# Written evidence from the University of Oxford

## Executive Summary


- **Pressure is increasing for international marine transportation to decarbonise, and no clear strategy for doing so yet exists**
- **An estimated 2.9% of global greenhouse gas (GHG) emissions are produced by the marine transportation sector**
- **Several technologies are strong candidates for shipping decarbonisation, and are at various stages of maturity in terms of development and adoption**
- **Clean fuels have seen a substantial decline in cost resulting from technological advances, particularly in renewable power generation.**
- **For zero-emissions shipping technologies to become commercially viable, greater regulatory support and a step change in financial investment is required**
- **Similar cost differentials have been successfully overcome in recent years across various sectors, particularly renewable energy**
- **Facilitating private investment into zero emissions shipping technologies is essential to the viability of clean shipping fuels at scale**
- **The long-term success of any market-based mechanism requires both economic and legal feasibility and buy-in from key stakeholders**
- **In a recently published report Oxford University researchers propose the use of a Contracts-for-Difference (CfD) scheme to encourage private investment and innovation in the development and uptake of technologies and fuels for zero-emissions shipping.**
- **With the help of legal experts Pinsent Masons, the report provides two legally workable mock-ups of CfD Heads of Agreement specifically designed to support a technology-neutral incentive programme for the decarbonisation of international shipping.**


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1. Submitted on behalf of University of Oxford and Pinsent Masons, co-authors of the recent report Zero-Emissions Shipping: Contracts-for-difference as incentives for the decarbonisation of international shipping.

2. *The Oxford Smith School of Enterprise and the Environment equips enterprise to achieve net zero emissions and the sustainable development goals, through our world-leading research, teaching, and partnerships.*

3. *The Oxford Martin Institute for New Economic Thinking is a multidisciplinary research centre dedicated to applying leading-edge thinking from the social and physical sciences to global economic challenges.*

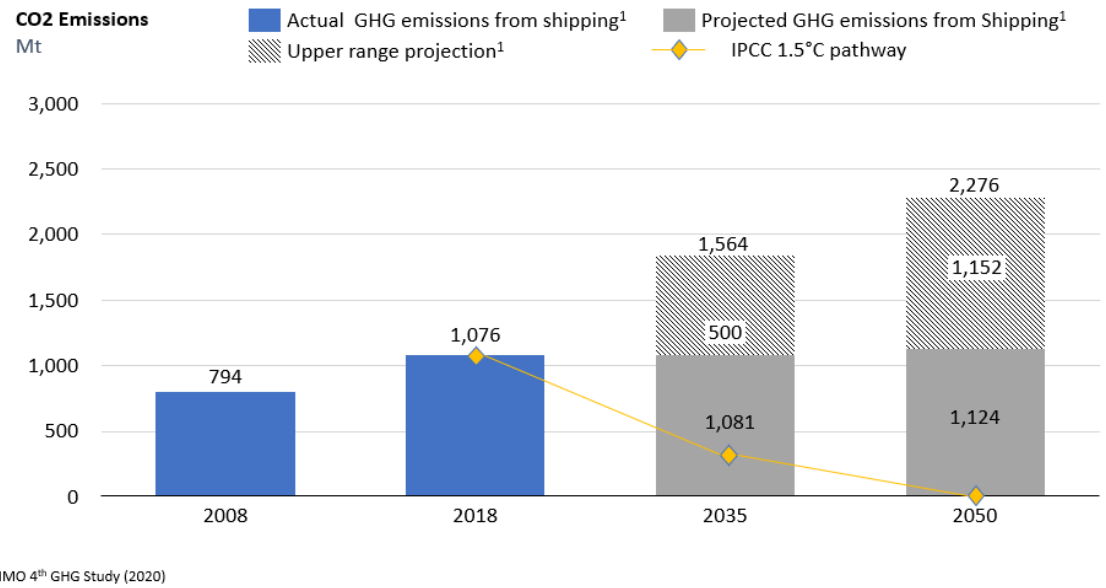
4. *Pinsent Masons is an international law firm which specialises in the energy, infrastructure, financial services, real estate and advanced manufacturing and technology sectors. The firm ranks among the top hundred law firms in the world by turnover.*

5. The UK has a rich and proud maritime history and is home to the International Maritime Organisation (IMO). In conjunction with this history comes a non-trivial contribution to the

estimated 2.9% of annual global emissions produced by the marine transportation sector. A global reduction in marine-associated emissions requires an international response. The UK is looking to position itself as a global leader in clean maritime growth and innovation. This is clearly laid out in the Department for Transport (DfT) Maritime 2050 policy paper and the Clean Maritime Plan, which provide details on the UK government's plans for the transition to zero-emission shipping.

