Idaho Law Review

Volume 53 | Number 1 Article 6

April 2017

The Environmental Tradeoffs of Removing Snake River Dams

Todd Myers

THE ENVIRONMENTAL TRADEOFFS OF REMOVING SNAKE RIVER DAMS

TODD MYERS*

TABLE OF CONTENTS

I. INTRODUCTION

Called by some the most important environmental issue we face, climate change has recently dominated environmental policy debate in the Northwest, the United States, and the world. Signed by more than 160 countries on Earth Day 2016, the Paris Climate Accord lays out the need to take action to reduce carbon emissions.[1] Noting that "climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries," the accord commits signatories to reduce carbon emissions using a range of

* Environmental Director, Washington Policy Center

1. UNITED NATIONS, ADOPTION OF THE PARIS AGREEMENT (2015), https://assets.documentcloud.org/documents/2646274/Updated-l09r01.pdf.

techniques.[2] President Obama added his voice in a speech to the Coast Guard Academy, telling them, "climate change constitutes a serious threat to global security, an immediate risk to our national security."[3] Washington Governor Jay Inslee has been even more emphatic, making climate change "the single most important issue for he and his cabinet."[4]

That important context has, however, been a side discussion in the debate about removing the four Lower Snake River dams and the carbon-free energy they provide. Although the impact of the dams on the environment has been debated for over a decade, much of the focus has, instead, been on the claimed impact to salmon, or the benefit to transportation and the economy of the region. On the one side, environmental activists like Patagonia Founder Yvon Chouinard argue tearing down the dams will provide "opportunities for the revival of endangered salmon populations."[5] Those who rely on the dams for navigation, like the Northwest RiverPartners note that "[t]he Columbia and Snake River system provide the primary route for delivering Northwest goods and products to national and international markets."[6]

Additionally, both sides have addressed the issue of hydro power and its role in determining the future of the dams. Northwest RiverPartners notes, "it's hydropower that supplies 90 percent of the region's renewable energy," not wind or solar.[7] Environ-

---

2. *Id.*

3. Barack Obama, *Remarks by the President at the United States Coast Guard Academy Commencement*, WHITE HOUSE (May 20, 2015), https://www.whitehouse.gov/the-press-office/2015/05/20/remarks-president-united-states-coast-guard-academy-commencement.

4. Dahr Jamail, *In Washington State, a Green Governor Fights Climate Change on Multiple Fronts*, YES! MAGAZINE (Oct. 28, 2014), http://www.yesmagazine.org/climate-in-our-hands/washington-state-green-governor-fights-climate-change-multiple-fronts.

5. Yvon Chouinard, *Tear Down 'Deadbeat' Dams*, N.Y. TIMES (May 7, 2014), http://www.nytimes.com/2014/05/08/opinion/tear-down-deadbeat-dams.html?_r=0.

6. *Hydropower Creates Northwest Jobs*, NW. RIVERPARTNERS, http://nwriverpartners.org/commerce-and-jobs (last visited Nov. 11, 2016).

7. *Climate Change*, NW. RIVERPARTNERS, http://nwriverpartners.org/climate-change (last visited Nov. 11, 2016).

mental groups, however, respond that the amount of power provided by the dams is a small portion of the Northwest's power, claiming they "provide marginal (and replaceable) electricity."[8]

Despite that, the analysis of the impact of removing the dams on carbon emissions has been limited. Calculations of the value of the dams must include more than just the price to replace that electricity and what it costs to maintain them. A thorough environmental analysis of the impact of removing the dams on carbon emissions must also consider potential increases in carbon emissions from the loss the dams. Considering these costs is about more than just economic impact; it is about increasing electricity costs to consumers and businesses. It also bears directly on the environmental funding available for other efforts in Washington state. Taxes and income that pay for energy to replace the lost carbon-free energy are funds that cannot go to pay for salmon-recovery projects or other environmental restoration. Rather than being separate considerations, efforts to reduce carbon emissions and efforts to help improve salmon runs are both dependent on funding for environmental projects.

In this piece, we will analyze the cost of replacing the energy and fully mitigating the carbon emissions associated with replacing energy lost from removal of the four Lower Snake River dams. Offering a range of costs for replacing the dams will provide a useful metric to understand how best to provide overall environmental benefit for salmon and other species. After taking into account the costs associated with removing the Snake River Dams, it becomes clear that the cost is very high for both the economy and the climate. Indeed, dam removal would eliminate carbon-free energy greater than the entire stock of wind and solar energy in Washington, and oblige utilities to replace a relatively low-cost source of energy with high cost alternatives, with no carbon-reduction benefit.

It must be noted that the decision about removing the dams is not entirely objective. Some people simply value the notion of free-flowing rivers more than others. Concurrently, others value a robust farming economy that exists in Southwest Washington and Northern Idaho. Those considerations provide a baseline for many other decisions about the value of the dams. For this reason, this analysis does not claim to be a mathematical calculation of the

8. Chouinard, *supra* note 5.

overall benefits and costs of removing the dams. Despite that ambiguity, however, providing a solid foundation of data about the economic and climate costs of losing the dams will help narrow and refine the debate.

A. Balancing the Roles of the Snake River Dams

"That's why our company has been involved in trying to take out obsolete and damaging dams since 1993."[9] Those are the words of Yvon Chouinard, the Founder and Owner of Patagonia clothing. Patagonia has been part of rekindling a fight over the future of the four dams on the lower Snake River — the Lower Monumental Dam, the Ice Harbor Dam, the Lower Granite Dam, and the Little Goose Dam.[10] The statement is part of Patagonia's effort to remove the four dams, claiming they do more harm than good. In their statement, they argue the dams "provide marginal benefit far outweighed by the opportunities for the revival of now-endangered wild salmon populations and the jobs and communities they support throughout the Northwest."[11] It is a sentiment that is shared by others. Environmental groups,[12] tribes,[13] and others have expressed concern about the impact the dams are having on salmon runs along the lower Snake River.[14]

On the other side, supporters of the dams argue they provide a wide range of benefits, including low-cost shipping, irrigation, flood control, and significant amounts of energy for the region.[15] Many of these advocates point to the efforts taken by the U.S. Army

---

9. Yvon Chouinard, *Patagonia on Dams and Dam Removal*, PATAGONIA 1 (2014), http://www.patagonia.com/pdf/en_US/DamNation_Statements_v1.pdf.

10. *Id.* at 2.

11. *Id.*

12. For example, the Snake River Waterkeepers and Save Our Wild Salmon both advocate removal.

13. The Nez Perce and Yakama have both expressed support for removing the dams.

14. Jim Waddell, *Dam-managing Agencies Won't Do the Right Thing for Snake River Dams,* SEATTLE TIMES, http://www.seattletimes.com/opinion/dam-managing-agencies-wont-do-the-right-thing/ (last visited Nov. 11, 2016).

15. *See* Nw. RiverPartners, http://nwriverpartners.org. (last visited Nov. 11, 2016).

