OCEANS NORTH

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FROM WIND TO WAKE:

Advancing Marine Electrification in Atlantic Canada

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PHOTON

ROBERT ALLAN Naval Architects & Marine Engineers

ROSBOROUGH BOATS

Transport Canada

world energy GH_2

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Introduction

Marine electrification—or the transition from diesel-powered boats to zero-emission hybrid and battery-electric boats—is more than a pathway to reduced greenhouse gas emissions. It's a catalyst for innovation in a net-zero economy, one with the potential to position Canada as a leader in sustainable maritime practices around the world.

On June 4, 2024, national and international leaders from across the marine and energy sectors gathered in Halifax, Nova Scotia for a first-of-its-kind roundtable discussion on the future of marine electrification.

"From Wind to Wake" was organized to break through the barriers preventing the adoption of electric and hybrid-electric boats in Canada's commercial fleet and to highlight the benefits of this transition, which include reducing emissions, improving working conditions and creating new business opportunities for boatbuilders and marine equipment suppliers.

The primary objectives of the roundtable were to:

1. Discuss the readiness of battery propulsion technologies to be deployed as viable alternatives to diesel-powered boats, and identify strategies to deploy these innovative technologies as quickly as possible;
2. Foster collaboration and share ideas among stakeholders to develop a new marine electrification value chain, which includes boat owners, boatbuilders, government, energy producers, industry, academia, and civil society; and
3. Develop a set of recommendations to advance marine electrification across Canada's coasts and inland waterways.

The event featured a dynamic agenda, beginning with a global perspective in the "Powering Up" session, which highlighted advancements in electric marine propulsion and the economic impact of zero-emission vessels. This was followed by "Watts on the Water," a session diving into electric boat technology and innovation, covering topics from propulsion advancements to design considerations for electric vessels. Finally, the "Charging Forward" session examined vessel-to-grid (V2G) and smart grid capabilities, focusing on how marine batteries could bolster grid resilience and efficiency.

This report articulates a shared vision for a sustainable and decarbonized marine sector in partnership with Indigenous and coastal communities, highlighting both the challenges and opportunities that lie ahead. It provides recommendations that are informative, actionable, and relevant for transforming Canada's maritime sector and setting a global example in marine electrification.

Executive Summary

Like the rise of electric and hybrid cars and trucks over the last decade, electric and hybrid-electric propulsion technologies are quickly becoming viable commercial alternatives to power coastal and near-shore vessels. There are hundreds of electric vessels operating around the globe, with ferries, tugboats, and harbour craft leading the charge. Efforts to scale these technologies across Canada's domestic fleets as quickly as possible will not only help to achieve the country's 2030 emission targets, but also create economies of scale across across the entire transportation network that will reduce costs and set the stage to decarbonize ocean-going trade.

From an economic standpoint, marine electrification could also provide a new investment opportunity in coastal communities across the country. The global commercial market for marine electric vessels is projected to expand from $10 billion USD as of 2022 to almost $30 billion USD by 2030, according to a July 2023 report by MarketsandMarkets™[1]. The increase in the availability and feasibility of electric maritime solutions is the primary factor driving growth in the market.

However, for Canada to compete, it is important that the boatbuilding industry and vessel owners are supported in the beginning by programs and incentives to kickstart the uptake of electric and hybrid-electric boats and that a network of shore-side charging infrastructure is developed to support and scale these technologies.

Many of the existing programs and incentives in place to promote electric cars and trucks, such as technology adoption targets and grants to subsidize charging infrastructure, can be used to support marine electrification. Government agencies such as Canada's Ocean Supercluster and the Atlantic Canada Opportunities Agency are well positioned to advance marine innovation and seed the development of a new marine electrification value chain that will bolster Canada's position as a blue economy leader. The majority of roundtable participants agreed that the electrification of coastal and near-shore vessels would have lasting social and environmental benefits that could create new opportunities to develop and grow the local economy.

What's holding Canada back? Participants identified consumer trust and confidence in the technology as being the number-one barrier to the adoption of electric boats. In other words, while proven elsewhere, **no commercial fisher has seen an electric boat that can do a full day's work on the water**.

For these new technologies to gain market traction, Canadians who make a living on the water will need to see this technology is safe and that its performance can match or exceed the performance of their existing boat.

