CARNIVAL CORPORATION & PLC

Shore Power, EGCS, and LNG Programs
AAPA Cruise Seminar

San Diego, CA

February 14, 2017

AIDA Carnival Costa CUNARD Holland America Line

P&O CRUISES P&O AUSTRALIA PRINCESS CRUISES SEABOURN

Carnival Shore Power Program

Criteria for a Successful Shore Power Project

- Availability of an adequate supply of electricity at a reasonable cost
- Frequency of calls by cruise vessels equipped to connect to Shore Power
- Availability of the same dock and pier facility for these vessels for every call
- Adequate dock and uplands space for equipment
- Willing partners including: utility, port and government agencies

Cruise Ship Shore Power Project
Shipboard Installation

DRAFT

Cruise Ship Shore Power Program
Shoreside installation

- Power is transmitted from an onshore substation equipped with a dual voltage transformer that will supply power to 11kV or 6.6kV class ships.

- Internal shore side monitoring and protection is achieved with protection relays to ensure safety and protection of both ship and shore electrical systems.

- Flexibility to connect either 11kV or 6.6kV ships is achieved by two independent secondary breakers with Kirk-Key interlocks.

- Power is carried to the ship through five flexible “Ship Cables” routed through a grounding switch.

- The grounding switch works in conjunction with the ships automation system to ensure safety and reliability during the cable handling from shore to ship.

Port of Long Beach, California

Statistics

Date Completed: 2011

Annual Connections:

2011-2016: 900

2016: 217

Connection Duration:

2011-2016: 7,924 hours

2016: 2,296 hours

Total Power Used:

2011-2016: 37,836,785 KWH

2016: 10,714,158 KWH

Port of Long Beach


02.13.2012
Port of Long Beach

Port of Halifax, Nova Scotia

Statistics

Date Completed: 2014

Annual Connections:

2014-2016: 54

2016: 31

Connection Duration:

2014-2016: 275 hours

2016: 188 hours

Total Power Used:

2014-2016: 1,498,768 KWH

2016: 1,011,957 KWH

Port of Halifax

Port of Halifax

Port of Seattle, Washington

Statistics

Terminal 30 Date Completed: 2005

Terminal 91 Date Completed: 2009

Annual Connections:

2005-2016: 757

2016: 75

Connection Duration:

2005-2016: 5,084 hours

2016: 546 hours

Total Power Used:

2005-2016: 36,424,368 KWH

2016: 3,575,680 KWH

Port of Seattle

Port of Seattle

Port of San Francisco, California

Statistics

Date Completed: 2011

Annual Connections:

2011-2016: 88

2016: 33

Connection Duration:

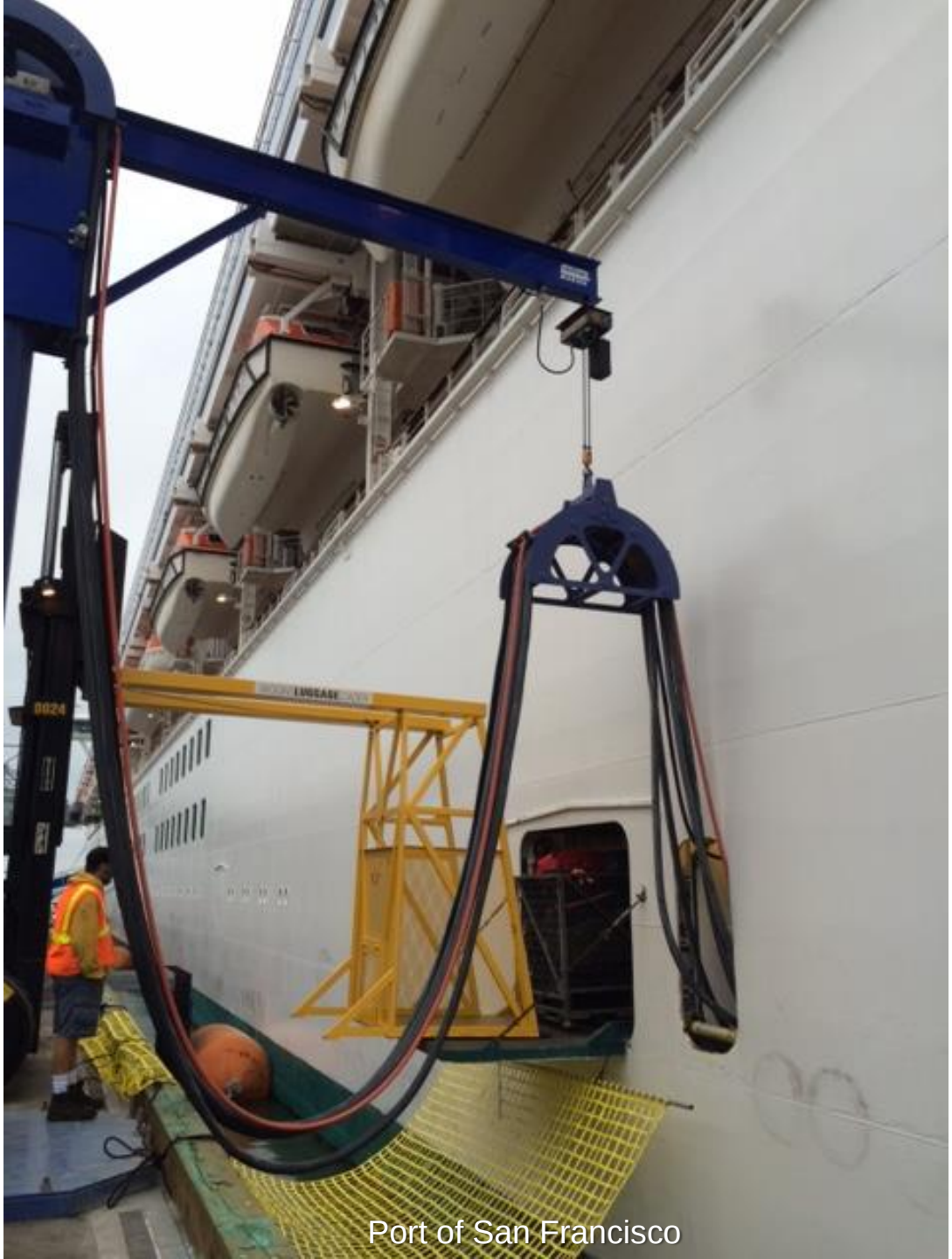
2011-2016: 728 hours

2016: 306 hours

Total Power Used:

2011-2016: 6,310,237 KWH

2016: 2,769,081 KWH



Port of San Francisco

Port of San Diego, California

Statistics

Date Completed: 2010

Annual Connections:

2010-2016: 172

2016: 36

Connection Duration:

2010-2016: 1,210 hours

2016: 256 hours

Total Power Used:

2010-2016: 1,896,633 KWH

2016: 8,250,314 KWH

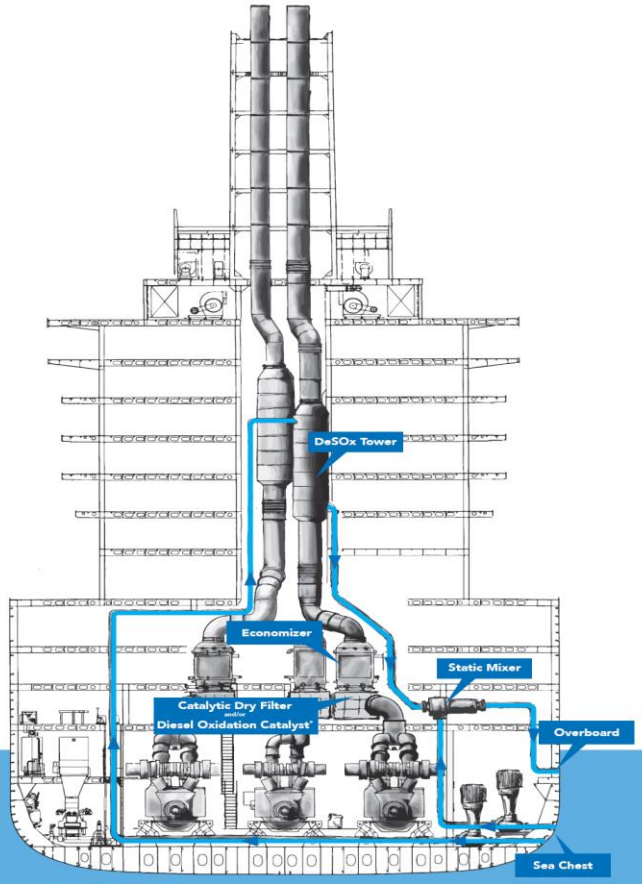
Port of San Diego

Port of San Diego

Carnival Exhaust Gas Cleaning Program

ECO-EGC SYSTEM OPEN LOOP

ECOSPRAY TECHNOLOGIES



* In cooperation with Haldor Topsoe S/A

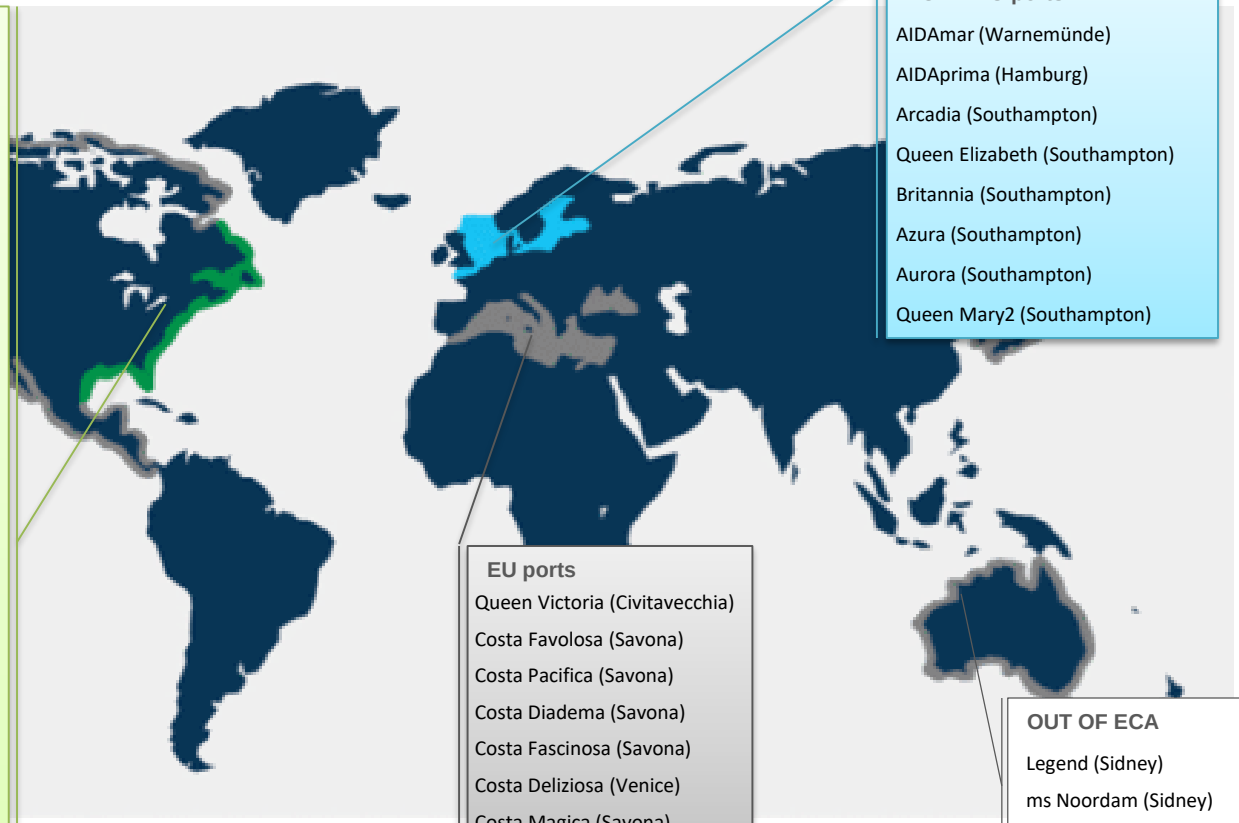
Exhaust Gas Cleaning System (EGCS) tower installation

Carnival Corporation EGCS ships - Q4 2016 operating areas

60 EGCS ships with 151 certified EGC systems

ECA+VGP

- AIDAluna (New York)
- AIDAdiva (New York/Montreal)
- AIDAvita (Miami)
- Carnival Pride (Baltimore)
- Carnival Freedom (Galveston)
- Carnival Breeze (Galveston)
- Carnival Paradise (Tampa)
- Carnival Ecstasy (Charleston)
- Carnival Victory (Port Canaveral/Miami)
- Carnival Magic (Port Canaveral)
- Carnival Elation (Jacksonville)
- Carnival Glory (Miami)
- Carnival Conquest (Ft. Lauderdale)
- Carnival Miracle (Los Angeles)
- Carnival Triumph (New Orleans)
- Carnival Fantasy (Miami)
- Carnival Valor (Port Canaveral)
- Carnival Sunshine (New York/Port Canaveral)
- ms Westerdam (San Diego)
- ms Amsterdam (San Diego)
- ms Nieuw Amsterdam (Ft. Lauderdale)
- ms Zuiderdam (Ft. Lauderdale)
- ms Veendam (San Diego/Ft. Lauderdale)
- ms Rotterdam (Montreal/Boston)
- ms Eurodam (Ft. Lauderdale)
- ms Oosterdam (Tampa)
- Star Princess (Los Angeles)
- Grand Princess (San Francisco)
- Crown Princess (Los Angeles)
- Ruby Princess (Los Angeles)
- Island Princess (Port Everglades/Los Angeles)
- Coral Princess (Port Everglades)
- Caribbean Princess (Port Everglades)



ECA + EU ports

- AIDAmar (Warnemünde)
- AIDAprima (Hamburg)
- Arcadia (Southampton)
- Queen Elizabeth (Southampton)
- Britannia (Southampton)
- Azura (Southampton)
- Aurora (Southampton)
- Queen Mary2 (Southampton)

EU ports

- Queen Victoria (Civitavecchia)
- Costa Favolosa (Savona)
- Costa Pacifica (Savona)
- Costa Diadema (Savona)
- Costa Fascinosa (Savona)
- Costa Deliziosa (Venice)
- Costa Magica (Savona)

OUT OF ECA

- Legend (Sidney)
- ms Noordam (Sidney)
- ms Maasdam (Auckland/Sidney)
- ms Zaandam (Buenos Aires)
- ms Volendam (Singapore/Hong Kong)
- Emerald Princess (Sidney)
- Golden Princess (Asia)
- Pacific Aria (Brisbane)
- Costa Luminosa (Asia)

