Turning the Tide: A Just Transition to Low-Emission Marine Propulsion Solutions in Coastal Indigenous Communities

by

Katarina Heim

B.A. (Geography and Environmental Studies), University of Victoria, 2017

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Declaration of Committee

Name: Katarina Heim

Degree: Master of Resource Management (Planning)

Title: Turning the Tide: A Just Transition to Low-Emission Marine Propulsion Solutions in Coastal Indigenous Communities

Committee:

Niis Na'yaa/Kam'ayaam/Chachim'multhnii (Clifford Gordon Atleo)
Supervisor
Assistant Professor, Resource and Environment Management

Sean Markey
Committee Member
Professor, Resource and Environment Management

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Abstract

The renewable energy transition in Canada is marred by colonialism and the dispossession of Indigenous lands. Despite these continuing historical legacies, many Indigenous communities are actively addressing the climate crisis and spearheading renewable energy initiatives. This research employs a sociotechnical approach to bridge existing knowledge gaps in the field of energy transitions, specifically focusing on the decarbonization of fishing and passenger vessels in coastal Indigenous communities in British Columbia. As marine vessels are an important consideration in the net-zero targets of these coastal communities, this study, conducted in collaboration with the Nuu-chah-nulth Tribal Council, seeks to address the potential opportunities and barriers in this transition. Research methods include a narrative literature review, semi-structured interviews, a policy scan, and a comparative policy analysis. The results provide a roadmap for future actions while delivering policy recommendations tailored to support an inclusive and equitable transition to low-emission marine propulsion solutions in coastal Indigenous communities.

Keywords: Indigenous; just transition; renewable energy transition; low-emission propulsion, marine decarbonization; climate policy

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List of Acronyms

BC	British Columbia
CEEP	Community Energy and Emissions Plan
CO_2	Carbon dioxide
ECCC	Environment and Climate Change Canada
DRIPA	Declaration on the Rights of Indigenous Peoples Act
GHG	Greenhouse gas
IMO	International Maritime Organization
IPP	Independent Power Producer
LNG	Liquid Natural Gas
LPG	Liquefied petroleum gas
NO_x	Nitrogen oxides
NTC	Nuu-chah-nulth Tribal Council
SBC	Skidegate Band Council
SFU	Simon Fraser University
SOP	Standing Offer Program
SO_x	Sulfur oxide
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
URN	Underwater radiating noise
ZEV	Zero-emissions vehicle

Chapter 1. Introduction

1.1. Research Context

Many Indigenous Peoples remain closely connected to natural systems and depend upon the land and ocean for food security, trade, cultural connection, and harvesting and preserving food resources (Turner et al., 2013; Whitney et al., 2020). Climate change poses a significant and disproportionate threat to communities whose livelihoods and cultures are intimately tied to the land and ocean (Hoicka et al., 2021; UN Press, 2018). Rapidly developing and complex climate change impacts are altering weather patterns and the phenology of food sources worldwide, resulting in profound implications for Indigenous communities. Coastal communities, in particular, are facing the impacts of ocean acidification and warming, influencing species distribution and availability (Ainsworth et al., 2011; Cheung et al., 2015). Immediate adaptation and mitigation actions are required for both social and ecological systems (Whitney et al., 2020; Whyte, 2020). As a result, there is a global push to transition away from fossil fuels to renewable energy sources in an effort to maintain warming temperatures below 1.5 degrees Celsius.

The transition to renewable energy sources is widely recognized as a crucial pathway for reducing greenhouse gas (GHG) emissions and increasing economic and community resilience in the face of climate change. However, Krupa et al (2015) argue that Canada’s history of colonization and the associated politics of dispossession persist throughout the transition to renewables, serving to further separate Indigenous Peoples from their territories. For example, the province of British Columbia (BC) has a history of constructing mega-dam hydroelectric projects like the Site C and WAC Bennett dams, displacing communities and violating Indigenous rights and title (Yunker, 2022). Consequently, Canada's transition to renewable energy is not inherently just or positive for Indigenous Peoples (Whyte, 2020). Despite federal and provincial governments’ efforts to introduce collaborative and equitable policies, including the adoption of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) in 2021 through Bill C-15 and the Declaration on the Rights of Indigenous Peoples Act (DRIPA, 2019), energy agendas have remained state-centric with regulatory control and ownership retained by colonial governments (Molander, 2022).

Nonetheless, First Nations[1] are at the forefront of the transition to renewable energy sources on Turtle Island. A significant driver in this movement is the transition of remote communities away from diesel dependency. There are 292 remote off-grid communities in Canada, including 170 Indigenous, relying on diesel-generated electricity year-round (MacArthur et al., 2020). Recognizing the significant environmental and health challenges posed by diesel usage, funding and policy initiatives are being allocated to provide remote communities with pathways to renewable energy alternatives. Until now, the majority of low-emission energy development and research has been conducted on land-based systems as research on technology, consumer markets, and policy for land-based zero-emissions vehicles (ZEV) has grown steadily in recent years. Comparatively, little research has taken place in the marine transportation sector, despite marine vessels being a significant contributor to global GHG emissions (Greer et al., 2019).

Marine vessels are a common mode of transportation and a significant contributor to community GHG emissions for remote coastal Indigenous communities in BC, as they operate primarily on marine gas or other fossil fuels. For example, the community of Bella Bella in Haíłzaqv Territory emits approximately 5,136 tonnes of CO2 annually, 15% of which comes from marine gas. This makes marine transportation the third highest emitting sector after heating and auto gas (Haíłzaqv Community Energy Plan, 2022). Decarbonizing marine transportation represents a major opportunity to offset emissions and is an important consideration for coastal communities. However, low-emission marine propulsion systems and infrastructure are not yet prevalent in Canada's large-scale policy, planning or practice, leaving First Nations to forge the path to renewable energy adoption in the marine context. Notably, many coastal Indigenous communities in BC are addressing the climate emergency through the development of climate action strategies, net-zero plans and community energy and emissions plans

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[1] The terms “First Nations” and “Indigenous Peoples” are used interchangeably throughout this research paper. It is important to acknowledge that these words carry distinct meanings and nuances. In a Canadian colonial context, the term Indigenous Peoples (referred to as “Aboriginal” in the Constitution Act, 1982) refers to the distinct societies of First Nations, Inuit, and Métis, as well as individuals who identify as Indigenous based on their cultural heritage but who may not possess legal recognition under the *Indian Act*. The term First Nation(s) is used when referring to a specific segment of Indigenous Peoples while recognizing the cultural integrity of First Nations and that they are comprised of highly diverse knowledge systems, philosophies, and lived experiences.

(CEEP). Several of these communities include the consideration of low-emissions marine propulsion within these plans. This research aims to support this process.

This work is part of an Indigenous-led project titled *Turning the Tide: Exploring Clean Marine Propulsion in Coastal Indigenous Communities*, which is an interdisciplinary undertaking with the Resource and Environmental Management Department at Simon Fraser University (SFU) and the Engineering Department at the University of Victoria. This project has partnered with the Nuu-chah-nulth Tribal Council (NTC), a not-for-profit society that supports 14 First Nations located on Vancouver Island (the Ditidaht, Huu-ay-aht, Hupacasath, Tseshaht, Uchucklesaht, Ahousaht, Hesquiaht, Tla-o-qui-aht, Toquaht, and Yuu-cluth-aht, Ehattesaht, Ka:'yu:'k't'h'/Che:k:tles7et'h', Mowachaht/Muchalaht, and Nuchatlaht First Nations, see below in **Error! Reference source not found.**), and the Skidegate Band Council (SBC) on Haida Gwaii. The purpose of this research is to provide a roadmap for the NTC and SBC as well as other remote coastal Indigenous and non-Indigenous communities who are considering transitioning to low-emission marine transportation systems.

Due to the limited scope of this research paper, data will be gathered solely from the NTC Nations. Each Nation supported by the NTC is distinct in size, culture, and governance. Table 1 provides a sense of the scale of these communities as well as their accessibility. Notably, the communities of Ahousaht, Hesquiaht, Ka:'yu:'k't'h'/Che:k'tles7et'h', and Uchucklesaht are only accessible by boat as is the case with large swaths of territory in this remote coastal region. The small population size and remote nature of many NTC communities come with unique challenges inherent to rural communities including limited employment opportunities, inconsistent access to healthcare and increased cost of goods and services (Markey et al., 2023; Cummings, 2023). Despite the challenges, NTC Nations continue to show leadership in the face of climate change as they work tirelessly to achieve their emissions reduction targets and build resilient communities that live in harmony with their surroundings. Low-emission marine vessels are a part of this vision and the future of these communities.

Table 1. Population and community accessibility of the 14 NTC Nations

Nation	On-Reserve Population	Off-Reserve Population	Community Access
Ahousaht	754	1478	Boat access only
Ditidaht	165	605	Road access
Ehattesaht	104	448	Logging road access
Hesquiaht	117	638	Boat access only
Hupacasath	132	229	Road access
Huu-ay-aht	96	610	Partially accessible by road
Ka:'yu:'k't'h'/Che:k:tles7et'h'	164	420	Boat access only
Mowachaht/ Muchalaht	223	392	Road access
Nuchatlaht	23	146	Logging road access
Tla-o-qui-aht	394	809	Partially accessible by road
Toquaht	10	138	Road access
Tseshaht	463	808	Road access
Uchucklesaht	27	220	Boat access only
Yuu-cluth-aht	209	462	Road access

Source: CIRNAC First Nations Profiles, 2021

This research paper examines marine decarbonization efforts and the implementation of low-emission marine vessels in remote coastal Indigenous communities using a sociotechnical approach that is grounded in the principles of energy justice. Sovacool et al (2017 a) characterize sociotechnical approaches within the context of energy transitions to extend beyond the technical considerations of designing new technology, to include social, cultural, political, and economic values and implications. While the importance of vessel and battery design, onshore grid infrastructure, and information systems pertaining to low-emission marine propulsion is great, a sociotechnical approach also emphasizes the need to consider social justice, equity, cultural integrity, and self-determination in the context of our partner communities. This approach is grounded in systems thinking and recognizes the interconnectedness of all things. The Nuu-chah-nulth phrase, *hishookish tsawalk,* which means “everything is one” captures this nicely (Atleo, 2004). Jenkins et al (2018) highlight that the ‘socio’ aspect is often missing in transition plans despite being inherently rooted in core notions of equity and justice. By incorporating an energy justice framework, this research seeks to rectify this gap by examining how the implementation of low-emission marine propulsion systems can align with principles of energy justice and sovereignty, fostering a holistic and inclusive approach to marine decarbonization in remote coastal Indigenous communities.

Figure 1. Nuu-chah-nulth Traditional Territory (Native Land Digital, n.d.)

1.2. Research Objectives

1. To consider the social, economic, cultural, technical, and policy dimensions of adopting low-emission marine propulsion systems.
2. To understand how low-emission marine propulsion may fit into the energy planning of remote coastal Indigenous communities with particular emphasis on self-determination priorities and cultural and environmental considerations.
3. To provide recommendations for policymakers to support a pathway to low-emission marine propulsion solutions.

1.3. Research Questions

1. What are the opportunities and barriers surrounding the transition to low-emission marine propulsion systems in remote coastal Indigenous communities?
2. How can climate policy and planning support the just transition to low-emission marine propulsion in remote coastal Indigenous communities?

1.4. Positionality Statement

I am a white, cis-gendered, able-bodied woman who was born and raised on the stolen lands of the Wabanaki, N'dakina, and Nanrantsouak Peoples. I am a descendant of settler-colonial ancestry with roots in the United Kingdom. I grew up with a supportive family who taught me to care for the land and those living on it. Every day they encourage me to continue learning and to lead with love. I recognize with humility the immense privilege I have, to pursue higher education as a white researcher and student engaging with Indigenous topics. I am an outsider to the Indigenous communities centred in this work and thus I may lack the essential social and cultural insights required to fully comprehend the complexities of this research. My work intends to be as holistic as possible, linking understandings and experiences from different fields, as I attempt to be a vehicle of communication for our Indigenous research partners and the broader Clean Marine Solutions research group.

While I research the clean energy transition as it pertains to marine decarbonization in remote Indigenous communities, I am aware of the troubled history surrounding settler research of Indigenous communities as often contributing “damage-centered and damaging research” (Tuck, 2009, p. 413). I recognize that the history of resource extraction, fuel production and the associated policies and practices in BC have caused pain and harm to Indigenous Peoples and their lands. As a white settler researcher, it is important to locate myself within these processes to not only be mindful of the ethical responsibility I hold as an academic, but also to recognize the limitations of my understanding as a settler. Ultimately, I want to be accountable to the Nuu-chah-nulth and Haida Nations and my readers and acknowledge that this research is inherently shaped by my perspectives. My intention in this space is not to victimize or absorb diverse identities or ways of life into settler-colonial thought but to describe the existing barriers and provide potential pathways for a just transition to marine decarbonization.

Chapter 2. Literature Review

2.1. The Indigenous Renewable Energy Transition

Transitioning away from fossil fuels to renewable energy sources is an important step in mitigating climate change and achieving legislated GHG emission reduction targets, but renewable energy development in Canada is fraught with conflict, violence, and the ongoing dispossession of Indigenous lands (Hoicka et al., 2021; Atleo & Boron, 2022). As a settler colonial state, Canada is built upon the imposition of colonial laws and governance, serving to effectively erase Indigenous economies, cultures and political organizations (Hoicka et al., 2021; McGregor et al., 2020). Patrick Wolfe (2006) describes settler-colonialism[2] as not simply a historical event but as a distinct structure focused on resource and land acquisition, and embedded in policy and governance systems. Anishinaabe scholar, Deborah McGregor (2019) clarifies that this "[colonial structure] continues to alienate Indigenous Peoples from the lands/waters and creates the conditions for climate change vulnerability" (p. 144).

Despite being disproportionately vulnerable to and affected by climate change (UN Press, 2018), Indigenous Peoples have historically been excluded from resource development and energy planning in Canada (Hoicka et al., 2021). The Bennett, Peace Canyon, and Site C Hydroelectric Dams are but a few major energy projects that have proceeded in blatant violation of treaty rights, dispossessing Indigenous Peoples of their land, and ignoring a legal duty to consult (Yunker, 2022). Projects such as these are built in the name of BC's "clean" energy future, however, energy is often not as clean as it is made out to be (Molander, 2022; Indigenous Climate Action [ICA], 2021). Today, many First Nations are participating in renewable energy development as a way to assert their collective rights to land and self-determination and confront this pattern of colonial destruction (Hoicka et al., 2021). As such, renewable energy development may be undertaken as a potential path toward reconciliation but also has the potential to

[2] Settler-colonialism is a distinct form of colonialism that is characterized by the settler's intent to permanently control and occupy the land. The displacement and assimilation of Indigenous Peoples is necessary to enable settlers to reshape the land according to their own needs and desires and impose their own institutions, laws, and cultural norms. Wolfe's analysis focuses on the structural and ongoing nature of settler-colonialism, highlighting the impact and enduring legacies of dispossession, marginalization, and cultural erasure.

continue perpetuating colonial structures of exploitation (Hoicka et al., 2021; Whyte, 2020).

Indigenous Peoples are at the forefront of the renewable energy transition in Canada and have played a vital role in energy production and innovation for many decades (Indigenous Clean Energy [ICE], 2022; Pembina Institute, 2022 a). Indigenous renewable energy projects in Canada have been on the rise since 2017, with a growth rate of 29.6% for medium-to-large projects (ICE, 2022). Today, First Nations entities are partners or beneficiaries of almost 20% of Canada's electricity-generating infrastructure (ICE, 2022). In BC, Indigenous energy leadership is increasingly prominent as First Nations deliver approximately 13% of the province's electricity (Hoicka et al., 2021), providing a combined power capacity of 2553 megawatts, which is more than double the expected capacity of the Site C dam (Pembina Institute & New Relationship Trust, 2021). In 2017, the BC First Nation Clean Energy Working Group conducted a study that found 98% of First Nation communities in BC want to participate in the renewable energy sector (Pembina Institute, 2022 a).

