



U.S. Hydropower Market Report Update (September 2021)

Megan Johnson
Rocío Uría-Martínez

Oak Ridge National Laboratory



These slides provide updates to some of the key metrics included in the [Hydropower Market Report \(January 2021 edition\)](#). The Hydropower Market Report aims to continuously improve publicly available, comprehensive information on the U.S. hydropower fleet and the industry that supports it and develops new projects.

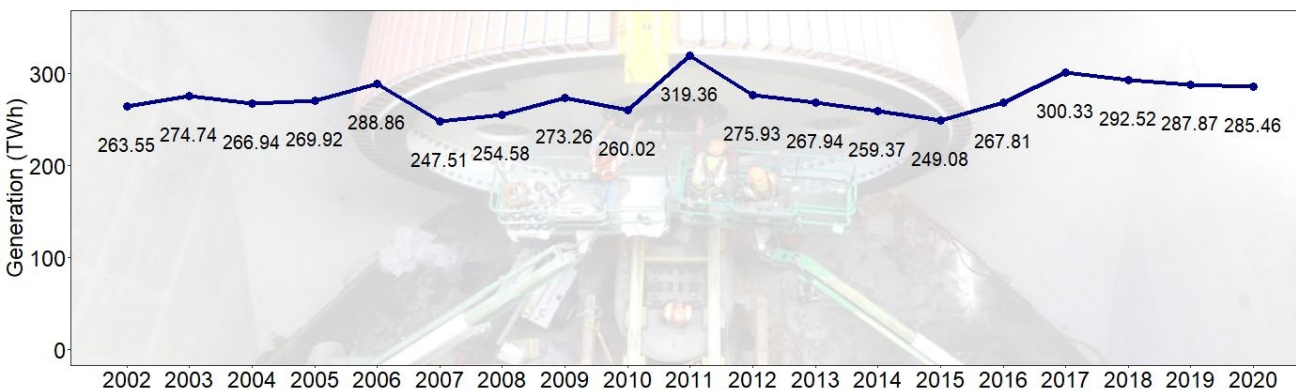
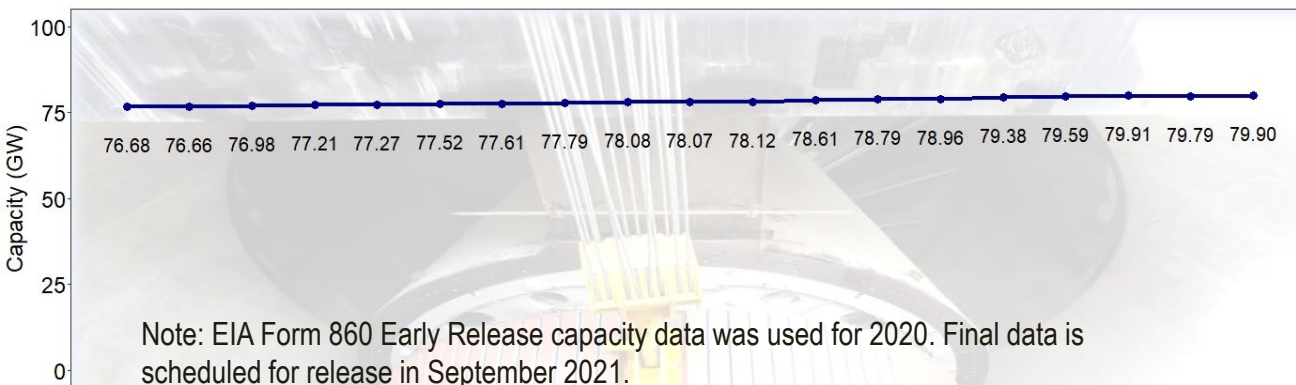
The updated content shown here covers the following topics:

- Installed capacity and generation trends
- Regional generation and drought trends
- Investment on rehabilitations and upgrades to the existing hydropower fleet
- December 31, 2020 snapshots of the hydropower and pumped storage hydropower project development pipeline
- Hydraulic turbine import and export trends
- Any changes to relevant policies and/or markets

The last year of data shown in each of the plots will be 2020 (with the exception of slide 4 which includes some preliminary 2021 data).

This work has been funded by the Water Power Technologies Office, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC05-00OR22725. Any errors in this document are the sole responsibility of the authors.

U.S. hydropower capacity remained stable in 2020; hydropower generation decreased for the third year in a row.



