Hydropower

Hydropower is the United States' oldest and most reliable renewable energy resource, and its potential still is not fully tapped. As we work to decarbonize the power sector, hydropower's unique benefits are an essential part of any climate solution. Only a small percentage of the dams in the United States are used to generate electricity. Investment in upgrading existing facilities and constructing new hydropower projects could increase the current generating capacity of hydropower by up to 50 percent by 2050. CRES Forum believes in strengthening efforts to harness hydropower's potential to contribute to a resilient, reliable energy supply chain that is economical for consumers.

Growth Potential

Today, clean and renewable hydropower provides energy to over 30 million American homes. It is the second-largest source of renewable energy in the United States after wind, accounting for 6.6 percent of total electricity generation and 37.7 percent of renewable electricity generation in 2019.[1] As impressive as that sounds, its growth potential remains immense. According to the Department of Energy's (DOE) Hydropower Vision Report, hydropower can sustainably grow its current 101 GW of capacity by an additional **50 GW by 2050.**

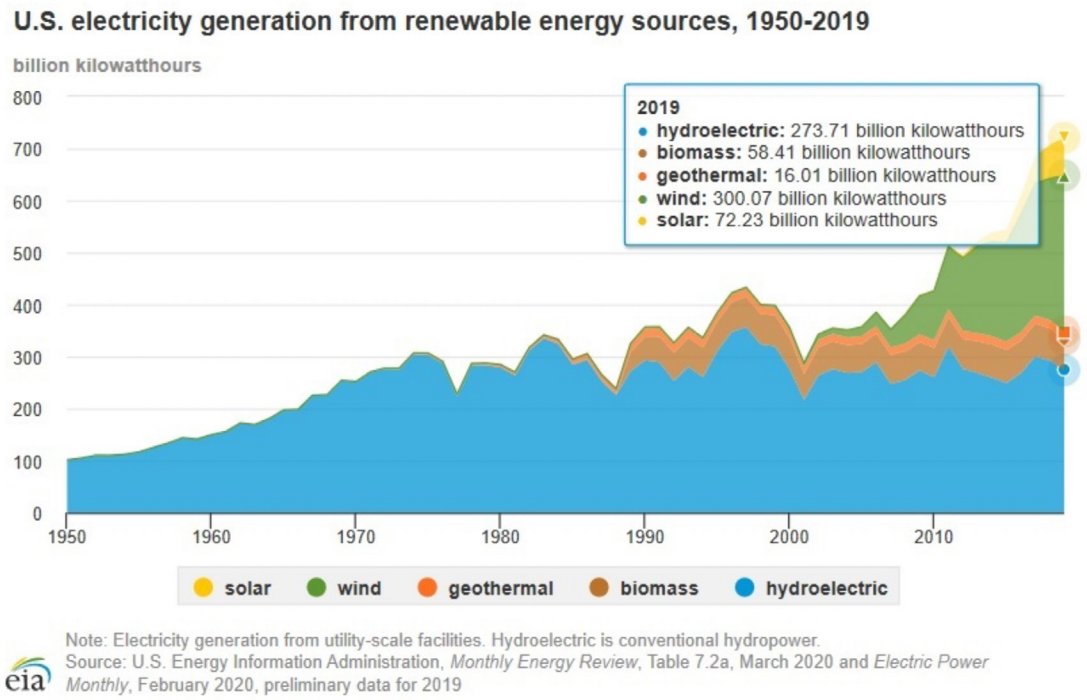

Figure 1. Evolution of U.S. electricity generation by type of energy. Source: U.S. Energy Information Administration, "Electricity explained Electricity in the United States," 20 March 2020 https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php.

[1] U.S. Energy Information Administration (EIA), "What is U.S. electricity generation by energy source?" 2019. Available at https://www.eia.gov/tools/faqs/faq.php?id=427&t=3.

Today, only 3 percent of the nation's 80,000 dams have electricity generating equipment.[2] This provides an opportunity to produce a substantial amount of renewable electricity by converting some non-powered dams to include clean generation. Moreover, hydropower has great potential to do more, especially through new, innovative technologies.

