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# Dams and Doubt: Reassessing Hydropower's Place in Renewable Energy

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## I. INTRODUCTION

The need for renewable energy sources, driven by the depletion, rising costs, and environmental impact of oil and gas, has positioned them as a cornerstone in the international effort to combat the escalating dangers of climate change.[1] Generated from naturally replenishable resources, renewable energy is central to reducing our reliance on fossil fuels.[2] In the United States, state renewable portfolio standards (RPS) regulations require energy utilities to increase renewable energy production.[3] Consequently, the categorization of energy sources is not merely definitional, but rather critically impacts their inclusion and prominence under these standards.[4] Historically, hydropower has dominated this "renewable" category.[5] For over a century, the dams central to hydropower production have harnessed the power of flowing water and been widely seen as a clean and safe source of renewable energy.[6] However, despite this historical significance and traditional classification, challenges are now emerging on multiple fronts that

1. *See Renewable Energy—Powering a Safer Future*, Climate Action, U.N., https://www.un.org/en/climatechange/raising-ambition/renewable-energy.

2. *Id.*

3. *Renewable Energy Explained Portfolio Standards*, U.S. ENERGY INFO. ADMIN. (EIA), https://www.eia.gov/energyexplained/renewable-sources/portfolio-standards.php.

4. *See* Talha Bin Nadeem et al., *Distributed Energy Systems: A Review of Classification, Technologies, Applications, and Policies,* ENERGY STRATEGY REVS., July 2023, https://doi.org/10.1016/j.esr.2023.101096.

5. *History of Hydropower*, U.S. DEP'T OF ENERGY, https://www.energy.gov/eere/water/history-hydropower.

6. *See id.*

question the universal acceptance of large-scale hydropower as a "renewable" energy source.

This Comment examines two key issues that necessitate a reevaluation of the blanket categorization of large-scale hydropower as a renewable energy source. First, some RPS exempt large-scale hydropower facilities, a practice causing significant legal issues, particularly concerning the U.S. Constitution's Commerce Clause.[7] These exemptions intend to encourage energy providers to invest in smaller, less impactful renewable projects rather than relying solely on a single large dam to meet portfolio requirements.[8] However, this differential treatment necessitates a reevaluation of how large-scale hydropower is categorized and regulated. Second, emerging empirical research from the scientific community indicates that large hydropower reservoirs are themselves a significant source of greenhouse gas (GHG) emissions, notably methane.[9] This research casts doubt on the conventional understanding of hydropower as a "clean" energy source.

To explore these challenges, this Comment performs a two-part analysis. Part II examines the legal ramifications of state RPS exclusions targeting large-scale hydropower, with a specific focus on their potential to infringe upon the Commerce Clause. This analysis draws upon relevant case law and legal scholarship to evaluate the constitutionality of these exclusionary measures. Part III delves into the environmental impacts of large-scale hydropower, addressing the emerging scientific research that highlights the substantial GHG emissions associated with reservoir operations. By investigating these interconnected legal and environmental concerns, this Comment aims to contribute to a more nuanced and comprehensive understanding of the complex role that large-scale hydropower plays within the evolving landscape of renewable energy law and policy.

## II. RENEWABLE PORTFOLIO STANDARDS AND HYDROPOWER

As highlighted above, a primary challenge confronting the classification of large-scale hydropower as a uniformly eligible renewable energy source stems from its often differential treatment within state RPS.[10] This practice, which frequently involves the exclusion of large

7. Val Stori, *The Role of Hydropower in State Clean Energy Policy*, CLEAN ENERGY STATES ALLIANCE, 13 (Aug. 2020), https://www.cesa.org/wp-content/uploads/Role-of-Hydropower.pdf [hereinafter *Hydropower*].

8. *Id.*

9. *See infra* Part II.

10. Stori, *supra* note 7, at 13.

hydropower facilities from RPS mandates, not only impacts renewable energy markets by potentially favoring specific technologies, but also raises significant legal questions regarding consistency with the U.S. Constitution's Commerce Clause.[11] This section delves into the specifics of state RPS policies as they pertain to hydropower and analyzes the constitutional implications arising from the exclusion of large-scale hydropower facilities.

To explore this issue, this part first provides a background on state RPS, outlining their purpose and the diverse ways in which states classify and treat hydropower, including the specific criteria often used for eligibility. It then examines the common practice of excluding large-scale hydropower facilities, detailing the environmental and policy rationales commonly used to justify these exclusions. Subsequently, the part analyzes the legal ramifications under the Commerce Clause, discussing foundational principles, the application of the Dormant Commerce Clause (DCC) doctrine to state energy regulations, the potential burden on interstate and foreign commerce, and relevant judicial precedent, before assessing the potential for legal challenges against such exclusionary policies. This analysis lays the groundwork for understanding the complex legal landscape surrounding large-scale hydropower's role in state RPS.

