National Hydropower Association

Hydropower – A New Look at Opportunities for America’s First Renewable Energy Resource

Environmental and Energy Study Institute Briefing

April 24, 2019
Presentation Overview

• About NHA
• Current state of hydropower
• Growth potential
• Benefits – climate, environmental, grid reliability
• Federal and state policy, market and valuation challenges
• Q&A
NHA’S VISION
Hydropower, in all of its forms, is valued as America’s first, and most flexible renewable energy resource to achieve a sustainable, clean, and secure electric system in North America.

NHA’S MISSION
Champion waterpower as America’s premier carbon-free renewable energy resource. Inform public policy to protect, enhance and expand waterpower within the U.S. electric system. Share technological advancement and encourage operational excellence among our members.

NHA’S VALUES
NHA will achieve its goals through a culture of:
- Organizational Excellence:
  • A competent, responsive and committed staff
  • Strong, forward thinking leadership
  • Excellent stewardship of resources
  • Inclusiveness of its member companies
- Collaboration:
  • Water users and other stakeholders
  • The environmental community
  • The regulatory community
  • National and regional industry associations
Current state of hydropower
2018 Hydropower Renewable Generation

In 2018, hydropower made up 7 percent of total U.S. electricity generation and 39.5 percent of renewable electricity generation.

While hydro generation declined slightly by 3.3% (from 300 TWh in 2017 to 292 TWh in 2018) due to a drier year in the west, it still remains the largest source of renewable generation.

Approximately 102 GW of existing capacity, includes 23 GW of pumped storage – 95 percent of U.S. energy storage

The U. S. Hydropower Fleet

Legend
Capacity
- 0 - 100 MW
- 100 - 500 MW
- 500 - 1500 MW
- 1500 - 3000 MW
- 3000 - 6809 MW

Build Time
- pre 1900
- 1900 - 1929
- 1930 - 1939
- 1940 - 1949
- 1950 - 1969
- 1970 - 1989
- 1990 - 2008

Map information was compiled from the best available sources. No warranty is made for its accuracy and completeness.
Sources: ORNL, NID

Wind surpassed hydro in capacity in 2016.

U.S. cumulative renewable capacity

Hydro still top generator of RE power.
RE comparisons

Total renewable capacity has nearly doubled since 2008, reaching 239GW in 2017 (excluding pumped hydro).

Nearly all the growth has come from wind and solar, which together jumped 471% during that period while other technologies held flat, in part due to weaker tax policy support. Wind and solar have also benefited from state-level renewable portfolio standards (RPS) and rapidly declining system costs.
Growth Potential
DOE Hydropower Vision

With NHA as the lead partner, DOE issued a first-of-its kind report in 2016 of hydro’s contributions to the nation’s energy portfolio as well as its future growth.

Hits the reset button on hydropower.

The Report finds upwards of **26 GW by 2030** and almost **50 GW by 2050**.

Hydro is not tapped out.

As a nation, we have a clear choice to make about our clean energy future: Stand still or unlock hydropower's potential.

- **1.75 GW**: New Stream-reach development
- **6.3 GW**: Upgrades at existing hydropower projects
- **4.8 GW**: Developing on existing non-powered dams
- **35.5 GW**: New pumped storage projects, along with upgrades at existing facilities.
80,000+ U.S. Dams – only 3% powered

Source: USACE, ORNL
Conventional Hydro Growth – Upgrades at Existing Facilities

The potential for new conventional hydro generation is not just about adding capacity at non-powered dams.

Existing hydro facilities are expanding through upgrades and efficiency improvements.

In fact, since EPAct 2005 and the inclusion of hydro in the production tax credit (PTC) and later the investment tax credit (ITC), 150+ projects have seen, on average, about a 9 percent gain in generation. (FERC data)
Typical Pumped Storage Plant Arrangement (Source: GE)
Issued Preliminary Permits for Pumped Storage Projects

