NET-METERED INFRASTRUCTURE-BASED HYDROPOWER

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INTRODUCTION

Climate change is upon us, and its effects are dire. Caused by anthropogenic greenhouse gas (GHG) emissions,[1] our changing climate

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1. *See generally How Do We Know that Humans are the Major Cause of Global Warming?*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/global_warming/science_and_impacts/science/human-contribution-to-gw-faq.html#.WDrvICMrIy4 (last visited Apr. 17, 2018) (discussing the detection and effects of greenhouse gases, and other anthropogenic causes of global warming).

unabated. Indeed, the Environmental Protection Agency (EPA) estimates the average social cost of carbon as $11–56 per metric ton of carbon dioxide (CO_2) in 2015, an amount that will steadily increase to $26–95 by 2050.[5] This amounts (conservatively) to almost $120 billion in lost wages, productivity, and health effects by 2050, assuming that carbon emissions do not increase.[6] These figures only consider CO_2; other GHGs, such as methane and sulfur oxides, threaten similar harm in addition to that caused by CO_2.[7] Moreover, these are the direct effects of climate change; the consequences are not limited to these effects.[8] In essence, climate change invites catastrophe. Therefore, public and private actors must seek answers to the globe's most pressing issue.

One of these answers is energy policy. Fossil fuel electric generation is the nation's single largest source of GHGs.[9] By reducing or even ending fossil fuel generation, the U.S. can significantly reduce its GHG emissions.[10] Of course, the U.S. will still need electricity.[11] Thus, in place of fossil fuel generation, the U.S. should build renewable energy generation—generation with no GHG emissions from electricity

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2. *See e.g.*, Mark C. *Urban, Accelerating Extinction Risk from Climate Change*, SCIENCE, May. 2015, at 571. (finding that up to 54% of species could go extinct due to climate change).

3. BENJAMIN K. SOVACOOL & MICHAEL H. DWORKIN, GLOBAL ENERGY JUSTICE 129 (2014) (noting that the effects of climate change will fall disproportionately on the world's poor and cause a climate-based refugee crisis).

4. *Id.* at 128 (noting that the cost of climate change would amount to losing 5% of the world's GDP per year until climate change is addressed).

5. INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS 3 (2013), https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf.

6. *See id.* (discussing how numbers are based on multiplying cost of carbon by emissions per year); *Sources of Greenhouse Gas Emissions*, U.S. ENVT'L PROT. AGENCY, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#electricity (last visited Apr. 17, 2018).

7. Alex L. Marten & Stephen C. Newbold, *Estimating the Social Cost of Non-CO_2 Emissions* 13–14 (Envtl. Prot. Agency, Working Paper No. 11-01, 2012), https://www.epa.gov/sites/production/files/2014-12/documents/estimating_the_social_cost_of_non-co2_ghg_emissions_0.pdf.

8. *E.g.* U.S. DEP'T OF DEF., NATIONAL SECURITY IMPLICATIONS OF CLIMATE RELATED RISK AND A CHANGING CLIMATE 3 (2015), http://archive.defense.gov/pubs/150724-congressional-report-on-national-implications-of-climate-change.pdf (describing climate change as a grave national security risk).

9. *Sources of Greenhouse Gas Emissions*, *supra* note 6.

10. *See id.* (explaining that electricity generation produces 30% of GHG emissions; thus, an all-renewable energy sector would reduce emissions by 30%).

11. ENERGY INFO. AGENCY, ANNUAL ENERGY OUTLOOK 2017 75-76 (2017).

production.[12] Renewable energy takes many forms including solar, wind, geothermal, biodigesters, and hydropower.[13] No one source of renewable power is sufficient to meet all U.S. energy needs.[14] Nor should it: diversification of our energy supply increases the security and reliability of our grid.[15] As such, energy policy must reflect the value and necessity of renewable energy.

Increasingly, it falls to the states to address and mitigate its contribution to climate change through policy. On the international stage, several agreements, such as the Kyoto Protocol,[16] bind countries to reduce their GHG emissions. However, the United States is not a party to the Kyoto Protocol.[17] Further, agreements to which America *was* a party—the Paris Agreement[18]—may now be back on the table.[19]

The federal government has few renewable energy policies. It promotes renewable energy through tax credits,[20] grants,[21] and funding research and development.[22] Additionally, federal agencies have jurisdiction over leasing

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12. *See* JOSEPH P. TOMAIN & RICHARD D. CUDAHY, ENERGY LAW IN A NUTSHELL 509–511 (2nd ed. 2011) (describing a case for the "seemingly limitless renewable resources" as "inexpensive or costless, and relatively environmentally benign.").

13. *See, e.g.*, *Renewable Energy*, U.S. ENVT'L. PROT, AGENCY, https://www.epa.gov/greeningepa/renewable-energy (last updated Sept. 1, 2011).

14. U.S. DEP'T OF ENERGY, WIND VISION: A NEW ERA OF WIND POWER IN THE UNITED STATES 2 (2015), http://www.energy.gov/sites/prod/files/WindVision_Report_final.pdf (finding that wind energy could supply up to 35% of America's power by 2050).

15. *See infra*, Part II.A.

16. Kyoto Protocol to the United Nations Framework Convention on Climate Change, *Opened for signature* Mar. 16, 1998, 2303 U.N.T.S. 148 1-2 (entered into force Feb. 16,2005).

17. United Nations Framework Convention on Climate Change, *Status of Ratification of the Kyoto Protocol*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php (last visited Apr. 04, 2018).

18. *Communication Regarding Intent To Withdraw From Paris Agreement*, U.S. DEPT. OF STATE (Aug. 4, 2017), https://www.state.gov/r/pa/prs/ps/2017/08/273050.htm

19. *Trump seeking quickest way to quit Paris climate agreement, says report*, THE GUARDIAN (Nov. 13, 2016, 4:02 AM), https://www.theguardian.com/us-news/2016/nov/13/trump-looking-at-quickest-way-to-quit-paris-climate-agreement-says-report; *see also Donald Trump Says US could Re-enter Paris Climate Deal*, THE GUARDIAN (Jan. 28, 2018, 7:04 PM), https://www.theguardian.com/us-news/2018/jan/28/donald-trump-says-us-could-re-enter-paris-climate-deal-itv-interview.

20. *E.g.*, *Renewable Energy Production Tax Credit (PTC)*, U.S. DEP'T OF ENERGY, http://energy.gov/savings/renewable-electricity-production-tax-credit-ptc (last visited Apr. 04, 2016) (describing the federal production tax credit for renewable technologies).

21. *Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants*, U.S. DEP'T AGRIC., https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency (last visited Apr. 18, 2018).

22. *See e.g.*, *Research and Development*, U.S. DEP'T OF ENERGY, http://energy.gov/eere/ssl/research-development (last visited Nov. 22, 2016) (summarizing Office of Energy Efficiency and Renewable Energy's research and development projects).

Federal Energy Regulatory Commission (FERC) regulates wholesale electricity—bulk electricity in interstate commerce for resale[24]—with an eye towards resource neutrality.[25] Again, the Trump administration has expressed interest in traditional fossil fuels rather than renewable sources.[26] Support is waning or deficient at international or federal levels and the states are left to shoulder the burden of developing energy policies addressing climate change.

And states have been doing just that.[27] States support renewable energy through tax credits and tax breaks,[28] direct subsidies,[29] and a host of other programs that finance projects and reduce barriers to renewable energy adoption.[30] However, this support is not evenly spread amongst renewable technologies.[31] Most notably, hydropower receives the short end of the stick in several states. While many states[32] (and the federal government[33]) have removed some of the significant permitting and administrative barriers to hydropower, one significant barrier remains—financial barriers. Simply

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23. TOMAIN & CUDAHY, *supra* note 12, at 484–487 (reviewing the scope of federal jurisdiction for licensing hydropower).

24. Id.

25. *E.g.*, FERC, Order No. 755, 137 FERC ¶ 61,064 at page 105 (Oct. 20, 2011) (issuing frequency regulation rule in part because it is resource neutral).

26. Opinion Letter, Rick Perry, Sec'y of Energy, Secretary of Energy's Direction that the Federal Energy Regulatory Commission Issue Grid Resiliency Rules Pursuant to the Secretary's Authority Under Section 403 of the Department of Energy Reorganization Act (Sept. 28, 2017), (pushing baseload reliability in a thinly-veiled attempt to subsidize Midwestern coal-fired generation); *see generally An America First Energy Plan*, Donald J. Trump, https://www.donaldjtrump.com/policies/energy (last visited Nov. 27, 2016) (discussing Trump's intention to prioritize shale, oil, and natural gas as sources of energy); *But cf.* Steve Mitnick, *What the election means for utility regulation and policy*, Pub. Utils. Fortnightly, https://www.fortnightly.com/fortnightly/2015/12-0/president-elect-trump-and-utilities (last visited Apr. 04, 2018) (arguing that Trump's policies cannot overcome market forces, which will keep renewable technologies strong).

27. LEARNING FROM STATE ACTION ON CLIMATE CHANGE, PEW CENTER ON GLOBAL CLIMATE CHANGE 1 (2015), http://www.climatechange.ca.gov/climate_action_team/reports/2006report/2005-12-08_PEW_CENTER_REPORT.PDF.

28. *Id.* at 7-8.

29. *See* Steven Ferrey, *Sustainable Energy, Environmental Policy, and States' Rights: Discerning the Energy Future through the Eye of the Dormant Commerce Clause*, 12. N.Y.U. ENVTL. L.J. 2004, 507, 507–08.

30. LEARNING FROM STATE ACTION ON CLIMATE CHANGE, *supra* note 27, at 5.

31. *See* Ferrey, *supra* note 29, at 525.

