The underlying idea of the REFRESH[1] was to identify retrofitting solutions considering mutual interaction of integrated shipboard systems and functions or services. The concept of integration of multiple solutions constituted the central concept and the driving force of the project. Obviously, the idea of assessing impact of local changes (i.e. retrofitting) on overall performance had not been new but REFRESH aimed at bringing the concept into a new level. The goal was to move beyond simple integration of physical components into energy models.

The work carried out within the first half of the project resulted in developing a versatile computational platform. The software brings together the rapid modelling techniques (implemented earlier within the EU-funded project TARGETS) with a powerful sensitivity framework. This allows a thermo-hydraulic network (fully integrated with an electrical grid, a control layer and top-level functions, such as propulsion) to virtually reproduce any level of complexity to be assessed for energy performance as well as for system integrity. The framework identifies important interactions between components and physical parameters (e.g. heat-exchange or flow characteristics) playing dominant role in the systems' performance, hence providing a benchmark for future tasks, such as optimisation.

In REFRESH, the optimisation of energy performance was carried out for a number of systems (such as cooling system for a VLCC[2] or HVAC[3] system of a passenger ferry), but the most complete studies were undertaken for a cargo handling system of an oil tanker. These studies involved the optimisation of the system's topology as well as its sizing and operational efficiency.

One of the major difficulties in assessing energy performance of ship systems is the amount of data required for running simulations and validating results. Accuracy of numerical predictions is highly dependent on both the quality of the data and the resolution of the models. Furthermore, high-resolution models often produce large amount of data that is used as final results or just for quality control. Operational data is also necessary for validation and verification of the predictions, and all this results in a need for efficient technologies for data storage and information management. This complex task was addressed within the project by a dedicated team aiming to develop a database solution, universal enough to meet the needs of various partners and different applications. An additional requirement imposed to the development of the database was to make it compatible with advanced data-mining techniques and probabilistic modelling (Bayesian Network). For this, in REFRESH the suitability of data-intensive models in retrofitting problems was investigated in parallel to parametric modelling.

All the tools and methodologies developed or refined in the project were brought together, unveiling the required strategy for handling the whole energy modelling application process, which allows the installation on-board of a DST[4] for efficient operation based on DEM[5].

[1] 7 FP EU funded project
[2] Very Large Crude Carrier
[3] Heating, Ventilation and Air Conditioning
[4] Decision Support Tool
[5] Dynamic Energy Models
[6] Energy Saving Potentials

The tool installed on-board a RoPax ship aims to use parametric models of the ship propulsion and auxiliary plant as well as live feeds from the navigational system and ship's automation data to identify operational deficiencies in. Once the efficiency issues are properly evaluated the tool produces a list of actions and recommendations for improving energy efficiency in operation. Furthermore, the system stores the data for use in finding retrofitting solutions for the efficiency failings originating in suboptimal performance of the systems' components.

The above description would not be complete without mentioning major difficulties encountered during the project's execution. Most of these stemmed from the project's inherent over-reliance on operational data, which proved to be far too scarce and too unreliable to provide the basis for accurate assessment and generalisation of the results. Other information-related challenges were encountered while calibrating numerical models as well as during the installation of the DST (backward compatibility of data exchange interfaces within onboard automation systems). The latter issue may require paying particular attention for the regulatory framework on monitoring, reporting and verification. On the other hand, the troublesome reliance highlights the importance of numerical prediction (combined with targeted audits) and use of sensitivity analysis for (educated) decision making in retrofitting, both applied during the course of the project.