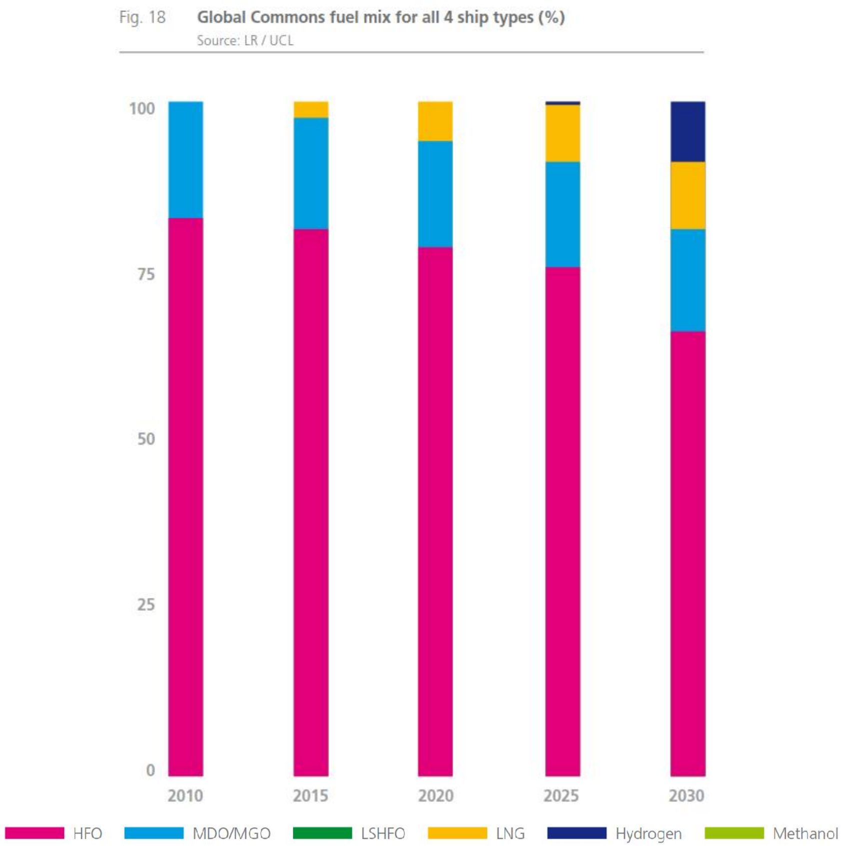
Winterthur Gas & Diesel

The Future in Naval Transportation

*An overview on propulsion for **deep sea** shipping*

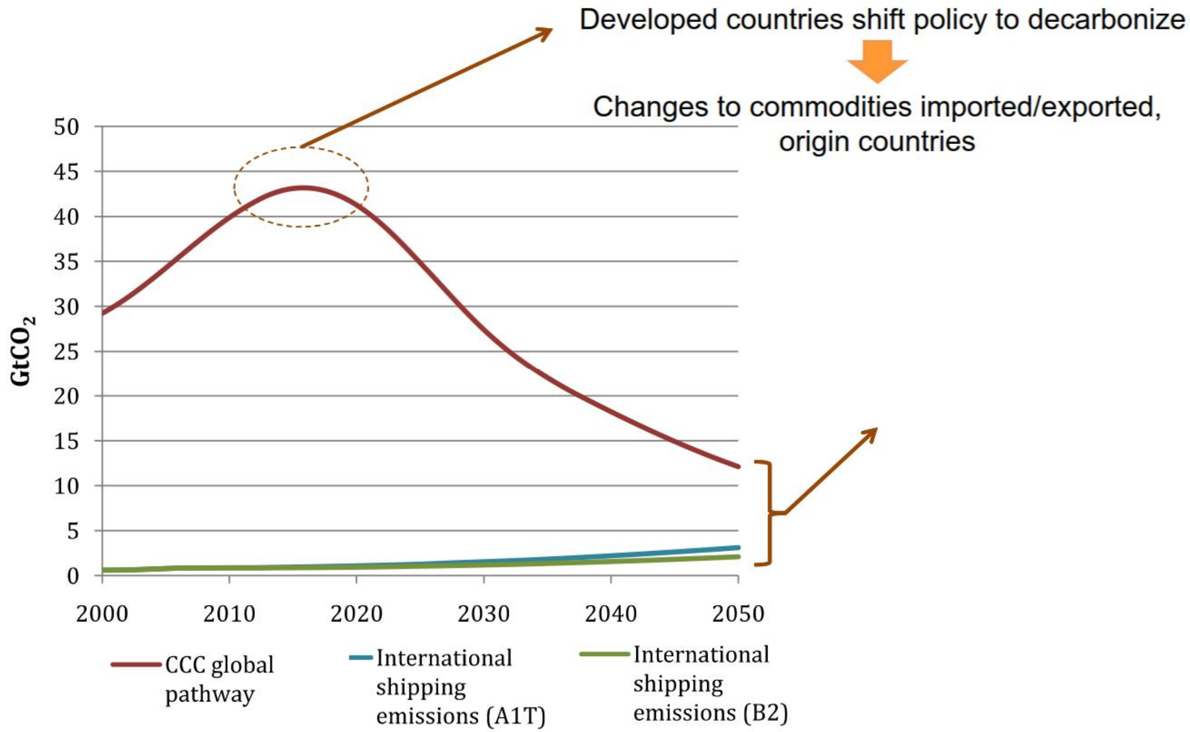
Bad news

Until 2030 >99% of the global deep sea shipping will rely on fossil fuels



Good news

This doesn’t jeopardize 2°C -goal



Winterthur Gas & Diesel

Overview

1 Introduction: WinGD and its products

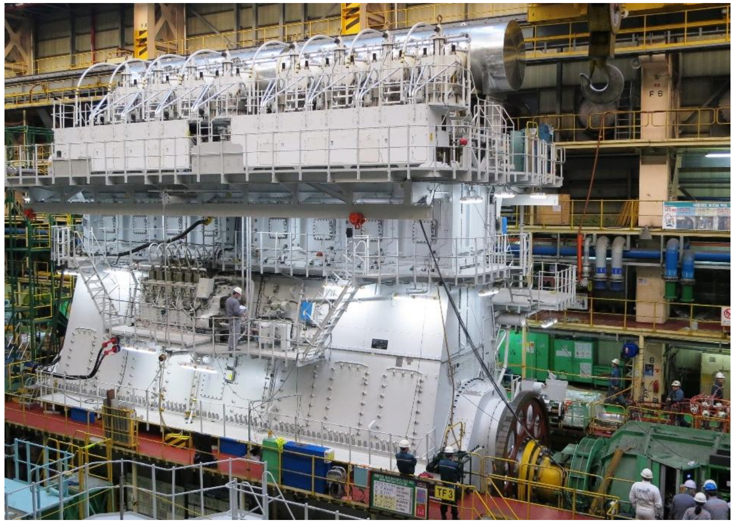
2 The Marine Market: Who is the customer and what drives the development

3 Research & Future Trends

WIN GD
Winterthur Gas & Diesel

Winterthur Gas & Diesel Ltd.

Sulzer Diesel => Wärtsilä Switzerland => WinGD



Swiss based company, developing 2-stroke marine engines.

About 330 employees world wide.
About 280 employees in Switzerland.

