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MariEMS Learning Material

This is the 29th compilation by Professor Dr Reza Ziarati on the work of the EU funded Erasmus + MariEMS' partners and material extracted from the IMO TTT Course. The material is composed from Chapter 29 of the learning material. Readers are also advised to refer to the papers on IdeaPort and IdealShip projects led by C4FF and published by MariFuture.

29. Shipping Company Energy Management

29.1 Overview

29.1.1 Introduction

Energy management includes planning and operation of corporate activities including all aspects of a company's production, transport and service aspects with the main aim of reducing the energy use. The wider objectives of energy management are resource conservation, environmental (mainly climate global warming) protection and cost savings, while ensuring the security of supply of energy. As such, energy management is closely linked to environmental management, production management, logistics and other related business functions. Within this context, energy management may be referred to as "the proactive, organized and systematic coordination of a company's (and its ships) use of energy to meet the requirements, taking into account environmental and economic objectives".

The translation of the above for a shipping company will mean planning and operation of a fleet of ships with the aim of reducing the total ships' fuel consumption or CO_2 emissions with due consideration for the company's quality delivery of services to customers (under ISO 9001), safety and environmental objectives (under ISM code and ISO 14001) and risk avert and safety of personnel (under for example OHSAS 18001). Reduced fuel consumption is part of a two prong strategy of reducing GHG emissions from shipping as well as reducing fuel cost to shipping companies; thus it is a win-win strategy for environment and business profitability.

29.1.2 Fuel (energy) Cost

In shipping, fuel management is an important part of a shipping company's activities since a significant proportion (more than 30%) of a ship's operational costs are related to fuel costs. Figure 29.1.1 (a) shows typical costs for a tanker; showing high percentage of fuel cost in the overall ship's operational costs. Figure 29.1.1(b) shows similar data for containerships but includes total cost inclusive of capital costs. Both show high percentage of fuel cost in the overall ship's operational or total costs. The numbers presented are typical and percentages are a function of the ship type, ship size, bunker fuel prices as well as mode of operation of the ships.