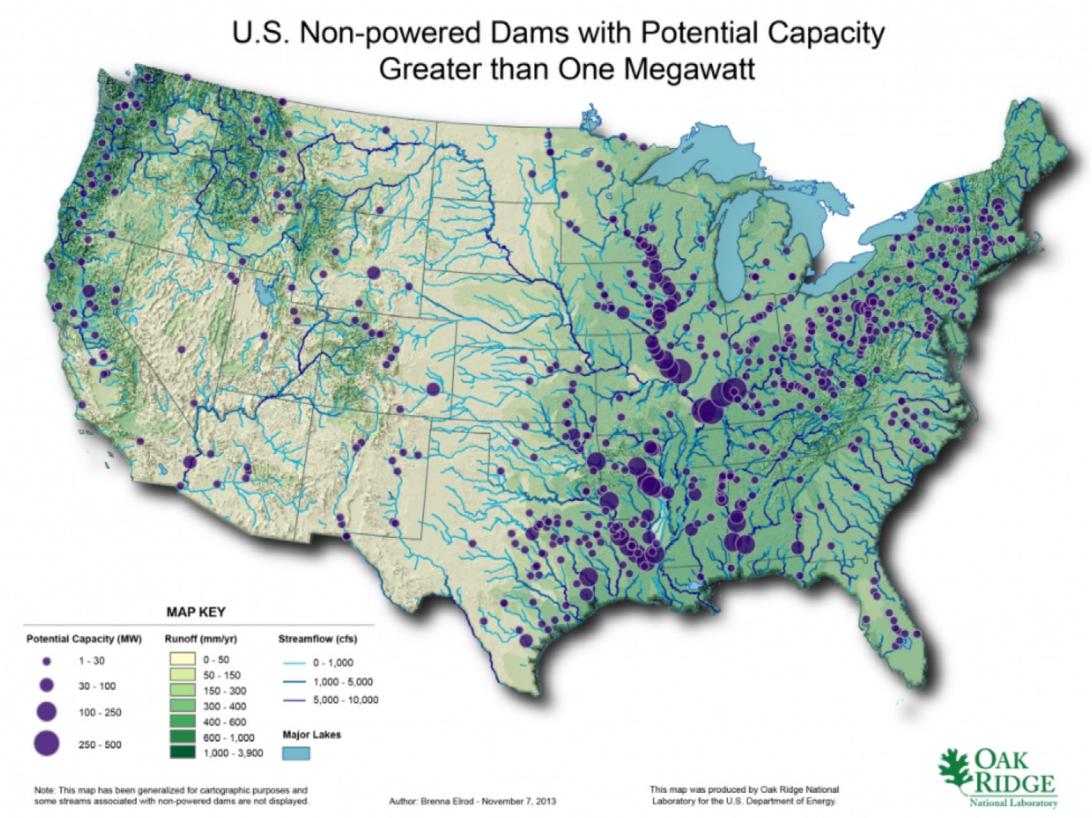

Figure 2. Non-powered dams in the U.S. Source: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Hydropower Resource Assessment and Characterization," available at https://www.energy.gov/eere/water/hydropower-resource-assessment-and-characterization. Map produced by Oak Ridge National Laboratory for the Department of Energy.

Deployable Hydropower Technologies

Conduit hydropower. Thousands of miles of man-made canals, pipes, tunnels, and aqueducts in the United States are constantly carrying water—for irrigation, to larger bodies of water, to households, or into municipal wastewater systems. Conduit hydropower improves upon existing water infrastructure to produce power without the need for a large dam or reservoir.

Conduit hydropower projects divert water from a reservoir, lake, or river through a pipe of some kind. The water flows through hydraulic turbines on its way to its ultimate destination, which may be to irrigate crops or the city's municipal water system. By fitting these existing pipes with turbines, a new, efficient, innovative power source is borne out of generation that is otherwise uncaptured.

