ABB's Energy Efficiency and Advisory Systems

The common nominator for all the Advisory Systems products is the significance of full scale measurements. ABB has developed algorithms using multidimensional non-linear regression model methods to measure and interpret the vessel operations. The algorithms provide much more accurate results than for example CFD calculations or towing tank tests. Most of the Advisory Systems products require a three month learning period after installation to fill in the statistical database. Using this data the solution is then commissioned and the user interface providing the decision support is turned on.

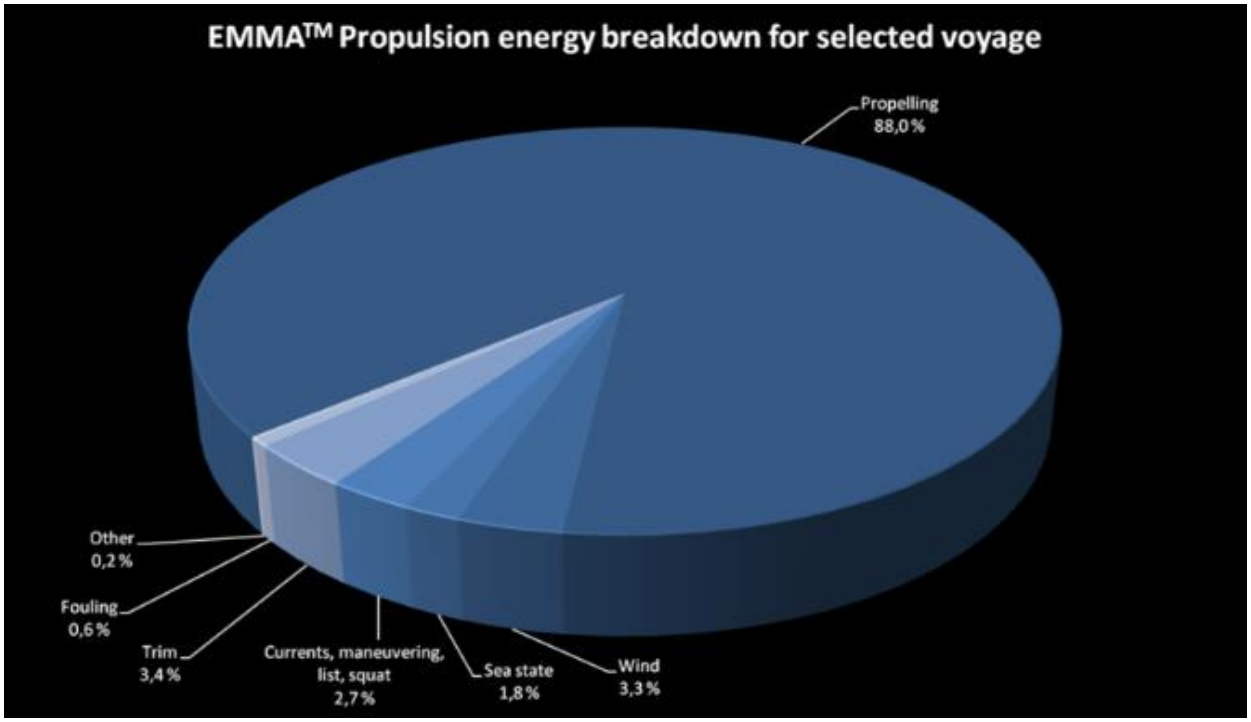

Figure 1: Propulsion energy breakdown showing exactly where the produced energy is consumed

The statistical model of the vessel provides very accurate results and moreover, perfect analysis tools for operations. For example, the propulsion energy breakdown (Figure 1) can be calculated with the dynamic trim model. From this presentation, the user can easily grasp where energy is used. The voyage view (Figure 2) shows the user an even more detailed analysis of the energy usage. In the visualized example, the vessel experienced heavy weather conditions with strong winds and higher than 10 meter waves about 30 hours after leaving the harbor. The graph shows that during these conditions, more than half of the vessel's energy was spent on fighting the forces of nature.

