Behind the Concrete Curtain: Acknowledging and Curbing Greenhouse Gas Emissions from Hydroelectric Facilities and River Impoundments

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I. INTRODUCTION

From its early use as kinetic power to kick start the industrial revolution,[1] a consensus emerged that hydroelectric power is clean, renewable, and reliable.[2] In contemporary parlance it is universally classified as either "carbon free"[3] or "low-carbon."[4] The history of hydropower in the United States supports this belief, and its use has rarely been scrutinized.[5] However, an emerging consensus indicates scrutiny is necessary (for hydroelectric power and other energy sources avoiding acute assessment) given the challenges foisted upon us by anthropogenic climate change.[6]

This Article will put the standard hydropower consensus to task and analyze whether it holds water as a resource that can be heavily relied upon in a clean energy transition. First, a review of the United States' history with hydropower will summarize the construction of a ubiquitous pro-power narrative that pervaded hydroelectric conversations well into the 1970s. A narrative that has recently found favor again as the global community seeks a path to avoid the worst effects of climate change. Second, this Article will discuss the nascent scientific consensus around the impact of twentieth and twenty-first century proliferation of hydropower and river impoundments. Third, this Article will explore current federal legislative tools available to account for and mitigate future impacts, including suggestions to amend current legislation to require analysis of hydroelectric impact on

1. *See* U.S. DEP'T OF ENERGY, HYDROPOWER VISION: A NEW CHAPTER FOR AMERICA'S 1ST RENEWABLE ELECTRICITY SOURCE 73 (2016), https://www.energy.gov/sites/default/files/2018/02/f49/Hydropower-Vision-021518.pdf [https://perma.cc/DT94-7YF7].

2. *Id.* at 7.

3. Malcolm Wolf, *The Path to Carbon Free Flows Through Hydropower*, THE HILL: CONG. BLOG (Oct. 22, 2019, 5:30 PM), https://thehill.com/blogs/congress-blog/energy-environment/466938-the-path-to-carbon-free-flows-through-hydropower [https://perma.cc/VV76-H8X3].

4. U.S. DEP'T OF ENERGY, *supra* note 1, at 1.

5. *See* Kavya Balaraman, *100+ Hydro Plants Have Greater Warming Impact Than Fossil Fuels: EDF Study*, UTILITYDIVE (Nov. 19, 2019), https://www.utilitydive.com/news/hydropower-emissions-fossil-fuels/567572/ [https://perma.cc/T4QR-EP2T].

6. Ilissa B. Ocko and Steven P. Hamburg, *Climate Impacts of Hydropower: Enormous Differences Among Facilities and Over Time*, 53 ENV'T SCI AND TECH. 14070 (2019); Philip Fearnside, *Greenhouse Gas Emissions from Hydroelectric Dams: Controversies Provide a Springboard for Rethinking a Supposedly "Clean" Energy Source*, 66 CLIMATIC CHANGE 1, 5 (2004).

climate change. Finally, this Article will analyze national policy regarding prospective development and reliance on hydropower.

A. Building the Curtain: Development of the United States Hydroelectric Industry

Deployment of natural river streams as power-generating mechanisms is an ancient technology.[7] Hydroelectric technology has been harnessed over centuries, resulting in structural behemoths such as the Grand Coulee and Hoover Dams. Primitive models of hydroelectric power came into existence in the early eighteenth century. These models used run of the river water wheels to harness the kinetic power of flowing water for early industrial manufacturing.[8] Mechanical developments advanced in the late nineteenth century, producing modern hydroelectric turbines and the hydroelectric plant's progenitors.

The science is straightforward; streams are interrupted by an impoundment that floods the upstream riparian area to create a reservoir called the "head."[9] Headwater is then released downward through the dam, creating a "flow" into a powerhouse which contains a turbine spun by the passing water.[10] This process powers an electric generator connected to power lines transporting electricity to consumers.[11]

Simple yet powerful, this mechanism has yielded significant electricity generation capacity when operated at scale. By 1912, hydroelectric power accounted for thirty percent of the United States electricity market.[12] Up to 1912, hydroelectric development went largely unregulated, controlled by only two narrow federal statutes: (1) the Rivers and Harbors Appropriation Act of 1899, which subjected impoundments on navigable streams to Congressional approval;[13] and (2) the Reclamation Act of 1902 which created the Bureau of Reclamation and empowered the agency to develop federal hydroelectric impoundments in the American West.[14]

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7. *Hydropower Program: The History of Hydropower Development in the United States*, BUREAU OF RECLAMATION (Feb. 3, 2016), https://www.usbr.gov/power/edu/history.html [https://perma.cc/7D8D-BSQT].
8. U.S. DEP'T OF ENERGY, *supra* note 1, at 75.
9. *Id.* at 76.
10. *Id.*
11. U.S. DEP'T OF ENERGY, *supra* note 1, at 76, 78.
12. U.S. DEP'T OF ENERGY, *supra* note 1, at 75.
13. *Id.* at 92.
14. *Id.*; *see also* BUREAU OF RECLAMATION, *supra* note 7.

1920 saddled the first substantive hydroelectric development regulations with the Federal Power Water Power Act (FWPA), amended in 1935[15] as the Federal Power Act (FPA). The FPA established the Federal Power Commission[16] to coordinate a unified planning and regulatory mechanism for hydroelectric development throughout the United States.[17] Once reorganized and established as the Federal Energy Regulatory Committee (hereinafter "FERC" or "the Commission"), FERC took on the role of mandating the issuance of licenses

> [F]or the development. . . and utilization of power . . . [which] in the judgement of the commission will be best adapted to a comprehensive scheme for improving or developing a waterway. . . for the benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, and of other beneficial public uses.[18]

For over three decades after its inauguration, FERC treated this original mandate as an endowment of free reign to pursue pro-power interests. The Commission operated with a general disregard for its secondary mandate to consider "other beneficial public uses."[19] Running with its primary pro-power mandate, FERC impeded thousands of American rivers with impoundments and other generating facilities in just a few decades between the 1940s and 1960s.[20]

After three decades of FERC's unchallenged impounding of rivers in the United States, the country began to feel the adverse impacts of plugging rivers without due consideration of environmental effects.[21] The golden era of dams ended as the rise of the environmental movement moved to the fore. Environmental activists exposed the considerable damage massive impoundments were having on riverine ecosystems due to ill-conceived development plans.[22] The 1960s, 1970s, and 1980s brought a deluge of

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15. *See* Federal Power Act, 16 U.S.C. § 792-828(c) (1935).
16. Federal Energy Regulatory Commission, 42 U.S.C. § 7171(a) (1977).
17. 16 U.S.C. § 797(e) (1935).
18. 16 U.S.C. §§ 797(e), 803(a) (1935).
19. J.R. DeShazo & Jody Freeman, *Public Agencies as Lobbyists*, 105 COLUM. L. REV. 2217, 2236 (2005); 16 U.S.C. §§ 797(e), 803(a) (1935).
20. U.S. DEP'T OF ENERGY, *supra* note 1, at 72, 76.
21. *See* Anna Lieb, *The Undamming of America*, PBS (Aug. 12, 2015), https://www.pbs.org/wgbh/nova/article/dam-removals/ [https://perma.cc/33MP-8DQK].
22. *See id.*; *See also How Dams Damage Rivers*, AMERICAN RIVERS (2019), https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/how-dams-damage-rivers/ [https://perma.cc/TYR5-ZBTL].

federal legislation[23] and pro-environment federal court rulings,[24] furthering the adverse impact on hydropower.

Initial legislative attempts to regulate dam development sought to balance two central objectives. First, legislatures intended to ensure the continued growth of energy generation through hydropower. Second, legislators hoped to mitigate the adverse environmental impacts from future dam development. These statutes included the National Environmental Policy Act,[25] the Clean Water Act,[26] the Fish and Wildlife Conservation Act,[27] the Wild and Scenic Rivers Act,[28] and the Endangered Species Act.[29]

Despite Congress taking superficially proactive measures to balance FERC's pro-power stance, power generation still ruled the day due to a confluence of factors, including the lack of intensive oversight, the oil embargo, and an energy crisis in the 1970s and 1980s.[30] As a result, environmental considerations took a back seat, though certainly in a better position than in previous decades. Pro-power trends continued into the 1980s until the enactment of the Electric Consumers Protection Act (ECPA), which amended the FPA, and forcefully redirected FERC to consider a range of environmental factors when licensing or relicensing publicly owned hydroelectric facilities. The ECPA required FERC to provide "equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife . . . the protection of recreational opportunities, and the preservation of other aspects of environmental quality."[31]

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23. *See Environmental Policy in the United States*, BALLOTPEDIA, https://ballotpedia.org/Environmental_policy_in_the_United_States (last visited Oct. 31, 2021) [https://perma.cc/8VHP-ZU8N].

24. *See also* Udall v. Fed. Power Comm'n, 387 U.S. 428 (1967); *see generally* Scenic Hudson Preservation Conference v. Fed. Power Comm'n, 354 F.2d 608 (1965).