Setup of the company:
- *Research & Development*
- *Operations*
- *Sales*

The engines are built at licensees

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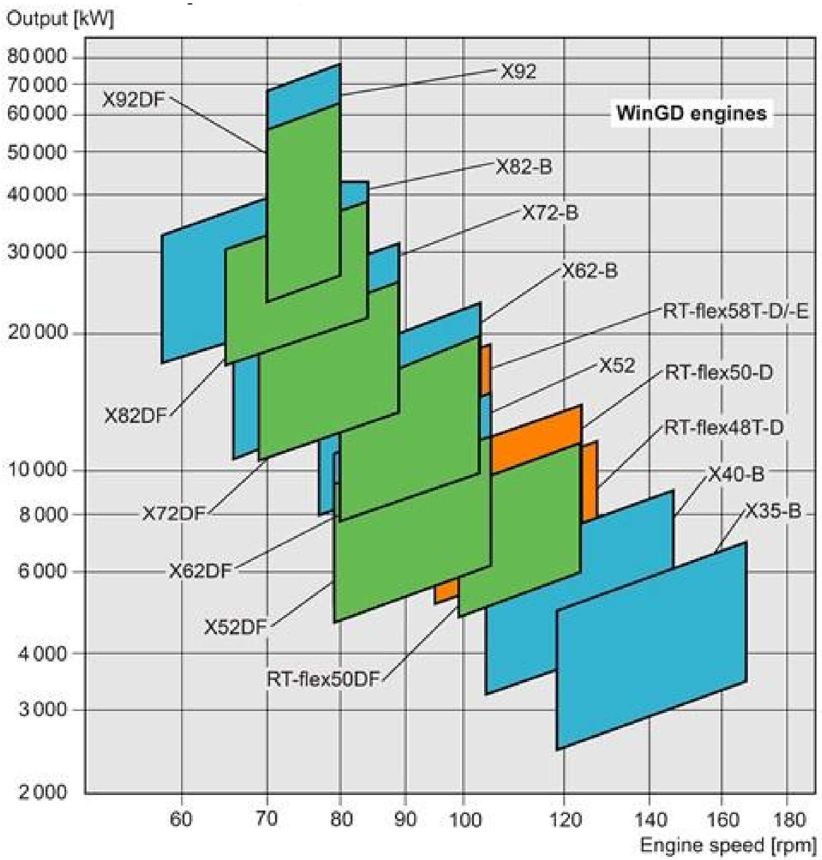
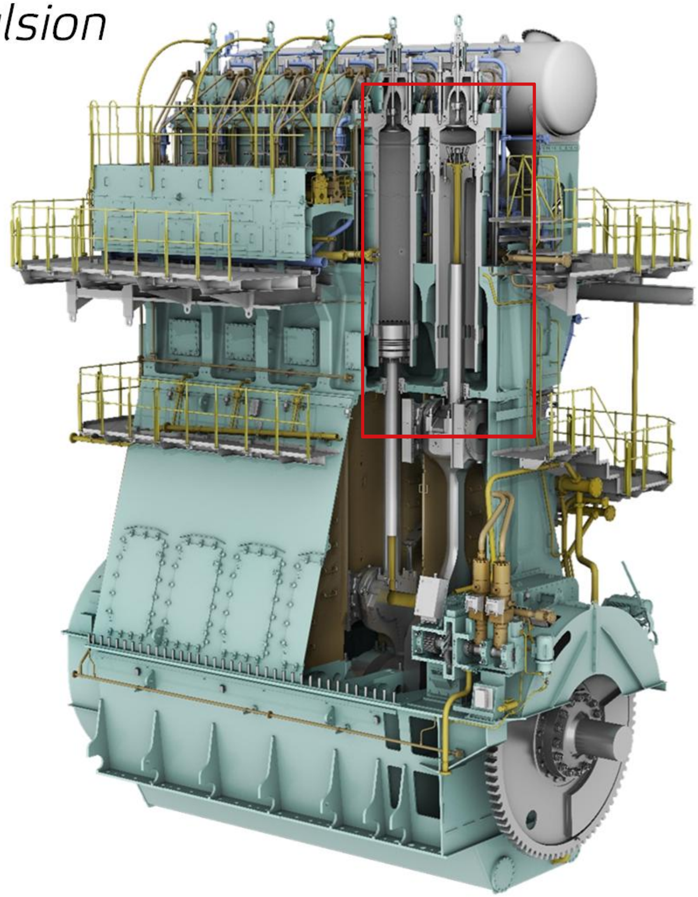
What are 2-stroke engines

Designed for most effective propulsion





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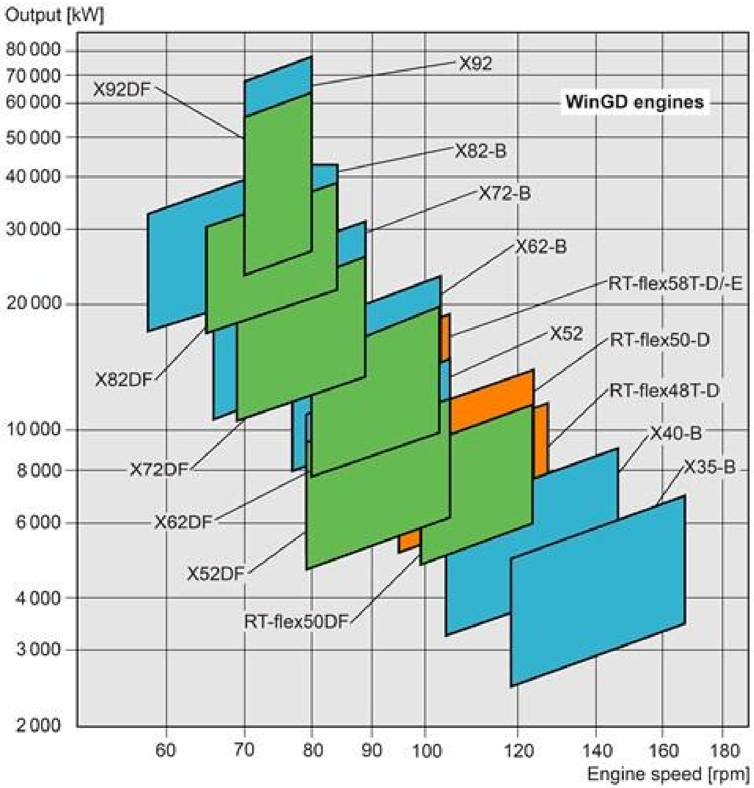
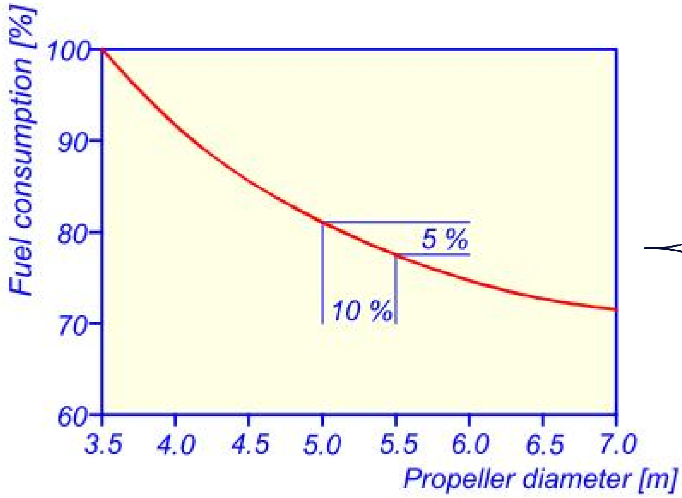
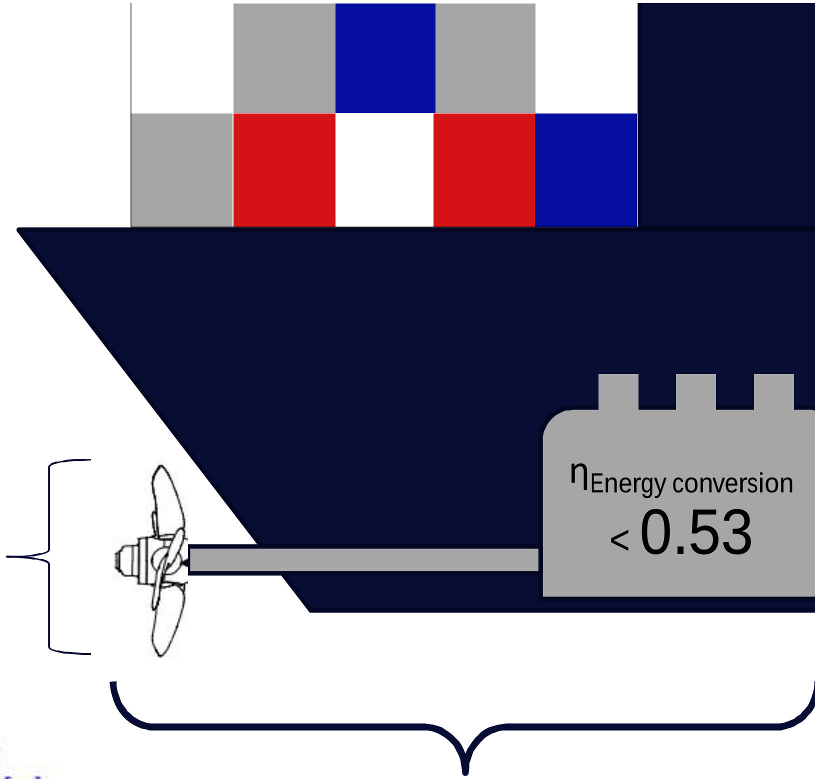
Why Two-stroke engines?

The propeller! $\eta_{Propeller} = \frac{Thrust\ Power}{2 \cdot \pi \cdot n \cdot M_{Shaft}}$







$\eta_{Propeller}$ $\eta_{Transmission}$ $\eta_{Energy\ conversion}$

With direct shaft: $\eta_{Transmission} = 0.99$

Additional:
Very flexible in fuel type and quality.
Low service and maintenance cost.

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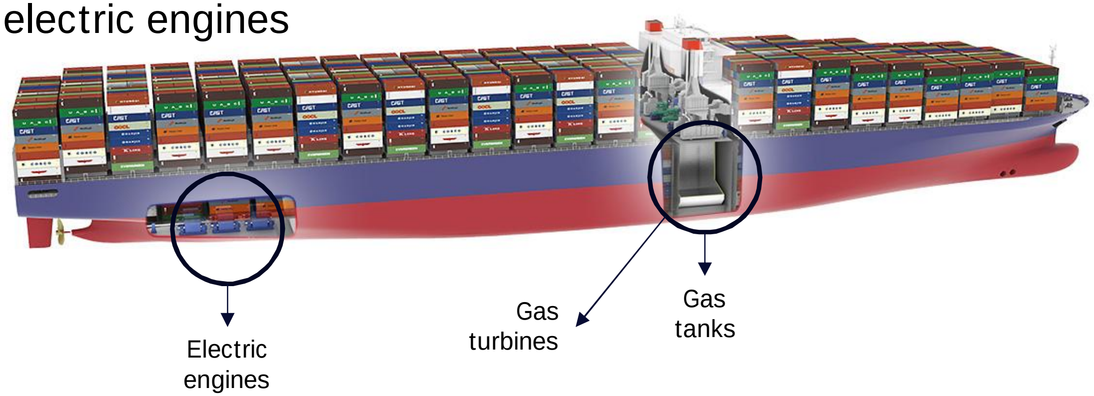
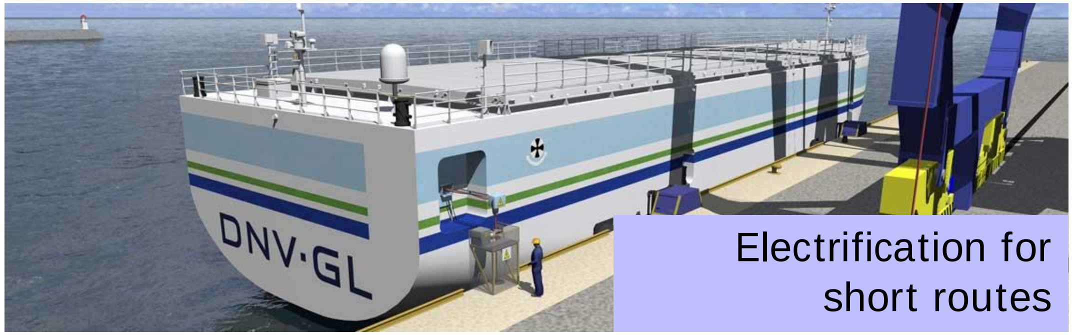
Alternatives

