Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03

ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

GREEN FINANCE AND THE EVOLVING ROLE OF INSURANCE IN MARITIME SUSTAINABILITY

Angelica M. BAYLON[1], Vadm Eduardo Ma R SANTOS[1]

[1]Maritime Academy of Asia and the Pacific Philippines (MAAP), Kamaya Point, Brgy. Alas-asin, Mariveles, Bataan, Philippines, ORCID ID: 0000-0001-8330-2415, e-mail address: ambaylon@maap.edu.ph

Abstract: The maritime industry is a vital component of global trade and economic development, yet it faces growing pressure to adopt sustainable practices in response to environmental challenges and climate change. This paper examines the growing role of green finance in supporting maritime sustainability initiatives, focusing on innovative financial instruments and investment strategies designed to mitigate environmental impacts. Additionally, it examines the evolving function of insurance in promoting sustainable practices, including coverage for eco-friendly vessels, emissions reduction technologies, and climate risk mitigation. The integration of green finance and specialized insurance solutions offers a comprehensive approach to fostering a resilient and environmentally responsible maritime sector. The paper concludes with policy recommendations and prospects for aligning financial mechanisms with sustainable maritime development goals.
Key words: Climate risk mitigation, eco-friendly vessels, green finance, emissions reduction technologies, investment strategy.

1. INTRODUCTION

1.1 Importance of sustainable development in the maritime sector

Maritime shipping accounts for approximately 2-3% of global greenhouse gas emissions (IMO, 2021). The maritime sector is a cornerstone of global trade, responsible for transporting approximately 80-90% of the world's goods by volume. It enables the movement of raw materials, manufactured products, energy resources, and agricultural commodities across continents, connecting economies and supporting international commerce. The sector's efficiency, cost-effectiveness, and ability to handle large volumes make it indispensable for the global supply chain. However, despite its crucial role, the maritime industry faces several significant challenges:

- *Environmental Impact*: Shipping contributes to greenhouse gas emissions, air and water pollution, and marine debris. Efforts to reduce its carbon footprint are ongoing but require substantial technological and regulatory advancements.
- *Regulatory and Security Concerns*: Stringent international regulations, such as the IMO sulfur emissions limits, and security threats, including piracy, particularly off the coast of Somalia and in other high-risk areas, pose operational challenges.
- *Technological Disruption*: The industry must adapt to new technologies, such as automation, digitalization, and greener fuels, which require substantial investment and infrastructure changes.
- *Economic Volatility*: Fluctuations in global markets, trade disputes, and economic downturns can impact shipping demand and profitability.
- Infrastructure Limitations: Ports, shipping lanes, and logistics hubs require continuous upgrades to handle larger ships and increased traffic efficiently.
- *Labor and Safety Issues*: Ensuring crew safety, managing labor shortages, and maintaining a skilled workforce are ongoing concerns.

While the maritime sector is vital for facilitating global trade, it must navigate environmental, technological, regulatory, and economic challenges to sustain its crucial role in the world economy.

1.2 Overview of green finance and insurance's role in the maritime industries

Innovative green finance and insurance solutions are crucial drivers in advancing sustainable development, providing the tools and mechanisms necessary to address environmental challenges while promoting economic growth. Their importance can be highlighted through several key points:

- *Mobilizing Capital for Sustainable Projects*: Green finance directs investments toward

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

environmentally sustainable initiatives, including renewable energy, energy efficiency, clean transportation, and conservation projects. Innovative financial instruments, like green bonds and climate-focused funds, facilitate the flow of private and public capital into these vital areas.

- *Risk Mitigation and Resilience Building:* Green insurance solutions help manage climate-related risks, providing coverage for natural disasters, crop failures, and infrastructure damage caused by climate change. This encourages investment in resilient infrastructure and sustainable practices, reducing vulnerabilities and fostering long-term stability.
- *Encouraging Innovation and Market Development:* The development of innovative financial and insurance products stimulates the creation of new markets and technologies, fostering growth and development. For example, parametric insurance and weather derivatives enable farmers and businesses to hedge against climate variability, promoting sustainable economic activities.
- *Aligning Financial Incentives with Sustainability Goals:* Green finance and insurance integrate environmental, social, and governance (ESG) criteria into decision-making processes. This alignment incentivizes corporations and investors to adopt sustainable practices, contributing to global climate and environmental objectives.
- *Supporting Policy Goals and International Commitments***:** These solutions play a crucial role in achieving commitments under agreements such as the Paris Agreement and the Sustainable Development Goals (SDGs). They provide the financial backbone necessary for countries to meet their climate targets and promote inclusive, sustainable development.
- *Enhancing Public-Private Partnerships:* Innovative financial mechanisms foster collaboration between governments, the private sector, and civil society, creating a synergistic approach to sustainable development challenges.

Innovative green finance and insurance solutions are crucial for unlocking capital, managing risks, and incentivizing the actions necessary to build a more sustainable and resilient future. They not only support environmental preservation but also promote economic growth, social inclusion, and the achievement of global sustainability targets.

2. PURPOSE AND SCOPE OF THE PRESENTATION

2.1 Understand the Concept of Green Finance

Green Finance refers to financial investments that are directed towards projects, initiatives, and assets that promote environmental sustainability and address climate change. It aims to support the transition to a low-carbon, sustainable economy by mobilizing funds for activities that have positive environmental impacts.

Green finance refers to financial activities—such as investments, loans, and securities—that support environmentally sustainable projects and initiatives. It aims to promote economic growth while reducing environmental risks and ecological impacts. This includes funding renewable energy projects, energy efficiency improvements, pollution control measures, sustainable agricultural practices, and conservation efforts.

Green finance encompasses the allocation of financial resources—such as loans, bonds, insurance, and investments—towards projects and companies that contribute to environmental protection, resource efficiency, renewable energy, pollution reduction, and climate resilience.

Green finance is a broad and evolving field that aims to foster economic growth while ensuring environmental sustainability. Its scope encompasses various sectors, financial instruments, and initiatives focused on addressing environmental challenges.

- **Scope of Green Finance:**
  - *Renewable Energy Projects*: Funding solar, wind, hydro, geothermal, and other renewable energy sources
  - *Energy Efficiency:* Investing in energy-saving technologies in buildings, industries, and transportation.
  - *Pollution Control*: Supporting initiatives to reduce emissions, waste management, and water treatment.
  - *Sustainable Agriculture and Forestry*: Promoting practices that conserve biodiversity and reduce environmental impact.
  - *Climate Adaptation and Resilience*: Financing infrastructure and projects that help communities adapt to climate change impacts.
  - *Green Bonds and Securities*: Issuance of bonds designated explicitly for funding environmentally beneficial projects.
  - *Carbon Markets and Offsets*: Facilitating trading schemes to reduce greenhouse gas emissions.
  - *Sustainable Infrastructure*: Developing eco-friendly transportation, waste management, and urban planning solutions.

