Alternative Fuels for Shipping

Prices and Availability

Prof. Dr. Michele Acciaro

Kühne Logistics University,
Hamburg, Germany

A FEW WORDS ABOUT ME

- Work
  - Since 2013, Assistant **Professor of Maritime Logistics** at the KLU in Hamburg
  - Previously: Senior Researcher – Green Shipping at the Research and Innovation department of Det Norske Veritas AS (now DNV GL) in Høvik, near Oslo
  - Deputy Director/Research Associate at Erasmus University Rotterdam, Center for Maritime Economics and Logistics (MEL)

- Education
  - BSc and a MSc (cum Laude) in Statistics;
  - a MSc in Maritime Economics and Logistics from Erasmus University (hons);
  - and a PhD in Logistics also from Erasmus University Rotterdam

Contacts:
michele.acciaro@the-klu.org

CONTENTS

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- Introduction 04–05
- Short term 06–18
  - Fuel consumption 07–10
  - fuel supply 11–13
  - Price and availability impacts 14–17
- Long term 18–33
  - Biofuels 19–21
  - LNG 22–26
  - Methanol 27–32
- Concluding remarks 33–36
- Bibliographical references 37–39

BEFORE WE START

Regulation is the major driver for alternative fuels (what regulation?)

- Alternative (reference case) is running on distillates
- Fuel has to be cheaper and it has to be available
- The technology has to be reliable
- CAPEX have to be low enough
- Safety issues

In this presentation we are focusing on

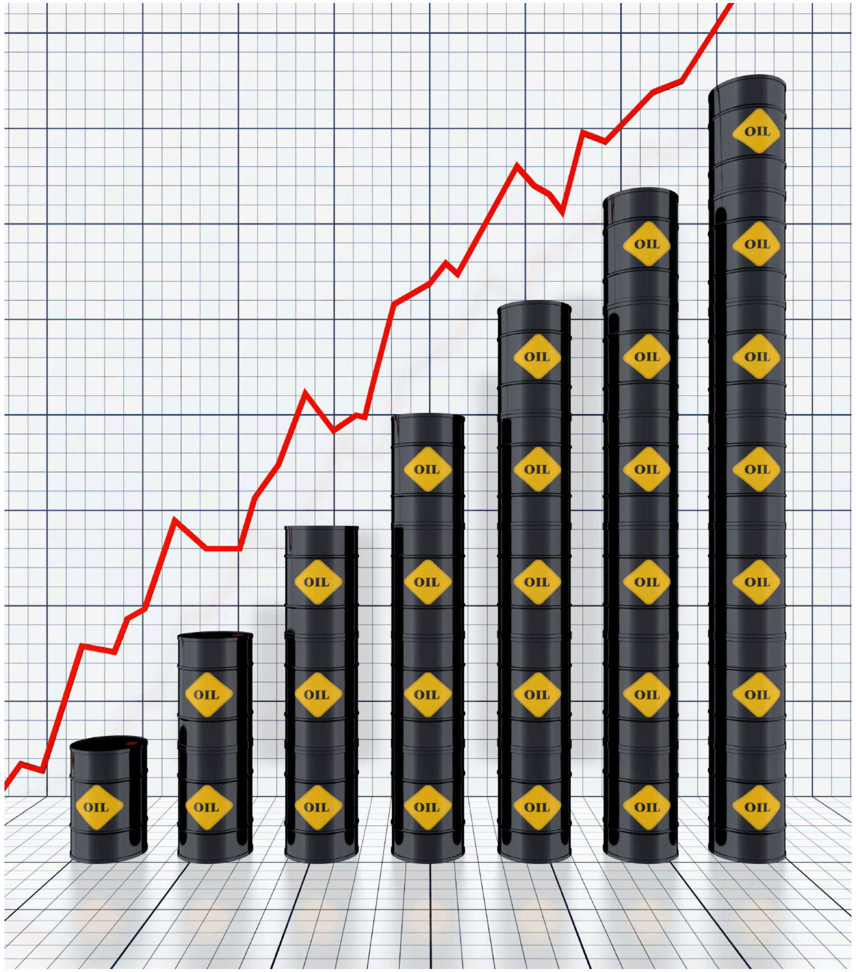
- Prices
- Availability

DIFFERENT PROBLEMS

Short term
Tomorrow (5 weeks) ECA compliance
(do not forget NOx coming up)

Medium term
Fuel transition because of:

- Peak-oil/high bunker fuel costs
- Low sulphur regulation globally
- Other regulation (e.g. NOx, CO_2)



SHORT TERM

Focus on imminent regulation
- SOx
- NOx
- Other issues are in the short term irrelevant
  - E.g. methane slip, CO_2, life cycle analiyisis

Let's face it, the direct solution for those 8000 vessels is to switch to distillates

Uptake of scrubbers and LNG is too marginal to make a difference

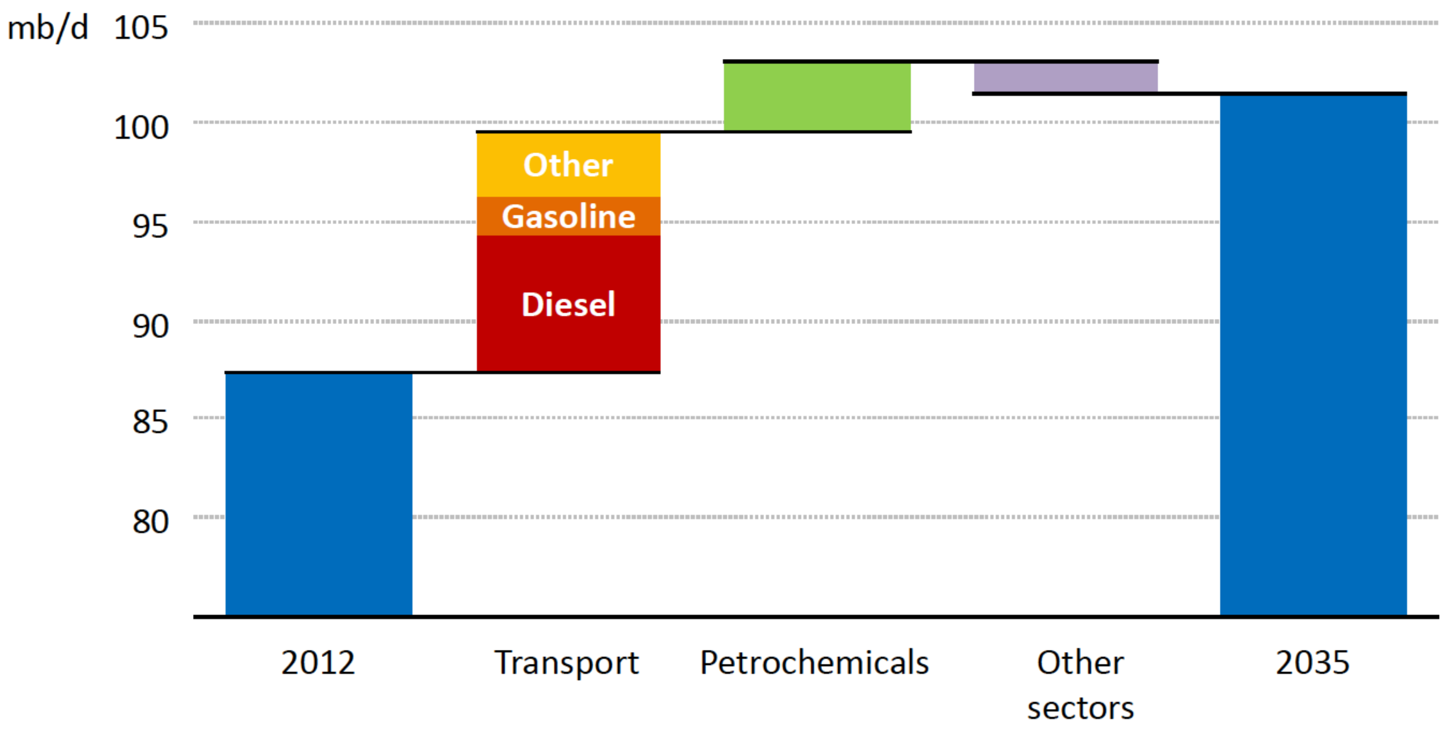
TOTAL FUEL CONSUMPTION FOR SHIPPING (IMO 2014)

Over the period 2007-2012, average annual fuel consumption ranged between **approximately 250 million and 325 million tonnes** of fuel consumed by all ships within this study, reflecting top-down and bottom-up methods, respectively. Of that total, **international shipping** fuel consumption ranged between approximately **200 million and 270 million tonnes per year**, depending on whether consumption was defined as fuel allocated to international voyages (top-down) or fuel used by ships engaged in international shipping (bottom-up), respectively.