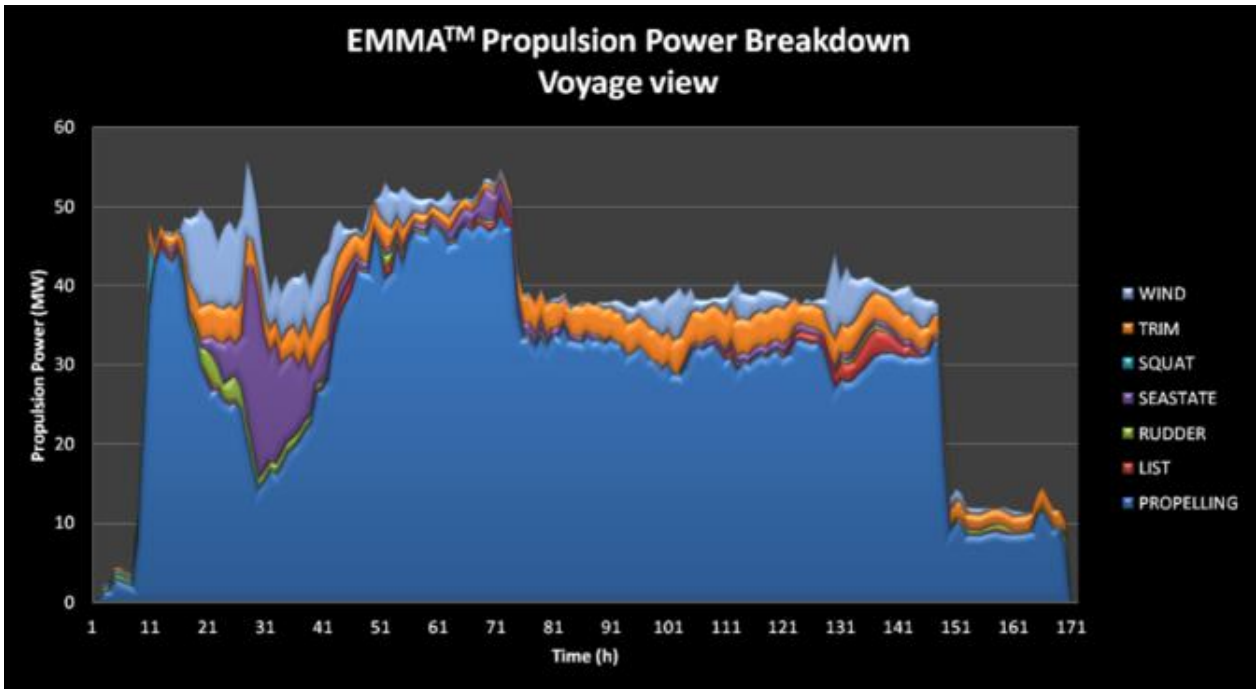

Figure 2: Propulsion energy breakdown can also be shown in function of time

User experience is one of the main design principles of ABB's Advisory Systems. The market has already seen many solutions that are too difficult to use. All the Advisory Systems modules have been designed so that they can be taken into full use with none or minimal training needs. If training is needed, it can be completed during the commissioning of the system.

Advisory Systems is a modular solution, and the correct set of modules is defined together with the customer to fully support the vessel type and operations in question. All the modules of ABB's Advisory Systems can easily be either retrofitted in operations or installed to a new building at the shipyard. Retrofitting can be done without interrupting the operations. Most of the Advisory Systems' practices and software modules can be directly documented as energy measures in SEEMP (Ship Energy Efficiency Management Plan) according to IMO definitions. ABB designs the package together with the customer and can provide the complete solution as a turnkey delivery, providing all the required design, hardware, sensors and interfaces to other vessel systems. The following chapters introduce some of these available modules for efficient and safe operations.

