

# Role of LNG & Smart Ships in Reducing GHG

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**LNG & Hybrid – Asia**

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# JOURNEY SO FAR

AOG 2017 – LNG AS A MARINE FUEL

AOG 2018 - MARINE GAS FUTURE – MAKING IT A REALITY

## RECAP - 2018

Emission – Why we need to change

Challenges & Options

Is the industry and technology ready?



# THIS IS WÄRTSILÄ

A global leader in smart technologies  
and complete lifecycle solutions for  
the marine and energy markets

# MARINE SOLUTIONS

Committed to this journey...

...towards a Sustainable Future

# MARINE SOLUTIONS THE MOST COMPLETE MARINE OFFERING ON EARTH





LOCAL

$\text{NO}_x$

Acid rains  
Tier II (2011)  
Tier III (2016)

LOCAL

$\text{SO}_x$

Acid rains  
Sulphur content in fuel  
SECA (2015) – Global 2020/2025

LOCAL

Particulate  
matter

Direct impact on humans  
Locally regulated

GLOBAL

$\text{CO}_2$

Greenhouse effect  
Under evaluation by IMO  
EEDI / SEEMP

## Emissions from engines can be divided in two categories

Gas engines can have negligible local emissions and deliver substantial GHG benefits



### Category 1: Local emissions: health & environment related

- Contribute to deterioration of human health, loss of wellbeing, early death
- Mainly NO<sub>x</sub>, SO<sub>x</sub> and particulates
- Also impact the natural environment (flora & fauna) on short term
- Impact depends very much on location of emission. Focus on densely populated areas and sensitive ecosystems



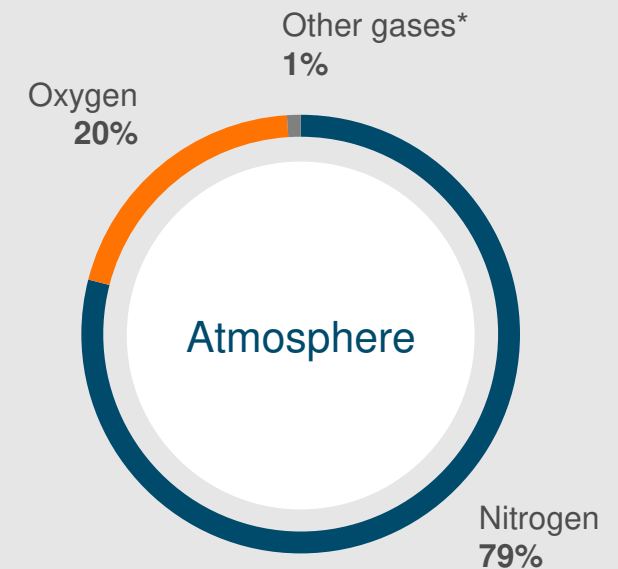
### Category 2: GHG emissions: climate related

- Contribute to global warming / climate change
- Mainly CO<sub>2</sub> and CH<sub>4</sub> (methane)
- Low to no impact on human health or the natural environment on short term
- Impact is not dependent on location of emission, as climate change is a global problem

## Physics govern the formation of emissions

Emissions are formed during fuel combustion. Either from full or partial combustion of fuel, or by reaction of components in air due to high temperature and pressure

- $\text{CO}_2$  stems from carbon in the fuel, bonded with atmospheric oxygen
- $\text{CH}_4$  is simply non-combusted natural gas, hence the term “methane slip”
- Nitric oxides or  $\text{NO}_x$  forms from atmospheric oxygen and nitrogen in the high temperature combustion zone
- $\text{SO}_x$  is combusted Sulphur that was present in the fuel, bonded with atmospheric oxygen
- Particulates consist of non- (or partially) combusted fuel, lubricating oil, dust present in intake air or from other sources. It is a blanket term covering all kinds of emissions, from simple elemental carbon to highly complex structures



\*) “Other gases” includes carbon dioxide (0.03%) and small proportions of argon and water vapour.

