

Fuels of the future – what will come next after HFO

Alternative fuels and power sources options

Time span 2010 - 2030

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Alternative fuels

Long list of alternative fuels:

- Bio fuel (fame)
- GTL (synthetic diesel oil)
- DME
- Hydrogen
- Gas (LNG, LPG)
- ...

To make a difference the fuel have to be available world wide and be economical viable

Based on that and the time frame in question, LNG is consider to be the only alternative fuel to MGO and HFO

Large LNG terminals in Europe

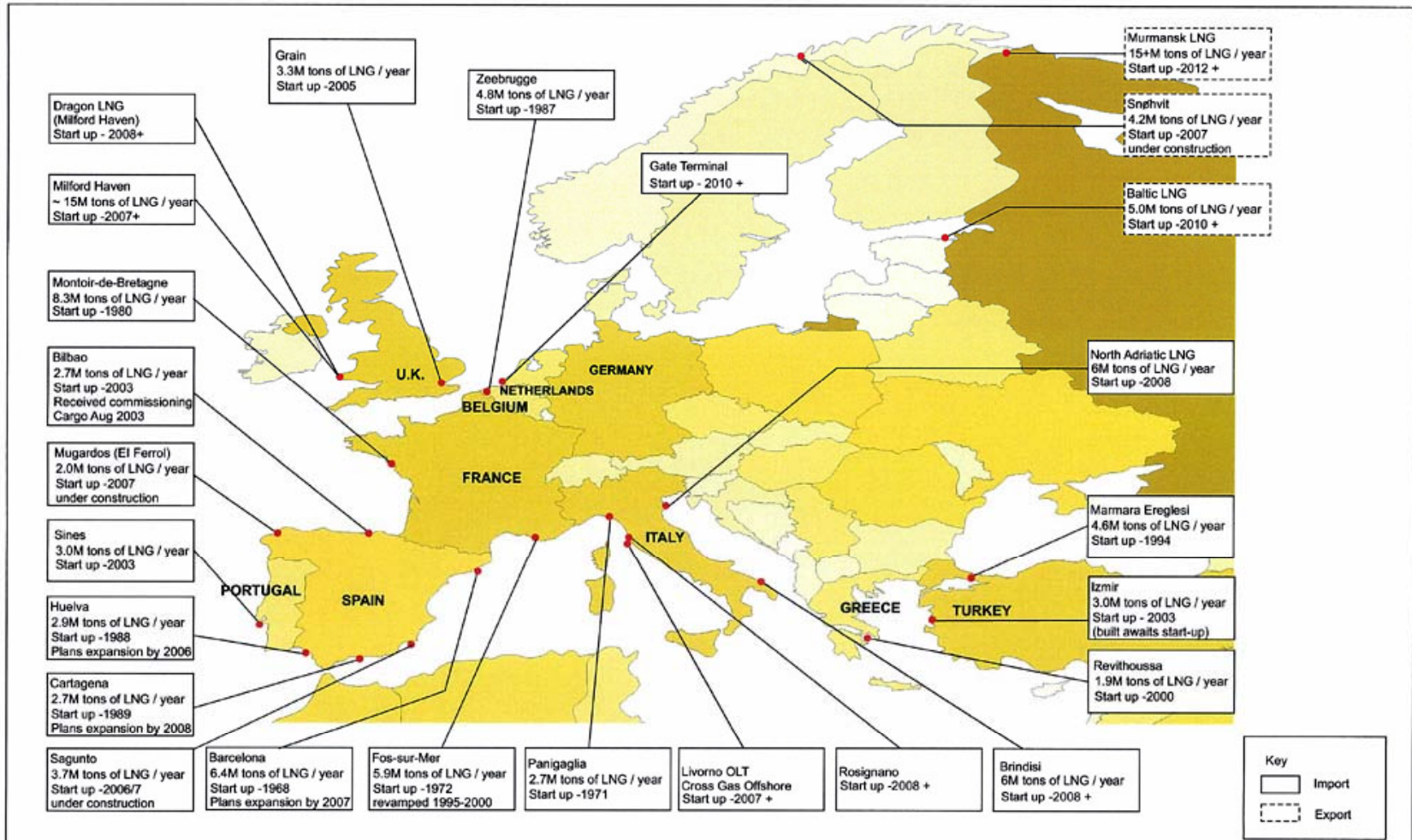


Figure 3.7

LNG TERMINALS (EUROPE)
 (SOURCES: WORLD LNG MAP FEBRUARY 2006 EDITION. PETROLEUM ECONOMIST & THE GLOBAL LIQUEFIED NATURAL GAS MARKET: STATUS AND OUTLOOK. ENERGY INFORMATION ADMINISTRATION, US DEPARTMENT OF ENERGY, DECEMBER 2003)

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Environmental Resources Management



LNG powered RoRo freight ship (gas only)

