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Wind technologies: Opportunities and barriers to a low carbon shipping industry

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ABSTRACT

The abatement potential of wind technologies on ships is estimated to be around 10–60% by various sources. To date there has been minimal uptake of this promising technology, despite a number of commercially available solutions that have been developed to harness this free and abundant energy source. Several barriers have been referred to in the literature that inhibit uptake of energy efficiency measures in shipping. This paper provides a systematic analysis of the viability of wind technology on ships and the barriers to their implementation, both from the perspective of the technology providers and technology users (ship owner–operators), using the survey and the deliberative workshop method. The data generated from these methods is analysed using the qualitative content analysis method. The results show that whilst there is renewed interest in wind power, there are several common economic barriers that are hindering the mass uptake of wind technologies. Our analysis shows that third party capital is a plausible solution to overcoming the cost of capital, split incentives and information barriers that have contributed to inhibiting the uptake of wind technology in the shipping industry.

1. Introduction

The shipping industry is commonly cited as the most energy efficient mode of transport, but this will be a challenge in the future as its current contribution (around 3% of global CO_2 emissions) is expected to increase to around 20–25% of global anthropogenic CO_2 emissions by 2050 due to growth in international trade and other industry sector decarbonisation [1]. Several technical and operational energy efficiency measures have been identified that can be applied to new and existing ships to reduce fuel costs and meet this climate change challenge. Solutions could come from a combination of step-change technologies that provide significant energy and emissions reductions, alternative fuels and operational improvements that provide nominal energy reductions.

Under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), greenhouse gas emissions from shipping have been left to the United Nation's International Maritime Organisation (IMO). The IMO introduced the Energy Efficiency Design Index (EEDI), which sets mandatory CO_2 reduction targets for all newly built ships built from 2013 onwards. The reduction targets are tightened every five years up until 2030 to ensure that ship owners order more efficient ships. The amendment also introduced the Ship Energy Efficiency Management Plan (SEEMP) requiring ship owners to have a plan on-board each vessel to improve operational efficiency.

The impact of these policies is estimated to reduce CO_2 emissions by 25% reduction in a business-as-usual scenario by 2050 [2], whereas the reductions required if the industry is to be sustainable are in the region of 80% compared to current levels [3]. Recent reports submitted to the IMO Marine Environment Protection Committee (MEPC) [4,5] showed that the EEDI is only spurring 'mainstream' innovation (e.g. hydrodynamics, hull and propeller appendages) and there has been no uptake at all of innovative measures that yield significant savings, which are necessary to keep shipping's CO_2 emissions in line with either the 1.5 or 2 °C targets (Internationally agreed limits on average global warming above pre-industrial levels) [6].

Wind technologies offer significant savings on existing ships that can allow ship owners to operate competitively with new ships. There are three different technologies through which wind energy can be harnessed for propulsion purposes: Flettner rotors, kites and sails. The fuel savings that can be achieved from these wind-assistance technologies depend on the design of the ship (particularly the rig and hull), the operating speed, and the wind speeds and directions experienced.

Wind speeds vary depending on the route and season. Higher wind speeds allow a ship to harness more wind as power to propel

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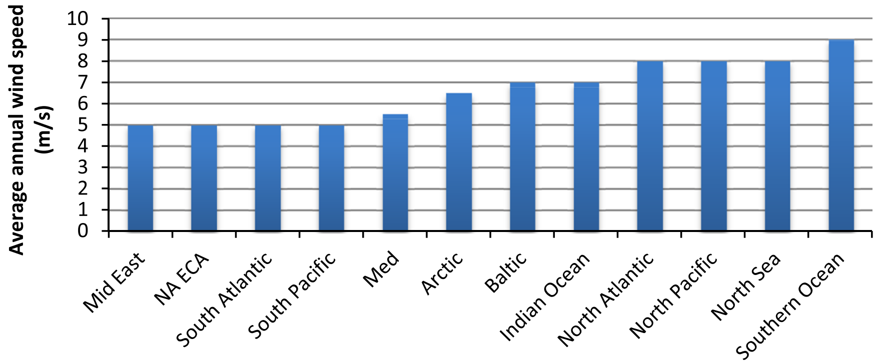

Fig. 1. Estimated average annual wind speed in different sea areas. Data from NASA Surface meteorology and Solar Energy for the period 1983–1993 (http://eosweb.larc.nasa.gov).

the ship and less power from the diesel engine. For many ships, the operating profile and routes taken are variable and can change from one voyage charter to the next, such that there is heterogeneity in the fuel savings for different ship types and some uncertainty in predicting fuel savings. An initial assessment of the viability can be obtained by understanding the average wind speeds for the areas of operation of a particular ship type. (Fig. 1) classifies the average annual wind speeds into different sea regions, ranked from least windy sea region (the Mid-East, North Atlantic Emission Control Area and South Atlantic) to the most windy sea regions (North Pacific, North Sea, and Southern Ocean).