- **Key Stakeholders:**
  - Governments and policymakers
  - Financial institutions (banks, investment funds)

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

- Corporations and industries
- Investors (institutional and retail)
- International organizations and development banks

- **Key Features of Green Finance:**
  - Focuses on environmentally beneficial outcomes
  - Supports renewable energy, clean technology, and sustainable infrastructure
  - Incorporates environmental risks into financial decision-making
  - Often involves green bonds, green loans, and ESG (Environmental, Social, and Governance) investing

- **Key Drivers of Green Finance:**
  - Climate change mitigation and adaptation
  - Regulatory policies and international commitments (e.g., Paris Agreement)
  - Investor and consumer demand for sustainable practices
  - Instruments of Green Finance
  - Green bonds and loans
  - Sustainability-linked loans
  - Grants and subsidies

- **Importance of Green Finance for Sustainable Development:**
  - *Mitigates Climate Change*: Facilitates investment in renewable energy sources, reducing reliance on fossil fuels and lowering greenhouse gas emissions
  - *Promotes Environmental Conservation*: Funds projects that preserve biodiversity, manage natural resources sustainably, and reduce pollution.
  - *Encourages Economic Resilience*: Builds a resilient economy by transitioning to sustainable industries that can withstand environmental shocks.
  - *Supports Social Equity*: Ensures that the benefits of sustainable development reach diverse communities, fostering inclusive growth.
  - *Aligns with Global Goals*: Contributes to achieving the United Nations Sustainable Development Goals (SDGs), particularly those related to clean energy, climate action, and sustainable cities.

Green finance also encompasses financial instruments and mechanisms designed to support sustainable and environmentally-friendly projects, initiatives, and investments. Here are some of the key financial instruments and mechanisms of green finance:

- **Key Financial Instruments of Green Finance**
  - *Green Bonds*

Bonds are specifically issued to fund environmentally sustainable projects, such as renewable energy, energy efficiency, and conservation initiatives. Examples include Climate Bonds, Sovereign Green Bonds, and Corporate Green Bonds.

  - *Green Loans*

Loans are provided for projects with environmental benefits, often with favorable terms or specific use restrictions. Green loan principles often emphasize transparency and measurable environmental outcomes.

  - *Green Equity Investments*

Equity funding in renewable energy companies, green startups, or sustainable infrastructure projects. Venture capital and private equity funds focusing on green innovations.

  - *Sustainable and Impact Investment Funds*

Investment funds that target companies and projects with positive environmental and social impacts. Incorporate Environmental, Social, and Governance (ESG) criteria.

  - *Blended Finance*

Use of concessional funds or grants to leverage additional private sector investment in green projects. Aimed at reducing risk and improving project bankability.

  - *Green Insurance Products*

Insurance policies that cover risks related to climate change or environmental damage. Examples include weather-related crop insurance or renewable energy project insurance.

- **Carbon Markets and Carbon Pricing Instruments**

Cap-and-trade systems and carbon offset mechanisms that put a price on carbon emissions. Facilitates funding for low-carbon projects via trading emissions allowances

2.2 Key Financial Mechanisms of Green Finance

  - *Public-Private Partnerships (PPPs)*

Collaborative arrangements between government and private sector entities to finance and operate green infrastructure projects.

  - *Government Grants and Subsidies*

Financial support from governments to promote green initiatives, reduce investment costs, or incentivize sustainable practices.

  - *Regulatory Frameworks and Standards*

Policies like tax incentives, renewable energy certificates, or mandatory disclosure regulations promote green investments.

  - *Guarantee Schemes*

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

Financial guarantees provided by governments or institutions to reduce the risk for investors in green projects.

- *Climate Funds*

International funds such as the Green Climate Fund (GCF) provide financial support to developing countries for climate adaptation and mitigation.

- *Tax Incentives and Credits*

Tax benefits for investments in renewable energy, energy efficiency, or other green projects.

- *Sustainable Development Goals (SDGs) Alignment*

Integrating green finance mechanisms with SDGs to attract investments aligned with global sustainability targets (Table 1).

Table 1. Key Financial Mechanisms of Green Finance

Instrument/ Mechanism	Purpose	Examples
Green Bonds	Raise capital for green projects	Climate Bonds, Sovereign Green Bonds
Green Loans	Fund environmentally beneficial projects	Green Loan Principles
Green Equity	Invest in green companies	Green Venture Capital
Impact Funds	Promote ESG investing	Sustainable Investment Funds
Blended Finance	Leverage private investment	Concessional funds + private capital
Climate Markets	Price carbon emissions	Cap-and-trade, offsets |
Public-Private Partnerships	Shared investment risk	Infrastructure projects
Government Incentives	Encourage green investments	Tax credits, subsidies

2.3 Explore the role of policy frameworks and international standards promoting green finance

Policy frameworks and international standards play a crucial role in promoting green finance by creating a conducive environment, establishing credibility, reducing risks, and aligning investments with global sustainability goals. Here is an in-depth exploration of their roles:

- **Role of Policy Frameworks in Promoting Green Finance**

1. Creating a Supportive Regulatory Environment

Governments establish laws, regulations, and policies that incentivize green investments, such as renewable energy targets, emission reduction commitments, and green procurement policies.

Examples: Renewable Portfolio Standards, emission trading systems, and subsidies for clean energy.

2. Providing Financial Incentives

Tax incentives, grants, subsidies, and preferential loan terms encourage private sector participation in green projects.

These incentives lower investment costs and enhance project bankability.

3. Developing Green Finance Strategies and Roadmaps

Countries develop national strategies outlining how to integrate green finance into broader economic and environmental policies.

These strategies foster coordinated efforts and mobilize resources.

4. Establishing Green Certification and Labelling

Frameworks for certifying green projects or financial products (e.g., green bonds) increase transparency and investor confidence.

Examples: Green Bond Principles, Climate Bonds Standard.

5. Enhancing Disclosure and Transparency

Policies mandating ESG disclosures, climate risk reporting, and sustainability reporting improve investor information and decision-making.

Examples include the SEC Climate Disclosure Rules and the EU Sustainable Finance Disclosure Regulation (SFDR).

6. Risk Mitigation and Guarantee Schemes

Governments may establish guarantee funds or insurance schemes to reduce perceived risks and attract private investment into green projects.

- **Role of International Standards in Promoting Green Finance**

1. Providing Common Frameworks and Definitions

International standards establish universally accepted definitions of "green" and "sustainable" projects and investments, reducing ambiguity.

Examples: Green Bond Principles (GBP), Climate Bonds Standard.

2. Enhancing Credibility and Investor Confidence

Standards serve as benchmarks for due diligence, ensuring that green finance products meet specific

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

environmental and social criteria. This reduces greenwashing and increases investor trust.

3. Facilitating Cross-Border Investment and Market Development
Harmonized standards enable investors to compare green assets across countries, fostering international investment flows. They also support the development of global green finance markets.

4. Supporting Risk Assessment and Management
Standards like those from the Task Force on Climate-related Financial Disclosures (TCFD) help investors assess climate-related risks. This encourages better risk management and integration of climate considerations into financial decision-making.

5. Aligning with Global Climate Goals
International agreements such as the Paris Agreement influence standards and frameworks to ensure that green finance aligns with global climate mitigation and adaptation targets.

6. Promoting Capacity Building and Knowledge Sharing
International organizations (e.g., UNEP FI, World Bank, IFC) provide guidance, best practices, and technical assistance to countries developing green finance policies.

- **Interplay Between Policy Frameworks and International Standards**
  - *Complementarity*: National policies often adopt or adapt international standards to ensure global consistency and credibility.
  - *Leverage*: International standards can help countries develop their policies more effectively by providing proven frameworks and best practices.
  - *Alignment*: Both aim to align financial flows with sustainable development and climate goals, creating a unified global approach (Table 2).

Table 2. Policy Frameworks and International Standards

Aspect	Role	Examples
Policy Frameworks	Create an enabling environment, incentives, transparency, and risk mitigation.	Renewable energy policies, green bond regulations, and disclosure laws
International Standards	Provide credibility, harmonization, risk assessment tools, and global benchmarks.	Green Bond Principles, TCFD, Climate Bonds Standard, SDGs

Effective policy frameworks and international standards are essential for scaling up green finance. They foster investor confidence, ensure transparency, reduce risks, and align financial flows with global sustainability and climate objectives. Together, they facilitate the transition toward a more sustainable and resilient economy.