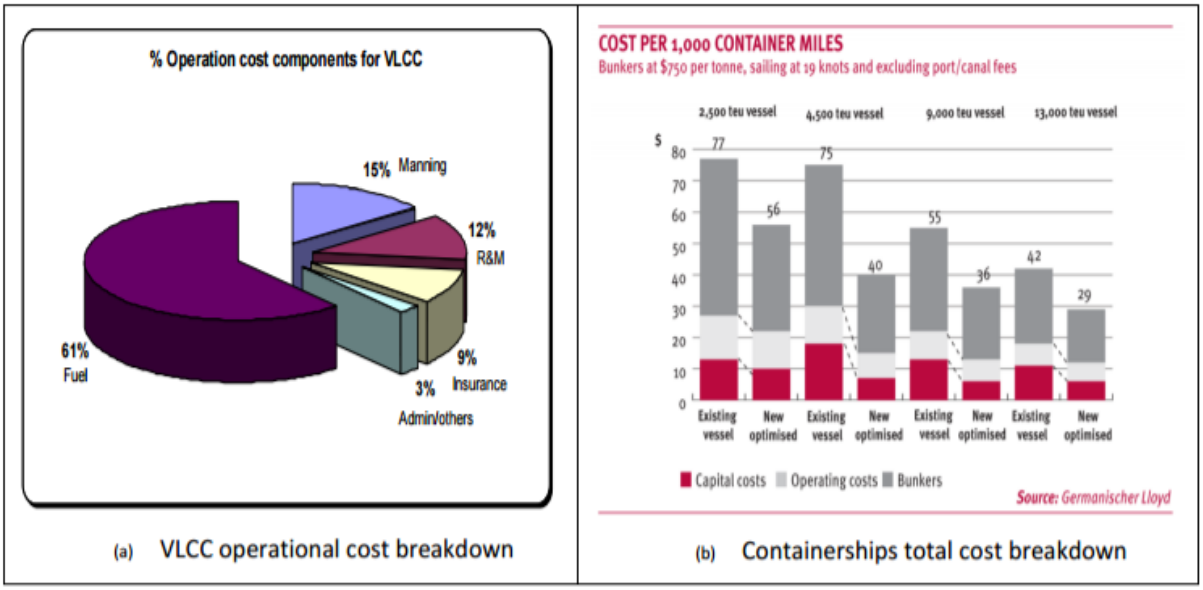

Figure 29.1.1 – Typical ship costs and fuel costs

29.1.3 Climate change

Apart from ship costs, the issue of environmental impact of shipping has been under scrutiny for a number of years. An estimate of the total emissions of exhaust gases from ships that can be attributed to international shipping was made by the IMO and indicated to be at 2.2% of global man-made GHG emissions in 2012 accordingly to IMO Third GHG Study 2014. Also, it was shown if no action takes place, the shipping GHG emissions will increase by 50% to 250% by 2050. This level of growth in shipping GHG emissions is not acceptable by the international community. Thus a way must be found to reduce shipping GHG emissions much below current day levels.

29.1.4 Scope for energy saving

The question of feasibility of reducing shipping fuel consumption has been the subject of numerous studies in the past 15 years. All studies show that on a wider scale, it is possible to significantly reduce the shipping fuel consumption and GHG emissions. Table 29.1.4.1 shows an example of such studies.

	Saving of CO_2/tonne-mile	Combined	Combined
DESIGN (New ships)			
Concept, speed and capability	2% to 50%†		
Hull and superstructure	2% to 20%		
Power and propulsion systems	5% to 15%	10% to 50%†	
Low-carbon fuels	5% to 15%*		
Renewable energy	1% to 10%		25% to 75%†
Exhaust gas CO_2 reduction	0%		
OPERATION (All ships)			
Fleet management, logistics & incentives	5% to 50%†		
Voyage optimization	1% to 10%	10% to 50%†	
Energy management	1% to 10%		

* CO_2 equivalent, based on the use of LNG.
† Reductions at this level would require reductions of operational speed.

Table 29.1.4.1 – Potential for shipping fuel consumption reduction [IMO Second GHG Study 2009]

There is a large number of operational energy efficiency measures for existing fleet that would yield the above mentioned energy savings. Examples are:

Enhanced ship's technical and operational management: Measures include:

- Enhanced weather routing.
- Optimized trim and ballasting.
- Hull and propeller cleaning.
- Better main and auxiliary engine maintenance and tuning.
- Enhanced voyage execution and performance measurement.
- Monitoring and reporting.
- Efficient operation of major electrical consumers.
- Deployment of cost effective propulsion, engines and auxiliary technology upgrades.

Enhanced logistics and fleet planning: Measures include:

- Combining cargoes, where possible, to achieve a higher utilisation rate,
- Use of combination carriers' (to reduce ballast voyages).
- Optimisation of logistic chains.
- Enhanced routing and itinerary.
- Fewer/shorter ballast legs.
- Larger cargo batches (better ship load factor).
- Just in time operation and slow steaming.
- Changes to charter-party contract formats between charterer and ship-owner to facilitate the above.

As an example of well-researched results, Table 29.1.4.1.2 shows the potential for reduction of fuel consumption and GHG emissions from existing ships (operation) based on a study commissioned by IMO; indicating that a big potential for shipping energy use reduction.