Corps of Engineers to reduce the impact of the dams on fish.[16] The Corps, who oversee the operation and maintenance of the dams, notes the dams were built to encompass multiple benefits, including making the Snake River navigable, with hydroelectric power being added as a goal in 1938.[17] The web page for the Little Goose Dam notes, "[t]his congressionally authorized project includes a dam, navigation lock, power plant, fish ladder, and appurtenant facilities. It provides navigation, hydroelectric power generation, recreation, and incidental irrigation."[18]

Interestingly, however, both sides recognize the value of the dams is related to a wide range of benefits. While emphasizing the harm to salmon, opponents of the dams have acknowledged the other benefits that removing the dams would provide. In a study of the value of the dams, the research firm Earth Economics claimed, "in terms of the anticipated recreation tourism economy from a free-flowing river, dam removal is only expected to benefit the area with more jobs and revenue."[19] Defenders of the dams also point to the numerous benefits, arguing that the cumulative gain from these various uses outweigh the limited number of fish killed by the dams.

II. THE NORTHWEST ELECTRIC SYSTEM

The Northwest's electric system is significantly different than almost any other in the country. The balance of resources, legal requirements, and load growth has created a system that is heavily dependent on hydroelectric power. Washington alone accounts for nearly one-third of all hydroelectric power produced in the nation,

---

16. Columbia River Fish Mitigation, US ARMY CORPS OF ENG'RS, http://www.nwd.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/475821/columbia-river-fish-mitigation (last visited Nov. 11, 2016).

17. John Harris, *Dams: History and Purpose*, NWCOUNCIL (Oct. 31, 2008), http://www.nwcouncil.org/history/DamsHistory.

18. *Little Goose Lock and Dam*, U.S. ARMY CORPS OF ENG'RS, http://www.nww.usace.army.mil/Locations/DistrictLocksandDams/LittleGooseLockandDam.aspx (last visited Nov. 11, 2016).

19. *Report Release: Lower Snake River Dams*, EARTHECONOMICS (Mar. 16, 2016), http://www.eartheconomics.org/latest-news-blog/2016/1/8/lower-snake-river-dams.

and about 70 percent of all energy in the state.[20] By contrast, the state has very little energy from coal or natural gas. Only about 13 percent of the state's electricity generation is from natural gas, while less than eight percent is from coal.[21]

Renewables represent a small percentage of total production. Wind energy is the largest renewable source, accounting for about 6.25 percent in 2014.[22] Wood and other biomass represent an additional 1.5 percent.[23] Industrial solar is virtually nonexistent, accounting for 0.001 percent of electricity generated in Washington.[24]

For Washington, that mix is likely to remain similar for many years. The state's only coal plant is scheduled to switch from coal to natural gas by 2025.[25] The state is not suited to solar energy, and the most aggressive estimates are that by the year 2020, it will account for about 0.1 percent of the total energy production in the state.[26] Wind energy is expanding in the state, and during the five years from 2010 through 2014, it increased by about 50 percent.[27]

---

20. U.S. ENERGY INFO. ADMIN., WASHINGTON STATE ENERGY PROFILE (2015), http://www.eia.gov/state/print.cfm?sid=WA [hereinafter *Washington State Energy Profile*]; U.S. ENERGY INFO. ADMIN., WASHINGTON STATE PROFILE AND ENERGY ESTIMATES (2015), http://www.eia.gov/state/analysis.cfm?sid=WA&CFID=10682315&CFTOKEN=8e2df1a2c7e8e09f-3E9E8E78-5056-A727-5966543F5E600897&jsessionid=8430b72feace7f90f70e136f7a444d40395d [hereinafter *Washington Energy Estimates*].

21. *Washington State Energy Profile*, *supra* note 20.

22. *Id.*

23. *Id.*

24. *Id.*

25. Mike Lindblom & Craig Welch, *Agreement Reaches to Stop Burning Coal at Centralia Power Plant*, SEATTLE TIMES (Mar. 15, 2011), http://www.seattletimes.com/seattle-news/agreement-reached-to-stop-burning-coal-at-centralia-power-plant/.

26. TODD MYERS, WASHINGTON POLICY CENTER, HB 2346: SOLAR SUBSIDY BILL WOULD SPEND $100 TO GET $1 OF ENVIRONMENTAL BENEFIT 1 (2016), http://www.washingtonpolicy.org/library/doclib/Myers-HB-2346-Solar-Subsidy.pdf.

27. U.S. ENERGY INFO. ADMIN., TABLE 5. ELECTRIC POWER INDUSTRY GENERATION BY PRIMARY ENERGY SOURCE, 1990 THROUGH 2014 (2014), http://www.eia.gov/electricity/state/washington/xls/sept05wa.xls [hereinafter *Electric Power Industry Generation by Source*].

Most of that increase, however, occurred in the first two years, and the amount of new wind energy has begun to level off.[28]

That energy mix is extremely different than the nation as a whole. Across the United States, coal and natural gas are the top sources of energy production, each accounting for one-third of total production.[29] Nuclear is next, representing about 20 percent of total production,[30] compared to Washington with only about nine percent of energy coming from nuclear.[31] Hydroelectric power accounts for only about six percent of electricity nationwide.[32]

The high concentration of hydroelectric power means Washington has very low energy costs.[33] The Energy Information Administration notes, "[i]n 2014, Washington had the lowest average residential retail electricity prices in the nation and the lowest average combined retail electricity price across all sectors."[34] The cost differential is significant. In December 2015, Washington's residential rates averaged 9.19 cents per kilowatt hour (kWh) compared to 12.36 cents per kWh nationwide, a 25 percent difference.[35] The cost differential for industrial users is even greater.[36] Average electricity rates in December 2015 for industrial users were 4.17 cents per kWh compared to 6.42 cents nationwide – about 54 percent more expensive.[37] Those low costs are one reason some companies have chosen to manufacture in Washington. The port of Moses Lake, where REC Silicon chose to locate a plant, notes that, "the

28. *Id.*

29. *Frequently Asked Questions: What is U.S. Electricity Generation by Energy Source?,* U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (last visited Nov. 11, 2016). [hereinafter *Frequently Asked Questions*].

30. *Id.*

31. *Washington State Energy Profile, supra* note 20.

32. *Frequently Asked Questions, supra* note 29.

33. *Washington State Energy Profile, supra* note 20.

34. *Id.*

35. *Id.*

36. *Id.*

37. *Id.*

best power rates in the nation have attracted major manufacturers with national and international footprints."[38]

However, relying on hydroelectric power can also mean significant annual fluctuations in energy production related to annual snowpack.[39] The amount of hydroelectric power generated is closely related to the snowpack in mountains of the Northwest.[40] In high snowpack years, like 2011, there can be a surplus of energy.[41] In low snowpack years, like 2010, other sectors have to make up the difference. In just one year, hydroelectric generation in Washington went from 68.1 million megawatt hours (MMW) in 2010 to 91.8 MMW in 2011, an increase of about 35 percent.[42] As a result of the low snowpack in the winter of 2009–10, energy production shifted from hydro to coal, nuclear and natural gas.[43] From 2010, when Washington had low snowpack, to 2011, when snowpack was significantly above average, coal generation fell by nearly 40 percent, nuclear production fell 48 percent and natural gas electric production fell by 53 percent.[44] These numbers provide some indication of how Washington and the Northwest would replace energy lost by removing the Snake River dams.[45] Although wind energy is expanding in the state, it still represents a relatively small amount of total production at only six percent.[46] This may change in the future, but there are limitations to the amount of intermittent energy, like wind power, the grid can accommodate. Some portion of the electricity will have to be provided by dispatchable energy

---

38. *Manufacturing*, PORT OF MOSES LAKE, http://www.portofmoseslake.com/key-industries/manufacturing/ (last visited Nov. 11, 2016).

