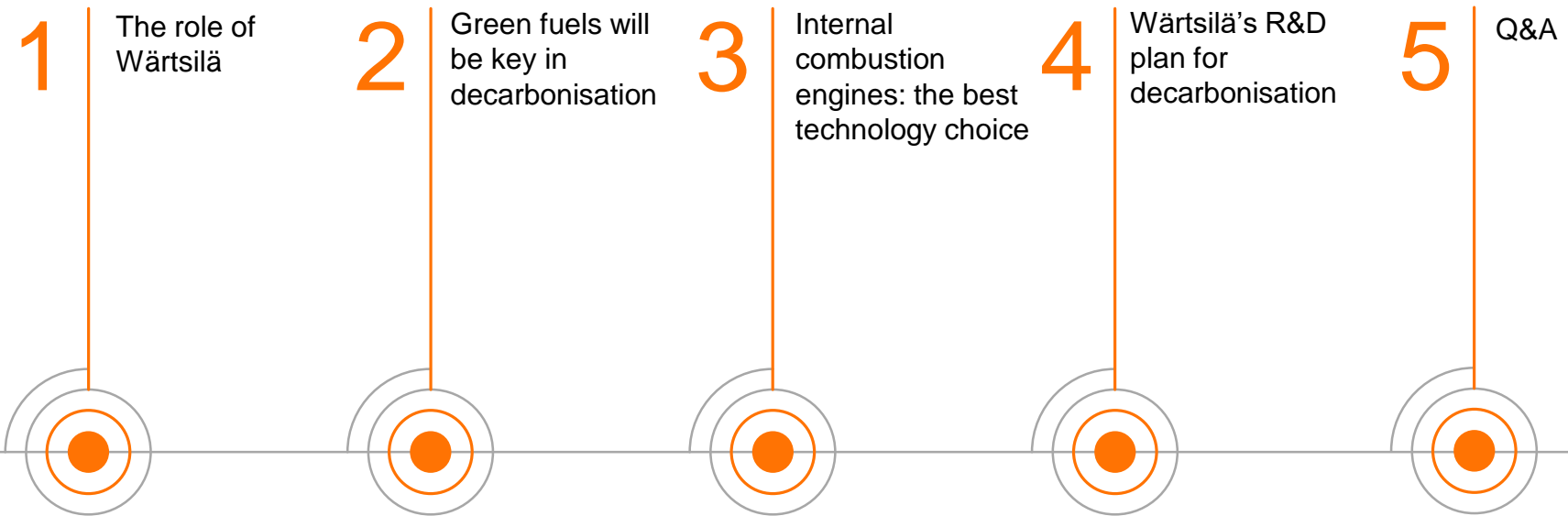


# WÄRTSILÄ & HYDROGEN

Dr Juha Kytölä  
Director R&D and Engineering

## TOPICS FOR TODAY





OUR PURPOSE:

# ENABLING SUSTAINABLE SOCIETIES WITH SMART TECHNOLOGY

SHIP TECHNOLOGY

ENERGY PLANTS

LIFECYCLE FOCUS



FOUNDED IN 1834

# GLOBAL LEADER

in sustainable solutions for the marine and energy markets

COMPARABLE OPERATING  
RESULT

**457 MEUR**

ORDER INTAKE

**5,327 MEUR**

NET SALES

**5,170 MEUR**

OPERATIONS IN OVER

**200 LOCATIONS**

OUR PERSONNEL

**19,000**

NATIONALITIES

**140**

Financials are for fiscal year 2019. Location, personnel and nationalities figures are approximations based on the status in December 2019.



# 164 MEUR

In 2019 research & development investments amounted to 164 MEUR, representing 3.2% of net sales.

# 2,900 PATENTS AND APPLICATIONS

Approximately 2,300 patents and 600 patent applications.