### *A. State Renewable Portfolio Standards Background*

RPS are a policy mechanism employed by numerous states to encourage energy providers to transition towards a cleaner energy portfolio.[12] RPS regulations typically mandate that electric utilities and other retail electricity providers supply a specified minimum percentage of their electricity load from designated eligible renewable energy sources by a certain deadline.[13] The primary objective of these standards is multi-faceted: stimulating investment in renewable energy technologies, diversifying state energy supplies to enhance energy security, mitigating the environmental impacts of conventional fossil fuel generation (particularly GHG emissions), and fostering economic development within the renewable energy sector.[14] Compliance is often tracked and

11. *See* Harvey L. Reiter, *When Is Renewable not Renewable? The Constitutionality of State Laws Denying New Large Canadian Hydroelectric Projects Treatment as Renewable Resources*, 5 HARV. BUS. L. REV. 76 (2015), https://journals.law.harvard.edu/hblr//wp-content/uploads/sites/87/2015/04/Reiter-FINAL.pdf.

12. *Renewable Energy Explained Portfolio Standards*, *supra* note 3.

13. *Id.*

14. *Id.*

demonstrated through the acquisition and retirement of renewable energy credits (REC); one REC typically represents the generation of one megawatt-hour (MWh) of qualifying renewable electricity.[15]

### *B. Varying Treatment of Hydropower in Renewable Portfolio Standards*

Despite the prevalence of RPS policies nationwide, the treatment of hydropower within these regulatory frameworks varies.[16] There is no uniform approach to these policies; instead, state legislatures have adopted a wide spectrum of classifications and eligibility criteria for hydroelectric generation. Very few states fully include hydropower, regardless of facility size or commissioning date.[17] Conversely, many states impose significant limitations or exclude hydropower entirely from RPS eligibility.[18] Common restrictions include eligibility caps based on generating capacity (often distinguishing between "small" and "large" hydro), limitations based on the facility's in-service date (grandfathering older facilities while excluding new ones, or vice-versa), requirements for efficiency upgrades at existing facilities, or specific environmental certification prerequisites.[19] These different approaches reflect complex policy debates surrounding the environmental impacts of hydropower and the desired targets for RPS incentive structures.

### *C. Large-Scale Hydropower Exclusions*

As explained above, a frequent feature within state RPS frameworks is the partial or complete exclusion of "large-scale" hydropower facilities. The definition of large-scale hydropower varies, with state-specific capacity thresholds differing significantly, often ranging from facilities greater than 30 megawatts (MW) to those exceeding 100 MW.[20] The

15. *U.S. Renewable Electricity Market*, U.S. EPA, https://www.epa.gov/green-power-markets/us-renewable-electricity-market.

16. Stori, *supra* note 7, at 13.

17. *Id. See e.g.,* Or. Rev. Stat. § 469a; Senate Bill 1547 (2016); Or. House Bill 2021 (2021); Pa. Cons. Stat. tit. 66 § 2814.

18. Stori, *supra* note 7, at 13. *See e.g.,* Conn. Gen. Stat. § 16-245a et seq.; Conn. Gen. Stat. § 16-1; Conn. Senate Bill 9 (2018); Conn. SB 10 (2022); Md. Public Utilities Code Ann. § 7-701 et seq.; Md. Senate Bill 516 (2019); Md. Senate Bill 65 (2021); N.M. Stat. Ann. § 62-15-1 et seq.; N.M. Stat. Ann. § 62-16-1 et seq.; N.M. Senate Bill 489 (2019).

19. *See generally* Val Stori, *Environmental Rules for Hydropower in State Renewable Portfolio Standards*, CLEAN ENERGY STATES ALLIANCE, 13 (Apr. 2013).

20. *See id.* at 8-19.

rationales underpinning these exclusions are diverse and often contentious.

A primary justification for excluding large hydroelectric facilities from RPS centers on the significant and often irreversible environmental impacts associated with these large-scale projects.[21] Unlike distributed generation resources like solar or wind, which generally have a smaller physical footprint and more localized effects, the construction and operation of large hydroelectric dams fundamentally alter the natural dynamics of river ecosystems.[22] These impacts include the disruption of natural river flows, impacts on fish migration and survival (despite mitigation efforts like fish ladders), degradation of water quality, sediment trapping, and inundation of terrestrial habitats resulting from reservoir creation.[23] Proponents of exclusion argue that directing RPS incentives toward renewable sources with demonstrably lower ecological footprints is a more effective and environmentally responsible approach to fostering truly sustainable energy development.

Beyond environmental considerations, policy objectives represent another significant factor driving the exclusion of large-scale hydroelectric facilities from RPS. A core aim of many RPS programs is to actively cultivate the growth and widespread adoption of emerging renewable energy technologies, such as solar and wind power, which were less established when many early RPS programs were designed.[24] Introducing electricity generated by large-scale hydropower, particularly from sizable preexisting facilities that have long been operational, into the REC market in unlimited quantities could significantly distort this market.[25] The substantial volume of REC generated by these mature, often fully amortized assets could potentially flood the market, leading to a decrease in the price of these credits.[26] This depression of REC prices would, in turn, diminish the crucial financial incentives that RPS policies are intended to provide for investment in newer, less established

21. *Id.* at 5.

22. *See* Dol Raj Chalise, *Spectral Signatures of Flow Regime Alteration by Dams Across the United States*, 11 EARTH'S FUTURE (Jan. 24, 2023), https://doi.org/10.1029/2022EF003078.

23. Arushi Arora, *Dams: Economic Assets or Ecological Liabilities?*, EARTH.ORG (Jan. 28, 2024) https://earth.org/dams-economic-assets-or-ecological-liabilities/; *Dams: Impacts on Salmon and Steelhead*, NW. POWER AND CONSERVATION COUNCIL, https://www.nwcouncil.org/reports/columbia-river-history/damsimpacts/.

