

A LIFE CYCLE APPROACH TO SHIPBUILDING AND SHIP OPERATION

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*RINA Conference : "Ship Design and Operation for
Environmental Sustainability"*

Industrial Consortium

- Project leaders :
 - An Industrial Network : **NEOPOLIA**
 - Coordinating Person : **Stirling Design International**
- Industrial Consortium of the French Marine Industry:
 - **STX France Cruise**
 - **DCNS**
 - **BUREAU VERITAS**
 - A team of 10 SME
- An expert in Life Cycle Analysis software :
 - **EVEA**



State of the Art in Environmental sustainability of Ships

- Major aspects of Ship Design:
 - Performance / Weight / Cost
 - Environmental aspects ?
- A long history of environmental progress in term of :
 - Ship systems:
 - Advanced water treatment
 - Engine emission
 - Anti-fouling, etc...
 - Industrial site (ISO 14001)
 - Dangerous goods (Green passport)
- Existing studies of the environmental impact of ships through Life Cycle Analysis:
 - Norwegian University of Science and Technology (2002) *for fishing vessels*
 - National Maritime Research Institute of Japan (2004) for 8 cargo vessels
 - *Swedish Maritime Organization (2004) : LCA SHIP Software*

A common goal : to find holistic and optimum solutions for Sustainable Ship Design (SSD)

- Study of the ship and components as a whole
- Study of the ship through the entire life cycle :
 - *Raw materials*
 - *Transport*
 - *Pre-transformation*
 - *Assembly at the yard*
 - *Ship operation*
 - *Maintenance*
 - *Dismantling*
 - *Recycling of materials*
- Study of major environmental impacts through a selection of environmental criteria