Energy Efficiency Measure	Bulk carrier		Gas tanker		Tanker		Container ship		General cargo/Reefer	
	Handymax 30-40k DWT	Capesize >100k DWT	LNG 125-155k m3	LNG >175k m3	Panamax 60-85k DWT	VLCC >200k DWT	Panamax (4-5k TEU)	NPX (12-14k TEU)	~3.5k DWT	~10k DWT
Engine tuning and monitoring	2.5	1.8	1.8	1.8	2.2	1.6	1.6	1.6	2.9	2.9
Hull condition	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Propeller condition	1.1	0.8	1.1	0.8	1.1	0.8	0.8	0.8	1.1	1.1
Reduced auxiliary power	0.6	0.9	0.7	1	0.6	1.7	0.8	1	2.6	1.1
Speed reduction (increased port efficiency)	15	15	12	10	13	12	10	11	21	13
Trim/draft	0.7	0.7	1	1.4	0.7	0.7	1.7	1.7	0.7	0.7
Voyage execution	2.5	3.4	2.5	3.4	2.5	3.4	1.4	1.4	2.5	2.5
Weather routing	0.1	1	0.1	1	0.2	1	1	0.8	0.1	1
Advanced hull coating	3	3	3	3	3	3	3	3	3	3
Propeller upgrade and aft body flow devices	3	3	3	3	3	3	3	3	3	3
SEEMP potential taking into acc. Overlaps	**28.7**	**29.6**	**25.9**	**26.0**	**26.8**	**27.7**	**24.3**	**25.2**	**36.0**	**28.4**

Table 29.1.4.1.2 – Operational energy saving potentials in % [LR and DNV]

The above energy efficiency measures and how they lead to energy saving and reduction of GHG emissions, have been explained in detail in TTT modules 3 and 4. The important point to make here is that without having a proper regulatory framework and a good management system in place, the above measures cannot be systematically and successfully implemented on existing ships. In this module, the topic of application of energy management system to a shipping company and its fleet will be discussed further in order to clarify how the above mentioned systematic approach may be pursued in a shipping company.

29.1.5 Shipping companies approach

The central aim of shipping energy management is to reduce energy costs and GHG emissions without compromising the operational and technical aspects of ships operations in particular the safety, availability and service life of the equipment and their reliable and ease of use.

The regulatory framework for shipping energy efficiency for new ships is to a large extent in place. For existing vessels, the SEEMP regulations are in place and work on "further operational measures" is underway and has progressed well so far. For existing vessels, there will be more regulations on data collection and reporting in the future.

Within the IMO guidelines on SEEMP, the shipping companies are encouraged to have a "company energy efficiency management plan" in order to do the overall fleet optimisation and management of the relevant stakeholders. Although the company energy efficiency management plan is not a mandatory requirement, a question is normally raised that how a company energy efficiency management plan should be developed, documented and implemented. In this course, it is advocated that a company is best to develop such a company-level plan under the name of a Company Energy Management System (CEnMS). Also in this course, it is advocated that the CEnMS is best to be developed using principles as described within ISO 50001.

As the requirements for SEEMP (by IMO guidelines) and CEnMS (by ISO 50001) have already been presented and discussed, the aim of this section is to deal with more detailed and practical aspect of application of SEEMP and CEnMS to a shipping company and its fleet to ensure that the company achieves what it has planned. For a shipping company to succeed, it needs to implement SEEMP effectively at ship-level and CEnMS at the company-level. The SEEMP and CEnMS should work hand in hand to manage the overall processes.

29.1.6 CEnMS and SEEMP scope of application

Although CEnMS and SEEMP may be assumed to be similar by readers, in fact they are different and will have different scope. Some complementary aspects of the two are highlighted here:

- SEEMP is only applicable to a "specific ship" and is used mainly on-board ships. CEnMS is not for a specific ship but for a "specific company". The CEnMS will be mainly implemented at shore office. Thus CEnMS will include more generic and higher-level activities than the SEEMP.

- SEEMP contents are primarily implementation oriented. This means that the strength of a SEEMP should be on how to implement the EEMs at the ship-level together with a good definition of what to be done and ship staff's roles and responsibilities. Although aspects of planning, monitoring and self-assessment are included in the SEEMP, they are not normally the responsibility of the ship-board staff to implement.

