Sustainability:
Environment – Shipping

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Sustainability

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HISTORY

KIVI NIRIA

In 1927, the brothers Jan and Rien Damen started building boats in an old construction shed in a small village about ten kilometers from the current Damen headquarters.

Understanding that meeting a customer's needs with an affordable product is crucial . They expanded their customer base steadily and guaranteed their company's growth and success .

The defining moment came in 1969 however, when Kommer Damen, the son of founder Jan, took over the company.

Kommer Damen had something in mind that was new to the world of shipbuilding: the standardization and series-production of workboats.

He listened closely to his customers and noted their requirements and demands.

GLOBAL ACTIVITIES DAMEN SHIPYARDS GROUP

▽ Damen Technical Cooperation projects (current and recent)

* Joint venture ** Business cooperation

THE NETHERLANDS

1. Damen Shipyards Gorinchem
2. Damen Marine Services
3. Damen Trading & Chartering
4. Damen Schelde Naval Shipbuilding
5. Damen Schelde Gears
6. Damen Schelde Marine Services
7. Amels
8. Bodewes Binnenvaart Millingen
9. Damen Dredging Equipment
10. Damen Marine Components Netherlands
11. Damen Shiprepair Rotterdam
12. Damen Anchor & Chain Factory
13. Damen Shipyards Bergum
14. Damen Shipyards Hardinxveld
15. Maaskant Shipyards Stellendam
16. Oranjewerf
17. Scheldepoort
18. Spares Services Maritime Europe
19. Van Brink Rotterdam
20. Visser Den Helder

EUROPE

1. Götaverken Cityvarvet
2. Damen Shipyards Gdynia
3. Damen Marine Components Gdansk
4. Damen Shipyards Kozle
5. Brixham Marine Services
6. Damen Shipyards Galati

AFRICA

1. Damen Shipyards Cape Town

MIDDLE EAST

1. Albwardy Marine Engineering*
2. Nakilat Damen Shipyards Qatar*
3. Damen Shipyards Sharjah (FZE)*

AMERICAS

1. Damex*
2. Wilson, Sons**

ASIA PACIFIC

1. Damen Marine Components Suzhou & Damen Trading Suzhou
2. Damen Yichang Shipyard*
3. Damen Shipyards Changde
4. Afai Southern Shipyard**
5. Song Cam Shipyard**
6. Damen Vinashin Shipyard*
7. Song Thu Shipyard**
8. Damen Shipyards Singapore & Spares Services Maritime Asia
9. PT Dumas**

