UNCTAD Multiyear Expert Meeting on Transport, Trade Logistics and Trade Facilitation

21-23 November 2018, Geneva

"Sustainable freight transport in support of the 2030 Agenda for Sustainable Development"

Potential GHG Reduction Pathways for International Shipping

by

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Nov 2018

Contents

- Possible scenarios for CO2, trade and fuels
- Estimates of CO2 abatement costs
- Drivers of CO2 abatement costs

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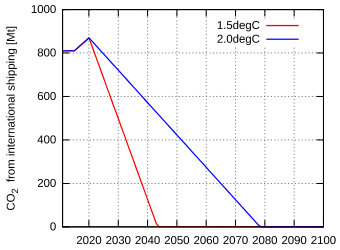
Enabling CO2 reduction



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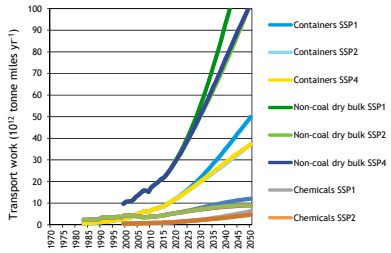
Whilst supporting growth in trade



= high rates of carbon intensity reduction

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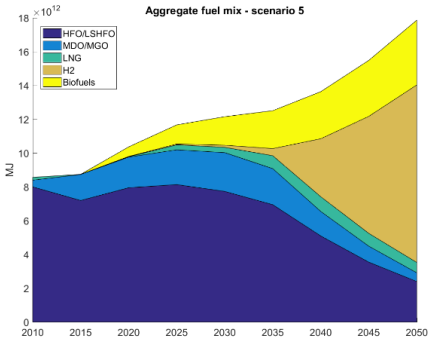
Fuel Mix – possible scenarios for 1.5 and 2 degrees



