INNOVATIONS IN

LNG SHIPPING

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Reserves: Our use of the term "reserves" in this presentation means SEC proved oil and gas reserves. **Resources:** Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions. **Organic:** Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact. **Resources plays:** our use of the term 'resources plays' refers to tight, shale and coal bed methane oil and gas acreage.

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PROJECTED ENERGY OUTLOOK BY 2050

9 BILLION people, 75% living in cities

(2 BILLION more than today)

2 BILLION vehicles

(800 MILLION at the moment)

Many MILLIONS of people will rise out of energy poverty; with higher living standards energy use rises

Energy demand could DOUBLE from its level in 2000… while CO_2 emissions must be HALF today's to avoid serious climate change

Twice as efficient, using HALF the energy to produce each dollar of wealth

Renewables could supply up to 30% of the world's energy

Projections are based on the Shell Scenario Estimates – a planning tool used by Shell to explore alternative views of the future by considering long-term trends in economics, energy supply and demand, geopolitical shifts and social change, as well as the motivating factors that drive change.

NO SINGLE SOLUTION FOR OIL BASED TRANSPORT

THERE IS NO "SILVER BULLET"

LNG IS ONE OPTION IN AN EVOLVING FUEL MIX

AVAILABLE
ACCEPTABLE
AFFORDABLE

LNG CAN OFFER A COMPELLING VALUE PROPOSITION

Shell
LNG
TOMORROW'S FUEL TODAY

1 **Cost competitive fuel**

2 **Cleaner burning fuel**
Can contribute to lower local exhaust emissions and global greenhouse gas emissions

