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TIDAL ENERGY LAW IN CANADA: HINDERING AN UNTAPPED POTENTIAL FOR INTERNATIONAL PRIMACY

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INTRODUCTION

In recent years, countries around the world have been making significant strides toward building or renewing their energy infrastructures based on clear renewable portfolio standards ("RPS"), in which they set targets for renewable energy production within a given timeframe.[1] Early in the spring of 2015, for example, Costa Rica made news for having powered its entire country off of renewable energy alone for three full months.[2] Every morning, Icelanders turn on their lights without emitting an ounce of carbon into the atmosphere, thanks to the country's strong geothermal and hydro energy grid.[3] When it comes to riding the wave of renewable energy, Canada is no exception: the country produces almost 60 percent of its total energy from renewable sources, primarily hydropower.[4]

Despite such promising numbers, however, drastic discrepancies exist among provinces. On one hand, Quebecers enjoy over 90 percent of their electricity from renewable sources.[5] On the other, Nunavummiut[6] depend wholly on diesel-fueled generators to power their lives, while the territory's system does not benefit from a single input of renewable energy.[7] As renewable energy sources are geographically specific, Canada has struggled to diversify its infrastructure, depending primarily on hydropower installations developed from the 1950s to the 1970s to meet its renewable energy targets.

The Prairie provinces, the Maritime provinces, and the Arctic territories are among the jurisdictions with the lowest amount of renewables in their energy mix.[8] Yet, a tremendous untapped resource—42,000 megawatts (MW), enough to provide over 70 percent of Canada's present annual electricity consumption,[9] to be precise—exists just offshore of the maritime and arctic regions. That untapped resource is tidal energy.

I. PURPOSE & FOCUS

With tidal energy's potential to provide so much of Canada's energy, it is important to question why a valuable and promising resource is being ignored in favour of conventional energy development.[10] Political will, financial capabilities, regulatory difficulties, and

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1 For more on renewable portfolio standards in Japan and the United States, see e.g. Walter Musial & Bonnie Ram, "Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers" (2010) National Renewable Energy Laboratory at 27.

2 Using generally a combination of hydropower, geothermal, solar power, and wind power. Lindsay Fendt, "The truth behind Costa Rica's renewable energy", *The Guardian* (30 Mar 2015), online: <http://www.theguardian.com/commentisfree/2015/mar/30/truth-behind-costa-rica-renewable-energy-reservoirs-climate-change> archived at <https://perma.cc/E55S-M3WA>.

3 Cheryl Katz, "Iceland Seeks to Cash In On Its Abundant Renewable Energy" (3 October 2013), *Yale Environment 360*, online: <http://e360.yale.edu/feature/iceland_seeks_to_cash_in_on_its_abundant_renewable_energy/2697/> archived at <https://perma.cc/DS3Q-T55T>.

4 Energy and Mines Ministers' Conference, "Canada – A Global Leader in Renewable Energy: Enhancing Collaboration on Renewable Energy Technologies" (2013) Energy and Mines Ministers' Conference.

5 *Ibid.*

6 People of Nunavut.

7 Government of Nunavut, "Ikummatiit: Government of Nunavut Energy Strategy" (2007) Government of Nunavut.

8 Carol Ní Ghiollarnáth, *Renewable Energy Tax Incentives and WTO Law: Irreconcilably Incompatible?* (Nijmegen, NL: Wolf Legal Publishers, 2011).

9 Michael Tarbotton & Max Larson, "Canada Ocean Energy Atlas (Phase 1): Potential Tidal Current Energy Resources" (2006) Triton Consultants for Canadian Hydraulics Centre at 30.

10 Referring specifically to the continuing focus of energy development in Alberta's oilsands, in offshore oil & gas in the Atlantic Ocean, and in developing capabilities for drilling in the Arctic, broadly.

infrastructural gaps all contribute to the dearth of Canadian investment in tidal energy development. This paper explores the worldwide evolution of law, policy, and regulation surrounding tidal energy with the goal of clarifying a Canadian role in the industry. Furthermore, this paper identifies best practices for sustainable development of tidal energy in Canada, and aims to foster a debate around the role tidal energy can play in an international push toward carbon-free energy generation.

This paper begins with an overview of the various modes of ocean energy generation, and will underline the significance of in-stream tidal technology for this research. It will then provide an argument for the adoption of tidal energy at relevant and strategic sites in Canada. In doing so, this paper touches on the dynamics of energy law, examines the pros and cons of regulatory policy, and compares innovative models of financing. It also identifies potential difficulties regarding tidal energy implementation. This paper takes a historical and analytical approach to question strategic infrastructural and transmission development throughout the nation. A clear link is drawn between tidal energy development and obligations for increases in renewable energy, and invites readers to view this discussion from a holistic approach.

Finally, this paper identifies a framework for Canadian tidal energy development, including focus regions, regulatory overhaul, and investment strategies, with a specific focus on in-stream tidal power, which is a developing technology that is rapidly approaching commercial viability. Specific mention will be given to the importance and viability of developing tidal energy in Nunavut and Nova Scotia.

II. BACKGROUND ON OCEAN ENERGY

A. A Short Primer on Ocean Energy

Harnessing power from the ocean predates industrialization. As early as the 11th century, English farmers operated primitive tidal mills that generated churning energy from the rise and fall of the sea.[11] This technology slowly moved into Western Europe some seven centuries later.[12] Meanwhile, the Portuguese have experimented with tidal gates to provide energy to communities by operating dam-like structures on their coasts since the 15th century. Yet, during the last two hundred years of industrialization, ocean power's popularity drastically fell, as fossil fuels flourished and became regarded as the engine for growth. Non-renewable inputs fueled electrical development, infrastructural upheaval, and societal change in our homes, vehicles, and products, shaping the world as we know it.

The world continued developing on the back of oil and gas until the 1973 OPEC oil embargo, when prices of oil tripled overnight, sending economies worldwide into crisis. It was this shock to the system that reframed the mindset of vulnerable nations, and helped motivate renewed interest in alternative energy sources. Just as states went back to the windmill (in the form of wind energy), governments began reinvesting in ocean energy projects, albeit to a lesser extent.

Ocean energy encompasses a vast array of electrification technologies, with the umbrella term referring to energy produced by waves, tides, salinity gradients, and ocean thermal

11 Brian Polagye, Brie Van Cleve, Andrea Copping, & Keith Kirkendall, eds, *Environmental Effects of Tidal Energy Development: Proceedings of a Scientific Workshop, Seattle, 2010* (Seattle: National Oceanic and Atmospheric Administration: National Marine Fisheries Service, 2011).

12 Matter Network, "Why Tidal Power is Europe's Best Near-Term Ocean Energy Technology" *World Environment Magazine & TV*, online: <http://www.worldenvironment.tv/green-news/86-energy/579-why-tidal-power-is-europes-best-near-term-ocean-energy-technology> archived at <https://perma.cc/LWE9-BZYF>.

convection units. Each of these technologies are evolving and commercializing at their specific paces. This paper focuses solely on the harnessing of tides for energy, as the most relevant technology to the Canadian context. Elsewhere, wave energy is nearing commercial operation in Portugal, salinity gradients are being tested in Norway, and ocean thermal convection units are being commercialized in the Philippines.[13] Each of these methods and technologies suffer similar barriers to development, and tidal energy is no exception. Thus, the results obtained from this paper's analysis will prove equally cogent to international analysis of ocean energy development.

B. Benefits of In-Stream Tidal

Tidal energy was one of the first forms of ocean energy brought into the grid over the course of the 20th century. In 1967, the La Rance tidal barrage was erected on the Rance River, in Brittany, France.[14] It produces up to 240 MW of power in a structure similar to that of a hydroelectric dam.[15] Canadians followed this lead in 1980, with the construction of the Annapolis Royal tidal barrage in Digby Neck, Nova Scotia, an installation that presently generates 20 MW of power for the province's grid.[16] Six tidal barrages currently operate throughout the world, with the largest located in South Korea.[17] However, tidal barrages have been found to have significant deleterious environmental impacts on local ecosystems. They also require very particular geographical locations for successful operation. Although potential exists for their development, tidal barrages are generally not seen as the most effective way of harnessing the ocean's tides for energy.[18]

Tidal lagoons are a variation of the barrages, and employ tidal fences to shuttle water in and out of man-made ponds by using the changing sea levels as two-way electricity generation.[19] This technology is still in development, although it is suggested that lagoons will have fewer environmental impacts than barrage systems.[20] Lagoons, however, are not the preferred technology of analysis for this paper as the bays and harbors necessary for its implementation are not present in Canada. Tidal lagoons show their greatest promise in and around the United Kingdom, where strong currents from the Gulf Stream provide powerful tides into select bays on that island.[21]

In-stream tidal technology, the focus for this paper, can take many shapes and sizes. Examples include tidal fences, vertical axis turbines, horizontal axis turbines, and

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13 Richard L Ottinger, *Renewable Energy Law & Development: Case Study Analysis* (Northhampton, MA: Edward Elgar, 2013) at 65.

