

Charting the Course: Caribbean Maritime Decarbonization Amid Uncertainty and Just Transition

Written by Nikita Kunar

Have you ever paused to think about international shipping, maybe while sipping your morning coffee, unboxing an online order, or during your weekly grocery run? Maybe not. But for me, it's impossible not to. Maritime transport is the heartbeat of modern society, carrying roughly 80% of global trade by sea.¹ Every product we touch and every supply chain we rely on moves across the oceans, and the decisions we make today in shipping will shape climate outcomes and regional economies for decades.

International shipping contributes nearly 3% of global greenhouse gas (GHG) emissions, making it a pivotal sector for achieving SDG 13 (Climate Action).² Recognizing this, the International Maritime Organization (IMO) has set ambitious targets: reduce shipping emissions by 20% by 2030 and 70% by 2050.³ Achieving these goals requires transformative action, from alternative fuels and electrification technologies to scaling shore power, guided by evidence-based strategies that prioritize measurable emission reductions and sustainable implementation. However, the pathways to achieving emission reduction are lined with uncertainty creating significant complexity in decision-making.

For the Caribbean, this complexity is compounded by vulnerability. The region stands on the frontline of climate change: regional mean temperatures have risen from 0.8°C in 1990 to 1.6°C in 2024, with climate-related events increasing by 35.7 percent over the same period.⁴ In this context, understanding the complex web of solutions becomes paramount. For the region, decarbonization is not merely a global ambition; it is essential for energy security, economic resilience, and sustainable development.

A Complex Web of Solutions

As shipowners seek to remain in compliance, vessels over 5,000 GT are required to align with increasingly ambitious decarbonization targets. This affects container ships, bulk carriers, tankers, and cruise vessels alike. In response, shipowners are evaluating the most cost-effective and reliable pathways, creating a complex web of mitigation technologies. Increasingly, these pathways are assessed using a well-to-wake approach, ensuring emissions are evaluated across the entire lifecycle of energy sources being considered for maritime transition. Within this transition, multiple solutions are emerging, of which I will highlight a few.

➤ Alternative Fuels: Grey, Blue, and Green

The International Maritime Organization (IMO) applies a well-to-wake framework to assess fuels, from raw material sourcing and production to transport and combustion. This lifecycle lens ensures that

¹ UNCTAD. (2025, April 15). *Shipping data: UNCTAD releases new seaborne trade statistics*. United Nations Conference on Trade and Development. <https://unctad.org/news/shipping-data-unctad-releases-new-seaborne-trade-statistics>

² International Maritime Organization. (2021). *Fourth IMO GHG Study 2020: Full report and annexes* (PDF). <https://www.wcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf>

³ International Maritime Organization. (2023). *Annex 15: 2023 IMO strategy on reduction of GHG emissions from ships* (Annex to MEPC 80/17/Add.1). <https://www.wcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf>

⁴ Economic Commission for Latin America and the Caribbean (ECLAC). (n.d.). *CEPALSTAT: Statistical data portal and publications*. Retrieved [date you accessed it], from <https://statistics.cepal.org/portal/cepalstat/dashboard.html?theme=3&lang=en>

compliance-driven fuel shifts do not unintentionally increase overall greenhouse gas emissions or harm ecosystems.

Alternative fuels are generally categorized as:

- **Grey fuels:** Conventional fossil fuels without emissions abatement; high lifecycle GHG emissions.
- **Blue fuels:** Fossil fuels produced with carbon capture or mitigation technologies; lower lifecycle emissions but still dependent on non-renewable feedstocks.
- **Green fuels:** Derived from renewable electricity or sustainable biomass; minimal lifecycle emissions.

➤ **Onboard Carbon Capture and Utilization**

Onboard carbon capture systems intercept CO₂ (carbon dioxide) at the point of combustion, potentially capturing up to 70% of emissions, with the remainder released into the atmosphere. Captured carbon can be reused in applications such as:

- Synthetic materials (including industrial-grade diamonds)
- Greenhouse enhancement for plant growth
- Limestone production for construction
- Industrial inks and materials

However, this pathway increases fuel consumption due to the additional energy required for capture and storage. While still under exploration, it offers a transitional solution for both existing and new vessels.

➤ **Shore Power (Cold Ironing)**

Shore power allows vessels to switch off auxiliary engines while at Berth and connect to landside electricity. This significantly reduces in-port emissions and improves performance under the IMO's Carbon Intensity Indicator (CII), effectively a vessel's annual emissions performance rating. However, this option requires significant levels of renewable energy to be considered as a green alternative.