# FOCUS AREAS FOR OUR RESEARCH & DEVELOPMENT



**FUEL FLEXIBILITY  
AND FUTURE FUELS**



**OPTIMISING  
ENERGY SYSTEMS**



**TOWARDS  
DECARBONISED  
MARITIME**

# ENABLING SUSTAINABLE SOCIETIES MEANS ADDRESSING CLIMATE CHANGE

## Energy

The path towards 100% renewable power generation means a shift of baseload towards renewables as wind & solar + flexibility for peaking

## Marine

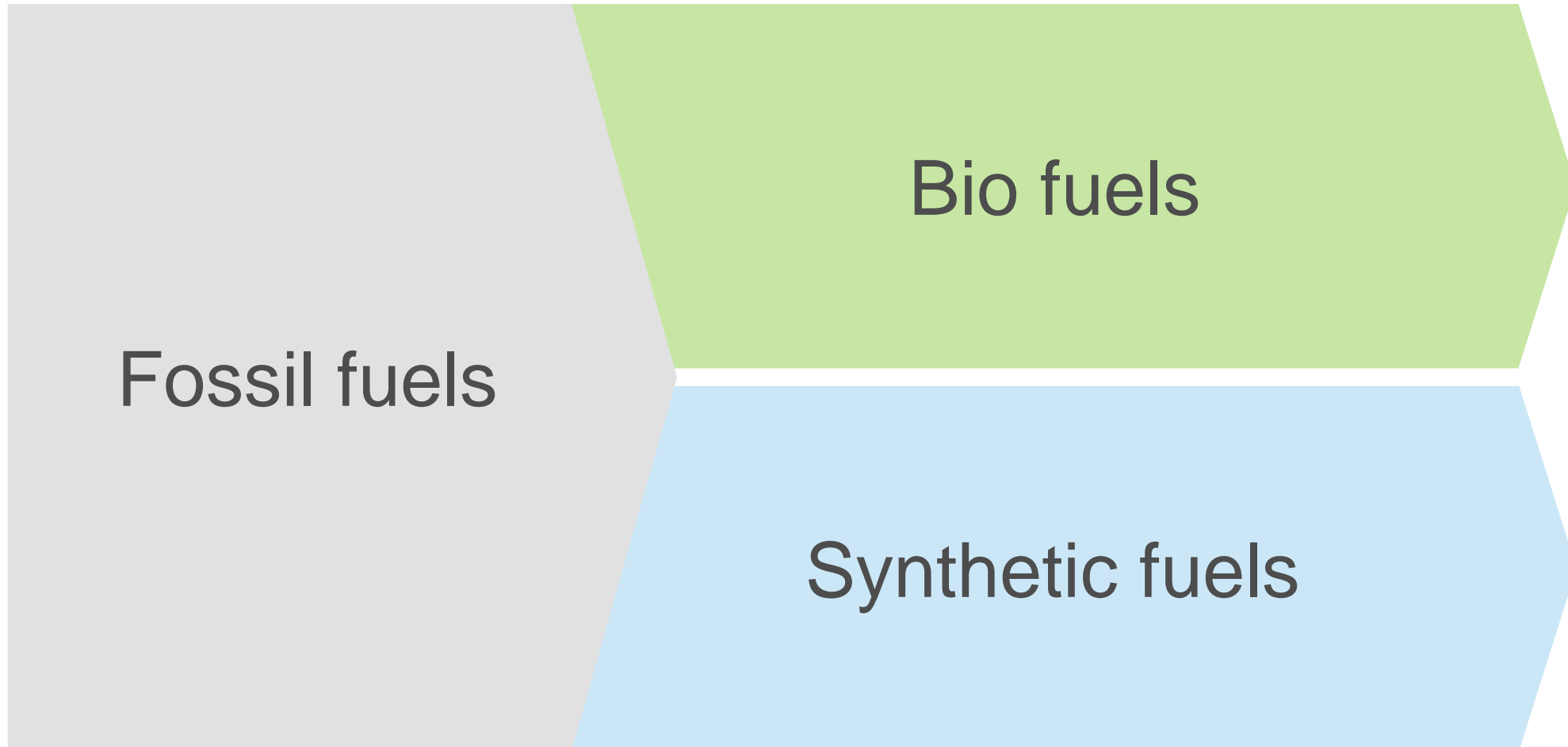
GHG reduction targets set by IMO will require a shift towards carbon neutral fuels