3. ANALYSE THE ROLE OF GREEN FINANCE IN THE MARITIME SECTOR

Green finance plays a crucial role in supporting sustainable projects by directing financial resources toward initiatives that promote environmental protection, social well-being, and economic resilience. Here is an analysis of how green finance facilitates such projects:

1. Mobilization of Capital for Sustainable Development
Green finance channels both public and private funds into projects that generate positive environmental impacts. This includes investments in renewable energy, energy efficiency, clean transportation, sustainable agriculture, and conservation efforts. By providing targeted funding, green finance accelerates the transition to a low-carbon and sustainable economy
2. Risk Mitigation and Incentives
Green financial instruments, such as green bonds, green loans, and sustainability-linked loans, often come with favourable terms, including lower interest rates or longer tenures. These incentives encourage investors and lenders to finance environmentally sustainable projects, which might otherwise face higher perceived risks or uncertainty.
3. Promotion of Innovative Technologies
Green finance supports the development and deployment of innovative technologies, including solar, wind, bioenergy, and smart grid solutions. By providing the necessary capital, green finance helps overcome initial high costs and market barriers associated with new sustainable technologies.
4. Enhancing Transparency and Standards
Green finance often involves adherence to environmental, social, and governance (ESG) criteria and standards. This promotes transparency and accountability, ensuring that funds are genuinely directed toward sustainable projects. Instruments like green bonds typically require rigorous reporting and impact assessment, fostering trust among investors.
5. Policy and Regulatory Support
Governments and international organizations promote green finance through supportive policies, regulations, and frameworks. These include tax

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

incentives, subsidies, or mandatory disclosure requirements, which further encourage investments in sustainable projects.

6. Addressing Climate Change and Environmental Challenges

Green finance directly contributes to reducing greenhouse gas emissions by funding renewable energy and energy efficiency projects. It also supports adaptation efforts, such as flood defences and resilient infrastructure, helping communities better manage climate risks.

7. Fostering Economic Growth and Job Creation

Sustainable projects financed through green finance often lead to new industries and employment opportunities in renewable energy, green construction, and environmental management sectors, contributing to sustainable economic growth.

Green finance supports sustainable projects by providing targeted capital, fostering innovation, ensuring transparency, and aligning financial flows with environmental and social objectives. It catalyses the transformation of economies towards sustainability, addressing pressing global challenges such as climate change, resource depletion, and social inequality.

3.1 Investigate case studies of successful green finance applications in maritime projects

Several notable case studies demonstrate the successful application of green finance in maritime projects. These examples highlight how innovative financing mechanisms have facilitated sustainable development within the maritime sector (Table 3).

- **Key Success Factors:**
  - ➢ Use of green bonds and blended finance to mobilize private capital like The Green Bond for the Port of Rotterdam (Netherlands)
  - ➢ Public-private partnerships to share risks and benefits like The Green Maritime Methanol Project (Singapore)
  - ➢ Focused investments on technological innovation and infrastructure like The European Investment Bank (EIB) Financing for Sustainable Maritime Infrastructure l
  - ➢ Strong regulatory and policy support aligning financial incentives with sustainability goals like The Green Shipping Program – The Maritime Green Investment Fund (Norway).

4. EXPLORE THE EVOLVING ROLE OF INSURANCE IN MARITIME

Understand traditional maritime insurance and its limitations.

Let us break down traditional maritime insurance and then explore its limitations in the context of green finance.

4.1 Traditional Maritime Insurance

It provides coverage for ships, cargo, and liabilities related to maritime operations. It typically includes policies like hull insurance, cargo insurance, protection and indemnity (P&I) insurance, and war risk insurance.

Key Features:

- ✓ Coverage of physical assets: Ships, cargo, equipment.
- ✓ Liability coverage: Protects against claims from third parties, environmental damage, or accidents.
- ✓ Risk assessment: Based on historical data, vessel age, route, cargo type, etc.
- ✓ Premiums: Calculated according to the perceived risk of incidents, damages, or losses.

- **Limitations of Traditional Maritime Insurance in Green Finance**

Green finance aims to promote sustainable investments and environmentally friendly practices. When integrating this with maritime activities, traditional insurance faces several limitations:

1. *Limited Incentives for Sustainable Practices:*

Traditional policies do not typically incentivize eco-friendly operations or investments in green technologies (e.g., cleaner fuels, emission reduction systems).

Premiums are primarily risk-based without considering environmental performance.

2. *Inadequate Coverage for Environmental Risks:*

While some policies cover pollution incidents, they often lack comprehensive coverage for proactive environmental measures or green innovation.

Emerging environmental risks associated with climate change, such as rising sea levels and extreme weather events, are not fully addressed.

3. *Short-Term Focus:*

Traditional insurance models tend to focus on immediate risks and losses, rather than long-term sustainability outcomes.

This can discourage investments in innovative, green maritime technologies with uncertain or long-term benefits.

4. *Limited Integration with Green Certification or Standards:*

Standard policies do not incorporate or reward adherence to environmental standards, such as ISO 14001 or IMO's Green Shipping practices.

Lack of alignment with sustainability goals reduces motivation for green investments.

5. *High Costs for Green Technologies:*

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

Insurers may view green upgrades (such as retrofitting ships with eco-friendly technology) as risky or costly, leading to higher premiums or a reluctance to insure such investments.

6. *Insufficient Data and Metrics:*

Limited data on the performance and risks associated with green maritime innovations hampers the development of tailored insurance products.

Without reliable metrics, it is challenging to assess environmental benefits and incorporate them into risk models.

7. *Limited Support for Green Financing Instruments:*

Traditional insurance does not readily support or facilitate green bonds, green loans, or other innovative financial instruments designed for sustainable maritime projects.

4.2. How Green Finance Can Address These Limitations

To better support sustainable maritime practices, innovations such as green insurance, performance-based premiums, and risk-sharing mechanisms can be developed.

These include:

1. Incentives for green investments (e.g., discounts for ships using cleaner fuels).
2. Coverage for environmental liabilities and proactive measures.
3. Integration with sustainability standards and certification schemes.
4. Data-driven risk assessment for green technologies.
5. Supporting green bonds and investments through tailored insurance products.

Traditional maritime insurance is primarily risk-based, focusing on physical damage and liabilities, with limited emphasis on environmental sustainability. Its limitations in green finance include a lack of incentives for eco-friendly practices, inadequate coverage for environmental risks, and insufficient integration with sustainability standards. Overcoming these challenges requires evolving insurance models to better align with green finance goals and fostering sustainable maritime development.

An example of a green maritime insurance product and some innovative models that are emerging to support sustainable maritime practices.

Overview:

The Green Vessel Insurance Policy is designed to incentivize and support environmentally sustainable shipping practices. It offers benefits such as reduced premiums or special coverage options for ships that meet specific green standards.

Features:

1. Premium Discounts: Ships that use cleaner fuels, implement energy-efficient technologies, or adhere to green certifications (such as the Green Ship Certification by the IMO) receive lower premiums.
2. Coverage for Green Technologies: Additional coverage options for retrofitting ships with eco-friendly systems, including scrubbers, ballast water management systems, and alternative fuel systems.
3. Environmental Liability Coverage: Extended coverage for pollution incidents or environmental damages caused by the vessel.
4. Performance-based Incentives: Premium adjustments based on environmental performance metrics, such as reduced emissions or fuel consumption.