Indigenous renewable energy leadership is particularly prominent in the context of remote communities in Canada. The Government of Canada's Energy Regulator (2023) estimates that 178 remote Indigenous communities in Canada are not connected to the North American energy grid and are thus largely reliant on diesel-generated electricity. Of these communities, 44 are located in BC and in 2019 they consumed at least 19.1 million litres of diesel, emitting the equivalent of 51,784 tonnes of carbon dioxide (CO_2) (Government of BC, 2023). As part of an initiative to reduce emissions and address climate change, the Government of Canada has pledged that remote communities will transition away from diesel by 2030 (Trudeau, 2021). In addition to high purchase and transport costs, burning diesel emits carbon and particulate matter affecting air quality and contributing to climate change (Natural Resources Canada, 2023). Further risk of environmental harm stems from the potential of diesel leaking or spilling during transport (see section 2.3.3.), in storage or from home tanks. As such, many remote First Nations communities in BC are taking action to transition away from diesel.

Remote Indigenous communities are at the forefront of the country's renewable energy evolution and are leading the way toward a transition away from diesel and diesel-generated electricity (ICE, 2022). For coastal communities, the decarbonization of marine propulsion systems is a critical consideration in this transition as most marine vessels require fossil fuels to operate. Until now, the majority of energy transition research pertains to land-based systems resulting in a lack of long-term experience with the implementation of low-emission marine propulsion systems (see section 2.4.). Nonetheless, Karanasios & Parker (2018) affirm that learning through experimentation leads to the empowerment of local governments and maximizes community sustainability. Therefore, not only is marine decarbonization a critical consideration for coastal communities working towards a transition away from diesel but it represents an innovative opportunity to strengthen community resilience and sustainability in the process.

2.2. Equity, Justice & Sovereignty in the Energy Transition

Energy systems are socio-technical networks, involving not only machines, pipes, and refineries, but also the humans responsible for designing, creating, and managing these technologies, as well as those of us who use and consume energy. In turn, energy systems include financial networks, labour forces requiring specialized education, regulatory commissions, multi-level governance structures, and companies as well as social norms and values that assure their proper functioning (Miller et al., 2013). In Canada, socio-technical energy systems have long since been dependent on fossil fuels. The decarbonization of marine transportation is reliant upon a broader societal transition to renewable energy sources but energy transitions like this are complex and multifaceted (Miller et al., 2013). Large-scale transitions, in particular, can be disjointed and have the potential to perpetuate inequity through the advancement of colonial and capitalist energy agendas (Hoicka et al., 2021). Several of our community partners, along with many other remote Indigenous communities in the province, are not connected to the BC Hydro grid and are transitioning away from diesel-generated electricity. This transition must occur in a just and equitable manner, upholding the colonial government's commitments to reconciliation and UNDRIP (Bill C-15, 2021) and DRIPA (2019), as outlined in the Truth and Reconciliation Calls to Action (TRC, 2015).

An expanding body of literature exists surrounding justice in transitions, with a particular focus on the energy sector (Hurlbert & Rayner, 2018; Jenkins et al., 2017, 2018; Sovacool et al., 2017 b; Williams & Doyon, 2019). Sovacool et al (2017 b) define energy justice as “a global energy system that fairly distributes both the benefits and burdens of energy services and one that contributes to more representative and inclusive energy decision-making” (p. 1). By applying concepts of social justice to an energy system and critically examining the harms and benefits, who wins and who loses, and recognizing the historical exclusion of peoples and worldviews, this framework can contribute to making informed energy choices that are both sustainable and just (Doyon et al., 2021; Sovacool et al., 2017 b). Williams & Doyon (2019) ascertain that an unjust transition is not sustainable and political support for transitions wears down when justice is not considered. Effectively, inattention to social justice can cause injustice (Jenkins et al., 2017).

Climate policy in Canada does not adequately account for justice in the transition away from fossil fuels as “little meaningful progress has been made to address colonialism, reduce the disproportionate climate impacts on Indigenous Peoples, and advance Indigenous-led solutions” (Reed et al., 2021, p. 8). On the contrary, federal climate policy demonstrates conflicting commitments to reconciliation and the advancement of nation-to-nation relationships, while simultaneously largely ignoring Indigenous perspectives, knowledge, and climate adaptation strategies. For example, the field of energy justice and its representation in climate discourse is overwhelmingly concerned with the ethics and relationships between humans (Sovacool et al., 2017 b). An Indigenous justice approach broadens horizons to recognize the agency of *all relations*, including non-humans and the Earth itself (McGregor et al., 2020). This approach is best expressed through Indigenous knowledge and governance systems, entities that are largely non-existent in federal climate policy. As such, McGregor et al (2020) state that “not only do current global, national and local governance and legal systems fail Indigenous peoples, they fail all life” (p. 35).

Researchers are highlighting a critical need to Indigenize and decolonize climate policy in Canada (Deranger et al., 2022; Reed et al., 2021; Whyte, 2017) through avenues such as increasing federal and provincial support of Indigenous self-determination, resurgence, sovereignty and repatriation (Coulthard, 2014; Corntassel, 2012; Tuck & Yang, 2012) and by dismantling Western decision-making processes and colonial relationships across energy systems (Whyte, 2017). Energy sovereignty, in particular, is recognized as an important pathway to centring the rights of communities to make their own decisions regarding the forms, scales, organization, patterning, and sources of energy. However, current energy policy does not prioritize energy sovereignty, and in many cases actually works against it (Schelly et al., 2020). For example, the Wet'suwet'en Nation has never ceded or sold their Territory, underscoring their rightful claim to sovereignty. Despite this, their Territory is being invaded by the Canadian Royal Mounted Police as Coastal GasLink moves ahead with a controversial pipeline project. The existing energy policy regimes deny their right to sovereignty, self-determination or governance as the federal government stated that First Nations do not have veto power over energy infrastructure projects (Schelly et al., 2020).

In light of the need for justice and equity in energy transitions, considerations of self-determination and sovereignty should extend beyond land-based contexts to encompass marine decarbonization solutions as well. The importance of marine decarbonization lies not only in mitigating climate change and reducing GHG emissions but also in upholding the rights and perspectives of Indigenous Peoples and ensuring a just, equitable and inclusive transition. To achieve such a transition, it is crucial to centre the principles of energy justice and right historical wrongs as we begin to understand the diverse environments and user needs at play as well as the climate impacts associated with fossil fuel-powered marine propulsion systems and the current state of low-emission marine propulsion.

2.3. More-Than-Human Considerations: Impacts of Fossil Fuel-Powered Marine Propulsion Systems on Coastal and Marine Ecosystems

2.3.1. GHG Emissions & Air Pollution

Marine transportation is an integral part of our global economy with continuous vessel traffic transferring goods across oceans worldwide. Marine vessels largely operate on fossil fuels, emitting CO_2, nitrogen oxides (NO_x), sulphur dioxide (SO_x), and particulate matter into the atmosphere (Jeong et al., 2022). In 2022, maritime transportation was responsible for 3.2% of global GHG emissions, the majority of which were attributed to international shipping as it was responsible for 87% of these emissions (Furfari & Mund, 2022). International and domestic shipping is increasing worldwide and if this trend continues, shipping emissions are expected to grow by 50-250% from 2008 levels by 2050 (Razy-Yanuv et al., 2022; Reusser & Pérez Osses, 2021). Consequently, the International Maritime Organization (IMO) has implemented various energy efficiency regulations for ships in an effort to decarbonize the industry and reduce global shipping emissions (International Maritime Organization [IMO], 2018). Due to the proven environmental impact of maritime shipping and established energy efficiency requirements in the sector, it is a prominently researched area (Feng et al., 2022; Jeong et al., 2022; Reusser & Pérez Osses, 2021; Skjong et al., 2016).

Despite the established impact of maritime shipping on the environment, there are still areas of marine transportation that are under-researched. The environmental impacts of the shipping industry are established and well-studied, however, it is important to note that fishing, passenger, and personal vessels account for 5% of marine transportation emissions (Reusser & Pérez Osses, 2021). Smaller vessels of this type are commonplace in coastal areas and are a primary means of transportation for some. Still, Greer et al (2019) determined that they are rarely studied or accounted for in emissions reduction strategies and regulations. This is important to understand as "reducing GHG emissions and mitigating the effects of climate change depends on our understanding of what sectors are significant contributors to CO_2 emissions, and where reduction strategies can be effectively implemented" (Greer et al., 2019, p. 1). In their study, Greer et al (2019) calculated CO_2 emissions from the world's fishing fleets and found the results to be significantly higher than previously thought in both absolute terms and emissions intensity. Furthermore, approximately 70% of marine transportation emissions are estimated to occur within 400 kilometres of land (Viana et al., 2014), an area where smaller vessels primarily operate. The potential of air pollution and GHGs to harm the health of coastal communities further highlights the importance of incorporating the emissions of smaller vessels into emissions calculations and reduction targets (Viana et al., 2014). Since the highest percentage of ship emissions come from propulsion systems, transitioning to low-emission marine propulsion systems is considered a "rich research point" (Ammar & Seddiek, 2021, p. 37852).

2.3.2. Underwater Radiating Noise Pollution

Underwater anthropogenic noise pollution is a well-documented area of research and a growing concern (Chahouri et al., 2022). Anthropogenic noise is generated by a variety of marine industrial activities and technology development, however, underwater radiating noise (URN) from fossil-fuel-powered propellor cavitation and the turbulence of marine vessels represents the largest source of anthropogenic noise in oceans worldwide (McIntyre et al., 2021). Large commercial shipping vessels create low-frequency noise of 10 to 500 hertz, allowing for long-range propagation within up to a 100 kilometre radius (Hildebrand, 2009). Smaller vessels, relevant to our partner communities, generally contribute noise at a medium frequency of 500 hertz to 25 kilohertz, resulting in higher frequency but a lower propagation distance of approximately 10 kilometres (Hildebrand, 2009). Small boats undeniably increase ambient noise in local coastal settings and are an important component to consider as marine traffic increases (Hildebrand, 2009), especially as their impact on marine ecosystems is further uncovered.

Sound is known to be a key aspect of marine organisms' ecology and URN represents a consistent and persistent stressor on marine ecosystems, impacting the anatomy, physiology, and behaviour of many marine animals (Dooling et al., 2015; Hildebrand, 2009; McIntyre et al., 2021). The literature recognizes the significant threat that propeller-induced cavitation URN poses to marine ecosystems, however, the exact effects on many marine organisms remain understudied. The impacts of URN on marine mammals are more well-known. For example, studies show the disturbance from URN significantly impacts southern resident orca whales by masking the acoustic signals and echolocation clicks that orca whales use to hunt, navigate, and communicate (Holt et al., 2009; Williams et al., 2021; Burnham et al., 2023). Southern resident orca whales are endangered and Williams et al (2021) found that as URN increases they are more likely to stop foraging, greatly impacting their ability to survive. Superimposed noise levels from multiple vessels are assumed to cause permanent hearing loss over prolonged exposure (Erbe, 2002). As vessel traffic continues to increase in the coastal waters of BC (Greene & Aschoff, 2023), the well-being of marine ecosystems, particularly the species at risk that inhabit these waters, is imperilled.

As such, URN is considered a major environmental problem and scholars are modelling cavitation noise prediction with the intent of reducing overall noise pollution in the world's oceans (Ge et al., 2022; McIntyre et al., 2021; Park et al., 2020). The level of underwater noise radiating from fossil fuel-powered marine vessels can be correlated to their velocity, increasing as vessels travel faster. Thus, to date, the primary solution proposed in response to the issue of URN has been to reduce vessel speeds in critical habitats and areas of concern (Joy et al., 2019; McIntyre et al., 2021; R. Williams et al., 2021). Although reduced vessel speeds have shown a decrease in total ambient noise (Joy et al., 2019), this correlation is not universal and speed limits do not account for the significant variation in speed-noise behaviour between vessels (McIntyre et al., 2021). The variation in noise emissions based on vessel types, speeds, and loads makes it challenging to propose effective policies when addressing this problem (McIntyre et al., 2021). Although the literature on this topic has not yet created a clear link between low-emission marine propulsion systems resulting in reduced URN, Porru et al (2020, p. 1) confirm that "electric propulsion systems are very silent" thus highlighting clean marine propulsion systems as a potential emergent solution.

2.3.3. Oil Spills & Other Pollutants

Marine diesel oil is the standard fuel used in fishing vessels and recreational boats. It is also one of the most frequent petroleum derivatives found in the marine environment in the form of toxic petroleum hydrocarbons (specifically total petroleum hydrocarbons and polycyclic aromatic hydrocarbons) (de Santana et al., 2021). Oil contaminants primarily enter the aquatic environment due to operational failures and leakages or during major maritime events such as explosions, collisions, and shipwrecks (de Santana et al., 2021). Of particular concern in BC is an escalation in vessel traffic due to the increased transportation of bitumen along the provincial coastline. A simultaneous increase in other types of marine traffic naturally heightens the risk of collision or other events that may result in a significant oil spill (Greene & Aschoff, 2023). Oil spills resulting from maritime accidents represent a significant risk not only to marine ecosystems but also have lasting and devastating impacts on the culture, government, laws, and economies of coastal peoples (Curran et al., 2020).

In acknowledgment of the risks and harm posed by oil spills, Canada touts a 'world-class' oil spill response plan in the form of Transport Canada's (2014) National Oil Spill Preparedness and Response Regime and BC's Ministry of the Environment (2013) Marine Oil Spill Response Plan (The Narwhal, 2017). Both plans outline policies and procedures for industry and governments in the event of an oil spill in coastal waters. Neither framework, however, addresses the challenges associated with oil spills occurring in remote areas nor do they acknowledge Aboriginal rights pertaining to the economic, social, and ceremonial importance of marine resources.

The deficiencies of Canada's oil spill response plans were made clear on October 13, 2016, when the Nathan E. Stewart barge ran aground in *Q'vúqvai*, releasing over one hundred and ten thousand litres of diesel fuel and lubricant oils into the ocean in Haíłzaqv territory (Curran et al., 2020). It took the Coast Guard three hours after the accident to alert the Haíłzaqv Nation and the nearby community of Bella Bella, and a further seventeen hours for Transport Canada's oil spill response team to arrive on the scene (Heiltsuk Tribal Council, 2017). Upon arrival, equipment was poorly deployed, and safety gear and clear instructions were missing for Haíłzaqv first responders, resulting in inexplicable damage that reverberated throughout the community (Curran et al., 2020).

Confronted with the shortcomings and inefficiencies of provincial and federal strategies in dealing with a life-altering oil spill, the Haíłzaqv Nation found increased motivation to reduce their reliance on imported diesel (Vernet & Kulkarni, 2022). Since 2016, the Haíłzaqv Climate Action Team has set clear climate action goals, culminating in an award-winning Haíłzaqv Community Energy Plan (2022) in which they commit to electrifying 50% of marine vessels within the following five years. The impetus for this transition is a recognition that "switching to electric modes of transportation on the water will bring our community back into alignment with our Haíłzaqv values" (Haíłzaqv Community Energy Plan, 2022, p. 60).

2.4. Low-Emission Marine Propulsion Technologies

The marine transportation industry is currently dominated by internal combustion engines and steam or gas turbine propulsion systems that derive power from diesel and other petroleum-based fuels (Hayton, 2023). The related emissions are significant considering that globally the marine transport sector serves approximately 2.1 billion people and 250 million vehicles every year compared to air transportation which moves roughly 2.3 billion people a year (Cherchi et al., 2021). Therefore, transitioning away from fossil fuels in the marine sector is recognized as a potential solution to reducing transportation-related emissions (Ammar & Seddiek, 2021; Reusser & Pérez Osses, 2021) and has been recognized as an urgent global issue (Jeong et al., 2022).

Reducing dependence on diesel through the decarbonization of transportation systems is critical to achieving Canada's net-zero targets. In 2019, more than half of the total GHG emissions in numerous remote communities were attributed to emissions from transportation (Pembina Institute, 2022 a). As such, Environment and Climate Change Canada (ECCC) released its 2030 Emissions Reduction Plan (2022), committing to reducing carbon emissions from transportation by up to 18 megatons per year by 2030. The roadmap to achieving this is largely focused on road-based transportation, notably through the imposition of a sales mandate whereby 100% of new passenger vehicles sold in Canada will be ZEVs by 2035 (Transport Canada, 2021). This initiative will be supported by ZEV consumer incentive programs and by the implementation of the Clean Fuel Regulation which improves accessibility to charging infrastructure and low-carbon fuels technologies. The transition to clean energy and ZEVs is well underway on road-based vehicles with researchers dedicated to understanding the user needs, policy requirements and planning considerations (Axsen & Sovacool, 2019; Long et al., 2020; Sovacool & Axsen, 2018).