# Decarbonisation

# GREEN FUELS WILL BE KEY IN DECARBONISATION



## TRANSITION OF FUELS IS TAKING PLACE



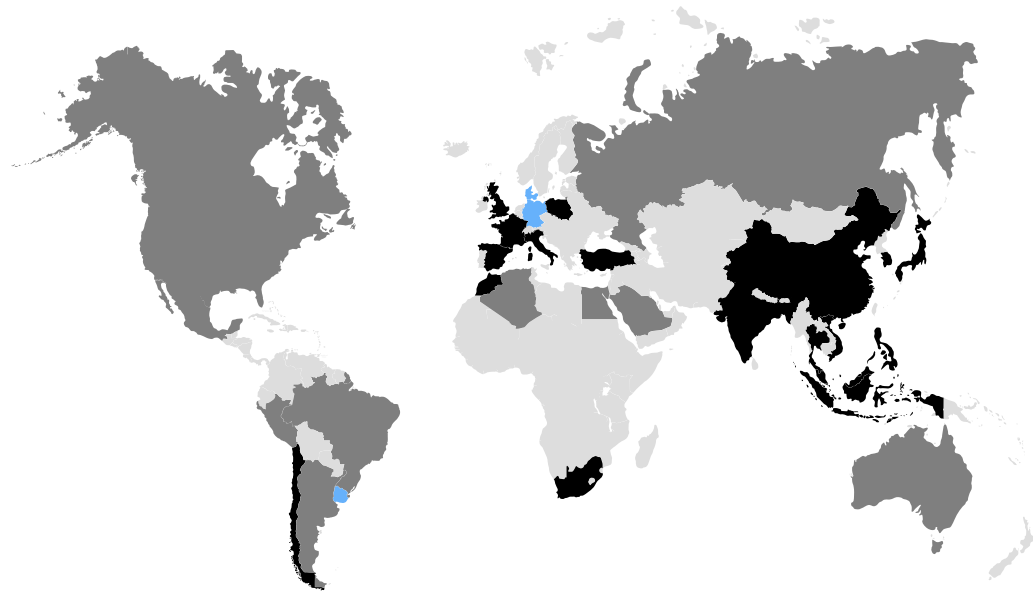
**Decarbonisation**

It is very likely that there will be multiple fuels in the market in the future



