ENERGY EFFICIENCY IN VESSEL OPERATIONS

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Energy efficiency in vessel operations

A BRIEF HISTORY...

VIKING SHIP PROPELLED BY A COMBINATION OF MAN POWER AND WIND

LATE 15th - 16th CENTURY SHIP TYPICAL OF THE RENAISSANCE PERIOD

19TH CENTURY SHIP POWERED BY A COMBINATION OF STEAM AND SAIL

STEAM ENGINE
The Internal Combustion Engine

- Mechanical energy through combustion of fossil fuel, combined with an oxidiser other than coal gas
- Controllable thermal losses with increased energy efficiency
- Higher calorific value than methane gas
- Natural lubricants in fuel oil
- Lower maintenance frequency
- Higher applied energy
- New technology giving rise to electronic engines
- More precise controllable loads
- Greater mechanical efficiency
What is Energy?

Energy is the capacity of a physical system to perform work.
What is Efficiency?

A level of performance that describes a process that uses the lowest amount of inputs to create the greatest amount of outputs, including personal time and energy.
**Energy Efficiency – The big picture**

An inherent and fundamental necessity for efficient energy

<table>
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<tr>
<th>Need for faster ships</th>
<th>Able to carry more goods</th>
<th>Sail further</th>
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<tbody>
<tr>
<td>More environmentally friendly</td>
<td>Consume less fuel</td>
<td>Cost effective</td>
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Underlying pre-requisite: An efficient energy conversion process on board

[Diagram showing various energy consumption areas such as propulsion, auxiliary machinery, and hotel loads, along with categories like fuel input, mechanical electricity, heating, cooling, cargo handling (refrigerated, liquid, gas, ventilation), and maneuvering.]
Understanding the Energy Balance

• An indication of the actual fuel consumption per vessel/service

• A calculation based on ship’s designs and verified by onboard measurements

• Essential for addressing the key consumers onboard

• On board assessment – each consumer can be monitored for use in the energy balance
Route & Voyage Management

Modification to service speeds
- Easiest and most effective way to achieve fuel saving
- Lower fuel consumption through fuel management

Fleet-wide implications
- Port operations
- Port approaches
- Terminal velocity

Benefits
- Revised efficient timetables
- Efficient engine operations
- Immediate payback
Shipboard Operations

Tank Management
- Ship stability criteria
- Maximum vs. minimum ballast
- Adjustment of machinery system

Optimum Trim
- Positive vs. negative trim
- Speed through the water
- Impact on fuel consumption

Weather Routing
- Forecasting & planning ahead
- Avoid loss and delays
- Increase service efficiency
Regular propeller polishing
• Checks marine fouling
• Counters galvanic action
• **Prolongs propeller efficiency**

Regular hull cleaning
• Checks marine fouling
• Counters galvanic action
• **Enhances underwater efficiency**
Terminal Velocity & Port Turnaround

Terminal Productivity
- Low crane intensity
- Delays due to fuel transfers
- Delays due to adverse weather

Vessel’s Performance
- Higher sea speed
- Port omissions
- Higher fuel consumption
- Lower energy efficiency
<table>
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<th>Paths of Energy Improvement Solutions</th>
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<tr>
<td>Hull Form Optimization</td>
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<td>Propulsion Efficiency devices</td>
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<tr>
<td>Anti-Fouling &amp; Coating</td>
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<td>Waste Heat Recovery</td>
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<td>Auxiliary Engine</td>
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<td>Engine/components tuning</td>
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<td>Speed Control of Pumps and Fans</td>
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<tr>
<td>Trim Optimization</td>
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<tr>
<td>Weather Routing</td>
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<tr>
<td>Speed Optimization</td>
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<td>Port/Ship Logistics</td>
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<tr>
<td>Performance/Energy Monitoring</td>
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<tr>
<td>Improved Power Management</td>
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<tr>
<td><strong>Crew Awareness</strong></td>
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<tr>
<td>Type of Fuel and Lubricants</td>
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Crew Competence – Training & Management

- Increase awareness of energy efficiency
- Training of key personnel onboard ships
- Understanding key areas for optimal operations
- Understanding energy efficiency
- Commitment and sustenance of energy efficiency
Energy Monitoring

• Logging of ship’s performance

• Utilization of energy data
  – Electrical energy consumption
  – Main engine & auxiliary engine loads
  – Fuel consumption
  – Energy losses

Accountability

• Assigning a person or team
• Full-time focus on energy efficiency
• Project execution
• Project investment & budget
Energy Efficiency...2015+

Ship Design – Optimizing water flow around

• Bulbous bow
• The water plane of the hull
• Propulsion improvement devices & PBCF
• The ship’s rudder

Pre-swirl Stator
Mewis Duct
Energy Efficiency...2015+

Network Optimization
• Slow steaming vs. optimum speed

Effects & Barriers
• Charter parties
• World bunker prices
• Carbon dioxide emissions

Policies & Incentives
• SEEMP
• EEDI
• Carbon emission trade

Cold Ironing – Alternative maritime power

Intermodal Transportation
• Transport Chain Optimization
Alternative fuel – Liquid Natural Gas

- The good guys!
- A clean & efficient energy option
- No unburned residue
- High calorific value achieves a higher energy efficiency
- Reduced governmental levies on carbon emissions
- Methanol alcohol – a ‘fossil fuel-free future’
- Better fuel economy – distance per volume metrics

- The bad guys!
- Costly engine retrofits
- Storage space
- Lack of port infrastructure
- Not economically viable due to high production cost
### Summary of current and future practices

#### Design of Ship and Systems
- Optimisation of bulbous bow
- Hull form design

#### Optimal Operation of Components and Systems
- Soot blowing
- Auxiliary engine
- Trim optimisation
- Hull cleaning
- Propeller polishing

#### Optimisation of Trading, Operating, and Ship Management Procedures
- Route planning
- Voyage management
- Speed management
- Bunkering/de-sludging
- Port approach notices
- Port activities
- Fuel grade
- Crew engagement (training, incentive program)

#### Future of Energy Efficiency in Ship Operations
- Fossil fuel-free future
- Alternative fuel – LNG
- Hull & propeller geometry
- Shore power/cold ironing
- Intermodal transport
- SEEMP/EEDI
- CO₂ emissions
A Point to ponder

• Time = Money

• 50 Kw electrical load in continuous operation

• Approximately 100 M/T of fuel per year

• Approximately US$60,000 per year/ship
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THANK YOU