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Barriers to improving energy efficiency in short sea shipping: an action research case study

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ABSTRACT

Increased energy efficiency will be paramount in mitigating CO_2 emissions from shipping. Paradoxically, previous research has shown that a substantial amount of measures that typically increase energy efficiency, should be cost-efficient to implement. This is often explained in literature in terms of barriers in markets, institutions and organizations. This article is the first of a series of articles from a joint industry project aiming at understanding good energy management practices in shipping companies. It explores barriers to energy efficiency in shipping through a case study of a short sea shipping company in their process to implement an energy management system. An action research design was chosen to contribute to better practice as well as knowledge in the research community. The study shows that work with energy efficiency was not straightforward, and several challenge areas could be discerned: project management capabilities, ship-shore communication, division of responsibilities, access to performance measurements, and competence in energy efficiency. It is proposed that interpretative research methodologies such as action research could contribute to new perspectives on the traditional barrier discourse.

1. Introduction

The potential for improving CO_2 efficiency in shipping is evident. In a report to the International Maritime Organization (IMO), Buhaug et al. (2009) estimated that this potential ranged from 25% to 75%, through more efficient operations of existing ships, increased energy efficiency in the design of new ships, and introduction of alternative fuels. Eide et al. (2011) concluded further that 33% could be reduced by 2030 at zero cost, due to the fact that most measures that increase energy efficiency are cost-efficient. This kind of situation, where a large potential for improvement exists without being realized at the expected pace, has been shown to exist in many sectors and is commonly called an "energy efficiency gap" (e.g. Jaffe and Stavins, 1994). The gap has been attributed to barriers and failures in markets, institutions and organizations (Sorrell et al., 2004).

Despite this substantial potential in increased *efficiency*, reducing *total* CO_2 emissions from shipping will be a challenge due to the growth of the sector. Increased global economic growth is expected to continue to be coupled with an increased need for transportation by sea. As a consequence, the contribution of shipping in terms of global emissions (about 3.3% in 2007) is expected to double or even triple by 2050 (Buhaug et al., 2009). International regulation directed at energy efficiency in shipping, applicable to all countries, has now been moved in place. Since 1st of January 2013, all new ships have to comply with an Energy Efficiency Design Index (EEDI) and all ships will have to carry a Ship Energy Efficiency Management Plan (SEEMP).[1] In a report to the IMO by Bazari and Longva (2011), it was shown that emissions will continue to rise despite these measures, due to sector growth. While there are no set goals for GHG emissions from shipping on an international level, the European Commission (EC) has recently set a goal for a reduction of 40–50% by 2050 (EC, 2011). However, Eide et al. (2011) showed that even at high costs of CO_2 emissions – via, e.g. a future bunker fuel levy or an emissions trading scheme – it is not possible to increase efficiency faster than the growth of the sector. Indeed, Buhaug et al. (2009, p. 149) called for "radical change" in this area.

Energy efficiency may be of particular importance in short sea shipping (SSS), typically defined as the movement of cargo and passengers by sea between ports that does not involve an ocean crossing. Energy costs are on the rise in this sector, not only due to increasing costs of crude oil, but because of more strict requirements on sulphur content in marine fuel in designated

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[1] The environmental impact of shipping is regulated on an international level mainly through the International Convention for the Prevention of Pollution from Ships (MARPOL). The climate impact of shipping is regulated in the air pollution section – Annex VI – to this convention.

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Sulphur Emission Control Areas (ECAs) (Svensson, 2011; Winebrake et al., 2009). Compared to deep-sea shipping, SSS is also more exposed to competition from other means of transport, such as rail or truck transport (Paixão and Marlow, 2002). There is thus a risk that increased energy costs could cause a modal-shift of cargo to land-based transportation, effectively increasing the total environmental impact (Notteboom et al., 2010).

To better understand energy efficiency gaps or barriers, researchers have called for more studies on energy management practices in companies (Thollander and Ottosson, 2010), particularly using participatory methodologies (Thollander and Palm, 2012). This article is the first of a series of articles based on a joint industry-academia project on understanding and improving energy management practices in shipping companies (Johnson, 2013, pp. 49–54). An action research approach is used to implement an energy management system according to the ISO 50001 standard in two shipping companies. In this first article, the work that took place in one of the companies – a short sea shipping company – leading up to the conduction of an energy audit, is described and analysed.

The paper has the following structure: Section 2 introduces energy efficiency and management in shipping while Section 3 describes and motivates the action research approach. Section 4 contains the case study, followed by the analysis in Section 5. A discussion in Section 6 includes, amongst other things, the prospects of generalising the results. Section 7 concludes.

2. Energy efficiency in shipping

Shipping is often presented as an energy and CO_2 efficient mode of transport compared to other modes such as air, truck or rail (e.g. Buhaug et al., 2009). Concurrently, the potential for improvement has been shown to be substantial. In Table 1 below, the potential of 25–75% mentioned above is broken down into smaller groups of measures.