Environnemental Impacts



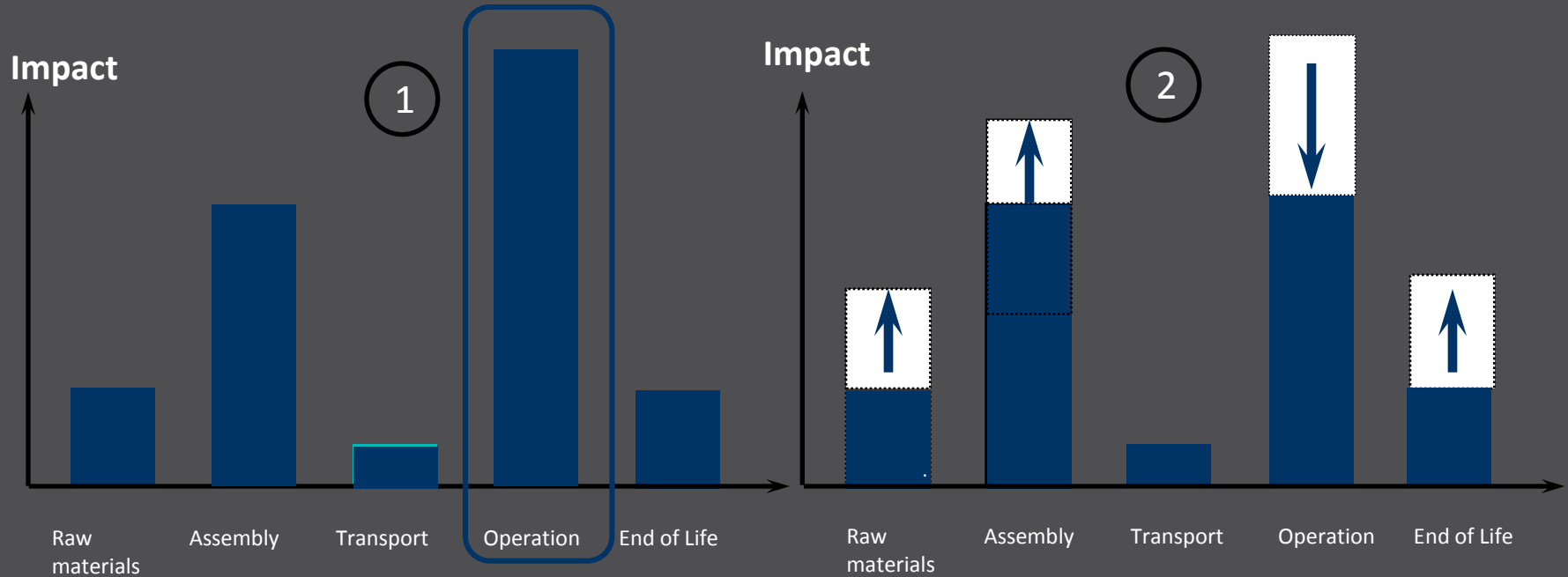
➤ Impact Indicators

- Global warming – IPCC 2007 (CO2 equivalent)
- Eutrophication (PO4 equivalent)
- Atmospheric acidification (SO2 equivalent)
- Ozone layer depletion (CFC11 equivalent)
- Human toxicity (1.4-DB equivalent)
- Fresh water aquatic eco toxicity (1.4-DB eq.)
- Marine aquatic ecotoxicity (1.4-DB eq.)
- Terrestrial ecotoxicity (1.4-DB eq.)
- Respiratory effects (PM 2.5 equivalent)
- Abiotic depletion (Antimony - Sb - equivalent)

➤ Flow Indicators

- Water (m3),
- Energy consumption (MJ eq.),
- Bulk waste production (kg)
- Hazardous waste production (kg)

Avoiding pollution transfers



Major environmental Impacts are generated during ship operation

Reduction of environmental impacts during ship operation may induce increased pollution during construction phase and end of life of the ship.

SSD Project : An innovative approach

➤ Global sharing of environmental data among a large industrial consortium

- Definition of specific materials and process of the marine industry
- Definition of a specific ship life cycle: transports / consumptions / wastes



➤ SimaPro 7.1 : The Modular and Flexible Architecture of a commercial software

- Parameterized modeling (Ship nomenclature, Operation profile, etc...)
- Interactive results analysis
- Large included database (ecoinvent).
- Updates and User support
- International recognition

Case Study I

30 meter Aluminum Passenger vessel

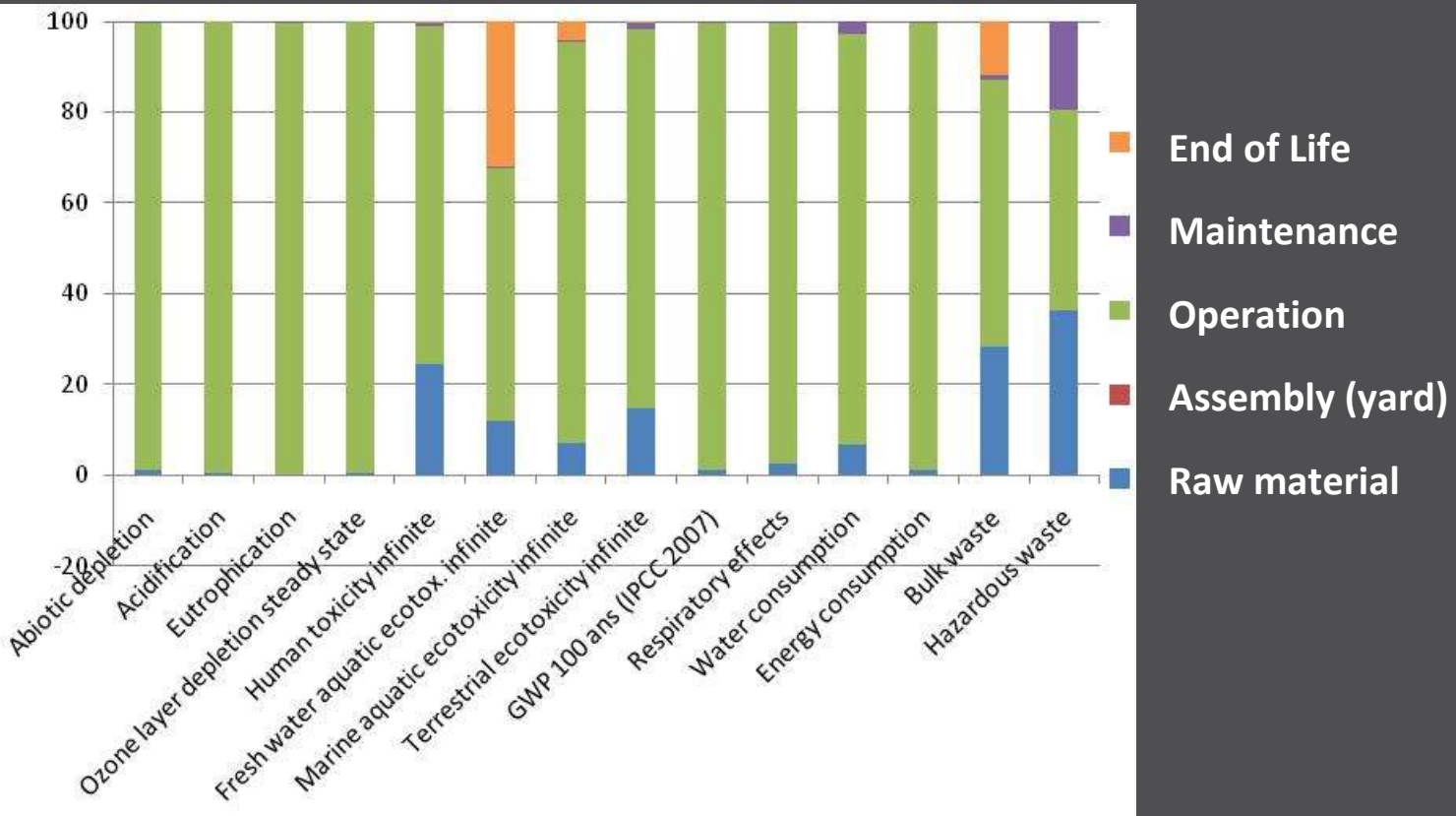
Coastal operation at a service speed of 16 knots