Source: IMO 2014 GHG Study.

WHAT ARE WE TALKING ABOUT

Shippings is accountable of 4% of global oil demand, circa 4 mboe/d (IEA 2014)



Source EIA 2014

TOTAL FUEL CONSUMPTION IN ECAS

The North Sea and Baltic ECAs account for approximately 27 million tonnes (IMO 2009), approximately 9% of total bunker fuel used in the maritime industry, more than half of the bunker fuel consumed in Europe

North America accounts for approximately 10 million tonnes which makes a total of 37, maybe 40 million tonnes (DNV study shipping 2020 assumed 45)

10 million becomes 16.5 in 2020 (EPA estimates) and considering similar growth rates we get to a 60/70 million tonnes by 2020 (still roughly 10% of global bunker fuel consumption). North American ECAs will represent an estimated oil consumption of around 20 million tonnes (0.35 mb/d) of fuel by 2020 (EPA, 2009)

8000 vessels affected by ECA regulation (out of 60’000 commercial/90’000 total excluding shipping)

PROJECTED FUEL MIX 2020

Vessel types	Small vessels, ferries etc.	Cargo ships with sulfur removal	Cargo ships without sulfur removal	Total
No. of vessels	55.000	30.000	20.000	105.000
HFO [Mton/yr]	-	204	-	204
LSFO [Mton/yr]	-	-	110	110
MGO/MDO [Mton/yr]	44	-	25	69
LNG [Mton/yr]	15	-	-	15
Biofuels etc. [Mton/yr]	1	-	1	2
Total fuel [Mton/yr]	60	204	136	400
Market per cent	15%	51%	34%	100%

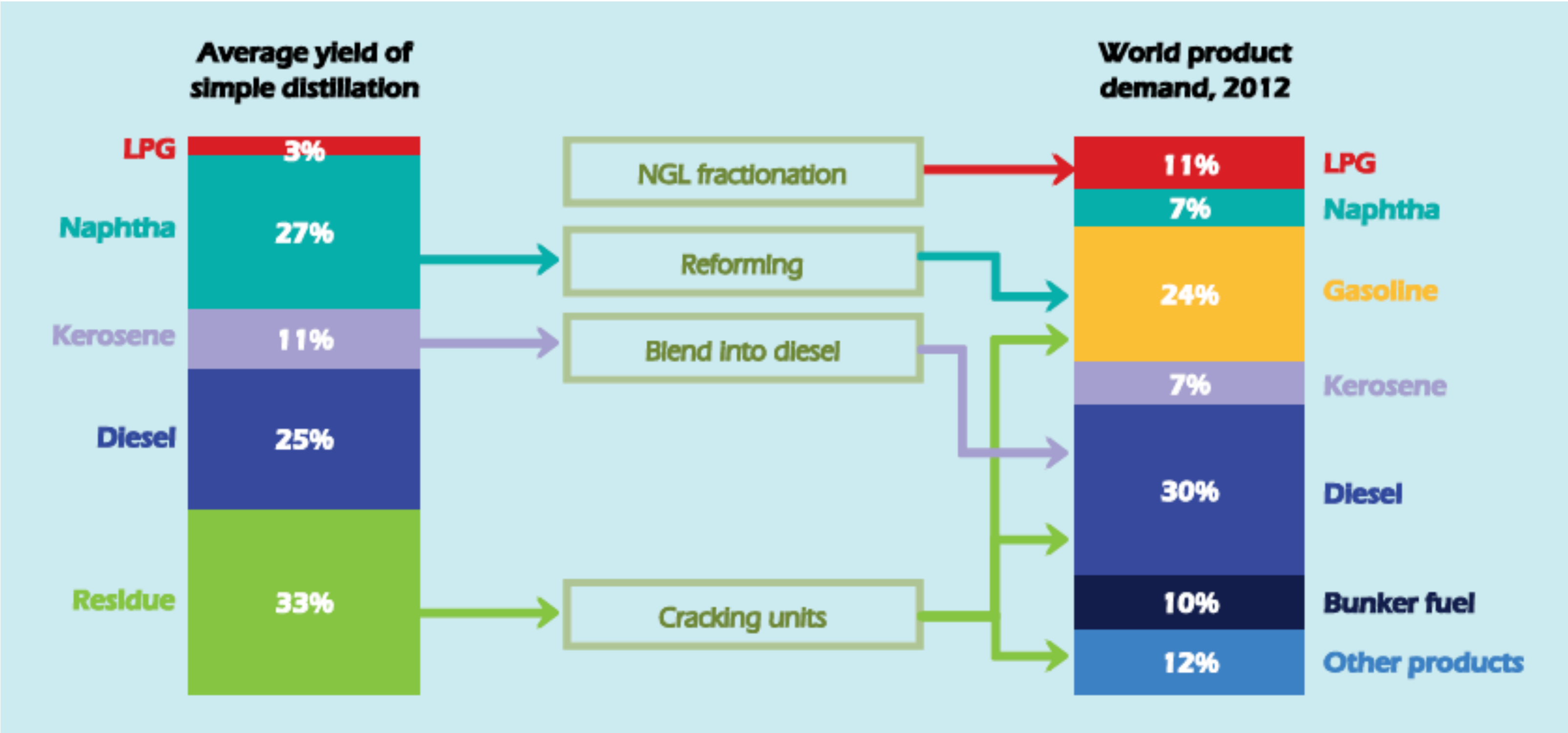
Source: Bill Remley, USC Alternative Fuel workshop 2014.