6. The Maritime 2050 plan provides a roadmap for the UK's leadership in clean maritime growth and innovation, focusing on the transition to zero-emission shipping. The plan aims to support an effective global response prompted by localised leadership. The DfT plan stresses the importance of the need to couple energy efficiency improvements with the development and use of alternative fuels such as green hydrogen and ammonia. It also acknowledges the substantial capital cost barriers faced by maritime asset owners and operators in undertaking this transition. Maritime 2050 contains the foundational building blocks of a government-backed maritime sector focused "green financing" program that will contribute to the broader UK green transition plan and competitive positioning of the UK as a green finance hub.

7. The Maritime 2050 strategy functions nationally within the IMO's 2050 decarbonisation targets. These targets call for a reduction of emissions in the sector to 50% of 2008 levels by 2050. Without clear and strong decarbonisation policy, even this target, insufficient for meeting the UK's legal obligation to meet net zero emissions by 2050, will not be achievable. Shipping emissions are expected to remain steady or increase significantly over the next few decades, with the IMO itself predicting that the sector's emissions could increase by 90-130% from 2008 levels by 2050. As shown in Figure 1, the emissions gap between the range of projected shipping emissions and the net zero requirements of the Paris Agreement's aspirational target of 1.5C are daunting. The recently released IPCC Sixth Assessment Report findings further bolster the importance of immediate action on decarbonisation. Action must be decisive, swift, and promote private sector participation.




1) IMO 4th GHG Study (2020)

*Figure 1: IMO emission targets and current emissions from shipping compared with the requirements of an IPCC 1.5 degrees pathway (Source: IMO 4th IMO GHG Study 2020)*

8. In a report recently published by Oxford University and Pinsent Masons titled Zero-Emissions Shipping: Contracts-for-difference as incentives for the decarbonisation of international shipping, we propose the implementation and administration of a Contracts-for-Difference (CfD) scheme to encourage the development and uptake of technologies and fuels for zero-emissions shipping. By backing such a scheme nationally, the United Kingdom would benefit from a first-mover advantage, bolstered by its already substantial expertise and success with CfDs. Additionally, our stakeholder interview process found keen interest from the European Union (EU) for the use of such CfD schemes to decarbonise shipping. The UK is well-poised to act as a significant initial provider of green (i.e., zero-emissions) fuel in the region, thanks to its relative abundance of low-cost green energy from existing old nuclear infrastructure and newer offshore wind energy. This combination positions the UK in a leading role for fostering international action on maritime related emissions reductions.

9. Incentivising private investment is key to the necessary scaling and adoption of clean shipping fuels. The UK has a demonstrated history of success in this area, via the role of the Low Carbon Contracts Company in the development of the UK offshore wind and solar industries. The viability of any incentive mechanism depends on both legal and economic feasibility as well as appetite for uptake by relevant stakeholders. Any CfD solution must therefore be sensitive to the needs of the shipping community and providers of supporting infrastructure. Consequently, a key focus of the Oxford report was a stakeholder engagement process aimed at understanding myriad viewpoints from shipping and energy industries, government and regulatory bodies, financial institutions, researchers, and civil society. In designing the mock-up CfDs, we strove to strike the right balance between stakeholder needs, political and practical feasibility, the need for technology-neutrality and a level playing field, and the need for specificity in the policy mechanism.

10. We propose a framework for designing CfDs for international shipping, based on implementations of this instrument in other sectors, the specific features of the shipping industry, and stakeholder views. We explore two CfD options in detail:

    i. A “Fuel-only” CfD, which is the simplest and most popular solution with stakeholders, providing shippers with zero-carbon emission fuels at the same price as Marine Gas Oil (MGO). While this solution may not cover 100% of the costs of switching from to zero-emission shipping, or necessarily provide support for infrastructure and retrofitting costs, it can be applied transparently and equally to all shipping segments. It does not favour ‘non-fuel’, highly capital-intensive options like nuclear powered or wind assisted ships.

    ii. A “Total Cost of Ownership” (TCO)-based CfD, which covers all incremental costs associated with building and running a zero-carbon emission ship compared to a standard ship. This option is administratively much more difficult to manage and would likely require many variants to cover all shipping segments but is potentially better for fostering competition on fuel options, and for making progress on the cost of non-fuel capital components required to build and operate zero-emissions ships.

