U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

WIND AND WATER POWER TECHNOLOGIES OFFICE

2014 Hydropower Market Report Highlights

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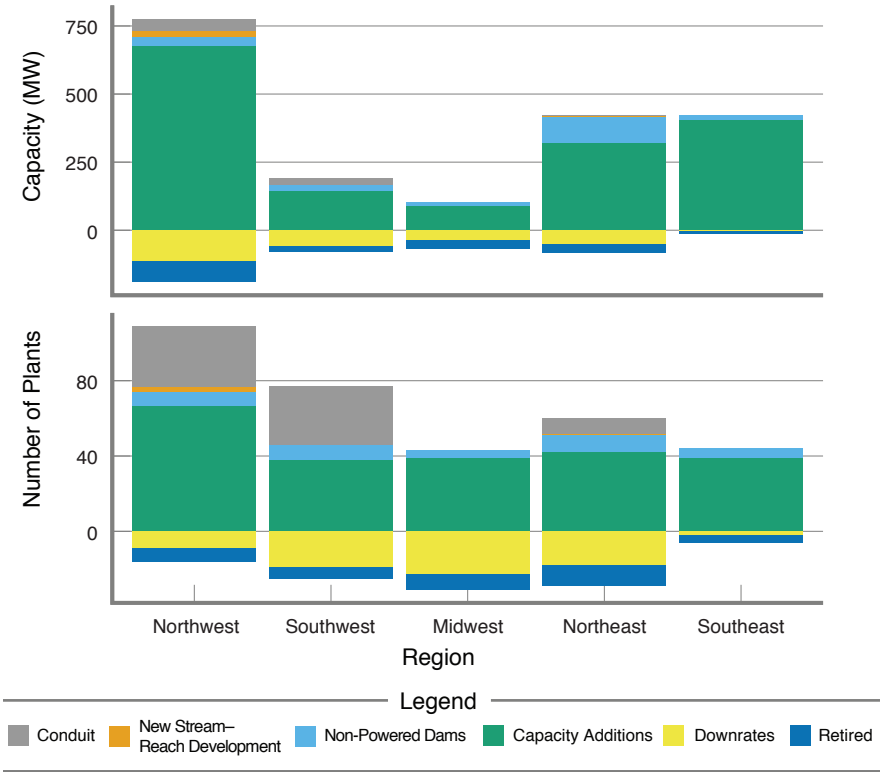
The U.S. hydropower fleet has provided clean, reliable power for more than a hundred years, and remains the largest source of renewable electricity in the United States, allowing the nation to avoid 200 million metric tons of carbon emissions each year. However, no systematic documentation exists of the U.S. fleet and the trends influencing it in recent years. The 2014 Hydropower Market Report provides industry, policymakers, and other interested stakeholders with important data and information on the distribution, characteristics and trends of the hydropower industry in the United States. Download a copy of the report by visiting energy.gov/hydropowerreport.

Recent Growth in U.S. Hydropower

Overall, the size of the U.S. hydropower fleet has grown over the last decade as owners optimize and upgrade existing assets, and some new projects are constructed. Hydropower currently accounts for roughly 7% of installed generation capacity (excluding pumped storage), enough to power more than 20 million U.S. homes. The U.S. hydropower fleet has a total capacity of 79.64 gigawatts (GW) and experienced a net capacity increase of 1.48 GW from 2005 to 2013. Hydropower growth was positive in every region of the country but was largest in the Northwest, where more than 580 megawatts (MW) were added. The majority of newly-constructed projects have been associated with existing water infrastructure, as the hydropower industry has continued to focus on "low-hanging fruit," developing non-powered dams (NPD) and conduits.