24. *State Renewable Portfolio Standards*, NCSL (Aug. 2021), https://www.ncsl.org/energy/state-renewable-portfolio-standards-and-goals.

25. Stori, *Hydropower*, *supra* note 7, at 10-15.

26. Nancy Rader and Scott Hempling, *The Renewables Portfolio Standard: A Practical Guide*, NAT'L ASS'N OF REGUL. UTIL. COMM'RS, xv (Feb. 2001).

renewable projects.[27] Furthermore, from a policy perspective, large-scale hydropower is often viewed as a mature and, in many cases, already cost-competitive technology that benefits from established infrastructure and market presence.[28] As such, it may not require the same level of targeted policy support and financial stimulus that is deemed necessary to accelerate the deployment and market penetration of nascent renewable industries crucial for diversifying the energy mix and driving future technological innovation.

### *D. Commerce Clause Implications*

Having examined the environmental and policy-driven rationales frequently cited for excluding large-scale hydropower within renewable energy frameworks, this subpart examines a critical legal dimension influencing state-level energy regulation: the constraints imposed by the United States Constitution. This subpart explores how the Commerce Clause, particularly the implied limitation of the DCC, establishes foundational principles governing the authority of states to enact legislation, including RPS, that may impact interstate and foreign commerce. This subpart delves into the Supreme Court's framework for analyzing state laws under the DCC, assessing how state RPS provisions that exclude or limit large-scale hydropower could potentially be challenged as imposing an undue burden or discriminating against out-of-state or foreign commerce. By analyzing relevant case law and the specific arguments likely to be raised in legal challenges, this subpart aims to illuminate the significant constitutional considerations that necessitate a reevaluation of large hydropower's definitional status in renewable energy.

#### 1. The Commerce Clause: Foundational Principles

The authority and limitations surrounding state regulation of energy markets, including the implementation of RPS, are significantly influenced by the Commerce Clause of the United States Constitution. Article I, Section 8, Clause 3 grants Congress the power "[t]o regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes."[29] The primary purpose of this affirmative grant of power is to enable Congress to foster a unified national market, preventing economic conflicts among the states that could stifle the

27. *Id.*
28. *Id.*
29. U.S. Const. art. I, § 8, cl. 3.

national economy.[30] While explicitly empowering Congress, the Commerce Clause has also been interpreted to implicitly limit the power of states to enact legislation that interferes with interstate and foreign commerce.[31]

2. The Dormant Commerce Clause Doctrine

The implied limitation on state authority is known as the DCC doctrine. The DCC precludes states from enacting laws that improperly burden or discriminate against interstate or foreign commerce, preserving Congress's authority over these areas.[32] The Supreme Court has developed a two-tiered framework for analyzing state laws under the DCC.[33] First, state laws that facially discriminate against out-of-state commerce, have a discriminatory purpose, or exhibit a discriminatory effect are subject to a "virtually per se rule of invalidity."[34] State laws that fall under this category will be struck down unless the state can demonstrate that the law serves a legitimate local purpose unrelated to economic protectionism and that this purpose could not be served as well by available nondiscriminatory means.[35] This exception is similar to strict scrutiny and is exceedingly difficult for a state to overcome. Second, where a state law regulates fairly between states to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits.[36] This requires a balancing test, known as the *Pike* test, weighing the local interests against the burden on interstate commerce.[37]

30. *See* Gibbons v. Ogden, 22 U.S. 1 (1824). *See also The Dormant Commerce Clause and Moral Complicity in a National Marketplace*, 137 HARV. L. REV. 3, 1 (Jan. 2024).

31. *See* U.S. v. Lopez, 514 U.S. 549, 594 (1995).

32. Ass'n des Éleveurs de Canards et d'Oies du Québec v. Harris, 729 F.3d 937, 947 (9th Cir. 2013).

33. Brown-Forman Distillers Corp. v. N.Y. State Liquor Auth., 476 U.S. 573, 578-79 (1986).

34. *Id.* at 579; Or. Waste Systems, Inc. v. Dep't of Env't Quality of Or., 511 U.S. 93, 99 (1994).

35. Me. v. Taylor, 477 U.S. 131, 138 (1986).

36. Pike v. Bruce Church, Inc., 397 U.S. 137, 142 (1970).

37. *Id.*; R. R. Kelso, *The Proper Structure of Dormant Commerce Clause Review*, 59 TULSA L. REV. 109, 118-119 (2024).

### 3. Applying the Commerce Clause to Renewable Portfolio Standards Exclusions

RPS provisions that exclude large-scale hydropower, particularly when such exclusions disproportionately affect out-of-state or foreign sources, raise significant concerns under the DCC.[38] It has been argued that such exclusions, even if facially neutral (e.g., based on facility size or technology type rather than geographic origin), may function in effect as discriminatory barriers against interstate and foreign commerce.[39]

The discriminatory impact can be particularly pronounced with respect to foreign commerce, specifically hydropower imported from Canada. When states like those in the northeastern U.S. exclude large-scale hydropower from RPS eligibility, they effectively disadvantage major Canadian hydroelectric facilities that are significant exporters to the region.[40] This exclusion arguably favors in-state renewable generators (often wind or solar) that are eligible for RPS credits.[41] Such favoring of local industries at the expense of out-of-state or foreign competitors is the hallmark of economic protectionism that the DCC aims to prevent.[42] Discrimination against foreign commerce can sometimes invite even stricter scrutiny than discrimination against interstate commerce.[43]