14 Ernst & Young Global Cleantech Center, "Rising tide: Global trends in the emerging ocean energy market" (2013), Ernst & Young, online: <http://ey.com/cleantech> archived at <https://perma.cc/VP7E-MTXX>.

15 *Ibid*.

16 *Ibid*; OEER Association, "Fundy Tidal Energy Strategic Environmental Assessment: Final Report" (2008) OEER Fundy Tidal Energy for Nova Scotia Department of Energy at 14; Marine Renewables Canada, "Marine Renewable Energy in Canada & the Global Context: State of the Sector Report – 2013" Marine Renewables Canada at 28.

17 "Hydropower Explained: Tidal Power" (2016), *US Energy Information Association*, online: <http://www.eia.gov/energyexplained/index.cfm?page=hydropower_tidal>. archived at <https://perma.cc/3FPS-3TGZ>.

18 *Ibid*.

19 Vicki James, *Marine Renewable Energy: A Global Review of the Extent of Marine Renewable Energy Developments, the Developing Technologies and Possible Conservation Implications for Cetaceans* (Chippenham, UK: Whale and Dolphin Conservation, 2013) V1 at 12.

20 Linus Mofor, Jarrett Goldsmith & Fliss Jones, "Ocean Energy: Technology Readiness, Patents, Deployment Status and Outlook" (2014) International Renewable Energy Agency at 43.

21 Kolliatsas et al, *Offshore Renewable Energy: Accelerating the Deployment of Offshore Wind, Tidal and Wave Technologies* (New York: Earthscan, 2012) at 280.

oscillating hydrofoils.[22] The two most common variations include one with a closed-hub design (resembling a wheel hub) and another "water turbine," that resembles an inverted wind turbine.

Although still in the product development stage, in-stream tidal turbines have tremendous potential for electricity generation and commercialization. As water is 800 times denser than air, the energy potential in tides is exponentially greater than wind.[23] However, this has also caused great technological challenges for how to design tidal blades to resist breaking under the force of tidal currents.[24] While this challenge has resulted in making the tidal blades more expensive to build, tidal turbines capture the most energy per square foot of structure than any other ocean energy technology, thus greatly lessening their impact on the environment.[25] Two tidal turbines are currently in testing and operation in Scotland and South Korea.[26]

Tidal turbines hold considerable advantages over other forms of ocean and offshore energy. Generally located on the ocean floor, tidal turbines allow for multiple compatible uses of the ocean environment in their vicinity. Most other iterations of ocean energy are not well-suited for this arrangement, and require their own designated space. Compared to other kinds of offshore energy, tidal turbines are not visible from the mainland, mitigating NIMBY[27] concerns. Moreover, turbines—when commercially viable—will be most economical by having numerous turbine installations within close proximity of each other in "farm" environments. Even within such an environment, the ecological impact of turbine "farms" is predicted to be significantly less than that of fences, barrages, or lagoons, and will also allow for free passage of marine life and low tides.[28]

C. Siting and Geography

Tides are a natural phenomenon that can be harvested in ways similar to other existing renewable energy sources, such as solar, wind, hydro, or geothermal. Despite being intermittent, tidal energy is the most dependable form of renewable energy.[29] Based on the position of the moon, astronomers can predict how high tides will be on a given hour and day years in advance, and thus can allow tidal energy operators to schedule output according to forecasted energy demand.[30]

However, tidal energy requires very specific conditions for production. Tidal difference must be at least seven meters between high and low tide, an unusual condition that is unique to only a few places on the planet.[31] Although many states have shown interest

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22 OEER, *supra* note 16 at 13.

23 Ron R Luoma, "Capturing the Ocean's Energy" (1 December 2008), *Yale Environment 360*, online: <http://e360.yale.edu/feature/capturing_the_oceans_energy/2093/> archived at <https://perma.cc/543D-9RQW>.

24 Richard S Stein & Joseph Powers, *The Energy Problem* (Singapore: World Scientific, 2011) at 125.

25 US Energy Information Association, *supra* note 17.

26 *Ibid.* While another had been in testing in Nova Scotia, it could not withstand the strength of the Bay of Fundy's powerful tides. For more, see Jane Taber, "Project seeks to harness – and harvest – the force of Fundy", *The Globe and Mail* (16 Nov 2014), online: <http://www.theglobeandmail.com/news/national/project-seeks-to-harness-and-harvest-the-force-of-fundy/article21609715/> archived at <https://perma.cc/NV84-K9WW>.

27 Not in My Backyard. A term in environmental management of development, refers to the want to benefit from positive infrastructural projects, yet resisting siting in one's vicinity.

28 US Energy Information Association, *supra* note 17.

29 Tidal energy produces power dependably in 6-12 hour increments all year long.

30 Markian MW Melnyk & Robert M Andersen, *Offshore Power: Building Renewable Energy Projects in US Waters* (Tulsa, OK: PennWell, 2009).

31 Charlotte Helston, "Tidal Power" (2012), Energy BC – Profiles, online: <http://www.energybc.ca/profiles/tidal.html> archived at <https://perma.cc/G7KC-VER3>.

in tidal energy development, the geographic potential is greatest in Canada, France, England, and Russia.[32] Canada alone possesses 191 unique sites for potential generation, subject to accessibility and feasibility.[33] In addition to a large differential range, potential tidal energy production sites are generally found in channels with swift moving water that maximizes system input.[34] The best acknowledged sites for tidal energy development in Canada are in the Bay of Fundy (Nova Scotia), the Ungava and Hudson Straits (Quebec, Newfoundland and Labrador, and Nunavut), and the Georgia and Johnstone Straits (British Columbia).[35] Many also acknowledge the St. Lawrence River (Quebec), the west coast of Vancouver Island (British Columbia), and Frobisher Bay (Nunavut) as primary, albeit smaller, sites for development.[36]

Table 1: Canada Potential Tidal Current Energy by Province

Province	Potential Tidal Current Energy (MW)	Number of Sites (-)	Average Size (MW)
Northwest Territories	35	4	9
British Columbia	4,015	89	45
Quebec	4,288	16	268
Nunavut	30,567	34	899
New Brunswick	636	14	45
PEI	33	4	8
Nova Scotia	2,122	15	141
Newfoundland	544	15	36
TOTAL	**42,240**	**191**	**221**

Source: Michael Tarbotton & Max Larson, "Canada Ocean Energy Atlas (Phase 1): Potential Tidal Current Energy Resources" (2006) Triton Consultants for Canadian Hydraulics Centre at 15.

Besides ocean siting concerns, tidal developers need to consider the challenges of getting their energy to market. Although the example of the offshore wind industry has leveled the learning curve for tidal developers, bringing voltage onto land remains a serious challenge. In the United Kingdom, for instance, tidal energy projects are hampered by their remoteness and the inability of rural grids to handle extensive energy inputs from the sea. In the United States, the opposite is true: here, direct-link tidal sites near large urban centers have the potential to relieve congestion along overused transmission lines into cities.[37]

Finally, underwater geology is vital to correct siting of tidal energy projects, due to the ocean floor's dramatic impact on tide generation.[38] Unfortunately, little is known of the seabed geology and marine ecology of potential tidal development sites. Numerical and graphic modeling of tidal currents, river flows, and wave effect is required in order to properly test potential sites for development.[39]

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32 US Energy Information Association, *supra* note 17.
33 Kolliatsas et al, *supra* note 21 at 232.
34 Stein & Powers, *supra* note 24 at 124.
35 Tarbotton & Larson, *supra* note 9.
36 National Research Council Canada, "Archived – Oceans of Energy" (2008), *Government of Canada*, online: <http://nrccnrc.gc.ca> archived at <https://perma.cc/E8ZX-S6H2>.
37 Kolliatsas et al, *supra* note 21 at 326.
38 Melnyk & Andersen, *supra* note 30 at 39.
39 National Research Council Canada, *supra* note 36.

D. Technology Take-Aways

Although in-stream tidal energy is not yet commercially viable, it is less than a decade away from being ready for implementation.[40] A strong focus on research and development of wind technology brought offshore wind farms into the world's energy mix approximately twenty-five years after serious investment began in commercializing the product, time not currently afforded to tidal energy production. With our world's climate changing faster than ever, societal demands for alternative energy sources are continuing to increase. Nova Scotia has set some of the world's most stringent renewable energy standards in order to achieve 40 percent clean energy by 2020, which accounts for a jump from just 6 percent in 2005.[41]

Deployment of tidal energy brings about not only environmental benefits, but social and economic ones as well. Just as Quebec became a world leader in hydropower technology through its network development in the second half of the twentieth century, Canada's oceanfront provinces and territories have the potential to become early adopters of tidal technology and the opportunity to seize first-mover advantage in positioning an export market in the long term.[42]

However, the industry needs assistance. Despite rapid and promising technological progress, serious barriers to commercialization of tidal energy remain. Through a focus on global case studies, the following sections will analyze the financial, legal, regulatory, and infrastructural impediments to tidal energy development. Using Canada as a background setting, best practices will also be identified for legislative and policy reform.

