March 21, 2022

Michael Regan
Administrator
United States Environmental Protection Agency
Office of the Administrator, Mail Code 1101A
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Washington DC 20460
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Submitted via Email and Certified Mail, Return Receipt Requested

Re: Petition for rulemaking to add dams and reservoirs as a source category under the Greenhouse Gas Reporting Program

Dear Administrator Regan:

Earthjustice respectfully submits this Petition for Rulemaking on behalf of Patagonia and Save the Colorado. Over 130 other organizations and businesses that are listed on the final pages of the Petition have joined the Petition as well. The Petitioners request that the U.S. Environmental Protection Agency (EPA) exercise its authorities under Clean Air Act section 114(a)(1) and the Administrative Procedure Act and promptly initiate a rulemaking to add dams and reservoirs as a source category under the Greenhouse Gas Reporting Program (GHGRP).

Numerous scientific studies over the past two decades have established that dams and reservoirs produce and emit substantial amounts of carbon dioxide, methane, and nitrous oxide. These greenhouse gas (GHG) emissions include reservoir surface emissions, which occur when dams trap organic material and leached synthetic fertilizers that decompose beneath a reservoir's water. Dam and reservoir operations also emit GHGs from several other emission points, including hydropower turbines, spillways, and downstream water discharges.

These scientific studies show that individual dams and reservoirs emit large amounts of GHGs every year. For example, Hoover Dam and Lake Mead (which is a reservoir and not a natural lake) emit approximately 12.3 million metric tons of carbon dioxide equivalent (CO_2e) annually. These emissions include 3.1 million metric tons of CO_2e attributable to hydropower infrastructure and generation. Kentucky Lake (which is also a reservoir and not a natural lake) emits over 1.8 million metric tons per year of CO_2e, including 407,000 metric tons attributed to hydropower infrastructure and generation. These emissions exceed the annual GHG emissions from coal- and gas-fired power plants with similar generation capacity, and these emissions are equivalent to the GHG emissions of hundreds of thousands, even millions, of gas-powered vehicles. In addition, the collective GHG emissions of all dams and reservoirs across the United States are significant. Notably, a 2020 scientific study co-authored by an EPA researcher estimated that reservoirs in Ohio are the state's fourth largest anthropogenic source of methane emissions.

Although dams and reservoirs emit large amounts of GHGs, these facilities are currently not required to measure or report their GHG emissions. As a result, federal agencies, states, utilities, and other stakeholders frequently overlook and ignore these GHG emissions. For example, dams and reservoirs are interconnected and necessary components of most hydropower generation. Regulators and policymakers often incorrectly assume and state that hydropower is a clean energy resource that emits zero carbon, when in fact some hydropower facilities emit massive amounts of GHGs. As a result, the federal government, states, and utilities frequently make decisions regarding climate policies and advancing toward a cleaner electric sector based on incomplete information and mistaken assumptions regarding dams and reservoirs' GHG emissions. In addition, federal agencies typically fail to assess dams and reservoirs' substantial GHG emissions when they analyze and approve new water supply projects and make other management decisions regarding water projects.

Because of the lack of awareness and mistaken assumptions regarding dams and reservoirs' GHG emissions, this Petition requests that EPA promptly initiate a rulemaking to add dams and reservoirs as a source category under the GHGRP. Granting this Petition would be an important step toward raising awareness of dams and reservoirs' GHG emissions and ensuring that regulators, policymakers, and the public have access to accurate and timely GHG data for this source category. Adding dams and reservoirs to the GHGRP would also result in better-informed climate policies at the federal, state, and local levels. Requiring dams and reservoirs to report their GHG emissions will ensure that agencies and utilities have access to the best available information regarding hydropower's GHG emissions as they make decisions on the future of the electric sector, and not risk inadvertently pursuing a clean energy future that is not actually clean. Moreover, obtaining accurate and timely data on dams and reservoirs' substantial methane emissions will help the United States achieve the Global Methane Pledge, which commits the United States to reducing its methane emissions 30% by 2030.

Granting this petition would also align with recent statements from the Biden Administration and EPA that highlight the need for better data and inventories of methane emissions. For example, a recent White House statement regarding the Global Methane Pledge noted that participating nations should commit to "moving towards using best

available inventory methodologies to quantify methane emissions."[1] But this is currently not the case for dams and reservoirs. In addition, a news article regarding EPA's new methane regulations for the oil and gas sector quoted Administrator Regan as stating: "Methane is such a potent pollutant, it's important that we understand what the contribution is from this industry."[2] This statement applies equally to methane emissions from dams and reservoirs, and this Petition seeks to advance the understanding and awareness of this substantial source of methane emissions.

When EPA implemented the GHGRP in 2009, it recognized that the program should expand and evolve over time to include additional source categories. Yet EPA has not added any new source categories to the GHGRP since 2010. Because dams and reservoirs emit large amounts of GHGs and because these emissions are often overlooked, EPA should seize this opportunity to expand and evolve the GHGRP so that policymakers and the public have accurate and timely information regarding these significant sources of GHG emissions.

BACKGROUND

I. Petitioners

Founded by Yvon Chouinard in 1973, Patagonia is an outdoor apparel company based in Ventura, California. As a Certified B Corporation, the company is in business to save our home planet. Patagonia's grant making, advocacy, communications, and activism have long prioritized the health of America's freshwater ecosystems. Patagonia has advocated for the removal of dams to support the protection of wild, native fish populations and the communities that depend on them. This has included more than $4 million in grants to nonprofit groups since 2000, as well as numerous films and campaigns, including three award-winning documentaries: *DamNation*, *Blue Heart*, and *Artifishal*.

Save the Colorado is a grassroots, non-profit 501(c)(3) environmental organization dedicated to the protection and restoration of the Colorado River and its tributaries. Save the Colorado has approximately 25,000 members, supporters, and followers throughout the Colorado River Basin who live, work, and recreate on the Colorado River and other rivers that are impacted by dams and reservoirs. Save the Colorado's mission is to promote the conservation of the Colorado River and its tributaries through science, public education, advocacy, and litigation.

The additional undersigned Petitioners listed on the final pages of this Petition include international, national, regional, and local nonprofit organizations that represent

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[1] Press Release, White House, Joint US-EU Press Release on the Global Methane Pledge (Sept. 18, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/18/joint-us-eu-press-release-on-the-global-methane-pledge/.

[2] Dino Grandoni & Tony Romm, *White House doubles down on executive action as Democrats weigh trimming Hill climate plan*, Wash. Post, Oct. 19, 2021, https://www.washingtonpost.com/climate-environment/2021/10/19/climate-reconciliation-biden-white-house/.

members and supporters who have an interest in mitigating the climate crisis and ensuring that EPA accurately accounts for the GHG emissions from dams and reservoirs. These Petitioners include organizations that have thousands of members who live, work, and enjoy outdoor activities and recreation throughout the United States, including on rivers that are impacted by dams and reservoirs.

II. Statutory and Regulatory Background

A. The Greenhouse Gas Reporting Program

The GHGRP requires sources to report their GHG emissions to EPA. 40 C.F.R. Part 98. A source must generally report its GHG emissions to EPA annually if the source is in a listed source category and it emits more than 25,000 metric tons or more per year of CO_2e. *Id.* §§ 98.1, 98.2. A source must report its GHG emissions at the facility level, except certain suppliers and vehicle and engine manufacturers report GHG emissions at the corporate level. Mandatory Reporting of Greenhouse Gases, 74 Fed. Reg. 56,260, 56,264 (Oct. 30, 2009) [hereinafter "Final 2009 GHGRP Rule"]. EPA currently requires over forty source categories to report their GHG emissions through the GHGRP. *See* 40 C.F.R. Part 98, Subparts B–UU. Since 2011, EPA has collected and reported GHG emissions from approximately 8,000 facilities and other sources through the GHGRP.[3]

When EPA implemented the GHGRP in 2009, it recognized that obtaining accurate and detailed GHG emissions data is a critical first step for addressing climate change. EPA articulated the following principles that underlie the GHGRP:

- <u>The GHGRP should provide GHG emissions data that informs climate change policies at the federal, state, and local levels</u>.

  EPA stated that "[a]ccurate and timely information on GHG emissions is essential for informing many future climate change policy decisions," and "the data collected in this rule will provide useful information for a variety of policies." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. The agency noted that "[t]he data collected by this rule will also improve the U.S. government's ability to formulate climate policies." *Id.* EPA further explained that it "is promulgating this rule to gather GHG information to assist EPA in assessing how to address GHG emissions and climate change under the Clean Air Act." *Id.* The agency also stated that it "expect[s] that the information will prove useful for other purposes as well [because] [f]or example, using the rich data set provided by this rulemaking, EPA, States and the public will be able to track emission trends from industries and facilities within industries over time, particularly in response to policies and potential regulations." *Id.*

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[3] Angela Jones, Cong. Rsch. Serv., IF11754, *In Focus: EPA's Greenhouse Gas Reporting Program* 1 (Nov. 16, 2021), https://crsreports.congress.gov/product/pdf/IF/IF11754.

- The GHGRP should document the relative GHG emissions of various industries and source categories.

  EPA explained that "[t]hrough data collected under [the GHGRP], EPA, States and the public will gain a better understanding of the relative emissions of specific industries across the nation." *Id.* The agency stated that "[t]he data collected by this rule will also improve the U.S. government's ability to . . . assess which industries might be affected, and how these industries might be affected by potential [climate] policies." *Id.*

- The GHGRP should document the GHG emissions of specific facilities within an industry or source category.

  EPA noted that the GHGRP will provide "EPA, States and the public [with] a better understanding of . . . the distribution of emissions from individual facilities within [specific] industries." *Id.* The agency further explained that "[t]he facility-specific data will also improve our understanding of the factors that influence GHG emission rates and actions that facilities could in the future or already take to reduce emissions, including under traditional and more flexible programs." *Id.*

- The GHGRP data should raise awareness of sources' GHG emissions.

  EPA stated that its "experience with other reporting programs is that such programs raise awareness of emissions among reporters and other stakeholders, and thus contribute to efforts to identify and implement emission reduction opportunities." *Id.* The agency explained that "[t]hese data can also be coupled with efforts at the local, State and Federal levels to assist corporations and facilities in determining their GHG footprints and identifying opportunities to reduce emissions." *Id.*

- The GHGRP should expand and evolve over time.

  EPA recognized that while the initial scope of the GHGRP would provide useful information, "additional data collection (e.g., for other source categories or to support additional policy or program needs) will no doubt be required as the development of climate policies evolves." *Id.*

The Congressional Research Service also recently recognized that the GHGRP will likely need to expand and evolve. Its November 2021 report on the GHGRP raised several issues for Congress, including whether "the application and scope of GHGRP regulations align with EPA's stated goal of enhanced understanding of GHG emissions now and in the future."[4] The report also stated that "policymakers could consider expanding the scope of sources required to report and/or adjust the emissions reporting threshold for particular sources."[5]

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4 Jones, Cong. Rsch. Serv., *supra* note 3, at 2.

5 *Id.*

After EPA implemented the GHGRP in 2009, it promptly added several additional source categories to the program that were not covered by its initial rulemaking.[6] However, EPA has not added any new source categories to the GHGRP since 2010.[7]

B. Clean Air Act Section 114 and the Administrative Procedure Act

EPA has the authority to grant this Petition and require dams and reservoirs to report their GHG emissions through the GHGRP under the Administrative Procedure Act and Clean Air Act section 114(a)(1). The Administrative Procedure Act requires federal agencies to provide "an interested person the right to petition for the issuance, amendment, or repeal of a rule." 5 U.S.C. § 553(e).