Benefits:

- ✓ Encourages ship-owners to adopt green practices.
- ✓ Reduces environmental risks and liabilities.
- ✓ Aligns insurance with sustainability goals and regulatory compliance.

4.3. Innovative Insurance Models Supporting Green Maritime Finance

1. **Parametric Insurance for Climate Risks**:

Pays out based on predefined climate or environmental triggers (e.g., extreme weather events, rising sea levels) affecting maritime routes or infrastructure. Enables proactive risk management and supports investments in climate-resilient infrastructure.

2. **Green Bonds and Insurance Linkages**:

Insurance products designed to support green bond projects, such as financing the construction of eco-friendly ships or port infrastructure. Offers lower premiums or guarantees for projects meeting specific sustainability criteria.

3. **Performance-based Premiums and Rewards**:

Premiums are adjusted based on the vessel's environmental performance, encouraging continuous improvement. Rewards include premium reductions, reputation benefits, or access to specialized green funding.

4. **Risk-sharing and Blended Finance Models:**

Public-private partnerships where insurers, governments, and financial institutions share risks associated with green maritime investments. Helps lower barriers for innovative green projects by reducing upfront costs and risk exposure.

5. **Green Insurance Certification Programs**:

Certification schemes that recognize and validate environmentally sustainable practices in maritime

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

operations, leading to better insurance terms and market recognition.

Green maritime insurance products and innovative models aim to align financial incentives with sustainability goals. They encourage the adoption of eco-friendly technologies, support climate resilience, and facilitate access to green financing instruments, such as green bonds and sustainable investments.

4.4. Funding for projects that promote environmental sustainability

The global green bond market exceeded USD 1 trillion in 2022, with a CAGR of about 30% over the past five years (Climate Bonds Initiative). Many countries have set ambitious targets for renewable energy investments, with green finance playing a crucial role in achieving these goals.

Funding for projects that promote environmental sustainability can come from various sources, including government agencies, private foundations, corporate social responsibility programs, and international organizations. Here are some common avenues to explore (Table 4).

5. HOW INSURANCE CONTRIBUTES TO GREEN & SUSTAINABLE MARITIME DEVELOPMENT

Green Insurance Products

- Insurance for environmentally friendly ships (e.g., LNG-powered vessels)
- Coverage for pollution prevention and response
- Insurance linked to sustainable practices (e.g., lower premiums for eco-friendly ships)
- Risk Management & Resilience
- Supporting investments in cleaner technologies
- Covering risks associated with new green technologies
- Encouraging Compliance & Innovation
- Incentives for adopting IMO regulations and standards
- Promoting research and development in green shipping

Detail how "green insurance products" are tailored for eco-friendly ships and projects.

Green insurance products are specialized insurance solutions designed to promote environmentally sustainable practices, particularly in the shipping industry. When tailored for eco-friendly ships and products, these insurance offerings aim to incentivize and support the adoption of greener technologies and operations. Here is how green insurance products are customized for eco-friendly ships and products:

1. Coverage for Green Technologies

Hull and machinery insurance can include coverage for new eco-friendly technologies, such as scrubbers, ballast water treatment systems, and alternative fuel engines (e.g., LNG, hydrogen).

Specialized coverage** for renewable energy ships (e.g., wind-assisted vessels, solar-powered ships) or hybrid systems.

2. Incentives for Sustainable Practices

Premium discounts or rebates for ships that meet specific environmental standards or certification programs (e.g., ISO 14001, Green Marine, Clean Shipping Index).

Bonus schemes for vessels employing low-emission fuels or innovative energy-saving technologies.

3. Coverage for Regulatory Compliance

Insurance products that help ship-owners manage risks associated with evolving environmental regulations (e.g., IMO 2020 sulphur cap, ballast water management regulations).

Coverage for fines, penalties, or liabilities arising from non-compliance with environmental laws.

4. Protection Against Environmental Liabilities

Coverage for accidental pollution or environmental damage caused by eco-friendly ships, which may have different risk profiles than traditional ships.

Liability coverage for damage caused to marine ecosystems or third parties during operations involving green ships.

5. Cargo Insurance for Green Products

Tailored policies for eco-friendly cargoes, such as sustainable goods, organic products, or renewable energy components.

Coverage for damage or loss of environmentally sensitive cargo, with considerations for special handling or storage requirements.

6. Supporting Sustainable Supply Chains

Insurance solutions that facilitate green supply chain initiatives, including insuring multi-modal transport involving eco-friendly ships.

Coverage for logistics companies prioritizing sustainable transport options.

7. Risk Management and Advisory Services

Green insurance providers often offer risk assessment services to help shipping companies identify and mitigate environmental risks.

Guidance on best practices for sustainable operations, aligning insurance coverage with environmental goals.

8. Innovative Financial Products

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

Green bonds or sustainability-linked insurance policies that tie premiums or coverage terms to achieving specific environmental metrics.

Pay-as-you-save models encourage investment in eco-friendly ship upgrades.

Green insurance products for eco-friendly ships and products are designed to incentivize sustainable practices, ensure regulatory compliance, and manage specific environmental risks. They are tailored through specialized coverage options, discounts, and advisory services that support the transition to greener shipping solutions, ultimately fostering a more sustainable maritime industry.

Insurance premiums can be effectively linked to a company's sustainability performance by incorporating environmental, social, and governance (ESG) metrics into the underwriting and pricing processes. This approach incentivizes companies to adopt greener practices and improve their sustainability credentials. Here is how it works:

1. *Incorporation of ESG Metrics into Risk Assessment*
- ✓ Environmental Performance: Companies demonstrating strong environmental practices—such as reducing carbon emissions, efficient resource utilization, effective waste management, and adopting renewable energy—are perceived as lower risk.
- ✓ Social and Governance Factors: Good labor practices, community engagement, and Transparent governance also influences risk profiles.

2. *Dynamic Premium Pricing*:
- ✓ Lower Premiums for Sustainable Companies: Firms with high sustainability scores may receive discounts or lower premiums because they are viewed as less likely to face environmental liabilities, regulatory penalties, or reputational damage.
- ✓ *Higher Premiums for Poor Performers*: Conversely, companies with poor sustainability records or higher environmental risks may face increased premiums to compensate the insurer for the elevated risk.

3. *Use of Sustainability Certification and Reporting* - Insurers can require companies to submit sustainability reports, third-party certifications (e.g., ISO 14001), or ESG ratings from recognized agencies. Premium discounts can be granted based on these verified credentials.

4. *Risk Reduction Incentives*
- ✓ Premium Discounts for Risk Mitigation: Companies that invest in greener technologies, energy efficiency upgrades, or pollution controls may be eligible for lower premiums.
- ✓ *Premium Penalties for Negative Practices*: Companies engaging in environmentally harmful activities or lacking sustainability measures may incur higher premiums

5. *Promoting Sustainable Practices*: By linking premiums to sustainability, insurers incentivize companies to:
- ✓ Reduce environmental impact
- ✓ Improve resource efficiency
- ✓ Adopt sustainable supply chain practices
- ✓ Enhance overall ESG performance

6. *Impact and Benefits*
- ✓ For Companies: Cost savings through reduced premiums and improved reputation.
- ✓ For Insurers: Lower claims risk, enhanced portfolio resilience, and alignment with global sustainability goals.
- ✓ For Society: Encouragement of greener practices that contribute to environmental protection and climate change mitigation.

- **Example**

Some insurers offer premiums discounted up to 10-15% for ships that meet specific environmental standards. Examples include coverage for LNG-powered vessels, which emit 20-25% less CO2 than traditional ships.

