"LNG as fuel"

Get ready for the future - today?

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8th World Ocean Forum 2014 , 18th Sep., Busan Korea

Drivers for alternative fuels in shipping

Rising fuel costs and stricter regulations call for a rethink in fuelling options

The drivers for alternative fuels in shipping are interlinked

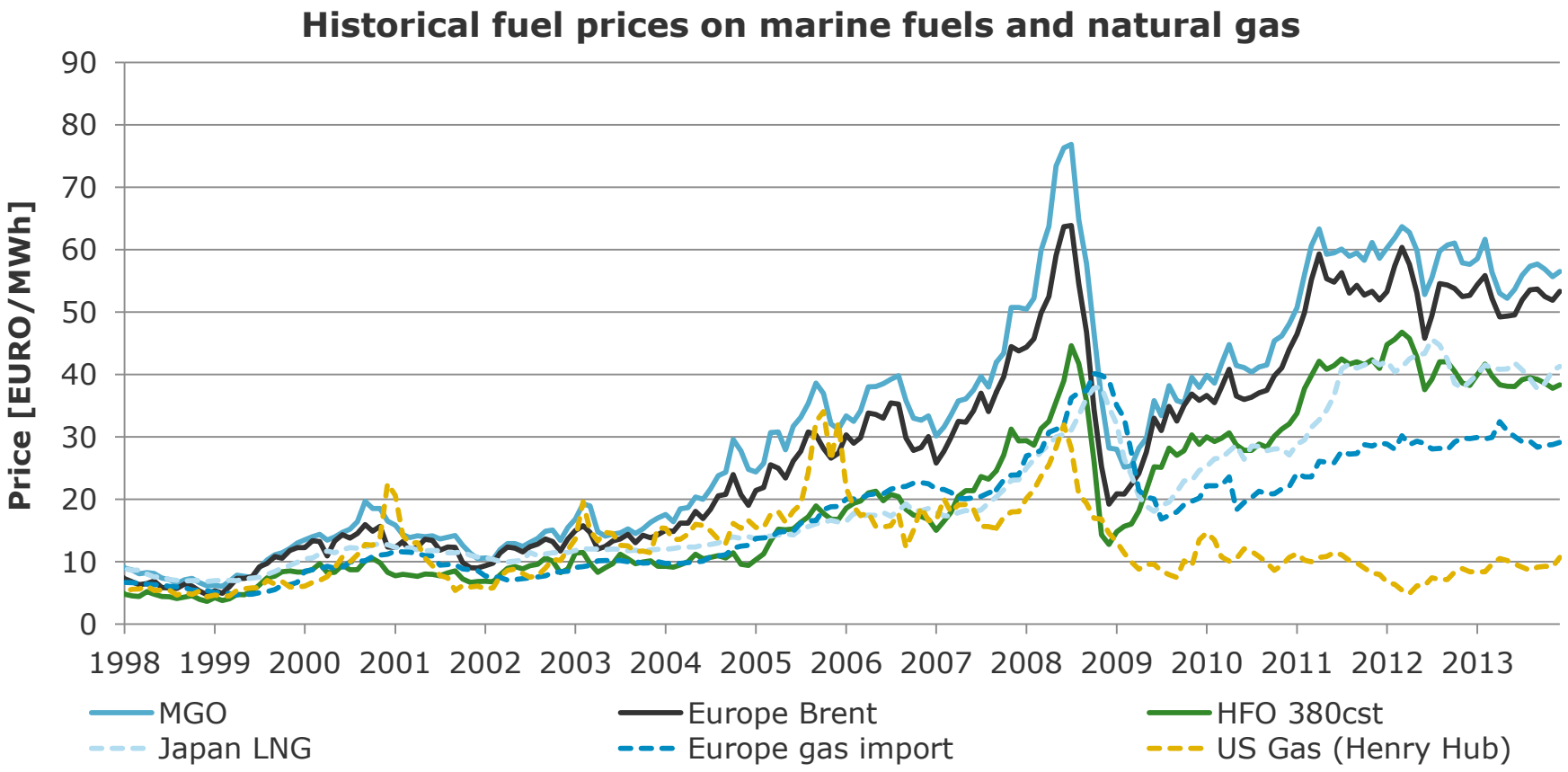
Increased fuel prices

More stringent environmental regulations

Availability of new energy sources

Stakeholder pressure to manage environmental and climate risks

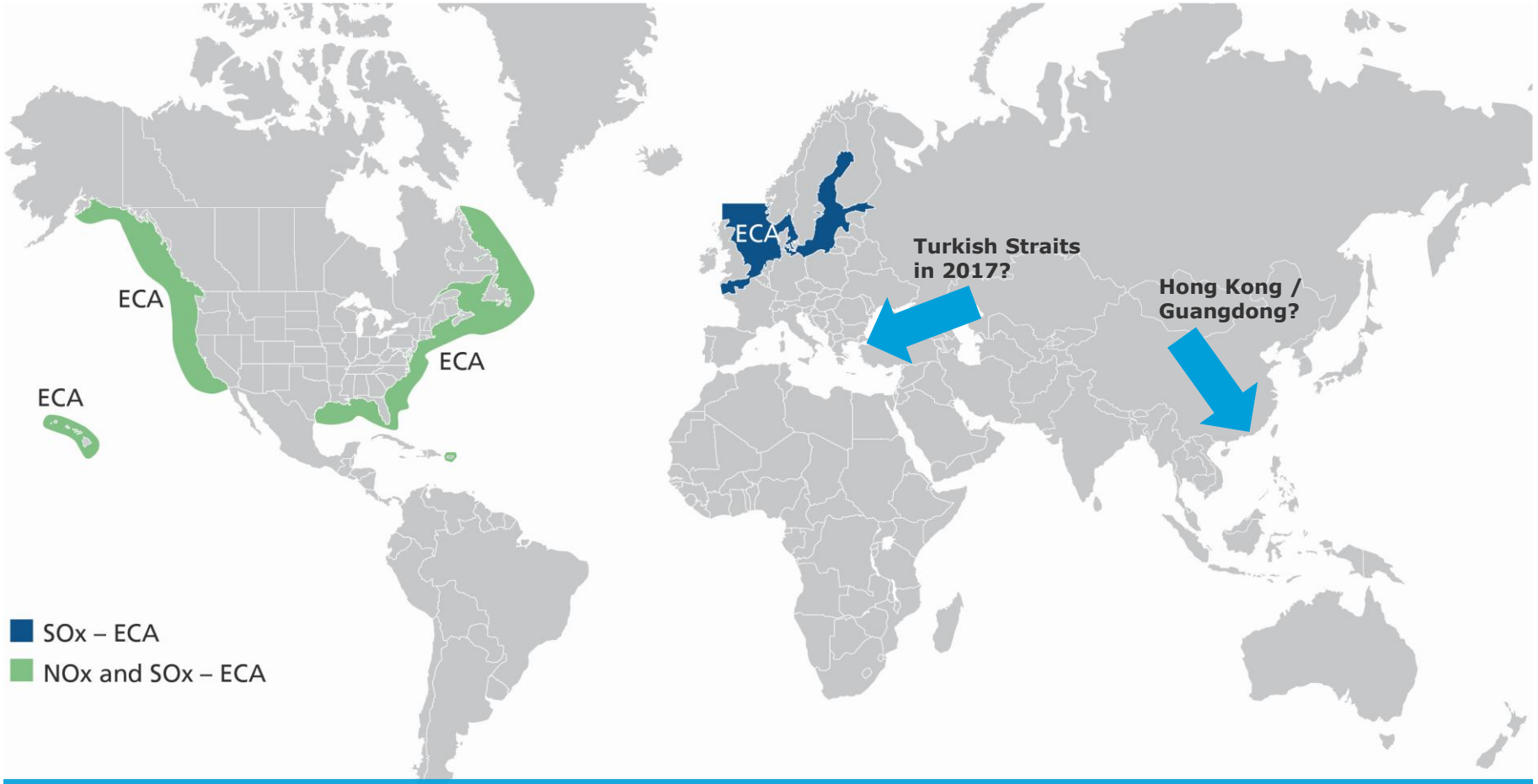
Increased fuel prices