Sustainability:
Environment – Shipping

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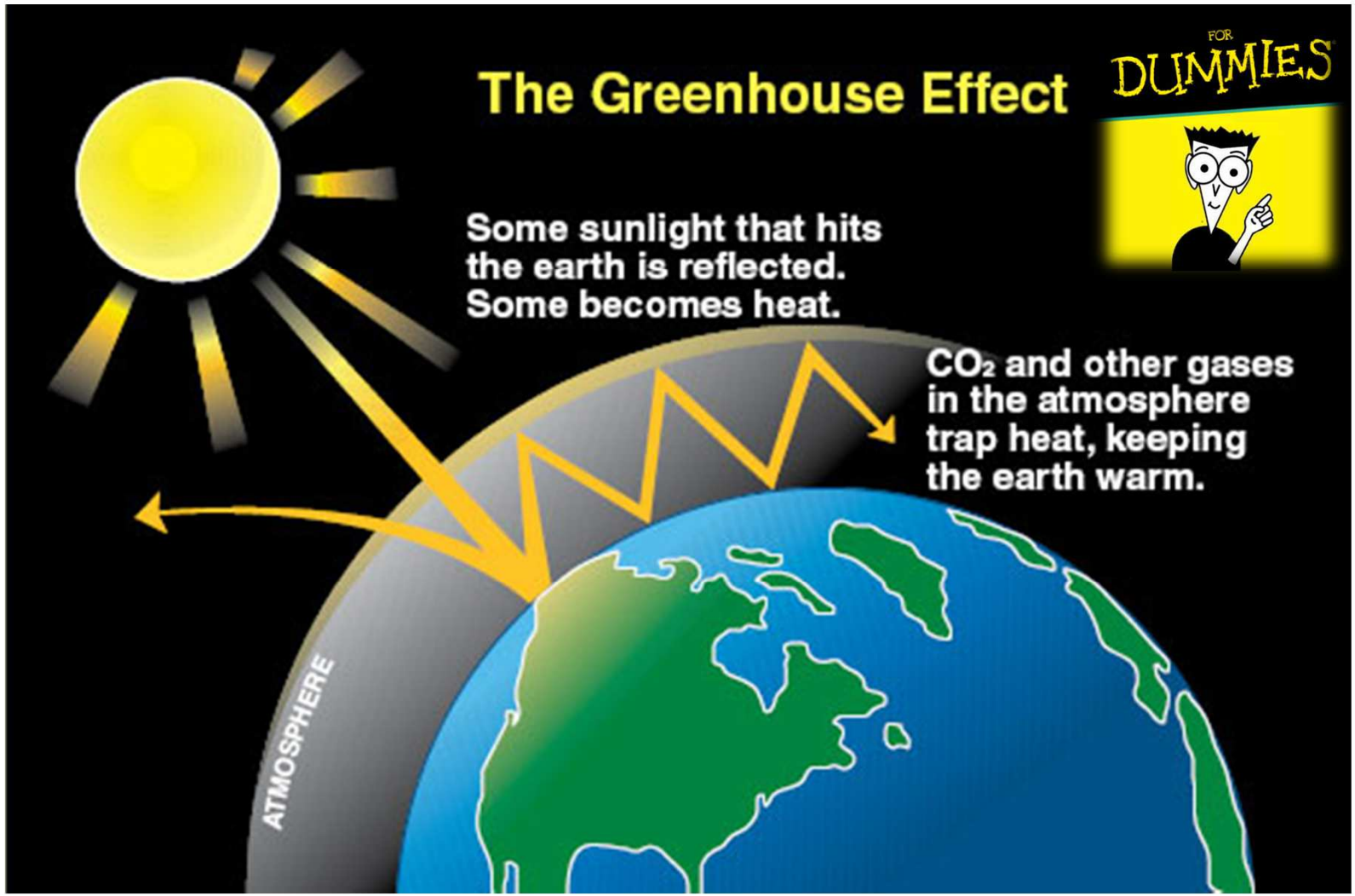
FACTS AND FIGURES 2012

- **Annual Turnover :** **1,7 billion Euro**
- **Damen Shipyard Group:** **38 yards worldwide**
  - The Netherlands: 16
  - Abroad: 22
- **Employees:** **7,700 worldwide**
  - The Netherlands: 2,700
  - International: 5,000
- **Annual deliveries 2012:** **157**
  - Tugs / Workboats: 80
  - Offshore Vessels: 6
  - High Speed Craft & Ferries: 42
  - Pontoons & Barges: 7
  - Dredging & Specials: 7
  - Cargo Vessels/Inland & Coastal: 8
  - Naval & Yachts: 7

Environment

- CO_2 – Greenhouse Effect
- Finiteness of Fossile Energy
- Air Pollution & Healt Risks