25. National Environmental Protection Act, 42 U.S.C. § 4231 et. seq. (1970).

26. Clean Water Act, 33 U.S.C. § 1251 et. seq. (2008).

27. Fish and Wildlife Conservation Act, 16 U.S.C. § 2901 et. seq. (1980).

28. Wild and Scenic Rivers Act, 16 U.S.C. § 1271 et. seq. (1968).

29. Endangered Species Act, 16 U.S.C. § 1531 et. seq. (1973).

30. *See 7. Hydroelectric Power in the 20th Century and Beyond*, NAT'L PARK SERV., https://www.nps.gov/articles/7-hydroelectric-power-in-the-20th-century-and-beyond.htm [https://perma.cc/5FET-A3X8].

31. 16 U.S.C. § 797(e) (1920); *see* DeShazo & Freeman, *supra* note 19, at 2253, 2262.

Upon the enacting of the ECPA, big dam and hydroelectric development in the United States drastically receded.[32] Projects that were licensed or relicensed were subjected to nearly twice as many conditions.[33] Thereafter, the force of a quarter-century of environmental activism, court rulings, and federal legislation eventually began to pressure pro-power forces to accept responsibility for clotting the nation's riparian arteries. Few impoundments were erected in the following decades.

However, this comment is neither intended to lament the lapse of the faith in dams nor to hail environmental victories over big hydropower supporters. The true lament is that among the hundreds of dams decommissioned since the passage of the ECPA, greenhouse gas (GHG) emissions remain unlisted as a cause for removal.[34] FERC, the Department of Energy, and other agencies responsible for dam development pursuant to the FPA regularly refer to hydroelectric development as "clean,"[35] "carbon-free,"[36] or "low-carbon."[37] While the latter is closer to the actual state of affairs, even "low-carbon" is not a global truth. That label's veracity is highly dependent on pre-development considerations of local hydrologic, riverine, riparian, and wildlife ecosystems.[38] Absent these considerations, negligently developed hydroelectric impoundments and dams possess the potential to significantly contribute to global carbon dioxide, methane, and nitrous oxide emissions.

II. EMERGING CONSENSUS: HYDROELECTRIC GENERATION IS NOT ALWAYS CLEAN ENERGY GENERATION

Decades of scientific consensus and news reports have laid bare the consequences of wealthy energy companies refusing to come to terms

32. *See* Philip Shabecoff, *After 85 Years, the Era of Big Dams Nears End*, N.Y. TIMES (Jan. 24, 1987), https://www.nytimes.com/1987/01/24/us/after-85-years-the-era-of-big-dams-nears-end [https://perma.cc/M2M9-A4AM].

33. DeShazo & Freeman, *supra* note 19, at 2227.

34. *See generally,* J. Ryan Bellmore et al, *Status and Trends of Dam Removal Research in the United States*, 4 WIREs WATER 1 (2017).

35. U.S. DEP'T OF ENERGY, *supra* note 1, at 2.

36. Wolf, *supra* note 3.

37. U.S. DEP'T OF ENERGY, *supra* note 1, at 1.

38. *See* Ocko & Hamburg, *supra* note 6, at 14070–71, 14079; *see also* Elizabeth A. Ingram, *Exploring Reasons Behind Dam Removal*, HYDRO REV., (Mar. 1, 2012), https://www.renewableenergyworld.com/baseload/exploring-the-reasons-behind-dam-removal/#gref [https://perma.cc/5USE-XQVN]; *see also* Yves. T. Prairie et al., *Greenhouse Gas Emissions from Freshwater Reservoirs: What Does the Atmosphere See?*, 21 ECOSYSTEMS 1058, 1058–63 (2018).

with their investments' environmental consequences.[39] While it is clear that proliferation of hydroelectric impoundments has nowhere near the climactic impact of big oil, the hydropower industry suffers from the same cognitive mistakes that befell big oil companies.[40] No significant government agencies or officials, along with hydropower developers, have agreed about the extent to which hydroelectric power contributes to global GHG emissions. Ossified positions on this issue stem from a belief that hydroelectric power either does not emit GHG's, or if it does, it does so at a microscopic level relative to its energy generation. However, scientific research over the last two decades has eroded the belief that hydropower is always clean energy.[41] Climate change is too invidious and evasive of a threat to allow anything besides hard data to prevail. And the emerging consensus indicates the pervasive conception of hydroelectric energy as even "low-carbon" is a circumstantial statement.[42]

Reasons abound why the image of hydroelectric energy as an emissions producer can be so swiftly cast aside. In everyday life, dams never need to be considered. Stoking anger over climate change inaction toward the persistence of fossil fuel is much easier in that sense. Fossil fuels are ever-present. Gas stations are found on nearly every major street corner and fumes of smoke are a regular sight for cities in close proximity to oil refineries. In contrast, hydroelectric plants are hidden away. Most people never glimpse the unnatural behemoths fighting back millions of gallons of plugged-up river unless they are enjoying a weekend on the lake or fishing an out-of-the-way river. Even then, most will never witness a release indicative of fugitive gasses leaking from their surface. As with many societal issues, hydroelectric impoundment emissions fester below the surface and remain unacknowledged by the uninquisitive eye.

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39. *See* Ove Hoegh-Guldberg et al., *2018: Impacts of 1.5°C of Global Warming on Natural Human Systems, Intergovernmental Panel on Climate Change*, *in* GLOBAL WARMING OF 1.5°C 175, 177 (Jose A. Marengo, et. al. eds., 2018).

40. *See* Linda Ciocci, The Climate Registry: Electric Power Sector Protocol, Public Comment of Linda Ciocci Executive Director, Nat'l Hydropower Ass'n (2009) (unpublished comment) (on file with author) (arguing it would be a mistake and counterproductive to register hydroelectric reservoirs as fugitive emissions sources); *see also* U.S. DEP'T OF ENERGY, *supra* note 1, at 301, 303–05 (arguing measurement technology is not yet capable of making a dispositive decision as to the level of emissions).

41. *See* Fearnside, *supra* note 6, at 4–5.

42. Ocko & Hamburg, *supra* note 6, at 14070, 14079–80; *see* Prairie, *supra* note 38, at 1067.

Further, early studies on the theory that hydro-impoundments yield GHG emissions, such as those by Philip Fearnside of the National Institute for Research in the Amazon, were conducted on rivers far from the United States and in disparate climates from those experienced in the United States.[43] However, in 2004, Fearnside elaborated on research conducted in the 1990s, establishing early estimates of productivity and mechanisms of emissions from hydroelectric impoundments.[44] From his research came early signs that, unlike natural lakes and rivers, which produce negligible carbon dioxide emissions, once impeded by a dam, reservoirs produce significantly higher levels of carbon dioxide and methane.[45]

Flooding large swaths of land for sustained periods results in organic decomposition.[46] Organic decomposition is a chemical process whereby organic matter and underground biomass are killed (terminating its capacity to absorb atmospheric CO_2). Microbial bacteria then decompose the matter releasing carbon dioxide and methane.[47] Fearnside measured these emissions, and estimated hydroelectric reservoirs contributed ten million tons of carbon dioxide at Brazil's major hydroelectric facilities alone.[48]

Fearnside's findings have been repeated, refined, and substantiated.[49] Original studies failed to asses factors in hydroelectric development and the pro-power lobby could placate fears of significant emissions in the United States.[50] More recent studies have assessed the contributors to high emission dams and determined which climatic, ecological, and structural factors tend to result in significant emissions, and quantify the level of emissions produced.[51] Generally, contributors to direct emissions include geographical location, temperature, precipitation, submerged vegetation characteristics, net primary productivity,[52] age, area, volume, depth, and

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43. *See generally* Fearnside, *supra* note 6, at 1.

44. *See id.* at 4.

45. *Id.* at 2–4.

46. Vincent St. Louis et al., *Reservoir Surfaces as Sources of Greenhouse Gases to the Atmosphere: A Global Estimate*, 50 BIOSCIENCE 766, 766 (Sept. 2000).

47. *See id.* at 766–67.

48. Fearnside, *supra* note 6, at 4 (indicating greater emissions rates in tropical climates).

49. St. Louis et al., *supra* note 46, at 768–71; Ocko & Hamburg, *supra* note 6, at 14070–71.

50. *See* Nat'l Hydropower Ass'n Membership Directory, NAT'L HYDROPOWER ASS'N (June 2020), https://www.hydro.org/membership/members-directory/ [https://perma.cc/FUS7-G43P].

51. *See* William Steinhurst et al., *Hydropower Greenhouse Gas Emissions: State of the Research*, SYNAPSE ENERGY ECON. INC., 13 (Feb. 14, 2012); Ocko & Hamburg, *supra* note 6, at 14070-14071.

52. Prairie et al. *supra* note 38, at 4–7 (describing river processes of naturally emitting carbon dioxide before impoundment construction and explaining that pre-impoundment emissions should be deducted from post-impoundment emissions to reach a reasonable conclusion of anthropogenic emissions).

extent and duration of water level fluctuations.[53] Had the pro-hydropower lobby promoted consideration of these siting factors, a significant portion of impoundment emissions could have been mitigated.

