

Energy Efficiency Overview

Reducing greenhouse gas (GHG) emissions is our #1 sustainability priority as we aspire to reach net zero GHG emissions from our ship operations by 2050.

A key component of our strategy is our energy efficiency investment program and our efforts to reduce fuel consumption and emissions throughout our fleet. This includes over \$600 million invested in energy-efficient innovations since 2015.



Designing Ships for Greater Efficiency

- Optimize hull and propeller design to minimize drag
- Fit ships with higher efficiency, 360-degree steerable propulsion units to reduce fuel consumption and GHG emissions by up to 10% compared to conventional propellers
- Select fuel-efficient engine equipment, including medium-speed diesel and Liquefied Natural Gas (LNG) combustion engines
- Convert thermal energy into usable power for onboard operations with Waste Heat Recovery Systems



Implementing Power Saver Packs

- Improve onboard energy saving technologies that deliver an average of 5% fuel savings per ship
- Make comprehensive upgrades to each ship's hotel heating ventilation and air-conditioning (HVAC) systems, including sophisticated control systems to improve energy efficiency
- Use on-demand automated control systems for engine room ventilation, AC chillers and cooling pumps
- Install LED lighting and motion-sensing smart lighting systems
- Install connectivity to support increased technical data flow
- Monitor and maintain systems and ship's energy performance remotely to ensure peak efficiency



Installing Air Lubrication Systems (ALS)

- Generate a cushion of air bubbles to lubricate the flat bottom of a ship's hull
- Reduce friction and minimize drag to cut fuel use for propulsion by ~5% when in speed range



Expanding Shore Power Capabilities

- Pioneered shore power in the cruise industry over 20 years ago in Juneau, Alaska
- Use shoreside electric power, where available, while in port rather than running ship engines
- Reduce engine emissions and noise in port
- Lead the industry in ships capable of "plugging in"
- Actively work with ports to prioritize investment in and adoption of capability



Increasing Efficiency Through Ship Operations & Maintenance

- Optimize diesel-electric propulsion system use at sea and in port
- Testing the use of fuel treatment systems to remove residue deposits and build-up to improve engine performance, increase engine power and reduce fuel consumption
- Manage use of evaporators and reverse osmosis plants for producing water to use on board
- Monitor and improve chiller performance to reduce energy needed to deliver cooling around the ship
- Utilize "on-demand" methodology for chilled water, air handling and galley ventilation control systems
- Apply highly efficient anti-fouling marine hull coatings to control surface roughness and minimize drag
- Regularly inspect and clean underwater hulls and propellers – including using state-of-the-art underwater robots – to reduce friction caused by attached debris
- Monitor technical and energy systems around the clock to target energy consumption improvements
- Capture and reuse more heat from engine exhaust for a wide range of applications



Implementing Other Energy-Saving Initiatives

- Designing more fuel-efficient itineraries based on the optimal speed to maximize fuel efficiency for each ship design
- Using voyage optimization tools to fine-tune sailing routes for shortest distance and to leverage currents like the Gulf Stream
- Increasing energy use awareness through education and training of guests and crew
- Trialing energy storage battery systems for peak shaving to store excess energy produced when it's not needed and use it during high-demand times, helping engines run more smoothly and efficiently
- Designing decision-support tools for optimizing engine and machinery configuration



Minimizing Other Emissions

- Developing our ability to use alternative fuels including biofuels and biofuel blends
- Install Advanced Air Quality Systems (AAQS) to "scrub" engine exhaust with seawater to remove 99% of sulfur and 60-90% of particulate matter from engine emissions
- Fitting Selective Catalytic Reduction (SCR) systems to reduce nitrogen oxide emissions
- Using alternative fuels like LNG, the best readily available, proven and commercially scalable fuel for the maritime industry today that reduces direct greenhouse gases and other atmospheric emissions and particulate matter
- Use refrigerants with reduced climate impacts or natural refrigerants where possible, including freezer and cold storage rooms, etc.
- Researching and developing emissions-reduction technologies such as fuel cells