Written Testimony of

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On behalf of

The National Hydropower Association

Before the

House Energy and Commerce Committee
Subcommittee on Energy

Hearing on "Powering America: Valuing Reliability in a Transforming Electricity Industry"

October 3, 2017

Executive Summary

- Hydropower is the premiere electric generating resource. It is low cost, emission-free and, unlike any other generating resource, can provide *all* components of reliability, including: energy, peak capacity, voltage support, regulation, spinning and non-spinning reserves, storage, black start capability, and inertia.

- As the electric grid integrates more and more variable energy resources, hydropower's ability to provide peaking capacity, flexibility and storage are increasingly important.

- Hydropower projects have a long lifespan, with major equipment lasting fifty years or more. The levelized cost of electricity from existing large hydropower is low and new hydropower can be very competitive, though it is at a disadvantage compared to other renewables due to the inequity in federal tax incentives.

- Hydropower represents a "least cost" path to addressing emissions concerns.

- Yet hydropower faces several key challenges:

  ➢ There is a massive need for reinvestment in the existing aging fleet. The largest hydropower projects were built between 1930 and 1975 and many are undergoing, or will need to undergo, major rehabilitation.

  ➢ Market rules generally undervalue operational flexibility, which is a prime attribute of hydropower. Because the services are not appropriately compensated, these valuable attributes are not optimized and potentially wasted.

  ➢ Public policy has created programs, such as renewable portfolio standards, that tend to exclude and devalue hydropower compared to other renewable or carbon free resources.

  ➢ The hydroelectric relicensing process can take 10 years or more to complete, with process costs representing a significant portion of a licensee's overall costs to obtain and implement a 30-50 year license. In the next 15 years, over 500 hydroelectric projects license will expire and require renewal by the Federal Energy Regulatory Commission (FERC).

  ➢ Costs and delays associated with hydropower licensing can affect the timing and level of ongoing investments. In addition, the operational capability of hydropower – its major benefit for reliability – is often limited or diminished in order to carry out the commitments required to obtain a new license.

- Legislation to improve the licensing process, such as H.R. 3043, the Hydropower Policy Modernization Act of 2017, and the hydropower provisions in S. 1460, the Energy and Natural Resources Act of 2017, will help preserve and grow the nation's hydropower fleet.

Introduction

Good morning Chairman Upton, Ranking Member Rush, and members of the Committee. I am Steve Wright, General Manager of the Chelan County Public Utility District in Wenatchee, Washington. I am testifying on behalf of the National Hydropower Association (NHA), a nonprofit national association dedicated to promoting clean, affordable, renewable U.S. hydropower. NHA represents more than 220 companies, from Fortune 500 corporations to family-owned small businesses. Its members include both public and investor-owned utilities, independent power producers, developers, equipment manufacturers and other service providers, and academic professionals.

Chelan PUD is a member of NHA. We own and operate three hydroelectric projects in Washington State, Rocky Reach (P-2145), Rock Island (P-943) and the Lake Chelan Project (P-637). Combined, these projects generate approximately 10 million megawatt hours of clean, reliable, emission-free electricity annually – enough to power a city of one million people. Before being named as General Manager at Chelan PUD in 2013, I was the Administrator of the Bonneville Power Administration, a position I held for more than 12 years, serving under three U.S. presidents. In the Pacific Northwest, reliable and affordable hydropower is the lifeblood of the economy and I am pleased to be here to discuss its importance to the U.S. electric system.

Hydropower is a Premier, Multi-Purpose Renewable Resource

In the United States, almost 2,200 hydropower plants with a total capacity of 80 gigawatts (GW) provide about 6 percent of the nation's electric generation. These plants also represent almost half of the country's renewable energy generation. Meanwhile, an additional 42 hydropower pumped storage plants with approximately 22 GW of capacity provide 97 percent of U.S. energy storage.[1] A 2016 report from

[1] Please see the testimony submitted by the National Hydropower Association before the Energy Subcommittee on May 3, 2017 and the Senate Energy and Natural Resources Committee on March 14, 2017 (also attached) for a full description of

the Department of Energy, Hydropower Vision[2], projects that hydropower potentially could grow by 49 GW by 2050. Hydropower's infrastructure helps to manage and balance river flow for flood control, drought management, water supply, irrigation and ecosystem purposes. It also protects air quality by avoiding greenhouse gas emissions from fossil fuels in the electric and transportation sectors. And, it is capable of providing *all of the services* generally recognized as crucial for maintaining electric grid reliability.

Hydropower Serves the Grid

There are many characteristics of generating resources that are necessary to maintain grid reliability. But there is only one generating resource that can effectively address all the reliability requirements. The graphic below compares a large hydropower project to other generating resources across a broad spectrum of energy, capacity and ancillary services. Although each plant is different and some (particularly the larger projects) have greater capabilities than others, here are hydropower's reliability characteristics:

- *Annual Energy*

  Even though streamflows can vary, hydropower is a reliable resource that produces energy throughout the year. Electric power systems use energy from hydropower to both avoid building new generation and reduce the use of existing fossil fuel fired resources.

- *Peak Capacity*

  Hydropower systems are generally built to take advantage of high streamflows and hence have available capacity that can be called upon at virtually no additional cost to meet system peaks due to

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hydropower's contribution and growth potential, along with a discussion of the licensing issues, regulatory inefficiencies and tax treatment that present challenges for preserving and growing the nation's hydropower fleet.

[2] Hydropower Vision, A New Chapter for America's 1st Renewable Electricity Source. U.S. Department of Energy, 2016. Overview. https://energy.gov/eere/water/articles/hydropower-vision-new-chapter-america-s-1st-renewable-electricity-source

low or high temperatures. Meeting these extreme events is one of the most significant costs for any electric power system

- *Voltage Support and Reactive Power*

  Reactive power is necessary to keep voltage at levels necessary to maintain reliability under a wide range of conditions. Hydro generators are very well suited by design and inherent capability to maintain system voltage, providing substantial increase or decrease in voltage as necessary. No other generation source is better able to provide reactive power. Some hydropower units can produce reactive power even when not producing power (MWs).

- *Regulation (Frequency Response)*

  In order to preserve grid reliability, supply and demand must remain in balance – not only hour to hour, but second to second. Every electric system must maintain generation that can react quickly to assure loads and resources are constantly in balance. Hydropower projects are best suited to provide this service because it can be accomplished merely by allowing more water to pass through turbines using automatic generator control or simply by relying on the large inertia of the machines.

Sample resource characteristics of electric power sources[3]

	Peak capacity	Annual energy	Regulation	Spin reserves	Non-spin reserves	Storage	Inertia	Black Start
Hydroelectric (large project)	yes, water dependent	yes, water dependent	yes	yes	yes	yes	yes	yes
Gas (CCCT)	yes	yes	yes, could be limited	yes, could be limited	yes, could be limited	no	yes	yes
Gas (frame SSCT)	yes	yes, could be limited	yes, could be limited	yes, could be limited	yes, could be limited	no	yes	yes
Gas (flexible SSCT)	yes	yes, could be limited	yes	yes	yes	no	yes	yes
Coal	yes	yes	limited	limited	no	no	yes	no
Nuclear	yes	yes	no	no	no	no	yes	no
Biomass	yes	yes	yes, could be limited	yes, could be limited	yes, could be limited	no	no	no
Geothermal	yes	yes	yes	yes	yes	no	no	no
Solar, PV	location dependent	yes, location dependent	yes, limited by energy potential	yes, limited by energy potential	yes, limited by energy potential	no	no	no
Solar, thermal	limited to yes	yes, location dependent	yes, limited by energy potential	yes, limited by energy potential	yes, limited by energy potential	yes	no	no
Wind	location dependent	yes, location dependent	yes, limited by energy potential	yes, limited by energy potential	yes, limited by energy potential	no	possibly, using synthetic product	no
Demand response	reduces peak need	no	program dependent	program dependent	program dependent	no	no	no
Energy efficiency	reduces peak need	reduces energy need	no	no	no	no	no	no
Batteries	yes	uses energy	yes	yes, depends on size	yes, depends on size	yes	no	yes, limited by size

[3] Based on Value of Hydropower to the Northwest Grid, Pacific Northwest Utilities Conference Committee (PNUCC). November 2016. P. 22. http://www.pnucc.org/sites/default/files/Value%20of%20Hydro%20PNUCC%20Nov%2022%202016.pdf as amended by Chelan PUD. September 2017. This table is for illustrative purposes only – it is not a definitive guide to resource characteristics. Utilities and other organizations may assume different characteristics from the same resources.

- *Spinning Reserve*

  On a sub-hourly basis, generating units are maintained in a "spinning" status ready to rapidly react to unanticipated increases in load or decreases in generation across the power system. Spinning reserves are there to respond to load changes as fast as 10 seconds and up to 10 minutes. These resources stabilize system frequency during emergency operating conditions and unforeseen load swings. Because hydropower projects generally have multiple turbines that are not fully loaded, hydropower is a natural fit for supplying reserves including over extended periods of time.

- *Non-Spinning Reserve*

  Non-spinning resources are units that are able to quickly turn on and provide power in less than 10 minutes, maintaining output for at least two hours. Hydropower can also provide this service using less than fully loaded turbines.