Recent studies indicate the level of expected emissions depends upon a confluence of the various factors mentioned above. These results cast a shadow over current policies favoring reinvestment in hydroelectric development. Synapse Energy Economics, an energy research and consulting firm, recently estimated that, although the variability in emissions between hydropower plants is immense, Fearnside's theory holds water regarding hydroelectric development in the United States.[54] Synapse estimated run of the river reservoirs emit between 0.5 and 153 kg CO_2eq/MWh (carbon dioxide equivalent GHGs produced per megawatt-hour of electricity generated), and newly flooded boreal reservoirs emit between 160 to 250 kg CO_2eq/MWh.[55] A far cry from newly flooded tropical reservoirs, which show signs of 1,300 to 3,000 kg CO_2eq/MWh.[56] These findings should not be disregarded especially considering they reflect conservative estimations of emissions potentials.

It is essential to determine the increase in emissions after impoundment development compared to waterway emissions in their natural state, without impoundments.[57] This determination would yield a gross and net emissions calculation identifying the emissions attributable to the proliferation of impoundments, thereby dispensing the unproductive counterpoint that all waterways have some emissions potential.[58] This complicated process has been the scapegoat of those with a pro-power agenda at the cost of environmental precaution.[59]

Researchers have provided guidelines for how to produce accurate GHG emission estimates. Yves Prairie, the Global Environmental Change Chairman at UNESCO, argues accurate calculations are reached by first quantifying pre-impoundment carbon dioxide emissions from organic carbon,

53. Ocko & Hamburg, *supra* note 6, at 14070–71; *see* Steinhurst et al., *supra* note 51, at 13; *see also* Hyojin Jin et al., *Enhanced Greenhouse Gas Emission from Exposed Sediments Along a Hydroelectric Reservoir During an Extreme Drought Event*, 11 ENV'T RES. LETTERS, at 2 (2016).
54. Steinhurst et al., *supra* note 51, at 2, 9.
55. Steinhurst et al., *supra* note 51, at 2.
56. *Id.*
57. Ocko & Hamburg, *supra* note 6, at 14070–71.
58. Prairie et al, *supra* note 38, at 3, 8.
59. U.S. DEP'T OF ENERGY, *supra* note 1, at 301, 303–05; Wolf, *supra* note 3.

decomposed vegetation, and sediment in the run of the river.[60] Prairie would discount these pre-impoundment emissions as a product of natural ecological systems.[61] However, an increase in emissions from submerged surface area post-impoundment should count toward overall emissions.[62] Prairie used this method to conclude that twenty-five percent of river produced carbon dioxide emissions are attributable to development of impoundments. However, he concluded that all methane emissions are anthropogenic.[63] Accordingly, hydroelectric impoundments remain well within the substantial net emissions category.

The Environmental Defense Fund conducted a study in 2019 which demonstrated that average hydroelectric GHG emissions are eight to thirty times greater than that of nuclear, solar, and wind GHG emissions.[64] However, hydroelectric emissions do fall short of coal and natural gas GHG emissions.[65] Strikingly, within the initial years after hydroelectric development, when organic decomposition is the strongest, hydroelectric reservoirs produce between thirty-five and forty percent of natural gas and coal emissions.[66]

It is essential to keep in mind the "carbon free" context that interested parties have pushed from the Department of Energy to the National Hydropower Association. While one can engage in a semantic argument that, unlike fossil fuels, the actual production of power does not cause emissions, the stakes at issue are too far-reaching and devastating to entertain this. Hydroelectric power is not "carbon-free," nor is it universally "low-carbon."

More destructive than the levels of carbon dioxide are high global warming potential (GWP) emissions including methane and, to a lesser degree, nitrous oxide.[67] The presence of these gasses has been theorized since Fearnside's 1990's studies; More recent studies by Fearnside and other researchers, including Prarie's, have solidified their early premise.[68]

Synapse in 2012, Bridget Deemer in 2016, and Ilissa Ocko in 2019 (researchers who in three separate studies analyzed hydroelectric emissions)

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60. Prairie et al., *supra* note 38, at 5; *contra* Jin et al., *supra* note 53, at 5, 8 (establishing that fluctuating water levels result in increased CO_2 emissions from pre-impoundment levels).
61. Prairie et al., *supra* note 38, at 5.
62. *Id.* at 7–8.
63. *Id.* at 8.
64. *See* Ocko & Hamburg, *supra* note 6, at 14073–74.
65. *Id*. at 14074.
66. *Id*.
67. Steinhurst et al., *supra* note 51, at 6; Bridget R. Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis*, 66 BIOSCIENCE 949, 949 (Nov. 2016) (discussing the harm of nitrous oxide).
68. Fearnside, *supra* note 6, at 4–5; Prairie et al. *supra* note 38, at 4–10.

conducted studies that indicate significant potential for methane emissions from hydroelectric reservoirs in various climates.[69] Establishing methane emissions calculations is vital because methane traps seventy-two times more heat per kilogram than carbon dioxide in the first year after emission.[70] Presence of considerable methane emissions makes the necessity of progressive action on this issue even more dire. Most climate action plans in the United States and the world have established short-term targets, which they seek to achieve by 2025, 2030, or 2040.[71] Regardless of whether remedies are established at the source, if an effort is not made to account for such fugitive emissions, achieving those objectives will constitute pyrrhic victories.

Given the scientific consensus on current emissions levels, responsible agencies must make an effort to account for the GHG emissions produced by hydroelectric reservoirs. Even if Prarie's conservative allocation for carbon dioxide emissions is relied upon, it is vital that such emissions be acknowledged. Failure to do so results in overall misleading GHG emissions estimates and mitigation targets. This problem also has potential to be exacerbated by the impending, worsening effects of climate change. Separate Studies conducted by Hoyin Jin of Ewha Woman's University, Seoul Department of Environmental Science and Engineering, and Ulf Malfast of Leipzig's Helmholtz Center for Environmental Research reached similar conclusions, the effects of climate change exacerbate emissions. Both studies found that anthropogenically aggravated drought conditions will result in increased emissions from impounded rivers.[72]

Along with the aforementioned emissions sources, degassing and ebullition, sediment build-up trapped by impoundments act as a methane storage facility. As sediment lifted by streams settle in a dam's headwater, it brings down methane released from decomposed biomass with it.[73] Logically this would seem beneficial in the short run as it limits the quantity

69. Steinhurst et al., *supra* note 51, at 12; *see* Deemer et al., *supra* note 67, at 953; *see also* Ocko & Hamburg, *supra* note 6, at 14075.

70. Steinhurst et al., *supra* note 51, at 6.

71. National Conference of State Legislatures, *State Renewable Portfolios and Standards*, https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx (last visited Sept. 24, 2021) [https://perma.cc/HB42-PBYK].

72. Jin et al., *supra* note 53, at 1; Ulf Malfast et al., *Spatial Upscaling of CO_2 Emissions from Exposed River Sediments of the Elbe River During an Extreme Drought*, 13 ECOHYDROLOGY, at 1 (Apr. 2020).

73. Andreas Maeck et al., *Sediment Trapping by Dams Creates Methane Emission Hot Spots*, 47 ENVTL. SCI. TECH. 8130, 8130 (2013).

of methane which ultimately bubbles to the surface. That assumption only holds, however, if steady water levels are assumed.

Jin and Malfast's studies on rivers where hydroelectric impoundments were present in years when water levels subsided due to drought conditions revealed the consequences of inevitable water level fluctuation. Both studies concluded that sediment exposed by fluctuated water levels result in significantly increased carbon dioxide flux.[74] Additionally, Jin's study indicates even more significant increases in methane and nitrous oxide emissions from exposed sediment.[75] These findings forecast another grim climate change-induced cycle; climate-induced ecological changes result in greater emissions and more daunting climatic effects. This equation should create a bright red flashing light. If action is not taken to develop solutions or alter existing policies, the climatic gears already in motion have self-perpetuating force that may reap further devastation so long as it remains unconsidered.

III. INEFFECTIVE IMPLEMENTATION OF EXISTING LEGISLATIVE SOLUTIONS

Fugitive emissions have been recognized as an issue in the struggle to mediate the worst results of climate change's inevitable effects. Required advancements must be both technological and legislative. Technological solutions to this problem will be briefly addressed later, but the more pressing problem FERC's disregard for emissions estimates in its legislative mandate, addressed in detail below. The critical pieces of legislation implicated in hydroelectric development, which demonstrate the current state of unpreparedness to address this staple of climate change resistance, include: (1) the Federal Power Act (FPA); (2) the National Environmental Policy Act (NEPA); and (3) the Clean Water Act (CWA). Each statute will be addressed in order, along with the precedent that exists to implement such policies appropriately to this pressing problem. Subsequently, amendments will be proposed to each that could motivate attentiveness to GHG emission.