What could replace the 2-stroke engine

Gas turbines &
electric engines

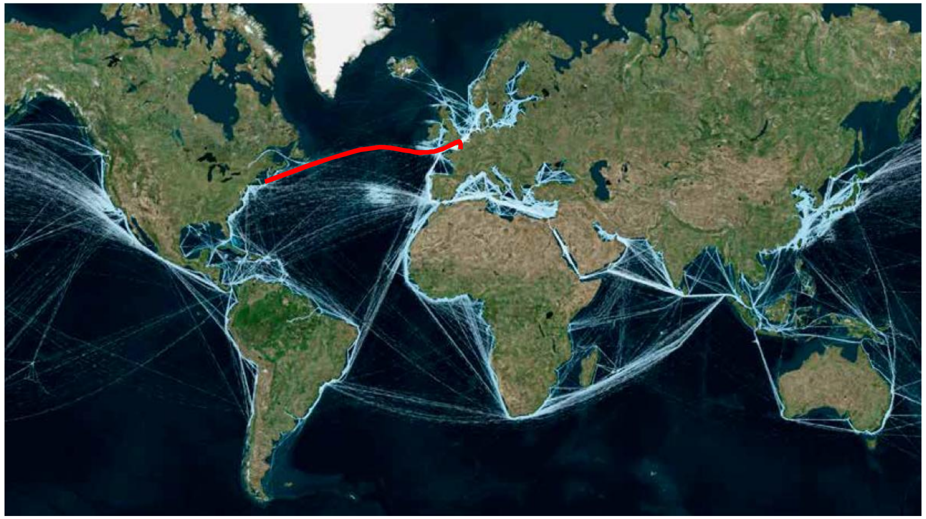




Energy to propel a large container ship

Energy consumption, comparison:
Rotterdam – New York: 6300 km ≈ 3400 nm

	Distance	Speed	Energy consumed	CO_2	number of containers	CO_2 per container
	[km]	[km/h]	[MWh]	[t]	[-]	[kg]
Ship	6300	25	7926	4522	16000	283
Truck	6300	80	18	6	2	2977



CMA CGM Marco Polo
14-RT-Flex 96 C - 80 MW (max. Power)
Built in 2012

http://www.cma-cgm.com/media/magazine-article/1/cma-cgm-marco-polo-round-the-world-in-77-days-

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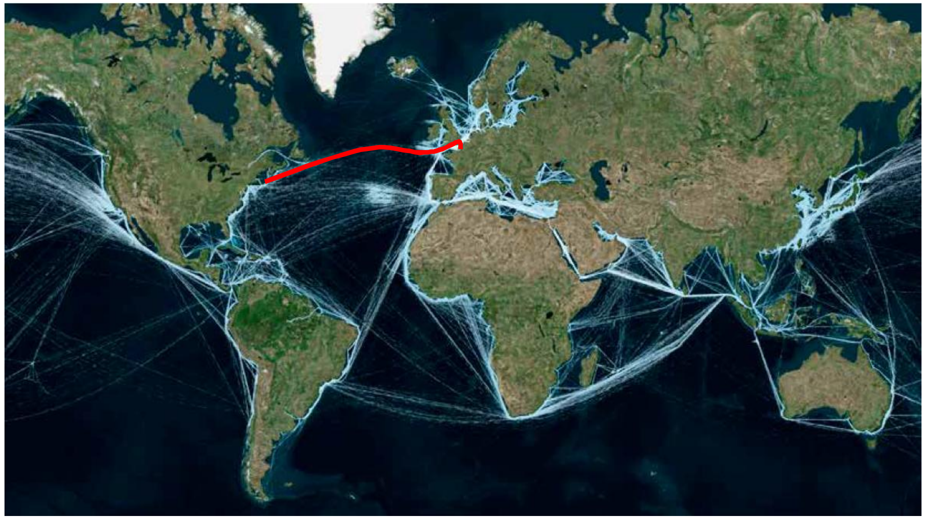