Clean Air Act section 114 authorizes EPA to require sources to monitor and report their emissions, and it authorizes the agency to request information from sources that will assist EPA in carrying out any Clean Air Act provision. 42 U.S.C. § 7414. As EPA previously explained, the agency implemented the GHGRP pursuant to its existing authority under Clean Air Act sections 114(a)(1) and 208, as these sections "provide EPA broad authority to require the information mandated by [the GHGRP] because such data will inform and are relevant to EPA's carrying out a wide variety of [Clean Air Act] provisions." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,264. EPA has added additional source categories to the GHGRP pursuant to its authority under Clean Air Act section 114(a)(1), and it also recognized that the program informs its implementation of sector-based non-regulatory strategies to reduce air pollutants under Clean Air Act section 103(g). *See, e.g.*, Mandatory Reporting of Greenhouse Gases: Petroleum and Natural Gas Systems, 75 Fed. Reg. 74,458, 74,460–61 (Nov. 30, 2010); Mandatory Reporting of Greenhouse Gases From Magnesium Production, Underground Coal Mines, Industrial Wastewater Treatment, and Industrial Waste Landfills, 75 Fed. Reg. 39,736, 39,738–39 (July 12, 2010).

FACTUAL BACKGROUND REGARDING GREENHOUSE GAS EMISSIONS FROM DAMS AND RESERVOIRS

I. Dams, reservoirs, and hydropower facilities in the United States.

Dams and reservoirs are located throughout the United States. These facilities have been built for numerous purposes, including water supply, hydroelectric power generation, flood control, recreation, irrigation, and navigation.

According to the U.S. Army Corps of Engineers, approximately 3% of the dams and reservoirs in the United include hydropower generation.[8] In 2020, hydropower accounted

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6 EPA, Greenhouse Gas Reporting Program (GHGRP), Historical Rulemakings, https://www.epa.gov/ghgreporting/historical-rulemakings (last visited Mar. 18, 2022).

7 *Id.*

8 U.S. Army Corps of Eng'rs, National Inventory of Dams, https://nid.usace.army.mil (last visited Mar. 18, 2022).

for approximately 7% of the total utility-scale electricity generation in the United States.[9] Although some hydropower generation occurs at run-of-the-river dams that may not have a reservoir (or a small reservoir), the U.S. Energy Information Administration has explained that "[m]ost U.S. hydroelectricity is produced at large dams on major rivers, and most of these hydroelectric dams were built before the mid-1970s by federal government agencies."[10] The largest hydropower facility in the United States is the Grand Coulee Dam facility in Washington, which has 6,765 megawatts of total generation capacity.[11]

This Petition to list dams and reservoirs as a source category under the GHGRP encompasses dams and reservoirs that generate hydropower, as well as dams and reservoirs without hydropower components. Moreover, when this Petition discusses hydropower facilities, it is referring to hydropower facilities that include dams and reservoirs that divert, manipulate, or impound water, which account for most of the hydropower generation in the United States.

II. Methane, carbon dioxide, and nitrous oxide are key drivers of the climate change crisis, yet greenhouse gas emissions from dams and reservoirs are often overlooked.

In August 2021, the Intergovernmental Panel on Climate Change (IPCC) issued several reports that vividly highlight the climate emergency the planet is facing.[12] Heat-trapping climate pollution—especially methane, carbon dioxide, and nitrous oxide—are singled out by climate scientists as GHGs for having the intense short- and long-term effects of increasing the "greenhouse effect" that causes climate change.

In the United States, scientists have linked climate change to the ever-increasing environmental calamities battering our landscape, such as wildfires, hurricanes, and drought. The 2021 IPCC reports have been described as a "code red for humanity."[13] In 2021 alone, wildfires in California and the Pacific Northwest, drought in the Southwest, and hurricanes in the East have been particularly intense and financially damaging.

Climate scientists, including those affiliated with the IPCC and EPA, have identified many of the primary GHG emission sources in numerous reports. Chief among those sources is the production and consumption of fossil fuels and GHG emissions from land use, including high-intensity industrial agriculture, forestry, and land use changes.[14] The EPA,

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9 U.S. Energy Info. Admin., Hydropower explained, https://www.eia.gov/energyexplained/hydropower/ (last visited Mar. 18, 2022).

10 *Id.*

11 *Id.*

12 IPCC, *Sixth Assessment Report, Climate Change 2021: The Physical Science Basis (*2021), https://www.ipcc.ch/report/ar6/wg1/.

13 Matt McGrath, *Climate change: IPCC report is 'code red for humanity,'* BBC News, Aug. 9, 2021, https://www.bbc.com/news/science-environment-58130705.

14 *See, e.g.*, EPA, Sources of Greenhouse Gas Emissions, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (last visited Mar. 18, 2022).

other federal agencies, and governments across the world have conducted considerable research regarding the GHG emissions from these sources, and regulatory efforts in the United States have primarily focused on reducing emissions from fossil fuel production and consumption.

Some sources of GHG emissions have historically received less scientific and regulatory attention. Yet these overlooked GHG sources are gaining increasing attention as scientific evidence of their impacts accumulates. As an example, in a 2006 report the IPCC provided a framework for calculating methane emissions from flooded landscapes, including reservoirs.[15] The IPCC further refined these GHG estimates for flooded lands in 2019.[16] This 2019 refinement focuses on "Flooded Land" and includes a discussion of GHG emissions from reservoirs.[17] Although the IPCC has developed these frameworks for emissions inventories, GHG emissions from flooded lands and reservoirs have largely been overlooked. For example, the EPA currently does not recognize GHG emissions from dams and reservoirs as a source category with emissions that must be measured, reported, or regulated, despite the growing evidence regarding GHG emissions from reservoirs.

III. Multiple peer-reviewed scientific studies show that dams and reservoirs directly emit substantial amounts of methane and carbon dioxide annually.

A. Scientists have repeatedly documented substantial greenhouse gas emissions from dams and reservoirs in the United States and across the world.

Twenty-five years ago, a team of scientists in Brazil began measuring the methane produced at hydropower dams and reservoirs. Led by Dr. Philip Fearnside, a research scientist at Brazil's National Institute for Amazonian Research, these scientists discovered something new at the time: hydropower dams and reservoirs in tropical countries such as Brazil emit high levels of GHGs, especially methane. Some of the hydropower facilities they studied produced several times more GHG emissions than coal-fired power plants, when the emissions were attributed to the energy produced. Dr. Fearnside first reported the discovery of GHG emissions from these facilities in 1995, and after years of research, he published a 2008 article in *Oecologia Australis* detailing these findings.[18]

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15 *See* IPCC, *App. 3, CH_4 Emissions from Flooded Land: Basis for Future Methodological Development, in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4: Agriculture, Forestry and Other Land Use* (2006), https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

16 IPCC, *Chapter 7: Wetlands*, *in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4: Agriculture, Forestry and Other Land Use* (2019), https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html.

17 *Id.* § 7.3.

18 Philip Fearnside, *Hydroelectric Dams as "Methane Factories": The Role of Reservoirs in Tropical Forest Areas as Sources of Greenhouse Gases*, 12 Oecologia Australis (2008), https://www.semanticscholar.org/paper/HYDROELECTRIC-DAMS-AS-%E2%80%9CMETHANE-FACTORIES%E2%80%9D%3A-THE-ROLE-Fearnside/a4454cf836d9543cc3f087e47457749207d943d0.

Around the same time, other scientists around the world launched new studies that confirmed the Brazilian results in subtropical and temperate regions. International studies of dams and their reservoirs multiplied over the last two decades. For the first time in 2006, the IPCC included calculations for measuring methane emissions from flooded lands in national greenhouse gas inventories.[19] Since 2006, study after study has confirmed high levels of methane emissions from many dams and reservoirs. One 2016 study co-authored by an EPA researcher found methane emissions from a reservoir in the midwestern United States to be as high as those measured at hydropower facilities in Brazil.[20] EPA published a blog highlighting the study, which noted that "improved estimates of methane emissions from reservoirs will result in better information that can aid in the global effort to reduce greenhouse gas emissions."[21]

While the initial dam and reservoir GHG studies were conducted in tropical locations, more recent studies have also found significant emissions at dams and reservoirs in northern latitudes, including northern regions of the United States. In 2016, this science came to a head when an international team of scientists synthesized dozens of studies from around the world, which indicated that methane emissions from dams and reservoirs have been widely ignored and dramatically underestimated.[22] The EPA, the U.S. Army Corps of Engineers, and the National Science Foundation funded this *Bioscience* study.[23] The study made international news and stated that the IPCC should revise its calculations for GHG inventories for flooded lands and include dams and reservoirs' significant GHG emissions.[24] Additional data published in 2020 associated with this analysis further supports the earlier findings that reservoirs are a large source of GHG emissions across the world.[25]

Attachment 1 to this Petition lists many of the scientific studies conducted over the past twenty-five years that analyze and document the GHG emissions of dams and reservoirs. These forty-four scientific studies are among the most significant studies on this issue, and this body of science makes clear that dams and reservoirs are substantial sources of GHG emissions in tropical, temperate, and other regions around the world.

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19 IPCC, *Chapter 7: Wetlands*, *in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Vol. 4: Agriculture, Forestry and Other Land Use* § 7.3 (2006), https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

20 Jake Beaulieu et al., *Estimates of reservoir methane emissions based on a spatially balanced probabilistic-survey*, 61 Limnology and Oceanography S27 (2016), https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.10284.

21 EPA, Bubbling Up: Methane from Reservoirs Presents Climate Change Challenge, The EPA Blog (Sept. 8, 2016).

22 Bridget Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis*, 66 BioSci. 949, 949–50, 954–61 (Nov. 2016), https://academic.oup.com/bioscience/article/66/11/949/2754271.

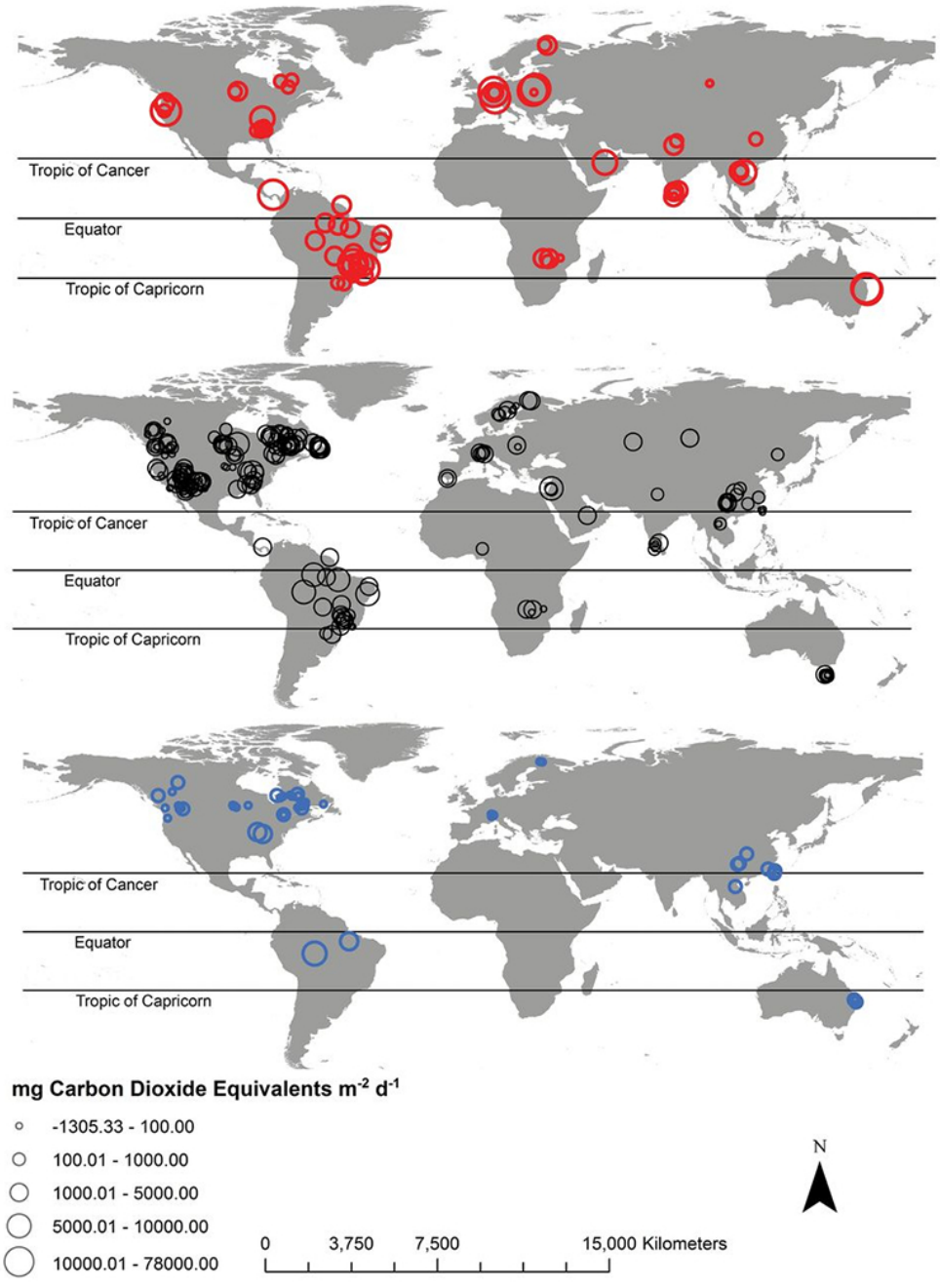
23 *Id.* at 961.