- The CEnMP on the other hand is more oriented to planning, monitoring and self-assessment of the fleet's SEEMPs effectiveness and other high level management activities relating to energy such as bunkering, provision of third party services to ships and so on. Thus it should provide company-wide and fleet-wide activities that ensure a better planning and energy management activities and a better monitoring and assessment of the results of implementation of these activities along with the external stakeholder management aspects. Along this scope of work, the following are mainly should be reflected in the CEnMS:

  - Energy planning activities for improvement of both CEnMS and SEEMPs.

  - Energy policy development for the company as a whole inclusive of ships in the fleet.

- Definition of monitoring system and relevant KPIs, baselines, data collection and data analysis systems. Establishment of a monitoring and reporting system for energy efficiency data.
- Methods for the self-evaluation (company level) of the effectiveness of various SEEMPs plus the CEnMS itself.
- Coordination and collaboration with the major external stakeholders that influence fleet's operation.

Based on the above, the scope of the CEnMS and ship-level SEEMPs will be different and they will be more complementary rather than overlapping. This is important for ensuring that the company does all elements of activities that are foreseen under IMO SEEMP and ISO 50001 in a harmonious way.

29.2 Ship-Level Energy Management Plan (SEEMP)

29.2.1 EEMs at the core of a SEEMP

In this section, ship-level energy management is discussed with specific reference to SEEMP. The methodology for the development of a SEEMP should be based on the IMO MEPC guidelines. Accordingly, the SEEMP development involves all aspects of planning including:

- Identification of current status of the ship in terms of energy use and performance.
- Target setting for energy use or energy performance of the ship (voluntary).
- Identification of EEMs (Energy Efficiency Measures).
- For each selected EEM for implementation, the following should be done:
  - Definition of implementation method,
  - Definition of monitoring method
  - Definition of assessment method
- Documentation of all the above in the SEEMP.

Under IMO SEEMP development guidelines, there is no requirement for the development of an "energy policy" and setting target for energy saving is also voluntary. Monitoring at the overall-level is advocated via use of the EEOI or another indicator but no references are made to the monitoring of individual EEMs. Additionally, it is mentioned that monitoring should be done by shore-based staff rather than ship-board personnel. Also, the SEEMP is ship-specific, thus for every ship a separate SEEMP that is compatible with ship systems, its operation pattern, etc. need to be developed.

29.2.2 Implementation of EEMs

The implementation of a SEEMP could take a variety of forms. It is argued here that each of the EEMs within a SEEMP needs to be implemented as if it is a form of a "technical and operational project". The term project is used here to emphasise that each EEM need to have a starting date and end date, it would have a budget and responsible person(s), it would have criteria for monitoring and measuring success and so on. This approach is different from those currently practiced that just provide a listing of a number of EEMs in a SEEMP and leave them to goodwill of relevant managers and personnel to implement. Development of a CEnMS could help to organise this process.

As far as a shipping company's energy management activities are concerned, the ship-board activities are mostly devoted to the implementation side. This means that various identified EEMs need to be implemented by ship staff. Planning, monitoring and self-assessment of ship-board activities are

mainly done by the head-office staff and should be the subject of significant work within the CEnMS framework.

29.2.3 Continuous improvement approach

To include continuous improvement, the energy management systems will be done in steps through a number of cycles (see Figure 29.2.3.1).