39. *Washington Energy Estimates, supra* note 20.

40. *Reduced Snow Pack and Earlier Runoff,* DEP'T OF ECOLOGY STATE OF WASH., http://www.ecy.wa.gov/climatechange/reducedsnow_more.htm (last visited Nov. 11, 2016).

41. Scott DiSavino & Eileen O'Grady, *U.S. Northwest Hydro Supplies Near Record Highs*, REUTERS (June 27, 2011), http://www.reuters.com/article/utilities-usnorthwest-hydropower-idUSN1E75Q1AL20110627.

42. *Electric Power Industry Generation by Source, supra* note 27.

43. *Id.*

44. *Id.*

45. *Id.*

46. *Id.*

sources, like natural gas. I will address this in more detail below, but it is unlikely that renewables could make up for the electricity lost by the dams in the near term.

There will, however, be new pressures on that balance of electricity production due to the move toward renewable energy. In Washington, the Energy Independence Act[47], also called Initiative 937, requires utilities to provide 15 percent of energy from qualifying renewable energy sources by 2020.[48] In practice, "renewable energy sources" has meant wind energy. Biomass is included as an option in the law,[49] but several efforts to open biomass-powered generating plants have been blocked by local protests.[50] Oregon also is dramatically increasing the demand for renewable energy. In 2016, the state enacted Senate Bill 1547,[51] which requires the two large investor-owned utilities to supply half of their electricity from renewable sources by 2040.[52] This is likely to put pressure on Washington and other states in the region. The Energy Information Administration (EIA) notes "Oregon's utilities will likely comply with the new RPS targets by either building more renewable-sourced generators in Oregon or by using out-of-state sources."[53] In other words, utilities will compete with other utilities in the region to buy wind energy.

Both Washington and Oregon are also attempting to phase out coal-generated electricity.[54] Washington's only coal-generating

---

47. WASH. REV. CODE § 19.285 (2014) (Energy Independence Act).

48. *Id.* at § 19.285.040(f)(2)(a)(iii).

49. *Id.* at §§ 19.285.030–040.

50. John Dodge, *Biomass plan for Shelton area hits end of the road*, THE OLYMPIAN (March 15, 2011), http://www.theolympian.com/news/business/article25290154.html.

51. S.B. 1547, 78th Or. Legis. Assemb. (Or. 2016).

52. *Id.* at § 5(h).

53. *Higher Oregon renewable portfolio standard targets likely to boost wind power*, U.S. ENERGY INFO. ADMIN. (April 22, 2016), http://www.eia.gov/todayinenergy/detail.cfm?id=25932.

54. Aisling Irwin, *Oregon becomes the first US state to vote to go coal free,* NEW SCIENTIST (Mar. 3, 2016), https://www.newscientist.com/article/2079541-oregon-becomes-the-first-us-state-to-vote-to-go-coal-free/.

plant will switch to natural gas before 2025, and both states are looking to reduce the amount of coal-generated electricity the states' utilities purchase from coal-fired plants in other states like Montana.[55]

Importantly, hydroelectric power from facilities built before 1999 does not count toward the target in either Washington or Oregon.[56] As a result, while removing the Snake River dams would not make it more difficult to reach the renewable targets, it would mean that utilities might replace that electricity with either nuclear or natural gas. Replacing that electricity with wind, however, would be more difficult since the demand for wind energy is likely to dramatically increase in the near future and new production will be necessary to meet the obligations. In fact, there has been opposition to locating wind turbines in some of the best locations to produce wind energy in the Northwest, including the Columbia Gorge[57] and Eastern Washington,[58] making it more difficult to replace the lost energy with new wind turbines.

As the amount of wind energy grows, the need for electricity that can be quickly turned on and off will increase along with it. Power plants that can back up wind when the weather is not favorable is known as "firming," and only a few types of energy can fill that role.[59] Nuclear energy is used as base load to fill predictable demand and is not immediately dispatchable.[60] On the other hand, natural gas, coal, and hydroelectric can be dispatched quickly to

55. *Id.*

56. WASH. STATE SEC'Y OF STATE, INITIATIVE 937 2, https://www.sos.wa.gov/elections/initiatives/text/i937.pdf (last visited Nov. 11, 2016).

57. *See Whistling Ridge Energy Project*, FRIENDS OF THE COLUMBIA GORGE, http://www.gorgefriends.org/section.php?id=56 (last visited Nov. 11, 2016).

58. *Kittitas Conservation Concerns*, KITTITAS AUDUBON SOCIETY, http://www.kittitasaudubon.org/ConservationIssues.htm (last visited Nov. 11, 2016).

59. TOM ACKER, NORTHERN ARIZONA UNIV., WIND AND HYDROPOWER INTEGRATION – OVERVIEW, http://www.science.smith.edu/~jcardell/Readings/Wind/Wind-Hydro%20Integr.pdf (last visited Nov. 11, 2016).

60. William Nuttall, *Why is nuclear power baseload?,* EU ENERGY POLICY BLOG (July 1, 2007), http://www.energypolicyblog.com/2007/07/01/why-is-nuclear-power-baseload/.

make up for the times when wind is not generating electricity.[61] This further limits the options to replace the hydro from the Snake River dams, making natural gas the most likely alternative, since Washington and Oregon are both looking to reduce the amount of coal-generated electricity.

Finally, Washington State expects demand for electricity to grow during the next two decades. The Northwest Power and Conservation Council (NWPCC) estimates demand will increase between 0.5 percent and 2 percent annually through 2035.[62] To meet that growing demand, NWPCC identifies three types of energy it calls "primary" sources – natural gas-fired turbines, solar photovoltaic, and onshore wind.[63] These primary sources "have the potential to be developed within the twenty year planning horizon and play a major role in the future regional power system."[64] These are proven technologies that can be developed within the next twenty years. As we've noted above, photovoltaic solar is an extremely small percentage of Washington's energy. To meet the growing demand, therefore, the Northwest will likely see an expansion of natural gas and wind-generated energy.

Removing the electricity generated by the Snake River dams from this equation would add additional pressures. The demand for electricity will increase during the next two decades, making it costlier to eliminate current sources. Additionally, the best options to replace existing sources and meet that new demand are likely to be natural gas and wind energy. With the already growing demands on new wind energy and the need to firm up the intermittent power supplied by those sources, natural gas is likely to play the primary role in meeting the electricity demands for the Northwest.

---

61. Jordan Hanania et al., *Dispatchable source of electricity,* ENERGY EDUCATION, http://energyeducation.ca/encyclopedia/Dispatchable_source_of_electricity (last visited Nov. 11, 2016).

62. NORTHWEST POWER & CONSERVATION COUNCIL, SEVENTH NORTHWEST CONSERVATION AND ELECTRIC POWER PLAN 7-7 (2016), http://www.nwcouncil.org/media/7149940/7thplanfinal_allchapters.pdf.

63. *Id.* at 13-3.

64. *Id.*

To understand how those various pressures would play out, we need to take a close look at the current role of the electricity provided by the four Snake River dams.

III. CALCULATING THE CARBON VALUE OF ELECTRICITY

In 2014, the four dams represented about 8 percent of Washington state's electricity, producing about 8.37 MMWh.[65] This was a relatively typical production year for the dams, consistent with the average of the last ten years.[66] Overall, that amounts to about 8 percent of Washington state's total energy generated in 2014.[67] Opponents of the dams have tended to choose a lower number, saying "the four LSR dams contribute just 2.9 percent of the region's power,"[68] a region that includes local states other than Washington.