III. ECONOMICS OF TIDAL POWER

When wind energy became an evolving input into the electricity grid in the early 1980s, it sold for a pricey 80 cents per kilowatt-hour (kWh). Utilities nevertheless incorporated this source of energy into their mix, whether willingly or through governmental mandate. Today, the most efficient wind turbines generate electricity for only 3-4 cents per kWh, approximately the same cost as hydroelectric dams, the most economical source of renewable energy.[43]

Nova Scotia is the first jurisdiction to offer producers a set price for tidal power, pricing the inputs at 78 cents per kWh in the scheme of its Community Feed-In Tariff (ComFIT) program. Nova Scotia's price is seen as offering a pricey premium for this technology, with central estimates for tidal energy hovering closer to 24-30 cents per kWh.[44] Nonetheless, the point being that the cost of producing tidal energy via clean, sustainable means is generally quite high. However, one only needs to look at producers' experience with wind energy development to clearly identify the cost reduction potential in a relatively short twenty-five year period. In less than three decades, as mentioned above, wind energy costs per kilowatt-hour have declined from an initial cost of over 55 cents per kWh to less than 5 cents per kWh, due in large part to technological development, grid integration, and economies of scale.[45] Tidal energy generators are likely to go through the same costing curve, with similar input factors (grid connectivity

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40 Ernst & Young, *supra* note 14.

41 NS Reg 25/2010, c 25; Energy and Mines Ministers' Conference, *supra* note 4 at 10.

42 Marine Renewables Canada, *supra* note 16.

43 Helston, *supra* note 31.

44 Melnyk & Andersen, *supra* note 30.

45 See, as reference, Levi Tillemann, "Revolution Now: The Future Arrives for Four Clean Energy Technologies" (2013) US Department of Energy; Navigant Consulting Inc, "Offshore Wind Market and Economic Analysis: Annual Market Assessment" (22 February 2013), *US Department of Energy*, online: <http://www.navigant.com> at 50.

and technological development) and economic realities (scale and financing) likely to support decreasing costs. For instance, the Electric Power Research Institute projects that a 100 MW tidal energy farm (approximately 80-100 turbines) could generate power at a cost of 6-9 cents per kWh, bringing it within the competitive pricing fold of other renewable energy technologies.[46]

Whereas conventional and land-based renewables may be connected directly into the existing grid infrastructure and benefit from publicly financed rights of way, tidal energy producers must account for the expensive interconnection and transmission infrastructure required to get their power to market.[47] As will be further discussed, these capital costs need to be integrated into the public funding structure if a state wishes tidal to be a successful renewable resource input in the near future.

IV. PROJECT FINANCING

Financing offshore renewables involves a large amount of capital investment, which is not always easy to come by.[48] In the past twenty years, small private companies that largely rely on outside investment, as opposed to internal research and development funds, have mostly driven tidal technology development.[49] Yet the compounded immaturity of the industry, uncertainty over project viability, and the large amount of technical and performance risks has soured the investment market.[50]

Unlike the case of wind energy, where significant amounts of government funding were put into technology development in the 1970s, tidal energy has broadly been a privately financed endeavor. No standard model currently exists for project financing, which has required promoters of the technology to "reinvent the wheel" for every project financing strategy designed.[51] To date, venture capitalists and hedge funds—higher risk investors—have shown great reluctance towards entering the tidal energy market, citing the lack of governmental support and instability of long-term policy commitments.[52]

In order to manage investment risk, developers must be careful in site selection. In a clear catch-22, investors are reluctant to finance development at higher-yield energy sites, due to the unforeseen risk of trying to harness the strongest tides in the world.[53] As such, tidal projects are left selecting sub-optimal sites for energy and technological development in order to attract capital to their projects. This is a considerable research burden for an industry whose technology is still relatively nascent.

Where large tidal projects do happen, they require significant financial intervention from governments.[54] However, this requires drawing a delicate balance between industrial support and backing a particular technology among emerging designs.[55] Since governments do not want to be seen "picking winners," general financial instruments, such as feed-in tariffs, tax credits, tradable certificates, incentive payments and

46 Matter Network, *supra* note 12.
47 Ernst & Young, *supra* note 14.
48 Kolliatsas et al, *supra* note 21 at 88.
49 Some exceptions, such as Siemens, do exist. Some private enterprises work in private-public partnership settings.
50 Kolliatsas et al, *supra* note 21 at 95.
51 As does exist with offshore wind development, see e.g. Kolliatsas et al, *supra* note 21.
52 *Ibid* at 195.
53 For more information on the 2009 breakdown of a testing turbine in the Minas Passage, please refer to Taber, *supra* note 26.
54 Kolliatsas et al, *supra* note 21 at 90.
55 *Ibid* at 106.

capital grants, have become the norm in the industry.[56] These are generally driven by broad governmental renewable energy directives, and subject to broad discretion and politicization, which can often leave potential investors with a reluctance to finance such projects. While similar financial investment for solar and wind energy have been largely successful through such programs, the increased risk in tidal energy development has detracted investors from applying the same system to investments in this industry.

Financing of comprehensive research budgets for tidal energy development, however, is one area where governments have been successful. The United States, the United Kingdom, Japan, and Canada round out the top spenders in research and development of tidal energy technologies.[57] As previously stated, most enterprises operating in this field are smaller companies that are unable to finance development through other revenue sources. As such, public-private partnerships have proven vital to growing the industry. Firms receiving public research and development support have been successful in leveraging this funding to attract investment from the private sector.[58] Yet, failed endeavors have dampened the entrepreneurial drive in this field. Too little support has kept numerous designs and technologies from ever being driven or tested in ocean environments.

V. ENERGY LAW & POLICY

Building on the financial means of private enterprise in the provision of tidal power, governmental law and policy with regards to renewable energy development largely determines the fate of successful enterprises in designing, testing, and anticipating risks inherent to their technologies. One of private developers' leading concerns is the lack of overall knowledge of the seabed, as well as hydrokinetic currents existent in the ecosystem.[59] As oceanographer Paul Snelgrove stated, "We know more about the surface of the Moon and about Mars than we do about [the deep sea floor]."[60]

Governments must therefore invest in conducting research in this area. The United States Department of Energy ("DOE") has spent more than $100 million USD to research marine hydrokinetics, providing developers a good knowledge base to help them site their projects, while lessening the risk of unknown siting effects.[61] In Canada, the National Research Council-led Canada Ocean Energy Atlas, which has worked toward modeling potential tidal current energy reserves throughout the country, has achieved similar results.[62] Drawing inspiration from the comprehensive Canadian Wind Energy Atlas, an initial tidal survey project was completed in 2006. Private developers have used its results to draw further investment to research and development in the sector.[63] However, unlike the Wind Atlas, no follow-up studies have been funded, leaving the Ocean Atlas as only a dream for the industry. Of key need are comprehensive resource assessments of targeted development regions, as well as interactive features allowing a variety of actors to make use of the tool.[64] Such a project is far too comprehensive and

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56 *Ibid* at 54.

57 *Ibid* at 57.

58 Inspired from Abbie Badcock-Broe et el, "Wave and Tidal Energy Market Deployment Strategy for Europe" (2014) Strategic Institute for Ocean Energy.

59 See generally, OEER, *supra* note 16.

60 "Sea Quotes: Ocean Exploration", *Sea and Sky*, online: <http://www.seasky.org/quotes/sea-quotes-ocean-exploration.html> archived at <https://perma.cc/2MHW-6UPM>.

61 Bryan Cronan, "How ocean current could power half the homes in Florida" (4 December 2014), *Christian Science Monitor*, online: <http://www.csmonitor.com/Technology/Pioneers/2014/1204/How-ocean-current-could-power-half-the-homes-in-Florida> archived at <https://perma.cc/9WNZ-2SFQ>.

62 Tarbotton & Larson, *supra* note 9.

63 National Research Council Canada, *supra* note 36.

64 *Ibid*.

expensive for an industrial actor to undertake without further support and, as such, falls squarely on the responsibility of governmental energy policy.