Two ships under construction for delivery in 2011-12



Vacuum isolated pressure storage tanks

Tailor made LNG Fuel tank systems

Storage factor 2-3 times HFO



LIQUILINE

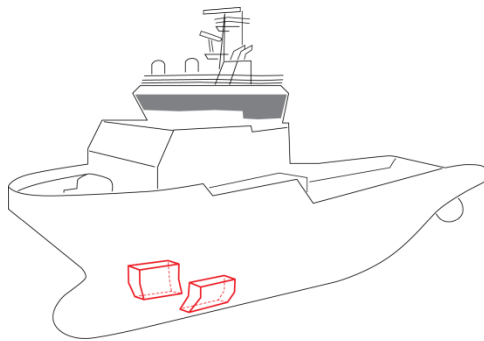
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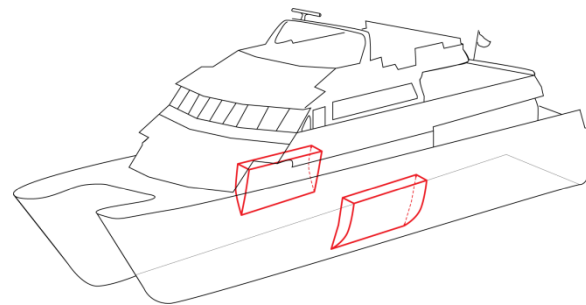
TI marine contracting as



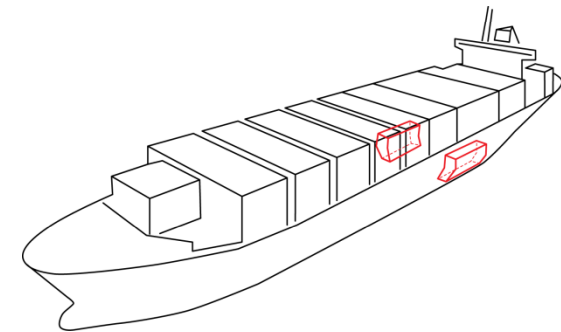
Wilhelmsen Marine Consultants



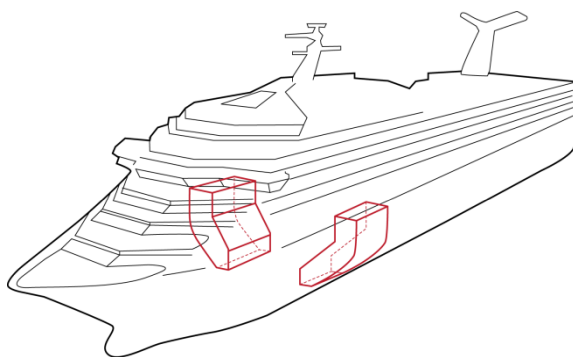
Anchor handlers



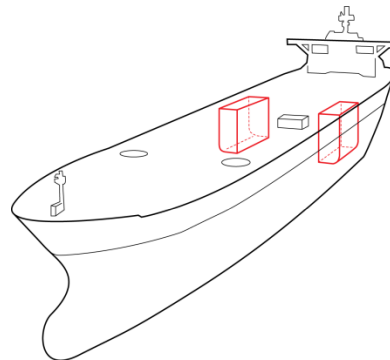
Passenger ferries



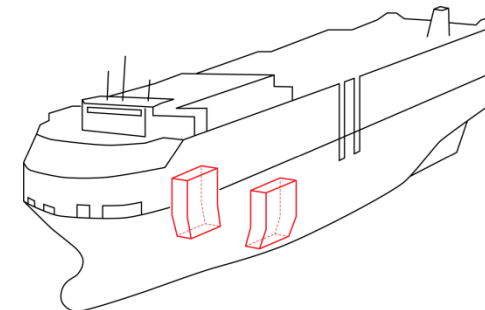
Container carriers



Cruise ships



Oil Tankers



Ro-Ro vessels

...and many other sectors. Bespoke design. Under development now.

Gas engine concepts – 4 stroke

- Lean Burn spark ignited (gas only)
- Dual Fuel low pressure gas (5 bar)

Both can meet IMO tier III and have a significant potential for GHG reduction (methane slip must be reduced)

- Dual Fuel high pressure gas (about 350 bar)

Maintain diesel engine performance. No methane slip.

Not sensitive to gas quality

GHG reduction in the range of 30%

Need SCR for NO_x reduction to meet IMO tier III

Gas engine concept – 2 stroke

- Dual Fuel high pressure gas (about 350 bar)
Maintain diesel engine performance.
No methane slip, GHG reduction in the range of 30%
Not sensitive to gas quality
Need SCR for NOx reduction to meet IMO tier III
- Pumping LNG to 350 bar and evaporate is simple and with low energy requirement
- Flexibility in fuel mix (LNG HFO)

Is LNG economical competitive to HFO?

Natural gas prices (including LNG) has been reduced the last two years due to the introduction of shale gas in the US market

Due to that LNG has improved its competitiveness to HFO

For comparing fuel economy there two cost components for HFO to be considered:

- Cost purchase the fuel
- Cost for burning the fuel (levy, tax, operation of exhaust gas cleaning)

and than the big question; what will be the price HFO in the future?

LNG is competitive to HFO today in some areas and we believe that LNG will improve its competitiveness in the actual time frame considered

Summing up

- LNG is available world wide
- Small scale distribution by dedicated ships are available
- Storage technology for ships are available and under further development
- Gas engine technology is available for all types of piston engines, can meet the coming emissions limits and contributes to a net reduction of GHG
- LNG has the potential to be economical competitive to HFO