Style : Joel Grégoire - 2008



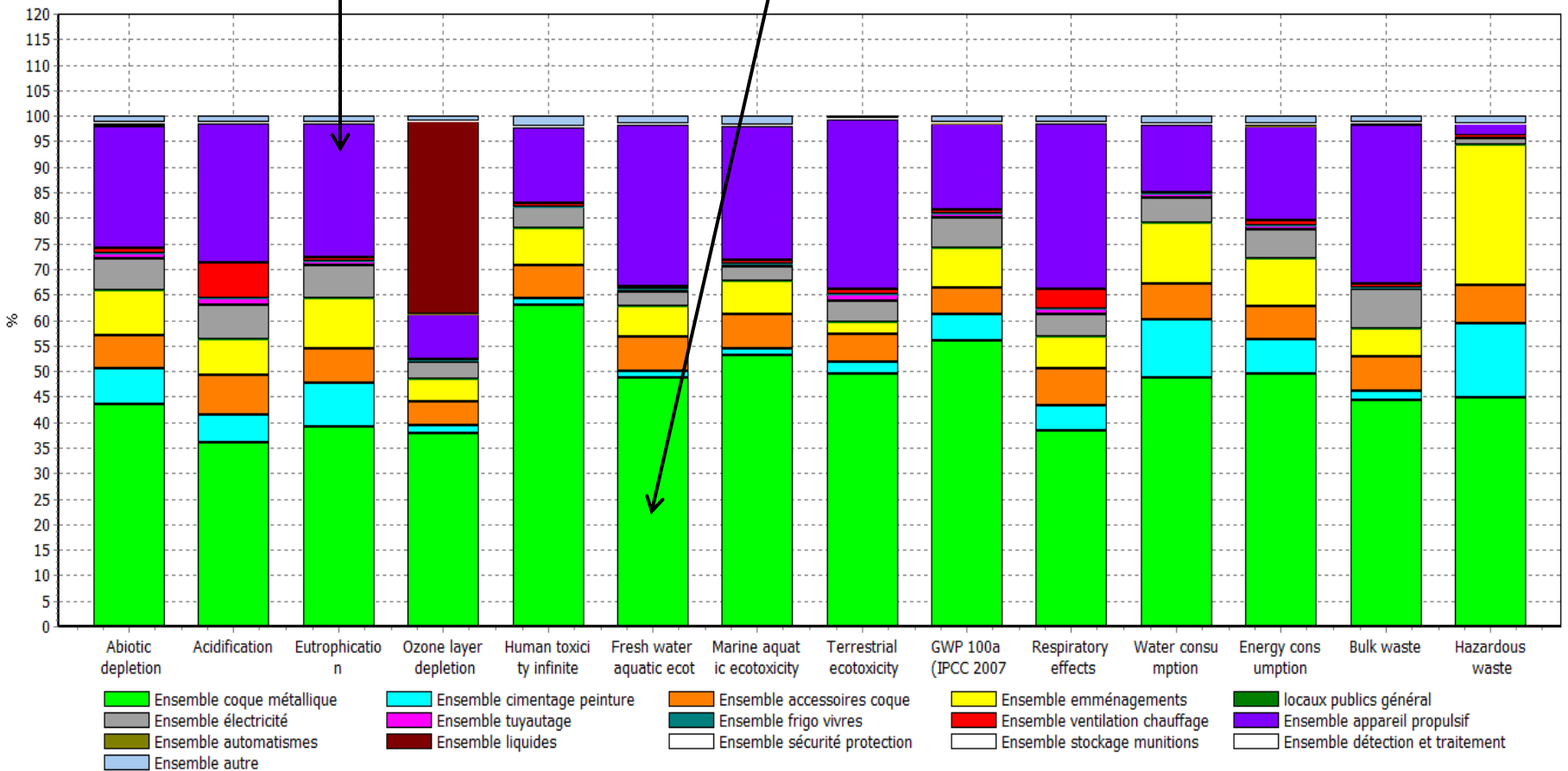
30 meter Aluminum Passenger vessel : Full Life Cycle



