“ECO PRESSURES”
WAYS OF DEALING WITH THEM.

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Objectives

1. Present today's "environmental" challenges for shipping companies.
2. Present methods of dealing with them for enhancing company's overall "technical" performance .

Challenges of Ship Management.

The marine Industry in this decade is undergoing transformation . Besides implementing effective measures for dealing with "usual commercial challenges "

- Achieve competitiveness / add value in a tough market environment.
- Increase in operating costs.
- Limitations on Crew Resources.

The industry in one way or another, has to protect its assets by addressing "Environmental Challenges" now for tomorrow's "big decisions".

Environmental Challenges

- *Implement the BWM convention.*
- *Reduce fuel consumptions / CO2 emissions. (EEOI/ EEDI)*
- *Reduce SOx emissions. Implement caps on sulfur content of fuel oil. 0.1% in (SOx)ECA areas as from 1/1/15, 0.5% world wide from 2020.*
- *Reduce Nox emissions Tier III NOx Emission limits in (Nox)ECA areas.*
- *Recycling. (The Recycling convention Ships)*
- *Others*

"Environmental Challenges"

Reducing CO2 emissions. (IMO EEDI /EEOI.)

- Both indices have long been "debated" in the Industry. Their adequacy in defining and comparing energy efficient ships is really in question, We can continue "debating" ….
- However, I presume there is no doubt within this room that both indices are: performance indicators / drivers for improving energy efficiency.

IMO EEOI formula.(Applicable to existing / delivered ships).

$$EEOI = \frac{\sum_j FC_j \times C_{Fj}}{m_{cargo} \times D}$$

- A key performance indicator providing the CO2 level per unit of cargo distance.
- Mcargo = Mass of cargo (ton / TEU / Passenger.
- FC= actual Fuel consumption measurements.
- D = actual distance traveled over ground.

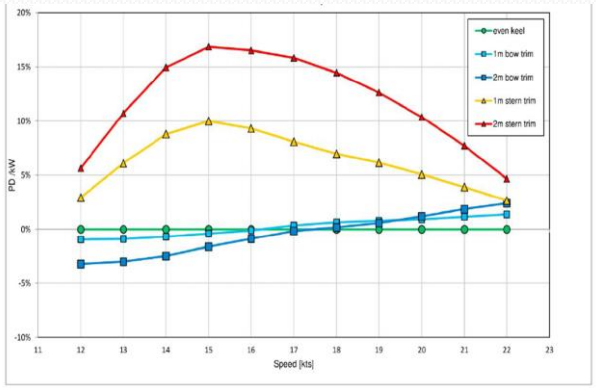
Type of fuel	Reference	Carbon content	C_F (t-CO_2/t-Fuel)
1. Diesel/Gas Oil	ISO 8217 Grades DMX through DMC	0.875	3.206000
2. Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	0.86	3.151040
3. Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	0.85	3.114400
4. Liquified Petroleum Gas (LPG)	Propane Butane	0.819 0.827	3.000000 3.030000
5. Liquified Natural Gas (LNG)		0.75	2.750000

Dealing with challenges

How to reduce EEOI :

In mathematical Terms, this can be done by reducing the nominator and or increasing the denominator.

The nominator can be reduced by implementing "operational procedures" for reducing " required power/ energy".



- Slow Steaming, Main Engine Turbo Charger Cut Out.
- Trim optimization .
- Weather routing.
- Optimization of engine efficiency /maintenance.
- Propeller polishing and hull cleaning.
- Operator awareness for saving energy and or implementation of "technical measures:

The denominator can be increased on "rolling" average by:

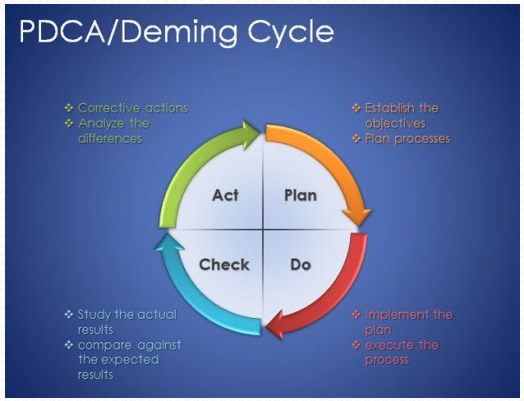
- "Minimizing" ballast voyages and or maximizing of the cargo intake.

Dealing with challenges

How to reduce EEOI? Cont.