Monitoring tool

With the advanced monitoring tools provided by ABB's Advisory Systems, the vessel's operating crew and the shipping company's office personnel can easily follow the performance of an individual vessel or the whole fleet. The vessel's performance is monitored as a whole,

summarizing it using four different key performance indicators: cost, energy, transported goods and optimization level. Traditional monitoring systems compare the vessel's performance to fixed limits. Instead of this approach, ABB's solution utilizes an adaptive target calculation which evaluates the performance taking in account the speed, loading conditions, surrounding weather conditions and other factors affecting the vessel's performance. This provides the operating crew with more realistic targets and increases their energy awareness. All the relevant data is also transmitted to a fleet management tool to enable fleet-level follow-up and decision support.

Figure 3: EMMA uses adaptive targets to provide the operating crew with realistic goals

Trim optimization

EMMA's dynamic trim optimization is a good example of the adaptive and self-learning algorithm ABB has developed. This solution advises the operating crew on the vessel's optimum trim in all operating conditions (including variations in conditions such as speed, draft, water depth, wind and waves). Depending on the vessel type and operational profile, the savings potential can be up to 5% of propulsion energy costs. The user interface (Figure 4) follows the latest design guidelines in user experience and works intuitively without any user input or configuration.

Trim is an important part of voyage optimization and it is recommended to be used in combination with speed/RPM optimization.

Figure 4: EMMA trim optimization user interface

Fleet management

ABB's Advisory Systems offers a modern cloud-based service for fleet management. With the EMMA™ Fleet Control tool, the monitored fleet is clearly summarized and visualized and the information is easily accessible for all users via a smartphone, computer or tablet with an internet connection. With the cloud service, our customers do not need to worry about servers, security, databases or backups; ABB takes care of all this. The cloud service also enables easy extension; the Fleet Control tool can be initially taken into use with one vessel and easily scaled to cover the whole fleet.