To this end, "From Wind to Wake" participants discussed solutions to increase visibility and trust in battery-propulsion technology, concluding that the first order of business is to increase the number of demonstration and commercial pilot projects on the water. The first generation of projects will require support from governments and power utilities to make strategic investments and develop innovative financial mechanisms, such as Vessel-to-Grid (V2G) connectivity, to capitalize and de-risk both the electric boat projects and the onshore charging infrastructure.

DID YOU KNOW?

In Canada, more than half the country's fleet of 80,000 vessels are workboats operating over more than 900 harbours across the country. Electrifying this fleet could eliminate almost 900,000 tonnes of carbon dioxide equivalent (CO2e) emissions per year, according to the federal Marine Emissions Inventory Tool.[2]

> **Climate change is a burden to manage, but it's also an opportunity to grow Canada's businesses and create a healthier, more resilient society.**
>
> *— Brent Dancey, Director of Marine Climate Action, Oceans North*

Insights & Recommendations

01. Dedicated Government Funding for Electric and Hybrid-electric Demonstration and Commercial Pilot Projects

It is well understood that electric and hybrid propulsion systems are commercially ready and deployable for near-shore and coastal vessels. To build trust in the technology at a local level, commercial pilot projects are seen as the most important thing that needs to happen in the near term. While participants acknowledged the environmental and health benefits of replacing diesel with electrification, the majority would not consider taking on the risk of adopting the new system without government support.

- It is recommended that federal and provincial governments establish dedicated funding streams to support electric and hybrid-electric demonstration and commercial pilot projects, reducing financial risks for early adopters and accelerating the transition to cleaner marine technologies.

02. Investments and Policy Support for Shoreside Infrastructure and Grid Connectivity

The additional cost of shoreside charging infrastructure and limited availability of renewable energy at wharfs was identified as a significant barrier to marine electrification. At present, early adopters looking to invest in electric vessels must also cover the cost of the charging infrastructure and grid upgrades. Power utilities expressed interest in supporting marine electrification but acknowledged limitations to the extent to which their mandate allows them to invest in shoreside charging infrastructure.

- It is recommended that governments and power utilities work together to develop a regulatory framework and suite of financial incentives to facilitate marine electrification.
- It is further recommended that government ownership of charging infrastructure be explored, with the Department of Fisheries and Oceans taking the lead through its Small Craft Harbouts program.
- Additionally, V2G charging incentives should be developed for vessel owners providing battery capacity into the electricity grid to address peak load.

03. Technology Adoption Targets

Technology adoption targets are a useful tool in creating momentum for new technologies to take off by sending a signal to investors and early adopters. These kinds of targets are used today in the auto sector, with Canada and California both aiming to have 100 per cent of new car sales to be zero-emission vehicles by 2035.[3]

- It is recommended that Canada establish a technology adoption target between 5 and 10 per cent of Canada's commercial fleet by 2030.

"POWERING UP": Marine Electrification in a Global Context

Globally, the transition towards marine electrification is already happening, and quickly.

According to DNV—a globally recognized classification society and marine consultancy firm—battery-electric and hybrid-electric propulsion systems are the most deployable solution for decarbonizing coastal and near-shore vessels such as ferries, tugboats and workboats.[4]

DNV has been a global leader in developing technical safety standards for fire-prevention and housing integrity to prevent water from reaching the battery system for more than a decade, emphasizing the fact that regulators are laser focused on updating and improving the standards to facilitate the scaling of these technologies, find efficiencies and meet emission reduction targets.

According to DNV's vessel technology tracking system, there are more than 1,000 battery-electric and hybrid-electric vessels on the water and more under development today.