<table>
<thead>
<tr>
<th>State</th>
<th>Proposed Capacity (MW)</th>
<th>State</th>
<th>Proposed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>600</td>
<td>OR</td>
<td>500</td>
</tr>
<tr>
<td>AZ</td>
<td>2,150</td>
<td>PA</td>
<td>1,561</td>
</tr>
<tr>
<td>CA</td>
<td>1,094</td>
<td>SD</td>
<td>1,200</td>
</tr>
<tr>
<td>KY</td>
<td>500</td>
<td>UT</td>
<td>1,050</td>
</tr>
<tr>
<td>MN</td>
<td>1,332</td>
<td>VA</td>
<td>870</td>
</tr>
<tr>
<td>MT</td>
<td>280</td>
<td>WA</td>
<td>5</td>
</tr>
<tr>
<td>NV</td>
<td>1,550</td>
<td>WV</td>
<td>1,000</td>
</tr>
<tr>
<td>NY</td>
<td>49</td>
<td>WY</td>
<td>1,100</td>
</tr>
<tr>
<td>OH</td>
<td>1,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL CAPACITY</strong></td>
<td><strong>16,341 MW</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: FERC Staff, February 1, 2019
## Marine and Hydrokinetic Resource Potentials

<table>
<thead>
<tr>
<th>RESOURCE ASSESSMENT</th>
<th>RESOURCE POTENTIAL$^1$</th>
</tr>
</thead>
</table>
| Waves$^2$           | Theoretical: 1,594-2,640 TWh/year$^3$
                      | Technical: 898-1,229 TWh/year |
| Tidal streams       | Theoretical: 445 TWh/year
                      | Technical: 222-334 TWh/year   |
| Ocean currents       | Theoretical: 200 TWh/year
                      | Technical: 45-163 TWh/year   |
| River currents       | Theoretical: 1,381 TWh/year
                      | Technical: 120 TWh/year      |

From DOE Waterpower Technologies Office
Benefits: climate, environmental, and grid reliability
**Climate, environmental benefits**

**Growing Hydropower by 50 GW by 2050 means...**

<table>
<thead>
<tr>
<th>Significant Economic and Social Benefits:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GHG</strong></td>
</tr>
<tr>
<td>$209 billion savings from avoided global damages from GHG emissions</td>
</tr>
<tr>
<td><strong>Air Pollution</strong></td>
</tr>
<tr>
<td>$58 billion savings in avoided mortality, morbidity, and economic damages from emissions reduction (SO₂, NOx, and PM2.5)</td>
</tr>
<tr>
<td><strong>Water</strong></td>
</tr>
<tr>
<td>30 trillion gallons of avoided water use</td>
</tr>
<tr>
<td><strong>Jobs</strong></td>
</tr>
<tr>
<td>195,000 jobs supported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A Healthier America - Reductions in:</th>
</tr>
</thead>
</table>
| Fewer cases of lower respiratory symptoms  
  (age 7-14)  | 217,000 |
| Fewer cases of upper respiratory symptoms  
  (asthmatics age 9-11)  | 323,000 |
| Fewer minor restricted-activity days  
  (age 18-65)  | 8,203,000 |
| Fewer lost work days  
  (age 18-65)  | 1,363,000 |
| Fewer cases of asthma exacerbation  
  (age 6-18)  | 757,000 |
| Fewer cases of acute respiratory symptoms  
  (ages 18-65)  | 4,965,000 |

DOE 2016 Hydropower Vision Report
Grid reliability and resiliency benefits

Hydropower is a premiere flexible generating resource.

It provides the following reliability components including:

energy,
peak capacity,
voltage support,
regulation,
spinning and non-spinning reserves,
storage,
black start capability, and
inertia.

For more details see House E&C Committee testimony of Steve Wright, General Manager of Chelan County PUD. October 2017
<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Essential Reliability Services</th>
<th>Fuel Assurance</th>
<th>Flexibility</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency Response (Inertia &amp; Primary)</td>
<td>Voltage Control</td>
<td>Contingency Reserve</td>
<td>Load Following</td>
</tr>
<tr>
<td>Hydro</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Natural Gas - Combustion Turbine</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Oil - Steam</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Coal - Steam</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Natural Gas - Steam</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Oil / Diesel - Combustion Turbine</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Battery / Storage</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Demand Response</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>

Source: PJM 2017
Federal and state policy, market, and valuation challenges
Challenges to Hydro Growth

- **Long development lead times**
  - Permitting and licensing can take up to/longer than a decade, followed by construction.
  - Incentives expired, or extended on short-term basis.

- **Large up-front capital investment required**
  - Beyond licensing, studies, PM&E costs, projects require significant capital. (new pumped storage - $1-2 billion).
  - Projects economic over long term, but high upfront costs.

- **Uncertainty re: incentives, markets and regulatory policy**
  - Financial community concerned that incentives for hydro are not be renewed before project comes online.
  - Market policies don’t fully compensate hydro’s services.
  - Affects utilities and developers (large & small) alike.


Relicensing Pipeline

Over 300+ existing hydro projects will have licenses that expire over the next 10+ years.