Even if an RPS exclusion is not deemed overtly discriminatory, it must still survive scrutiny under the second prong of the DCC test, the *Pike* balancing test. States argue that the hydropower exclusion serves legitimate local purposes, such as promoting the development of emerging renewable technologies (such as wind and solar power) deemed to require RPS support, or addressing specific environmental concerns associated only with large-scale dams (e.g., fish passage and downstream flow impacts) that are distinct from other renewables.[44] However, challengers argue that these objectives could potentially be achieved through less burdensome means, such as setting specific environmental standards applicable to all generator types or creating tiered RPS programs that provide different levels of support for various technologies

38. Reiter, *supra* note 11.
39. *Id.*
40. *Id.*
41. *Id.*
42. *See* C&A Carbone, Inc. v. Town of Clarkstown, 511 U.S. 383 (1994).
43. *See, e.g.*, Japan Line, Ltd. v. Cnty of L.A., 441 U.S. 434 (1979) (noting additional concerns like international relations impact).
44. *See* Stori, *Hydropower*, *supra* note 7, at 10-15.

without outright exclusion.[45] Furthermore, the burden on commerce—potentially restricting access to vast quantities of cost-effective electricity from established hydropower resources—could be argued as clearly excessive compared to the marginal benefit of excluding large hydropower versus regulating it or incentivizing other renewables through different means.[46]

4. Impact on Interstate Commerce

The disparate treatment and, specifically, the exclusion of large-scale hydropower from state RPS programs carry significant implications for interstate commerce, potentially violating the DCC. When a state RPS excludes large-scale hydropower, which is often generated out-of-state or imported, while simultaneously incentivizing in-state renewable resources (which may predominantly be non-hydro), it raises concerns about protectionism and discrimination.[47] Such exclusions can create significant barriers for large hydropower producers seeking to sell their output into states with restrictive RPS policies.[48] By deeming large hydropower ineligible for RPS compliance, state policies effectively discriminate against this source of power based on its origin or specific characteristics (e.g., facility size), which disproportionately affects out-of-state generators.[49] Such measures may be interpreted as favoring local

45. *See* Kyle Aarons et al., *Canadian Hydropower and the Clean Power Plan*, CTR. FOR CLIMATE AND ENERGY SOLS., 15-16 (Apr. 2015).

46. Reiter, *supra* note 11.

47. Japan Line, Ltd. v. Cnty. of L.A., 441 U.S. 434, 448-49 (1979); Kraft Gen. Foods, Inc. v. Iowa Dept. of Revenue and Fin., 505 U.S. 71, 80 (1992).

48. Reiter, *supra* note 11.

49. *Id.*; *See* Daniel K. Lee & Timothy P. Duane, *Putting the Dormant Commerce Clause Back to Sleep: Adapting the Doctrine to Support State Renewable Portfolio Standards*, 43 ENV'T L. 295 (2013); Steven Ferrey, *Threading the Constitutional Needle with Care: The Commerce Clause Threat to the New Infrastructure of Renewable Power*, 7 TEX. J. OIL, GAS, & ENERGY L. 59 (2012); Carolyn Elefant & Edward A. Holt, The Commerce Clause and Implications for State Renewable Portfolio Standard Programs, Clean Energy States Alliance State RPS Policy Report (2011); Stephen C. Braverman, *State Renewable Portfolio Standards and the Commerce Clause*, 25 SPG NAT. RES. & ENV'T 15 (2011); Trevor D. Stiles, *Renewable Resources and the Dormant Commerce Clause*, 4 ENV'T & ENERGY L. & POL'Y J. 33 (2009); Nathan E. Endrud, *State Renewable Portfolio Standards: Their Continued Validity and Relevance in Light of the Dormant Commerce Clause, the Supremacy Clause, and Possible Federal Legislation*, 45 HARV. J. ON LEGIS. 259 (2008); Patrick R. Jacobi, *Renewable Portfolio Standard Generator Applicability Requirements: How States Can Stop Worrying and Learn to Love the Dormant Commerce Clause*, 30 VT. L. REV. 1079 (2006); Nancy Rader & Scott Hempling, Nat'l Ass'n of Regul. Util. Comm'rs, *The Renewables Portfolio Standard: A Practical Guide*, A-2-4 (2001), http://www.scotthemplinglaw.com/files/naruc.org/Publications/rps.pdf; Kirsten H. Engel, *The Dormant*

renewable energy developers over out-of-state competitors, potentially imposing an undue burden on the free flow of energy across state and international borders, thereby inviting legal challenges under the DCC.[50]

5. Case Law Analysis

Relevant case law provides context for assessing potential DCC challenges to RPS hydropower exclusions. Courts have invalidated state energy regulations found to be protectionist. For instance, in *New England Power Co. v. New Hampshire*,[51] the Supreme Court struck down a state law prohibiting a utility from exporting locally generated hydropower, deeming it protectionist and a violation of the DCC.[52] Similarly, attempts by states to hoard resources or give preference to in-state economic interests over out-of-state competitors in waste disposal and other markets have consistently been invalidated.[53]

Conversely, state regulations affecting the energy sector have been upheld when found to be non-discriminatory and serving legitimate state interests, such as environmental protection or public health, where the burden on commerce was deemed incidental. In *Minnesota v. Clover Leaf Creamery Co.*[54] the Court upheld a state ban on plastic milk containers, finding it served a legitimate environmental purpose and burdened interstate commerce incidentally, as both in-state and out-of-state producers were affected.[55] More recently, lower courts have grappled with DCC challenges to state renewable energy programs, with varied outcomes often turning on the specific program design and whether it favors in-state entities through mechanisms like REC procurement or transmission rights.[56]

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*Commerce Clause Threat to Market-Based Environmental Regulation: The Case of Electricity Deregulation*, 26 ECOLOGY L.Q. 243, 268-81 (1999).