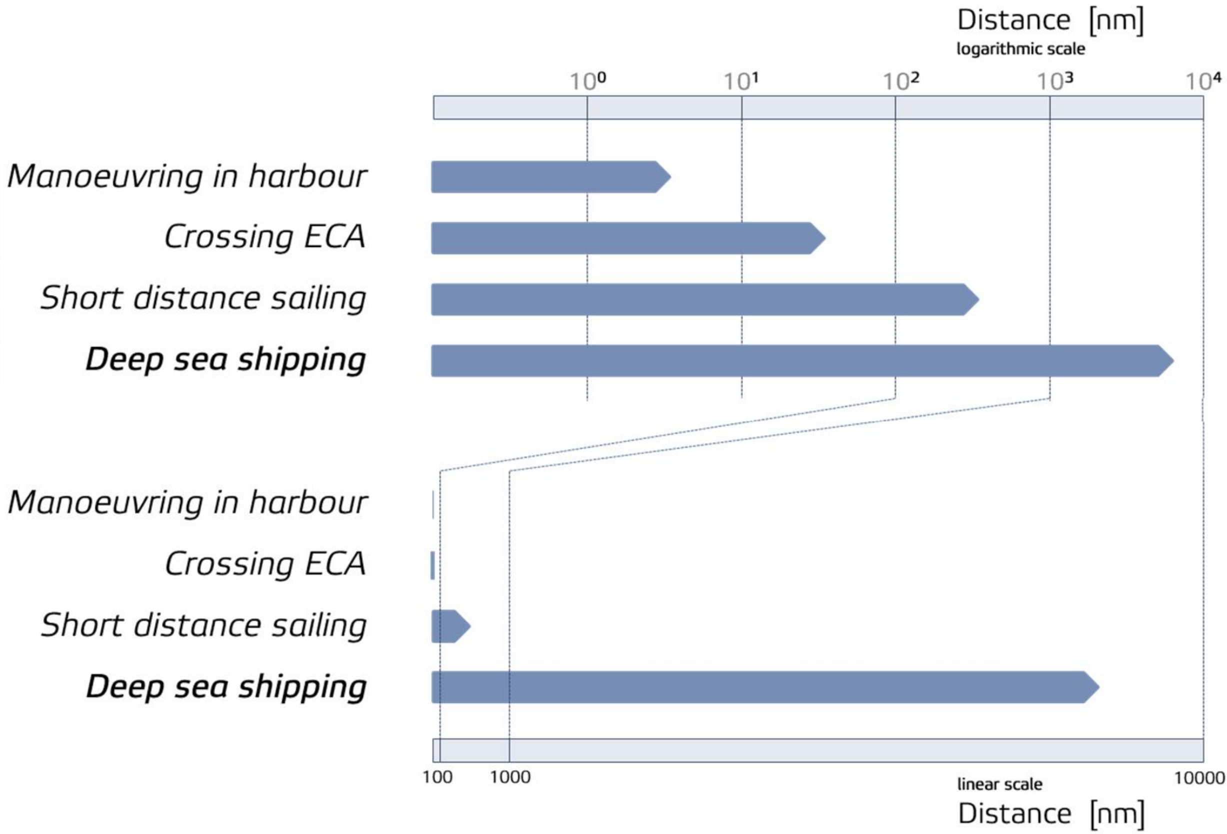

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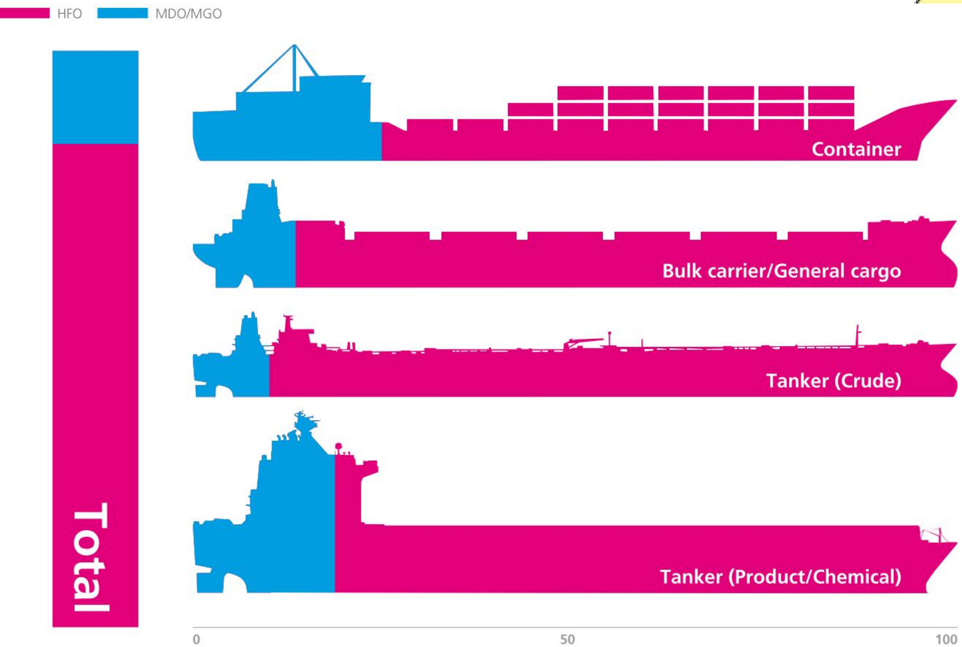
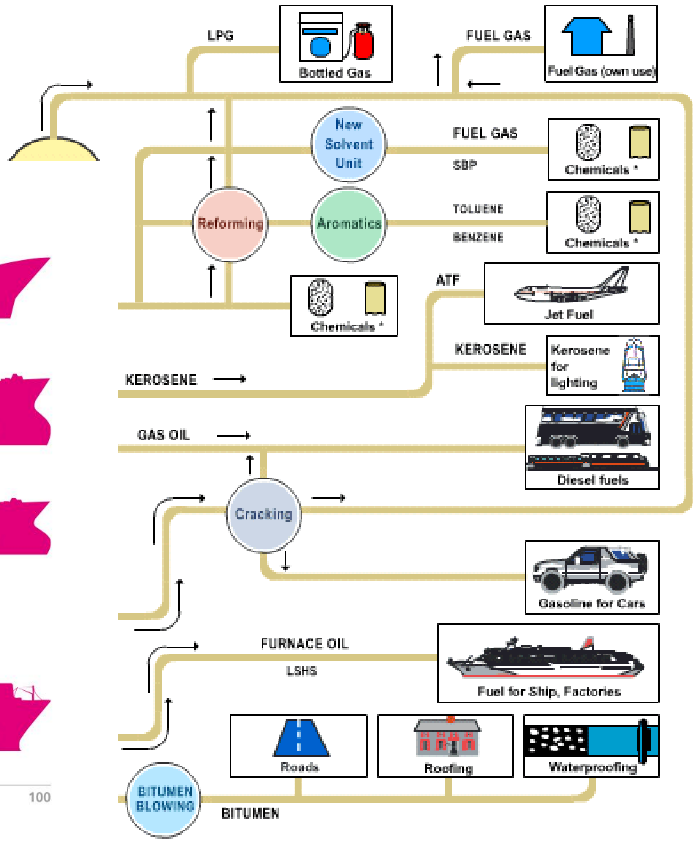
Where does the energy come from…

Consumption marine liquid fuels : 350 Mt / year

About 90% of this is used by cargo ships

Over 75% of it is Heavy Fuel Oil - HFO





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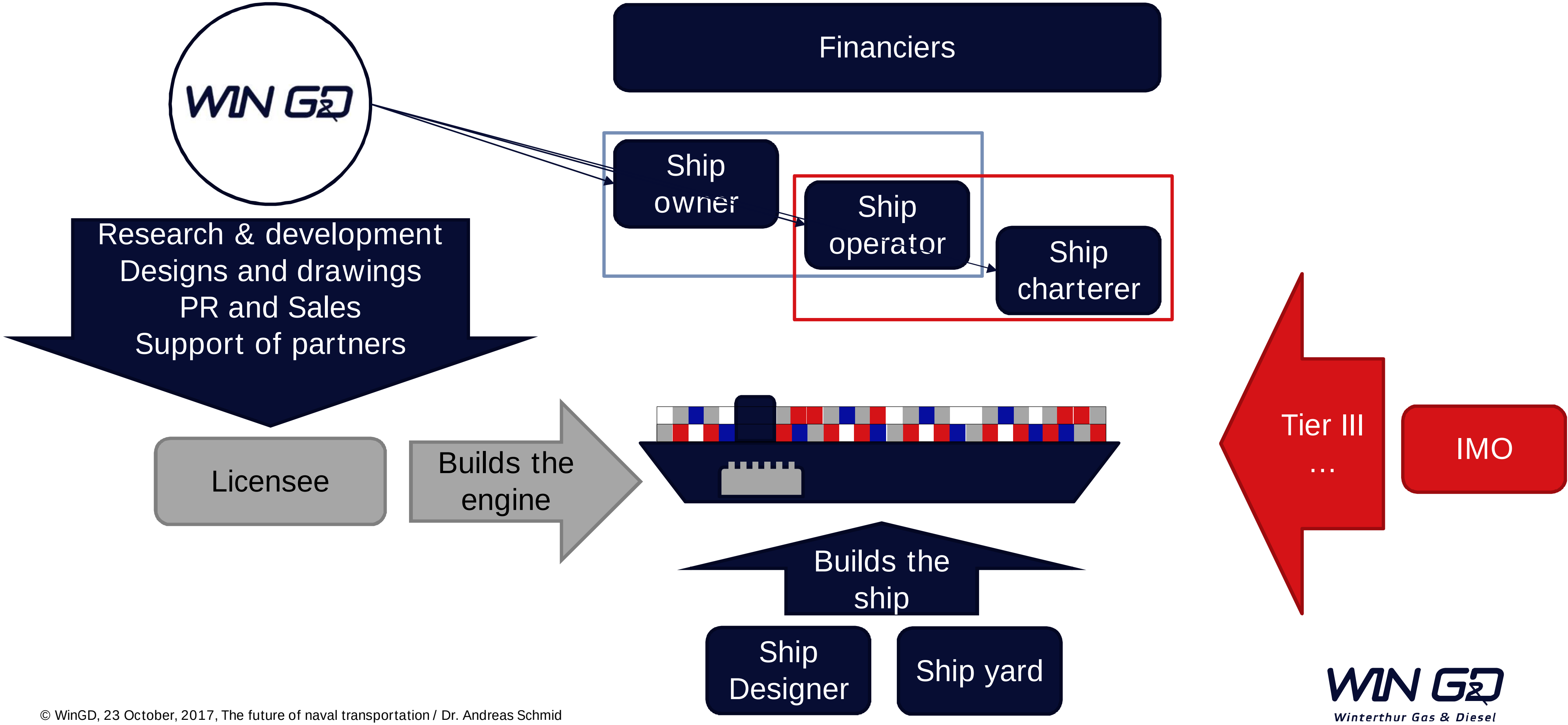
Our Customers

No such thing as THE customer, but rather a variety of partners



The Marine Market

90% of the global trade is performed with two-stroke engines

*This is a very **conservative** market:*

- *Ships are in service for around 20 years (up to 30-40 years is still possible)*
- *The wrong engine can become very cost intensive*
- *Small incidents can have strong effects (software failure=> engine loss=> loss of manoeuvrability…)*

*Over the past this market has only been driven by 1 factor **costs**:*

- *High Efficiency*
- *High Reliability*
- *Low Service intensity*

*End of the last century **emission regulations** started to shape the market as well:*

- *NO_x regulations*
- *Sulphur regulations on the fuel*

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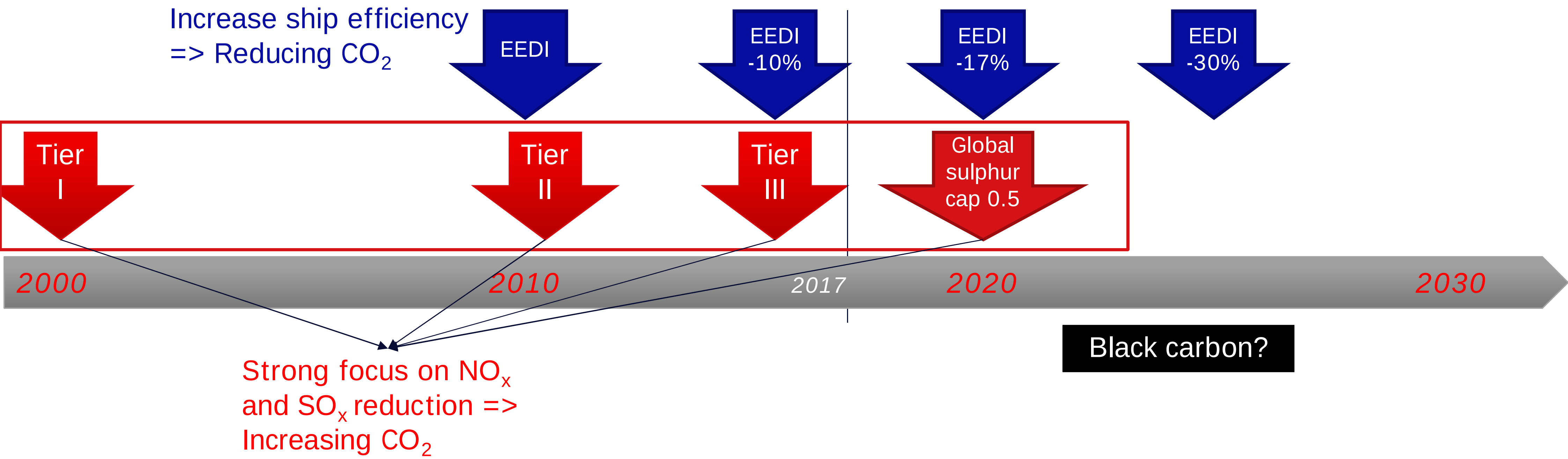
The Marine Market