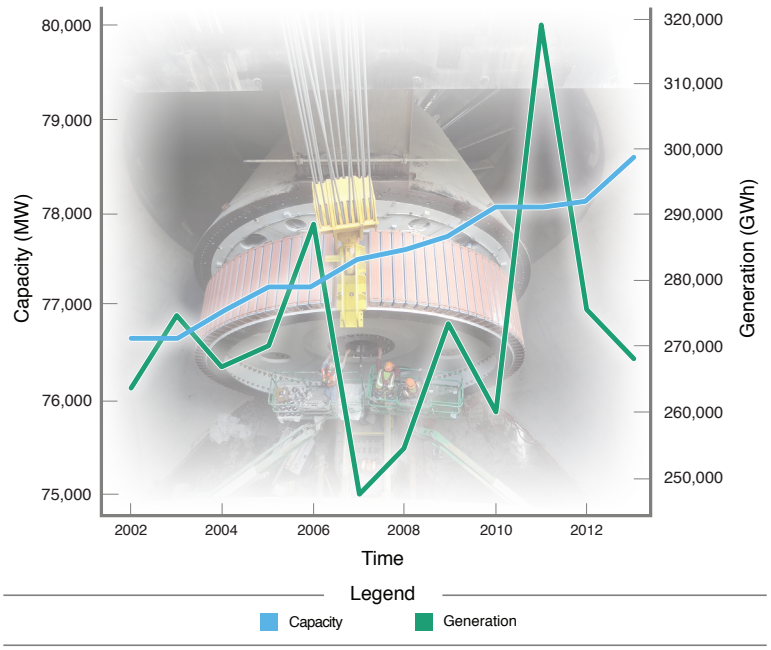
Recent Hydropower Capacity Changes by Region and Project Type (2005-2013). *Source EIA Form 860 and NHAAP.*

While installed capacity has continued to grow over time, hydropower generation experiences significant nationwide inter-annual variability due to the availability of water. Though the total electricity generated from hydropower varies from year to year, there are relatively predictable patterns in the geographical and seasonal distribution of annual generation as outlined in the report.

Top 20 States by Installed Hydropower Capacity and Hydropower Percentage of In-State Generation

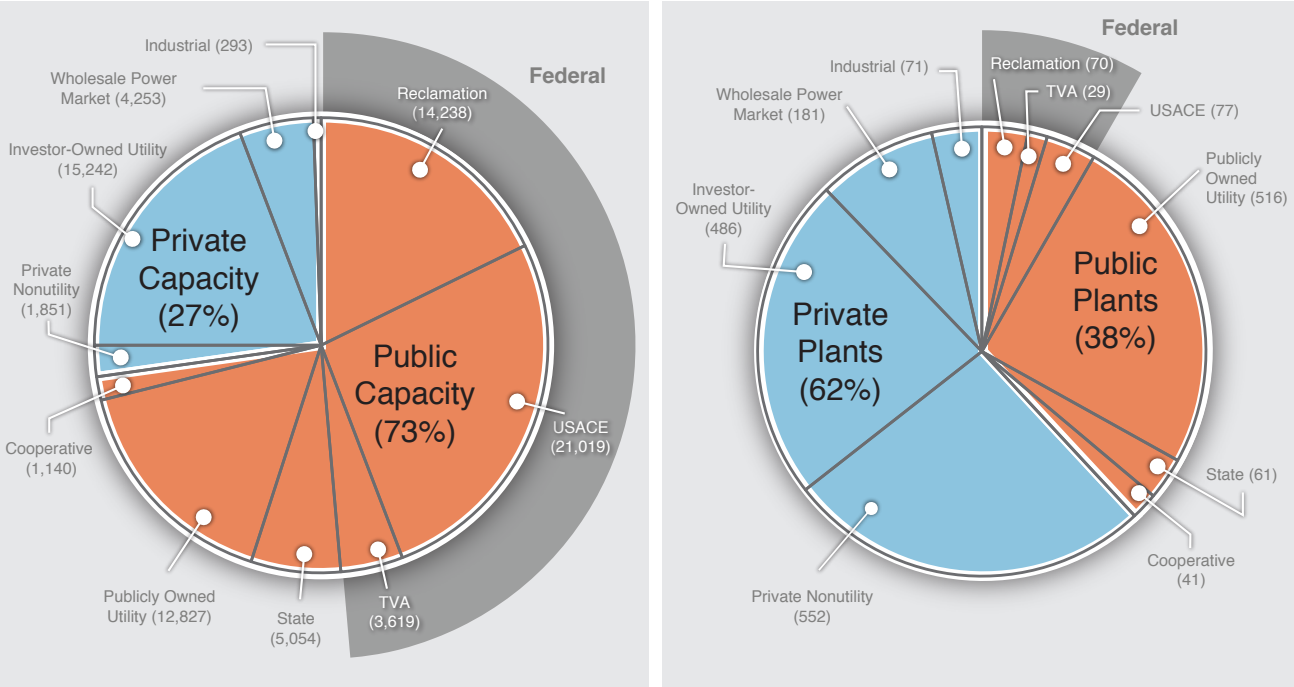
Hydropower Capacity (MW)		Hydropower Percentage of In-State Generation (%)	
Cumulative (end of 2014)		Average (2011-2013)	
WA	21,303	WA	74.89
CA	10,334	ID	68.98
OR	8,335	OR	63.60
NY	4,673	SD	48.32
AL	3,109	MT	39.10
MT	2,638	ME	25.69
ID	2,568	AK	21.45
TN	2,499	NY	18.94
GA	2,241	VT	18.89
NV	2,096	CA	15.49
NC	1,904	TN	12.70
AZ	1,679	NH	7.30
SD	1,600	NV	7.05
SC	1,371	AZ	6.62
AR	1,321	ND	6.48
PA	882	AL	6.36
OK	807	MD	5.10
KY	805	AR	4.20
VA	786	NC	3.99
ME	723	NE	3.73
Rest of United States	723	Rest of United States	1.01
TOTAL	79,637	TOTAL	7.06

