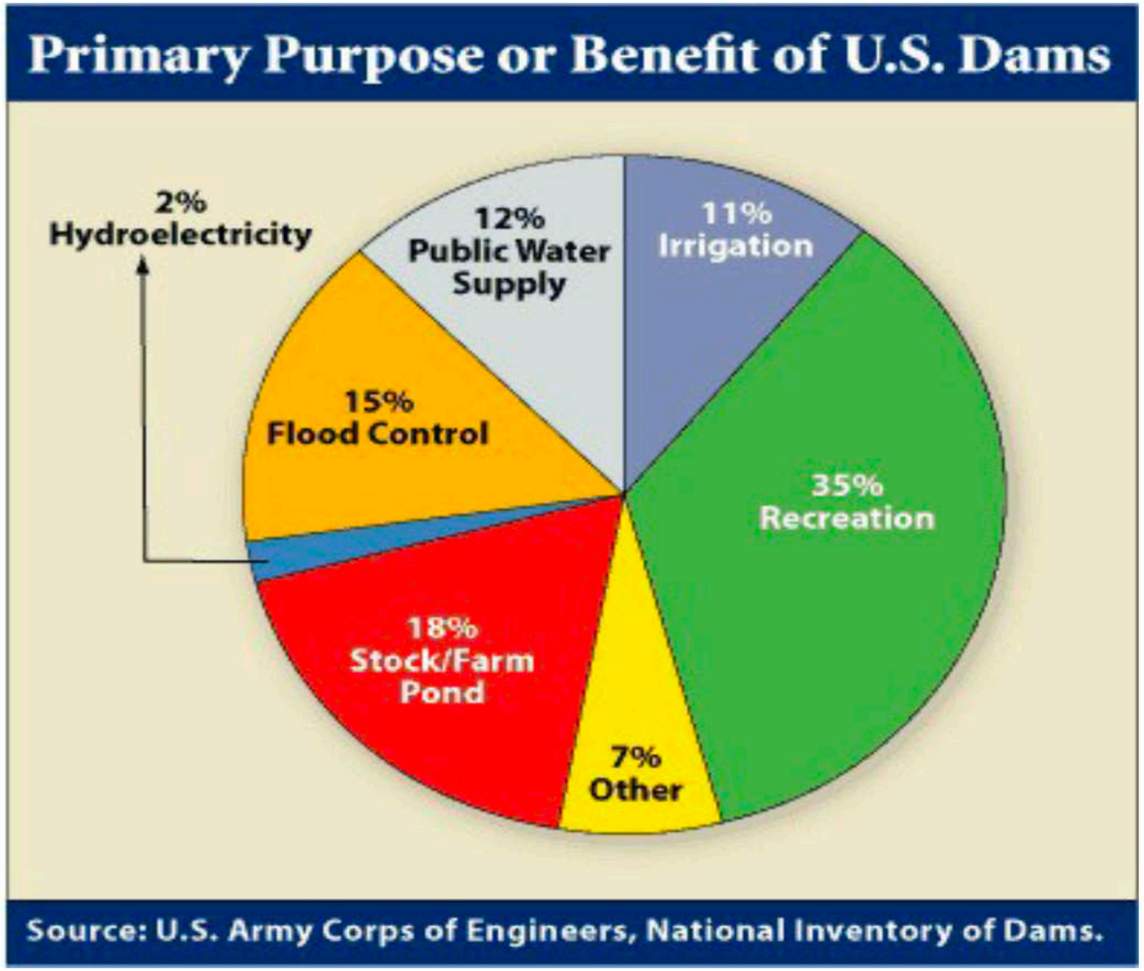
Hydropower Resource Potential

- Hydropower provides 6–8% of the nation's electricity
- Non-Powered Dams (ORNL)
  - Technical Potential to add up to 12.1 GW (12,100 MW) at NPDs in the US. However, this estimate does not consider economic limitations on facility capacity—it does include assumptions that all of the water passing a facility can be converted to electrical energy and that hydraulic head is constant at facilities.
- New Stream Reach Potential (ORNL)
  - The resource potential is 85 GW of capacity. When federally protected lands—national parks, national wild and scenic rivers, and wilderness areas—are excluded, the potential is over 65 GW of capacity or 347 TWh/year of generation.
  - Pump Storage Hydropower (NREL)
  - In the US, there are currently 40 pumped storage plants in operation with a combined capacity of 22 GW, accounting for 95 percent of all energy storage capacity in the power grid.

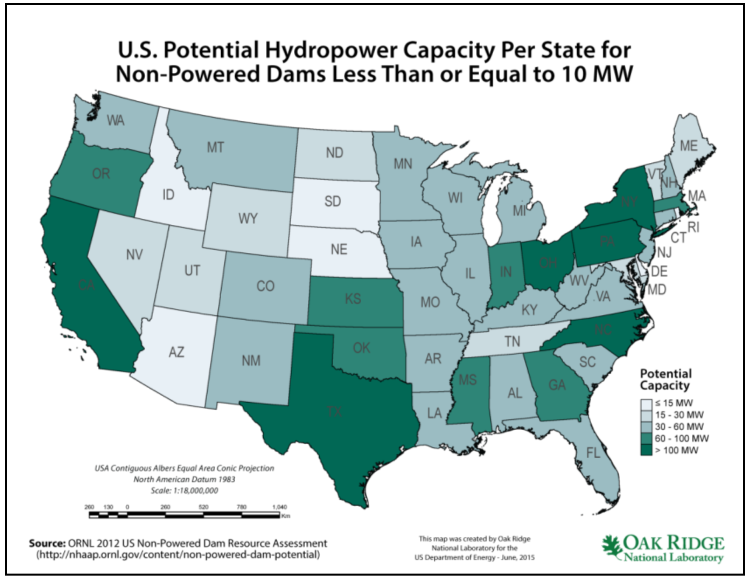
Non-powered dams in US

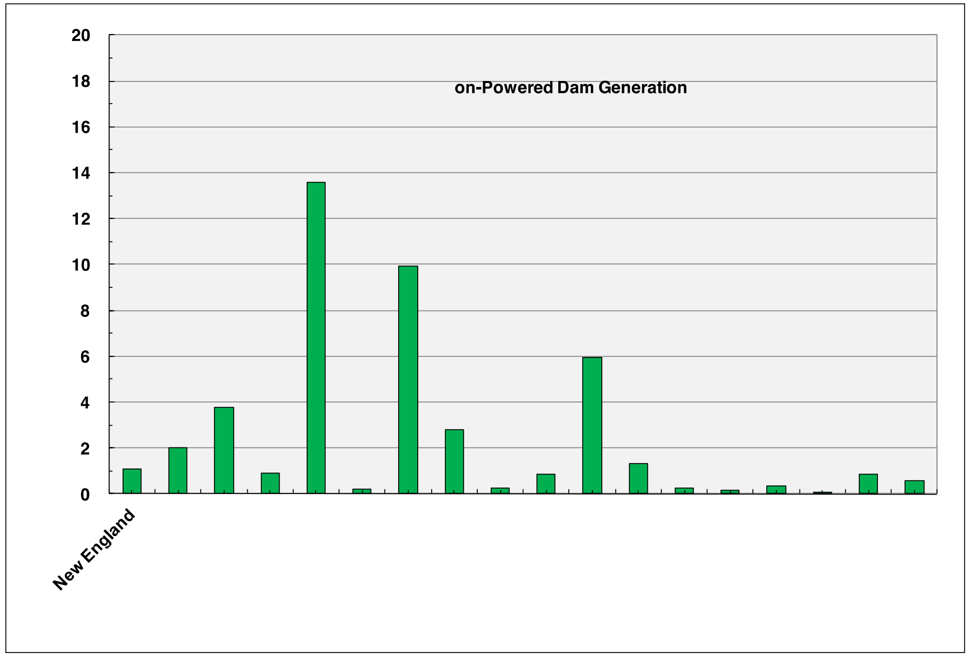
90,000+ U.S. Dams





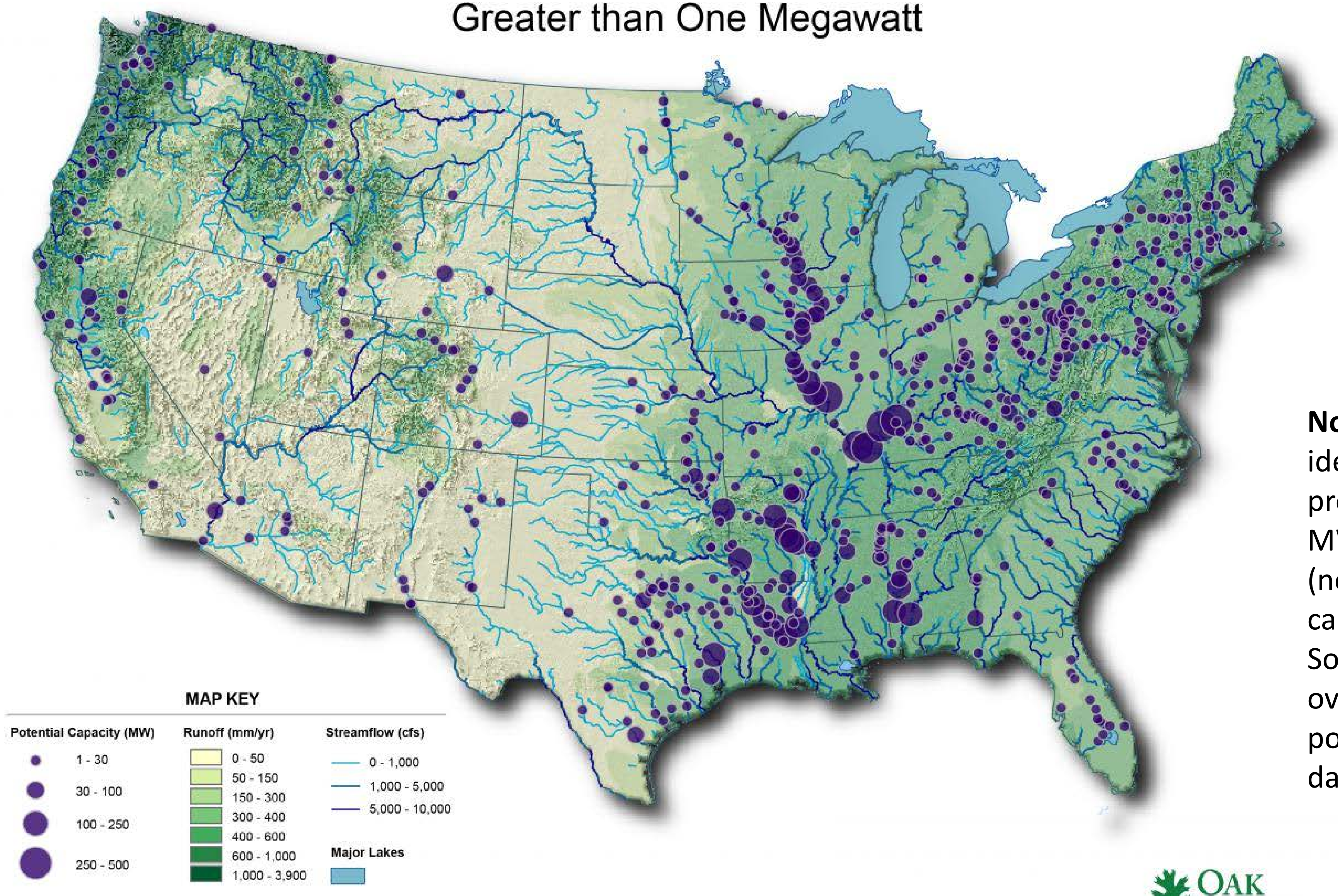
NPDs have large Generation Potential





- Most of the capacity potential found in the study was from just 100 sites of 54,391 sites nationwide
- The study did not consider any sites < 1MW, nor did it qualify estimated potential for feasibility

U.S. Non-powered Dams with Potential Capacity Greater than One Megawatt



Note: This map has been generalized for cartographic purposes and some streams associated with non-powered dams are not displayed.