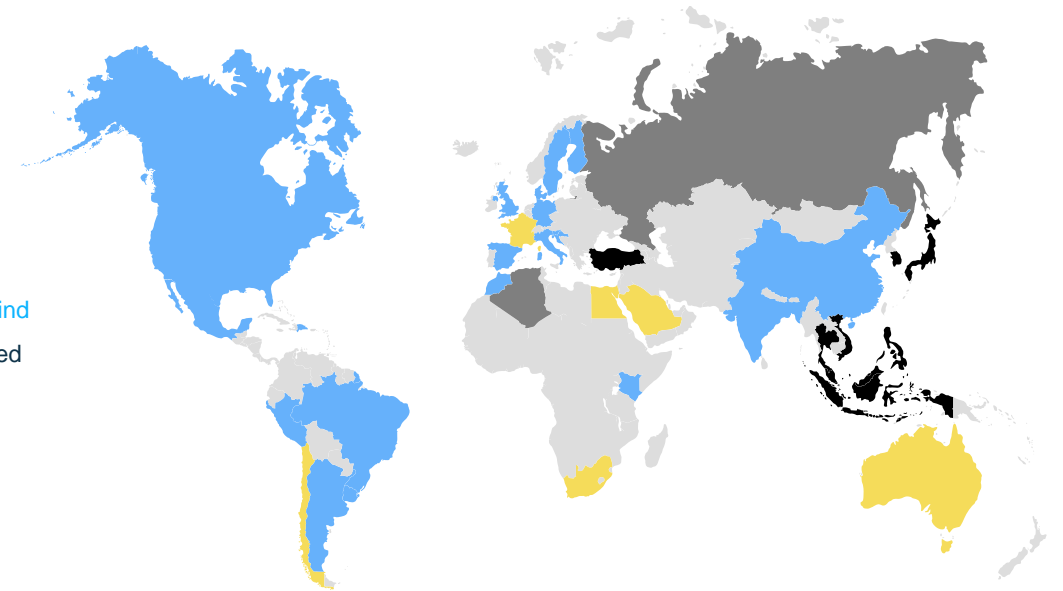
# PRICE ALONE WILL TURN MOST OF THE WORLD TO RENEWABLE ENERGY

MOST COMPETITIVE SOURCE OF NEW BULK GENERATION IN 2014



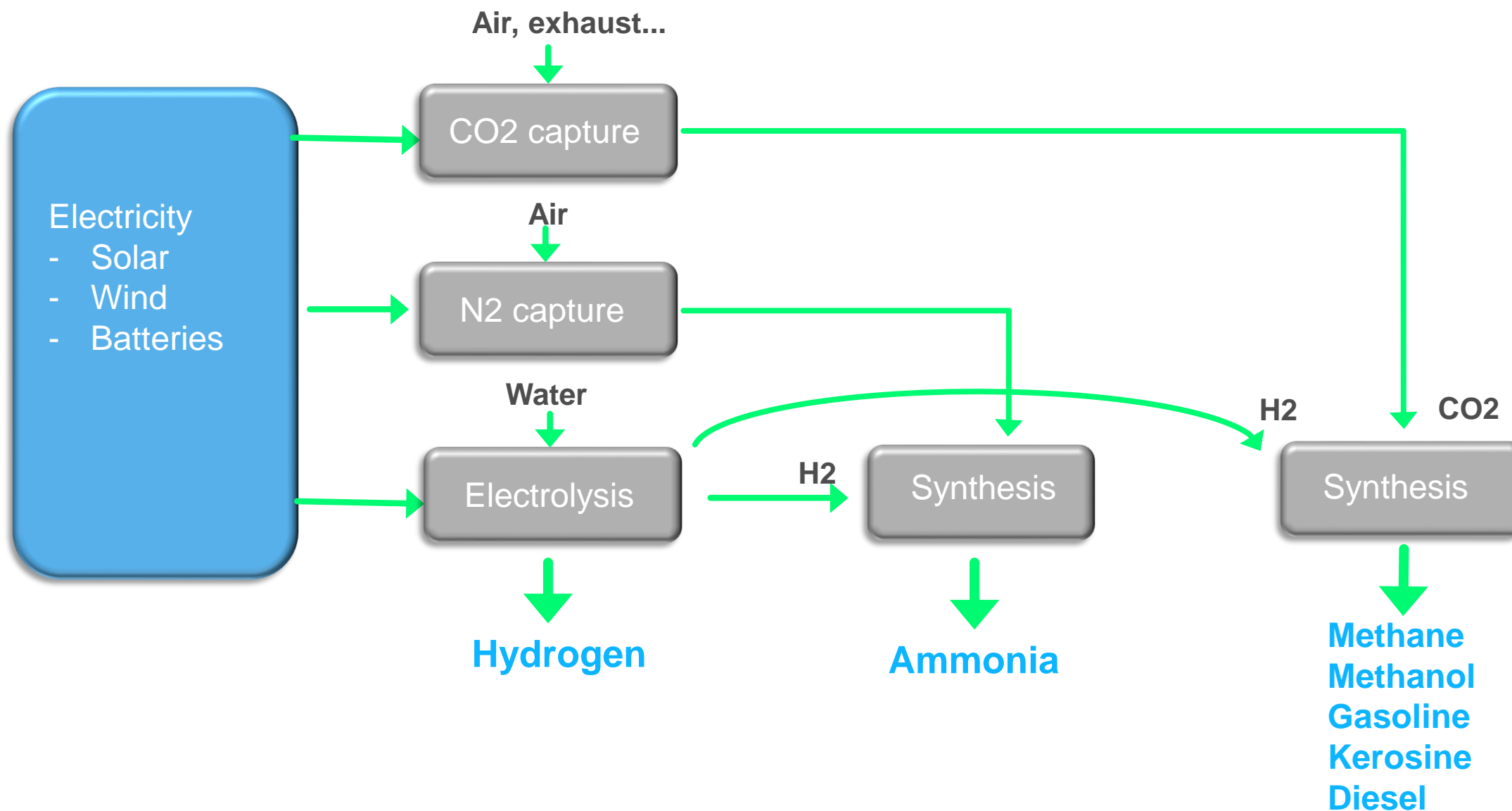
MOST COMPETITIVE SOURCE OF NEW BULK GENERATION IN 2020