The importance of transitioning to low-emission propulsion solutions in the marine sector is acknowledged, however, the climate policy landscape in Canada does not yet give it the same recognition as road-based transportation. Until recently, electric energy has been supplied to marine vessels only, if at all, for auxiliary loads such as lighting, heating and ventilation, when boats are docked in a harbour (Mehammer et al., 2023). Now, there is a movement to implement electric, hydrogen fuel cell, and hybrid marine propulsion systems in coastal regions around the world. A transition of this scale will require an enormous shift (Mehammer et al., 2023) but is already yielding a multitude of benefits in comparison to traditional internal combustion engines, including energy diversification and increased efficiency (Hayton, 2023).

2.4.1. Low-Emission Propulsion Alternatives

Increased emissions regulations, global volatility of petroleum supply chains, and a significant push to source energy from renewable and sustainable sources are encouraging a global transition away from petroleum-based products in the marine transportation sector (Hayton, 2023). The options below are currently under consideration or being implemented as we move towards low- or zero-emission marine vessels. It is important to note, however, that researchers and industry, for example, Reusser & Perez Osses (2021), often present clean marine vessels as being zero-emission ships when in fact the life cycle of the fuel used is not considered. Fernández-Ríos et al (2022, p. 9) state that “to guarantee cleaner and more sustainable mobility, it is necessary to evaluate alternative technologies and low carbon fuels assessing and acting on all stages of their life cycle." Perčić et al (2021) and Jeong et al (2022) conducted comparative analyses to quantify the trade-offs between diesel and battery power systems and found that over half of the energy used in battery power systems was derived from fossil fuels. Thus, for each of the alternatives presented below it is important to conduct a life cycle analysis of the fuel to assess the primary sources used in production before implementation.

Low Carbon Content Alternative Fuels: Biofuels, Liquid Natural Gas (LNG), Liquefied Petroleum Gas (LPG)

Alternative fuels differ from fossil fuels based on their lower carbon content. Fuels such as LNG, LPG and biofuels have been shown to reduce SO_x, NO_x, and particulate matter, emissions that are deemed to affect coastal areas the most (Tan et al., 2022; Yeo et al., 2022). Reusser & Perez Osses (2021) highlight the potential of alternative fuels to ease the transition towards zero-emissions propulsion systems as they bridge the gap between traditional fossil fuels and zero-carbon technologies.

The use of LNG as an alternative marine fuel is garnering increased attention from the marine industry and is the most researched and used alternative fuel for marine vessels (Chun et al., 2022; Jeong et al., 2022; Perčić et al., 2020). Fuels such as LNG and LPG provide an opportunity to reduce emissions at a lower production and implementation cost in comparison to other clean marine propulsion alternatives. Biofuels, although still in the early stages of application in the marine industry, offer the added benefit of being blended with petroleum fuels thus reducing transition costs while still lowering emissions (Tan et al., 2022). For the benefits of alternative fuels to be realized and impactful, their adoption will need to be widespread, but it is important to note that the supply of such fuels is finite. Further knowledge gaps exist, particularly regarding the use of biofuels, including the life-cycle environmental impacts of these fuels, their compatibility to be blended with conventional marine fuels, the scalability of their implementation, and the associated cost (Tan et al., 2022).

Battery Electric

Battery electric propulsion systems are part of a growing list of solutions for achieving carbon-neutral or zero-emissions marine transportation. They operate by using an electric motor to convert electrical energy from the batteries into mechanical energy to propel the vessel forward. Battery electric vessels are emerging as one of the most realistic solutions to achieving emissions targets (Jeong et al., 2022). The number of battery-powered vessels is growing rapidly around the world. Jeong et al (2022) estimate that as of March 2019, there were more than 150 battery-powered vessels in operation worldwide compared to only 1 in 1998. In order to support increasingly widespread marine electrification, port technology and onshore charging infrastructure will need to be developed, industry standards need to be implemented and the transition incentivized by local governments.

The advantages of plug-in battery electric propulsion systems are multifold. Primarily, they reduce emissions and potentially eliminate fossil fuel consumption (Cherchi et al., 2021). For example, *Ellen*, a Danish electric ferry reduced CO_2, NO_x and SO_x emissions by 2000, 41.5 and 1.35 tons respectively in one year of operation, compared to a diesel-powered engine (Cherchi et al., 2021). Secondly, battery-powered vessels are easy to use and thus have lower operating and maintenance costs over diesel systems (Jeong et al., 2022). Lastly, they are highly efficient in comparison to conventional fuel-based propulsion systems as energy expenditures adjust to the load onboard (Cherchi et al., 2021; Hayton, 2023). In other words, electric motors operate consistently at 95% efficiency whereas internal combustion engines operate largely at 40% efficiency with a drastic performance drop occurring with light loads (Cherchi et al., 2021).

Although highly beneficial in several ways, there is a lack of long-term experience with maritime plug-based solutions. Little is known about batteries' long-term viability and charging infrastructure in wet and salty environments (Mehammer et al., 2023). Additionally, there is minimal port interface support, limited energy storage capacity of batteries, low energy density, and high initial production and implementation costs (Cherchi et al., 2021; Reusser & Pérez Osses, 2021). Nevertheless, innovative solutions are being tested worldwide, and some options may address these challenges. Currently, conventional plug-based methods are considered the most achievable and practical solution, but researchers are exploring alternatives such as wireless charging and battery swapping to eliminate plugs and receptacles, increase utilization of docking time, and reduce demand for local power grids (Mehammer et al., 2023).

Wireless charging has been successfully implemented for the *MF Folgefonn* in Norway serving to eliminate plugs and receptacles as well as the maintenance and safety issues associated with harsh marine environments (Wärtsilä, 2023). This charging method also maximizes the utilization of docking time. A further option is to implement battery swapping while vessels are at berth. Since batteries don't require rapid charging, this method reduces the demand on local power grids and can be used in locations with no grid connection (Mehammer et al., 2023).

Hydrogen Fuel Cell

Hydrogen fuel cells generate carbon-free electricity through a chemical reaction between hydrogen and oxygen, producing only water and heat as by-products (Fernández-Ríos et al., 2022). This technology is of interest to the maritime transportation sector as it operates with high efficiency, eliminates noise pollution and is a zero-emission burning fuel (Cavo et al., 2022; Fernández-Ríos et al., 2022; Ustolin et al., 2022). Hydrogen vessels are in operation around the world; however, this technology is still far from being commonplace. Canada has recognized the potential of hydrogen energy to contribute to the transition away from fossil fuels, particularly in sectors such as heavy-duty transportation that are notoriously difficult to decarbonize (Pembina Institute, 2022 a). The federal government further solidified this stance with the announcement that hydrogen power will make up as much as 30% of Canada's end-use energy by 2050 (Natural Resources Canada, 2020).

While hydrogen fuel cell technology offers several advantages, there are substantial challenges to consider. Despite the inherent carbon-free nature of burning hydrogen fuel, the process of extracting and producing hydrogen relies on fuel inputs, introducing a potential carbon footprint (Fernández-Ríos et al., 2022). The methods used for extracting hydrogen have led to distinct categories of hydrogen fuels: brown and grey hydrogen, produced through coal and gas combustion, releasing CO_2 and methane into the atmosphere; blue hydrogen, generated from fossil fuels with carbon capture technology mitigating approximately 12% of emissions underground; and green hydrogen, extracted from water through electrolysis using renewable-sourced electricity (Howarth & Jacobson, 2021; Lakhani, 2023). Currently, blue hydrogen plays a prominent role in Canada's energy future, however, Howarth & Jacobson's (2021) analysis of emissions associated with blue hydrogen suggests that there "is no role for blue hydrogen in a carbon-free future" (p. 1685) and that renewable electricity would be best used by society in ways other than hydrogen production. Although this statement does not pertain directly to the heavy-duty transportation sector, it emphasizes the need for lifecycle analyses.

Further hydrogen fuel cell considerations include the fact that hydrogen gas is highly flammable presenting challenges in handling and storage, particularly onboard moving vessels (Fernández-Ríos et al., 2022; Ustolin et al., 2022). Another challenge is the need for a consistent supply, which could be problematic for remote communities lacking on-site production infrastructure. Furthermore, while hydrogen fuel cells have a long lifespan, their long-term durability in marine environments is still largely unknown. Given that this technology is evolving and demands new production methods and engine systems, its associated investment and production costs are notably high (Perčić et al., 2020).

Despite the concerns and gaps in knowledge regarding hydrogen fuel cells, they are considered to be a viable option for marine propulsion as they are highly efficient, versatile, and operate with low noise or vibration emissions (Reusser & Pérez Osses, 2021). In recent years, many prototype hydrogen fuel cell-powered vessels have been successfully implemented (Cavo et al., 2022). Several more international projects are currently in development including the following ships: Nemo H2 (ESMARTCITY, 2009), Hydrogenesis ("Hydrogenesis Passenger Ferry," n.d.), and FreeCO_2ast (HavHydrogen, 2021). The success of these projects confirms that it is possible to install and successfully operate hydrogen-powered zero-emissions vessels, however, if decarbonization is the goal it is important to analyze the lifecycle of the hydrogen being used and ensure it is, in fact, green.

Hybrid

Hybrid marine propulsion technology is being widely researched and implemented in the marine transportation industry as a way to reduce emissions and improve the efficiency of vessels (Cherchi et al., 2021; Planakis et al., 2021; Reusser & Pérez Osses, 2021). Reusser & Pérez Osses (2021) note the added benefit of hybrid technology in facilitating the transitional process towards eventual zero-emissions engine configurations. Hybrid propulsion systems with backup fuel may ease the transition by increasing user confidence and trust. Furthermore, while fully electric propulsion systems are optimal for point-to-point vessels (Emblemsvag, 2017), they may never be a viable stand-alone option for larger sea-faring ships or certain fishing vessel profiles (Mehammer et al., 2023). Most commonly, hybrid propulsion systems combine diesel engines and gas turbines with renewable energy systems, however, hybrid systems have also implemented alternative fuels in place of marine diesel (Tan et al., 2022), thus still offering a transition away from diesel entirely.

2.4.2. State-of-the-Art: Low-Emission Vessel Profiles

Hybrid or fully electric marine propulsion systems are the future of marine transportation, however, the level of electrification of various types of vessels differs at present. Since the shipping industry is responsible for the majority of marine transportation emissions, the IMO updated regulations and committed to cutting global shipping emissions in half by 2050 compared to 2008 (International Maritime Organization, 2018; Reusser & Pérez Osses, 2021). Still, due to technology constraints, large offshore vessels are less suited to electrification since their energy requirements are larger than currently available energy storage systems (Cherchi et al., 2021). Overall, shipping is a conservative industry with little incentive for risk-taking, however, several shipping providers around the world are implementing wind-assisted propulsion, cutting up to 90% of GHG emissions (De Beukelaer, 2023). This sail technology presents an opportunity to stretch our carbon budget as we develop appropriate alternative fuels for cargo ships. Meanwhile, Hayton (2023, p. 869) recognizes that “although fully electric shipping for large-scale containerships and freighters is currently not feasible, electrification solutions for smaller operations are realistic and lucrative.”

The predictable operational profile of vessels going point-to-point (ie. ferries, water taxis, etc.) made them a primary target for electrification (Emblemsvag, 2017). The first fully electric ferry, the MV Ampere, was launched in 2015 in Norway (Cherchi et al., 2021). Since then, Norway has been a leader in marine electrification (see section 4.2.). As of July 2022, there were 58 electric ferries in operation with 14 more to come by the end of the year (Mehammer et al., 2023). The transition has been further incentivized through policy like the European Union’s Alternative Fuels Infrastructure Regulation that requires all ports in the Trans-European Transportation Network to offer onshore power supply to vessels by 2030. In response, Sweden and Norway are set to implement 400 super-charging stations along their coastline by 2025 (Tellefsdal, 2022). The next target in Scandinavia is Norway’s fishing fleet of approximately 6,000 vessels that currently operate on diesel fuel (Mehammer et al., 2023).

Efforts to decarbonize point-to-point vessels are gaining momentum in Canada, with initiatives underway on both the east and west coasts. In Nova Scotia’s Halifax Regional Municipality, the Mill Cove ferry service is being electrified and is expected to be operational by 2024 (Ingram, 2021). Meanwhile, BC Ferries, a publicly owned and independently managed ferry service company, is spearheading the electrification of its fleet through the Island Class Vessel Electrification Program (BC Ferries, 2023). BC Ferries believes that this program “offers the opportunity to help decarbonize the ferry service, trigger market transformation, and set a new precedent for greenhouse gas emissions reduction initiatives” (BC Ferries, 2021, p.2). As of July 2023, six hybrid vessels are in operation along the BC coast as part of this program, including the *Island Discovery* pictured in Figure 2 (BC Ferries, 2023). Although these Island Class vessels have the capability to run entirely on battery electric power, the current lack of onshore charging infrastructure necessitates their operation on diesel fuel (Wilson, 2023). When in full electric operation these ships reduce URN while simultaneously increasing efficiency and reliability (BC Ferries, 2023). A terminal electrification project is outlined in the Island Class Vessel Electrification Program; however, onshore transitions are costly and therefore dependent upon funding from the federal and provincial governments.

To date, most efforts to reduce emissions in the maritime sector have primarily targeted shipping and point-to-point vessels like ferries, tugboats, and water taxis. Fishing and other such working vessels are more challenging to decarbonize but hold immense potential for emissions reductions (Mehammer et al., 2023). In addition to the lack of long-term experience with maritime plug-based solutions, Mehammer et al’s (2023) comprehensive analysis of electrification solutions for fishing vessels has highlighted numerous obstacles in this pursuit. The irregular operational patterns of fishing vessels influenced by variations in fish location and weather conditions, heighten the risk of power depletion while at sea. Additionally, the lower energy density of batteries compared to fossil fuels limits the range and flexibility of vessels. Lastly, the diverse range of vessel sizes and types requires tailored energy and power solutions as there isn’t a one-size-fits-all approach. Ultimately, solutions need to be cost-effective, safe, easy to use, and robust enough to withstand harsh maritime conditions (Hayton et al., 2023; Mehammer et al., 2023).

Figure 2. The *Island Discovery* is one of six hybrid electric vessels designed and operated by BC Ferries (BC Ferries, 2023).

While complete marine electrification remains a future goal, significant efforts are already underway to decarbonize marine vessels in BC. In Haíłzaqv Territory, the Haíłzaqv Climate Action Team is implementing renewable diesel, derived from plant materials, as a simple, effective, and affordable pathway to transition away from diesel (Pembina Institute, 2022 b). The Haíłzaqv Climate Action Team's goal is to convert 50% of their fleet to electric vessels within the next five years, with full electrification being the ultimate target. In the meantime, renewable diesel serves as a cleaner alternative to conventional marine fuel, as it is compatible with existing engines and has already demonstrated successful implementation within the community.

Coastal Indigenous communities in BC are poised to continue leading the transition away from diesel. For the Haíłzaqv Nation, low-emission marine propulsion solutions are a reality and marine decarbonization is likely the future for many more. The successful implementation of low-emission marine propulsion solutions depends upon the needs of the user communities and their specific energy, environmental, and social contexts (Hayton et al., 2023). The following policy scan and research findings will provide context to the needs, concerns, priorities, and desires of our partner communities regarding the decarbonization of their passenger and fishing fleets. It will also provide an overview of energy and infrastructure availability, challenges, and opportunities in Canada and BC.

Chapter 3. Methodology

This research is mindful of Indigenous methodologies including the "Four R's" put forth by Cree scholars Verna J. Kirkness and Ray Barnhardt (1991), committing to cultivating an ethic of Respect, Reciprocity, Relevance, and Responsibility in this work. This research is also informed by the Indigenous Research Paradigm put forth by Anishinaabe scholar, Deborah McGregor (2018), privileging research that centres Indigenous worldviews, epistemologies, and knowledges. Further, Doyon et al (2021) invite researchers to contribute to unsettling transitions research with the intent of broadening conceptual lenses to respectfully include different perspectives. Thus, my approach is to centre worldviews, stories, expertise, relationships, and research by Indigenous Peoples and simultaneously challenge the dominant assumptions underlying colonial systems of climate solutions. Through this work, I hope to support and advance Indigenous self-determination, sovereignty, and just climate futures.