24 *Id.* at 960–61.

25 Bridget Deemer et al., *Data from: Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis,* Dryad Dataset (Jan. 6, 2020), https://datadryad.org/stash/dataset/doi:10.5061/dryad.d2kv0.

Figure 1 below—which is a map from the 2016 *Bioscience* study—provides one example that illustrates the scope of GHG emissions from dams and reservoirs in the United States and across the world.

Figure 1. GHG Flux Estimates from Reservoirs: Diffusive + Ebullitive Methane (top), Carbon Dioxide (middle), and Nitrous Oxide (bottom) on a CO_2-Equivalent Basis (100-year horizon)[26]



[26] Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces*, *supra* note 22, at 953.

B. The peer-reviewed scientific studies show that U.S. dams and reservoirs directly emit large amounts of methane and carbon dioxide annually, both individually and collectively.

A study published in September 2016 by a team of Swiss scientists used previous measurements at dams and reservoirs around the world to create a model that estimates the equivalent carbon emissions from nearly 1,500 hydropower facilities, including 350 hydropower facilities in the United States.[27] The study findings illustrate that individual dams and reservoirs across the United States emit massive amounts of GHGs each year. These emissions include the following prominent examples:

- Lake Mead (Reservoir): Lake Mead and Hoover Dam emit CO_2e equal to that of a coal-fired power plant producing the same amount of electricity. The total reservoir emissions are approximately 9.2 million metric tons of CO_2e per year. This is equivalent to the emissions from approximately 2 million gas-powered automobiles per year.[28] In addition to these reservoir emissions, the total emissions attributed solely to the hydropower turbines equal about 3.1 million metric tons of CO_2e per year. The hydropower turbine emissions are equivalent to the annual emissions from approximately 674,000 vehicles.[29]

- Lake Whitney (Reservoir): In Texas, Whitney Dam and Lake Whitney (which is a reservoir and not a natural lake) emit six times more CO_2e than a coal-fired power plant producing the same amount of electricity. The total reservoir emissions equal about 884,000 metric tons of CO_2e per year, or the equivalent emissions from about 192,000 gas-powered vehicles per year.[30] In addition to these reservoir emissions, the total emissions attributed to hydropower equal about 250,000 metric tons of CO_2e per year. The hydropower turbine emissions are equivalent to the annual emissions from approximately 54,370 vehicles.[31]

- Kentucky Lake (Reservoir): Kentucky Lake is the largest reservoir in the eastern United States, and it emits approximately 80% as much CO_2e as a natural gas-fired power plant producing the same amount of electricity. The total reservoir emissions equal about 1.4 million metric tons of CO_2e per year, or the equivalent emissions from about 304,000 gas-powered vehicles per year.[32] In addition to these reservoir emissions, the total emissions attributed to hydropower equal about 407,000 metric

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27 Laura Scherer & Stephan Pfister, *Hydropower's Biogenic Carbon Footprint*, PLoS ONE (Sept. 14, 2016), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0161947.

28 EPA, Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (last visited Mar. 18, 2022).

29 *Id.*

30 *Id.*

31 *Id.*

32 *Id.*

tons of CO_2e per year. The hydropower turbine emissions are equivalent to the annual emissions from approximately 88,000 vehicles.[33]

In addition, a 2020 study co-authored by an EPA researcher highlights the substantial scope of dams and reservoirs' collective GHG emissions. The study abstract explained that estimating the carbon dioxide and methane emissions from reservoirs "is important for regional and national greenhouse gas inventories."[34] The study analyzed the carbon dioxide and methane emissions from thirty-two reservoirs, and it found that all the reservoirs are a source of methane.[35] Notably, the study estimated that dams and reservoirs in Ohio are the state's fourth largest anthropogenic methane source.[36]

IV. The current scientific studies underestimate the full scope of dams and reservoirs' greenhouse gas emissions.

The current peer-reviewed science has largely focused on direct GHG emissions from reservoir surfaces. At least two major sources of organic material in reservoirs cause these surface emissions. One source is organic materials that are washed into reservoirs and unnaturally trapped by the dams from upstream watersheds (e.g., soils, suspended organic matter, organic matter in sediments, and algae). Another source is synthetic fertilizer and livestock manure leaching, and runoff from agricultural fields and pastures in the upstream watershed. This runoff effectively fertilizes reservoirs and leads to higher algae growth in reservoirs. These organic materials and leached synthetic fertilizers become trapped behind dams because of their operations and are decomposed or mineralized by microbes and other organisms beneath the reservoir surface. Anaerobic decomposition in the oxygen-depleted reservoir depths creates methane as a byproduct, and aerobic decomposition in other parts of the reservoir creates carbon dioxide and nitrous oxide. It is concerning that warming temperatures and eutrophication of water bodies significantly increase both the surface carbon dioxide and nitrous oxide, as well as subsurface methane in the anoxic zones from which hydropower facilities draw water into turbines. The more eutrophication and warming that occur, the greater the GHG emissions. Moreover, a warming climate can produce a positive feedback loop that exacerbates the problem. Eutrophication is a major problem in the United States, and it affects the great majority of waterways and reservoirs.[37] Yet the increase in GHG emissions caused by eutrophication has only been partially quantified, and the impact of warmer air and water temperatures on reservoir emissions has also not been adequately assessed.

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33 *Id.*

34 Jake Beaulieu et al., *Methane and Carbon Dioxide Emissions from Reservoirs: Controls and Upscaling*, 125 J. Geophysical Rsch. Biogeosciences 1 (2020), https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019JG005474.

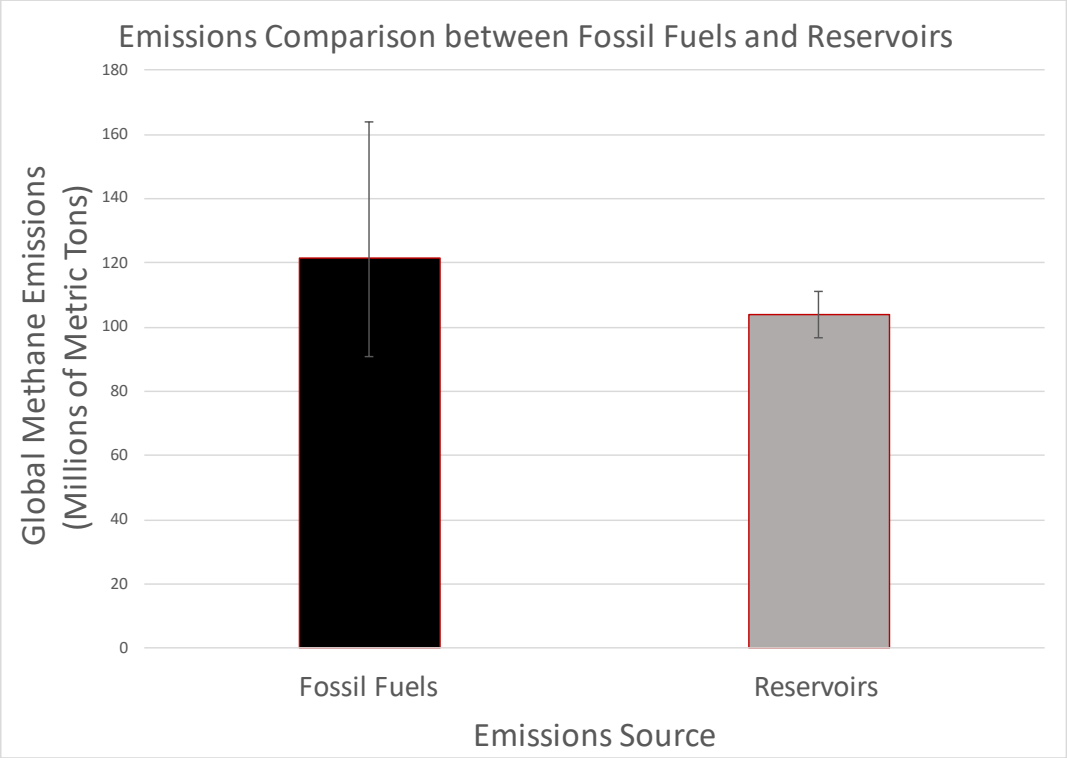
35 *Id.* at 1, 9–10, 15.

36 *Id.* at 1–2, 19.

37 Walter Dodds et al., *Eutrophication of U.S. Freshwaters: Analysis of Potential Economic Damages*, 43 Envtl. Sci. & Tech. 12, 15–16 (2009), https://pubs.acs.org/doi/10.1021/es801217q.

Looking solely at the methane emissions from reservoir surfaces, dams and reservoirs are a significant and consequential contributor to climate change. The most recent comprehensive review of global methane emissions estimates that methane emissions from the production and distribution of fossil fuels was between 91 and 164 teragrams in 2017, averaging 122 teragrams.[38] In comparison, a 2008 study stated that reservoirs could emit 104 +/- 7.2 teragrams annually.[39] Figure 2 below highlights the comparative global methane emissions from fossil fuels and reservoirs.

Figure 2. Comparison of Methane Emissions from Fossil Fuels and Reservoirs



To further illustrate the overall magnitude of GHG emissions from dam and reservoir operations in the United States, Mark Easter has authored a white paper in support of this Petition, which estimates the surface emissions from U.S. reservoirs using a combination of publicly available, peer-reviewed sources.[40] Mr. Easter is an ecologist and research affiliate at Colorado State University, and his white paper is included as Attachment 2 to the Petition. Mr. Easter concludes that reservoir surface emissions alone

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[38] Marielle Saunois et al., *The Global Methane Budget 2000–2017*, 12 Earth Sys. Sci. Data 1561, 1580 (2020), https://essd.copernicus.org/articles/12/1561/2020/.

[39] Ivan Lima et al., *Methane Emissions from Large Dams as Renewable Energy Resources: A Developing Nation Perspective*, 13 Mitigation & Adaptation Strategies for Glob. Change 193, 201 (2008), https://link.springer.com/article/10.1007/s11027-007-9086-5.