32. *E.g.,* PUB. SERV. DEPT. OF VT., VT SMALL HYDROPOWER ASSISTANCE PROGRAM, http://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/Resources/Hydro/VT%20Small%20Hydropower%20Assistance%20Program%20Overview.pdf (developing a program to ease administrative burdens on Vermont hydropower).

33. Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 493 (2013) (codified in scattered sections of 16 U.S.C.).

put, state policies that create necessary financial incentives for other renewable technologies do not extend these policies to hydropower.[34] In light of these policies, and because of hydropower's advantages as a renewable energy source,[35] this note argues that state policies should at least put hydropower on equal footing with other renewable energy technologies. Part I of this note examines the advantages of hydropower and the varieties of hydropower available. In doing so, it notes that lack of awareness may explain these policies. Part II looks at the role that the federal and state governments play in hydropower, revealing that states have primary responsibility for supporting hydropower. This section also gives an overview of all financial incentive programs, with an emphasis on net metering. Part III looks at Vermont's net metering program and compares it to examples in other states to evaluate and recommend a better template for renewable energy programs. This note concludes that hydropower is one of our nation's answers to global warming, equal to other sources of renewable power, and must be treated as such. Further, the recommendations in this note apply to all distributed renewable energy generation resources. Ultimately, hydropower "will never be a complete answer . . . [but] it can be a useful part of the answer."[36]

I. HYDROPOWER, LARGE AND SMALL

A. The Advantages of Hydropower

Hydropower, aside from emitting no GHGs during power production, offers many advantages over other renewable technologies: a reliable electric supply, high and predictable capacity factors, and wide availability.[37] States must draft policies that capitalize on the wealth of benefits hydropower provides. First, hydropower increases grid reliability and resiliency[38] through portfolio diversity and because it does not rely on

34. *PTC, supra* note 20 (describing the federal production tax credit for renewable technologies).
35. *See infra*, Part II.A.
36. Lea Kosnik, *The Potential of Water Power in the Fight Against Global Warming in the U.S.*, 36 ENERGY POL'Y 2 (2008) [hereinafter Kosnik, *Potential of Water Power*].
37. H.R. 267, 113th Cong. (1st Sess. 2013).
38. Are reliability and resiliency something for which generators must be compensated? Are these attributes a legitimate issue? A battle between coal-fired generation (ostensibly baseload generation) and resource-neutral wholesale markets is underway, with the opening skirmishes ending with the issue being kicked down the road. *Compare* DEP'T OF ENERGY, GRID RESILIENCY PRICING RULE NOTICE OF PROPOSED RULEMAKING, https://www.energy.gov/sites/prod/files/2017/09/f37/Notice%20of%20Proposed%20Rulemaking%20.p

the grid: should one technology become unavailable (such as solar at night), other technologies can pick up the slack. [40] Diversification reduces the cost of power, saving upwards of $93 billion per year.[41] Hydropower is reliable because it runs on flowing water, rather than fuel—water does not need to be purchased and delivered through pipelines or rails.[42] Thus, unlike fossil fuel generation, hydropower is insulated from geopolitical events and natural disasters in far-flung regions.[43]

Second, hydropower has a capacity factor[44] higher than other sources of renewables, zero-emission energy such as photovoltaic (PV), solar thermal, and wind.[45] For example, the average capacity factor for hydropower nationwide in 2015 was 35.9%, higher than wind's 32.5%, and utility-scale PV's 28.6%.[46] In certain regions, the difference in capacity factors between renewable energy technologies is even higher. The Northeast (including

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df (proposing that FERC initiate rulemaking to compensate baseload generators for having fuel reserves on site) *with* FERC, ORDER TERMINATING RULEMAKING PROCEEDING, INITIATING NEW PROCEEDING, AND ESTABLISHING ADDITIONAL PROCEDURES, 162 FERC ¶ 61, 12 (Jan. 8, 2018), https://www.ferc.gov/CalendarFiles/20180108161614-RM18-1-000.pdf. (rejecting DOE's NOPR and passing the issue to the RTOs and ISOs) This paper will not weigh in on this debate; however, because hydropower does not rely on fuel, it may meet DOE's proposed resiliency criteria).

39. PETER H. GLEICK, PACIFIC INSTITUTE, IMPACTS OF CALIFORNIA'S ONGOING DROUGHT: HYDROELECTRIC GENERATION UPDATE 2015 5 (2016), http://large.stanford.edu/courses/2016/ph240/goodwin2/docs/gleick.pdf (explaining that hydropower does have an Achilles' heel: drought).

40. *See* SUSAN F. TIERNEY ET AL., FUEL DIVERSITY IN THE NEW YORK ELECTRICITY MARKET, N.Y. INDEP. SYS. OPERATOR 4-1 (2008) http://www.nyiso.com/public/webdocs/media_room/publications_presentations/White_Papers/White_Papers/fuel_diversity_11202008.pdf (explaining that multiple fuel options reduce reliability concerns); *see also* *Energy Diversity*, Clay Electric, http://www.clayelectric.com/sites/default/files//doc/Energy%20Diversity.pdf (last visited Nov. 17, 2016) (explaining that fuel diversity increases reliability because not all "eggs are in onebasket.").

41. LAWRENCE J. MAKOVICH ET AL., IHS ENERGY, THE VALUE OF US POWER SUPPLY DIVERSITY 5 (2014), http://www.energyxxi.org/sites/default/files/USPowerSupplyDiversityStudy.pdf (arriving at this figure by comparing a hypothetical, less-diverse scenario with current fuel diversity).

42. PPL Montana, LLC v. Montana, 565 U.S. 576, 580–81 (2012).

43. Tierney, *supra* note 40, at 24.

44. ROCÍO URÍA-MARTÍNEZ ET AL., U.S. DEP'T OF ENERGY, 2014 HYDROPOWER MARKET REPORT 36 (2014), http://www.energy.gov/sites/prod/files/2015/04/f22/2014%20Hydropower%20Market%20Report_20150424.pdf ("The capacity factor of a hydropower plant is the ratio of actual output to potential output [nameplate capacity] over a given period of time where the potential output is computed by multiplying the number of period hours times the nameplate capacity of the plant.").

45. U.S. ENERGY INFO. ADMIN., ELECTRIC POWER MONTHLY (Sept. 2016), https://www.eia.gov/electricity/monthly/archive/september2016.pdf.

46. Id.

Vermont)—a region with high hydropower potential[47]—sees solar capacities of about 15%.[48] These capacity factors for hydropower reflect an average across all regions and all hydropower technologies.[49] Small; run-of-river additions to non-powered dams, and conduit hydropower see capacity factors of over 55%.[50] While hydropower is an intermittent electricity source like wind and solar, its intermittency is predictable and varies seasonally rather than hourly.[51] For example, the nationwide average capacity for hydropower increases in the rainy months and decreases in the drier winter and summer.[52] Hydropower's peak capacities correspond to when wind's production is at its lowest, therefore complementing other renewable technologies.[53] In sum, when the wind does not blow and the sun does not shine, water still flows downhill.

Lastly, hydropower is widely available, particularly in regions where other common renewable technologies are less available.[54] The Department of Energy (DOE) notes that small, low-impact hydropower has great potential in the Northeast.[55] All Northeastern states (except New York) could at least double their hydroelectric output.[56] Some states, like New Jersey, have the potential for a tenfold increase in hydropower.[57] Ultimately, the Northeast has about 1,891 megawatts (MW)[58] of hydropower potential.[59] If fully developed, the electric output from these hydropower facilities would represent a small but significant portion of the

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47. *See* DOUGLAS G. HALL ET AL., U.S. DEP'T OF ENERGY, DOE-ID-11263, FEASIBILITY ASSESSMENT OF THE WATER ENERGY RESOURCES OF THE UNITED STATES FOR NEW LOW POWER AND SMALL HYDRO CLASSES OF HYDROELECTRIC PLANTS 26 (2006), http://www1.eere.energy.gov/water/pdfs/doewater-11263.pdf (finding high hydropower potential for northeastern states).

48. JON BLACK, ISO-NEW ENGLAND, PV ENERGY FORECAST UPDATE 9 (2014), https://www.iso-ne.com/static-assets/documents/2014/09/pv_energy_frcst_update_09152014.pdf.

49. U.S. ENERGY INFO. ADMIN., *supra* note 45.

50. URÍA-MARTÍNEZ, *supra* note 44, at 36.

51. Kosnik, *Potential of Water Power supra* note 36, at 7.

52. U.S. ENERGY INFO. ADMIN., *supra* note 45

53. *See* Lea Kosnik, *The Potential for Small Scale Hydropower Development in the U.S.*, 38 Energy Pol'y 5512, 5513 (2010) (showing that hydropower complements other technologies) [hereinafter Kosnik, *Hydropower Development*]; *see* Kosnik, *Potential of Water Power supra* note 36, at 7 (comparing wind, solar, and hydropower capacities and finding that hydropower balances the former two).

54. Kosnik, *Hydropower Development, supra* note 53, at 5512–5513.

55. HALL ET AL., *supra* note 47, at 26.

56. *Id.*

57. *Id.*

58. *See generally* ALEXANDRA VON MEIER, ELECTRIC POWER SYSTEMS: A CONCEPTUAL INTRODUCTION 66 (Emmanuel Desurvire ed., 2006).

59. HALL ET AL., *supra* note 47, at 26.

potential hydropower on non-powered dams and conduits is abundant.[61]

Additionally, hydropower is most available in regions where other renewable technologies are not, or cannot, be fully realized. For example, Northeastern states have low solar capacity due to their latitude.[62] The region has onshore wind potential,[63] but resistance to wind projects, particularly on ridgelines, suggests that this potential may remain at least partially untapped.[64] Even if the region's wind and solar are fully developed, these resources may not be able to fully cover the region's energy needs. If these states wish to produce zero-carbon electricity, solar and wind power may not be enough. Thus, these states must—and can—install additional hydropower capacity.

