Draft discussion Paper: What are the implementation barriers to low carbon shipping?

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To meet any future incentive (economic or regulatory), a number of options exist for either the increase of energy efficiency or the abatement of CO_2 and GHG emissions. These options can be applied to newbuild ships and in some cases also for retrofit to existing ships. Examples of attempts to compile lists of these options, their characteristics and economic attractiveness can be found in IMO 2010a. For example:

- drag reduction
- propulsion energy efficiency increase
- energy and machinery decarbonisation and efficiency increase
- operational changes

In each case, specifying changes from standard technology (those associated with the existing low cost, volume ship building) incurs costs, but can also provide a benefit. That benefit could be an increase in energy efficiency (which will have an economic impact dependent on the fuel price), the satisfaction of a policy for carbon abatement, or a reputation gain associated with a reduction in environmental impact.

A common method of presenting analysis of the order in which options might be adopted and the likelihood of investment, particularly for policy work, is the Marginal Abatement Cost Curve (MACC), examples of which for shipping can be found in Faber et al. 2009, Bauhaug et al. 2009, IMO 2010a, IMO 2010b, Det Norske Veritas 2009.

Besides the inherent shortcomings in MACC analysis (Kesicki 2010), for shipping it is commonly undertaken with an incomplete representation of costs and little representation of risk (beyond the investment rate of return). The result from the referenced analyses has so far been the identification of substantial (e.g. up to 30%) unrealised abatement potential using options that often appear to be cost-negative at current fuel prices. This contradicts the logic that a competitive industry with a dominant energy cost should be overlooking opportunities to increase efficiency at a profit. Possible explanations are that either:

- Models for analysis are inadequate for representing costs/benefits of low carbon and energy efficiency investment or the data used are incorrect; or
- Other implementation barriers/failures exist which are obstructing the shipping industry's implementation of low carbon

It is possible to gain some insight into the relative significance of each of these explanations, by looking at how this work has been discussed by others both for shipping and other industries. Survey work is also under way to attempt to quantify the relative importance of the possible explanations.

<u>What are the possible omissions from the existing analysis/data?:</u>

Heterogeneity –although a technology may be cost-effective on average for a class of users taken in aggregate, the class (e.g. panaxmax container ships, specific routes, commodities), itself, consists of a distribution of owners/operators: some could economically purchase additional efficiency, while others will find the new level of efficiency not cost effective (Sweeney 1993).

Risk - technologies are assumed incorrectly to be mature or a risk is perceived that performance may be lower than expected - risk premiums and depreciation are not adequately included in the model. Early investors may be sceptical about the prospects of a technology and demand a premium on return in order to cover the risks of the investment (CE Delft et al, 2009). When commissioning newbuilds if depreciation is faster than expected (due to the adoption of technology (diffusion), lower costs due to the learning curve), the solvency of the company may be threatened. So in some cases a ship owner commissioning a new ship would have to compare the risk of having a ship with an innovative design that may depreciate faster than expected with the risk of having a ship with a conventional design but higher operational costs. In such an assessment, the most fuel efficient ship may not always come out best. CE Delft et al, 2009.

Hidden costs (n.b. hidden to the analyst but not the investing company) - the following costs may not have been included:
Life cycle costs - Hidden costs relating to the energy efficient option's life cycle costs including: identification/search costs, project appraisal costs, commissioning costs, disruption/opportunity costs and additional/specific engineering costs.
Transactional costs – Transaction costs and other unobserved cost items may render apparently cost-effective measures costly. Especially smaller ship owners and operators may experience high transaction costs as they cannot spread the costs of e.g. gathering information over a large number of ships (CE Delft, 2009)
Commissioning/disruption costs - Some measures to reduce emissions require retrofits that can only be installed by temporarily suspending production. These measures are very costly to implement except at times when production is halted for other reasons, such as major maintenance of installations. There may therefore be a lag between the time when a measure becomes available and its actual implementation. Retrofits to existing ships such as the installation of wind power, stern flaps, waste heat recovery systems et cetera can only be done cost-effectively when a ship undergoes a major overhaul. This causes a time-lag of several years in the implementation of cost-effective measures.

If we could accurately represent all the above data/method modifications in a model and still show existence of apparent cost-negative options that were not being employed, we could then draw the conclusion that additional implementation barriers existed. One could then say that there is a gap between the potential reduction achievable and current state, defined as the energy efficiency gap. A barrier may be defined as a postulated mechanism that inhibits investments in technologies that are both energy efficient and economically efficient (cost-negative) (Sorrell et al., 2004). Implementation barriers can be divided into three broad categories – Economic (market barriers & market failures), Behavoiural and Organisational. The focus of this paper is on economic barriers that are inhibiting the uptake of cost-negative measures in shipping.

