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THE ENERGY REVOLUTION IN NORTH AMERICA--FACILITATING DYNAMIC SHIFTS IN TRADE AND TRANSPORTATION

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December 3, 2014

EcoNomics

Current Market Drivers

- Renewed access to previously stranded Upstream Oil Developments
  - Canadian Oil Sands
  - Arctic Russian Finds
  - South American opening oil fields

- Natural Gas Markets in the USA (Bakken Crude, Natural Gas, Natural Gas Liquids –NGLs)
  - Utica and Marcellus Shales
  - Persell and Barnett Shales
  - Permian Basin

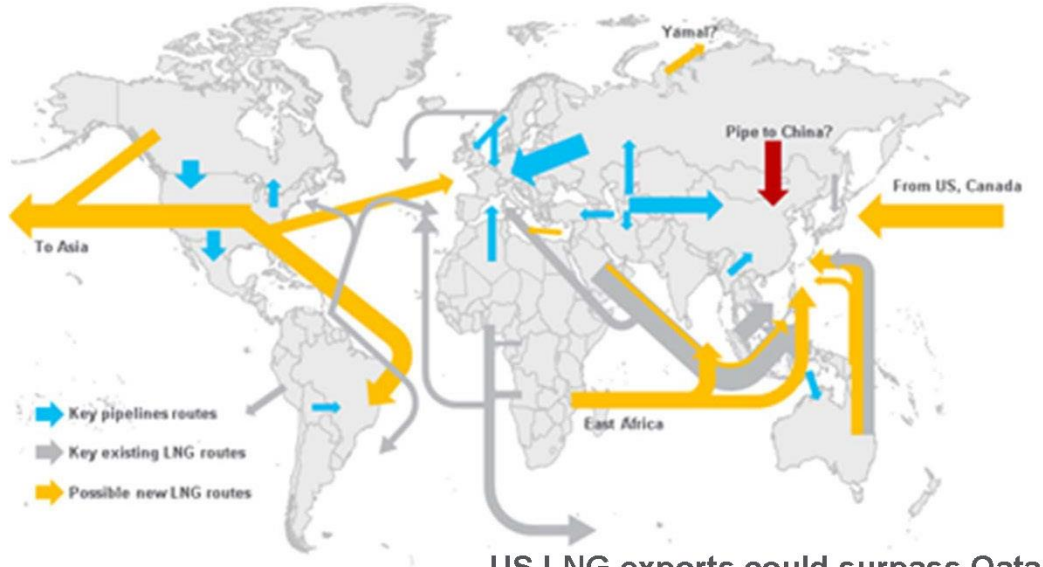
- Inexpensive Natural gas is driving the Chemical processing industry around the production of ethylene and methanol which are energy intensive – 18 Projects valued at $US1B or more.
- Refining Resources
- Coal Gasification to Produce DME
- Oil “Trans-shipment” and Liquid Bulk Storage Regional Facilities

“For Shipping IMO Marpol VI”

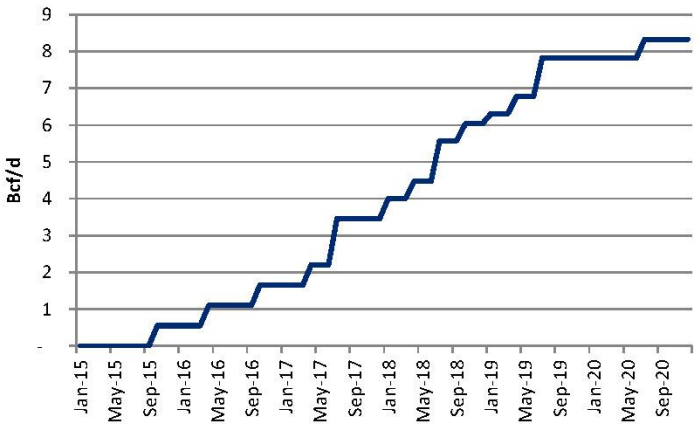
“Not “Either-Or” but a part of the energy mix”

Map of Future Gas Flows

Map of future global gas flow



Possible amount of US LNG exports (2015-2020)

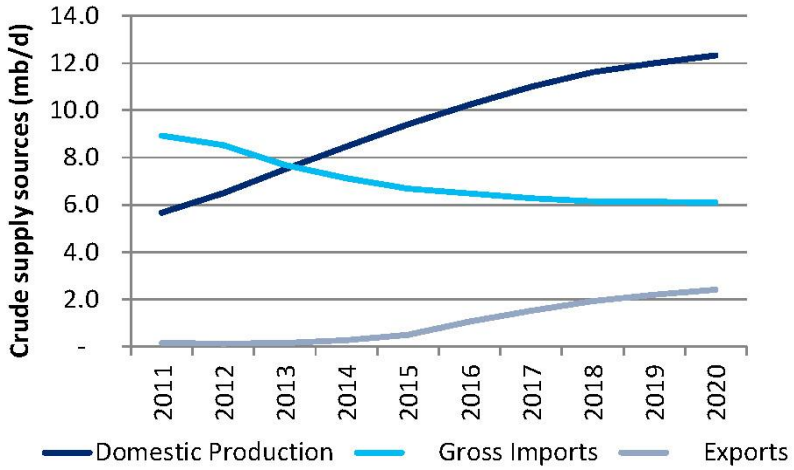


US LNG exports could surpass Qatar and Australia by 2020

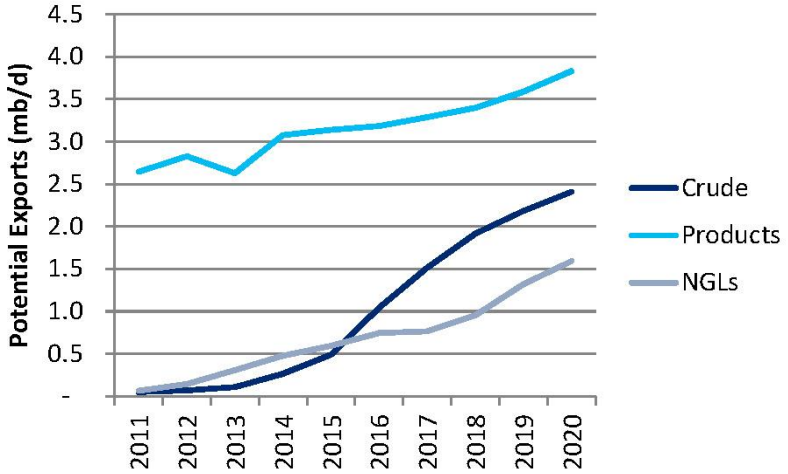
Terminal	Company	Location	mtpa	Bcf/d
Approved (non-FTA)				
Sabine Pass	Cheniere	Cameron, LA	16.5	2.2
Freeport	Freeport/Macquarie	Freeport, TX	10.5	1.4
Lake Charles	Energy Transfer Partners	Lake Charles, LA	15.0	2.0
Cove Point	Dominion	Lusby, MD	5.8	0.8
Freeport expansion	Freeport/Macquarie	Freeport, TX	3.0	0.4
Cameron	Sempra	Hackberry, LA	12.8	1.7
Pending				
Jordan Cove	Jordan Cove	Coos Bay, OR	6.8	0.9
Oregon	LNG Dev Co.		9.4	1.3
Corpus Christi	Cheniere	Corpus Christi, TX	15.8	2.1
Lavaca Bay	Exelerate	Port Lavaca, TX	10.4	1.4
Gulf Coast	Gulf Coast LNG	Brownsville, TX	21.1	2.8
Southern LNG	Southern LNG	Savannah, GA	3.8	0.5
Gulf LNG	Gulf Coast LNG Export	Pascagoula, MS	11.3	1.5
CE FLNG	CE FLNG	Plaquemine, LA	8.0	1.1
Golden Pass	Golden Pass Products	Port Arthur, TX	19.5	2.6
South Texas LNG	Pangea LNG	Offshore, TX	8.2	1.1
Main Pass	Freeport-McMoRan	Offshore, LA	24.2	3.2
Sabine Pass	Sabine Pass Liquefaction	Cameron, LA	2.1	0.3
Sabine Pass	Sabine Pass Liquefaction	Cameron, LA	1.8	0.2