SUPPLY

Estimates (Pappos and Skjølsvik 2002) estimated supply for low sulphur fuel at 6.5 million tonnes in Europe

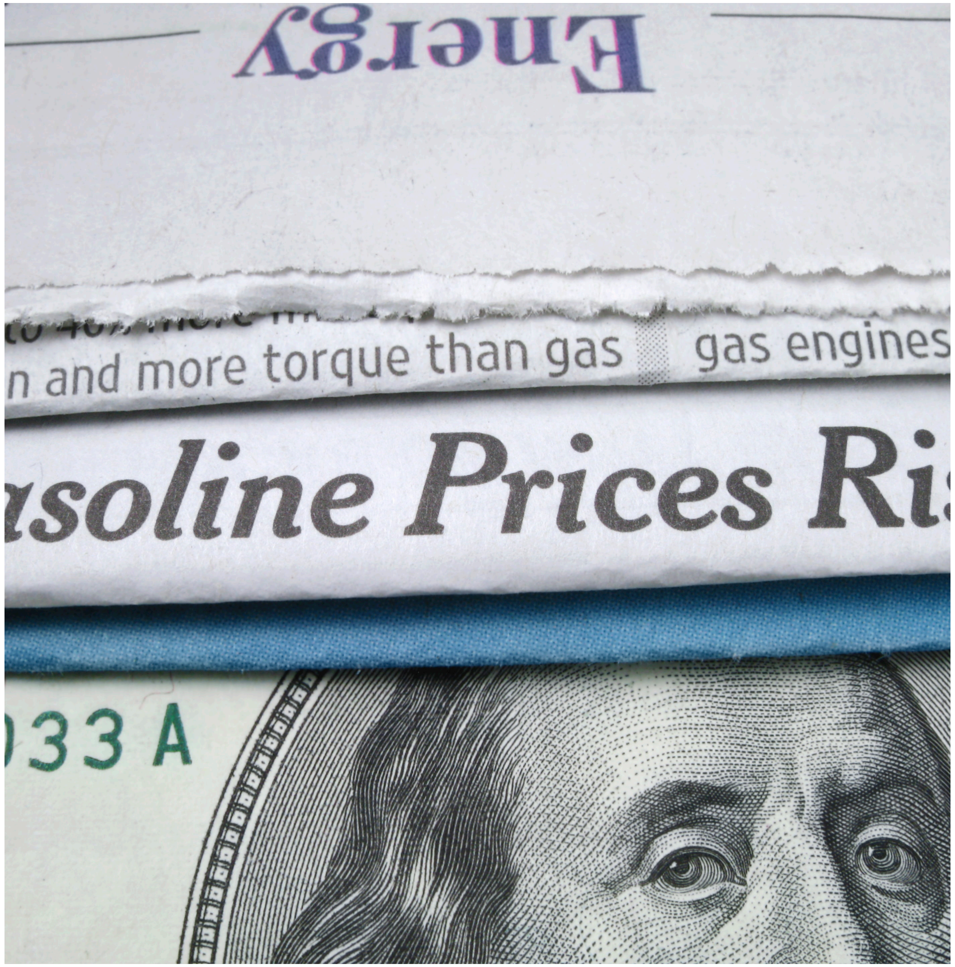
- of this less than a million go for shipping
- The situation has worsened since then
- From the supply side (limited growth and not much more can be taken out from a barrel or oil)
- And from the demand side
  1) Low sulphur fuel at ports
  2) 1 January 2015…

THE REFINERY PERSPECTIVE



Already overcapacity with very thin margins!

PROBLEM



Limited supply
Middle distillates are already the fastest growing market in the world

If demand increases and supply does not…

… prices go up

DO WE SEE PRICE INCREASES?

NOT FOR THE TIME BEING…

BWI 1091

Bunkerworld Index

Day: -6 Week: -43 30-Day: -91

BWDI $783.00

Bunkerworld Index

Day: +2.00 Week: -19.00 30-Day: -39.00

Source: Bunkerworld 17-11-2014

CRUDE OIL PRICE (BRENT)

Source: Bunkerworld 17-11-2014

ISSUE IN PERSPECTIVE

The issue is not so much the cost of fuel (that is beyond control of the maritime industry) but more related to the difference between distillates and heavy fuel oil

- Low oil prices -> low bunker fuel prices
- High oil prices -> high bunker fuel prices

Issue of decoupling: to assess this we need to assess the importance of ECAs in the great scheme of world fuels

TAKE AWAY NO 1

Shipping matters relatively little to the world of fuels in general with the exception of residual fuels

However considering the little size of ECAs we are unlikely to see a decoupling of the maritime bunker fuels

MEDIUM TERM PERSPECTIVE MAJOR TYPES OF FUELS RELEVANT FOR MARITIME TRANSPORT

Looking on the literature most promising fuels seem to be:

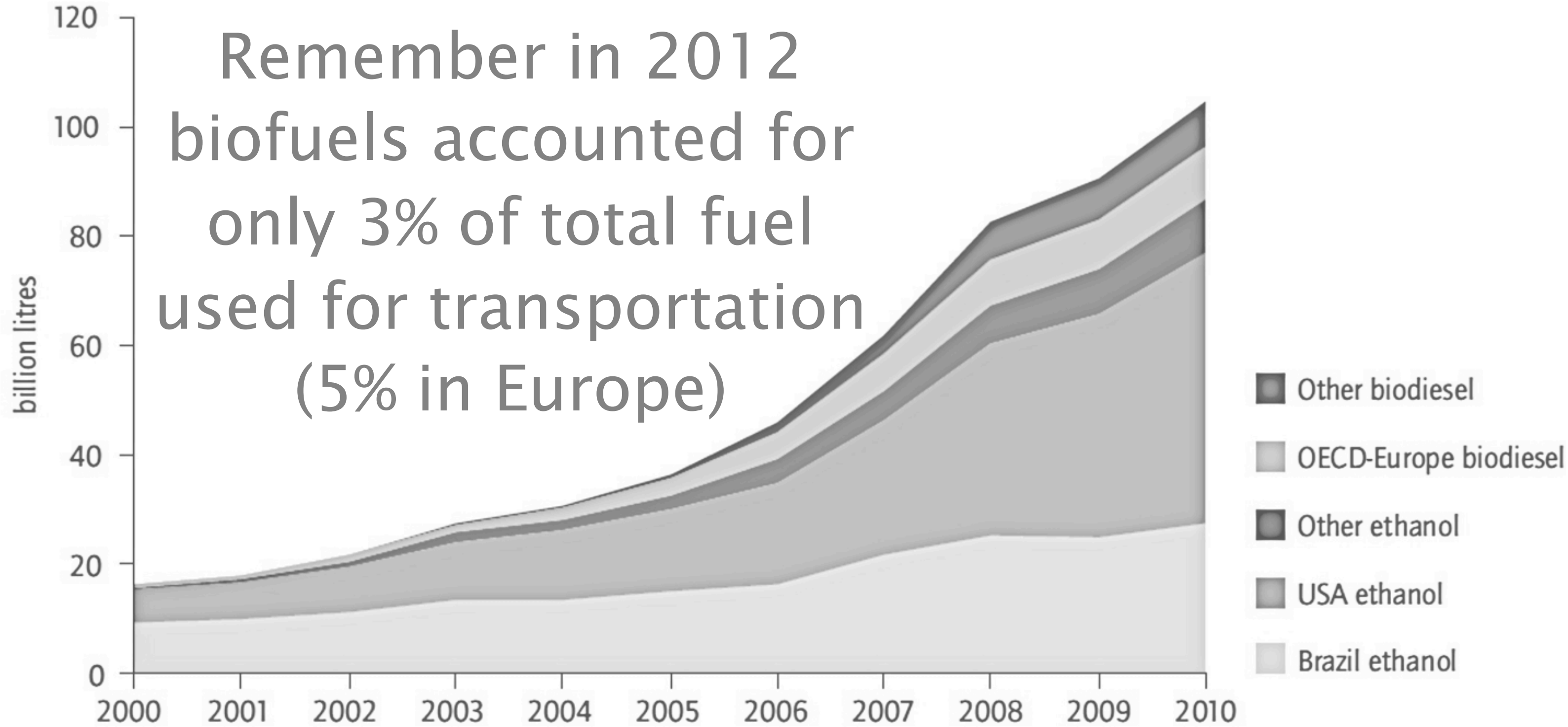
- Diesel Fuels (low sulphur and biofuels)
- LNG (Methane and biogas)
- Alcohols (methanol)
- Hydrogen (also combined with batteries)
- Other fuels

IMPORTANT:

- Alternative propulsion
- Sun, wind, wave, electricity, batteries, nuclear… feasible alternatives that need to be looked at, but not in this presentation.
- Also note that efficiency improvements can be obtained from other measures (technical and operational)