Reducing the cost of transportation is a key driver for alternative fuels

Sources: Clarkson, World Bank

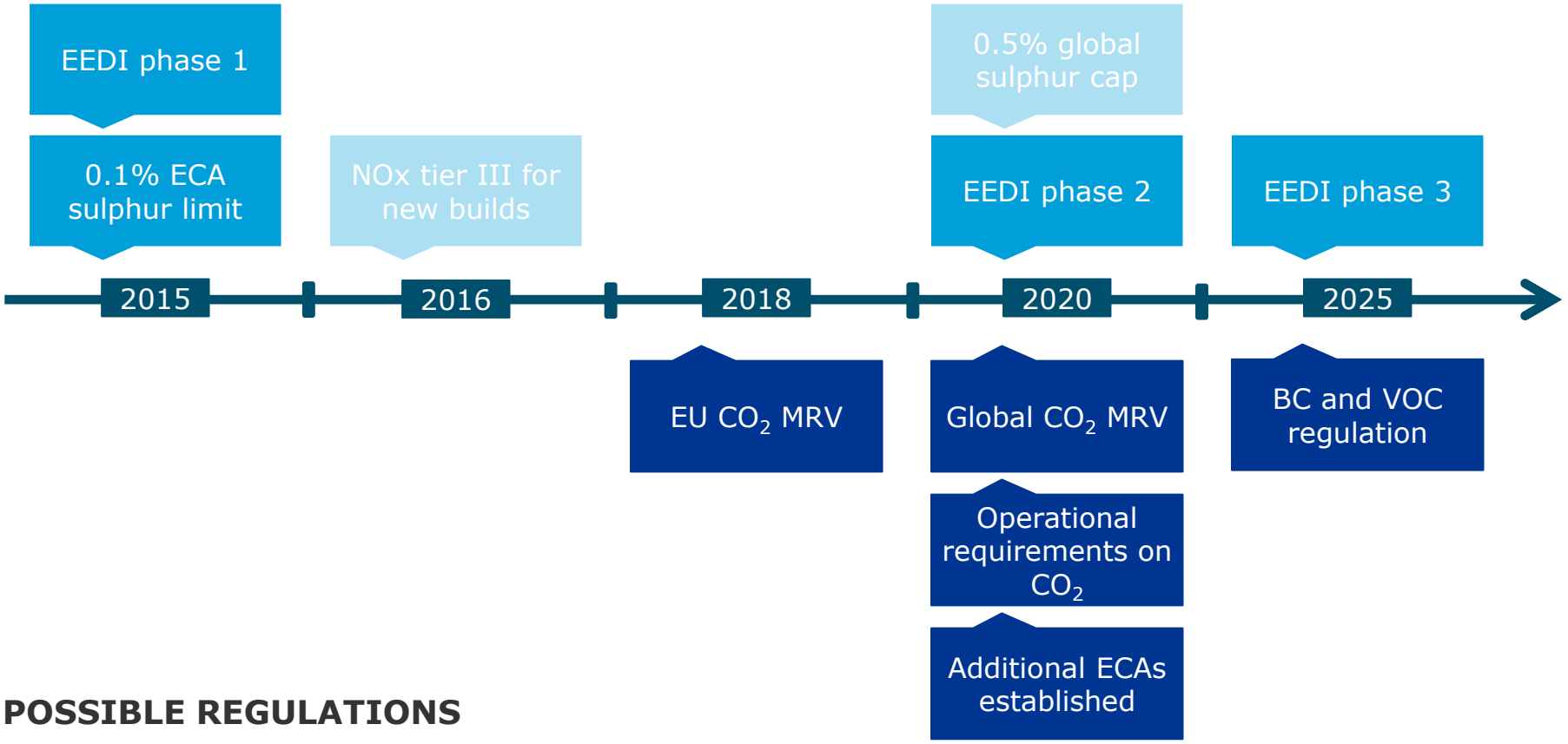
More stringent regulations on emissions to air



A number of alternative fuels will ensure compliance with upcoming requirements

A number of environmental regulations are on the horizon

ADOPTED REGULATIONS



POSSIBLE REGULATIONS

Existing and forecast of global LNG bunkering infrastructure

Existing

Planned (*Feasibility study, risk study, proposed locations, pending approval*)

Proposed (*currently being discussed*)

* See detailed map

Existing and forecast of LNG Bunkering infrastructure in Baltic & North Sea ECA

Existing:

