A Review of the Impacts of Government on Hydroelectric Power Generation and Development

Table of Contents

Executive Summary

Hydropower, which is generated from flowing water spinning a turbine, provides about 6.3 percent of United States electricity, with a total installed capacity of 79.9 GW.[1] The United States has more than 80,000 dams but only about 2,400 of them generate power.[2] In a report for the Department of Energy (DOE) prepared by Oak Ridge National Lab (ORNL), it was estimated that there are approximately 12 GW of capacity available at United States non-powered dams (NPDs), and that the top 100 sites alone could generate 8 GW if developed.[3] That is considerable generating

[1] Oak Ridge National Laboratory. "2017 Hydropower Market Report." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/downloads/2017-hydropower-market-report.

[2] "Types of Hydropower Plants." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/types-hydropower-plants.

[3] "An Assessment of Energy Potential at Non-Powered Dams in the United States." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/downloads/assessment-energy-potential-non-powered-dams-united-states.

capacity for which the greatest cost to development, dam construction, has already occurred.

There is also considerable opportunity for small-scale development as most of the currently non-powered dams are small hydropower sites, those under 10 MW, with 2,446 MW untapped across 54,191 possible sites.[4]

This does not include the countless pipes, canals, and other fixtures that could also be retrofitted to generate power, as no national study of all water conduits has been conducted. Current small hydropower capacity in the United States comes from 1,640 plants that combined generate about 3,670 MW.[5]

- Government regulations are the primary barrier to the development of new hydropower capacity.

- State Renewable Portfolio Standards often do not give hydropower the same treatment as wind, solar, and other energy technologies.

- There are non-regulatory barriers to hydropower development, these include high cost-benefit to developing some sites, risk aversion of water managers to use their infrastructure for anything other than water delivery, the lack of mass produced or easily replicable systems, and construction costs.

- Humans have used waterpower for millennia, and over time this capability developed from grinding grain to generating electricity, as technology evolved and improved.

- The large dams of the early 20th century not only created large amounts of cheap power, they also revolutionized American agriculture with irrigation and flood control.

- When the Public Utilities Regulatory Policies Act was enacted, it created a brief boom in small hydropower development which new reform might be able to imitate.

---

[4] Kurt, Johnson, and Hadjerioua Boualem. "Small Hydropower in the United States." Oak Ridge National Lab, September 2015. https://info.ornl.gov/sites/publications/files/Pub56556.pdf.

[5] Kurt, Johnson, and Hadjerioua Boualem. "Small Hydropower in the United States." Oak Ridge National Lab, September 2015. https://info.ornl.gov/sites/publications/files/Pub56556.pdf.

- Hydropower is useful for the grid because it can be used as baseload power, or dispatched to meet peak demand.

- Federal tax policy does not treat hydropower as favorably as wind and solar.

Background

There are three broad categories of hydropower generation: impoundment, diversion, and pumped-storage.

Impoundment hydropower generation involves the use of a dam to store water in a reservoir. This water is released through a turbine, powering a generator and creating electricity.[6] This is the most widespread type of hydropower generation. At a mention of hydroelectricity, imagery of massive dams is evoked, the Hoover, Grand Coulee, Bonneville, and others, dispersed across the country, but especially out west. There is a certain expectation of size regarding dams. People tend to assume that these projects are exclusively large projects involving significant ecosystem disruption, and generating massive amounts of power. But, while some of the projects are these large-scale projects we envision, there are also many small dams.

Another type of hydropower generation is diversion (also called run-of-river), these systems take some water out of the main body of water, and divert it into a conduit: a tunnel, pipeline, or canal. The water once diverted can then be used to spin a turbine and generate power. Diversion can exist primarily for the purpose of hydroelectric generation, but many conduits serve other purposes, for example irrigating a field or bringing drinking water to a town. These existing conduits can sometimes be retrofitted for purposes of power generation even when that was not part of their initial purpose.

The third type of hydropower generation, pumped-storage, involves pumping water from a low reservoir to one up higher while electricity demand is low, and then allowing the water to flow back down and spin a turbine when demand is high, generating power when the grid needs it, and using power when it does not.[7] This is

---

[6] "Types of Hydropower Plants." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/types-hydropower-plants.

[7] "Conventional Hydroelectric Dams" Accessed September 18, 2019. https://www.e-education.psu.edu/earth104/node/1067.

done in order to meet peak demand, and in this way pumped-storage hydropower functions as a sort of battery.