Greenhouse effect



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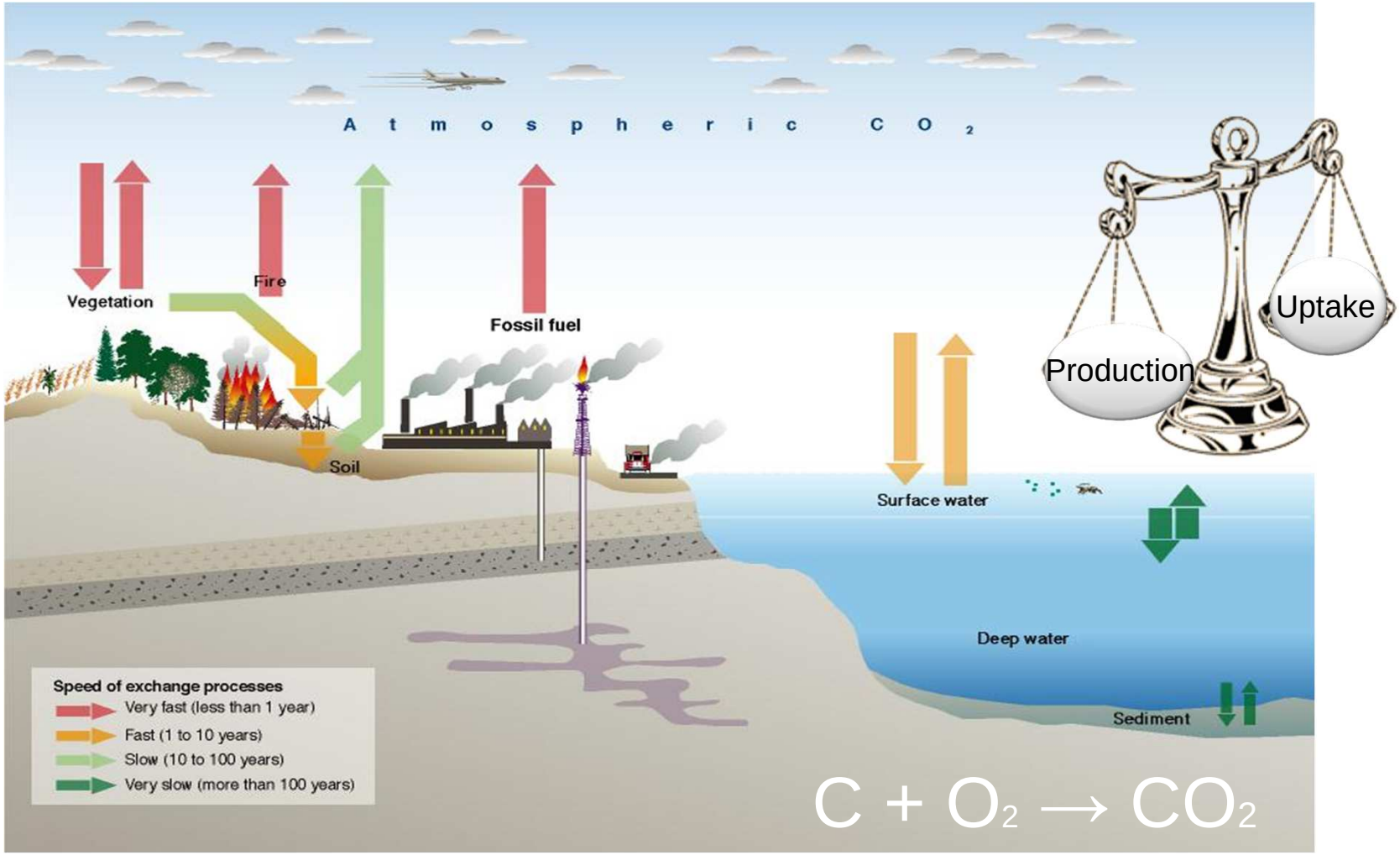
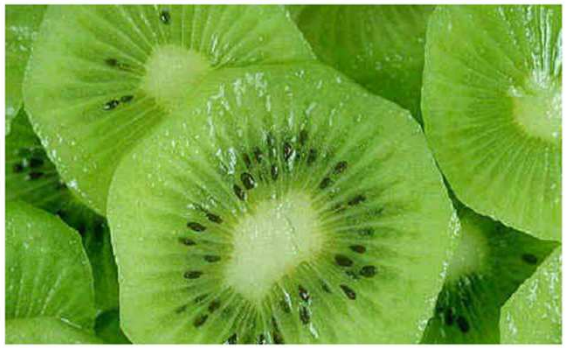
Carbon cycle