The primary research methods for this project include a narrative literature review, semi-structured interviews, a policy scan, and a comparative policy analysis.

3.1. Literature Review

A literature review was undertaken following a sociotechnical approach brought forth by Sovacool et al (2017 a). This approach incorporates technical research primarily conducted by engineers and natural scientists with context-specific economics, politics, social and cultural values, and business models. This is based upon the recognition that clean marine propulsion is not simply an engineered vessel but a system involving organizations, institutional structures, cultural values, and ecosystems. This sociotechnical approach is grounded in explicit engagement with an energy justice framework put forth by Jenkins et al (2018) to align the technical considerations with principles of energy justice and sovereignty. Thus, a narrative literature review was conducted through the review of online scholarly journals and academic papers accessible through Google Scholar and the SFU library. Preference was given to recent publications and the key search words are represented in Table 2. Additionally, a thorough review of grey literature including newspaper articles, legal documents, community planning documents, and multi-jurisdictional climate policies and strategies was incorporated.

Table 2. List of literature review search terms

Literature Review Sections	Search Terms
Section 2.1.	Indigenous clean energy, Indigenous renewable energy, Indigenous energy transition
Section 2.2.	Energy transition, justice, equity, just transition, Indigenous energy sovereignty, energy poverty
Section 2.3.	Marine greenhouse gas emissions, marine transportation emissions, marine transportation air pollution, vessel noise pollution, marine noise pollution
Section 2.4.	Marine electrification, electric marine propulsion, electric boat infrastructure, marine transportation decarbonization, low-emission marine propulsion, clean marine transportation

3.2. Semi-structured Interviews

Semi-structured interviews were selected as a further research method for this study due to their inherent qualities that encourage participants to share their experiences and perspectives without the constraints of rigidly predefined questions. This approach allows for a dynamic and flexible interaction, giving space for a deeper exploration of participants' viewpoints, interpretations, and storytelling. The interviews were conducted by project leader, Dr. Cliff Atleo. Dr. Atleo has strong community connections in many of the NTC Nations and is responsible for mediating the relationship between the research team and our community partners. His established connections to the communities ensured a high level of engagement and rapport while also hopefully reducing the potential for research fatigue and over-consultation with community members.

The five participants for these semi-structured interviews were selected based on their role within the community (outlined in Table 3 below). As the transition to low-emission marine propulsion is in its very initial stages, we chose to focus our interview efforts on community leaders. This leadership-oriented approach aimed to gather insights from individuals who hold significant influence and are at the forefront of the transitional process. These leaders were identified as pivotal figures in driving the momentum of the transition towards low-emissions marine transportation within their respective communities. Many interviewees are boat users themselves, however, a significant effort to interview and survey community boat users will be conducted at a later stage within the broader research project. The primary goal of this first round of interviews was to gain a comprehensive understanding of the current priorities, opportunities, and motivations of these Nations concerning low-emission marine propulsion while seeking to also uncover the underlying perspectives, challenges, and aspirations that shape their engagement with this transition. Lastly, it's important to note that while both the NTC and SBC are partners in this project, the interviews primarily centred around the Nuu-chah-nulth Nations due to considerations of scale and the specific objectives of this research paper. While the SBC is a valuable and integral part of the project, their participation was not the focus of this round of interviews.

Table 3. List of interview participants (n=5)

Interview Participant	Role
Saya Masso	Lands and Resource Director for the Tlaoquiaht Nation
Ken Watts	Chief of the Tseshaht Nation
Naas Ałuk, John Rampanen	Chief of the Ahousaht Nation
Nitanis Desjarlais	Ahousaht community member and wife of John Rampanen
Tyson Atleo	Hereditary Chief of the Ahousaht Nation

3.3. Policy Scan and Comparative Policy Analysis

A thorough review of 16 policy documents (listed in Table 4) was conducted to provide a comprehensive evaluation of marine decarbonization efforts across Turtle Island. These policy documents were selected to represent federal, provincial and First Nations governments and gain a comprehensive understanding of the transportation, climate, and energy policy landscapes across the country and in BC.

Each document was rigorously scanned and reviewed based on the following evaluation criteria:

- Inclusion of marine decarbonization
- Policy instruments, goals and targets pertaining to energy generation, infrastructure, storage, and transmission
- Synergy with other policy documents and legislation including UNDRIP and DRIPA
- Indigenous collaboration and involvement
- Energy justice and equity: support of Indigenous self-determination, resurgence, sovereignty and repatriation (Corntassel, 2012; Tuck & Yang, 2012; Coulthard, 2014)
- Availability of subsidies, incentives, and funding investment

Table 4. Federal, provincial, and First Nations documents comprised in the marine decarbonization policy scan

Federal Policy and Plans	Provincial Policy and Plans	First Nations Policy and Plans
Pan-Canadian Framework on Clean Growth and Climate Change	Clean BC Roadmap to 2030	First Nations Climate Initiative Climate Action Plan
A Healthy Environment and a Healthy Economy	Declaration on the Rights of Indigenous Peoples Action Plan	BC First Nations Climate Strategy and Action Plan
2030 Emissions Reduction Plan	Climate Preparedness and Adaptation Strategy	Coastal First Nations Climate Action Report
Ocean Protection Plan	Clean BC Remote Community Energy Strategy	Community Energy Plan from the Heiltsuk Nation
Indigenous Off-Diesel Initiative	BC Hydro’s Electrification Plan	Community Energy Plan from the Uchucklesaht Nation
Green Shipping Corridors Framework		

The analysis of results from the policy scan was also guided by the JUST (Justice, Universal, Space, and Time) framework put forth by Heffron and McCauley (2018). This conceptual framework was established to qualitatively measure policy changes within the field of energy transitions with the understanding that a rapid and just energy transition requires the unification of the fields of energy, environment, and climate justice. By framing justice and transitions theory within a legal geography lens, this framework aims to capture research on people, space, time, and law in a way that identifies problems and provides policy-led solutions (Heffron & McCauley, 2018). However, the JUST framework does not integrate Indigenous perspectives. To broaden the conceptual lens and adapt this framework to the context of Indigenous epistemologies, policy and perspectives from Indigenous sources will be centred throughout the analysis. As such, the policy scan results were analyzed and situated within space and time to understand who is included and the speed at which the transition to low-emission marine propulsion may take place.

J	**T R A N S I T I O N**	**Justice**	**Justice takes the form of 3 forms of justice** **Distributional** **Procedural** **Restorative**
U		**Universal**	**Universal takes the form of two universal forms of justice** **Recognition** **Cosmopolitanism**
S		**Space**	**Space brings in location, where are 'events' happening ? (in principle, at local, national and international levels)**
T		**Time**	**Time brings into transition timelines such 2030, 2050, 2080 etc. and also 'speed' of the energy transition (i.e. is it happening fast enough?).**

Figure 3. The "JUST" Framework by Heffron & McCauley (2018, p.6)

Following the policy scan, a comparative policy analysis is conducted to present the case study of Norway's transition to electric marine propulsion systems. The JUST framework is again applied to qualitatively review and compare Norway's successful policy approach to implementing an energy transition and Canada's failure, as of yet, to do so. Energy and climate policy from both countries is analyzed for inclusion of distributional, procedural, and recognition justice to determine policy-led pathways and solutions in the Canadian context. This comparative analysis will outline the similarities and differences between the two countries and highlight applicable learning opportunities for those interested in transitioning to low-emission marine propulsion.

3.4. Study Limitations

This study is the first to emerge from the *Clean Marine Solutions* research project. It is designed as a preliminary assessment of available low-emissions propulsion solutions and a general feasibility study. The overarching goal is to provide our community partners, the NTC and SBC, with an overview of existing technology and the expected challenges and opportunities in the transition to low-emission marine propulsion systems. As such, several limitations exist within this study. One constraint pertains to the limited number of conducted interviews (n=5). The objective was to hear from NTC and SBC community leaders, however, due to time constraints, scheduling hurdles, and out of respect for community relationships, the final count was fewer than expected. Furthermore, with one of the research objectives of this study being to better inform governmental decision-makers and policymakers, the lack of input from this demographic is a shortcoming as my knowledge of climate policy can be gleaned solely from information available publicly. To mediate this limitation, additional time was spent conducting a policy scan and researching climate and energy policy as it pertains to marine decarbonization. As the broader research project advances, opportunities for further research include gaining input from policymakers and government officials regarding the feasibility of this transition from a policy perspective.

Chapter 4. Research Findings

4.1. NTC Interview Results

This section provides a subjective review of the findings in relation to the literature review and policy scan, focusing on the role of First Nations in driving Canada's transition to renewable energy. Our leadership-oriented interviews uncover the motivations, opportunities, challenges, and limitations that drive this interest in clean marine propulsion. Sections 4.1.1. and 4.1.2. will summarize the findings by extracting the overarching themes. In so doing, it is important to remember that every community is unique. Their energy generation capacity, electricity demand, geographic location, financial circumstances, priorities, needs, abilities, and thus, viable options vary widely. Chief John Rampanen of the Ahousaht Nation, likens Nuu-chah-nulth Nations to apples and oranges, emphasizing their uniqueness. Therefore, the objective of this chapter is to provide a condensed summary of key findings, available for communities to consider on their own journey towards marine decarbonization.

4.1.1. Opportunities & Motivations

Alignment With Community Values

In conversation with NTC community leaders, cultural values of interconnectedness, respect, and a responsibility to future generations emerged as driving factors in the quest for sustainable solutions to GHG emissions reductions. The effects of climate change are impacting food security and the health of NTC Nations as the oceans continue to warm, weather events increase in intensity, and species distribution and availability are shifting. Climate change is a real concern and is a driving force behind political decisions in many of the NTC Nations. Ken Watts expressed that there is great political will right now to "walk the walk and put your money where your mouth is." In the case of the Ahousaht Nation, this political drive is accompanied by a shift in leadership:

> *[Ahousaht has a young Council] and with that youthfulness comes a different perspective too and I think that there's a lot more inclination to look at longer-term, sustainable approaches than what we were used to before.*
> *– John Rampanen*

Along with this momentum and political drive to align with cultural values, there is recognition that vessel traffic and human presence on the water are continuing to grow. In Tofino, for example, the tourism industry is booming and bringing with it a myriad of economic benefits while also increasing the associated impacts of diesel and oil in the marine ecosystems. As such, implementing low-emission marine propulsion solutions aligns with community values and will be a priority in so far as capacity and resources for each individual Nation allow. As Watts says: “It’s exciting to be a part of this transition!”

Reduce GHG Emissions & the Impact of Cumulative Effects

In the literature review, it was found that maritime transportation was responsible for 3.2% of global GHG emissions. This number may appear insignificant; however, the impacts are disproportionately high for coastal First Nations as marine vessels are often a primary mode of transportation. The need to protect and sustain marine ecosystems for future generations is visceral among NTC community leaders. Nitanis Desjarlais reminds us that before the arrival of European settlers, the Nuu-chah-nulth peoples used to travel these waters by canoe. The arrival of fossil fuel-powered vessels brought ease of use, but they have impacts on marine ecosystems that were not present prior to colonization.

Today, the impacts of diesel and oil on marine ecosystems are well understood but they aren’t always well documented. For example, Watts, Chief of the Tseshaht Nation, says that:

> *We have six community boats owned by the Tseshaht Nation right now, but from a community fisheries perspective, we have over 100 boats. The cumulative impacts of that many boats are actually probably pretty staggering. You know, they fish Sunday to Wednesday, but they're also out monitoring and checking up on the territory throughout the week during the summer months. So that’s a pretty considerable amount. It would be great to see some type of reduction and find a way to make that not just more energy efficient, but also better for the environment. – Ken Watts*

The desire to address climate change and plan for a sustainable future drives the renewable energy transition for NTC Nations. Implementing low-emission marine propulsion systems has been named a priority by several NTC Nations due to their ability to mitigate emissions.

High Cost of Fossil Fuels

Lastly, the high cost of fossil fuels has arisen as a motivator behind the transition to clean marine propulsion systems. The Tseshaht Nation owns a gas station that used to provide them with a steady stream of revenue, however, the rising cost of fuel, the prevalence of ZEVs, and the removal of fuel tax exemptions for First Nations members have significantly lowered the demand for fuel. The increase in price is impacting Tseshaht Nation members' ability to move around the territory and make ends meet. Watts is witnessing this dramatic increase in fuel prices that aren't being mirrored or accounted for by their funders, thus impacting the Nation's budgets and programming. He summarizes the situation:

> *We've seen the impacts of fuel prices on our budgets and programming. We've tried to share with our funders that, hey, gas is 50 cents more than it was several years ago, but it's not being taken into account. From a boating perspective, you know, fishers really feel it in their pocket too, in their bottom line, right, they go out fishing and they only made $200 but they had to spend 100 on gas. It adds up, especially for those fishers, you know, whose livelihood relies on the fishery too. – Ken Watts*

The Tseshaht Nation's experience reflects that of other Nuu-chah-nulth Nations as well. Whereas cheap fuel used to be a barrier in the renewable energy transition, market dynamics are shifting in a way that now presents it as a motivator.

Opportunities and Priorities for NTC Nations

It is likely that the transition to clean marine propulsion systems will be accompanied by a broader community transition to renewable energy sources. An increase in energy demand is therefore predicted. This expected increase along with a desire for energy sovereignty and self-sufficiency has led many NTC Nations to increase their energy generation capacity. For grid-tied communities, an opportunity arises in the potential for producing electricity to provide for community needs and generate a profit by selling the excess to BC Hydro. This drive for innovation, profit, and redefining the relationship with BC Hydro is important to Rampanen, but he cautions that the transition to clean marine propulsion solutions "shouldn't be driven by that, it should be driven by self-sufficiency and the impact that we have on our local environment."

Overall, the interviewees were cautiously excited about the possibilities of clean marine propulsion. The top priorities highlighted by NTC community leaders were safety and reliability. Safety is always the primary concern, especially in marine environments where weather is notoriously unpredictable. Saya Masso, the Lands and Resources Director for the Tlaoquiaht Nation, emphasizes that the transition to electric propulsion should keep you safe while also not hindering your ability to fully utilize your boat. Finally, a transition of this scale can be daunting. Several community leaders emphasized the benefit of celebrating the small victories and remembering that change will not happen overnight.

4.1.2. Barriers & Challenges

Cost & Resource Limitations

The financial cost is a primary barrier in the transition to low-emission marine propulsion solutions. New boats will need to be purchased, old boats retrofitted, new charging and moorage infrastructure built, supplemental batteries purchased, and the list goes on. Further considerations include the cost of clean energy development, mechanic training, and education for the general public to build trust and confidence in this new technology. Funding is currently available, however, not to the scale required for this transition. This will be the biggest hurdle as currently exemplified by the BC Ferries Island Class vessels that are not operating to their full potential due to lack of funding and government support. Despite this, there is hope on behalf of community leaders for momentum to build, increasing the pace of change and driving costs down.

Furthermore, Masso reminds us of the toll that tourism has on First Nations communities. Tourism brings economic growth, but this also serves to drive up the cost of living and property value while also greatly impacting the surrounding ecosystems and putting pressure on community food and water supply. Ultimately, life is expensive for Nuu-chah-nulth Nations and Masso cautions that he “doesn’t know many people who are going to pay more for an electric boat until the cost is on par with a fossil fuel-powered boat.”

Knowledge Gap

“There is huge interest in clean marine alternatives but admittedly, we know very little about what potentials are out there,” says Rampanen, exemplifying the complexity of propulsion options available. As underscored in the literature review, most research in this sphere pertains to large ships and point-to-point vessels, leaving a notable gap when it comes to electrifying a fishing fleet. Thus, the Nations recognize that as leaders in this transition, they will be trailblazing innovators bearing the consequences if the transition is not successful. This is no small burden, especially given that certain Nuu-chah-nulth Nations have only recently established basic infrastructure like paved roads. Therefore, the prospect of implementing electric or hybrid boats feels like a giant step forward, particularly considering the lack of knowledge surrounding electric fishing vessels. When considering this specific challenge, Rampanen emphasizes that this transition needs to be facilitated by a simultaneous effort to train mechanics and technicians to ensure the Nation remains self-sufficient and avoid making lawn ornaments of broken electric vessels.