## Three principle sources of unburnt fuel in premixed charge gas engines

### FLAME QUENCHING IN THE BULK CHARGE

- Lambda distribution
- Residuals from previous cycle
- Temperature

Generally load dependent in g/kWh

### SCAVENGING LOSSES

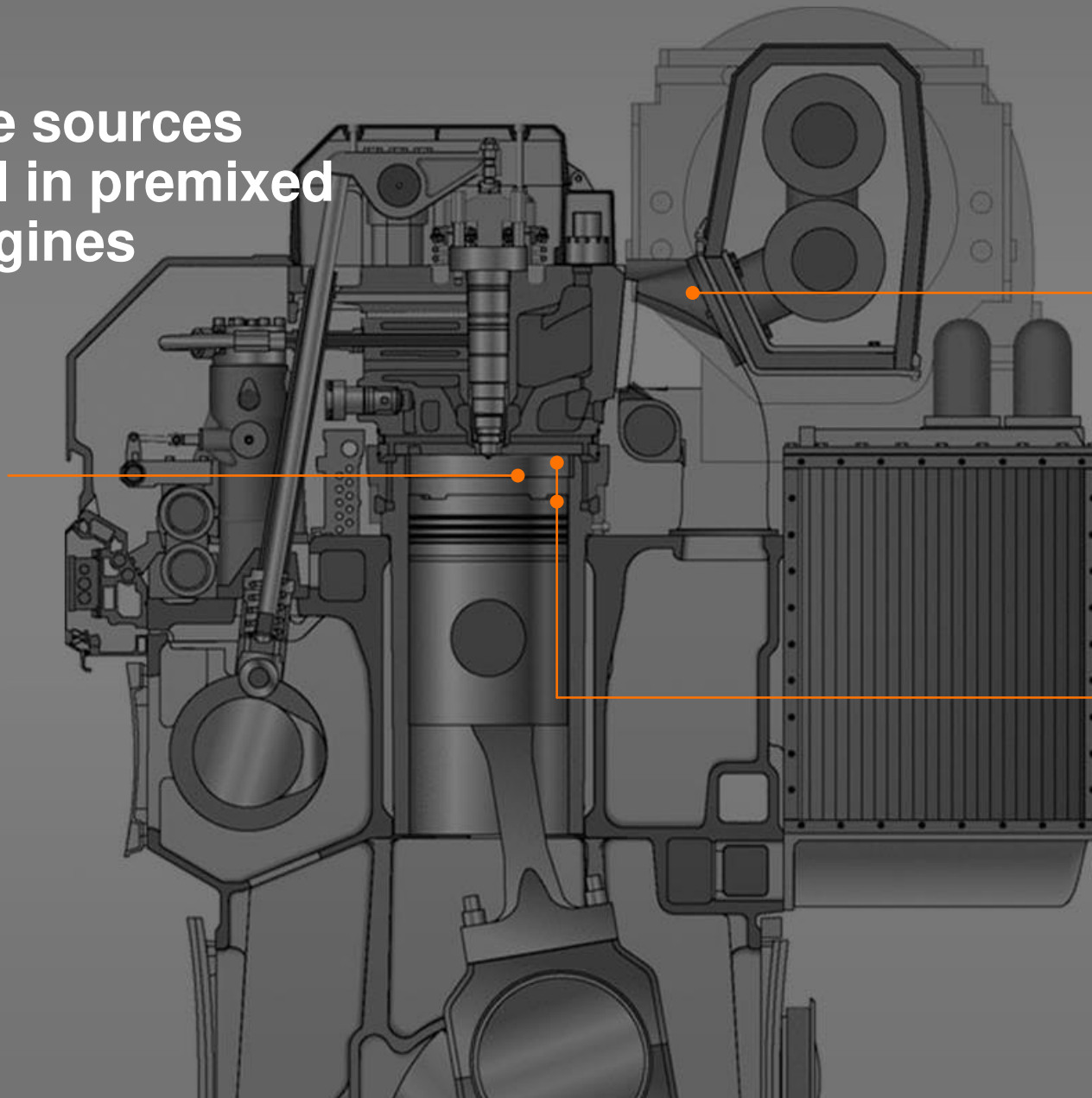
- Valve overlap
- Pressure differential

Generally not load dependent in g/kWh

### FLAME QUENCHING IN CREVICES

- Above top ring
- Between liner & head
- At Anti Polishing Ring

Generally not load dependent in g/kWh



## Many options exist to reduce GHG emissions

GHG reduction technology can be grouped in the following way:



Engine efficiency improvements, leading to lower engine CO<sub>2</sub> emissions

Fuel de-carbonization, utilizing fuels with a lower carbon content


**Example 1:** LNG vs. diesel. Per unit of energy, LNG causes ~20% less CO<sub>2</sub> emission

**Example 2:** Biofuels that have a negative CO<sub>2</sub> emission during their production; either by absorbing CO<sub>2</sub> from the air, or by avoiding emissions when feedstock is not used as fuel.