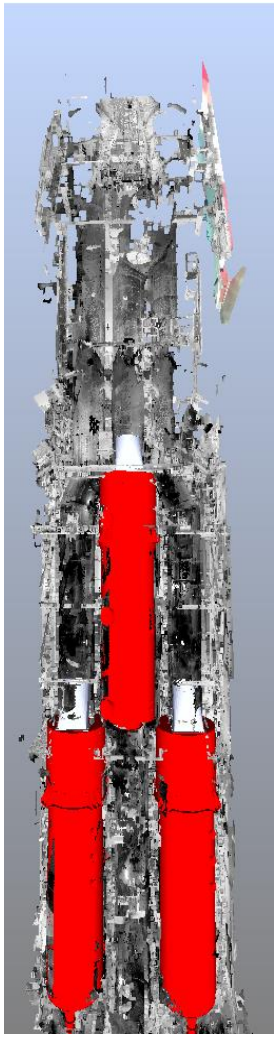
*most recurrent area during the Q4 period

Carnival Exhaust Gas Cleaning System (EGCS) Program

A major commitment to EGCS technology

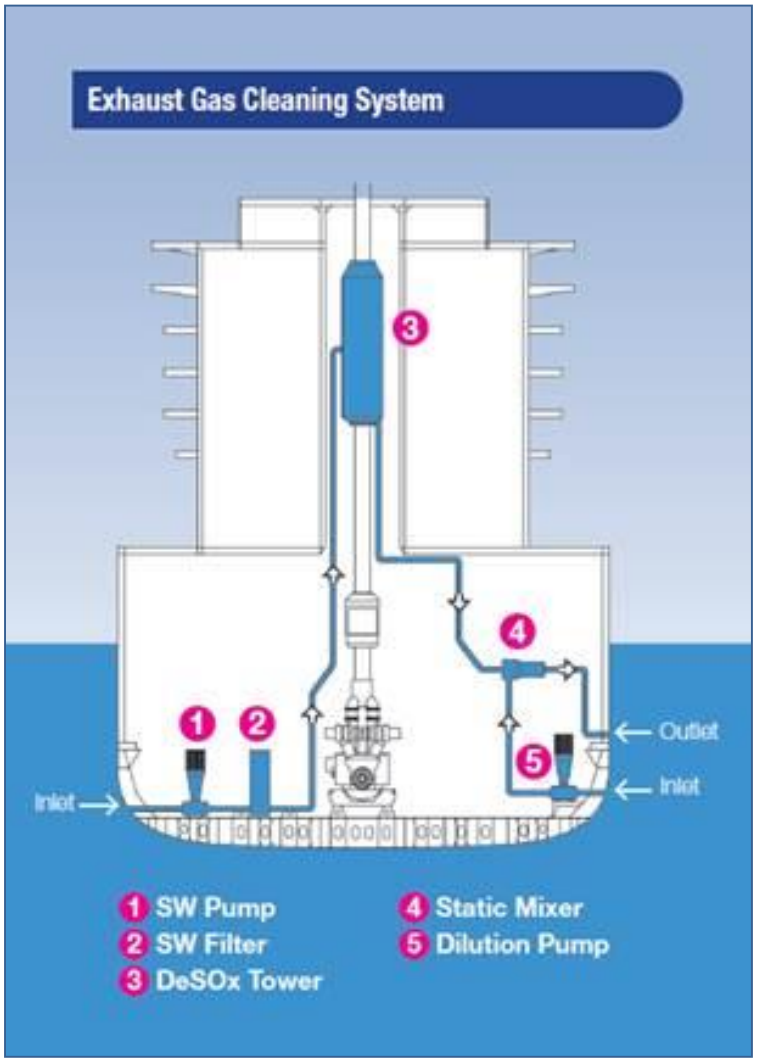
- First to start regular EGCS operation inside NorthAm and EU ECAs in March 2015.
- Developed in partnership with a leading scrubber engineering company,.
- Open-loop EGCS: safe, practical, environmentally sound.