Sources: EIA Form 860 (capacity), EIA Form 923 (generation), Electric Power Monthly (2020 generation)

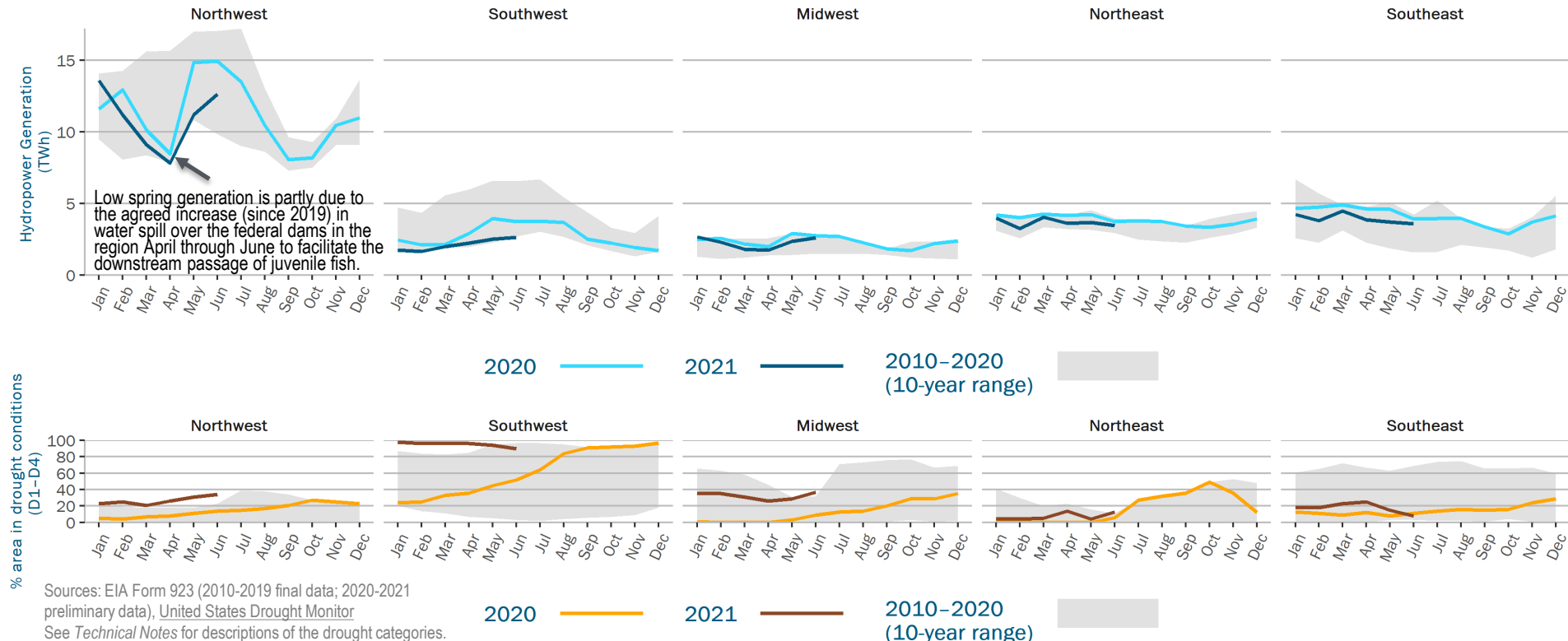
Installed capacity increased by ~100 MW in 2020 mostly due to capacity additions.

- Over 90 MW were retired or derated
- 10 plants had capacity additions or uprates, including Wanapum's last refurbished unit (122 MW)
- 6 new projects came online:
 - 4 qualifying conduits and 1 licensed project all under 1 MW (not reported in EIA)
 - 26.7 MW RC Thomas Hydroelectric Project (also known as Lake Livingston) in Texas

Hydroelectric generation in 2020 was 285.46 TWh (less than 1% decrease relative to 2019).

- Hydropower generation accounted for 36.7% of renewable electricity generation and 7.3% of total electricity generation (U.S. electricity generation decreased 3% in 2020 relative to 2019).

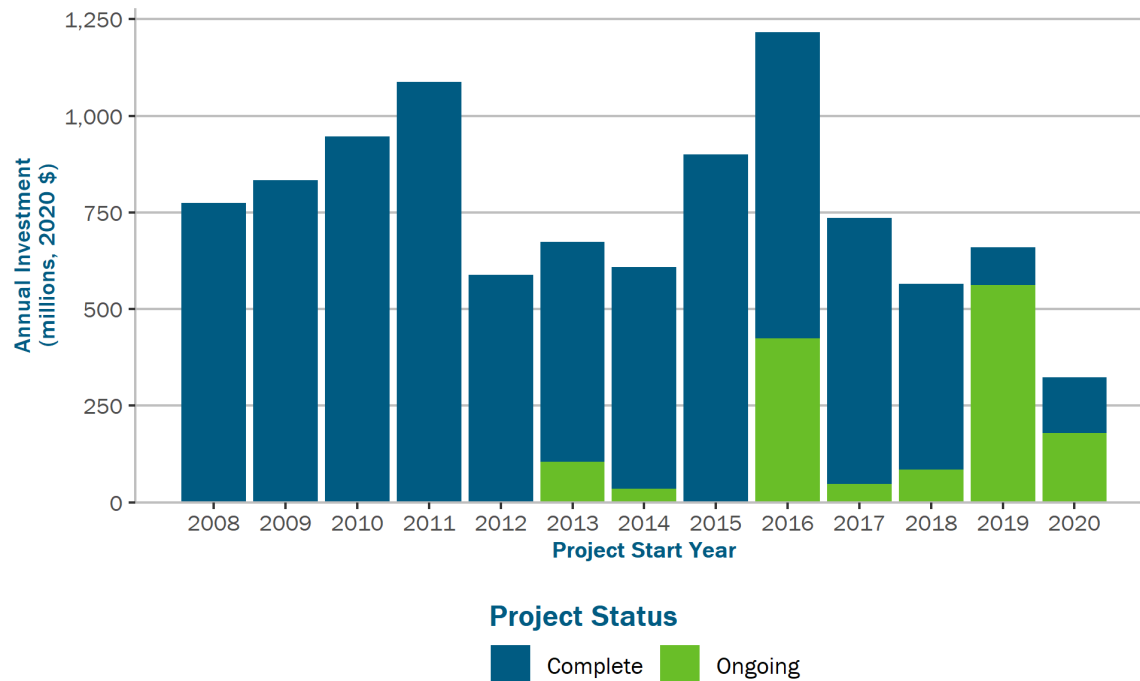
Widespread and severe drought in the Southwest has driven 2020–2021 hydropower generation in that region to the lower end of the 2010–2020 range; hydropower output in the eastern half of the country is toward the high end of the 10-year range.