USA Net Energy Exporter

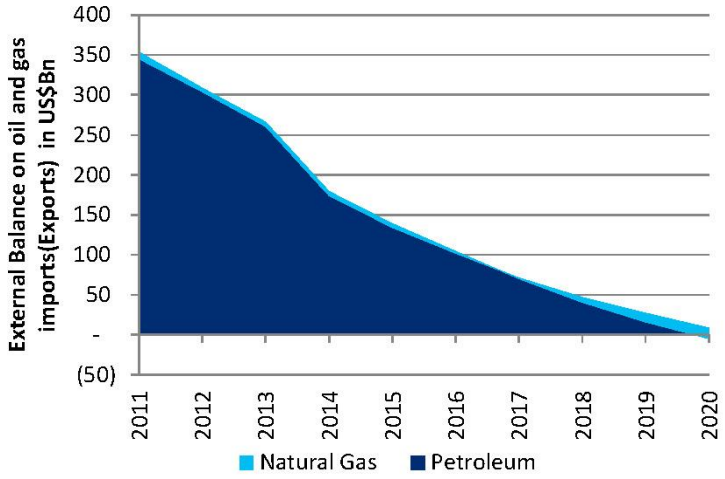
Rising US production to reduce imports and spur exports



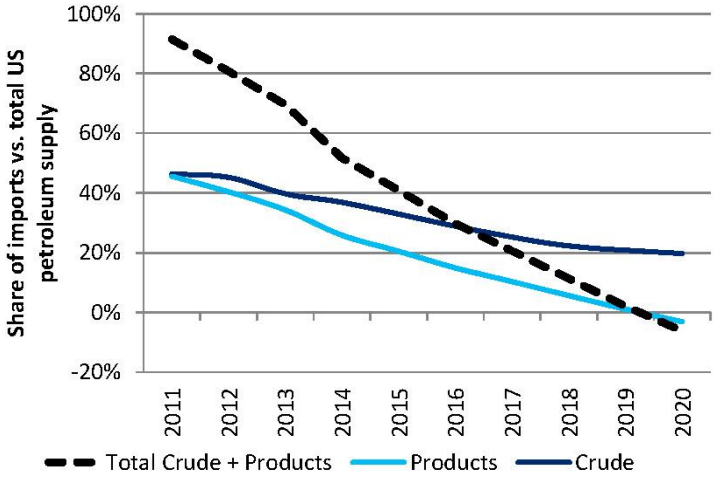
The exports of excess light crude could surge starting in 2015, along with strong product and NGL exports



Oil/gas trade balance could go from a deficit of $354Bn in 2011 due to imports to +$5Bn in 2020 due to exports

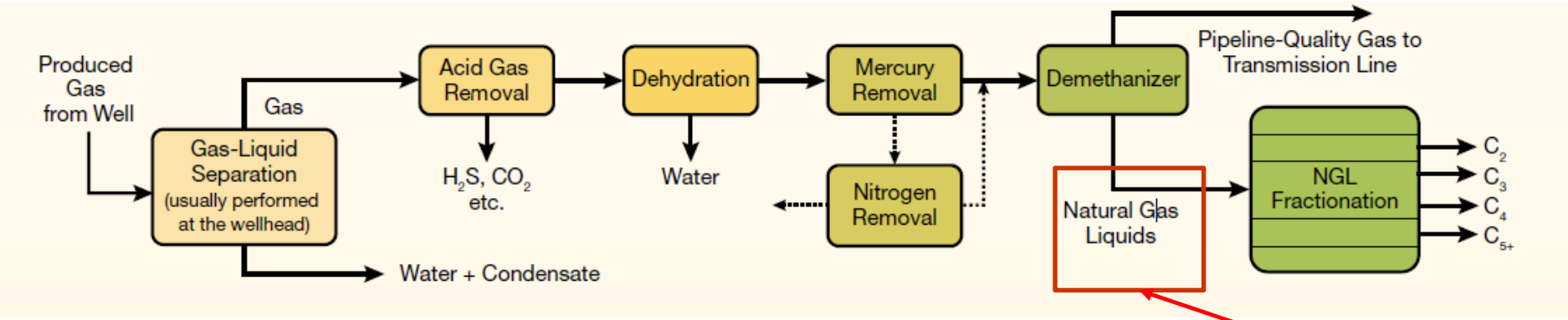


Dependence on foreign oil? The US could be a net exporter of petroleum as soon as 2019 (volume share of total US petroleum supply)



USA Shale Plays

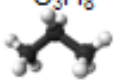
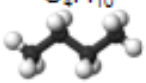
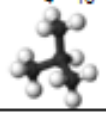
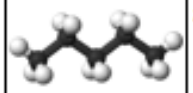
Natural Gas Liquids
The "Process"



Represents opportunities for the Infrastructure Transportation Markets Including Ports

- Well known processes
- Different constraints = different outcomes for transportation and logistics
- Each connectivity line in the above diagram represents a need for storage/transportation