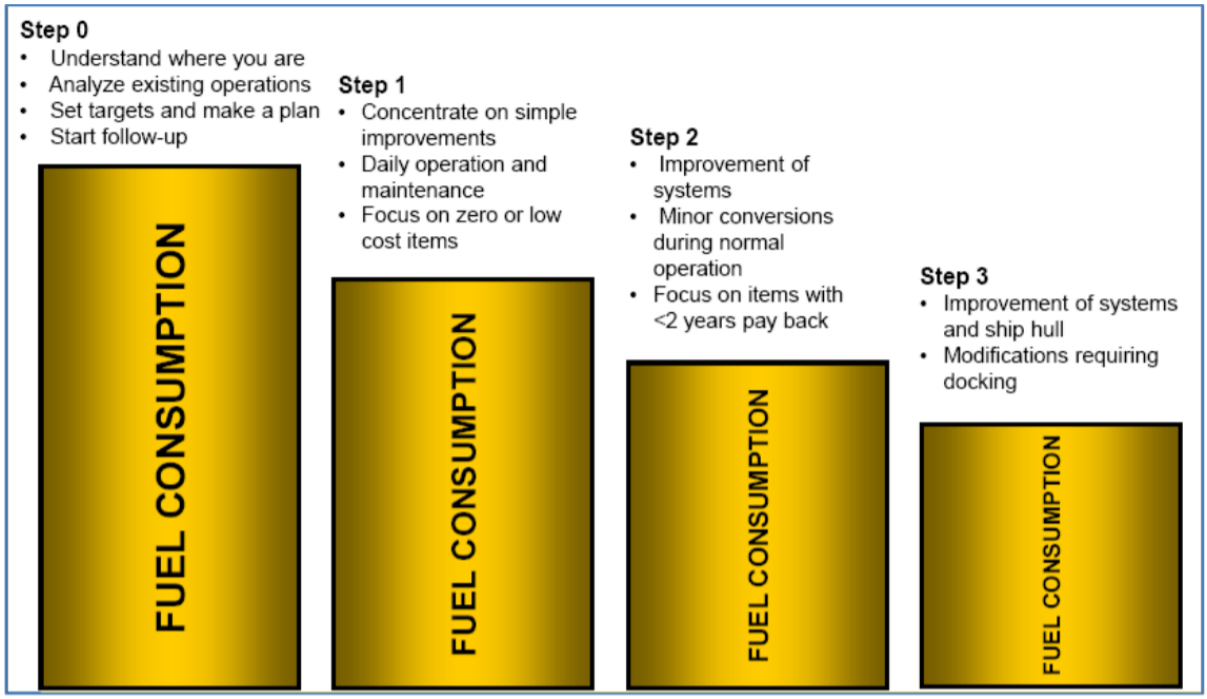

Figure 29.2.3.1 – The concept of step-by-step approach to energy management

As indicated above, typical steps could be:

- Step 0 (initial planning): Understand where the ship/company is, analyse potential for improvements and decide where the ship/company wants to save energy and start define the target and develop the energy management action plan.
- Step 1 (low cost measures): These are normally referred to EEMs that can be implemented at zero or very low cost. They are the so-called “low hanging fruits”. In this step, the concentration will be on these EEMs that may largely include aspects such as improvement to daily operations and maintenance activities. This implementation may require significant effort of cultural change on how things should be done as against how they are done now.
- Step 2 (medium cost measures): When step 1 targets are achieved, then EEMs that would involve some cost expenditure for implementation will need to be handled. These are measures that could offer a good return on investment and typically have payback periods of less than 2 years.
- Step 3 (high cost measures): These are measures that may have significant cost of implementation (e.g. technology upgrade) or commercial implications (e.g. slow steaming or itinerary changes). These measures need significantly more analysis, deliberations with stakeholders (e.g. charterers) and so on. In fact, the longer term potential for financial return for these measures may be higher compared to other measures but elements of risks are also higher.

The above step-by-step approach to the issue of energy management is compatible with continuous improvement cycle approach that is built in the SEEMP and ISO 50001. Figure 29.2.3.2 shows the

associated costs and payback related to the above three steps. As mentioned, latter steps will include measures that could be more costly as well as return on investment (payback) will not be necessarily in the short term.