A. Federal Power Act

Originally established in 1920 as the Federal Water Power Act, reorganized as the FPA in 1935, the original mandate of FERC was to issue licenses "for the development . . . of power [which] . . . in the judgement of the commission will be best adapted to a comprehensive scheme for improving or developing a waterway . . . for the benefit of interstate or foreign

74. Malfast et al., *supra* note 72, at 12; Jin et al., *supra* note 53, at 5.
75. Jin et al., *supra* note 53, at 6.

commerce, for the improvement and utilization of water-power development, and of other beneficial public uses."[76] To assure developers that cost recovery would be allowed and consumers that sufficient energy would be produced, the FPA provided that licenses would be granted for up to fifty years, after which relicensing procedures would occur.[77] FPA Section 808 established that in relicensing determinations, the public interest should remain considered along with various other factors.[78]

Despite requiring consideration of the public interest, as described in Section I, environmental interests were summarily ignored for nearly thirty years until environmental advocacy and court rulings began to move the needle.[79] Ironically this occurred when the earlier of the first generation of FPA dams were coming up for relicensing. The first landmark case considering the application of the FPA was *Scenic Hudson Preservation Conference v. Fed. Power Comm'n*. The *Scenic Hudson* court remanded FERC's license grant to construct a pumped storage hydroelectric facility on New York's Hudson River for renewed proceedings.[80] In doing so, the court made several groundbreaking statements regarding necessary considerations in licensing, which provided context to the mandates of sections 797 and 803 to establish the "best adapted comprehensive scheme." This decision finally emphasized considerating adverse impacts on the "public interest," and the court asserted that the public is due "active and affirmative protection" by FERC.[81] The court elaborated that within the licensing provisions of the FPA, "recreational purposes" include

76. 16 U.S.C. §§ 797(e), 803(a) (1935).
77. *Id*. at §§ 799, 808.
78. *Id.* at § 808.
79. *See generally Preservation and Perseverance: Pillars of Scenic Hudson's Grassroot Legacy*, HUDSON RIVER MARITIME ACADEMY (Aug. 5, 2020), https://www.hrmm.org/history-blog/preservation-and-perseverance-pillars-of-scenic-hudsons-grassroots-legacy [https://perma.cc/8NPM-KAYX] [hereinafter *Preservation and Perseverance*] (following Scenic Hudson, the National Environmental Policy Act was adopted which granted citizens the right to comment on projects which will impact their environment); *see also*, DAVID SCHUYLER, EMBATTLED RIVER: THE HUDSON AND MODERN AMERICAN ENVIRONMENTALISM 25–26 (Cornell Univ. Press 2018) (outlining that despite no consensus emerging, authorities from judges to litigators believe that core NEPA requirements, federal agency mandates to evaluate the environmental impact of projects and requirement to identify reasonable project alternatives, were derived from the key holdings of Scenic Hudson).
80. Scenic Hudson Preservation Conference v. Fed. Power Comm'n, 354 F.2d 608, 624 (1965).
81. *Id.* at 620.

"conservation of natural resources, [and] the maintenance of natural beauty. . ." and FERC must weigh each of these factors.[82]

Scenic Hudson spurred action at both the federal and state levels.[83] Within a decade of the landmark case, NEPA was enacted with various statutes that permitted private citizens to gain standing and oppose projects with adverse environmental consequences.[84] Despite these advances, FERC action lagged, even defying the Council on Environmental Quality's (CEQ) requirement for all federal agencies to develop environmental compliance standards. FERC relied on its status as an independent agency to claim CEQ had no binding effect on the Commission's environmental considerations.[85] FERC held their position despite the Supreme Court's subsequent ruling in *Udall v. FPC*, which again chastised the Commission for failing to consider public interest factors such as "preserving. . . wilderness areas. . . and the protection of wildlife."[86] The court asserted that the "choices available to satisfy future demands" must be among the considerations to avert such impacts.[87]

Despite these changes, hydropower continued to be a heavily relied upon source of energy. FERC continued to ignore court precedent, which sought to create a framework for and emphasize a balanced evaluation of interests. The limited number of environmental conditions placed on licensing and relicensing agreements around this time reflects FERC's resistance.[88] Such stubbornness is a common issue with secondary legislative mandates, or what an agency views as its secondary mandate.[89]

Momentous tipping of the scale away from hydroelectric interests toward environmental consideration was delayed until 1986 with the ECPA passage.[90] Passage of ECPA triggered movement toward considering the broader effects of development on the riverine ecosystems. Subsequently, agency reconfiguration established an office dedicated to hydroelectric licensing and a wave of environmental experts were hired;[91] Congress had finally acted.

The ECPA reconfigured the entire structure of decision-making within the FPA, and therefore within FERC, as it related to environmental impacts

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82. *Id.* at 614.
83. *See Preservation and Perseverance, supra* note 79.
84. *Id.*
85. DeShazo & Freeman, *supra* note 19, at 2247.
86. Udall v. Fed. Power Comm'n, 387 U.S. 428, 450 (1967).
87. *Id.*
88. DeShazo & Freeman, *supra* note 19, at 2264.
89. *Id.* at 2220.
90. Electric Consumers Protection Act, 16 U.S.C. § 797 et. seq. (1986); *see also* Deshazo & Freeman, *supra* note 19, at 2222–23.
91. *See* Deshazo & Freeman, *supra* note 19, at 2258.

of hydroelectric facilities. Although the list of factors to be considered did not include greenhouse gasses, it nonetheless altered the scope of implementing agencies. While not expressly included, *Massachusetts v. EPA*[92] provides authority for requiring consideration of GHGs. However, *Massachusetts v. EPA* remains unlikely to consistently yield such results without further legislative amendment. Court rulings on greenhouse gas issues have widely varied and should not be relied on in agenda setting, especially relating to intricate scientific considerations due to the broad deference provided to agencies assessing which impacts to consider.[93]

ECPA required FERC to "give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife. . . and preservation of other aspects of environmental quality".[94] The ECPA's demand was in addition to its original mandate of "improvement and utilization of water-power development."[95] The remodeled statute required FERC to account for these considerations when granting original licenses and considering relicensing. Further, the ECPA strongly encouraged interagency cooperation throughout hydroelectric project development. Support for interagency cooperation in sections 797(c), 803(a)(3), and 803(j)(1) requires cooperation in preparation of environmental documents, and other required licensing processes.[96] Renovation of pertinent legislative control on FERC and hydroelectric licensing magnified the cost of anti-environment decisions. Thus, the quantity of lateral agencies, in this case state fish and wildlife agencies, proposed environmental conditions which FERC has implemented into licensing agreements significantly increased over the proceeding decades.[97]

In the decades since the EPCA, there has been no fundamental retooling of the FPA's consideration of environmental impacts caused by hydroelectric development. While the FPA was amended several times, the purpose has

92. *See* Massachusetts v. Env't. Prot. Agency, 127 S. Ct. 1438, 1458–61 (2007).
93. Burger and Wentz, *Downstream and Upstream Greenhouse Gas Emissions: The Proper Scope of NEPA Review*, 41 HARV. ENVTL. L. REV. 109, 142–44 (2017).
94. 16 U.S.C. § 797(e) (2005).
95. 16 U.S.C. § 803 (2005).
96. 16 U.S.C. §§ 797(c), 803(a)(3), 803(j)(1) (2005).
97. *See* DeShazo & Freeman, *supra* note 19, at 2263–65, 2272 (explaining that the ECPA required FERC to consult with specific resource agencies including fish and wildlife agencies and "[Any] agency established pursuant to Federal Law that has the authority to prepare such a plan; or the state in which it is located"); *see also* 16 U.S.C. § 803(a)(3), (j)(1).

been mainly to expand renewable energy without considering climatic effects.

This evolution indicates two things: (1) the present verbiage of the FPA could be interpreted to enforce GHG mitigation measures whether pre- or post-impoundment; and (2) FERC's resilience to increased conditioning considerations oversight suggests more stringent measures will be necessary. This dichotomy is demonstrated by the fact that despite 2015[98] and 2017[99] Policy Statements reaffirming commitment to environmental protection purposes that have adverse human impacts, neither Wisconsin's Kimberly Hydroelectric Project nor the Klamath decommissioning project considered potential emissions.[100]

B. National Environmental Policy Act

The National Environmental Policy Act (NEPA) has become central to energy development licensing procedures, including FERC's hydroelectric licensing. On January 1, 1970, NEPA was enacted and set the groundwork for environmental legislation for several decades.[101] At its core, NEPA requires various agencies to conduct pre-action assessments of both environmental impacts and less invasive alternatives. However, it is now widely recognized that the environmental movement's nascent legislation was highly aspirational. Aspiration is no doubt required in this regard, but it also yielded a myriad issue that remains today.[102]

NEPA's stated purpose is to "encourage productive and enjoyable harmony between man and his environment; [and] to promote efforts which will prevent or eliminate damage to the environment. . . ."[103] Certain agencies have interpreted NEPA as a vehicle primed for application to the issue of GHG emissions and climate change; others have neglected to do so or

98. 18 C.F.R. § 380.4 (2015).

99. FED. ENERGY REG. COMM'N, PL17-3-000, POLICY STATEMENT ON ESTABLISHING TERMS FOR HYDROELECTRIC PROJECTS (2017).

100. *See generally* FED. ENERGY REG. COMM'N, P-10674-017, ENVIRONMENTAL ASSESSMENT FOR HYDROPOWER LICENSE: KIMBERLY HYDROELECTRIC PROJECT 14–25 (2020) (failing to mention potential for GHG emissions or address the fact that they may be present in the headwater); ORDER AMENDING LICENSE AND DEFERRING CONSIDERATION OF TRANSFER APPLICATION, 162 FERC ¶ 61,236 (Mar. 15, 2018).

