SYSTEMATIC SHIP ENERGY EFFICIENCY AUDIT AND DATA UNIFICATION

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ABSTRACT

Climate change increases awareness of the impact of shipping on the emission of pollutants. Operating ships in an energy efficient manner contributes to lowering emissions and promotes more sustainable shipping. This study proposes a methodology that will allow an energy audit to be carried out in a systematic manner throughout the vessel. The data collected will be unified under a common hub for processing in order to generate useful information on-board and will allow further analysis for improvement of fleet management on shore. This systematic process is introduced and outlined here, and includes ship survey, data collection, data processing and data analysis. The aim of this study is to understand the energy flow architecture breakdown, the method used to gather data from sensors and transformation of the collected data into useful knowledge. This method is being tested on-board the Newcastle University research vessel, RV Princess Royal.

Keywords: *Energy efficient ships, systematic data handling, energy flow architecture*

INTRODUCTION

There is an urgent need to understand and operate ships efficiently to motivate a lower level of greenhouse gas emissions. Existing methods have been applied mainly on larger vessels, however, there are many ships operating nearer to shore that could have a more immediate effect on local communities. A systematic rationale for assessing energy flow across the entire vessel operation is carried out to understand the links between energy consumption and different modes of operation. This method is generic and can be applied to a broad range of vessels. In this paper, systematic energy efficiency management steps are presented. This approach will allow decisions to be made on operational strategies to manage energy efficiently.

METHODOLOGY

The holistic energy efficiency methodology is made up of four steps as illustrated in *Figure 1*. The first step is a vessel survey to understand the overall energy architecture breakdown on the vessel. The second step is the data collection from all sensors, which are unified under one common hub. This step is illustrated further in *Figure 2* and *3*. The first and second steps are the raw data collected for data processing in the third step. Data processing can be accomplished using mathematical relations to transform the raw data into useful information that could be presented on-board as well as sent to an on-shore management centre for further analysis. The final step is data analysis, where analytical statistics can be used to interpret the trends of the data where rational decision making for improved energy efficiency can be carried out. This data will allow ship owners and operators to monitor and manage energy usage across their fleet.

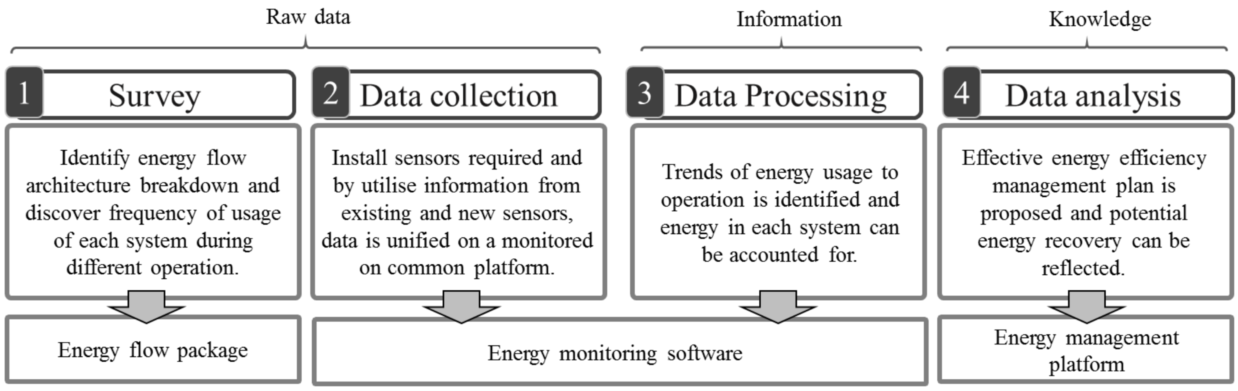

Figure 1. Systematic efficient ship energy audit

Figure 2 further illustrates the timeline from vessel selection to data monitoring. When a candidate vessel for auditing is identified, preparations are made prior to a vessel survey to understand system layouts and the operations of the vessel. An energy flow architecture breakdown is generated to show the flow of energy from the source, how the energy is converted, stored, and consumed on-board. An example of this is shown in *Figure 4a*.