[2]Department of Energy, "Top 10 Things You Didn't Know About Hydropower," 27 April 2015. Available at https://www.energy.gov/articles/top-10-things-you-didnt-know-about-hydropower.

Run-of-the-river facilities channel part of the stream through a powerhouse before the water rejoins the main river. Generation depends on natural incoming flows.

Pumped storage works like a battery, storing the electricity generated by other power sources like solar, wind, and nuclear for later use. It stores energy by pumping water uphill to a reservoir at higher elevation from a second reservoir at a lower elevation. When the demand for electricity is low, a pumped storage facility stores energy by pumping water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir and turns a turbine, generating electricity.

The Hydropower Research and Development Pipeline

Current generation captures the energy from river currents with structures similar to wind turbines.

Tidal barrage is a dam-like structure that generates electricity by capturing the energy of rising and falling tides in bays or estuaries. Only a few barrage power stations exist in the world.

The placement of turbines in the path of an ocean current can also harness the energy of moving water, although this technology is in development stages. Certain technologies are also being tested to capture the energy of waves in the ocean, using pressure differences to move hydraulic pumps[3]

Benefits of Hydropower

Black start

A "black start" resource is a power source that does not need energy from the grid to begin generating electricity. In the event of grid outages, hydroelectric power plants have significant black start capabilities. According to the Department of Energy, hydropower accounts for as much as 40 percent of the black start resources in the United States.[4] Hydroelectric plants have a constant, nearly unlimited fuel source to draw from (except in cases of severe drought), as reservoirs generally store sufficient water to begin producing power without requiring an external energy source.[5] The Bath County Pumped Storage Station in Virginia, for example, has been called "the World's Biggest Battery,"[6] given its net generating capacity of 3,003 megawatts.[7] It is the largest pumped storage station in the world[8] and provides power for 750,000 homes.[9]

Hydroelectric plants are also able to start generating relatively quickly, given that they require little auxiliary equipment or preparatory operations.[10] Around 80 percent of the hydropower capacity in the United States can go from zero to maximum power output within 10 minutes.[11] During the 2003 northeast blackout, for example, hydropower facilities such as the Niagara and St. Lawrence-FDR operated continuously and helped restore power to millions of homes.[12] Hydropower plants are a reliable source of power that can be rapidly activated in emergencies and play an important role in ensuring the resilience of the U.S. power grid.[13]

Zero emissions

Hydroelectric facilities are a renewable energy source. They do not directly produce any greenhouse gas (GHG) emissions and do not pollute the water as it passes through the turbines. While there is a degree of methane emitted as vegetation rots in valleys flooded for reservoirs, the emissions vary greatly by geographic region.[14] There are also CO2 emissions associated with the manufacture of cement and steel used to construct dams, but the long lifespan of a hydropower plant, which may operate for as long as 50 or 100 years, offsets the emissions embedded in its construction.[15]

[3]Information on river current, tidal and wave energy generation from Environmental and Energy Study Institute (EESI), "Hydropower and Other Water Energy Technologies," available at https://www.eesi.org/topics/water-hydropower-wave-power/description.

[4]Jose R. Gracia, Patrick W. O'Connor, Lawrence C. Markel, Rui Shan, D. Thomas Rizy and Alfonso Tarditi, Hydropower Plants as Black Start Resources. U.S. Department of Energy, May 2019. Available at https://www.energy.gov/sites/prod/files/2019/05/f62/Hydro-Black-Start_May2019.pdf.

[5]Ibid.

[6]National Public Radio, "The World's Biggest Battery," Planet Money episode #848, 15 June 2018. Available at https://www.npr.org/transcripts/620288114?storyId=620288114?storyId=620288114.

[7]Dominion Energy, "Bath County Pumped Storage Station." Available at https://www.dominionenergy.com/company/making-energy/renewable-generation/water/bath-county-pumped-storage-station.

[8]National Public Radio, op. cit. It will become the second largest once the Fengning Pumped Storage Power Station in China is completed (operations scheduled to begin in 2021).

[9]Dominion Energy, op. cit.