The top five states by installed hydropower capacity are Washington, California, Oregon, New York, and Alabama, and 11 states receive greater than 10% of their electricity from hydropower. A larger number of plants are owned privately, but publicly-owned plants tend to be larger in size, and make up 73% of all capacity. Additionally, not all public plants are federally-owned; in fact, about one quarter of the capacity in the country (or one-third of all the publically-owned capacity) is non-federal, and held by publically-owned utilities, states, and cooperatives.



Note: EIA data cover only a fraction of hydropower plants with nameplate capacity lower than 1 MW. The set of plants included in this figure accounts for approximately 98% of the total hydropower capacity estimated by NHAAP.

Annual Hydropower Capacity and Generation (2002-2013). *Source: EIA Form 860 and EIA Form 923.*



U.S. Hydropower Fleet Ownership Mix. *Source: NHAAP, EIP Form 861, FERC Market-Based Rated Contact List, and web searches.*

New Projects Under Development

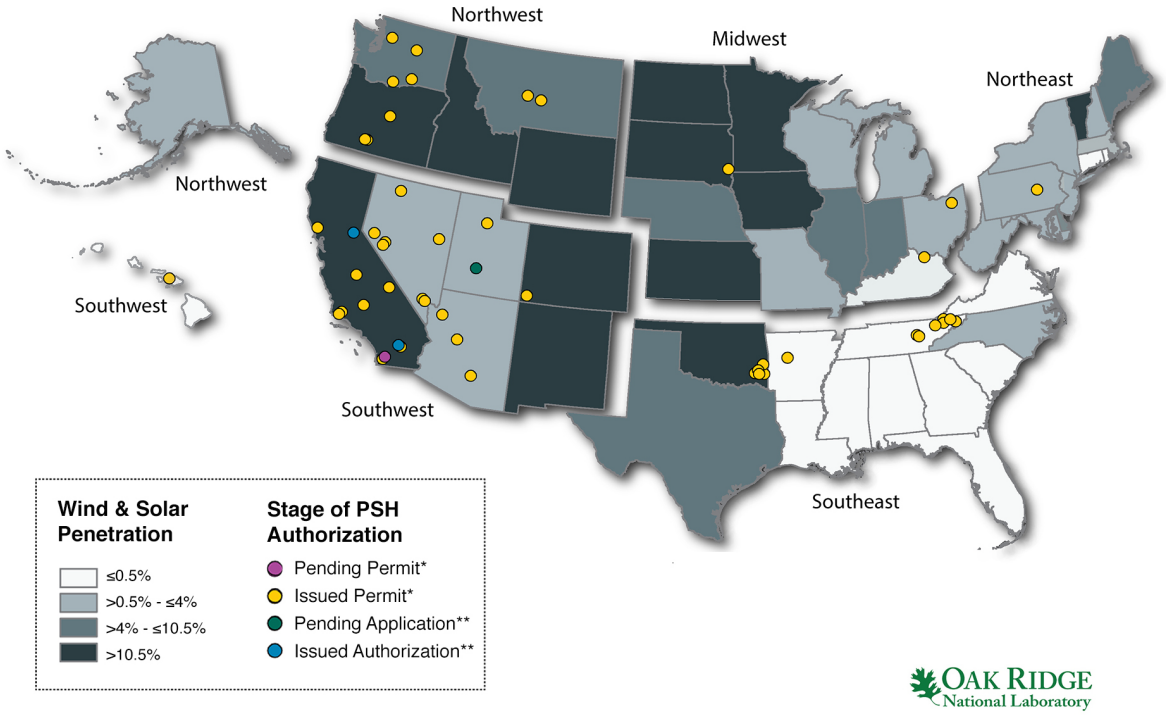
Development of non-powered dams (NPD) and conduits, along with dozens of new large-scale pumped storage hydropower (PSH) projects, dominate the current development pipeline (which includes projects in various stages of development, but which have not completed construction). The median project size in the development pipeline, regardless of modality (NPD, conduit, new stream-reach development [NSD]) is small (10 MW or less). Most conduit projects being pursued are located in the western half of the country, and NSD projects-those on previously undeveloped stream-reaches-are overwhelmingly concentrated in the Northwest, including Alaska. Also, the permitting and licensing process for many smaller hydropower projects has changed in recent years, which could result in less cost and time spent in federal permitting and continue to spur greater interest in development.

As of December 2014, there were 331 projects in the development pipeline, amounting to a total capacity of 4.37 GW. There are 407 MW of capacity currently under construction, with another 263 MW having received the necessary authorizations. It must be noted that the majority of projects in the development pipeline are in relatively early stages of the development process, having only begun to study project feasibility and apply for necessary authorizations. For any stage of development before construction begins, there is a nontrivial probability that the projects will be abandoned, though that likelihood decreases with each step of the process.

Hydropower Flexibility and Pumped Storage

Hydropower can be highly flexible and rapidly respond to fluctuations in the demand for electricity. Pumped storage hydropower (PSH) plants also are capable of providing a range of ancillary services to support the integration of variable renewables into the grid. The existing 21.6 GW of PSH capacity comprise the overwhelming majority (97%) of utility-scale electricity storage in the United States. Unlike the existing PSH fleet, largely built to complement baseload nuclear or thermal plants, one of the main reasons for new development of new PSH is that its flexibility makes it ideal for the integration of additional clean energy technologies.

This map lays out the 51 active PSH projects in the Federal Energy Regulatory Commission licensing process as of December 2014. The projects add up to 39 GW of total capacity and all are 150 MW or larger (the average size is 787 MW). In an attempt to explore the degree of correlation between the location of variable renewables and the location of proposed PSH projects, the map displays a base layer showing the fraction of total installed generating capacity in each state that is attributed to wind or solar (as reported in EIA Form 860).