- Both the Northwest and the Southwest have the largest percentage of their area under drought since at least 2010; however, the drought is more extended and acute in the Southwest (90% of area under drought of which 39% is in the D4 “exceptional drought” category in June 2021) than the Northwest (34% of area under drought, 0% in D4 category) which explains why hydropower output has only dropped to the lower end of the 10-year range in the Southwest.
- In the rest of the country, the percentage of area under drought conditions has increased in 2021 relative to 2020 but it remains below 40% and most of that area is on the less severe drought categories (D1, D2).



New investment committed to hydropower rehabilitations and upgrades (R&U) in 2020 was less than half the investment in 2019 and lowest in more than one decade.



Source: Industrial Info Resources

Note: This plot provides a December 2020 snapshot of completed or ongoing R&U projects started since 2008.

See *Technical Notes* for further details about the data shown in this plot.

- 28 new R&U projects at 20 hydropower plants started in 2020 with a total estimated value of \$323 million
 - Less than half of the projects involved refurbishments or upgrades to turbine-generator units.
 - Robert H. Moses project, a controls upgrade (digitalization), accounted for more than a third of the investment dollars in 2020.

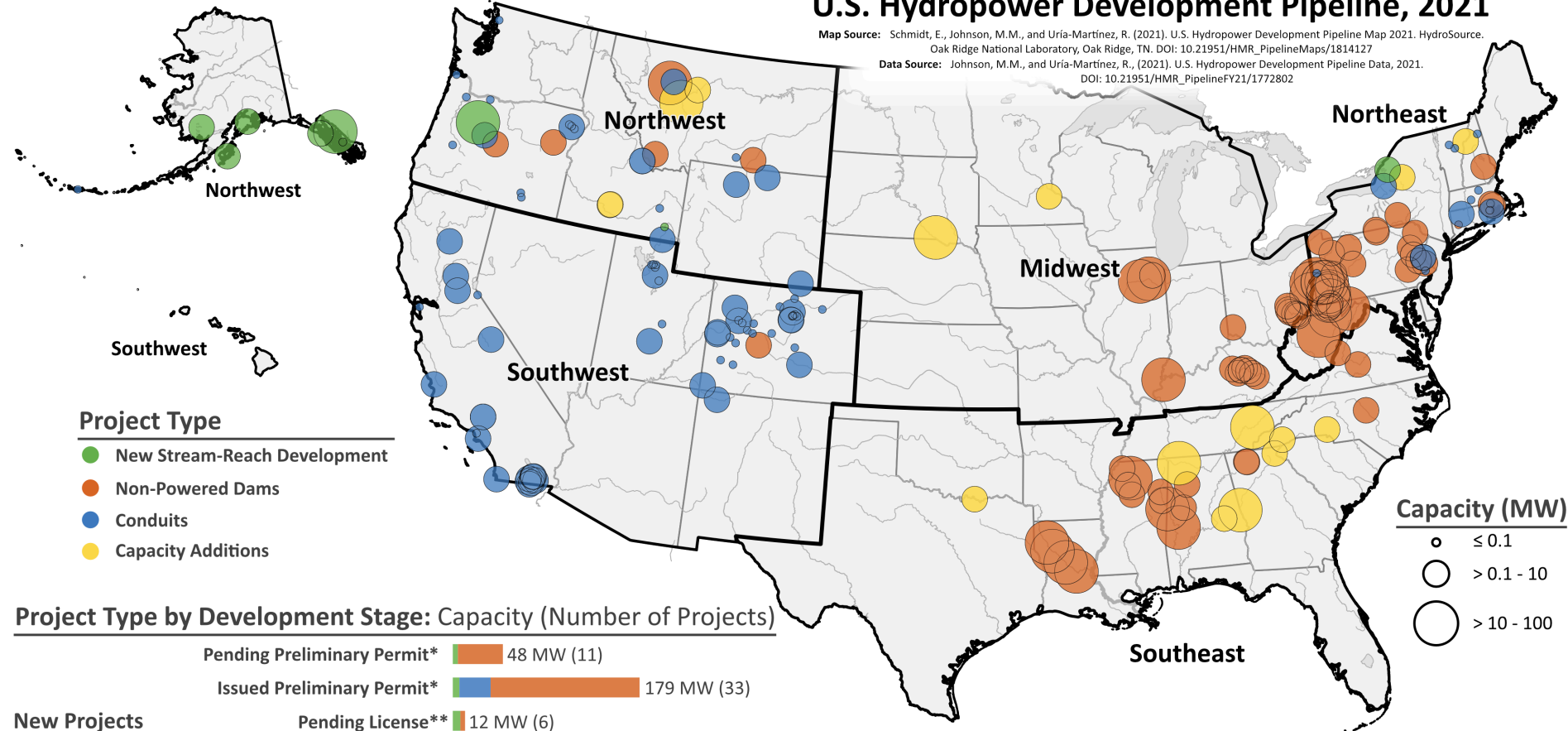
- Distribution of 2020 new investment by owner type:
 - Federal: 71% of new projects (20) accounting for 35.5% of investment
 - Public, non-federal: 17.8% of new projects accounting for 51.1% of investment
 - Privately-owned: 10.7% of new projects (3) accounting for 13.3% of investment

