An economically feasible approach toward a sustainable future

Stefano Cantarut
Segment Manager Cruise & Ferry
THIS IS WÄRTSILÄ

A global leader in smart technologies and complete lifecycle solutions for the marine and energy markets
CLEAN ENVIRONMENT
A future without emissions or pollution

MARKET SHAPING & INNOVATION
A union of new technology and business models

ENERGY INTELLIGENCE
An optimised way of producing and using energy

WÄRTSILÄ’S PURPOSE is to enable sustainable societies with smart technology.
WARTSILA EXPERIENCE

Not only engine’s maker but also System integrator

Just two examples

2009

Viking Lady
330kW fuel cell – 18’500rhs
500kWh ESS
https://www.youtube.com/watch?v=BmCPYoIvBbM

2018

Victoria of Wight
408kWh ESS
https://www.youtube.com/watch?v=18k5XIABt-w

This document is the property of Wärtsilä which retains all rights, including copyrights, relating to the information contained herein. This document or any part hereof shall not be copied, reproduced, published, distributed or disclosed to a third party without the consent of the owner.
1. Assess the actual situation
2. Set the path
It’s a «diesel» world that is slowly changing toward LNG

Today world fleet fuel spread
(source Clarksons)

Diesel 68%
LNG 1%
Unknown 31% read «diesel»

On a total of about 123’000 ships

Today world fleet fuel spread – power
(source Clarksons)

Total installed power [GW]

Year Built


16% LNG
TCO – Total Cost of Ownership

The key parameter for decision making into the financial world

20y window for the marine business

Initial investment (CapEx)
- Machinery costs included
- Balance of plant NOT INCLUDED

Operating costs (OpEx)
- Maintenance costs included
- Fuel costs included
- Fuel supply costs NOT INCLUDED

20’000 kW
5000 rhs/y
CapEx - energy producer only*

SOFC
PEM
Reciprocating engine

Expected lifetime

Fuel cell
Reciprocating engine

Efficiency

Fuel cell
Reciprocating engine

Fuel prices

Hydrogen
LNG
HFO

Running hours [krhs]

0 100 200 300 400 500

0 2000 4000 6000 8000 10000

0 2000 4000 6000 8000 10000

Fuel cells are 10 – 30 times more expensive, with an expected lifetime that is less than 1/10

*Indicative market prices
**Total cost of ownership - 20'000 kW installation - 5000 rhs/y**

(initial CapEx + maintenance + fuel)

- **Initial investment:** 60 MEUR
- **First stack's replacement after 35'000rhs:** $1/2 \rightarrow 30$ MEUR
- **Second stack's replacement after 35'000rhs:** $1/4 \rightarrow 15$ MEUR

**TCO at 20 years:** 982 MEUR

- **Note:** worldwide availability of 20MW fuel cell?
- **Note:** worldwide availability of enough hydrogen for 1 ship?
Total cost of ownership - 20'000 kW installation - 5000 rhs/y
(initial CapEx + maintenance + fuel)

- Initial investment: 8 MEUR
- TCO at 20 years: 117 MEUR
- PEM running with hydrogen
- HFO reciprocating engine - Yearly maintenance: 5% of fuel bill

Who pays?
+ 43 MEUR/y
Total cost of ownership - 20'000 kW installation - 5000 rhs/y
(initial CapEx + maintenance + fuel)

Note: LNG reciprocating engine emits 30% less CO2 emissions than Diesel
ASSESSMENT

Total cost of ownership - 20'000 kW installation - 5000 rhs/y
(initial CapEx + maintenance + fuel)

Hydrogen price: 9500 EUR/ton

75% reduction of the hydrogen’s price in 20y scenario

Hydrogen price: 2375 EUR/ton

Who pays?

+ 27 MEUR/y average
How to make a sustainable future economically accessible? 

Not in one jump, we need middle steps!
Reciprocating engine running with hydrogen

- Reduced initial investment while fuel cell market would develop
- Possibility to run multiple fuels in order to reduce OpEx and operate worldwide while the hydrogen’s supply chain would develop

Fuel Cells fueled with LNG

- Possibility to run with available fuels worldwide
- Lower TCO at 20y than hydrogen
Reciprocating engines running with carbon neutral fuels (Liquid Bio Gas – LBG)

- Possibility to run with actual engine technology
- Almost Zero CO2 emission on the fuel cycle
- Low fuel costs
Total cost of ownership - 20'000 kW installation - 5000 rhs/y
(initial CapEx + maintenance + fuel)

Reciprocating engine running with LBG:
economically accessible in a wide range of fuel prices

Note
Used prices:
LNG: 350 EUR/ton
HFO: 350 EUR/ton
H2: 9500 EUR/ton
Flexible system architecture

Multi fuel & multi technology optimized integrated system