BIOFUELS – AVAILABILITY

Steep increase in world production

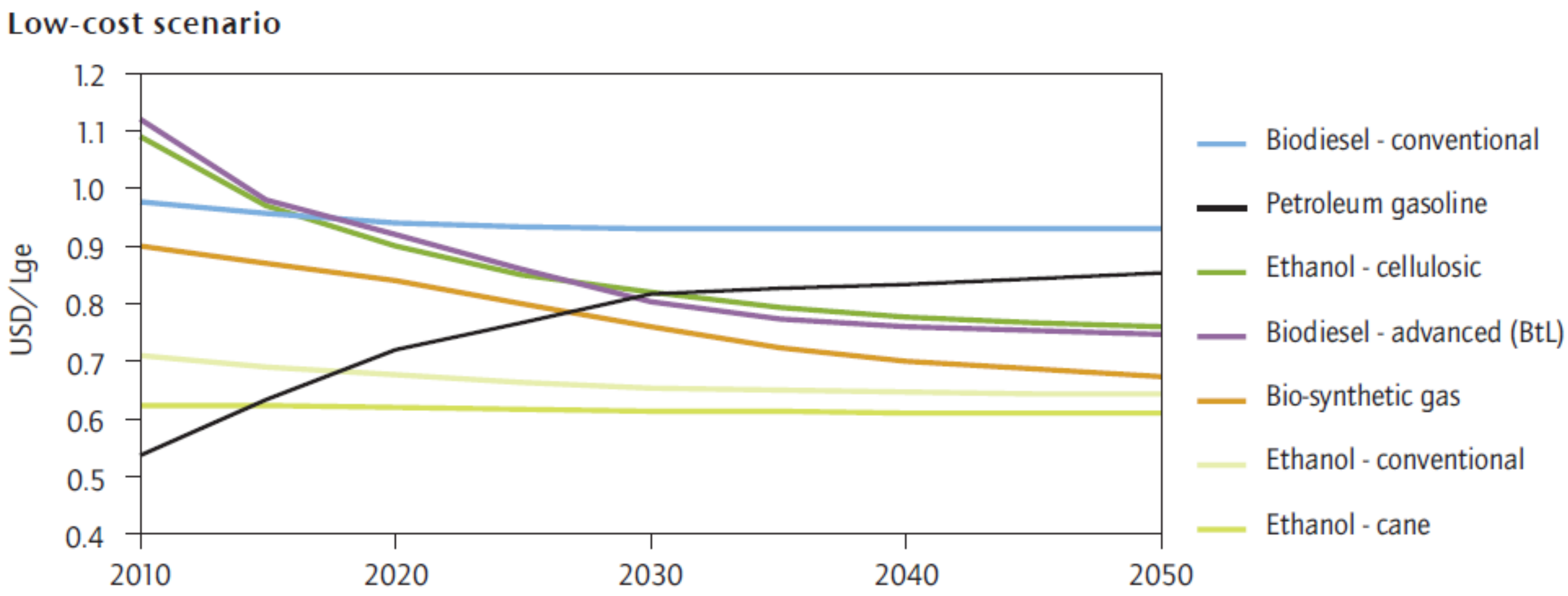


Remember in 2012 biofuels accounted for only 3% of total fuel used for transportation (5% in Europe)

Global biofuel production 2000–2010

Source: IEA 2010a.

BIOFUEL – PRICE OUTLOOK



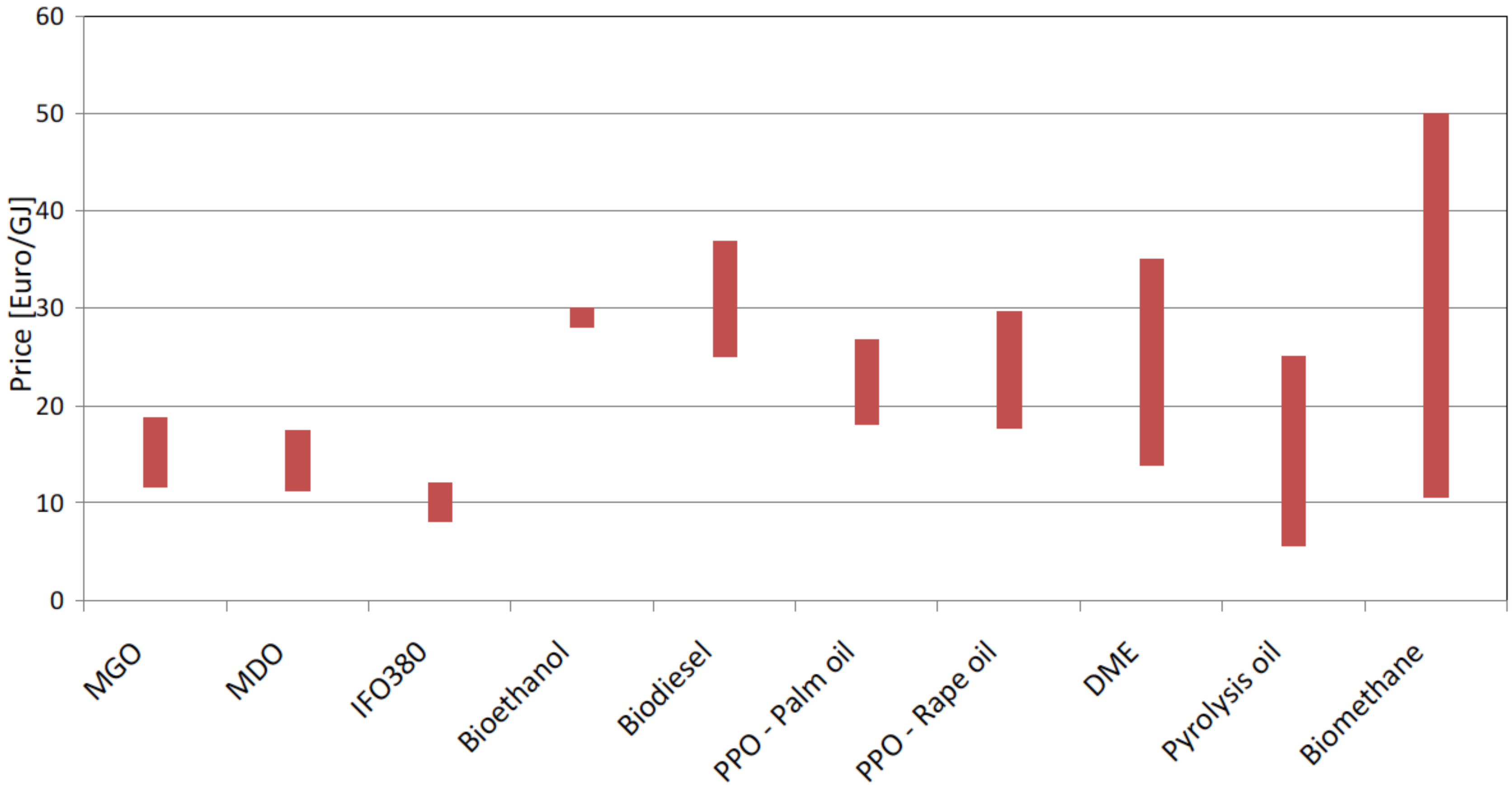
Costs of different biofuels compared to gasoline (BLEU Map Scenario). There is also a high cost scenario and only in the low cost scenario there is a chance for biofuels (depending on gasoline price)

Source: IEA 2011d, figure 13, pg. 32.