101. *Id.; see also* Richard Lazarus, *Greening of America and the Graying of United States Environmental Law: Reflections on Environmental Law's First Three Decades in the United States*, 20 VA. Env't. L.J. 75, 77 (2001).

102. *See* Richard Glick, Commissioner Richard Glick Dissent in Part Regarding Mountain Valley Pipeline, LLC, Federal Energy Regulatory Commission (June 18, 2020), [https://perma.cc/FYV9-S94V].

103. 42 U.S.C. § 4321 (1970).

applied it to GHG's more selectively.[104] Unfortunately, FERC falls neatly under the latter description. Various FERC commissioners, including Trump Administration Chairman Neal Chatterjee, have explicitly—though symbolically—recognized the pressing need to reckon with GHG emissions.[105] Like Richard Glick, the new FERC Chairman, others have openly criticized the Commission for its failure to adequately shift policy to address emissions produced by energy development and facilities.[106]

Environmental Assessments (EA) and Environmental Impact Statements (EIS) are the two key tools utilized to achieve NEPA's objective to "insure integrated use of natural and social sciences and environmental design. . . in decision-making which may have an impact on man's environment."[107]

NEPA requires Environmental Assessments in every energy facility's proposal to support licensing decisions environmental impacts.[108] However, NEPA's text only ambiguously demands statements on "(i)the environmental impact . . . (ii) adverse environmental effects which cannot be avoided . . . [and] (iii) [project] alternatives."[109] NEPA also vaguely requires evaluation of "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity."[110] This verbiage has led to broad, unpredictable implementation by agencies. Federal regulations have further clarified that the EA's serve as a brief statement to determine the necessity of a more detailed EIS.[111]

When required, Environmental Impact Statements for hydroelectric facility license applications must include: water use and quality, fish,

104. Rich Glick & Matthew Christiansen, *FERC and Climate Change*, 40 ENERGY L.J. 1, 6 (2019); *see also* U.S. GLOB. CHANGE RSCH. PROGRAM, IMPACTS, RISKS, AND ADAPTATIONS IN THE UNITED STATES (2018), https://nca2018.globalchange.gov/ [https://perma.cc/5K8K-4CA3].

105. FED. ENERGY REG. COMM'N, AD20-14-000, CARBON PRICING IN ORGANIZED WHOLESALE ELECTRICITY, 173 FERC ¶ 61,062 (2020); *see also* Christopher J. Bateman & James T.B. Tripp, *Toward Greener FERC Regulation of the Power Industry*, 38 HARV. ENVTL. L. REV. 275, 278 (2014).

106. Glick & Christiansen, *supra* note 104, at 6; *see also* Walker Stanovsky et al., *D.C. Circuit Sinks FERC Hydro License for Failure to Adequately Consider Past Environmental Harms*, DAVIS WRIGHT TREMAINE LLP (July 11, 2018), https://www.dwt.com/insights/2018/07/dc-circuit-sinks-ferc-hydro-license-for-failure-to#_ftn1 [https://perma.cc/T38C-U3BT].

107. 40 C.F.R. § 1501.5; 40 C.F.R. § 1502.2; 42 U.S.C. § 4332(A).

108. 42 U.S.C. § 4332(C).

109. 42 U.S.C. § 4332(C)(i)–(iii).

110. *See* 42 U.S.C. § 4332(C)(iv).

111. 40 C.F.R. § 1501.5(c)(1).

wildlife, vegetation, cultural, and socioeconomic impacts.[112] Along with these considerations, NEPA mandates various siting requirements for all non-exempt projects in order to minimize environmental impacts on the abovementioned resources, and insure safety and energy generation capacity.[113]

Less frequently required, and demanding stricter procedural rules, are Environmental Impact Statements—obligatory for all major actions "significantly affecting the human environment" as dictated by the initial Environmental Assessment findings.[114] No specific considerations are required by the EIS, instead impacts unearthed in the EA guide a more detailed EIS analysis. The analysis is also generally required to examine the cumulative resource impacts and areas of controversy.[115] Further, the EIS consultant is chosen and instructed by the Commission. Without strict baselines to follow, the consultant's decisions can potentially be tailored to the analyze impacts they view as necessary.[116] Accordingly, an EIS for hydroelectric facilities generally examines factors such as water quality, water supply, flow rates, water temperatures, and erosion control. The scope of those findings and suggested actions can be interpreted as FERC pleases.[117]

Attempts have been made to restrain this unwieldy authority through interagency cooperation; however, they have produced marginal success. For instance, amendments to the FPA in the 2005 Energy Policy Act created "trial type-hearings" on disputed material fact in the licensing process, and recent court rulings indicate FERC should be considering emissions in environmental effects.[118] However, even with these advancements, NEPA is considered a fundamentally flawed legislative tool.[119] Prominent regulators such as FERC Chairman Richard Glick have repeatedly expressed[120] this view as it relates to Natural Gas development. His criticisms are equally applicable to hydroelectric development.

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112. *See generally* 18 C.F.R. § 380.16.

113. *See generally* 18 C.F.R. § 380.15.

114. FED. ENERGY REG. COMM'N, PREPARING ENVIRONMENTAL DOCUMENTS: GUIDELINES FOR APPLICANTS, CONTRACTORS, AND STAFF (Sept. 2008) at v.

115. *Id*. at 46–47; *see also* 40 C.F.R. § 1502.15 (2020).

116. FED. ENERGY REG. COMM'N, PREPARING ENVIRONMENTAL DOCUMENTS: GUIDELINES FOR APPLICANTS, CONTRACTORS, AND STAFF, v–vi (2008).

117. 16 U.S.C.A. § 797(e) (2005); *see also* DeShazo & Freeman, *supra* note 19, at 2270 (arguing that despite the implementation of the ECPA and the requirement of EIS's as of the time of the article, FERC had declined only one project out of 222, which demonstrates the focus is on conditioning grants, not fitness).

118. Sierra Club v. FERC, 867 F.3d 1357, 1374–75 (D.C. Cir. 2017).

119. DeShazo & Freeman, *supra* note 19, at 2228; *see also* Bateman & Tripp, *supra* note 105, at 297, 300.

120. Glick & Christiansen, *supra* note 104, at 42–43.

Commissioner Glick has repeatedly claimed that, similar to the FPA, if NEPA were properly and ubiquitously implemented, it would contain sufficient tools to regulate and mitigate emissions.[121] Glick has stated that reasoned decision-making does not support the Commission's current public interest determinations and that climatic effects of energy sources deserve consideration under NEPA.[122]

The federal district courts have concurred on several grounds. In *American Rivers v. FERC*, the D.C. Circuit fundamentally opposed FERC's approach to hydroelectric licensing under NEPA.[123] The court held that FERC had "declined to factor in the decades of environmental damage already wrought by exploitation of the waterway for power generation and that damage's continuing ecological effects."[124] Just a year earlier, the D.C. Circuit similarly ruled against FERC's baseline utilization of NEPA. Contemplating the extent to which an EIS must discuss emissions, the court asserted FERC "should have estimated the amount of power-plant carbon emissions."[125] The court elaborated that despite several contributing variables making precise quantification challenging, "NEPA analysis necessarily involves some 'reasonable forecasting.'"[126] Further, FERC could "reasonably foresee" such emissions, and therefore has an obligation to mitigate, or at a minimum, discuss the emissions' significance.[127]

Similar to the current state of the FPA, NEPA has been systemically underutilized. As Commissioner Glick has intimated, there is plenty FERC can do within existing NEPA framework to mandate consideration of GHG emissions.[128] Lacking "absolute certainty" or a single comprehensive methodology to quantify emissions does not mean the task is impossible.[129] NEPA's encouragement of agencies to identify and remedy deficiencies in their current policy in section 103 supports Commissioner Glick's position.[130]

NEPA retains potential functionality if regulators implement several scientific methods researchers have used to quantify project emissions

121. Glick & Christiansen, *supra* note 104, at 66–67.
122. Glick & Christiansen, *supra* note 104, at 12, 42.
123. American Rivers v. FERC, 895 F.3d 32, 37 (D.C. Cir. 2018).
124. *Id*.
125. Sierra Club v. FERC, 867 F.3d 1357, 1374–75 (D.C. Cir. 2017).
126. *Id.* at 1374.
127. *Id.*
128. Glick & Christiansen, *supra* note 104, at 6.
129. *See* Glick & Christiansen, *supra* note 104, at 4.
130. 42 U.S.C § 4333.

(methodologies that yielded the estimates discussed in Section II). While quantification methods would likely vary, assessing the climatic impacts within each project's environmental report's scope is necessary to reach informed decisions in granting or rejecting proposals. Analysis of emissions could also help to provide a more holistic measure of per capita GHG emissions.

C. Clean Water Act

Encouraging states to pursue stringent enforcement of the CWA potentially presents a straightforward solution to the hydroelectric fugitive emissions dilemma. Several other statutes have been relied on to control dam commissioning and decommissioning. However, these statutes fail to drive at the heart of the matter, whereas the CWA deals directly with water quality.[131] Therefore, it possesses the potential to regulate levels of accumulated GHGs within headwaters.