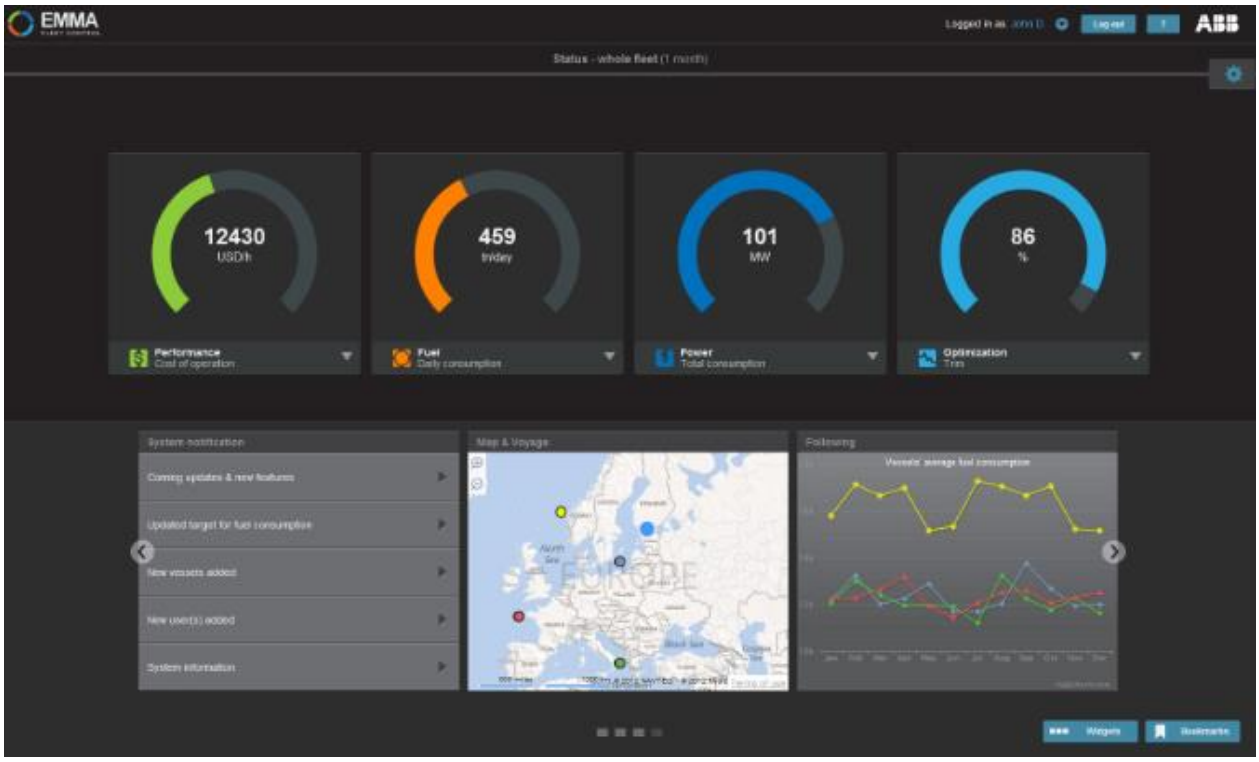

Figure 5: ABB's Fleet management tool shows a clear overview of the whole fleet

Speed optimization

A customer's study shows that, on average, fluctuations in RPM cause 4.7% losses in propulsion energy costs. Using EMMA's speed/RPM advice, the losses reduced significantly to only 1%, improving the propulsion energy consumption by 3.7%. The optimum speed/RPM profile is calculated using the intended route, required estimated time of arrival (ETA), weather forecasts and vessel characteristics. This information is then presented as a clear advice for the operating crew. The advised sailing schedule is updated whenever new forecasts are available or a new ETA is required.

Speed optimization can also be delivered together with the stabilizer fin usage advice module for relevant vessel types. With this module, even larger energy savings can be achieved by optimizing the usage of the stabilizer fins according to the vessel movements.

Hull cleaning scheduling

EMMA's advanced data model enables a so-called propulsion power breakdown of the operating vessel. This data follows every drop of used fuel oil and shows where it was

consumed (see Figure 1 for an example). However, one energy consuming item is a bit different from the others: hull fouling. Instead of varying in function of speed, loading conditions or weather, it grows in function of time. If the vessel always operates approximately in the same sea area, this growth can be assumed to be almost linear. Using this data model, ABB has developed an office-based tool (accessible through ABB's Fleet Control tool), which estimates and forecasts the hull and propeller fouling. Using the clear report available from the tool, a cleaning schedule can be justified and the return of investment easily calculated.

Motion monitoring and forecasting

Especially in heavy weather conditions, the OCTOPUS tool provides valuable support for the operating crew. Calculating any sea keeping attribute, such as rolling, slamming probability or parametric roll, OCTOPUS offers a simple user interface (Figure 6) advising the user on safe speeds, headings and operating windows. Originally developed as a tool for safe and economic navigation on board container vessels, OCTOPUS has since evolved into a complete vessel motion monitoring and forecasting system that offers advice on issues such as the vessel's DP capability, safe windows for helideck or crane operations, different offshore loading/discharging scenarios and possible speed losses due to weather.