30 meter Aluminum Passenger vessel : Construction Phase

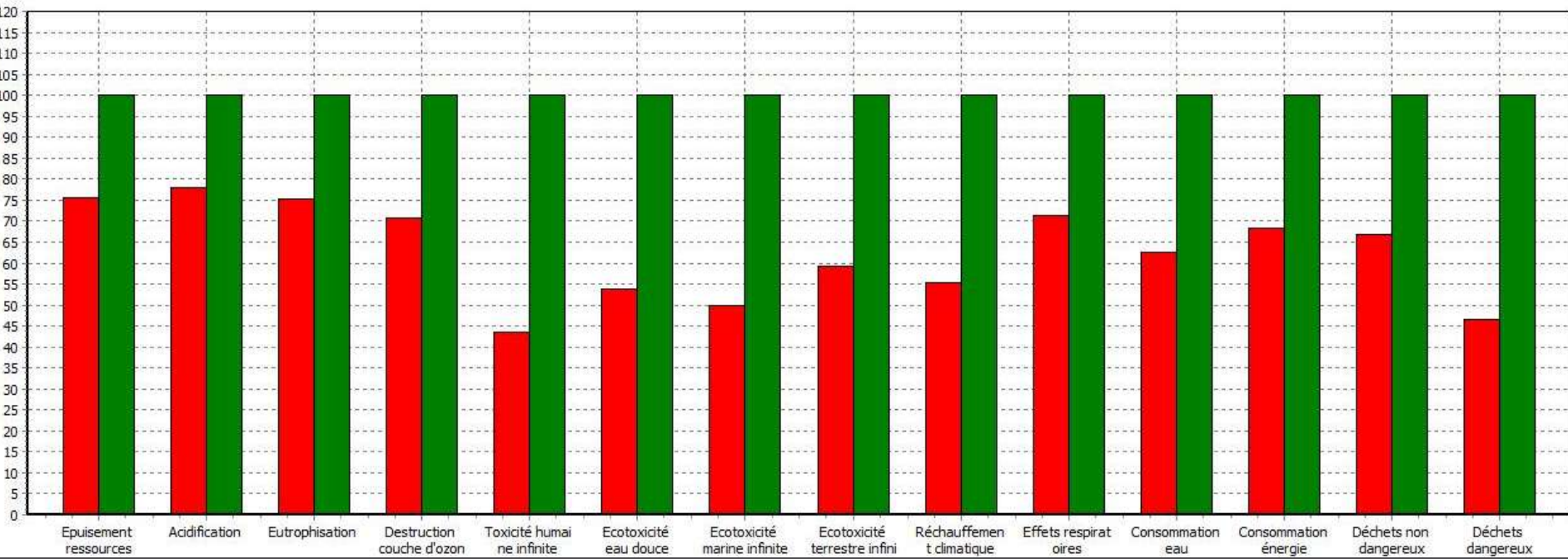
Machinery

Hull



Analyzing 1 p 'Ensemble matériaux construction'; Method: CML 2001 pour SSD V2.04 / World, 1990 / characterization