2 degrees

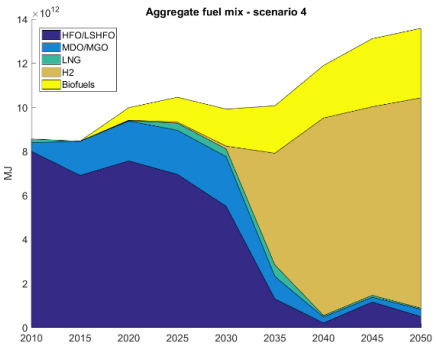


Image Source: Shipping In Changing Climates

1.5 degrees

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Hydrogen

Image source: bairdmaritime.com

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Biofuels

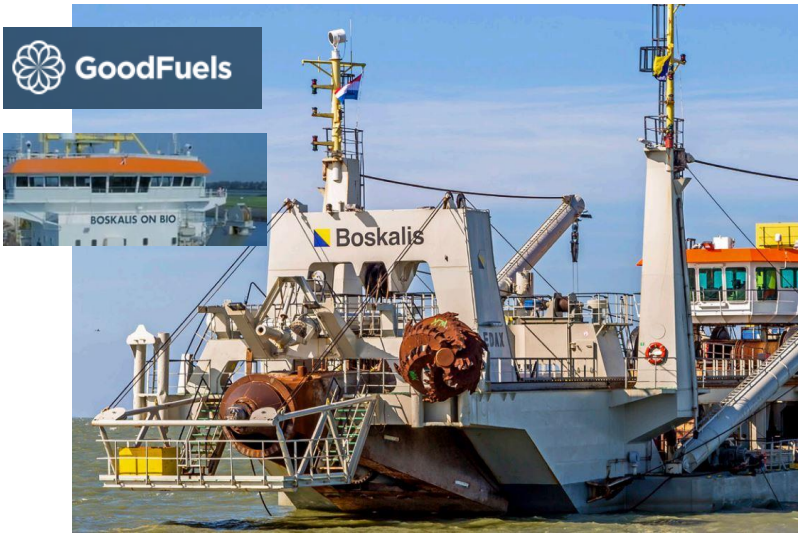

Image source: Boskalis and GoodFuels

Wingsail technology (bound4blue) - built in Peru

Image source: bound4blue

China launches world's first all-electric cargo ship

Image source: Chinanews.com

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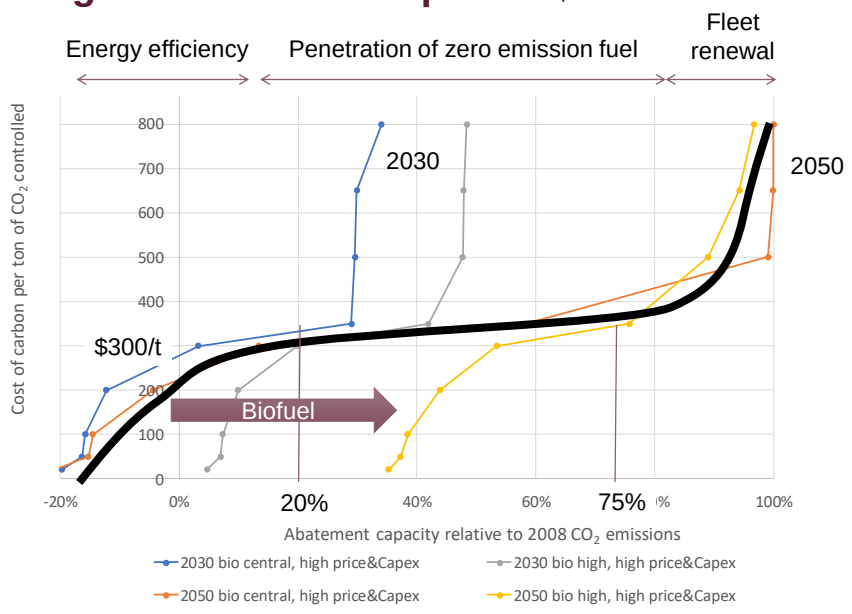
High renewable fuel price - $60/MWh



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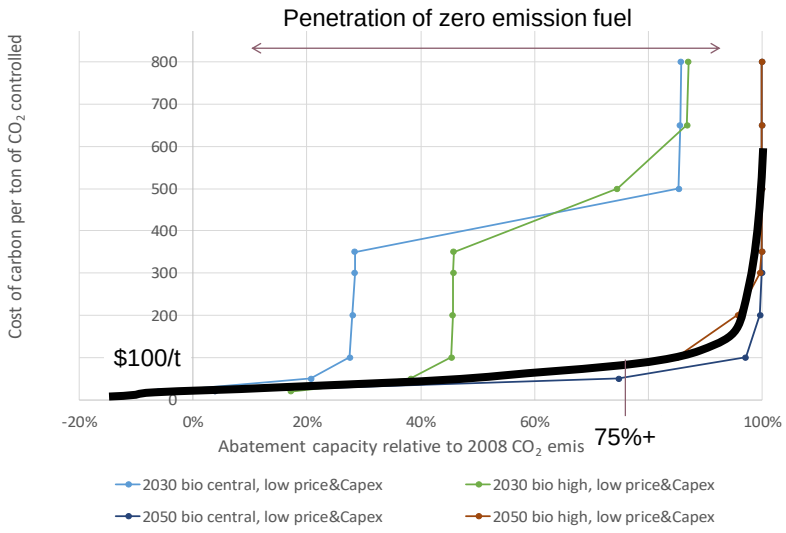
Low renewable fuel price - $30/MWh



ISWG 3-3

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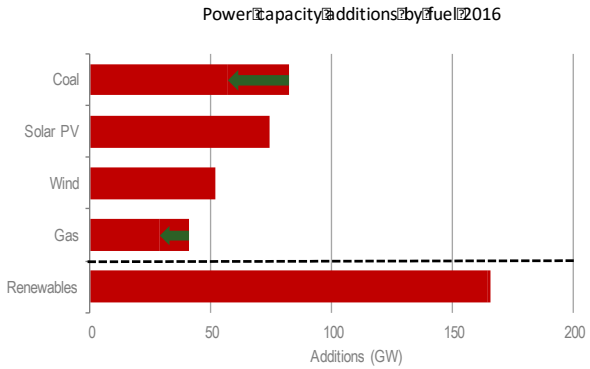
Renewable electricity at $30/MWh?