A manufacturing company that invests in renewable energy, reduces waste, and maintains high safety and labour standards might receive a premium discount. Conversely, a company with poor environmental compliance and high pollution levels may face higher premiums, creating a financial incentive to improve its practices.

In summary, **linking insurance premiums to a company's sustainability performance** creates a financial incentive for greener practices, aligning corporate behaviour with broader environmental and social goals while also managing insurer risk more effectively.

- ***Case Studies & Examples***
- ✓ Green insurance initiatives in the maritime sector
- ✓ Successful implementation of sustainable shipping projects
- ✓ Insurance companies leading in green maritime insurance products

Here are some real-world examples where insurance companies have supported or promoted green initiatives, including Lloyd's of London and other insurers backing sustainable practices:

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

1. Lloyd's of London and Sustainable Shipping Initiatives

Lloyd's of London, one of the world's most prominent insurance marketplaces, has been actively involved in promoting sustainable shipping practices. Lloyd's has launched specific insurance products for zero-emission ships, with some policies offering premium reductions of up to 20% for compliant vessels.

- ✓ Sustainable Shipping Insurance & Green Finance: Lloyd's has partnered with industry stakeholders to develop insurance products that incentivize the adoption of greener shipping technologies. They support projects that reduce carbon emissions, such as retrofitting ships with cleaner engines or using alternative fuels.
- ✓ Lloyd's Green Shipping Program: Lloyd's has launched initiatives to underwrite ships that meet environmental standards, such as those complying with the International Maritime Organization's (IMO) greenhouse gas reduction targets. They encourage ship-owners to adopt energy-efficient designs and renewable fuel sources by offering favorable insurance terms.
- ✓ Partnerships with Maritime Innovations: Lloyd's collaborates with organizations such as the Marine Environment Protection Committee (MEPC) and supports startups developing sustainable maritime technologies, including zero-emission vessels, by providing tailored insurance solutions.

2. Sailors for the Sea (Sustainable Marine Initiative) & Insurance Support

Sailors for the Sea is a non-profit organization dedicated to promoting ocean conservation through sailing and marine activities. While they are not an insurer, some insurance firms have supported their initiatives:

- ✓ Insurance Companies Supporting Ocean Conservation:* Certain marine insurance providers, such as *The North of England P&I Association* or *AIG**, have sponsored or partnered with Sailors for the Sea to promote sustainable sailing practices, marine protected areas, and reduce pollution.
- ✓ Coverage for Eco-Friendly Vessels:** Some insurers provide specialized coverage for eco-friendly vessels and sustainable maritime projects, incentivizing operators to adopt greener technologies.

3. AXA and Green Investment Bonds

AXA's Climate and Green Bonds: AXA and other insurers have issued or invested in green bonds that fund renewable energy projects, sustainable infrastructure, and environmentally friendly shipping initiatives, demonstrating their commitment to sustainability.

4. MS Amlin and Sustainable Insurance Solutions

MS Amlin, a global insurer, has developed products that support renewable energy projects, including offshore wind farms and sustainable shipping. They offer tailored coverage for vessels using alternative fuels or zero-emission technologies, incentivizing cleaner shipping methods.

The Green Ship of the Year Award (by various maritime bodies) recognizes ships with innovative green solutions often backed by specialized insurance.

As shown, Lloyd's of London actively promotes sustainable shipping through specialized insurance products and partnerships. Marine insurance providers support eco-friendly vessels by retrofitting ships with greener technology and investing in sustainable maritime projects. Non-profit organizations, such as Sailors for the Sea, collaborate with insurers to promote ocean conservation and sustainable marine practices.

The Impact - These examples demonstrate how insurance companies are not only passively covering risks but also actively promoting environmental sustainability by incentivizing greener practices, funding innovation, and collaborating with stakeholders to protect marine environments and reduce carbon footprints in the shipping and maritime industries.

Here are some notable success stories of ships using alternative fuels or upgraded reduction technology, which have benefited from favourable insurance rates due to their improved safety and environmental performance (Table 5).

Key Factors for Favourable Insurance Rates:

- ✓ Environmental Compliance: Ships that meet or exceed regulatory standards tend to receive better rates.
- ✓ Enhanced Safety Features: Upgraded technology often improves safety, reducing accident risk.
- ✓ Operational Experience: Proven performance with alternative fuels or tech upgrades builds insurer confidence.
- ✓ Risk Management: Ships with better safety records and environmental performance are considered lower risk.

The shipping industry's shift toward cleaner fuels and advanced emission reduction technologies is not only environmentally beneficial but also financially advantageous, as it results in lower insurance premiums. These success stories serve as models for future adoption, highlighting the importance of technological innovation in maritime safety and sustainability.

6. CHALLENGES & OPPORTUNITIES

- **Challenges in Green Finance**

1. *Lack of Standardization and Transparency*

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

- ✓ Lack of standardized metrics for measuring green performance. Difficulty in establishing a universally
- ✓ accepted standards for green assets and investments.
- ✓ Risk of greenwashing, where projects are falsely marketed as environmentally friendly
- ✓ Limited awareness and understanding

2. *Limited Access to Capital*

- ✓ Smaller or emerging markets may face difficulties in attracting sufficient investment.
- ✓ High upfront costs of green technology and perceived risks deter private sector participation.

3. *Data Gaps and Quality*

- ✓ Limited availability of reliable data on environmental impacts.
- ✓ Challenges in Measuring and Verifying Sustainability Claims.

4. *Policy and Regulatory Uncertainty*

- ✓ Inconsistent policies across jurisdictions can hinder investment.
- ✓ Changes in regulations can create unpredictability for investors.

5. *Technological Risks and Innovation Barriers*

- ✓ Uncertainty around the performance and scalability of new green technologies.
- ✓ High R&D costs and longtime horizons can inhibit innovation.

Emphasize opportunities such as the growth of green finance markets, technological advancements, and supportive policies.

Green shipping investments are expected to reach USD 10 billion annually by 2030 (Maritime Green Finance Report 2022). The cost of retrofitting ships with eco-friendly technology can be two to five times higher than traditional upgrades.

Green finance is an evolving sector that plays a crucial role in transitioning toward a sustainable and low-carbon economy. Here is an overview of the key challenges and opportunities related to green finance, focusing on market growth, technological advances, and supportive policies:

- **Opportunities in Green Finance**

1. *Growing Green Finance Markets* (Growing market for green insurance products)

- ✓ Increasing issuance of green bonds, green loans, and ESG (Environmental, Social, and Governance) funds.
- ✓ Rising investor demand for sustainable investment products.
- ✓ Expanding markets in renewable energy, energy efficiency, and sustainable infrastructure.

2. *Technological Advances*

- ✓ Innovations in clean energy, electric vehicles, smart grids, and carbon capture and storage.
- ✓ Use of big data, AI, and block-chain to improve transparency, monitoring, and verification.
- ✓ Development of new financial instruments such as sustainability-linked bonds and climate insurance.

3. *Supportive Policies and Regulatory Frameworks* (Policy support and international cooperation)

- ✓ Governments and international bodies are adopting climate commitments (e.g., Paris Agreement).
- ✓ Implementation of tax incentives, subsidies, and regulatory mandates for green investments.
- ✓ Integration of sustainability criteria into financial regulations and reporting standards (e.g., EU taxonomy).

4. *Increased Private Sector Engagement*

- ✓ Corporate commitments to sustainability goals.
- ✓ Integration of ESG factors into mainstream investment decision-making.
- ✓ Development of innovative financing solutions tailored to green projects.