3 **Proven and reliable LNG engine technology availability**

4 **LNG Availability, Safe and reliable supply chain**

LNG FROM REALITY TO MATERIALITY: TIPPING THE BALANCE

STANDARDS

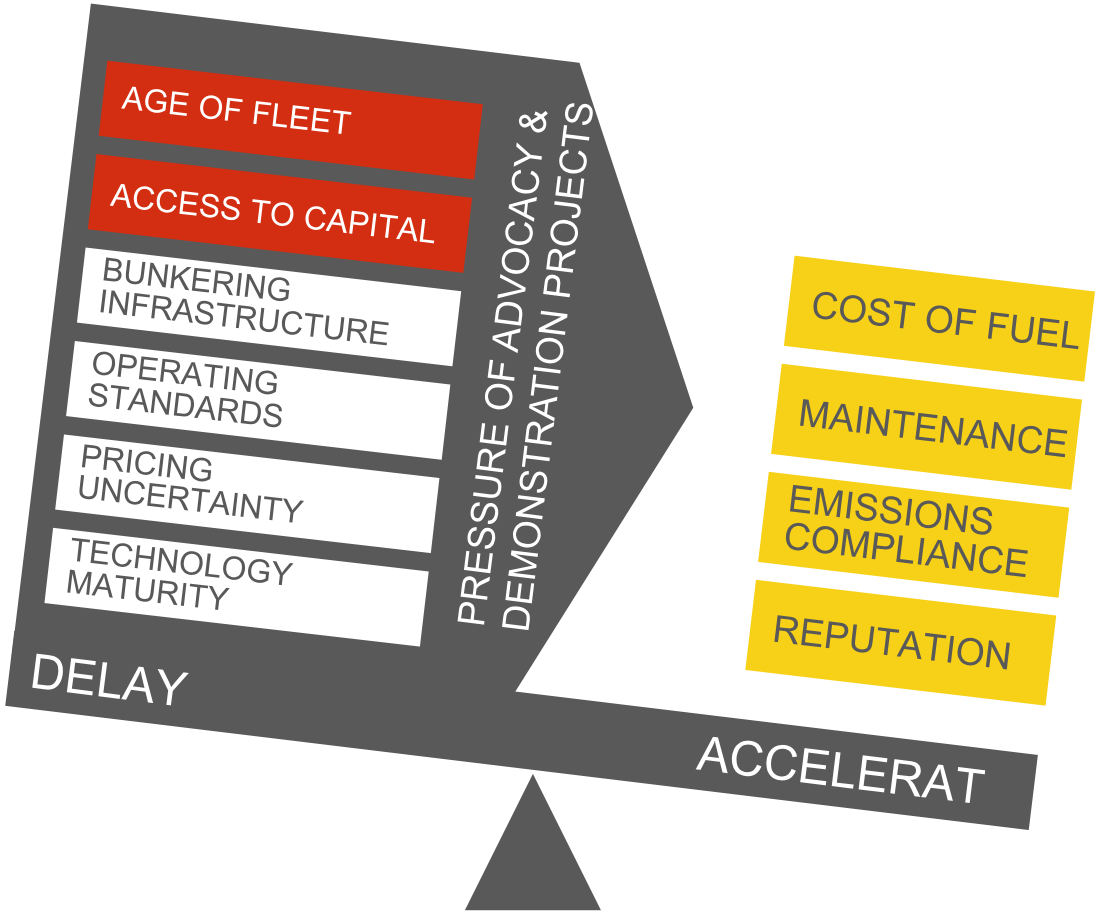
REGULATIONS

INFRASTRUCTURE

INNOVATION

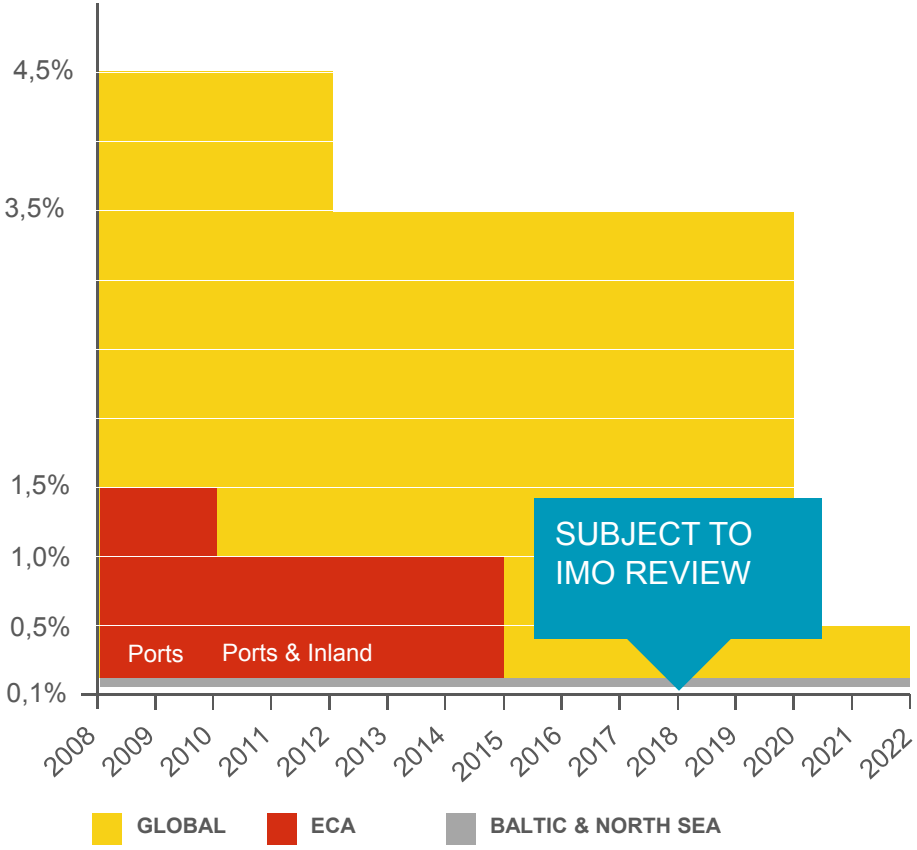
PARTNERSHIPS

ECONOMICS

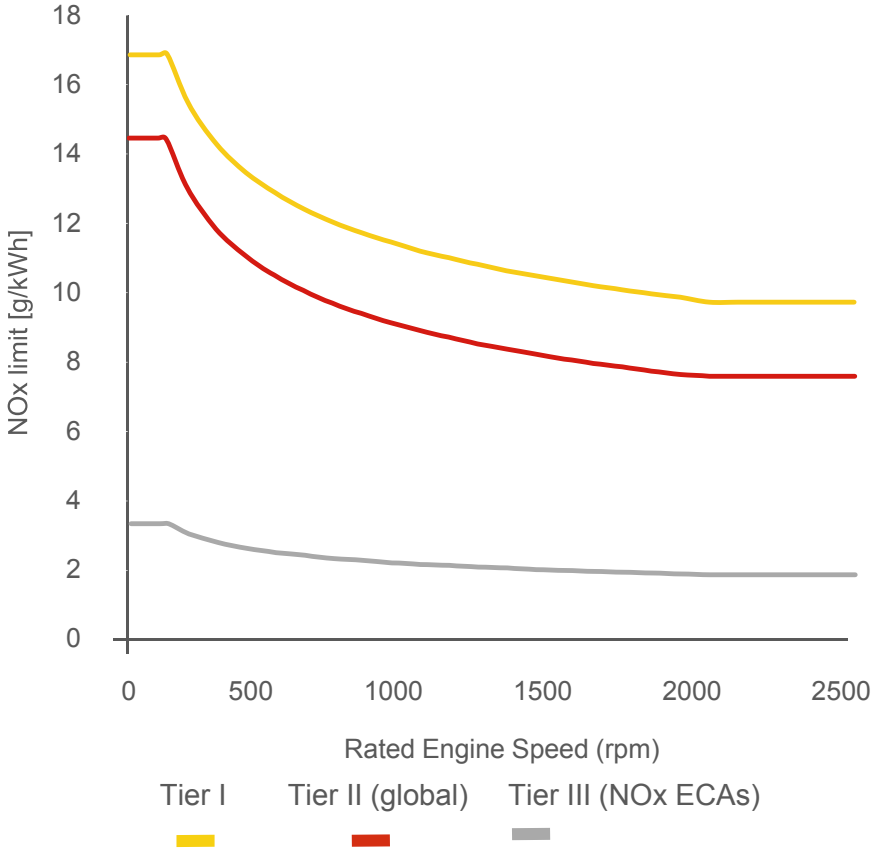


EMISSION CONTROL AREAS (ECAS)