Biofuels remain expensive

USD/lge (liter of gasoline equivalent)

BIOFUELS COMPARED TO OTHER FUELS FOR MARITIME TRANSPORT



Source: Ecofys (2012), figure 18, pg. 81

LNG DEMAND/PRICE

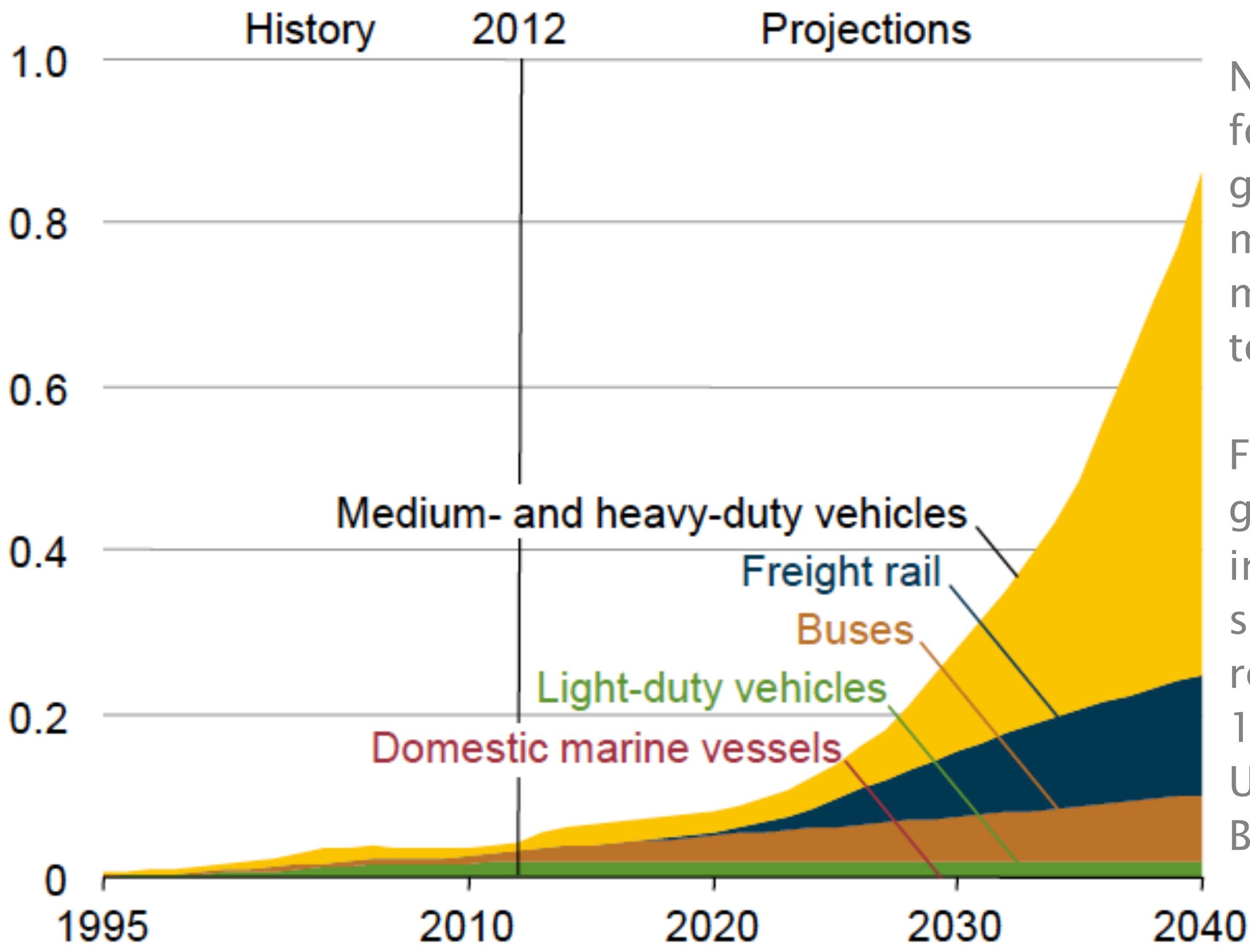
50 LNG fuelled vessels sailing, and 110 in total including the contracted new buildings (excluding the LNG carriers), compared to some 80–100.000 diesel fuelled ships (50% increase every year)

If we were to convert the roughly 4% of global oil demand per year attributable to shipping, we would have (energy equivalent) an annual consumption of 230 billion cubic metres, that is about 2/3 of total LNG global demand.

LNG Prices:

Natural gas price + Logistics + local differences +  = price of LNG

TRANSPORT AND LNG

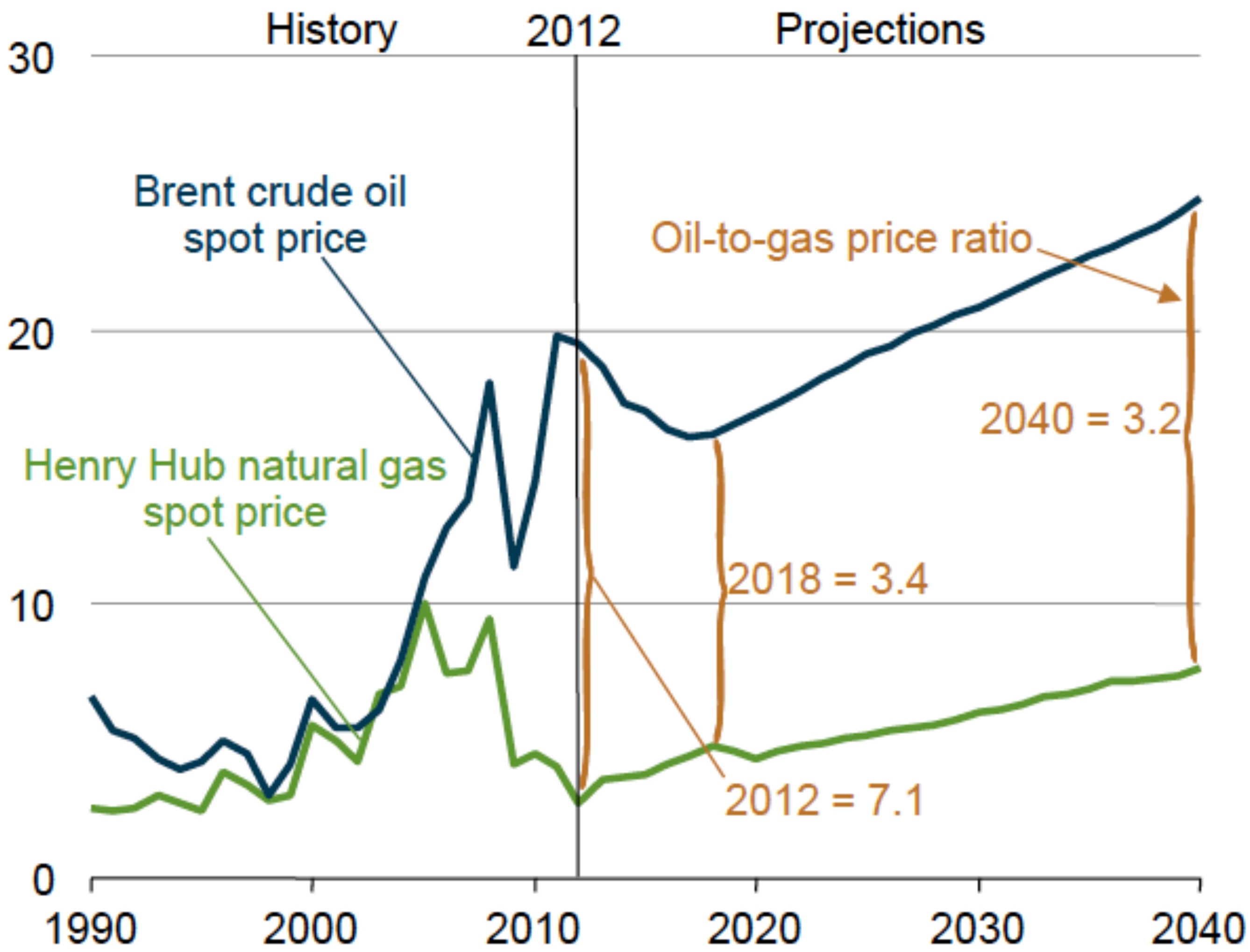


Natural gas use for transport fuel grows but still makes up a modest share of total use

Figure: natural gas consumption in the transport sector in the reference case, 1995–2050 in the US (quadrillion Btu)

Source: US EIA 2014, pg. MT15.