A. Large Hydropower

The classic image of hydropower is that of a large, concrete dam that spans the length of a river, takes years and millions of dollars to complete, and leaves a massive reservoir behind it. The classic image is essentially the Hoover Dam.[65] This note does not consider financial and administrative burdens on large-scale hydropower. However, an examination of large-scale hydropower serves to illustrate just how different other hydropower technologies are from the classic bigger-is-better model.

Large hydropower differs from small hydropower in two ways. First, there is limited potential for new large-scale hydropower development in

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60. *See, e.g.*, ISO-NE, SUMMER 2015 WEATHER NORMAL PEAK LOAD 1 (2015), https://www.iso-ne.com/static-assets/documents/2015/12/summer_peak_normal_2015.pdf (detailing a median distribution of 28,000 MW (75th percentile) in New England during summer months).

61. Gina S. Warren, *Hydropower: Time for a Small Makeover*, 24 IND. INT'L & COMP. L. REV. 249, 253 (2014) (noting that there were an estimated 54,000 non-powered dams that *could* be powered to increase the current hydropower generation in the United States by 15 percent) (emphasis added) [hereinafter Warren, *Small Makeover* 2014].

62. BLACK, *supra* note 48, at 3.

63. WALT MUSIAL ET AL., NAT'L RENEWABLE ENERGY LAB., 2016 OFFSHORE WIND ENERGY RESOURCE ASSESSMENT FOR THE UNITED STATES viii (2016), http://www.nrel.gov/docs/fy16osti/66599.pdf. (explaining that this region has considerable *offshore* wind potential, which once fully developed can meet a substantial portion—if not all—of this region's energy needs).

64. Robert Bryce, *Wind Backlash Takes Center State in Vermont's Gubernatorial Race*, Nat'l Rev. (Aug. 9, 2016, 8:00 AM), https://www.nationalreview.com/2016/08/vermonts-wind-power-backlash-governors-race-issue/.

65. Gina S. Warren, *Hydropower: It's A Small World After All*, 91 NEB. L. REV. 925, 936 (2013) [hereinafter Warren, *Small World* 2013].

America.[66] Simply, all of the rivers with this potential are used up.[67] Even if there were untapped rivers, the public has shown that it will not stomach further damming.[68] Essentially, the biggest difference between traditional, large-scale hydropower and other hydropower technologies is that there is no more room for large hydropower development.[69] In contrast, small hydropower has considerable room to grow.

Second, large hydropower comes with a correspondingly large price tag. Eventually, large hydro pays for itself, especially considering that the fuel—moving water—is essentially free.[70] However, in the short run of about fifty years, large hydropower has proved extremely expensive.[71] The average nameplate capacity of a hydroelectric facility is 40MW.[72] Such a facility requires a capital investment of about $80 million.[73] This investment makes financial incentives for hydropower correspondingly more expensive for hydropower developers. Small hydropower incentives need to cover only a fraction of what large hydropower incentives would because the construction of small facilities costs less than the large hydro project with 100MW capacity or more.[74] Small capital investment makes small-hydro capacity projects more accessible to small, distributed

66. TOMAIN & CUDAHY, *supra* note 12, at 478 ("Today the expansion of hydroelectric facilities is limited by the small number of sites on which new dams may be located ...... ").

67. Id.

68. *E.g.*, Rupak Thapaliya, *167 Groups Urge Congress to Drop Hydropower Provisions from Energy Bill,* HYDROPOWER REFORM COAL., https://www.hydroreform.org/news/2016/11/23/167-groups-urge-congress-drop-hydropower-provisions-energy-bill (Nov. 23, 2016, 10:24 AM) (noting opposition to hydropower based on environmental concerns).

69. *Compare* Warren, *Small Makeover* 2014, supra note 61, at 253 (noting that there are 54,000 non-powered dams that are potentially capable for hydroelectric development), *with* TOMAIN & CUDAHY, *supra* note 12, at 478 ("Today the expansion of hydroelectric facilities is limited by the small number of sites on which new dams may be located ").

70. TOMAIN & CUDAHY, *supra* note 12, at 477.

71. U.S. GEOLOGICAL SURV., HYDROELECTRIC POWER WATER USE, (last updated Dec. 6, 2017, 8:15 AM), https://water.usgs.gov/edu/wuhy.html.

72. *See* URÍA-MARTÍNEZ, *supra* note 44, at v (calculating the average capacity of a hydropower facility by dividing the total capacity of the U.S. Hydropower fleet at 79.64 GW by the 2,198 active plants averages at 40 MW per plant).

73. *See* Int'l Renewable Energy Agency [IRENA], *Renewable Energy Technologies: Cost Analysis Series*, at 18, Vol. 1: Power Sector, Issue 3/5 Hydropower (June 2012), https://www.irena.org/documentdownloads/publications/re_technologies_cost_analysis-hydropower.pdf (finding that the cost of hydropower can vary from $500/kW to $3,500/kW therefore the total cost for a 40 MG plant could range from $20 million to $140 million).

74. *See Id.* at 11, 18 (defining small hydropower as a project with a maximum nameplate capacity of 20MW, while large hydropower is typically described as facilities having a capacity of 100MW or more and detailing the cost differential).

justify.

Notably, the large and small hydro cost comparisons do not include levelized costs.[76] The levelized cost is the net present value of the hydropower system.[77] The current research on levelized cost is incomplete and somewhat inconsistent.[78] There are three takeaways from the data on levelized cost analysis. First, more research must be done before levelized cost can be used to compare small and large hydropower projects.[79] Second, the presence of existing infrastructure seems to have the greatest impact on levelized cost.[80] Third, and perhaps most importantly, small hydropower can offer significant "soft" benefits to the local communities.[81]

Lastly, the environmental impact of large hydropower is greater than small hydropower. Large hydropower generally creates a reservoir behind a dam.[82] While hydropower is an emission-free source of power, the reservoirs behind these large facilities are not emission-free.[83] For example, the total GHG emissions of all reservoirs may be equivalent to all of the rice patties in the world.[84] In addition to emitting GHGs, dams also produce

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75. QIN FEN ZHANG ET AL, OAK RIDGE NATIONAL LABORATORY, ORNL/TM-2012/501, SMALL HYDROPOWER COST REFERENCE MODEL 1 (2012), https://info.ornl.gov/sites/publications/files/Pub39663.pdf (noting the cost benefits of small hydropower over large).

76. *Id.* at 1.

77. IRENA, *supra* note 73, at 27.

78. *Compare id.* (noting that there are numerous benefits hydropower offers that were not included in the levelized cost analysis and that because each project is "very site-specific," no average levelized cost value can accurately capture the technology's levelized cost), *with* ZHANG ET AL., *supra* note 76, at ix ("no acceptable regression equation could be arrived at because of the limited sample size or inherent weak correlations.").

79. 2015 DOE QUADRENNIAL TECH. REV.: HYDROPOWER TECH. ASSESSMENT 9–10 (2015) (suggesting the need for more research on different technology to assess the levelized costs).

80. IRENA, *supra* note 73, at 30.

81. *See id.* at 12 (describing that local management and control and rural electrification can create sustainable benefits beyond the levelized cost saving of electricity from large hydropower); *see also* TIM BAILEY & ROBERT BASS, AN ASSESSMENT OF THE FEASIBILITY OF GENERATING ELECTRIC POWER USING URBAN STORMWATER IN OREGON CITY at iii (June 2009), http://www.oit.edu/docs/default-source/strategic-partnerships-and-government-relations/applied-research/oc-hydro-study-report-r1.pdf?sfvrsn=4 (finding that even if low-capacity conduit hydropower is economically infeasible, the other benefits it produces "may prove to be incalculable.").

82. IRENA, *supra* note 73, at 5.

83. *See* WILLIAM STEINHURST ET AL., SYNAPSE ENERGY ECON., HYDROPOWER GREENHOUSE GAS EMISSIONS 9–10, 12–13 (2012) (identifying plant and biomass decay under newly flooded conditions behind hydropower reservoirs emit variable levels of GHGs).

84. Chris Mooney, *Reservoirs Are a Major Source of Global Greenhouse Gases, Scientists Say*, WASH. POST (Sept. 28, 2016), https://www.washingtonpost.com/news/energy-environment/wp/2016/09/28/scientists-just-found-yet-another-way-that-humans-are-creating-greenhouse-gases/?utm_term=.42c16763d491.

serious ecological impacts for the rivers they block: dams reduce sediment flows, block fish migrations, change river temperatures, and flood riparian ecosystems.[85] Indeed, dams are a significant contributor to declining fish stocks.[86] Large hydropower, for all its benefits,[87] comes at a terrible cost to our rivers and ecosystems.[88] In short, large hydropower is large: large prices and large environmental impacts.

B. Small Hydropower

In the same way that large hydropower comes with large price tags and large environmental impacts, small hydropower comes with small price tags and small environmental impacts. Definitions vary from state to state, but, generally speaking, small hydropower is no more than 20 MW[89] and is usually 10 MW or less.[90] This is the upper limit—there are sub-classifications for projects dipping into the 100 kW or lower range, for example.[91] Whatever the definition or terminology used, the fact of the matter is that small capacity hydropower is significantly smaller than large capacity hydropower.

Another distinction is that small hydropower is usually run-of-river or dam-free[92] Run-of-river hydropower can include the dams of large hydropower; however, it returns water to the river immediately, rather than storing water.[93] This avoids most of the negative impacts associated with

85. Roddy Scheer & Doug Moss, *The Downside of Dams: Is the Environmental Price of Hydroelectric Power Too High?*, SCI. AM., https://www.scientificamerican.com/article/how-do-dams-hurt-rivers/ (last visited Apr. 5, 2018); *see, e.g.,* Warren, *Small World* 2013, *supra* note 65, at 953 (describing environmental damage caused a dam on the Kennebec River in Maine).