50. Reiter, *supra* note 11. *See, e.g.*, Pike v. Bruce Church, Inc., 397 U.S. 137 (1970) (discussing the undue burden balancing test).

51. 455 U.S. 331 (1982).

52. *Id.* at 344.

53. *See* Phila. v. N.J., 437 U.S. 617, 629 (1978) (holding that a New Jersey statute discriminated against other states because it imposed on out-of-state commercial interests the full burden of conserving the state's remaining landfill space); Hughes v. Okla., 441 U.S. 322, 338-39 (1979) (invalidating a statute prohibiting export of locally caught minnows).

54. 449 U.S. 456 (1981).

55. *Id.* at 474.

56. *See, e.g.*, Allco Finance Ltd. v. Klee, 861 F.3d 82, 108 (2d Cir. 2017) (upholding state renewable energy procurement). *Cf.* Hughes v. Talen Energy Mktg., LLC, 578 U.S. 150, 166 (2016) (invalidating a state energy subsidy program intruding on federal wholesale market jurisdiction, though primarily on preemption grounds).

6. Assessment of Potential Challenges

Assessing the likelihood of a successful DCC challenge to RPS exclusions of large-scale hydropower requires a fact-intensive analysis of the specific state law, its demonstrable purpose, and its practical effects on commerce. If an exclusion is found to be purposefully discriminatory or to have the practical effect of barring primarily out-of-state or foreign hydropower while favoring in-state renewables, it faces a high risk of invalidation.[57] Defending such a law would require the state to meet the stringent burden of proving that no less discriminatory alternatives exist.[58]

If the exclusion is viewed as regulating even-handedly (e.g., applying a size cap neutrally regardless of origin) but still burdens commerce, its fate hinges on the second prong of the analysis, the *Pike* balancing test.[59] The outcome would depend on whether a court finds the asserted local benefits (e.g., fostering specific technologies or addressing unique environmental impacts of large dams) outweigh the burden imposed on interstate and foreign commerce by restricting access to large-scale hydropower resources.[60] The availability of imported Canadian hydropower makes the foreign commerce dimension particularly salient.[61] Given the jurisprudence favoring national markets and disfavoring state-level protectionism, RPS exclusions targeting large-scale hydropower, especially those impacting international trade, remain constitutionally vulnerable under the DCC.[62]

## *E. The Necessity of Reevaluating Large-Scale Hydropower*

The preceding subparts explored the diverse and often restrictive treatment of large-scale hydropower within RPS, detailing the environmental and policy rationales behind its exclusion and examining the significant legal questions this differential treatment raises under the DCC. This complex interplay of factors—ranging from concerns over ecological impacts and the strategic channeling of renewable energy incentives to the constitutional imperative against state-level protectionism impacting interstate and foreign commerce—underscores a fundamental tension in current renewable energy classification. The

57. *See* Reiter, *supra* note 11; *Philadelphia*, 437 U.S. at 629; *Brown-Forman Distillers Corp*., 476 U.S. at 578-79.

58. *Maine*, 477 U.S. at 138.

59. *Pike*, 397 U.S. at 142.

60. *Id.*; Kelso, *supra* note 37, at 118-119.

61. Reiter, *supra* note 11.

62. *See Hughes*, 578 at 166.

exclusion or limited inclusion of large-scale hydropower from mechanisms designed to promote renewable energy portfolios necessitates a critical reevaluation of its categorization and the regulatory frameworks applied to it. Given its capacity to provide significant baseload power, a more consistent and constitutionally sound approach is required to determine its appropriate role and regulation within the evolving landscape of renewable energy policy.

## III. ENVIRONMENTAL IMPACTS OF LARGE-SCALE HYDROPOWER

In addition to the legal and policy complexities surrounding its treatment in state RPS, a second critical area necessitating a reevaluation of large-scale hydropower concerns is its environmental footprint. Despite being historically relied upon as a renewable energy source due to its lack of direct combustion emissions, the environmental impacts associated with the significant infrastructure required by large hydroelectric projects are now facing increasing scrutiny.[63] This part delves into the environmental impacts of large-scale hydropower facilities, particularly focusing on challenges to the long-held perception of hydropower as a universally "clean" or GHG-neutral energy source due to emerging scientific evidence regarding GHG emissions from reservoirs.