What remaining implementation barriers may there be?:

Access and costs of capital - Restricted access to capital markets is often considered to be an important barrier to investing in energy efficiency. That is, investments may not be profitable because companies face a high price for capital. As a result, only investments yielding an expected return that exceeds this (high) hurdle rate will be realised (Schleich & Grubber, 2008). Capital rationing is often used within firms as an allocation means for investments, leading to hurdle rates that are much higher than the cost of capital, especially for small projects (Ross, 1986). This leads to competition between projects within a company and may lead to low priority given to energy efficiency. If improving energy efficiency comes at the cost of forgoing other more cost-effective opportunities (because of capital or labour constraints or because the projects are mutually exclusive alternatives), it would be rational for the firm to give energy efficiency a low priority (CE Delft, 2009).

Principal-Agent problems - PA problems refer to the potential difficulties that arise when two parties engaged in a contract have different goals and different levels of information (IEA, 2007). One example is misplaced or split incentives which occur when the costs and benefits of energy efficiency accrue to different agents (Blumstein, 1980, Fisher & Rothkopf, 1989, Howarth & Winslow 1994). In shipping, split incentives are likely to occur due to the different types of charter (and the divided responsibility for fuel costs) existing between shipowners and charterers. For further explanation of this refer to Rehmatulla (2011). Ship owners who invest in fuel efficiency improving measures cannot, in general, recoup their investment, unless they operate their own ships or have long term agreements with charterers currently, because neither charter rates nor second hand prices of ships reflect the economic benefit of its fuel efficiency (CE Delft, 2009, 2011). Charter markets not representing fuel efficiency could be due to the variability of actual fuel use, it is risky for the ship owner to guarantee a low fuel use and hence the fuel efficiency is not reflected in the charter market (IMarEST, 2010). Similarly in time charter contracts speed may be understated and fuel consumption per day may be overstated (Veenstra & Dalen, 2008)

Information problems - Accurate information may be difficult to obtain; those who have information have strategic reasons to manipulate it in order to inflate its value. Sellers advertise and promote their goods by providing information about their own goods. Self-interest is an incentive for the provision of misinformation by sellers, and the costs of acquiring additional information may be high enough to inhibit acquisition of sufficient unbiased information to overcome well-distributed misinformation. Even when provided with information (via labeling) establishing the cost effectiveness of such purchases, is that consumers are wary and mistrustful because of past experience with advertised misinformation (Stern and Aronson 1984). EEDI and other indicators of fuel efficiency thus may not increase the transparency in the market and owners of efficient ships may not be able to command higher charter rates (CE Delft, 2011). One party may have relevant information on the costs and benefits of an energy efficiency investment, but may find this difficult to convey to the other party (Jaffe & Stavins, 1994 p805). If there were no informational problems, the parties would be able to enter into contracts to share the costs and benefits of the investment. However sometimes this may be outweighed by the transaction costs involved hence investment is likely to be forgone despite potential advantages to both parties (Sorrell et al, 2004). A solution to this would be to create a cookie cutter (CCW, 2011) approach of standardising contracts. The information created by the adoption of a new technology by a given firm also has the characteristics of a public good. To the extent that this information is known by competitors, the risk associated with the subsequent adoption of this same technology may be reduced, yet the value inherent in this reduced risk cannot be captured by its creator (Golove & Eto, 1996)

Behavioural barriers for example:
Bounded rationality - Instead of being based on perfect information, decisions are made by rule of thumb Stern & Aronson, 1984.
Inertia In short, inertia means that individuals and organizations are, in part, creatures of habit and established routines, which may make it difficult to create changes to such behaviours and habits. This is stated as an explanatory variable to the "gap". People work to reduce uncertainty and change in their environments, and avoid or ignore problems (Stern and Aronson, 1984).
Values Values such as helping others, concern for the environment and a moral commitment to use energy more efficiently are influencing individuals and groups of individuals to adopt energy efficiency measures. Thollander et al (2010)
Credibility and trust Another factor that may inhibit adoption is the receiver's perceived credibility of and trust in the information provider. Energy users cannot always easily gain accurate information about the ultimate comparative cost of different investment options; they will rely on the most credible available information. Thollander et al (2010)

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