86. *See, e.g.*, Merrit Kennedy, *For the First Time in Decades, Herring are Spawning in a Hudson River Tributary*, NPR (Jun. 11, 2016, 1:43 PM), https://www.npr.org/sections/thetwo-way/2016/06/11/481684318/for-the-first-time-in-decades-herring-are-spawning-in-a-hudson-river-tributary (reporting that dams that block spawning grounds are a significant factor in declining fish stocks).

87. IRENA, *supra* note 73, at 27.

88. *See* Warren, *Small World* 2013, supra note 65, at 937 (2013) (discussing how environmental laws addressed potential environmental damages from hydropower development); *see also* JAMES LOVELOCK, THE REVENGE OF GAIA: EARTH'S CLIMATE IN CRISIS AND THE FATE OF HUMANITY 85 (2006) (stating the harmful environmental impacts of hydropower are necessary for the clean power they create).

89. IRENA, *supra* note 73, at 11 (noting that the maximum nameplate capacity for small hydropower is 20MW).

90. *See e.g.*, FED. ENERGY REG. COMM'N, SMALL/LOW-IMPACT HYDROPOWER PROGRAM, https://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact.asp (last visited Apr. 5, 2018) (capping small hydropower licensing exemptions at 10 MW).

91. IRENA, *supra* note 73, at 11.

92. *Hydropower Development*, *supra* note 53, at 5513–14.

93. IRENA, *supra* note 73, at 8.

dams—sediment buildup, temperature change, and large-scale flooding.[94] Run-of-river hydropower is mostly devoid of serious environmental impacts.[95]

Still, most dams block fish passage.[96] However, the small-scale nature of these hydropower projects allow for fish bypasses around the section of the river dammed.[97] Further, small-scale hydropower can use weirs instead of dams, preventing any blocking of fish passages.[98] In essence, small hydropower has significantly fewer drawbacks of large hydropower, but has all of the benefits.

C. Infrastructure-Based Small Hydropower

Small-scale, run-of-river technologies have a small impact to be sure,[99] but they first must be built. Small-scale hydropower's cost per kW is similar to that of large-scale hydropower.[100] Thus, small-scale infrastructure's only downfall is the expense which could be lessened with the right financial incentives.[101] However, two other breeds of hydropower exist: conduit hydropower and adding hydropower capacity to non-powered dams.[102] Both of these are unique in that their cost is minimal, their environmental impact is already justified, and they are built on pre-existing infrastructure.[103]

First, conduit projects are, legally speaking, a fairly recent invention.[104] They are the simplest of all hydropower technologies. Essentially, conduit projects put a turbine on a preexisting flow of water, such as one used for

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94. See Scheer & Moss, *supra* note 85, for an explanation of the chief environmental concerns from dams.

95. *Hydropower Development*, *supra* note 53, at 5514.

96. Jean Therrien & Gilles Bourgeois, Int'l Energy Agency [IEA], *Fish Passage at Small Hydro Sites*, at 1(Mar. 2000), https://www.ieahydro.org/media/42697113/Fish%20Passage%20at%20Small-hydro%20Sites.pdf.

97. *Id.* at 77.

98. *Hydropower Development*, *supra* note 53, at 5514.

99. OFF. OF ENERGY PROJECTS, HYDROPOWER PRIMER 12, fn. 10 (2017) https://www.ferc.gov/legal/staff-reports/2017/hydropower-primer.pdf.

100. *See* ZHANG ET AL., *supra* note 75, at 7 (reporting the per kilowatt price for initial hydropower projects ranging between US $1800 and $8000); *but see* IRENA, *supra* note 73, at 18 (finding that the cost of hydropower can vary from $500/kW to $3,500/kW).

101. *Id.* at 2.

102. *Id.* at ix.

103. *Id.*

104. *See* Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 493-94 (2013) (recognizing that Congress codified conduit hydropower regulations in 2013).

municipal water delivery.[105] This has two substantial benefits. Primarily, conduit projects require lower investments per kW than large or small hydropower, averaging around $500/kW to build—a difference of $1500/kW.[106] This is because the infrastructure needed for the hydropower has already been built; all a developer needs to add is a turbine to produce zero-emission electricity.[107] Adding capacity at a non-powered dam has a similar cost.[108] The expense of conduit projects and adding to non-powered dams is further reduced because they forgo the need for additional transmission lines.[109] To that end, adding to non-powered dams and conduits costs less, and therefore is of great benefit.

Because conduit projects employ preexisting infrastructure to produce electricity, they have two additional benefits. First, they are widely available. Hydropower is dependent upon geography—there must be streams and rivers with enough flow to generate electricity.[110] Conduits are dependent not on geography, but rather the presence of infrastructure. Conduits include pipes, flumes, ditches, or canals,[111] and where conduits exist, hydropower can also exist.[112] Because infrastructure is everywhere, even states with negligible hydropower potential have the potential for conduit projects. [113]

Second, restructuring dams and conduits to make them hydropower compatible has minimal environmental impacts.[114] Actually, such may produce a positive environmental impact when accounting for new operation and maintenance technologies.[115] In the case of conduits, that impact is already minimal—drinking water pipes do not block fish

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105. *E.g.*, *Conduit Hydropower*, NAT'L HYDROPOWER ASS'N, http://www.hydro.org/policy/technology/conduit/ (last visited Apr. 5, 2018) (describing San Diego Water Authority's conduit hydropower facility in their municipal water distribution system).

106. BAILEY & BASS, *supra* note 81, at 41.

107. NAT'L HYDROPOWER ASS'N, *supra* note 105.

108. Qin Fen Zhang et al., supra note 75, at 16.

109. *See* Warren, *Small Makeover* 2014, *supra* note 61, at 254–255 (building generation near populated areas forgoes the need for additional transmission lines because they already exist).

110. *See* TOMAIN & CUDAHY, *supra* note 12, at 477 (noting that hydropower development is limited to certain rivers and streams).

111. Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 494 (2013).

112. OFFICE OF ENERGY PROJECTS, *supra* note 99, at 5.

113. HALL ET AL., *supra* note 47, at 26

114. Warren, *Small Makeover* 2014, *supra* note 61, at 255.

115. *Id.*

migrations, for example.[116] However, for non-powered dams, the impacts are more significant.[117] Even if there are environmental impacts from the preexisting infrastructure, those impacts are justified by the purposes that the infrastructure serves.[118] Many dams serve important flood-control functions that make areas around rivers livable for people.[119] In some cases, conduits can deliver water.[120] If the environmental impact these structures create is justified based on their use, adding renewable energy only increases their value.

Small hydropower is varied and widely available, unlike large hydropower. Small hydropower is also just that: small. Whether it is the cost or environmental impact, small hydropower requires only minimal expenditure (relative to large hydropower) and a minimal (or no) environmental impact. Of all of the renewable energy systems available, hydropower is more reliable than other sources of zero-emission energy such as wind or solar.[121] Thus, policies should reflect the value of small hydropower.

II. FEDERAL AND STATE RESPONSIBILITIES OVER HYDROPOWER

Traditionally, the federal government has had exclusive jurisdiction over hydropower siting and licensing,[122] as well as many of the environmental impacts of hydropower.[123] Over time, states have gained some jurisdiction over hydropower, particularly in regards to the water-

116. *See, e.g., Portland Now Generating Hydropower in its Water Pipes*, KUOW.org (Jan. 20, 2015, 4:45 PM), http://kuow.org/post/portland-now-generating-hydropower-its-water-pipes ("Portland start-up [Lucid Energy] has tapped the city's water pipes as a new source of renewable hydropower that doesn't disrupt fish migration or stream flows.").

117. *Environmental Impacts of Hydroelectric Power*, UNION OF CONCERNED SCIENTISTS, https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-hydroelectric-power.html (last visited Apr. 8, 2018) (describing the environmental impacts from dams and hydroelectric energy projects and comparing degrees of impact depending on size of the electrical generation and the topography of the land placement).

118. Warren, *Small Makeover* 2014, *supra* note 61, at 255.

119. URÍA-MARTÍNEZ, *supra* note 44, at 10.

120. NAT'L HYDROPOWER ASS'N, *supra* note 105.

121. *See* KOSNIK, *supra* note 36, at 7 (noting that renewables, such as wind and solar power, are limited by weather consistency).

122. *Hydropower Transmission Siting and Interconnection Overview,* OPENEI https://openei.org/wiki/RAPID/Roadmap/8_(2) (last visited Apr. 17, 2018).

123. *See generally* TOMAIN & CUDAHY, *supra* note 12, at 494–500 (summarizing the interactions between hydropower and the Clean Water Act, the Wild and Scenic Rivers Act, and the Endangered Species Act).

quality impacts of hydroelectric dams.[124] State and federal regulation of hydropower has served as the primary barrier to hydroelectric development, creating expensive and time-consuming licensing and permitting processes that disproportionately affect small, low-impact hydropower.[125] However, the administrative hurdles related to permitting and siting are slowly eroding.[126] Congress has passed several laws to reduce the burden on small hydropower, and states have significantly reduced the state licensing process.[127] However, another type of impediment remains: financial barriers.[128]

A. Federal Licensing and Permitting

This section discusses federal permitting and licensing in only enough detail to describe the barriers to hydropower.[129] The hydropower regulatory scheme at the federal level is onerous at best. Indeed, hydropower is the most regulated form of energy in America.[130] Most of the licensing is done through FERC under the Federal Power Act (FPA).[131] Other statutes in the environmental realm, such as the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA), create additional regulatory schemes for hydropower.[132] All of these combine to ensure that our waterways,[133] the Earth's species,[134] and the quality of our environment[135] remain intact and healthy for generations to come. However, this worthy

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124. *See* Pub. Util. Dist. No. 1 v. Washington Dep't of Ecology, 511 U.S. 700, 724 (1994) (holding that § 401 discharge permits under the Clean Water Act are a necessary part of state authority).