The root of the hydroelectric impoundment emissions problem is referenced in the CWA's opening stanza, which set its original policy objective.[132] Section 401(a)(1) mandates that developers obtain water quality certification from the relevant states and state agencies before FERC may proceed with licensing.[133] Pursuant to state certification, water quality standards become binding for the duration of the project license.[134] Under the CWA, water quality standards must conform to public safety. States' promulgation of standards, through certification requirements, have bolstered the contemporary Environmental Protection Agency's (EPA) water quality standards.[135]

Broader implementation of the Clean Water Act (CWA) could mitigate hydroelectric emissions. Pooling headwaters at reservoirs can transform water quality due to temperature fluctuations and decreased oxygen levels.[136] Because some dams are designed to mitigate temperature fluctuations by releasing cooler water from the bottom of the reservoir, the potential for emissions may go unchecked at dams whose siting did not account for the high emissions factors identified by Illisa Ocko's

131. 33 U.S.C. § 1341(a)(1).
132. 33 U.S.C. § 1251(a).
133. 33 U.S.C. § 1341(a).
134. FED. ENERGY REG. COMM'N, HYDROPOWER PRIMER: A HANDBOOK OF HYDROPOWER BASICS 21 (2017).
135. 40 C.F.R. § 131.4 (2021).
136. *How Dams Damage Rivers*, American Rivers (2019), https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/how-dams-damage-rivers/ [https://perma.cc/L77S-7JXH].

study.[137] Along with state actions, the EPA could mitigate this potential by first updating the established list of toxic pollutants[138] to include carbon dioxide, methane, and nitrous oxide. Second, as courts have interpreted state application of CWA water quality certifications broadly,[139] the statute could be used to condition licenses on requisite temperature levels and dissolved oxygen fluctuations. Along with intermittent measurement of subsurface greenhouse gas build-ups, these two factors could serve as a proxy for such potential emissions before facility development.

One option for states to move in this direction is through 40 C.F.R. 131.11(b)(2)[140] authorization, which allows states to "establish narrative criteria . . . where numeric criteria cannot be established."[141] While numerical data is attainable, as the above referenced scientific data demonstrates, this represents a method to circumvent the DOE and FERC absconding responsibility through claims that ascertaining accurate emissions measures is too difficult.[142]

D. Minimal Shifts in Statutory Application Has the Potential to Mitigate Future Emissions

Each of these statutes substantively contributed to the progressive movement to condition and experiment with hydroelectric licenses. However, the statutes could be interpreted as constructing a barrier that effectively renders adverse impacts, such as GHG emissions, unnecessary to mitigate or consider. Desire to move rapidly to contain the worst effects of climate change through deployment of renewable energy sources has resulted in these policies. Whether intentional or through misapplication, some of these policies have missed their mark. The three legislative policies identified above are equipped to address GHG emissions caused

137. *Id.*; *see also* Ocko & Hamburg, *supra* note 6, at 14079 (explaining that warmer temperatures indicate low levels of water column mixing and thus greater anoxic conditions which promote methane production); Fearnside, *supra* note 6, at 2 (describing how releases of water through the turbine allow gasses to escape).

138. 40 C.F.R. § 401.15 (2021).

139. *See* Charles R. Sensiba et al., *Deep Decarbonization and Hydropower*, 48 ENVTL. L. REP. 10309, 10313 (2018) (citing Pub. Util. Dist. No. 1 of Jefferson City v. Wash. Dep't of Ecology, 511 U.S. 700, 716 (1994)).

140. 40 C.F.R. § 131.11(b)(2) (2020).

141. ENVIRONMENTAL PROTECTION AGENCY, EPA-823-B-17-001, WATER QUALITY STANDARDS HANDBOOK CHAPTER 3: WATER QUALITY CRITERIA 4–5 (2017).

142. *See* U.S. DEP'T OF ENERGY, *supra* note 1, at 301, 303–05.

by hydroelectric proliferation. Slight amendments, or FERC willingness to broadly construe their mandates as courts have deemed acceptable, could overhaul the current licensing process and mitigate emissions potential, without turning away from hydropower.

IV. UNITED STATES' FUTURE IN HYDROELECTRIC DEVELOPMENT

Over the past two decades, the reality of climate change as a looming global menace has occupied center stage. Nations worldwide have attempted to respond by implementing emission reduction standards, renewable portfolios, building standards, and energy efficiency standards. Most of these efforts focus on divestiture from fossil fuels and reallocation of budgets toward renewable resources. Among the obstacles inherent in pursuing an efficient revision of energy, plans have been developing clean, efficient replacements for fossil fuels.

Fossil Fuels are non-intermittent energy sources, as they do not rely on outside sources, such as daylight or wind patterns, and possess instant start-up ability whenever called upon.[143] Hydropower can also start up instantly with a release of headwater through a turbine, essentially serving as an energy bank. Hydroelectric power's non-intermittent nature makes it a rational replacement for baseline capacity generation.[144] This characteristic should deepen our concern regarding potentially extensive emissions, which researchers have concluded the development of hydroelectric impoundments exacerbates. While cleaner than fossil fuels, hydroelectric impoundments often come with unaddressed emissions of their own.

In 2012 over 80,000 dams existed in the United States.[145] Although energy production is a crucial purpose for hydroelectric impoundments, energy capacity represents one of its many uses. Given the versatility of river impoundments—including everything from irrigation, to fire protection, flood control, and recreation—not all of these impoundments could or should be eliminated.[146] In fact, approximately 2,500 impoundments contribute 101 gigawatt (GW) of energy capacity to energy grids across the nation.[147] However, federal legislation has targeted hydroelectric power for increased investment and streamlined licensing procedures over the last few decades.[148]

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143. *See* Steinhurst et al., *supra* note 51, at 4.

144. *Id.*

145. BOUALEM HADJERIOUA ET AL., U.S. DEP'T OF ENERGY, AN ASSESSMENT OF ENERGY POTENTIAL AT NON-POWERED DAMS IN THE U.S. 5 (2012).

146. U.S. DEP'T OF THE INTERIOR, EROSION AND SEDIMENTATION MANUAL 8-1 (2006).

147. U.S. DEP'T OF ENERGY, *supra* note 1, at 9, 76 (explaining hydroelectric accounted for 6.2 percent of all generation and sixty-two percent of renewable energy resources between 2006 and 2015).

148. Hydropower Regul. Efficiency Act of 2013, 16 U.S.C. § 791 (2013).

According to the Department of Energy, by retrofitting abandoned and non-powered dams, nearly 100 GW of new energy potential exists between new site development (NSD) and pumped storage hydropower (PSH).[149]

River conservation organizations oppose such developments, although many support retrofitting existing non-powered structures, as most have surpassed their ten-year peak emissions periods.[150] Many federal agencies, including the Department of Energy and its independent sub-agency, FERC, recognize climatic changes could result in drought to some undefined extent.[151] NASA, along with other researchers, have concurred on this point.[152] Regarding hydroelectric power, this means two things: (1) the potential for energy capacity at NSD's may be slightly overstated given potentially volatile water supply; and (2) significant water level drawbacks from current impoundments may result in increased GHG secretion from riverine sediment deposits. As such, proposed developments require scrutiny before the Hydropower Regulatory Efficiency Act and other measures intended to streamline hydroelectric permitting move forward. Without novel preventative measures there is no assurance that new facilities will fall on the low end of the emissions spectrum outlined by Synapse Energy.

Mitigating GHG mistakes of the past remains a tenable objective for FERC, U.S. Army Corps of Engineers, and other hydroelectric development agencies. As the bastions of the era of renewable energy, these agencies should not overlook or conceal the energy source's emissions potential they are intertwined with, as occurred over the last century with fossil fuel dominance and related agencies. As nearly all parties concur, hydropower should be relied upon as a massive contributor to the United States' energy generation composition going forward. Accordingly, while necessary in certain situations, the movement toward decommissioning (over 1,000

149. U.S. DEP'T OF ENERGY, *supra* note 1, at 95, 265.

150. *Is Hydropower "Clean Energy,"* AM. RIVERS (2019) https://www.americanrivers.org/threats-solutions/energy-development/hydropower/ [https://perma.cc/3RNB-W55L]; *see also* Ocko & Hamburg, *supra* note 6, at 10479.

151. FED. ENERGY REG. COMM'N, FERC TO EXAMINE ELECTRIC RELIABILITY IN THE FACE OF CLIMATE CHANGE (Feb. 22, 2021) https://www.ferc.gov/news-events/news/ferc-examine-electric-reliability-face-climate-change [https://perma.cc/Q9VJ-2R2T]; *see also* U.S. DEP'T OF ENERGY, *supra* note 1, at 365.

152. Ellen Gray & Jessica Merzdorf, *Earth's Freshwater Future: Extremes of Flood and Drought*, NASA CLIMATE CHANGE: VITAL SIGNS OF THE PLANET (June 13, 2019) https://climate.nasa.gov/news/2881/earths-freshwater-future-extremes-of-flood-and-drought/ [https://perma.cc/HMJ7-892M].

dams since 1912, mostly in recent decades)[153] should not be the fallback; decommissioning dams is extravagantly expensive, potentially counterproductive (as hydropower is one of the few non-intermittent sources outside fossil fuels), and generally an unrealistic solution. The following section will assess how amended policy structures and objectives could be implemented to balance the need for hydroelectric generation against its potential for counterproductive emissions.