To understand whether wind technology is likely to be viable for a certain ship type, the information about relative wind speeds needs to be matched to activity data that describes ships' movements. (Fig. 2) displays this information for dry bulk carriers in two size ranges, 0–10,000 and 10–35,000 DWT capacities, using data from Smith et al. [7]. The graph shows that in many instances there is a good alignment between the windier sea areas and the areas where there is significant shipping activity (for example, North Pacific, North Atlantic and the Indian Ocean). This implies that at least for these two example ship types and sizes, if a ship operated a sequence of voyages over a year that mirrored the aggregate average activity in different sea regions shown in Fig. 2, there is a good probability of experiencing higher than average wind speeds and a good level of utilisation (fuel cost savings) from wind assistance technology.

Whilst this information shows that there is sufficient wind strength for the areas where ships operate, the commercial viability of wind technology requires quantifying the amount of fuel savings that can be achieved. This requires further data on the specifics of ship operation for a given voyage – the typical operating speeds, routes taken, fuel consumption of ships on certain representative voyages and specifics on the savings achieved by the technology. Fuel savings modelled as a simulation show that for that range of speeds, season, and ship designs, the average voyage fuel savings were approximately 10–60% [8]. These results provide encouragement that there is good potential for fuel saving, but further verification needs to be obtained from actual sea trials.

There are a number of technical issues, related to operation and safety, which constrain the types of ships suitable for wind technology. Examples of these considerations include visibility obstruction, cargo handling, air draught constraints, crew safety, crew training, structural integrity, and stability and heel. For example, cargo-handling considerations have prevented containerships from being a market target of wind technology. Careful consideration has been given to all of these issues by the various technology providers with wind-assistance technology offerings and a majority of these issues do not appear to be insurmountable for a large percentage of the shipping market. The clearest proof of this is the class approval that has been achieved by a number of the technology providers.

Despite the viability of wind technology to deliver significant fuel savings in the shipping industry, there are a number of barriers that have prevented its uptake in the sector. In a study of perceptions of Norwegian ship owners on CO_2 abatement technologies, Acciaro, Hoffmann and Eide [9] show that wind technologies score the worst in most barriers categories compared to other technical energy efficiency measures such as cold ironing, waste heat recovery and propeller efficiency devices. The respondents were not familiar with the wind technologies, percieved them as less safe or reliable, and felt they were less effective compared to other technologies [9]. Using technological innovation systems theory, semi-structured interviews and content analysis, Rojon and Dieperink [10] suggest that the key barriers to

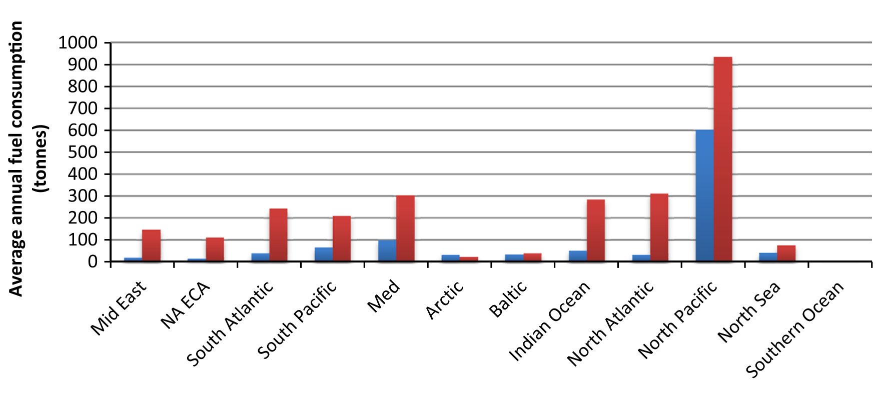

Fig. 2. Average annual fuel consumption in different sea areas. Data from Smith et al. [7].

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