

# 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 use up to ~7% less fuel than 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



## 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
- Reduces 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



## IMPLEMENTING POWER SAVER PACKS

- Improve onboard energy-saving technologies that deliver an average of 5-6% 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 pump
- 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



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## 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 lower-emission alternative fuels like LNG
- 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