- The value of tracked R&U investment since 2008 is over \$9.5 billion distributed among 190 hydropower facilities.
 - Value by region: Northwest (33.8%), Southwest (12.9%), Midwest (15.7%), Northeast (12.8%), Southeast (24.8%)

At the end of 2020, 198 new hydropower projects with a combined capacity of 863 MW were in the U.S. hydropower development pipeline; additionally, 16 ongoing upgrade projects would add 176 MW to the existing fleet.

U.S. Hydropower Development Pipeline, 2021

Map Source: Schmidt, E., Johnson, M.M., and Uriá-Martínez, R. (2021). U.S. Hydropower Development Pipeline Map 2021. HydroSource. Oak Ridge National Laboratory, Oak Ridge, TN. DOI: 10.21951/HMR_PipelineMaps/1814127
Data Source: Johnson, M.M., and Uriá-Martínez, R., (2021). U.S. Hydropower Development Pipeline Data, 2021. DOI: 10.21951/HMR_PipelineFY21/1772802



Project Type

- New Stream-Reach Development
- Non-Powered Dams
- Conduits
- Capacity Additions

Capacity (MW)

- ≤ 0.1
- > 0.1 - 10
- > 10 - 100

Project Type by Development Stage: Capacity (Number of Projects)

Pending Preliminary Permit* ■ 48 MW (11)

Issued Preliminary Permit* ■ ■ 179 MW (33)

Pending License** ■ ■ 12 MW (6)

Issued License** ■ ■ ■ 612 MW (130)

Under Construction ■ 12 MW (2)

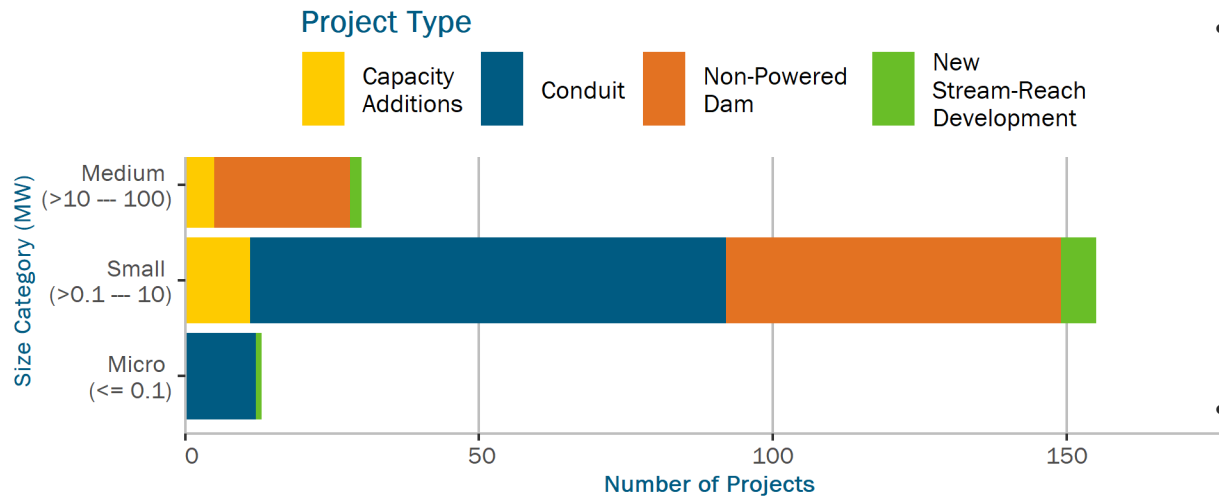
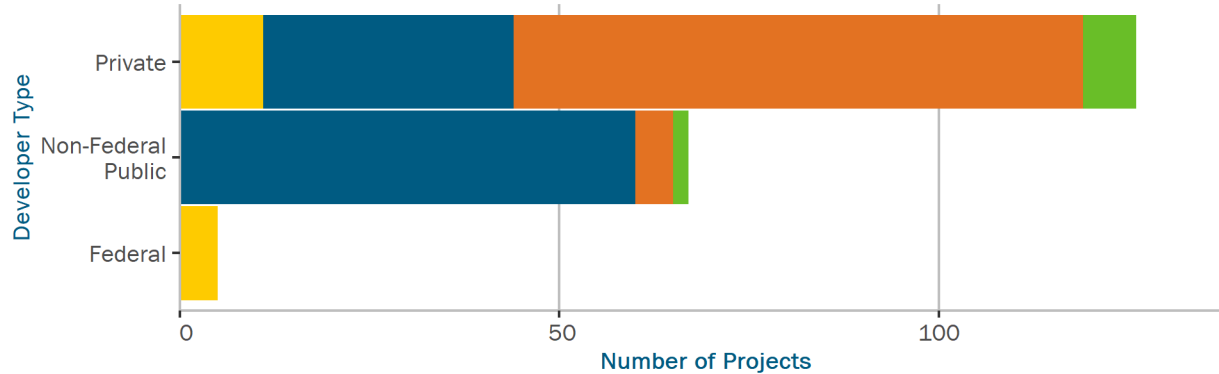
Planning ■ 157 MW (10)