Hydropower generation is also often categorized by size, and although there is not a globally recognized size standard, this paper will use the categorization found in most DOE hydropower reports which use the following classifications: “Micro (<0.5 MW), Small (0.5-10 MW), Medium (10 MW-100 MW), Large (100 MW-500 MW), and Very Large (>500 MW).”[8] These and similar classifications make it possible for clear lines to be drawn between different project sizes.

Significant resources are unutilized across all of these categories. Large non-powered dams continue to languish, and numerous small conduits are not utilized despite their potential. Much of the reason for this potential generating capability remaining unutilized is government interference of one sort or another. Although the government has been the major actor in constructing hydropower generation, the processes currently in place are redundant and ungainly. Despite attempts to subsidize, mandate, and encourage hydro development at both the federal and state levels, the federal government continues to impose regulations that are confusing, excessive, and often misapplied.

Because of this system, regulatory agencies and federal laws undermine the development that the government encourages and sometimes even funds. This patchwork system of regulation is difficult to navigate, and often prohibitively expensive, especially for small developers, such as municipalities. The federal government should not stifle progress on projects that it grants funds to, as to do so is entirely counterintuitive. Government actions serve both to encourage and complicate hydropower generation, and constitute a massive misallocation of time and material resources.

History of Hydropower

Pre-Industrial

For millennia, humans have used water to perform work. Water wheels have been used to grind grain since the Ancient Greeks.[9] The process of developing the modern

---

[8] Oak Ridge National Laboratory. “2017 Hydropower Market Report.” Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/downloads/2017-hydropower-market-report.

[9] “History of Hydropower.” Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/history-hydropower.

turbine began in the mid-1700s with Bernard Forest de Belidor's four volume series of books, *Architecture Hydraulique* in which he covered the rudiments of hydraulics, which laid the groundwork for future development.[10]

Major Innovation

In the 19th century, waterpower was harnessed in a new way, for the generation of electricity. The first modern water turbine was developed by James Francis in 1849; the Francis Turbine remains the most commonly used design to this day.[11]

The first commercial hydroelectric power station was the Vulcan Street Plant, which opened in 1882 on the Fox River in Appleton, Wisconsin.[12] From 1880 to 1895, the hydropower plants that were developed produced direct current and were mainly used to power the electric lighting that the newly developed incandescent light bulb produced.[13] Once alternating current electricity was developed, it was possible to transmit power over greater distances, and it became far more useful. Development increased, and new plant designs were attempted, as further power plants and dam sites were developed.

Growth of Hydropower

In 1902, the United States Bureau of Reclamation (USBR) was established in order to manage western water resources, primarily through the construction and maintenance of dams.[14] The USBR's first hydropower plant was built in 1909 to provide the energy necessary for the construction of the Theodore Roosevelt dam.[15]

---

[10] "Bernard Forest de Belidor | French Engineer | Britannica.Com." Accessed September 18, 2019. https://www.britannica.com/biography/Bernard-Forest-de-Belidor.

[11] "A Brief History of Hydropower | International Hydropower Association." Accessed September 18, 2019. https://www.hydropower.org/a-brief-history-of-hydropower.

[12] Christina, Nunez. "Hydropower, Explained." National Geographic, May 13, 2019. https://www.nationalgeographic.com/environment/global-warming/hydropower/.

[13] "Hydropower Program | Bureau of Reclamation." Accessed October 8, 2019. https://www.usbr.gov/power/edu/history.html.

[14] "History of Hydropower." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/history-hydropower.

[15] "Hydropower Program | Bureau of Reclamation." Accessed October 8, 2019. https://www.usbr.gov/power/edu/history.html.

Then, in 1913 the Kaplan turbine, was developed by Austrian Professor Viktor Kaplan, it is the second most commonly used design.[16] This turbine, a derivative of the Francis turbine, was more efficient at low head and high flow rates. Francis turbines struggle under these conditions, so the innovation allowed for turbines to work across a broader range of conditions.

The New Deal

In the 1920s, the Army Corps of Engineers (USACE) received congressional authorization to construct hydroelectric power plants, and were followed in the 1930s by the Tennessee Valley Authority (TVA) Bonneville Power Administration (BPA), and other New Deal construction. The USACE now manages 75 power plants, and the TVA an additional 29.[17]

As a result of New Deal legislation, and because of growing national demands for electricity, from 1950 to 1970, United States hydropower generating capacity grew massively, from 100,000 to 275,000 GW per year.[18]

It is important to note that almost from its outset, dam construction was mostly a government run endeavor. Many of the great American dams, including the Hoover, Grand Coulee, and Bonneville were constructed as part of Franklin D. Roosevelt's New Deal.[19] Government funded and government built; there was little space at the time for private development in the hydropower sphere. The remnants of this mindset are still present in much of the permitting process, and its layers of bureaucracy, and redundant action by multiple agencies. Understanding this legacy is essential to untangling the current regulatory regime.

