

Case Study for Energy Management on a Commercial Vessel

Energy audits provide an assessment of energy usage aboard ship. Alaris uses a systematic approach to measure how much energy is consumed, how much of the energy produced useful work, with the remainder being losses. The goal is to continue the useful work while eliminating or reducing losses from inefficient equipment and operating practices. Part of a shipboard energy audit includes measuring each electrical consumer for energy consumed, then determining how much of the energy is lost to heat, magnetic losses, etc. It is important to understand how often and for what duration the equipment is operated. The total vessel load and generator load point determines the cost of electricity aboard, which varies as the vessel transitions from in port to at sea operations and operates in different climates. The vessel baseline and load profile for each piece of equipment is used to build an energy model in our program EQUATE.

EQUATE allows like equipment, such as motors, HVAC equipment, and lighting to be analyzed as a group for performance and consideration for improvements known as energy conservation measures, or ECMs. Using the load profile, equipment that is run more often will provide increased benefit from the application of an ECM than one that is less used. Upgrading the least efficient equipment can offer the greatest return on investment and quickest payback. The program produces a cost benefit analysis for each ECM based on energy consumption, efficiency improvements, maintenance costs and other user defined variables, along with customer dictated escalation rates, desired payback period, etc., based on the determined cost of electricity measured during the audit.

Alaris performed an energy audit on a commercial cargo vessel. Each electrical circuit was measured in order to establish an energy baseline and for efficiency analysis. Figure 1 displays the percentage of energy consumed by each type of analyzed equipment. To obtain the greatest savings, we look to the largest consumers for efficiency improvements, in this case the motors.

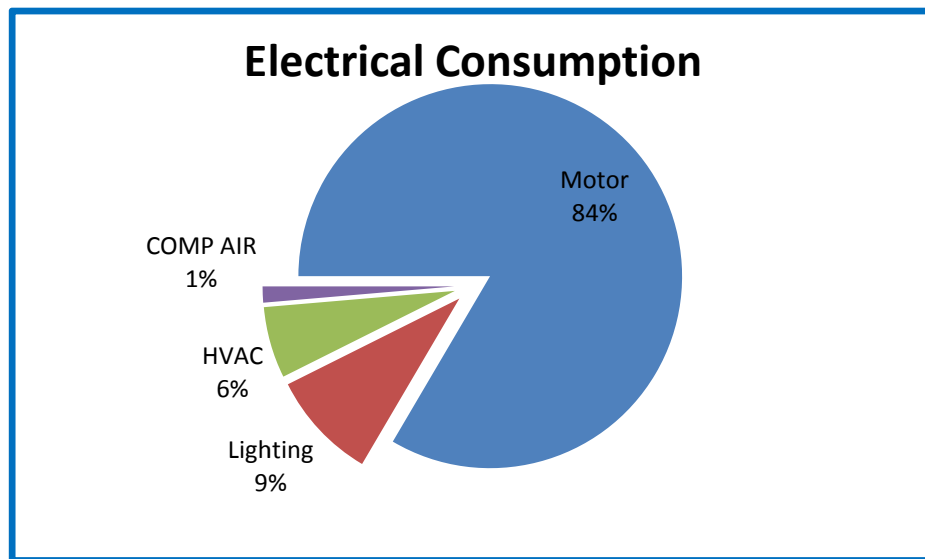


Figure 1 Energy Consumption by Equipment Type as a Percentage of the Total Electrical Consumption of the Subject Vessel

There are 121 motors aboard the vessel, used to drive pumps, fans, fuel and lube oil purifiers, and other equipment necessary to operate a ship. The motors were generally standard efficiency motors

manufactured prior to 2005. Advances in motor construction have improved the efficiency of new motor operation since the original motors were constructed.