Auction prices $/MWh

2016:
UAE - 24
Morocco - 30
Chile –29
Peru –37
Mexico - 32

2017:
Saudi Arabia - 18
Mexico - 18
Chile –21

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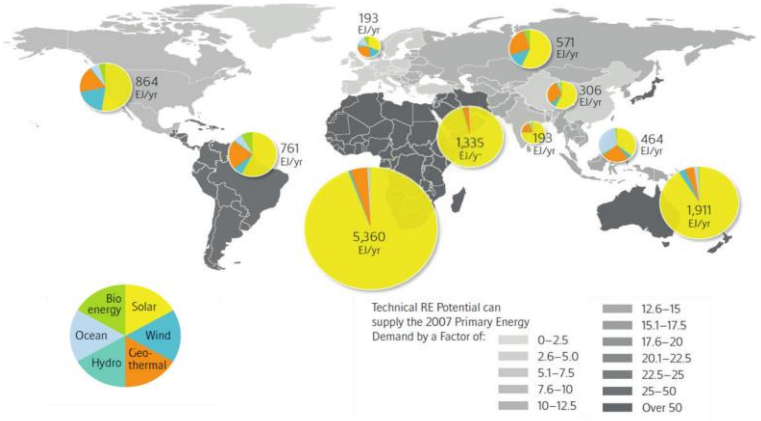
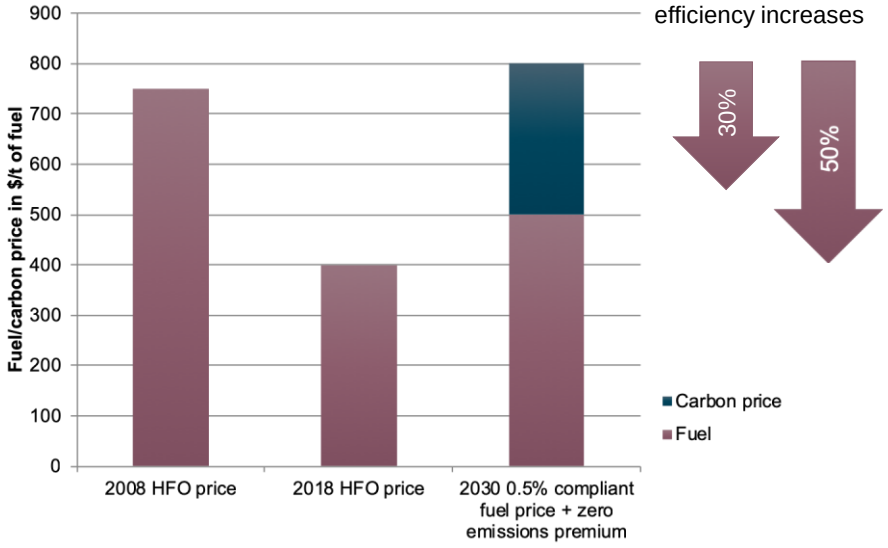
Many countries have the potential for renewable fuel provision

- Shipping – 20-40EJ/yr



IEA Renewable Fue

How might this relate to historic costs/prices?



Concluding remarks - technology

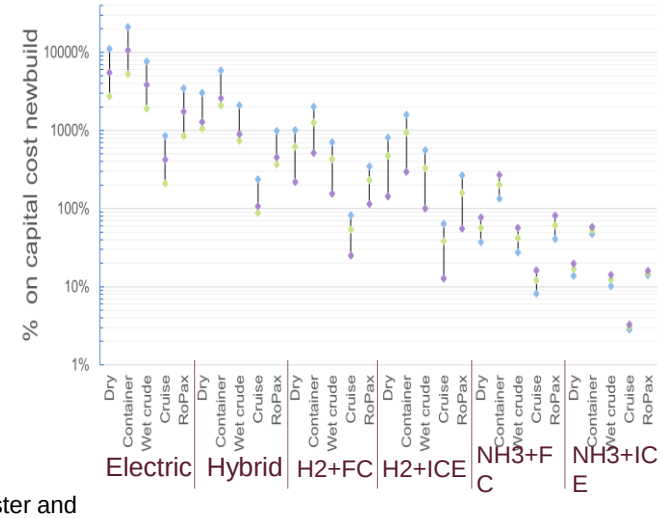
- For almost any rate of decarbonisation, zero emission fuels for ships will need to be entering the market in 10-15 year's time
- Batteries look challenging for deep sea applications
- But several liquid renewable fuels (bio, hydrogen, ammonia) have potential
- The cost of decarbonisation is closely linked to the cost of zero emission fuels and renewable electricity prices
- Any increase in energy efficiency reduces the impact on transport cost of fuel/energy cost
- A lot of work is already underway in shipping, and can also be leveraged from the wider economy's decarbonisation efforts

Questions?

Thank you for your attention

Backup material…

What are the capital cost implications?