Consumer society

Consumer society

Food from all over the world in our local supermarket		
		Kiwis from New Zealand
Fruit from Asia		Wine from South America

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Consumer society

2011: More than 25 cities with more than **10 million inhabitants**

Number of megacities increased with 25% over the past 5 years

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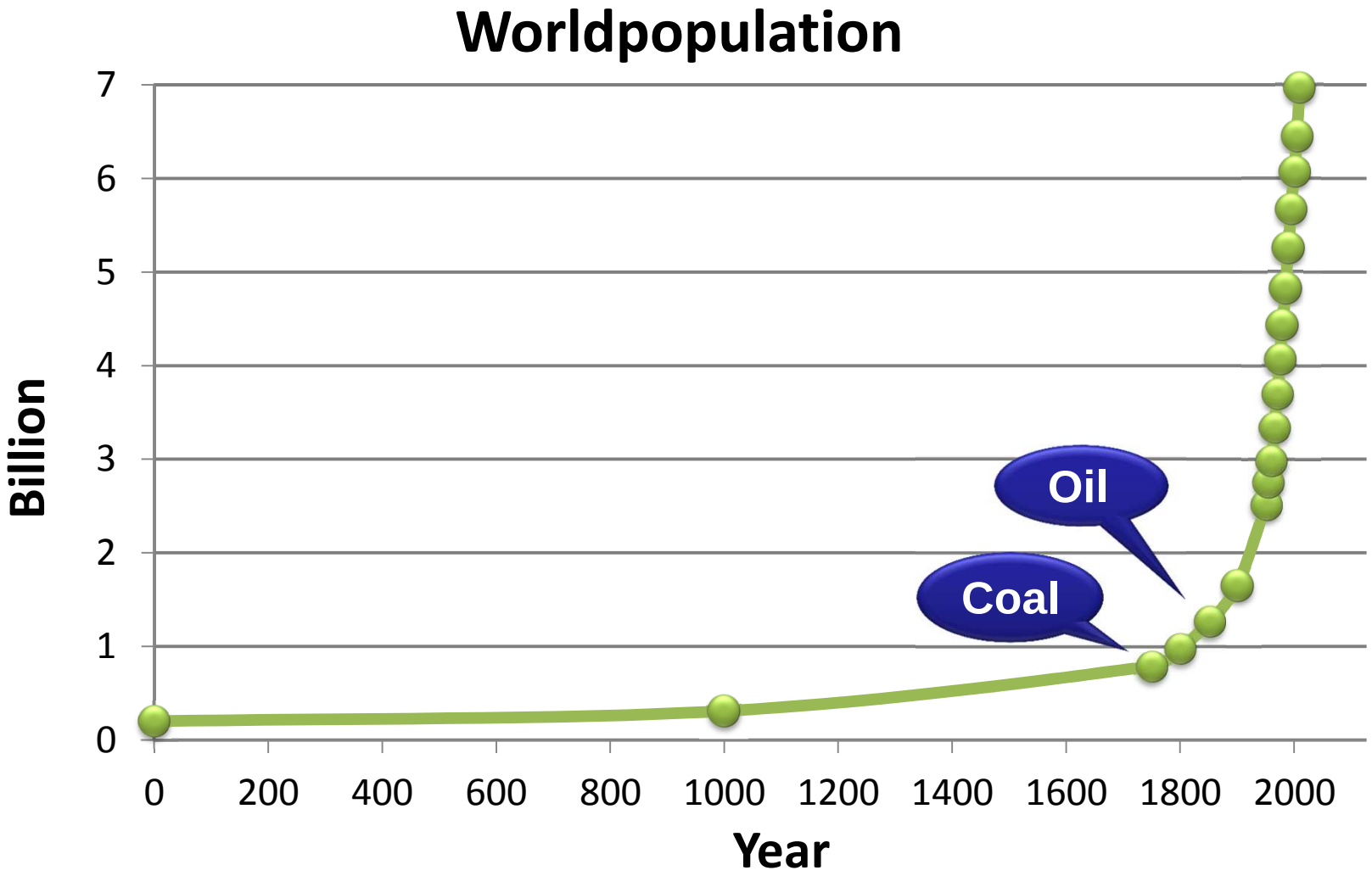
Consumer society