---

[16] "Kaplan Turbine - Its Components, Working and Application." The Constructor, September 15, 2010. https://theconstructor.org/practical-guide/kaplan-turbine-component-working/2904/.

[17] "History of Hydropower." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/history-hydropower.

[18] Panarella, Samuel. "Troubled Water: Building a Bridge to Clean Energy through Small Hydropower Regulatory Reform." *UCLA J. Envtl. L. & Pol'y* 36, no. 2 (January 1, 2018): 232. https://scholarship.law.umt.edu/faculty_lawreviews/151.

[19] Ibid.

Figure 1 below illustrates the concentration of new generation coming online, from the 1950s to the 1970s the new generation comes mostly from larger projects, and the later burst in the 1980s comes primarily from small hydro development. By the end of the 20th century, the United States had 75,000 dams over six feet in height, and with these dams came irrigation for agriculture, reduced flooding, and inexpensive electricity.[20]

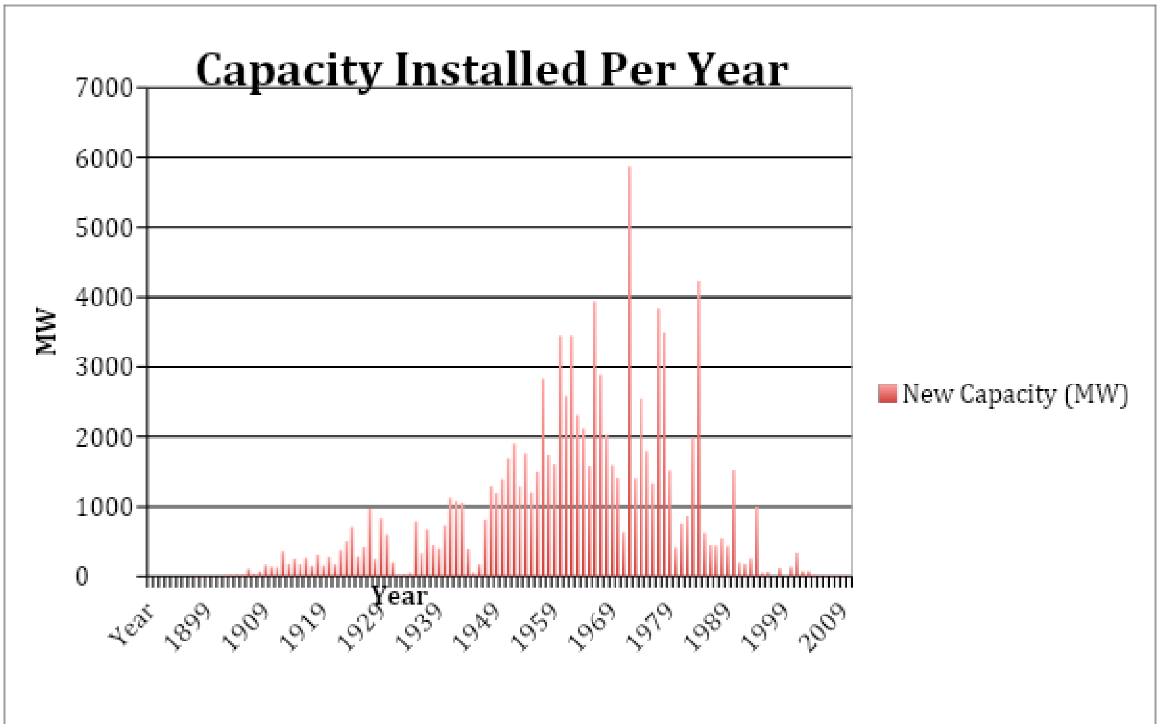

Figure 1 *Source*: "Hydropower Has a Long History in the United States - Today in Energy - U.S. Energy Information Administration (EIA)." Accessed October 8, 2019. https://www.eia.gov/todayinenergy/detail.php?id=2130.

The Public Utility Regulatory Policies Act

When the Public Utility Regulatory Policies Act of 1978 (PURPA) was passed, it introduced competition into the utilities marketplace, requiring utilities to buy electricity produced by "qualifying facilities," at the time mostly small hydro and natural gas facilities. This new law spurred a burst of hydropower development. This time it was not large dams being built, but smaller PURPA qualifying facilities.