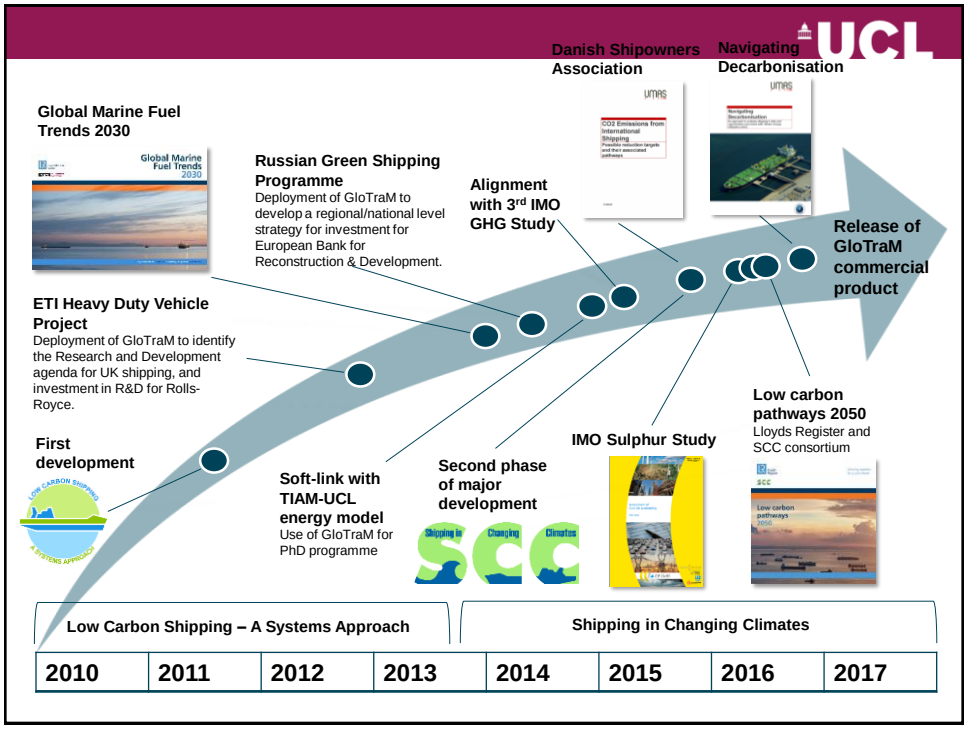


Lloyd's Register and

What are the options?

	Operating speed	2008 spec	Max spec (no wind)	Max spec wind	Max spec wind + 50% fuel carbon factor reduction	Max spec wind + 75% fuel carbon factor reduction
Panamax bulk carrier	4.5	25%	29%	19%	10%	5%
	6.0	31%	32%	21%	10%	5%
	8.9	52%	49%	33%	16%	8%
	9.7	60%	55%	38%	19%	9%
	11.3	77%	69%	49%	24%	12%
	11.7	83%	74%	52%	26%	13%
	11.9	86%	76%	54%	27%	14%
	12.0	88%	78%	55%	27%	14%
	12.8	**100%**	87%	62%	31%	15%
	14.3	134%	110%	78%	39%	19%
	15.0	158%	127%	88%	44%	22%