- *Storage*

  Many large conventional hydropower projects can provide storage capability through the use of reservoirs, providing opportunities to better balance loads and generating resources. It's important to note, however, that pumped storage is particularly well positioned to reduce curtailment of excess generation by providing load and energy storage. Pumped storage includes both a load (to pump water uphill) and generation. These units can rapidly increase generation or load as needed for grid stability and economic efficiency. Storage gives hydropower projects the fuel (water) to provide all the various reliability services.

- *Black Start Capability*

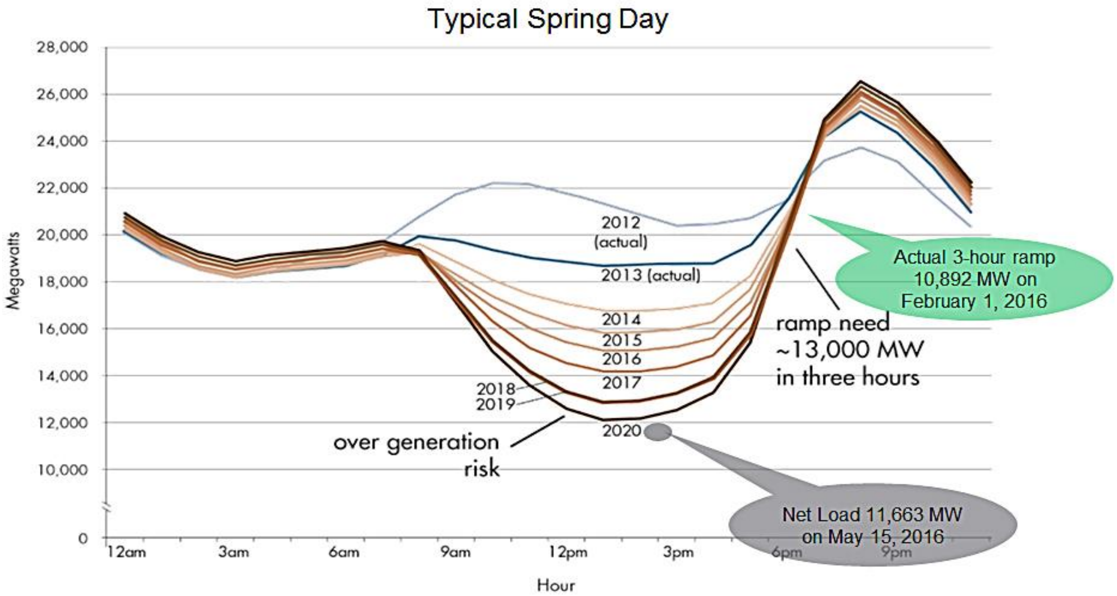
  During outages, hydropower can help restart the power system without support from the transmission grid, enabling other generators to come online. Hydro resources can normally be operational very quickly to support grid restoration. They generally have adequate fuel supply (the reservoir), and can provide a sustained response.

- *Inertia*

Hydropower units are also a source of inertia that is important for avoiding widespread blackouts. Inertia provided by the large rotating mass of traditional generators has historically stabilized the Western Interconnection's frequency by slowing frequency decline and, with the help of power system stabilizers, dampening the cascading oscillations that can occur when there is a disturbance (such as the sudden loss of large generation). Hydropower resources have a lot of mass that provides significant inertia.

- *Flexible Capacity*

As the grid becomes increasingly reliant on variable energy resources, there is an increasing need for flexible capacity that can respond, given the production uncertainty of resources such as wind and solar. Many hydropower projects are flexible enough to move generation around during the day to provide a dispatchable generation to assure loads and resources stay in balance. As an example, the California grid depends on flexible resources like hydropower to come online in the afternoon when the sun sets, limiting solar power generation. During a typical spring day, resources like hydropower must ramp up to meet demand very quickly in the evening after net load has bottomed out during the middle of the day. The graphic below from the California Independent System Operators (CAISO) depicts this phenomenon as the now-famous "duck curve". Unlike fossil fired resources, hydropower can be available to respond to change in net load (load minus variable energy resources) without burning fuel to be kept in a ready state.



Source: CAISO, 2016.

<u>Hydropower Is Cost-Effective</u>

Generally, in life we have to face a trade-off between quality and cost. Not so with respect to hydropower. Hydropower is an affordable and low-cost resource, benefiting consumers through lower electricity costs. The projects are long-lived, with major equipment such as turbines and generators lasting 30 – 50 years. With costs spread out over the life of the project, hydropower has a relatively low levelized cost of electricity (LCOE). New hydropower is also cost-competitive, particularly hydropower added to currently non-powered dams, though disparate tax treatment and the lack of certainty are issues. These can have a significant impact on the ability of developers to finance projects.

In addition to being a low-cost generating resource, hydropower is a least-cost method of addressing carbon emission concerns. Generating with hydropower produces no nitrogen oxides (NOx) or sulphur oxides (Sox); no mercury or particulate matter; and no greenhouse gases. As the nation increasingly confronts the societal costs of air emissions, hydropower represents a least cost path to meeting both our reliability and air emissions objectives. By utilizing hydropower, utility planners can help achieve the simultaneous goals of least cost planning for load and emissions reductions.

Hydropower Faces Challenges

A variety of economic factors can affect the timing and extent of investments for hydropower licensees. These include forecasted energy prices, capacity and ancillary services markets, relicensing requirements, federal and state policies that may disadvantage hydropower, and tax treatment. Hydropower is facing challenges that could affect the continued viability of existing projects and new project development.

- *Aging Fleet*

As acknowledged in the Department of Energy's 2016 Hydropower Vision report, "America's first renewable electricity source, hydropower, has been providing flexible, low-cost, and low-emission renewable energy for more than 100 years."[4] Hydropower, for the most part, is taken for granted. However, there is a massive need for reinvestment in the existing aging fleet. Most of the largest hydropower projects were built between 1930 and 1975 and many are undergoing, or will need to undergo, major rehabilitation. At Chelan PUD, we have begun upgrading the Rock Island Hydroelectric Project – the first dam on the Columbia River. Although it had a design life of 50 years, it has been operating since the first power house was completed in 1933 (with a capacity expansion in 1952-53) and the second powerhouse was completed in 1979. In other words, the project has operated for nearly *85 years with much of the original components*. But last year, we discovered that the original turbine blades on four units have stress fractures that will require replacement of the entire turbine unit. This type of event is happening up and down the Columbia in a region where roughly 60 percent of the electricity is provided by hydro-turbines.

Extending the life of the Rock Island project will likely require an investment of roughly a half billion dollars before the current license expires in 2028. This anticipated work includes rehabilitation project of

[4] Hydropower Vision report, Message from the Director.

Rock Island Powerhouse 1 that is expected to cost roughly a quarter billion, as well as a modernization of Rock Island Powerhouse 2 at an estimated $240 – $400 million, which is expected to begin in 2018. The decision whether to replace the units can be described rather simply. The cost of replacement must be compared to other alternatives, including market purchases. When weighing hydropower investments, we will take three primary values taken into consideration: energy, capacity and carbon. The higher these values, the more likely hydropower reinvestment will occur. At Chelan PUD, we sell a significant portion of our hydropower on the market. Hence, we have insights into the value being currently offered in western power markets and how these factors can affect hydropower investment.

- *Market Valuation*

Energy values in the western power markets have fallen dramatically in the last 5 years due to low natural gas prices and the infusion of variable energy resources (primarily wind and solar) resulting from renewable portfolio standards adopted by western states. Price reductions due to a surplus of supply, economies of scale, and federal production and investment tax credits for wind and solar have had a significant effect on lowering wholesale energy prices. At times there is so much energy available that plant owners are willing to pay purchasers to take energy in order to receive the tax credits. These factors reduce the revenues received by hydropower owners while the hydro plants are still providing valuable reliability services.

In the west, capacity is generally sold in bilateral markets rather than in organized markets as in other parts of the country. Capacity is not a single product, but many different products that are necessary to achieve high reliability. In some cases, such as with frequency response, there are evolving markets that are beginning to provide value for capacity. But for the most part, capacity products tend to be undervalued when there is an energy surplus, as is being experienced in the west. The Department of Energy's Hydropower Vision report came to a similar conclusion when it commented that "not all benefits provided by hydropower facilities are readily quantifiable or easily attributable to hydropower in a market framework" and "[I]t's possible that no value or inadequate value may be placed on some services, such as those provided by hydropower generators with characteristics that allow for rapid and precise response to instability in the grid."[5]

Today's power prices are also influenced by carbon prices and other markets for environmental attributes. Hydropower marketing is complicated by inconsistent treatment of hydropower as a renewable from state to state. Renewable portfolio standards often do not treat hydropower equitably with other carbon free and renewable resources. These can include restrictions on qualifying hydropower based on size, operations, or placed in service dates. Carbon markets present some opportunity for hydropower. For example, California has recently extended its cap-and-trade market through 2030. As west coast power markets are heavily influenced by the California market, the current carbon price does have an impact on wholesale electricity prices. But at $15 a ton, it is far below the price required to achieve the level of carbon reduction sought by west coast states.