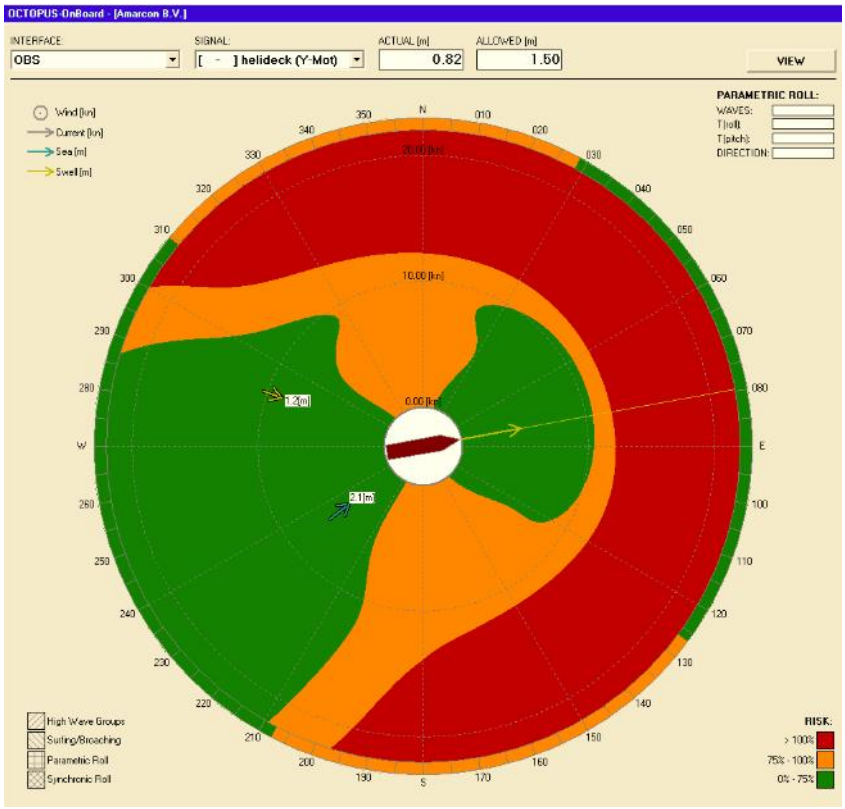

Figure 6: OCTOPUS forecasts showing the heading and speed under which an operation at sea can be safely executed

Sloshing prevention

The sloshing advisory function is an advanced extension within OCTOPUS. In case of a risk of sloshing in the LNG tanks, the system provides a warning and informs the crew on how to stay within the set limits and avoid the risk of sloshing and possible consequential damage. ABB works together with GTT on sloshing prevention. GTT specializes in designing and licensing the construction of cryogenic LNG storage tanks for the shipbuilding industry. The risk of sloshing is calculated by combining the motion measurements or forecasts from OCTOPUS with GTT's model test results for determination of the sloshing criteria. On the bridge, OCTOPUS then provides the vessel's captain with a clear view on how to operate the vessel so that the risk of sloshing is minimized.

Figure 7: OCTOPUS forecasts the risks for sloshing for each individual LNG tank onboard LNG vessels

DP capability forecasting

For vessels equipped with a Dynamic Positioning (DP) system, OCTOPUS provides the DP Capability function. This function gives offshore vessels the possibility to take maximum advantage of the safe time window for their weather-sensitive operations. The calculations are based on thruster properties, measured environmental conditions and weather forecasts, which are an integrated part of OCTOPUS. If the vessel is capable of maintaining her position and heading in changing environmental and weather conditions, a forecast can be given hours and

days ahead. This leads to maximized workability and more productive hours during operations where the DP system is used.

Power plant optimization

ABB's strong expertize in optimizing various kinds of processes in shore-based industries such as power plants, pulp factories and paper mills can also be utilized in marine industries. Especially on vessels equipped with diesel-electric and hybrid solutions, the operating crew can affect not only the vessel's energy consumption but also the way the required energy is produced.

EMMA’s power plant optimization includes a model of all the energy producers on board and capability to forecast the required load. It calculates the optimum load between the various producers, such as diesel generators, shaft motors, main engine, waste heat recovery and batteries, and clearly visualizes this information for the engineers on board the vessel (see Figure 8) enabling them to efficiently balance the load between the vessel’s producers.

Figure 8: EMMA’s power plant optimization user interface

Benefits of ABB's Advisory Systems

- A complete energy, fuel and process monitoring and benchmarking tool.
- Dynamic trim optimization for reducing energy costs.
- Optimal use of the Dynamic Positioning (DP) system with DP Capability forecasting.
- Speed/RPM optimization for making the whole voyage with minimum energy costs.
- Power plant optimization for ensuring the most economical way to produce the required power on board.
- Motion monitoring including alarms in case vessel limits are exceeded.
- Motion forecasting for preventing damages or losses to cargo.
- The Clean Hull module for reminding personnel on hull and propeller cleaning schedules.
- The sloshing forecasting system for preventing damages within LNG tanks.

Savings and payback time

As an example, a combined solution for optimizing the dynamic trim and speed/rpm can easily save up to 7% in propulsion energy costs. On a large container vessel with a capacity of 13,000 TEU, this means a payback time as short as two months. Taking into account the three-month delivery time and the data collection period of approximately three months required before trim and speed optimization is taken into use, the investment is returned in a total of eight months.

Source: ABB BU Marine and Cranes, Energy Efficiency Guide