Fear, Uncertainty, & Other Concerns

Many concerns brought forth in conversations with community leaders stemmed from the broader knowledge gap surrounding low-emission marine propulsion. These concerns are important to keep in mind and address them as we progress with this transition. Firstly, there are concerns surrounding the torque and power of electric motors as fishing vessels will often pull nets of 500+ fish from the ocean requiring deep and reliable power. Furthermore, concern was expressed surrounding the geographical complexity of the various regions and locations of NTC Nation communities. For example, the Tseshaht Nation is located inland along the Alberni inlet. Boats accessing Tseshaht will need to navigate with confidence both shallower inland waters as well as the open ocean.

In addition to the technical concerns about the propulsion systems themselves, there is also concern regarding energy sourcing to support the community-wide transition to renewable energy. Both on and off-grid Nations experience frequent power outages leading Rampanen to reflect:

> *I'm thinking, well, if we are reliant on energy for transportation, that's gonna cripple us, if we're going through a power outage, right? So technically, we're not prepared in that regard. – John Rampanen*

This perspective highlights the need for a comprehensive approach that addresses both the transition to electrification and the resilience of energy supply in diverse scenarios.

4.2. Marine Decarbonization Policy Scan

Marine decarbonization in Canada is in its infancy and low-emission marine propulsion systems are far from being the norm. As of August 2023, six hybrid diesel-electric ferries and one fully electric tugboat are in operation in BC, and one electric ferry project is in development in Nova Scotia (BC Ferries, 2023; Ingram, 2021; Ruttle, 2023). Infrastructure barriers in BC still prevent most of these vessels from operating primarily in electric mode, resulting in minimal impact in lowering emissions. Clearly, low-emission marine propulsion technology exists but is not being implemented due to barriers largely pertaining to infrastructure deficits, battery procurement and an unfavourable policy landscape. This chapter will provide the results of a policy scan conducted with the purpose of understanding if, and how, climate policy in Canada and BC addresses marine decarbonization. Following the policy scan is a comparative policy analysis case study highlighting the successful implementation of clean marine propulsion systems in Norway.

4.2.1. Federal Strategies

Large-scale energy transitions are often complex, lengthy and at times highly disjointed (Sovacool, 2017). Although examples of rapid energy transformations exist, such as Norway's transition to electric marine propulsion (see section 4.2.), the transition to renewable energy sources in Canada has been slow and protracted. On November 4, 2021, Canada signed the *Statement on International Public Support for the Clean Energy Transition* at the United Nations Framework Convention on Climate Change. Canada also signed the *Declaration on Zero Emission Shipping by 2050* in April 2022, in recognition of the growing marine transportation sector in this country and the expected increase in associated emissions. While demonstrating awareness of the problem at hand, declarations such as these are not legally binding and do not necessitate direct action on behalf of the Canadian government. We must look to policy, plans, and legislation acting upon these declarations and signatures to determine Canada's true commitment to marine decarbonization.

ECCC's 2030 Emissions Reduction Plan (2022) states a clear commitment to achieving net-zero emissions in the marine sector by 2050. The majority of Canada's marine transportation emissions come from the shipping industry; hence federal policymakers are concentrating their efforts on addressing large-scale marine transportation. In 2022, Transport Canada released the Green Shipping Corridors Framework which addresses the high energy demands of the shipping industry and provides a pathway to achieve carbon-neutral shipping by 2050 (Transport Canada, 2022). The framework depends upon implementing global initiatives at the local level and empowering industry to lead the transition through the sharing of information and communication of progress. The federal government recognizes that "Indigenous leadership and knowledge are critical to achieving Canada's climate change goals in the marine sector, and First Nations, Inuit and Métis people's involvement is central to advancing reconciliation and self-determination" (Transport Canada, 2022, pp. 3). There is no further direction beyond this statement regarding how they plan to involve Indigenous Peoples in the process of marine decarbonization.

Scaling down, energy policy concerning smaller fishing and transportation vessels is determined by provincial and territorial governments. Where the federal government may play a role is through the allocation of funding. Currently, numerous funding opportunities are available for remote communities seeking to develop renewable energy projects, decarbonize their housing and transportation systems, and transition away from diesel. Funding programs like the Indigenous Off Diesel Initiative are geared towards reconciliation with Indigenous communities, however, they fail to provide unique or additional benefits beyond what non-Indigenous-led projects receive (Laboucan-Massimo et al., 2023). Despite the federal adoption of UNDRIP (Bill C-15, 2021), which directs the government to uphold Indigenous rights through the enhancement of social and economic conditions, the strengthening of Indigenous institutions, and providing stable, long-term funding to First Nations, there remains a disconnect in how these policies are developed. This demonstrates a need for more equity-based, targeted funding programs that are specifically designed to address historical injustices and generations of unequal treatment towards Indigenous Peoples.

When looking at federal climate frameworks such as the Pan-Canadian Framework on Clean Growth and Climate Change (2016) and A Healthy Environment and a Healthy Economy (2020), similar pledges and timelines are proposed to reduce emissions. However, despite efforts to cut pollution and create employment, these climate frameworks continue to infringe upon Indigenous rights by promoting 'clean' energy sources that inadvertently contribute to environmental injustice (ICA, 2021). For instance, referring to hydroelectricity as a ‘clean energy source’ disregards the impact on Indigenous lives and lands flooded to generate cheap electricity. As such, accountability for UNDRIP within federal climate and energy policy has yet to be fully realized and Indigenous contributions to climate solutions have yet to be meaningfully included.

4.2.2. Provincial Strategies

The Clean BC Roadmap to 2030 (2018) includes a range of initiatives aimed at reducing emissions from the transportation sector including supporting the development of low-carbon fuels and updating the Low Carbon Fuel Standard to include marine transportation. Although the provincial government justifies that “electric ferries are the wave of the future,” current decarbonization efforts primarily focus on the development and incentivization of lower carbon-intensive marine fuels such as LNG (Clean BC, 2018, p. 37). BC is advantageously positioned with enabling policies and established low-carbon fuel supply chains, which should lead to reduced carbon emissions from the marine sector in the coming years (Mandegari et al., 2023). However, the government’s notable inexperience with marine decarbonization presents challenges including permit delays and bureaucratic roadblocks, resulting in inefficiencies and frustrations for those leading the transition. For example, BC Ferries has invested over 600 million dollars in low-carbon technology over the past eight years and has six hybrid diesel-electric ferries currently in operation. These ferries have the potential to run in fully electric mode if the necessary onshore charging infrastructure is built at their terminals, however, five terminal projects are currently stalled in up to 100 provincial and federal permit processes (Green, 2022). BC Ferries awaits communication and funding from both the federal and provincial governments which has been slow to materialize (Wilson, 2023).

Despite the inclusion of marine decarbonization in climate and energy policy, neither the federal nor provincial government is actively facilitating a transition to low-emission marine propulsion solutions. One underlying reason for this slow progress and reluctance to fully embrace marine decarbonization may be attributed to Canada’s significant oil and gas sector. As a nation heavily invested in these industries, there is resistance to fully decarbonizing the energy systems as it may threaten existing economic interests and established power structures (MacArthur et al., 2020). Despite this apparent conflict of interest, the province is pushing forward with electrification targets. BC Hydro is a leader in the transition and currently maintains a monopoly-like position within the electricity system. BC Hydro's Electrification Plan (2021) boasts an abundance of the "cleanest electricity generated in Western North America" (p. 4) and paints a picture of a future powered by water. These claims are muddied by the contentious mega-dams that produce this energy as well as the conspicuous absence of Indigenous Peoples or Territories in this document.

Historically, energy systems in BC have operated through centralized and top-down planning systems that prioritize private ownership, creating a policy landscape that restricts, prevents, and undermines the inherent sovereignty, jurisdiction, and governing practices of First Nations (McGregor, 2019). Although publicly owned, BC Hydro is operating within this status quo and is hesitant to relinquish its monopoly within the industry. Throughout the 2000s, BC Hydro was purchasing electricity from Independent Power Producers (IPPs) through the Standing Offer Program (SOP) as a means of supplementing the grid (West Coast Environmental Law, 2009). Many First Nations seized this opportunity to increase their community's energy sovereignty while also making a profit. Unfortunately, the SOP was suspended in 2019 upon approval of the Site C dam; however, it is now clear that mega-dams alone will not provide sufficient energy to meet BC's needs. BC Hydro's unreliable decision-making, their history of Indigenous rights and title violations, as well as unjust amendments to the Clean Energy Act through Bill 17[3], constitute actions that are not in congruence with a just transition to a low carbon future nor are they in alignment with the province's legislated commitments to DRIPA.

4.2.3. Policy Solutions in Indigenous Communities

Thus far, the results of the policy scan demonstrate an awareness of marine decarbonization. Despite setting targets and signing declarations, colonial governments across Turtle Island remain risk-averse and hesitant to take on leadership or responsibility in response to the climate crisis. Simultaneously, they resist relinquishing control over decision-making structures despite repeatedly stating their intentions of working in nation-to-nation relations with Indigenous Peoples in pursuit of reconciliation

[3] The Clean Energy Act was amended in 2020 through a process that did not include Indigenous consultation. The changes enacted through Bill 17 include repealing the definition of 'electricity self-sufficiency' as well as intentionally not including a definition for 'clean energy'. This means that BC Hydro can buy electricity without prioritizing local procurement as well as use the term 'clean energy' at their discretion.

(Laboucan-Massimo et al., 2023; Atleo, 2021). The rigidity of top-down structures, inherent to colonial policy frameworks is starkly contrasted with Indigenous climate policy solutions that clearly prioritize energy sovereignty and community-scale decision-making.

In the face of structural injustice and power imbalances, Indigenous communities continue to lead marine decarbonization efforts. Indigenous communities are the first across Turtle Island to set marine decarbonization targets and timelines directed at fishing and passenger vessels. The challenges are multifold as progressing the grid in a more sustainable direction will demand substantial time and resources as well as a realignment of values pertaining to Indigenous rights and reconciliation in climate and energy policy. These challenges become more formidable in increasingly remote communities, yet, they still have the advantage of transitioning on a smaller scale. This enhances the opportunity for community-scale decision-making and implementation. To enhance self-determination capacity and encourage Indigenous participation in the transition to renewable energy, Schelly et al (2020) suggest that policymakers should prioritize community voices and design policies based on concepts of energy sovereignty.

Abundant renewable energy potential exists within the territories of many diverse Indigenous Nations with powerful claims to sovereignty and self-governance (MacArthur et al., 2020). Many First Nations are developing this potential with the intent of reducing emissions and increasing their self-determination and energy sovereignty. Currently, government resources are provided in the form of funding but assistance with market transition, capacity-building, education, and training is severely lacking. To facilitate this transition, governments must take a leading role in research (Hayton, 2023) and formulate policy that accelerates decarbonization while removing barriers for Indigenous communities and empowering community-scale decision-making (Schelly et al., 2020).

In sum, the multi-faceted nature of the marine sector necessitates decarbonization targets that engage a wide range of stakeholders as well as enabling and supportive policy measures that bridge the price gap between fossil and low-carbon fuels (Mandegari et al., 2023). Therefore, governments at all levels have an important role to play in achieving marine decarbonization targets and facilitating a marine energy transition. The Norwegian state played an important role in facilitating a rapid energy transition and the following section will explore the policy lessons learned from their experience.

4.3. Comparative Policy Analysis: Norway Case Study

Decarbonizing marine transportation is notoriously difficult but Norway is leading the way to cleaner marine transportation solutions. Not only is Norway uniquely positioned geographically, with the world's second-longest coastline and numerous fjords and islands accessible only by boat, but it is also considered a maritime superpower. Norwegians have long been seafaring people and this tradition continues as commercial shipping, fishing, and aquaculture form a significant part of their economy. This robust maritime community is spearheading the development of zero-emissions vessels and backed by the Norwegian government, is actively lobbying the IMO to ban fossil fuels by 2050 (International Energy Agency [IEA], 2022). The electrification of Norwegian ferries, the first of which is pictured in Figure 4, demonstrates that energy transitions can happen quickly and efficiently. The purpose of this comparative policy analysis is to understand the policy tools implemented by Norway and apply lessons learned to the Canadian context.

Figure 4. The world's first fully electric ferry, the MV Ampere (Cherchi et al., 2021)

The mass electrification of marine vessels in Norway is the result of context-specific factors including favourable economic circumstances and its unique geographic location, as well as an intentional mix of active government policy and regulations, support scheme alignment and private sector initiatives (Sæther & Moe, 2021). Firstly, the push to electrify was driven in part by the price of oil dropping in 2014, affecting the offshore oil and gas sector and Norwegian shipyards, both with considerable political influence. Almost 100% of electricity in Norway comes from renewable sources and is cheaper for them to produce than other fuels like LNG or biodiesel, thus creating an incentive to maximize electrification with a distinct lack of strong opposing interests (Sæther & Moe, 2021). This prompted a coalition across political party lines and a motion was passed in parliament obligating the government to present measures to increase the use of low and zero-carbon technologies in the marine sector. Sæther & Moe (2021) studied this politically driven process and believe that this moment did not create the transition, but it accelerated it by creating a policy window for politicians and industry to combine efforts and pursue a cleaner and more competitive marine sector. The Norwegian state ended up playing an active role in market creation and transformation by taking advantage of these favourable conditions to create structural change.

Marine decarbonization in Norway is largely influenced by public procurement processes and emissions regulations (Mehammer et al., 2023; Sæther & Moe, 2021). The Norwegian state acted entrepreneurially to design public procurement processes that promote the adoption of low-emission vessels, providing incentives and financial support for shipowners and operators to invest in cleaner technologies. As such, Norway was able to facilitate a domestic maritime battery supply chain, build transition-enabling infrastructure and contribute to a just transition through the creation of a transitionary job market. Moreover, strong public-private partnerships were instrumental in facilitating the transition (Hessevik, 2022). The Norwegian state partnered with Norway's Green Shipping Programme, Maritime Clean Tech, Innovation Norway, and several non-governmental organizations to engage in policymaking and fund the transition. Through these partnerships, support programs were made available for the installation of onshore charging facilities for these vessels, providing subsidies of up to 50% (Mehammer et al., 2023). Lastly, stringent emissions regulations were implemented, setting strict limits on GHG emissions from marine vessels and mandating the use of cleaner fuels. These regulations have created a clear framework and a level playing field for industry players, encouraging innovation and the development of cleaner alternatives.

4.3.1. Lessons Learned in the Canadian Context

The Norwegian government has implemented ambitious policies prioritizing sustainability and environmental stewardship in the maritime sector. Although the transition scale in Norway is much greater than that of this case study, key lessons learned may still apply to the Canadian context, especially as Norway turns efforts towards electrifying its fishing fleet (Mehammer et al., 2023). Three policy lessons, in particular, proved to be instrumental for Norway and may be transferred to other governments seeking to implement marine decarbonization:

Create a System of Innovation, Collaboration, and Transparency

A culture of close collaboration, mutual trust, transparency, and information sharing characterizes the Norwegian maritime system. Early dialogue between all levels of government, marine vessel operators and supply chains was crucial in growing this culture. Hessevik (2022) documented consistent and long-term collaboration among industry players as they worked together when it proved to be beneficial. The fact that they all speak the same language, share a similar business culture, and can travel short distances to physically see each other improved the speed of coordination and innovation. Furthermore, since the entire value chain for this transition (battery production, system integration, charging infrastructure, etc.) is located in Norway, the potential for Norwegian technology development and job creation made it easier to gain industry support and create market change (Sæther & Moe, 2021).

Encourage Interaction between Industry and Government

Norway's approach to climate and industrial policy since the 1990s has been characterized by a strong market orientation, emphasizing industrial neutrality and cost-effectiveness. However, this transition went beyond simply relying on market-based solutions. It necessitated a combination of policy measures, regulations, and incentives to achieve the results observed in Norway. The coordination efforts between the state and industry were vital, as market mechanisms alone would not have produced the same results (Sæther & Moe, 2021). For industrial actors, marine electrification represented a business opportunity, whereas for the state it was enticing because it combined climate policy objectives with industrial policy opportunities, resulting in market incentives and ambitious climate targets. Together they were able to exploit Norway's existing competitive advantages. The Norwegian state acted by not only de-risking the process but also serving as a key partner to the private sector and demonstrating strong political commitment. As the first to transition to widespread marine electrification, the decision-making process was complex, but it led to innovation in procurement contracts and created a dynamic and strategic transitionary process.