1. Florø
2. CCB
3. Halhjem
4. Snurrevarden
5. Risavika
6. Stockholm
7. Bodø
8. Vestbase
9. Moskenes
10. Lødingen

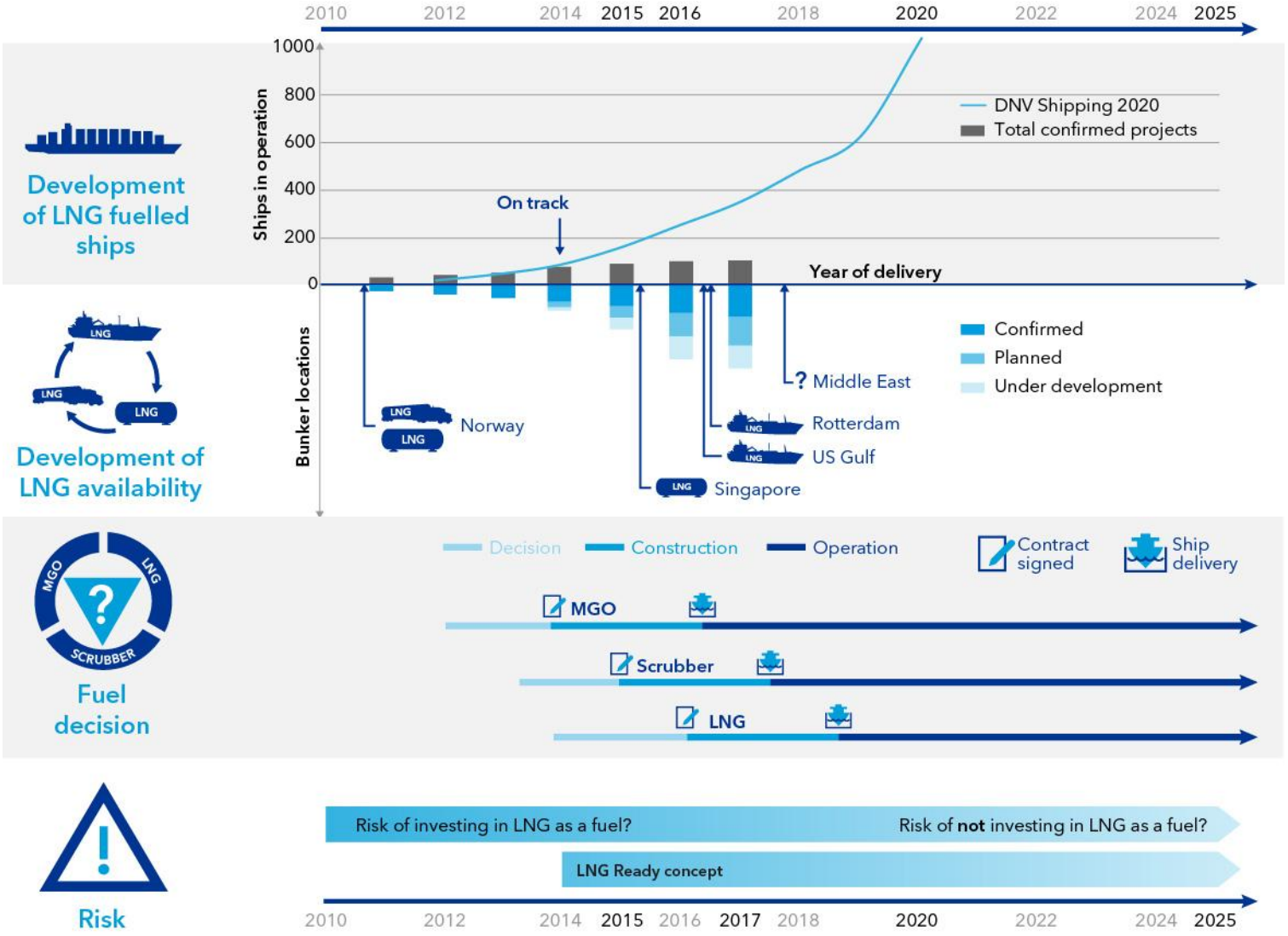
Planned:

11. Turku
12. Øra
13. Lysekil
14. Tallin
15. Hirtshals
16. Brunsbüttel
17. Hamburg
18. Rotterdam
19. Antwerp
20. Zeebrugge
21. Ghent
22. Mongstad
23. Gothenborg
24. Helsinborg
25. Copenhagen
26. Aarhus
27. Lubeck
28. Roscoff
29. Helsinki
30. Hammerfest

Proposed:

31. Swinoujscie
32. Rostock
33. Cuxhaven
34. Grain
35. Tornio
36. Klaipeda
37. Hou Harbour
38. Dunkirk

Careful evaluation of fuelling options is required due to exponential growth in LNG bunkering infrastructure



LNG will become a major fuel – it is only a question of when

LNG as fuel is now a proven and available solution

LNG should be seriously considered for all new builds

Partnerships and close cooperation is vital for commercial projects to succeed in this early phase

The (commercial) risk of choosing LNG is considered high – but what is the risk of not considering LNG fuel?

Market, regulatory and technology developments:

49 LNG fuelled ships in operation worldwide

Ships in operation

Year	Type of vessel	Owner	Class
2000	Car/passenger ferry	Fjord1	DNV
2003	PSV	Simon Møkster	DNV
2003	PSV	Eidesvik	DNV
2006	Car/passenger ferry	Fjord1	DNV
2007	Car/passenger ferry	Fjord1	DNV
2007	Car/passenger ferry	Fjord1	DNV
2007	Car/passenger ferry	Fjord1	DNV
2007	Car/passenger ferry	Fjord1	DNV
2008	PSV	Eidesvik Shipping	DNV
2009	PSV	Eidesvik Shipping	DNV
2009	Car/passenger ferry	Tide Sjø	DNV
2009	Car/passenger ferry	Tide Sjø	DNV
2009	Car/passenger ferry	Tide Sjø	DNV
2009	Patrol vessel	Remøy Management	DNV
2009	Car/passenger ferry	Fjord1	DNV
2010	Patrol vessel	Remøy Management	DNV
2010	Car/passenger ferry	Fjord1	DNV
2010	Patrol vessel	Remøy Management	DNV
2010	Car/passenger ferry	Fjord1	DNV
2010	Car/passenger ferry	Fjord1	DNV
2010	Car/passenger ferry	Fosen Namsos Sjø	DNV
2011	PSV	DOF	DNV
2011*	Chemical tanker	Tarbit Shipping	GL
2011	Car/passenger ferry	Fjord1	DNV
2011	PSV	Solstad Rederi	DNV
2012*	Car/passenger ferry	Fjord1	DNV
2012	PSV	Eidesvik	DNV
2012	PSV	Olympic Shipping	DNV
2012	PSV	Island Offshore	DNV
2012	General Cargo	Nordnorsk Shipping	DNV
2012	PSV	Eidesvik Shipping	DNV
2012	PSV	Island Offshore	DNV
2012	Car/passenger ferry	Torghatten Nord	DNV
2012	Car/passenger ferry	Torghatten Nord	DNV
2012	Car/passenger ferry	Torghatten Nord	DNV
2013	PSV	REM	DNV
2013	RoPax	Viking Line	LR
2013	Car/passenger ferry	Torghatten Nord	DNV
2013	Harbor vessel	Incheon Port Authority	KR
2013	General Cargo	Eidsvaag	DNV
2013	RoPax	Fjordline	DNV
2013	High speed RoPax	Buquebus	DNV
2013	Tug	CNOOC	CCS
2013	Tug	CNOOC	CCS
2013	Car/passenger ferry	Norled	DNV
2014	Car/passenger ferry	Norled	DNV
2014	Tug	Buksér & Berging	DNV
2014	RoPax	Fjordline	DNV
2014	Patrol vessel	Finish Border Guard	GL

Updated 06.06.2014

**** Conversion project***

Excluding LNG carriers and inland waterway vessels

62 confirmed LNG fuelled newbuilds - DNV GL also first choice for future projects (1/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class
2014	Ro-Ro	Norlines	DNV
2014	Ro-Ro	Norlines	DNV
2014	Car/passenger ferry	Society of Quebec	LR
2014	Car/passenger ferry	Society of Quebec	LR
2014	Car/passenger ferry	Society of Quebec	LR
2014	Tug	Buksér & Berging	DNV
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	Gas carrier	SABIC	BV
2014	Gas carrier	SABIC	BV
2014*	Product tanker	Bergen Tankers	LR
2014	General Cargo	Egil Ulvan Rederi	DNV
2014	General Cargo	Egil Ulvan Rederi	DNV
2014	PSV	Remøy Shipping	DNV
2014	Car/passenger ferry	AG Ems	GL
2014*	Car/passenger ferry	AG Ems	GL
2014	Car/passenger ferry	Samsoe Municipality	DNV
2014	Ro-Ro	Sea-Cargo	DNV
2014	Ro-Ro	Sea-Cargo	DNV
2014	Tug	CNOOC	CCS
2015	Tug	CNOOC	CCS
2015	PSV	Siem Offshore	DNV
2015	PSV	Siem Offshore	DNV
2015	PSV	Simon Møkster	DNV