The net effect of today's projected energy, capacity and carbon values resulted in a decision by Chelan PUD to pursue refurbishment of its Rock Island facilities. But the conclusion on the economics was closer than one would have expected for a dam that is already constructed. Further declining prices place existing hydropower at risk. New hydropower resources would face a more difficult challenge, particularly given the extended periods required for hydropower relicensing.

While low wholesale electricity prices sound good for consumers, a downside exists if certain generating resources are expected to provide services with inadequate compensation – particularly since increased reliability services can provide wear and tear on hydropower units. Inadequate compensation can lead to inadequate investment, resulting in supply/demand imbalances. Such imbalances were the

[5] Hydropower Vision Report. Section 2.3.1.

root cause of the 2001 west coast energy crisis, which substantially harmed west coast electricity consumers. For hydropower, concerns about inadequate compensation will come into sharper focus as reinvestment decisions are made in advance of relicensing. The Department of Energy's Hydropower Vision report states that "Enhancing existing market approaches and developing new approaches can help facilitate full recognition and compensation of the suite of grid services, operational flexibility, and system-wide benefits offered by new and existing hydropower."[6] NHA agrees with this conclusion and believes that full recognition of hydropower's benefits for grid reliability and system stability will improve hydropower economics.

- *Federal Policy*

As described in the testimony of Jeffrey Leahey, Deputy Executive Director of NHA before the Senate Energy and Natural Resources Committee on March 14, 2017 (testimony attached), federal policy needs to evolve to support the reinvestment and development of low cost hydropower. Specifically:

➢ Licensing reform. Hydropower has the longest, most complex development timeline for project relicensing or new project approvals of any of the renewable energy technologies, with some projects taking 10 years or longer form the start of the licensing process through construction to being placed-in-service. See *Leahey*, beginning page 12. In addition to these process reforms, the Federal Energy Regulatory Commission should encourage hydropower investments by crediting a licensee's "early actions" when considering the term of the next project license, as this can create more certainty for licensees approaching license renewal. To address many of these process issues, NHA supports congressional efforts to improve the licensing process, including H.R. 3043, the Hydropower Policy Modernization Act of 2017, and the hydropower provisions in S. 1460, the Energy and Natural

[6] Ibid, Page 29.

Resources Act of 2017. NHA is pleased the Committee passed H.R. 3043 in June and we look forward to the legislation advancing.

- ➢ Tax treatment. Disparity in the level and duration of tax credits for hydropower and other renewable resources presents an inequity for hydropower development. See *Leahey*, page 15.
- ➢ Research and Development. While federal support for hydropower research and development has been improving over the last few years, the Water Power program is still one of the smallest in the Office of Energy Efficiency and Renewable Energy. See *Leahey*, page 15.

Conclusion

Hydropower is the nation's premier renewable resource from a cost, emissions and reliability perspective. Due to its quiet long history and relative success, it has for the most part been taken for granted in federal public policy debates. Given the aging infrastructure and potential for new development, it deserves more focus in the development of federal energy policy. As the Congress works to address our energy and infrastructure needs, NHA encourages policies that promote reinvestment, value reliability services, and improve the licensing process to facilitate hydropower's future contributions to electric reliability. Continued investment and re-investment in the system is critical to our energy future and national security. Hydropower's relative value is increasing even as energy prices fall.

- o It is a capacity resource as fossil generation shuts down;
- o It is flexible enough to follow load changes;
- o It provides ancillary services to support grid reliability;
- o It is a low-cost source of emissions-free energy; and
- o It provides products increasingly critical to reliability as the use of variable energy solar and wind expands.

NHA looks forward to working with you to better allow hydropower to contribute to meeting our nation's economic and environmental objectives. Hydropower is not just a legacy resource. Its owners and operators are planning hydropower’s next 100 years of service to this country, and it can grow with adequate compensation and appropriate regulatory policy. I thank the Committee for this opportunity to testify and I look forward to answering your questions.

Attachment – Supplemental Materials

Written Testimony of

Jeffrey Leahey
Deputy Executive Director

On behalf of

The National Hydropower Association

Before the

Senate Energy and Natural Resources Committee
Hearing to Receive Testimony on Opportunities to Improve American Energy Infrastructure

Regarding

An Overview of Hydropower, its Benefits, and Policy Issues

March 14, 2017

Executive Summary

1. In the last several years, hydropower has provided approximately 6 percent of all U.S. electricity generation and nearly half of renewable generation. By 2030, approximately 400 projects representing 18,000 MW of capacity of the existing system will be up for relicensing.

2. Hydropower has significant untapped growth potential, particularly at existing infrastructure and with low impact projects, such as capacity additions at current hydropower facilities, adding generation to non-powered dams, and closed-loop pumped storage, among others. The Department of Energy's recent Hydropower Vision Report estimates that close to 50 GW of new capacity is available by 2050, with the right conditions and policy support in place.

3. New hydropower project development, as well as the relicensing of existing projects, faces a variety of obstacles. These include: a regulatory process that can be modernized to increase coordination and reduce unnecessary duplication, delays and costs; a lack of valuation of grid security and reliability services; and inequitable treatment and recognition under renewable energy tax incentives and other renewable/clean energy programs, including federal R&D funding to support new technologies. Combined, these issues are impacting hydropower competitiveness and creating unnecessary challenges that hold back growth.

4. NHA supports policies to address regulatory inefficiencies and to improve coordination in the overall hydropower project approval process and calls on Congress and the Administration to address this and other energy and market policy issues that limit investment in hydropower infrastructure. And, we believe this can all be done in ways that promote the hydropower resource while protecting environmental values.

5. Hydropower has a critical role to play in meeting our nation's energy, environment, and economic objectives. The benefits from this resource are many – low-cost, reliable, base load renewable electricity, along with additional ancillary grid services (load following, frequency response, energy storage, etc.) – services that will allow our country to add significantly to our national portfolio of renewable, clean energy resources.

6. Finally, as the Congress works to address our energy and infrastructure needs, whether that be on a new national infrastructure program or further work on an energy bill, policies that support the preservation of the existing hydropower system and promote the deployment of new projects (for all categories of water power technologies) must be included. A greater recognition that our hydropower infrastructure is incredibly valuable is needed, and continued investment and re-investment in the system is critical to our energy future and national security.

Introduction

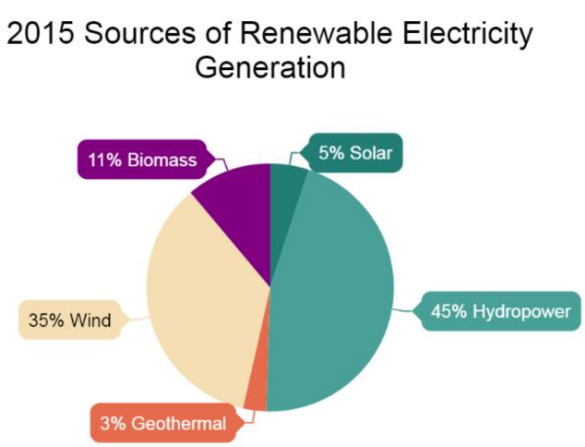
Good morning Chairman Murkowski, Ranking Member Cantwell, and members of the Committee. I am Jeffrey Leahey, Deputy Executive Director of the National Hydropower Association (NHA). I am pleased to be here to discuss the importance of hydropower to the U.S. electric system, the untapped growth potential across the various sectors of the industry, and the policy issues that need to be addressed to fully realize that growth.

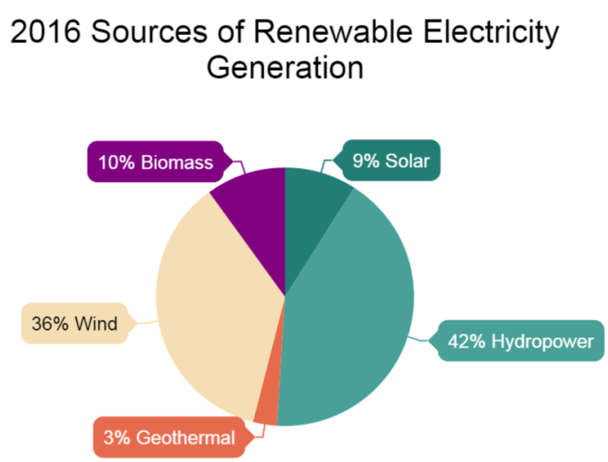
As background, NHA is a nonprofit national association dedicated to promoting clean, affordable, renewable U.S. hydropower – from conventional hydropower to pumped storage to marine energy to conduit power projects. NHA represents more than 220 companies, from Fortune 500 corporations to family-owned small businesses. Our members include both public and investor-owned utilities, independent power producers, developers, equipment manufacturers and other service providers, and academic professionals.

U.S. Hydropower Statistics

Currently, the U.S. conventional hydropower fleet is made up of almost **2200 individual plants** with a total capacity around **80 GW**. In the last two years, these plants provided approximately **6 percent** of all U.S. electricity generation and **almost half** of all renewable electricity generation – making hydropower the single largest provider of renewable electric power in our country. Looking over the long term, hydropower has supplied a cumulative 10 percent of U.S. electricity generation over the past 65 years (1950-2015), and 85 percent of cumulative renewable power generation over the same time period.