Under Construction ■ 19 MW (6)

*Projects in the Pending Preliminary Permit and Issued Preliminary Permit stages are undergoing feasibility studies and have high attrition rates.

**Pending License includes projects that have applied for authorization from FERC (license, FERC exemption, or "qualifying conduit" status) or Bureau of Reclamation. Issued License includes projects that have received those authorizations.

Over 87% of projects in the development pipeline would add hydropower to existing conduits or non-powered dams; 78% of projects are small (≤ 10 MW) and none are large (> 100 MW).



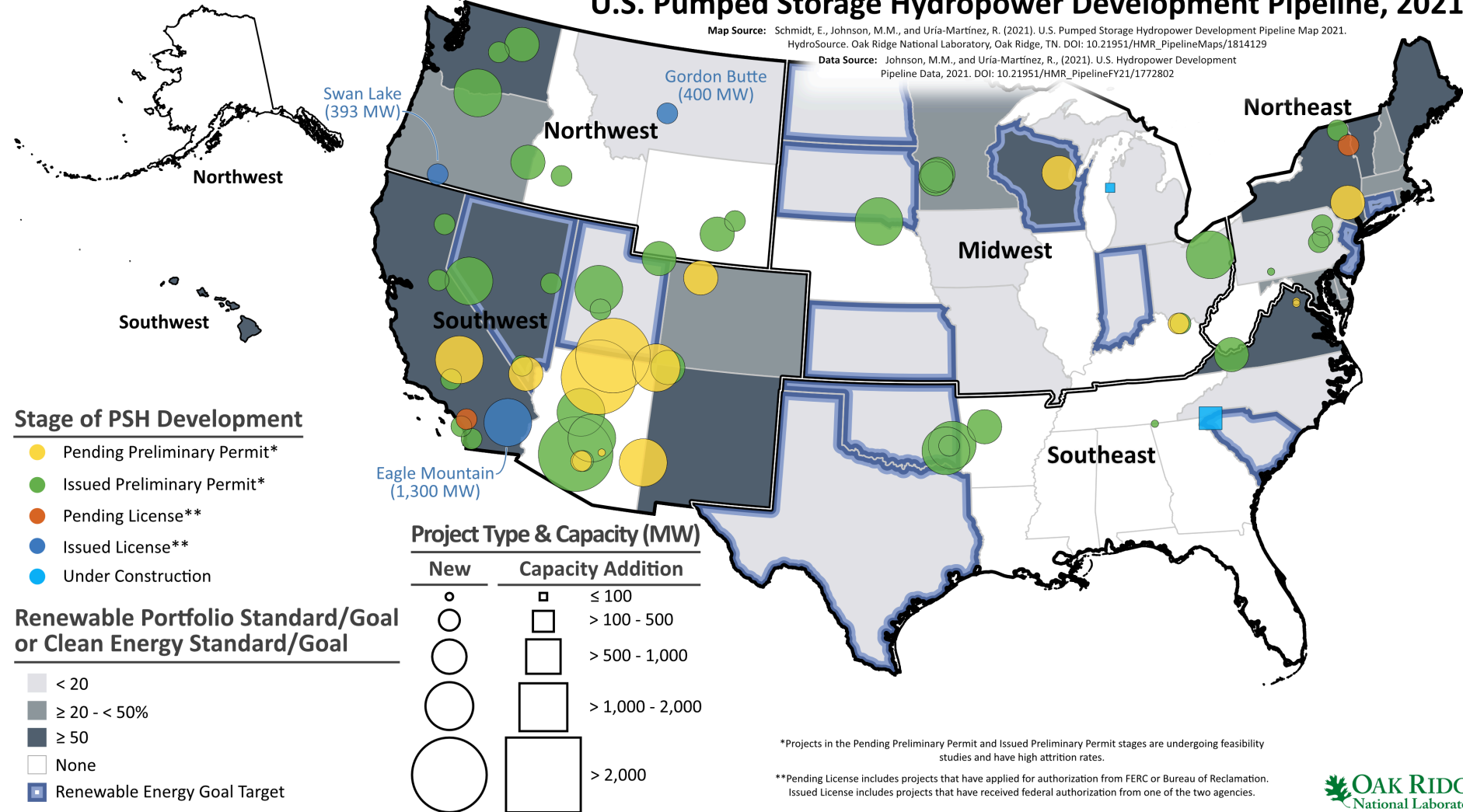
- Over 86% of the proposed conduit projects are 'qualifying conduit' determinations (instead of a FERC exemption/license or LOPP project)
 - Until October 2018, 5 MW was the capacity limit for non-federal conduits to apply for "qualifying conduit" determination (instead of a FERC exemption); the America's Water Infrastructure Act of 2018 increased that size limit to 40 MW.
- Private developers account for 64% of projects and 83% of proposed capacity
 - Non-Federal public entities carry out much of the 'qualifying conduit' development because they typically own the irrigation and water supply infrastructure retrofitted in that type of project
- All federal projects are for capacity additions at existing facilities.
 - However, 32.5% of new projects propose adding hydropower generation capability to federal dams.