Governmental energy policy with respect to tidal projects can dramatically change the feasibility of the industry in the early stages of development. While financing is a known barrier to entry, regulatory issues affect producers from the very beginning, in approving testing sites for devices.[65] One of the best-known tidal energy projects in the world, Verdant Power's East River project, is located between Manhattan and Queens in a narrow channel in the heart of New York City. In applying for testing sites, Verdant underwent over six years of regulatory hurdles in order to have two test turbines approved.[66] Five years into their application, Verdant's CEO, Gilbert Sterling, made the challenges obvious: "As new companies, we cannot compete with traditional energy. Our ability to survive without revenue is limited."[67]

Thus, the importance of pre-approved testing sites for development of new technologies becomes clear. As key cornerstones of comprehensive energy policy, governments need to invest in testing centers pre-permitted for the outlay of devices in ocean environments, so as to allow for their deployment as soon as technologically feasible.[68] The United States has taken the lead in the development of these sites by opening two at the University of Hawaii Honolulu and Oregon State University.[69] Canada followed suit with the opening of the Fundy Ocean Research Centre for Energy ("FORCE") in Parrsboro, Nova Scotia in 2006. However, Canada still lacks comprehensive testing facilities in its Pacific and Arctic environments, where key distinctions underlay the utility of tidal technology in these basins.[70]

VI. REGULATORY APPROACHES

Regulating the development of tidal energy systems has been one of the most contentious debates surrounding the deployment of the technology. Governmental regulation affects all aspects of tidal energy expansion, from the mode of energy capture, to transmission abilities, to financing the project, and finally, to building and installing the actual technology. As previously discussed, burdensome regimes can frustrate stakeholders and impede development, hindering a state's ability to reach renewable portfolio targets within its given timeframe. Stable and appropriate regulatory regimes are key for conscientious, wise, and strategic development of tidal power resources.

States take various approaches to regulating tidal energy, yet one thing is certain: stable regulatory regimes are essential for tidal development. Being a new technology, tidal energy has a steep commercialization curve, and is vulnerable to rafts of new permitting hurdles in attaining commercialization. States, broadly speaking, take very precautionary approaches to tidal development, putting the burden on proponents to prove the safety and environmental consciousness of their product.[71]

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65 Governmental regulatory approaches will be further discussed in the next section. For now, we discuss regulation in terms of barriers to product testing.

66 Luoma, *supra* note 23.

67 Kolliatsas et al, *supra* note 21 at 125.

68 Pre-permitted testing sites are those whose national, provincial, and local regulatory bodies have all given approval for a broad base of products to be tested in a given environment. They allow industry to bypass cumbersome regulatory hurdles in gaining approval for device testing.

69 Melnyk & Andersen, *supra* note 30 at 390.

70 In the Arctic realm, for instance, tidal turbines must be constructed to withstand the planet's fiercest temperature gradients and environmental conditions.

71 This is commonly referred to as the precautionary principle in law. For more, see "Definition of the Precautionary Principle", *The Canadian Chamber of Commerce*, online: <http://chamber.ca> archived at <https://perma.cc/SA7T-ZWHA>.

In large part, states have done little to create distinct regulatory regimes for tidal energy deployment.[72] Governments, such as the United States, rely on established permitting processes for granting development licenses, leasing ocean plots, and evaluating technological strength. Unfortunately, the regulatory regimes in place for other energy sources are simply not compatible with the needs of tidal energy systems. Particular issues identified by the International Energy Agency are the lack of clear permitting pathways, an overreliance on bespoken permitting processes, overly detailed design requirements, a lack of regulatory capacity and expertise, and unclear environmental impact assessment criteria. Together, these joint factors cause uncertainty, unpredictability, and a lack of coherence throughout the regulatory system.

In Canada, for instance, a proponent looking for regulatory approval to install a tidal turbine must hypothetically gain approval through dozens of pieces of legislation, including, but not limited to, the *Fisheries Act*,[73] the *Canadian Environmental Assessment Act*,[74] the *Species at Risk Act*,[75] the *Migratory Birds Convention Act*,[76] the *Navigable Waters Protection Act*,[77] the *National Energy Board Act*,[78] the *Oceans Act*,[79] the *Canada Environmental Protection Act*,[80] the *Shipping Act*,[81] and the *Canada Labour Code*.[82] In doing so, a company would likely interact with Natural Resources Canada, Fisheries and Oceans Canada, Environment Canada, the Canadian Environmental Assessment Agency, and Transport Canada at the federal level.[83] At the provincial level, they would

72 The key exception here is the United Kingdom, whose model regulatory structure will be studied in this section.

73 *Fisheries Act*, RSC 1985, c F-14, online: <http://www.dfo-mpo.gc.ca/habi- tat/role/141/1415/14151-eng.htm> archived at <https://perma.cc/N8WG-96W2>. The *Fisheries Act* is binding to all levels of government in Canada, applying to all inland waters, territorial seas, and fishing zones on the country's three coasts. Sections 32 & 35-37 are of particular relevance.

74 *Canadian Environmental Assessment Act*, SC 1992, c 37, online: <http://laws-lois.justice.gc.ca/eng/acts/C-15.2/> archived at <https://perma.cc/V763-U27K>. Applicable to the EAs of any project involving decision-making, regulated under federal legislation, obtaining federal funding, on federal land, or under federal jurisdiction. Section 5 is particularly of importance.

75 *Species At Risk Act*, SC 2002, c 29 [*SARA*] online: <http://www.ec.gc. ca/alef-ewe/default.asp?lang=en&n=ED2FFC37-1> archived at <https://perma.cc/6BEC-XWUR>. Protects species at risk on federal lands, territorial seas, and inland waters. Sections 32-33, 58, & 73 may be invoked.

76 *Migratory Birds Convention Act*, 1994, SC 1994, c 22, online: <http://www.ec.gc. ca/nature/default.asp?lang=En&n=7CEBB77D-1> archived at <https://perma.cc/MY7B-XLB5>. Similar to *SARA*, designed to protect migratory birds (whose flight patterns naturally cross jurisdictional borders).

77 *Navigable Waters Protection Act*, RS 1985, c N-22, online: <http://laws-lois.justice.gc.ca/eng/acts/N-22/> archived at <https://perma.cc/YNQ9-6V5H>. Requires permitting for any building project undertaken in waters which are navigable, which includes the Bay of Fundy and the Hudson Strait(s). Section 5 is of relevance to tidal energy projects.

78 *National Energy Board Act*, RS, c N-6, online: <http://laws-lois.justice.gc.ca/eng/acts/n-7/FullText.html> archived at <https://perma.cc/RM34-K2UY>. Important in electricity generation and export contexts, as applies to any project crossing a provincial or territorial border. Section 58 is important for purposes of cross-border permitting.

79 *Oceans Act*, SC 1996, c 31, online: <http://laws-lois.justice.gc.ca/eng/acts/O-2.4/> archived at <https://perma.cc/84E5-LHKY>. Applicable to both the Bay of Fundy and Hudson Strait(s) projects, as internal waters within national territorial zones.

80 *Canadian Environmental Protection Act, 1999*, SC 1999, c 33, online: <http://laws-lois.justice.gc.ca/PDF/C-15.31.pdf> archived at <https://perma.cc/6U8W-E8M7>. Designed to protect both human health and the environment, nationally. Codifies precautionary principle into Canadian law (discussed below) while outlining public participation requirements.

81 *Canada Shipping Act, 2001*, SC 2001, c 26, online: <http://laws-lois.justice.gc.ca/PDF/C-10.15.pdf> archived at <https://perma.cc/A9QC-S7X6>.

82 *Canada Labour Code,* RSC 1985, c L-2, online: <http://laws-lois.justice.gc.ca/PDF/L-2.pdf> archived at <https://perma.cc/3KZ9-T39K>.

83 Nova Scotia Department of Energy, "Marine Renewable Energy Legislation for Nova Scotia" *Province of Nova Scotia*, online: <gov.ns.ca/energy> archived at <https://perma.cc/8EX9-PHUA> at 13; Elisa Obermann, "The Regulatory Regime for Tidal Energy" Acadia Tidal Energy Institute, Acadia University at 67.

likely further seek approval from departments of energy, environment, natural resources, fisheries/aquaculture, Aboriginal affairs, and labour.[84] Once approved through each of these distinct channels, a company must seek the green light from local municipalities,[85] Indigenous groups,[86] and displaced stakeholders.[87]

One can see how these processes may lack a coordinated permitting approach, and result in untimely delays in the development process. Although these permitting requirements are standard for all energy development, one must keep in mind the uncertain nature of tidal energy deployment, the unpredictable outcomes, and the unforeseeable results. As much as impact assessments and studies attempt to define the potential consequences of turbine deployment, they are not always correct, especially given the lack of professional capacity within regulatory agencies.[88] Moreover, developers seldom know which legislation they need to comply with, resulting from regulatory uncertainty and lack of precedent.[89]

A. Developments Towards a Unique Approach

International actors have begun to work around these developmental challenges, in gaining support from governments for more streamlined and efficient permitting systems. In the United States, the Federal Energy Regulatory Commission and the Mineral Management Service signed a comprehensive Memorandum of Understanding ("MOU") in 2009, dividing regulatory tasks between them in distinct areas of renewable energy development.[90] Since then, the United States government has been signing MOUs with individual coastal states, each deferring some responsibility over traditional constitutional jurisdiction in order to streamline the tidal energy permitting process.[91]

The United Kingdom possesses the most robust regulatory and licensing scheme for tidal energy. In part aided by its unitary state structure, United Kingdom developers must approach a single authority for seabed leases,[92] and another for all permitting requirements, the Marine Management Organization (England) or Marine Scotland (Scotland).[93] The approval processes were streamlined through the Marine Bill for projects of less than 100 MW capacity.[94] This simplified permitting system is known in the industry as the Rochdale Envelope, referring to the egregious lead times experienced

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84 Herein using the example of Nova Scotia, see *ibid*. Although jurisdiction over indigenous affairs in Canadian constitution is vested with the federal government, administered through the latter's Department of Indigenous and Northern Affairs, the province of Nova Scotia maintains an Office of Aboriginal Affairs for the implementation of the unique Mi'kmaq-Nova Scotia-Canada Tripartite Forum and the Made-in-Nova Scotia Process. For more information, see *Nova Scotia Office of Aboriginal Affairs*, online: <http://novascotia.ca/abor/> archived at <https://perma.cc/5LNX-HQZY>.