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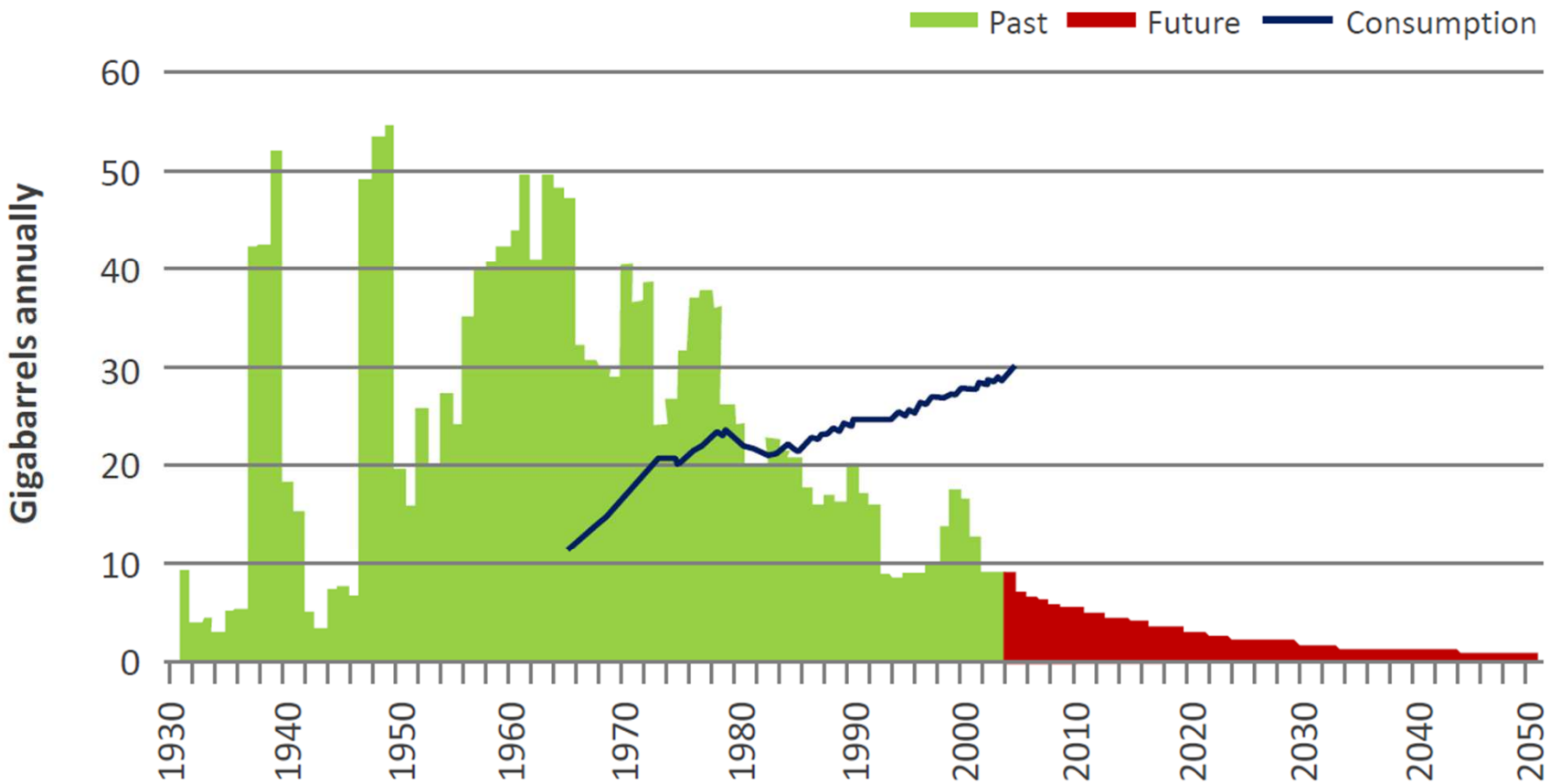