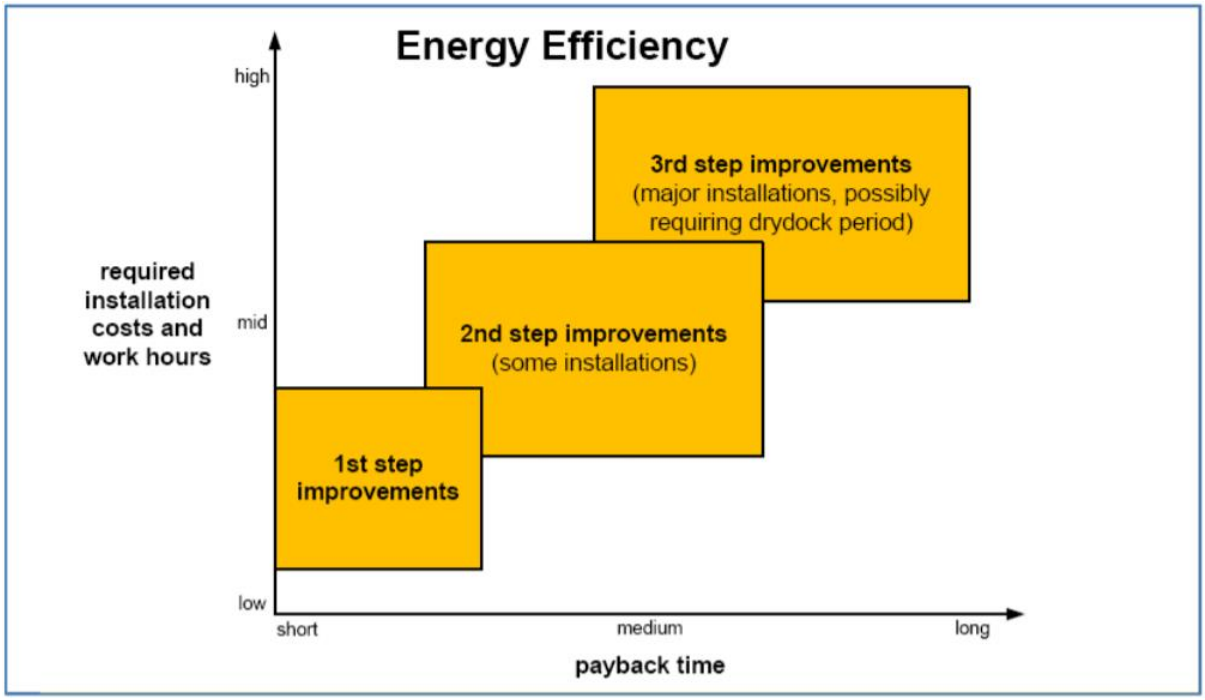

Figure 29.2.3.2 – Cost and payback for measures under step 1 to step 3

29.3 Company-Level Energy Management System

As advocated under IMO SEEMP, a company needs to have a company energy management system in order to coordinate not only the fleet SEEMPs but also provide company level coordination with external stakeholders such as charterer, shipper, shipbuilder, and other service providers. To do this, the best option will be to develop a CEnMS based on ISO 50001 principles.

The development of company-level CEnMS based on ISO 50001 would need to be defined by the company. As indicated before, the following areas need to be dealt with in a shipping company CEnMS:

- Energy policy, its communication and awareness raising on the subject.
- Monitoring system and its implementation inclusive of KPIs, baselines, data collection, data analysis and so on.
- Self-evaluation methods and how to evaluate the performance of various SEEMPs at top management level
- Training of staff at company-wide level. Increasing motivation and competence to deal with energy saving aspects.
- Reporting to external stakeholders including major clients and regulatory authorities

The above topics will be further discussed with a view to understand that a CEnMS is the home for delivery of the all the above in an integrated fashion while ship-level SEEMPs are exclusively devoted to implementation of EEMs.

29.3.1 Company Energy Policy

The company energy efficiency policy is of vital importance in determining and setting the agenda for GHG emissions and fuel cost reductions in the fleet. It must be recognised that the policy not only will

give the top-level management endorsement and support for relevant activities but also will be a significant document for communicating company values and targets, awareness raising and securing commitment by other staff. The policy would include various important aspects including for example stakeholders' management in particular the clients with whom the company intends to work most closely and effectively to achieve the objectives.