Main drivers



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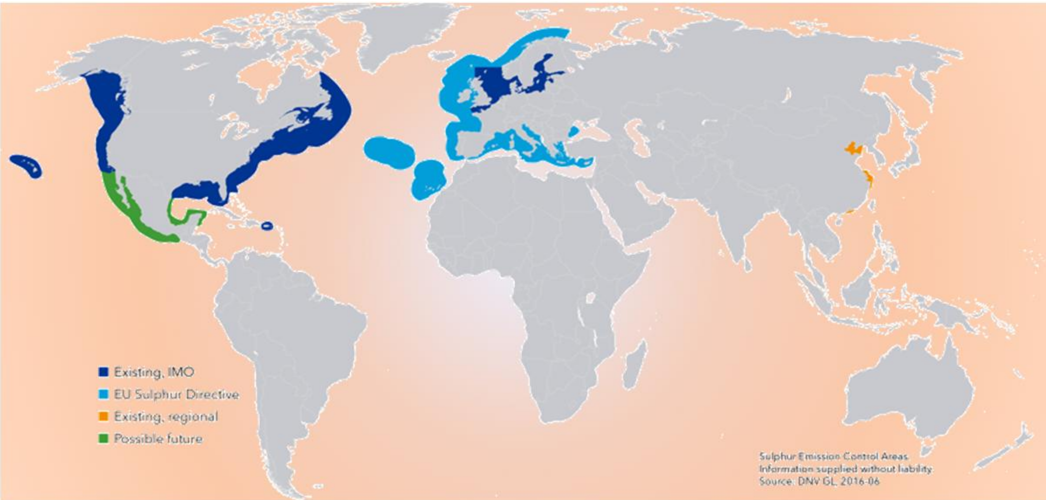
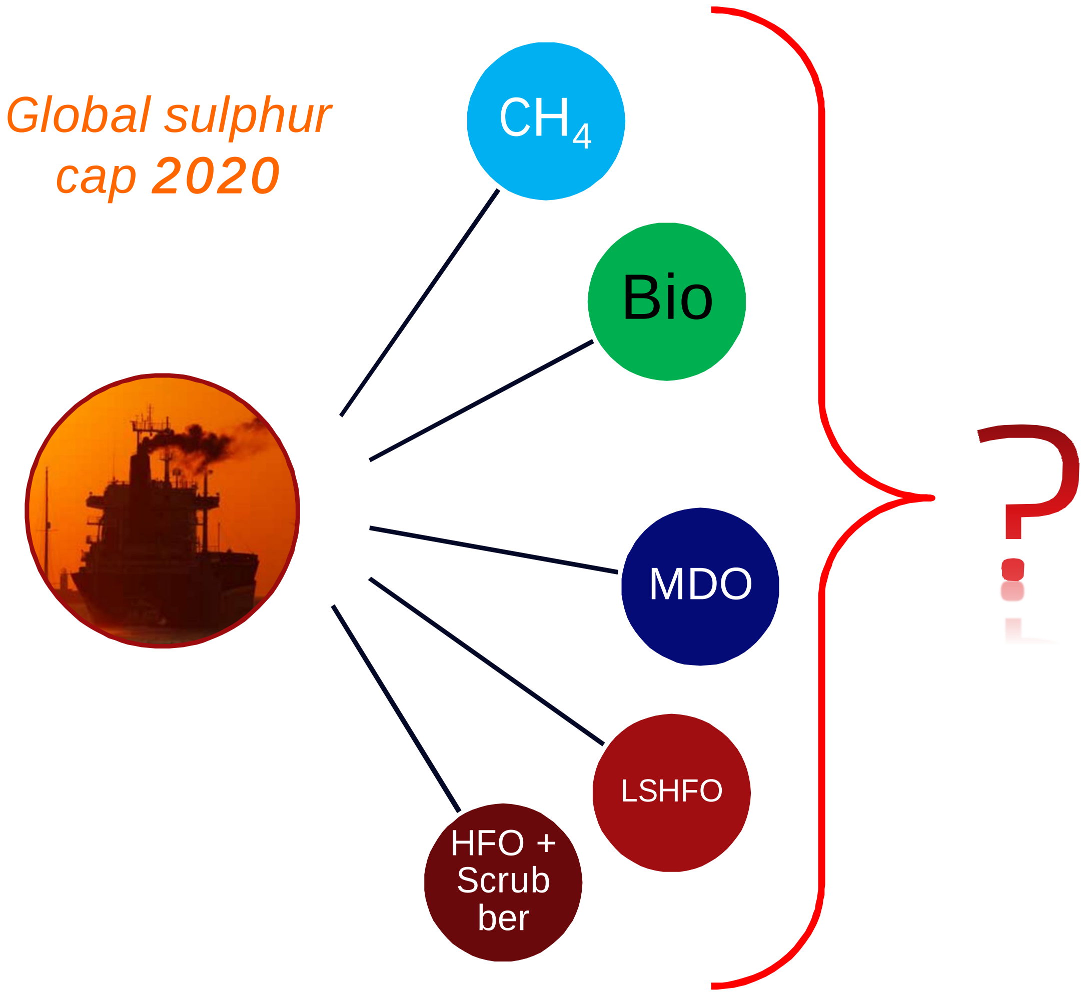
The Marine Market

Global sulphur cap 2020

Todays SECAs, ECAs





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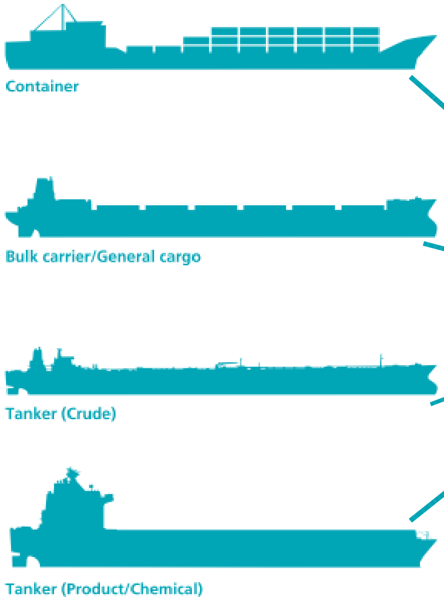
The Marine Market

Scenarios

Depending on ship category



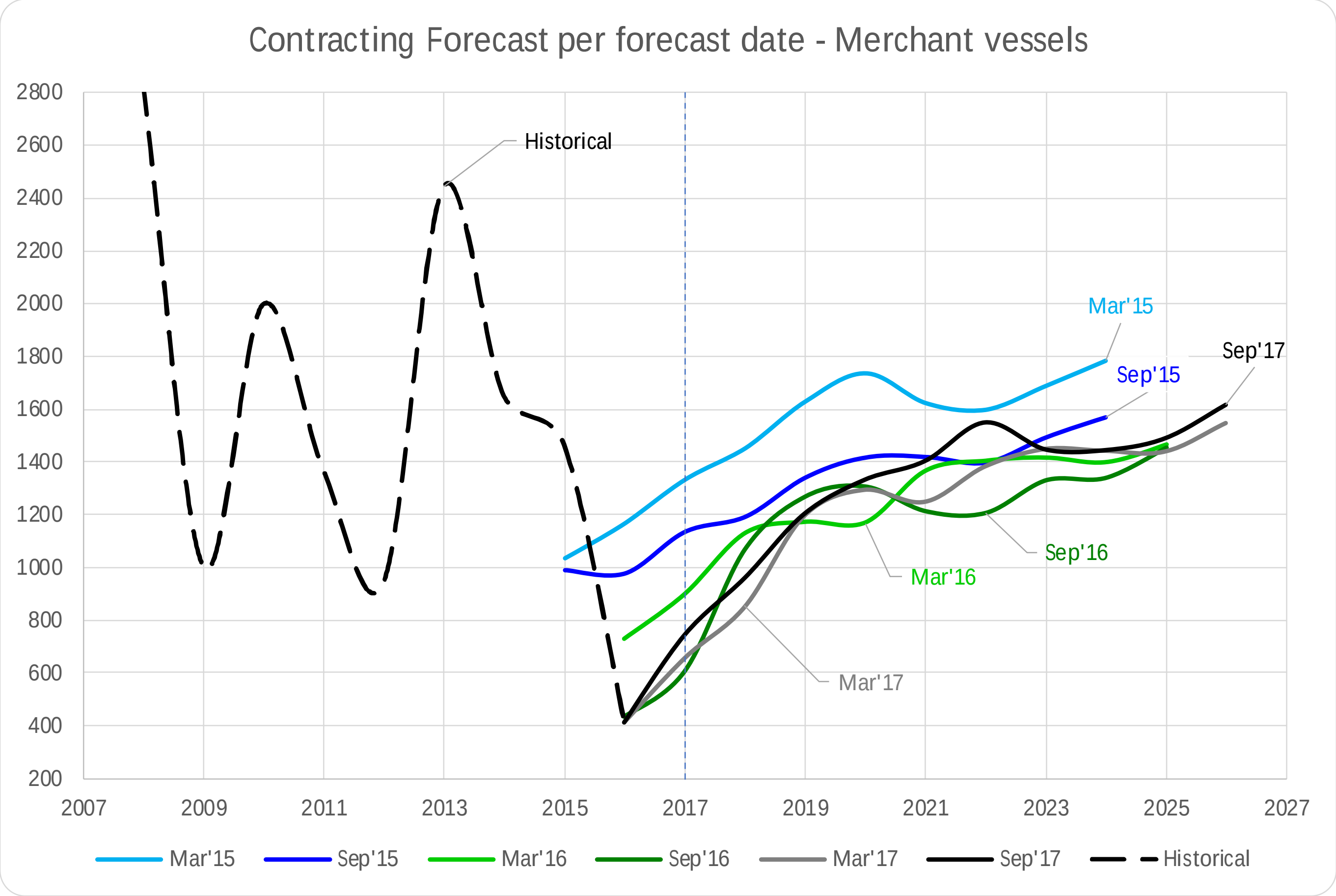
Depending on the operational areas and routes the ship takes