85 By virtue of their jurisdiction over zoning and relevant onshore facilities.

86 *Mi'kmaq - Nova Scotia - Canada Framework Agreement*, 23 Feb 2007, online: <http://www.aadnc-aandc.gc.ca/eng/1100100031915/1100100031916> archived at <https://perma.cc/ML5K-3PSM>.

87 Information throughout this paragraph drawn from Meinhard Doelle et al, "Tidal Energy: Governance Options for NS" (2006) Dalhousie Law School: Marine & Environmental Law Institute.

88 Nicole C McDonald & Joshua M Pearce, "Renewable Energy Policies and Programs in Nunavut: Perspectives from the Federal and Territorial Governments" (2012) 65:4 Arctic 465.

89 Mofor, *supra* note 20 at 43.

90 Federal Energy Regulatory Commission will now control permitting on all tidal and wave current projects, while Mineral Management Service will license solar and offshore wind projects. Each will consult with the other where expertise requires.

91 Maine Department of Environmental Protection, "Information Sheet: Regulation of Tidal and Wave Energy Projects" (2010) Maine DEP.

92 Marine Renewables Canada, *supra* note 16.

93 *Ibid*.

94 Kolliatsas et al, *supra* note 21 at 380.

by offshore wind developers in the early days of that British industry.[95] Serious permitting delays between first project application and actual construction were so long, that by the time of approval, firms had to re-apply for agency consent as their technology had changed significantly in the interim, invalidating the original permit.[96] The Rochdale Envelope is an agglomeration of various permitting requirements brought together under the mantra of United Kingdom planning law.

B. Canadian Structure

The Canadian structure, as briefly discussed above, is more complicated than that of the United Kingdom, and more resembles the United States' approach to regulation. Unlike other natural resources extracted in the country, there is currently no specific regulatory scheme for tidal renewable energy in Canada.[97] Due to provinces' constitutional obligations, regulation with respect to the seabed must be undertaken at that level.[98] The federal government is then obliged to regulate due to its jurisdiction over fishing and navigation rights.[99]

Attempting to emulate the United Kingdom's success, Nova Scotia has been studying methods to develop an efficient and certain legal framework and regulatory process for assessing tidal energy projects.[100] Short of an improved seabed-licensing regime signed in 2011,[101] the federal government has had little buy in to this comprehensive legislation.[102] One development made news in 2014: the changing definition of the word "Province" in the framework legislation.[103] Although seemingly trivial, this small change could be significant in bringing certainty for developers by delineating jurisdictional project lines based on the wording used by the Canada-Nova Scotia Offshore Petroleum Board ("CNSOPB").[104] For a province with a strong history of provincial-federal cooperation through the CNSOPB, Nova Scotia's joint legislation could set forth a framework for inter-jurisdictional cooperation in regulatory permitting for tidal energy in Canada. Given this lack of framework in any other province, its establishment in Nova Scotia would be a clear step forward in clarifying permitting processes for tidal projects in the country.

It is conceded that changes to energy development requirements need a certain political will in order to move forward. Thus far, that political will has been most clearly exhibited in the United Kingdom, Germany, and Belgium, but remains absent in Canada.[105] However, existing processes may also be utilized to simplify the current regulatory structure. Strategic environmental assessments ("SEAs") are one way in which

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95 Badcock-Broe et al, *supra* note 58.

96 *Ibid.*

97 Obermann, *supra* note 83.

98 *Constitution Act, 1867,* (UK) 30 & 31 Vict, c 3, s 91, reprinted in RSC 1985, App II, No 5.

99 *Ibid,* s 92.

100 Obermann, *supra* note 83.

101 The Land Use Operational Policy for Ocean Energy Projects, see Marine Renewables Canada, *supra* note 16 at 72.

102 Marine Renewables Canada, *supra* note 16.

103 Matthew Clarke & Sara Mahaney, "Legal Alert: NS Keeps Ball Rolling with New Tidal Energy Regulations" (2014), *McInnes Cooper*, online: <http://www.mcinnescooper.com/> archived at <https://perma.cc/2TFS-QHKH>.

104 "The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) is the independent joint agency of the Governments of Canada and Nova Scotia responsible for the regulation of petroleum activities in the Nova Scotia Offshore Area. It was established in 1990 pursuant to the Canada-Nova Scotia Offshore Petroleum Accord Implementation Acts (Accord Acts)." For more, see *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, RSC 1985, c 28.

105 Kolliatsas et al, *supra* note 21 at 68.

governments can better understand and prepare for energy developments in a calculated manner. A SEA evaluates the potential environmental effects of a policy, plan, or program over a development jurisdiction before actual siting, so as to identify and predict effects relevant to the planning and design process.[106] Through public debate, regional forums, and advance conversation, SEAs invite stakeholder participation prior to project commitment, allowing governmental entities to plan around potential roadblocks in developing energy projects.[107]

The Offshore Energy Research Association conducted a comprehensive SEA of the Bay of Fundy in 2011 on behalf of Nova Scotia Power, yielding 29 recommendations for the utility and government. Among them is the need to develop comprehensive tidal energy legislation, as previously discussed. Another of importance to regulators is the need to create marine spatial plans for tidal energy development.[108] Employing detailed and distinct resource assessments, such as the Ocean Energy Atlas identified previously, lawmakers are able to incorporate ocean energy development in regional planning, instead of doing so on an ad hoc basis. Leading this field are Germany, Sweden, and the Netherlands, with national marine spatial plans already in place.[109] In order to attain this level of regulatory ability and efficiency, Canadian institutions will have to invest in developing the detailed regional assessments called for by the survey report of the Ocean Energy Atlas.[110]

Finally, regulatory regimes, even with the implemented set of remedies described above, still impede development of new technologies, as a result of the precautionary approaches taken.[111] Clearly for the better, our environment is now more strongly protected in large part due to the rigorous assessment processes that are required of development projects and natural resource based industries. Yet, by the same token, innovation is stymied in a regulatory environment by which companies struggle to test their technologies due to cumbersome legislative barriers. For this reason, states have implemented test centers, designed to minimize the burdens associated with obtaining testing and study permits. The implementation of these pre-consented sites has been a success in the United States, Ireland, and Canada.[112]

Prototype testing in Canada has been undertaken at the $70 million CAD FORCE center in Nova Scotia.[113] This public private partnership invites technology developers from throughout the world to test their product in the Minas Passage, the "Holy Grail" of world tides.[114] Although projects here have failed,[115] their impact on the local environment has been scientifically negligible.[116] Despite its relative youth,[117] the Center

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106 Obermann, *supra* note 83.

107 OEER, *supra* note 16.

108 Mofor, *supra* note 20.

109 *Ibid*. Canada has one marine spatial plan on its coastline, commissioned by UNESCO, the Eastern Scotian Shelf Integrated Management Plan. However, this plan does not touch on any potential zones for tidal energy generation, nor does it consider many other uses of the sea besides fisheries.

110 This is not an easy task, as it will require years of inexistent surveys to be done, new science to be recorded, and public meetings to be held.

111 Chamber.ca, *supra* note 71.

112 Mofor, *supra* note 20 at 42.

113 Fundy Ocean Research Centre for Energy, as described in OEER, *supra* note 16.

114 Tides in this part of the Bay of Fundy rise to 16 meters, a full 9 meters above the required 7 for ability to generate.

115 See Taber, *supra* note 26.

116 Natural Resources Canada, "Tidal Energy Project in the Bay of Fundy", *Renewable Energy and Clean Energy Systems Demonstration Projects*, online: <http://www.nrcan.gc.ca/energy/funding/current-funding-programs/cef/4955> archived at <https://perma.cc/QM8D-859K>.