Yellow = 30-70% of 2008 baseline EEOI
Green < 30% of 2008 baseline EEOI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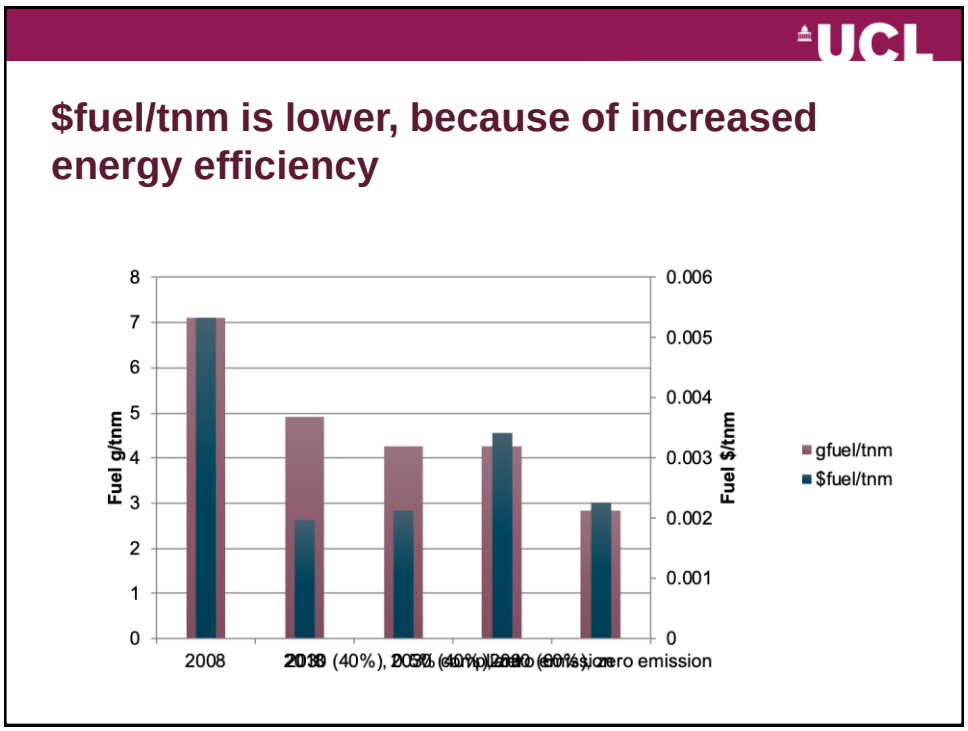
Danish Shipowners Association
Navigating Decarbonisation
Global Marine Fuel Trends 2030
Russian Green Shipping Programme
Deployment of GloTraM to develop a regional/national level strategy for investment for European Bank for Reconstruction & Development.
Alignment with 3rd IMO GHG Study
Release of GloTraM commercial product
ETI Heavy Duty Vehicle Project
Deployment of GloTraM to identify the Research and Development agenda for UK shipping, and investment in R&D for Rolls-Royce.
Low carbon pathways 2050
Lloyds Register and SCC consortium
First development
Soft-link with TIAM-UCL energy model
Use of GloTraM for PhD programme
Second phase of major development
IMO Sulphur Study
Low Carbon Shipping – A Systems Approach
Shipping in Changing Climates
2010
2011
2012
2013
2014
2015
2016
2017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$fuel/tnm is lower, because of increased energy efficiency
Fuel g/tnm
Fuel $/tnm
gfuel/tnm
$fuel/tnm
2008
zero emission

Lloyd's Register and UMAS

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7 Zero-emission technologies & 5 Ships

Electric	Hybrid hydrogen	Hydrogen fuel cell	Hydrogen + HFO	Ammonia fuel cell	Ammonia + HFO	Biofuel
Electricity	Hydrogen storage	Hydrogen storage	Hydrogen storage	Ammonia storage	Ammonia storage	Biofuel tank
Batteries	Batteries	Fuel cell	'Emergency' HFO tank	Reformer	'Emergency' HFO tank	
	Fuel cell			Fuel cell		
Electric motor	Electric motor	Electric motor	Dual fuel internal combustion engine	Electric motor	Dual fuel internal combustion engine	Internal combustion engine

21

Lloyd's Register and UMAS

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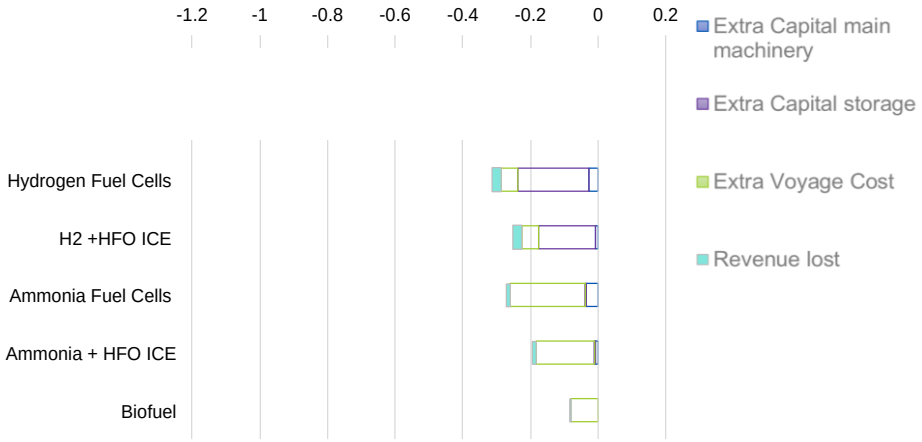
How do costs change relative to a conventional ship (9000TEU container) ?



22