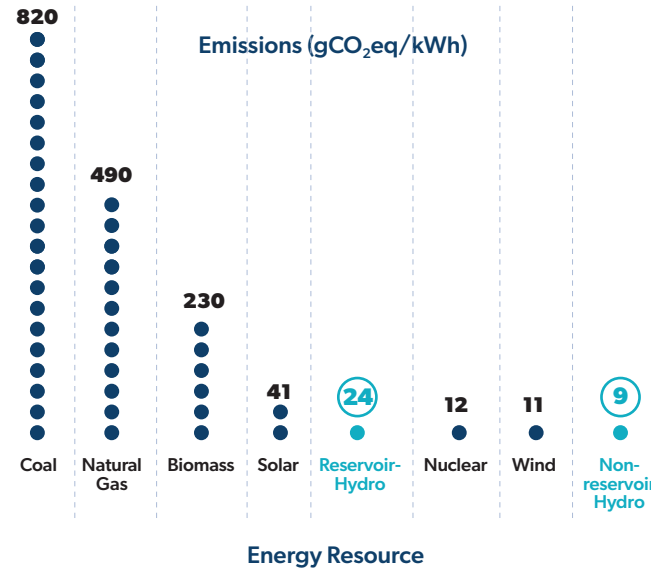
Hydropower in Context

U.S. Greenhouse Gas Emissions

The United Nations Intergovernmental Panel on Climate Change (IPCC) found lifecycle greenhouse gas (GHG) emissions from run-of-river and pumped storage hydropower are the lowest of any energy resource.[1] Similar to wind and solar, lifecycle emissions from hydropower are not related to power generation, but are attributable to construction, operation, and decommissioning. Estimates for new reservoir-based hydropower are slightly higher, but significantly lower than fossil fuels.[2]

Lifecycle Greenhouse Emissions



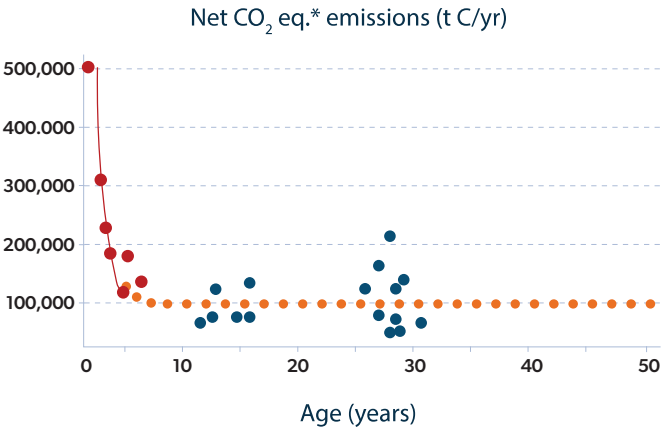
Source: UN IPCC median data from SRREN and 5th Assessment

Reservoir Lifecycle Emissions

All freshwater ecosystems produce methane emissions, including wetlands, canals, ponds, and reservoirs.[3] The science is evolving, but IPCC found decomposing vegetation in a new reservoir can produce a net-increase in methane emissions for the first few years.[4] Methane emissions are higher in reservoirs in warm climates with heavy vegetation and lower in North America,[5] which the U.S. International Trade Commission recently confirmed.[6]

For GHG accounting purposes, IPCC recommends distributing total reservoir emissions between the reservoir's functions, such as drinking water, recreation, irrigation, flood control, navigation, and hydropower.[7] No emissions should be attributable to hydropower that was added to the reservoir after initial construction.

Reservoir Emissions Decrease Over Time



Source: Hydro Québec (2017)