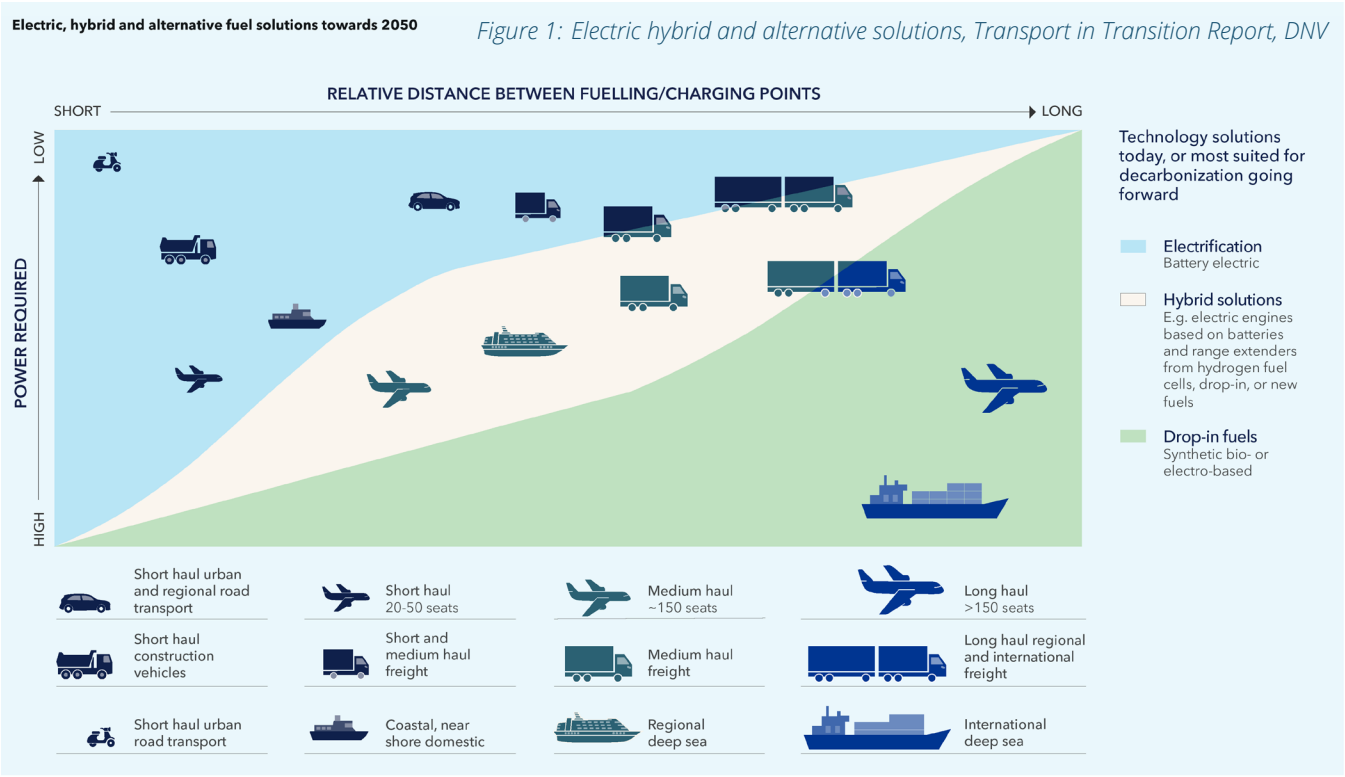

Figure 1: Electric hybrid and alternative solutions, Transport in Transition Report, DNV

> **There is really no time to waste. We need to make the decision—now, in this decade—to set the pathway to full decarbonization of maritime and shipping by 2050. The marine industry is at a pivotal moment where technology, policy, and market forces are converging to make electrification not only feasible but also economically advantageous.**
>
> *— Jan Hagen Andersen, Business Development Director - Maritime, DNV*

"WATTS ON THE WATER": Electric Boat Technology and Innovation

Canada is home to a diverse fleet of marine vessels, each playing a crucial role in the nation's economy and way of life. Lobster fishing boats and harbour craft like pilot boats, tugboats, and ferries are ripe for electrification due to their predictable routes and frequent docking, which simplify the logistics of charging.

Recent deployments of battery-powered tugboats on the West Coast underscore the potential for electric and hybrid-electric boats to replace diesel-powered boats for even the toughest jobs in the harbour. The first of five fully electric tugboats is now in operation in Vancouver. One of these tugboats boasts an impressive battery capacity of more than 5000 kWh – which is the equivalent of running 70 Teslas all day.[5] This project includes investments from BC Hydro for the charging infrastructure needed to power the boats.

The new fleet of electric tugboats is a testament to the potential of battery electric propulsion to decarbonize marine activities when powered by renewable energy sources.