The energy policy will need to be prepared for the company as a whole. To achieve maximum reduction of GHGs, it is important that the management has a policy to improve the energy efficiency of all the ships it operates. Looking at individual ships in isolation will not reap the highest benefits. The company management should define and communicate the companies' values and aspirations in the policy and provide details of how they intend to achieve these objectives.

The content of the policy will be influenced and dictated by the company's nature of business, the types of ships, the area of operation, the trade the ships are on, the size of the fleet and overall company strategies. The list below provides some aspects that could be included in the company's energy policy:

- Commitment at the highest level: Creation of policy provides a significant signal by the company management, at the highest level, to demonstrate commitment to a GHG reduction and energy saving policy. This is very important as otherwise it will imply that top management is not taking this issue seriously. If the commitment of top management is not expressed clearly to staff, then it is very unlikely that the operational shore staff or ship's crew will take energy saving activities seriously. One of the best ways to demonstrate the companies' commitment to energy efficiency is by including this commitment in the policy statement right from the beginning.

- Company targets: The policy would need to include targets, if any, to give credibility to the policy statement. Although a policy could be developed without specific targets, it would be much more effective to have targets and monitor progress at a later stage against the target. However, targets should be easy to understand and feasible to be achieved with foreseen workforce and financial resources.

- Communication to staff: The dissemination of information to internal workforce and wider international community is important for motivation of staff and branding of the company. The communication aspects need to be included in the policy statement.

- Monitoring methods: There have to be provisions in the policy how the monitoring of achievements will be made. The company policy should clearly state how the company intends to monitors the energy efficiency activities. The company may decide to implement energy audits or other means for this purpose, it is best that these are mentioned in the policy document.

- Reporting and communication to external stakeholders: The policy document should detail how it intends to measure, monitor and report the energy efficiency activities to external bodies. The reasons/basis for sharing this information need to be mentioned to strengthen the policy statement.

- Importance of ship specific SEEMPs: The policy should also stress the importance of the ship specific SEEMPs for ship-level energy management activities and endorse management commitment to their full implementation.

- Other specific aspects: The policy is best to contain the strategic aspects for improving the utilisation of its fleet's capacity and stress the need for planning. This could include the

reduction of long ballast voyages, port times, time it takes to load or discharge or the use of shore power or weather routing services. The policy could also include the replacement of older tonnage with new more efficient ships or technology upgrade aspects that would show financial commitment to future improvements. In short, anything important from top management point of view needs to be included.

The policy document, when developed and endorsed by top management, should be available to all of the employees. The document should be written clearly and unambiguously and set achievable and understandable objectives. The content of CEnMS and SEEMPs should be compatible with the policy statement.

29.3.2 Energy review

As part of SEEMP and also CEnMS developments, energy planning and reviews or audits need to be carried out. Energy reviews can be used either as part of planning or monitoring phases of the energy management activities. For planning phase purposes, the end result of energy review or audit would be a set of recommendations on best ways of saving energy in the form of a prioritized list of Energy Efficiency Measures (EEMs).

For monitoring phase purposes, the main aim of using energy review or audit would be to check if the implementation of various EEMs or overall reduction in energy performance indicators has undergone according to plan and if any quantitative savings have been accrued. Thus, for the two purposes, two different approaches may be used but techniques used for identifying the potentials will be the same. The energy review involves a number of activities such as definition of energy baseline(s), energy performance indicators, energy objectives and targets and most of all the energy efficiency measures. The final choice of measures to be implemented will be decided by technical feasibility study as well as economic-cost-effectiveness assessment.