To put the total generation of the four dams in context, it represents about 90 percent of the total amount of wind, biomass and industrial solar energy produced in Washington in 2014.[69] Imagine eliminating virtually all of Washington's non-hydro renewable energy at once. This would rightly be seen as an enormous setback for efforts to reduce carbon emissions. That, however, is exactly what is being proposed by removing the dams and the carbon-free energy they produce. At a time when Washington and Oregon are attempting to move away from carbon-based energy to carbon-free, removing this source of energy would be a setback. As a result, additional costs of replacing that carbon-free energy would yield no

65. U.S. ENVTL. PROT. AGENCY, EGRID 2012 DATA FILE (2012), https://www.epa.gov/sites/production/files/2015-10/egrid2012_data.xlsx.

66. *Electric Power Industry Generation by Source, supra* note 27.

67. *Id.*

68. JOHNNY MOJICA ET AL., EARTH ECONOMICS NATIONAL ECONOMIC ANALYSIS OF THE FOUR LOWER SNAKE RIVER DAMS: A REVIEW OF THE 2002 LOWER SNAKE FEASIBILITY REPORT/ENVIRONMENTAL IMPACT STATEMENT 7 (2016), http://www.damsense.org/wp-content/uploads/2014/12/National-Economic-Analysis-of-the-Four-Lower-Snake-River-Dams-2.16.pdf.

69. *Electric Power Industry Generation by Source*, *supra* note 27.

additional carbon emission benefit. Germany, for example, is dealing with a similar challenge as they phase out nuclear power.[70] Despite an increase in renewables in recent years, German carbon emissions actually increased in 2015 because nuclear energy is being replaced with coal.[71]

Put simply, there is also a cost to the increase in carbon emissions. Both Washington and Oregon have legally binding targets for renewable energy.[72] Additionally, Washington state has a series of emissions targets, designed to reduce overall carbon emissions from electricity and transportation.[73] To meet those goals, states would need to replace carbon reductions with other strategies.

That comes at a cost and allows us to calculate the environmental value of the carbon avoided by the Snake River dams. There are two methods of calculating the value of those carbon emissions.

The first method is to estimate the cost of reducing carbon emissions elsewhere. This includes a wide range of investments in carbon reduction projects beyond simply renewable energy sources. Carbon reductions can be achieved at a lower price because we don't care how emissions are reduced, simply that the worldwide impact of carbon dioxide declines. To calculate the value of these reductions we can look at two sources:

1) The market price of carbon reduction permits in California, where they have a functioning cap-and-trade system.

2) The market price for certified carbon offsets available to individuals and businesses available publicly.

Each of these provides a real-world metric indicating how much it costs businesses to reduce one metric ton (MT) of carbon

---

70. Megan Darby, *Carbon CO2 emissions rise 1% in 2015*, CLIMATE HOME (Mar. 14, 2016), http://www.climatechangenews.com/2016/03/14/german-co2-emissions-rise-10-million-tonnes-in-2015/.

71. *Id.*

72. S.B. 1547, 78th Or. Legis. Assemb. (Or. 2016); WASH. STATE SEC'Y OF STATE , *supra* note 56.

73. WASH. REV. CODE § 70.235.020.

dioxide or an equivalent greenhouse gas.[74] In each case, above the price listed, carbon emitters indicate it is less expensive to reduce emissions on their own rather than buy a permit or pay someone else to do it. Thus, these prices represent the lowest cost to achieve those reductions.

California established its cap-and-trade system to reduce carbon emissions in 2012, holding the first auction on November 14 of that year.[75] The California Air Resources Board (CARB) holds regular auctions to sell permits to companies looking to emit carbon dioxide or other greenhouse gases.[76] The cost of those permits varies with market forces and to meet the annual emissions limit set by the State of California.[77] After initial instability, the permit price to emit CO2e has stabilized, reaching $12.63 per metric ton of CO2e on April 25, 2016.[78] Prices have stabilized in this range for the last two years, fluctuating between $11.65 and $13.24 per MT of CO2e.[79] As noted above, this price represents not just the price to emit a MT of CO2e, it represents the price above which emitters could reduce emissions more cheaply themselves. For example, if it costs $13 to reduce a MT of CO2e by installing new equipment, they will make that investment when the price of permits rises above that level. Below that price, the company will simply buy a permit. Since there are a limited number of permits, the price reaches equilibrium at the price where companies find it equally expensive to buy a permit or invest in efforts to reduce their own emissions.

---

74. Hereafter we will use the term CO2e to indicate reductions that may be CO2 or an equivalent amount of other greenhouse gases like methane (CH4), nitrous oxide (NO), or others.

75. *Cap and Trade Program*, CAL. AIR RES. BD., https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm (last visited Sept. 28, 2016); *ARB Emissions Trading Program*, CAL. AIR RES. BD. (Feb. 9, 2015), https://www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf. [hereinafter *ARB Emissions Trading Program]*.

76. *ARB Emissions Trading Program*, *supra* note 75.

77. *Id.*

78. *California Carbon Dashboard*, CLIMATE POLICY INITIATIVE, http://calcarbondash.org/ (last visited Nov. 11, 2016).

79. *Id.*

That is not the only real-world measure of reducing emissions. Individuals and businesses who are not required to reduce emissions can voluntarily invest in projects to cut emissions. For example, in many parts of the country, landfills do not capture methane emissions.[80] Creating the infrastructure to capture those emissions can be expensive, so companies can pay to help create that infrastructure and turn those emissions into energy.[81] It is something like a crowdfunding approach, where each business or individual pays a portion of the total cost to reduce those emissions.

To ensure projects actually achieve the promised emissions reductions, we are using the price set by TerraPass, a publicly available organization that sells carbon offsets.[82] The projects TerraPass invests in are certified by Green-e, an organization that audits projects to determine if the emissions being reduced by the project are real and would not have been avoided anyway due to other regulations or investments. [83] As they note, "Green-e Climate is the first and only independent, third-party certification program for retail carbon offsets sold in the voluntary market."[84] This provides certainty that the projects have real-world benefits and reduce carbon emissions. Not surprisingly, the price being charged by TerraPass is similar to the price being charged in California. Currently, TerraPass charges $5.95 per 1,000 lbs. of CO2e, or an equivalent of $13.11 per MT of CO2e.

This isn't entirely equivalent to the California price because the price in a cap-and-trade system is also dependent on how strict the cap is. The stricter the cap, the higher the price. The fact that they are similar is, to some extent, happenstance. It does, however,

---

80. U.S. ENVTL. PROT. AGENCY, LANDFILL GAS ENERGY PROJECT DATA AND LANDFILL TECHNICAL DATA (2016), https://www.epa.gov/lmop/landfill-gas-energy-project-data-and-landfill-technical-data#states.

81. U.S. ENVTL. PROT. AGENCY, LANDFILL GAS ENERGY PROJECT DEVELOPMENT HANDBOOK 4–17, https://www.epa.gov/sites/production/files/2016-09/documents/pdh_chapter4.pdf (last visited Nov. 11, 2016).

82. *Personal Carbon Offsets*, TERRAPASS, http://www.terrapass.com/product-category/individuals/carbon-offsets/ (last visited Nov. 11, 2016).