> **"We must be very careful about how we define electric homogeny in terms of where that electricity is coming from and how it's stored and how it's generated. That is a critical part of the conversation because we cannot decarbonize and call it an electric boat if we are running diesel gensets. That is just not the answer.**
>
> *— Jim Hyslop, Director of Project Development, Robert Allan Ltd.*

Batteries Have Come a Long Way

Advancements in battery chemistry, energy density, and thermal management are enabling longer range and higher performance for electric boats while reducing the overall costs of battery systems. At the same time, advancements are being made in fast-charging and wireless charging technologies for commercial consumers in the electric vehicle sector.

"Lithium-ion batteries revolutionized consumer electronics over 30 years ago, and while the core chemistry remains familiar, today's advancements continue to transform the landscape. We've been optimizing materials and designs, pushing boundaries to make batteries not only more energy and power-dense but, crucially, more affordable. This cost reduction is key to unlocking the potential of emerging sectors. Marine electrification stands poised to capitalize on the trillions of dollars invested in EV systems, ushering in a new era of clean energy for the industry."

— Chris Burns, NOVONIX

Increasing Trust and Reducing Cost

"Confidence is one of the biggest barriers."

— Naval Architect

Building trust in electric and hybrid-electric technologies was a recurring theme throughout the discussion. Stakeholders emphasized the importance of demonstration and commercial pilot projects to showcase the reliability and performance of electric vessels in a local context.

"You really need some kind of proof of concept out there for people to see. Just having people be able to go out and see that they could do a day of fishing without any issue is going to go a long way. We really are lacking education and that's going to be a crucial part of the transition: having something in the water that people can really see that they can understand is reliable and see it as a viable option."

— Fisher

The availability of government programming to support marine electrification was seen by participants as an essential element for the transition. In fact, most participants would not consider taking on the risk of replacing their existing boats with battery-powered boats without government support.

The additional cost for charging infrastructure on top of the higher cost for electric propulsion borne by the boatowner further underscored the need for public incentives in the early years of the transition. Government grants, both federal and provincial, as well as access to zero-interest loans, were discussed as key actions to get projects on the water and begin building trust in new technologies at the local level.

The Membertou *Lektrike'l Walipotl* Electric Lobster Boat Pilot Project, **now in its final design phase**, is an Indigenous-led initiative focused on creating the first all-electric boat tailored for the demands of the commercial lobster fishery in Cape Breton.[6] Spearheaded by Membertou and supported by various partners, including Oceans North, Allswater, and BlueGrid Energy, with funding from ClimateWorks Foundation, Google Canada, and the Royal Bank of Canada's Tech for Nature Program. This project aims to develop a sustainable, zero-emission lobster boat that aligns with traditional environmental stewardship practices.

Data Collection and Design are Key to Getting It Right

Sizing the electric motor and battery to match the mission profile of the existing boat is the first and most important step in designing an electric or hybrid-electric boat. To do this, naval architects need to work more closely with boat operators to collect data and develop more efficient boat designs.

"Accurate data collection and a thorough understanding of the boat's operation is crucial when designing an electric boat. We analyze the entire energy cycle from start to finish, breaking it down to the second to determine how much energy the vessel uses. From there, we examine the efficiency of the hull to ensure that we grab every little bit of energy reduction we can. From this we then determine how many batteries are required to efficiently operate the vessel electrically."

— Rob Crutcher, Allswater

Regulatory Review and Standardization

Participants believed that governments and regulatory bodies were not keeping pace with the technological advancements happening in the marine sector and that greater effort was needed to develop a regulatory framework to better enable marine electrification.

"The commercial aspect is essentially impossible to do without government regulation. The government just has to say, 'This is what we've got to do to go electric.'"

— Marine Engineer

This regulatory framework should include additional resources, including staff who can function as "navigators" within their organizations to provide information to companies pursuing electric vessel solutions.

There was strong recognition of the need for collaboration, including between government

agencies, utility companies, and industry, to ensure that all parties are aligned and can address regulatory and infrastructural challenges collectively.

Participants discussed the possibility of an industry-standard "electrification kit" that would provide boatbuilders, technology companies, and others with a set of standardized or minimum requirements for electric marine vessels, ensuring some degree of uniformity of adoption across various locations. This could reduce the need for repeated studies and analysis across the sector, as today, industry leaders incur significant costs for evaluating different approaches and technologies.

"Right now, the culture is to design new propulsion systems customized for each vessel. We need to move toward standard-size systems. If we don't get to some sort of consolidation, we're not going to get economies of scale."