29.3.3 Energy efficiency monitoring and reporting

Energy efficiency performance monitoring should be done as part of SEEMPs or CEnMS for the company's internal purposes to ensure that various EEMs are properly implemented. Monitoring should be part of both SEEMPs and CEnMS with main emphasis on activities to be carried out at the head office. For monitoring of major EEMs and dealing with a large number of fleet wide EEMs, the monitoring could be more of a technical challenge and would involve provision of KPIs and their trends to identify how various ships are performing in relation to energy efficiency. In most cases, one or each set of EEMs (e.g. hull maintenance) will have its own methods and KPIs for monitoring purposes.

29.3.4 Energy efficiency training of staff

Increasing the energy efficiency awareness of the shore-based and ship-board staff by means of training can lead to a change in behaviour that has positive impacts on the reduction of ship-board energy use and fuel consumption. For effective implementation of the company's energy efficiency policy it is necessary to raise awareness and providing the necessary training both for shore based and shipboard personnel.

The company should ensure that as part of each crew member's initial on board familiarisation, they are instructed on the part that they each can play in reducing on-board ship fuel consumption. The company may also consider the implement 'Computer Based Training (CBT)' program and poster campaign to increase crew awareness of GHG emissions issues. There should be regular on board meetings with all the crew to discuss the effectiveness of the shipboard energy efficiency plan. Ideas of best practice received from the seafarers should be documented and passed back to shore so that

they can be evaluated for use on other vessels and perhaps included in a company-wide energy efficiency bulletin.

It is often a good policy for officers and in particular senior officers joining company vessels to be briefed in the shore office by the superintendent responsible for implementing the energy efficiency plan. The senior officers should be asked to study the documented energy policy, relevant SEEMP and be familiar with CEnMS, if applicable. This familiarisation should be assessed and verified prior to joining the vessels. If this is not practical for officers at operating level, then they should be required to study the policy document on board and confirm that they have read and understood it. The designated on board environmental officer may consider regular on-board awareness and training programs for shipboard personnel which could form part of the on-board Safety Management System (SMS) training program. The results of these training sessions should be reported back to shore office for information.

Company management should also provide regular updates to explain how well the company is performing and if practical provide incentives for those ships or employees that demonstrate both results and commitment to the company's energy policy and objectives. The company magazine or other publicity documents could contain regular articles on not only the company's policies and objectives but general articles of the causes and effects of GHG emissions is a global problem that requires input and efforts by all.

29.4 Summary Main Features of Company Energy Management System

A good energy management system will have the following main characteristics:

- **Corporate leadership:**
    - Management understanding and commitment via a written energy efficiency policy.
    - Allocation of resources (man-power, funding etc.) for implementation.
    - Review of energy management performance and setting targets for continuous improvement.
- **Planning aspects**:
    - A documented energy efficiency plan is in place.
    - Energy efficiency plan is linked to policy, programme and targets on energy efficiency.
    - Energy efficiency measures are fully documented and ready for implementation.
- **Human resources and training:**
    - Energy management roles and responsibilities and team are defined and operational.
    - Increasing awareness through communication and training have created the personnel's commitment and support.
    - Recognition system for energy management achievements is in place.
- **On technical and operation management**
    - This includes considering energy efficiency in ship design, purchasing of material and equipment, maintenance and ship operation.

- Accurate analysis of the energy use in all processes and equipment is in place.
- Best-practice performance monitoring for assessment of success level.
- Best-practice maintenance of equipment for energy efficiency.
- Operation profile controls and ship itinerary (activity) management are important aspects in this regard.

- **Information gathering and management**
  - Company collects and keeps history of accurate energy use and performance data.
  - Clear and effective communication procedures are in place to keep the staff and external stakeholders informed of progress.
  - A proper information management system is implemented.
- **Reviews and assessment**
  - The organisation monitors and controls the energy management system performance on a continuous basis.
  - The organisation has in place appropriate KPI's for checking the energy management performance.
  - The organisation conducts management review on a regular basis to track the achievements and identify opportunities for further improvement.

29.5 Referencing and Further Reading

The following list provides references for this section and additional publications that may be used for more in-depth study of topics covered in this section:

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