Year	Type of vessel	Owner	Class
2015	PSV	Harvey Gulf Int.	ABS
2015	PSV	Harvey Gulf Int.	ABS
2015	Tug	NYK	NK
2015	LEG carrier	Evergas	BV
2015	LEG carrier	Evergas	BV
2015	LEG carrier	Evergas	BV
2015	Bulk ship	Erik Thun	LR
2015	Container Ship	Brodosplit	DNV GL
2015	Container Ship	Brodosplit	DNV GL
2015	PSV	Siem Offshore	DNV GL
2015	PSV	Siem Offshore	DNV GL
2015	Container Ship	TOTE Shipholdings	ABS
2016	Container Ship	TOTE Shipholdings	ABS
2016	Icebreaker	Finnish Transport A.	LR
2016	PSV	Siem Offshore	DNV GL
2016	PSV	Siem Offshore	DNV GL
2016	Chemical tanker	Terntank	BV
2016	Chemical tanker	Terntank	BV
2016*	Ro-Ro	TOTE Shipholdings	ABS
2016*	Ro-Ro	TOTE Shipholdings	ABS
2016	Car carrier	UECC	LR
2016	Car carrier	UECC	LR
2016	Car/passenger ferry	Boreal Transport	DNV GL
2016	Car/passenger ferry	Boreal Transport	DNV GL

Updated 06.06.2014

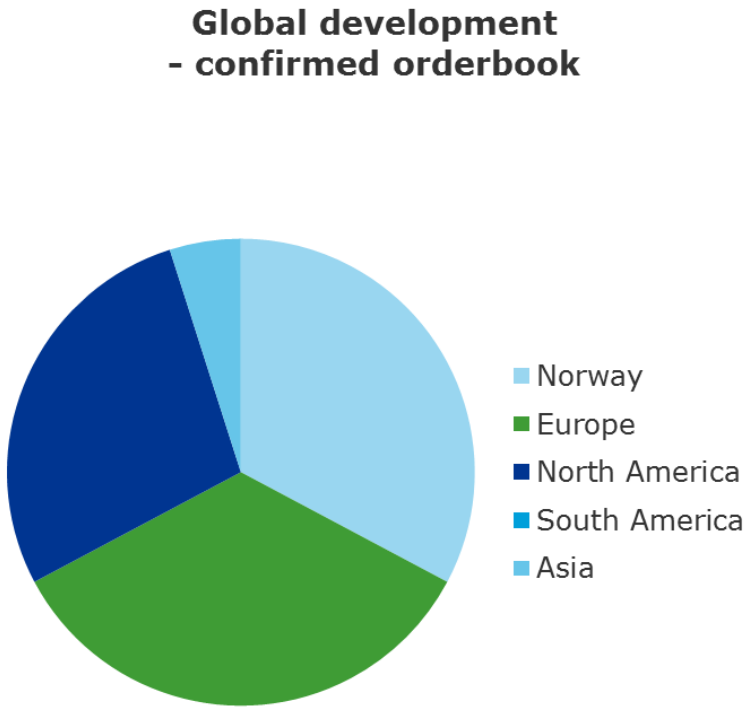
**** Conversion project***

Excluding LNG carriers and inland waterway vessels

62 confirmed LNG fuelled newbuilds - DNV GL also first choice for future projects (2/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class
2016	Container Ship	GNS/Nordic Hamburg	ABS
2016	Container Ship	GNS/Nordic Hamburg	ABS
2016	Ro-Ro	SeaRoad Holdings	
2016	Container Ship	Universal Marine	DNV GL
2016	Container Ship	Universal Marine	DNV GL
2017	Container Ship	Universal Marine	DNV GL
2017	Container Ship	Universal Marine	DNV GL
2017	RoPax	Brittany Ferries	BV
2017	Container Ship	Crowley Maritime	DNV GL
2017	Container Ship	Crowley Maritime	DNV GL
2018	Container Ship	Matson Navigation	DNV GL
2018	Container Ship	Matson Navigation	DNV GL