125. Fredric Beck & Eric Martinot, *Renewable Energy Policies and Barriers*, *in* ENCYCLOPEDIA OF ENERGY, VOL. 5 365, 367–69 (2004).

126. *See* Regina Cline, *Hydropower in U.S. Gets Boost from New Laws. Will Congress Do More?*, BLOOMBERG (Jan. 30, 2014), https://www.bna.com/hydropower-us-gets-b17179881735/ (showing that the new laws have reduce the burden on hydropower).

127. *See id.* (showing that the new laws have reduce the burden on hydropower).

128. NAT'L HYDROPOWER ASS'N, SMALL HYDRO COUNCIL INITIAL REPORT 24 (2010) (explaining that financial barriers impede hydropower development).

129. *See* generally Tomain & Cudahy, *supra* note 11, at Ch. X (exploring the interactions between the Federal Law and hydropower generation).

130. Warren, *Small World* 2013, *supra* note 66, at 958.

131. Federal Power Act, 16 U.S.C. §§ 791–823 (1920).

132. *See* Warren, *Small World* 2013, *supra* note 66, at 938–42 (discussing the interplay between hydropower licensing and the Wild and Scenic Rivers Act, the National Environmental Policy Act, and the Endangered Species Act).

133. *See id.* at 933 ("The purpose of the FPA was to set forth a comprehensive plan for development of the Nation's water resources that were within the jurisdiction of the federal government.").

134. Endangered Species Act, 16 U.S.C. §§ 1531 et seq. (2012).

135. 42 U.S.C. §§ 4321-4347 (2012) (detailing the protectionist purpose in passing the National Environmental Policy Act).

goal has the side effect of creating a difficult, and expensive to navigate, web of regulations. First, the licensing process takes a long time to complete, sometimes longer than installing the facility itself.[136] This delay causes expenses to rise as the interest on capital begins to accrue.[137] Second, the actual cost of permitting is prohibitively expensive, costing at *minimum* $10,000 (and usually significantly more) per license.[138] The cost of installing small hydropower runs about $2,000/kW.[139] As such, a hydropower facility must increase production to make licensing a small portion of the total project cost worthwhile.[140] Simply preparing and filing the paperwork and documentation for a license can exceed the cost of the project itself.[141] Understandably, the licensing and permitting processes are the most significant barriers to small hydropower.[142]

These policies are reasonable for their intended technology: large hydropower.[143] As noted above, large hydropower has a large environmental impact,[144] one that must be regulated to reduce the negative externalities of hydropower. However, small hydropower has a proportionally smaller (or non-existent) environmental impact, and policies must reflect this. Congress noted this disconnect between the administrative apparatus and environmental impact when it passed the Hydropower Regulatory Efficiency Act of 2013 (HREA).[145] In doing so, Congress created a small/low-impact exemption (a less-onerous licensing process) for small hydropower and a special process for Qualified Conduit Hydropower Facilities.[146] This process is exclusively for conduit projects under 5 MW that are added to conduits designed for agricultural, industrial, or municipal

136. *See* Warren, *Small Makeover* 2014, *supra* note 61, at 260 (noting that the licensing process can take years to complete).

137. Lea-Rachel D. Kosnik, *Sources of Bureaucratic Delay: A Case Study of FERC Dam Relicensing*, 22 J. L., ECON., & ORG. 258, 259 (2005) (identifying the challenges in delaying licensing for the investments in hydropower); *see generally* ENVTL. PROT. AGENCY, DISCOUNTING FUTURE BENEFITS AND COSTS, GUIDELINES FOR PREPARING ECONOMIC ANALYSES 6-4 (Dec. 2010), https://www.epa.gov/sites/production/files/2017-09/documents/ee-0568-06.pdf (providing methods to account for the compounding interest on the price of capital and acknowledging the potential for increasing regulatory costs).

138. Warren, *Small World* 2013, *supra* note 65, at 963.

139. IRENA, *supra* note 73, at 18.

140. Warren, *Small World* 2013, *supra* note 65, at 962–63.

141. *Id.*

142. *Id.* at 957, 962–63.

143. *Id.* at 935–36.

144. *See* Scheer & Moss, *supra* note 85 (describing some large environmental impacts from dams).

145. *See* Hydropower Regulatory Efficiency Act, Pub. L. No. 113-23, 127 Stat. 493 (2013) (regulating hydropower and improving the regulatory process).

146. *Id.* at 493–94

purposes.[147] The Act removes the aforementioned expensive paperwork and documentation process and replaces it with a notice of intent, a less-than-ten-page template accessible to any developer.[148] Not only is the paperwork reduced, but also the time—the whole process takes 60 days.[149] In short, the federal government recognizes the potential of small hydropower and is removing administrative barriers to its development.

B. State Licensing and Permitting

States have far less control over hydropower permitting and licensing than the federal government. However, their influence still creates administrative barriers. State administrative barriers fall into two categories: state responsibilities over federal statutes and state-specific licensing. An example of the first category is the NPDES permit under the Clean Water Act.[150] All hydropower that eventually discharges into waters of the United States requires a Section 401 water quality permit, or at least a waiver of the discharge permit.[151] State agencies are usually involved in the issuance of Section 401 permits.[152] Having to communicate with several agencies (and having the agencies communicate amongst each other) increases the cost and time required to obtain a permit. Much like Congress' assessment that current federal permitting and licensing schemes create an undue burden on small hydropower,[153] states have created policies to ease the administrative burden.[154] A good example is Vermont's Act 165,[155] in which Vermont's Agency of Natural Resources entered into a memorandum of understanding with other concerned agencies to streamline

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147. *Id.* at 494.

148. *How to File a Notice of Intent to Construct a Qualifying Conduit Hydropower Facility*, FED. ENERGY REG. COMM'N., https://www.ferc.gov/industries/hydropower/indus-act/efficiency-act/qua-conduit.asp (last updated Mar. 8, 2018) (containing a link to notice of intent template).

149. 127 Stat. at 496.

150. *See* Pub. Util. Dist. No. 1 v. Washington Dep't of Ecology, 511 U.S. 700, 709 (1994) (describing state responsibilities under the Clean Water Act).

151. *Id.*

152. *See* VT. DEP'T OF PUB. SERV., VT SMALL HYDROPOWER ASSISTANCE PROGRAM (2015) http://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/Resources/Hydro/VT%20Small%20Hydropower%20Assistance%20Program%20Overview.pdf (showing that there are two agencies in Vermont that are involved in the permitting process).

153. 127 Stat. at 494.

154. VT. DEP'T OF PUB. SERV., *supra* note 152

155. 10 VT. STAT. ANN. tit. 10, § 1006.

the permitting process.[156] In doing so, interagency cooperation and communication quicken the Section 401 permitting process.[157]

Not all administrative barriers to hydropower are federally created.[158] States require electric generation facilities to obtain a certificate of public good (CPG).[159] How a facility receives a CPG varies from state to state and even within states; some methods are onerous while others are simple.[160] Vermont has both of these methods.[161] Some generation facilities must go through an application process, a complicated procedure that resembles litigation.[162] The registration process is the exact opposite, such as a notice of intent under HREA.[163] Registration merely requires the facility to fill out a form to receive a CPG.[164] Formerly, hydropower went through the application process, adding another level of licensing to an already onerous process.[165] Under the current revision to Vermont's net-metering rules, a hydropower facility generating 500 kW or less must complete the far simpler registration process, eliminating the need to engage in what amounts to litigation.[166] Ultimately, states add another layer of complexity to hydropower licensing and permitting, but like their federal counterparts, they are easing or eliminating these burdens.[167]

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156. VERMONT GEN. ASSEMBLY, ACT 165 REPORT: A BIENNIAL REPORT TO THE VERMONT GENERAL ASSEMBLY ON PROCEDURES FOR FACILITATING DEVELOPMENT OF SMALL AND MICRO HYDROELECTRIC PROJECTS 1 (2016), http://legislature.vermont.gov/assets/Legislative-Reports/Act-165-Legislative-Report-Final-011516.pdf.

157. VT. DEP'T OF PUB. SERV., *supra* note 152.

158. *See* DEVIN HARTMAN & TOM RUSSO, R STREET POLICY STUDY NO. 105, EBBING THE FLOW OF HYDROPOWER RED TAPE 1 (2017) (describing the "*de facto* power [that state agencies] have over permitting approvals, denials, and delays of hydropower licensure.").

159. VT. STAT. ANN. tit. 30, § 248(a). The name of this certificate varies from state to state and at the federal level. For the purposes of this note, CPG will refer to the licensing document permitting construction and operation.

160. VIRGINIA STATE CORPORATION COMMISSION, STAFF INVESTIGATION ON THE RESTRUCTURING OF THE ELECTRIC INDUSTRY, 1, 13-14 (2007), https://www.scc.virginia.gov/comm/reports/restrct3.pdf.

161. 30000-5100 Vt. Code R. §§ 5.104–5.105 (2018) (describing eligibility and registration).

162. VT. STAT. ANN. tit. 30, § 248(j).

163. Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 494.

164. 30000-5100 Vt. Code R. § 5.105(2018).

165. *Id.*

166. *Id.*at § 5.104(E).

167. Steven Ferrey, *Sustainable Energy, Environment Policy, and States Rights: Discerning the Energy Future Through the Eye of the Dormant Commerce* Clause, 12 N.Y.U ENVTL. L.J. 507, 507-08 (2004) (introducing a transition in energy portfolios).