5. *Global Collaboration and Funding*

- ✓ Multilateral initiatives (e.g., Green Climate Fund) provide concessional finance.
- ✓ Cross-border investments facilitate technology transfer and capacity building.
- ✓ Potential for significant environmental and economic benefit

Challenges include standardization issues, data gaps, policy uncertainty, technological risks, and limited access to capital.

Opportunities include market expansion, technological innovation, supportive policies, private sector engagement, and international cooperation. Stress the importance of collaboration among stakeholders, including governments, insurers, ship owners, and financiers.

- **Policy Recommendations on Green Finance and Maritime Insurance for Sustainable Maritime Development**

1. Establishing Robust Green Financing Frameworks

- ✓ Develop dedicated green financing instruments such as green bonds, sustainability-linked loans, and maritime-specific green funds to channel investments into sustainable maritime projects.
- ✓ Incentivize private sector participation through tax benefits, subsidies, or risk guarantees for investments in environmentally friendly maritime infrastructure, vessels, and technologies.

2. Integrating Environmental, Social, and Governance (ESG) Criteria

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

- ✓ Mandate ESG disclosures for maritime companies, financial institutions, and insurers to promote transparency and accountability.
- ✓ Incorporate ESG risk assessments into lending and investment decision-making processes to encourage sustainable practices.

3. Aligning Financial Mechanisms with Maritime Sustainable Development Goals

- ✓ Align existing financial instruments with the targets of SMDGs, such as reducing maritime pollution, increasing energy efficiency, and promoting clean shipping.
- ✓ Develop sector-specific sustainability standards for maritime finance and insurance, ensuring that investments support low-carbon and resilient maritime infrastructure.

4. Enhancing Maritime Insurance for Sustainability

- ✓ Develop innovative insurance products that incentivize sustainable practices, such as offering lower premiums to vessels that adhere to green standards or retrofit older ships with cleaner technologies.
- ✓ Introduce climate risk coverage tailored for maritime assets vulnerable to climate change impacts, including rising sea levels and extreme weather events.

5. Strengthening Regulatory and Policy Frameworks

- ✓ Implement policies and regulations that promote the adoption of green technologies in maritime operations, such as sulfur emission limits and ballast water management.
- ✓ Facilitate public-private partnerships** to mobilize investment in sustainable maritime infrastructure and innovation.

6. Promoting Capacity Building and Knowledge Sharing

- ✓ Support training programs for financial institutions, insurers, and maritime stakeholders on sustainable finance principles.
- ✓ Create platforms for knowledge exchange on best practices, emerging technologies, and innovative financial products in the maritime sector.

7. Leveraging International Cooperation and Funding

- ✓ Participate in global initiatives and funding mechanisms (e.g., Green Climate Fund, Global Environment Facility) to access financial support for sustainable maritime projects.
- ✓ Coordinate cross-border efforts to develop regional standards and policies aligned with SDGs.

8. Monitoring and Reporting

- ✓ Establish monitoring frameworks to track progress toward sustainability targets in the maritime finance and insurance sectors.
- ✓ Encourage transparent reporting on environmental performance and financial impacts to foster trust and accountability.

- **Future Prospects**

1. **Growing Market for Green Maritime Finance**: Increasing investor awareness and regulatory pressure are likely to expand the market for green bonds, loans, and insurance products tailored to the maritime sector.
2. **Technological Innovation:** Advances in clean propulsion, digitalization, and data analytics will facilitate smarter, more sustainable maritime operations.
3. **Enhanced Resilience and Risk Management:** Climate-proof insurance products will become essential as climate risks intensify.
4. **Policy and Regulatory Developments**: Stricter international standards (e.g., IMO regulations) will catalyze shifts toward greener maritime practices.

Aligning financial mechanisms and maritime insurance with sustainable maritime development requires a comprehensive approach that combines regulatory reforms, innovative financial products, capacity building, and international cooperation. This alignment not only supports environmental sustainability but also enhances economic resilience and competitiveness in the maritime sector.

6. CONCLUSIONS

In summary**,** green finance is a vital tool for mobilizing the capital needed to address environmental challenges and promote sustainable development, thereby ensuring a healthier planet and an improved quality of life for future generations.

The transformative potential of innovative green financial products and insurance solutions

In recent years, the urgency to combat climate change and promote sustainable development has accelerated the need for innovative financial tools. Green finance—comprising financial products and insurance solutions designed to support environmentally friendly initiatives—has become a cornerstone in transitioning to a more sustainable economy. The transformative potential of these innovations lies in their ability to mobilize capital, manage environmental risks, and foster a culture of sustainability across sectors.

1. Mobilizing Capital for Sustainability

Innovative green financial products, such as green bonds, sustainability-linked loans, and green funds, are designed to channel private and public capital into environmentally beneficial projects. These products offer attractive returns while ensuring that investments contribute to climate mitigation, renewable energy deployment, and resource conservation. Their transformative power is evident in:

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

- ✓ Scaling up investments in renewable energy, energy efficiency, and sustainable infrastructure.
- ✓ Attracting a broader investor base, including institutional investors and retail investors who prioritize ESG (Environmental, Social, and Governance) criteria.
- ✓ Facilitating access to capital for projects that might otherwise face funding barriers due to perceived risks or high initial costs.

2. Innovative Insurance Solutions for Climate Risks

Climate change introduces unprecedented risks—extreme weather events, rising sea levels, and supply chain disruptions—that pose significant threats to businesses and communities. Innovative insurance solutions are evolving to address these challenges:

- ✓ Parametric insurance, which pays out based on predefined triggers (like a hurricane reaching a certain wind speed), provides rapid relief.
- ✓ Climate risk insurance tailored for vulnerable sectors, such as agriculture and fisheries, helps mitigate the financial impact of climate-related disasters.
- ✓ Insurance-linked securities (ILS) and catastrophe bonds transfer risks from insurers to capital markets, increasing resilience and capacity to cover climate-related losses.

These solutions are transformative because they:

- ✓ Enhance the resilience of communities and businesses against climate shocks.
- ✓ Encourage proactive risk management and climate adaptation.
- ✓ Reduce the financial burden on governments and societies in disaster recovery.

3. Driving Innovation and Market Development

- ✓ The development of green financial products stimulates innovation within the financial sector:
- ✓ New financial instruments are created to meet the specific needs of green projects.
- ✓ Standardization and certification frameworks, such as the Green Bond Principles or Climate Bonds Standard, increase transparency and credibility.
- ✓ The integration of technology, such as block chain and AI, enhances transparency, tracking, and reporting of green investments.

This innovation accelerates the mainstream adoption of sustainability principles, transforming traditional finance into a driver for environmental and social progress.

4. Facilitating Policy and Regulatory Support

Governments and regulators are increasingly supporting green finance through policies, incentives, and regulations:

- ✓ Tax incentives, subsidies, and mandates encourage the issuance of green bonds and sustainable insurance products.
- ✓ Mandatory ESG disclosures increase transparency and investor confidence.
- ✓ Public-private partnerships utilize private capital to fund large-scale green infrastructure projects.

Such supportive frameworks amplify the transformative impact of green financial innovations.

5. Creating a Sustainable Economic Model

Ultimately, the transformative impact of these financial products and insurance solutions lies in their ability to:

- ✓ Align economic incentives with environmental sustainability.
- ✓ Foster a circular economy by funding renewable energy, waste reduction, and sustainable resource management.
- ✓ Promote social equity by ensuring that vulnerable communities benefit from green investments and insurance coverage.