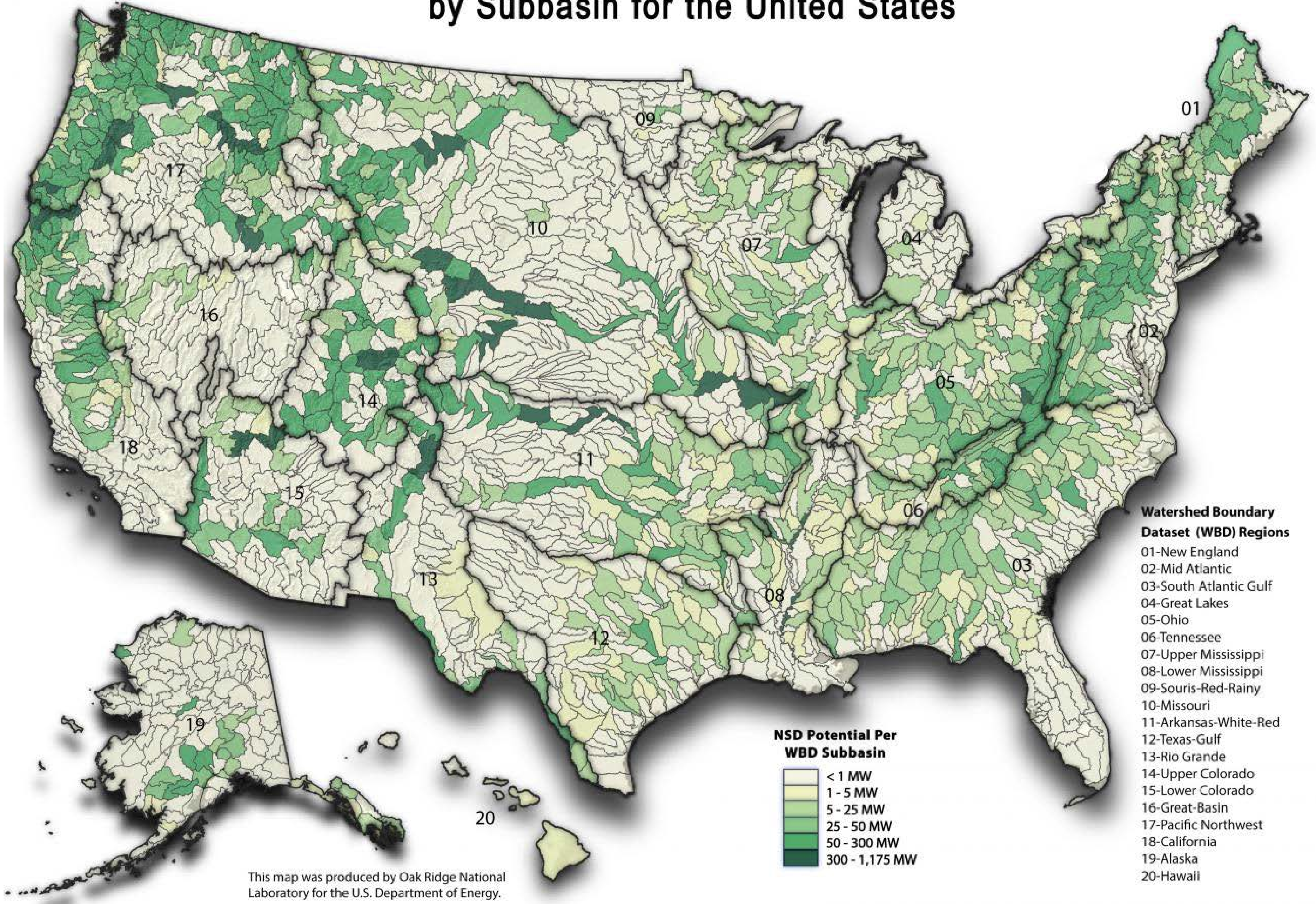
Author: Brenna Elrod - November 7, 2013

This map was produced by Oak Ridge National Laboratory for the U.S. Department of Energy.

OAK RIDGE National Laboratory

Note: The ORNL database identifies 397 dams that can produce between 1 and 10 MWs. Tens of thousands more (not included in this ORNL study) can produce under 1 MW
Source: https://hydrosource.ornl.gov/dataset/us-hydropower-potential-existing-non-powered-dams-greater-1mw

New Stream-reach Development (NSD) Potential by Subbasin for the United States

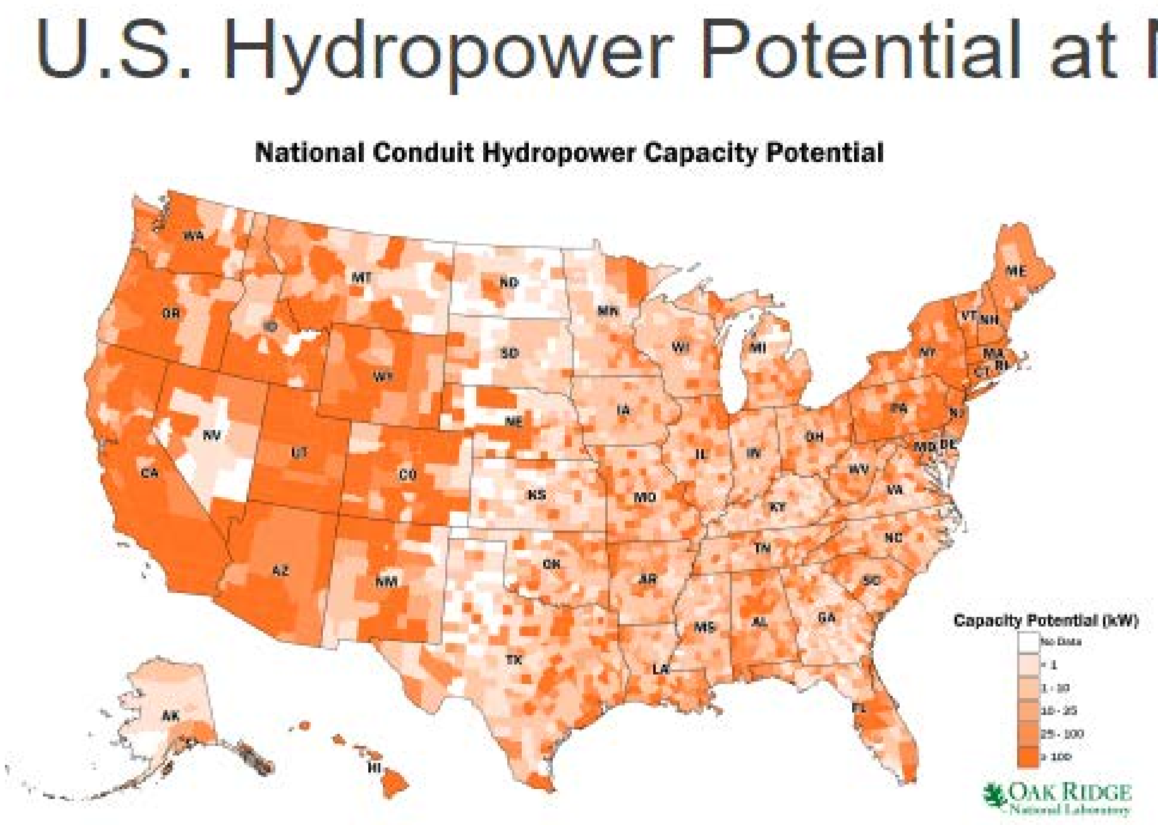


Watershed Boundary Dataset (WBD) Regions

01-New England
02-Mid Atlantic
03-South Atlantic Gulf
04-Great Lakes
05-Ohio
06-Tennessee
07-Upper Mississippi
08-Lower Mississippi
09-Souris-Red-Rainy
10-Missouri
11-Arkansas-White-Red
12-Texas-Gulf
13-Rio Grande
14-Upper Colorado
15-Lower Colorado
16-Great-Basin
17-Pacific Northwest
18-California
19-Alaska
20-Hawaii

This map was produced by Oak Ridge National Laboratory for the U.S. Department of Energy.

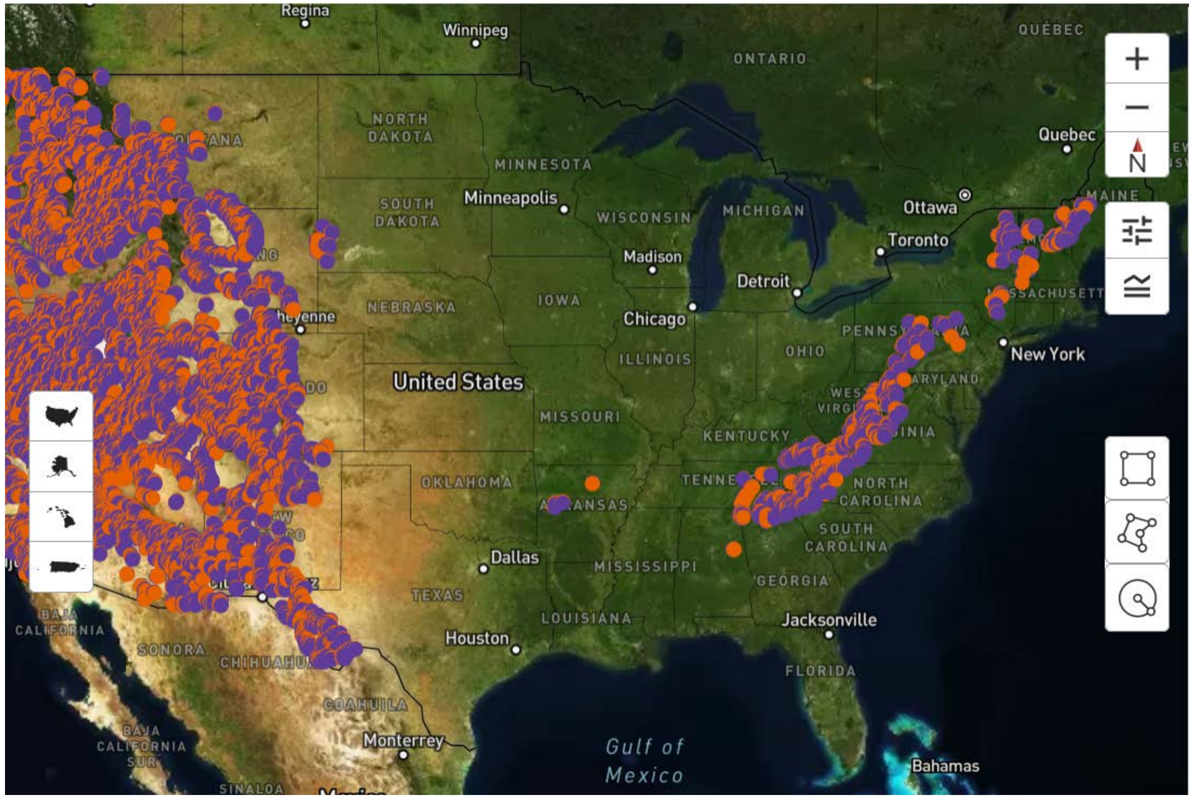
Conduit Potential



[Link: U.S. Hydropower Potential at National Conduits]