— Sue Molloy, Glas Ocean Electric

Community Engagement and Indigenous Leadership

Engaging with local communities and stakeholders to build knowledge and awareness of technologies and programs was identified as crucial for the successful adoption of marine electrification. Participants stressed the importance of collecting data and analyzing use cases for marine electrification to inform the vessel owners and communities about the benefits and practicalities of electric vessels. This educational approach helps build trust and reduces resistance to new technologies.

Indigenous participation is pivotal in the transition to sustainable fishing practices and the adoption of electric vessels. Indigenous communities possess a deep understanding of their local ecosystems and sustainable practices, which is essential information to help governments tailor programs that foster greater participation. They also are most likely to have community-owned fleets in need of retrofits. By leveraging existing programs offered through the Canada Infrastructure Bank and the First Nation Financing Authority, Indigenous communities are well-positioned to lead a successful electrification project.

"First Nations need to be there because it is one of the perfect entry markets. Most of the First Nations have a fleet of between five all the way up to 20 vessels. They could access capital to renew their whole fleet as most of the vessels are over 25 years old. So, in terms of the asset retirement obligation, it's time to roll them over."

— Community Member

“CHARGING FORWARD”: Shoreside Charging Infrastructure Cost and Ownership Models

When you buy a car, you don’t have to buy a gas station too. Yet that is exactly the situation early adopters find themselves in with electric boats, which require shoreside charging infrastructure and potential grid upgrades to bring electricity to the wharf. It follows that continued investments are needed to decarbonize provincial grids for electric boats to be truly zero emission.

The accessibility of shoreside charging infrastructure at local wharfs, particularly in small-scale fisheries and remote communities, remains a significant concern for vessel owners. Without government support, many vessel owners would not pay the cost differential for an electric boat, let alone the additional cost for the charging infrastructure. It was observed by some that the challenge of supplying renewable energy at the wharf was a greater challenge than the technological challenge of

> **We need to figure out who’s going to be paying for the shoreside infrastructure. All this talk about incentivizing electrification doesn’t matter if there’s not a place to charge. For an electric utility in Nova Scotia… this is true of most in Canada, we’re just not able to invest in charging infrastructure.**
>
> *— Utility*

Utility representatives acknowledged the supply challenges and the need for them to play a greater role in scaling the adoption of electric vessels going forward. Many of the Small Craft Harbours and wharfs in Nova Scotia and across Canada are in remote areas and lack the capacity to manage significant new electrical demand. Coordinating grid upgrades and chargers with anticipated vessel electrification is key to scaling the technology.

Participants emphasized the importance of shared ownership models to avoid burdening individual vessel owners with the costs of installing and maintaining charging infrastructure. They proposed a market-wide ownership structure that ensures charging stations are publicly accessible and funded through collective mechanisms.

The Department of Fisheries and Oceans, as the federal department responsible for Canada's Small Craft Harbours program, was identified as a key stakeholder in facilitating the uptake of electric boats. Participants agreed that coordinated efforts from this department would be crucial in managing the necessary infrastructure developments, ensuring that investments are strategically placed to maximize benefits, and supporting the widespread adoption of electric vessels.

Bi-directional Charging and Vessel-to-Grid (V2G) Technologies

Bi-directional charging or V2G infrastructure—chargers that allow electric vessels to both draw electricity from the grid to charge their batteries and feed stored electricity back into the grid when needed—offer the potential to ease concerns around affordability.

V2G programs that are emerging in the context of electric school bus fleets generate a model for bi-directional charging that can unlock the potential of the batteries onboard electric and hybrid electric boats to provide both a revenue stream for boat owners and grid storage capacity for power utilities.

The BlueGrid V2G Initiative marked a milestone with ABCO's high-power electric workboat, the first in the world capable of V2G electricity transfer.[8] Demonstrated at COVE Demo Day in Halifax Harbour, this emission-free vessel, once diesel-powered, is now fully electric, with speeds reaching 38 knots. Uniquely, it supports two-way power transfer, enabling it to store energy and return it to the grid during peak demand—a feature that provides a new revenue stream for vessel owners, reducing ownership costs and advancing emissions-free operations.

The Pathways for Canadian Electric School Bus Adoption report, prepared by Dunsky Energy + Climate Advisors for Équiterre and the Canadian Electric School Bus Alliance, explores the potential of electric school buses to support the electrical grid.[7] Given their limited daily usage, school buses can serve as mobile energy storage units, providing power back to the grid during peak demand times.