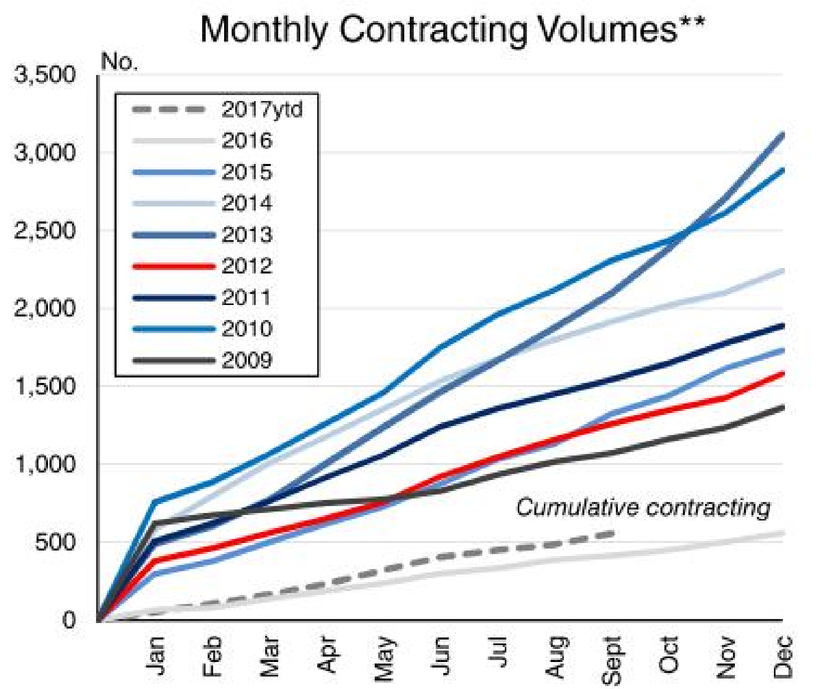
Customer setup and financial situation

Best solution

The Marine Market

Clarkson's Report





*Year-to-date contracting, annualised.

**Total includes those ship-shaped offshore units below 2,000 Dwt/GT

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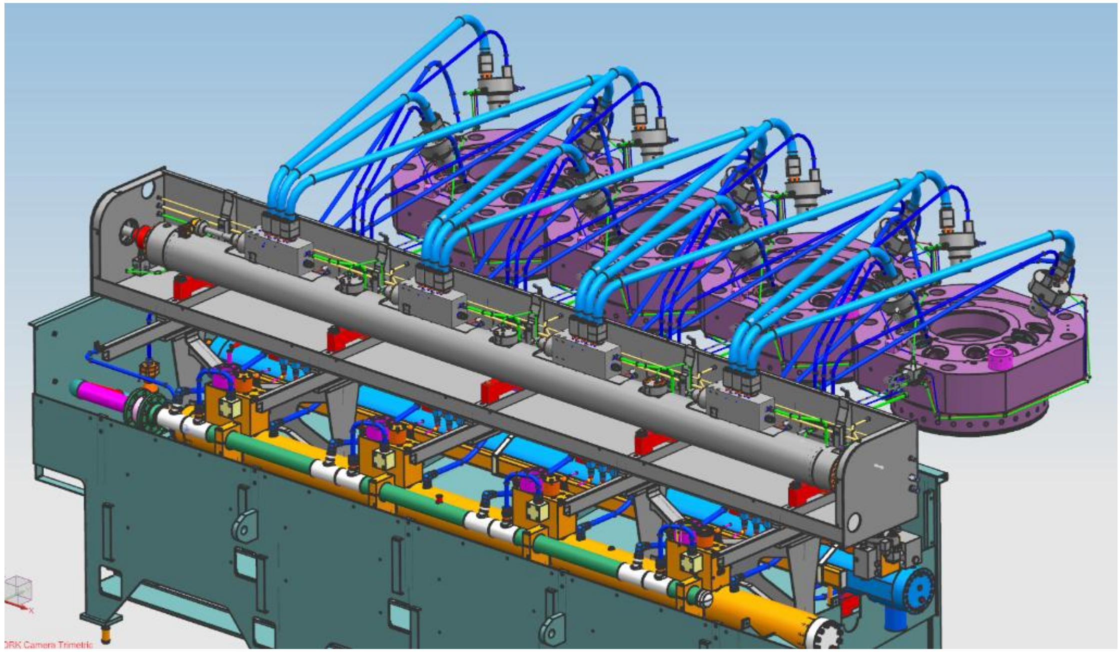
How does WinGD prepare its products for the future?



Systems for increased fuel flexibility:

- *Be prepared for a variety of fuels*
- *Allow for exotic fuels*
- *Allow the owner for a high flexibility in his fuel choice*

Increase efficiency:

- *Introduce new technology (e.g. combustion pack)*

Be aware of new technologies:

- *Follow and actively support fuel alternative investigations*

FALCON

http://www.falcon-biorefinery.eu/

Possible Future Research Topics

The challenges ahead

Hybridisation

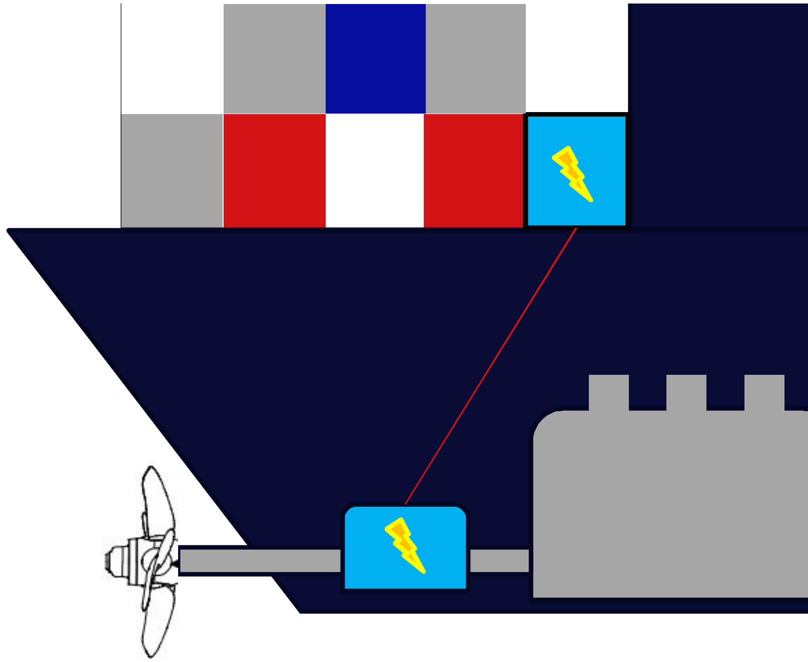
- Electrification
  - ECA - passage
  - Manoeuvring
  - Power compensation (sea margin)
- Energy share on board
  - Investigate the common energy forms on board
  - Find overlapping

Power Generation => Bio-SWEET?

- Fuel flexibility
- Efficiency
- Simplicity

Engine efficiency

- Further reduce Methane slip for DF engines
- "Combustion pack follow up", increase combustion pressure
- Intelligent control system



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Conclusions

- *The shipping business is already on a very high level of efficiency*
- *Shipping industry is under high financial pressure, budgets for investments are very limited*
- *The large amounts of mobilised energy and their worldwide availability reduce the options*
- *The current situation (market & legislations) makes a prediction on future energy very difficult*
- *There is not a single solution which fits all situation*
- *WinGD is preparing for a variety of fuels and expects a slight shift towards Methane.*
- *Most probably the focus in the marine industry remains on classic fuels for the near and mid term future*

Thank you!