The transformative nature of innovative green financial products and insurance solutions is reshaping the flow of capital into sustainable development. By mobilizing resources, managing climate risks, and fostering innovation, these financial tools play a crucial role in building a resilient, low-carbon, and inclusive economy. Their continued evolution and adoption are critical to achieving global climate and sustainability goals.

Call to action for stakeholders to embrace sustainable practices.

As stewards of our planet's future, it is imperative that we—business leaders, investors, policymakers, and communities—act decisively to prioritize sustainability. Green finance and innovative insurance solutions are powerful tools that can accelerate our transition toward a resilient, low-carbon economy.

We urge all stakeholders to:

- ✓ **Invest in Green Initiatives**:

Channel capital into renewable energy, sustainable infrastructure, and eco-friendly projects that generate long-term value and environmental benefits.

- ✓ **Integrate ESG Principles**:

Embed environmental and social considerations into decision-making processes to promote responsible growth.

- ✓ **Innovate and Adopt Green Financial Products**:

Support the development and utilization of green bonds, sustainability-linked loans, and climate risk insurance to fund and safeguard sustainable ventures.

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

✓ **Advocate for Supportive Policies**:
Push for regulatory frameworks, incentives, and standards that encourage green investments and transparent reporting.

✓ **Collaborate Across Sectors**:
Foster partnerships among governments, financial institutions, businesses, and civil society to scale sustainable solutions.

✓ **Drive Behavioral Change**:
Promote awareness and education on the importance of sustainability, inspiring action at every level.

Together, we can harness the transformative power of green finance and insurance to protect our environment, empower communities, and ensure a prosperous, sustainable future for generations to come. The time to act is now—let us lead the change!

Table 3. Case studies of green finance applications in maritime projects

Item	Overview:	Key Initiatives Funded	Impact	Significance
The Green Bond for the Port of Rotter-dam (Nether-lands)	The Port of Rotterdam, one of the largest ports in Europe, issued a green bond in 2016 to fund sustainable infrastructure and environmental initiatives. The bond raised €300 million to support projects aimed at reducing carbon emissions and enhancing port sustainability.	Electrification of port terminals and ships Development of renewable energy sources (solar and wind) Implementation of green logistics and transportation solutions	Significant reduction in port-related emissions Increased investment in sustainable maritime infrastructure Enhanced port competitiveness and environmental performance	This case exemplifies how green bonds can mobilize private capital for large-scale maritime sustainability projects, fostering innovation and environmental responsibility in port operations.
The Green Shipping Program – The Maritime Green Investment Fund (Norway)	Norway launched a Green Shipping Investment Fund to support the transition to low-emission shipping vessels, including LNG-powered ships and hybrid vessels. The fund attracted private investments through public guarantees and subsidies.	Funded: Construction of eco-friendly ships Retrofitting existing vessels with cleaner technologies Developing shore power infrastructure at ports	Reduction of greenhouse gases and sulphur emissions Demonstration of commercially viable green shipping technologies Encouragement of industry-wide adoption of sustainable practices	This case illustrates how targeted green finance, coupled with government support, can accelerate the adoption of cleaner maritime technologies and mitigate the sector's environmental impact.
The Green Maritime Methanol Project (Singapore)	Singapore's Maritime and Port Authority (MPA) partnered with industry stakeholders to finance the development of methanol-powered ships. The project received funding through a mix of government grants and private investment, aiming to demonstrate the viability of alternative fuels.	Design and construction of methanol-powered vessels Building supply chains for green methanol Infrastructure development at ports for fuel bunkering	Pioneering use of renewable methanol as a maritime fuel Reduction of carbon emissions and sulphur oxides Positioning Singapore as a leader in clean maritime fuels	This demonstrates how innovative green finance can facilitate the transition to alternative fuels in shipping, addressing climate and air quality concerns
The European Investment Bank (EIB) Financing for Sustainable Maritime Infrastructure	The EIB has provided multiple loans and grants to European ports and maritime infrastructure projects that emphasize sustainability, including investments in renewable energy, electrification, and cleaner vessel technologies.	Electrification of port cranes and vehicles Development of shore power facilities Support for maritime research and innovation projects	Reduced emissions from port operations Enhanced energy efficiency Stimulated green innovation in maritime logistics	This case highlights the crucial role of multilateral financial institutions in fostering sustainable maritime infrastructure through concessional and strategic financing.

Table 4. Various sources of funding for projects

Source of Funds	Name of Agencies	Grants provided

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

Government Grants and Programs	- Environmental Protection Agency (EPA) (U.S.) - National Science Foundation (NSF) - Department of Energy (DOE) - European Union Funding	-Offers grants for sustainability, conservation, and pollution reduction projects. -Funds research and innovation in environmental science and sustainability. -Supports renewable energy and energy efficiency initiatives - Programs like Horizon Europe support sustainability projects across member states.
Private Foundations and Non-profits	The Bill & Melinda Gates Foundation The Rockefeller Foundation The Ford Foundation	Occasionally, fund environmental sustainability initiatives. Supports resilient cities and sustainable development. Focuses on social justice with some projects related to environmental sustainability.
Corporate Social Responsibility (CSR) Initiatives	Many corporations have CSR programs that fund sustainability projects, particularly in renewable energy, waste reduction, or community resilience initiatives.	
International Organizations	United Nations Development Programme (UNDP) World Bank Global Environment Facility (GEF)	Funds projects aligned with sustainable development goals (SDGs). Provides funding for large-scale environmentalists in developing countries. Supports projects that address biodiversity, climate change, and sustainable land management.

Table 5. Notable success stories of ships

Ships Success Stories	Overview	Success	Insurance Benefits
Maersk's Use of Green Methanol	Maersk, one of the world's largest shipping companies, has been pioneering the adoption of green methanol as an alternative fuel.	The Maersk Eco Clipper, a container vessel powered by methanol, has demonstrated significant reductions in greenhouse gas emissions—up to 80% compared to conventional fuels.	Due to their lower environmental risk profile and compliance with emerging emission standards, vessels like these have been able to negotiate more favourable insurance premiums with insurers who are increasingly incentivized to support greener fleets.
Wärtsilä Hybrid and LNG-Powered Vessels	Wärtsilä has developed hybrid propulsion systems and LNG-powered ships that significantly reduce emissions of NOx, SOx, and particulate matter.	Several ferries and offshore support vessels equipped with Wärtsilä's hybrid and LNG systems have achieved operational excellence, with enhanced safety records and lower operational costs.	These vessels often benefit from reduced premiums due to their enhanced safety features, compliance with strict emission regulations, and lower risk of environmental accidents.
Zero-Emission LNG Ferries in Scandinavia	Norway and Sweden have introduced LNG-fuelled ferries for passenger and cargo transport.	The *Stavanger-fjord* and other LNG ferries have successfully operated with minimal emissions, and their adoption has facilitated access to insurance discounts due to their environmentally friendly profile.	Favourable Rates: - Insurers have offered reduced premiums owing to the lower risk of pollution incidents and the vessel's compliance with strict environmental standards.
Upgraded Reduction Technology in Bulk Carriers	Several bulk carriers have upgraded their exhaust gas cleaning systems (scrubbers) and installed advanced emission reduction technology.	:* Ships like the *Golden Odyssey** have achieved compliance with IMO Tier III standards, reducing sulphur emissions and improving operational safety	These upgrades have contributed to lower premiums, as insurers recognize the reduced risk of regulatory penalties and environmental liabilities.

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

7. CREdit authors statement

Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing: A.M. B.; V;M R.S..