To explore these environmental considerations, this part first outlines the conventional view of hydropower's environmental benefits, highlighting its avoidance of typical atmospheric pollutants associated with fossil fuel combustion. It then presents and explains the growing body of scientific research documenting significant GHG emissions, such as methane and carbon dioxide, originating from hydroelectric reservoirs, discussing their sources, variability, and potential climate impact. Building on this evidence, the part then discuss the implications of these findings for hydropower's traditional status as a "renewable" and "clean" energy source in the context of climate policy. Finally, it argues how this scientific understanding of reservoir emissions directly contradicts the implicit "GHG-free" expectation underlying renewable energy definitions in policy and law, thereby necessitating a critical reevaluation of how large-scale hydropower is classified and regulated.

63. *See* Chalise, *supra* note 22; Arora, note 23.

### *A. The Conventional View of Hydropower*

Historically, hydropower has been widely regarded as a cornerstone of clean and renewable energy portfolios globally.[64] Operating without the direct combustion of fossil fuels, hydroelectric facilities avoid the atmospheric emissions of sulfur dioxide ($SO_2$), nitrogen oxides ($NO_X$), particulate matter, and, crucially, carbon dioxide ($CO_2$) associated with thermal power generation.[65] Hydropower's capacity for large-scale, dispatchable electricity generation, coupled with long operational lifespans and relatively low operating costs once built, has cemented its reputation as a sustainable power source, integral to decarbonization strategies.[66] This perspective, however, primarily focuses on emissions at the point of electricity generation asnd often overlooks the broader environmental footprint associated with hydropower infrastructure, particularly large reservoirs.

### *B. Emerging Evidence of Greenhouse Gas Emissions from Reservoirs*

Contrary to the conventional narrative of hydropower as emission-free, a growing body of scientific research over the past two decades has revealed that hydroelectric reservoirs, particularly large ones, can be significant sources of GHG emissions.[67] Hydro-electricity's GHG emissions come from the decomposition of vast amounts of organic material submerged when river valleys are flooded to create reservoirs.[68] This organic matter, including vegetation, soils, and incoming detritus from the watershed, undergoes decomposition, the pathway of which depends critically on oxygen availability.[69]

In the deep, oxygen-poor bottom waters and sediments of many reservoirs, microbial decomposition occurs via methanogenesis,

64. *See Hydroelectricity*, INT'L ENERGY AGENCY, https://www.iea.org/energy-system/renewables/hydroelectricity.

65. *See Benefits of Hydropower*, U.S. DEP'T OF ENERGY, https://www.energy.gov/eere/water/benefits-hydropower.

66. *Id. See generally* Greg Stark and Greg Brinkman, *The Role of Hydropower Flexibility in Integrating Renewables in a LowCarbon Grid*, NAT'L RENEWABLE ENERGY LAB'Y, NREL/TP-5700-86752 (2023), https://www.nrel.gov/docs/fy23osti/86752.pdf.

67. *See* J.J. Cole et al., *Plumbing the Global Carbon Cycle: Integrating Inland Waters into the Terrestrial Carbon Budget*, ECOSYSTEMS (Feb. 2007); Ilissa B. Ocko and Steven P. Hamburg, *Climate Impacts of Hydropower: Enormous Differences Among Facilities and over Time*, ENV'T SCI. & TECH. (Nov. 2019).

68. *Id.*

69. *Id.*

producing methane ($CH_4$).[70] Methane is a particularly potent GHG.[71] While its atmospheric lifetime is shorter than that of $CO_2$, its capacity to trap heat is substantially higher.[72] Over a twenty-year timeframe, methane's global warming potential is estimated to be more than eighty times that of $CO_2$, and even over a hundred-year timeframe, its global warming potential is approximately twenty-five to thirty times greater.[73] It has also been found that reservoirs also emit $CO_2$ through the aerobic decomposition of organic matter in shallower waters and across the reservoir surface, as well as nitrous oxide ($N_2O$), another potent GHG, although typically in smaller quantities than $CH_4$ and $CO_2$.[74]

Numerous studies have quantified these emissions, demonstrating considerable variability based on factors such as reservoir age (emissions are often highest in the initial years after flooding), geographic location (tropical reservoirs generally exhibit higher emissions due to warmer temperatures accelerating decomposition), reservoir depth and morphology, water level management, and the type and quantity of flooded biomass.[75] Some research indicates that methane emissions, particularly via ebullition (bubbling) from sediments and degassing at turbines and spillways, constitute the dominant share of the global warming potential impact from many reservoirs.[76] Critically, certain studies suggest that, on a life-cycle basis per unit of energy produced (e.g., grams of $CO_2$-equivalent per kilowatt-hour), the GHG footprint of some hydropower facilities can be comparable to that of fossil fuel power plants generating the same amount of electricity.[77]

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70. *See* Bridget R. Deemer et al., *Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis*, 66 BIOSCIENCE No. 11 (Nov. 2016), https://doi.org/10.1093/biosci/biw117.

71. EPA, *Importance of Methane* (Feb. 10, 2026), https://www.epa.gov/gmi/importance-methane.

72. *Id.*

73. EPA, *Understanding Global Warming Potentials* (Dec. 29, 2025), https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

74. Deemer, *supra* note 70.

75. Anna Turns, *Hydroelectricity Is a Hidden Source of Methane Emissions. These People Want to Solve That*, BBC (Mar. 27, 2024), https://www.bbc.com/future/article/20240326-how-hydroelectric-dams-are-a-hidden-source-of-carbon-emissions. *See* Cole, *supra* note 67; Ocko, *supra* note 67.

