CARNIVAL CORPORATION&PLC
Sustainability

ENERGY SAVING INITIATIVES

INITIATIVES AIMED AT REDUCING GREENHOUSE GASES AND OTHER EMISSIONS

We are continually investing in a broad range of voluntary initiatives aimed at reducing greenhouse gas and other emissions that meet or surpass the requirements of current laws and regulations. Reducing emissions and driving energy efficiency requires multimillion dollar investments and a multi-pronged strategy. Our ongoing energy efficiency investment program and efforts to reduce fuel consumption have included over $500 million invested in energy efficiency improvements since 2015, along with our fleet optimization strategy, the design of more efficient itineraries and our active installation programs for Service Power Package and Air Lubrication System investments.

DESIGNING SHIPS FOR GREATER EFFICIENCY

- Optimize hull and propeller design to minimize drag
- Fit higher efficiency podded propulsion units
- Select fuel-efficient combustion equipment
- Improved efficiency HVAC systems designs
- Improved efficiency Waste Heat Recovery Systems
- Install equipment such as steam turbines and absorption chillers to use waste heat

INCREASING EFFICIENCY THROUGH SHIP OPERATIONS AND MAINTENANCE

- Optimize diesel generator use at sea and in port
- Manage use of evaporators and reverse osmosis plants
- Use LED lighting and high-efficiency electric motors
- Utilize sophisticated control systems for heating ventilation and air-conditioning (HVAC) to improve energy efficiency
- Monitor and improve chiller performance
- Utilize 'on-demand' methodology for chilled water and air handling systems
- Apply highly efficient anti-fouling marine hull coatings
- Survey underwater hulls regularly using state-of- the-art underwater robots
- Clean hulls and propellers routinely
- Introduce detailed technical and energy-monitoring systems for shipboard and shoreside management to target improved energy consumption
- Increase volume and availability of waste heat from engine exhaust for a wide range of applications
- Use on-demand methodology for galley ventilation control

MINIMIZE FUEL USE AND ENGINE EMISSIONS

- Increase engine efficiency through fuel treatment systems which improve combustion and reduce fuel consumption
- Continually monitor and optimize the performance of diesel generators on board to improve efficiency
- Use heat generated by the ships' engine exhausts to make steam instead of utilizing the ships' boilers
- Use the waste heat generated by engine cooling water to meet onboard heat demands for hot potable water, swimming pools, laundry water, fuel oil pre-heating etc.
- Reduce the power required by engine room ventilation fans through use of variable frequency fan drive motors and related pressure and temperature control systems
- Use engine cooling pumps with variable speed drives to facilitate 'on-demand' operating philosophy

IMPLEMENTING OTHER ENERGY-SAVING INITIATIVES

- Design more fuel-efficient itineraries
- Use voyage optimization tools
- Increase energy use awareness through education and training of guests and crew
- Develop our ability to use alternative fuels
- Research and develop emissions-reduction technologies such as energy storage systems and fuel cells
- Design engine/machinery decision-support tools for optimizing plant configuration for energy efficiency

MINIMIZING OTHER EMISSIONS

- Use shore power while in port
- Install Advanced Air Quality Systems (AAQS)
- Fit Selective Catalytic Reduction (SCR) systems to reduce NO_x emissions
- Use alternative fuels like Liquefied Natural Gas (LNG)
- Use refrigerants with lower Global Warming Potential or natural refrigerants where possible for chillers and provision plants, etc

IMPLEMENTING SERVICE POWER PACKAGES

- Make comprehensive upgrades to each ship's hotel HVAC systems
- Use on-demand automated control systems for engine room ventilation, AC chillers and cooling pumps
- Install LED lighting systems
- Install Service Power Connectivity Package to support increased technical data flow
- Monitor system performance remotely

INSTALLING INNOVATIVE AIR LUBRICATION SYSTEMS

- Generate a cushion of air bubbles to lubricate the flat bottom of the ship's hull
- Reduce hull drag by ~5%