Construction Phase : Reduced impacts for Steel compared to Aluminum



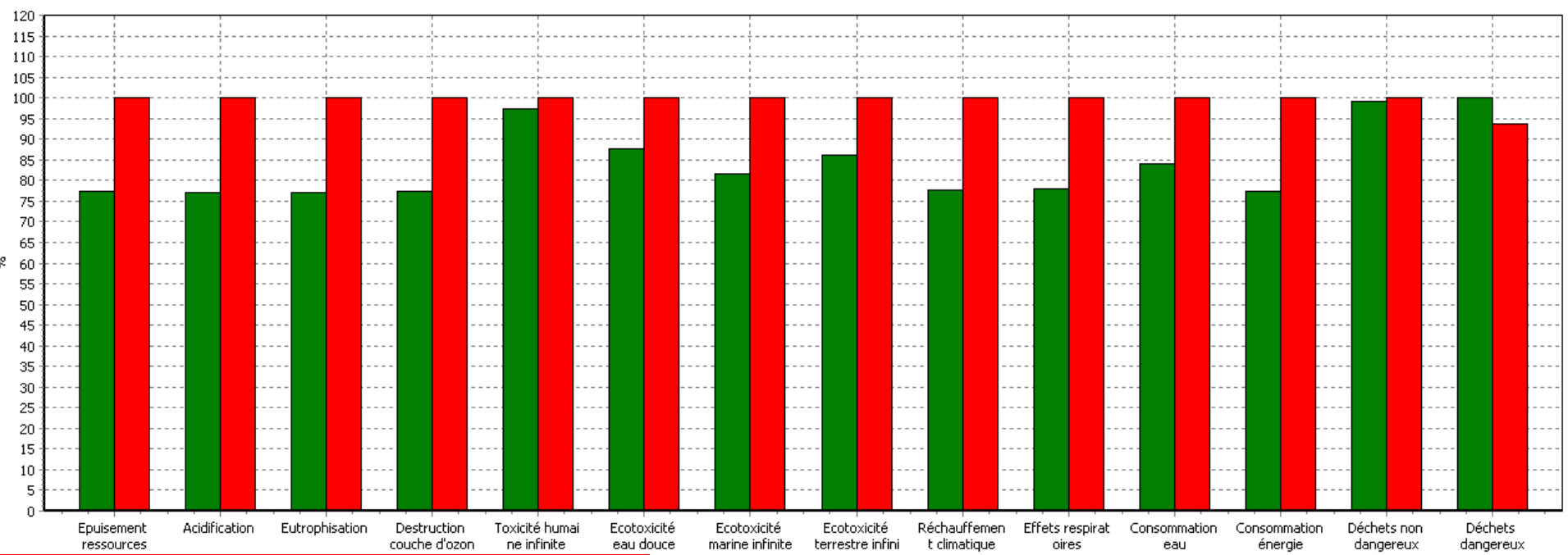
Environmental impact indicators

Ship in steel

Ship in Aluminum



Life Cycle: Reduced impact for aluminium compared to steel



Environmental impact indicators

Ship in steel

Ship in Aluminum



Case Study II

- 47 meter wind assisted cargo vessel

CTMV

Compagnie de Transport
Maritime à la Voile

Wine Transport between
Bordeaux & Dublin.