83. *Green-e Climate Certified Carbon Offsets*, GREEN-E, http://www.green-e.org/getcert_ghg_products.shtml (last visited Nov. 11, 2016).

84. *Id.*

indicate that the $12–$13 price range is a reasonable estimate on what it costs to effectively reduce a MT of CO2e. This sets the lower boundary of the value of carbon emissions avoided by generating hydroelectricity from the Snake River dams because it is based on the least expensive alternative for mitigating carbon emissions from alternative energy sources should the carbon-free energy from the dams be lost.

The alternative way to calculate the value of that carbon is to use a metric created by the Environmental Protection Agency (EPA) called the "social cost of carbon."[85] The social cost of carbon is designed to estimate the full cost of damage done by carbon emissions by calculating climate change impacts and allocating those costs to each MT of CO2e.[86] The EPA notes "[t]he SC-CO2 is an estimate of the economic damages associated with a small increase in carbon dioxide (CO2) emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a CO2 reduction)."[87] Replacing the carbon-free emissions from the dams with either coal or natural gas would increase emissions, creating a social cost.

There is a wide range of cost estimates based on a discount rate. Using 2020 as the base for comparison, the EPA estimates the social cost of carbon between $12 at an annual discount rate of 5 percent, $42 at 3 percent, and $62 using a discount rate of 2.5 percent.[88] The federal government uses these numbers to estimate the value of regulation designed to reduce carbon emissions, so this is the standard metric to determine the cost of federal actions that impact emissions.[89] Again it is worth noting that the low-end of the range of $12 per MT of CO2e closely matches the market price of the California and voluntary markets.

---

85. *The Social Cost of Carbon U.S.*, U.S. ENVTL. PROT. AGENCY, https://www3.epa.gov/climatechange/EPAactivities/economics/scc.html (last visited Nov. 11, 2016).

86. *Id.*

87. *Id.*

88. *Id.*

89. *Id.*

The value of carbon makes a significant difference in how we value the environmental benefits of the energy provided by the Snake River dams. A low cost, similar to the \$12–\$13 per MT of CO2e on the market, would reduce the value of that electricity, making it easier to replace the carbon reduction benefit of the dams with equivalent efforts elsewhere in the market. A high cost, like the \$42 per MT of CO2e that has been advocated by groups like the Natural Resources Defense Council, increases the value of the carbon-free electricity from the dams, making the loss of that electricity riskier and more expensive.[90] For the purposes of our report, we will stick with the lower range because it is more consistent with the cost of reducing the carbon. That is the real question we are attempting to address - if the dams are removed, what would it take to replace the environmental benefit of carbon-free hydroelectricity? The market price, reflected by the California and voluntary market, provides a good indicator of what it would take.

IV. THE ENVIRONMENTAL AND ENERGY VALUE OF THE SNAKE RIVER DAMS

To determine the value of the carbon-free energy from the four dams, we can combine the cost to replace that energy and the value of the carbon emissions that would occur if electricity from coal or natural gas replaced those kilowatt hours. That provides a baseline value of the electricity and the opportunity cost of losing that electricity. Of course the hydroelectricity is not free, so we will also subtract the costs to maintain the dams and the cost of capital upgrades planned by the Corps of Engineers. That amount will provide a reasonable estimate of the electricity and climate value of the energy.

This is an extremely useful piece of information because it can be used to help policymakers allocate resources in a way that best serves all environmental issues, from carbon emissions to salmon recovery and other benefits. If the cost of replacing the electricity and mitigating the carbon emission increase is small, it may mean the benefit to salmon is worth the cost. If, on the other hand, the cost of replacing the electricity and the carbon mitigation is high, removing the dams would siphon off funding that could go not only

---

90. Brian Kahn, *Social Cost of Carbon Greatly Underestimated: Report*, CLIMATE CENTRAL (Mar. 13, 2014), http://www.climatecentral.org/news/social-cost-of-carbon-is-greatly-underestimated-report-17170.

to cut carbon emissions, but to projects that would reduce salmon mortality across the Pacific Northwest. For example, the estimated cost to remove fish barriers on Washington State Department of Transportation projects alone is $310 million per biennium.[91] There is a long list of projects waiting for funding, so spending those funds to simply replace an existing resource like the energy from the dams, wouldn't be good for ratepayers, the climate or salmon.

Across Washington, 2014 was a fairly typical year for hydroelectric production. For the decade between 2005-14, the average statewide hydroelectric production was just over 79 MMWh.[92] During 2014, Washington dams produced just 0.5 percent more than that ten-year average.[93] During that year, the four Snake River dams produced 8.37 MMWh of electricity.[94] We will use this production level as the baseline for future comparison. During the next decade, the dams will see a combination of factors that affect that level, from high and low snowpack years, to improvements in the efficiency of the turbines. That production level, however, has been fairly consistent during the past decade, so this is a conservative estimate we can confidently project into the future.[95]

Estimating the cost to replace that electricity is a two-step process. First, we need to estimate the market value of the electricity from the four dams. Second, we need to compare that to the replacement cost of electricity from potential alternatives, including coal, natural gas and wind energy. The difference between those two numbers represents the additional annual cost borne by ratepayers to replace that energy. It should be remembered that this amount is not currently being captured entirely by government, so this amount of money should be seen as a loss to a range of societal

91. WASH. STATE DEP'T OF TRANSP, ACCELERATING FISH BARRIER CORRECTION: NEW REQUIREMENTS FOR WSDOT CULVERTS (2014), http://pugetsoundblogs.com/waterways/files/2015/01/14-07-0002596-Accelerating-Fish-Barrier-Correction_Leg-Folio.pdf.

92. *Electric Power Industry Generation by Source*, *supra* note 27.

93. *Id.*

94. Email from Dean Holecek, U.S. Army Corps of Eng'rs, to Todd Myers, Envtl. Dir., Wash. Policy Ctr. (April 26, 2016).

95. *Electric Power Industry Generation by Source*, *supra* note 27.

benefits, including economic activity, jobs, and well-being in addition to the portion that would be paid in taxes and would go toward various government projects, including environmental restoration.

The Bonneville Power Administration recently set rates through September 30, 2017.[96] There are a range of rates, but the most common is 3.5 cents per kWh.[97] At that rate, the estimated value of the 8.37 MMWh of electricity from the Snake River dams will be about $293,518,365 annually. As we noted above, this is one of the lowest rates for electricity in the country.[98]

The cost to replace that electricity with coal or natural gas is a combination of the projected rate for the electricity plus the value of the carbon emissions from those sources. The Energy Information Administration produces an annual projection of the future cost of electricity for each type of generation. Since it will take a few years to remove the dams and replace them, we have used the most recent estimate of levelized cost of electricity from the EIA, projecting costs for 2020.[99]

The projected cost of new coal generating plants will be higher in the future than it is today.[100] There are a variety of reasons for this, most notably the new environmental regulations from the Clean Power Plan (CPP), which adds significant requirements for existing and new coal-fired generation.[101] In 2020, the EIA projects the cost to produce a kWh of electricity in an "advanced coal" plant is 11.57 cents.[102] At that rate, replacing the 8.37 MMWh of electricity would cost $968.35 million a year – more than triple the current

96. *Current Power Rates*, BPA, BONNEVILLE POWER ADMIN., https://www.bpa.gov/Finance/RateInformation/Pages/Current-Power-Rates.aspx (last visited Nov. 11, 2016).