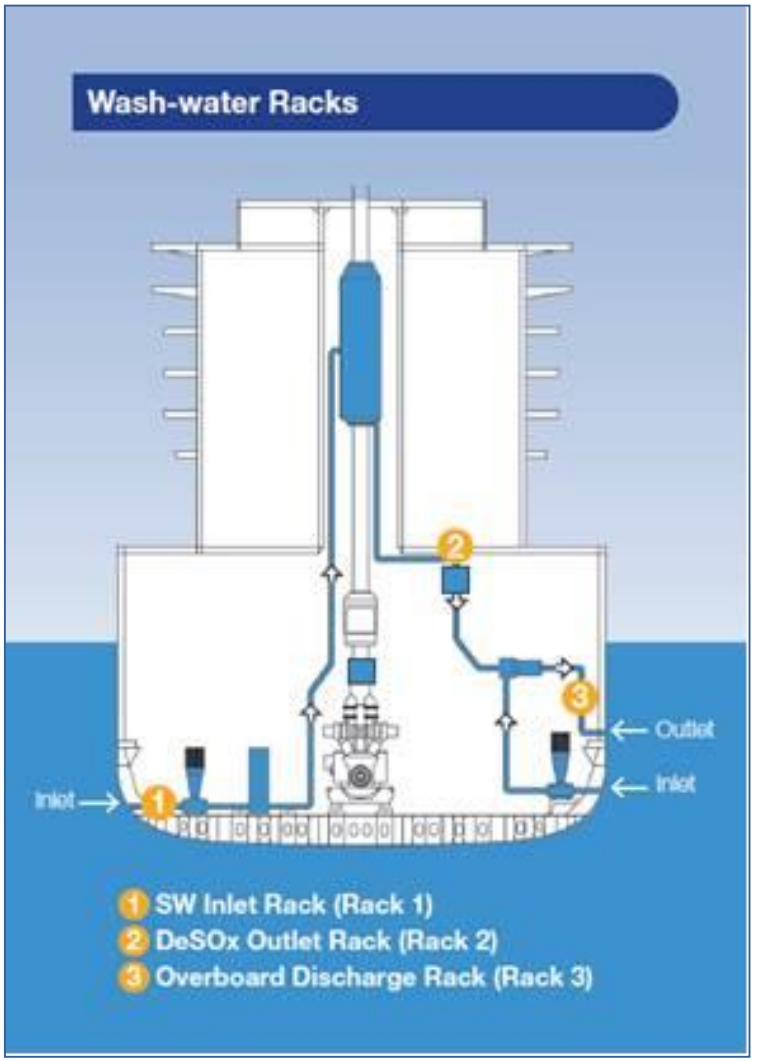
Towers – complex installations



Scrubber pump room “before--after”

Basic EGC System -- water flow and sampling





What's regulated?

For continuous monitoring: EGCS exhaust gas and wash-water quality

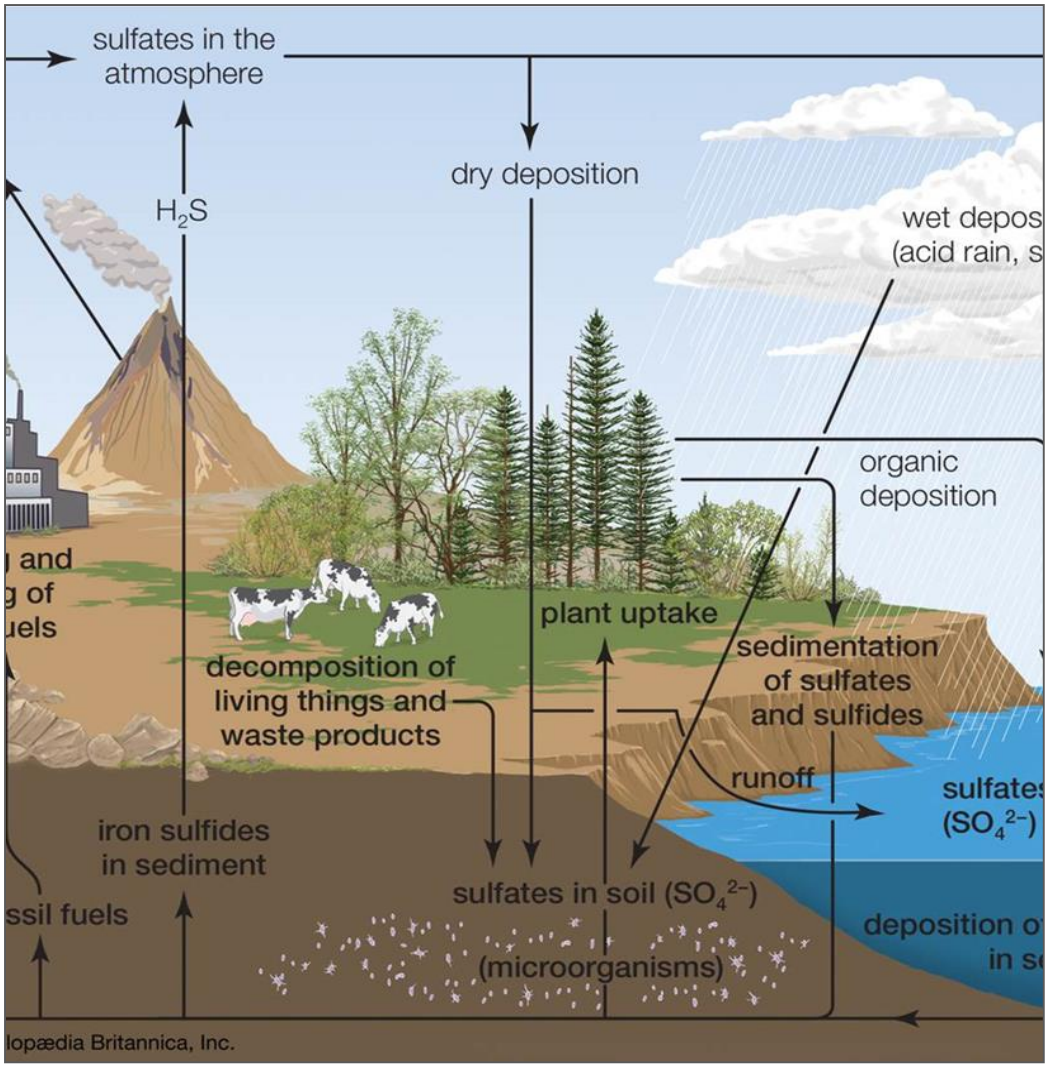
Regulated Item	US VGP waters (inside 3nm)	ECA's and EU Ports (Non-US VGP waters)
SOx	This is the calculated ratio between SO2/CO2 **= a limit of 4.3**. Equivalent to 0.1% sulfur in fuel.	Same
pH	pH at overboard discharge must always **be pH of 6.0 or higher**.	**pH at the discharge point must be high enough to ensure a minimum pH of 6.5 at 4m from the ship's side**. This is achieved by modeling or measurement, and varies for Carnival group ships between **4.0-5.5 pH at the discharge point**..
PAH	**< ~ 50 ppb (by formula)**	Same
Turbidity	**< 25 FNU (outlet – inlet)**	Same

Most commonly asked environmental question is…

Are we just taking sulfur from the air and putting into the ocean?

