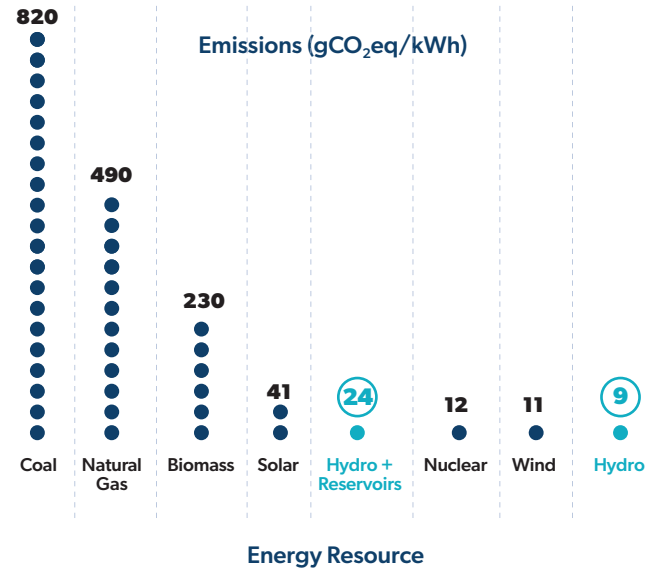
Hydropower in Context

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 Gas Emissions



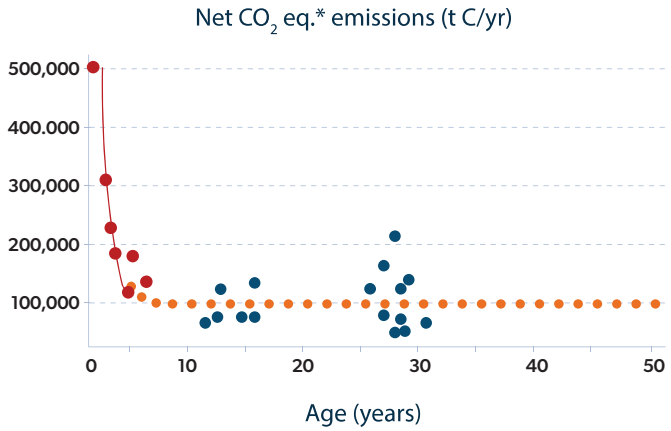
Source: UN IPCC median data from SRREN and 5th Assessment

Reservoir Lifecycle Emissions

All freshwater ecosystems can produce methane emissions, including wetlands, canals, ponds, and reservoirs.[3] The science is evolving, but IPCC found decomposing vegetation and nutrients in a new reservoir can produce a net-increase in methane emissions for the first few years.[4] Globally, 75% of methane emissions from reservoirs occur in the tropics,[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 because the reservoir would exist regardless of hydropower.

Reservoir Emissions Decrease Over Time



Source: Hydro Québec (2017)

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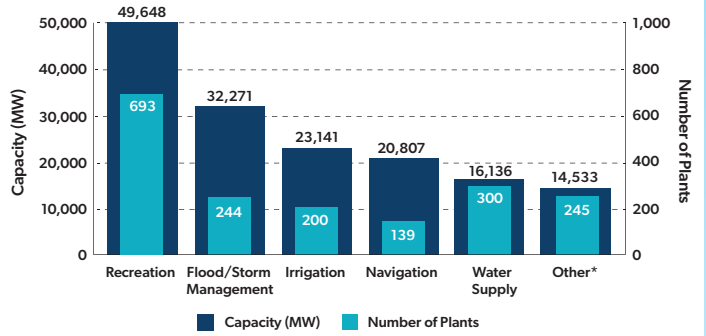
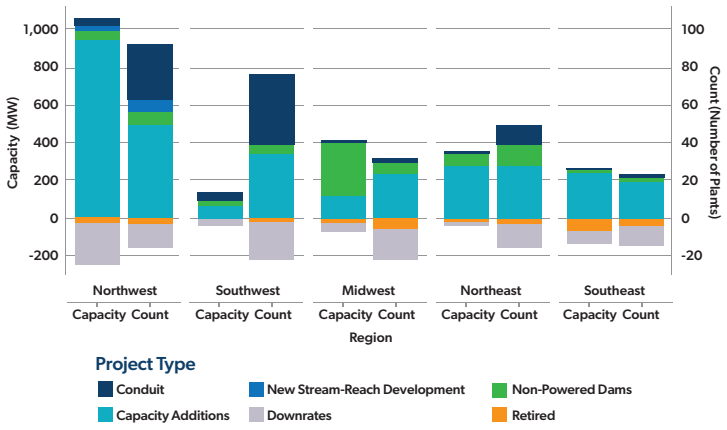
Multi-purpose functions of reservoirs in the United States that also produce hydropower



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 Growth in the United States from 2010-2019 did not create any new reservoirs



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 performed by the Environmental Defense Fund found 23% of reservoirs are carbon sinks, but 7% of reservoirs, mostly in Asia and Africa, can produce methane emissions on par with natural gas.[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 nutrient loading from human wastewater and agricultural runoff are the primary sources of reservoir emissions,[10] which the IPCC does not attribute to hydropower generation.[11]

Hydropower in the U.S.

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]

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 flexibility of some reservoir hydropower and pumped storage is being used to integrate significant amounts of variable wind and solar, a service that can only otherwise be provided by natural gas, which should be considered when analyzing hydropower GHG emissions.[14]

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.

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[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] Harrison et al: Year-2020 Global Distribution and Pathways of Reservoir Methane and Carbon Dioxide Emissions According to the Greenhouse Gas from Reservoirs (G-res) Model (2021)

[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)

[14] The Brattle Group, Leveraging Flexible Hydro in Wholesale Markets (2021)

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