---

20 Ibid.

Following the enactment of PURPA, applications for hydropower project permits increased dramatically, from around 100 in 1979 to more than 2100 in 1981.[21] This flurry of activity following PURPA's passage constitutes the second hydropower boom. PURPA incentivized the building of smaller facilities as it opened up the previously vertically integrated utilities marketplace to competition. Although the law has begun to show its age as outdated provisions lead to less than ideal outcomes and the push for reform grows, this was one of its early benefits. Figure 2 below displays the spike in small scale hydropower development that occurred during this period.

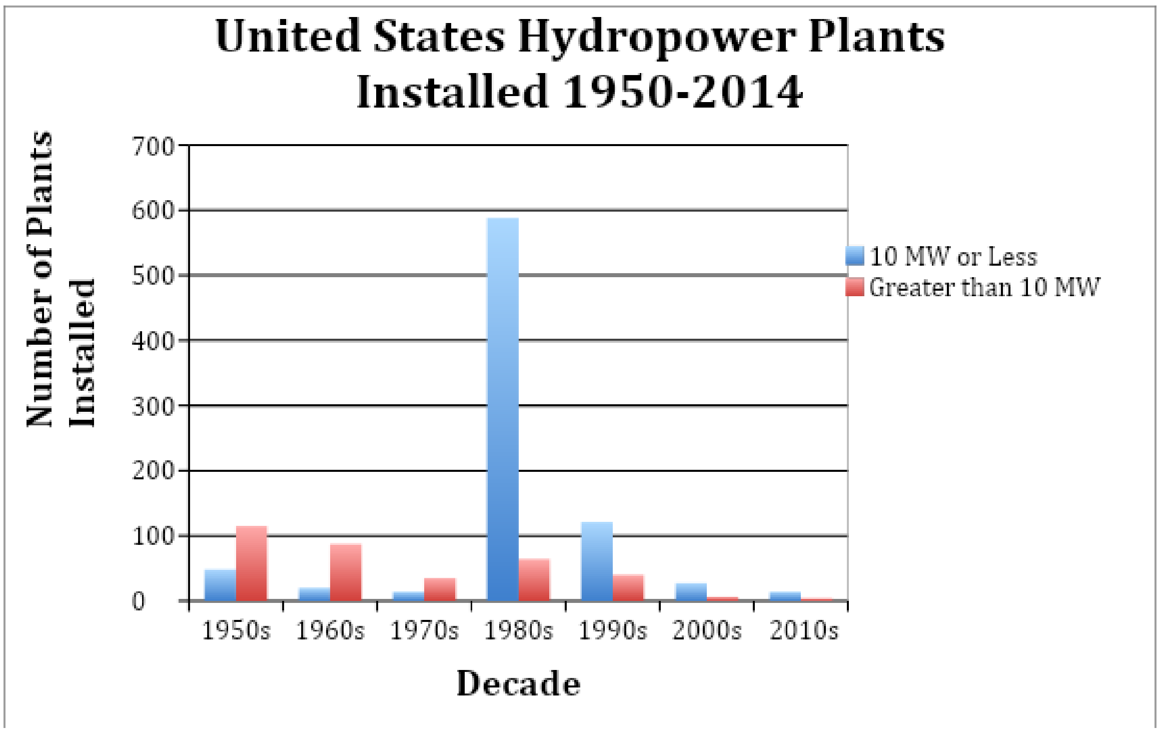

Figure 2 *Source*: National Hydropower Asset Assessment Program, "Existing Hydropower Assets: 2014," http://nhaap.ornl.gov/.

PURPA allowed small hydropower facilities to become profitable, and because it is dispatchable, small hydropower does not pose many of the difficulties for the grid that wind and solar can create, including issues like the solar value cliff, the drop off point after which solar power becomes a detriment rather than a benefit to the grid.

---

[21] Eckberg, David K. "CUMULATIVE IMPACTS OF HYDROPOWER DEVELOPMENT UNDER NEPA." *Environmental Law* 16, no. 3 (1986): 673-703. http://www.jstor.org/stable/43265769.

[22] Because it is more controlled and does not peak and abate with the blowing of the wind or the shining of the sun, hydropower is more reliable than these other generation sources. Water can of course cease to flow, but this is far less common than the faltering of wind and solar. Most of PURPA's present issues come from the stress that small wind and solar facilities put on the grid, problems that the small hydro facilities of the 1980s did not pose.