Pumped Storage Hydropower Potential

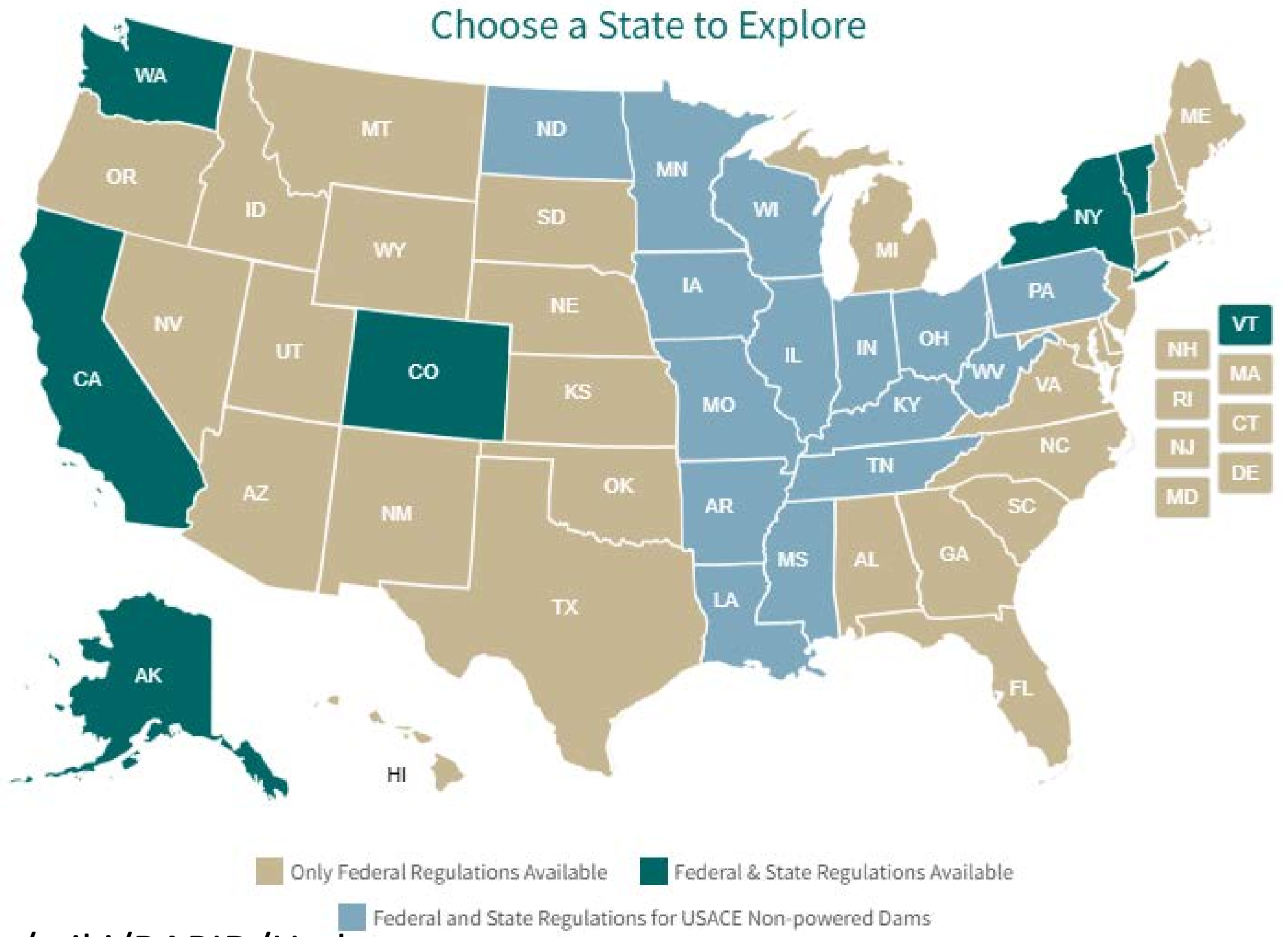
A [new interactive map](#) made by NREL researchers makes it easy for developers and other decision makers to explore potential PSH sites.



RAPID Toolkit can help Navigate the Permitting Process

Hydropower Regulations and Permitting

Choose a state from the map below to explore federal and state regulations and permitting processes that apply to hydropower projects. Or compare regulatory and permitting requirements in different states by selecting a topic and up to 4 jurisdictions at the bottom of the page. Users can also browse an overview of federal regulations that apply to all states.



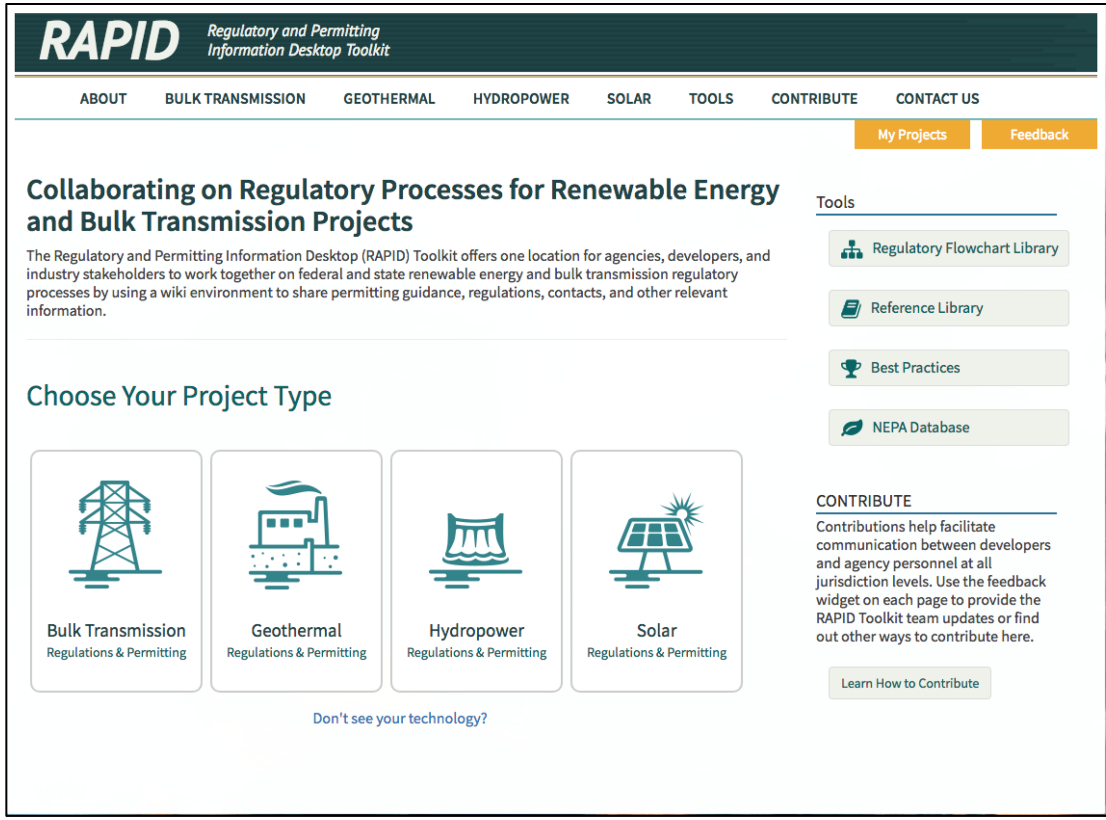
Source: NREL: https://openei.org/wiki/RAPID/Hydropower

Key takeaways from RAPID

The RAPID toolkit is an **online hydropower regulatory roadmap and related tools (including best practices/case studies)** for conventional hydro, micro hydro, and pumped storage development projects, **describing federal and state regulatory and permitting processes.**

Goals:

- To provide easy access to federal and state-level hydropower permitting information and tools, including: statutes, regulations, permit applications, processes guidance, manuals, examples, contacts, and other relevant information
- To convene industry stakeholders from agencies and industry to validate the permitting process
- To work with all stakeholders to promote integration of hydropower licensing regulatory processes
- To facilitate communication between project developers and agency personnel, among agencies at all jurisdictional levels, and among all project stakeholders.
- To identify best practices, case studies and lessons learned to better inform future hydropower project development.

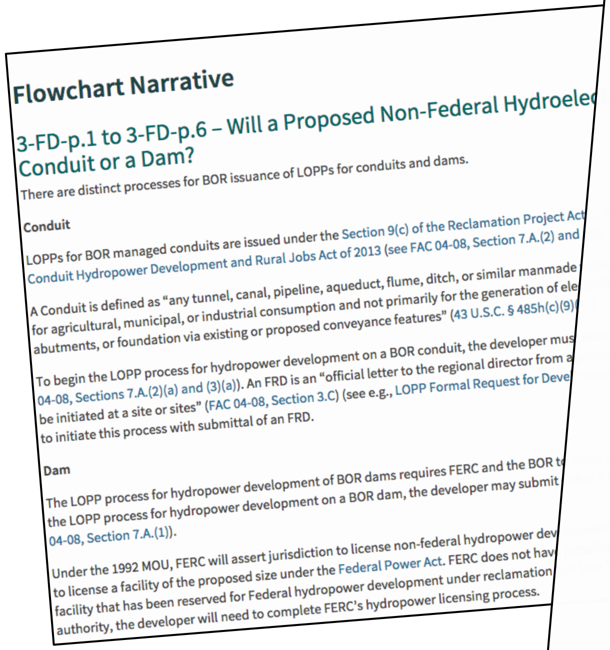


Regulatory Flowchart Library

The **Regulatory Flowchart Library** is a set of flowcharts providing detailed information outlining the requirements for developing energy projects, including topics such as land access, siting, exploration, drilling, plant construction and operation, grid interconnection, water resource acquisition, and relevant environmental considerations.

Leads the developer through a set of questions identifying potential permits that may be triggered by development activities

Consists of flowcharts and supporting materials, including links to relevant regulations and documents.



Flowchart Narrative

3-FD-p.1 to 3-FD-p.6 – Will a Proposed Non-Federal Hydroelec
Conduit or a Dam?

There are distinct processes for BOR issuance of LOPPs for conduits and dams.

