Baseline of Emissions Control and Energy Efficiency Measures (ECEEMs)

Mr. Stephan Nanan

Greenhouse Gas Advisor, 
MTCC Caribbean, 
The University of Trinidad and Tobago
Outline

• Emissions Control and Energy Efficiency Measures
• Sample Size
• Results from Data Collected
  • Total Vessels
  • Cruise Ships
  • Container Vessels
  • Tankers
• General Observations from data
### Energy Efficiency Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Average Efficiency</th>
<th>Retrofittable</th>
<th>Ship Type(s)</th>
<th>Payback Period</th>
<th>Investment</th>
<th>Technical Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull Coating</td>
<td>5%</td>
<td>YES</td>
<td>All vessels</td>
<td>Short (&lt; 3 years)</td>
<td>Medium</td>
<td>Mature</td>
</tr>
<tr>
<td>Air Cavity Lubrication</td>
<td>9%</td>
<td>NO</td>
<td>New builds</td>
<td>Medium (4-5 years)</td>
<td>Medium</td>
<td>Mature</td>
</tr>
<tr>
<td>Main Engine De-Rating</td>
<td>3%</td>
<td>Yes</td>
<td>All except ferry and cruise</td>
<td>Medium (4-5 years)</td>
<td>Low</td>
<td>Semi - Mature</td>
</tr>
<tr>
<td>Common Rail Upgrade</td>
<td>0.3%</td>
<td>Yes</td>
<td>All vessels</td>
<td>Medium (4-5 years)</td>
<td>Very Low</td>
<td>Semi - Mature</td>
</tr>
<tr>
<td>Waste Heat Recovery Systems</td>
<td>8%</td>
<td>NO</td>
<td>All vessels</td>
<td>Medium (4-5 years)</td>
<td>Medium</td>
<td>Semi - Mature</td>
</tr>
<tr>
<td>Contra - Rotating Propellers</td>
<td>13%</td>
<td>Yes</td>
<td>All vessels</td>
<td>Medium (4-5 years)</td>
<td>High</td>
<td>Mature</td>
</tr>
<tr>
<td>Energy Efficient Lighting System</td>
<td>CBC</td>
<td>Yes</td>
<td>All vessels</td>
<td>Short (&lt; 3 years)</td>
<td>Low</td>
<td>Mature</td>
</tr>
<tr>
<td>Solar Panels</td>
<td>CBC</td>
<td>Yes</td>
<td>All vessels</td>
<td></td>
<td>Non Mature</td>
<td></td>
</tr>
<tr>
<td>Kite</td>
<td>CBC</td>
<td>Yes</td>
<td>All vessels</td>
<td></td>
<td>Non Mature</td>
<td></td>
</tr>
</tbody>
</table>

Possible reduction of Energy Consumption & CO₂ Emissions by 75%

**Hydrodynamic Efficiency - Hull & PIDs**

**Improved Engine Efficiency - Control Systems**

**Renewable Energy Systems - Solar, Wind Assist**
ECEEMs

Energy Efficiency Technologies
- Hull Coating
- Air Cavity Lubrication
- Solar Panels
- Rotating Fuel Injector Controls
- Contra Rotating Propeller
- Propeller Boss Cap Fin
- M/E Shaft Generator
- Common Rail Injection
- Waste Heat Recovery (Main and Auxiliary)
- Kite

Energy Efficiency Operational Measures
- Voyage Planning and Execution
- Vessel Speed Reduction/Slow Steaming
- Voyage and Route Optimization
- Vessel Trim/Draft Optimisation

Emissions Control Measures
- Dual Fuel Engines
- Automated Engine Monitoring/Control Systems
- Selective Catalytic Reduction
- Alternative Fuels
- Water Injection
- Exhaust Gas Scrubbers
- Humid Air Method

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Sample Size

01st June, 2017 - 31st May, 2019

1,870 Port Call Reports

- Cruise Ships 24%
- Container Ships 30%
- Car Carriers 4%
- Bulk Carriers 5%
- General and Refrigerated Cargo 5%
- Tankers 31%
- Others 2%

518 Vessels Reporting

- Tankers 49%
- Car Carriers 4%
- Container Ships 12%
- Bulk Carriers 13%
- Cruise Ships 10%
- General and Refrigerated Cargo 10%
- Others 2%
- Others 2%
### Total Vessels - GRT

#### Percentage of Total Vessel Sample by GRT

- **91% of Vessels were 5,000 GRT and above**
- **56% of Vessels between 5,000 to 50,000 GRT**

#### Graph Details:

- The Project is Funded by the European Union and implemented by the International Maritime Organization.