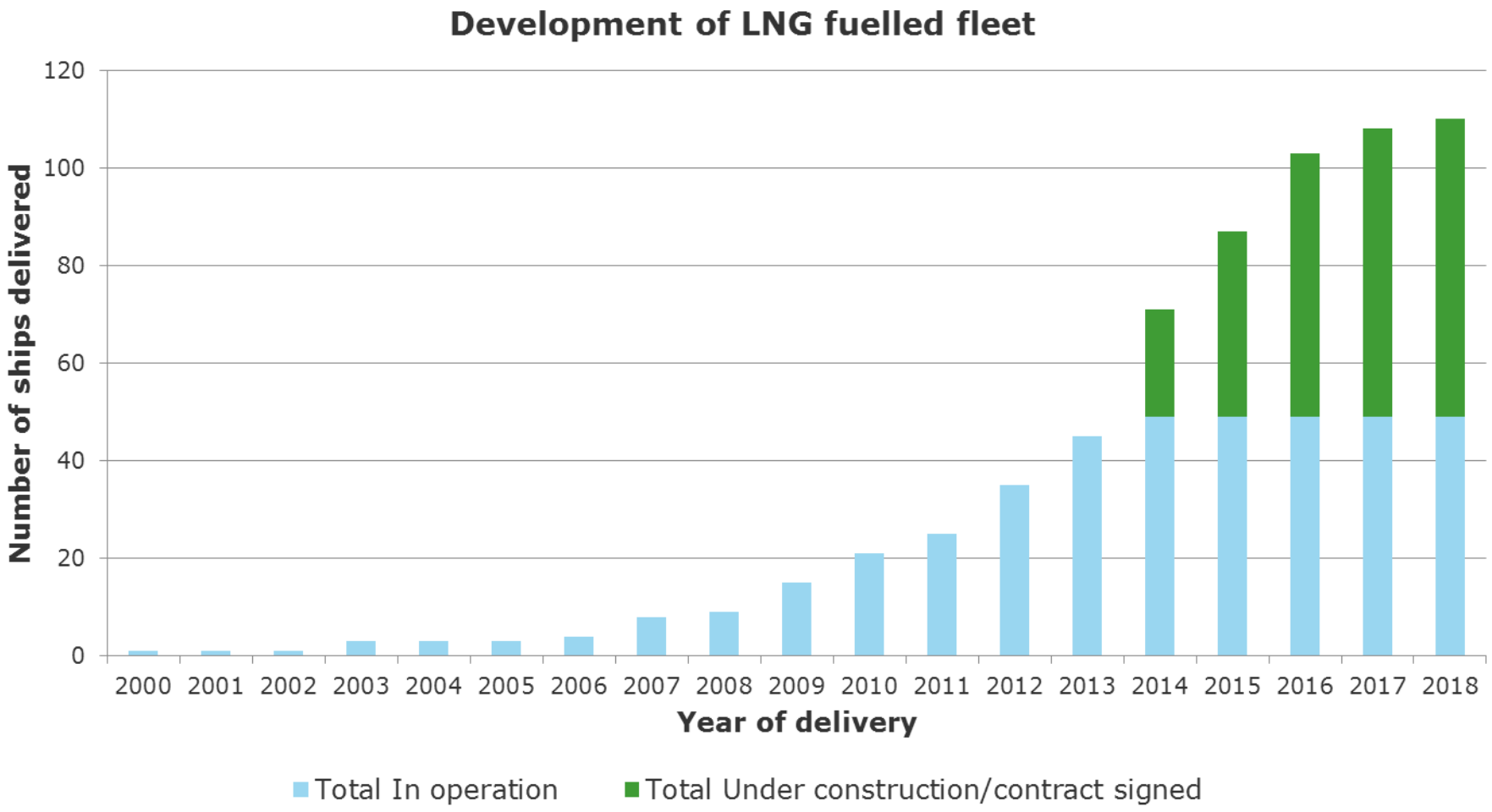


Updated 06.06.2014

**** Conversion project***

Excluding LNG carriers and inland waterway vessels

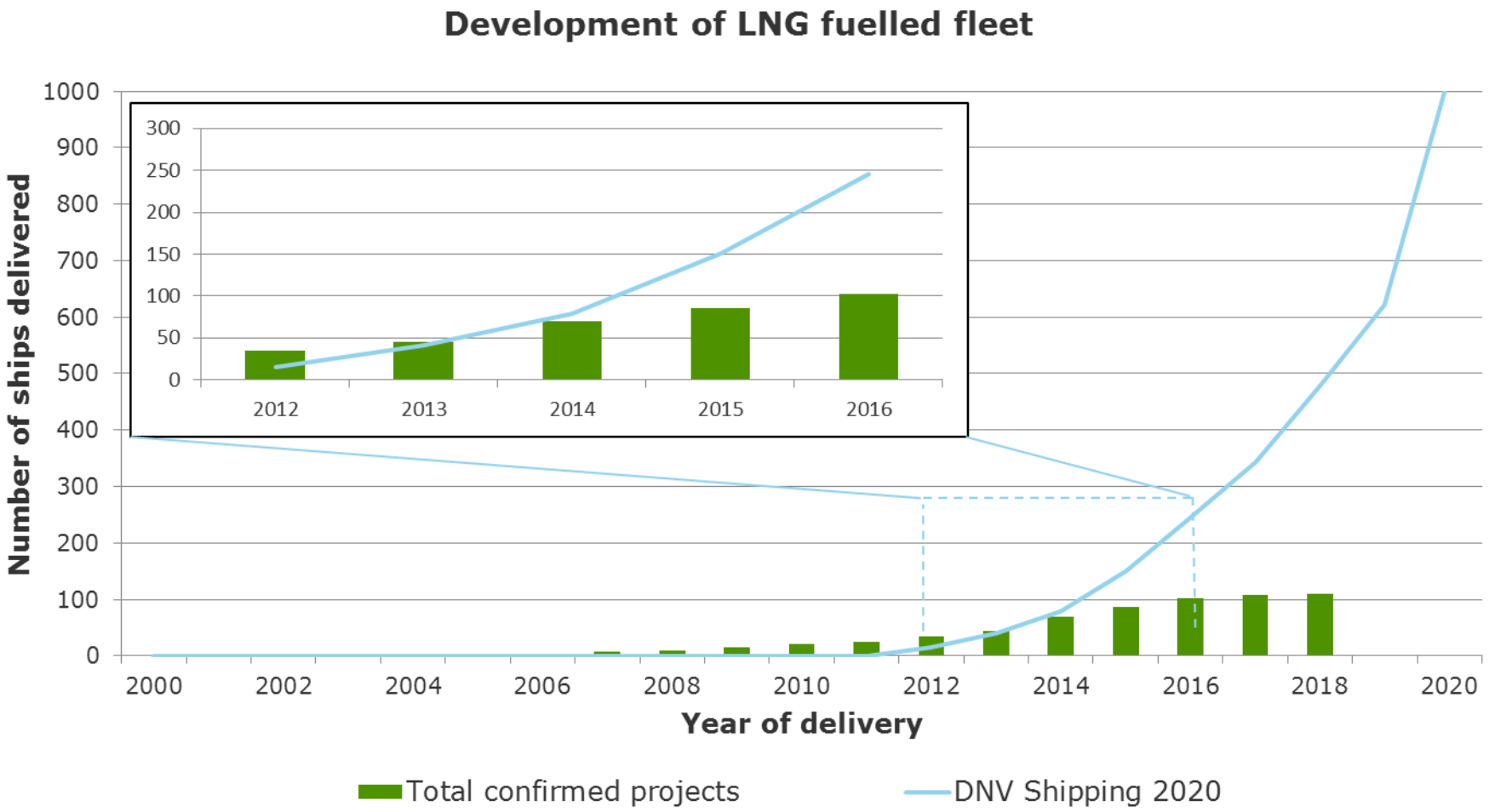
There are currently 111 confirmed LNG fuelled ship projects