NATURAL GAS PRICES



However HH is not the price at which LNG is available to shipping

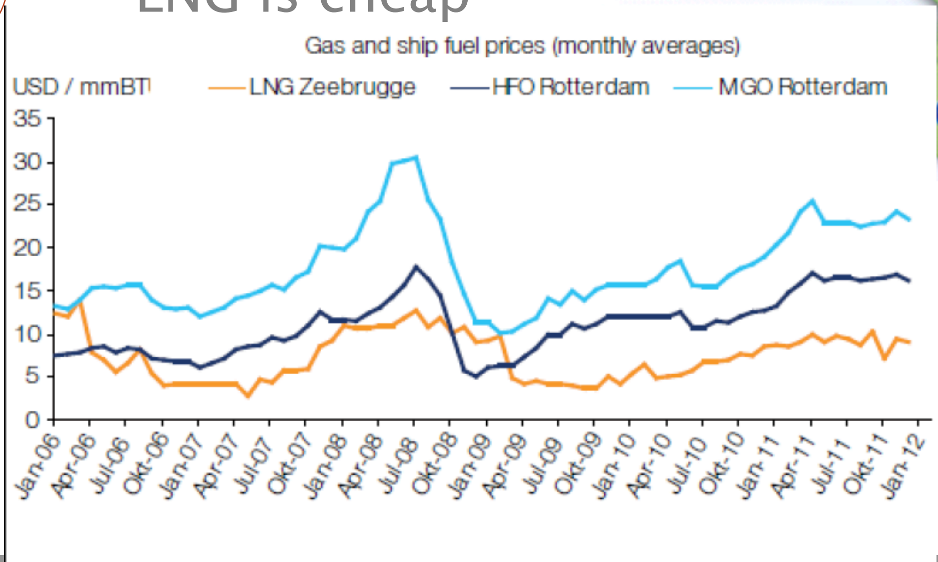
Furthermore no global market exists for natural gas or LNG

Figure: Comparison of spot prices for Brent crude oil and Henry Hub natural gas, 1990-2040 (2012 dollars per million Btu)

Source: IEA(2014) Energy outlook, IF1-3

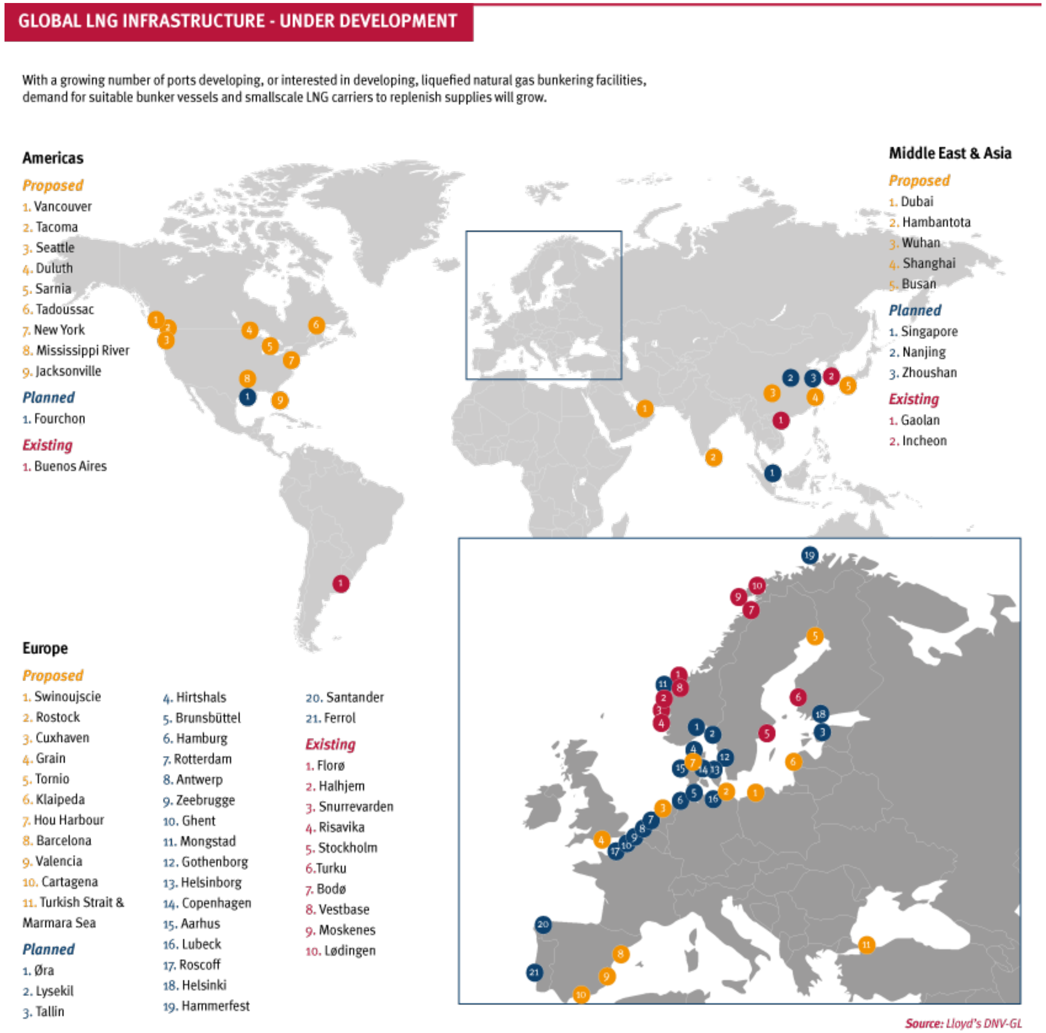
FUEL PRICES (NOVEMBER 2013)

- Price differentials across the world
- Even within Europe
- At major hubs LNG is cheap



Source: Bill Remley, USC Alternative Fuel workshop 2014 (top), left GL-Mann (2012)