#### Table:

<table>
<thead>
<tr>
<th>GRT Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001 - 5000</td>
<td>8.7%</td>
</tr>
<tr>
<td>5001 - 10000</td>
<td>7.1%</td>
</tr>
<tr>
<td>10001 - 15000</td>
<td>7.3%</td>
</tr>
<tr>
<td>15001 - 20000</td>
<td>6.8%</td>
</tr>
<tr>
<td>20001 - 25000</td>
<td>12.5%</td>
</tr>
<tr>
<td>25001 - 30000</td>
<td>3.5%</td>
</tr>
<tr>
<td>30001 - 35000</td>
<td>2.9%</td>
</tr>
<tr>
<td>35001 - 40000</td>
<td>2.5%</td>
</tr>
<tr>
<td>40001 - 45000</td>
<td>2.7%</td>
</tr>
<tr>
<td>45001 - 50000</td>
<td>4.4%</td>
</tr>
<tr>
<td>50001 - 55000</td>
<td>2.1%</td>
</tr>
<tr>
<td>55001 - 60000</td>
<td>1.7%</td>
</tr>
<tr>
<td>60001 - 65000</td>
<td>1.0%</td>
</tr>
<tr>
<td>65001 - 70000</td>
<td>0.6%</td>
</tr>
<tr>
<td>70001 - 75000</td>
<td>0.6%</td>
</tr>
<tr>
<td>75001 - 80000</td>
<td>0.6%</td>
</tr>
<tr>
<td>80001 - 85000</td>
<td>0.6%</td>
</tr>
<tr>
<td>85001 - 90000</td>
<td>0.4%</td>
</tr>
<tr>
<td>90001 - 95000</td>
<td>0.2%</td>
</tr>
<tr>
<td>95001 - 100000</td>
<td>0.4%</td>
</tr>
<tr>
<td>100001 - 105000</td>
<td>0.2%</td>
</tr>
<tr>
<td>105001 - 110000</td>
<td>0.0%</td>
</tr>
<tr>
<td>110001 - 115000</td>
<td>1.0%</td>
</tr>
<tr>
<td>115001 - 120000</td>
<td>0.4%</td>
</tr>
<tr>
<td>120001 - 125000</td>
<td>0.2%</td>
</tr>
<tr>
<td>125001 - 130000</td>
<td>0.4%</td>
</tr>
<tr>
<td>130001 - 135000</td>
<td>0.2%</td>
</tr>
<tr>
<td>135001 - 140000</td>
<td>0.0%</td>
</tr>
<tr>
<td>140001 - 145000</td>
<td>1.4%</td>
</tr>
<tr>
<td>145001 - 150000</td>
<td>0.2%</td>
</tr>
<tr>
<td>150001 - 155000</td>
<td>0.4%</td>
</tr>
<tr>
<td>155001 - 160000</td>
<td>0.0%</td>
</tr>
<tr>
<td>160001 - 165000</td>
<td>0.2%</td>
</tr>
<tr>
<td>165001 - 170000</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Total Vessels - Age

Age of Vessels in sample

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Total Vessels - ECEEEMs

Hull Coating
- Air cavity lubrication: 6.18%
- Contra rotating propeller: 9.65%
- Propeller boss cap fin: 29.34%
- Dual fuel engines: 37.84%

Automated Engine Monitoring/Control Systems
- Propulsion Engine Derating: 10.23%
- Common Rail Direct Injection System: 2.90%
- Rotating Fuel Injector Controls: 0.77%

Waste heat recovery system
- Auxiliary Engine Waste Heat Recovery: 1.74%
- Turbo Charger Cut Off: 0.58%
- High Efficiency Turbo Charger: 2.32%
- High Scavenge Pressure and Compression Ratio: 17.18%
- High Efficiency Boiler: 1.93%