- Coal
- Gas
- Solar PV
- Onshore wind
- Not identified



Source: BloombergNEF, Note: Reflective of the cheapest benchmark project for each technology and market

# SYNTHETIC FUEL PRODUCTION IS A KNOWN TECHNOLOGY





# NEW FUELS ENTERING THE MARKET

## Technology ready

### Fossil liquids

- High energy content
- Widespread availability

### Fossil gas

- Cleanest fossil fuel
- GHG reduction 5-20% depending on engine type (well-to-power)
- Widespread availability

### Bio and synthetic liquids

- GHG reduction 70-100% depending on source (well-to-power)
- Clear transition pathway as same infra can be used for all fuel types

### Bio and synthetic gas

- GHG reduction 70-100% depending on source (well-to-power)
- Clear transition pathway as same infra can be used for all fuel types

## Industrialisation needed

### Green methanol

- Carbon neutral
- Can be blended with liquids

## Under development

### Green Ammonia

- No CO2 emissions
- Can be blended with liquids or gases

### Green Hydrogen

- No CO2 emissions
- Can be blended with gases

# FUEL AVAILABILITY IS ONLY ONE OF THE DRIVERS

Many aspects to be considered in business



## FUEL AVAILABILITY

Variations due to local regulations and feedstock, production capacities and existing infrastructure

Marine

Energy



## INCREASED CAPEX AND OPEX

Carbon-neutral fuels typically require existing equipment to be replaced and are likely to be more expensive than fossil fuels at least initially

Marine

Energy



## INCREASED COMPLEXITY

Managing some cryogenic or toxic fuels will require more complex solutions to comply with rules and regulations

Marine

Energy



## IMPACT ON VESSEL STRUCTURE

Many carbon-neutral fuels will have lower volumetric energy density compared to HFO and LNG and require larger tanks to maintain vessel endurance

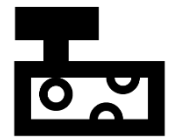
Marine



## SHIPYARD CAPACITY

There is a mismatch between the number of shipyards capable of handling the fuel conversion work and the size of the international commercial fleet

Marine



## AUXILIARY SYSTEMS AND STORAGE

Use of new fuels requires changes in auxiliary systems and potentially new storage systems

Energy



# INTERNAL COMBUSTION ENGINES: THE BEST TECHNOLOGY CHOICE

# RECIPROCATING ENGINES

- Highly tolerant for different fuels
  - different fuels can be combusted at the same time (liquid, gas)
- Best efficiency of any combustion method
  - highest combustion temperatures due to cyclic combustion
  - combustion is cyclic, thus materials stay cool  
(turbines, boilers... need low combustion temperatures)
- Engines can be modified / retrofitted for new fuels with minor effort
  - existing installations can be converted later in operational life