C. Financial State Programs

For non-administrative programs (most notably financial incentives), the situation is the reverse of administrative barriers.[168] States do far more to incentivize renewable technologies than the federal government does.[169] However, the situation is not much different from administrative laws.[170] Just as state and federal licensing and permitting programs tend to treat small hydropower the same as large hydropower, so do some state programs that deal with financial incentives. States have numerous tools at their disposal to incentivize renewable technologies.[171] As the next sections discuss, rarely do these policies benefit hydropower as much as other renewable technologies, and rarely do the policies consider the value and benefits of hydropower.[172] Essentially, states ought to recognize that "small facilities are not similarly situated [to large facilities], and should not be treated equally. . ." when given financial incentives.[173]

III. NET-METERING LAWS

A. Net-Metering and the Value of Distributed Generation

Net-metering is by far the most common policy states employ to promote renewable energy.[174] Each state-specific policy includes the same basic framework.[175] Net-metering is a payment system for behind-the-meter, customer-owned generation.[176] Net-metering only applies to specific

168. *See* Jeremiah I. Williamson & Matthias L. Sayer, *Federalism in Renewable Energy Policy,* NAT. RESOURCE & ENV'T., 2012, at 1.

169. Id.

170. Id.

171. *Id; see* Steven Ferrey, *Sustainable Energy, Environmental Policy, and States' Rights: Discerning the Energy Future through the Eye of the Dorman Commerce Clause*, 12 N.Y.U. ENVTL. L. J. 507, 524 – 25 (2004) (discussing various policy tools states use for the benefit of renewable technologies).

172. *PTC*, *supra* note 20 (describing the federal production tax credit for renewable technologies).

173. Warren, *Small World* 2013, *supra* note 65, at 928.

174. *Net Metering*, DATABASE FOR STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2016/07/Net_Metering1.pdf (last visited Dec. 8, 2016) (illustrating that 41 states, D.C., and three territories have mandatory net-metering laws).

175. *State Net Metering Policies*, NAT'L CONF. OF ST. LEGISLATURES (Nov. 20, 2017), http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx#statenet (showing that many states employ some form of net metering).

176. *Net Metering/Remote Net Metering and Interconnection*, NEW YORK STATE ENERGY RESEARCH & DEV. AUTH., https://www.nyserda.ny.gov/Researchers-and-Policymakers/Power-Generation/Net-Metering-Interconnection (last visited Apr. 5, 2018).

types of generation. Usually, these systems are renewable technologies (primarily solar),[177] although some laws allow efficient combined heat and power facilities.[178] These systems are customer owned, and unlike other generation facilities, they are connected to the distribution grid rather than the transmission grid.[179] Because of this and state-mandated caps on facility nameplate generation, distributed generation tends to be small, usually less than 1 MW.[180] Once interconnected to the distribution grid, generators are paid for their electricity on a per kWh basis.[181] This payment policy makes net-metering attractive and has created a boom in distributed generation, particularly photovoltaics.[182] It can even eliminate energy bills.[183] Eventually, net-metered systems pay for themselves, with some having short payback periods and good returns on investment.[184]

Net-metering policies exist because of the benefits of distributed generation.[185] In exchange for free or low-cost energy, net-metered customers provide benefits for the grid and state as a whole.[186] First among them is a reduction in GHG emissions; eligible facilities must be zero-emission technologies or at least very efficient fossil-fuel technologies like anaerobic digesters.[187] In addition, distributed technologies increase system reliability and decrease system cost by foregoing the need for transmission.[188] Distributed generation serves load on-site, displacing

177. *Net Metering by State*, SOLAR ENERGY INDUSTRIES ASSOCIATION, https://www.seia.org/research-resources/net-metering-state (last visited Apr. 6, 2018) ("Net energy metering is primarily used for solar photovoltaic (PV) systems ").

178. *See e.g.*, ME. STAT. tit. 35-A, §3210 (C)(1)-(2) (2015) (defining a "renewable resource" as a source of electrical generation that is derived from combined heat and power production facilities).

179. Warren, *supra* note 61, at 256.

180. 30000-5100 Vt. Code R. § 5.103 (2018) (limiting net metering capacity to 500kW).

181. Id.

182. *See* Mark Muro & Devashree Saha, *Rooftop Solar: Net Metering is a Net Benefit*, BROOKINGS (May 23, 2016), https://www.brookings.edu/research/rooftop-solar-net-metering-is-a-net-benefit/ (describing a wave of state policies aimed at reeling back net-metering policies because they have met their objective of incentivizing solar).

183. *Net Metering (Rhode Island)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY (Jan. 24, 2018), http://programs.dsireusa.org/system/program/detail/287.

184. Id.

185. *See generally* Richard L. Revesz and Burcin Unel, *Managing the Future of the Electricity Grid: Distributed Generation and Net Metering*, 41 HARV. ENVTL. L. REV. 43 (2017) (discussing how net metering benefits from distributed generation infrastructure).

186. *See, e.g.* Muro & Saha, *supra* note 182 (giving examples of states and academic organizations whose studies show net-metering benefits for the grid and the state).

187. *E.g.*, 220 Mass. Code Regs. 18.04 (2) (allowing anaerobic digestion to be net-metered).

188. Warren, *supra* note 61, at 256.

generation on a more than one-for-one basis by preventing transmission loss.[189] A distant generator must produce more power than an end-user requires because some of that power is lost as a matter of physics.[190] Utilities can avoid building expensive transmitters because their customers already have distributed generation located right at the demand for its power.[191] This has two effects. First, reliability increases.[192] Transmission is a choke point in the grid.[193] Relative to the number of end-users and generators, there are few transmission lines.[194] If a transmission line goes down, entire regions can follow.[195] Second, transmission is expensive, running upwards of a billion dollars for a new line.[196] Because utilities can defer these transmission investments, all customers' costs go down.[197]

These benefits are in addition to any advantages that the renewable technology itself brings. Thus, net-metered hydropower has a high capacity factor, low variability, and displaces the need for new transmission, thereby increasing grid reliability and decreasing cost. Despite this long list of benefits, states net-metering policies put hydropower on unequal footing with far more intermittent technologies.[198] In some cases, hydropower is treated as *less valuable* than other technologies.[199] States must consider the value of hydropower relative to other technologies and reflect this in their incentive systems.

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189. *See* VON MEIER, *supra* note 58, at 8–9, 74 (detailing that 1 MW solar array generating for one hour will deliver less than 1 MWh due to line losses if the power produced is delivered over the transmission grid).

190. *Id.* at 74.

191. *Id.* at 274-75.

192. *Id.*

193. *Id.*

194. *See id.*

195. *See*, *e.g.*, INITIAL BLACKOUT TIMELINE, FED. ENERGY REGULATORY COMM'N. 4 (2003), https://www.ferc.gov/industries/electric/indus-act/reliability/blackout/09-12-03-blackout-sum.pdf (recounting the transmission line losses leading up the 2003 blackout).

196. *See* MATTHEW H. BROWN & RICHARD P. SEDANO, ELECTRICITY TRANSMISSION A PRIMER, NAT'L. COUNCIL ON ELECTRICITY POLICY 15 (2004) (explaining that transmission lines can cost almost $2 million per mile).

197. JIM LAZAR, ELECTRICITY REGULATION IN THE U.S.: A GUIDE, 51–53, 61 (Regulatory Assistance Project 2nd ed., 2016) (stating that capital investments (e.g. transmission costs) are included in electricity rates).

198. *See, e.g*, *Net Metering (New Jersey)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY (Nov. 9, 2016), http://programs.dsireusa.org/system/program/detail/38 (stating New Jersey offers net metering to more intermittent renewable energy sources, such as wind and solar, but not to hydropower).

199. See Kosnik, *supra* note 53, at 5513.

B. Net-Metering Laws

All northeastern states allow customers to net-meter hydropower.[200] But no state in the northeast has a net-metering law that reflects the value of hydropower relative to other renewable technologies. Some states disadvantage hydropower more than others.[201] These net-metering laws fall into two main categories: (1) net-metering laws that put hydropower on equal footing with other renewable technologies; and (2) those that actively disadvantage hydropower relative to other technologies.[202] The first group is by far the largest; Maine,[203] Rhode Island,[204] Connecticut,[205] New Hampshire,[206] and New York[207] all treat hydropower as they treat other resources. While the specifics of each law are different, the basic structure is the same. All renewable or eligible technologies are on equal footing regardless of the benefits they provide. Under these laws, solar power, a low-capacity and highly variable technology, is treated the same as hydropower, a high-capacity and seasonally variable technology.[208] Nevertheless, the laws *do* incentivize hydropower. Considering the alternatives in the second group of net-metering, this is perhaps the second-best option for hydropower.

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200. *State Net Energy Billing Rates – Northeast States*, MAINE.GOV, http://www.maine.gov/legis/opla/NEBstatecreditchart.pdf (last visited Apr. 6, 2018); *Net Metering (Maryland)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/363 (last updated July 12, 2016), *Net Metering (Delaware)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/43 (last updated Jan. 11, 2016).

201. *See e.g., Net Metering (New Jersey)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/38 (last updated Nov. 9, 2016) (stating New Jersey offers net metering to renewable energy sources, such as wind, biomass and solar, but not to hydropower); *see also Net Metering (Rhode Island)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/277 (last updated Jan. 24, 2018)(stating Connecticut offers net metering to hydropower alongside other renewable energy technologies).

202. Id.

203. 313 ME. CODE R. § 1 (1998).

204. *Net Metering (Rhode Island)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/287 (last updated Jan. 24, 2018).

205. *Net Metering (Connecticut)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/277 (last updated Oct. 4, 2016).

206. *See generally* N.H. CODE ADMIN. R. ANN. PUC 902.17 (2015) (providing all regulations relating to net metering in New Hampshire).

207. *See generally* N.Y. COMP. CODES R. & REGS. tit. 16. § 66-j (2018) (outlining New York's net metering regulations for microhydroelectric generating equipment).

208. *See generally* KOSNIK, *supra* note 36 (showing that hydropower is treated the same as other renewable energy technologies under state laws although it has a higher capacity).