[10]Gracia, O'Connor, Markel, Shan, Rizy and Tarditi, op. cit.

[11]Ibid.

[12]National Hydropower Association (NHA), "Hydropower is Reliable." Available at https://www.hydro.org/waterpower/why-hydro/reliable/.

[13]Department of Energy, Office of Energy Efficiency and Renewable Energy, "4 Reasons Why Hydropower is the Guardian of the Grid," 01 May 2017. Available at https://www.energy.gov/eere/articles/4-reasons-why-hydropower-guardian-grid.

[14]EIA, "Hydropower explained: Hydropower and the environment," 09 April 2020. Available at https://www.eia.gov/energyexplained/hydropower/hydropower-and-the-environment.php.

[15]Ibid.

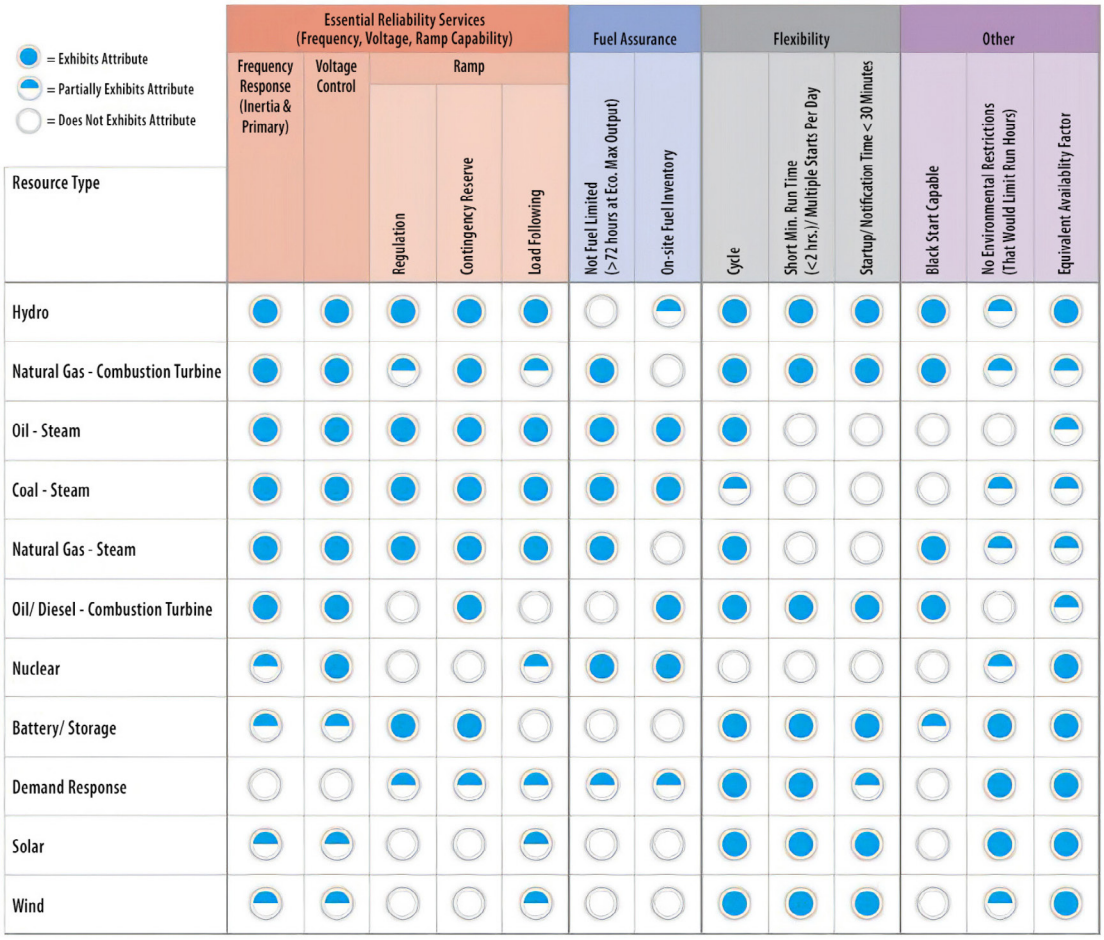

Table 1. Generator reliability attribute matrix. Source: NHA, Reinvigorating Hydropower, April 2019, available at https://www.hydro.org/wp-content/uploads/2019/04/Reinvigorating-Hydropower.pdf.