Conduit

LOPPs for BOR managed conduits are issued under the Section 9(c) of the Reclamation Project Act
Conduit Hydropower Development and Rural Jobs Act of 2013 (see FAC 04-08, Section 7.A.(2) and

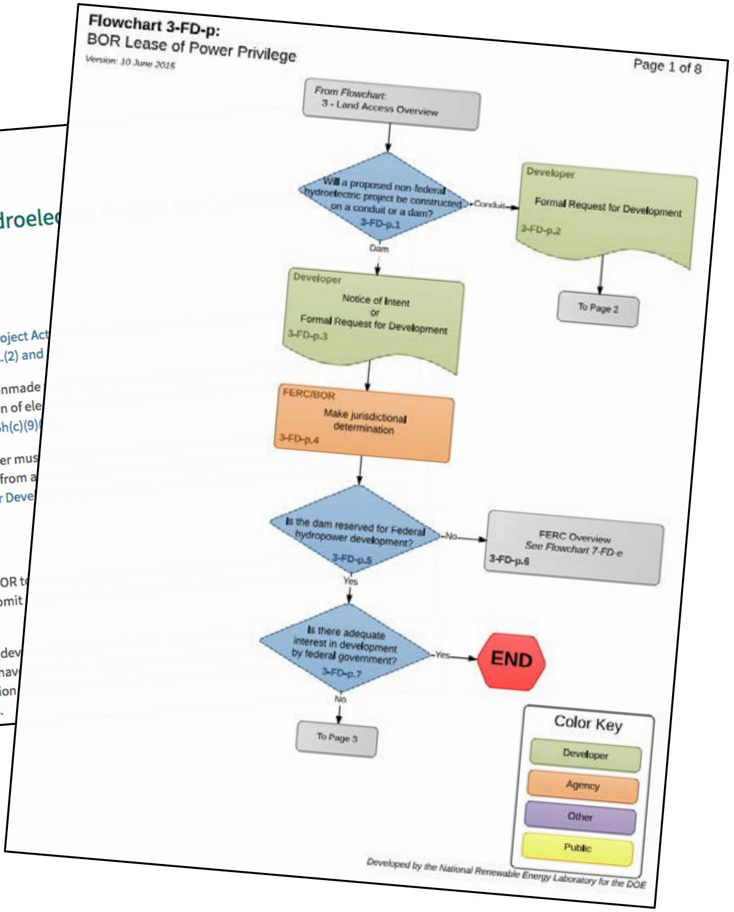
A Conduit is defined as "any tunnel, canal, pipeline, aqueduct, flume, ditch, or similar manmade
for agricultural, municipal, or industrial consumption and not primarily for the generation of ele
abutments, or foundation via existing or proposed conveyance features" (43 U.S.C. § 485h(c)(9)

To begin the LOPP process for hydropower development on a BOR conduit, the developer mus
04-08, Sections 7.A.(2)(a) and (3)(a)). An FRD is an "official letter to the regional director from a
be initiated at a site or sites" (FAC 04-08, Section 3.C) (see e.g., LOPP Formal Request for Deve
to initiate this process with submittal of an FRD.

Dam

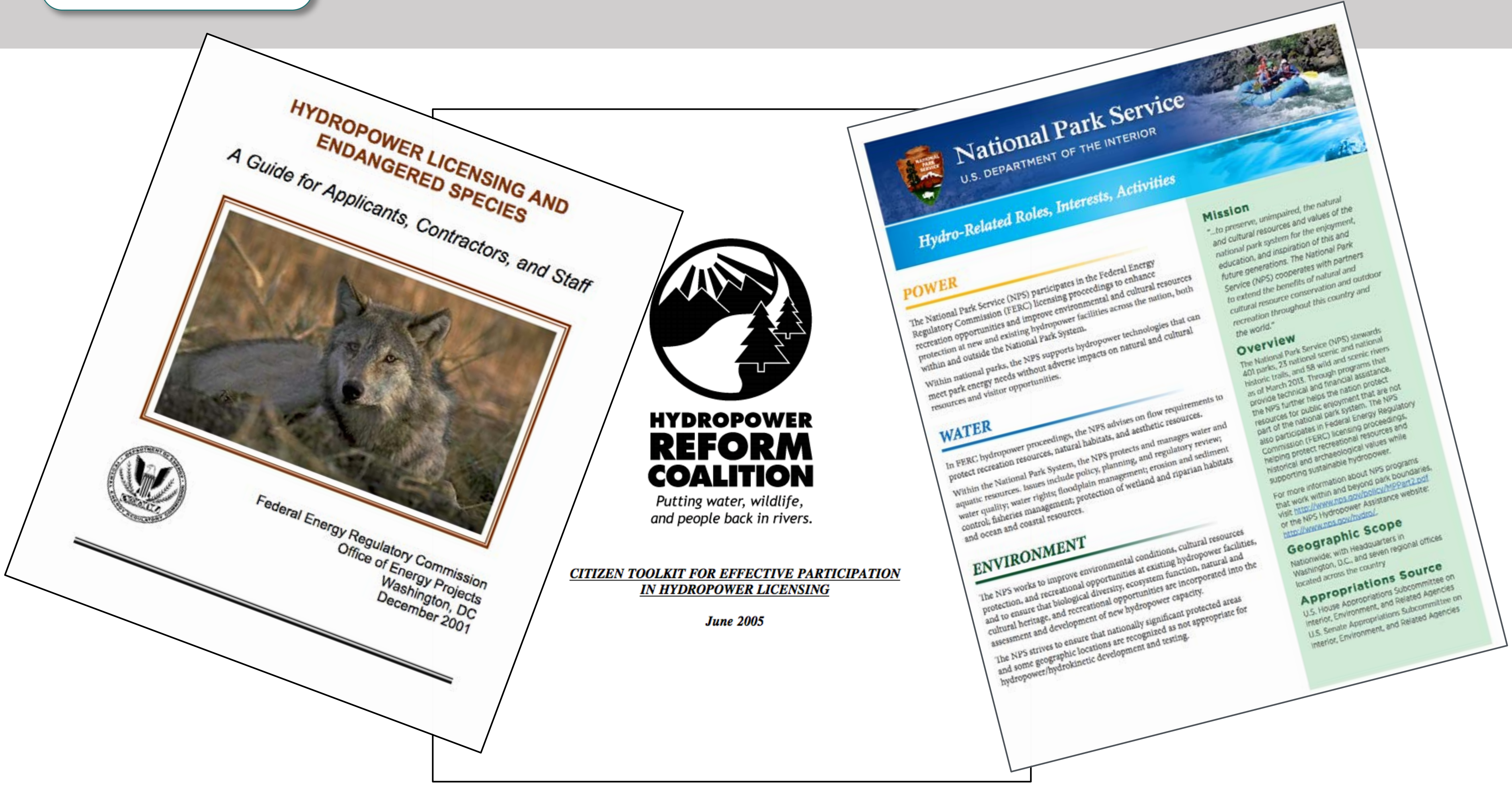
The LOPP process for hydropower development of BOR dams requires FERC and the BOR t
the LOPP process for hydropower development on a BOR dam, the developer may submit
04-08, Section 7.A.(1)).

Under the 1992 MOU, FERC will assert jurisdiction to license non-federal hydropower dev
to license a facility of the proposed size under the Federal Power Act. FERC does not hav
facility that has been reserved for Federal hydropower development under reclamation
authority, the developer will need to complete FERC's hydropower licensing process.



Reference Library

The **Reference Library** assembles links to applications, permits, processes, guidance, manuals, examples, regulations, rules, contacts, and other regulatory and permitting documents that are publicly available on other websites. Users can search the library to find related documents or add to the library by providing links to additional documents.

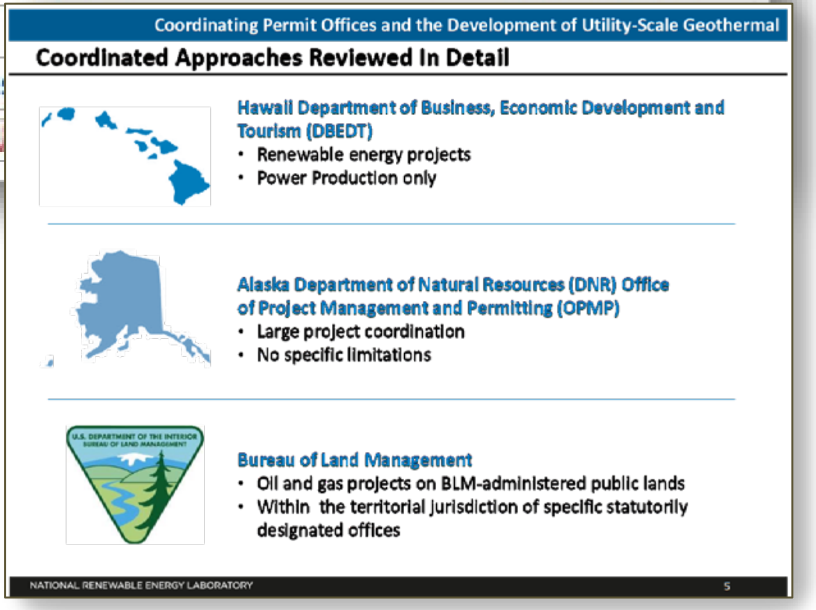


Best Practices

Best Practices provides a set of analyses outlining best practices, examples and templates for selected topics, such as developing memorandums of understanding (MOUs) among agencies and developing effective public involvement strategies.

Best Practices

TITLE	TECHNOLOGY
Coordinating Permit Offices and the Development of Utility-Scale Geothermal Energy	Geothermal
Memorandums of Understanding (MOUs) for Interstate Transmission Projects	Bulk Transmission
Public Involvement for Transmission Projects	
NEPA and CEQA: Integrating State and Federal Environmental Review	
NEPA and NHPA: A Handbook for Integrating NEPA and Section 106	



Small Hydro is Now Easier!