# WÄRTSILÄ'S R&D PLAN FOR DECARBONISATION

## Wärtsilä gas engines to burn 100% hydrogen

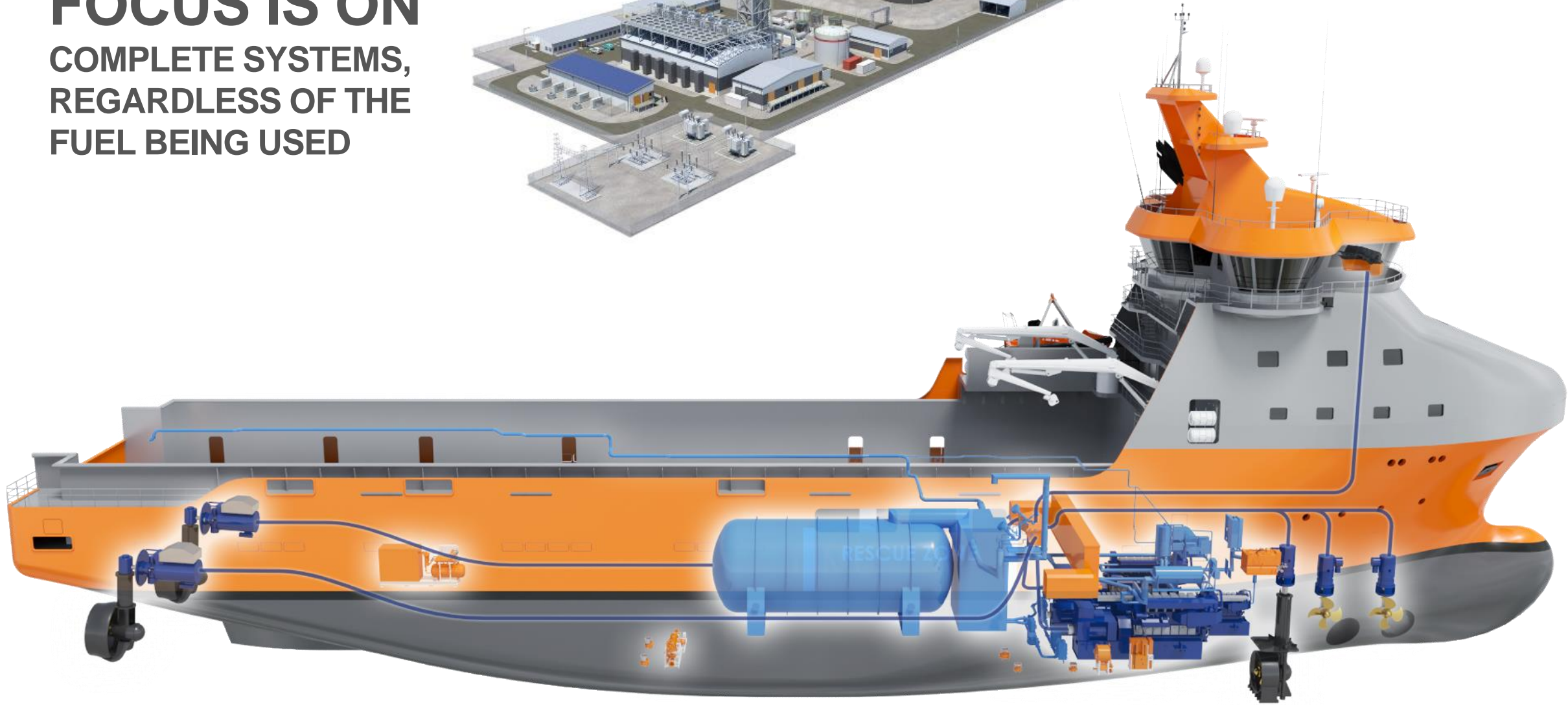
Wärtsilä Corporation, Press release, 5 May 2020 at 11:00 AM E. Europe Standard Time



The technology group Wärtsilä is developing the combustion process in its gas engines to enable them to burn 100% hydrogen fuel...tested its engines with blends of up to 60% hydrogen and 40% natural gas.. is part of the company's strategy to future-proof... the global trend towards decarbonisation of the energy and marine markets.

“The world is on a path towards 100% decarbonization, and Wärtsilä continues to support this trend with our research and development of future fuels, such as hydrogen. The market for hydrogen-fuelled power plants will emerge along with regulations restricting the burning of fossil fuels. We are well positioned to serve the power industry in its transition to 100% renewable electricity generation. Wärtsilä's engines, capable of running on a variety of sustainable fuels, are offering a highly dynamic balancing power for these future generating systems,” commented Marco Wiren, President, Wärtsilä Energy Business