Updated 06.06.2014
Excluding LNG carriers and inland waterway vessels

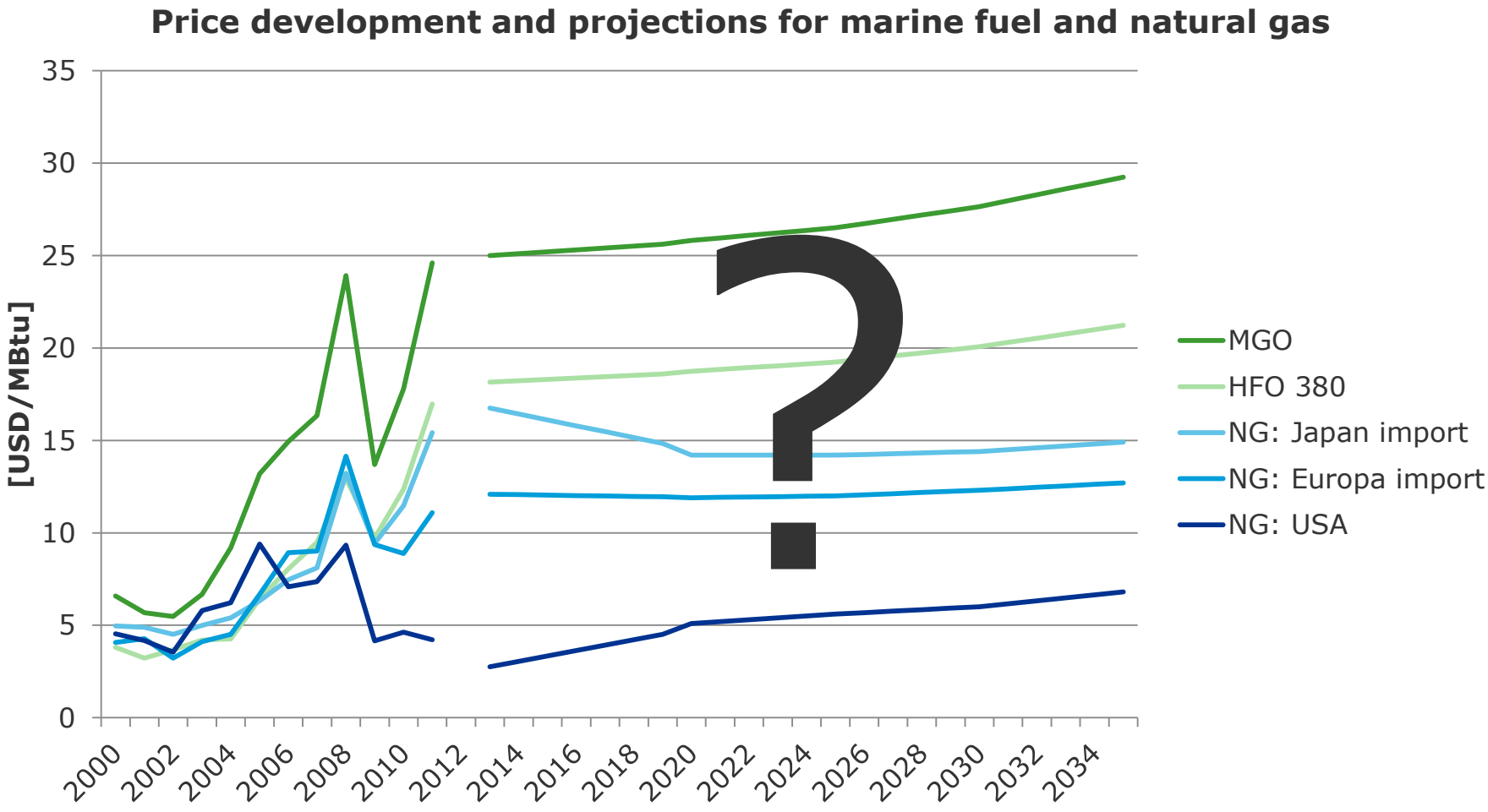
DNV·GL

Current development is in line with DNV GL projections
Will the exponential growth continue?



Updated 06.06.2014
Excluding LNG carriers and inland waterway vessels

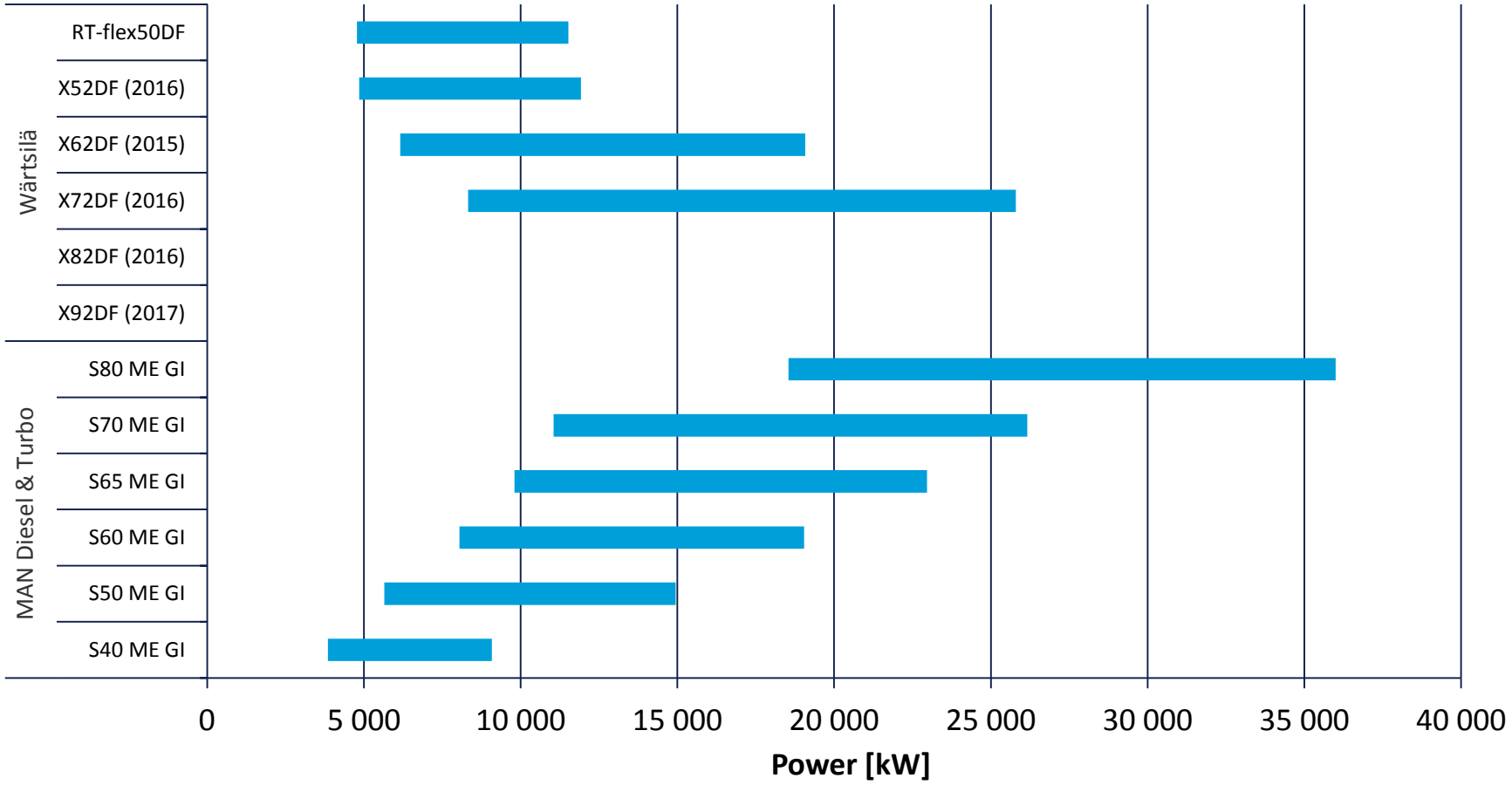
Gas prices are expected to remain competitive in the long-run