- 2013 legislation reduced administrative cost barrier
  - Prior to 2013 federal reforms, permitting costs could exceed equipment costs
- Federal 242 Hydroelectric Production Incentive Payment program funded starting in FY 2014, paying 1.5 cents/kWh for 10 years, additional funding in 2021 through BIL: https://www.energy.gov/gdo/section-242-hydroelectric-production-incentive-program
- Recent innovations in small hydro technology

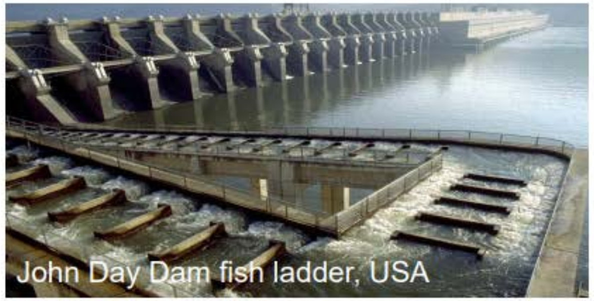
Fish Migration and Hydropower

- Many fish species migrate through river systems
  - Potadromous
    - Migrate solely through freshwater
    - E.g., Colorado pikeminnow, lake sturgeon
  - Anadromous
    - Migrate from the ocean to freshwater to spawn
    - E.g., Pacific salmon, Pacific lamprey, American shad
  - Catadromous
    - Migrate from freshwater to the ocean to spawn
    - E.g., American eels
- Challenges for Fish
  - Passage
    - Upstream
    - Downstream
  - River Flows
    - Water Quality
    - Habitat
    - Predators

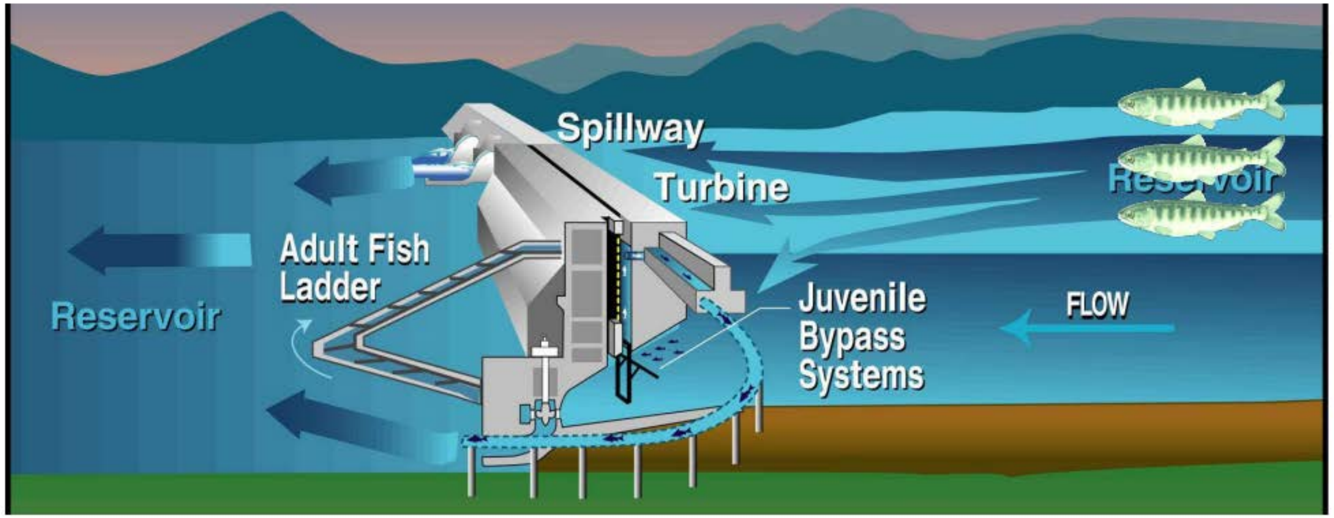
Source: Allison Colotelo, PNNL

Upstream Fish Passage

- Fish ladders
  - A series of pools of water that fish must swim or jump into to move upstream
- Fish elevators/lifts
  - Fish swim into collection area and are lifted over barrier
- Climbing ramps
  - Shallow channels with coarse climbing substrate
- New technologies
  - Whooshh fish transport system aka "Salmon Cannon"



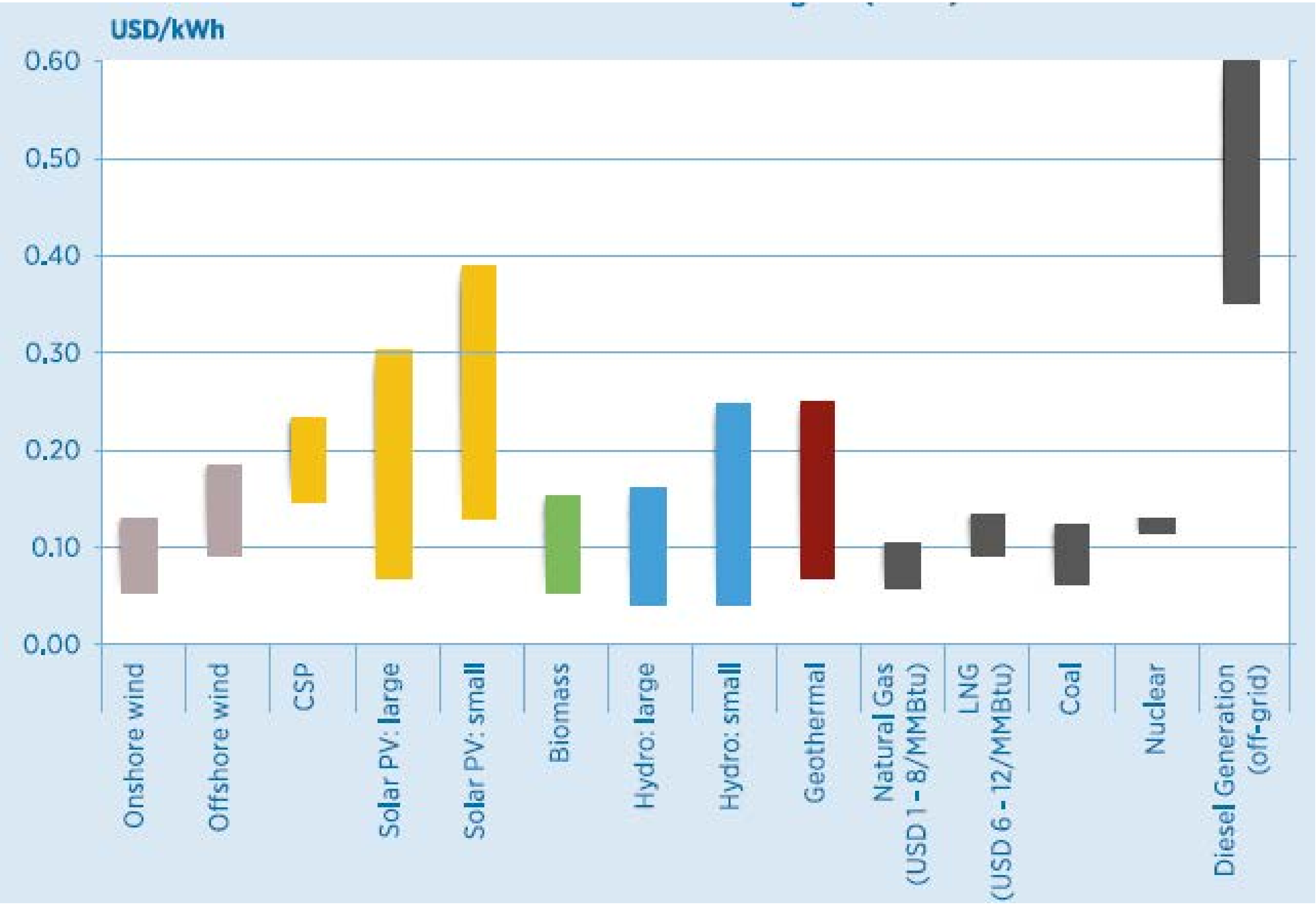
Downstream Fish Passage



Source: Allison Colotelo, PNNL

Technoeconomics

Hydropower is Cost Competitive



Source: IRENA - REthinking Energy - 2015

Financial Incentives for Hydro

Incentives for Renewable Energy Federal and state governments encourage the growth of renewable energy technologies by offering financial incentives for their development and deployment. Federal incentives that may be applied to conventional hydropower projects include:

- Renewable Electricity Production Tax Credit (PTC)
- Renewable Energy Investment Tax Credit (ITC)
- U.S. Department of Treasury — Renewable Energy Grants (Section 1603)
- Modified and Accelerated Cost Recovery System (MACRS)
- Clean Renewable Energy Bonds (CREBs)
- Qualified Energy Conservation Bonds (QECBs)
- Qualifying Advanced Energy Manufacturing Investment Tax Credit (Section 48C)

Energy Storage and Ancillary Benefits

- Among nine energy storage technologies, PSH currently provides lowest or competitive cost in eight of 12 applications
- Data from Imperial College LCOS tool: https://energystorage.shinyapps.io/LCOSApp/
- StoreFast tool from NREL confirms current and future LCOS competitiveness of PSH across scales of storage:

https://www.nrel.gov/storage/storefast.html

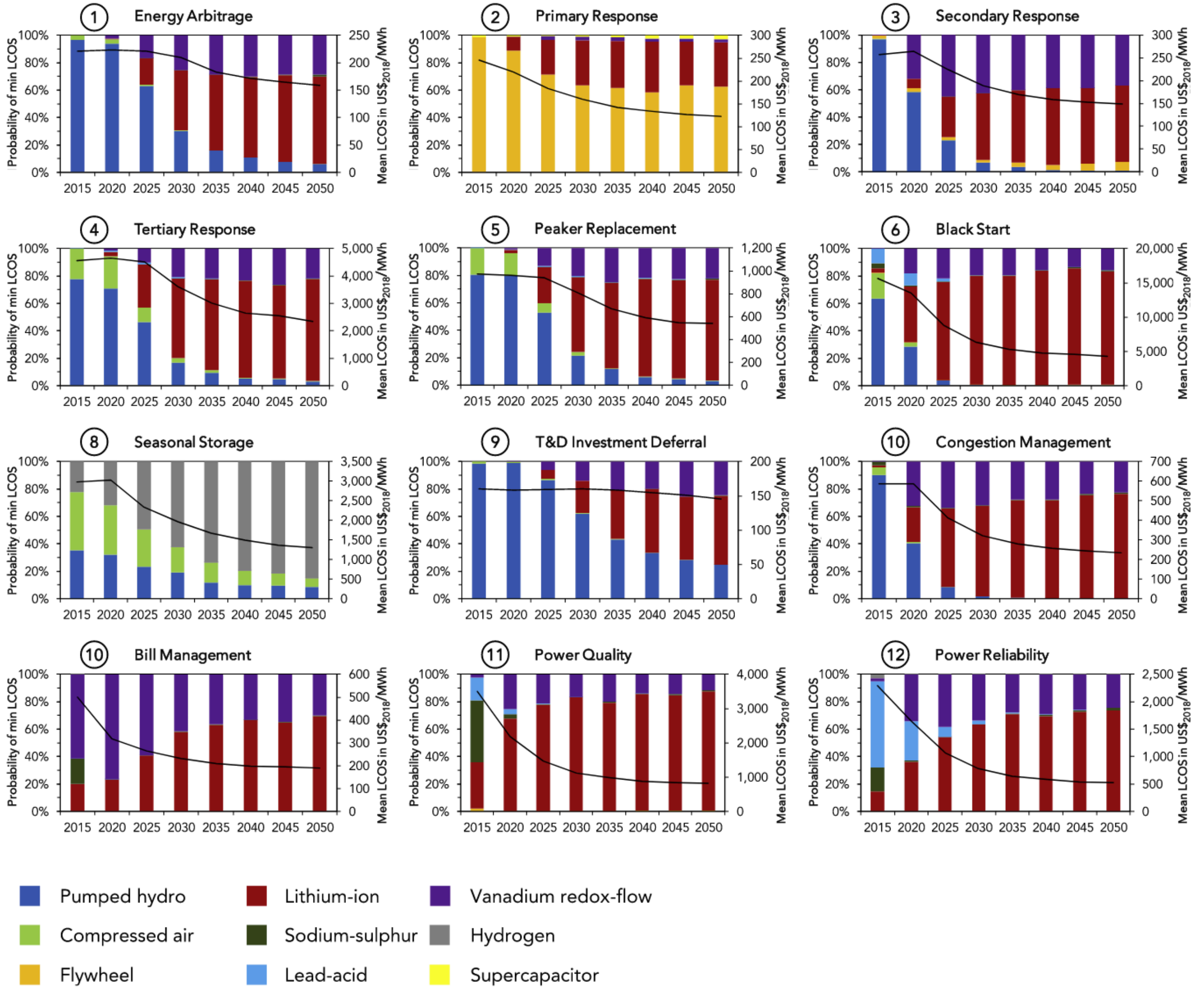
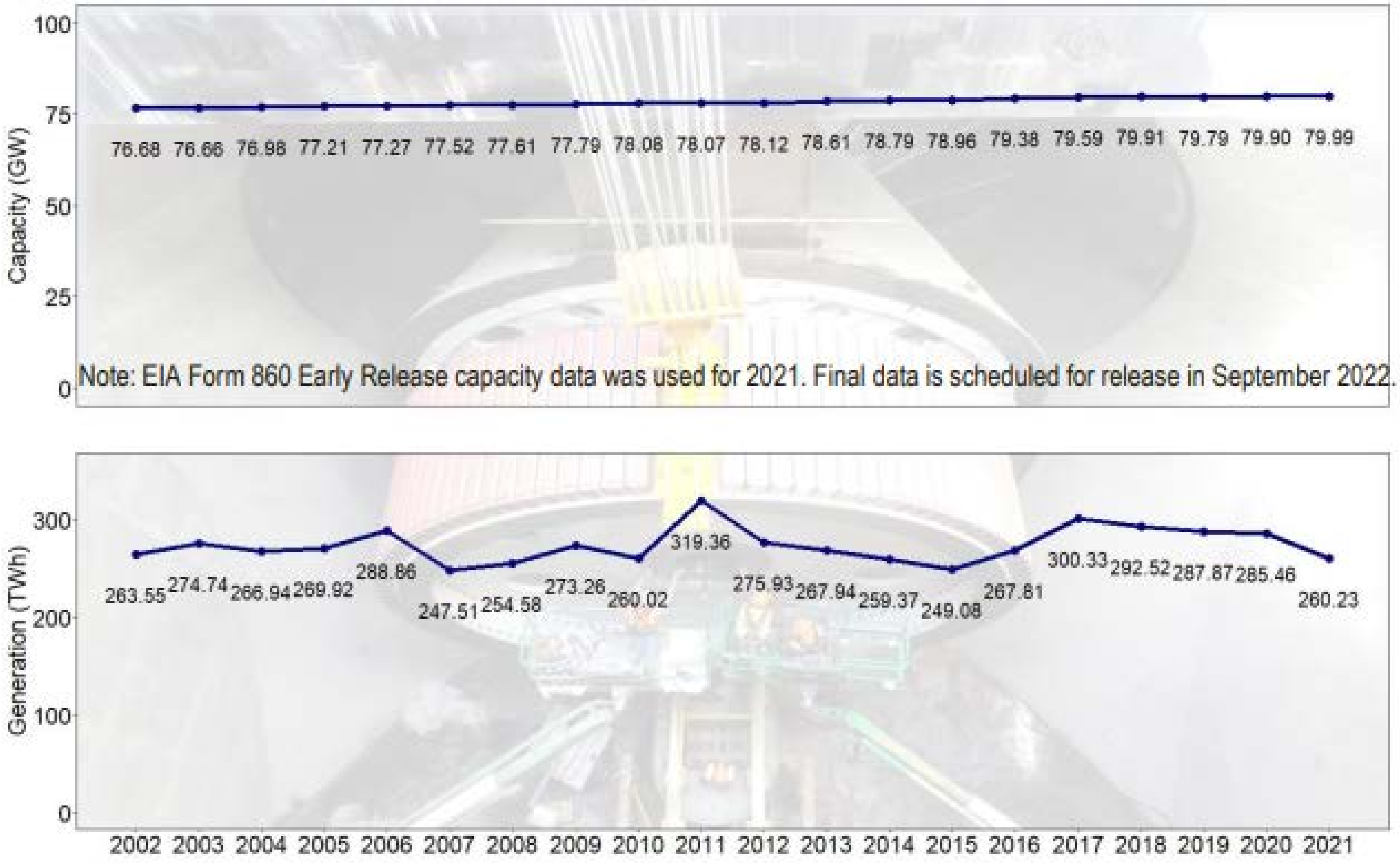


Figure 2. Lowest LCOS Probabilities for 9 Electricity Storage Technologies in 12 Applications from 2015 to 2050

Left-hand axis displays probability that a technology will exhibit the lowest LCOS in a specific application. Right-hand axis displays mean LCOS of technology with highest probability for lowest LCOS. Note there are different scales between panels. Probabilities reflect the frequency with which each technology offers the minimum LCOS accounting for the uncertainty ranges identified with the Monte-Carlo simulation of the LCOS calculation. Circled numbers in panel titles correspond to applications in Table 1. Note that applications like primary response or power quality are usually reimbursed for provision of power capacity, not energy output. Please refer to Figure S4 for probability analysis and projection of LCOS in power terms (i.e., annuitized capacity cost in US$/kW$_{year}$).

Market update - Hydro is well-established

- ORNL Market report
- [Hydropower Market Reports | Department of Energy]()



Sources: EIA Form 860 (capacity), EIA Form 923 (generation), Electric Power Monthly (2021 generation)

Socioeconomic Implications

Small Hydro Supports Energy, Economic, Environmental Goals

- Create new clean energy
- Create new jobs
- Create new revenue sources for rural areas

“Congress Finally Found an Energy Source Everyone Likes – Hydropower”

August 2, 2013, Headline in the *Washington Post* following unanimous Senate approval of the Hydropower Regulatory Efficiency Act and the Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act.

Slide Credit: Kurt Johnson, Telluride Energy

Uncommon Dialogue on Hydropower, River Restoration, and Public Safety

- **Broad Goal:** To better address climate change – and protect rivers – through a smarter approach to U.S. hydropower.
- **Specific Objective:** A 2020 Joint Statement between the U.S. hydropower industry and river conservation/environmental NGOs to improve the value of hydropower – and protect rivers.
- **Key Tools:** Rehabilitation, retrofits and removals (“3Rs”) of U.S. dams – both powered and non-powered – driven by improved policy, technology, and investment – on a basin scale.
- **Forum:** Stanford Woods Institute Uncommon Dialogue.

The ‘Three Rs’ of the Uncommon Dialogue

- **Rehabilitate** dams for improved safety and environmental performance.
- **Retrofit** powered and non-powered dams for increased electricity generation and storage; develop closed-loop pumped storage.
- **Remove** obsolete dams that are harming ecosystems, causing safety risks, and impeding recreation.

AUGUST 30, 2021

$2.3 billion to improve or remove U.S. dams included in new federal infrastructure bill in wake of a Stanford Uncommon Dialogue agreement

Key ideas and proposals from an agreement between the hydropower industry and environmental community, facilitated through a Stanford Woods Institute for the Environment Uncommon Dialogue, have been included in the $1 trillion infrastructure package adopted by the U.S. Senate.

BY DEVON RYAN

In the fall of 2020, amidst a global pandemic and one of the most divisive periods in American history, the hydropower and river conservation communities, traditionally at odds, reached an agreement to work together to address the nation’s more than 90,000 dams.

Case Studies

Case Study: Notre Dame Turbine-Generator

- Featured at https://www.hydropower.org/case-study/small-turbine-generator

100-1450 kW each

2022: Ten turbines installed in South Bend, IN for 2.5 MW system as part of Notre Dame's renewable supply
Project agreement entered 2016
Construction started 2019

Modular Solutions Could be an Option

- Technology advancements allow for the integration of modular turbine package into traditional gate design
- Opportunities here to formulate solutions that meet USACE navigation requirements and add additional reliable, power supply.
- Ideas include various crossflow turbine designs, as well as other approaches

notional cross-flow Pelton turbine

Emrgy – Canal Hydro

Canal hydropower solution

Denver Water pilot

https://www.youtube.com/watch?v=zEnSXb47WMc

Colorado State University – On-Farm Hydropower

https://extension.colostate.edu/topic-areas/natural-resources/6-708-agricultural-hydropower-generation-farm/

In 2012, a rancher in northeast Colorado wanted to reduce energy costs by retrofitting an existing center pivot with a new small hydropower turbine.

An evaluation of the site conditions identified a head of 126 feet and a predictable flow of 560 gallons per minute (gpm). These site conditions provide enough pressure to not only pressurize the sprinklers but also produce 5.2 kW of power, equivalent to 7 horsepower.

Using gravity to feed the sprinklers and produce energy eliminated the need for pumps and drive systems which reduces operating and maintenance costs.

Because of the incentives available for site and feasibility assessments, the only out-of-pocket cost to the farmer was the purchase of a Cornell turbine. The total project cost for the irrigator was $13,000.00 and an NRCS EQIP grant covered $6,000.00. The expense to the irrigator was $7,000.00 with an annual energy savings around $2,100.00.

This results in payback period of roughly 3.3 years. With a life expectancy of at least 20 years for a turbine, this put the total annual cost of the hydropower project at $350.00/year over 20 years.

An irrigator can expect to get more than 20 years of use from a single turbine if turbines are properly maintained (turbine maintenance is very similar to pump maintenance).

In this case, installing a small hydropower system and eliminating the electricity consumption of a center pivot, the net cost savings over a 20 year period will be around $35,000.00.

Resources

Resources for Additional Information

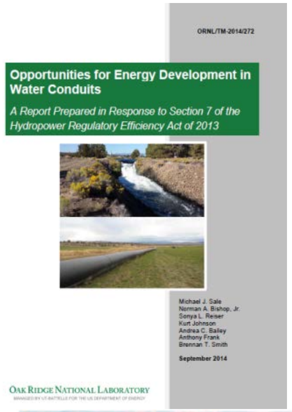
Colorado Small Hydropower Handbook
https://www.colorado.gov/pacific/sites/default/files/SmallHydroHandbook.pdf

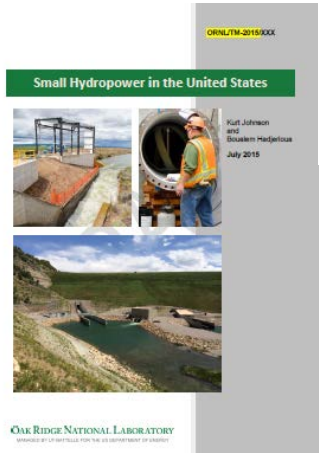
Recommendations for Developing Agricultural Hydropower in Colorado
https://www.colorado.gov/pacific/sites/default/files/AgHydroRoadmap.pdf

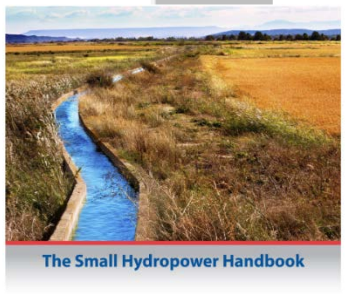
E3A: Exploring Energy Efficiency and Alternatives
www.e3a4u.info

ACRE3: Advancing Colorado Renewable Energy and Energy Efficiency
https://www.colorado.gov/pacific/agconservation/acre

Colorado State University Extension
https://extension.colostate.edu/topic-areas/hydropower-technology-basics/







NREL STEM Hydropower Portal

- https://openei.org/wiki/Hydropower/STEM

Then navigate to reports:
https://openei.org/wiki/Hydropower/Tools_%26_Reports

Then Navigate to Reports…..