Regulatory Barriers for Small and Micro Conduit Hydropower

Many localities have pipes, canals, and other water delivery infrastructure that is readily convertible for power generation, these can be broadly referred to as conduits, which exist primarily to convey water over distance from where it is stored to where it is used.[23] Conduit generation can face even more barriers than does other hydro generation because its primary role is to convey clean water to consumers, and any additional purpose must not subvert this one. Even when development poses no risk to water safety or quality, many municipal water managers are wary of any new development. Because of the drinking water element, the regulatory apparatus, and those in charge of these resources treat them with a higher degree of stringency than other hydro generation potential.

It is often the case with small hydropower projects that localities are the parties attempting to develop new generation potential and run up against unyielding and unwieldy federal regulation. The rigidity of these regulations prevents them from being sensitive to issues of scale and scope, and creates excessively burdensome regulation. In addition to this, developers must then also meet regulatory requirements that vary widely by state.

Because of a lack of communication between agencies, the licensing process is not only long, but also redundant. The same information must be filed separately with different agencies that rarely communicate with one another.

---

[22] "The Solar Value Cliff: The Diminishing Value of Solar Power." The Institute for Energy Research, August 2017. http://instituteforenergyresearch.org/wp-content/uploads/2017/08/The-Solar-Value-Cliff-August-21-1.pdf.

[23] "Pumped Storage and Potential Hydropower from Conduits." Energy.gov. Accessed August 19, 2019. https://www.energy.gov/eere/water/downloads/pumped-storage-and-potential-hydropower-conduits.

Small- and micro-hydro generators may have to obtain permits from 25 different government agencies in order to receive a FERC license.[24] Even in the most streamlined version of the process, it is not uncommon for the permitting process to take in excess of five years.[25]

Laws intended to prevent major impacts created by large-scale development end up slowing down production and increasing costs on projects to which the laws do not really apply. If the Antiquities Act exists primarily to protect "historic" structures, and a small project is located nowhere near any such structures, it seems wasteful to require a lengthy report on the impact of development on such nonexistent structures. The case is similar when it comes to application of the Endangered Species Act to small projects that are entirely or primarily self-contained within existing structures such as a water pipe. Adding generating capability to an already existing water pipe does not change the pipe's impact on surrounding species in a meaningful way, and significant effort and money will be wasted on compliance costs that are unnecessary.

In 2013, the Hydropower Regulatory Efficiency Act and the Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act took steps to ameliorate this issue, but they have had a somewhat limited impact.

HREA allows exemptions to licensing requirements for conduit based systems under 5 MW not located on federally owned lands, and gives FERC the authority to exempt non-conduit systems under 10 MW.[26] But, it is important to note that the process for receiving an exemption carries its own burdens, and requires significant paper work and studies.

HREA also extended preliminary permits an additional two years bringing the window up to five years, meaning that after receiving preliminary approval developers will have longer to determine site viability and plan. The law also exempts some conduit facilities from the licensing requirements of the Federal Powers Act (FPA) and directs FERC to investigate the feasibility of establishing a 2-year licensing process for non-powered dams and closed-loop pump storage

---

[24] Hansen, Megan, Randy T. Simmons, and Ryan M. Yonk. "The Regulatory Noose: Logan City's Adventures in Micro-Hydropower." *Energies* 9, no. 7 (July 2016): 482. https://doi.org/10.3390/en9070482.

[25] Panarella, Samuel. "Troubled Water: Building a Bridge to Clean Energy through Small Hydropower Regulatory Reform." *UCLA J. Envtl. L. & Pol'y* 36, no. 2 (January 1, 2018): 232. https://scholarship.law.umt.edu/faculty_lawreviews/151.

[26] "Reliability of Renewable Energy: HYDRO – Strata." Accessed October 8, 2019. https://www.strata.org/reliability-of-renewable-energy/hydro/.

projects.[27] The 2-year licensing process was tested, but FERC's ultimate conclusion was that 2-year licensing was already possible, and a separate process did not need to be developed. FERC "found that two-year license processing for new projects is feasible, and can occur within the existing legal and regulatory framework."[28]

In 2013, the year that HREA was passed, there was only one new FERC-permitted conduit that went into service. According to the report created in response to Section 7 of HREA, in the first half of 2014, of the 27 projects that applied for exemption under HREA, 20 received the exemption.[29] The law is having its desired impact for small conduits, but as the exemptions have a limited impact on actual project permitting cost and time, and only apply to a very small subset of all hydro power generation, they are ultimately limited in broader impact because, "The HREA's two-month approval process for conduit hydropower is a significant and noteworthy outlier in the otherwise lengthy and expensive hydropower licensing and exemption processes"[30] Ultimately, larger projects and different types of projects are no better off now than they were before HREA.

The Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act explicitly authorizes hydropower development on Bureau of Reclamation owned conduits, and exempts conduit facilities that are five MW or less from NEPA requirements, easing the permitting process for these facilities.[31]

---

[27] "FERC: Hydropower Regulatory Efficiency Act of 2013." Accessed August 19, 2019. https://www.ferc.gov/industries/hydropower/indus-act/efficiency-act.asp.

[28] "Report on the Pilot Two-Year Hydroelectric Licensing Process for Non-Powered Dams and Closed-Loop Pumped Storage Projects and Recommendations Pursuant to Section 6 of the Hydropower Regulatory Efficiency Act of 2013." Federal Energy Regulatory Commission, May 2017. https://www.ferc.gov/legal/staff-reports/2017/final-2-year-process.pdf.

[29] Sale, Michael, Norman Bishop, Sonya Reiser, Kurt Johnson, Andrea Bailey, Anthony Frank, and Brennan Smith. "Opportunities for Energy Development in Water Conduits: A Report Prepared in Response to Section 7 of the Hydropower Regulatory Efficiency Act of 2013." Oak Ridge National Lab, September 2014. https://info.ornl.gov/sites/publications/files/Pub50715.pdf.

[30] Panarella, Samuel. "Troubled Water: Building a Bridge to Clean Energy through Small Hydropower Regulatory Reform." *UCLA J. Envtl. L. & Pol'y* 36, no. 2 (January 1, 2018): 232. https://scholarship.law.umt.edu/faculty_lawreviews/151.

[31] "H.R. 678: Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act." gop.gov. Accessed October 8, 2019. https://www.gop.gov/bill/h-r-678-bureau-of-reclamation-small-conduit-hydropower-development-and-rural-jobs-act/.

This law is important because of the development potential of conduits that are U.S. Bureau of Reclamation (USBR) controlled. A 2012 assessment by the USBR found that about "268 MW and 1.2 million MWh of energy could be produced annually at existing Reclamation facilities if all 191 sites with the technical potential for development were developed."[32] The assessment also found that "A total of 225MW of installed capacity and 1.0 million MWh of energy could be produced annually at existing Reclamation facilities if all sites with a benefit cost ratio greater than 0.75 were developed."[33] The amount of generating capacity untapped at USBR sites makes this step in easing regulatory burdens for its development significant.

The changes promulgated by these laws, although a step toward reducing the regulatory burden in this area have achieved somewhat less than was expected. The requirements are still incredibly difficult for small developers to comply with. This is partially due to the expansive nature of the nexus of laws and regulations that apply. Even with a somewhat expedited permitting process, the number of hoops to jump through remains high. Applying for exemptions is in itself a difficult process which comes with its own uncertainties. Additionally, although both of these laws were passed in an attempt to ease regulatory burdens and spur development of small- and micro-hydropower,

The FERC permitting process is by no means the only barrier in place for developers. The array of laws and regulations with which they must comply is vast, and although both of these laws make the process somewhat easier for the smallest scale projects, there is still much regulatory reform to be had.

Developments for Dams and Pumped-Storage Hydro

Both dams and pumped-storage hydropower (PSH) projects face regulatory barriers, as well as push back for environmental impacts. Because the scale of these projects is generally much larger than conduit projects, they tend to have larger ecological impacts, but also generally have higher capacity for generation. Retrofitting projects, which allow existing dams to begin generating electricity, and facilities updates, which enable existing facilities to be more efficient and generate more power, are both means by which more generation can be achieved without significant additional environmental impact.

---

[32] "Hydropower Program | Bureau of Reclamation." Accessed October 8, 2019. https://www.usbr.gov/power/CanalReport/FinalReportMarch2012.pdf.

[33] Ibid.

The vast majority of recent dam development comes from the retrofitting of non-powered dams. As the DOE 2017 Hydropower Market Report prepared by ORNL points out, "Nationally, NPD projects account for 92% of proposed capacity. Thus, the success of recent initiatives to improve the efficiency of the authorization process for this type of project is crucial."[34]

Of the 118 new hydropower plants that began operation between 2006 and 2016, 40 were non-powered dams that had been retrofitted to generate power, and 73 were retrofitted conduits.[35] Because so much of hydropower development is now centered on the updating of existing facilities as opposed to new constructions, it is essential that regulations catch up, and adapt to this new reality, taking into account the lesser impacts of these projects in order to adjust the way that they are regulated to match.