97. *Id.*

98. *Washington State Energy Profile, supra* note 20.

99. U.S. ENERGY INFO. ADMIN., LEVELIZED COST AND LEVELIZED AVOIDED COST OF NEW GENERATION RESOURCES IN THE ANNUAL ENERGY OUTLOOK 2015 1 (2015), http://www.eia.gov/forecasts/archive/aeo15/pdf/electricity_generation_2015.pdf [hereinafter *Annual Energy Outlook 2015*].

100. *Id.*

101. *See* id.

102. *Id.*

cost. That amounts to an additional $674,832,785 per year for ratepayers in the Pacific Northwest compared to the current $293 million ratepayers currently pay for the 8.37 MMWh of hydroelectricity.

Additionally, coal is very carbon-intensive, so the value of the additional carbon would be significant. The EIA estimates that one kWh of coal generates between 2.07 and 2.17 pounds of CO2.[103] Using the lowest end of the range, replacing the entire production of the four dams with coal would emit 7.86 MMT of CO2. At the market rate of about $12 per MT of CO2e, coal would add $94,327,758 worth of carbon emissions you don't have with hydroelectric energy. Adding the two values together yields an annual electricity and climate cost for coal-generated electricity of $1.062 billion, or $769.1 million more than the cost from the Snake River dams every year. This, however, is unlikely because, as we noted, coal energy is being phased out in Oregon and is increasingly difficult to generate nationwide.[104] This amount should be considered a high-water mark for total additional electricity and climate cost for removing the dams.

Natural gas, on the other hand, has a number of advantages. First, due to improved extraction technology, the projected cost per kWh is lower than coal.[105] The EIA estimates the cost per kWh in 2020 for a new Advanced Combined Cycle natural gas plant will be only 7.26 cents.[106] Natural gas is also much less carbon-intensive than coal, with each kWh emitting only 1.22 pounds of CO2.[107] Despite these advantages, replacing hydro with natural gas is still fairly expensive. The cost to generate the equivalent amount of electricity in 2020 is estimated to be $607,625,700 annually. That

103. *Frequently Asked Questions: How much carbon dioxide is produced per kilowatthour when generating electricity with fossil fuels?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11 (last visited Nov. 11, 2016).

104. The Energy Information Administration notes: "Due to new regulations (CAA 111b), conventional coal plants cannot be built without CCS because they are required to meet specific CO_2 emission standards." *Annual Energy Outlook 2016*, *supra* note 99, at 7. This makes coal significantly more expensive than natural gas, meaning it is unlikely new coal generation would be added. *Id.*

105. *See id.*

106. *Id.* at 6.

107. U.S. ENERGY INFO. ADMIN., *supra* note 103.

amount of natural gas would emit 4.63 MMT of CO2 for a carbon value of $55,594,138. The total electricity and carbon cost associated with natural gas would be $663,219,838, or $369,701,473 more than the current cost.

One benefit of replacing hydroelectric power with coal or natural gas is that the energy would be dispatchable and could be used to adjust to fluctuating demand or intermittent supply from wind energy.[108] The Bonneville Power Administration notes that it relies on the four Snake River dams to adjust to those fluctuations.[109] They point out, "[m]uch of the year, BPA relies on the four lower Snake River dams specifically to meet peak loads" that come when demand increases during the day.[110] The BPA also notes that the dams are used to adjust to intermittent production from wind turbines.[111] The period from January 22–29, 2016, is instructive.[112] Demand fluctuated during the day and thermal sources, like natural gas, provided a consistent base of electricity.[113] The gap between thermal and demand was made up by a combination of wind and hydro.[114] About midnight on January 24, wind power peaked.[115] In order to adjust to the increased supply, hydro production declined significantly and then rose dramatically as the wind faded away during the rest of the day.[116] The Army Corps of Engineers notes that hydro can actually be dispatched more rapidly than thermal

---

108. Hanania et al., *supra* note 61.

109. BONNEVILLE POWER ADMIN., POWER BENEFITS OF THE LOWER SNAKE RIVER DAMS 1 (2009), https://www.bpa.gov/news/pubs/FactSheets/fs200901-Power%20benfits%20of%20the%20lower %20Snake %20River%20dams.pdf.

110. *Id.*

111. *Id.* at 3.

112. *BPA Balancing Authority Load and Total Wind, Hydro, and Thermal Generation, Near-Real-Time*, BONNEVILLE POWER ADMIN, http://transmission.bpa.gov/Business/Operations/Wind/baltwg.aspx (last visited Nov. 11, 2016).

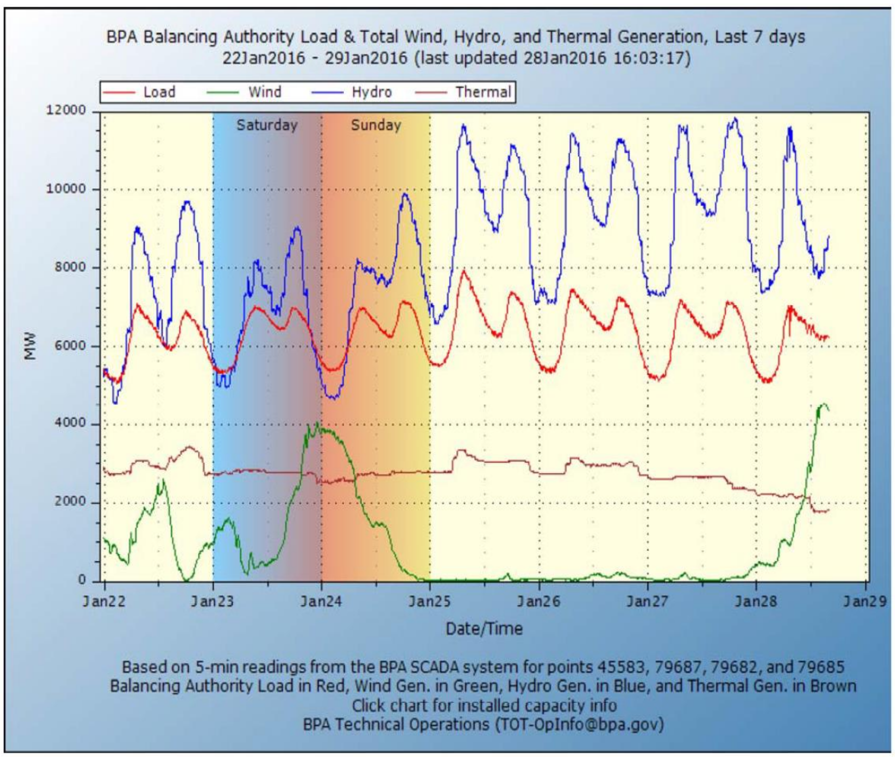
113. *Id.*

114. *Id.*

115. *Id.*

116. *Id.*

power, which is obvious in the graph.[117] Lt. Colonel Tim Vail, Commander of the Walla Walla District of the Army Corps of Engineers,[118] notes that the Snake River dams have the capacity to increase production significantly in only a few minutes, even more rapidly than other dispatchable sources like natural gas.[119] This ability to adjust to fluctuating demand and intermittent supply, makes coal and natural gas a more comparable replacement source of energy than wind or solar. This doesn't rule wind out as a source of replacement energy, but it is important to remember that losing this flexibility will come at a cost.