Hydropower Tools

RAPID Regulatory and Permitting Information Desktop Toolkit

Hydropower RAPID Toolkit

The RAPID Toolkit makes permitting information easily accessible from one online location.

Open Tool

Oak Ridge National Laboratory

Oak Ridge National Laboratory: HydroSource

The Oak Ridge National Laboratory: HydroSource is an integrated energy, water, and ecosystem research and geospatial data integration effort for efficient, sustainable, and environmentally friendly hydroelectricity generation and water management. (formerly the National Hydropower Asset Assessment Program)

Open Tool

eia

U.S. Energy Information Administration: Hydroelectric Power Resources Form Regional Clusters

Hydroelectric generators in and around the United States

Open Tool

USGS science for a changing world

National Atlas—Mapping Water of the United States

The online version of the National Atlas (officially known as the 1997-2014 Edition of the National Atlas of the United States) was removed from service in 2014. Some of its previous products and services are available.

Open Tool

USGS science for a changing world

U.S. Geological Survey: Water Watch

Shows real-time, recent, and past stream-flow conditions for the United States

Open Tool

USGS science for a changing world

U.S. Geological Survey: StreamStats

Provides users with access to an assortment of Geographic Information System (GIS) analytical tools that are useful for water-resources planning and management

Open Tool

https://openei.org/wiki/Hydropower/Tools_%26_Reports

Hydropower Reports

U.S. Department of Energy reports:

2017 Hydropower Market Report

The 2017 Hydropower Market Report provides industry, policy makers, and other interested stakeholders with important data and information on the distribution, characteristics, and trends of the hydropower industry in the United States.

Open Report

Water Power for a Clean Energy Future

The U.S. Department of Energy Water Power Program leads critical research and development efforts necessary to develop more efficient technologies that will drive sustainable growth and economic opportunity.

Open Report

U.S. Department of Energy Hydropower Projects

The breakdown of Water Power Program funding is presented in a report that showcases funded hydropower projects.

Open Report

Memorandum of Understanding for Hydropower Two-Year Progress Report

The MOU for Hydropower contains 13 high-level goals and 17 specific action items that are specifically targeted to help meet those goals.

Open Report

Effects of Climate Change on Federal Hydropower (Report to Congress)

The U.S. Department of Energy conducted a nationwide study of impacts on federal hydropower generation using climate modeling as well as hydrological and hydro power generation data.

Open Report

https://openei.org/wiki/Hydropower/Tools_%26_Reports

Water Power Technologies Office Publication and Product Library:

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
WATER POWER TECHNOLOGIES OFFICE

U.S. Department of Energy Water Power Program Publications Library

This Publication and Product Library features resources provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy's Water Power Technologies Office.

Open Report

Final Reports from U.S. Department of Energy-funded projects:

OSTI.GOV

Alabama Power Company: Final Technical Report

Upgrades to Alabama Power Company Hydroelectric Developments.

Open Report

OAK RIDGE National Laboratory

Oak Ridge National Laboratory: Assessment of the Effects of Climate Change on Federal Hydropower (Technical Report)

An Assessment Prepared in Response to Section 9505(c) of the SECURE Water Act of 2009.

Open Report

https://openei.org/wiki/Hydropower/Tools_%26_Reports

Thank You!

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How to Prepare Hydropower Applications for REAP

Overview

- Qualifications of the Project Team
- Agreements and Permits
- Resource Assessment
- Design and Engineering
- Project Development
- Equipment Procurement and Installation
- Project Economic Assessment
- Operations and Maintenance

Qualifications of the Project Team

- Describe the project team, their professional credentials, and relevant experience.

- The description shall support that key service providers in the project team have the necessary professional credentials, licenses, certifications, and relevant experience to develop the proposed project.

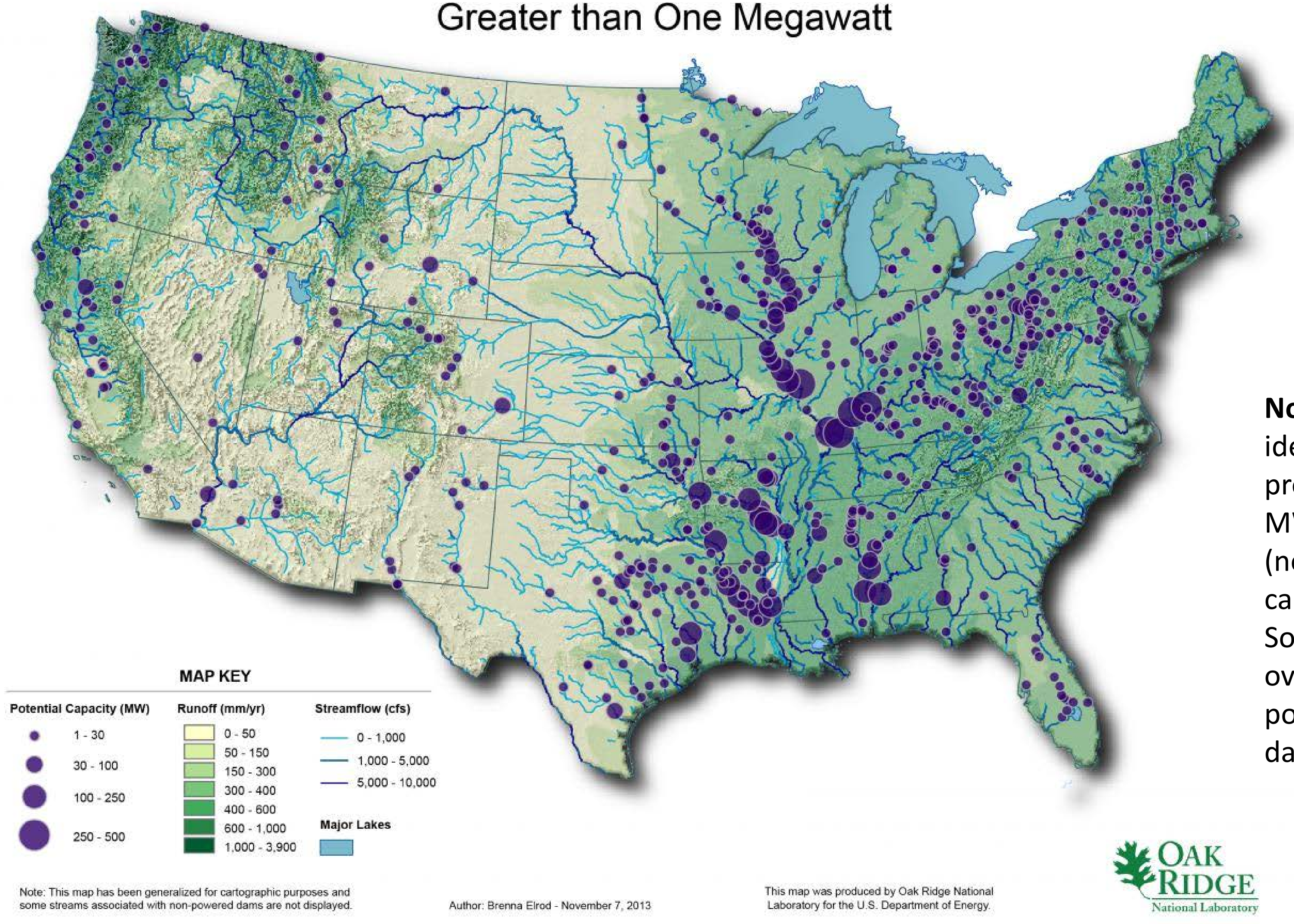
Agreements and Permits

- Any necessary local agreements and permits
- Interconnection and power purchase agreements

Resource Assessment

- Describe the quality and availability of hydropower resources and the amount of energy generated through the deployment of the proposed system.

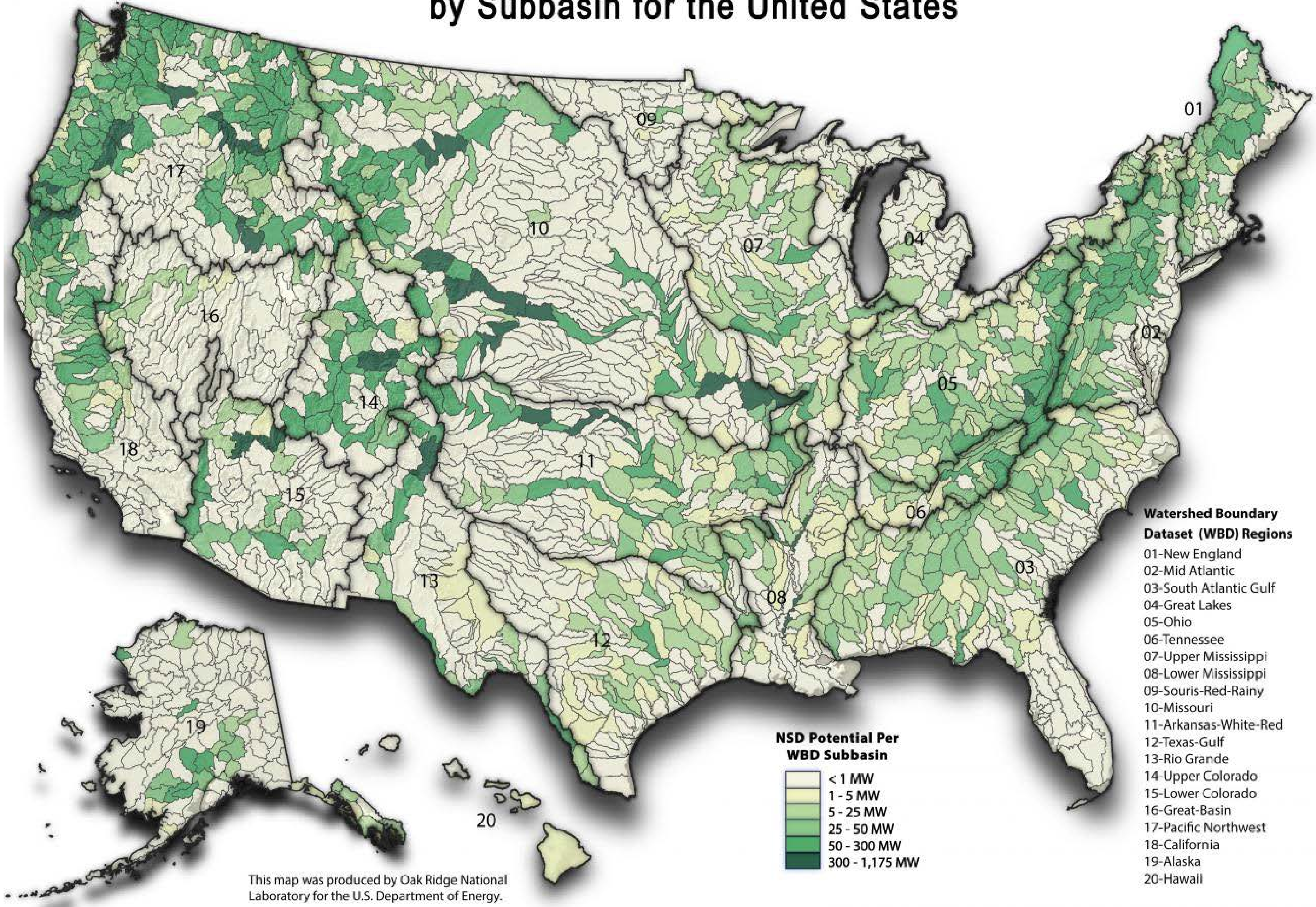
U.S. Non-powered Dams with Potential Capacity Greater than One Megawatt