There are significant gains in capacity available from retrofitting NPDS and conduits, from 2006 to 2016, 2,030 MW of hydropower capacity were added in the United States. The majority of this came from development of NPDs and the development of small conduits. The largest projects developed during this period were American Municipal Power's NPD projects on the Ohio River: Meldahl (105 MW), Cannelton (88 MW), Smithland (76 MW), and Willow Island (44 MW).[36] The report also points out that not only is building on existing infrastructure the most common development of late, it is also the trend in planned development.

From 2006 to 2016, there were also 2,074 MW of PSH capacity added in the United States.[37] The majority of this increase came from updating facilities with only one new 40 MW facility coming online.

The trend at present for both pumped-storage facilities and large dams is efficiency improvements on existing infrastructure rather than new construction.

---

[34] Oak Ridge National Laboratory. "2017 Hydropower Market Report." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/downloads/2017-hydropower-market-report.

[35] Ibid.

[36] Ibid.

[37] Ibid.

Non-Regulatory Barriers to Increasing Capacity

Of course regulatory barriers are not the only things stopping hydropower development. In some places, there is simply no use in adding capacity because the energy needs of the area are already taken care of by other energy production. There also may simply be no company or government willing to take on the scale and risk of a retrofitting project. In many cases it is these barriers, in addition to onerous regulation that ultimately prevent or discourage development.

Impacts of State Renewable Portfolio Standards on Hydro Development

Renewable Portfolio Standards (RPS) are policies that mandate that a certain percentage of a state's electricity generation be derived from renewable sources by a certain year. Twenty-nine states have mandatory RPS, and eight additional states and Washington, DC have non-mandatory RPS goals.[38] RPS apply to 56 percent of United States retail electricity sales,[39] so they have a significant impact on energy markets and their incentive structures.

The intention of these polices is to spur the development of renewable generation capacity, but they generally do not treat all types of renewable energy generation the same way. Many state policies treat hydropower much more stringently than other forms of renewable generation, or do not count it toward their goals at all. Because of this, they do not encourage construction of hydropower generation as they do wind and solar capability, effectively creating winners and losers in the renewable energy market.

The policies are so variant, in fact, that most analyses of the policies' impacts exclude hydropower entirely, because it is accepted differently by every statethe impacts of the policies difficult to compare. The DOE report on RPS standards

---

[38] "State Renewable Portfolio Standards and Goals." Accessed October 8, 2019. http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx.

[39] Barbose, Galen. "U.S. Renewables Portfolio Standards: 2019 Annual Status Update." Lawrence Berkley National Laboratory, July 2019. http://eta-publications.lbl.gov/sites/default/files/rps_annual_status_update-2019_edition.pdf.

performed annually by the Lawrence Berkley National Lab made clear that it its analysis of renewable generation growth did not include hydropower "because RPS rules typically allow only limited forms of hydro for compliance."[40] The current construction of RPS both tacitly discourages hydro development and makes it difficult to accurately calculate the policies' impacts.

The disparity among the states is significant. Some states only count hydropower facilities constructed before a certain date, while others only count those constructed after a certain date.

Some standards only accept some definition of small hydropower, whether they define it as a nameplate capacity of 5 MW or 30 MW or somewhere in between. Some states count pumped-storage hydropower, other states do not. Some of the rules are still more convoluted, counting all old hydropower and only new generation below a certain nameplate capacity. Some states also have different "classes" of renewable generation that have different quotas, and these classes categorize different types and sizes of hydropower generation separately. For example, in New Jersey, Class I must be under 3 MW and put in service after July 23, 2012, and meet certain low impact criteria, while Class II must be between 3 MW and 30 MW.[41] Some states count only very specific types of generation, while others exclude only specific types. Iowa only counts "small hydropower" facilities, but does not define them in terms of nameplate capacity, leaving a gray area in its policy.[42]

New Mexico only counts facilities brought into service after July 1, 2007,[43] so any existing capacity in the state does not add to its ability to attain the standard, nor does it count additions to existing facilities that increase capacity. This disincentivizes updates in favor of more costly and environmentally damaging new construction. Each of these policies has consequences, and many of them were constructed without paying those consequences any mind.

As a result, the state array of Renewable Portfolio Standards consists mostly of policies that disincentivize one of the most reliable and versatile forms of renewable energy in favor of other types. Below is a table of RPS and Non-RPS states, and of various restrictions that RPS policies place on hydropower.

---

[40] Ibid.

