Carnival Corporation Decarbonization Pathway

Achieved 29% Reduction from 2008 to 2019

Target 40% improvement by 2030

Focus area: energy savings, increased use of shore power, itinerary/speed adjustments and transition to LNG
Carnival Corporation Decarbonization Pathway

• Current techniques Carnival is using to meet global ECA compliance requirements, and their benefit in terms of GHG reduction:
  • **Compliant fuel**, MGO and VLSFO
  • **EGCS**, largest users in cruise industry, with a reduced lifecycle CO2 contribution compared to MGO/VLSFO.
  • **LNG**, largest users in cruise industry, with 5% benefit and potential for upwards of 20% benefit with planned slip reduction
  • **Shore Power**, largest user in cruise industry, with more ships configured than shore power locations.
  • EGCS has established itself as an effective means of 2020 compliance with SOx reduction exceeding that of MGO, but also has realized advantages in terms of NOx and PM reduction in addition to considerably reducing well to wake CO2 emissions compared to compliant fuel.
  • EGCS is expected to be an effective transitional technology en route to an alternative carbon-free future fuel.

![Figure 1](image)

**Figure 1** - Additional CO2 emissions (in %) for the reference ships for the different MARPOL Annex VI compliance options when using fuel with a sulphur content of 3.5% m/m

*Source: CE Delft, Comparison of CO2 emissions of MARPOL Annex VI compliance options in 2020*
Moving Forward

Leading the way for Sustainable Solutions

Maritime Air Pollution

Operators Round Table Discussion

Riviera Maritime Media

Steve Bee – Group Commercial Director

30th June 2021
Shipping’s Sustainable Focus

• IMO, Shipping & Bunkering Industries are firmly focused upon reducing emissions of all types.

• Maritime Sector emits to atmosphere 940million tons of CO₂ per year & contributes 3.0% of global Green House Gases

• IMO challenging targets to reduce shipping GHG emissions by 50% by 2050 compared to 2008 and reducing the carbon intensity of emissions by
  • 40% by 2030
  • 70% by 2050 compared to 2008 levels.

• This equates to reducing GHG emissions by almost 500million tons over the next 29 years.

• The different options for reducing GHG & Emissions from international shipping can be considered in four categories:
  • Technologies that can increase energy efficiency and reduce emissions.
  • Operational/Behavioural that can increase efficiency
  • Technologies specific to capture/treat exhaust emissions.
  • Alternative fuels and energy sources and related machinery

• Many possible solutions, but fuel-type will be a major factor
Technologies that can Increase Energy Efficiency & Reduce Emissions

- There are a number of devices and technologies that are options for increasing the energy efficiency of ships.
- One growing area is **Data-Driven Decarbonisation**
- Utilising onboard monitoring of numerous operations against an "ideal" baseline to achieve optimum efficiency.
- Ship to Shore data-feed via cloud-based software
- Such technologies can be applied to existing fleets, with the opportunity for real gains in efficiency.
Operational/Behaviour which can Increase Efficiency & Reduce Emissions

• Behavioural changes and modifications to operations can improve energy efficiency, eg:
  
• Slow Steaming

• Preventative Maintenance Programmes
  • Eg Oil Condition Monitoring (OCM), Purifier Efficiency Checks (FSCs)

• IMO-related activities:
  • SEEMP
  • EEDI
  • EEXI
  • CII
Technologies specific to capture/treat exhaust emissions

• Technology specific to the capture/treatment of exhaust emissions includes treatments that ‘purify’ the exhaust from the machinery or capture a component within the exhaust.

• Technologies that capture/treat the exhaust tend to be focused on specific air pollutant emissions and therefore may need to be used in combination with other options, depending on the fuel.

• It is possible to retrofit all these options onto existing ships, but there can be operational and technical issues on some ships, and the systems are typically slightly cheaper to integrate on a new ship.

• The take-up of exhaust gas cleaning systems has accelerated since the IMO confirmed that the sulphur content of marine fuel would be limited to 0.5%.

• Tier III NOx controls will incentivise the use of NOx abatement technologies.
Alternative Fuels & Energy Sources

- The fuel or energy source has a large impact on the operating emissions in shipping
- Alternative & future fuels all have their specific pro’s & con’s.
- Biofuels offer a very strong option as a positive future marine fuel.
- The gaseous alternative fuels, eg LNG & H₂, require compression or liquefaction, requiring new infrastructure and storage equipment. However, the energy densities of these fuels are lower than liquid fossil fuels, requiring more storage space and reducing the available cargo space for vessels.
- LNG, hydrogen and methanol have low flash points and will need to comply with appropriate safety regulations.
- Fuel cells require an electric motor and are therefore more suited to new-build ships.
- Fuel cells can be used with fuels such as H₂, LNG, NH₃ and MeOH. Fuel cells offer higher efficiency compared to combusting the same fuels in internal combustion engines. Still require significant further development.

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Biofuels</td>
<td>Low emissions, GHG, SOx, NOx, CO₂ reductions from 35%-90%, Can use existing infrastructure and engines, Can be blended with liquid fossil fuels, Low environmental risk.</td>
<td>Water contamination, Microbial Growth, Long-term storage issues, Cost, Availability</td>
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<tr>
<td>LNG</td>
<td>Low emissions of SOx, NOx, PM, CO₂ reductions, No exhaust gas treatment required</td>
<td>Limited GHG savings compared to traditional marine fuels, Methane Slip, Boil off causes reduction in LNG quality, Cryogenic handling of LNG in liquid phase, Infrastructure still not comprehensive</td>
</tr>
<tr>
<td>Methanol</td>
<td>Low in SOx, NOx and PM, Biodegradable, Widely available.</td>
<td>Flash Point of only 12°C, Less than half the energy content of HFO, VLSFO &amp; MGO</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Carbon-free fuel. Can be burnt in a combustion engine. Stores as a liquid at -33°C, or at room temp and 10bar pressure. 3 x volume of Ammonia to equal energy of HFO. Ammonia 2 x heavier than HFO. Ammonia is toxic.</td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Carbon-free fuel. Zero emissions issues. Environmental attractiveness means high investment appetite</td>
<td>No infrastructure as yet, Safety concerns, widely flammable, low ignition energy, highly reactive, Storage at very high pressures or very low temperatures</td>
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Thank You

Steve Bee

Steve.bee@vpsveritas.com

vpsveritas.com