Case study III

- Ecoship DCNS : 90 meters support vessel – Steel and Aluminium versions



Case study IV

- 1275 cabin Cruise vessel “Magnifica”
 - Owner : MSC



stx Europe

Two different operational profiles



Duration : 7 days

Distance : abt 2500 Nm

Average speed : 21.1 kts



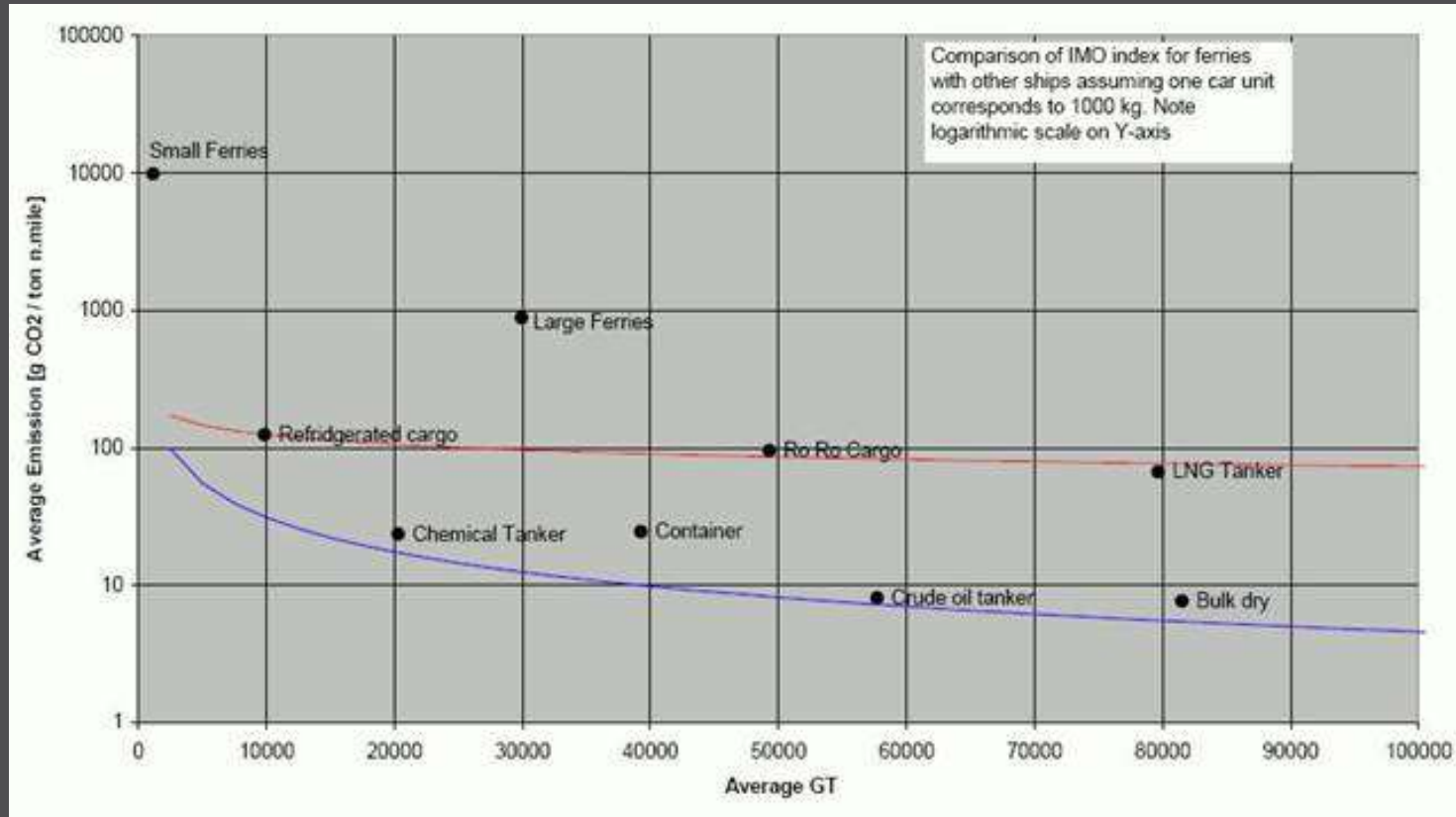
- **Duration : 7 days**
- **Distance : abt 1700 Nm**
- **Average speed : 19.1 kts**



stx Europe

CO2 Index - IMO (MEPC 58)

A mean to compare the environmental efficiency of transport



CO2 Index as a function of Gross Tonnage

A simplified methodology to evaluate « Green » Technologies

Lets's consider a specific Technology

- **W** : Weight
- **I** : Environmental impact though its life cycle.

For the following ship :

- **Δ** : Average Displacement (in Tons).
- **E** : Yearly environmental impact of propulsion during ship operation.
- **n** : Return on investment time (in years)

