Investigating the energy efficiency gap in shipping

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1 Introduction

The term 'energy efficiency gap' refers to the difference between the actual lower levels of implementation of energy efficiency measures and the higher level that would appear to be cost-beneficial or cost-effective from the consumers or firms point of view based on techno-economic analysis (Brown 2001). The gap can be attributed modelling artefacts (e.g. input assumptions), rational behaviour by actors (e.g. cost of capital) and existence of market failures (e.g. split incentives) that are not adequately captured in the modelling. A thorough analysis of the market barriers and failures can be found in Rehmatulla (2014) and Rehmatulla & Smith (2015a).

1.1 Objective

The objective of this research is to create a detailed picture of the implementation of energy efficiency technologies in maritime transport and then compare this data with implementation suggested in the GloTraM model, a bottom-up model for estimating the CO_2 emissions trajectories of the shipping industry.

2 Data/Methodology

To observe the current level of implementation a survey of 275 shipping companies with a fleet of around 6000 ships. The results of the extensive survey are compared with modelled implementation under the BAU scenario, in GloTraM.

2.1 Survey

The research uses data gathered from a cross-sectional online survey of shipping companies (owner-operators, operators, management companies and long term time charterers) deployed using the Tailored Design Method (Dillman 2009). The survey uses a census approach for large firms (50+ ships) (due to their limited number) and stratified sampling approach for the rest of the firms using the Clarksons Shipping Information Network database, stratified according to region, sector and size. The survey received 275 responses in total representing almost 20% of the wetbulk, drybulk and container fleet (approximately 5,500 ships out of 28,000 ships according to Third IMO GHG Study). Further details on the sampling methods and responses can be found in Rehmatulla & Calleya (2016).

2.2 GloTraM

The model applies time-domain simulation to calculate evolution the global fleet (Rehmatulla & Smith In Press). A more complete description of the method can be found in (Smith, O'Keefe & Haji 2013) and the derivation of the model's baseline input data can be found in (Smith et al. 2013) and further details on technology modelling can be found in (Calleya et al. 2012). For the purpose of investigating the of take-up of different technologies, the model was run with the BAU scenario from 2010 – 2015 (to coincide with the survey data collection period). The BAU scenario parameters are shown in Table 1.The observed scenario is based on our understanding of the existing/status quo investment parameters refer to Agnolucci, Smith & Rehmatulla (2014) Rehmatulla & Smith (In Press) and Rehmatulla (2015).

Table 1: Parameters for scenario runs in GloTraM

	Cost savings pass through from operator to owner	Discount rate	Return on investment period for owner
BAU scenario	50%	10%	3 years

3 Results

Out of the 32 technologies modelled in GloTraM, the baseline business as usual (BAU) run resulted in 10 technologies being implemented in the tanker and drybulk sector. Although not presented here, there were only four measures implemented in the container sector with an implementation range of 75%-100%. The remainder 20 technologies were not implemented in any of the sectors. From anecdotal evidence (company brochures, press releases and news media), it can be noted that there may have been implementation of the measures, such as waste heat recovery, foul release hull coating and energy saving lighting.

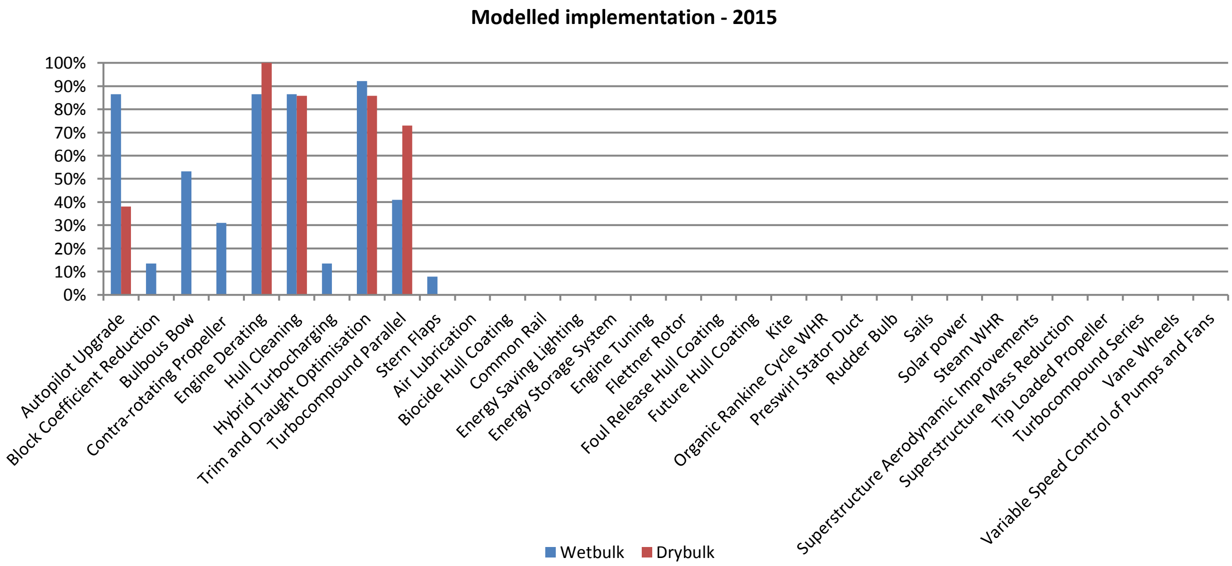

Figure 1: Modelled implementation in 2015

The survey covered almost fifty energy efficiency technologies. This section presents only a subset of the results and for some of the hydrodynamic technologies only. The results presented here show the take-up of technologies for firms that operate solely in one sector i.e. tanker, and drybulk[1]. Figure 2 shows that the take-up of five energy efficiency technologies differs by sector. On average the technologies are taken up more in the drybulk sector relative to the tanker sector, for example pre/post swirl devices was implemented between 17% to 33% of 892 tankers compared to 25% to 40% of 522 drybulk ships. Air lubrication had implementation which ranged between 1 – 5 ships of the responding companys' fleet, suggesting that the technology is still being trialed predominantly in the drybulk ships, given their higher frictional resistance due to their hull forms.