Consider the Central Sea Water Cooling Pump Motor, which is always in operation, 8760 hours per year. The 75 kW motor was found to be operating at 79% load, or 60 kW while at sea. The sea water cooling required while not underway is significantly less. The same volume of water is always pumped, with an average of 50% diversion directly back over the side. The motor efficiency at that load was 94%. A newly constructed premium efficient motor of the same frame has an efficiency of 95.4%. Using EQUATE, the program considers options for improvement. Should this working motor be replaced with a premium efficient motor now? If the motor fails, should the motor be rewound, should a standard efficiency motor be procured, or is a premium efficient motor the most cost effective option? Would the Sea Water Cooling System benefit from a variable frequency drive (VFD) being installed on the motor?

Using the load profile entered into the energy model, a cost benefit analysis is performed for each of the presented options. Buying and replacing a working motor has a payback period of over 16 years, which definitely excludes replacing the functioning motor. If the motor fails, the cost differential between a standard motor and a premium efficiency motor has a payback period of just over 1.4 years and 77% ROI. The cost differential for rewinding versus upgrading with a new, premium efficiency motor has a simple payback period of 4.8 years, with a 20% ROI.

The real benefit comes from upgrading the system operating profile. The addition of a variable frequency drive allows the pump motor unit to provide only the cooling water actually needed. Since the load is variable, significant savings is available. If the original motor is constructed to allow control by a VFD, the payback is estimated at less than 4 months, with a 350% ROI. Even if the motor needs to be upgraded to a premium efficiency motor, the upgrade pays back in 8 months with a 155% ROI. The alteration can save over \$30,000 per year.

Each motor is analyzed in the same manner. For the subject vessel, of the 121 motors aboard, 71 were candidates for ECMs, which based on the energy model would provide energy savings of over 520,000 kWh of electricity annually and a CO₂ emission reduction of approximately 450 MT annually.

Table 1 Summary of EQUATE Analysis Results for Motors on the Subject Vessel

Analysis of 121 Motors								
Criteria	# of Motors	Capital Cost (\$)	Annual Savings (\$)	Payback Period (YR)	ROI (%)	10 year NPV (\$)	CO ₂ REDUCTION (MT)	POWER REDUCTION (kWh)
Replace Running	18	(27,661)	11,464	2.4	45%	97,988	13.0	46,393
Upgrade Failed	48	(17,090)	13,701	1.2	85%	133,082	78.5	85,492
Upgrade and Install VFD	5	(45,100)	92,571	0.5	210%	969,520	358.0	389,755
Total	71	(89,851)	117,736	0.8	136%	1,200,589	449.5	521,641

Each fuel consumer and electricity consumer on the vessel is analyzed in a similar manner to establish a baseline to measure improvement against. A holistic analysis is performed to determine if proven ECMs are available and cost effective. The EQUATE energy model allows interdependent analysis of the effects for implementing ECMs on the vessel. For example, the implementation of ECMs may allow single

generator operation at a preferred, efficient operating point for the engine, vice two generators in operation near 50% load, not at an optimum efficient point.

Table 2 Total Estimated Savings for Implementation of ECMs on the Subject Vessel

	\$	HFO (MT)	CO ₂ Index (gCO ₂ /TONNE- NM)	Energy Index (kWh/TONNE- NM)	Carbon Footprint (tons CO ₂ /yr)
Savings			Reduction		
Total from EM	\$229,730	520	3.4	0.0086	1,619
Propulsion Savings	\$87,805	199	1.1	0.0048	619
Auxiliaries Savings	\$67,254	152	1.4	0.0037	474
Boiler Savings	\$74,671	169	0.9	4.1210	526

The results of the energy audit for the subject vessel indicated \$229,730 in annual savings could be available if all of the recommended ECMs were implemented, along with reducing the vessel’s carbon footprint by 1,619 MT of CO₂ per year. The baseline provided at the completion of an audit allows validating improvements as ECMs are implemented on the vessel.

The energy audit is only one piece of a successful energy management plan. The IMO has released a Ship Energy Efficiency Management Plan (MEPC.1/Circ. 683, 17 August 2009) guide which outlines the basis for establishing an energy policy, determining how energy is consumed aboard, defining the baseline of energy consumption for the vessel, the mechanisms of a management system to identify areas of improvement, install the improvements or change operating procedures, validation of the savings, and reevaluation to allow further savings identification. The access to the circular is available at the Alaris website, www.AlarisCompanies.com.