Simply, the answer is yes, we are taking sulfur from the air and putting in the ocean, though this is not a negative *but is a natural and inevitable process.*

Removing the sulfur compounds from the exhaust gas reduces the potential of the formation of acid rain and impact on humans and other living organisms. This bypasses that part of the cycle, *returning the sulfur to the ocean, which is a natural reservoir*.



Beyond regulations, some environmental benefits

Air Quality

- ***Reduced Sulfur levels, PMs(PAH's), CO, NOx***
  - ***Sulfur*** *-- SO2/CO2 ratio under 4.3, the equivalent of 0.1% sulfur*
  - ***Total PM reduced by 30-50%,*** *depending on engine load,*
  - ***Further PAH's, CO and Nox reductions*** *with added systems..*

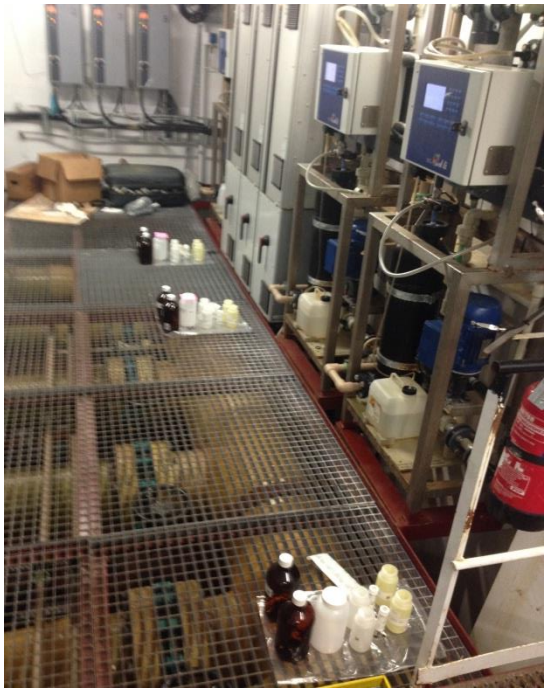
Water Quality

- ***Normal washwater****: lab analysis campaign shows wash-water well within IMO, VGP, Alaska, Baltic, and other major world discharge standards. Needed for: IMO, US EPA, Alaska, etc.*
- ***With added filtration:*** *significantly lower in most parameters.*

EGCS Washwater Sampling & Analysis Campaign

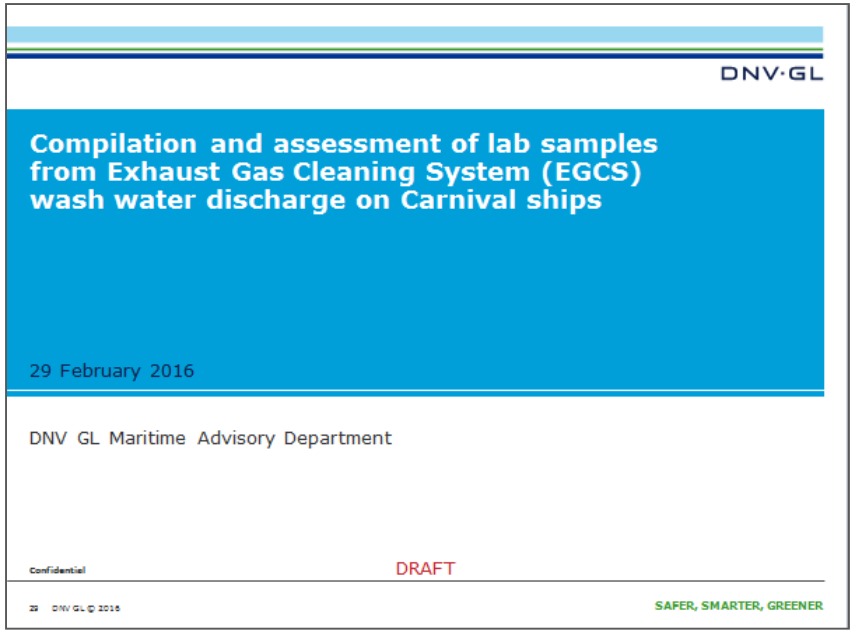
Wash-water sampling campaign analyzes over 50 parameters to provide fullest understanding of wash-water quality.

- Protocol developed in cooperation with labs, is consistent with the guidelines set forth in 40 CFR Part 136
- A sampling training program ensues that samples are collected in an appropriate and consistent manner.
- Sample kits are prepared and supplied by labs according to the method guidelines.