[40] Mark Easter, *Greenhouse Gas Emissions from Dams and Reservoirs in the United States* 3–5 (2022) (Attach. 2).

account for at least 459 teragrams (millions of metric tons) CO_2e per year.[41] GHG emissions from reservoir surfaces are thus comparable to the overall GHG emissions of the U.S. agricultural sector (669 teragrams of CO_2e in 2019) and home energy use in the United States (380 teragrams of CO_2e in 2019).[42] Mr. Easter's GHG calculations for reservoir surfaces are consistent on a per-area basis with emissions calculated in other peer-reviewed inventories in North America and other temperate regions.[43]

Some industry-affiliated studies have used or endorsed methodologies that result in less GHG emissions from dams and reservoirs.[44] However, these studies do not calculate reservoir surface emissions correctly. In addition, these studies often have at least one of the following three flaws: (1) they use faulty methods that underestimate the emissions from hydropower turbines;[45] (2) the measurements result in undercounting because they do not reflect seasonal variation, particularly during critical periods, such as when reservoirs "turn" in the spring and fall;[46] and (3) they omit crucial components of life cycle emissions, such as dam construction and decommissioning.[47] Ultimately, none of these studies dispute the central point that dams and reservoirs emit large amounts of GHGs.

In addition, while the GHG emissions from reservoir surfaces are substantial, these emissions are just one component of the overall GHG emissions from dams and reservoirs. Dams and reservoirs emit GHGs from many different emissions points that are spread across numerous processes and sources. In fact, scientists have identified at least seventeen distinct individual sources and sub-sources of GHG emissions from dams and reservoirs. These GHG emissions result from multiple GHG inventory sectors, including industrial processes, energy, and land use and forestry. Mr. Easter's white paper describes these seventeen distinct GHG emission points in greater detail.[48]

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41 *Id.* at 3–4.

42 EPA, Greenhouse Gas Inventory Data Explorer, https://cfpub.epa.gov/ghgdata/inventoryexplorer/ (last visited Mar. 18, 2022).

43 *See, e.g.*, Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces*, *supra* note 22; Deemer et al., *Data from: Greenhouse Gas Emissions from Reservoir Water Surfaces*, *supra* note 25; Scherer & Pfister, *supra* note 27.

44 *See, e.g.*, A. Levasseur et al., *Improving the accuracy of electricity carbon footprint: Estimation of hydroelectric reservoirs greenhouse gas emissions*, 136 Renewable & Sustainable Energy Revs. (2021), https://www.sciencedirect.com/science/article/pii/S1364032120307206.

45 *See generally* Int'l Hydropower Ass'n, GHG Measurement Guidelines for Freshwater Reservoirs, https://www.hydropower.org/publications/ghg-measurement-guidelines-for-freshwater-reservoirs (last visited Mar. 18, 2022).

46 Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces*, *supra* note 22, at 959.

47 Cuihong Song et al., *Cradle-to-grave greenhouse gas emissions from dams in the United States of America*, 90 Renewable & Sustainable Energy Revs. 7, 13–15 (2018), https://www.sciencedirect.com/science/article/abs/pii/S1364032118302235.

48 Easter, *supra* note 40, at 1–3 (Attach. 2).

Although most of the current science focuses on GHG emissions from reservoir surfaces, some of the peer-reviewed science also illustrates the size and scope of these other GHG emission points. These are just a few examples of the unquantified, or only partially quantified, GHG emissions from dams and reservoirs.

- GHG emissions from fluctuating reservoir levels: Dam operations often cause reservoir levels to rise and fall. When reservoir levels fall, revegetation occurs on reservoir banks. And when reservoirs levels subsequently rise, this vegetation is resubmerged and results in additional GHG emissions. Scientific studies have found that reservoir drawdowns increase overall GHG emissions from dams and reservoirs.[49]

- GHG emissions from degraded wetlands and riparian forests: The Colorado River delta historically contained two million acres of wetlands, riparian forests, and mangrove forests. After more than a century of dam construction, river diversions, and evaporation from reservoir surfaces, less than 5% of that area now contains wetlands and riparian forests, nearly all which are now degraded. No mangrove wetland forests remain. Based on a conservative estimate of 60 million metric tons of biomass carbon per hectare and 100 metric tons of soil carbon per hectare in these systems, the total ecosystem carbon loss exceeds 450 million metric tons CO_2e of ecosystem carbon, or approximately 4 million metric tons per year averaged over the period since dam construction began.[50] This does not include potential nitrous oxide losses from decaying vegetation or degraded riparian forests and riparian-associated wetlands in the watershed upstream of the delta.

- Loss of ecosystem function and the potential for carbon sequestration after dam decommissioning and restoration: Carbon sequestration occurs at restored dam sites in the United States. For example, it is estimated that the Elwha River watershed in the Olympic Peninsula and the White Salmon River watershed in the Columbia River Gorge sequester 6,023 and 286 metric tons CO_2e per year, respectively, as forests and vegetation reclaim formerly inundated sites.[51] The dam footprints of the formerly dammed Elwha and White Salmon rivers likely held biomass carbon stocks equal to or greater than 1.2 million metric tons CO_2e before they were inundated. This does not include the carbon in the soils of these forests, which would likely double the total ecosystem carbon stocks.

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49 *See, e.g.*, Philipp Keller et al., *Global Carbon Budget of Reservoirs is Overturned by the Quantification of Drawdown Areas*, 14 Nature Geoscience 402 (2021), https://www.nature.com/articles/s41561-021-00734-z.

50 *See generally* IPCC, *Chapter 11: Agriculture, Forestry and Other Land Use (AFOLU)*, *in Climate Change 2014*: *Mitigation of Climate Change* (2014), https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter11.pdf.

51 Carbon sequestration values calculated with the U.S. Department of Agriculture's COMET-Farm GHG accounting system. U.S. Dep't of Agric., COMET-Farm, https://comet-farm.com (last visited Mar. 18, 2022).

Beyond these additional GHG emission points, the full carbon footprint and climate impact of dams and reservoirs is expected to be far greater due to the millions of acres of destroyed and submerged forests, grasslands, soil, and farmlands caused by the construction and ongoing operations at dams and reservoirs across the country. GHG emissions from land use change are well understood and documented by the EPA in its existing national inventory, however most of the initial land use change from constructing dams and filling reservoirs occurred prior to the EPA inventory baseline year of 1990.[52] These reservoirs submerged lands that historically sequestered carbon, and thus inundating these lands by constructing a dam and reservoir has eliminated these expansive carbon sinks. Accordingly, the cumulative carbon footprint (and carbon equivalent) of dams and reservoirs is expected to be much higher than the direct GHG emissions alone.

Relatedly, recent dam removal projects around the country have restored thousands of acres of carbon-capturing habitats. These dam removal projects can significantly increase carbon capture objectives in the United States, without reducing or reforesting existing farmlands or other terrestrial habitats. In fact, removing dams and restoring former habitats and farmlands provides an unparalleled opportunity for the United States to simultaneously eliminate GHG emissions; create new carbon sinks; and increase biologically rich riparian and wetlands habitats, as well as productive alluvial soils and farmlands. Other climate-related opportunities exist with the elimination of dam and reservoir GHG emissions. For example, the recent federally-supported removal of two dams on the Elwha River in Washington State has created nearly 100 acres of new coastal habitat at its delta, by accumulating the beneficial sediment flushed from reservoirs behind the decommissioned dams. These projects also help sediment-deprived coastal communities build up their shorelines to combat sea level rise. The elimination of reservoirs paired with groundwater recharge and storage can also eliminate massive reservoir evaporation and promote more climate resilient water storage solutions without most of the dam and reservoir-related GHG emissions (and siltation/reduced storage problems).

In sum, as these studies and findings demonstrate, the GHG emissions from dams and reservoirs are even greater than the emissions identified in the peer-reviewed scientific studies summarized above. While some of these GHG emissions may be beyond the scope of what owners and operators would be required to report under the GHGRP, they illustrate the broad scope of GHG emissions from dams and reservoirs and the need for EPA to begin accounting for dams and reservoirs' direct GHG emissions.

V. Federal agencies, states, utilities, and other stakeholders often incorrectly assume and state that dams and reservoirs have no greenhouse gas emissions.

While the science has clearly and consistently shown that dams and reservoirs cause substantial annual GHG emissions, the federal agencies operating dams and reservoirs in the United States do not count or report these emissions. Moreover, federal agencies,

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[52] *See* EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks (last visited Mar. 18, 2022).

states, utilities, and other stakeholders often mistakenly claim that dams and reservoirs have no GHG emissions, and that hydropower is a low- or zero-carbon electricity source.

Numerous federal agencies incorrectly characterize hydropower as a clean energy resource. The Bureau of Reclamation's hydropower website claims that "[h]ydropower is a renewable and reliable resource providing clean energy to the western United States."[53] Similarly, the Tennessee Valley Authority states that "[h]ydroelectric power is the most clean, reliable, efficient and economical of all renewable energy sources."[54] The Bonneville Power Administration also claims that its hydropower facilities "fuel[] the cleanest power system in the nation."[55] However, Reclamation's statement disregards the fact that it operates Lake Mead and Hoover Dam, which emit approximately 12.3 million metric tons of CO_2e annually, including 3.1 million metric tons attributable to hydropower generation. *See supra* p. 11. The Tennessee Valley Authority's statement similarly ignores the fact that it operates Kentucky Lake, which emits over 1.8 million metric tons of CO_2e annually, including 407,000 metric tons attributed to hydropower generation. *Id.*

Beyond hydropower, federal agencies also commonly overlook and disregard the GHG emissions from dams and reservoirs when they conduct National Environmental Policy Act reviews of water supply and dam management projects. As one example, the U.S. Army Corps of Engineers issued a final environmental impact statement in 2018 for the Northern Integrated Supply Project in Colorado.[56] This water supply project will result in the construction of two new reservoirs, with capacities of 170,000 and 45,624 acre-feet.[57] However, the Army Corps of Engineers' environmental impact statement does not acknowledge or attempt to quantify the surface GHG emissions from these new dams and reservoirs, or most of the other emission points from dams and reservoirs.

States with ambitious climate goals also frequently overlook dams and reservoirs' GHG emissions, and mistakenly claim that hydropower is a clean energy resource. For example, California states that it "uses a wide range of renewable energy resources to meet its clean energy goals, combat climate change, and promote sustainable energy use."[58] Yet California characterizes hydropower as one of those clean energy resources, and small

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53 Bureau of Reclamation, Hydropower Program, https://www.usbr.gov/power/ (last visited Mar. 18, 2022).

54 Tenn. Valley Auth., Hydroelectric, https://www.tva.com/energy/our-power-system/hydroelectric (last visited Mar. 18, 2022).

55 Bonneville Power Admin., Clean Energy: The Northwest way of life, https://www.bpa.gov/learn-and-participate/community-education/hydropower-101/clean-energy (last visited Mar. 18, 2022).

56 U.S. Army Corps of Eng'rs, *Environmental Impact Statement – Northern Integrated Supply Project* (July 2018), https://www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado/EIS-NISP/.