V. POLICY SOLUTIONS: ACCOUNTING FOR AND MITIGATING EMISSIONS

Section III's discussion of flawed hydroelectric development and licensing legislation analyzed relatively straightforward remedies to this problem. This section will clarify those pertinent amendments in statutory text, interpretation, or enforcement. This section will also identify several policies that should be implemented going forward and one which is currently utilized but insufficient. Many of these policy strategies are currently used in other legislation, or areas of the energy sector, to promote/disincentive development of certain resources and punish ill-conceived developments. These include: (1) legislative amendments; (2) interagency collaboration; (3) using available technology to transform GHG sources into sinks; (4) physical and economic mitigation techniques; and (5) adaptive management plans.

A. Legislative Amendments

1. Federal Power Act

The Federal Power Act contains FERC's primary mandate: consequently, reform of the hydroelectric licensing and development process must first pass through that act. The success of the ECPA indicates that rudimentary reform in the textual requirements of the FPA can result in momentous strides in environmental conservation. Accordingly, using the ECPA as the framework for a GHG-centered amendment could generate the necessary outcomes.

The "equal consideration" provisions currently adhered to in the FPA as amended by the ECPA requires several considerations. These considerations include "protection, mitigation of damage to, and enhancement of, fish and wildlife . . . and the preservation of other aspects of the environment."[154] Requiring mitigation of GHG emissions detrimental to the environment and enhancement of protection against such emissions would fit effortlessly

153. *Restoring Damaged Rivers*, AM. RIVERS (2019), https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/ [https://perma.cc/DG4C-3YGC].

154. 16 U.S.C. § 797(e).

within the current text of the FPA. Simply altering the text to read "fish, wildlife, and detrimental emissions. . ." to the text in each licensing and relicensing provision would take FERC's current posture to a logical and concrete conclusion.[155] This measure would represent a substantial improvement, especially if girded by penalties for failure to consider such emissions in Environmental Impact Statements.

Expansion of the FPA's current requirements for interagency cooperation would entrench FERC's commitment to addressing GHG emissions relevant to prospective licensing decisions. Integral to the success of the ECPA was its amendment to the Federal Powers Act and its recurrent verbiage in other licensing consideration provisions. Section 797(c) requires FERC to "cooperate with the executive departments and other agencies of State or National Governments in such investigation" into licensing decisions based upon their fields of expertise.[156] This collaborative provision resulted in the proliferation of environmental conditions in FERC-issued development licenses.[157] While a portion of the increase in licensing conditions is attributable to FERC's consideration of private party recommendations, federal agencies accounted for more interventions and conditions than any other entity.[158]

Following the past successes, the Department of Energy and other agencies already agree that collaboration will be essential in rising to the challenge of a thorough energy transition.[159] The Department of Energy, under which FERC is an independent decision making agency, has recognized as much in its 2012 and 2015 assessments of hydroelectric potential;[160] however, they failed to promote such collaborative relationships with regard to GHG emissions.

The EPA recognized FERC should coordinate with themselves and several other agencies in licensing decisions. However, regarding the EPA, this is largely limited to water quality and possibly flow rate considerations

155. Carbon Pricing in Organized Wholesale Electric, 85 Fed. Reg. 66,965 (Oct. 15, 2020) (recognizing climate change as an issue in need of resolution and offering carbon pricing as a potential remedy); *see also* Glick & Christiansen, *supra* note 104, at 43.
156. 16 U.S.C. § 797(c).
157. DeShazo & Freeman, *supra* note 19, at 2264
158. *Id.* at 2265, 2272.
159. U.S. DEP'T OF ENERGY, *supra* note 1, at 51.
160. *Id*. at 144; *see also* DEP'T OF ENERGY, ED-19-07-04-2, AN ASSESSMENT OF ENERGY POTENTIAL AT NON-POWERED DAMS IN THE UNITED STATES, at 5 (April 2012).

under the Clean Water Act.[161] This coordination fails to go far enough to mitigate fugitive emissions effectively. Without concrete collaboration requirements, agencies favor their own work and recommendations and are motivated to limit reliance on other agencies.[162] A positive requirement for FERC to accept EPA GHG conditions on licenses, or a tiered system of recommendations mandating certain necessary conditions while other less vital recommendations remain discretionary, could work to resolve this issue.

Two amendments will not wholly remedy the emissions gaps in the FPA. However, as FERC's principal directive, the FPA must be amended before this problem will receive the attention it demands. These amendments would serve as a shot across the bow that emissions are being ignored, and FERC can be restrained in its licensing discretion if it does not properly address such vital issues.

2. National Environmental Policy Act

Improper implementation of NEPA has garnered massive attention in recent years.[163] However, with regards to emissions consideration, a shift in scope may be all that is required.[164] Enforcement of NEPA could be amended in three ways to provide the necessary attention to emissions from renewable development, particularly hydroelectric emissions.

First, readjusting how FERC observes the current mandate would help establish a comprehensive scheme to mitigate development of environmentally dangerous emissions. Despite the fact that FERC is "not a climate regulator," numerous FERC Commissioners have conceded that global climate change is unavoidably interconnected with their energy development and regulation mandate.[165]

A dual-purposed internal reform of FERC's procedural approach to NEPA review within environmental documents could improve emissions control. Effective NEPA reform would first require consideration of

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161. DEP'T OF THE INTERIOR, POTENTIAL HYDROELECTRIC DEVELOPMENT AT EXISTING FEDERAL FACILITIES, at 6, 9, 32 (May 2007).

162. Sensiba et al., *supra* note 139, at 10322.

163. Scott Slesinger, *What Can Happen When NEPA is Ignored: The Oroville Dam*, NRDC (April 25, 2018), https://www.nrdc.org/experts/scott-slesinger/what-can-happen-when-nepa-ignored-oroville-dam; *see also* Kelsey Kahn, *NEPA's Fatal Flaw: An Impediment to Collaboration*, Envtl. Dispute. Resolution Blog (Sept. 8, 2015) https://law.utah.edu/nepas-fatal-flaw-an-impediment-to-collaboration/.

164. Glick & Christiansen, *supra* note 104, at 43.

165. *Id*. at 1; *see also* FED. ENERGY REG. COMM'N, AD20-14-000, CARBON PRICING IN ORGANIZED WHOLESALE ELECTRICITY, 173 FERC ¶ 61,062, 2, 11 (Oct. 15, 2020); *see also* Christopher J. Bateman and James T.B. Tripp, *Toward Greener FERC Regulation of the Power Industry*, 38 HARV. ENVTL. L. REV. 275, 278 (2014).

factors determined to be predictors of significant emissions in hydroelectric siting. These factors include geographic location, water temperature, dissolved oxygen, and vegetation types in the proposed flood area.[166]

Second, effective reform would require the commission to take a more nuanced "hard look" at environmental impacts, including GHG emissions and their destructive potential. According to Chairman Glick, this would require before and after predictive assessment.[167] Complying with the administrative law concept of "hard look review"[168] would likely yield the benefit of avoiding remand of their decisions under APA requirements. Compliance would also require taking an active role in mitigating environmental deterioration, which NEPA technically already requires. Such reform could be accomplished by implementing similar requirements to those in the California Environmental Quality Act (CEQA)[169] regarding determinations of project emissions significance.

Under CEQA Guideline 15064.4, "careful judgment" is called for in establishing and analyzing a "threshold of significance"[170] for environmental impacts, including GHG emissions. Thresholds of significance allow for varied implementation while setting a minimum requirement for agencies to account for the emissions produced by a project.[171] It also ensures that where emissions are deemed significant, developers must implement mitigation measures to reduce emissions to a level below significance if the project is approved.[172] Establishing a threshold of significance requirement under "hard look review" would be a significant step toward ensuring that project emissions are acknowledged, poorly sited high emissions proposals

166. Ocko & Hamburg, *supra* note 6, at 14070–71.
167. Glick & Christiansen, *supra* note 104, at 10.
168. William H. Rodgers Jr., *A Hard Look at Vermont Yankee: Environmental Law Under Close Scrutiny*, 67 GEO. L.J. 699, 705–06 (1979) (explaining that to take a "hard look . . . for reasoned decisionmaking . . . assumptions must be spelled out, inconsistencies explained, methodologies disclosed, contradictory evidence rebutted, record references solidly grounded, guesswork eliminated and conclusions supported in a 'manner capable of judicial understanding.'").
169. *See* Cal. Public Resources Code §§ 21000–21189 (1970).
170. Association of Environmental Professionals, 2020 CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) STATUTE & GUIDELINES, § 15064.4(a) (2019); Association of Environmental Professionals, 2020 CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) STATUTE & GUIDELINES, § 15064.7(a) (2019) (explaining a threshold of significance is "an identifiable, quantitative, qualitative, or performance level of a particular environmental effect" above which an effect is significant and below which it is less than significant).
171. *Id.* at 159.
172. *Id.* at 155.

are denied or mitigated, and development of emission efficient projects continues.