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Total Vessels - ECEEMs

<table>
<thead>
<tr>
<th>Technology</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Engine Shaft Generator</td>
<td>18.53</td>
</tr>
<tr>
<td>Steam turbine generator</td>
<td>1.35</td>
</tr>
<tr>
<td>Frequency converters</td>
<td>24.32</td>
</tr>
<tr>
<td>Low Energy Lighting System</td>
<td>51.74</td>
</tr>
<tr>
<td>Solar panels</td>
<td>0.97</td>
</tr>
<tr>
<td>Water Injection and Water Emulsion</td>
<td>4.44</td>
</tr>
<tr>
<td>Humid Air Method</td>
<td>1.16</td>
</tr>
<tr>
<td>Selective Catalytic Reduction (SCR)</td>
<td>3.86</td>
</tr>
<tr>
<td>Exhaust Gas Scrubbers - Dry</td>
<td>4.25</td>
</tr>
<tr>
<td>Exhaust Gas Scrubbers - Wet</td>
<td>8.88</td>
</tr>
<tr>
<td>Low Sulphur Fuels</td>
<td>26.25</td>
</tr>
<tr>
<td>Voyage Planning and Execution</td>
<td>18.34</td>
</tr>
<tr>
<td>Voyage and Route Optimisation</td>
<td>44.21</td>
</tr>
<tr>
<td>Vessel Speed Reduction/Slow Steaming</td>
<td>11.97</td>
</tr>
<tr>
<td>Vessel Trim/Draft Optimisation</td>
<td>59.27</td>
</tr>
</tbody>
</table>

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Total Vessels - Fuels

- Heavy Fuel Oil (HFO) Only: 14
- Intermediate Fuel Oil (IFO) Only: 6
- Marine Diesel Oil (MDO) or Marine Gas Oil (MGO) Only: 4
- Liquified Natural Gas (LNG) Only: 1
- Low Sulphur (LS) MDO or LSMGO Only: 0
- HFO / IFO: 1
- HFO / IFO / MDO or MGO / LNG: 6
- HFO / MGO or MDO: 31
- HFO / LNG: 1
- HFO / MGO or MDO / LNG: 4
- HFO / LSMDO or LSMGO: 18
- HFO / ULSMDO or ULMGO: 1
- IFO / MGO or MDO: 8
- IFO / LSMDO or LSMGO: 4
- IFO / ULSMDO or ULMGO: 1
- LNG / MGO or MDO: 0
- LNG / LSMDO or LSMGO: 0
Cruise Ships - ECEEMs

- Hull Coating: 62.96%
- Air cavity lubrication: 7.41%
- Contra rotating propeller: 22.22%
- Propeller boss cap fin: 12.96%
- Dual fuel engines: 48.15%
- Automated Engine Monitoring/Control Systems: 22.22%
- Propulsion Engine Derating: 16.67%
- Common Rail Direct Injection System: 11.11%
- Rotating Fuel Injector Controls: 0.00%
- Waste heat recovery system: 72.22%
- Auxiliary Engine Waste Heat Recovery: 0.00%
- Turbo Charger Cut Off: 0.00%
- High Efficiency Turbo Charger: 3.70%
- High Scavenge Pressure and Compression Ratio: 12.96%
- High Efficiency Boiler: 3.70%
Cruise Ships - ECEEMs

- Main Engine Shaft Generator: 11.11
- Steam turbine Generator: 1.85
- Frequency converters: 70.37
- Low Energy Lighting System: 55.56
- Solar panels: 1.85
- Water Injection and Water Emulsion: 31.48
- Humid Air Method: 1.85
- Selective Catalytic Reduction (SCR): 1.85
- Exhaust Gas Scrubbers - Dry: 1.85
- Exhaust Gas Scrubbers - Wet: 64.81
- Low Sulphur Fuels: 50.00
- Voyage Planning and Execution: 37.04
- Voyage and Route Optimisation: 29.63
- Vessel Speed Reduction/Slow Steaming: 5.56
- Vessel Trim/Draft Optimisation: 61.11
Container Ships - GRT

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Container Ships - Age

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Container Ships - ECEEMs

- Hull Coating
- Air cavity lubrication
- Contra rotating propeller
- Propeller boss cap fin
- Dual fuel engines
- Automated Engine Monitoring/Control Systems
- Propulsion Engine Derating
- Common Rail Direct Injection System
- Waste heat recovery system
- High Scavenge Pressure and Compression Ratio
- High Efficiency Boiler

