5.5 Chiller Optimization
improving energy savings

In passenger vessels, the heating ventilation and air conditioning (HVAC) system is the second largest consumer of energy after propulsion.

It is estimated that up to 30% of the total energy consumption of a passenger ship comes from HVAC systems for cabins, public areas and galley ventilation. When the ship is berthed in the port, the HVAC system even becomes the main energy consumer. Needless to say, the HVAC system is not a negligible value and the gains with regards to energy efficiency are more than clear.

Where are the energy savings?
The total energy consumption of a HVAC system can be divided amongst the following area's:
- Chillers
- Air Handling Units and Fans
- Pumps

SOLUTION EXAMPLES

Chiller
Chilled water set-point optimization:
The solution optimizes chiller plant performance based on advanced algorithms, managing chiller plants using real-time data, weather forecasts and active learning.

Chiller energy consumption can be reduced up to 15% without affecting cooling capacity or indoor climate through the optimization of chilled water temperature set-point. A local onboard controller is interfaced to HVAC control system and chiller control panel. Client interface allows for active monitoring and control both onboard and off-shore via remote connection. Energy savings can be monitored trough a real-time online dash-board.

High efficiency chiller:
Chillers spend about 95% of their operating hours at part-load conditions. In new high efficiency chillers the compressor is coupled with a variable frequency drive (VFD); the chillers are consider-ably more efficient since the VFD allows to oper-ate at increased efficiency at part-load. Moreover, the usage of latest technology applied to flooded type shell and tube evaporator/condenser can im-prove the overall efficiency of the chiller system.

The main benefits are the following:

- Chiller energy consumption can be reduced up to 25%
- Improved efficiency, especially at part-load
- Negligible start-up current
- Accurate capacity control
- Equipment operates at lowest motor speed
- When multiple chillers are installed, a new high efficiency chiller can be used as a lead chiller to take care of the variable load and existing conventional chillers as backup operating at near full-load whenever they come on.

Air handling units and fans

Variable frequency drive on AHU fan motor:
A variable frequency drive can improve the operating efficiency of fan motors that operate 24h a day, 7 days a week. By doing so, the energy consumption of air handling unit fan motors can be reduced up to 60%. The Load profile and cooling demand of an air conditioning system are not constant, and they are subject to continuous variation depending on outdoor climate conditions, people presence and the required ambient set point.

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Up to 20% energy savings reductions in chiller energy consumption, without affecting cooling capacity or indoor climate, through the optimization of the chilled water temperature set point. Energy savings can be monitored through a real-time online dashboard.

The airflow of air handling units is designed to maximum cooling demand that is requested only during short periods, approximately 10% of yearly running time. During other periods the airflow can be reduced while maintaining the required indoor set point and ambient air quality conditions. Reducing the airflow at 80% of design value, the power consumption of fan motor is reduced by half.

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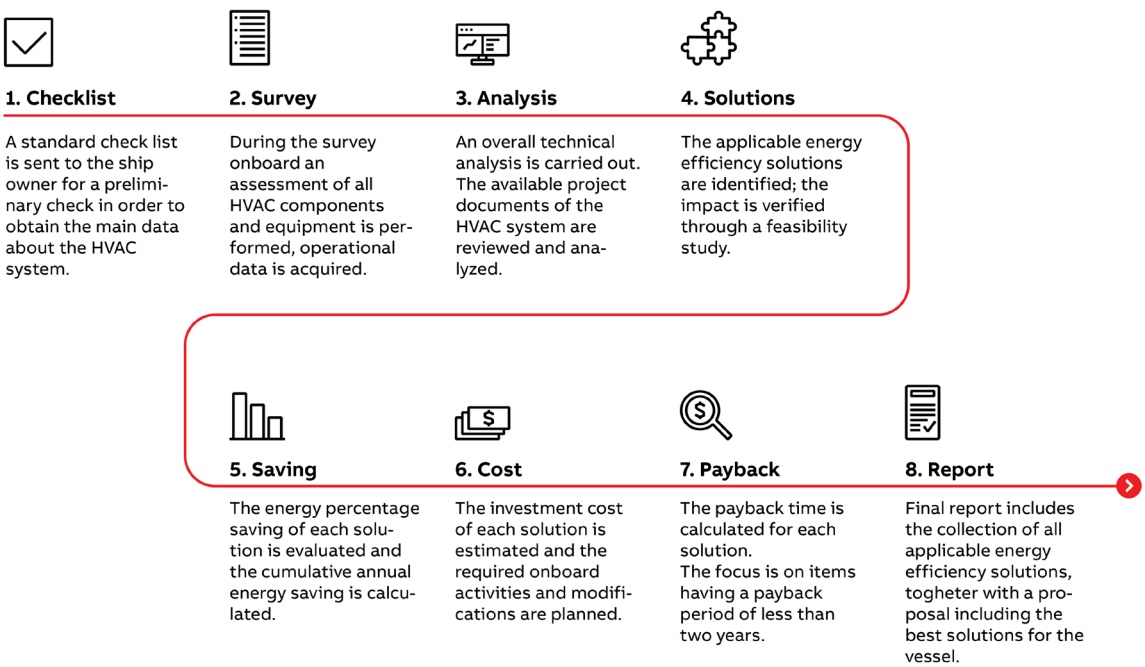
ABB 8 - step process towards more efficient chiller energy usage