117 The center was established in 2009.

has proven a valuable contributor to lessening regulatory burdens on testing innovative technology. What remains, however, is a clear opportunity for Canadians to establish further testing centers and pre-permitted regions. As previously discussed, the variety of factors affecting tidal energy viability and efficiency remains largely undiscovered.[118] Canada, with its diversity of ecoregions and environmental conditions, has the unique opportunity to become a world leader in providing test sites for novel turbine technology aimed at use throughout the world.

VII. INFRASTRUCTURE AND TRANSMISSION

The regulatory issues studied are wide in ambit, yet broadly political in achievement. Most important to the tidal energy industry is the ability to streamline processes of application, gain a holistic scientific understanding of the ocean environment to be dealt with, and enable technology testing through public-private partnerships. Whereas certain of these initiatives will require governmental expenditure of resources, they are broadly net-even in outcome, given the tremendous savings that would incur as a result of streamlined regulations, survey savings, and less burdensome testing processes.

This section, on the contrary, points out the need for substantial government intervention across a much wider and more applied spectrum. As previously discussed, and as is conventional in energy resource development, projects are typically sited close to grid infrastructure, so as to reduce capital costs in building transmission infrastructure to get energy to market.[119] A developer can anticipate marginal costs in ensuring connectivity, funding substations, and locating ideal positions resulting from siting near waterways, wind-prone regions, or on south-facing slopes.[120] However, conventional and typical renewable energy developers seldom are faced with the significant costs of building transmission infrastructure from their generation facilities to far-off grids. This truism is unfortunately not the case for tidal energy producers.

Governments in Canada have a long history of significant investment in transmission capacity. Beginning with the hydroelectric projects of the 1950s, successive provincial and federal governments funded thousands of kilometers of transmission cables to bring electrical current from distant dams to the homes and industry of southern Canada. Quebec, Ontario, and Manitoba's provincial systems are most noted for their significant infrastructural development, financed on the backs of state utilities. That trend continues today, with the great Maritime Link undersea cable connecting Lower Churchill and Muskrat Falls in Labrador to mainland Nova Scotia, at an estimated cost of over $1.3 billion CAD over thousands of kilometers. This project, financed by rate payers through Nova Scotia Power, promises decades of clean energy to Nova Scotians, while opening up the export potential of Labrador energy to the Northeastern United States.[121]

Governments have not taken the same approach to offshore energy development and project-based undersea transmission. Tidal energy developers shoulder one hundred percent of the cost of their projects' transmission infrastructure. This instantly drives up project cost, especially in the early stages of development, as turbines are only added upon completion of construction, and thus dependent on all other facets of the project being completed on time.[122] Building new transmission capacity—especially undersea—is an

118 Melnyk & Andersen, *supra* note 30 at 31.

119 Ernst & Young, *supra* note 14.

120 The last two being being industry choices in relation to wind and solar power, respectively.

121 Emera Newfoundland & Labrador, "The Maritime Link Project", *Emera NL*, online: <http://emeranl.com> archived at <https://perma.cc/F8HT-CMDV>.

122 The tidal turbine global supply chain is not significant enough at this moment for products to be ordered on demand. Long wait lists exist for products approaching commercial viability.

enormously expensive and time-consuming undertaking. What is more, tidal projects are often located in remote regions, where the existing grid is not robust enough to support substantial inputs of energy, such as those that would be generated from tidal projects.[123] As such, project proponents must ensure utility agreement and undertaking to shore up systems in order to be able to input the energy they produce into the existing grid.

Inherent issues arise in connecting offshore sites to a land-based transmission network, including loss of energy associated with grid length, dealing with unstable undersea soil conditions, and permitting for onshore receptors and substations.[124] Yet, global examples point to the ability to overcome these barriers to estimate a strong, viable system of offshore energy generation. Denmark's ability to shore up its national grid to receive substantial inputs from offshore wind projects is the prime example.[125] Domestically, Canada is a world leader in economical, efficient, and remote transmission infrastructure maintenance, with 231,966 kilometers of transmission lines nationwide.[126]

Building transmission capacity in the Bay of Fundy, on the one hand, would only require a 50-kilometer connection to the mainland grid.[127] This small connection is fractional in length to the world's longest undersea electrical cable, a 580-kilometer export link between Norway and the Netherlands (NorNed),[128] or Iceland's proposed 1000-kilometer export cable tied to northern Scotland.[129] Canada's work in progress, the Maritime Link, will constitute a 180-kilometer undersea cable linking Newfoundland to Nova Scotia.[130] The political reticence in funding a 50-kilometer transmission cable is a clear example of the vivid structural issues existent in the development of tidal power in Eastern Canada.

Whereas investment in transmission infrastructure is key to tidal energy development on Canada's Atlantic and Pacific coasts, it is even more primordial for harnessing Arctic tidal power. As discussed in the introduction, Canada's greatest tidal energy potential lies hidden in our remote northern waters.[131] This resource, albeit far-off, is not out of developmental question. Tidal resources in Hudson Strait all lay within 120 kilometers of land,[132] while strong tidal currents line the western edge of Hudson Bay, available for transmission through extensions of infrastructure from hydroelectric developments in northern Manitoba.[133] Further, with the growing interest in offshore oil and gas exploration in Arctic waters, strategic governmental energy policy has the potential to

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123 Natural Resources Canada, "About Renewable Energy" (18 December 2015), *Energy Sources and Distribution: Renewables*, online: <http://www.nrcan.gc.ca/energy/renewable-electricity/7295> archived at <https://perma.cc/F997-UC46>.

124 TOBIN Consulting Engineers, "The Grid West Project: Lead Consultant's Stage 1 Report" (2014) TOBIN.

125 Kolliatsas et al, *supra* note 21 at 329.

126 Sébastien Rioux, Jean-Pierre L Savard & Alyssa A Gerrick, "Avian mortalities due to transmission line collisions: a review of current estimates and field methods with an emphasis on applications to the Canadian electric network" 8 Avian Conserv Ecol 7.

127 Canadian Encyclopedia, "Bay of Fundy and Gulf of Maine", *Historica Canada*, online: <http://www.thecanadianencyclopedia.ca/en/article/bay-of-fundy-and-gulf-of-maine> archived at <https://perma.cc/T2RT-NCRR>.

128 Carlo Laszlo, "The world's longest underwater electricity cable", *NYNAS*, online: <http://www.nynas.com/Segment/Transformer-oils/Case-stories/The-worlds-longest-underwater-electricity-cable/> archived at <https://perma.cc/59WE-28LC>.

129 At a cost of $2.1 billion USD: Katz, *supra* note 3.

130 Emera, *supra* note 121.

131 For further detail, please see Table 1, above.

132 IP Martini, *Canadian Inland Seas* (UK: Elsevier, 2011) at 238.

133 A Northern Vision, "Paths to a Renewable North: A Pan-Territorial Renewable Energy Inventory" (2011) Governments of Yukon, the Northwest Territories, and Nunavut at 46.

jointly develop infrastructure for extractive industry sites while connecting tidal farms to a cohesive national grid.[134]

Although Arctic infrastructure development has long been the bane of Canadian northern pride,[135] current development projects point to the ability to develop efficient and effective infrastructural needs when necessary. The Mary River mine, operated by Baffinland, is the prime example of this Arctic ingenuity, with the first railroad, long distance road, and deep sea port all being constructed to support a single driver of economic development.[136] Mary River is far from a conventional mine, just as the harnessing of tidal energy is distinct from the production of conventional sources of energy. Whereas the political and economic will is clearly present at Mary River's extractive site, it is still absent from the renewable sites of Hudson Bay and the Hudson Strait. With a changing reality in the Arctic, infrastructural development is imperative to the energy development of the region.

Cautious optimism will be key to carefully and strategically developing tidal energy in northern waters. The use of tidal turbines will be limited to those capable of withstanding seasonal ice changes and frigid water temperatures. Developing resilient infrastructure and undersea cables capable of withstanding the pressure of sea ice will determine the efficacy of these developments. Investment from the public sector will be key to finding private financing for tidal projects in the world's most powerful undersea currents.

It is without question that the market for tidal energy is existent. The energy potential of Nunavut alone could change the face of renewable energy in Canada.[137] Moreover, with the Arctic Council currently taking up issues of oil and gas governance regimes, timing could not be better to integrate viable tidal energy debate into the discussion.[138] Tidal energy projects have the potential to create a new and sustainable northern economy. Central to this will be the ability of governmental energy policy to promote focus areas for tidal energy development, while financing transmission trunk lines into these regions. This strategic foundation will need to be supported by cost sharing across the entirety of utility consumers, and not solely developers of tidal energy projects.