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Container Ships - ECEEMs

- Main Engine Shaft Generator: 31.67%
- Frequency converters: 16.67%
- Low Energy Lighting System: 63.33%
- Solar panels: 1.67%
- Water Injection and Water Emulsion: 1.67%
- Humid Air Method: 1.67%
- Selective Catalytic Reduction (SCR): 5.00%
- Exhaust Gas Scrubbers - Dry: 3.33%
- Exhaust Gas Scrubbers - Wet: 0.00%
- Low Sulphur Fuels: 13.33%
- Voyage Planning and Execution: 15.00%
- Voyage and Route Optimisation: 55.00%
- Vessel Speed Reduction/Slow Steaming: 8.33%
- Vessel Trim/Draft Optimisation: 71.67%

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Container Ships - Fuels

- HFO: 30.00
- IFO: 3.33
- MGO and/or MDO: 1.67
- LNG and/or LPG: 0.00
- HSFO & LSFO: 3.33
- HFO & IFO: 0.00
- HFO & MGO/MDO: 1.67
- HFO & LSFO: 1.67
- HFO, IFO & MGO: 6.67
- HFO & MGO/MDO: 35.00
- IFO & MGO/MDO: 16.67

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Tankers - Age

The Project is Funded by the European Union and implemented by the International Maritime Organization.
Tankers - ECEEMs

- Hull Coating: 73.12%
- Air cavity lubrication: 6.72%
- Contra rotating propeller: 7.91%
- Propeller boss cap fin: 30.83%
- Dual fuel engines: 33.99%
- Automated Engine Monitoring/Control Systems: 9.09%
- Propulsion Engine Derating: 0.79%
- Common Rail Direct Injection System: 1.58%
- Rotating Fuel Injector Controls: 0.79%
- Waste heat recovery system: 55.73%
- Auxiliary Engine Waste Heat Recovery: 1.98%
- Turbo Charger Cut Off: 0.79%
- High Efficiency Turbo Charger: 3.56%
- High Scavenge Pressure and Compression Ratio: 16.21%
- High Efficiency Boiler: 2.37%
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Tankers - Fuels

- Heavy Fuel Oil (HFO) Only: 13.20
- Intermediate Fuel Oil (IFO) Only: 5.20
- Marine Diesel Oil (MDO) or Marine Gas Oil (MGO) Only: 2.00
- Liquified Natural Gas (LNG) Only: 2.40
- Low Sulphur (LS) MDO or LSMGO Only: 0.40
- Ultra Low Sulphur (ULS) MDO or ULSMGO Only: 0.80
- HFO / IFO: 0.80
- HFO / IFO / MDO or MGO / LNG: 5.60
- HFO / MGO or MDO: 24.00
- HFO / LNG: 3.20
- HFO / MGO or MDO / LNG: 24.40
- HFO / LSMDO or LSMGO: 1.20
- IFO / MGO or MDO: 4.80
- IFO / LNG: 9.60
- IFO / LSMDO or LSMGO: 2.40
- IFO / ULSMDO or ULMGO: 0.80
- LNG / MGO or MDO: 0.40
- LNG / LSMDO or LSMGO: 0.40

The Project is Funded by the European Union and Implemented by the International Maritime Organization.
Major Observations from Data

• Over 90% of vessels are 5,000 GRT and above.

• 77% of vessels are newer than 16 year.

• The majority of vessels with ECEEMs have mature technologies onboard.

• Cruise Ship use a higher number of ECEEMs than other types of vessels.

• HFO continues to be the dominant fuel within the energy mix of the fuels.
EEOI and Technology

Efficiency Improvement Scope

EEOI Baseline – Base ship

Increase in Deadweight (amount of cargo carried)

Operational measures (Slow Steaming, SEEMP)

Technology Use (Reduced fuel Consumption, Increase in efficiency)

EEOI Baseline – Modified ship

EEOI (g / tonne mile)

Fuel consumed (g) x Emission Factor
Cargo Mass (tonne) x Distance sailed (mile)

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Maritime Technology Adoption

Economics / Market
- Fuel Prices
- Incentives
- Business to Business

Regulatory
- International Conventions
- Regional, Coastal or Port regulations

Availability of Alternatives
- Low sulphur fuel
- EE technology
- Emission Abatement methods
- Alternative fuels (LNG)

Business / Social aspects
- CSR and Environmental Management system
Thank You!

www.u.tt/mtcc-caribbean

mtcc@utt.edu.tt