Many of these projects are small.

Areas of concentration include New York, New England and Upper Midwest.

See a listing at FERC at: https://ferc.gov/industries/hydropower.asp
Additional Policy Challenges

Federal Example – Production & Investment Tax Credits (PTC and ITC)

• Current tax policy is picking winners and losers, driving investment away from hydro, pumped storage and marine energy.

• **Today, tax incentives (PTC/ITC) for hydropower and marine energy have lapsed**, while the credits for other renewables, industries with which hydro competes have enjoyed long-term extensions.

This puts hydro at a severe competitive economic disadvantage in the marketplace, particularly for investors seeking clarity and certainty.

Also, there is no federal tax incentive for energy storage.
State Example – RPS Eligibility

- Current state RPSs do not value existing hydro commensurate with other renewables. This reflects original design intent and targets.

- Excluding Federal capacity, and assuming $5/REC in states w/o price data, a value gap for hydro of about $1.5 billion per year exists versus if hydro was supported similarly to wind and solar under State RPSs.

- The policy decision to exclude existing hydro may have made sense 25 years ago when there was significant existing hydro and minimal generation from other RE resources. But that has now changed. Yet, all of the now existing other RE generation continues to receive the financial benefit of RECs going forward, where existing hydro remains excluded.
State Example – energy storage targets and treatment of pumped storage

- There is an inconsistent treatment of pumped storage in energy storage policy (deadlines that do not account for longer development timelines, project size restrictions, technology definitions).

- Example - the CA Public Utilities Commission established 1,325 MW of energy storage by 2020, but severely limited pumped storage eligibility.

- “However, the sheer size of pumped storage projects would dwarf other smaller, emerging technologies; and as such, would inhibit the fulfillment of market transformation goals. The majority of pumped storage projects are 500 MW and over, which means a single project could be used to reach each target within a utility territory. Therefore, we find it is appropriate to exclude large-scale pumped storage projects from the procurement mechanism outlined in this decision. Accordingly, large-scale pumped storage projects greater than 50 MW will not be eligible to bid…”
Deployment: U.S. cumulative energy storage

Commissioned capacity

Market Policy Example – compensation of grid services

NHA agrees with the analysis by the DOE in the 2016 Hydropower Vision Report:

“Changes and trends in the electric sector call for a fresh look at the future role for hydropower. Lower natural gas prices, as well as coal and nuclear power plant retirements, contribute to a changing generation mix and potential markets for new generation sources. An increasing need to integrate variable generation resources, such as solar and wind, will lead to greater demand for grid flexibility and balancing services. Hydropower generation and PSH provide these needed services due to their consistent availability and their capability for rapid response to changes in demand.”

DOE Hydropower Vision Report. Executive Summary P.12
The Vision Report goes on:

“Inherent market and regulatory challenges must be overcome to realize hydropower’s potential to improve grid flexibility and facilitate integration of variable generation resources. The full valuation, optimization, and compensation for hydropower generation and ancillary services in power markets is difficult, and not all benefits and services provided by hydropower facilities are readily quantifiable or financially compensated in today’s market framework. In traditional and restructured markets, as well as in emerging environmental markets, many hydropower services and contributions are not explicitly monetized. In some cases, market rules undervalue operational flexibility, which is important to maintaining grid reliability and is a prime attribute of hydropower.”
NHA Messages to Policymakers

Regulatory Improvements
• Provide for a more efficient regulatory process for hydropower licensing, both new and existing projects.

Markets/Incentives
• Properly value the grid benefits that hydropower and pumped storage provides (PUCs, RTOs and ISOs)
• Provide continued federal tax policies that incentivize hydropower growth.

Funding
• Support technology advancement and project deployment with continued robust appropriations in FY 2020 for the DOE Water Power Technologies Office and the federal hydropower owners’ budgets.

Clean Energy Programs
• Include hydropower in programs designed to spur clean electricity growth (e.g. RPS, CES, climate, federal renewable power procurement, etc.)
NHA Conclusions

• Hydro is an important tool in the addressing climate challenges, not only for its own clean, renewable generation, but for its ability to integrate more renewables and for grid reliability services.

• Hydro is **not** tapped out - capacity additions/efficiency improvements at existing plants, building on existing infrastructure (dams and conduits), pumped storage, and marine energy.

• However, significant policy and market barriers prevent the full utilization of this growth, and the preservation of existing assets.

• Attention needed by all levels of government - federal, state, regional.
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Questions?