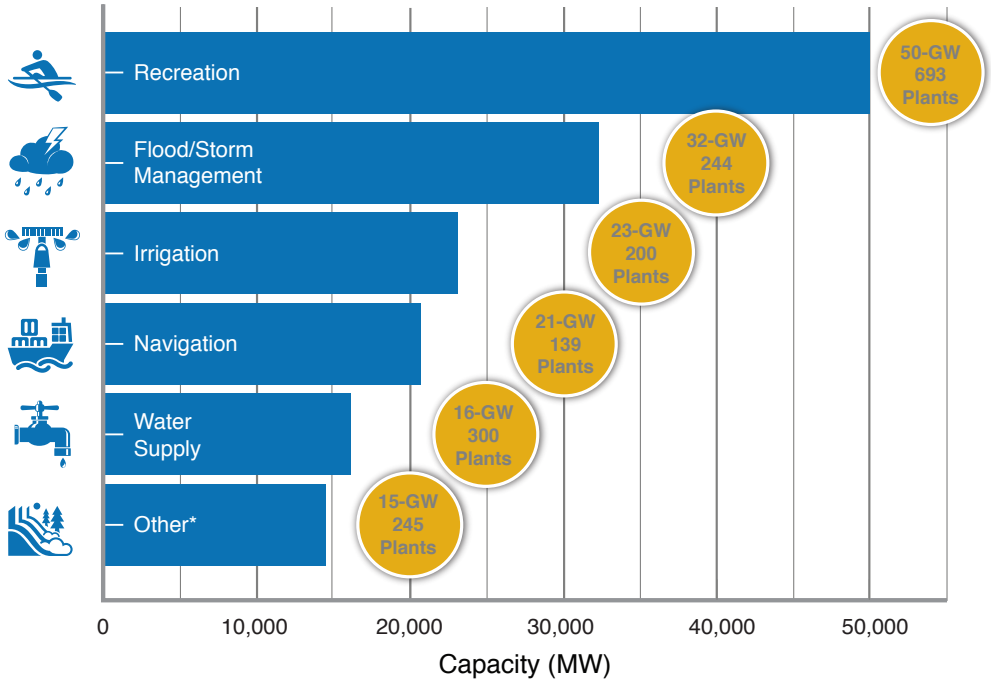


Note: This map displays the location and development status of proposed new pumped storage hydropower (PSH) projects in the United States in relation to the fraction of total generating capacity that is either wind or solar in each state. The point locations of PSH projects were derived by computing county centroids. Please note: some points overlap due to county level aggregation.

*Projects on the *Pending Permit* and *Issued Permit* stages have high attrition rates.

***Pending Application* includes projects that have applied for an original FERC license. *Issued Authorization* includes projects that have been issued an original FERC license.

Pumped Storage Hydropower Project Development Pipeline by Region and Status in Relation to State-Level Penetration or Variable Renewables (as of December 31, 2014). *Source: FERC.*