Create Win-Win Situations among Key Stakeholders

The transition in Norway was characterized by the creation of win-win situations among stakeholders (Sæther & Moe, 2021). Recognizing the significant size and importance of the maritime industry, the focus was placed on fostering a transition that not only prioritized sustainability but also addressed concerns about job security and the preservation of existing industries. Rather than approaching the transition as a destructive force that could potentially lead to job losses and industrial decline, the Norwegian government strategically positioned it as a priority. They ensured that all industry actors in public, private and academic sectors were enabled and supported to actively participate in the necessary changes. This inclusive and strategic approach is demonstrative of a just transition and forged a path to marine decarbonization that balanced economic considerations with environmental goals, ultimately benefiting all stakeholders involved.

These three policy lessons reinforce the fact that Norway was able to capitalize on market dynamics during an economic downturn and not only create an energy transition but do so efficiently and with little pushback. Norway actively facilitated the transition while the Canadian government is reluctant to step in and, in some cases, is even prohibiting the process. As previously discussed, federal climate strategies often rely on non-binding commitments making current timelines insufficient in effectively curbing warming temperatures to meet the Paris Agreement’s 1.5 C target (Beer, 2024). However, when incremental efforts are amalgamated there does appear to be momentum driving effective climate action in Canada. An independent assessment of Canada’s 2023 Emissions Reduction Plan compared existing climate policy against a no-climate-policy scenario, revealing that emissions today would be 7% higher and 41% higher in 2030 without the legislative and policy framework currently in place (Sawyer et al., 2023).

Despite these efforts, there are significant gaps in Canadian climate policy where the above lessons may be applied. Firstly, Canada is a large country with many co-existing and often conflicting realities making it challenging to build a culture of mutual trust and collaboration towards a common goal of electrification. Strategic and sustained lobbying from the fossil fuel industry continues to exert pressure on decision-makers to align climate policy with their interests, furthering the political divide and undermining consultation with Indigenous Peoples (Graham et al., 2019; Laboucan-Massimo et al., 2023). In light of this, the transition away from fossil fuels mustn't be positioned as a destructive force but as a just transition that leaves no one behind. In 2021, Iron and Earth commissioned a study of 300 Canadian residents working in the oil, gas, or coal sectors. The study revealed that 69% of workers are interested in switching to careers in the net-zero economy and 88% are interested in skills training and development for jobs in the net-zero economy (Abacus Data, Iron and Earth, 2021). These findings emphasize the need for retraining initiatives to ensure that workers and communities are properly supported as they make the transition to clean energy.

Finally, the pivotal difference between the Norwegian and Canadian experiences lies in Indigenous involvement. While Norway has not incorporated the Sami peoples into their clean energy transition, Canada’s transition to renewable energy and low-emission marine propulsion is being led by First Nations. The commitment and drive demonstrated by these communities in transitioning away from fossil fuels is an incredible benefit in the Canadian context. In fact, First Nations across Turtle Island own, co-own or have a defined financial benefit agreement in place for almost 20% of electricity-generating infrastructure, making them the largest asset owners outside of utilities (Stephenson, 2023). Moving forward, the focus should remain on reforming energy regulation and legislation to establish favourable conditions for Indigenous-led clean energy development and partnerships.

Chapter 5. Discussion & Calls to Action

The results of this study indicate that there is a shared interest among First Nations, the federal government, and the BC government in addressing marine decarbonization and seeking low-emission marine propulsion solutions that will reduce cumulative impacts on marine ecosystems. While a key consideration confronting this transition is the choice of propulsion system, options for which have been provided in the literature review, marine decarbonization vastly surpasses this sole aspect (Miller et al., 2013). The challenge is not simply a technical decision of choosing the appropriate new fuel but organizing and restructuring an entire energy system around the chosen fuel. Today, the shift toward renewables has begun, however, Canadian society still exists within the context of colonialism, extractive capitalism, and the dispossession of Indigenous lands, factors that do not inherently create the conditions for a just transition to occur. Addressing justice and equity through government intervention and climate policy will be critical moving forward.

Detailed examination of current government intervention, as revealed by the policy scan, highlights a prioritization of economic concerns in discussions surrounding climate change and marine decarbonization. Consequently, there is a strong emphasis on efficiency measures, the implementation of policy tools such as carbon taxes and subsidies, as well as continued support for the fossil fuel industry. Rarely are justice and equity considerations integrated into federal or provincial climate policy, despite research showing that transitions that create the conditions for social justice are more sustainable and widely supported in the long term (Jenkins et al., 2017; Williams & Doyon, 2019).

In the context of this research, a just energy transition should encompass not only technological shifts but also the dismantling of historical and systemic inequities through the implementation of comprehensive, socially just, and integrated climate policies. Technical decisions should be made with care and account for the numerous geographical, environmental, and user-specific factors, especially given the constraints imposed by limited budgets within a costly and lengthy process. However, beyond the realm of technical solutions are the social considerations of energy justice that enhance the prospects of a successful and equitable transition over the long term.

A just transition to low-emission propulsion solutions comprises three essential dimensions of energy justice: procedural, distributional, and recognition. Procedural justice gives increased decision-making power and control to communities regarding their energy planning by seeking consensual decisions from all stakeholders involved (Hurlbert & Rayner, 2018). Distributional justice involves a reimagination of the power dynamics that distribute the harms and benefits of an energy transition. For example, Indigenous Peoples often bear the cost of resource extraction and energy development while the benefits accrue elsewhere. A well-rounded understanding of Indigenous perspectives, adequate resource allocation, and the removal of colonial biases in research and practice will increase distributional energy justice (Doyon et al., 2021). Finally, recognition is a dimension of energy justice that involves the removal of value hierarchies that are created from institutionalized patterns of cultural valuation and ensures equitable participation in energy systems (Hulbert & Rayner, 2018). Recognition in this context could be achieved through a process of meaningful reconciliation that respects and supports Indigenous energy sovereignty.

In this evolving landscape, colonial institutions are making efforts to achieve recognition through meaningful reconciliation and repair relationships with the Indigenous Peoples of Turtle Island. The passage and adoption of DRIPA (2019) and UNDRIP (Bill C-15, 2021) are changing the legal and political landscape in Canada as we begin to reconcile with our harmful history. The systemic transformation required for a just transition to low-emission propulsion systems in Indigenous communities presents a unique opportunity for colonial governments to take decisive action toward reconciliation. Governmental support is critical to the successful execution of an energy transition, particularly for first-adopter communities as they will bear the cost if challenges arise. The incentive for governments and industry to focus on rural and remote communities may be low since economically it makes more sense to support economies of scale (Miller et al., 2013). Yet, governments have a responsibility to mitigate energy access, reliability, and affordability, as they influence who will benefit from new energy systems, who will lose, and whose lives and livelihoods will be put at risk. Moreover, these governments bear a legislated duty to uphold UNDRIP and DRIPA, as well as the moral obligation to pursue their commitments to reconciliation.

By recognizing the complexity of energy transitions and embracing an intersectional approach, policymakers can facilitate a just transition that not only transforms energy systems but fosters reconciliation, equity, and sustainable prosperity. Their challenge is to develop new approaches to innovation that integrate both technological and human dimensions in a socially just way.

Following are five key recommendations that are offered as calls to action for decision-makers, policymakers, and industry partners to support a just transition to low-emission marine propulsion solutions:

Decolonize Climate Policy and Decentralize Energy Systems

There is a resounding call from scholars to decolonize climate policy (Deranger et al., 2022; Hoicka et al., 2021; Mcgregor, 2019; Reed et al., 2021; Whitney et al., 2020). "Decolonization is about deconstructing and undoing the colonial frameworks which are predicated on systems of patriarchy, heteronormativity, capitalism, extractivism and systems of white supremacy" (Deranger et al., p. 67). These systems and colonial frameworks serve to alienate Indigenous Peoples from their lands and waters, making them increasingly vulnerable to the effects of climate change. Indigenous Peoples have been structurally excluded from the development of climate and energy policies (Molander, 2022; Hoicka et al., 2021) and these will continue to fail without a genuine restructuring and transformation of relationships between Indigenous Peoples and the state. Decolonizing climate policy is vital to ensuring that the path towards a just transition to low-emission marine propulsion systems resonates with the aspirations of coastal Indigenous communities.

There is an essential need for policymakers to integrate principles of decolonization in their work with the understanding that colonial solutions have the potential to perpetuate unequal relationships. Avoid creating policy that simply transfers the weight of responsibility onto Indigenous shoulders with no change in decision-making power. Instead, strengthen Indigenous governance, authority and autonomy over their lands and waters. Decentralize and democratize energy systems by incentivizing Indigenous utility ownership and resisting the current monopoly held by BC Hydro.

Centre Energy Sovereignty

The often-overlooked impacts of BC's clean energy agenda have disproportionately harmed Indigenous Peoples and their territories. Frequently, the interests of small communities are sidelined when decisions are taken to flood land or develop natural gas, which is ostensibly meant for the greater benefit of the province (ICA, 2021; Reed et al., 2021). In order to proceed toward a just energy transition, it is important to implement policy tools that center energy sovereignty and empower community-scale decision-making. Energy sovereignty centres the rights of communities to make their own choices and exercise control in mitigating the externalities associated with energy systems (Krupa et al., 2015; Schelly et al., 2020). When designing climate and energy policy, policymakers should prioritize community voices, enhance their decision-making power, incentivize Indigenous ownership, and meaningfully include Indigenous communities as full partners and co-creators of policy.

Provide Consistent Funding and Support

A complex and costly transition such as this necessitates a strategic approach and acknowledgement of the substantial financial implications involved at all levels. Firstly, as the maritime industry witnesses the emergence of new battery and fuel technologies, governments must be at the forefront of research and development efforts (Hayton, 2023). Governments should identify their competitive advantage in the transition and provide industry funding and support to help drive innovation, facilitate structural change, and orchestrate a sustainable shift in the maritime grid. Secondly, community capacity and resources are essential, particularly in remote regions located far from main gridlines as electrification will necessitate significant infrastructure upgrades. Governments should work with communities to explore ways to offset some of these expenses such as dock-side battery banks and longer scheduled charging times. Battery banks can also serve as valuable grid assets, contributing to peak shaving and localized demand response services (Saether & Moe, 2021).

Funding strategies should be designed to address not only the technical considerations but social aspects as well. Skills diversification, training for mechanics, and meaningful inclusion in decision-making processes will empower communities by developing the skills necessary to own and maintain energy systems. Capacity building such as this leads to energy sovereignty by creating employment, energy literacy, and increased community pride (Laboucan-Massimo et al., 2023) Funding is critical for a just transition and governments can create policies that provide Indigenous communities with better access to money and resources they need. Examples of such policies may include providing direct funding for community capacity building to reduce financial risk, incentivizing projects that practice early and respectful engagement and partnership with Indigenous communities and diversifying the energy supply to facilitate a move away from crown utility-led electricity and toward Indigenous-led electricity generation.

Implement Equity- and Justice-Oriented Policy

Policymakers should consider supportive policies to ease the transition away from fossil fuels in the marine sector. Examples of proven supportive policies include the removal of fossil fuel subsidies, the establishment of feed-in tariffs, net metering policies, supporting community-based renewable energy programs, and providing grants and subsidies for low-emission marine propulsion research and development. When designing supportive policies, decision-makers should consider the affordability impacts of decarbonization and the disproportionate impact that increasing energy and fuel costs can have on lower-income communities. It is important to tailor subsidies to low-income community members and provide long-term support to first-adopter communities as the costs and risks are greater. Policymakers can further contribute to a just transition by facilitating the participation of Indigenous renewable energy projects in regulated energy and grid systems and supporting IPPs, long-term Power Purchase Agreements and equitable power purchase rates.

Share Knowledge and Build Relationships

NTC community leaders are cautiously excited by the opportunities surrounding this transition, reflecting global interest in low-emission marine alternatives, however, Rampanen cautions that “we [the Ahousaht Nation] know very little about what potentials are out there.” This sentiment reflects a broader knowledge gap about the technicalities of low-emission marine propulsion options. Therefore, as we move forward with marine decarbonization initiatives, community education and outreach will be incredibly important to build trust, understanding, and capacity, and in ensuring the safety of boat users. Just transitions require a systems view encompassing not just the technical facets but also the social, cultural, and environmental dimensions. Not only is the design of a safe and efficient vessel paramount, but comprehensive user understanding, trust-building, and inclusivity are pivotal in ensuring a just transition. As exemplified by Norway, the sharing of knowledge is critical in ensuring a rapid transition and will contribute to building relationships among communities and across industries.

Chapter 6. Conclusion

As global momentum to address the climate crisis builds, Indigenous communities across Turtle Island continue to show leadership and innovation in the transition to renewable energy sources. They do so despite a history of colonialism, dispossession of land, and energy agendas that are largely state-centric with regulatory control and ownership remaining in the hands of colonial governments (Molander, 2022; Hoicka et al., 2021). In coastal BC many remote Indigenous communities are beginning to explore marine decarbonization solutions to reduce diesel dependency and achieve their net-zero emissions targets. This research was conducted to support these efforts by providing our community partners with low-emission marine propulsion solutions as well as decision-makers and policymakers with pathways toward upholding the rights of Indigenous Peoples and ensuring a just, equitable, and inclusive transition. The first research objective was to consider the social, economic, cultural, technical, and policy dimensions of adopting low-emission marine propulsion systems. We did so by applying an energy justice framework and sociotechnical lens to foster a holistic approach to marine decarbonization and align this transition with principles of equity, justice, and energy sovereignty.

The second research objective was to determine if and how low-emission marine propulsion may fit into the energy planning of remote coastal Indigenous communities. The results of this study indicate that low-emission marine propulsion solutions exist and may offer these communities an opportunity to reduce their GHG emissions while simultaneously aligning with community and cultural values. The emergence of viable propulsion options such as hydrogen fuel cells, battery electric systems, and hybrid technologies marks a significant step towards addressing environmental concerns and decarbonizing marine transportation. Although implementing hybrid or fully electric passenger, fishing, and other small vessels is feasible, it is not without significant challenges. Challenges include the cost of design and infrastructure implementation, a knowledge gap surrounding technical performance in maritime conditions, capacity, and resource limitations of first-adopter communities, and concerns regarding user adoption and trust. Low-emission marine propulsion solutions are evolving rapidly, demanding a context-dependent approach that considers vessel types, uses, and the environment in which they will operate. Ultimately, the solution will be different for each individual community and the choice of propulsion method will be driven by factors such as local energy availability, energy production capacity, budget, infrastructure implementation, geography, fuel lifecycle analyses, and the specific needs of the boat users themselves.

As transitions of this scale are often lengthy and arduous processes, the final objective of this research was to provide recommendations for policymakers to support and facilitate a just transition to low-emission marine propulsion solutions. Currently, climate policy in Canada does not adequately account for justice in energy transitions as little progress has been made to meaningfully address colonialism, advance Indigenous-led solutions, knowledge, perspectives, or adaptation strategies, or to reduce the disproportionate effects of climate change on Indigenous Peoples (Deranger et al., 2022; Reed et al., 2021). Instead of perpetuating historical injustices, BC should acknowledge the colonial roots of energy decision-making and take all measures necessary to decolonize climate and energy policy by privileging the knowledge and expertise of local Indigenous Peoples and centring principles of energy sovereignty. Furthermore, governments can assist in creating a just and smooth transition by facilitating research and development efforts, providing funding and support to help drive innovation and facilitate structural change, and providing communities with consistent financial, social, and political assistance. Currently, support is provided in the form of grants but assistance with market transition, capacity-building and education is severely lacking. Ultimately, governments need to be at the forefront of research and development to enforce safety regulations and create policy that accelerates decarbonization while empowering community-scale decision-making.

The ultimate objective remains the successful implementation of safe and efficient low-emission marine propulsion systems in remote Indigenous communities. Yet, the path we take to reach this goal matters greatly. Climate change embodies a sense of urgency, compelling us to act quickly, but equitable, just, and sustainable solutions require us to do the work intentionally and respectfully. The urgency of an energy transition can weigh heavy, yet, as many community leaders reminded us, it’s important to celebrate small steps in the right direction. Large-scale change is a series of small victories. Looking ahead, the path to marine decarbonization requires further interdisciplinary research that continues to delve into the social dimensions of energy transitions to create a future that is just and equitable for all.