The second group does not give hydropower the same incentives as other renewable technologies. This group is far less homogenous than the first group.[209] The strictest state is New Jersey, which does not consider hydropower a renewable resource and does not allow hydropower to net-meter.[210] Thus, there is no financial incentive to build hydropower in New Jersey, and its significant potential may never be realized. The two other states—Massachusetts and Vermont—do allow hydropower, but treat it differently than other resources.

Massachusetts deals two blows to hydropower through unequal incentives. First, Massachusetts creates three classes of resources, and treats those classes differently.[211] Solar, wind, and generation located on agricultural land are part of each class, and thus their compensation rate only differs based on nameplate capacity.[212] Hydropower, however, is only part of class I and is limited to no more than 60 kW of capacity.[213] This has the effect of significantly limiting small hydropower to the lower portion of its range. Larger units that can take advantage of economies of scale are left without a funding source.[214] Considering that there are a finite number of locations for hydropower, Massachusetts has capped the maximum possible energy from hydropower in its state, and in doing so may jeopardize its GHG emission goals.[215]

Second, Massachusetts does not compensate hydropower as much as other resources. Non-solar, non-wind class I net-metered renewable technologies are compensated at the wholesale rather than retail rate.[216] This entails a significantly longer payback period for net-metered hydropower systems. On average, a 60 kW small hydropower system not based on preexisting infrastructure runs about $2,000/kW, or $120,000.[217]

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209. *Compare Net Metering (New Jersey)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (Nov. 9, 2016), http://programs.dsireusa.org/system/program/detail/38 (stating New Jersey offers net metering to renewable energy sources, such as wind, biomass and solar, but not to hydropower) *with Net Metering (Vermont)* DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (Mar. 17, 2017) http://programs.dsireusa.org/system/program/detail/41 (showing Vermont offers some net metering incentives for hydropower facilities, but that those incentives are different from other renewable energy technologies).

210. *Net Metering (New Jersey)*, DATABASE OF STATE INCENTIVE FOR RENEWABLES & EFFICIENCY (Nov. 9, 2016), http://programs.dsireusa.org/system/program/detail/.

211. 220 MASS. CODE REGS. 18.02.

212. *Id.*

213. *Id.*

214. IRENA, *supra* note 73, at 18.

215. 220 MASS. CODE REGS. 18.07.

216. *Id*. at 18.04 (2).

217. IRENA, *supra* note 73, at 18.

At 50% capacity factor,[218] a small hydropower system is paid about $5,000 per year.[219] A small hydropower system creates a best-case-scenario payback period of 24 years, assuming no operations and maintenance costs. A similarly situated solar system could pay for itself in less than ten years.[220] In short, Massachusetts caps capacity and pays hydropower less than half what other technologies receive.

Vermont's treatment of net-metered hydropower is a different beast altogether. Vermont is unique because it considers more than just the retail (or wholesale) cost of power when creating its net-metering rule. It considers *where* the power is located when deciding how to compensate distributed generators.[221] For systems located on existing infrastructure, such as roofs, utilities are required to pay an additional $0.01/kWh.[222] In addition, the utility must purchase a generator's renewable energy credits for $0.03/kWh unless the generator elects to take a significant penalty.[223] Infrastructure-based small hydropower, then, appears to have found an ideal jurisdiction in Vermont. However, Vermont excludes hydropower from receiving the benefits it offers other technologies. Despite being a cost-effective, reliable, and zero-emission source of power, hydropower is not considered as valuable as other technologies, even though it would otherwise meet the citing requirements Vermont rewards.[224]

However, Vermont's additional credit adders are not set in stone. Included in the net metering rule is a biennial update requirement.[225] Once every two years, the Vermont Public Utility Commission (PUC) must reconsider adjustors, amongst other factors.[226] This built-in review program creates the flexibility needed to respond to changing electric system conditions. Also, the built-in review program corrects the omission of

218. URÍA-MARTÍNEZ, *supra* note 44, at 36.

219. Press Release, Independent System Operator-New England, New England's 2015 Average Wholesale Power Price Fell to Second-lowest Level Since 2003, (Mar. 29, 2016), https://www.isone.com/static-assets/documents/2016/03/20160329_prelim_2015_prices_release.pdf.

220. *See* Massachusetts Electric Rates, ELECTRICRATE, http://www.electricrate.com/residential-rates-massachusetts/ (last visited Apr. 14, 2018) (showing the different utilities, prices, and savings in Massachusetts).

221. 30000-5100 VT. CODE R. § 5.103 (2018).

222. *Id*. at § 5.126.

223. 30000-5100 Vt. Code R. § 5.126 (C)(2)(e) (2018).

224. *Id.*

225. 30000-5100 VT. CODE R. § 5.128 (2018).

226. *Id.*

hydropower from the regulatory benefits.[227] Any net metering law should include this review, especially when the benefits of hydropower become more apparent and net metering conduit hydropower becomes a more prevalent resource.

Ultimately, the best hydropower can expect in the northeast is equal treatment to that of other technologies, despite not being similarly situated. Other states go even further and actively disadvantage hydropower relative to other technologies, excluding hydropower from net-metering incentives altogether or cutting it out of more lucrative reward schemes. Hydropower's value in the fight against climate change is significant; state incentives must—but as of yet do not—reflect this value to receive hydropower's full potential.

C. Value-Based Compensation: A Potential Solution?

While no state *currently* creates a net-metering system that treats hydropower equitably vis-à-vis other technologies, a value-based net metering tariff may do so. Generically, net-metering laws compensate the generator at the retail rate.[228] This, however, is about administrative convenience rather than a fair and accurate compensation structure.[229] Moreover, there are equity considerations with the retail rate. Utilities cannot always collect the cost of service and a fair rate of return under a retail rate tariff, forcing other non-net-metered customers to pay proportionally more.[230] If the retail rate is less than the value of the distributed hydropower, there may be no incentive to augment our infrastructure with clean energy. Numerous researchers and policy makers have begun looking into a "value of solar tariff" to respond to these inherent issues.[231] While solar is popular, the value of distributed generation

227. *Net Metering (Vermont)* DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (Mar. 17, 2017) http://programs.dsireusa.org/system/program/detail/41 (showing Vermont does not offer credit adjustors to hydropower facilities).

228. 30-000-5100 VT. CODE R. § 5.127 (A) (2018).

229. *See* Karl R. Rábago, *Value of Solar Tariff: Net Metering 2.0*, ICER CHRON., 45, 46 (Dec. 2013) (showing that administrative simplicity rather than cost calculations is a motivator for using net-metering systems) [hereinafter Rábago, *Solar Tariff*].

230. *Id.* at 45; *see* Karl R. Rábago, *The Net Metering Riddle*, ELECTRICITYPOLICY.COM, Apr. 2013, at 4–5 (describing "access fees" used to cover revenue deficits for the utility to cover the cost of grid management and reliability).

231. *See e.g.*, Rábago, *Solar Tariff*, *supra* note 229, at 47–49 (detailing Austin Energy's value of solar tariff).

and the drawbacks of using only the retail rate apply to all resources.[232] States must consider a resource-neutral alternative.

New York is developing a resource-neutral, value-based net metering tariff.[233] Net metering can be more valuable than the retail rate, particularly if the net-metered technology offers less intermittency and the ability to be an addition to existing infrastructure.[234] One state—Vermont—attempts to codify these benefits with a siting adjustor, but fails to apply it to hydropower.[235] New York proposes to go beyond this with a formula for calculating net-metering compensation based on the value of the resource to the grid.[236]

New York bases this value on a simple formula: LMP+D,[237] which will replace traditional retail-rate compensation. LMP is the locational marginal price, which is the wholesale price of electricity for each zone within New York, modified by congestion and loss charges.[238] The LMP will not change based on any of the attributes of a renewable technology,[239] and will likely not influence compensation vis-à-vis other technologies.[240] Further, some regions have only one zone and as such LMP cannot change,

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232. *See, e.g.*, Ashley Brown & Jillian Bunyan, *Valuation of Distributed Solar: A Qualitative View*, 27, THE ELECTRICITY J. 27, 30–31 (Dec. 2014) (demonstrating the drawbacks of using only retail rates for natural resources like solar energy).

233. N.Y. DEP'T OF PUB. SERV., NO. 15-E-0751, STAFF REPORT AND RECOMMENDATIONS IN THE VALUE OF DISTRIBUTED ENERGY RESOURCES PROCEEDING 6 (Oct. 27, 2016) http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={59B620E6-87C4-4C80-8BEC-E15BB6E0545E} [hereinafter STAFF REPORT].

234. *See generally* KOSNIK, *supra* note 36 (showing that net metering can be more valuable than the retail rate); *see* Warren, *Small Makeover* 2014, *supra* note 61, at 255 (detailing how micro-level transmission and distribution grids are more resilient than distributed generation).

235. 30000-5100 Vt. Code R. § 5.126 (C) (2018).

236. STAFF REPORT, *supra* note 233, at 2 ("An integrated grid that enables dynamic operation of DERs will require more accurate pricing for the products and services that such DERs will provide.").

237. STAFF REPORT, *supra* note 233, at 14; Shayle Kann, *How to Find Compromise on Net Metering,* GREENTECH MEDIA *(Apr. 27, 2016),* https://www.greentechmedia.com/articles/read/how-to-find-compromise-on-net-metering.

238. ISONE, *FAQs: Locational Marginal Pricing*, https://www.iso-ne.com/participate/support/faq/lmp (last visited Apr. 04, 2018); NYISO, *Zone Maps*, http://www.nyiso.com/public/markets_operations/market_data/maps/index.jsp (last visited Apr. 04, 2018) (showing New York has eleven zones, and NYISO provides real-time LBMPs for each zone).

239. *See id.* (listing the factors in calculating LMP as only the wholesale cost modified by congestion and line loss charges).