Describing operational measures for reducing emissions may be useful, but they are not efficient without evaluating accurate and reliable data of vessel's performance.

To measure vessel's performance accurately and Implement energy efficiency measures companies need to:



- Establish reference fuel consumption. "base lines". (M/E vs speed; G/E, Boilers).
- Measure accurately and reliably fuel Consumptions speed drafts etc.
- Compare actual fuel consumptions /speed measurements against "base lines" then implement the plan /do check act cycle for improvements.

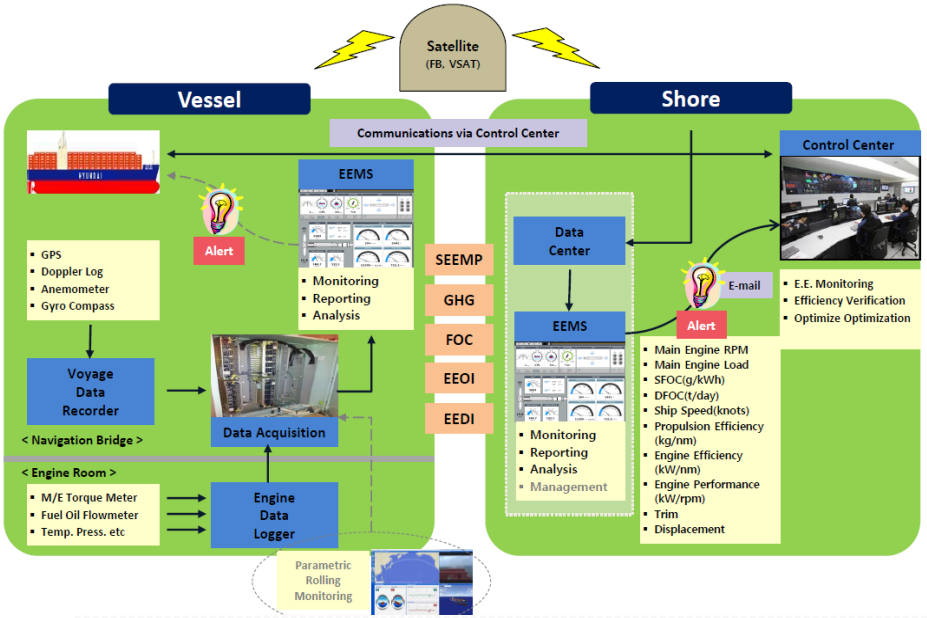
Evaluate "investment" costs and decide "Technical solutions" for improved performance.

Dealing with challenges

How to reduce EEOI? Cont.

Some "Technical solutions":

- Installing "reliable accurate" performance monitoring systems.
- Installing frequency converters / efficiency propulsion aids.
- Installing power management system,
- Installing composite exhaust gas boiler separate exhaust gas economizers for generators.
- Using high performance Anti Fouling Paints,
- Derating engine / modifying hull if worthwhile on existing vessels. etc.



ESD		PSS	Duct	Rudder Bulb	Propeller Cap Fin
Photo of the actual device installed					
Saving Effect		Up to 3 %	Up to 5 %	Up to 2 %	Up to 2 %
Applicable Ship type		All ship types	Tanker, B/C	All ship types	All ship types
Retrofit		Very difficult	Possible	Possible	Possible
Compatibility	PSS	Yes	No*	Yes	Yes
	Duct	No*	Yes	Yes	Yes
	Rudder Bulb	Yes	Yes	Yes	No*
	Propeller Cap Fin	Yes	Yes	No*	Yes

* The resultant gain from such a combination may produce higher efficiency gain than the ones expected from each member device of the combination, but, may not be so cost-effective.

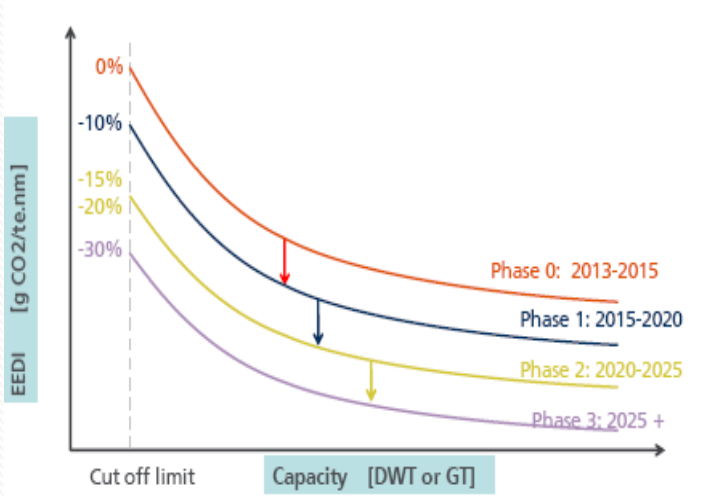
“ECO Pressure” Challenges.