References

Abacus Data, Iron and Earth. (2021). *Climate Emergency Polling and Transition to Renewable Sources with Oil and Gas Sector Workers.* https://d3n8a8pro7vhmx.cloudfront.net/ironandearth/pages/1668/attachments/original/1626802948/Iron___Earth_-_May_2021_-_Presentation_Updated.pdf?1626802948

Ainsworth, C. H., Samhouri, J. F., Busch, D. S., Cheung, W. W. L., Dunne, J., & Okey, T. A. (2011). Potential impacts of climate change on Northeast Pacific marine food webs and fisheries. *ICES Journal of Marine Science*, *68*(6), 1217–1229. https://doi.org/10.1093/icesjms/fsr043

Ammar, N. R., & Seddiek, I. S. (2021). Evaluation of the environmental and economic impacts of electric propulsion systems onboard ships: Case study passenger vessel. *Environmental Science and Pollution Research*, *28*(28), 37851–37866. https://doi.org/10.1007/s11356-021-13271-4

Atleo, E. R. (2004). *Tsawalk: a Nuu-chah-nulth worldview / Umeek (E. Richard Atleo)*. Canadian Electronic Library, Coherent Digital, & EBSCOhost. UBC Press.

Atleo, C. (2021). Between a Rock and a Hard Place. In W. K. Carroll (Ed.), *Regime of Obstruction: how corporate power blocks energy democracy* (pp. 355-373). Athabasca University Press.

Atleo, C., & Boron, J. (2022). Land Is Life: Indigenous Relationships to Territory and Navigating Settler Colonial Property Regimes in Canada. Land (Basel), 11(5), 609. https://doi.org/10.3390/land11050609

Axsen, J., & Sovacool, B. K. (2019). The roles of users in electric, shared and automated mobility transitions. *Transportation Research Part D: Transport and Environment*, *71*, 1–21. https://doi.org/10.1016/j.trd.2019.02.012

BC Ferries. (2021). *Application to the British Columbia Ferries Commissioner Pursuant to Section 55 (2) of the Coastal Ferry Act For the Island Class Electrification Program.* Retrieved from September 20, 2023, from /https://www.bcferries.com/web_image/hd7/hc2/8847900049438.pdf

BC Ferries. (2023). *The Island Class.* Retrieved October 18, 2023, from https://www.bcferries.com/in-the-community/projects/introducing-island-class-ferries

BC Hydro. (2021). *BC Hydro's Electrification Plan: A clean future powered by water.* https://www.bchydro.com/about/strategies-plans-regulatory/supply-operations/electrification-plan.html?utm_source=direct&utm_medium=redirect&utm_content=electrificationplan

Beer, T. (2024, February 8). *Changing the headline on climate progress*. Canada's National Observer. https://www.nationalobserver.com/2024/02/08/opinion/changing-headline-climate-progress

Bill C-15: An Act respecting the United Nations Declaration on the Rights of Indigenous Peoples. (2021). 3rd Reading May 25, 2021, 40th Parliament, 2nd session. https://parl.ca/DocumentViewer/en/43-2/bill/C-15/third-reading

British Columbia Ministry of the Environment. (2013). *Marine Oil Response Plan.* https://www2.gov.bc.ca/assets/gov/environment/air-land-water/spills-and-environmental-emergencies/docs/marine_oil_response_plan.pdf

Burnham, R. E., Vagle, S., Thupaki, P., & Thornton, S. J. (2023). Implications of wind and vessel noise on the sound fields experienced by southern resident killer whales Orcinus orca in the Salish Sea. *Endangered Species Research*, *50*, 31–46. https://doi.org/10.3354/esr01217

Canada Energy Regulator (CER). (2023). *Market Snapshot: Clean Energy Projects in Remote Indigenous and Northern Communities*. https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-clean-energy-projects-remote-indigenous-northern-communities.html

Cavo, M., Rivarolo, M., Gini, L., & Magistri, L. (2022). An advanced control method for fuel cells—Metal hydrides thermal management on the first Italian hydrogen propulsion ship. *International Journal of Hydrogen Energy*. https://doi.org/10.1016/j.ijhydene.2022.07.223

Chahouri, A., Elouahmani, N., & Ouchene, H. (2022). Recent progress in marine noise pollution: A thorough review. *Chemosphere*, *291*, 132983. https://doi.org/10.1016/j.chemosphere.2021.132983

Cherchi, F., Porru, M., & Serpi, A. (2021). Electrification of Commercial Vessels: Pilot Projects and Open Issues. *2021 IEEE Vehicle Power and Propulsion Conference (VPPC)*, 1–5. https://doi.org/10.1109/VPPC53923.2021.9699224

Cheung, W. W. L., Brodeur, R. D., Okey, T. A., & Pauly, D. (2015). Projecting future changes in distributions of pelagic fish species of Northeast Pacific shelf seas. *Progress in Oceanography*, *130*, 19–31. https://doi.org/10.1016/j.pocean.2014.09.003

Chun, K. W., Kim, M., & Hur, J.-J. (2022). Development of a Marine LPG-Fueled High-Speed Engine for Electric Propulsion Systems. *Journal of Marine Science and Engineering*, *10*(10), 1498. https://doi.org/10.3390/jmse10101498

Clean BC. (2021). *The CleanBC Roadmap to 2030*. https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

Corntassel, J. (2012). Re-envisioning resurgence: Indigenous pathways to decolonization and sustainable self-determination. *Decolonization: Indigeneity, Education & Society*, *1*(1), Article 1. https://jps.library.utoronto.ca/index.php/des/article/view/18627

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)s. (2021). *First Nation Profiles* [Fact sheet; resource list]. https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Index.aspx?lang=eng

Cummings, D. L. (2023). *Nuu-chah-nulth health and data sovereignty in the time of COVID-19*. Simon Fraser University. https://doi.org/10/etd22582.pdf

Curran, D., Kung, E., & Slett, Ǧáǧvi Marilyn. (2020). Ǧviḷ̓ás and Snəwayəɬ: Indigenous Laws, Economies, and Relationships with Place Speaking to State Extractions. *South Atlantic Quarterly*, *119*(2), 215–241. https://doi.org/10.1215/00382876-8177735

De Beukelaer, C. (2023, February 15). *Why cargo ships are bringing back sails*. Fast Company. Retrieved September 20, 2023, from https://www.fastcompany.com/90850262/why-cargo-ships-are-bringing-back-sails

de Santana, D. C. N., Perina, F. C., Lourenço, R. A., da Silva, J., Moreira, L. B., & de Souza Abessa, D. M. (2021). Levels of hydrocarbons and toxicity of water-soluble fractions of maritime fuels on neotropical invertebrates. *Ecotoxicology*, *30*(10), 2109–2118. https://doi.org/10.1007/s10646-021-02486-3

Declaration on the Rights of Indigenous Peoples Act (DRIPA). [SBC 2019], Chapter 44. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/19044

Deranger, E. T., Sinclair, R., Gray, B., McGregor, D., & Gobby, J. (2022). Decolonizing Climate Research and Policy: Making space to tell our own stories, in our own ways. *Community Development Journal*, *57*(1), 52–73. https://doi.org/10.1093/cdj/bsab050

Dooling, R. J., Leek, M. R., & Popper, A. N. (2015). Effects of noise on fishes: What we can learn from humans and birds. *Integrative Zoology*, *10*(1), 29–37. https://doi.org/10.1111/1749-4877.12094

Doyon, A., Boron, J., & Williams, S. (2021). Unsettling transitions: Representing Indigenous peoples and knowledge in transitions research. *Energy Research & Social Science*, *81*, 102255. https://doi.org/10.1016/j.erss.2021.102255

Emblemsvag, J. (2017). The Electrification of the Marine Industry [Viewpoint]. *IEEE Electrification Magazine*, *5*(3), 4–9. https://doi.org/10.1109/MELE.2017.2718821

Environment and Climate Change Canada. (ECCC). (2016). *Pan-Canadian Framework on Clean Growth and Climate Change: Canada's plan to address climate change and grow the economy.* (En4-294/2016E-PDF). publications.gc.ca/pub?id=9.828774&sl=0

Environment and Climate Change Canada (ECCC). (2021). *A Healthy Environment and a Healthy Economy*. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

Environment and Climate Change Canada (ECCC). (2022). *Canada's 2030 Emissions Reduction Plan.* https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/plan.html

Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. *Marine Mammal Science*, *18*, 394–418. https://doi.org/10.1111/j.1748-7692.2002.tb01045.x

ESMARTCITY. (2009, December 10). *Nemo H2*. Retrieved September 20, 2023, from https://www.esmartcity.es/2009/12/10/nemo-h2

Feng, X., Zainudin, E. B., Tseng, K. J., & Low, K. C. A. (2022). On maritime electrification – electrification technologies, charging infrastructure and energy management strategies. *Journal of Physics: Conference Series*, *2311*(1), 012034. https://doi.org/10.1088/1742-6596/2311/1/012034

Fernández-Ríos, A., Santos, G., Pinedo, J., Santos, E., Ruiz-Salmón, I., Laso, J., Lyne, A., Ortiz, A., Ortiz, I., Irabien, Á., Aldaco, R., & Margallo, M. (2022). Environmental sustainability of alternative marine propulsion technologies powered by hydrogen—A life cycle assessment approach. *Science of The Total Environment*, *820*, 153189. https://doi.org/10.1016/j.scitotenv.2022.153189

Furfari, S., & Mund, E. (2022). Advanced nuclear power for clean maritime propulsion. *The European Physical Journal Plus*, *137*(6), 747. https://doi.org/10.1140/epjp/s13360-022-02980-5

Ge, M., Svennberg, U., & Bensow, R. E. (2022). Investigations on prediction of ship noise using the FWH acoustic analogy with incompressible flow input. *Ocean Engineering*, *257*, 111531. https://doi.org/10.1016/j.oceaneng.2022.111531

Government of BC. (2023, January 16). *Remote First Nations communities advance clean-energy projects | BC Gov News*. https://news.gov.bc.ca/releases/2023EMLI0001-000034

Graham, N., Carroll, W. K., & Chen, D. (2019). *Big Oil's Political Reach - Mapping Fossil Fuel Lobbying from Harper to Trudeau.* Canadian Centre for Policy Alternatives. https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office%2C%20Saskatchewan%20Office/2019/11/ccpa-bc_cmp_BigOil_web.pdf

Green, K. (2022, May 12). *BC Ferries plans to go electric mired in government red tape: CEO*. Nanaimo News Bulletin. https://www.nanaimobulletin.com/news/bc-ferries-plans-to-go-electric-mired-in-government-red-tape-ceo/

Greene, H. G., & Aschoff, J. (2023). Oil spill assessment maps of the central Salish Sea – Marine seafloor & coastal habitats of concern – A tool for oil spill mitigation within the San Juan Archipelago, Washington State, USA. *Continental Shelf Research*, *253*, 104880. https://doi.org/10.1016/j.csr.2022.104880

Greer, K., Zeller, D., Woroniak, J., Coulter, A., Winchester, M., Palomares, M. L. D., & Pauly, D. (2019). Global trends in carbon dioxide (CO_2) emissions from fuel combustion in marine fisheries from 1950 to 2016. *Marine Policy*, *107*, 103382. https://doi.org/10.1016/j.marpol.2018.12.001

Haíłzaqv Climate Action Team. (2022). *Haíłzaqv Community Energy Plan.* https://heiltsukclimateaction.ca/community-energy-plan-submitted-version

HavHydrogen. (2021). *A Solution for the Future—FreeCO_2ast | HAV Hydrogen*. Retrieved September 20, 2023, from https://www.havhydrogen.no/hav-hydrogen/freeco2ast/

Hayton, M. (2023). Marine Electrification is the Future: A Tugboat Case Study. In Y. Li, Y. Hu, P. Rigo, F. E. Lefler, & G. Zhao (Eds.), *Proceedings of PIANC Smart Rivers 2022* (pp. 868–879). Springer Nature. https://doi.org/10.1007/978-981-19-6138-0_77

Heffron, R. J., & McCauley, D. (2018). What is the 'Just Transition'? *Geoforum*, *88*, 74–77. https://doi.org/10.1016/j.geoforum.2017.11.016

Heiltsuk Tribal Council. (2017). *Press Release—Diesel Spill in Heiltsuk Waters*. HIRMD. Retrieved September 20, 2023, from https://www.hirmd.ca/fuel-spill.html

Hessevik, A. (2022). Network-led advocacy for a green shipping transformation: A case study of governance networks in the Norwegian maritime sector. *Regulation & Governance*, *16*(4), 1101–1118. https://doi.org/10.1111/rego.12386

Hildebrand, J. A. (2009). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series*, *395*, 5–20. https://doi.org/10.3354/meps08353

Hoicka, C. E., Savic, K., & Campney, A. (2021). Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada. *Energy Research & Social Science*, *74*, 101897. https://doi.org/10.1016/j.erss.2020.101897

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K., & Veirs, S. (2009). Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. *The Journal of the Acoustical Society of America*, *125*(1), EL27–EL32. https://doi.org/10.1121/1.3040028

Howarth, R. W., & Jacobson, M. Z. (2021). How green is blue hydrogen? *Energy Science & Engineering*, *9*(10), 1676–1687. https://doi.org/10.1002/ese3.956

Hurlbert, M., & Rayner, J. (2018). Reconciling power, relations, and processes: The role of recognition in the achievement of energy justice for Aboriginal people. *Applied Energy*, *228*, 1320–1327. https://doi.org/10.1016/j.apenergy.2018.06.054

Hydrogenesis Passenger Ferry. (n.d.). *Ship Technology*. Retrieved May 3, 2023, from https://www.ship-technology.com/projects/hydrogenesis-passenger-ferry/

Indigenous Clean Energy (ICE). (2022). Waves of Change: Indigenous clean energy leadership for Canada's clean, electric future. https://climatechoices.ca/wp-content/uploads/2022/02/ICE-report-ENGLISHFINAL.pdf

Indigenous Climate Action (ICA). (2021). Decolonizing Climate Policy in Canada: Phase One Report. https://static1.squarespace.com/static/5e8e4b5ae8628564ab4bc44c/t/6061cb5926611066ba64a953/1617021791071/pcf_critique_FINAL.pdf

Ingram, K. (2021, June 23). *Nova Scotia to get first electric ferry and net-zero passenger terminal in $3.3 million initiative*. Electric Autonomy Canada. Retrieved from https://electricautonomy.ca/2021/06/22/nova-scotia-electric-ferry/

International Energy Agency (IEA). (2022). *Norway 2022 – Energy Policy Review*. IEA, Paris. https://www.iea.org/reports/norway-2022/executive-summary

International Maritime Organization. (2018). *Initial IMO GHG Strategy*. Retrieved from https://www.imo.org/en/MediaCentre/HotTopics/pages/reducing-greenhouse-gas-emissions-from-ships.aspx

Jenkins, K., McCauley, D., & Forman, A. (2017). Energy justice: A policy approach. *Energy Policy*, *105*, 631–634. https://doi.org/10.1016/j.enpol.2017.01.052

Jenkins, K., Sovacool, B. K., & McCauley, D. (2018). Humanizing sociotechnical transitions through energy justice: An ethical framework for global transformative change. *Energy Policy*, *117*, 66–74. https://doi.org/10.1016/j.enpol.2018.02.036

Jeong, B., Jang, H., Lee, W., Park, C., Ha, S., Kim, D. K., & Cho, N.-K. (2022). Is electric battery propulsion for ships truly the lifecycle energy solution for marine environmental protection as a whole? *Journal of Cleaner Production*, *355*, 131756. https://doi.org/10.1016/j.jclepro.2022.131756

Joy, R., Tollit, D., Wood, J., MacGillivray, A., Li, Z., Trounce, K., & Robinson, O. (2019). Potential Benefits of Vessel Slowdowns on Endangered Southern Resident Killer Whales. *Frontiers in Marine Science*. https://doi.org/10.3389/fmars.2019.00344

Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. *Energy Policy*, *118*, 169–181. https://doi.org/10.1016/j.enpol.2018.03.032

Krupa, J., Galbraith, L., & Burch, S. (2015). Participatory and multi-level governance: Applications to Aboriginal renewable energy projects. *Local Environment*, *20*(1), 81–101. https://doi.org/10.1080/13549839.2013.818956

Laboucan-Massimo, M., Rickerby-Nishi, F., Demeris, N., & Shahed, S. (2023). *Just Transition Guide*. Sacred Earth Solar and Indigenous Climate Action. https://static1.squarespace.com/static/5c9860bf77b9034bc5e70122/t/6555222edcea4d681ccf0454/1700078320040/Just+Transition+Guide.pdf

Lakhani, N. (2023, March 7). Is hydrogen really a clean enough fuel to tackle the climate crisis? *The Guardian*. Retrieved from https://www.theguardian.com/environment/2023/mar/07/hydrogen-clean-fuel-climate-crisis-explainer

Long, Z., Axsen, J., & Kitt, S. (2020). Public support for supply-focused transport policies: Vehicle emissions, low-carbon fuels, and ZEV sales standards in Canada and California. *Transportation Research Part A: Policy and Practice*, *141*, 98–115. https://doi.org/10.1016/j.tra.2020.08.008

MacArthur, J. L., Hoicka, C. E., Castleden, H., Das, R., & Lieu, J. (2020). Canada's Green New Deal: Forging the socio-political foundations of climate resilient infrastructure? *Energy Research & Social Science*, *65*, 101442. https://doi.org/10.1016/j.erss.2020.101442

Mandegari, M., Ebadian, M., van Dyk, S., & Saddler, J. (2023). Decarbonizing British Columbia's (BC's) marine sector by using low carbon intensive (CI) biofuels. *Biofuels, Bioproducts and Biorefining*, *17*(4), 1101–1114. https://doi.org/10.1002/bbb.2495

Markey, S., Gunton, C., Kelly, W., Pagani, M., & Reimer, W. (2023). Reversing the Retreat from Rural: Mobilizing Knowledge and Influencing Policy within the Rural Policy Learning Commons (RPLC): Journal of Rural & Community Development. *Journal of Rural & Community Development*, *18*(3), 69–87.