Finally, there is no mandate regarding the certainty of emissions predictions within NEPA requirements. Various departments have relied on claims that methods of greenhouse gas quantification are currently too varied to consider.[173] Nowhere in NEPA's environmental analysis requirements is there a provision demanding absolute certainty; in fact, educated assumptions in some contexts are considered inevitable in NEPA review.[174] Assumptions are accepted because current technological measures are not consistently precise, and it is impossible to ensure the outcome of a particular project will identically match predicted environmental impacts.[175] Accordingly, any of the methods of calculations used by researchers in Section III, and as Chairman Glick suggested using a state reduction target or another identifiable baseline would allow for reasonable comparison.[176]

Adopting these methods, or a spectrum of measures, would enable the Commission to determine whether hydroelectric projects are sufficiently in the "public interest" after a genuine "equal consideration" of factors. Requiring some form of estimated emissions would constitute a stride toward combating the most significant threat to environmental security currently looming over each NEPA review of energy projects licensing or relicensing decision.

NEPA review has the potential to be the most effective legislative tool available to quantify and address which projects impede GHG reduction objectives in our battle against the worst effects of climate change. The above-described amendments could be easily implemented and would not require any Congressional involvement.

3. Clean Water Act

The CWA, as currently constructed, provides the most direct, though unpredictable, route to implementing mitigation measures for carbon dioxide and methane in hydroelectric headwaters. Mandating state water quality certifications provides an open door to imposing such conditions absent any FERC action. Yet, under broad state delegation of power, this results in inconsistent application of water quality requirements across the nation.

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173. U.S. DEP'T OF ENERGY, *supra* note 1, at 301, 303–05; Massachusetts v. Envtl. Prot. Agency, 127 U.S. 1438, 1458, 1461 (2007).

174. Glick & Christiansen, *supra* note 104, at 4.

175. Glick & Christiansen, *supra* note 104, at 4; *see generally,* 42 U.S.C. § 4332 (A)-(C).

176. Glick & Christiansen, *supra* note 104, at 5; *see, e.g.*, Ocko & Hamburg, *supra* note 6, at 14076.

However, one amendment to current federal regulation standards for emissions could act as a policy statement directing states to take uniform action. Altering Title 40 of the Code of Federal Regulations Section 405.15[177] to include carbon dioxide and methane as toxic pollutants would demand that emissions are no longer to be overlooked in CWA water quality certifications under section 401.[178] While further action would undoubtedly be necessary, this would be a practical starting point. These two chemicals, in the truest sense are toxic pollutants. They possess the ability to fundamentally debase the environment we have built our societies on with the promise that it would remain sturdy. Accordingly, they are logical inclusions.

B. Increased Use of Mitigation Methods

Alternatives to amending the current legislative tools must also be considered, since current legislatures lack economic incentives to analyze emissions in hydroelectric development. One true economic incentive currently pushing the sector is section 824a-3, a series of guarantees for small-scale wholesale generators whose facilities that yield eighty megawatts (MW) or less qualify for an exemption.[179] This exemption demonstrates why a developer would opt not to fund an additional study for a project already reaching into the hundreds of millions to complete without strict licensing requirements.

As Section 824a-3 suggests, financial solutions exist to remedy this dilemma. One such disincentive to siting developments in areas with high emissions potential would be FERC accepting carbon pricing.[180] Former Chairman Chatterjee recently proposed a policy statement claiming FERC would accept and promote state-implemented attempts at carbon-pricing as a method to reduce GHG emissions from the electricity sector.[181] Although positive inducements, such as tax incentives or Commission support in completing emissions studies, would also be preferable, the stick can be just as beneficial as the carrot.

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177. 40 C.F.R. § 405.15 (2020).
178. 33 U.S.C. § 1311(b)(2)(F); *see generally* 33 U.S.C. § 1311(m).
179. 16 U.S.C. § 824a-3.
180. Susan Gluss, *Report: FERC Can Bypass Congress to Mitigate Climate Change*, BERKELEY LAW (July 24, 2014), https://www.law.berkeley.edu/article/report-ferc-can-bypass-congress-to-mitigate-climate-change/ [https://perma.cc/6QRG-7P9L].
181. FED. ENERGY REG. COMM'N, CARBON PRICING IN ORGANIZED WHOLESALE ELECTRICITY, 173 FERC ¶ 61,062, 2, 11 (Oct. 15, 2020).

The Commissioner briefly identified another policy that would likewise promote GHG emission reductions, while permitting limited emissions until hydroelectric developers discover better methods to physically mitigate headwater emissions.[182] This policy could either take the form of supporting, or in a revolutionary move, congressionally implementing, an emissions trading system. Under such a system, emissions producers are allotted an emissions cap and can trade away unused allowances.[183] Emissions trading provides a dual escape hatch—permitting emissions to an extent, while incentivizing development at low emissions potential sites. Thereafter, developers will later be capable of selling leftover allowances to more significant emitters.[184] This system would allow hydroelectric facilities to reach a net-zero emissions total by purchasing offsets to their emissions. While this does not remove emissions, it results in financial incentives to comply with carbon neutrality objectives because failure to remain within the allotted cap carries with it a guarantee of monetary sanctions.

Along with improvements in hydroelectric producing technology, the Department of Energy and FERC have emphasized using new technology such as "No-dam hydro," which could result in a generation that outstrips emissions.[185] The aforementioned incentives and disincentives built into the current licensing regime could result in significant progress toward consideration and mitigation of emissions. If the current state of anthropogenic climate change has taught the world one lesson, it is that, on average, developers and energy producers follow the money. It would be naïve to assume that, because hydroelectric developers are nominally renewable advocates, they are fundamentally different in regard to economic incentives. Therefore, providing them economic incentives along with procedural legislative licensing requirements, could go a long way in rapidly resolving fugitive hydroelectric emissions.

C. Adaptive Management Will Not Be Sufficient

Many hydroelectric stakeholders have billed adaptive management as an acceptable method to deal with the myriad environmental impacts from impoundments and other hydropower sources.[186] Adaptive management

182. *Id.* at 2–3, n.5.
183. *Id.*
184. *Id.*
185. U.S. DEP'T OF ENERGY, *supra* note 1, at 166–68 (describing devices such as compact hydropower device installed in a section of river using only apportion of river flow and requiring no river impediment, or oxygen diffusers to reduce methane production and control temperatures).
186. Daniel Pollak, *Adaptive Management in Hydropower Regulation*, 39 ENVTL. L. REP. NEWS & ANALYSIS 10979, 10998 (2009).

seeks to accommodate the complexity and unpredictability of watershed ecology and biodiversity, and address the difficulty in establishing a single predictive model to mitigate adverse impacts.[187] The premise is that making a single big decision on water quality, fish passage, or sediment accumulation standards is inadequate to deal with ever changing watershed conditions.[188]

Unfortunately, what works well regarding flow rates and fish passage in favoring a series of minor decisions over time to reduce scientific uncertainty and persistent mitigation measure[189] seems to be the fatal flaw of adaptive management in the context of emissions. Once an impoundment is established, the potential for emissions is set in stone. So as this issue comes to the forefront of consideration during development, it would be a mistake to rely on the management methods currently promoted by FERC and the Department of Energy for other environmental considerations.

VI. CONCLUSION

This article should not be taken as general opposition to hydroelectric development. Hydropower will remain a vital energy source in the transition into a renewable energy economy. The non-intermittent, high baseload potential of hydroelectric energy makes it an enticing source of electric capability. This Article seeks only to: (1) make the case against irresponsible hydroelectric development propagated by agencies and organizations who are aware of the consequences of their actions, and (2) address the current legislation allowing this behavior to persist. The advent of scientific studies demonstrating significant emissions from nominally carbon-free sources must detach the renewable energy community from flawed conceptions of hydropower. Approaching this issue objectively is necessary to address the tradeoffs that must be made to generate energy on our nation's rivers responsibly.

While FERC is not the sole responsible agency, it holds a considerable share of the power to address and resolve, to the extent possible, this nascently accepted issue. FERC holds the potential to avert mistakes similar to those caused by the history of federal acquiescence to the oil industry. Many of the directives that have proven functional in redressing other significant environmental dilemmas can lead FERC in the proper direction. However,

187. *See id.* at 10980.
188. *Id.* at 10984.
189. *See id.* at 10984, 10987.

within the revelation around the significant potential of hydroelectric and other impoundments as GHG sources, a more significant lesson is brought to the fore—one we should have already learned. At their inception, many technologies and developments are perceived as cure-alls to be relied upon to resolve immense problems, only to later reveal flaws that lay within. In the pivotal effort to repent the sins of carbon-intensive energy production over the past two centuries, and Earth's consequent trajectory toward climate disaster, we must not repeat the mistake of accepting an edifice of truth at the expense of drastic societal and ecologic degradation; degradation that we could have mitigated.

Over 80,000 impoundments dot the waters of the United States. It is time we acknowledge their adverse impacts and determine which ones we can live with, which ones we can live without, and how we can strike a balance moving forward.