EEDI.(Applicable for new buildings with construction date after 1/1/13)

- “Design” key performance indicator providing the CO2 level per unit of cargo moved per distance.

Attained EEDI ≤ Required EEDI = (1-X/100) × Reference line value

Reference line value = a × b^-c			
Ship type (as defined in MARPOL Annex VI Chapter 4, Regulation 2)	a	b	c
Bulk carrier	961.79	DWT of the ship	0.477
Gas carrier	1120.00	DWT of the ship	0.456
Tanker	1218.80	DWT of the ship	0.488
Container ship	174.22	DWT of the ship	0.201
General cargo ship	107.48	DWT of the ship	0.216
Refrigerated cargo carrier	227.01	DWT of the ship	0.244
Combination carrier	1219.00	DWT of the ship	0.488
Passenger ship	Not initially subject to reference lines. Attained EEDI still needs to be calculated.		
Ro-ro cargo ship			
Ro-ro passenger ship			



Main Engine(s) | AuX. Engine(s) | Energy Saving Technologies AuX. Engine(s) | Energy Saving Technologies Main Power)

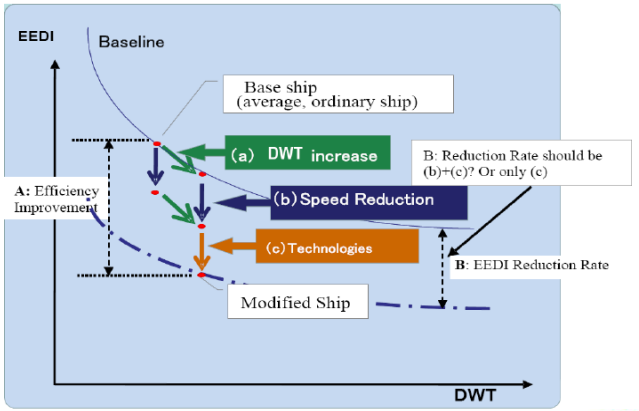
$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)}\, C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

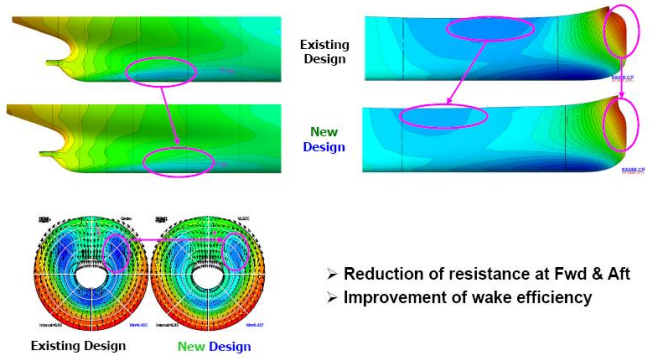
Transport Work

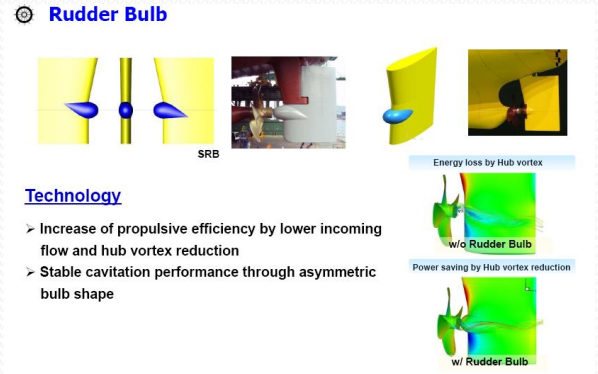
Dealing with challenges

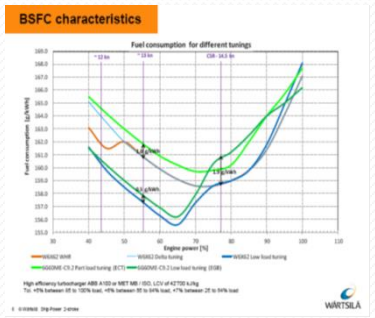
Methods for reducing EEDI: (valid for "design" condition not for the "operational profile "of the vessel).