*The "Other" category primarily includes fish and wildlife ponds, fire protection, stock or small farm ponds, debris control, and tailings (i.e., storage/receipt of waste rock from mining operations).

Distribution of Additional Purposes on Existing Hydropower Plants with Dams. *Source: NHAAP.*

Multiple Uses Associated with Hydropower

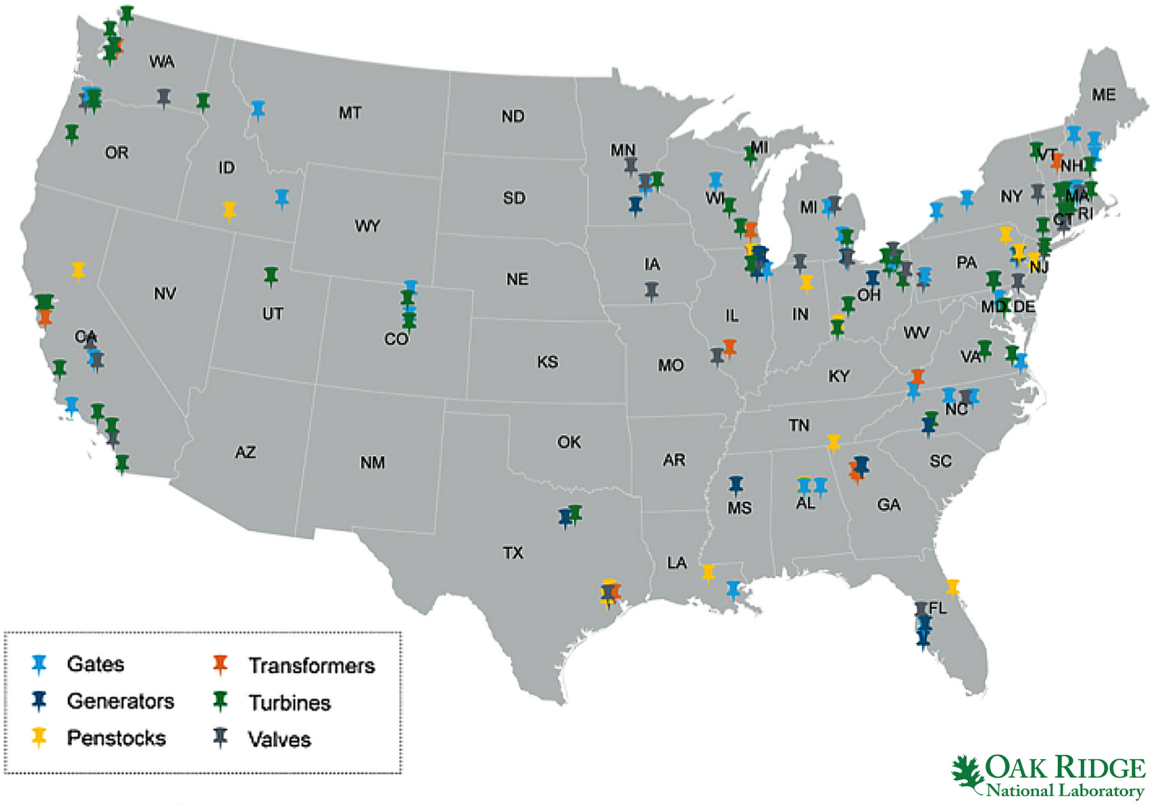
Hydropower projects support more than just the electrical grid: most installed hydropower capacity is connected to reservoirs that also provide recreation, flood control, irrigation, navigation, and/or water supply. At least 84% of the hydropower fleet (by capacity) provides one or more of these additional benefits, and a single project can support multiple purposes in addition to hydropower generation.