Dr. Andreas Schmid
Team Leader Future Technologies
Winterthur Gas & Diesel

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Winterthur Gas & Diesel

Text with Map

Support your audience with visual information

2 vs 4 stroke

WinGD RT-flex50DF

IMO Tier III in gas mode

Cylinder bore	500 mm
Piston stroke	2050 mm
Speed	99–124rpm
Mean effective pressure at R1	17.3 bar
Stroke/bore	4.10

Rated power, principal dimensions and weights

Cyl.	Output in kW at 124 rpm R1	124 rpm R2	99 rpm R3	99 rpm R4	Length A mm	Length A' mm	Weight tonnes
5	7 200	6 000	5 750	4 775	5 576	6 793	200
6	8 640	7 200	6 900	5 730	6 456	7 670	225
7	10 080	8 400	8 050	6 685	7 336		255
8	11 520	9 600	9 200	7 640	8 216		280

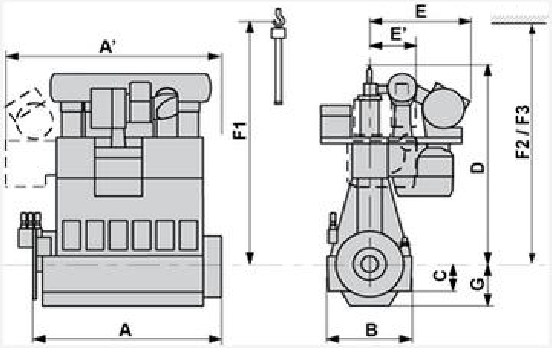
Dimensions (mm)	B	C	D	E	E'
	3 150	1 088	7 646	3 570	1 900
	F1	F2	F3	G	
	9 270	9 270	8 800	1 636	

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 200	7 158	7 200	7 158
BSGC (gas)	g/kWh	142.7	141.6	142.7	141.6
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1



WÄRTSILÄ Engines

MAIN TECHNICAL DATA WÄRTSILÄ 50DF

Cylinder bore	500 mm
Piston stroke	580 mm
Cylinder output	950/975 kW/cyl
Speed	500, 514 rpm
Mean effective pressure	20.0 bar
Piston speed	9.7, 9.9 m/s

MARINE ENGINES, IMO Tier II

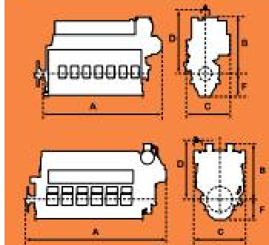
RATED POWER

Engine type	50 Hz Engine kW	50 Hz Gen. kW	60 Hz Engine kW	60 Hz Gen. kW
6L50DF	5 700	5 500	5 850	5 650
8L50DF	7 600	7 330	7 800	7 530
9L50DF	8 550	8 250	8 775	8 470
12V50DF	11 400	11 000	11 700	11 290
16V50DF	15 200	14 670	15 600	15 050
18V50DF	17 100	16 500	17 550	16 940

Generator output based on a generator efficiency of 96.5%.

ENGINE DIMENSIONS (MM) AND WEIGHTS (TONNES)

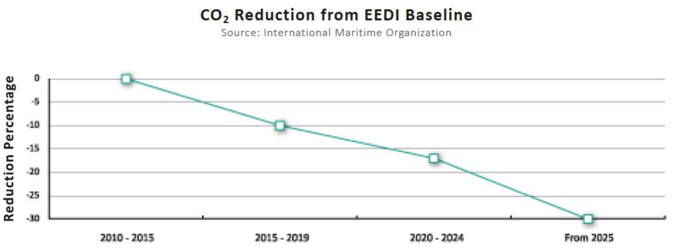
Engine type	A	B	C	D	F	Weight
6L50DF	8 115	3 580	2 850	3 820	1 455	96
8L50DF	9 950	3 600	3 100	3 820	1 455	128
9L50DF	10 800	3 600	3 100	3 820	1 455	148
12V50DF	10 465	4 055	3 810	3 600	1 500	175
16V50DF	12 665	4 055	4 530	3 600	1 500	220
18V50DF	13 725	4 280	4 530	3 600	1 500	240

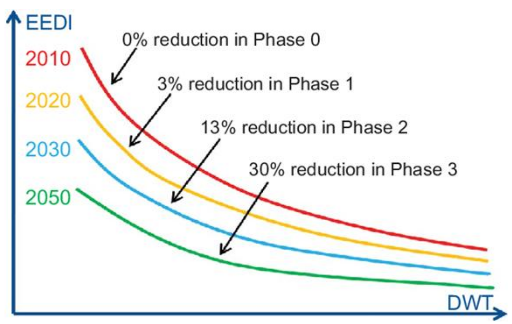


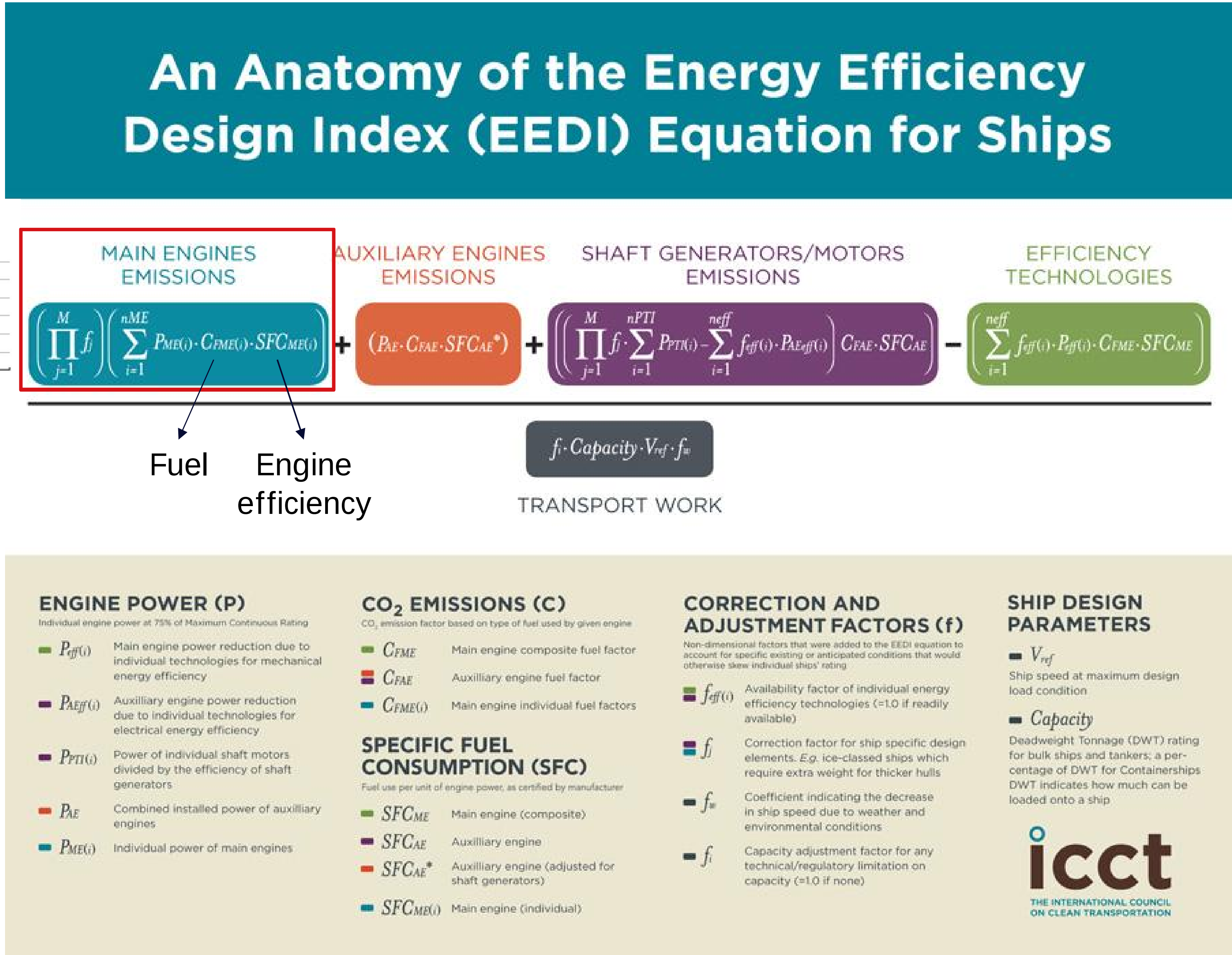
POWER PLANT ENGINES

TECHNICAL DATA 50 HZ/500 RPM	Unit	18V50DF	18V50DF*
Power, electrical	kW	16621	16621
Heat rate	kJ/kWh	7616	8185
Electrical efficiency	%	47.3	44.0
Technical data 60 Hz/514 rpm			
Power, electrical	kW	17076	17076
Heat rate	kJ/kWh	7616	8185
Electrical efficiency	%	47.3	44.0
Dimensions and dry weight with generating set			
Length	mm	18780	18780
Width	mm	4090	4090
Height	mm	6020	6020
Weight	tonne	355	355

Heat rate and electrical efficiency at generator terminals, including engine-driven pumps, ISO 3046 conditions and LHV. Tolerance 5%. Power factor 0.8. Gas Methane Number >80. *In liquid mode.