Sources: U.S. Hydropower Development Pipeline Data and Metadata, 2021, DOI: 10.21951/HMR_PipelineFY21/1772802

At the end of 2020, 63 new pumped storage hydropower projects were in the U.S. development pipeline and 3 of them already have a FERC license. Additionally, two ongoing upgrades to existing projects will add 250 MW to the existing fleet.

U.S. Pumped Storage Hydropower Development Pipeline, 2021

Map Source: Schmidt, E., Johnson, M.M., and Uriá-Martínez, R. (2021). U.S. Pumped Storage Hydropower Development Pipeline Map 2021. HydroSource. Oak Ridge National Laboratory, Oak Ridge, TN. DOI: 10.21951/HMR_PipelineMaps/1814129
Data Source: Johnson, M.M., and Uriá-Martínez, R. (2021). U.S. Hydropower Development Pipeline Data, 2021. DOI: 10.21951/HMR_PipelineFY21/1772802



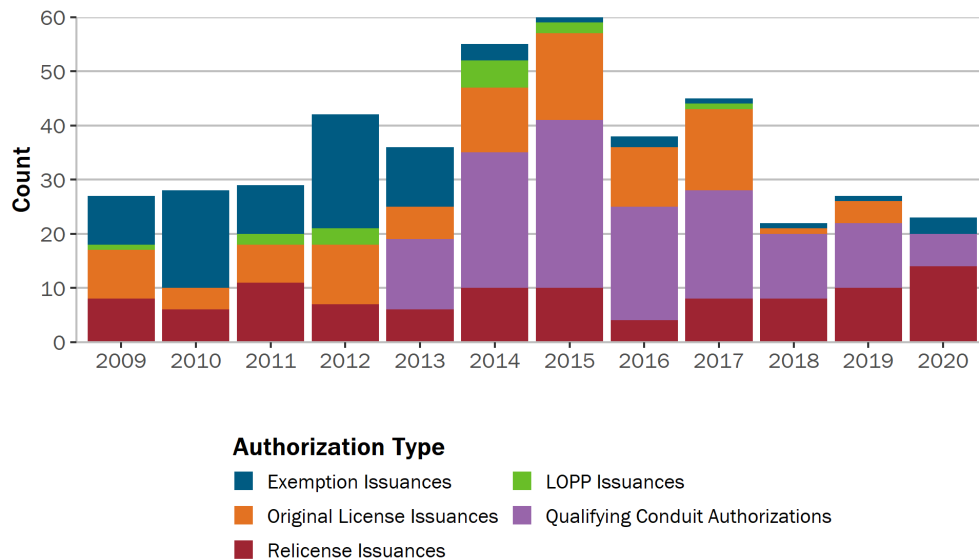
*Projects in the Pending Preliminary Permit and Issued Preliminary Permit stages are undergoing feasibility studies and have high attrition rates.

**Pending License includes projects that have applied for authorization from FERC or Bureau of Reclamation. Issued License includes projects that have received federal authorization from one of the two agencies.

If the three licensed new PSH projects move to construction, they would increase installed U.S. PSH capacity by ~10% (2.1GW); the combined capacity of all proposed PSH projects (46.7 GW) more than doubles the capacity of the existing fleet.

- The three projects that already have a FERC license are all closed-loop (i.e., not continuously connected to a naturally flowing water feature) and are designed to provide 8–9 hours of continuous storage duration each.
- The developers of the Goldendale Energy Storage Project (Washington, 1,200 MW) submitted a license application to FERC in June 2020.
 - By December 2020, FERC was still requesting additional information to resolve deficiencies in the application; for that reason, it does not yet show up as a pending license in the December 2020 snapshot map.
- Proposed new projects display a wide range of sizes (20 MW–3,600 MW)
 - The 8 proposed projects with capacities < 100 MW are all in the Northeast and Southeast regions
 - 12 of the 18 proposed projects with capacities ≥ 1,000 MW are in four Southwestern states (Arizona, California, Nevada, Utah)
- Over 90% of proposed new PSH projects are pursued by private developers (typically LLCs)
 - Only 1 project (Tazewell in Virginia) has an investor-owned utility as the developer
 - Investor-owned utilities tend to expand the capacity of their existing PSH assets instead of developing new ones: the two ongoing capacity upgrade projects (Ludington in Michigan and Bad Creek in South Carolina) belong to investor-owned utilities.