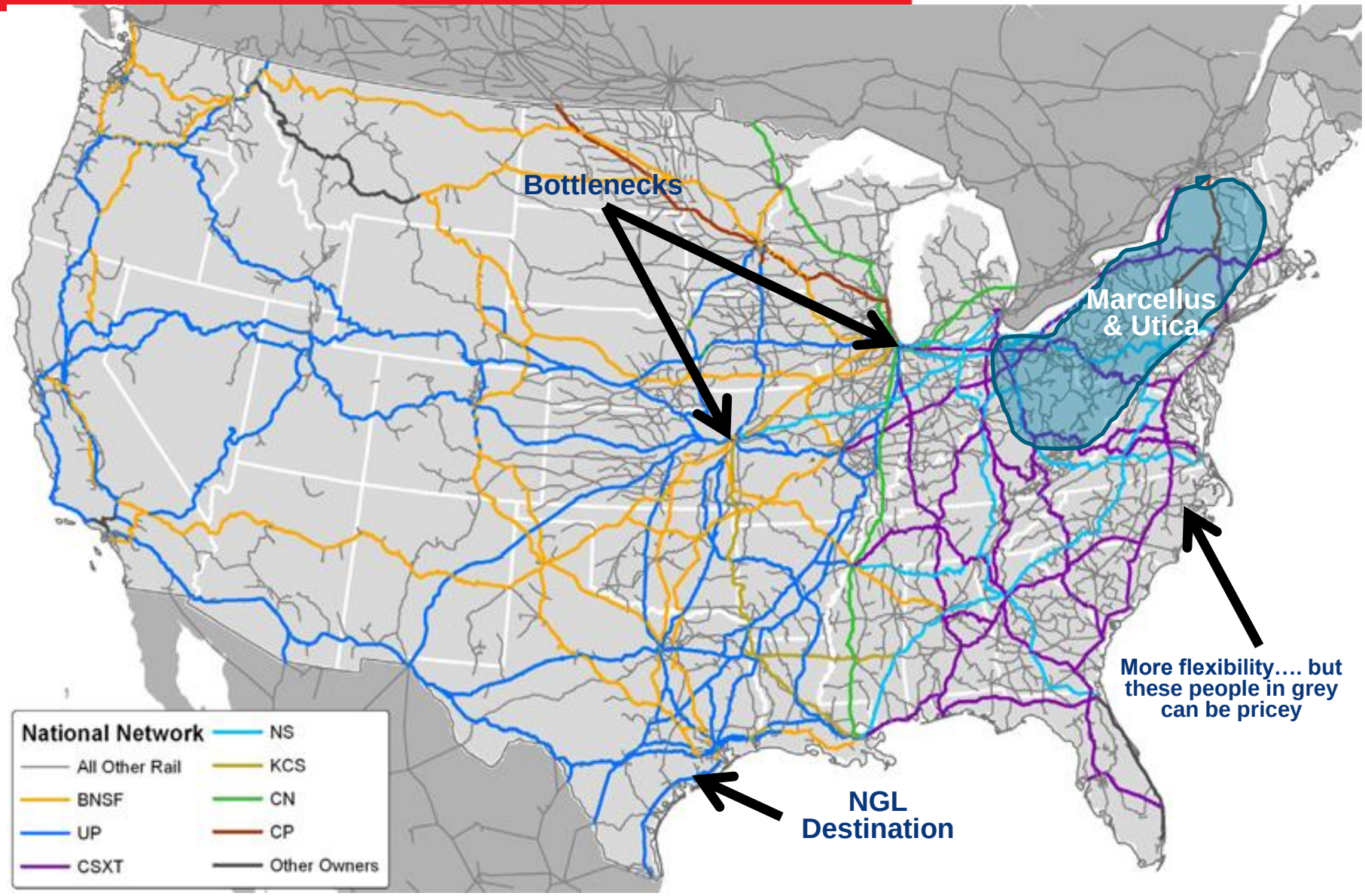
What are Natural Gas Liquids?

NGL Attribute Summary				eia
Natural Gas Liquid	**Chemical Formula**	**Applications**	**End Use Products**	**Primary Sectors**
Ethane	C_2H_6 	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	C_3H_8 	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, Residential, Commercial
Butane	C_4H_{10} 	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tires; LPG; lighter fuel	Industrial, Transportation
Isobutane	C_4H_{10} 	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	C_5H_{12} 	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentanes Plus*	Mix of C_5H_{12} and heavier	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oil sands production	Transportation

C indicates carbon, H indicates hydrogen; Ethane contains two carbon atoms and six hydrogen atoms

*Pentanes plus is also known as "natural gasoline." Contains pentane and heavier hydrocarbons.