240. *See* ISO New England, *Real-Time Maps and Charts*, ISO NEW ENGLAND, https://www.iso-ne.com/isoexpress/ (last visited Apr. 6, 2018) (depicting minimal differences in the LMP for each zone in relation to other energy technologies).

regardless of the technology employed.[241] The D value, on the other hand, is far more variable and influenced by choice of technology.[242] D is composed of several factors that encompass the value of distributed generation to the grid.[243] These values currently theoretical; they do not have a set numerical value or formula for calculation.[244] However, many of the listed variables promise to value hydropower equitably relative to other technologies.

1. Key Metrics and Hydropower

New York's formula consists of three variables that have great potential to benefit hydropower. First, the D value includes a temporal variable that encompasses the intermittency and dispatchability of a technology.[245] New York recognizes that intermittent resources require a greater balancing of the grid to ensure stability; those with high capacity factors require less balancing. These high-capacity technologies make it easier to meet peak demand by providing a constant, predictable flow of power.[246] Further, demand is not constant throughout the day. A high-capacity-factor technology provides power both when demand is lowest and highest.[247] Low-capacity factor technologies, such as PV, do not always produce when they are needed most.[248] Hydropower has a high capacity factor, and if its

241. *See, e.g.*, ISO New England, *Real-Time Maps and Charts*, ISO NEW ENGLAND, https://www.iso-ne.com/isoexpress/ (last visited Apr. 6, 2018) (illustrating that Massachusetts is the only state in New England able to change its LMP rate because it has more than one LMP zone).

242. John Farrell, *Is New York's "Compromise" The Future For Net Metering?*, CLEAN TECHNICA (Mar. 6, 2017), https://cleantechnica.com/2017/03/06/new-yorks-compromise-future-net-metering/;https://blog.aee.net/how-do-you-spell-the-future-of-net-metering-maybe-like-this-lmpd.

243. *Id.*; Ryan Katofsky, *How Do You Spell the Future of Net Metering? Maybe like this: LMP+D*, ADVANCED ENERGY PERSPECTIVES (May 12, 2016), https://blog.aee.net/how-do-you-spell-the-future-of-net-metering-maybe-like-this-lmpd.

244. STAFF REPORT, *supra* note 233, at 5.

245. Shayle Kann, *How to Find Compromise on Net Metering: The anatomy of New York's utility-solar partnership proposal*, GREENTECH MEDIA (April 27, 2016), https://www.greentechmedia.com/articles/read/how-to-find-compromise-on-net-metering#gs.Jidsf7M; STAFF REPORT, *supra* note 233, at 33.

246. STAFF REPORT, *supra* note 233, at 33 ("Intermittent technologies . . .have no control of when they generate and . . . may miss the [peak] hour due to due to uncontrollable, purely random events. . .").

247. OFFICE OF NUCLEAR ENERGY, U.S. DEP'T OF ENERGY, WHAT IS GENERATION CAPACITY?, (Jan. 29, 2018), https://www.energy.gov/ne/articles/what-generation-capacity.

248. *See* Jeff St. John, *The California Duck Curve is Real, and Bigger than Expected*, GREENTECH MEDIA (Nov. 3, 2016), https://www.greentechmedia.com/articles/read/the-california-duck-curve-is-real-and-bigger-than-expected (describing how the load-supply balance with electricity source output that varies hourly and consumer use of electricity does not match causing a need for higher ramps in the grid during off-peak production hours).

output varies, it does so seasonally.[249] Hydropower is the dependable technology that New York's formula seeks to reward.

Second, the D value encompasses a location value.[250] Distributed generation is usually located right next to the load it serves.[251] This saves on transmission and distribution costs because no power is lost during transmission.[252] The maintenance costs of the transmission and distribution systems are reduced because less power is flowing through lines[253], and can even avoid blackouts caused by overloaded transmission.[254] All distributed generation provides these benefits, but infrastructure-based hydropower—the variety with most of the administrative barriers already removed[255]—is poised to benefit most from this proximity rule because it is necessarily located next to the demand.[256]

Third, the environmental benefits are included in the D variable.[257] This encompasses the avoided costs high-carbon technologies impose upon society.[258] This value may not be limited to just carbon; New York is considering whether to include the costs of other GHGs, such as Nitrogen Oxides (NOx) and Sulphur Oxides (Sox).[259] This value, of course, will not differ between carbon-free technologies: carbon-free is carbon-free. This does directly reward hydropower for its contributions to state climate goals, something conspicuously lacking from other net-metering schemes.[260] Ultimately, New York seeks to encompass the value of distributed generation in its net-metering compensation scheme, something other states have not done. Because the true value of distributed generation is rewarded, hydropower's value is rewarded.

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249. U.S. ENERGY INFO. ADMIN., *supra* note 45.
250. STAFF REPORT, *supra* note 233, at 36.
251. Warren, *Small Makeover* 2014, *supra* note 61, at 254.
252. *Id.*; VON MEIER, *supra* note 58, at 274–75.
253. Beia Spiller, *Transforming the Electric System to Reduce Costs and Pollution*, ENV'T DEF. FUND (Apr. 8, 2016), http://blogs.edf.org/markets/2016/04/08/transforming-the-electric-system-to-reduce-costs-and-pollution/.
254. INITIAL BLACKOUT TIMELINE, *supra* note 195.
255. Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 494.
256. Warren, *Small Makeover* 2014, *supra* note 61, at 254.
257. STAFF REPORT, *supra* note 233, at 35.
258. *Id.*
259. *Id.* at 38.
260. *See generally* Luis Berga, *The Role of Hydropower in Climate Change Mitigation and Adaptation: A Review*, 2 ENGINEERING 313, 313 (2016) (discussing the positive impacts of hydropower on climate change and the reduction of GHGs).

2. Potential Issues

The variables that encompass the D value may nevertheless pose some issues to hydropower development. First, the formula equates intermittency and dispatchability: these two qualities are considered together in the temporal variable in the D value.[261] This equivalency is problematic. Intermittency refers to how constant a technology's generation is—essentially the capacity factor.[262] The value of high capacity factor is that it requires no stabilizing because it is a constant.[263] Utilities can easily account for the amount of power produced, and high-capacity technologies produce power when needed most.[264] Hydropower meets all of these characteristics.[265] Dispatchability, on the other hand, refers to the ability of a technology to respond to demand, rather than always being on.[266] Dispatchable technologies can turn on and off upon request.[267] This feature is most common in fossil-fuel generation, such as combined heat and power.[268] Equating these two means that hydropower's high capacity goes unrewarded, despite the benefits to the grid.[269] A value-based compensation system must recognize the benefits of these two qualities separately, so, it may reward resources that provide one system benefit without the other, like hydropower.

Second, LMP+D is not the retail rate and may be lower than the retail rate, even with the most favorable calculations for the D value's variables.[270] The purpose of net-metering is to provide an incentive to build distributed, renewable generation. Without sufficient incentive, projects cannot get off the ground. Value-based compensation may be a worthy goal, particularly for undervalued technologies like hydropower, but traditional net-metering is better if LMP+D fails to provide sufficient

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261. STAFF REPORT, *supra* note 233, at 20–21.
262. *Id.*
263. *See generally Capacity Factor (net)*, U.S. NUCLEAR REG. COMM'N https://www.nrc.gov/reading-rm/basic-ref/glossary/capacity-factor-net.html (last updated Apr. 10, 2017) (defining capacity factor).
264. *Id.* at 10.
265. *Hydropower*, NAT'L ACADEMY OF SCIENCES (2018), http://needtoknow.nas.edu/energy/energy-sources/renewable-sources/hydroelectric/.
266. STAFF REPORT, *supra* note 233, at 21.
267. *Id.*
268. *Id.*
269. *See generally*, Jordan Hanania et al., *Dispatchable Source of Electricity*, ENERGY EDUCATION http://energyeducation.ca/encyclopedia/Dispatchable_source_of_electricity (last visited Apr. 6, 2018) (discussing dispatchability in energy resources and the rate of hydropower).
270. Kann, *supra* note 245.

incentive. New York is aware of this and recommends that additional incentives provided outside of net-metering schemes remain in place.[271] This solution only works if the state provides other incentives. Thus, states should augment their value-based compensation schemes with additional incentives to fully realize the benefits of hydropower.

Finally, the value of proper siting is not considered. Location on the grid looks only at proximity to the load. It does not see whether the hydropower (or other resource) is damming a river.

Ultimately, value-based compensation is still in its infancy; this is merely a proposal for further research and not a law.[272] Nonetheless, it underlies a key principle of energy policy: resources that benefit the grid the most deserve to be valued for their contributions. Because of hydropower's significant contributions, value-based compensation for net-metering will properly reward hydropower and thereby help states meet their climate goals.

CONCLUSION

Climate change is one of the world's most pressing problems and is a problem in dire need of solutions. Electricity generation is responsible for a third of U.S. GHG emissions.[273] Part of the solution, then, is to shift from fossil fuel generation to zero-emission renewable generation. Increasingly, the policy burden for this shift falls on the states, usually through policies such as net metering.

Not all renewable energy is created equal. Hydropower complements the more common and intermittent solar and wind energy. However, barriers exist towards hydropower's implementation. Previously, these were permitting and licensing barriers. Increasingly, governments are removing these barriers, recognizing the promise of hydropower. Remaining are financial barriers. While not all renewables are created equal, hydropower systematically receives less than its value in net-metering laws. Some proposals are in the works to fix this inequity, but laws currently on the books give hydropower the short end of the stick. With a crisis as large as

271. STAFF REPORT, *supra* note 233, at 28.
272. *Id.* at 4.
273. *Sources of Greenhouse Gas Emissions*, *supra* note 6.

global warming, all solutions are necessary. Thus, states must recognize the value of hydropower and grant it the financial incentives it is due.