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The role of sea ports in end-to-end maritime transport chain emissions

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HIGHLIGHTS

- Investigates role of ports in mitigating GHG emissions in the end-to-end maritime transport chain.
- Emissions generated both by ports and by ships calling at ports are analysed.
- Shipping's emissions are far greater than those generated by port activities.
- Ports may have more impact through focusing efforts on reducing shipping's emissions.
- Options for ports to support and drive change in the maritime sector also considered.

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ABSTRACT

This paper's purpose is to investigate the role of sea ports in helping to mitigate the GHG emissions associated with the end-to-end maritime transport chain. The analysis is primarily focused on the UK, but is international in application. The paper is based on both the analysis of secondary data and information on actions taken by ports to reduce their emissions, with the latter data collected for the main UK ports via their published reports and/or via interviews. Only a small number of ports (representing 32% of UK port activity) actually measure and report their carbon emissions in the UK context. The emissions generated by ships calling at these ports are analysed using a method based on Department for Transport Maritime Statistics Data. In addition, a case example (Felixstowe) of emissions associated with HGV movements to and from ports is presented, and data on vessel emissions at berth are also considered.

Our analyses indicate that emissions generated by ships during their voyages between ports are of a far greater magnitude than those generated by the port activities. Thus while reducing the ports' own emissions is worthwhile, the results suggest that ports might have more impact through focusing their efforts on reducing shipping emissions.

1. Introduction

Environmental issues have long been a concern for ports, with the impacts mostly occurring through compliance with legal frameworks. These have included issues such as air quality, noise, water quality, biodiversity and natural habitat (dredging) (OECD, 2011). Among these, air quality issues, such as the generation of dust, particulate matter and nitrogen and sulphur oxides (NO_x and SO_x), have traditionally been considered by ports as a local pollution problem, particularly in cases where ports are close to urban centres. Only relatively recently, with rising concerns about anthropogenic CO_2 and its impact on climate change, have ports started to introduce specific programmes and policies to address their greenhouse gas emissions. In 2007, the International Association of Ports and Harbours (IAPH) (2007) published the 'Resolution on Clean Air Programs for Ports' which stresses the need 'to draw more attention to air quality of port areas and undertake as many efforts as possible to reduce air emissions from port operations'. A survey by the European Sea Ports Organisation (ESPO) (2010) of member ports found that 37% of respondent ports measured/estimated their carbon footprint, 51% were taking measures to reduce their carbon footprint, 57% had programmes to increase energy efficiency, and 20% of ports produced some form of renewable energy. In 2008 a group of 55 ports worldwide launched the World Ports Climate Initiative (WPCI).[1] The WPCI uses the GHG Protocol[2] which categorises emissions into the following three groups:

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[1] See ⟨wpci.iaphworldports.org⟩ for details.
[2] See ⟨www.ghgprotocol.org/standards⟩.

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- *Scope 1*: direct GHG emissions from sources owned or controlled by the company and under the day-to-day operational control of the port.
- *Scope 2*: GHG emissions which result indirectly from the port's electricity demand.
- *Scope 3*: other indirect emissions from the activities of the port including employee travel, outsourced activities, movement of vessels and trucks, and construction activities.

The WPCI has promoted a number of initiatives including On-Shore Power Supply, the Environmental Ship Index (ESI), intermodal transport, LNG-fuelled vessels and carbon footprinting to address these different aspects of maritime-related emissions. Individual port members have led on these different initiatives. For example, the Port of Los Angeles has led on carbon footprinting and subsequently shared its expertise on carbon footprint calculations for port operations with other member ports (IAPH, 2010). These measurements covered emission sources from all scopes, such as port-owned and leased vehicles, buildings, port-owned and operated cargo handling equipment (scope 1), port purchased electricity for port administration-owned buildings and operations (scope 2), tenant operations or employee commuting (scope 3). This and related experience resulted in the publication by the IAPH of a ‘toolbox’ for Port Clean Air Programs (IAPH, 2009). In this document, possible strategies for air quality improvement are provided, covering the following operational areas: Ocean Going Vessels; harbour craft; cargo handling equipment; heavy duty vehicles/trucks; light duty vehicles; locomotives and rail and construction equipment. Similarly, some UK ports also began to address measuring and reducing their own greenhouse gas emissions following the stimulus to action provided by the UK's Climate Change Act of 2008.