In addition to the conventional hydropower system there are an additional **42 hydropower pumped storage plants** with approximately **22 GW** of capacity – projects that make-up almost all, **97 percent**, of energy storage in the U.S. today.[7]

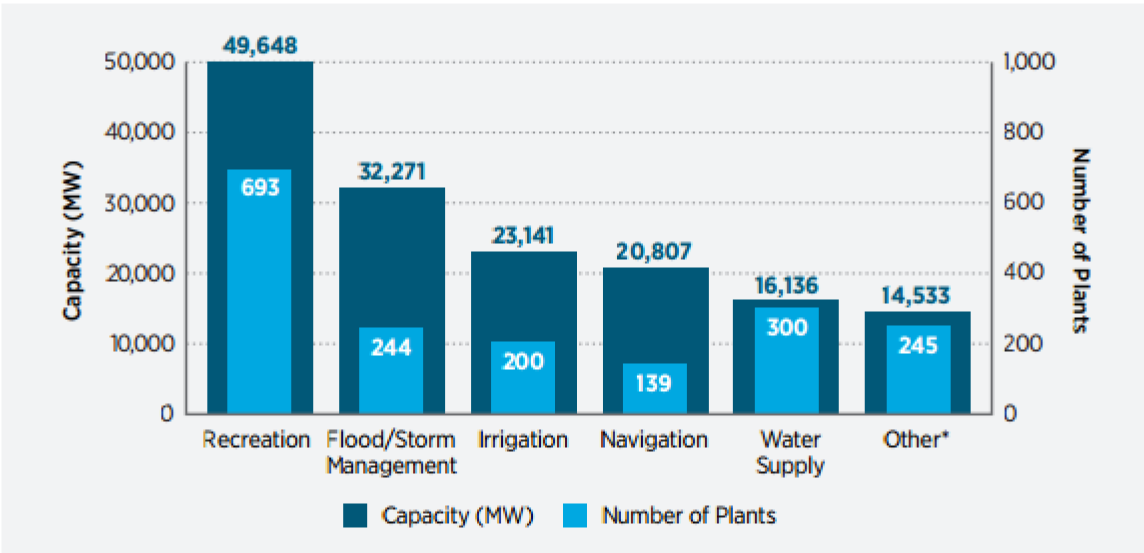




[7] 2016 Hydropower Vision Report, Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office, Executive Summary P. 9. https://energy.gov/sites/prod/files/2016/10/f33/Hydropower-Vision-Executive-Summary-10212016.pdf

Hydropower generation is a clean air resource and avoids millions of metric tons of carbon emissions each year. In fact, regions that rely on hydropower as a primary energy source (like the Northwest) reap the benefits of significantly cleaner air with some of the lowest carbon intensity rates in the country.

In addition to this clean and renewable energy, hydropower infrastructure provides other important benefits, including managing river flow for aquatic species and habitat protection, flood control and drought management, water supply, irrigation and more, as the chart below illustrates.[8]

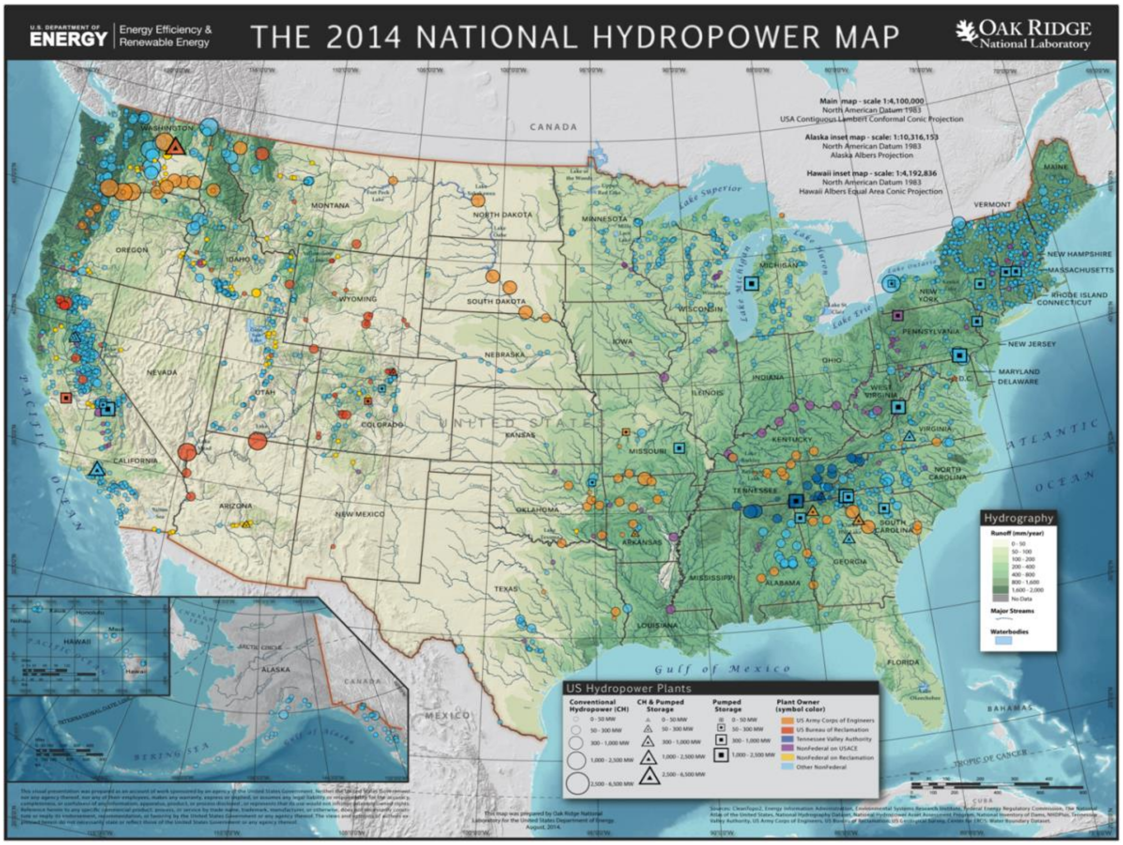


Note: The use categories are not mutually exclusive; a given dam can be included in more than one category. The data include only powered dams.
Source: Uría-Martínez et al. 2015 [2]

Figure 2-11. Total capacity and number of plants for six separate uses (illustrated by the blue bars) of existing hydropower dams and reservoirs

The next map below was developed by the Department of Energy (DOE) through Oak Ridge National Laboratory (ORNL) and provides a visual representation of the size and location of projects for both the federal and non-federal hydropower systems. Existing hydropower assets are located in all but two states (Delaware and Mississippi), though every state receives the benefit of the clean renewable generation that these projects provide.

[8] Hydropower Vision Report, Chapter 2, Page 83.



The contributions of the existing hydropower fleet to the electric grid are many (base load power, peaking generation, load-following, energy storage, reliability and more). With the need for more of these benefits and services, as the nation strives to become more energy independent, NHA has seen the hydropower industry grow and expand in recent years.

In fact, the United States experienced a net capacity increase of **1.4 GW**[9] from 2005 to 2013, enough to power over half a million homes[10]. FERC has reported an additional 260 MW of capacity being placed in service since then, with even more projects in licensing or in the construction phase today. And this number could significantly increase with a modernized regulatory approval process that currently takes years longer than that of other renewable resources – in some cases licensing can take 10 years or longer.

In addition, hydropower projects bring multiple economic benefits to the communities in which they are located and those that they serve. To start, the industry itself currently employs a sizable

[9] 2014 Hydropower Market Report, Executive Summary P. VI.

[10] An Assessment of Energy Potential at Non-Powered Dams in the United States, Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office and Oak Ridge National Laboratory, April 2012, Executive Summary P.VII, Footnote 1. http://nhaap.ornl.gov/sites/default/files/NHAAP_NPD_FY11_Final_Report.pdf

workforce. 143,000 jobs are created just from the continued operation and maintenance, as well as upgrades, of the existing system, with additional employment opportunities gained in the pursuit of new project development and deployment.[11]

One recent example that demonstrates the jobs benefit is AMP Public Power Partners of Ohio. AMP is building 4 new hydropower projects on existing Corps of Engineers' dams on the Ohio River (3 are completed and 1 is still under construction). The company reports that approximately 1800 construction jobs were created over a 4 year construction window, with the operation of the projects providing an additional 50 permanent jobs. Another example is Missouri River Energy Service's Red Rock project on the Des Moines River near Pella, Iowa, currently under construction at a Corps of Engineers dam. The company estimates that 250 workers will be needed on site through 2017-2018.