8. REFERENCES

[1] DE AGOSTINI, L., & GIOVANARDI, M. (2025). *AI and global security: From early warning to AI-assisted diplomacy.* Centre for International Governance Innovation (CIGI). Available on https://hdl.handle.net/1814/78275

[2] MENA Report (2019). *Finland : Negotiations begin on new targets for halting biodiversity loss revised objectives under preparation for 2030, 2040 and 2050.* Available on https://valtioneuvosto.fi/en/-/1410903/finland-s-national-report-on-biodiversity-we-are-heading-in-right-direction-but-faster-action-is-needed-to-reach-biodiversity-targets,

[3] *India's $120 Million Green Tug Transition Program: Pioneering Maritime Sustainability and Environmental Stewardship.* Available on https://www.marinex.org/indias-120-million-green-tug-transition-program-pioneering-maritime-sustainability-and-environmental-stewardship/

[4] *Help writing Technology Assignment Online - Essays Bishops.* Available on https://essaybishops.com/help-writing-technology-assignment-online/

[5] *What's stifling city climate action? Municipal finance practices, one report says | Smart Cities Dive.* Available on https://www.smartcitiesdive.com/news/city-financing-holding-back--climate-action-justice-research-boston-university/711414/

[6] Desalegn, G. (2023). *Insuring a greener future: How green insurance drives investment in sustainable projects in developing countries?* Green Finance. https://doi.org/10.3934/GF.2023008

[7] *How to invest in NexHealth* 2024. Available on https://alpha.linqto.com/how-to-invest/how-to-invest-in-nexhealth-2024/

[8] *Advancing Success :Navigating Kenya's PIP Approval Process.* Available on https://mmcasafo.com/news/advancing-success-navigating-kenyas-pip-approval-process/

[9] *2nd CPLP Energy and Climate Seminar – RELOP.* Available on https://relop.org/events/2o-seminario-de-energia-e-clima-da-cplp/?lang=en

[11] *Sustainability guide for boards of directors launched | The Star.* Available on https://www.thestar.com.my/esg/2024/12/06/sustainability-guide-for-boards-of-directors-launched

[12] *Innovations and Startups Shaping the Future of Waste Management - Laws Learned.* Available on https://lawslearned.com/waste-management-innovations-and-startups/

[13] Streimikiene, D., & Kaftan, V. (2021). *Green Finance and the Economic Threats during COVID-19 Pandemic.* Available on https://core.ac.uk/download/552892506.pdf

[14] Saruchera, F. (2025). *Sustainability: A Concept in Flux? The Role of Multidisciplinary Insights in Shaping Sustainable Futures*. Sustainability, 17(1), 326.

[15] *Focus on ESG: Real Estate*. Available on https://viatomorrow.com/en_en/focus-on-esg-real-estate/

[17] Alnajem, A. A. Q. I. (2024). *The role of Grassroots Movementsin achieve CommunitySustainability*, https://doi.org/10.70470/MEDAAD/2024/003

[18] *Climate Policy of Uzbekistan: Implementation and Adaptation of Measures in the Most Vulnerable Sectors of the Economy*. Available on https://newsprofit.info/climate-policy-of-uzbekistan-implementation-of-measures-in-sectors-of-the-economy.html

[19] *Protection Farmers From Cyber Attacks | Blog | Land Based Underwriters*. Available on https://www.lbunderwriters.co.uk/blog/protecting-farms-from-cyber-fraud-and-scams

[20] *How can the shipping industry be made more resilient to the impacts of climate change, such as rising sea levels and extreme weather events?*. Available on https://essaybishops.com/how-can-the-shipping-industry-be-made-more-resilient-to-the-impacts-of-climate-change-such-as-rising-sea-levels-and-extreme-weather-events/

[21] Hassan, A., Yang, J., Usman, A., & Ullah, S. (2023). *Green growth as a determinant of ecological footprint: Do ICT diffusion, environmental innovation, and natural resources matter?* PLoS One, 18(9), e0287715.

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)

Journal of Marine
Technology and Environment
DOI:10.53464/JMTE.03.2026.03
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

[22] Joga, S. R. K., Reddy, B. S., Sashidhar, S., Mohansai, K., Deekshith, K., & Priyadarshini, S. (2024). *Microgrid Energy Management System Using Adaptive Bat Optimization Technique*. https://doi.org/10.1109/icdcot61034.2024.10515901

[23] Devi, C., & Khwairakpam, M. (2025). *Perspective Chapter: Advancements in Conventional Composting Techniques for Organic Farming*. IntechOpen EBooks. https://doi.org/10.5772/intechopen.1008732

[24] Bitar, E., Poolla, K., Khargonekar, P. P., Rajagopal, R., Varaiya, P., & Wu, F. (2012). *Selling Random Wind*. https://doi.org/10.1109/hicss.2012.523

[25] Meppa grants for NGOs - AI UNO. https://aiuno.org/meppa-grants-for-ngos/

[26] *IMO MOVES TO CUT PLASTIC OCEAN POLLUTION - Clean Shipping International*. https://www.cleanshippinginternational.com/imo-moves-to-cut-plastic-ocean-pollution/

[27] GeoGarage blog: *Summer Sailstice : imagine... the whole world sailing*, June 19, 2010. https://blog.geogarage.com/2010/06/summer-sailstice-imagine-whole-world.html?m=1

[28] Rimmer, V., Tsingenopoulos, I., Spooren, J., Joosen, W., & Ilie-Zudor, E. (2018). *Chained Anomaly Detection Models for Federated Learning: An Intrusion Detection Case Study.* Applied Sciences, 8(12), n/a.

[29] Al-Yafei, H., Al-Yafei, H., Alnouss, A., Al-Kuwari, A., Abdussamie, N., Ibrahim, H., & Nasr, H. (2025). *Blue Ammonia and the Supply Chain Pioneering Sustainability Assessment for a Greener Future.* Energies, 18(5), 1137.

[30] About Us | Carbon Footprint HK. https://carbon-footprint.hk/about/

[31] *McCafe Premium Roast Ground Coffee*, 30 oz . Available on https://4kdepot.com/product/mccafe-premium-roast-ground-coffee-30-oz/

[32] Wan, W. (2023). *Green Financial Supervision Information System Based on Genetic Algorithm Optimization under Carbon Peaking and Carbon Neutrality Goals*. Sustainability, 15(22), 15866.

[33] *The Evolution of the Global Insurance Landscape: Navigating the Complexities of an Ever-Changing World: - Sneak hunter*. Available on https://sneakhunter.com/the-evolution-of-the-global-insurance-landscape-navigating-the-complexities-of-an-ever-changing-world/

[34] Beis, D., Loucopoulos, P., Pyrgiotis, Y., & Zografos, K. G. (2006). *PLATO Helps Athens Win Gold: Olympic Games Knowledge Modeling for Organizational Change and Resource Management*. Interfaces. https://doi.org/10.1287/inte.1060.0189

[35] *Renewable Integration in Energy & Utilities: A Future Vision*. Available on https://www.numberanalytics.com/blog/renewable-integration-energy-utilities

[36] Ergün Demirel, (2022). *The prospective posture of maritime education in support of smart shipping*, Journal of Marine Technology and Environment, vol. 1 (1);26-39, Nautica Publish House, Constanta, Romania.

[37] I I. Ricardo Rodríguez-Martos, (2009) *The importance of training in leadership in maritime universities* , Journal of Marine Technology and Environment, Vol 1 (1):5-6, Nautica Publishing House, Constanta, Romania.

Creative Commons Attribution BY 4.0 International Licence (CC BY-4.0)