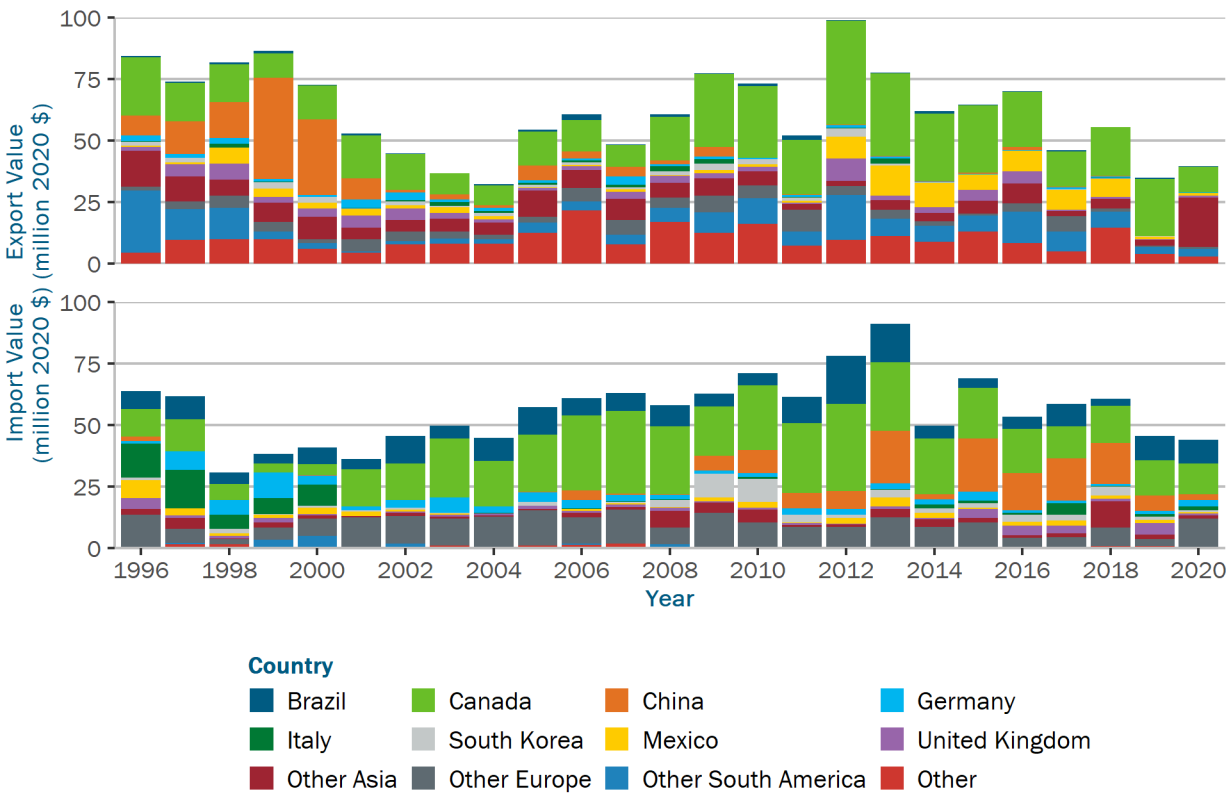
The number of hydropower projects that received a relicense from FERC in 2020 was the highest in the last decade; the number of authorizations for new projects was the lowest since at least 2009.



Sources: U.S. Hydropower Development Pipeline Data and Metadata, 2021, DOI: 10.21951/HMR_PipelineFY21/1772802
 Note: Licenses and exemptions that have been terminated post-issuance are also included in this plot.

- 23 hydropower projects were issued authorizations in the U.S. in 2020:
 - FERC issued 14 relicenses and 3 exemptions.
 - 6 projects obtained “qualifying conduit” determination from FERC.
 - Bureau of Reclamation issued no new leases of power privilege (LOPPs).
- For the first time in over a decade FERC did not issue any original licenses.
- Total new capacity authorized from 2009 to 2020 (excluding capacity additions approved through license amendments) was 3.1 GW.
 - The 9 conduit projects authorized in 2020 have a combined capacity of only 2.48 MW.
 - In 2019, over 400 MW were authorized, 393 MW is the authorization of Swan Lake pumped storage hydropower project.
- The number of relicense applications in 2020 was the highest in the last decade.
 - 25 relicense applications were submitted and one original license application

U.S. hydraulic turbine import and export values were low in 2019 and 2020 relative to the previous decade.