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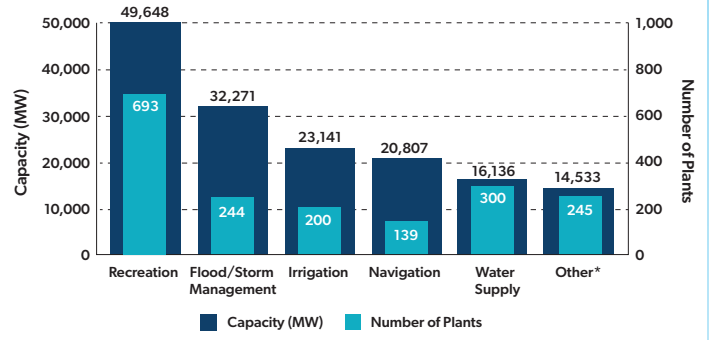
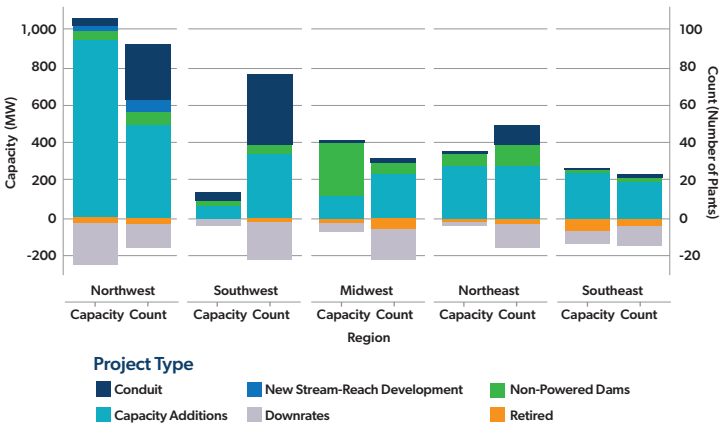
Total capacity and number of plants for six separate uses (illustrated by blue bars) of existing hydropower dams and reservoirs



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: Uria-Martinez et al. 2015

Source: Department of Energy: HydroVision Report (2016)

Hydropower capacity changes by region and type (2010-2019)



Sources: EIA Form 860 (2010-2018), EIA Form 860 Early Release (2019), Existing Hydropower Assets dataset, FERC eLibrary

According to the U.S. Department of Energy's Hydropower Vision:

"It is unlikely that powering existing NPDs [non-powered dam] would result in methane production higher than that caused by natural conditions in rivers and lakes."

The science has continued to evolve since publication of the IPCC's 5th Assessment report:

- One study promoted by the Environmental Defense Fund found 7% of new reservoirs, mostly in Asia and Africa, can produce methane emissions on par with natural gas, while 23% of reservoirs are carbon sinks.[8]
- A study of nearly 500 global reservoirs using the G-res Tool found hydropower median emissions to be 24 gCO_2/kWh, in line with IPCC calculations.[9]
- Another report found decomposing vegetation in new reservoirs is a non-factor, because it would have decomposed naturally. Instead, nutrient loading from human wastewater and agricultural runoff are primary sources of reservoir emissions,[10] which the IPCC does not attribute to hydropower generation.[11]

Since 2000, all 2,400 megawatts of hydropower growth in the U.S. were built without creating a single new reservoir. Instead, new hydropower is built on non-powered dams, conduits, marine energy, and upgrades to existing facilities.[12]

Only one pumped storage facility was built in the U.S. in the last 30 years, but there is renewed interest in pumped storage development for bulk energy storage. All three newly licensed but unconstructed pumped storage facilities are "closed loop" and not continuously connected to a river, which substantially reduces vegetation and nutrient input into the reservoirs.[13]

The science of GHG emissions from freshwater ecosystems is new, complex, and evolving.

NHA members will continue to monitor the progression of scientific research into this important field of study.

[1] UN IPCC Special Report: Renewable Energy Sources and Climate Change Mitigation (2012)
[2] UN IPCC 5th Assessment (2014)
[3] U.S. Environmental Protection Agency: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018
[4] UN IPCC: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019)
[5] Hydro Quebec: Understanding Quebec Hydropower (2017)
[6] U.S International Trade Commission: Renewable Electricity (2021)
[7] U.S. cities with reservoirs for water supply: New York, Los Angeles, Dallas, Houston, Phoenix, Boston, San Francisco, Seattle, San Diego, Denver, and Baltimore.
[8] Ocko et al: Climate Impacts of Hydropower: Enormous Differences among Facilities and over Time (2019)
[9] G-Res is a hydropower sustainability tool developed by the International Hydropower Association.
[10] Praire et al: Greenhouse Gas Emissions from Freshwater Reservoirs: What Does the Atmosphere See? (2017)
[11] UN IPCC: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019)
[12] Department of Energy: Hydropower Market Report
[13] Federal Energy Regulatory Commission: Licensed Pumped Storage Project (2021)

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