SOx Regulations



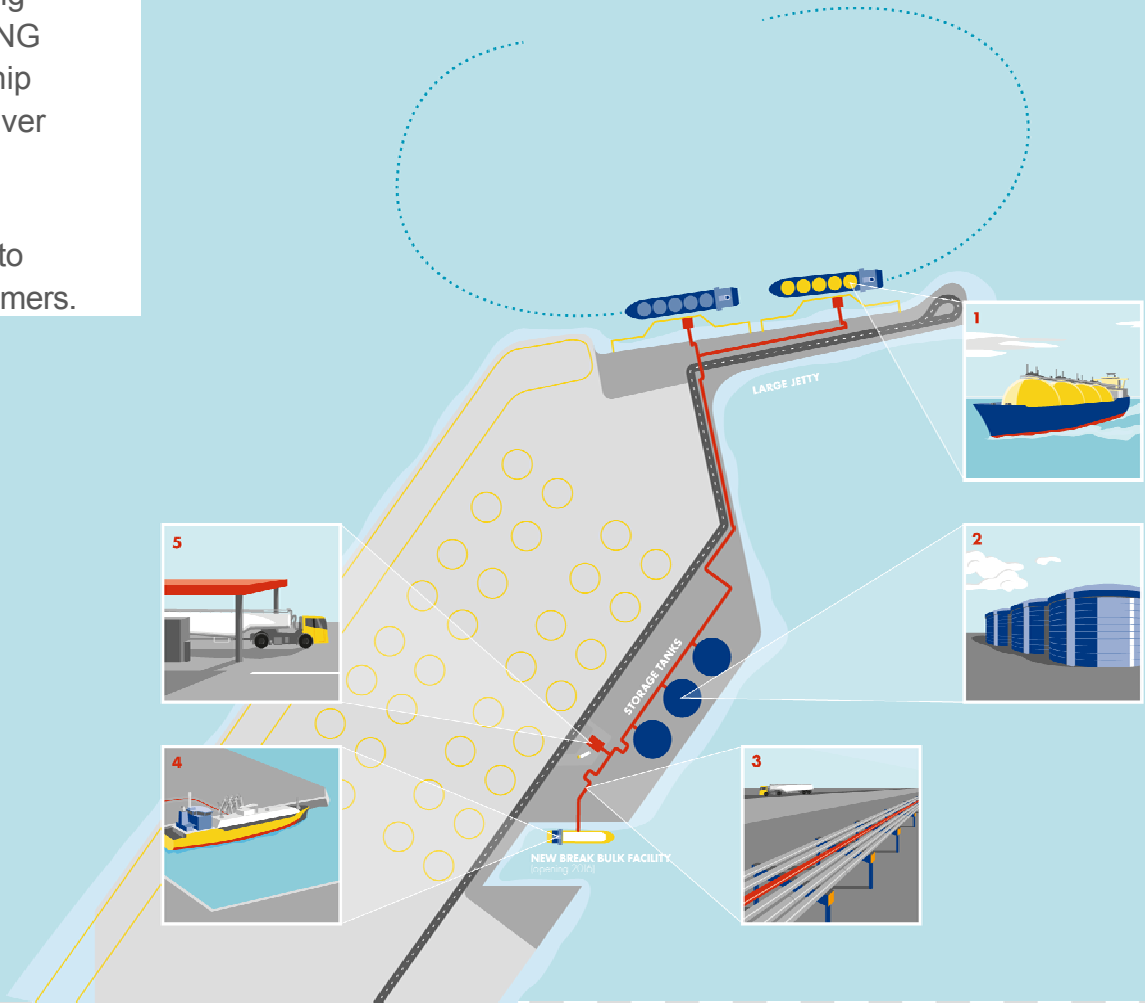
NOx Regulations



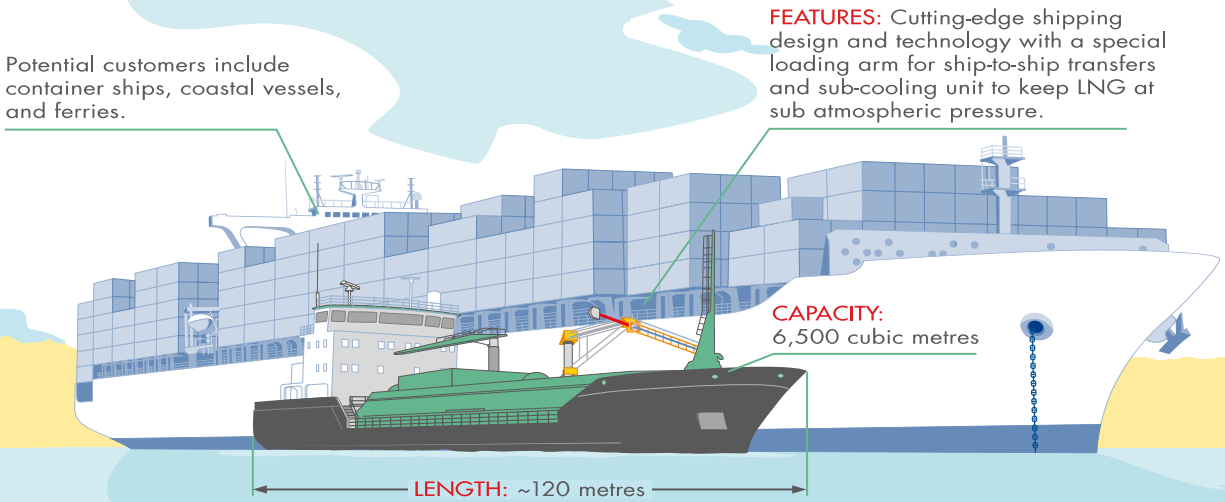
Source: IMO

GATE: LONG-TERM LNG FOR TRANSPORT

- Shell has announced investment into a break bulk jetty at the GATE (Gas Access To Europe) terminal.
- To serve marine customers in the port of Rotterdam, Shell is constructing together with STX shipyard an LNG bunker vessel facilitate ship to ship transfer operations, and also deliver LNG to secondary distribution terminals outside the port area.
- In addition, LNG will be loaded onto trucks and delivered to road customers.



AN INNOVATION IN THE LNG BUNKERING MARKET