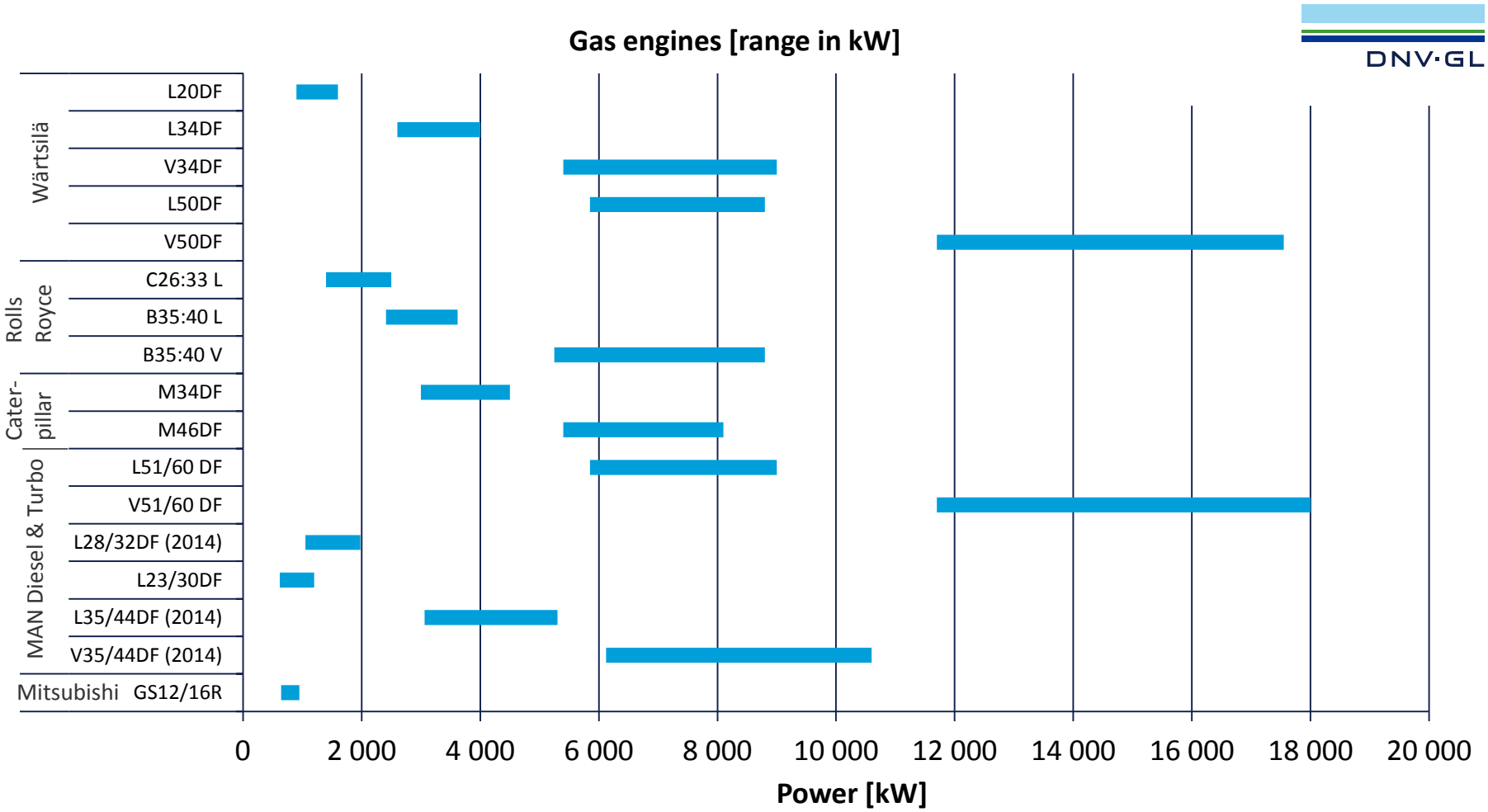
Source: HFO 380 and MGO historical prices (Clarkson), natural gas historical (World Bank). Projections based on IEA World Energy Outlook 2013.

DNV·GL

There is now a range of available and announced 2-stroke gas engines



And there is a also range of available and announced 4-stroke gas engines



Only type C tanks have been applied for ship fuel tanks so far, but ships with prismatic tanks are soon a reality

C

Type C tank

- Designed for pressure build-up
- Commonly used in LNG fuelled ships
- Leak free tank, leaks only possible from valves

B

Type B tank

- Only minor leaks of the tank structure possible
- Limited liquefied gas release has to be handled

A

Type A and membrane tank

- Complete first barrier failure not excluded
- Liquefied gas release has to be handled

The regulatory framework for LNG fuelled shipping is now in place

- IMO IGF Code (enforced 2017)
- IMO MSC.285(86) interim guidelines

- ISO TC 67 - Guidelines for systems and installations for supply of LNG as fuel to ships. Draft issued in June 2013.
- ISO TC 28 – LNG Quality (fuel standard for sampling and measuring)

- SIGTTO, Shell, NMD, Swedish Transport Agency, Port of Antwerp and DNV GL
- Development of safety guidelines for LNG as marine fuel

- DNV GL Recommended practice for Development and operation of LNG bunkering facilities, issued 2014-01
- DNV GL Standard for Competence related to the on board use of LNG as fuel
- First classification society to issue class rules

INTERNATIONAL CODE OF SAFETY FOR SHIPS USING GASES OR OTHER LOW-FLASHPOINT FUELS (IGF CODE)

- **3.1 GOAL**
- 3.1.1 The goal of this Code is to provide for safe and environmentally-friendly design, construction and operation of ships and in particular their installations of systems for propulsion machinery, auxiliary power generation machinery and/or other purpose machinery using gas or low-flashpoint fuel as fuel.
- **3.2 Functional requirements**
- *3.2.1 The safety, reliability and dependability of the systems shall be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery*
- **4 GENERAL REQUIREMENTS**
- **4.1 Goal**
- 4.1.1 The goal of this chapter is to ensure that the necessary assessments of the risks involved are carried out in order to eliminate or mitigate any adverse effect to the persons on board, the environment or the ship.
- *4.2.1 A risk assessment shall be conducted to ensure that risks arising from the use of gas-fuel or low-flashpoint fuels affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed. Consideration shall be given to the hazards associated with physical layout, operation, and maintenance, following any reasonably foreseeable failure.*

IGF Code - Implication of requirements in code

- The designers needs to comply with the code
- The designers needs to carry out risk assessment
- A competent risk analysis may reveal the need for risk control options, beyond the prescriptive requirements, because:
  - Collision including the LNG tank will create a delta risk compared to oil fuelled ships
- DNV GL will help designers/clients with possible risk control options (RCOs), and how to quantify the risk reduction effect
- Selection of cost optimum RCOs for specific designs is a task for the designers