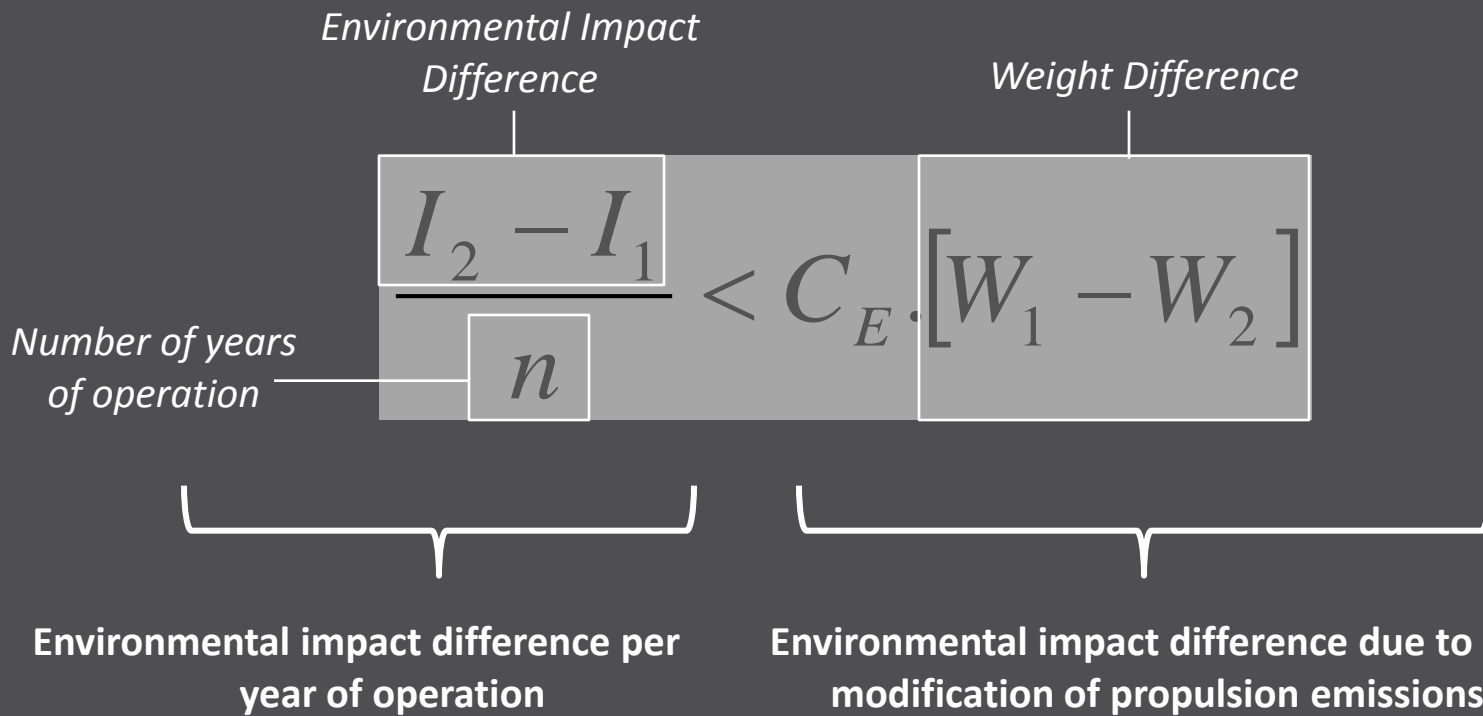
A detailed Life cycle analysis of the technology is required.

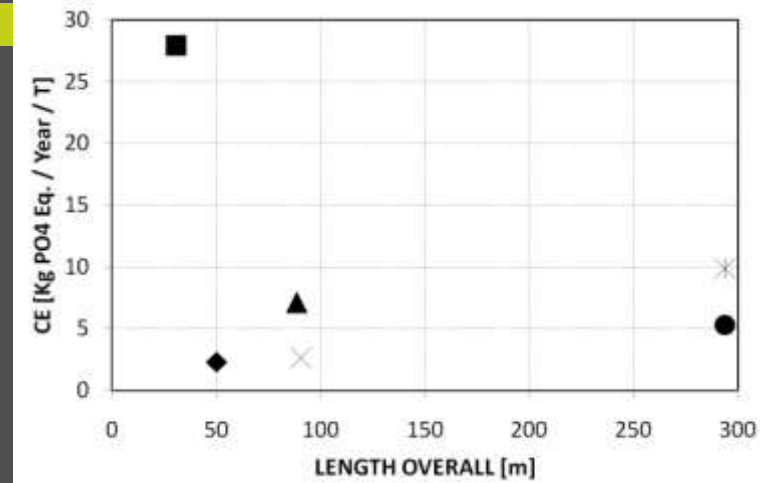
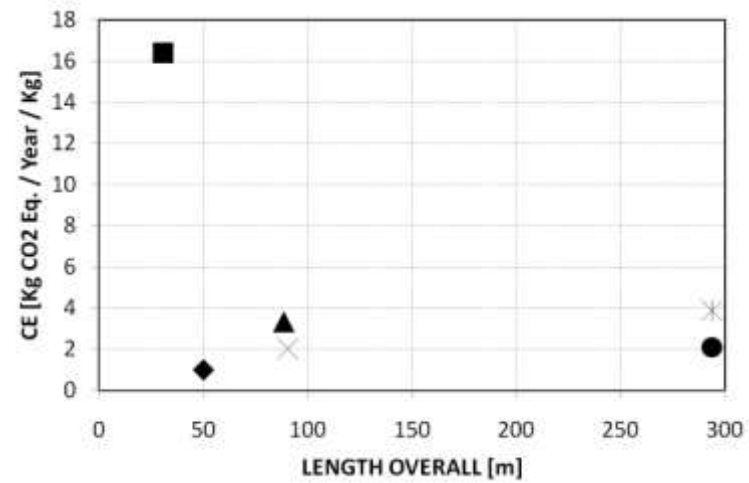
But no Life Cycle Analysis of the full ship is required.