The new vessel will be built by STX Offshore & Shipbuilding. It will be based at the port of Rotterdam in the Netherlands, and will load from the new LNG break bulk terminal and jetty to be constructed by the Gas Access to Europe (Gate) terminal. It will also be sea-going and, therefore, able to bunker customers at other locations.

CONSTRUCTION OF INNOVATIVE LNG BUNKER VESSEL

Sea Going Capability

Dual Fuel Engines

Sub cooler Unit

High & Low Manifold

Highly Manoeuverabl e

Transfer Arm System

Efficient Hull Design

Custody Transfer

Capacity 6.500 m3

Electric Propulsion

Co-financed by the European Union
Connecting Europe Facility

LNG BUNKER VESSEL – KEY PROJECT DATES

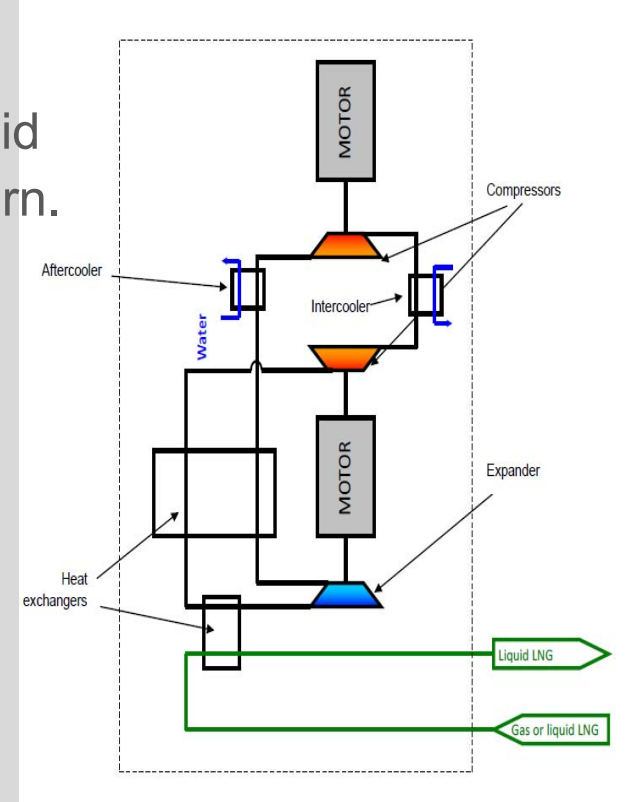
Milestone		Date
Contract Signing	√	Nov 2014
Steel Cutting	√	Dec 2015
Launching		Q3 2016
Delivery		Q1 2017
Ready for Service Rotterdam		Q2 2017