CO2 Reduction from EEDI Baseline
Source: International Maritime Organization
Reduction Percentage
0
-5
-10
-15
-20
-25
-30
2010 - 2015
2015 - 2019
2020 - 2024
From 2025


EEDI
2010
2020
2030
2050
0% reduction in Phase 0
3% reduction in Phase 1
13% reduction in Phase 2
30% reduction in Phase 3
DWT


An Anatomy of the Energy Efficiency Design Index (EEDI) Equation for Ships
MAIN ENGINES EMISSIONS
AUXILIARY ENGINES EMISSIONS
SHAFT GENERATORS/MOTORS EMISSIONS
EFFICIENCY TECHNOLOGIES
Fuel
Engine efficiency
TRANSPORT WORK
ENGINE POWER (P)
Individual engine power at 75% of Maximum Continuous Rating
Main engine power reduction due to individual technologies for mechanical energy efficiency
Auxilliary engine power reduction due to individual technologies for electrical energy efficiency
Power of individual shaft motors divided by the efficiency of shaft generators
Combined installed power of auxilliary engines
Individual power of main engines
CO2 EMISSIONS (C)
CO2 emission factor based on type of fuel used by given engine
Main engine composite fuel factor
Auxilliary engine fuel factor
Main engine individual fuel factors
SPECIFIC FUEL CONSUMPTION (SFC)
Fuel use per unit of engine power, as certified by manufacturer
Main engine (composite)
Auxilliary engine
Auxilliary engine (adjusted for shaft generators)
Main engine (individual)
CORRECTION AND ADJUSTMENT FACTORS (f)
Non-dimensional factors that were added to the EEDI equation to account for specific existing or anticipated conditions that would otherwise skew individual ships' rating
Availability factor of individual energy efficiency technologies (=1.0 if readily available)
Correction factor for ship specific design elements. E.g. ice-classed ships which require extra weight for thicker hulls
Coefficient indicating the decrease in ship speed due to weather and environmental conditions
Capacity adjustment factor for any technical/regulatory limitation on capacity (=1.0 if none)
SHIP DESIGN PARAMETERS
Ship speed at maximum design load condition
Capacity
Deadweight Tonnage (DWT) rating for bulk ships and tankers; a percentage of DWT for Containerships
DWT indicates how much can be loaded onto a ship
icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Tier	Ship construction date on or after	Total weighted cycle emission limit (g/kWh) n = engine's rated speed (rpm)		
		n < 130	n = 130 - 1999	n ≥ 2000
I	1 January 2000	17.0	$45 \cdot n^{(-0.2)}$ e.g., 720 rpm – 12.1	9.8
II	1 January 2011	14.4	$44 \cdot n^{(-0.23)}$ e.g., 720 rpm – 9.7	7.7
III	1 January 2016*	3.4	$9 \cdot n^{(-0.2)}$ e.g., 720 rpm – 2.4	2.0

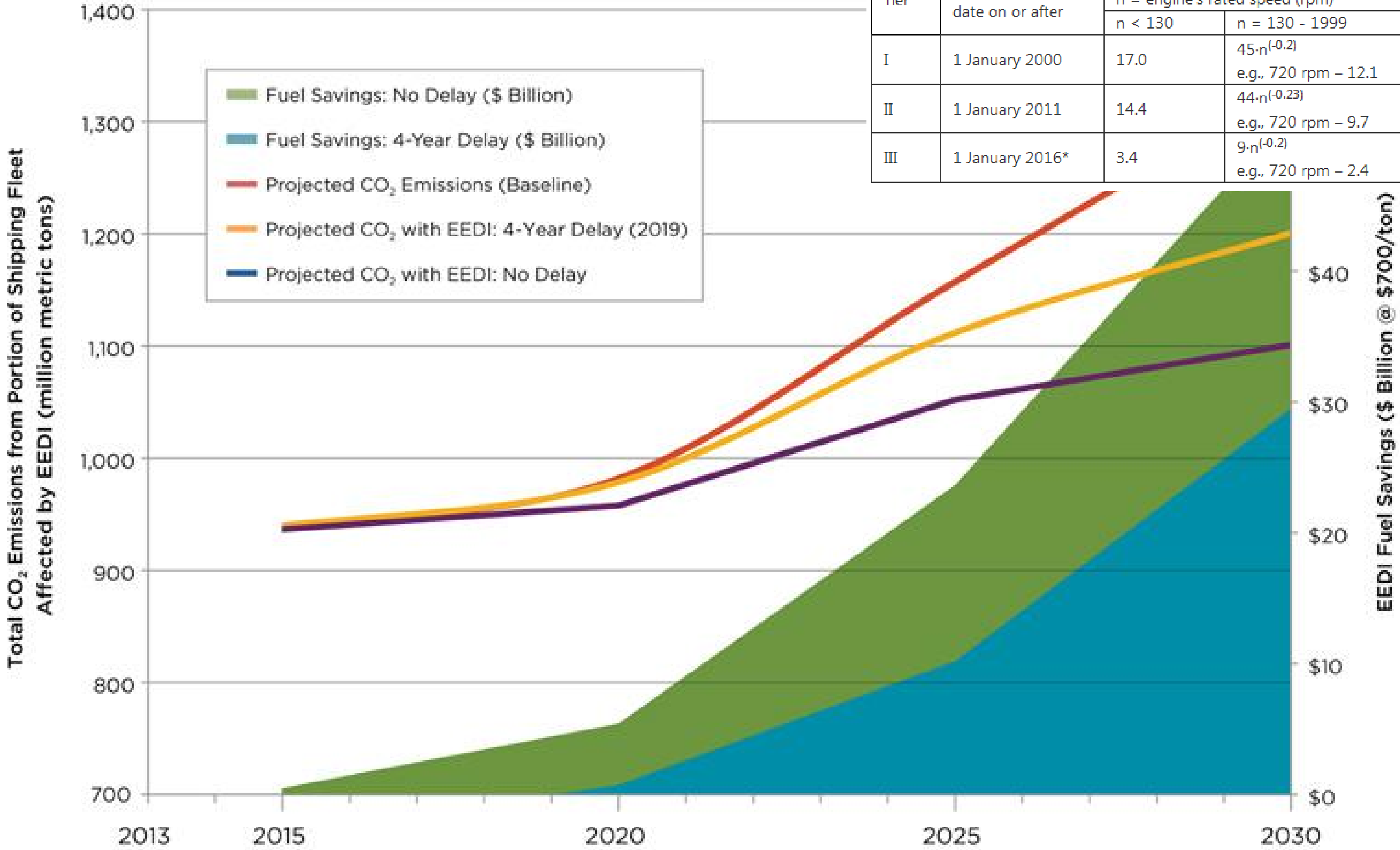
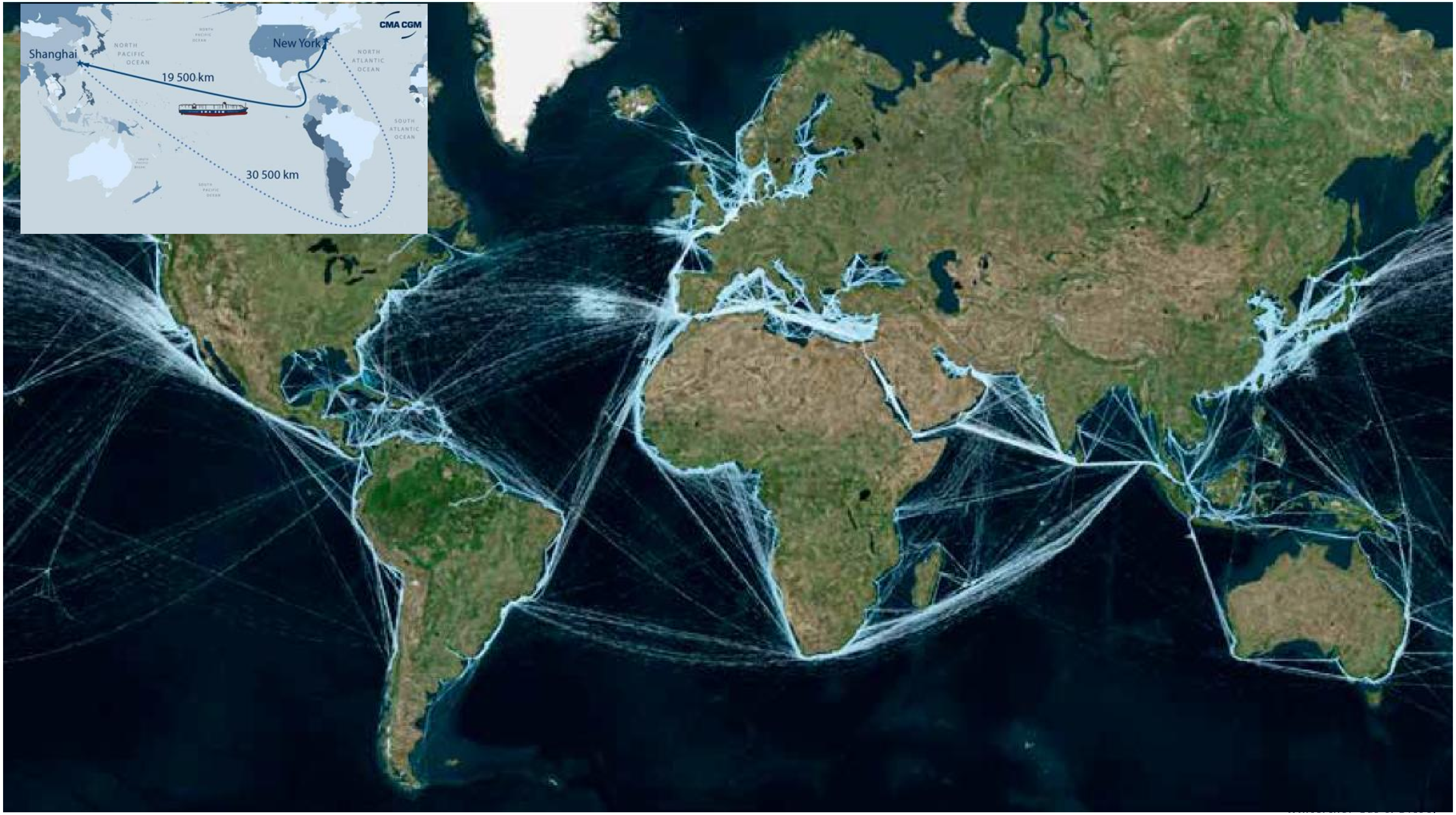


Figure 1. Projected CO_2 emissions and cost savings through 2030 from the shipping fleet affected by EEDI Regulation. IMO Scenario A2, with and without proposed 4-year delay.



LOW CARBON SHIPPING TOWARDS 2050, C. Chryssakis et. al., DNV GL