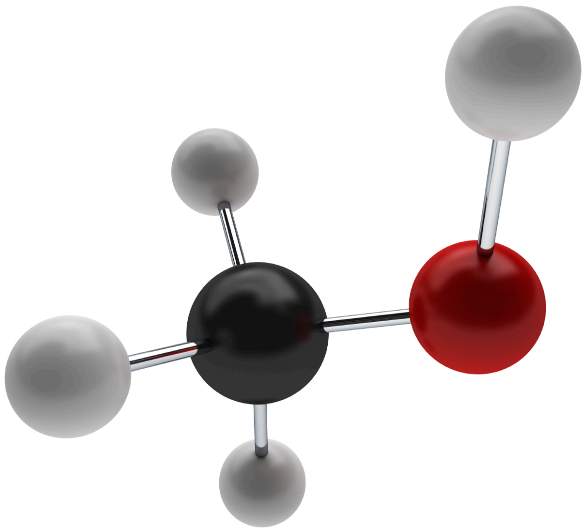
LNG BUNKERING AVAILABILITY



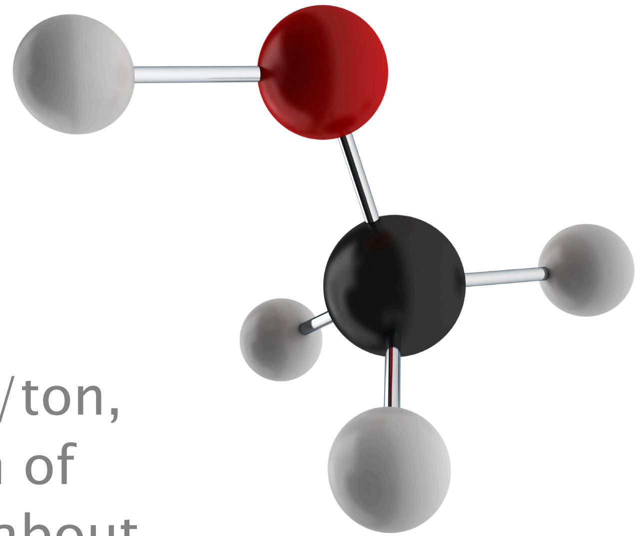
- The development of LNG bunkering facilities is a prerequisite for the uptake of LNG as a maritime fuel
- Innovation in energy is context-bound, so that economic, technological, political and environmental issues drive the uptake of the innovation
- Strategic consideration in respective political arenas are the most critical drivers for investment in new unproven technologies at port

Source: Eason, 2014; Acciaro & Gritsenko, 2014.

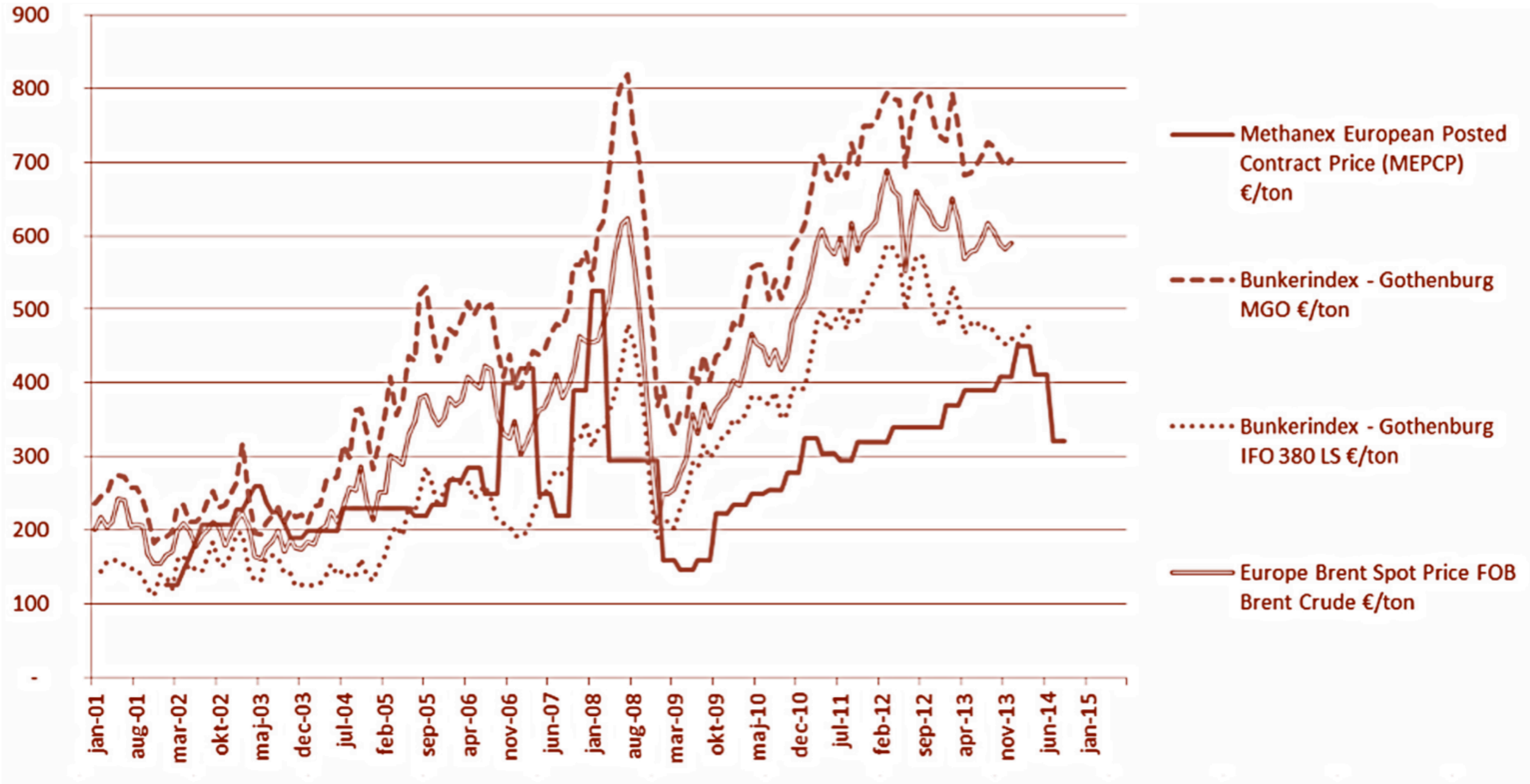
METHANOL PRICES



450/500 USD/ton, but one ton of methanol has about half the energy content (20 MJ/kg) of MGO (42 MJ/kg).