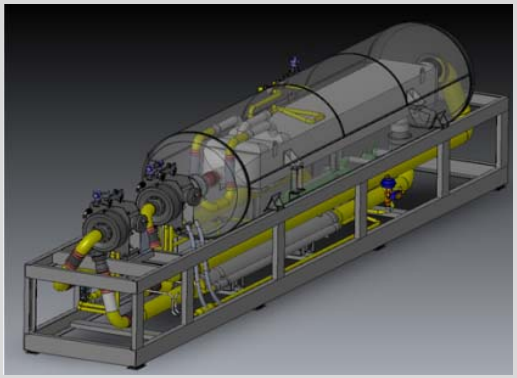
DESIGN FEATURES – SUB COOLER UNIT

Features

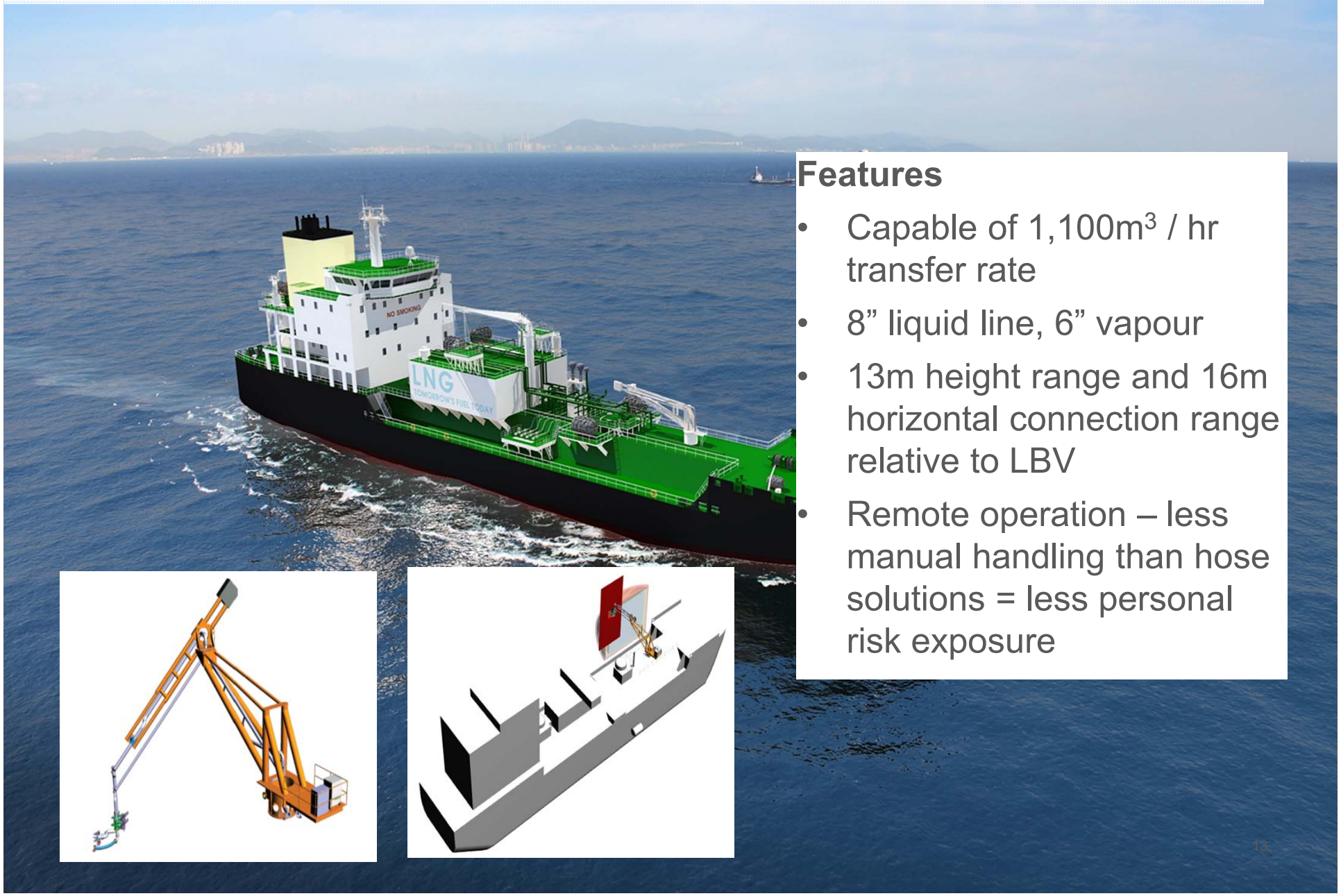
Prevention of BOG by heat extraction, taking liquid from the bottom of the tank and spraying the return.