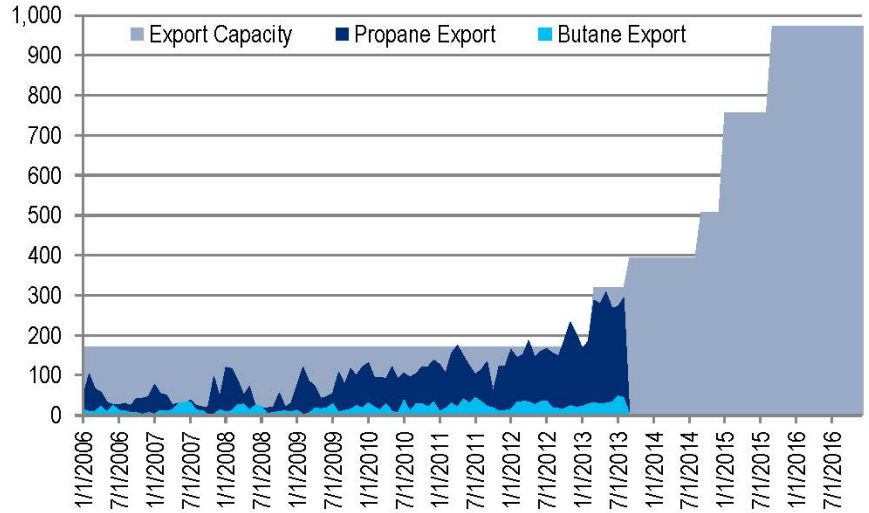
Rail Networks USA



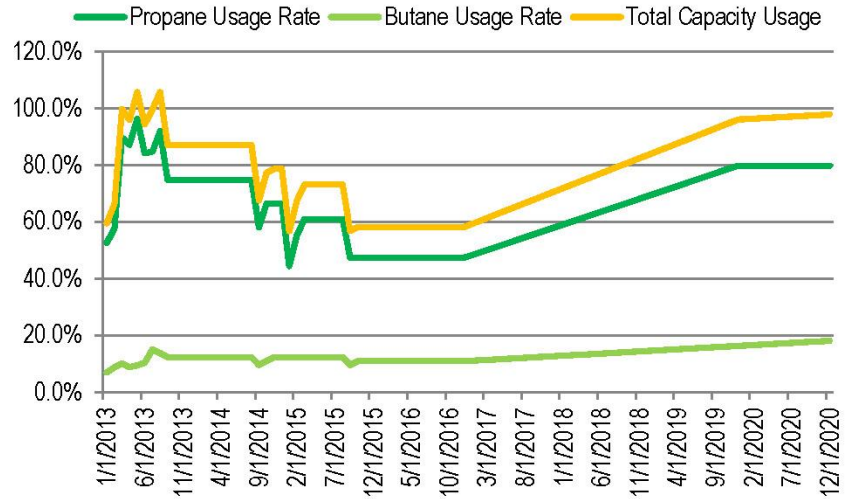
Road Networks USA

Map of Future Gas Flows

Higher demand for export incentivized capacity expansion



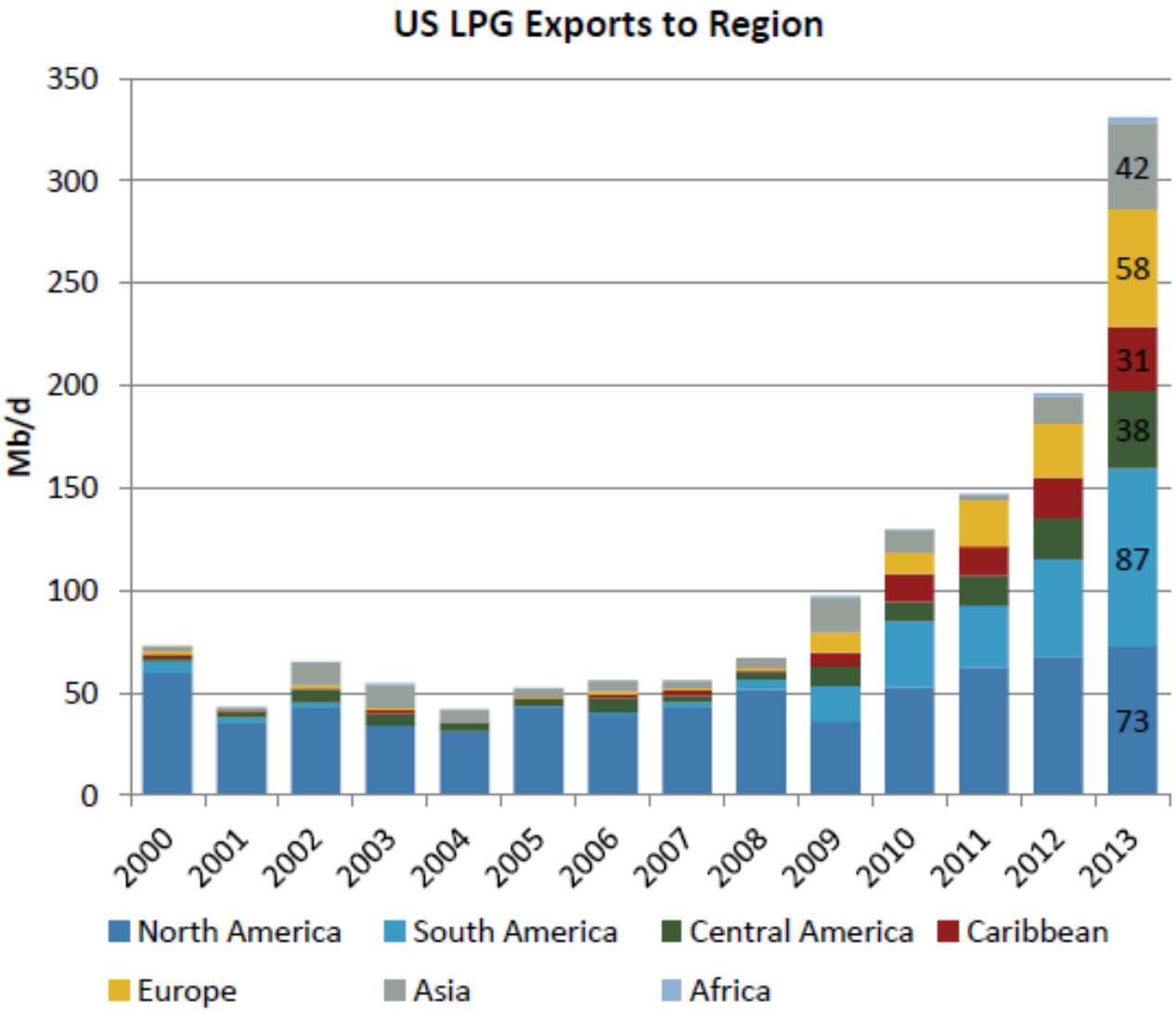
Capacity utilization of export facilities to stay low before production has grown large enough to supply globally

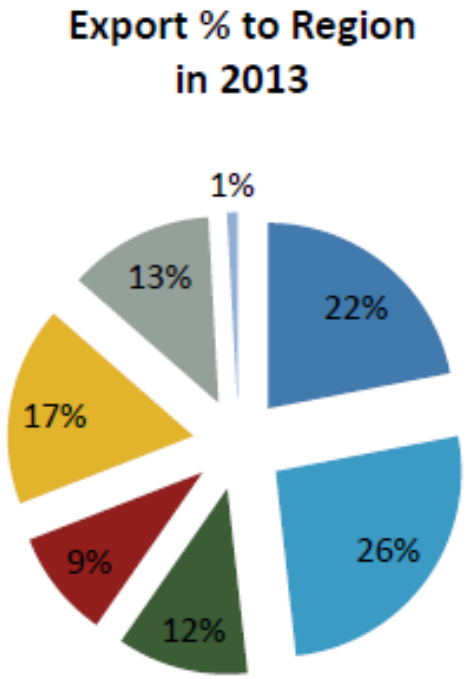


Export cost compositions versus competing benchmark

($/MMBtu)	LNG	Ethane	Ethane*	Propane
Commodity Cost	5.1	5.0	4.0	13.3
Capital Cost	3.0	2.5	2.5	0.8
Fuel Cost	0.8	0.5	0.4	0.5
FOB Cost	8.9	8.0	6.9	14.7
Freight Cost	0.9	0.9	0.9	1.1
CIF Cost	9.8	8.9	7.8	15.8
Competing Benchmark	10.0	11.8	11.8	16.6
Potential Arb	0.2	2.9	4.0	0.8

USA Example of Energy Sector Export Growth





Dollars and Sense

Liquid Fuel Price Comparison:

Date: 4-Feb-13

Sources: Wall Street Journal Cash Price; CME (OPIS); RBN Energy

			Commodity Price	Unit	Btu HHV/gallon	$/MMBtu HHV	Discount Ratio NG:Fuel	Price Ratio LNG:Fuel
WTI Crude Oil			**$97.77**	bbl = 42 gal	140,500	**$16.57**	0.20	0.72
ULS Diesel:			**$3.23**	gallon	138,490	**$23.32**	0.14	0.51
RBOB Gasoline:			**$3.05**	gallon	121,848	**$25.03**	0.13	0.48
Condensate: Est		Crude -$17	**$80.77**	bbl = 42 gal	112,000	**$17.17**	0.19	0.70
Butane:	77°F	SG = 0.542	**$1.70**	gallon	95,553	**$17.79**	0.19	0.67
Propane:	77°F	SG = 0.493	**$0.87**	gallon	88,370	**$9.84**	0.34	1.22
Ethane:	-50°F	SG = 0.50	**$0.27**	gallon	92,511	**$2.92**	1.14	4.11
Natural Gas (mostly methane):			**$3.34**	MMBtu HHV	NA	**$3.34**	1.00	3.59
LNG: (NG price + ~prod. cost):			**$12.00**	MMBtu HHV	84,820	**$12.00**	0.28	1.00

Note: Federal and state excise taxes, marketing and transportation costs are not included

Nearby Region Energy Projects

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What Does this Mean for the Shipping and Maritime Sector?