117. Interview with Lt. Col. Timothy Vail, Commander of the Walla Walla District, Army Corps of Eng'rs (Jan. 29, 2016).

118. *14-051 Vail takes command of Corp's Walla Walla District*, U.S. ARMY CORPS OF ENG'RS (Aug. 11, 2014), http://www.nww.usace.army.mil/Media/News-Releases/Article/486154/14-051-vail-takes-command-of-corps-walla-walla-district/.

119. Vail, *supra* note 117.

The final potential replacement source of energy is wind energy. It is the only viable source of carbon-free energy to replace the Snake River dams. Although the cost of wind energy is dependent on a favorable location, the EIA projects that improvements in turbine technology will drive down costs significantly.[120] By 2020, the EIA estimates wind energy will be only slightly more expensive than natural gas, costing just 7.36 cents per kWh.[121] To generate the amount of energy provided by the Snake River dams will cost an estimated $615,995,200, more than twice the amount ratepayers currently pay for the equivalent hydro power, adding $322,476,835 in electricity costs.

Although wind-generated electricity is essentially carbon-free, there are emissions associated with backing up wind turbines. As discussed above, wind energy must be "firmed"[122] to provide consistent supply when the wind dies down.[123] In the Pacific Northwest, that role is filled primarily by hydro power.[124] Elsewhere, however, that function is provided by natural gas.[125] Firming wind energy comes with a cost in carbon emissions. As one analysis of these emissions notes, "[w]hen turbines are quickly ramped up and down, their fuel use (and thus CO_2 emissions) may be larger than when they are operated at a steady power level."[126] Analysis of emissions associated with that fluctuation indicates carbon emissions reduction about 75 – 80 percent compared to the expected reduction.[127] Compared to replacing the electricity with natural gas

---

120. *Annual Energy Outlook 2015, supra* note 99, at 5.

121. *Annual Energy Outlook 2015, supra* note 99, at 6.

122. See s*upra* Section II.

123. ACKER, *supra* note 59.

124. PACIFIC NORTHWEST WATERWAYS ASSOCIATION, THE ROLE OF HYDROPOWER IN THE NORTHWEST*,* http://www.pnwa.net/new/Articles/Hydropower.pdf (last visited Nov. 11, 2016).

125. *See* ADVANCED ENERGY ECON. INST. & WIND ENERGY FOUND, WIND-GAS RELATIONSHIP STUDIES (2013), http://www.windenergyfoundation.org/sites/default/files/ckfinder/files/Wind%20Gas%20Studies%20Annotated%20Bibliography.pdf.

126. Warren Katzenstein & Jay Apt*, Air Emissions Due to Wind and Solar Power*, 43 ENVTL. SCI. TECH. 253 (2009), http://pubs.acs.org/doi/pdf/10.1021/es801437t.

127. *Id.* at 255.

based electricity, wind turbines would generate only about 1.77 MMT of CO_2.[128] This is significantly lower than emissions associated with natural gas, but still has a carbon value of $21,223,746. Adding that to the electricity cost yields an additional cost for wind energy of about $343.7 million.

V. OPERATION COSTS OF THE DAMS

The final piece of the cost puzzle is the cost to operate the dams. There are a number of costs associated with regular operation and capital costs of maintenance and modernization. First, the dams have annual operational costs. Although these fluctuate, according to the Army Corps of Engineers, the average cost is about $62 million a year.[129] This covers the cost of standard operation and maintenance associated with the annual production of the electricity from the dams.[130] Second, the Corps of Engineers also pay capital investment costs to upgrade the dams, improve efficiency, provide some habitat mitigation and maintenance.[131] The Corps of Engineers estimates the annual cost of these investments is about $52.4 million.[132]

Finally, the Corps also pays into the Bonneville Power Administration fish and wildlife mitigation program, designed to offset the impact of the dams on salmon and other species.[133] I am not arguing here that this funding eliminates the impact on the dams, I am simply indicating that these are annual costs associated with addressing those issues. It may be argued that this amount is not enough. I will address that issue below, but for now we need to establish a baseline of existing costs for the four dams. Going for-

---

128. *Id.*

129. Vail, *supra* note 117.

130. *Id.*

131. *Id.*

132. *Id.*

133. BONNEVILLE POWER ADMINISTRATION, BPA'S FISH AND WILDLIFE PROGRAM: THE NORTHWEST WORKING TOGETHER (2013), https://www.bpa.gov/news/pubs/FactSheets/fs-201305-BPAs-Fish-and-Wildlife-Program-the-Northwest-working-together.pdf.

ward, the Corps estimates the cost of the fish and wildlife mitigation for the dams amounts to $46.6 million.[134] This number is difficult to pin down because the total amount allocated by the Corps of Engineers is not determined for each dam, but for all dams managed by the Corps in the region. As a result, there are a range of numbers used to account for the Snake River dams' portion of these costs.[135] In my interviews with the leadership and staff of the Walla Walla District of the Corps, this amount represents a reasonable allocation for the Snake River dams.[136] Additionally, this is the amount that will be spent in future years. This is about $25 million lower than current expenditures due to the conclusion of a major effort to improve fish passage.[137] It is possible that some project will replace the current expenditure, but nothing is planned currently.

VI. NET ELECTRICITY AND CARBON VALUE

Combining each of these values, we can estimate the future electricity and carbon value of the Snake River Dams. This does not represent a complete accounting of the value of the dams or their removal. The goal is simply to provide a metric that can be used as a starting point for the discussion about economic and environmental values. If ratepayers have to pay more to replace the electricity from the dams, they are less likely to provide funding – directly or through taxes – to fund other environmental projects, including the salmon recovery projects we mentioned above. In this circumstance, removing the dams might provide a local benefit for salmon, but would cause greater damage to salmon populations across the Northwest by draining funding from salmon recovery efforts elsewhere.

Of course, the funding for salmon recovery efforts is not directly connected to the cost of replacing this electricity, and this is not to argue that salmon recovery funding would decline by the exact amount of the additional cost. Indeed, it is most likely that the additional cost will be made up with a combination of higher utility costs, reduced tax revenue, increased government subsidies for renewables and other sources. These additional costs, however,

134. Holecek, *supra* note 94.

135. *Id.*

136. *Id.*; Vail, *supra* note 117.

137. Holecek, *supra* note 94.

filter through the economy and government, reducing the opportunity to support a range of efforts. At a time when funding for salmon recovery is already under pressure from cuts at the state and federal level, additional pressure will further harm those efforts.

The spreadsheet below consolidates the numbers that have been outlined above. Each column represents a potential replacement for the electricity from the four dams using estimated costs for 2020 for both electricity and carbon value.

	Coal	**Natural Gas**	**Wind Power**
Cost to Generate 8.3 MMWh in 2020	$968,351,150	$607,625,700	$615,995,200
MMT CO2 from Alternatives	7860646.55	4632844.83	1768645.47
CO2 Value - $12	$94,327,759	$55,594,138	$21,223,746
Value of electricity from Snake River dams	$293,518,365	$293,518,365	$293,518,365
Total Additional Cost	$769,160,544	$369,701,473	$343,700,581
		Snake River Dams - Costs	
Annual Operations & Maintenance	$61,127,600	$61,127,600	$61,127,600
Capital Investment	$52,406,228	$52,406,228	$52,406,228
BPA Fish and Wildlife Program Snake River Allotment	$46,657,000	$46,657,000	$46,657,000
Total Value	$160,190,828	$160,190,828	$160,190,828
Net Annual Value of Alternative	**($608,969,715)**	**($209,510,645)**	**($183,509,752)**

[138]

138. Cost to generate 8.3 MMWh of electricity: U.S. ENERGY INFO. ADMIN., *supra* note 99. MMT of CO2 from alternatives: Warren Katzenstein & Jay Apt, *supra* note 126; U.S.