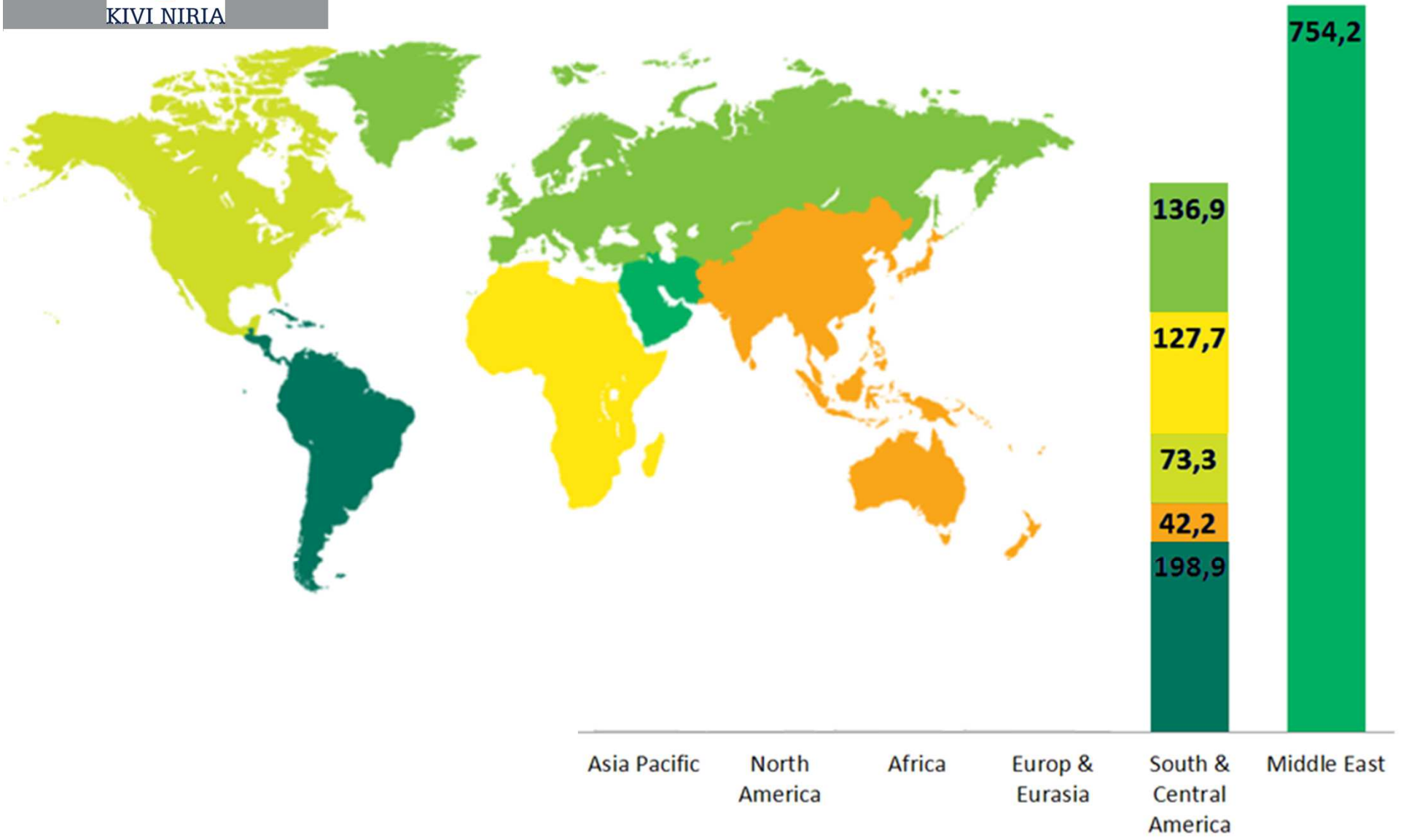
Energy cirsis