57 *Id.*

58 Cal. Energy Comm'n, Renewable Energy Resources, https://www.energy.ca.gov/programs-and-topics/topics/renewable-energy/renewable-energy-resources (last visited Mar. 18, 2022).

hydropower plants count toward the state's Renewables Portfolio Standard.[59] Similarly, New York counts hydropower generation in its Clean Energy Standard, which it claims is the "most comprehensive and ambitious clean energy goal in the State's history."[60] But hydropower currently accounts for the vast majority of New York's "clean energy" under this standard.[61] New York also plans to increase its hydropower generation, as it recently announced plans during "Climate Week" to power New York City with "wind, solar and hydropower projects from upstate New York and Canada."[62]

In addition, utilities across the United States often incorrectly presume that hydropower has a necessary role in a low- or zero-carbon future. For example, Xcel Energy— which is a utility with operations in Colorado, Michigan, Minnesota, New Mexico, North Dakota, South Dakota, Texas, and Wisconsin—touts its existing hydropower facilities as providing its customers with "clean, reliable power."[63] In a recent Colorado Public Utilities Commission filing, Xcel claimed that "resource technologies such as pumped storage hydropower . . . will be required to achieve 100 percent carbon reductions by 2050."[64] Additionally, a Deloitte article analyzing U.S. utilities' decarbonization strategies stated that "[h]ydroelectric power is expected to continue as an important cost-effective source of low-carbon baseload power."[65]

The hydropower industry also regularly repeats the false claim that hydropower is a clean energy resource. The National Hydropower Association states that hydropower is "clean, renewable energy," and that hydropower "provides clean, carbon-free energy."[66] The International Hydropower Association claims that pumped storage hydropower is an "ideal

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59 *Id.*; Cal. Energy Comm'n, Hydroelectric Power, https://www.energy.ca.gov/data-reports/california-power-generation-and-power-sources/hydroelectric-power (last visited Mar. 18, 2022).

60 N.Y. State Energy Rsch. & Dev. Auth., Clean Energy Standard, https://www.nyserda.ny.gov/all-programs/programs/clean-energy-standard (last visited Mar. 18, 2022).

61 *Id.*

62 Press Release, N.Y. State Energy Rsch. & Dev. Auth., During Climate Week, Governor Hochul Announces Major Green Energy Infrastructure Projects to Power New York City With Wind, Solar and Hydropower From Upstate New York and Canada (Sept. 20, 2021), https://www.nyserda.ny.gov/About/Newsroom/2021-Announcements/2021-09-20-Governor-Hochul-Announces-Major-Green-Energy-Infrastructure-Projects-to-Power-New-York-City-With-Wind.

63 Xcel Energy, Hydro Energy, https://co.my.xcelenergy.com/s/energy-portfolio/hydro (last visited Mar. 18, 2022).

64 Colo. Pub. Utils. Comm'n, Proceeding No. 21A-0141E, Brooke Trammell Direct Test. 8:14–15 (Mar. 31, 2021), https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Resource%20Plans/Clean%20Energy%20Plan/HE_103_-Direct_Testimony-Brooke_A_Trammell.pdf.

65 Stanley Porter et al., *Utility Decarbonization Strategies*, Deloitte Insights (Sept. 21, 2020), https://www2.deloitte.com/us/en/insights/industry/power-and-utilities/utility-decarbonization-strategies.html.

66 Nat'l Hydropower Ass'n, https://www.hydro.org/ (last visited Mar. 18, 2022).

complement to modern clean energy systems."[67] Multiple news articles have also repeated industry claims that pumped storage hydropower is critical to the clean energy future.[68]

Various other entities and stakeholders also frequently overlook GHG emissions from dams and reservoirs. For example, media coverage of the August 2021 IPCC report highlighting methane emissions often discussed the significant methane emissions from oil and gas production and agriculture, while failing to mention the large amounts of methane emissions from dams and reservoirs.[69] Similarly, a recent McKinsey research report regarding methane claimed that five industries are responsible for 98% of anthropogenic methane emissions: agriculture, oil and gas, coal mining, solid-waste management, and wastewater management.[70] This claim is likely incorrect, as the 2020 Beaulieu et al. study estimated that dams and reservoirs are the fourth largest source of anthropogenic methane emissions in Ohio.[71] Yet the McKinsey research made no mention of methane emissions from dams and reservoirs.

Perhaps the most telling example of how stakeholders overlook dams and reservoirs' methane emissions is The Climate Registry's Water-Energy Nexus Registry. The Climate Registry is a non-profit organization that various states and Canadian provinces advise, and it offers programs for businesses and other organizations to voluntarily measure and report their GHG emissions.[72] In 2019, The Climate Registry launched a Water-Energy Nexus Registry, which focuses on California water providers.[73] The Water-Energy Nexus Registry correctly recognizes that water supply systems cause substantial GHG emissions, and it provides a voluntary registry for water providers to measure and report their

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67 Int'l Hydropower Ass'n, Clean Energy Systems, https://www.hydropower.org/what-we-do/clean-energy (last visited Mar. 18, 2022).

68 *See, e.g.*, Theresa Smith, *Pumped Storage Hydropower Critical for Future Clean Energy Systems*, Power Eng'g Int'l (Sept. 20, 2021), https://www.powerengineeringint.com/smart-grid-td/energy-storage/pumped-storage-hydropower-critical-for-future-clean-energy-systems/; Sammy Roth, *Environmental Disaster or Key to a Clean Energy Future? A New Twist on Hydropower*, L.A. Times, Mar. 5, 2020, https://www.latimes.com/environment/story/2020-03-05/is-hydropower-key-to-a-clean-energy-future.

69 *See, e.g.*, Rebecca Leber, *It's Time to Freak Out About Methane Emissions*, Vox (Nov. 3, 2021, 4:14 PM), https://www.vox.com/22613532/climate-change-methane-emissions.

70 Sam DeFabrizio et al., *Curbing Methane Emissions: How Five Industries Can Counter a Major Climate Threat*, McKinsey Sustainability (Sept. 23, 2021), https://www.mckinsey.com/business-functions/sustainability/our-insights/curbing-methane-emissions-how-five-industries-can-counter-a-major-climate-threat.

71 Beaulieu et al., *Methane and Carbon Dioxide Emissions from Reservoirs*, *supra* note 34.

72 The Climate Registry, About Us, https://www.theclimateregistry.org/who-we-are/about-us/ (last visited Mar. 18, 2022).

73 The Climate Registry, Water-Energy Nexus Registry, History, https://www.theclimateregistry.org/waterenergynexusregistry/about/history/ (last visited Mar. 18, 2022).

systems' GHG emissions.[74] The registry claims its program allows water providers to calculate and track their carbon footprint. But the registry only measures and reports the GHG emissions resulting from the energy used to pump and transport water. The registry does not measure or account for reservoir surface emissions, or most of the other emission points from dams and reservoirs discussed above. *See supra* pp. 11–16. Consequently, this registry that purports to quantify the carbon footprint of water supply systems overlooks a significant portion of water providers' actual GHG emissions.

ARGUMENT

The Petitioners request that EPA grant this Petition and promptly initiate a rulemaking to list dams and reservoirs as a source category that must report GHG emissions under the GHGRP. 40 C.F.R. Part 98. EPA should grant this Petition and expand the scope of the GHGRP because dams and reservoirs emit substantial amounts of GHGs each year that are currently underreported and ignored. Accordingly, expanding the GHGRP to include dams and reservoirs will result in more accurate GHG emissions data from a long-overlooked source category of substantial GHG emissions. This additional data should result in increased awareness of GHG emissions from dams and reservoirs and better-informed climate policies at the federal, state, and local levels.

When EPA implemented the GHGRP in 2009, it recognized it would likely need to expand the program in the future by adding new source categories. Yet EPA has not added any source categories since 2010. This Petition provides EPA with a timely opportunity to expand the GHGRP so that regulators, policymakers, and the public will have access to important new data regarding this significant source category of GHG emissions.

I. Adding dams and reservoirs to the GHGRP will result in better informed U.S. climate policies by ensuring that dams and reservoirs' GHG emissions are no longer underreported and ignored.

Dams and reservoirs emit large amounts of GHGs each year, yet these emissions are often underreported and disregarded. As detailed above, some dams and reservoirs in the United States emit massive amounts of GHGs annually, at levels greater than the GHG emissions of coal- and gas-fired power plants and millions of gas-powered vehicles. For example, Lake Mead and its hydropower operations emit approximately 12.3 million metric tons of CO_2e annually, Kentucky Lake and its hydropower operations emit over 1.8 million metric tons of CO_2e annually, and Lake Whitney and its hydropower operations emit over 1.1 million metric tons of CO_2e per year. *See supra* p. 11. For comparison, Lake Mead's GHG emissions are equivalent to the emissions of over 2.6 million gas-powered vehicles, and Lake Whitney's GHG emissions are six times greater than a coal-fired power plant that produces a similar amount of energy. Yet these facilities are currently not required to measure or report their GHG emissions.

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[74] The Climate Registry, Programs and Services, Water-Energy Nexus Registry, https://www.theclimateregistry.org/programs-services/california-water-energy-nexus-registry/ (last visited Mar. 18, 2022); The Climate Registry, Water-Energy Nexus Registry, https://www.theclimateregistry.org/waterenergynexusregistry/ (last visited Mar. 18, 2022).

The collective GHG emissions of all dams and reservoirs across the nation are similarly underreported and disregarded. The 2020 Beaulieu et al. study estimated that Ohio's dams and reservoirs are the fourth largest source of anthropogenic methane emissions in the state.[75] And nationally, methane emissions from dam and reservoir surfaces are comparable to the methane emissions from the production and distribution of fossil fuels. *See supra* p. 13. Moreover, the overall CO_2e emissions from reservoir surfaces are comparable to the CO_2e emissions from the entire U.S. agricultural sector and home energy use in the United States. *See supra* pp. 13–14. Yet again, this source category's consequential GHG emissions are not measured or reported.

Because dam and reservoir facilities are not required to measure or report their annual GHG emissions, ignoring these emissions is the current status quo. Federal agencies, states, utilities, and other stakeholders too often assume that hydropower is a low- or zero-carbon resource, when that assumption is unfounded and incorrect. *See supra* pp. 16–20. Leaving the GHG emissions from dams and reservoirs "off the books" in this manner has given federal agencies, states, utilities, and private energy developers license to expand hydropower development, despite the substantial body of scientific research showing that dams and reservoirs are major contributors to the climate crisis.

This Petition seeks to rectify the omission of dam and reservoir GHG emissions from national inventories, so that EPA and other agencies and stakeholders can utilize accurate science and emissions data when they make decisions concerning the construction, operation, regulation, and decommissioning of dams in the United States. Adding dams and reservoirs to the GHGRP will ensure that policymakers and the public have access to greater and more accurate information regarding this significant source category of GHG emissions. This additional and improved emissions data will be a critical first step toward developing more well-informed policies on climate change, hydropower, and river management. GHG emissions data will also help ensure that the federal government does not provide funding for dam and reservoir facilities with GHG emissions that will frustrate the United States' climate goals. Similarly, water storage investments that utilize dams and reservoirs, rather than groundwater storage, may result in significantly higher GHG emissions and lost carbon capture opportunities. As EPA acknowledged when it implemented the GHGRP, "[a]ccurate and timely information on GHG emissions is essential for informing many future climate change policy decisions." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. But this essential information is lacking for dams and reservoirs. EPA should therefore grant this Petition and promptly initiate a rulemaking to list dams and reservoirs as a source category under the GHGRP.

II. Adding dams and reservoirs to the GHGRP will help prevent the ill-informed expansion of hydropower based on the mistaken assumption that hydropower is a carbon-free electricity source.

The August 2021 IPCC reports and the recent wildfires, hurricanes, and drought that have battered the United States have vividly highlighted the climate crisis and the

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[75] Beaulieu et al., *Methane and Carbon Dioxide Emissions from Reservoirs*, *supra* note 34.

need to take prompt actions to further reduce GHG emissions. The Biden Administration has set a goal of a 100% carbon-free electric sector by 2035.[76] President Biden also recently signed Executive Order 14057, which instructs the federal government to power its buildings and operations with 100% carbon pollution-free electricity by 2030. Exec. Order No. 14,057, 86 Fed. Reg. 70,935, 70,936 (Dec. 13, 2021). The Biden administration expects this order will "catalyze the development of at least 10 gigawatts of new American clean electricity production by 2030."[77] In addition, over the past year Congress has extensively debated legislation that would shape the future of our electricity system and accelerate the transition to clean energy.[78] Many states and utilities are similarly charting paths toward a zero-carbon future. *See supra* pp. 17–18.