Beyond these pathways, additional measures include onboard waste-to-energy systems, solar and wind integration, and operational efficiency technologies, all aimed at reducing overall emissions. For Caribbean ports, supporting the maritime decarbonization transition requires more than adopting new technologies. It demands a coordinated, system-level strategy that reflects the realities of Small Island Developing States (SIDS), including heavy reliance on maritime transport, geographic isolation, and deep integration into global trade and tourism networks.

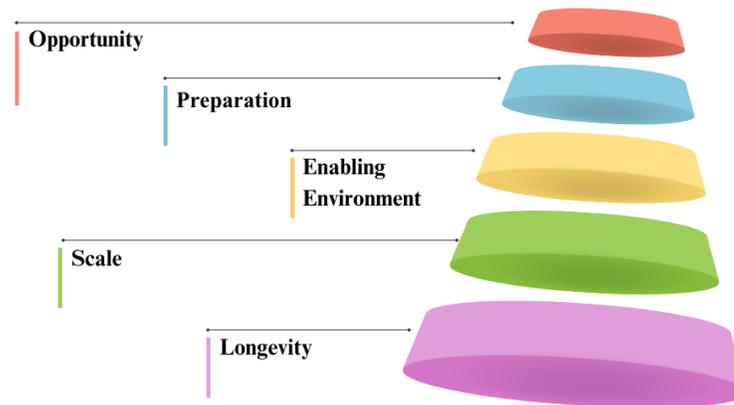
These structural constraints intersect with critical development priorities such as poverty reduction, food security, and inclusive economic growth. The challenge is not a lack of solutions; it is selecting the right combination. With multiple pathways emerging simultaneously, the key question becomes:

How does the Caribbean chart its course while aligning with vessels undergoing their own decarbonization transition?

Framing Caribbean Maritime Decarbonization

Navigating this complex landscape requires structure. The transition can be approached through five interconnected lenses: Opportunity, Preparation, Enabling Environment, Scale, and Longevity (OPESL), providing a practical framework for guiding Caribbean maritime decarbonization.

(OPESL) PRESPECTIVE



Opportunity: Maritime Decarbonization as a Catalyst for Caribbean Energy Transformation

When considering Maritime decarbonization as an opportunity it can be seen as a launchpad for Caribbean energy transformation. The region's abundant renewable energy potential, combined with geographic proximity, creates a competitive advantage: regional production reduces transportation emissions, and with renewable energy utilization this would lower production-phase emissions, and strengthen supply chains, supporting SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production), while unlocking new economic opportunities such as the following;

1. Waste Management & Biofuels

Methane emissions, a potent greenhouse gas, are like invisible heat bombs in our landfills, making effective waste management a climate priority. CARICOM countries have set ambitious NDC targets: Dominica aims to reduce waste-related GHG emissions by 78.6 percent.⁵ Meanwhile Suriname, Grenada, and St. Vincent and the Grenadines highlighted the need for the adoption of circular economy models.

Second-generation biofuels can be a pathway to reducing landfill waste and GHG emissions associated. These second-generation biofuels can be made from waste residues ensuring the protection of food security (SDG 2) while meeting IMO compliance requirements. In the Caribbean, sargassum seaweed, with seasonal

⁵ The Commonwealth of Dominica. (2022, July 4). *Updated nationally determined contribution (NDC)*. United Nations Framework Convention on Climate Change. <https://unfccc.int/sites/default/files/2022-07/The%20Commonwealth%20of%20Dominica%20updated%20NDC%20July%204%20%2C.pdf>

influxes of 0.45–1.7 million tonnes, represents a scalable feedstock.⁶ Its zero-sulfur content, low nitrogen levels, and carbon reduction potential make it ideal for cleaner marine fuel pathways.^{7,8} Organic food waste provides additional biofuel potential while reducing landfill dependency, supporting SDG 14 (Life Below Water) and SDG 15 (Life on Land).

2. Cross-Sector Decarbonization & Alternative Fuels

E-fuels, or synthetic fuels, are produced by combining renewable electricity with gases such as CO₂ (carbon dioxide), CH₄ (methane), or H₂ (hydrogen) to create usable fuels. These fuels enable direct carbon capture, reduce methane flaring, and support a just transition for workers in traditional energy sectors across Trinidad and Tobago, Guyana, and Suriname. In tourism-dependent economies, co-producing e-diesel and sustainable aviation fuel (SAF) can reduce emissions from transport, maritime shipping, and import-dependent energy consumption, unlocking integrated cross-sector benefits.