76. Zilin Wang et al., *The Role of Reservoir Size in Driving Methane Emissions in China*, 279 WATER RSCH. 123441 (July 1, 2025), https://doi.org/10.1016/j.watres.2025.123441; Deemer, *supra* note 70.

77. *See* Ocko, *supra* note 67; Patagonia, *New Report Finds Lower Snake River Dams Create Methane Emissions, Not Clean Energy*, PATAGONIA WORKS (Mar. 18, 2024), https://www.patagoniaworks.com/press/2024/3/18/new-report-finds-lower-snake-river-dams-create-methane-emissions-not-clean-energy; Alex Baumhardt, *Report Estimates Lower Snake River Dams,*

### *C. Implications for Hydropower's "Renewable" and "Clean" Status*

The scientific evidence documenting substantial GHG emissions from large hydropower reservoirs fundamentally challenges the unqualified classification of all hydropower as uniformly "clean" or "GHG-neutral." While hydropower avoids direct fossil fuel combustion, the indirect emissions resulting from the creation and operation of its associated infrastructure, particularly methane from reservoirs, represent a potentially significant climate impact that is often ignored in policy frameworks.

These findings undermine the assertion that large-scale hydropower inherently provides climate benefits superior to those of other energy sources. Instead, research suggests that the environmental profile of hydropower is more complex and variable than traditionally assumed, necessitating a more nuanced assessment of its role in climate change mitigation strategies and place as a traditional renewable energy source.[78] The significant global warming potential of methane shows that reservoir emissions can contribute materially to near-term warming, counteracting some of the intended climate benefits.[79]

Consequently, the scientific understanding of reservoir GHG emissions provides an empirical basis, distinct from the ecological concerns regarding dams or the economic arguments about market impacts, for questioning the inclusion of certain types of large-scale hydropower within policy mechanisms like RPS that are designed to promote low-emission energy sources. Future assessments of hydropower's sustainability and its eligibility for renewable energy incentives may increasingly need to incorporate site-specific or regionally differentiated estimates of life-cycle GHG emissions, moving beyond the simplistic assumption that all hydropower is inherently GHG-free.[80] This evolving scientific understanding complicates the legal and policy landscape surrounding hydropower, adding another layer to the debate

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*Reservoirs Emit Millions of Tons of Greenhouse Gasses*, THE COLUMBIAN (Apr. 12, 2024), https://www.columbian.com/news/2024/apr/12/report-estimates-lower-snake-river-dams-reservoirs-emit-millions-of-tons-of-greenhouse-gases/.

78. *See* Henriette I. Jagar et al., *Getting Lost Tracking the Carbon Footprint of Hydropower*, 162 RENEWABLE AND SUSTAINABLE ENERGY REVS. 112408 (Apr. 12, 2022), https://doi.org/10.1016/j.rser.2022.112408.

79. EPA, *See Understanding Global Warming Potentials* (Dec. 29, 2025), https://www.epa.gov/ghgemissions/understanding-global-warming-potentials; EPA, *Importance of Methane* (Feb. 10, 2026), https://www.epa.gov/gmi/importance-methane.

80. *See* Jagar et al., *supra* note 78; Deemer, *supra* note 70; Cole, *supra* note 67; Ocko, *supra* note 67.

over its appropriate classification and role in the transition to a sustainable energy future.

### *D. Reservoir Emissions and the Challenge to Classification*

The policy definition and legal classification of energy sources as renewable is intrinsically linked to the overarching goal of reducing GHG emissions and mitigating climate change.[81] RPS and similar frameworks are designed to incentivize sources that achieve this by displacing fossil fuels without incurring significant operational GHG emissions.[82] Thus, implicit within the classification of an energy source as renewable or clean under these policies is the expectation that it will have minimal to zero net GHG emissions on a lifecycle basis. Hydropower's historical inclusion in this category was predicated on its freedom from combustion emissions, fitting the conventional understanding of a GHG-neutral or clean energy source.[83]

However, the research presented above, detailing the significant emissions of potent GHGs, notably methane, from reservoirs, fundamentally challenges this premise for many large-scale facilities. These findings demonstrate that certain hydropower operations can have a non-negligible, and potentially substantial, GHG footprint that was not accounted for in the traditional clean definition. If sources classified as renewable are intended by policy to contribute to climate change mitigation by being nearly or entirely free of GHG emissions, then evidence of significant reservoir emissions directly contradicts the environmental basis for that classification. This scientific reality regarding the climate impact of reservoirs compels a critical reevaluation of how "renewable" energy is defined and treated within energy policy and law. It underscores the pressing need for a more scientifically accurate and transparent framework that comprehensively accounts for all significant life-cycle GHG emissions, specifically including those from hydropower project reservoirs. Such a robust framework is essential for determining whether and how large-scale hydropower should be categorized and regulated in the collective effort to construct a low-GHG energy system. Ultimately, the growing body of research necessitates a departure from simplistic technological classifications towards

81. *See generally* Intergovernmental Panel on Climate Change, *Renewable Energy Sources and Climate Change Mitigation*, CAMB. U. (2012), https://archive.ipcc.ch/pdf/special-reports/srren/SRREN_Full_Report.pdf.

82. *See Renewable Energy Explained Portfolio Standards*, *supra* note 3.