Lowering non-CO<sub>2</sub> emissions. Prime example is CH<sub>4</sub> emitted from gas engines.

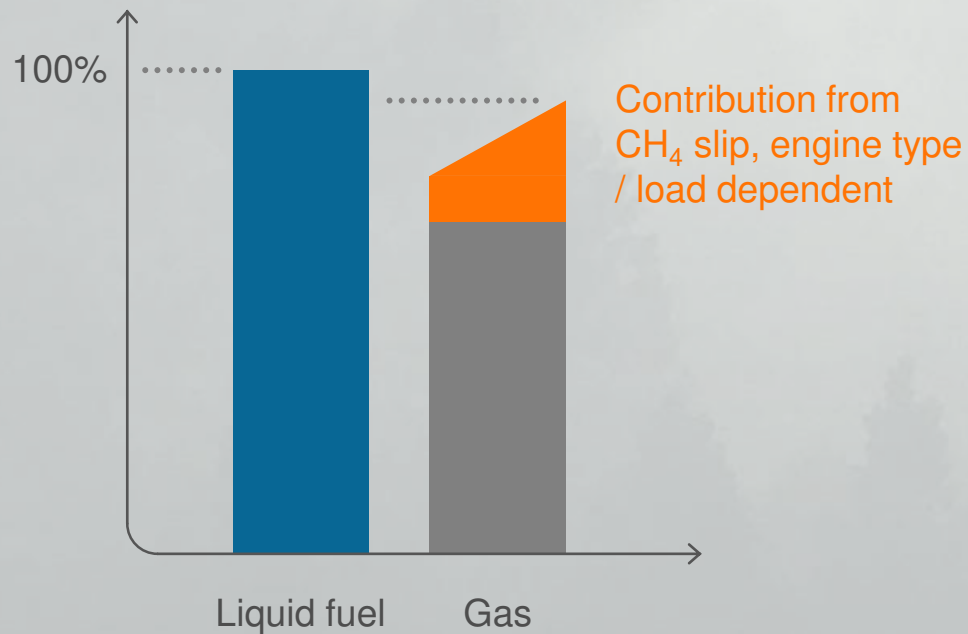
**Example 1:** lowering engine-out emissions by improving combustion

**Example 2:** lowering stack emissions by using after treatment

 The following slide shows a number of CH<sub>4</sub> emission mitigating technologies.

## Diesel and gas engines produce greenhouse gases...

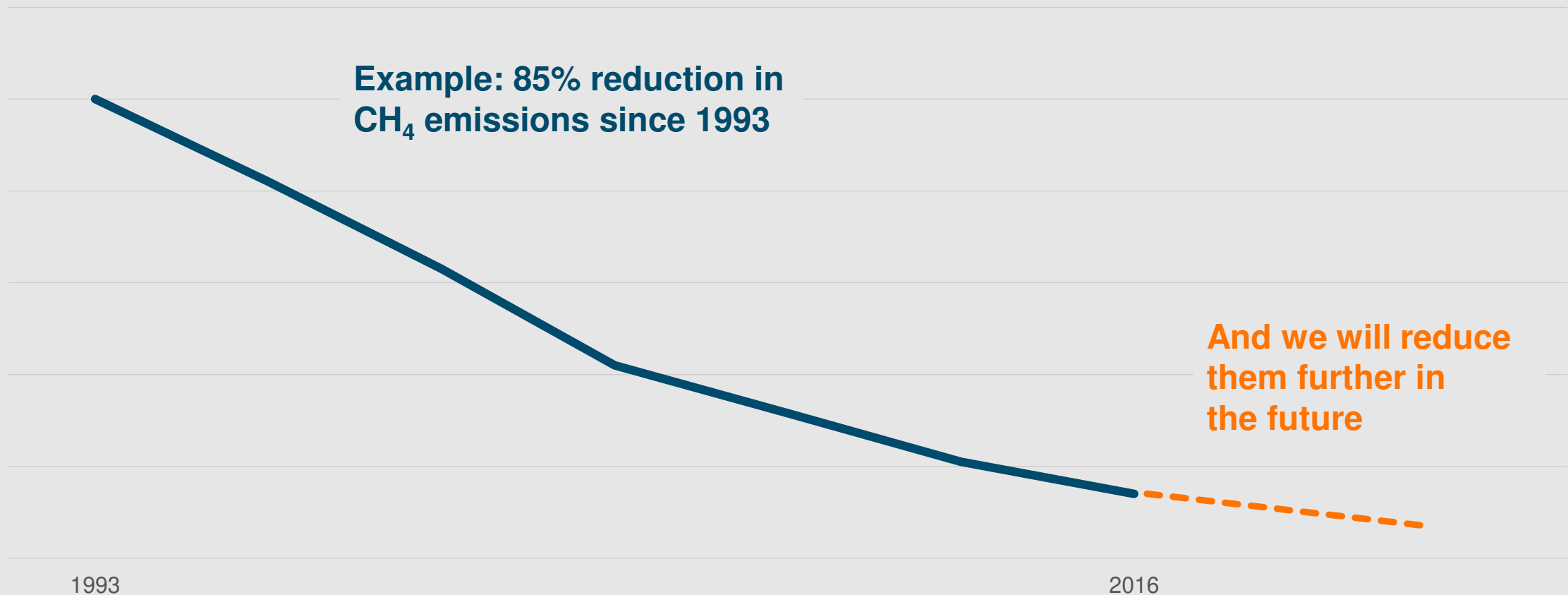
### Indexed GHG emissions as CO<sub>2</sub> equivalents