Product range	TBF-175	TBF-350	TBF-700	TBF-1050	TBF-1400
LNG reliquefaction flow rate	0.15 t/h	0.5 t/h	1 t/h	1.5 t/h	2 t/h
Footprint (L*W*H)	9.5*1.7*3 m	11*1.7*3 m	Layout to be confirmed during the project		
Motor mechanical power	175 kW	350 kW	700 kW	1050 kW	1400 kW
Weight	15T	17T	34T	51T	68T





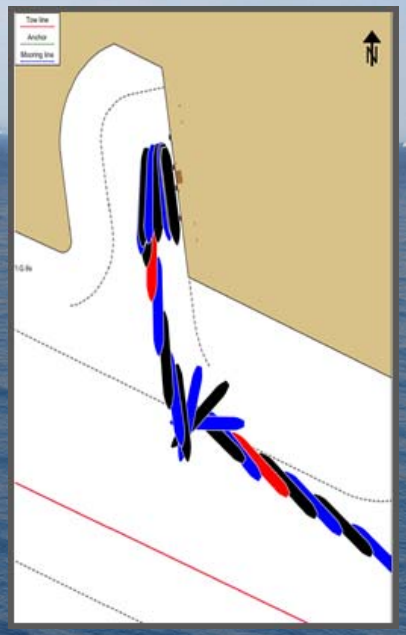
DESIGN FEATURES – TRANSFER ARM, SYSTEM



Features

- Capable of 1,100m^3 / hr transfer rate
- 8” liquid line, 6” vapour
- 13m height range and 16m horizontal connection range relative to LBV
- Remote operation – less manual handling than hose solutions = less personal risk exposure

DESIGN FEATURES – HIGHLY MANEUVERABLE



Features

- Analytical manoeuvring studies carried out for GATE to simulate jetty approach under various weather conditions.
- Twin screw with High Lift Rudders coupled with a bow thruster provided safe manoeuvring for required conditions.
- Manoeuvring model tests carried out at Sept 2015

TODAY, A NUMBER OF INLAND WATERWAY VESSELS ARE IN OPERATION

2012 "Argonon"
2x CAT DF conversion

2013 "Greenstream" & "Greenrhine"
"Scania" – Gas-Electric

2014 "Eiger" - Refit
Wärtsilä 2x 6L20DF -FPP

2014 "Sirocco"
Wärtsilä 1 x 8L20DF -FPP

GREENSTREAM AND GREENRHINE

Shell's support helped launch Greenstream and GreenRhine, the world's first LNG-powered barges to carry goods along Europe's River Rhine.

SHELL WILL CHARTER 15 NEW LNG-POWERED BARGES OPERATING ON THE RHINE

- Shell Trading Rotterdam BV (Shell) has signed a time-charter agreement with Plouvier Transport NV and Intertrans Tankschiffahrt AG for 15 new inland dual-fuel barges.
- These state-of-the-art barges, built by the Dutch shipyard VEKA Shipbuilding BV, will support Shell's growing business in trading and transporting mineral oil products in the ARA (Amsterdam-Rotterdam-Antwerp) and Rhinetrack (Germany/Switzerland) regions.
- The 110m long barges
- Designed for improved environmental performance, safety and optimal cargo carrying capacity in various water conditions.
- Their main engines provided by Wärtsilä will run on 95- 98% LNG fuel with a small proportion of diesel used for ignition.
- A staggered delivery of the barges is expected to take place between late-2016 and mid- 2018.

LNG INNOVATIONS- SUMMARY

DRIVERS

SUPPLY

ENVIRONMENT

COST

CHALLENGES

INFRASTRUCTURE

ENGINE & FUEL SYSTEM COST

REGULATORY