Economic benefits

Hydropower is not subject to market fluctuations of fuel sources such as coal, oil, or gas, which provides more price stability for end consumers.[16] While constructing dams can be very costly, they have low operating and maintenance costs, as well as long operating lifespans that can be extended by upgrades and the incorporation of new technologies.[17]

Hydroelectric facilities currently provide nearly 68,000 jobs in the United States, which could be greatly expanded given the large potential for growth in the sector.[18]

[16] United States Geological Survey (USGS), "Hydroelectric Power: Advantages of Production and Usage." Available at https://www.usgs.gov/special-topic/water-science-school/science/hydroelectric-power-advantages-production-and-usage?qt-science_center_objects=0#qt-science_center_objects. See also NHA, "Affordable," available at https://www.hydro.org/waterpower/why-hydro/affordable/.

[17] USGS, op. cit.

[18] National Association of State Energy Officials (NASEO) and Energy Futures Initiative (EFI), 2020 U.S. Energy & Employment Report, available at https://www.usenergyjobs.org/.

Other benefits

Many reservoirs benefit surrounding communities by creating opportunities for leisure activities such as swimming, boating, skiing, and fishing. Most hydropower facilities are required to allow some degree of public access to reservoirs.[19]

Dams also play a role in flood control, as they can capture floodwater and store it for later use or release it in a controlled fashion.[20] Reservoirs are also used for irrigation purposes: around 10 percent of crops grown in the United States are irrigated with water from dam reservoirs.[21]

Recommendations

- **Build on the significant untapped hydropower potential** in the country by upgrading existing facilities, retrofitting non-powered dams, and constructing new smaller, low-environmental impact impoundments. The Department of Energy's Hydropower Vision Report provides specific recommendations on how to achieve the potential 50 GW increase in generating capacity: 6.3 GW can be reached through upgrades at existing hydropower facilities; 4.8 GW by retrofitting existing, non-powered dams; 35.5 GW by constructing new pumped storage facilities and upgrading existing ones; and 1.7 GW through new stream-reach development.[22]

- **Create a more efficient licensing process** for hydropower projects, which currently takes up to 10 years, costs millions of dollars, and requires the involvement of multiple government agencies. These redundancies and inefficiencies also delay environmental enhancements.

- **Level the playing field** for hydropower in tax and renewables policy.

    - **Tax policy** should treat hydropower equitably with other renewable energy sources. Long-term extensions of the Production Tax Credit (PTC) and the Investment Tax Credit (ITC) are needed to accommodate the longer regulatory and development lead time associated with larger, capital-intensive hydropower projects.

    - As states and the federal government pursue policies to reduce greenhouse gas emissions and achieve net zero emissions by mid-century, **renewable and clean energy** policy should account for hydropower as a renewable resource.

- **Increase investment in hydropower R&D** to ensure the optimum modernization of hydroelectric infrastructure, including technological advancements in equipment and environmental mitigation.[3]

About CRES Forum

Citizens for Responsible Energy Solutions (CRES) Forum is a 501(c)(3) non-profit organization that educates the public and influences the national conversation around responsible clean energy solutions that are actionable, market-friendly, and responsible. Founded in 2017, our organization provides expert information to key decisionmakers so they are empowered to act.

[19]Department of Energy, Office of Energy Efficiency and Renewable Energy, "Benefits of Hydropower." Available at https://www.energy.gov/eere/water/benefits-hydropower.
[20]Federal Emergency Management Agency (FEMA), "Benefits of Dams," 22 October 2019. Available at https://www.fema.gov/benefits-dams.
[21]Ibid.
[22]NHA, "50 by 2050: Hydropower's vision for growth." Available at https://www.hydropowervision.org/.