On top of this, the access to low-cost, reliable clean power is attracting many companies to regions with hydropower. For example, major high-tech companies like Google, Facebook, and Yahoo require large, energy-intensive data centers to drive their businesses. Specifically, in September 2010, Yahoo opened a new facility in Lockport, New York to utilize hydropower provided by the New York Power Authority. And again, in 2013, New York officials cited the importance of low-cost hydropower in Yahoo's decision to expand the Lockport facility.[12]

Another example of hydropower supporting economic development and new job creation partnerships is BMW. Access to low-cost and reliable hydropower along with other renewables lured the company to Moses Lake, Washington. Breaking ground on its $200 million manufacturing facility in July 2010, the plant, a joint venture with SGL Automotive Carbon Fibers, was built to supply parts for BMW's line of high performance cars. In fact, the company in 2014 announced it would fund a $100 million expansion of the facility – again citing access to affordable hydropower along with other renewables.[13]

Growth Potential

One of the largest misconceptions of the hydropower industry is that any growth potential is "tapped out". In its new report issued in 2016 titled, Hydropower Vision: A New Chapter for America's 1st Renewable Electricity Resource, the Department of Energy smashes that myth. The Vision analysis finds that U.S. hydropower could grow to nearly **150 GW by 2050**. This would represent close to a **50 percent** increase in capacity.

The report identifies opportunities for **13 GW** of new hydropower capacity by adding generating facilities to existing non-powered dams and canals, upgrades to existing hydropower facilities, and limited development of new stream reaches. It also finds the potential to add up to **36 GW** of new pumped storage capacity.

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[11] Vision Chapter 2, Page 203-204. https://energy.gov/sites/prod/files/2016/10/f33/Hydropower-Vision-Chapter-2-10212016.pdf

[12] http://www.nypa.gov/Press/2013/130322.pdf

[13] http://www.seattletimes.com/business/bmw-plans-big-expansion-of-moses-lake-carbon-fiber-plant/

Looking to the benefits of this potential, the report finds $148 billion in cumulative economic investment. $58 billion in savings in avoided mortality, morbidity and economic damages from air pollution. Cumulative 30 trillion gallons of water withdrawals avoided for the electric power sector. 5,600,000,000 metric tons of CO_2 emissions reductions with $209 billion in avoided global damages. And over 195,000 hydropower-related gross jobs spread across the nation in 2050.[14] Those are quite substantial benefits for our country.

Adding Generation to Non-powered Dams

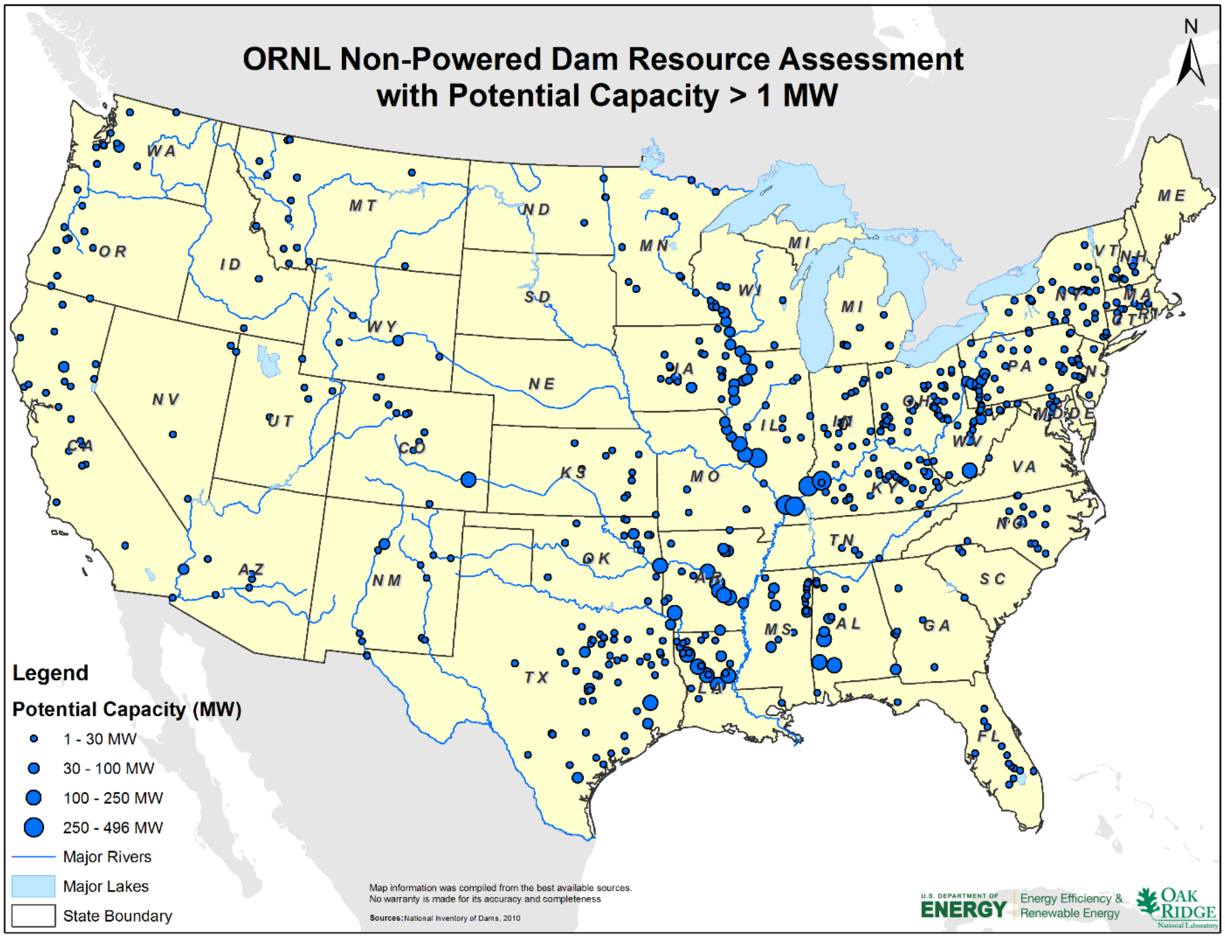
One of the prime areas of growth in the hydropower industry is on existing infrastructure, such as non-powered dams and conduits. Of the approximately 80,000 dams in the U.S. today only **3 percent** have electric generating facilities. Put another way, **97 percent** of our dams do not produce power and were built for other purposes such as water supply, irrigation, navigation and recreation.

NHA recognizes that not every existing dam may be a suitable candidate to add power generating equipment, as many factors come into play in development decisions: project development costs and revenue opportunities; energy generation potential; natural resource considerations; transmission needs; dam safety; etc. However, what this statistic shows is the large untapped universe of potential opportunities that exist – and that are not being developed in significant part because of the concerns about the uncertain, duplicative and lengthy regulatory process.

Those dams that are candidates for hydropower development are infrastructure that will continue to exist, operate and release flows to meet water supply, irrigation, flood control, and other purposes for which they were originally constructed – regardless of whether hydropower facilities are installed. It is good public policy to take advantage of these existing releases to capture the energy currently untapped at these sites to add to our portfolio of renewable, carbon-free resources.

The U.S. Department of Energy recognized this opportunity and in 2012, through the Oak Ridge National Laboratory, released an assessment of potential capacity at non-powered dams for projects greater than 1MW. The map below on the following page depicts the size and location of the top projects of that survey with capacity greater than 1 MW.[15]

[14] Hydropower Vision, Executive Summary P. 7 and 23.
[15] http://www.energy.gov/eere/water/hydropower-resource-assessment-and-characterization



The results of the study show that over **12 GW** of potential exist across the existing system with **8 GW** of potential available at the top 100 sites.[16] Also of interest, **81 of the top 100** sites were located on federal facilities, in particular, Army Corps of Engineers dams.[17]

These types of projects are some of the lowest impact new developments in the energy sector. No new dams need to be built and the projects aim to utilize existing flows through the projects. This water is already moving through the system, what better way to maximize the benefits of this infrastructure by also generating clean, renewable power with them.

Capacity Additions/Efficiency Improvements at Existing Hydropower Infrastructure

The potential for new conventional hydropower generation is not only about adding new capacity at non-powered dams. Existing hydropower facilities are also expanding through upgrades and efficiency improvements.

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[16] 2012 Non-Powered Dams Report, Executive Summary P.VII and VIII.

[17] 2012 Non-Powered Dams Report, Executive Summary P.VIII.

In fact, since EPAct of 2005 and the inclusion of hydropower as an eligible technology in the production tax credit (PTC), over **150 projects** have received certification. These projects have seen, on average, about a **9 percent** gain in generation.[18] These 150 projects represent a small fraction of the hydropower fleet, so there are even further gains to be had if more projects undertake these kinds of upgrades.

And in many instances with these upgrades, the project realizes not only an increase in capacity or generation, but also an increase in environmental performance. The Wanapum Dam Turbine Replacement Project by Grant County Public Utility District in the state of Washington illustrates this. The project includes replacing the original turbines and replacing or refurbishing generating equipment at the dam. The advanced equipment is designed to be 3 percent more efficient. It will also reduce wear on the equipment and improve passage of juvenile salmon.[19]

NHA also notes from an infrastructure perspective that there is tremendous opportunity for re-investment in the federal hydropower system. Almost half of the U.S. hydropower generation comes from the federal system, with the bulk owned and operated by the U.S. Army Corps of Engineers, the Bureau of Reclamation and the Tennessee Valley Authority. The median age for federal hydropower projects is 50 years.[20] Turbine and other equipment refurbishments (including repairs, replacements and upgrades) are available and can improve the performance of these projects both from an energy and environmental perspective.