**...but gas engines compare favorably to diesel engines!**

# GHG emissions from Wärtsilä engines have been decreasing for decades

Wärtsilä gas engines now outperform Wärtsilä diesel engines by 12-30%





## Combination of efforts

E.g. optimized propulsion systems, propulsion energy saving devices, hull and ballast optimization, trim optimization, air lubrication

E.g. highest efficiency and cleaner fuels

Optimized  
Voyage

Vessel  
Energy  
Need

Power  
Distribution

Efficient  
Energy  
Generation

E.g. lowest possible speeds and optimum routing and digital port integration

E.g. hybrids and associated battery storage, power-take-in from renewable sources such as wind, solar

## Asset Management

Power Supply  
NavCom  
Ship Monitoring  
Automation  
Ship Performance  
Environment  
Propulsion  
Fuel Gas

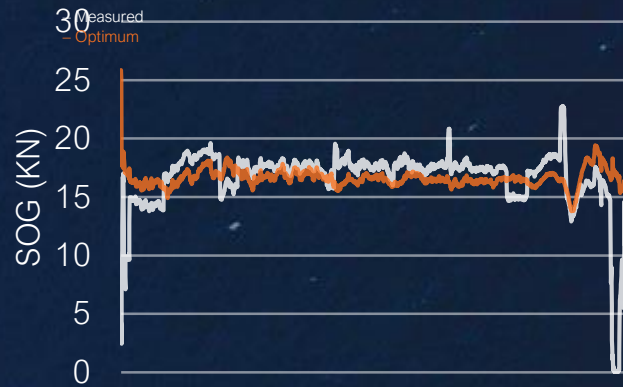
## Voyage Management

Voyage Optimization  
Smart Port Connection  
Fleet Optimization  
Ship Traffic Control