The purpose of this paper is to investigate the role of ports in helping to mitigate the greenhouse gas emissions of the end-to-end maritime transport chain. The analysis is primarily focused on the UK, but is international in application. The boundaries of port-related emissions are examined through a comparative analysis of port and shipping emissions, and potential emissions reduction strategies are evaluated. A systems approach is adopted in that ports are considered as part of a wider supply chain system and thus included in our focus are strategies with effects that may cross a port's physical and organisational boundaries. The paper attempts to assess the differences in magnitude of emissions at different points in the UK maritime sector; emissions generated by port operations (as reported by the ports themselves), by the vessels at berth (mainly emissions from auxiliary engines), and the emissions generated by the seaborne trade handled at these ports. This segmentation is important because each segment may require different mitigation strategies. Having established this overview, a list of possible strategies that are currently being applied or tested by leading ports are reviewed, and their applicability is discussed in the UK context.

Data sources used for the analysis in this paper include secondary data taken from published and on-line reports, industry websites and government statistics. In addition telephone interviews and email exchanges were conducted with staff at the following ports/port groups: ABP; Port of Dover; Port of Los Angeles; Port of Felixstowe; Milford Haven; and Port of London.

Previous contributions to this journal have explored the topic of GHG emissions from ports—Villalba and Gemchu (2011) examined the emissions from Barcelona Port in the context of those from the contiguous city; the system boundary of that study was one nautical mile on the sea side of the port. The study reported in this paper endeavours to extend the system boundary further and consider port emissions in the context of the wider end-to-end maritime transport chain. While Villalba and Gemchu's approach consists in measuring emissions from one port, our approach aims at reproducing a similar analysis, but at a higher level, for a group of UK ports. In our study, the calculations of land-based emissions are based on the ports' own GHG inventories (see Section 2). These port emissions include those from handling equipment, buildings, lighting, harbour vessels (such as tugs), but exclude Ocean Going Vessels emissions at berth. In our definition, sea side emissions include both emissions from the maritime transport chain (outlined in Section 3) and emissions at berth (outlined in Section 4). These two emissions sources were calculated utilising two independent approaches: end-to-end emissions were estimated using the model described in Section 3; while emissions at berth were estimated from a study conducted by Entec for Defra (Entec, 2010) using the approach described in Section 4. By contrast, Villalba and Gemchu (2011) include emissions due to vessel movements (arrival, departure, hotelling and manoeuvering) within Barcelona's port emissions and categorise these as sea-based emissions. Our view is that these emissions are out with the direct responsibility of the port operators even though, as we demonstrate, they may be amenable to actions taken by the port.

Another previous contribution to this journal—Fitzgerald et al. (2011)—utilised a similar approach to assess end-to-end emissions at the national level, using New Zealand as a case study. As is the case for the United Kingdom (Rigot-Müller et al., 2012), most of New Zealand's trade in tonnage is conducted by sea, so in this case maritime statistics represent a large proportion of total traded tonnage. However, Fitzgerald et al. use trade statistics, whereas we utilise cargo statistics by origin and destination, consolidated from ports. Our approach to estimate emission factors is also different, since we use vessel average size from Eurostat data and not vessel specifications from the Advance Notices of Arrival. Fitzgerald et al. (2011) also exclude port related emissions (manoeuvering, loading/unloading, hotelling) from their calculations. Despite these methodological differences, the general purpose of our approach aims to achieve similar results to that of Fitzgerald et al. (2011) as regards an analysis of emissions resulting from maritime transport, but applied to the UK.

2. Carbon footprint of port operations: the case of UK ports

The first carbon footprint projects for UK ports' operations started in the late 2000s. For example the port of Dover began monitoring emissions in 2008, based on data from 2006 to 2008, while Associated British Ports (ABP) also started measuring emissions using 2006–2008 data, and were subsequently awarded the Carbon Trust Standard in 2009 (Associated British Ports, 2010). Such measurements were frequently made in anticipation of the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme, a carbon trading scheme applicable to all organisations with more than 6000 mWh consumption measured through a half hourly electricity metre. The Carbon Reduction Commitment applies to all Harbour Authorities in England and Wales responsible for Ports dealing with over 10 million t of commercial cargo annually. The following port companies are covered by the CRC; ABP Harbour Authority (Hull, Humber, Immingham, Southampton), Dover Harbour Board, Harwich Haven Authority, Mersey Docks and Harbour Company, Milford Haven Port Authority, PD Teesport Ltd., Port of London Authority, Port of Sheerness Ltd. and The Felixstowe Dock and Railway Company.

In 2011 five port companies in the UK were already reporting and publishing their carbon emissions from port operations: Associated British Ports, the Felixstowe Dock and Railway Company, the Dover Harbour Board, Aberdeen Harbour Board and Poole Harbour Commissioners. These companies manage 12 UK ports (Cardiff, Goole, Hull, Immingham, Ipswich, Plymouth, Port

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