As the federal government, states, and utilities determine how they will decarbonize the electric sector, it is imperative that they accurately account for the GHG emissions of various generation resources. The GHG emissions from coal- and gas-fired power plants, wind, and solar are well understood. In contrast, the GHG emissions from hydropower facilities are typically not recognized and not quantified. Even more problematically, the federal government, states, and utilities almost uniformly assume that hydropower is a clean and zero-carbon generation resource. *See supra* pp. 16–20. But that is not true for many hydropower facilities. The federal government, states, and utilities should not continue to make important and long-lasting decisions regarding the future of the electric sector based on incomplete and incorrect information that ignores hydropower's GHG emissions.

Granting this Petition and adding dams and reservoirs to the GHGRP will help ensure that the federal government, states, and utilities no longer mistakenly presume that hydropower is a clean energy resource. The core problem is the lack of awareness of dams and reservoirs' GHG emissions, and increasing this awareness and understanding is precisely the point of the GHGRP. When EPA implemented the GHGRP, it recognized that reporting programs "raise awareness of emissions among reporters and other stakeholders, and thus contribute to efforts to identify and implement emission reduction opportunities." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. This is a pivotal time to ensure the federal government, states, and utilities have access to accurate and timely information

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[76] Fact Sheet, The White House, President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies (Apr. 22, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

[77] Fact Sheet, The White House, President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability (Dec. 8, 2021); https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/.

[78] *See, e.g.,* Brad Plumer & Winston Choi-Schagrin, *Major Climate Action at Stake in Fight Over Twin Bills Pending in Congress*, N.Y. Times, Oct. 10, 2021, https://www.nytimes.com/2021/10/10/climate/climate-action-congress.html.

regarding hydropower's GHG emissions. If regulators and policymakers continue to disregard or undercount the GHG emissions from the dams and reservoirs used for hydropower generation, the United States runs the risk of inadvertently pursuing a "clean" electric sector that is not actually clean.

Given the imperative to promptly reduce GHG emissions, the United States cannot afford to make ill-informed and mistaken decisions regarding hydropower's role in a zero-carbon future, particularly when data on hydropower's GHG emissions can be calculated but these facilities are not required to measure and report their emissions. The EPA should therefore grant this Petition and ensure that the federal government, states, utilities, and other stakeholders have access to the best available information on dams and reservoirs' GHG emissions as they make crucial decisions regarding the electric sector's future.

III. Adding dams and reservoirs to the GHGRP will assist the United States in achieving its Global Methane Pledge.

In August 2021, the IPCC issued a report highlighting methane's contribution to climate change and the need to promptly reduce methane emissions.[79] In October 2021, the United States announced that it will join the Global Methane Pledge to reduce methane emissions 30% by 2030, and more than one-hundred governments have now joined the pledge.[80]

Dams and reservoirs emit large amounts of methane. Individual dams and reservoirs can emit substantial amounts of methane annually, and the collective methane emissions of all dams and reservoirs across the United States are exceedingly large. As previously noted, the 2020 Beaulieu et al. study estimated that Ohio's dams and reservoirs are the fourth largest source of anthropogenic methane emissions in the state.[81] Yet again, these methane emissions from dams and reservoirs are mostly overlooked and ignored.

The Biden Administration and EPA have recently acknowledged the need for better data regarding methane emissions. For example, a White House statement regarding the Global Methane Pledge noted that participating countries commit to "moving towards using

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[79] *See supra* pp. 7–8; Matt McGrath, *Climate Change: Curbing Methane Emissions Will 'Buy Us Time,'* BBC News, Aug. 11, 2021, https://www.bbc.com/news/science-environment-58174111.

[80] Lisa Friedman, *More Than 30 Countries Join U.S. Pledge to Slash Methane Emissions*, N.Y. Times, Oct. 11, 2021, https://www.nytimes.com/2021/10/11/climate/methane-global-climate.html; Fact Sheet, The White House, President Biden Tackles Methane Emissions, Spurs Innovations, and Supports Sustainable Agriculture to Build a Clean Energy Economy and Create Jobs (Nov. 2, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/02/fact-sheet-president-biden-tackles-methane-emissions-spurs-innovations-and-supports-sustainable-agriculture-to-build-a-clean-energy-economy-and-create-jobs/.

[81] Beaulieu et al., *Methane and Carbon Dioxide Emissions from Reservoirs*, *supra* note 34.

best available inventory methodologies to quantify methane emissions."[82] In addition, a news article regarding EPA's new methane regulations for the oil and gas sector quoted Administrator Regan as stating that "[m]ethane is such a potent pollutant, it's important that we understand what the contribution is from this industry."[83] Moreover, a recent Washington Post investigation found that countries around the world collectively underreport their methane emissions by 57 million to 76 million tons, and that this underreporting of methane emissions (and other GHGs) presents a significant hurdle to achieving climate goals.[84]

To effectively reduce the United States' methane emissions, it is imperative that EPA and other federal agencies understand the contribution of methane emissions from dams and reservoirs. Granting this Petition and adding dams and reservoirs to the GHGRP would further that goal and help ensure that the federal government possesses accurate and timely information on dams and reservoirs' methane emissions as it determines how it will meet the Global Methane Pledge. The federal government will be better positioned to achieve this goal if it understands the relative contribution of methane emissions from dams and reservoirs compared to other source categories, and this is one of the GHGRP's primary purposes. As EPA stated when it implemented the program, "[t]hrough data collected under [the GHGRP], EPA, States and the public will gain a better understanding of the relative emissions of specific industries across the nation." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. Moreover, the data regarding methane emissions from individual dams and reservoirs may illustrate additional ways the United States can achieve its methane goal, such as decommissioning certain high-emitting facilities. Granting this petition will thus help ensure that the federal government has access to the best available information on methane emissions from dams and reservoirs as it determines how it will reduce the nation's methane emissions 30% by 2030.

IV. Adding dams and reservoirs to the GHGRP will further the program's underlying principles.

EPA should grant this Petition because adding dams and reservoirs to the GHGRP will further the underlying purposes of the program. When EPA implemented the GHGRP in 2009 it articulated five principles for the program, and expanding the program to include dams and reservoirs will advance each principle.

First, EPA stated that the program should provide GHG emissions data that informs climate change policies at all levels of government. For example, EPA stated that "[a]ccurate and timely information on GHG emissions is essential for informing many future climate change policy decisions," and the data will "improve the U.S. government's ability to formulate climate policies." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. As detailed throughout this Petition, GHG emissions from dams and reservoirs are

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82 Press Release, The White House, *supra* note 1.

83 Grandoni & Romm, *supra* note 2.

84 Chris Mooney et al., *Countries' Climate Pledges Built on Flawed Data, Post Investigation Finds*, Wash. Post, Nov. 7, 2021, https://www.washingtonpost.com/climate-environment/interactive/2021/greenhouse-gas-emissions-pledges-data/.

substantial, yet federal agencies, states, utilities, and other stakeholders frequently overlook and ignore these emissions. As a result, regulators and policymakers in the United States have developed climate polices that are based on fundamentally flawed and incorrect assumptions that hydropower is a clean energy resource, and that dams and reservoirs are not significant contributors to climate change. Granting this Petition will be an important step toward better-informed climate policies for federal, state, and local governments.

Second, EPA explained that the GHGRP should document the relative GHG emissions of different industries and source categories. EPA stated that "[t]hrough data collected under [the GHGRP], EPA, States and the public will gain a better understanding of the relative emissions of specific industries across the nation." *Id.* Adding dams and reservoirs to the GHGRP will advance this goal in several ways. Some individual dams and reservoirs have annual GHG emissions greater than coal- and gas-fired power plants, yet federal agencies, states, utilities, and other stakeholders often presume that all hydropower is a clean energy resource. In addition, water storage projects that utilize dams and reservoirs have greater GHG emissions than groundwater storage or other water storage options that do not involve dams and reservoirs. Requiring dams and reservoirs to report their GHG emissions will therefore allow regulators and utilities to compare an individual dam and reservoir facility's GHG emissions to the emissions of other generation resources and other water storage systems.

In addition, requiring dams and reservoirs to report their GHG emissions will allow agencies, states, and stakeholders to compare the collective GHG emissions from dams and reservoirs to the GHG emissions from other source categories. For example, many stakeholders overlook dams and reservoirs as a substantial source of methane emissions, and instead focus only on methane emissions from oil and gas production, agriculture, and landfills. *See supra* p. 19. Yet the 2020 Beaulieu et al. study estimated that Ohio's dams and reservoirs are the fourth largest source of anthropogenic methane emissions in that state.[85] Granting this petition will provide important insights into how the GHG emissions from dams and reservoirs compare to the GHG emissions from other industries and source categories.

Third, EPA stated that the GHGRP should document the GHG emissions of specific facilities within an industry or source category. EPA explained that the GHGRP will provide "EPA, States and the public [with] a better understanding of . . . the distribution of emissions from individual facilities within [an] industr[y]," and that "the facility-specific data will also improve our understanding of the factors that influence GHG emission rates and actions that facilities could in the future or already take to reduce emissions." Final 2009 GHGRP Rule, 74 Fed. Reg. at 56,265. Requiring dams and reservoirs to report their GHG emissions will advance this goal. Some dam and reservoir facilities emit massive amounts of GHGs, while other dams and reservoirs emit less GHGs. Consequently, requiring dams and reservoirs to report their emissions will provide valuable data regarding the relative GHG emissions between different facilities, and this will help

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[85] Beaulieu et al., *Methane and Carbon Dioxide Emissions from Reservoirs*, *supra* note 34.

policymakers develop more effective climate policies to reduce GHG emissions from dams and reservoirs.

Fourth, EPA explained that the GHGRP data should raise awareness of sources' GHG emissions. EPA stated that its "experience with other reporting programs is that such programs raise awareness of emissions among reporters and other stakeholders, and thus contribute to efforts to identify and implement emission reduction opportunities." *Id.* As detailed throughout this Petition, the lack of awareness of dams and reservoirs' GHG emissions—even among federal agencies and states—is a fundamental problem. In short, there is a pressing need to raise awareness of the GHG emissions from dams and reservoirs, and requiring facilities to measure and report their emissions through the GHGRP will increase public awareness of these emissions.

Finally, EPA acknowledged that the GHGRP should expand and evolve over time to include additional source categories. EPA stated that "additional data collection (e.g., for other source categories or to support additional policy or program needs) will no doubt be required as the development of climate policies evolves." *Id.* The Congressional Research Service also recently reiterated this principle and stated that "policymakers could consider expanding the scope of sources required to report."[86] However, EPA has not added any new source categories to the GHGRP since 2010.[87] For all the reasons discussed above, dams and reservoirs are a source category that warrant expanding the GHGRP. EPA should therefore seize this opportunity to expand and evolve the GHGRP to cover dams and reservoirs, so that policymakers and the public have access to accurate and timely information regarding this significant source of GHG emissions.

V. Dams and reservoirs meet the definition of a "facility" under the GHGRP, and EPA may consider subcategories and determine the GHG calculation methodology in a future rulemaking.

If EPA grants this Petition and begins a rulemaking to list dams and reservoirs as a source category under the GHGRP, the Petitioners look forward to working with EPA and other stakeholders regarding the details of the reporting requirements for dams and reservoirs. The Petitioners offer the following preliminary comments regarding some of the technical matters that would be the subject of the future rulemaking.