11. To provide industry stakeholders with a tangible legal product for closer scrutiny and application, the report concludes with draft "Heads of Agreement" (HoA) for each of the above two CfD options. These documents were drawn up by experienced CfD specialists, law firm Pinsent Masons, based on the findings of the report. They are concise legal blueprints that can be used to define the terms of an agreement in principle between parties and counterparties, laying out in sufficient detail how each CfD would work and under what terms it would operate. They are intended to provide readers with a detailed understanding of how the CfD mechanisms might work and enable industry stakeholders to see the concrete details of the contracts, to find points of agreement, and uncover any issues that might require further negotiation.

**12. Technology Overview**

The technology-neutral CfD approach we have taken would allow for private investment to be crowded into several key clean technology options at various stages of development and adoption. The popularity, current state of development, barriers to adoption, and benefits of each are detailed below.

*13. Green Ammonia*

Amongst zero-emissions fuels, green ammonia is often pointed to as one of the most viable long-term solutions. The process through which ammonia is produced, the Haber-Bosch process, is incredibly energy-intensive. At present, the energy for the process is primarily derived from fossil fuels. The adoption of ammonia over hydrogen is favourable for several reasons, provided the energy inputs are green, including:

1) Ammonia has more than twice the volumetric energy density of liquid hydrogen;
2) Ammonia can be stored as a liquid and a relatively high temperature;
3) Fire risk associated with Ammonia is lower than both hydrogen and hydrocarbons;
4) A robust system of safety standards surrounding ammonia storage, transport and handling already exists;
5) The global infrastructure system for ammonia is already substantially more developed than that of hydrogen.

*14. Green Hydrogen*

1) Hydrogen is one of the cleanest fuels to burn in that it produces primarily water and zero $CO_2$ when combusted. When produced from water through electrolysis (and with green energy) the process is less energy intensive than that of ammonia. While simpler to produce than ammonia, there are a number of substantial hurdles in the widescale adoption of green hydrogen;
2) Storage and transportation 'destroy the business case for hydrogen' (Clark et al., 2021);
3) Requires cryogenic storage which comes at substantial cost both at sea and on land;
4) A global lack of distribution and bunkering infrastructure.

*15. Wind and Sail*

While estimated to achieve a 10-30% reduction in fuel consumption wind is an intermittent source of propulsion. As such the variety of existing technologies including sails, kites, and rotors will require pairing with another zero-emissions technology to meet the requirements of most vessels.

16. *Batteries*
When the electric power stored within a battery is derived from green electricity, batteries can be considered as zero-carbon. There is substantial market precedence for the widescale adoption of batteries in the short-haul and towage market including tugboats and ferries. Unfortunately, given batteries lack of energy density (1/30$^{th}$ of conventional fuels) weight and space requirements are prohibitive in the deep-sea market.

17. *Nuclear Technologies*
There are two distinct routes to decarbonisation via nuclear energy. Firstly, existing nuclear plants can provide cheap clean energy to produce clean shipping fuels including ammonia and hydrogen. Many of these reactors already exist and have substantial projected lifespans with low continuing capital costs. The second option involves installing nuclear reactors onboard vessels, with hopes of cost declines being achieved in coming decades through mass production of small modular reactors. Nuclear options generally face greater safety, regulatory, social, and environmental risks.

**18. Economic Barriers**
The key barriers to large-scale private investment and adoption of such clean fuels are well-known and include high perceived technology risks, lack of supporting infrastructure, lack of a project pipeline, lack of stable and scalable fuel supplies, and perhaps most importantly their high relative costs in the absence of very high carbon pricing (or its equivalent) on existing fuels.

19. At present each of the alternative propulsion energy source discussed above is costlier than conventional maritime fuels. Top contenders, including green ammonia and hydrogen, have substantial upfront investment costs in addition to retrofitting bills or higher costs associated with new fuel engine development.

20. For economic parity, it is essential that zero-emission fuels trade at a price similar to, or less than the global MGO benchmark rate. The shift to zero-emission fuels will undoubtedly raise costs for asset operators in the short term. Given the inherent inelasticity of demand for shipping services, market participants noted that the increased costs would not prove prohibitive so long as a level playing field is maintained, such that all shippers faced the same fuel costs (which, in the absence of a global carbon price, a CfD is designed to achieve). As zero-emission fuels are developed further, technological innovation particularly in renewables are expected to contribute to substantial cost declines for clean energy fuels (Ives, M. C. et al., 2021).

**21. Environmental, Regulatory and Safety Barriers**
Maintaining the integrity of the environment is a critical concern in the adoption of any zero-emissions solution. The safety structure surrounding conventional fuels is well established including double hulled vessels and well-developed handling procedures. These conventional fuels are covered by the IMO International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF). At present, the IGF does not cover any of the fuels proposed in this submission.