Some current studies

- ***Carnival/DNVGL(Oslo).*** Compares washwater lab analyses from 35 ships (85 samples) to well-known water standards beyond the regulatory standards, for a broad perspective::


DNV·GL

Compilation and assessment of lab samples from Exhaust Gas Cleaning System (EGCS) wash water discharge on Carnival ships

29 February 2016

DNV GL Maritime Advisory Department

Confidential DRAFT

SAFER, SMARTER, GREENER

- ***CLIA/University of Delft.*** To evaluate environmental impact of open loop EGCS in European ports.

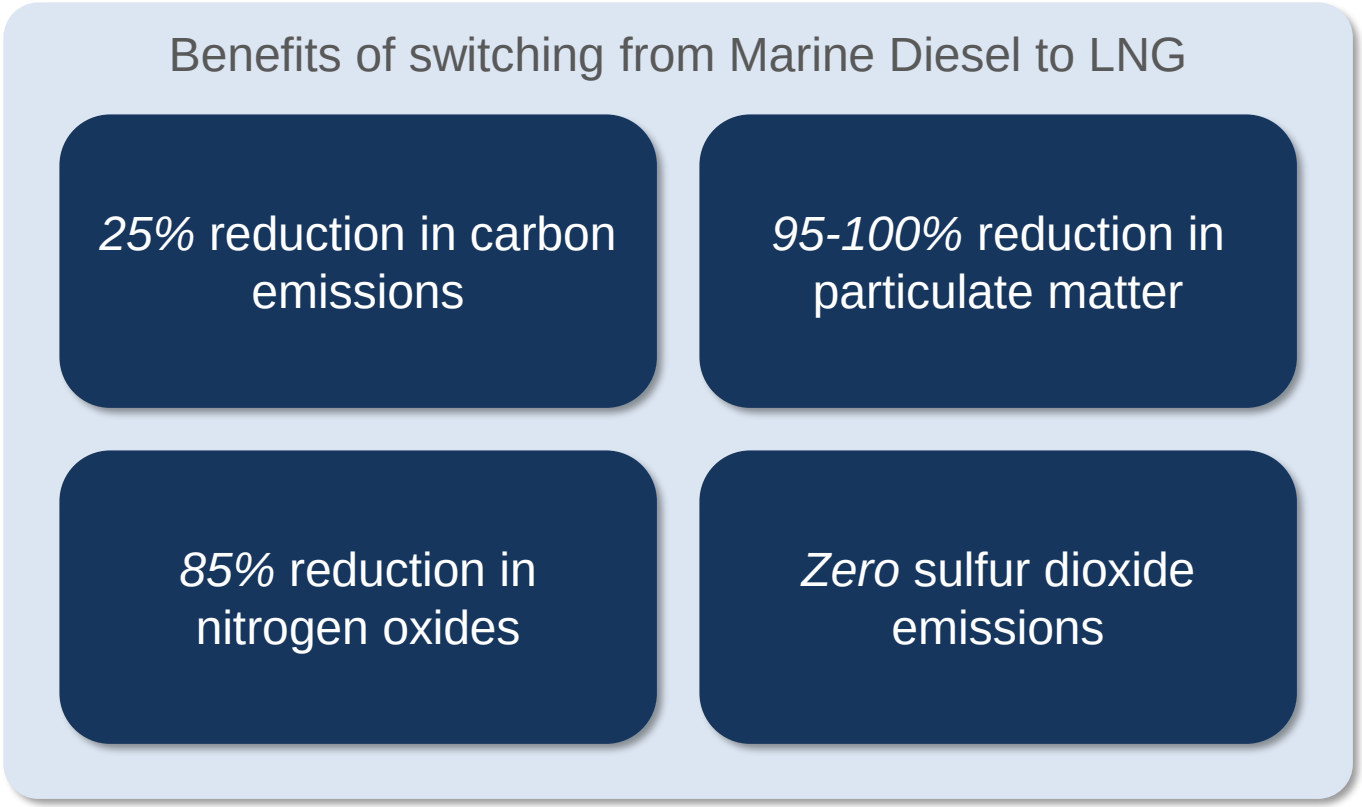
- ***Cetena (Italy).*** EGCS/HFO vs. MGO engine exhaust analysis study

- ***EPA/University of California.*** Evaluate the effectiveness of EGCS plus added filtration systems for reducing PM including PAH in marine diesel engine exhaust.

Carnival Liquid Natural Gas (LNG) Program

Why LNG?

- New platform allows us to consider all options and to future proof our vessels from ever increasing environmental regulatory pressure
- Environmental benefits + changes in regulatory & supply chain factors + economics = favorable choice for LNG



Carnival's LNG strategy

- In 2015, AIDAsol was the first cruise ship to be supplied with power from an LNG-Hybrid barge
- The AIDAprima was delivered in 2016 and uses LNG in port
- We have seven LNG powered next-generation cruise ships on order
- By 2019 we will be the first cruise company to use LNG at sea/in port with our first fully LNG-powered ship.