Hydropower Pumped Storage

Pumped storage is a modified use of conventional hydropower technology to store and manage electricity. As shown below, pumped storage projects store potential electricity by circulating water between an upper and lower reservoir.[21]

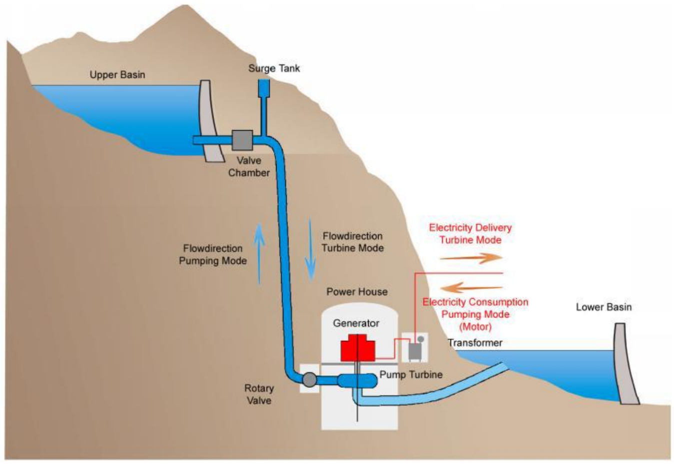
Electric energy is converted to potential energy and stored in the form of water at an upper elevation. Pumping the water uphill for temporary storage "recharges the water battery" and, during periods of high electricity demand, the stored water is released back through the turbines and converted back to electricity like a conventional hydropower station. See illustration below.

[18] Federal Energy Regulatory Commission data.

[19] http://www.grantpud.org/your-pud/projects/wanapum-dam-turbine-and-generator-replacement-project

[20] Hydropower Vision, Chapter 2, Page 147.

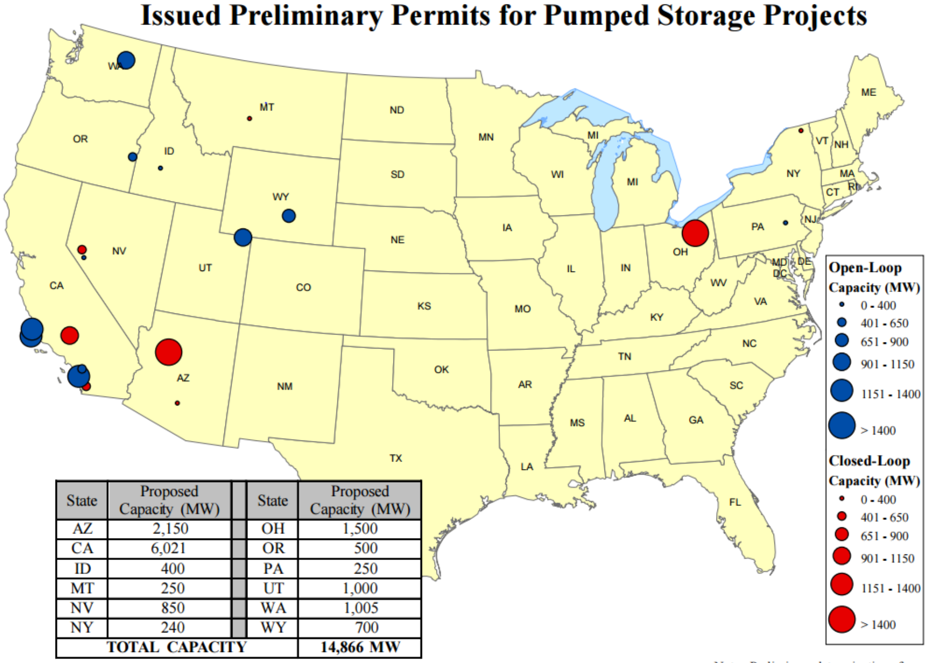
[21] Illustration provided by GE Renewable Energy.



Pumped storage projects able to rapidly shift, store, and reuse energy generated until there is the corresponding system demand and for variable energy integration. This energy shifting can alleviate transmission congestion, which helps more efficiently manage the electric grid, and can reduce the need for costly new transmission projects, as well as to avoid potential interruptions to energy supply.

As more intermittent generation is added to the grid, particularly in the West, the need for the services that pumped storage provides is increasing. As a result, we are seeing a significant renewed interest in these projects, including closed-loop project proposals.[22] As the map below shows, there are currently close to **15,000 MW** of proposed new pumped storage projects before FERC with preliminary permits right now.

Issued Preliminary Permits for Pumped Storage Projects



State	Proposed Capacity (MW)	State	Proposed Capacity (MW)
AZ	2,150	OH	1,500
CA	6,021	OR	500
ID	400	PA	250
MT	250	UT	1,000
NV	850	WA	1,005
NY	240	WY	700
TOTAL CAPACITY			14,866 MW

Note: Preliminary determination of open- vs. closed-loop classification based on preliminary permit application.

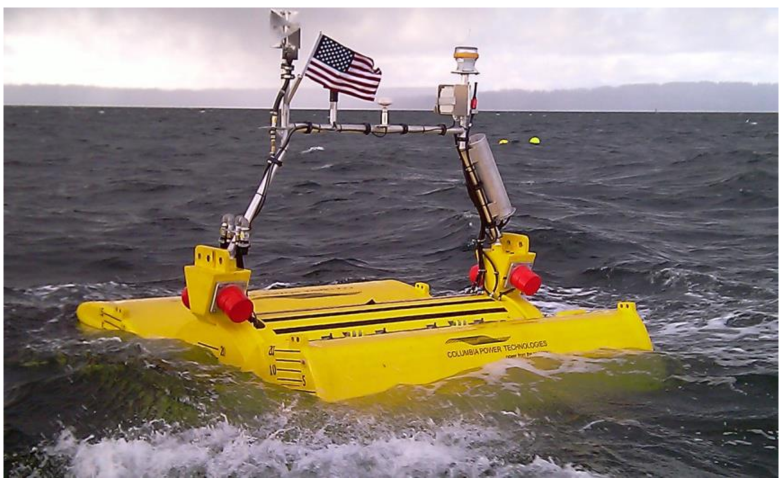
Source: FERC Staff, January 12, 2017

[22] Closed loop pumped storage projects are physically separated from existing river systems. They present minimal to no impact to existing river systems because after the initial filling of the reservoirs, the only additional water requirement is minimal operational make-up water required to offset evaporation or seepage losses.

Again, NHA recognizes that not all of these projects may be developed, however, they clearly rebut the proposition that hydropower is a “tapped out” resource.

Marine Energy and Hydrokinetics

With more than 50 percent of the U.S. population living within 50 miles of coastlines, there is vast potential to provide clean, renewable electricity to communities and cities across the United States using marine and hydrokinetic (MHK) technologies. MHK technologies extract energy from waves, tides, ocean currents, rivers, streams, and ocean thermal gradients. Though still in its early stages of development as a whole, the MHK industry continues to move forward with new technological innovations, test site developments, and demonstration projects.[23] DOE assessments have estimated that the total marine resource potential represents up to 25 percent of projected U.S. electricity generation requirements by 2050.[24]



Conduits

Conduit projects utilize existing tunnels, canals, pipelines, aqueducts and other manmade structures that move water. These are fitted with electric generating equipment and are often small projects that are able to extract power from the water without the need for additional infrastructure or a reservoir.

One of the prime opportunities in this sector is at Bureau of Reclamation infrastructure. In a recent study, Reclamation identified 373 potential sites with a capacity of 103 MW, enough to power 33,000 homes.[25]

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[23] Photo below of technology demonstration of Columbia Power Technologies of Charlottesville, Virginia
[24] https://energy.gov/eere/water/marine-and-hydrokinetic-resource-assessment-and-characterization
[25] Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits (Final Report - March 2012). https://www.usbr.gov/power/CanalReport/

In addition, as a result of the expedited review of non-federal conduit projects under the Hydropower Regulatory Efficiency Act of 2013, the Federal Energy Regulatory Commission (FERC) has approved dozens of small conduit projects across the country.[26][27]

Also, in 2013, legislation was passed focused on similar small conduit development at Bureau of Reclamation infrastructure and Reclamation has made changes to its lease of power privilege (LOPP) program. Reclamation continues to see increased interest in these project opportunities as well.[28]

New Stream-Reach Development

Lastly, the DOE has also recently conducted a study of potential new greenfield projects. The assessment concluded that the technical 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 about 65 GW of capacity.[29] Not all of these new hydropower opportunities are likely to move forward once site-specific considerations are taken into account. Site selection will be an important factor. Additionally, the industry and the DOE are investigating innovative new technologies and operational regimes to see where some of this potential can be realized, while also minimizing potential impact.