Premium efficiency motor
Since a standard motor for HVAC AHU consumes its initial capital investment in electricity in approximately 2000 running hours, the total cost of ownership should be taken into account when planning an investment for a new motor. Replacement of the old standard motors with new "Premium Efficiency" IE3 motors, the Motor energy consumption can be reduced up to 5%.

The "Premium Efficiency" IE3 motors provide the following benefits:
- High availability of motors, throughout low temperature rise
- High quality, lower maintenance, longer lifetime
- Fully compatible with variable frequency drive
- Meeting the highest efficiency requirements, especially in all load points

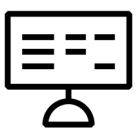
Pumps
Variable frequency drive on pump motor:
Chilled water flow and condenser seawater flow are always dimensioned according to the design point so that they can deliver the cooling demand for all the extreme conditions that the vessel may operate in. The easiest and most efficient way to reduce the power consumption in these processes is to install a variable frequency drive to control the flow of chilled water pumps and condenser seawater cooling pumps, when they operate at less than extreme conditions. A modest speed reduction can yield significant energy savings: by reducing the motor speed by 20%, the power consumption of pumps motor is reduced by 50%.

Savings for the forced ventilation system
Apart from the above mentioned solutions that are directly related to HVAC system, similar technology can be applied to the forced ventilation system. By implementing variable frequency drives, the energy consumption of ventilation fans that are used in for instance the engine room, car deck and cargo spaces can be reduced up to 60%.

Our holistic approach
The total offering from ABB's digital portfolio is the most comprehensive suite available within the maritime industry and provides seamless exchange of data, full integration of sensors, automation, and ship software and cloud solutions. Important elements within the suite are decision support software for safety and comfort and energy efficient operations, and remote diagnostics technology that preventatively and continuously monitors critical equipment onboard of a ship.

Furthermore, ABB has invested heavily in shore side expertise, analytics firepower and engineering availability to provide 24/7 support from our ABB Ability™ Collaborative Operations Centers that support troubleshooting, maintenance planning, benchmarking, and interventions based on predictive diagnostics.

Algorithms manage the chiller units unique real-time data, weather forecasts and active learning.



Onboard Controller is interfaced with the existing HVAC control system and chiller control panels. Client interface allows for active monitoing and can be controlled both onboard and ashore via remote connection.

Up to 20% energy savings reductions in chiller energy consumption, without affecting cooling capacity or indoor climate, through the optimization of the chilled water temperature set-point. Energy savings can be monitored through a real-time online dashboard.

ABB helps ferry achieve exceptional fuel savings with first chiller optimization project for marine

ABB's chiller optimization solution for passenger ships achieves over 18% energy savings on board ferry La Suprema.

ABB and Italian shipping company GNV (Grandi Navi Veloci) have completed a first-of-its-kind retrofit of a technology that optimizes the performance of chillers used for heating ventilation and air-conditioning (HVAC) systems on ferries – and the results have exceeded all expectations.

"GNV is committed to investing in modern and advanced solutions to renew on-board systems and to improve the energy performance and consumption of our fleet," said Mr. Antonio Campagnuolo, GNV Marine Operations Director. "Working together with ABB helps to achieve our goal of providing an efficient and safe transport service through important investments in energy-saving solutions of our fleet".

Energy efficiency initiatives for ship operations generally focus on main propulsion, but ABB's chiller optimization targets the substantial hotel load required for a HVAC system on board passenger ships.

Based on a target set for chiller optimization to save 10% of the energy used by chillers, pilot results cut consumption of power on board the ferry La Suprema by 18%. The results suggest that the owner will save 70 MWh of power every month.

Actual energy consumption was depicted in real-time via an online dashboard. The results from the optimization solution consistently showed direct energy savings.

The technology draws on active monitoring on board and data processing ashore through a remote connection and only requires a local on-board controller to interface with the chiller control. Based on algorithms generated from real-time data, such as weather forecasts, active learning and 250 HVAC system variables, chiller energy use can be cut significantly without compromising on cooling capacity or indoor climate. All data analysis and energy saving calculations have been verified by an independent analyst Into Trend.

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GNV (Grande Navi Veloci) ship La Suprema