[41] The Hydropower Reform Coalition. "State Renewable Portfolio Standards (RPS) And Hydropower Provisions," July 2014. https://www.hydroreform.org/sites/default/files/2014-07%20hrc_state_rps_3.pdf.

[42] Ibid.

[43] Ibid.

What a majority of have in common is that they place significant limits on which hydropower can count toward the standards, how large it can be, and when it must have gone in service. Because of the requirements of their RPS standards, even if a state utilizes significant energy from hydropower, it may still fail to meet its RPS standard. If they are intended to be benchmarks for renewables production, it makes little sense to arbitrarily exclude certain types of renewables.

RPS States	Some Construction Date Restriction	Some Capacity Restriction	Other Restrictions
Arizona	✓	✓	✓
California	✗	✓	✓
Colorado	✗	✓	✓
Connecticut	✓	✗	✗
Delaware	✗	✓	✗
District of Columbia	✗	✗	✓
Hawaii	✗	✗	✓
Illinois	✗	✗	✓
Indiana	✗	✗	✗
Iowa	✓	✗	✗
Kansas	✓	✓	✓
Maine	✗	✓	✓
Maryland	✓	✓	✓
Massachusetts	✓	✓	✓
Michigan	✓	✗	✓
Minnesota	✗	✓	✓
Missouri	✗	✓	✓

Montana	✓	✓	✓
Nevada	✗	✓	✓
New Hampshire	✓	✓	✓
New Jersey	✓	✓	✓
New Mexico	✓	✗	✗
New York	✓	✓	✓
North Carolina	✗	✓	✗
North Dakota	✓	✗	✗
Ohio	✗	✗	✓
Oklahoma	✗	✗	✗
Oregon	✓	✗	✓
Pennsylvania	✓	✓	✓
Rhode Island	✗	✗	✗
South Dakota	✗	✓	✗
Texas	✗	✗	✗
Utah	✓	✗	✗
Vermont	✗	✓	✗
Virginia	✗	✗	✓
Washington	✓	✗	✗
West Virginia	✗	✗	✗
Wisconsin	✓	✗	✗

Figure 3 *Source*: The Hydropower Reform Coalition. "State Renewable Portfolio Standards (RPS) And Hydropower Provisions," July 2014. https://www.hydroreform.org/sites/default/files/2014-07%20hrc_state_rps_3.pdf.

Baseload and Dispatchable Generation

As more wind and solar capacity continues to be brought online, there is increasing need for reliable dispatchable capacity, that is, power that can be ramped up or ramped down according to present grid demands. One of the major benefits of hydroelectric power generation is that most of it can provide reliable baseload power while also being quickly dispatchable. Because of this, hydropower, like natural gas, is an essential complement to solar and wind installation. Without both reliable baseload and readily dispatchable capacity, wind and solar would create grid instability.

Impacts of Federal Tax Policy on Hydropower

Hydropower is subsidized as a renewable energy source, but it receives much less benefit than solar and wind. Hydropower receives half the production tax credit value that is provided to other renewable generators.[44] This disparity may artificially discourage hydro development in favor of other more subsidized renewables.

Conclusion

While hydropower currently generates 6.3 percent of U.S. electricity,[45] there is room for increased capacity. Years of stifling regulation that have hampered growth and prevented or delayed the construction of new projects.

---

[44] "Pumped Storage and Potential Hydropower from Conduits." Energy.gov. Accessed August 19, 2019. https://www.energy.gov/eere/water/downloads/pumped-storage-and-potential-hydropower-conduits.

[45] Oak Ridge National Laboratory. "2017 Hydropower Market Report." Energy.gov. Accessed September 18, 2019. https://www.energy.gov/eere/water/downloads/2017-hydropower-market-report.Energy.gov.

Hydropower does not receive the same tax treatment as other renewable energies, namely wind and solar, and is also generally far less favored in policies like Renewable Portfolio Standards. Because of such discrepancies, wind and solar may be favored for construction even when in an unskewed market hydro would offer a better return.

Over hydropower's history, government policy has both encouraged its development, through direct construction, grants, and tax credits, and discouraged it through complicated regulatory processes that reduce the cost-benefit ratio of investment. Only about 3 percent of the United States' more than 80,000 dams generate electricity, and there are countless other conduits that could be readily outfitted for the generation of electricity.

Attempts to reform hydropower regulation through HREA and Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act have been good progress, but do not apply to all hydropower and so have had limited impact. Further reforms to hydropower regulation could somewhat ameliorate current policy imbalances between hydro and other generation sources. Additionally, the proposed 2-year FERC permitting process would be a meaningful step and should be revisited.