VIII. TIDAL ENERGY, ENVIRONMENT, & CLIMATE CHANGE

Tidal turbines, just as any other commercial energy projects, must undergo rigorous standards testing, environmental impact assessments, and public consultation prior to their approval. As discussed in the financing and regulatory sections of this paper, these steps are meant to mitigate environmental and social impact of technology deployment, while maintaining a strict set of standards across the industry. This section does not purport to re-enter the technical discussion of certification processes or licensing schemes, but rather, calls for a holistic approach to tidal energy development, taking into consideration its relatively minor environmental impacts, the innovative and novel nature of the technology, and its place in national energy plans. Discussing the tribulations of tidal energy project standards, Melnyk and Andersen put it best: "Given

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134 Bernard Funston, "Arctic Energy" (2009) Arctic Council: Sustainable Development Working Group.

135 Author's opinion.

136 "Location and Project History", *Baffinland*, online: <http://www.baffinland.com/the-project/location-and-project-history/?lang=en> archived at <https://perma.cc/J96M-GWDC>.

137 Governments of Yukon, the Northwest Territories, and Nunavut, *supra* note 133 at 57.

138 The Arctic Council is "a high level intergovernmental forum to provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection in the Arctic." "About the Arctic Council", *Arctic Council*, online: <http://www.arctic-council.org/index.php/en/about-us/arctic-council/about-arctic-council> archived at <https://perma.cc/T27V-XUHF>.

that renewable energy is, overall, the most environmentally sound source of energy, it is ironic that the various environmental laws are so significant a hurdle for developers of offshore renewable energy projects."[139]

A. Precautionary Principle

In Canada, the "various environmental laws" to which Melnyk and Andersen refer include the *Canadian Environmental Protection Act*, the *Oceans Act*, and the *Species at Risk Act*, to name just a few.[140] These laws all have a common thread, in that they call for a precautionary approach to environmental management within their preambles. Not uncommon across the Western world, the precautionary principle is a principle arising out of the international law. In jurisdictions where it has been adopted, the legal principle shifts the burden of proof onto a project's proponent, requiring them to prove that their actions will not cause harm to something that has yet to be proven.[141] Widely regarded as customary international law, the Supreme Court of Canada formally adopted the precautionary principle in the Canadian common law in *Spraytech v Hudson* ("*Spraytech*").[142]

Judicial interpretation of the precautionary principle in Canada was recently clarified in *Morton v Canada (Fisheries and Oceans),* in which the Federal Court supported "erring on the side of caution" in situations where full scientific certainty could not be provided as to the potential environmental harm caused by an industrial action.[143] In short, this means that lax regulation cannot be excused by incomplete technical knowledge, and governments must show restraint in allowing development, while prioritizing environmental protection.[144] In the fourteen years since *Spraytech*, Canadian courts have recognized the precautionary principle as one moving from mere public policy, to an important element of statutory interpretation drawn from substantive domestic law and customary international law.[145]

The precautionary principle is a valuable one in environmental law, and has undoubtedly made huge strides in our legal understanding of environmental risk mitigation. This paper does not seek to mitigate its utility or legitimacy in any way. Rather, it seeks to draw attention to the inherent difficulties that tidal energy developers have in overcoming burdens of proofs with regards to the precautionary principle in administrative permitting process. Little is known about the effects that large tidal farms might have on the underwater ecosystem in general.[146] On the whole, turbines are expected to slightly modify their ecosystems through inputs of ambient electricity in transmission, through vibration from the construction and operation of generation facilities,[147] through potential collision risk of fish stock and marine mammals,[148] and through the alteration of existing

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139 Melnyk & Andersen, *supra* note 30 at 168.

140 More are listed and discussed in the section on Regulatory Approaches.

141 Environmental Law Centre – University of Victoria, "The Precautionary Principle in Canada" (2010), *ELC Associates Program*, online: <http://www.elc.uvic.ca/associates/documents/Jun14.10-Precautionary-Principle-Backgrounder.pdf> archived at <https://perma.cc/V69X-BTNW>.

142 *114957 Canada Ltée (Spraytech, Société d'arrosage) v. Hudson (Town)*, 2001 SCC 40 at paras 31-32.

143 *Morton v Canada (Fisheries and Oceans),* 2015 FC 575 [*Morton*].

144 Dianne Saxe, "Precautionary principle stronger part of Canadian law" (31 August 2015), *Siskinds: The Law Firm*, online: <http://envirolaw.com/precautionary-principle-stronger-part-of-canadian-law/> archived at <https://perma.cc/Z3DL-EM4G>.

145 *Morton, supra* note 143 at para 43.

146 Luoma, *supra* note 23.

147 US Office of Indian Energy and Economic Development, "Hydrokinetic Energy Facility Construction Impacts", *Tribal Energy and Environmental Information Clearinghouse: Environmental resources for tribal energy development*, online: <http://teeic.indianaffairs.gov/er/hydrokinetic/impact/construct/index.htm> archived at <https://perma.cc/LVW7-W7BD>.

148 Although certain authors say this is grossly overplayed. See e.g. Mofor, *supra* note 20.

marine currents and wave regimes. Yet little of this is proven, and initial studies show far less impact than expected on the marine environment.[149] Conventional uses of the ocean environment, such as shipping, fisheries, and oil and gas development, have far greater environmental impacts than tidal energy development. However, these impacts are more certain, assessed, and comprise a socially (or politically) accepted risk in development.

The inherent issue in tidal energy regulation is that the potential risk factors, despite being increasingly understood and accepted, are not being integrated into legal change at the regulatory and licensing stages of analysis. In order to promote a strong and viable tidal energy market, the removal of excessive legal environmental barriers for innovative technology is necessary. Just as SEAs promote sustainable development through planning of the marine environment, [150] and RPSs allow states to designate the development of tidal power as vital to meeting renewable energy goals,[151] these high level designations do little to ease the burden on developers during impact assessment processes. Individual tidal projects should thus not be seen in silos. Tidal turbines, and their related environmental impacts, should be considered amongst higher-level environmental goals, such as energy security policy, meeting compulsory greenhouse gas reduction targets,[152] diversifying provincial energy mix, and mitigating impact to the seabed while promoting diversified uses of the ocean environment.

B. Climate Change

In helping change the environmental assessment scheme for tidal energy, legislators will better position the industry and their provinces for entry into growing regional and international movements to combat climate change. The sale and purchase of carbon credits, conventionally known as a cap and trade system, is growing internationally. Called for in the United Nations Framework Convention on Climate Change, carbon credits were concretized in the Kyoto Protocol.[153] However, rather than evolving at a global level, as originally forecasted, carbon trading schemes developed regionally through provincial, national, and trans-border agreements.[154] Recently, the Western Climate Initiative, of which California and Quebec are the largest drivers and proponents, added on another signatory in the province of Ontario.[155] Canada's largest potential tidal producers have not yet commit themselves to these agreements.[156]

However, with Canada's ascension to the Paris climate accords, it is time for serious thought about entry into a carbon trading system or implementation of a carbon tax for Canada's tidal jurisdictions. The Maritime provinces, the Arctic region, and the West Coast would benefit from their investment and development of tidal energy in any

149 Obermann, *supra* note 83.

150 Strategic Environmental Assessments are discussed above.

151 Renewable portfolio standards are discussed in the introduction to this paper.

152 As would have been the case had Canada still been a part of the Kyoto Protocol at time of writing (2015-2016). This statement is made in the expectation that the Paris Conference of December 2015 drew renewed interest from the Canadian government for involvement in these international commitments.

153 *UN Report of the United Conference on Environment and Development,* Rio de Janeiro, 3-14 June 1992, Annex I, "Rio Declaration on Environment and Development", UN Doc A/CONF 151/26 (Vol I) (1992) [Rio Declaration]; *Kyoto Protocol to the United Nations Framework Convention on Climate Change,* 10 Dec 1997, UN Doc FCCC/CP/1997/7/Add 1, 37 ILM 22 (entered into force 16 Feb 2005) [Kyoto Protocol].

154 Grant Boyle, "A Review of Emerging GHG Emissions Trading in North America: Fragmentation or Progress?" (2009) 46 Alta L Rev 173.

155 Saqib Butt & Joanna Rosengarten, "Ontario Introduces Cap & Trade System" (21 April 2015) *Canadian Energy Law Blog*, online: <http://www.canadianenergylawblog.com/2015/04/21/ontario-introduces-cap-trade-system/?utm_source=Mondaq&utm_medium=syndication&utm_campaign=View-Original> archived at <https://perma.cc/J7KC-ZP9A>.

156 With the exception of British Columbia's internal carbon tax.

evolving accord to reduce emissions in line with Canada's commitments at Paris. By betting on technological development and less costly access to renewables, tidal energy producers have the potential to reshape electricity generation mix in their grids in the coming years.[157]

C. Mitigation of Environmental Concerns

Drawing further on the environmental benefits of tidal energy, a brief comparison is made here to conventional sources of energy, as well as other forms of renewable energy, in order to add context to the holistic discussion on energy strategy.