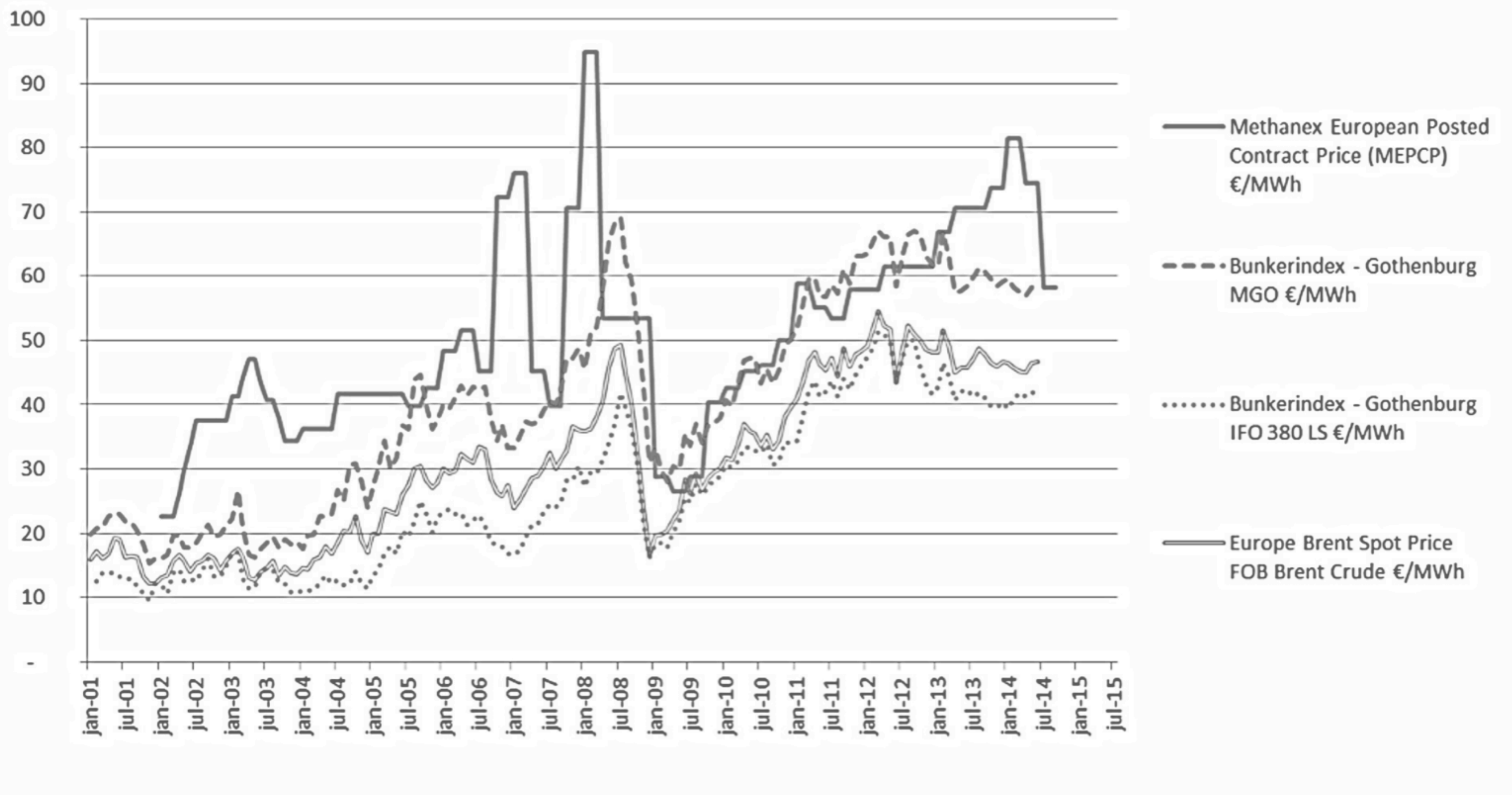


METHANOL PRICES (€/Ton)



Source: Marinemethanol.com, 19-11-14

METHANOL PRICES (€/MWh)



Source: Marinemethanol.com, 19-11-14

AVAILABILITY

Where does it come from:

- Biomass
- Fossil hydrocarbons

Biomass far too limited for a large scale although it is what makes methanol particularly attractive

Mostly hydrocarbons (maybe in the future alternative sources)

Major issue, far too little for large scale implementation

AVAILABILITY COMPARISON (CURRENT CONSUMPTION)

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Fuel	2010 Total consumption (million TOE/year)
Oil-based	4,028*
Natural Gas	2,858
Of which LNG	250-300
Biodiesel	18-20
LPG	275
Methanol	23
Ethanol	58
DME	3-5
Fischer-Tropsch	15
Biogas	Very low
Hydrogen	Very low

** Approximately 7-8% for shipping*

Source: DNV-GL 2014

FUEL PRICES (INDEXED TO 2010 HFO PRICE)

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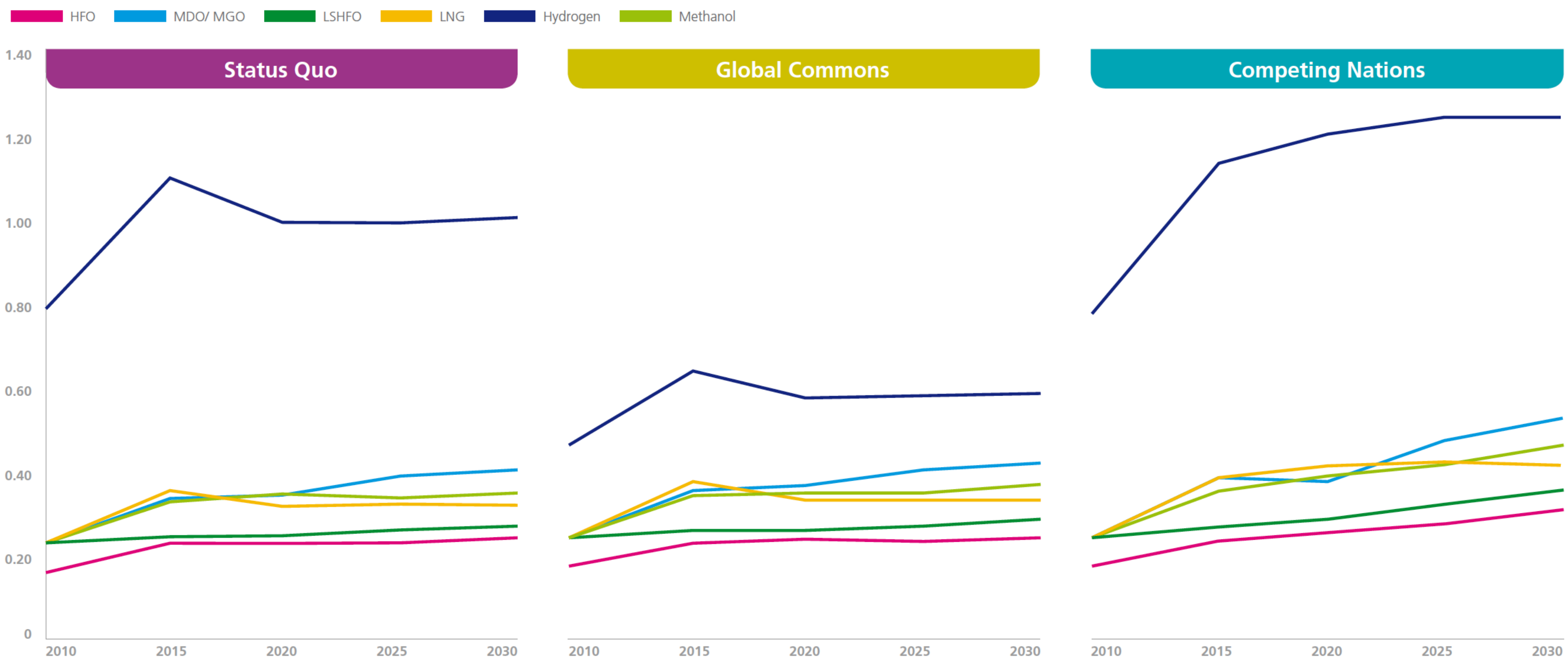

Source: Lloyds register Marine and UCL (2014)

TAKEAWAY NO 2

We are likely to see the coexistence of multiple compliance strategies and various fuels in the near future

- Biofuels: Expensive in most instances comparable with distillates, Maybe some low grade fuels, Production is limited
- LNG: Cheap, widely available (expensive capital costs), high uncertainty
- Methanol: comparable in terms of price to distillates, very flexible, limited availability

RESEARCH NEEDS (TECHNICAL)

- Methane slip
- Engine technology (e.g. combustion efficiency, blending, hydrocarbons slip);
- Total fuel efficiency;
- Systems interaction, optimal integration;
- Compatibility with maritime use (e.g. long storage, corrosion, water infiltration, high salinity environment);
- Environmental impacts;
- Safety issues in handling procedures and storage (e.g. LNG IGF code, tank locations, concomitant presence of multiple fuels on board, bunkering procedures);
- Classification rules development, design guidelines, recommended practices, and standardisation;
- Value chain analysis and optimisation;
- Human factors.

FURTHER RESEARCH NEEDS

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- Supply and feedstock availability (e.g. refinery capacity, demand from other modes of transport);
- Distribution constraints (e.g. availability of storage and transport capacity, storage and transport costs);
- Retrofit and conversion costs;
- Port storage and bunkering infrastructure (e.g. technical challenges, infrastructure development);
- Market constraints and pricing (e.g. price levels, legal constraints, policy, impact of incentives);
- Life cycle analysis issues (e.g. emissions along the supply chain, well to propeller environmental footprint including production impact, land use, societal aspects, etc).

CONCLUDING REMARKS

Open research issues

- Technical issues still critical
- Multiple fuels might have to coexist
- Issues at port and in distribution chains
- Uncertainty on fuel availability and fuel prices
- Safety issues on board and at port
- Integration of new technologies on board and environmental and efficiency lifecycle considerations

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