In conclusion, measures are found in various parts of the shipping system, requiring improvement and support also by actors other than shipping companies, such as shipyards and banks (to finance and build more energy efficient ships), ports and cargo owners (to ensure more efficient logistics), regulatory bodies, etc.

The matter of an energy efficiency gap in shipping has mainly been discussed outside of peer-reviewed literature. In a report to the IMO, Buhaug et al. (2009) acknowledges the significance of contractual arrangements and incentives in influencing energy efficiency. In particular, energy costs are in many contractual forms paid by the cargo owner, and not the shipping company (Pirrong, 1993; Wang et al., 2011), causing a split incentive problem. In a report to the European Commission (EC), Faber et al. (2009) discuss low priority of energy efficiency in companies due to low fuel prices in the past, split incentives between cargo owners and shipping companies, and transaction costs due to search for information on measures. This list is expanded in report by Faber et al. (2011), to also include e.g. a lack of trust in data concerning the effectiveness of measures, that shipyards may minimize building costs rather than cost of ownership, and that it can be difficult for smaller ship owners to gain access to finance for investing in measures. In a report to the EC, MaddoxConsulting (2012), discuss "administrative barriers" to energy efficiency, presumed to exist in smaller shipping companies without sufficient resources to analyse, making decisions and implementing energy efficiency solutions.

Thus, similarly to other sectors, there is a need for further understanding the perspective of organizing work with energy efficiency in a company – of actual energy management practice. For example: what are these "administrative barriers", and how could they be mitigated?

Table 1
Measures to improve CO_2 efficiency in shipping. Adapted from Buhaug et al. (2009).

	Saving of CO_2/tonne-mile (%)	Combined (%)	Combined (%)
Design (New ships)			
Concept, speed and capability	2–50	10–50	
Hull and superstructure	2–20		
Power and propulsion systems	5–15		
Low-carbon fuels	5–15[a]		
Renewable energy	1–10		
Exhaust gas CO_2 reduction	0		25–75
Operation (all ships)			
Fleet management, logistics and incentives	5–50[b]	10–50	
Voyage optimization	1–10		
Energy management	1–10		

[a] Based on the use of Liquid Natural Gas (LNG).
[b] Including reduced operational speed.

3. Methodological choices

It has been argued that policy-making and society sometimes require solutions to problems different from those asked by science itself (Weinberg, 1972), and that they often align themselves in the intersection between scientific disciplines (Collingridge and Reeve, 1986). Action research (Lewin, 1946), transdisciplinary research (e.g. Max-Neef, 2005), sustainability science (Clark and Dickson, 2003), post-normal research (Funtowicz and Ravetz, 1993), mode-2 research (Gibbons, 2000) and phronetic research (Flyvbjerg, 2001) may be seen as different research frameworks to address such problems. While a traditional view of the scientist is that he or she "need not choose problems because they urgently need solution and without regard for the tools available to solve them" (Kuhn, 1996), a scientist active within these frameworks have other working conditions: knowledge is produced based on identified needs and problems in society (Funtowicz and Ravetz, 1993; Gibbons et al., 1994); "quality" of research is assessed by a wider range of stakeholders (Clark and Dickson, 2003; Funtowicz and Ravetz, 1993), and is as such also assessed on the extent that the research has an impact on practice (Flyvbjerg et al., 2012). Finally, it is argued that knowledge needs to be "co-produced" in close collaboration between researchers and practitioners (Clark and Dickson, 2003; Max-Neef, 2005).

The case study reported in this article follows this movement: understanding how companies can improve their performance with respect to energy efficiency is a matter of great societal interest. It is important that the research results lead to better practice amongst stakeholders, in this case shipping companies.

The study is part of a larger collaborative industry-academia project, with the goal of understanding what are good energy management practices in shipping companies through the study of the implementation of an energy management system (EnMS) standard (ISO 50001) in such companies.[2] As seen in Fig. 1, it consists of a university, two shipping companies, and a consultancy. An action research approach is used, where one of us (first author)

[2] The purpose of an EnMS can be defined as "to enable organizations to establish the systems and processes necessary to improve energy performance, including energy efficiency, use and consumption" (ISO, 2011). Energy management systems: requirements with guidance for use. The company in this study focused on the international standard ISO 50001 – "[…] upon which an organization can develop and implement an energy policy, and establish objectives, targets and action plans which take into account legal requirements and information related to significant energy use" (ISO, 2011). Briefly, the phases of formation of an energy policy, the energy planning and auditing, and implementation and operation are followed by a state of constant "checking". This is in turn supported by an internal auditing system, processes for monitoring, measurement and analysis as well as for nonconformities, correction, corrective and preventive action. A periodical management review completes the cycle.