83. Stori, *Hydropower*, *supra* note 7, at 13.

definitions grounded in a thorough and comprehensive understanding of environmental impacts across a project's lifespan.

## IV. THE FUTURE ROLE OF LARGE-SCALE HYDROPOWER

The future role of large-scale hydropower in renewable energy appears more complex and contingent than its historical prominence might suggest. Its inherent benefits, offering significant, dispatchable generation capacity crucial for grid stability, providing long asset life and avoiding direct combustion emissions typically associated with thermal power plants, remain important advantages in the energy transition and for complementing variable renewable sources like solar and wind. However, as this Comment's analysis has demonstrated, these benefits must be carefully weighed against substantial challenges that necessitate a fundamental reevaluation of its classification and regulation within renewable energy frameworks. These challenges include the legal and constitutional risks posed by state RPS policies and the environmental costs associated with large projects, informed by emerging science on GHG emissions from reservoirs.

As discussed in this Comment's examination of state RPS and the Commerce Clause, the varied and often exclusionary treatment of large-scale hydropower creates significant legal uncertainty and potential constitutional vulnerability. Policies that disproportionately disadvantage out-of-state or foreign hydropower, even if based on criteria like facility size or age, risk being viewed as protectionist barriers under the DCC. This inconsistency and potential for legal challenge undermine the development of a coherent, national approach to clean energy integration and hinder the optimal deployment of low-GHG resources across state lines and international borders. Consequently, the legal and policy framework governing large-scale hydropower's inclusion in RPS requires reevaluation to ensure it is constitutionally sound, promotes rather than hinders interstate commerce in clean energy, and provides a stable, defensible basis for investment and classification.

Furthermore, this Comment's analysis of the environmental impacts of large-scale hydropower highlights the necessity of moving beyond a simplistic "clean" label. While avoiding combustion emissions is a key benefit, the growing body of scientific evidence regarding significant GHG emissions, particularly potent methane, from reservoirs fundamentally challenges the assumption of carbon neutrality for all large projects. This scientific reality directly contradicts the underlying premise that renewable energy sources are inherently GHG-free or have negligible

climate footprints, a premise often implicit in their definition and incentivization within climate-driven energy policies like RPS. Therefore, a reevaluation of large hydropower's classification must be scientifically grounded, accounting for all environmental impacts, including reservoir emissions. Future policy decisions regarding large-scale hydropower's eligibility for renewable incentives must incorporate site-specific or regionally relevant GHG assessments to accurately reflect its true contribution to climate goals, moving beyond a purely technological definition.

The confluence of these legal, policy, and environmental complexities demonstrates that integrating large-scale hydropower into a sustainable energy future requires a more nuanced approach than currently exists in many state policies. Navigating the constitutional pitfalls associated with potentially discriminatory treatment and accurately accounting for the environmental costs are essential for crafting effective clean energy policy that genuinely promotes decarbonization and environmental protection. A sustainable path forward likely involves prioritizing investments in efficiency upgrades and environmental retrofits at existing facilities to mitigate ecological impacts and potentially reduce reservoir emissions where possible.[84] Crucially, any proposed new large-scale projects must undergo rigorous, comprehensive environmental review that explicitly includes detailed lifecycle GHG accounting as a condition of approval or renewable classification.

While large-scale hydropower can remain a vital component of the electricity mix, its designation and incentivization within renewable energy frameworks demand a more nuanced, scientifically grounded, and constitutionally sound approach than has often been applied in the past. Crafting such policies, informed by both legal principles and the latest scientific understanding of their full environmental footprint, is essential for navigating the energy transition effectively and achieving genuine, verifiable GHG reductions.

## V. CONCLUSION

As this Comment has demonstrated, the traditional classification and regulatory treatment of large-scale hydropower within U.S. clean energy policy, especially within state RPS, is subject to significant challenges that demand critical reevaluation. The analysis presented a dual imperative for this reconsideration. Firstly, the varied and often

84. Turns, *supra* note 75.

exclusionary approaches taken by states toward large hydroelectric facilities create tangible legal vulnerabilities under the DCC, raising concerns about potential discrimination against interstate and foreign commerce and undermining the goal of a seamless national clean energy market. Such inconsistent policy risks are constitutionally questionable and hinder efficient resource deployment.

Secondly, and distinct from legal or policy design debates, the growing body of scientific evidence documenting significant GHG emissions, particularly methane, from hydroelectric reservoirs fundamentally challenges the historical assumption of large-scale hydropower as a universally GHG-neutral source. This scientific reality directly contradicts the core environmental premise underlying the definition of renewable within climate-driven policies—that these sources achieve decarbonization by displacing fossil fuels without incurring their own substantial GHG burdens.

Together, these legal complexities and environmental realities compel a departure from simplistic, technology-based categorizations of large-scale hydropower. Maintaining policies that are either constitutionally vulnerable or based on an incomplete scientific understanding risks undermining the very goals of the clean energy transition. Moving forward, policymakers must adopt approaches to large-scale hydropower that are both legally robust, ensuring fair treatment and compliance with constitutional principles, and scientifically informed by a comprehensive accounting of environmental impacts, including lifecycle GHG emissions from reservoirs. Only through such a nuanced, evidence-based reevaluation can large-scale hydropower's appropriate and sustainable role in the future energy landscape be accurately determined and integrated into a genuinely clean, effective, and legally defensible energy system.