The GHGRP requires owners and operators of covered facilities to report their GHG emissions. 40 C.F.R. § 98.1. The GHGRP regulations define a "facility" as "any physical property, plant, building, structure, source, or stationary equipment located on one or more contiguous or adjacent properties . . . that emits or may emit any greenhouse gas." *Id.* § 98.6. A dam and its artificially produced and maintained reservoir meet this definition of a "facility." A dam is a "structure," and its reservoir is a connected, interdependent, and essential part of the physical property, plant, and source. Moreover, a dam and its reservoir often include buildings, structures, stationary equipment, and plants that emit GHGs, such as turbines and spillways. Accordingly, the "facility" that must report GHG

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86 Cong. Research Serv., *supra* note 3, at 2.

87 EPA, GHGRP Historical Rulemakings, *supra* note 6.

emissions for the dam and reservoir source category should include the dam, the reservoir, and all other buildings, structures, stationary equipment, and plants located at the property that emit GHGs.

Relatedly, when EPA defines the source category in the subsequent rulemaking, it should define the dam and reservoir source category to include, at a minimum, each dam; the reservoir it creates, including the maximum fill line and area of the reservoir; and related infrastructure (e.g., hydropower turbines, spillways, desilting operations, and fish passage operations). EPA may also consider creating subcategories of dams and reservoirs that would be required to report their GHG emissions. For example, dams and reservoirs with hydropower generation could be a separate subcategory from non-hydro dams and reservoirs, if different reporting thresholds or reporting requirements are reasonable for these hydropower facilities.

In addition, there are several methodologies currently used for calculating GHG emissions from dams and reservoirs. As noted above, some of these methodologies more accurately calculate dams and reservoirs' GHG emissions than others. *See supra* p. 14. As a result, it will be important in future rulemakings for EPA to ensure that the equations and methodologies it requires owners and operators to use for this source category represent the best available science and accurately reflect the actual and complete GHG emissions from dams and reservoirs.

CONCLUSION

The time to take prompt and decisive action on climate change is now. Every day that dams and reservoirs continue to emit large amounts of GHGs that go uncounted and unreported is a missed opportunity to better understand and address this significant source of GHG emissions. Moreover, every day that federal agencies, states, and utilities incorrectly assume and state that all hydropower is a low- or zero-carbon resource—or that reservoir water storage has no GHG emissions—the United States goes further down the path of making pivotal and long-lasting decisions regarding electricity and water based on mistaken assumptions. Continuing these erroneous assumptions and ill-informed decisions will have dire consequences. For these reasons, the Petitioners strongly urge the EPA to grant this Petition and promptly initiate a rulemaking to add dams and reservoirs as a source category under the GHGRP.

We look forward to your prompt reply to this Petition, no later than 180 days from today. If you have any questions about this Petition, please contact Michael Hiatt at Earthjustice (303-996-9617).

Sincerely,

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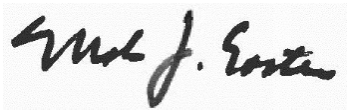

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SUBMITTED ON BEHALF OF THE FOLLOWING ADDITIONAL UNDERSIGNED PETITIONERS:

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350 Brattleboro
350 Maine
350 Seattle
Addison County River Watch Collaborative (VT)
Alabama Rivers Alliance
Alliance for the Wild Rockies
Alvraddarnas Waterkeeper

American Alpine Club
American Rivers
American Whitewater
Association "Resource Aarhus center in BiH"
Atchafalaya Basinkeeper
Atlantic Salmon Federation
Back Country Excursions of Maine, LLC
Backbone Campaign
Balkanka Association Sofia, Bulgaria
Beyond Searsville Dam
Black Warrior Riverkeeper
Boulder Waterkeeper
Bozeman Birders
Cahaba Riverkeeper
California Trout
California Wilderness Coalition (CalWild)
Centar za životnu sredinu/Center for Environment
Center for Biological Diversity
Coastal Watershed Institute
Collier County Waterkeeper
Columbia Riverkeeper
Commons BC
Connecticut River Conservancy
Creative Chi
Dam Sense
Dam Watch International
Deschutes Estuary Restoration Team
Downeast Salmon Federation
Earth Law Center
Earth Matters/350VT
EcoAlbania
Elliotsville Foundation
Endangered Species Coalition
Energy and Climate Upper Valley
Energy Balance, Inc.
Environmental Defense Center
Environmental Stewardship
EuroNatur
Foothill Conservancy

Forest Ecology Network
Friends of Butte Creek
Friends of Merrymeeting Bay
Friends of Sebago Lake
Friends of the Eel River
Friends of the River
Gallatin Wildlife Association
Glen Canyon Institute
Global Justice Ecology Project
Grand Riverkeeper Labrador, Inc.
Great Basin Waterkeeper and Great Basin Water Network
Idaho Rivers United
International Rivers
Lake Pend Oreille Waterkeeper
Last Tree Laws
LEAD Agency, Inc.
Living Rivers and Colorado Riverkeeper
Long Island Soundkeeper
Los Padres ForestWatch
LRB Hydrology & Analytics
Maine Youth for Climate Justice
Matilija Coalition
Mediterranean Institute for Nature and Anthropos
MHG Solar LLC
Milwaukee Riverkeeper
Missouri Confluence Waterkeeper
National Lawyers Guild - NYC Environmental Justice Committee
Native Fish Society
Nevada Conservation League
New York Environmental Law and Justice Project
NGO Green Home
Nimiipuu Protecting the Environment
North American Megadam Resistance Alliance
North Fork Studios
Northern California Council, Fly Fishers International
o2 Utah
Orange County Coastkeeper
Outdoor Alliance
Peace Valley Environment Association

Peace Valley Landowner Association
Peconic Baykeeper
Pippin Ventures
Port Phillip EcoCentre / Port Phillip Baykeeper
Raincoast Conservation Foundation
RAVEN (Respecting Aboriginal Values and Environmental Needs)
Restore Hetch Hetchy
RESTORE: The North Woods
Rio Grande Waterkeeper
Ríos to Rivers
Riverkeeper
Rivers for Change
Riverwatch
Rogue Riverkeeper
Sacramento River Council
San Francisco Baykeeper
San Luis Obispo Coastkeeper
San Marcos High School
Satilla Riverkeeper
Save Our Wild Salmon Coalition
Save The Poudre
Sierra Club
Slovenian Native Fish Society
Snake River Waterkeeper
Solutionary Rail
South Yuba River Citizens League
Stoecker Ecological
SunCommon
Surfrider Foundation
Tennessee Riverkeeper
The Conservation Alliance
The Rewilding Institute
The Sierra Fund
Three Rivers Waterkeeper
Tualatin Riverkeepers
Two Rivers Action Coalition
University of Montana, Flathead Lake Biological Station
Upper Colorado River Watershed Group
Upper Valley Affinity Group (Vermont)

Vermont Chapter of the Sierra Club
Washington Wild
Water Climate Trust
Waterkeeper Alliance, Inc.
Waterkeepers Chesapeake
Wild Fish Conservancy
Wild Orca
WildEarth Guardians
William S. Boyd School of Law's Environmental Law Society

Attachments

Attachment 1: Bibliography of Scientific Studies
Attachment 2: Mark Easter, *Greenhouse Gas Emissions from Dams and Reservoirs in the United States* (2022)
Attachment 3: List of Cited Documents and Sources Provided to EPA

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Attachment 1

Scientific Studies Documenting Greenhouse Gas Emissions from Dams and Reservoirs

2021

- Dailson Bertassoli Jr. et al., *How Green can Amazon Hydropower be? Net Carbon emission from the largest hydropower plant in Amazonia*, 7 Sci. Advances (June 25, 2021), https://www.science.org/doi/10.1126/sciadv.abe1470.

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Attachment 2

Greenhouse Gas Emissions from Dams and Reservoirs in the US

Mark Easter, Independent Consultant

March 19, 2022

Following is a summary of seventeen identified emissions source and sub source categories, by EPA GHG inventory sector, with an indication whether generalizable emissions models currently exist that can be utilized either in GHG inventories or life cycle assessments or other analyses that assess scope 1, 2, or 3 emissions:

Table 1. Greenhouse gas emissions sources and sub sources from Reservoir Systems.

Emissions Sector	Emissions source category	Emissions sub source categories	Do generally applicable emissions models exist?	Yearly or one-time emissions?	Citations
Industrial Processes	Mineral Products	CO_2 from Cement Production	yes	One-time at beginning of life cycle.	[1]
Energy	Fossil Fuel Combustion for Mining and Dam Construction	CO_2	yes	One-time at beginning of life cycle.	[5]
Energy	Fossil Fuel for Dam and Reservoir Operations	CO_2	yes	Yearly over the life cycle until dam removal and remediation.	[5]

[1] U.S. Environmental Protection Agency. 2021. Inventory of Greenhouse Gas Emissions and Sinks 1990-2019. https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf?VersionId=yu89kg1O2qP754CdR8Qmyn4RRWc5iodZ, viewed on 16 November 2021.

Emissions Sector	**Emissions source category**	**Emissions sub source categories**	**Do generally applicable emissions models exist?**	**Yearly or one-time emissions?**	**Citations**
Energy	Biogenic emissions from hydropower turbines	CH_4	no	Yearly over the life cycle until dam removal and remediation.	[2] [3] [4] [5] [6]
Land Use and Forestry	Surface Emissions from Lakes and Reservoirs	CO_2, CH_4, N_2O	yes	Yearly over the life cycle until dam removal and remediation.	[7] [8]
Land Use and Forestry	Wetlands and Riparian Forest Degradation	CO_2, CH_4, N_2O	no	Yearly over the first several decades after dam construction.	[12]

[2] Fearnside, P. (1995). Hydroelectric Dams in the Brazilian Amazon as Sources of 'Greenhouse' Gases. *Environmental Conservation, 22*(1), 7-19. doi:10.1017/S0376892900034020

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Emissions Sector	**Emissions source category**	**Emissions sub source categories**	**Do generally applicable emissions models exist?**	**Yearly or one-time emissions?**	**Citations**
Land Use and Forestry	Reservoir Banks	CO_2, CH_4 N_2O	no	Yearly over the life cycle until dam removal and remediation.	[9] [10]
Land Use and Forestry	Dam and Reservoir Decommissioning and Restoration	CO_2, CH_4, N_2O	no	One-time after dam removal and site restoration.	[11] [12]
Land Use and Forestry	Loss of ecosystem function (carbon sequestration)	CO_2	no	One-time after dam construction and inundation, and then potentially yearly over the life cycle until dam removal and remediation.	[5]

As shown in the table above, only seven of these seventeen emissions sources have been quantified to the extent that generalized emissions models can be applied in a greenhouse gas inventory at the country level. The fact that emissions are dispersed across multiple sectors, and that many of the identified emissions have yet to be fully quantified, has created the impression that dams, reservoirs, and their associated land uses, which prominently includes hydropower, are low-carbon or even zero-carbon enterprises. This perception is made even worse when the

[9] Keller, P.S., Marcé, R., Obrador, B. *et al.* (2021) Global Carbon Budget of Reservoirs is Overturned by the Quantification of Drawdown Areas. *Nat. Geosci.* https://www.nature.com/articles/s41561-021-00734-z, viewed on 16 November 2016.
[10] Marcé, R. *et al*. (2019) Emissions from Dry Inland Waters are a Blind Spot in the Global Carbon Cycle. *Earth Sci. Rev*. 188, 240–248. https://doi.org/10.1016/j.earscirev.2018.11.012, viewed on 16 November 2016.
[11] Hertwich EG.(2013). Addressing biogenic greenhouse gas emissions from hydropower in LCA. Environ Sci Technol. 2013 Sep 3;47(17):9604-11. doi: 10.1021/es401820p.
[12] Song, C, K Gardner, S Klein, SP Souza, W Mo. 2018. Cradle to Grave Greenhouse Gas Emissions from Dams in the United States of America. Renewable and Sustainable Energy Reviews 90:945-956. https://doi.org/10.1016/j.rser.2018.04.014

magnitude of emissions are diluted or downplayed by attributing them to other co-occurring uses for reservoirs, such as recreation or flood control. When the emissions are examined in aggregate, however, the evidence clearly indicates that the emissions from dams and reservoirs are very high.