Source: USITC Interactive Tariff and Trade Data
See *Technical Notes* for country selection criterion

- Hydraulic turbines and turbine parts are the only hydropower equipment component for which international transactions can be tracked from USITC data.
- Total export value in 2020 was ~\$40 million, a 14% increase from 2019 but was ~36% below the 2010–2020 average.
- Total import value in 2020 (\$43.9 million) decreased by 3.5% relative to the previous year and was 29% below the 2010–2020 average.
- 2020 U.S. exports to Canada and Mexico were the lowest they have been in the last decade but the highest for some “Other Asia” countries like Indonesia and Papua New Guinea.
- Canada continues to be a significant exporter (29% in 2020) of turbines and turbine parts to the U.S., followed by Brazil and several European countries.

- The Energy Act of 2020 (Pub. L. 116-260) expanded the definition of “qualified hydroelectric facilities” that can benefit from the [Section 242 Hydroelectric Production Incentive Program](#)
 - Old definition: hydropower turbine owned and operated by non-federal entity added to an existing dam or conduit
 - New definition also includes hydropower turbines owned and operated by non-federal entity with up to 20 MW of capacity constructed in areas in which there is “inadequate electricity service”
 - Adequacy of electricity service criteria include degree of access to the grid, frequency of electric outages, and affordability of electricity.
- Several policy goals and legislative proposals under discussion could encourage hydropower investments
 - The Biden administration announced the goal to transition to a 100% carbon pollution-free power sector by 2035
 - The goal is part of the 2021 Nationally Determined Contribution (NDC) that outlines U.S. plans to achieve the purpose of the Paris Agreement.
 - The Infrastructure Investment and Jobs Act (H.R. 3864) [passed in the Senate] contains multiple provisions to fund R&U in the existing hydropower fleet
 - Proposals being considered as part of the budget reconciliation package:
 - A 30% tax credit for energy storage including pumped storage hydropower
 - A 10-year extension of the production tax credit for new hydropower from efficiency improvements and non-powered dam or conduit retrofits
 - The tax credit for hydropower would continue to be half as much as for other renewables
 - A Clean Electric Performance Program would require electric suppliers to increase the amount of clean energy distributed to customers by 4% per year from 2023 to 2030.
 - Electric suppliers would receive grants if they met the annual targets and owe penalties if they did not.
 - The Twenty-First Century Dams Act [introduced in the Senate (S.2356) and in the House (H.R. 4375)] calls for \$25.8 billion investment to enhance the safety, grid resilience benefits and power generation capacity of America’s dams.

- Installed U.S. hydropower capacity increased by ~100 MW in 2020 with most of the increase originating in capacity increases at existing facilities.
- Despite slight declines for 3 years in a row mostly driven by worsening drought conditions in the West, U.S. hydropower generation in 2020 (285.46 TWh) was 2.7% above the 2010–2020 average.
- Hydropower generation accounted for 36.7% of renewable electricity generation and 7.3% of total electricity generation in 2020.
- U.S. hydropower rehabilitation and upgrade (R&U) projects with an estimated value of \$323 million started in 2020 (this is the lowest tracked amount of new R&U investments in more than a decade).
- The project pipeline at the end of 2020 shows continued strong interest in development of new hydropower and PSH projects
 - Most projects are either retrofits of existing non-powered dams (80 projects; 767 MW) or conduits (93 projects; 41 MW), or closed-loop pumped storage facilities (48 projects; 34 GW)
 - 130 hydropower projects and 3 PSH projects already have FERC authorization.
- In 2020, most of FERC’s permitting activity concentrated on the relicensing of existing hydropower facilities (25 relicense applications submitted; 14 relicenses issued)
- The value of U.S. imports and exports of turbine and turbine parts in 2019 and 2020 has been the lowest in more than a decade
 - U.S. 2020 imports originated primarily in Canada, Brazil, and several European countries; U.S 2020 exports had Canada and several Asian countries as the main destinations.

Slide 4:

- The U.S. Drought Monitor considers the following drought categories:
 - D0: abnormally dry
 - D1: moderate drought
 - D2: severe drought
 - D3: extreme drought
 - D4: exceptional drought
- Detailed explanations of the metrics associated with each category and the types of impacts associated with them are available at <https://droughtmonitor.unl.edu/About/WhatistheUSDM.aspx>

Slide 5:

- The full value of each project is assigned to the project start year. The green portions of the bars in slide 5 correspond to projects that have not yet been completed as of December 2018.
- Minimum total investment value of projects tracked by Industrial Info Resources (IIR) is \$1 million.
- Updates to project value or completion date can also result in changes in the total estimated value for a given year from one snapshot to the next.
- The value of refurbishment and upgrade projects started before 2007 is not reported due to the finding that IIR PECWeb Dashboard queries produce incomplete results for projects completed earlier than that year.

Slide 11:

- The 8 individual countries shown in the plot correspond to the 8 countries with the largest total trade flows (imports or exports) over 1996–2018.

*For further inquiries about the content of these slides, please contact the authors:
Megan M. Johnson (johnsonmm@ornl.gov) and Rocío Uría-Martínez (uriamartiner@ornl.gov).*