Note: The ORNL database identifies 397 dams that can produce between 1 and 10 MWs. Tens of thousands more (not included in this ORNL study) can produce under 1 MW

Source: https://hydrosource.ornl.gov/dataset/us-hydropower-potential-existing-non-powered-dams-greater-1mw

New Stream-reach Development (NSD) Potential by Subbasin for the United States



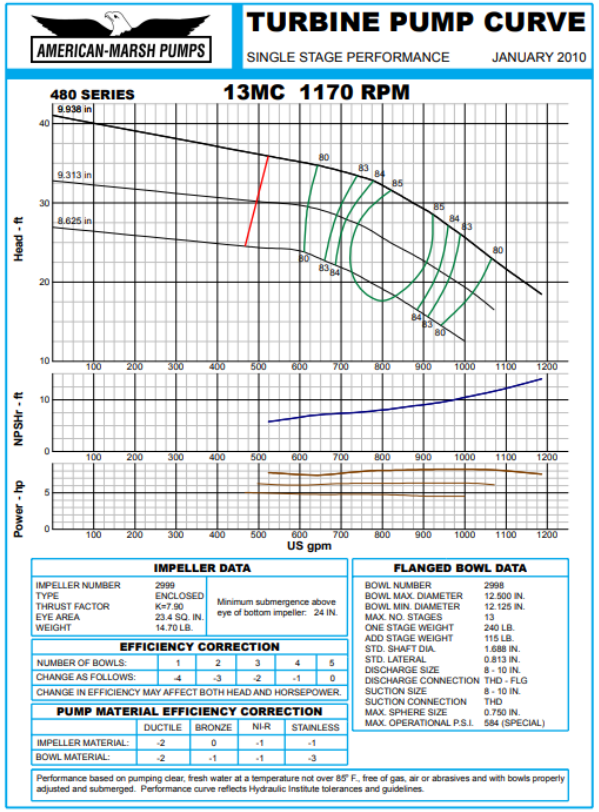
Design and Engineering

- Describe objectives of the project.

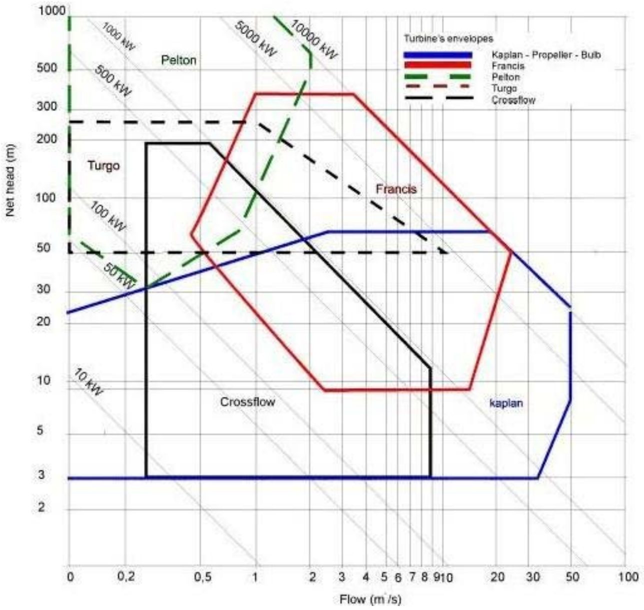
- Describe the design, engineering, testing, and monitoring details with supporting materials.

- Identify all major equipment is commercially available, including proprietary equipment, and justify how this unique equipment is needed to meet the requirements of the proposed design.

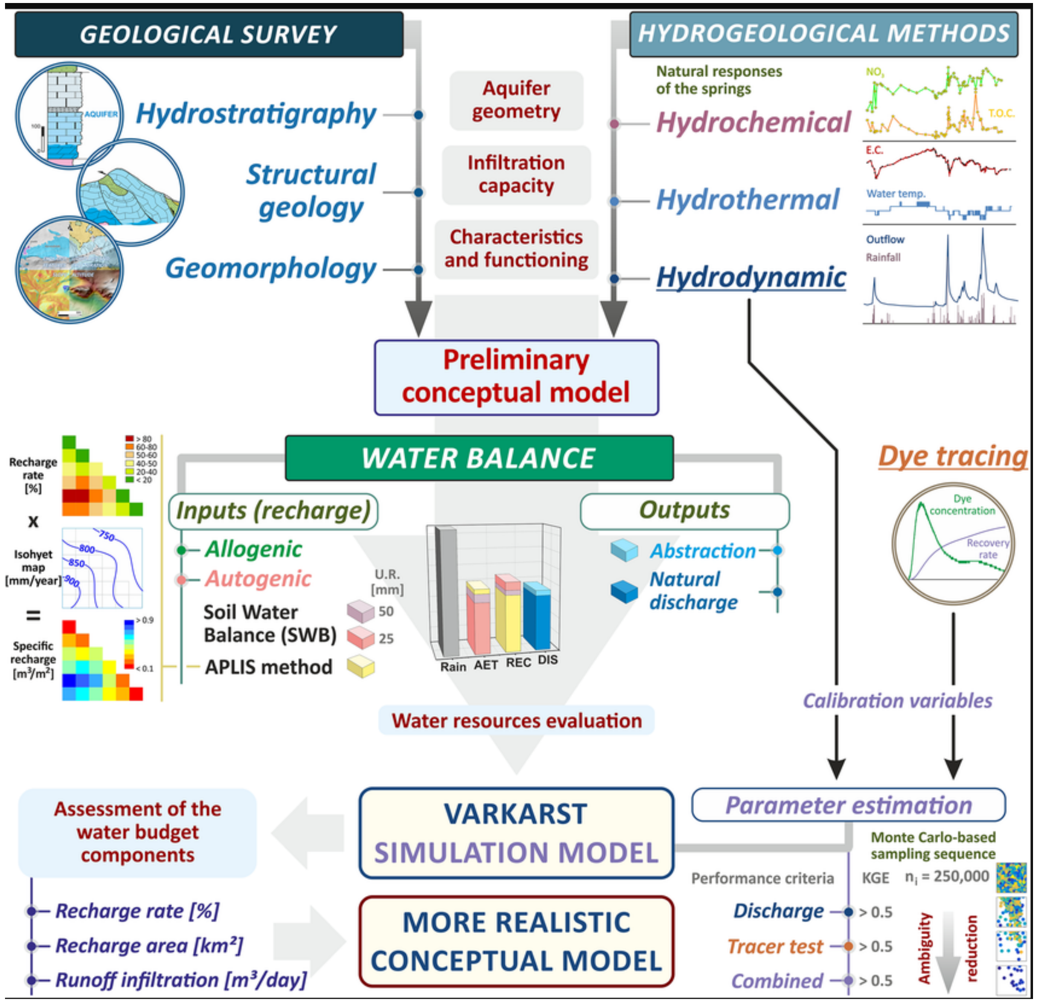
Example Supporting Materials



https://cms.media.wilo.com/cdndoc/wilo497061/5797295/wilo497061.pdf



Review of Optimal Selection of Turbines for Hydroelectric Projects - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Turbine-selection-chart-based-on-head-and-flow-rate-1_fig2_292726939 [accessed 16 Sept 2024]



https://www.researchgate.net/profile/Andreas-Hartmann-10/publication/330461973/figure/fig2/AS:11431281177716510@1690582747860/Schematic-representation-of-the-workflow-addressed-in-this-research-including-the.png

Project Development Schedule

- Describe the overall project development method, including the key project development activities and the proposed schedule for each activity.

- The description shall address cash flow for the project development.

- Details for equipment procurement and installation shall be addressed.

Equipment Procurement and Installation

- Describe the availability of the equipment required by the system.
- Describe the plan for site development and system installation, including any special equipment requirements.
- In all cases, the system or improvement shall be installed in conformance with manufacturer's specifications and design requirements, and comply with applicable laws, regulations, agreements, permits, codes, and standards.

Operations and Maintenance

- Describe financial performance of the proposed project, including simple payback estimation.

- The description addresses the project costs and revenues, such as applicable investment and production incentive and other information to allow the assessment of the project’s cost effectiveness.

Q&A

For REAP

Evaluating Proposals

Things to Look For…there are some significant hydropower challenges

- **Technology Costs and Performance:** High costs associated with powertrain technology, civil works, and project deployment for the remaining U.S. hydropower resources reduce the cost-competitiveness of new hydropower projects. This results in barriers to upgrades and retrofits at existing facilities, the development of new stream reach and conduit generation, non-powered dams, and new pumped storage capacity. In addition, the development of cost-effective, high-performing new hydropower technologies, particularly for low-head applications, is limited by the lack of permitted, full-scale test facilities.
- **Environmental Impacts:** Legitimate environmental concerns associated with impacts of construction and operation of hydropower projects must be addressed and mitigated to ensure long-term sustainable operation of new and existing hydropower and pumped storage facilities.
- **Regulatory & Market Structures:** Uncertain regulatory timeframes and complexities result in higher costs to developers and increases uncertainty for project financing, which reduces the market competitiveness of hydropower and PSH. Additionally, current market structures do not properly recognize, value or compensate grid services provided by hydropower and PSH.
- **Awareness & Perception:** Stakeholders (i.e., investors, general public, policy makers, NGOs, resource agencies, owners/developers, and others) are, in some cases, not adequately informed and/or have misconceptions about the state of the industry, technological advances, and opportunities for new approaches to hydropower development. This can impact, among many things, hydropower-related energy policy at local, state and federal levels, public support for new projects, hydropower as a career choice, and willingness to invest in both research and project development .

Things to Look For in Proposals…

Procurement:
- What stage of the procurement are they in?
- Is there a schedule for procurement?

Engineering:
- Is there a feasibility report?
- Has the site been selected?
- Are there any preliminary designs for the asset?
- Is there a schedule for design & construction?
- Are there any specifications for the asset?

Environmental:
- Has there been any communication with the Government agencies?
- Has there been an environmental impact assessment (EIA)?
- Has there been a geological assessment of the site? Are the site conditions known?
- Have any permits been submitted?

Are the following categories addressed or mentioned to some extent:

- Data Review and Assessment
- Hydrological Studies
- Site Reconnaissance
- Topographic Mapping
- Conceptual Layouts and Cost Estimates
- Hydrology
- Geotechnical Assessment
- Regional Geology
- Site Access Conditions
- Construction Materials
- Seismicity
- Geotechnical Design Issues
- Preliminary Layouts and Site Locations