3. Shore Power

The Caribbean is the world's top cruise tourism destination, accounting for 44.2% of the global market share in 2023.⁹ This makes ports in the region significant sources of emissions, but it also presents untapped opportunities. By implementing shore power systems, ports can connect vessels to local renewable electricity, reducing emissions from docked ships. Under growing market demand, this creates a key opportunity for renewable energy investment and positions the Caribbean as a leader in clean, sustainable port operations.

Preparation: Infrastructure & Supply Chain Readiness

Opportunity alone isn't enough. Success depends on resilient infrastructure, human capital, and operational readiness. Key priorities include:

- **Port & infrastructure planning:** Assess port readiness for new fuels, fleet profiles, fuel storage capabilities, and waste-to-fuel streams.
- **Renewable energy investment:** Expand deployment and energy efficiency initiatives to create conditions for clean fuel production aligned with NDC commitments.
- **Human capital & R&D:** Strengthen workforce transition programs, technical training, and research initiatives to improve fuel scalability, enable technology transfer, and support commercialization pathways.

Pairing preparation with government and private-sector coordination ensures financial investment matches operational needs, creating a robust enabling environment for a sustainable, resilient, and economically beneficial low-carbon maritime future.

Enabling Environment: From Ambition to Action

Uptake of alternative fuels in the maritime sector is primarily driven in mature markets by regulatory mandates, private-sector investment, and growing market demand. According to the IEA (2025), biodiesel

⁶ Caribbean Coastal Ocean Observing System. (n.d.). *Sargassum tracker*. CARICOOS. Retrieved February 21, 2026, from <https://www.caricoos.org/sargassum>

⁷ Farobie, O., Amrullah, A., Bayu, A., Syaftika, N., Anis, L. A., & Hartulistiyoso, E. (2022). *In-depth study of bio-oil and biochar production from macroalgae Sargassum sp. via slow pyrolysis*. RSC Advances, 12(16), 9567–9578. <https://doi.org/10.1039/D2RA00702A>

⁸ Rahbari, H., Akram, A., Pazoki, M., & Aghbashlo, M. (2019). *Bio-oil production from Sargassum macroalgae: A green and healthy source of energy*. Jundishapur Journal of Health Sciences, 11(1), e84301. <https://doi.org/10.5812/jjhs.84301>

⁹ Cruise Lines International Association. (2023). *2023 State of the Cruise Industry Report*. Cruise Lines International Association. <https://cruising.org/resources/2023-state-cruise-industry-report>

uptake in shipping is expected to double by 2030, covering roughly 1% of maritime fuel demand, with Europe leading growth.¹⁰ Progress is closely linked to policies such as FuelEU Maritime, which encourage private-sector engagement across the supply chain and toward end-user adoption.

For the Caribbean, creating an enabling environment requires tailored actions across regulatory, economic, and financial dimensions to encourage the uptake of alternative solutions during vessel operations in the region, including:

- **Environmental Regulations:** Protect marine ecosystems and enforce emissions standards for fuels and shore power.
- **Mitigation Technologies:** Deploy proven shore power systems and low-carbon fuel solutions with clear performance standards.
- **Risk-sharing and finance frameworks:** Structure funding to address data gaps, capacity constraints, and early-stage risks, ensuring long-term system performance and avoiding stranded assets.
- **Building Trust:** Provide transparent information, certifications, and pilot projects to assure maritime customers that regional fuels and services are safe, reliable, and sustainable.

By combining regulations, technologies, robust market financial mechanisms and trust-building, the Caribbean can create trusted, investable opportunities for low-carbon maritime solutions.

Scale & Longevity: Stronger Together

Small market sizes can limit economic and operational viability. Regional aggregation, pooling demand and infrastructure across member states, can achieve economies of scale, reduces costs, and limits dependence on volatile global markets. Leveraging base-load renewable energy, local fuel production infrastructure, and technical expertise further strengthens the transition.

A phased, flexible, and system-aligned approach minimizes stranded-asset risk, aligns investments with readiness, and embeds risk-sharing into financing structures. Regional coordination ensures equity and a Just Transition, allowing all Caribbean nations to benefit.

Captains of Our Destiny

In conclusion, with the right combination of Opportunity, Preparation, Enabling Environment, Scale, and Longevity, Caribbean nations have the potential to navigate maritime decarbonization by shifting from fragmented initiatives to a coordinated and evidence-based transition, positioning the region's maritime sector for environmental sustainability and long-term economic resilience.

¹⁰ International Energy Agency. (2025). *Renewables 2025*. IEA. <https://www.iea.org/reports/renewables-2025>