EcoNomics

Marpol Annex VI Impacts Emission Control Areas (ECA)

Global and ECA SOx Limits

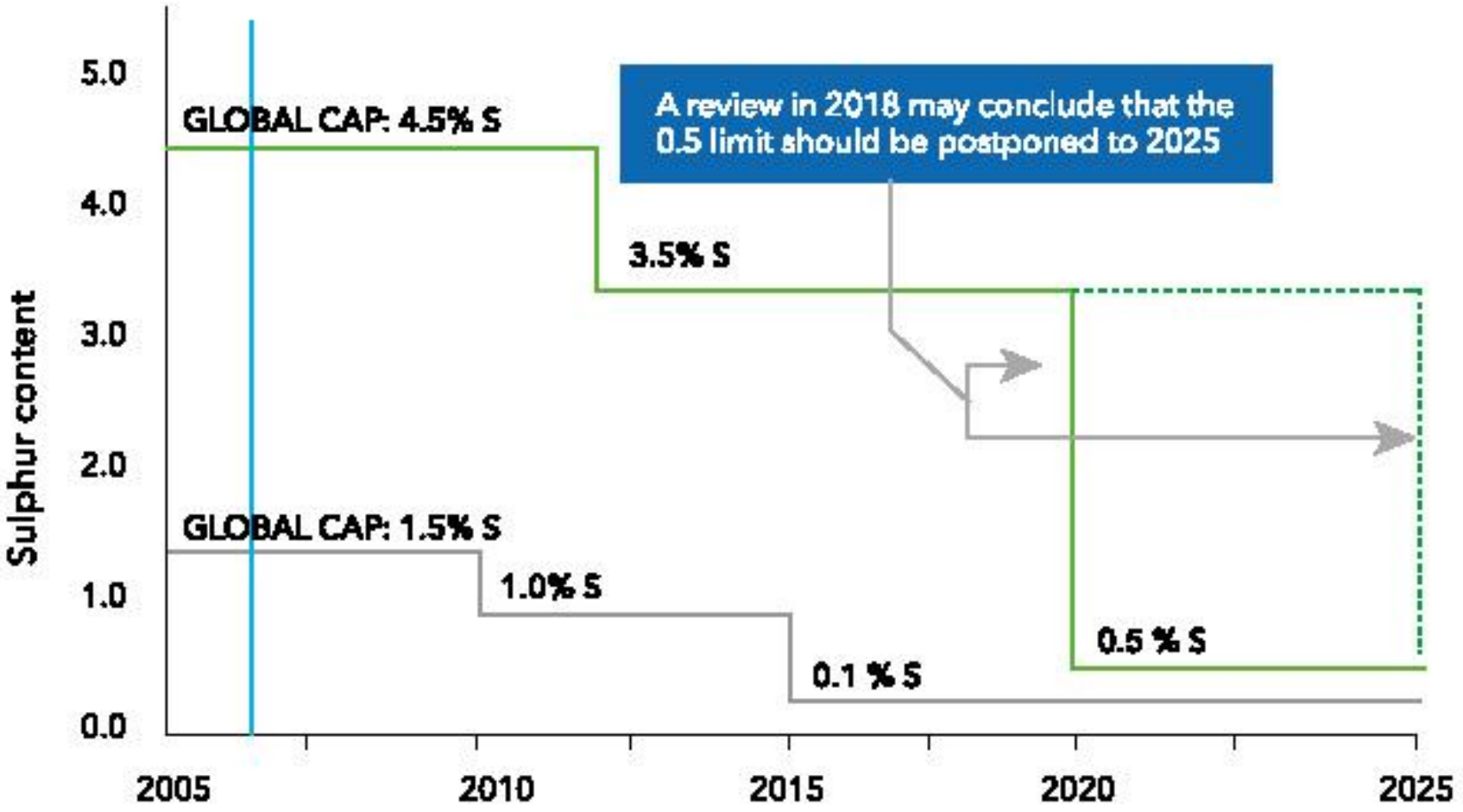


Figure 1. MARPOL Annex VI fuel sulphur content limits

Energy Sources for Shipping and Shipping Opportunities

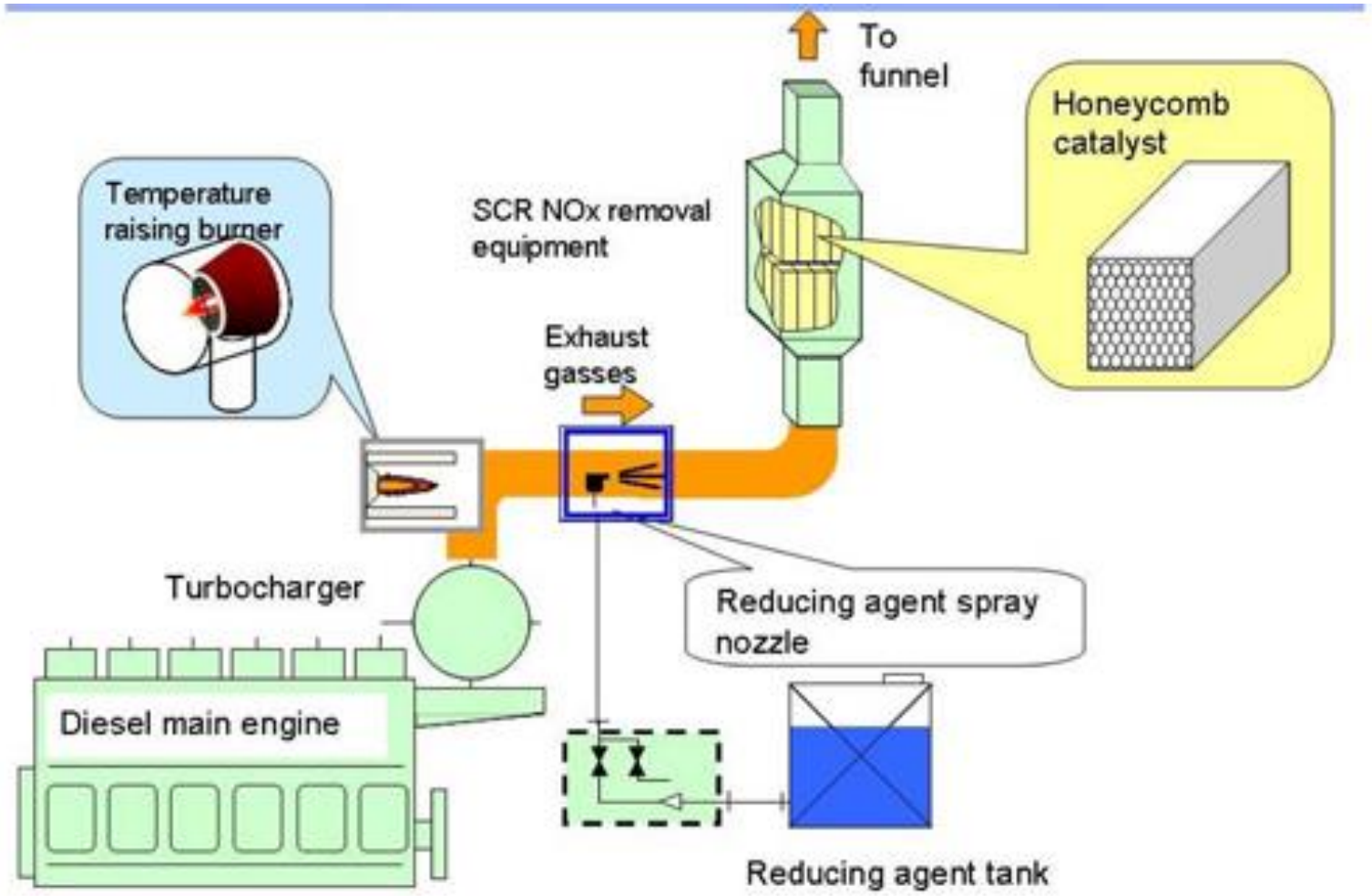
A number of studies are underway for alternative fuels or energy carriers that are already used or could be potentially used in shipping in the future. These fuels are:

- Liquefied Natural Gas (LNG)
- Liquefied Petroleum Gas (LPG)
- Methanol and Ethanol
- Di-Methyl Ether (DME)
- Synthetic Fuels (Fischer-Tropsch)
- Biodiesel
- Biogas
- Use of electricity for charging
- Batteries and cold ironing
- Hydrogen
- Nuclear Fuel

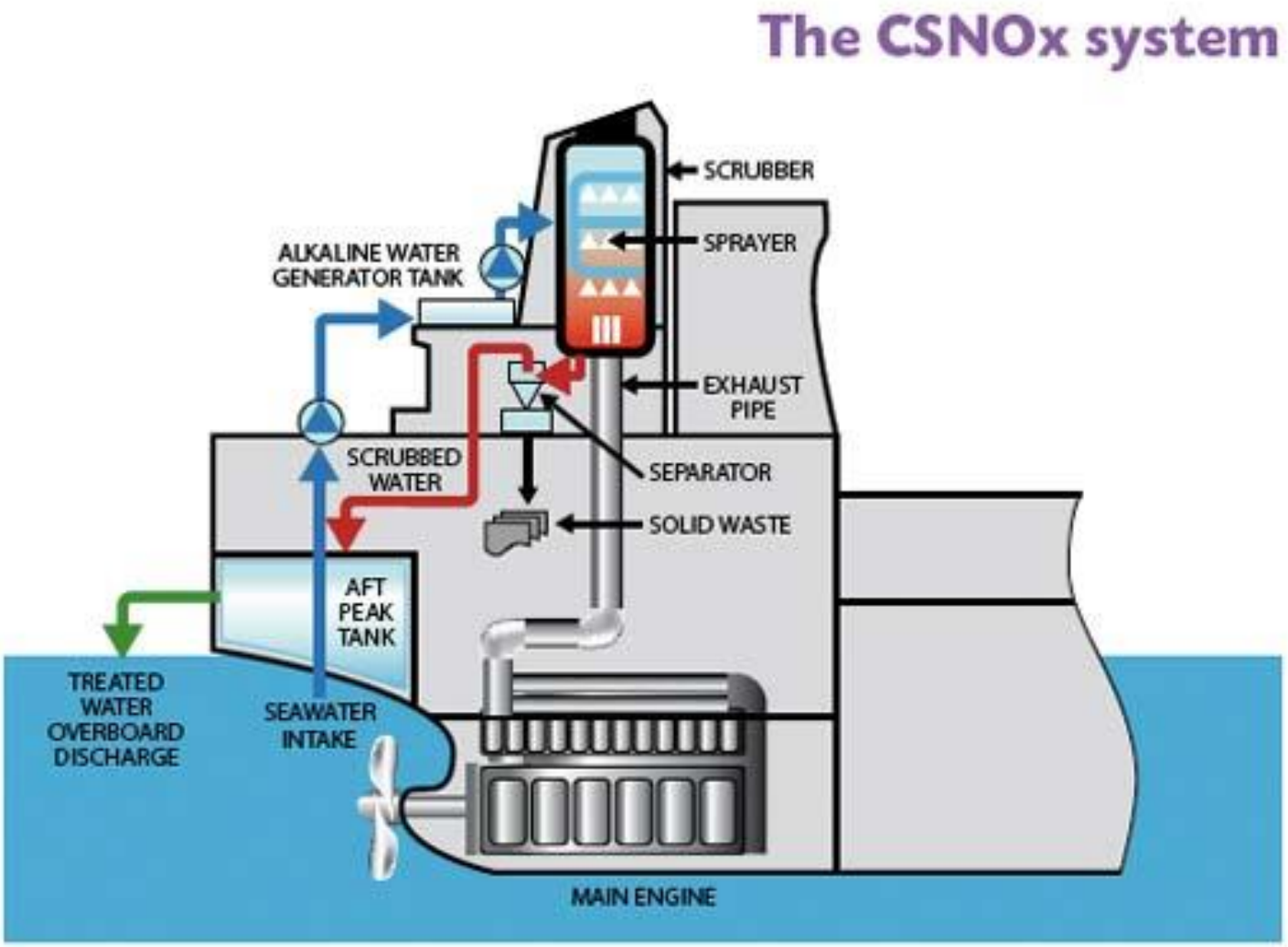
Factors affecting Alternate Fuels for Shipping

- Physical and chemical characteristics
- Production, availability and cost: information on production methods, current production volumes and prices, infrastructure, and future forecast, where available
- Applications and current status: applications in the maritime and in other sectors. Overview of technology including engines and storage tanks
- Safety considerations
- Emissions and environmental considerations