[1] Data on other sectors and mixed fleet firms is also available

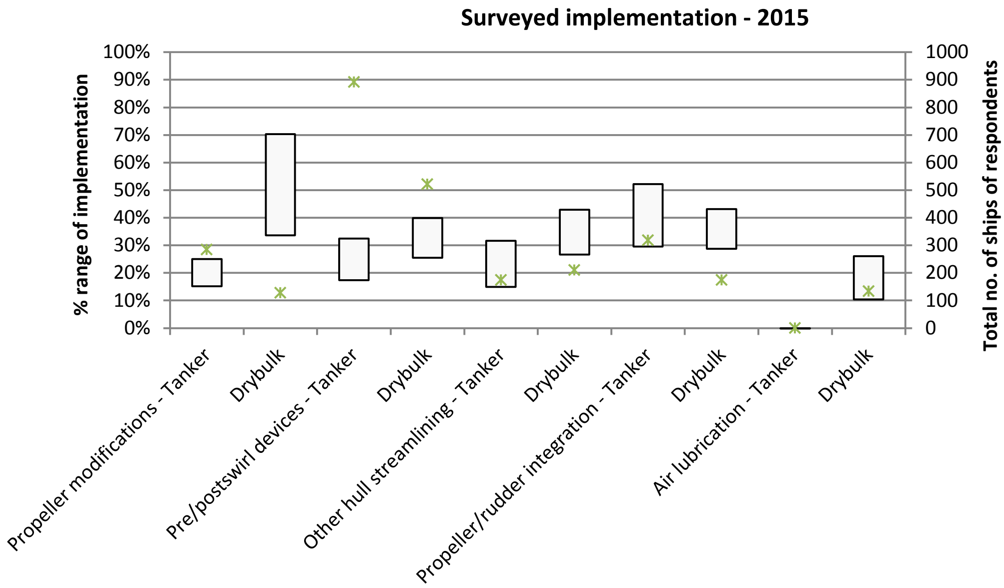

Figure 2: Implementation estimate from survey

Figure 1 and Figure 2, show there were several technologies that were suggested to be implemented in the model and the survey. Figure 3 only shows the modelled implementation and implementation indicated in the survey for two technologies for the drybulk and tanker sector. The energy efficiency gap implies that the techno-economic modelling usually over-estimates the implementation compared to that observed. Figure 3, shows an inconsistent pattern, for the bulbous bow the sample estimate (maximum of the range) is much higher compared to the modelled implementation, whereas for engine derating the survey estimate is significantly lower compared to modelled implementation.

The difference in implementation in the modelling can be due to several reasons, some of which includes the investment parameters, technology data and the underlying profit maximisation model. The survey estimates can also be different from the reality due to several reasons, some of which include response biases such as social desirability and acquiescence, and assumptions used in the analysis e.g. size of companies and it's relation to the number of ships. Currently the categorical size variable, e.g. medium (11-49 ships) is multiplied by the average of the sampling frame from Clarkson's Wolrd Fleet Register (20 ships).

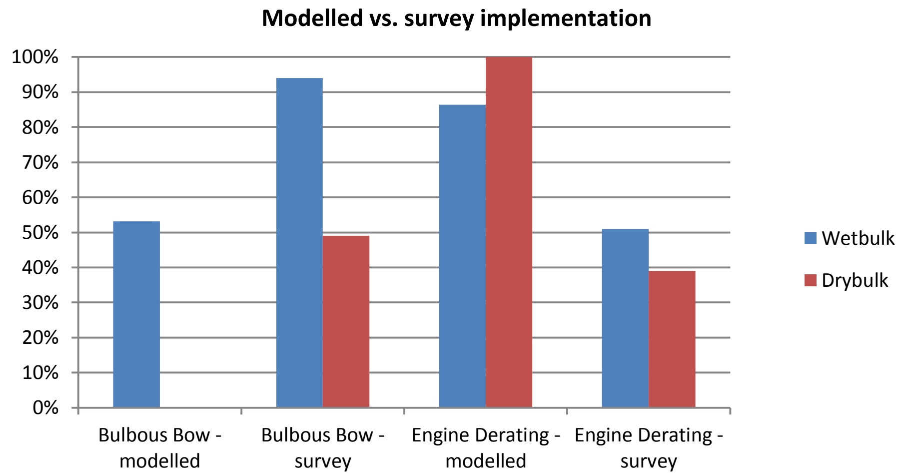

Figure 3: Comparison of modelled & survey implementation

4 Concluding remarks

The results from the survey and modelling suggest differences in the modelled and observed implementation of technical energy efficiency measures. The results also show that there are differences in the type of measures being taken up. Furthermore, for the technologies that were compared, there was an inconsistent pattern between modelled and survey indicated implementation, i.e. for one technology the model over-estimated the implementation and for another under-estimated the implementation relative to the survey. As a result there is inconclusive evidence on the existence of an energy efficiency gap in shipping.

Further work is therefore required to review investment parameters used in GloTraM to reflect the heterogeneity of the shipping sector and to extend the survey analysis to operational measures that are included in the modelling.

5 References

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