To illustrate the potential overall magnitude of greenhouse gases (GHGs) from dams and reservoirs (hereinafter referred to as "reservoir systems"), consider the emissions from one single source category – that of reservoir surfaces. Deemer *et al*. (2016, 2020) developed generalized greenhouse gas inventory emissions that may be applied to greenhouse gas inventories of reservoirs based on their trophic states (oligotrophic, mesotrophic, and eutrophic)[13]. Using the US Army Corps of Engineers National Inventory of Dams as a primary data source for the area of water bodies that are technically classified as reservoirs[14] the total reservoir surface area in the inventory was calculated at 12,471,527 hectares (30,804,671 acres). This estimate of surface area is likely conservatively small, for the following reasons:

1) It does not include the SOO Locks on the St. Mary's River downstream of Lake Superior. The National Inventory of Dams includes the surface area of Lake Superior associated with the locks, which skews the inventory upwards. Eutrophication and downstream impacts associated with the locks are not incorporated into this assessment.
2) At the time the version of the national inventory of dams was downloaded (October, 2021) more than 21,823 of the 91,457 records did not contain a record of surface area for the reservoir associated with the dam. A simple linear regression technique that predicts surface area from NID storage in the dataset indicates that approximately 6 million acres of reservoirs are not accounted for in the assessment.

In order to assess the proportion of dams in the different trophic classes, this analysis utilized the EPA 2012 National Lakes Assessment[15], which indicates that reservoirs in the U.S. fall into the relative fractions of trophic classes shown in the table below. Combining that with the emission factors produces the following results:

[13] Trophic State Index. 2021. https://en.wikipedia.org/wiki/Trophic_state_index, viewed 16 November 2021.
[14] US Army Corps of Engineers. 2021. National Inventory of Dams. https://nid.usace.army.mil/ords/f?p=105:1, viewed 16 November 2021.
[15] US Environmental Protection Agency. 2016. National Lakes Assessment for 2012. https://www.epa.gov/sites/default/files/2016-12/documents/nla_report_dec_2016.pdf, page 12, viewed on 16 November 2021.

Surface Emissions	fraction	area (ha)	Emission factor	units	Emissions (Mg CO2e/yr)
Totals	***1***	***12,471,527***			***459,405,494***
oligotrophic	0.10	1,247,153	1087	mg CO2e/m^2/day	4,948,141
mesotrophic	0.35	4,365,034	3782	mg CO2e/m^2/day	60,256,244
eutrophic	0.34	4,240,319	15745	mg CO2e/m^2/day	243,687,959
hypereutrophic	0.21	2,619,021	15745	mg CO2e/m^2/day	150,513,151

In summary, the total surface emissions estimated from this analysis is 459 MMT CO2e/yr, shown in the figure below in comparison with other U.S. greenhouse gas emissions sectors.

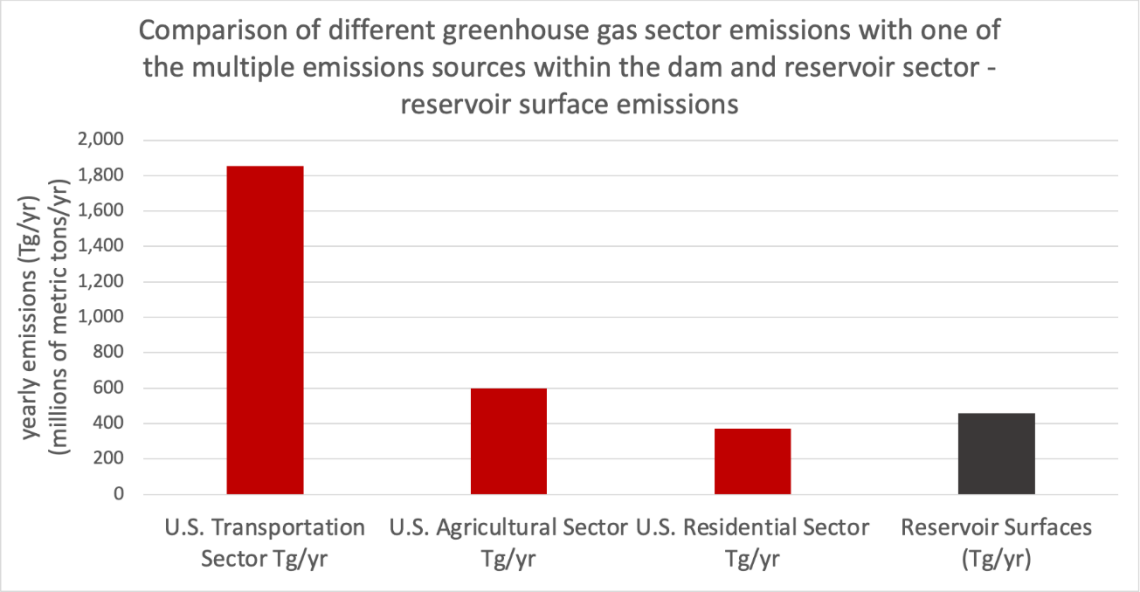

Figure 1. Comparison of U.S. reservoir surface emissions with other U.S. Emissions Source Categories. Sources: U.S. EPA Greenhouse Gas Inventory Data Explorer, U.S. Army Corps of Engineers National Inventory of Dams, U.S. EPA National Lakes Assessment, and Deemer et al. (2016, 2020). Note: Depending on the type of dam and reservoir operations, total emissions will include additional known emissions sources, including hydroelectric turbines, fuel used for dam and reservoir construction and operations, cement used in dam construction, reservoir banks, lost or damaged downstream forests and wetlands disrupted by dam operations, deforestation before inundation, lost carbon sequestration opportunities after inundation, and ecosystem carbon losses after inevitable dam decommissioning.

In addition to the likely under-estimate of the total surface area of reservoirs in the Corps of Engineers National Dam Inventory, this estimate of total emissions from reservoir surfaces is likely conservatively small for other reasons. No separate emissions factor has been calculated for hypereutrophic water bodies, and so the emission factor for eutrophic water bodies was

used to estimate emissions for hypereutrophic water bodies. Considering that emissions increase with the eutrophic state of the water body, combined with the fact that more than a fifth of U.S. water bodies are classified by the National Lakes Assessment as hypereutrophic, this calculated emission factor of 459 million metric tons of CO2e per year from reservoir surfaces is likely much higher. If combined with the other sixteen emissions source categories across the complete life cycle of a reservoir system, the total emissions elevate reservoir systems into one of the most significant greenhouse gas emissions categories in the U.S.

This analysis compares favorably with other studies. Total per-area emissions average 36.8 Mg CO2e/ha/yr for U.S. reservoirs, which is comparable to the Deemer *et al*. analyses showing emissions of 24.9 Mg CO2e/ha/yr for a subsample of reservoirs internationally. The higher fraction of U.S. reservoirs in eutrophic or hypereutrophic states, compared with that fraction internationally, is the driving factor for a higher per-area analysis.

It is notable to point out that these emissions, on a per-area basis, are among the highest for any non-urban land use in the U.S. For example, the highest emissions from agricultural lands are likely from cropland on drained organic soils (35 Mg CO_2e/ha)[16] [17].

Once they are quantified in a way that can be implemented in GHG inventories, the GHG emissions from currently unquantified emissions sources (hydropower turbines, reservoir banks, inevitable dam decommissioning, loss of ecosystem function, loss of ecosystem carbon and nitrogen downstream of dams) are likely to significantly increase the inventoried emissions from reservoirs and emissions attributed to hydropower. Emissions from dam decommissioning

[16] IPCC. 2013. 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Chapter 2: Drained Inland Organic Soils. https://www.ipcc-nggip.iges.or.jp/public/wetlands/pdf/Wetlands_separate_files/WS_Chp2_Drained_Inland_Organic_Soils.pdf, viewed 16 November 2021.

[17] It is important to note that the emissions from land use change are currently quantified in annual EPA GHG inventory, however the total land use change resulting from the construction of the current inventory of dams in the United States was largely complete by 1990, the baseline year of the U.S. GHG inventory.

could be very high.[18] The loss of terrestrial ecosystem carbon sequestration due to inundation largely remains unquantified. One recent study in Oct. 2021, addressed aspects of this issue[19].

Some parties have argued dams and reservoirs simply move carbon around and do not result in net emissions over their lifecycle. There is an increasing body of evidence, codified in the bibliography provided, that casts great doubt upon that assertion. Studies that tout the benefits of reservoirs or low emissions from hydropower all share at least one of the following problems:

- Emissions from hydropower turbines are quantified using faulty methods that can lead to a substantial undercounting of GHG concentrations upstream of hydropower turbines[20]. This can lead to major under-estimation of off-gassed GHG emissions relative to the trace gas emissions downstream of turbines.

- Measurements not taken at appropriate time steps, or missing measurements during critical periods, such as when temperate and boreal reservoirs "turn" in the spring and fall, can lead to significant undercounting of total yearly GHG emissions[21].

- Critical components of life cycle emissions, such as inevitable dam decommissioning, ecosystem carbon and nitrogen losses downstream due to flow alterations, dam construction, or other emissions source categories have not been included[22].

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[18] Cuihong Song *et al.*, *Cradle-to-Grave Greenhouse Gas Emissions from Dams in the United States of America*, 90 Renewable & Sustainable Energy Reviews 945 (2018), https://www.sciencedirect.com/science/article/abs/pii/S1364032118302235, viewed 16 November 2021.

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[21] Deemer, Bridget R., John A. Harrison, Siyue Li, Jake J. Beaulieu, Tonya DelSontro, Nathan Barros, José F. Bezerra-Neto, Stephen M. Powers, Marco A. dos Santos, J. Arie Vonk, (2016). Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis, *BioScience*, Volume 66, Issue 11, 1 November 2016, Pages 949–964, https://doi.org/10.1093/biosci/biw117, viewed 16 November 2021.

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To summarize:

- Scientists have identified at least seventeen sources of greenhouse gas emissions from reservoir systems, which occur across multiple greenhouse gas inventory categories, including energy, industrial processes, and land use & forestry.
- Only seven emissions sources from reservoir systems are currently accounted for in the US EPA annual greenhouse gas inventory.
- The fact that so many emissions sources are uncounted, and the ones that are counted are distributed across multiple emissions categories, creates the impression that emissions are relatively small compared with other types of land use, industrial processes, or energy sources.
- Critical steps need to be taken to correct this GHG undercounting bias from reservoir systems, including:
    - Incorporate currently available scientific methods and evidence into the US EPA annual greenhouse gas inventory to fill existing inventory gaps, beginning with reservoir surface emissions and lost carbon sequestration
    - Initiate studies to collect the data necessary to construct general models that can be applied in a general way to the remaining missing GHG sources, including emissions from hydropower turbines and reservoir banks, inevitable dam decommissioning and reservoir site remediation, disrupted wetlands and riparian forests due to altered downstream flow regimes, and lost carbon sequestration potential after dam construction and reservoir inundation.

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Attachment 3

The Petitioners have provided EPA via USB flash drive the following documents cited in the Patagonia et al. Petition to Add Dams and Reservoirs to the Greenhouse Gas Reporting Program.

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