According to our analysis, coal replacement has the highest overall replacement cost as regulation will make it increasingly difficult to build new coal-fired electricity production. Our estimate is that it would cost an additional $609 million every year in electricity costs and carbon value to replace the lost electricity from the dams. It is possible that existing, underutilized plants, including those in Montana and elsewhere, would increase production to make up for some of the loss. It is unlikely, however, that the entire difference will be made up using coal.

The second lowest cost alternative is natural gas.[139] Costs per kWh are lower and the total value of the carbon emissions is significantly lower.[140] Compared to current production, natural gas production would add $209.5 million a year in electricity and carbon costs. Natural gas is more likely to make up a significant part of the difference.[141] As the amount of wind energy elsewhere on the grid increases, the demand for dispatchable electricity will grow.[142] In 2010, when hydro power fell due to low snowpack, it was replaced by a significant increase in natural gas and nuclear energy.[143] The low cost and carbon emissions associated with natural gas make it a better choice to replace the lost electricity.

Finally, the lowest cost alternative is wind energy.[144] The Energy Information Administration estimates the cost of wind will fall significantly in the next few years, making it competitive with

---

ENERGY INFO. ADMIN., *supra* note 103. CO2 Value: CLIMATE POLICY INITIATIVE, *supra* note 78. Value of electricity from Snake River dams: *Annual Energy Outlook 2015*, *supra* note 99, at 1; Holecek, *supra* note 94; Vail, *supra* note 117.

139. *Annual Energy Outlook 2015*, *supra* note 99.

140. *Id.* at 1; U.S. ENERGY INFO. ADMIN., *supra* note 103.

141. *Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016,* U.S. ENERGY INFO. ADMIN., http://www.eia.gov/todayinenergy/detail.cfm?id=25392 (last visited Nov. 11, 2016).

142. ADVANCED ENERGY ECON. INST. & WIND ENERGY FOUND., *supra* note 125.

143. U.S. ENERGY INFO. ADMIN., TABLE CT2. PRIMARY ENERGY CONSUMPTION ESTIMATES, 1960-2014, WASHINGTON (TRILLION BTU), http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/total/use_tot_WAcb.html&sid=WA(last visited Nov. 11, 2016).

144. *Annual Energy Outlook 2015*, *supra* note 99, at 1.

natural gas when federal subsidies are included.[145] That low cost and the relatively low carbon emissions make it slightly less expensive than natural gas, adding about $183.5 million a year in electricity and carbon costs. Of course, this does not tell the entire story. It is unlikely that wind energy could replace a meaningful amount of lost electricity. As noted above, the electricity produced by the four Snake River dams exceeds the total amount of wind energy currently in Washington.[146] That amount would have to double in a very short period of time, which is virtually impossible. Additionally, since wind is unpredictable, replacing the hydroelectric power with wind would significantly increase grid instability, making it more difficult to adjust to fluctuations in demand. Ultimately, wind may provide some of the lost electricity, but not all.

The most likely scenario is a combination of the three, probably weighted heavily toward natural gas. With higher costs, consumers may also find ways to increase conservation, cutting the total cost of replacement by a marginal amount. The result of these calculations, however, make it clear there is a significant cost to losing the dams. As the calculations above demonstrate, any reasonable combination of replacement electricity will add at least $200 million a year in electricity costs and carbon emissions value. This is nearly twice the annual amount of habitat improvement grants from the Washington Salmon Recovery Funding Board in the 2015–17 budget.[147]

To this calculation can be added the costs and benefits in a number of other areas:

1) Navigation: This was the original justification for construction of the dams.[148] They still play a significant role in moving

145. *Id.*

146. U.S. ENVTL. PROT. AGENCY, *supra* note 66; U.S. ENERGY INFO. ADMIN, *supra* note 27.

147. *Salmon Recovery Funding Board*, WASH. STATE SALMON RECOVERY FUNDING BD., http://www.rco.wa.gov/boards/srfb.shtml (last visited Nov. 11, 2016).

148. *Navigation*, NORTHWEST POWER & CONSERVATION COUNCIL (Oct. 31, 2008), https://www.nwcouncil.org/history/Navigation.

products down the Snake.[149] The value of the transportation is so significant that fifty percent of Kansas' wheat is shipped by rail to the Snake River ports, unloaded and then shipped the rest of the way.[150] Additionally, we have not estimated the carbon cost of moving from barges to trucks and rail.

2) Recreation: Advocates and opponents of the Snake River dams claim increased recreation as part of their argument.[151] Estimates of future recreational value, however, are highly speculative. While at the Washington State Department of Natural Resources, I spoke with local businesses near a new Natural Resource Conservation Area to see if recreation had increased and found there was no perceptible impact despite promises. Surveys of what people might do years from now, like a recent projection from Earth Economics,[152] should be taken with a grain of salt.

3) Salmon Population: This is the primary area of debate with each side making claims about the current impact of the dams on salmon runs.[153] Whatever analysis is used, however, it should be kept in mind that resources spent to make up for lost electricity and carbon reduction put pressure on funding for salmon recovery in the Snake and Columbia Rivers, and the region as a whole.

There are other benefits, such as flood control, that can be included as well.[154] Those seeking to remove the dams, however, will have to show how they make up for an annual loss of $200 million in carbon and electricity benefits.

---

149. *Snake River Dams Vital to Northwest and the Nation*, WASH. PUB. PORTS ASS'N (Oct. 3, 2015), https://washingtonports.org/snake-river-dams-vital-to-northwest-and-the-nation/.

150. Interview with Keva Herron Guszkowski, Wash. Ass'n of Wheat Growers (Jan. 22, 2016); Telephone interview with Keven Guszkowski, Policy Dir., Wash. Ass'n of Wheat Growers (Jan. 22, 2016).

151. MOJICA ET AL., *supra* note 68, at 14; *Recreation*, NW. RIVERPARTNERS, http://nwriverpartners.org/recreation (last visited Nov. 11, 2016).

152. MOJICA ET AL., *supra* note 68, at 14.

153. *See generally* Chouinard, *supra* note 5; Waddell, *supra* note 14.

154. *Flood Control,* NW. RIVERPARTNERS, http://nwriverpartners.org/flood-control (last visited Nov. 11, 2016).

VII. CONCLUSION

The four Snake River dams provide important benefits to Washington and the region as a whole. The low-cost electricity they provide is a significant consideration for manufacturers and other businesses looking to locate in the Pacific Northwest. The carbon-free energy is extremely valuable at a time when carbon policy is a central consideration of Washington and Oregon and the region is looking to move away from coal-burning electricity. As demand for electricity increases as projected and constraints on carbon emissions become tighter, the value of the carbon-free energy will increase.

Using 2020 as a baseline for projections of electricity and carbon costs, removing the dams would come with a huge price tag, eclipsing the entire annual salmon recovery budget for Washington. Advocates of dam removal should think twice before they find that their proposal simply robs Peter to pay Paul, or worse, ends up doing more environmental harm than good.