Fuel Scrubbing Technologies NOx

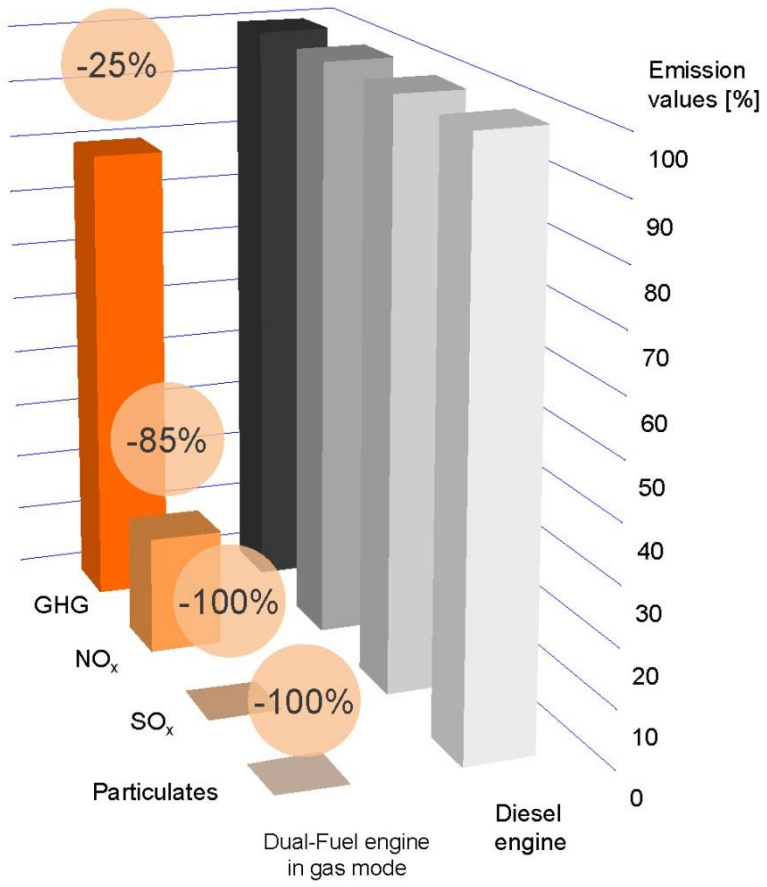


Fuel Scrubbing Technologies
SOx

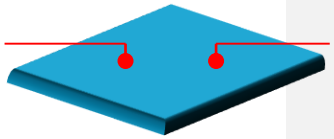


Marpol Annex VI Impacts

LNG PROVIDES COMPLIANCE WITH EMISSION REQUIREMENTS WITHOUT ABATEMENT TECHNOLOGIES



Infrastructure Challenges



Factors

SAFETY/SECURITY

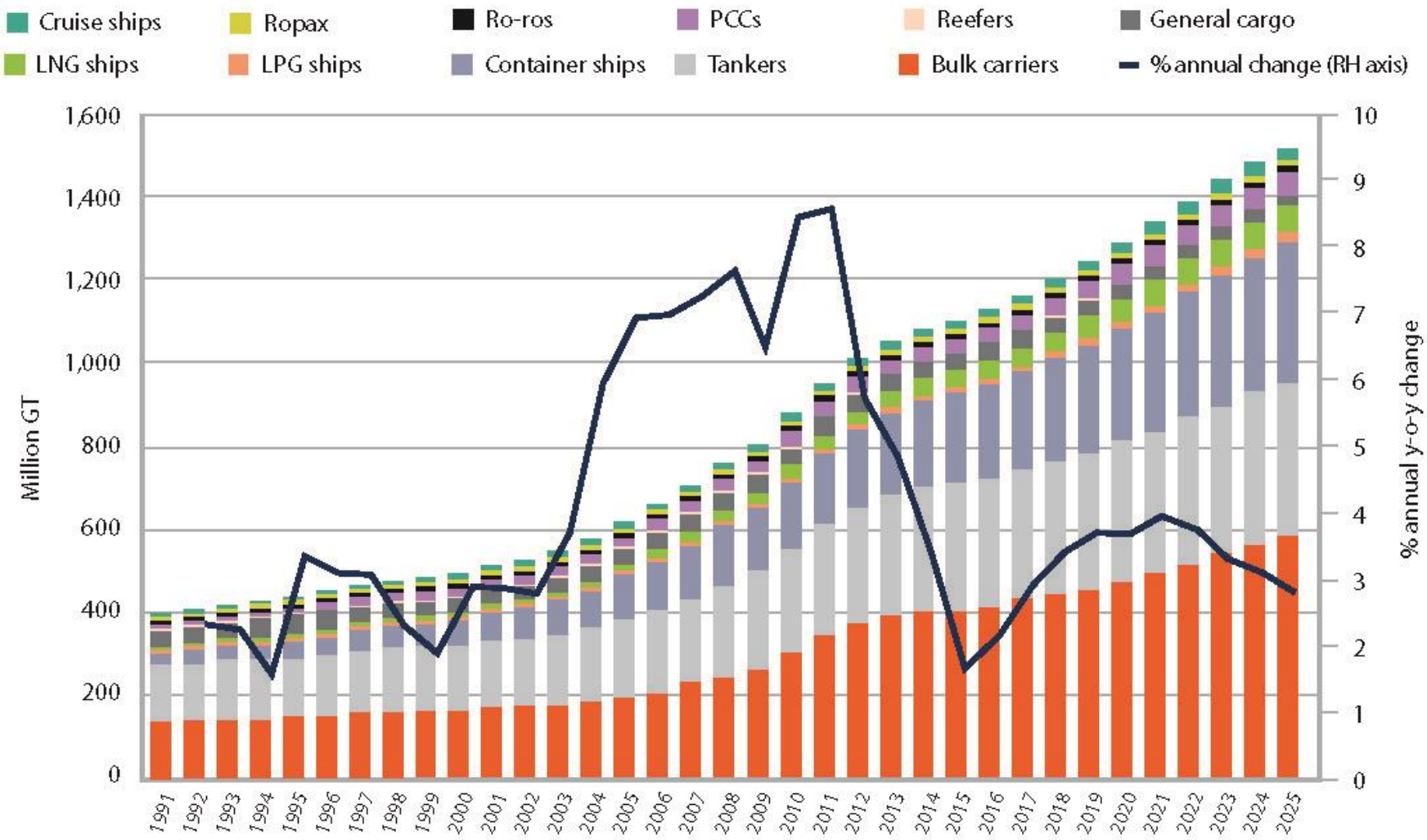
LOADING ARM TECHNOLOGY

SHIPS AND NEW BUILD VS CONVERSION

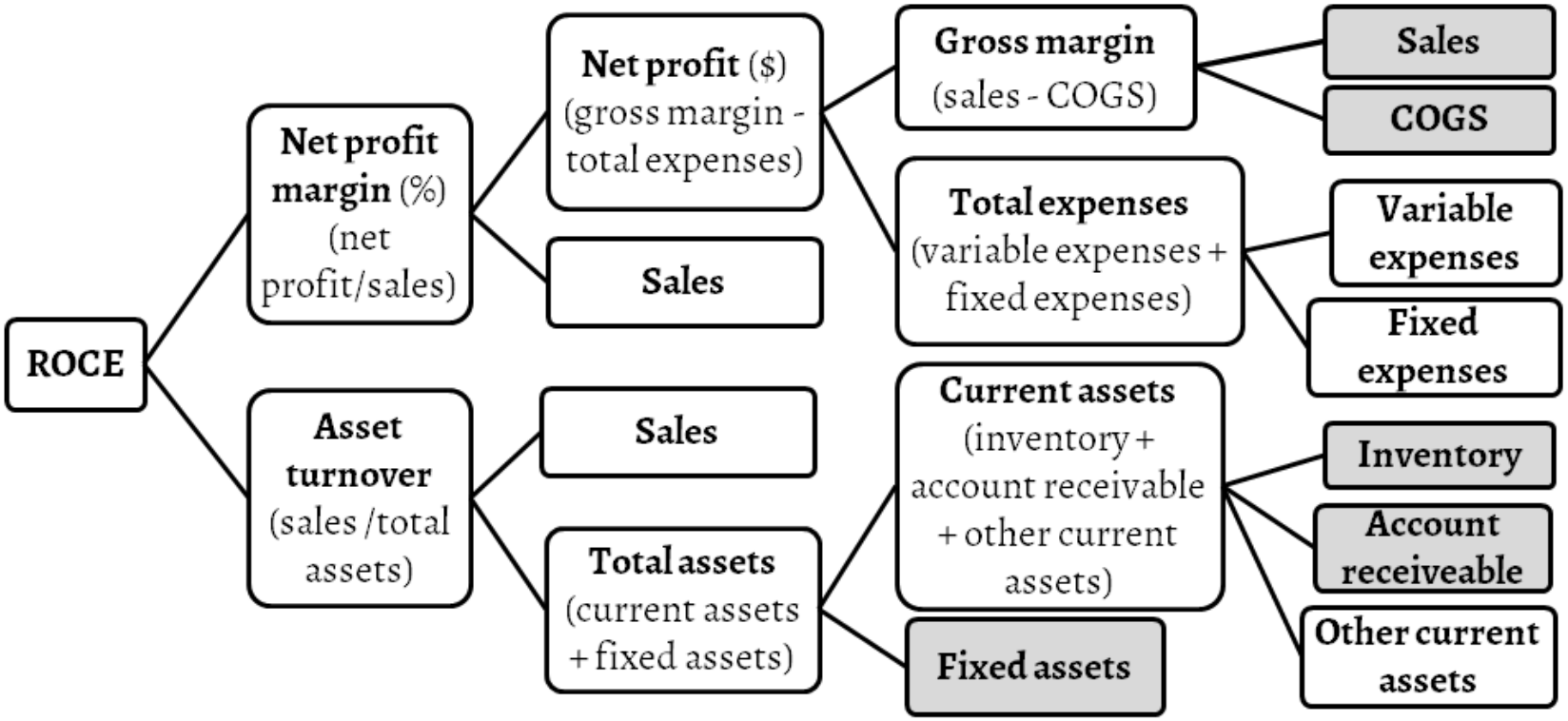
- Cost of a new LNG vessel is 10 to 15% higher
- Abatement Sulphur scrubbing technology costs about USD$4M/vessel
- Payback times for LNG Vessels vs Scrubbers is about 2 to 4 years depending on LNG price point assumed. Vessels above 2,500 TEU have even shorter payback periods in ECA Zones