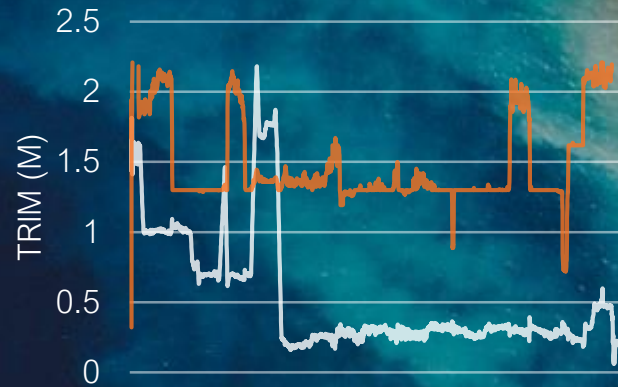
**Smart Vessel**

# OUR VOYAGE



SPEED & POWER PLANT

-7.1%



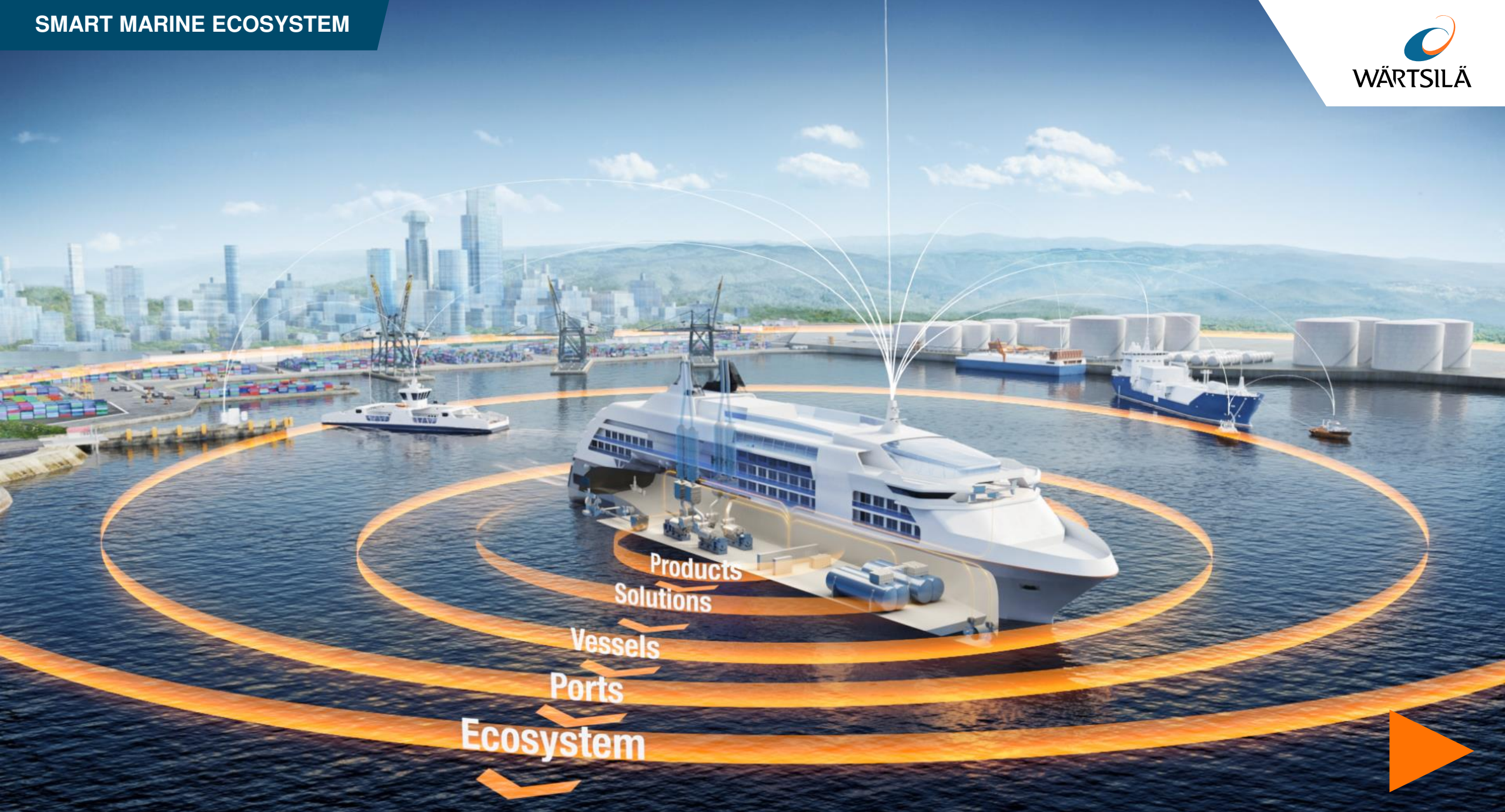
TRIM

-2.1%



ROUTE

-2.7%



## GHG emission reduction strategy – A challenge for the industry

- A huge challenge for the industry
- Keeping in the mind of the following parameters:
  - The increase of shipping
  - Renewal rate of global fleet
  - No single solution available
- However the challenge is positive, if various stakeholders work together, huge potential for whole value chain
  - Increased efficiency
  - Reduced emissions
  - Increased safety of the operations

## No single solution available

- The future roadmap should be based on the combination of various technologies and solutions including
  - switching to cleaner fuels
  - designing more efficient vessels
  - utilization of hybrid technologies
  - making vessels more intelligent
  - Integrating vessels to ports

## Solution provider perspective

- Engine type specific solutions required - Increasing portfolio flexibility
- Limited interest for total optimization of the vessel design and performance
- Availability of alternative fuel infrastructure, e.g. LNG



THANK YOU



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