The seasonality of fishing vessels may offer even greater potential than school buses because of the larger batteries onboard and longer period of commercial inactivity. The idea the batteries onboard the boat could be passive revenue generators when not fulfilling their main objective was intriguing for fishers and vessel owners not familiar with V2G. Given the potential for V2G to provide revenue for boatowners and reduce costs, it was suggested that a mandate be put in place that all new electric vessels be capable of bi-directional charging as a minimum standard.

"Lobster fishers fish for like seven weeks and then for 10 months of the year, the boat sits there. All you got to do is money out for 10 months, and then for two months, you pound it. So how can you offset that? I don't think it takes a genius to see there is a business model there. It can't come at a cost elsewhere because they have two months that boat has got to run, but that [V2G charging] is part of the business model that's so attractive."

— Boatbuilder

Despite the promising financial prospects, the electric bus report highlights that bi-directional charging alone cannot offset the higher costs without additional funding and regulatory incentives like fuel switching credits.

"V2G revenue can sweeten the deal and certainly it can help make a compelling business case when it's coupled with other revenue streams like government funding. This shows how innovative financial models and robust funding mechanisms are essential to drive the adoption of marine electrification."

— Lauren McNutt, Dunsky Energy + Climate Advisors

Developing Coastal "Smart Grids" and Microgrids

The integration of large numbers of electric vessels into the grid poses challenges, such as increased demand for electricity infrastructure and available renewable electricity.

Participants highlighted the role of coastal "smart grids" and microgrids to address these challenges by integrating renewable energy sources, energy storage systems, and digital technologies to optimize energy production, distribution, and usage in coastal areas. These grids are particularly suited to support the electrification of marine vessels, as well as the energy needs of nearby coastal communities.

Microgrids at ports and community wharfs can support vessel electrification by generating their

own power and managing energy storage efficiently, therefore minimizing grid dependency. The ability to charge batteries during low-demand periods and discharge them during peak times can stabilize the grid and reduce the need for coal-fired power generation, especially during winter peaks.

"Imagine a marina where you have solar plus a stationary microgrid. You're topping off the battery there so it's not truly off grid, but it's more thinking the marina is disconnected from getting it all the way back to the grid. So the marina owner benefits in that scenario."

— Technology Provider

Integrating renewable energy sources with energy storage systems in microgrids can help absorb excess generation from sources like wind and solar, enhancing grid stability and maximizing renewable energy use.

Participants also noted the need for regulatory frameworks and financial support to encourage investment and ensure seamless integration with existing grid infrastructure. Clear policies and incentives are crucial for overcoming financial barriers and supporting microgrid development.

Additionally, comprehensive data on energy use patterns and vessel operations is essential for designing effective microgrids that meet the specific needs and behaviours of end-users. It was suggested that as more and more data is collected, the opportunity for decision-makers to use artificial intelligence programs to create models that evaluate the feasibility of scaling up V2G connections will become possible, accelerating decision-making and reducing risk.

Participants highlighted that smart grid technology at the community level could help overcome challenges related to grid congestion. By optimizing energy flow between vessels, local grids, and central energy systems, coastal smart grids can deliver cleaner, more efficient power distribution.

Conclusion:
Call to Action and Vision for the Future

The transition to marine electrification in Canada is not just a technological shift but a visionary leap towards a sustainable future. However, it is going to take time and partnership across multiple sectors to break into the global market.

The insights and recommendations gathered in this report underscore the potential for electric and hybrid boats to not only reduce marine emissions but also create new economic opportunities and improve community resilience. Canada can and should lead in marine electrification, leveraging its expertise in boatbuilding and fishing to secure a prosperous, low-emission future. By embracing this transition, Canada can join the ranks of nations such as Norway that are already reaping the benefits of zero-emission marine technologies. However, demonstration projects, strategic investments in shoreside charging infrastructure, and supportive policies with clear targets are essential to build trust and drive adoption. The active participation of Indigenous communities and a strong focus on cooperation between government, industry, and academia will ensure a comprehensive and inclusive approach.

With collaboration, the vision of a decarbonized marine industry is within reach. Together, we can pave the way for a cleaner, more sustainable future.

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