- DWT Increase.
- Speed reduction
- Use of Advanced Technologies
  - Hydrodynamics, Hull /propeller / water flow optimization.
  - Installation of energy efficiency devices.
  - Main engine selection / Derating / Tuning
  - Installation of heat recovery systems :
  - Exhaust gas power turbine / T/G.
  - Waste fuel recovery systems etc







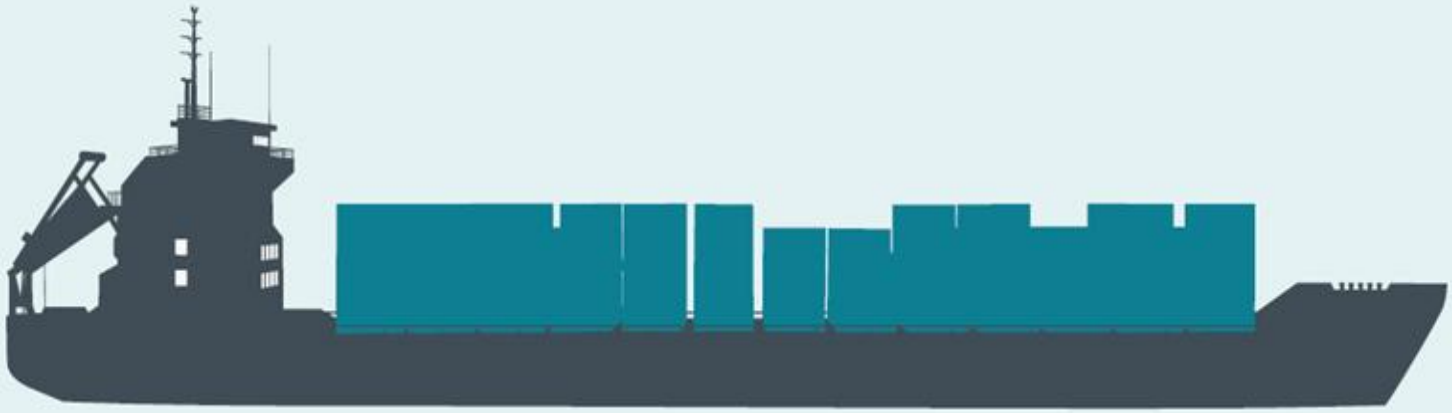


Effectiveness of energy-efficiency measures. (Expectations)

Operational
Weather routing **1-4%**
Autopilot upgrade **1-3%**
Speed reduction **10-30%**

Auxiliary power
Efficient pumps, fans **0-1%**
High efficiency lighting **0-1%**
Solar panel **0-3%**

Aerodynamics
Air lubrication **5-15%**
Wind engine **3-12%**
Kite **2-10%**



Thrust efficiency
Propeller polishing **3-8%**
Propeller upgrade **1-3%**
Prop/rudder retrofit **2-6%**

Engine efficiency
Waste heat recovery **6-8%**
Engine controls **0-1%**
Engine common rail **0-1%**
Engine speed de-rating **10-30%**

Hydrodynamics
Hull cleaning **1-10%**
Hull coating **1-5%**
Water flow optimization **1-4%**

Figure 1: *Potential fuel use and CO_2 reductions from various efficiency approaches for ships (International Council on Clean Transportation (ICCT, July 2013). Long-term potential for increased shipping efficiency through the adoption of industry-leading practices.*

Dealing with challenges

Caps on Fuel Sulfur content in force from 1/1/2015 onwards.

Existing vessels .

- Use low sulfur residual or distillate marine fuels in existing machinery,
- Install new machinery (or convert existing machinery where possible) designed to operate on an inherently low sulfur alternative fuel, such as LNG, or
- Install an exhaust gas cleaning (EGC) after-treatment system (scrubber).