McGregor, D. (2018). From 'Decolonized' To Reconciliation Research in Canada: Drawing From Indigenous Research Paradigms. *ACME: An International Journal for Critical Geographies*, *17*(3), Article 3.

Mcgregor, D. (2019). Reconciliation, Colonization, and Climate Futures. In C. H. Tuohy, S. Borwein, P. J. Loewen, & A. Potter (Eds.), *Policy Transformation in Canada* (pp. 139–148). University of Toronto Press. https://www.jstor.org/stable/10.3138/j.ctvfjcz59.19

McGregor, D., Whitaker, S., & Sritharan, M. (2020). Indigenous environmental justice and sustainability. *Current Opinion in Environmental Sustainability*, *43*, 35–40. https://doi.org/10.1016/j.cosust.2020.01.007

McIntyre, D., Lee, W., Frouin-Mouy, H., Hannay, D., & Oshkai, P. (2021). Influence of propellers and operating conditions on underwater radiated noise from coastal ferry vessels. *Ocean Engineering*, *232*, 109075. https://doi.org/10.1016/j.oceaneng.2021.109075

Mehammer, E. B., Strand, H., Magnusson, N., Thinn, K. S., & Eberg, E. (2023). How to Plug In the Fishing Fleet: Connectors in charging infrastructure for small fishing boats. *IEEE Electrification Magazine*, *11*(1), 73–82. https://doi.org/10.1109/MELE.2022.3233116

Miller, C. A., Iles, A., & Jones, C. F. (2013). The Social Dimensions of Energy Transitions. *Science as Culture*, *22*(2), 135–148. https://doi.org/10.1080/09505431.2013.786989

Molander, M. (2022). *Renewables and reconciliation: Decolonizing climate policies for a just transition to a low-carbon future*. Simon Fraser University. http://summit.sfu.ca/item/35325

Native Land Digital. (n.d.). nuučaaṅuułʔatḥ nisṁa (Nuu-chah-nulth) Territories. Retrieved October 20, 2023, from https://native-land.ca/maps/territories/nuu-chah-nulth-tribal-council/

Natural Resources Canada. (2020). *The Hydrogen Strategy*. https://natural-resources.canada.ca/climate-change-adapting-impacts-and-reducing-emissions/canadas-green-future/the-hydrogen-strategy/23080

Park, C., Kim, G. D., Yim, G.-T., Park, Y., & Moon, I. (2020). A validation study of the model test method for propeller cavitation noise prediction. *Ocean Engineering*, *213*, 107655. https://doi.org/10.1016/j.oceaneng.2020.107655

Pembina Institute. (2022 a). *First Nation leadership in British Columbia's renewable energy future*. Pembina Institute. Retrieved from www.pembina.org/pub/first-nation-leadership-british-columbias-renewable-energy-future

Pembina Institute. (2022 b, April 27). *RiRC 2022 Plenary Day 2 - Reclaiming Energy Sovereignty: Clean Energy Solutions for the Haíłzaqv*. Youtube. https://www.youtube.com/watch?v=fbJkGvOwi8c

Pembina Institute & New Relationship Trust. (2021). Finding a path forward: First Nation leadership in B.C.'s renewable energy future. Authors: Lovekin, D., Whitestone, M., and Kasteel, C. Originally published in August 2021, revised in January 2022.

Perčić, M., Ančić, I., Vladimir, N., Fan, A., & He, Y. (2021). Comparative life cycle assessment of battery- and diesel engine-powered river cruise ship. In *Maritime Technology and Engineering 5 Volume 1*. CRC Press.

Perčić, M., Vladimir, N., & Fan, A. (2020). Life-cycle cost assessment of alternative marine fuels to reduce the carbon footprint in short-sea shipping: A case study of Croatia. *Applied Energy*, *279*, 115848. https://doi.org/10.1016/j.apenergy.2020.115848

Planakis, N., Papalambrou, G., & Kyrtatos, N. (2021). Predictive power-split system of hybrid ship propulsion for energy management and emissions reduction. *Control Engineering Practice*, *111*, 104795. https://doi.org/10.1016/j.conengprac.2021.104795

Porru, M., Pisano, M., Serpi, A., & Pilo, F. (2020). Electrification of Leisure Boats: A commercial State-of-the-Art. *2020 IEEE Vehicle Power and Propulsion Conference (VPPC)*, 1–6. https://doi.org/10.1109/VPPC49601.2020.9330879

Razy-Yanuv, E., Barak, Y., Noam, O., & Madar, D. (2022). Marine Air Pollution in Israel: Extent, Proposed Mitigation Targets, Benefits and Feasibility. *Atmosphere*, *13*(2), 241. http://dx.doi.org.proxy.lib.sfu.ca/10.3390/atmos13020241

Reed, G., Gobby, J., Sinclair, R., Ivey, R., & Matthews, H. D. (2021). Indigenizing Climate Policy in Canada: A Critical Examination of the Pan-Canadian Framework and the ZéN RoadMap. *Frontiers in Sustainable Cities*, *3*. https://www.frontiersin.org/article/10.3389/frsc.2021.644675

Reusser, C. A., & Pérez Osses, J. R. (2021). Challenges for Zero-Emissions Ship. *Journal of Marine Science and Engineering*, *9*(10), Article 10. https://doi.org/10.3390/jmse9101042

Ruttle, J. (2023, July 16). *First all-electric tugboat in Canada now plying the waters of B.C.* Vancouver Sun. Retrieved from https://vancouversun.com/business/local-business/first-electric-tugboat-arrives-bc-haisea-marine-seaspan

Sæther, S. R., & Moe, E. (2021). A green maritime shift: Lessons from the electrification of ferries in Norway. *Energy Research & Social Science*, *81*, 102282. https://doi.org/10.1016/j.erss.2021.102282

Sawyer, D., Kanduth, A., Griffin, B., Forg, F., Linden-Fraser, R., & Zhang, A. (2023). *Independent Assessment of Canada's 2023 Emissions Reduction Plan Progress Report*. Canadian Climate Institute. https://www.documentcloud.org/documents/24409106-erp-assessment-2023-en-final#document/p6/a2426444

Schelly, C., Bessette, D., Brosemer, K., Gagnon, V., Arola, K. L., Fiss, A., Pearce, J. M., & Halvorsen, K. E. (2020). Energy policy for energy sovereignty: Can policy tools enhance energy sovereignty? *Solar Energy*, *205*, 109–112. https://doi.org/10.1016/j.solener.2020.05.056

Skjong, E., Volden, R., Rødskar, E., Molinas, M., Johansen, T. A., & Cunningham, J. (2016). Past, Present, and Future Challenges of the Marine Vessel's Electrical Power System. *IEEE Transactions on Transportation Electrification*, *2*(4), 522–537. https://doi.org/10.1109/TTE.2016.2552720

Sovacool, B. K. (2017). The History and Politics of Energy Transitions: Comparing Contested Views and Finding Common Ground. In D. Arent, C. Arndt, M. Miller, F. Tarp, & O. Zinaman (Eds.), *The Political Economy of Clean Energy Transitions* (p. 0). Oxford University Press. https://doi.org/10.1093/oso/9780198802242.003.0002

Sovacool, B. K., & Axsen, J. (2018). Functional, symbolic and societal frames for automobility: Implications for sustainability transitions. *Transportation Research Part A: Policy and Practice*, *118*, 730–746. https://doi.org/10.1016/j.tra.2018.10.008

Sovacool, B. K., Axsen, J., & Kempton, W. (2017 a). The Future Promise of Vehicle-to-Grid (V2G) Integration: A Sociotechnical Review and Research Agenda. *Annual Review of Environment and Resources*, *42*(1), 377–406. https://doi.org/10.1146/annurev-environ-030117-020220

Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017 b). New frontiers and conceptual frameworks for energy justice. *Energy Policy*, *105*, 677–691. https://doi.org/10.1016/j.enpol.2017.03.005

Stephenson, A. (2023, March 20). *Indigenous Communities Leading Canada's Clean Energy Boom.* BNN Bloomberg. https://www.bnnbloomberg.ca/indigenous-communities-leading-canada-s-clean-energy-boom-1.1897860

Tan, E. C. D., Harris, K., Tifft, S. M., Steward, D., Kinchin, C., & Thompson, T. N. (2022). Adoption of biofuels for marine shipping decarbonization: A long-term price and scalability assessment. *Biofuels, Bioproducts and Biorefining*, *16*(4), 942–961. https://doi.org/10.1002/bbb.2350

Tellefsdal, P. (2022, December 23). *Massive breakthrough for maritime charging infrastructure!* Elbåtnettverket. Retrieved September 20, 2023, from https://www.elbatnettverket.no//articles/massive-breakthrough-for-maritime-charging-infrastructure

The Narwhal. (2017, September 1). Why We're Taking Canada to Court Over That Promise of 'World-Class' Oil Spill Response. *The Narwhal*. https://thenarwhal.ca/why-we-re-taking-government-court-over-promise-world-class-oil-spill-response/

Transport Canada. (2014). *National Oil Spill Preparedness and Response Regime.* https://tc.canada.ca/en/marine-transportation/marine-safety/national-oil-spill-preparedness-response-regime-0

Transport Canada. (2021). *Canada's Zero-Emission Vehicle (ZEV) sales targets*. AHSB 17484854. https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/canada-s-zero-emission-vehicle-zev-sales-targets

Transport Canada. (2022). *Canadian Green Shipping Corridors Framework*. ACSA 18569534. https://tc.canada.ca/en/marine-transportation/marine-pollution-environmental-response/canadian-green-shipping-corridors-framework

Trudeau, J. (2021). *Minister of Natural Resources Mandate Letter*. Retrieved from the Office of the Prime Minister website: https://pm.gc.ca/en/mandate-letters/2021/12/16/minister-natural-resources-mandate-letter

Truth and Reconciliation Commission of Canada (TRC). (2015). *Truth and Reconciliation Commission of Canada: Calls to Action.* https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/Calls_to_Action_English2.pdf

Tuck, E. (2009). Suspending Damage: A Letter to Communities. *Harvard Educational Review*, *79*(3), 409–428. https://doi.org/10.17763/haer.79.3.n0016675661t3n15

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society*, *1*(1), Article 1. https://jps.library.utoronto.ca/index.php/des/article/view/18630

Turner, N. J., Berkes, F., Stephenson, J., & Dick, J. (2013). Blundering Intruders: Extraneous Impacts on Two Indigenous Food Systems. *Human Ecology*, *41*(4), 563–574. https://doi.org/10.1007/s10745-013-9591-y

UN Press (2018). *Indigenous Peoples Disproportionately Impacted by Climate Change, Systematically Targeted for Defending Freedoms, Speakers Tell Permanent Forum.* https://press.un.org/en/2018/hr5389.doc.htm

Ustolin, F., Campari, A., & Taccani, R. (2022). An Extensive Review of Liquid Hydrogen in Transportation with Focus on the Maritime Sector. *Journal of Marine Science and Engineering*, *10*(9), 1222. https://doi.org/10.3390/jmse10091222

Vernet, C., & Kulkarni, A. (2022, December 4). *First Nation in western B.C. making strides toward energy sovereignty*. CBC. https://www.cbc.ca/news/canada/british-columbia/heilstuk-nation-energy-sovereignty-1.6672940

Viana, M., Hammingh, P., Colette, A., Querol, X., Degraeuwe, B., Vlieger, I. de, & van Aardenne, J. (2014). Impact of maritime transport emissions on coastal air quality in Europe. *Atmospheric Environment*, *90*, 96–105. https://doi.org/10.1016/j.atmosenv.2014.03.046

Wärtsilä. (2023). *MF Folgefonn*. Wartsila.Com. Retrieved September 20, 2023, from https://www.wartsila.com/marine/customer-segments/references/ferry/mf-folgefonn

West Coast Environmental Law. (2009). *Backgrounder: Independent Power Producer (IPP) Projects in British Columbia*. https://www.wcel.org/sites/default/files/publications/Independent%20Power%20Producer%20(IPP)%20Projects%20In%20British%20Columbia%20-%20Legal%20Backgrounder.pdf

Whitney, C., Frid, A., Edgar, B., Walkus, J., Siwallace, P., Siwallace, I., & Ban, N. (2020). “Like the plains people losing the buffalo”: Perceptions of climate change impacts, fisheries management, and adaptation actions by Indigenous peoples in coastal British Columbia, Canada. *Ecology and Society*, *25*(4). https://doi.org/10.5751/ES-12027-250433

Whyte, K. (2017). Indigenous Climate Change Studies: Indigenizing Futures, Decolonizing the Anthropocene. *English Language Notes*, *55*(1–2), 153–162. https://doi.org/10.1215/00138282-55.1-2.153

Whyte, K. (2020). Too late for indigenous climate justice: Ecological and relational tipping points. *WIREs Climate Change*, *11*(1), e603. https://doi.org/10.1002/wcc.603

Williams, R., Ashe, E., Yruretagoyena, L., Mastick, N., Siple, M., Wood, J., Joy, R., Langrock, R., Mews, S., & Finne, E. (2021). Reducing vessel noise increases foraging in endangered killer whales. *Marine Pollution Bulletin*, *173*, 112976. https://doi.org/10.1016/j.marpolbul.2021.112976

Williams, S., & Doyon, A. (2019). Justice in energy transitions. *Environmental Innovation and Societal Transitions*, *31*, 144–153. https://doi.org/10.1016/j.eist.2018.12.001

Wilson, C. (2023, March 23). *B.C. Ferries seeking designs for electrical charging at terminals*. Times Colonist. https://www.timescolonist.com/business/bc-ferries-seeking-designs-for-electrical-charging-at-terminals-6743954

Wolfe, P. (2006). Settler colonialism and the elimination of the native. *Journal of Genocide Research*, *8*(4), 387–409. https://doi.org/10.1080/14623520601056240

Yeo, S.-J., Kim, J., & Lee, W.-J. (2022). Potential economic and environmental advantages of liquid petroleum gas as a marine fuel through analysis of registered ships in South Korea. *Journal of Cleaner Production*, *330*, 129955. https://doi.org/10.1016/j.jclepro.2021.129955

Yunker, Z. (2022, April 19). *Their Land Was Drowned by a Flood of Hydropower*. The Tyee. https://thetyee.ca/News/2022/04/19/Their-Land-Was-Drowned-By-A-Flood-Of-Hydropower/