Challenges for Hydropower and Policy Needs

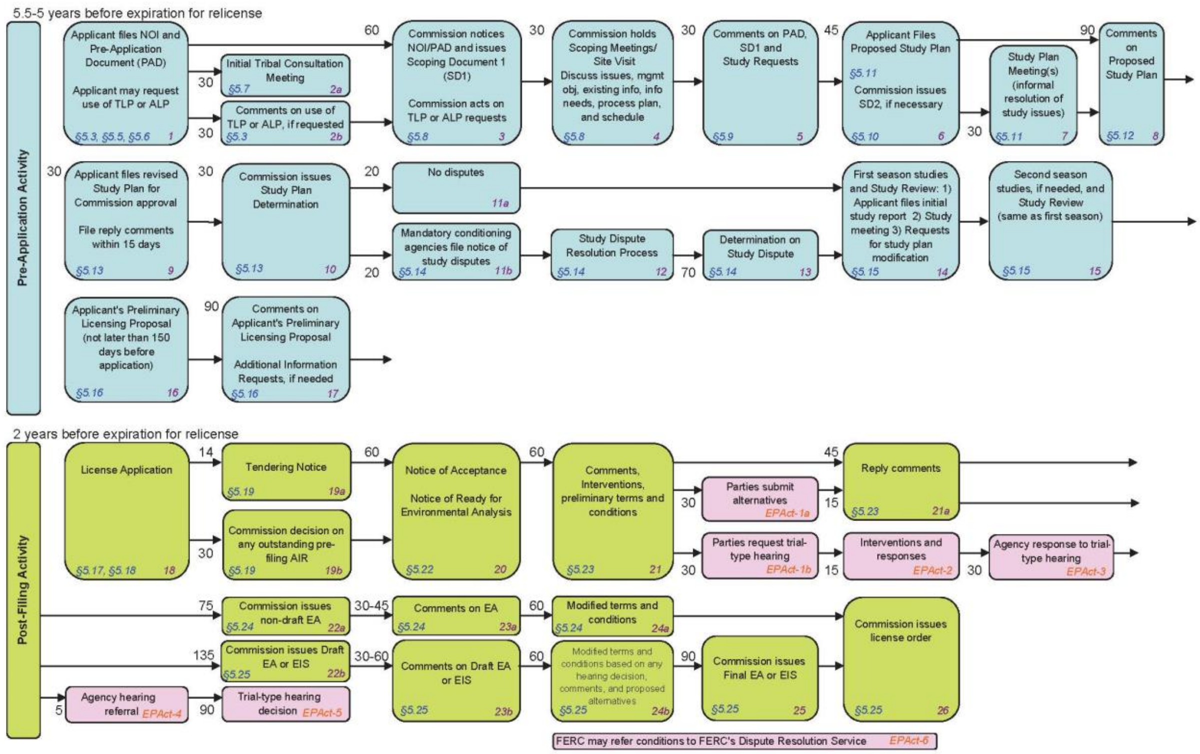
To begin, hydropower has the longest, most complex development timeline (for project relicensing or new project approvals) of any of the renewable energy technologies, with some

[26] https://www.ferc.gov/industries/hydropower/indus-act/efficiency-act/qua-conduit.asp
[27] Picture of Natel Energy, Monroe Hydro Project, a 250 kw hydroelectric plant located in an irrigation canal, in partnership with Apple.
[28] https://www.usbr.gov/power/LOPP/index.html
[29] http://www.energy.gov/eere/water/downloads/new-stream-reach-hydropower-development-fact-sheet

projects taking **<u>10 years or longer</u>** from the start of the licensing process through construction to being placed-in-service.

This process requires a considerable up-front financial commitment from the developer or asset owner to undertake the engineering and environmental studies required for various federal and state approvals. The chart below outlines the integrated licensing process or ILP, the default process, of several, for authorizing hydropower projects.

Integrated Licensing Process
(Section 241 of the Energy Policy Act of 2005)



*Section 241 of the Energy Policy Act of 2005 in pink.

A multitude of federal and state agencies, as well as the public and other stakeholders, play a major and important role in the process. And in the chart above, additional authorizations such as those required by federal dam owners if building on their infrastructure, are not included. These decisions and authorizations have tended to come at the end of the timeline after the FERC issuance of the license.

Water is a public resource and NHA and the industry recognize the necessity for and value of thorough review of project applications. However, redundancies and sequential reviews contained in the overall process are key reasons for delays. For example, for projects adding generating facilities to non-powered federal dams, FERC may issue a license, yet that project cannot commence construction until it has received additional approvals from the federal owner of the dam (Corps of Engineers or Bureau of Reclamation). If there are unanticipated delays for those additional needed approvals, no work can commence. It is a similar case for state issuances of Clean Water Act Section 401 water quality certifications. A license cannot be issued, nor work commenced, until the certificate is approved.

NHA believes the time, cost and risks associated with licensing hydropower projects are not commensurate with the impacts, particularly when compared with other forms of generation – conventional or renewable. As former NHA President John Suloway testified before Congress in 2015[30], because of this, when faced with the choice of what type of generation to install, there is less risk in choosing a simple cycle turbine or a combined cycle plant that burns natural gas or low-sulfur oil, than building a hydropower plant.

While there is some variability with regard to size and location, the regulatory approval processes for simple cycle turbine or combined cycle plants are generally 1-2 years – even in urban areas like New York City. The FERC licensing process for hydro plants is generally 8 years or more, including both licensing and pre-filing activities. With regard to licensing costs, a combined cycle plant is approximately $1 to $2 million; whereas, some studies alone can cost multiples of that figure for a hydropower project. It is not uncommon for a hydropower license applicant to spend $10 million or more on just the licensing process.

And this is not just an issue for new project deployment, but also for existing projects that are undergoing relicensing. In fact, by 2030, **approximately 400 projects**, representing **18,000 MW** of capacity, will be in or have gone through relicensing. NHA has already begun to hear from owners of smaller projects, particularly in the Northeast, but across the country, that the process costs for licensing may render projects uneconomic and result in the surrender of licenses. As states continue to press for more clean and renewable energy resources, it would be unfortunate to lose the many benefits these existing hydropower projects provide.

NHA believes that Congress and the Administration should seek to reduce uncertainties in the hydropower licensing and relicensing processes, eliminate unnecessary and/or duplicative studies or other requirements, create discipline in the schedule, and reduce the time for obtaining federal and state approvals. In doing so, policymakers would be recognizing the value of hydropower as a critical component in the nation's energy supply portfolio. In addition, NHA believes process improvements can maintain the substantive ability of federal and state regulators to appropriately protect, mitigate and enhance natural resources.

Another issue that holds back hydropower is its limited recognition, or the complete lack thereof, as a renewable and/or clean energy resource under federal or state programs/environmental markets. State renewable portfolio standards provide one good example, and often contain restrictions on the amount of hydropower that is eligible. These include: project capacity limitations (30 MWs or less); placed-in-service restrictions (no eligibility for existing generation); resource and technology limitations (i.e. existing infrastructure; no new dams; capacity uprates or efficiency improvements only); explicit operational or impact criteria (run-of-river; low-impact certified), among others.

[30] https://energycommerce.house.gov/hearings-and-votes/hearings/discussion-drafts-addressing-hydropower-regulatory-modernization-and

On the federal side, there are many recent examples of initiatives related to renewable energy development on public lands, federal renewable energy procurement policies, and government-wide sustainability goals that either excluded hydropower as an eligible renewable technology, or qualified hydropower in a way that significantly reduces (or effectively eliminates) its ability to participate.

For example, in 2015, Executive Order No. 13,693 utilized a definition of "renewable electric energy" that includes only new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project and yet excludes generation added to non-powered dams and others.[31] Another example is the 2012 U.S. Army Corps of Engineers proposal for "Large Scale Renewable Energy Production for Federal Installations", which completely excluded hydropower as an eligible resource. And also, the EPA's Green Power Partnership Program significantly limits the definition of qualifying hydropower. When hydropower is not included and recognized as a renewable resource on par with other resources like wind and solar, it creates a distinct economic and market disadvantage for the industry participants (existing asset owners and developers alike).

This disadvantage is no more clearly illustrated than in the context of the extension of the renewable energy tax incentives (Section 45 production tax credit (PTC) and Section 48 investment tax credit (ITC)). The PATH Act of 2015 created a competitive imbalance between incentives for wind and solar and other renewables, including hydropower. While the PTC and ITC for hydropower, MHK, and other technologies was extended through the end of 2016 (now lapsed), the credits for electricity produced from wind and solar facilities was extended for years longer. This on top of the fact that the hydropower industry, only receives, and has only ever received, half-credit under the PTC since becoming eligible years after the program was created for the wind industry.

As hydropower projects continue to compete for investment dollars, the policies adopted at the end of 2015 tipped the scales against investment in hydropower, putting the industry at a distinct disadvantage – a disadvantage that is magnified when you include the RPS policy treatment other renewable resources have as described above. NHA is working to fix this inequity to allow hydropower resources to better compete in the marketplace without the thumb on the scale tipped in favor of other renewable resources in the tax arena.

Lastly, on the federal policy front, NHA highlights investment in R&D for technology innovation. The DOE Water Power program, which represents the single largest source of renewable electricity in the United States today, still remains one of the smallest of the Office of Energy Efficiency and Renewable Energy (EERE), particularly when compared to the funding levels for other EERE programs.