For New buildings,

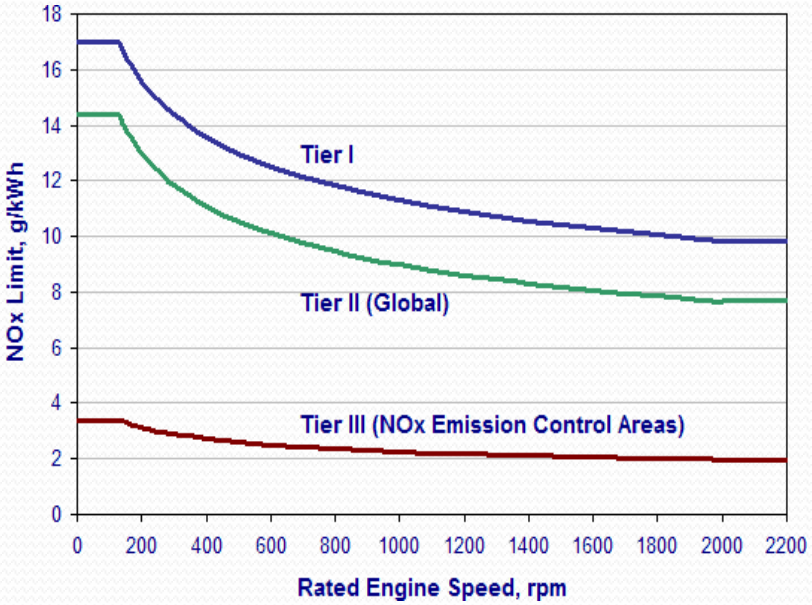
- As above or
- Prepare for such installations?

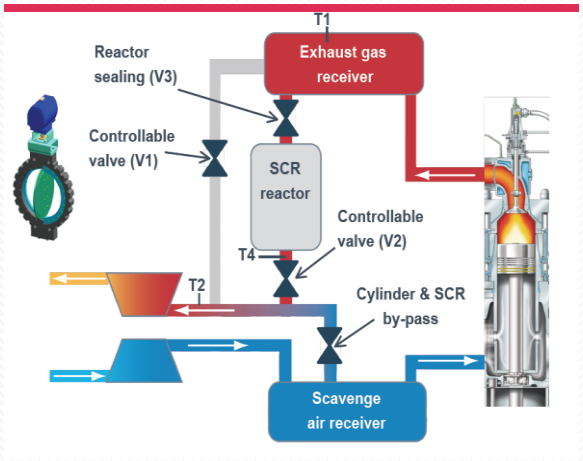
A feasibility study with life cycle cost analysis for each vessel is recommended prior to deciding best solution suitable for her operating profile.

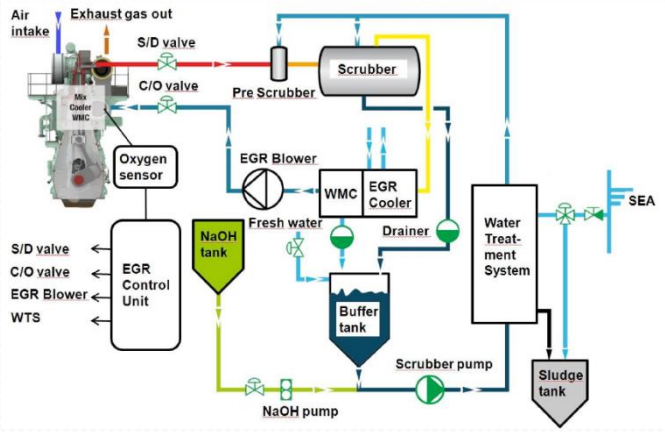
Dealing with challenges

Tier III Engines (Reducing NOx Emission limits by 90% for NOx ECA areas).

- Burning LNG. Two-stage turbocharging
- Selective catalytic reduction / Exhaust gas recirculation.







Dealing with challenges

Compliance with the BWM convention.

Various systems of different technologies are available. (Filter – electrolysis - UV, Electroclorination / Neutralization, Filter coagulation - Ozone etc. Managers will have to select what is best for the ship.

Considerations for Compliance with the BWM convention.

- **System suitability.** (Existing equipment, ballasting requirements –active substances salinity –trading pattern- approvals.)
- **Costs considerations.** (Capital outlay per vessel –initial installation costs /time - operating expenses –electrical power – maintenance costs – adverse effects- etc.
- **Lay out considerations** (space – dimensions –piping and cabling – storage in case of active substances etc.).
- **System supplier**. (experience – reliability – support availability- spare part supply etc.).

A feasibility study with life cycle cost analysis for each vessel is recommended prior to deciding the best solution.

Dealing with challenges

Besides addressing operational and or technical measures for improving the of energy efficiency of ships;

“The human factor”

“Competence” of human resources with the right attitude / dedication in fulfilling tasks effectively

as well as

the “Management of change”

both from the operations and maintenance point of view should not be neglected.

It is the good machinery and human interface that will provide the best results.