Key to tidal energy devices is their siting on the ocean surface. As they cannot be seen or heard, they draw relatively less concern over view shed pollution than do other forms of offshore energy projects, such as wind farms or conventional oil and gas exploration.[158] While having fewer overall NIMBY concerns, tidal projects still challenge traditional uses of the marine environment, potentially interfering with shipping, fisheries, and aquaculture activities.[159] Key to this adaptation of environmental use are holistic strategic plans calling for open dialogue of mitigation strategies in a given region.[160]

Tidal energy projects have a lesser effect on bird life, given their subsurface siting.[161] Their impact on marine life has thus far been perceived as minimal, and their development is even envisaged in certain marine protected areas, contingent on agreeability with the management plan of the region.[162] The alteration they may bring about to existing marine currents and tidal regimes is currently unclear, though should be studied extensively throughout deployment, so as to inform future projects.[163] Tidal energy farms are projected to have a clearly beneficial effect on the benthic (ocean bottom) environment, akin to that of a marine protected area.[164] By limited fishing and drag-netting operations across a surface, tidal platforms and installation will provide safe space for benthic organisms to affix onto new structures, while promoting fish spawning grounds and potential lessening of shipping activity in a region. Experience with offshore wind projects in Europe shows a clear rebound in marine life following platform construction.[165]

IX. A FRAMEWORK FOR TIDAL ENERGY DEVELOPMENT

This paper has sought to analyze various aspects of tidal energy development throughout the world. With a strong focus on the role of governmental regulation and intervention in the industry, this paper has touched on technological breakthroughs, energy law and policy, project financing, regulatory approaches, infrastructure and grid development, and tidal power's effects on the environment and climate change. Throughout, the author has sought to make reference to two specific case studies: Arctic Canada and the

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157 Drawn from Wendy Koch, "After Paris, 3 Reasons the World Could Bid Adieu to Fossil Fuels" (14 December 2015), *National Geographic: Paris Climate Talks*, online: <http://news.nationalgeographic.com/energy/2015/12/151214-can-the-world-bid-adieu-to-fossil-fuels-paris-climate-talks/> archived at <https://perma.cc/42Z7-TB9A>.

158 Drawn from research by Navigant Consulting Inc, "Offshore Wind Market and Economic Analysis: Annual Market Assessment" (22 February 2013), *US Department of Energy*, online: <http://www.navigant.com> archived at <https://perma.cc/2CNK-X8YS>.

159 Matter Network, *supra* note 12.

160 Kolliatsas et al, *supra* note 21 at 100.

161 Luoma, *supra* note 23.

162 Inger et al, "Marine renewable energy: potential benefits to biodiversity? An urgent call for research" (2009) 46 J Appl Ecol 1145.

163 Kolliatsas et al, *supra* note 21 at 235.

164 Inger, *supra* note 162.

165 *Ibid*.

Bay of Fundy, generally.[166] While other identified regions have been referred to—such as the Pacific Coast and the St. Lawrence River—the author does not purport to canvass these regions fully, which would be beyond the scope of this paper. Instead, concluding remarks are offered through an in-depth analysis of opportunities and cautions in moving forward with the development of tidal energy in the Arctic and Maritime regions.

A. Nunavut

In today's privately developed tidal energy industry, finding the right offshore renewable energy market begins on land. The first step to establishing a successful business is finding locations where the provision of tidal energy would yield the highest price.[167] In the United States, that location is Hawaii, with energy prices almost four times the mainland average.[168] In Canada, that location is Nunavut, where per capita energy use is double the Canadian average and government subsidized energy cost can amount to over $11,000 CAD per person, per year.[169] The costs of shipping fossil fuels to remote hamlets is extremely expensive, and limited to a very short shipping window. As such, the development of renewable fuels is essential to sustainability of this region.

An economic incentive is clearly present for tidal energy development to support Nunavut's communities. With energy cost above $1 per kWh in some communities, tidal energy generation becomes a profitable endeavor.[170] Moreover, technological development and investment in the region will yield the world's most durable turbines, capable of withstanding changes in sea ice, dramatic seafloor geology, and durable transmission systems.

Given the lack of a commercially ready turbine in the world, Nunavut's micro-grid communities are the ideal testing site for smaller projects generating few megawatts and having little impact on the surrounding environment. When ready for commercialization, these systems should be strategically expanded and connected to an expanded Canadian transmission infrastructure, through waypoints in the Northwest Territories, Manitoba, or Quebec. Over seventy percent of Canada's tidal current energy lies in the Hudson Strait and surrounding regions, offering plentiful potential for expansion.[171]

However, in order for this development to occur in the private sector, governments must adopt comprehensive and predictable energy policies to promote investment. These include (1) completing detailed resource assessments for tidal waters in the Arctic region, (2) funding strategic environment assessments of Nunavut waters, (3) promoting the development of a marine spatial plan for the region, (4) establishing pre-permitted test sites, and (5) making commitments to expand infrastructural transmission capacity to allow for product export. Working in coordination with ongoing conventional energy development in Canada's north and internationally, the aforementioned policy implements will serve as the groundwork for a solid energy regulation promoting private investment in tidal energy development.

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166 Referred throughout the text as referencing to Nunavut and Nova Scotia.

167 In order to cover the high cost of production, mostly.

168 Musial & Ram, *supra* note 1.

169 Energy Facts, "Energy Use in Canada's North: An Overview of Yukon, Northwest Territories, and Nunavut" (2011) National Energy Board.

170 Peter Varga, "Start-up company pitches tidal power for Nunavut: Frobisher Bay tides could phase out high-cost diesel generation, says Iqaluit entrepreneur" (19 November 2014), *Nunatsiaq Online*, online: <http://nunatsiaqonline.ca> archived at <https://perma.cc/GW9X-PNBT>.

171 "Offshore Renewable Energy", *Fisheries and Oceans Canada*, online: <http://www.dfo-mpo.gc.ca/science/oceanography-oceanographie/adaptation/offshore-eng.html> archived at <https://perma.cc/2VVG-CV9M>.

B. Nova Scotia

With its FORCE testing center in place, strategic environmental assessments of resources having been conducted, and ingenious projects already taking place in other energy sectors throughout the province,[172] Nova Scotia has taken initial steps to becoming an strong producer of renewable energy on a global scale. However, the province suffers from a federal inability to fully coordinate action in order to allow for the development of commercial scale tidal projects, which loom just over the horizon.[173]

Further, the development of Nova Scotia's tidal industry has rarely been run locally. Nova Scotia (and Canada as a whole) lags behind in turbine development, despite the investment of over $795 million CAD in a clean energy fund for tidal power innovation.[174] As such, although Nova Scotia remains an important and convenient testing site for new tidal technologies,[175] few to none are natively developed.[176]

In order to reverse this trend, political will must emanate from all levels of government: federal, provincial, local, and Aboriginal. Nova Scotia must invest in skills transfer from its lucrative and advanced oil extraction and shipbuilding sectors,[177] while establishing clear legislative priorities for development of the marine sector.

For this development to occur, both the federal and provincial governments must prioritize an energy policy that (1) commits to completing detailed resource assessments for all tidal channels in the Bay of Fundy, (2) promotes the development of a comprehensive marine spatial plan, (3) restructures financing models for transmission links to the grid infrastructure, (4) completes a marine renewable energy legislation, giving jurisdictional certainty to producers, and (5) clarifies the role and purpose of tidal energy as a central facet of the region's renewable energy development, ensuring a reduction of increasing burdens on the burgeoning technology.

CONCLUSION

In sum, Canada is a fortunate land. Endowed with seemingly innumerable conventional energy reserves, the Canadian economy has grown on the back of its natural resources. Yet Canadian energy policy and regulation must challenge the bent favoring conventional energy extraction, and focus on emerging renewable energy technologies as drivers of future economic success. Using its challenging climatic and geographical conditions to develop the most dependable tidal turbine technology in the world, Canada has the potential to become an export leader in innovative marine renewable technology, while developing two of its most economically deprived regions.[178] In order to spur this change, governmental energy policy and regulation need take heed of global change.

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172 Emera, *supra* note 121.

173 Despite Nova Scotia's Marine Renewable Energy Legislation framework having been discussed, debated, and published, the Government of Canada has made no mention of the possibility of establishing a coordinating agency between the two entities, as it had done in 1990 with the CNSOPB.

174 Kolliatsas et al, *supra* note 21 at 232.

175 The Minas Passage is considered the best testing sites in the world. If a turbine can stand up to the "Fundy Standard", it is said that it will be structurally successful in any of the world's waterways and channels.

176 Mofor, *supra* note 20 at 24.

177 Kolliatsas et al, *supra* note 21 at 155.

178 The Arctic and the Maritimes, broadly.