Environmental Design Index

“Emission of ship propulsion per unit weight » :

$$C_E = \frac{2}{3} \cdot \frac{\alpha \cdot E}{\Delta}$$





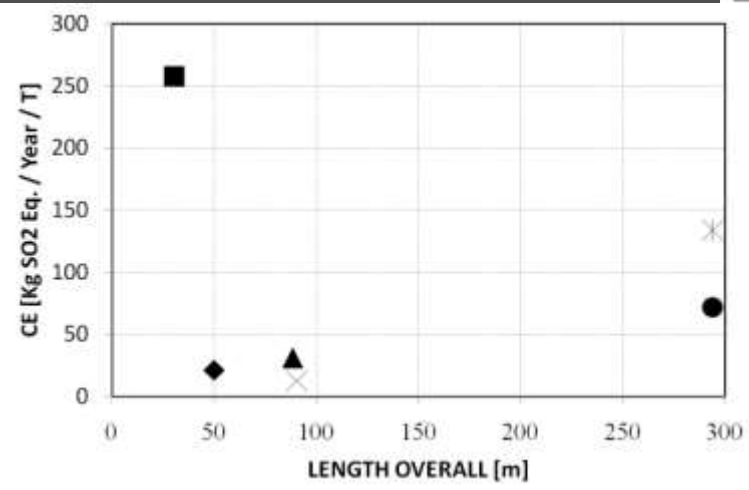
CO2

Acidification

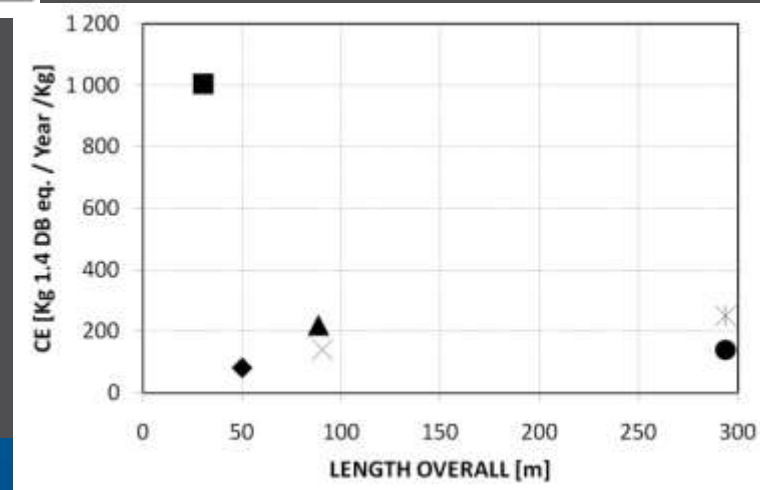
- 30 M Passenger Vessel
- ◆ 50 M wind assisted cargo vessel
- ▲ 88 M steel Support Vessel
- × 90 M aluminium Support Vessel
- 294 M Cruise vessel (19 knots)
- × 294 M Cruise vessel (21 knots)

Eutrophication

Marine Toxicity



Environmental Design Index of the case studies



For more information...

www.sustainableshipdesign.com

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