Investing in Hydropower

Despite being one of the oldest sources of electricity generation, hydropower continues to grow and expand. The hydropower industry accounts for more than 55,000 direct jobs in the United States, while companies in the hydropower supply chain are active in 38 states. At least 172 companies have manufacturing facilities in the United States where they produce one or more of six major hydropower components (turbines, generators, transformers, penstocks, gates, and valves).

Throughout the past decade, at least $6 billion has been invested in refurbishments, replacements, and upgrades to U.S. hydropower plants. Capital investment has not only been made with the purpose of improving performance metrics but also to mitigate environmental impacts. However, the expiration of the financial incentive programs that many recent hydropower projects have used poses questions as to the effects on new project development and which financing mechanisms will be relied upon in the future.

By optimizing and upgrading existing assets, hydropower can continue to be an important source of flexible, cost-competitive, and carbon-free renewable energy.



Note: This map is not intended to include all hydropower supply chain participants but to provide insight on the location of domestic manufacturers for key hydropower electromechanical and civil equipment components. Those facilities labeled as "Turbines" can include turbines and any combination of generators, transformers, and/or gates. In other cases, the manufacturing facilities can produce any combination of generators, transformers, gates, valves, and/or penstocks.

U.S. Hydropower Domestic Manufacturing Map. *Source: Technology/Equipment Companies & Products Guide from HydroWorld Buyers Guide: http://buyersguide.hydroworld.com/c/technologyequipment.html, International Water Power & Dam Construction Contractors by Category: http://www.waterpowermagazine.com/contractors/, and U.S. Hydropower Industry Snapshot data gathered by the National Hydropower Association: http://www.hydro.org/why-hydro/available/industrysnapshot.*

Conclusions

Hydropower remains a major contributor to the U.S. power system, accounting for approximately 7% of installed generation capacity and—on average over the last three years—7.1% of generation (both exclusive of pumped storage). The existing fleet was constructed over the course of an entire century, and is very diverse in terms of location, size, ownership and operational modes. The fleet includes high-flexibility PSH and peaking hydropower plants, run-of-river facilities with capacity factors as high as 80%, and projects associated with large reservoirs where electricity generation is viewed as a complement to other authorized purposes. This first Hydropower Market Report attempts to document that diversity through discussion of a selected set of attributes in a comprehensive fashion, for the entire fleet.

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Front Cover Image

Smithland hydropower plant, KY

Top Back Image

Meldahl hydropower plant, KY

Bottom Back Image

Cannelton hydropower plant, KY

(Images courtesy of American Municipal Power)

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