AIDAPrima

- 1st cruise vessel with a dual fuel main engine and auxiliary boiler
  - Allows the use of LNG as a fuel source when at berth to generate electricity and steam/hotwater for the hotel load.
- The dual fuel engine is supplied by onshore LNG truck
- Regular 7-day-schedule calling Hamburg, Le Havre, Southampton, Zeebrugge and Rotterdam throughout the entire year
  - Truck delivery to each port
  - Different approach taken by each national authority
  - Approvals gained from each respective local agency

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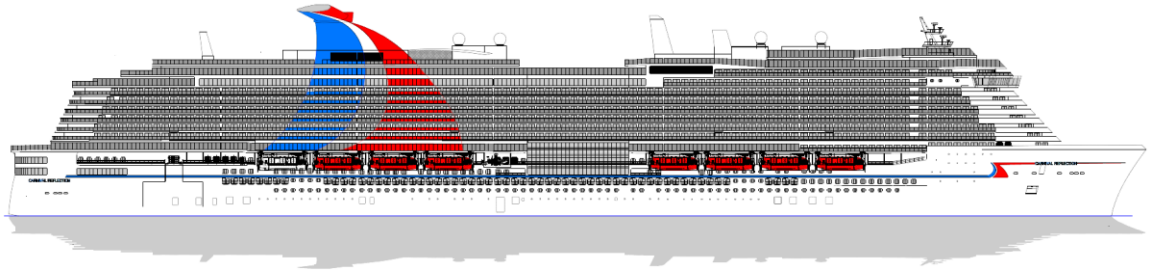
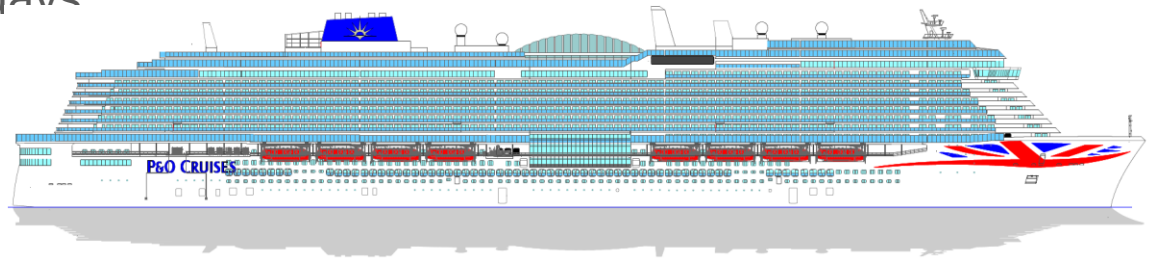
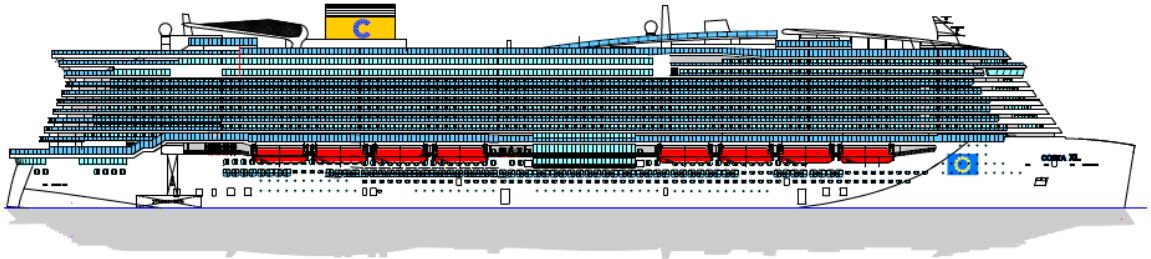
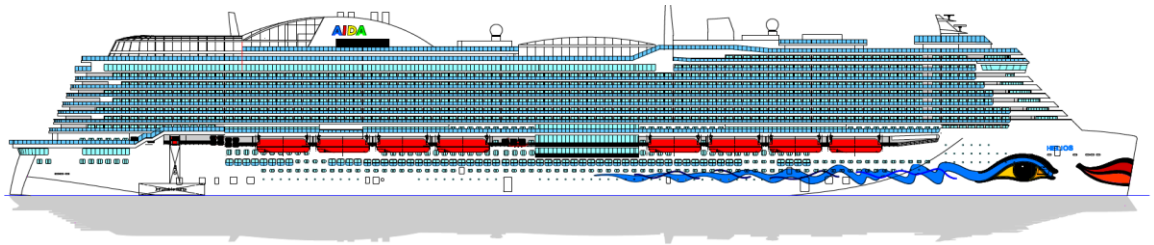
Next generation - ONE platform for ANY brand

- 180,000 grt
- 6500 pax (max)
- Bunkering LNG
  - Every 14 days via barge
- 3 type C tanks
  - 3600m³ capacity









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Some initial lessons learnt

- Safety is critical – choose partners who share the same values and objectives
- LNG is available, but not always everywhere
  - Cost is relative to distance from source
- Long term strategic relationships and commitments are needed to ensure reliability
- Don’t reinvent the ‘wheel’. Use existing industry associations
  - SGMF for bunkering guidelines & competency standards
  - SEA\LNG is a strategic coalition across the whole LNG value chain
- Relationships with all the stakeholders are essential, especially with the regulators
  - Keep them informed
  - Work with Coast Guards
- Not all ports are the same.

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Thank you