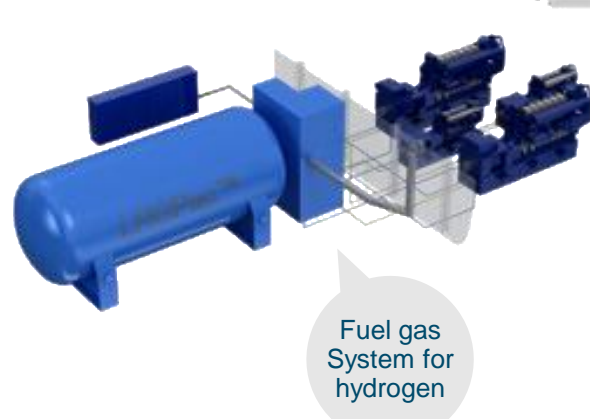
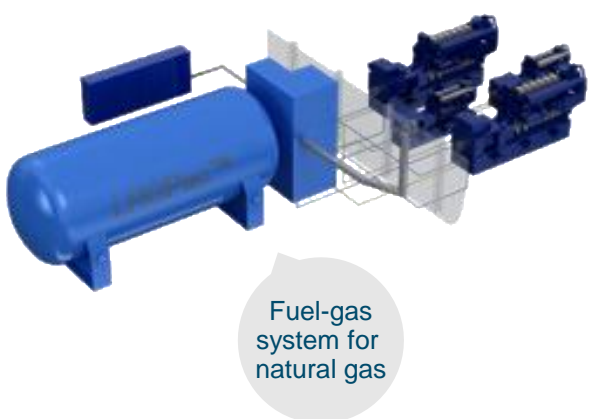
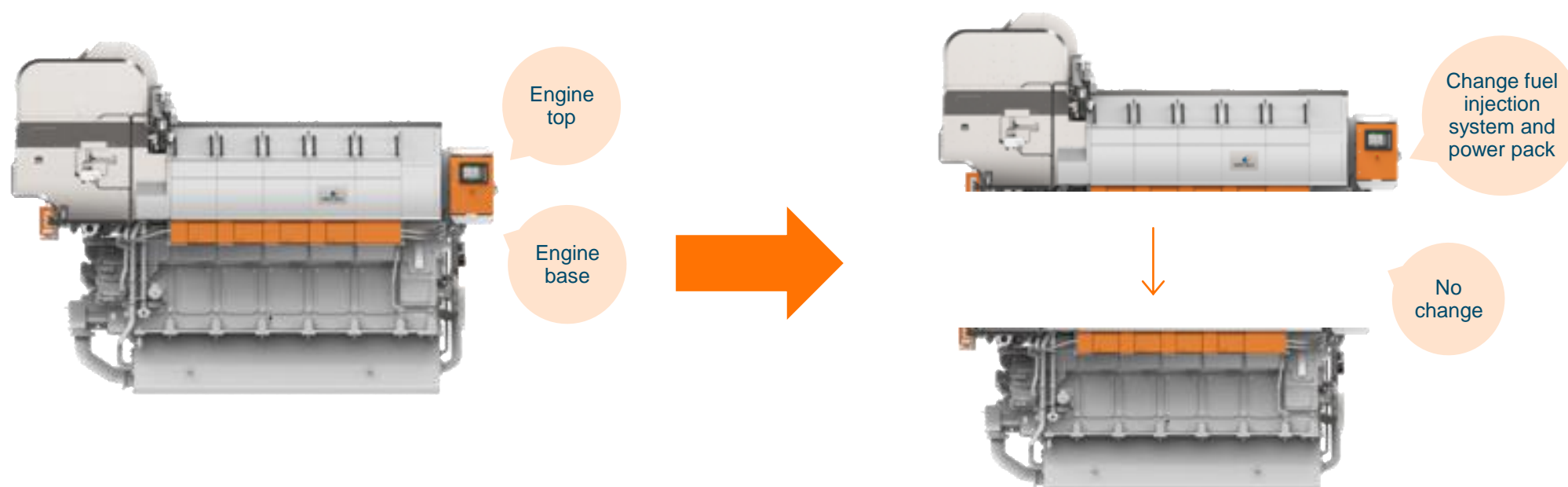
# FOCUS IS ON COMPLETE SYSTEMS, REGARDLESS OF THE FUEL BEING USED





# CONVERSION TECHNOLOGY FOR HYDROGEN

## CONVERSION LNG -> HYDROGEN





HYDROGEN PROVIDES AN OPPORTUNITY TO EXECUTE OUR PURPOSE:  
**ENABLING SUSTAINABLE SOCIETIES  
WITH SMART TECHNOLOGY**



**THANK YOU**