IGF Code – Expected Timeline to Entry Into Force

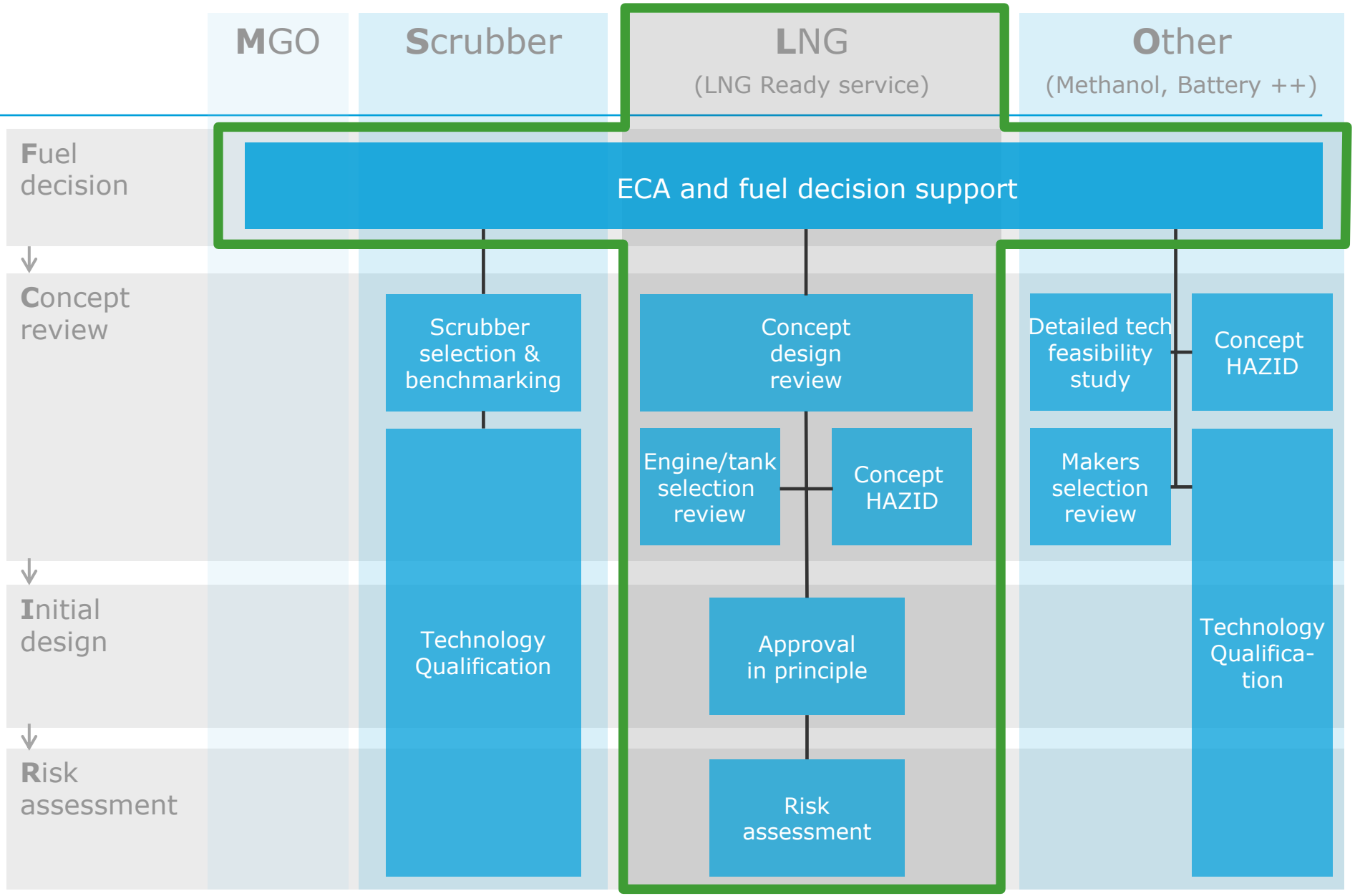
- Finalization of draft code: Sub-committee on Carriage of Cargoes And Containers, CCC1, September 8-12, 2014
- Agreement on Code: Maritime Safety Committee, MSC94, November 8-12
  - Presumably only tank location requirement discussed at MSC94
- Adoption of Code: Maritime Safety Committee, MSC 95, June 1- 12, 2015
- Entry Into Force: January 1, 2017
- **NOTE: In this case users will ("try to") comply with the code from January 1, 2015**
  - If agreed at MSC94

IGF Code - Special Features of the Code

- The Code contains (Part A)
  - Requirements for equivalence to conventional fuel
  - Requirements to carry out risk assessment
- And
  - Prescriptive requirements (Part A1)
- Unique:
  - Complying with the prescriptive requirements (A1), does not guarantee compliance with the high level requirements in part A

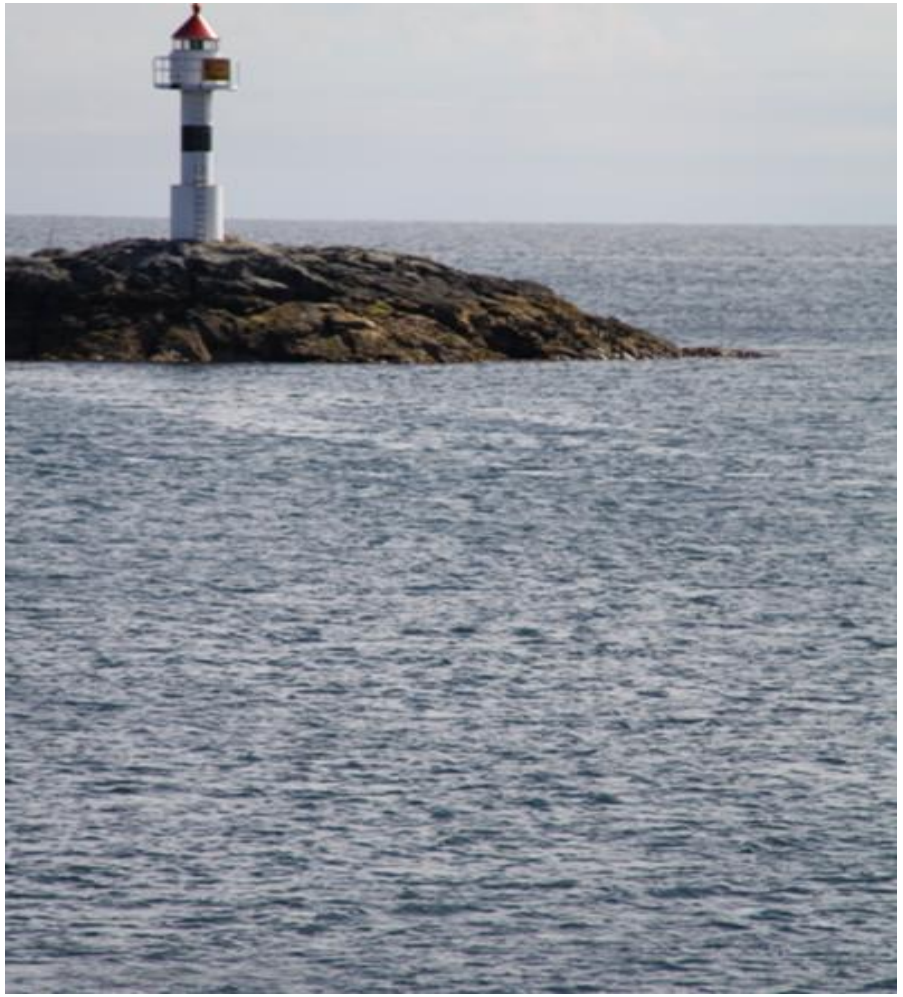
LNG Ready

Get ready for the future - today


MGO
Scrubber
LNG
(LNG Ready service)
Other
(Methanol, Battery ++)
Fuel decision
ECA and fuel decision support
Concept review
Scrubber selection & benchmarking
Concept design review
Detailed tech feasibility study
Concept HAZID
Engine/tank selection review
Concept HAZID
Makers selection review
Initial design
Technology Qualification
Approval in principle
Technology Qualifica-tion
Risk assessment
Risk assessment

Forward-thinking LNG ready

- LNG as fuel can ensure regulatory compliance and reduced fuel costs
- Considering LNG fuel introduces increased complexity, novel design options, and new risks
- Accumulated experience with LNG as ship fuel in service
- Tried-and-tested process – from planning and concept design to approval in principle and final risk assessment – will get you started on the course to LNG as ship fuel



There are four steps to become LNG ready

1. FUEL DECISION SUPPORT
- Operational profile
- Concept design (tank size & location)
- Financial assessment (CAPEX, OPEX, pay-back time and sensitivity analysis)
- Fuel availability

Basis for investment decision and outline specification

2. CONCEPT REVIEW
- Review of engine and tank type selection
- Concept Design Review
  - Rules and regulations
  - Fit for purpose and best practice
- Concept HAZID

Basis for yard/designer negotiations

3. APPROVAL IN PRINCIPLE
- For novel designs
- For LNG Ready designs

Basis for contract

4. RISK ASSESSMENT
- Assessment of safety level of LNG fuel system (mandatory by IMO)

Basis for acceptance by administration

CLASS APPROVAL
(after vessel is 'LNG Ready')

Decision Points. Proceed with the LNG option or not.

Thank you for attention !!

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