The graph that follows charts the funding levels for the EERE programs from FY 2008 through the Administration's FY 2017 funding request, including American Recovery and Reinvestment Act of 2009 (ARRA).

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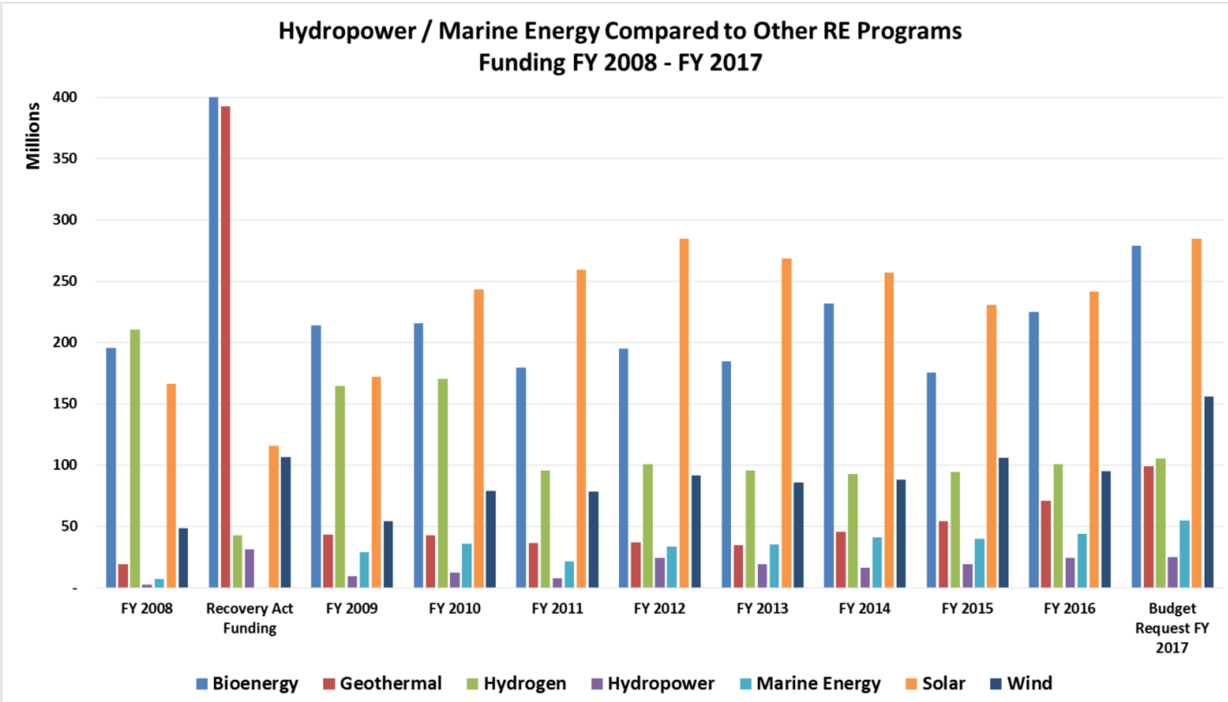
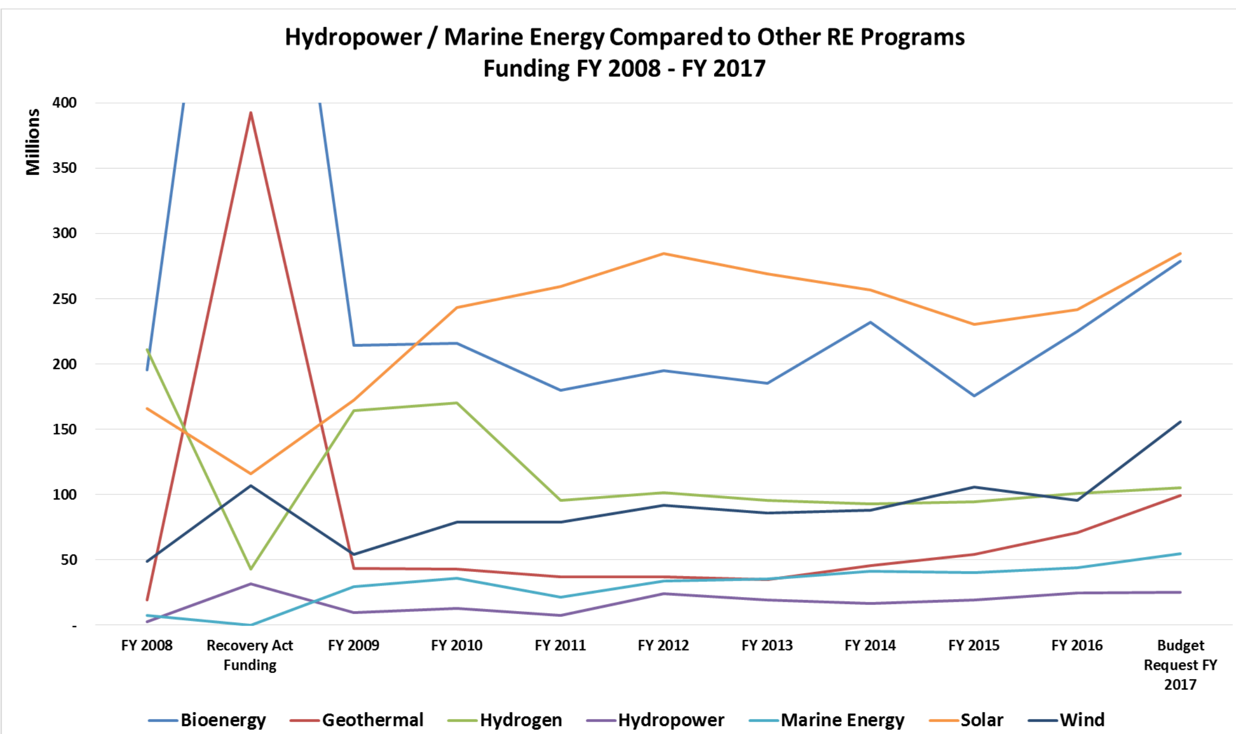
[31] Fixing America's Surface Transportation Act (Pub. L. No. 114-94) Executive Order No. 13,693, Planning for Federal Sustainability in the Next Decade (2015)



The next graph below presents the same information, but more clearly shows the trend lines through time for each individual renewable energy technology program.



NHA appreciates and is encouraged by the growing investments by Congress in the DOE's Water Power program activities in recent years. However, as these charts clearly indicate, the level is still substantially below that afforded other EERE programs, with the hydropower program receiving the least funding, followed by the MHK program receiving the next lowest level of funding. One of the factors for the tremendous growth in other renewables over the last several years is the sustained investment shown by the federal government in technology R&D and market acceleration initiatives in these sectors.

One final policy area that NHA would like to raise is that of regional electricity/power markets. Similar to what was discussed above on the state and federal energy policy front, oftentimes the various grid benefits both hydropower and pumped storage projects provide are not valued or compensated in our existing electricity markets. NHA, in 2015, filed comments with FERC on this issue that we believe are useful in this discussion and highlight the need to re-examine policies in order to promote hydropower deployment.[32]

In its filing, NHA notes:

> "While energy storage projects are eligible to participate in some markets, there are several attributes of energy storage and specifically pumped storage units that are not currently addressed by these tariffs. Pumped-storage plants can offer significantly more benefits to the electric system than those commonly recognized by ISOs and included in the comments previously received by the ISO commenters. Specifically pumped storage plants can offer real time system inertia [see FERC 755 reference to flywheel effect], generator droop setting that can respond to system conditions instantaneously, and Automatic Voltage Regulation Control (AVR) that can adjust rotor field strength in real time. All three of these services can be provided by traditional hydropower generators as well and pumped storage plants. These three services are critical services that allow instantaneous response to grid conditions that keep the voltage and frequency stable as other services like AGC respond in the ultrafast 1-4 second time frame. Markets are not currently available to compensate for these services.
>
> Additionally, energy storage devices are able to provide grid services that offset the need for new transmission and or distribution infrastructure. Under the current regulatory environment, energy storage plants are classified as a generation resource and are not currently eligible for to get a transmission rate of return for these services."

Conclusion

Both the existing system and new hydropower projects have a critical role to play in meeting our nation's energy, environment, and economic development objectives and much is at stake for hydropower and the families, businesses and communities that rely on its low-cost, reliable, renewable generation.

[32] See: Electric Storage Participation in Regions with Organized Wholesale Electric Markets, FERC Docket No. AD16-20-000

NHA and the hydropower industry stand ready to help meet our common clean energy goals and we look forward to working further with Congress and the Administration to find pathways to address the important policy issues – federal, regional and state – to fully maximize and unlock the potential of the hydropower resource.

As the Congress works to address our energy and infrastructure needs, whether that be on a new national infrastructure program or further work on an energy bill, policies that support the preservation of the existing hydropower system and promote the deployment of new projects (for all categories of water power technologies) must be included. A greater recognition that our hydropower infrastructure is incredibly valuable is needed, and continued investment and re-investment in the system is critical to our energy future and national security.

I thank the Committee for providing me this opportunity to testify and I look forward to answering your questions.