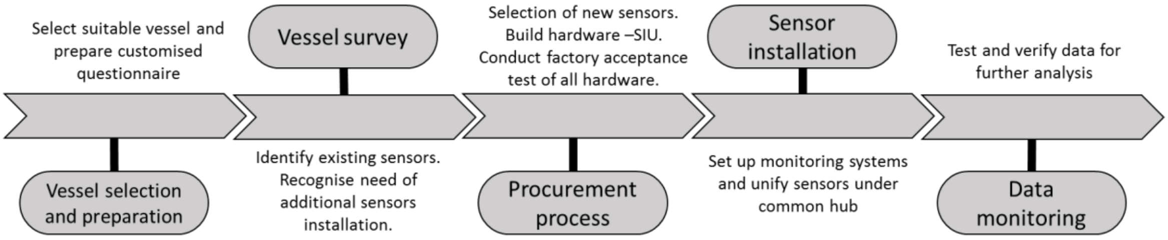

Figure 2. Timeline to acquire data from sensors on vessels

During the vessel survey, systems and a list of existing sensors are identified. The knowledge from the survey will lead to identification of the need for additional sensors and their installation requirements. An example of systematic steps and the requirement for monitoring the fuel consumption and the main engine power is shown in *Figure 3*, which illustrates the essential parameters, appropriate sensors and hardware that are needed for monitoring. The essential parameters such as the mass flow rate and temperature at the fuel supply and return pipeline are measured to monitor fuel consumption. This can be carried out using flow meters and resistance temperature detectors. The essential parameters needed to quantify the main engine power are the shaft torque and the shaft speed, which can be measured using a strain gauge sensor or an optical sensor.

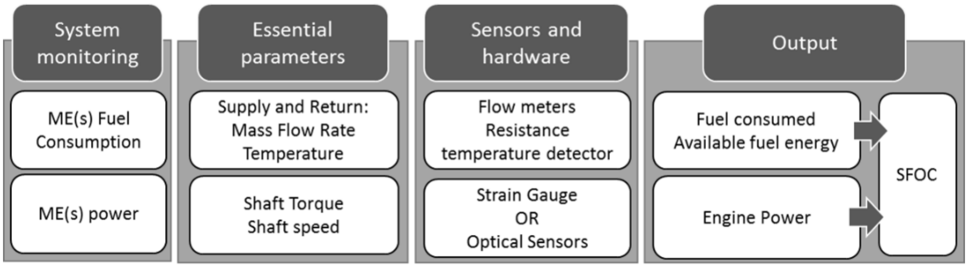

Figure 3. Examples of system monitoring and essential parameters to be collected

RESULTS

Energy architecture breakdown of the RV Princess Royal was generated by processing the system drawings of the vessel. The energy flow diagram shows the energy source, energy conversion and storage and finally energy use and distribution throughout the entire vessel. Through the data collection and processing steps, a Sankey Diagram can be used to demonstrate the energy flow which is shown in *Figure 4b*, when the vessel is travelling at 13 knots.

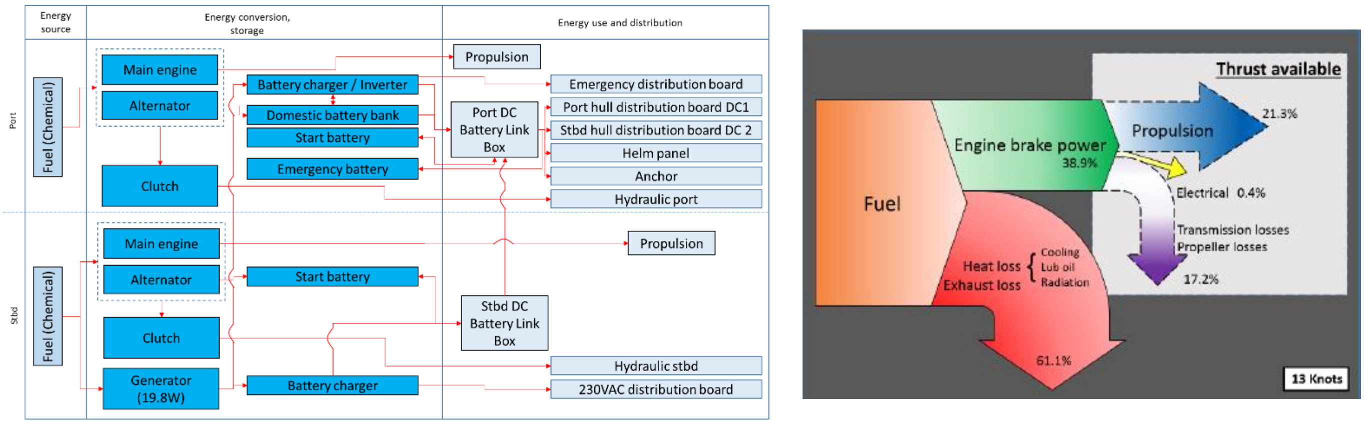

Figure 4. (a) Energy architecture breakdown. (b) Sankey diagram of energy flow

CONCLUSIONS AND FUTURE PLANS

Unification and understanding of large quantities of data is important to improve vessel operation efficiency. The next steps are to test the common hub to allow automatic fault detection to improve safety and asset management. The ultimate goal of the research is to create a platform to facilitate holistic vessel energy management. This methodology allows the transformation of vast quantities of collected data into useful information and knowledge that can feed into a culture of better operation and design of vessels.

**This work was conducted within the *Whole Vessel Energy Management* Project, funded by *Innovate UK* (project reference 102431)