22. The adoption of ammonia or hydrogen would require adjustment to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC) as they currently are prohibited from use as marine fuels (IMO IGC, pp. 37).

23. These barriers are reflected in the increased costs associated with their use and implementation. Zero-emissions fuels are at a clear disadvantage due to immature technological development, regulation or prohibitive rules that prevent their widescale adoption.

24. The implementation of a CfD scheme would require sufficient regulatory support to provide private investors with enough certainty to adequately facilitate the inclusion of enough private capital.

**25. Institutional Barriers**

Most substantially, institutional barriers to the adoption of zero-emissions fuels are the most prohibitive yet may also simultaneously act as the greatest asset for UK adoption and implementation of a CfD.

26. The slow pace of regulatory development at the IMO was seen by many stakeholders as one of the largest hurdles to global implementation of a CfD scheme. To satisfy the roadmap as set out in Maritime 2050 and the Clean Maritime Plan, the transition to zero-emissions fuels must eventually be led by the IMO but regional, or route or sector-specific solutions are most likely to succeed in the short term.

27. When looking to other jurisdictions with the wherewithal to implement such a scheme, the EU may be a natural answer. Unfortunately, the recent European Green Deal likely cannot on its own facilitate the required scale of private investment to successfully decarbonise the maritime industry, requiring the use of complementary policy measures. Despite this lack of maritime-focused facilitation beyond its expected inclusion in the ETS, the EU remains a critical trade partner of the United Kingdom which may benefit a UK-based CfD scheme.

**28. CfD: Overview and Outline**

Fundamentally a CfD is a subsidy mechanism intended to reduce the price gap between old and new technologies (Clark et al., 2021). This reduction can be achieved via CfD without the long-term market distortions generally associated with broad-based subsidies. Ultimately the financial burden of a CfD on government should be limited when compared with other subsidy mechanisms. Given sufficient cost declines the ultimate clean technology-driven solution may also result in significant cost savings (Ives, M. C. et al., 2021).

29. CfDs are attractive as a policy instrument for a number of reasons. Chiefly, they act to limit the risk faced by suppliers of a new technology or commodity. This risk is mitigated by facilitating a payment to the supplier at a rate required for the economic viability of the supply. For optimal results, a zero-emissions shipping fuel CfD should maintain a level playing field. Second, the CfD can be coupled with an off-taker agreement to provide certainty to private sector investors that there will be a market for the new product.

30. CfDs have a demonstrated history of success in the renewables space. They have been a primary driver behind increased investment and the subsequent rapid adoption of renewable energy sources (Grubb, M. and Newberry, D., 2018).

31. The UK has been an early adopter and champion of CfDs in the offshore wind and solar energy markets. Implemented as a reform component within the broader electricity market, these CfDs have been positively received and viewed as largely successful. These CfDs have been administered by the LCCC, a government-backed corporation responsible for CfD auctions, administration, and payment settlement.

32. Substantial private investment, primarily in the offshore wind industry, has been attributed to the implementation of a CfD scheme. This success has seen large declines in levelised costs and acted as a market hedge for investors at a discounted burden to government as compared to feed-in-tariffs or traditional direct subsidies (Clark et al., 2021).

**33. The United Kingdom as a CfD Implementation Champion**

The UK has substantial experience with CfDs and when combined with the slow current pace of innovation and change at the London-domiciled IMO, the UK has multiple clear advantages in being a first mover on CfD implementation in the maritime sector.

34. The UK merchant fleet is the 18th largest in the world and considerably well integrated with the European market. When combined with crown dependencies and overseas territories, the 10th largest. As a champion of CfD for renewable energy, the UK sits at the nexus of innovative financial tools and maritime influence. This positioning promotes the ability of the UK to act as a catalyst for the development of zero-emissions fuels globally. The availability of both cheap legacy nuclear technology and abundant renewable energy, itself deployed with the support of CfD mechanisms, and political benefits of being a first mover, make the United Kingdom the ideal candidate for the implementation of a government-affiliated CfD scheme.

35. The Zero-Emissions Shipping report provides a valuable analysis on the viability of CfDs as a mechanism to decarbonise the deep-sea shipping industry. It includes two draft "Heads of Agreement" CfD options that together provide industry stakeholders with a tangible legal product for closer scrutiny of this proposed solution.

36. It is our hope that Parliament might gain from this joint Oxford University and Pinsent Masons report. We submit for consideration the belief that a zero-emissions shipping future is not only an economically viable possibility, but that the UK has a leading role to play in making this future a reality.

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