***** DNV predicts that 30 percent of all newbuilds worldwide will have LNG propulsion by 2020 ** -***

Ship New Build to 2025



Why Does This Matter?



- fixed assets are impacted by improved space and equipment utilization;
- sales are impacted by order fill rate and customer service responsiveness;
- cost of goods sold is impacted by **freight** costs;
- accounts receivables are impacted by order cycle time;
- (inventory is impacted by transportation management and lead-time reliability.

Source: *Coyle, Ruamsook, Russell, and Thomchick (working paper)*

Closing Thoughts

- There is an energy evolution underway rather than an energy revolution
- There will be a general push to cleaner burning fuels with high BTU and BTU/$ returns
- $/BTU of LPG, Ethane and LNG including CAPEX onshore development is approximately coming out at 20 to 25% cheaper than traditional oil/coal energy developments
- Cost of fleet vessel conversions and timeline scale for conversions (scrubbers/LNG) will have a longer horizon to see recognition of value from lower pricing for fuel
- Near term increase in fuel costs as vessels switch to low-sulphur MGO (RD or MD)
  - Resultant increase in cost of good sold regionally (and globally)
- Longer term fall in Fuel Costs as markets shake out and technology matures

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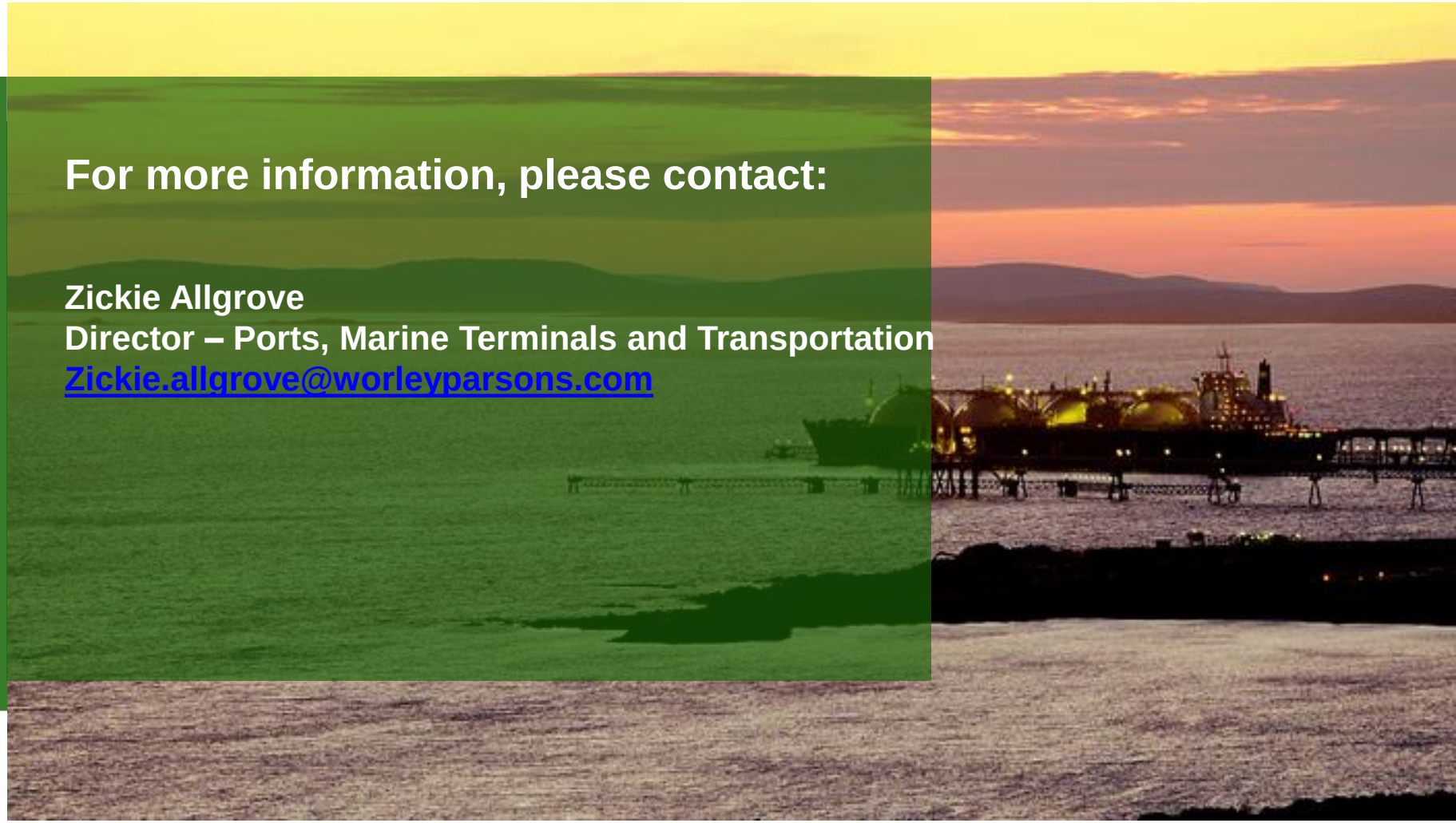

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