Proved oil reserves at end 2009



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Energy crisis

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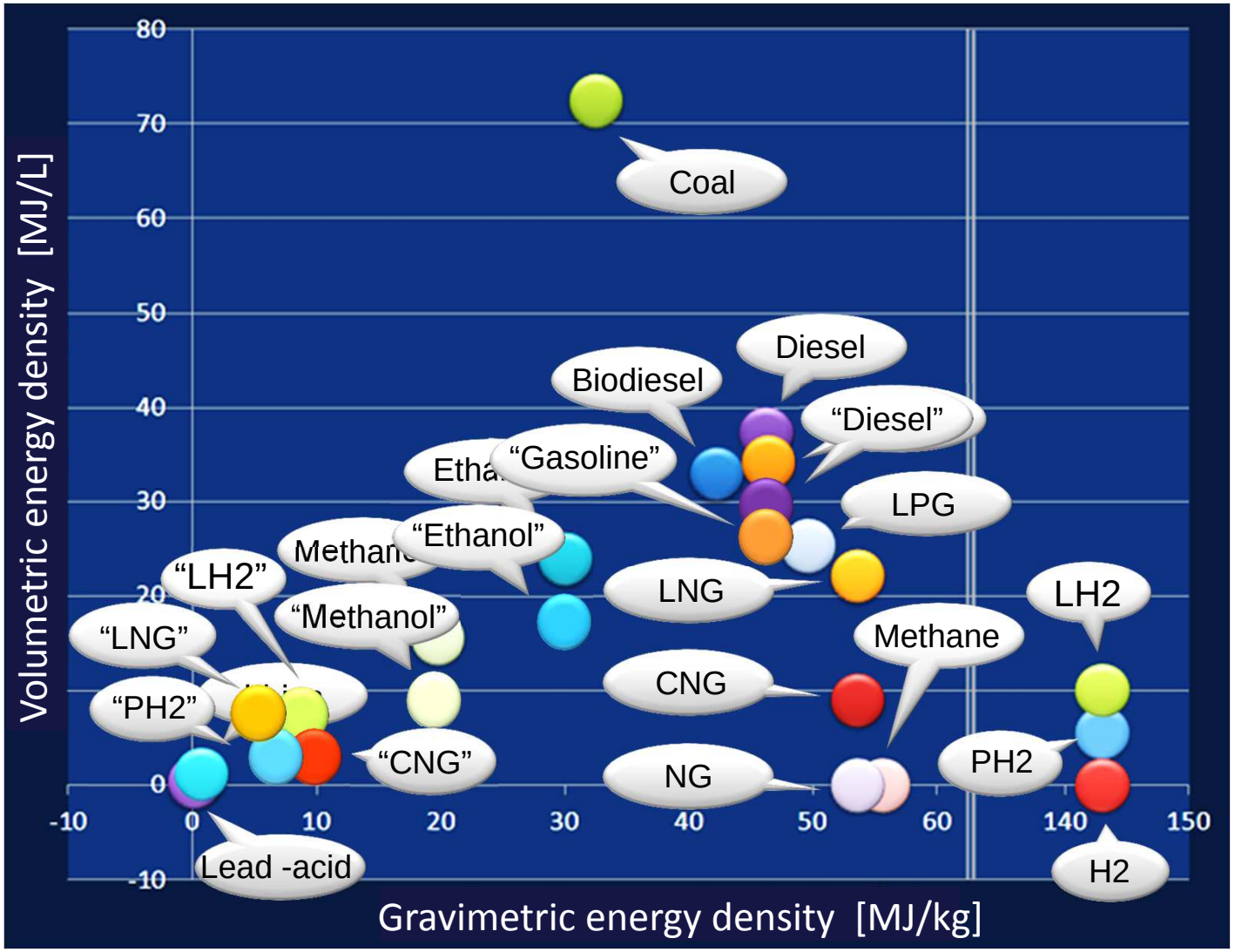
Alternative energy sources



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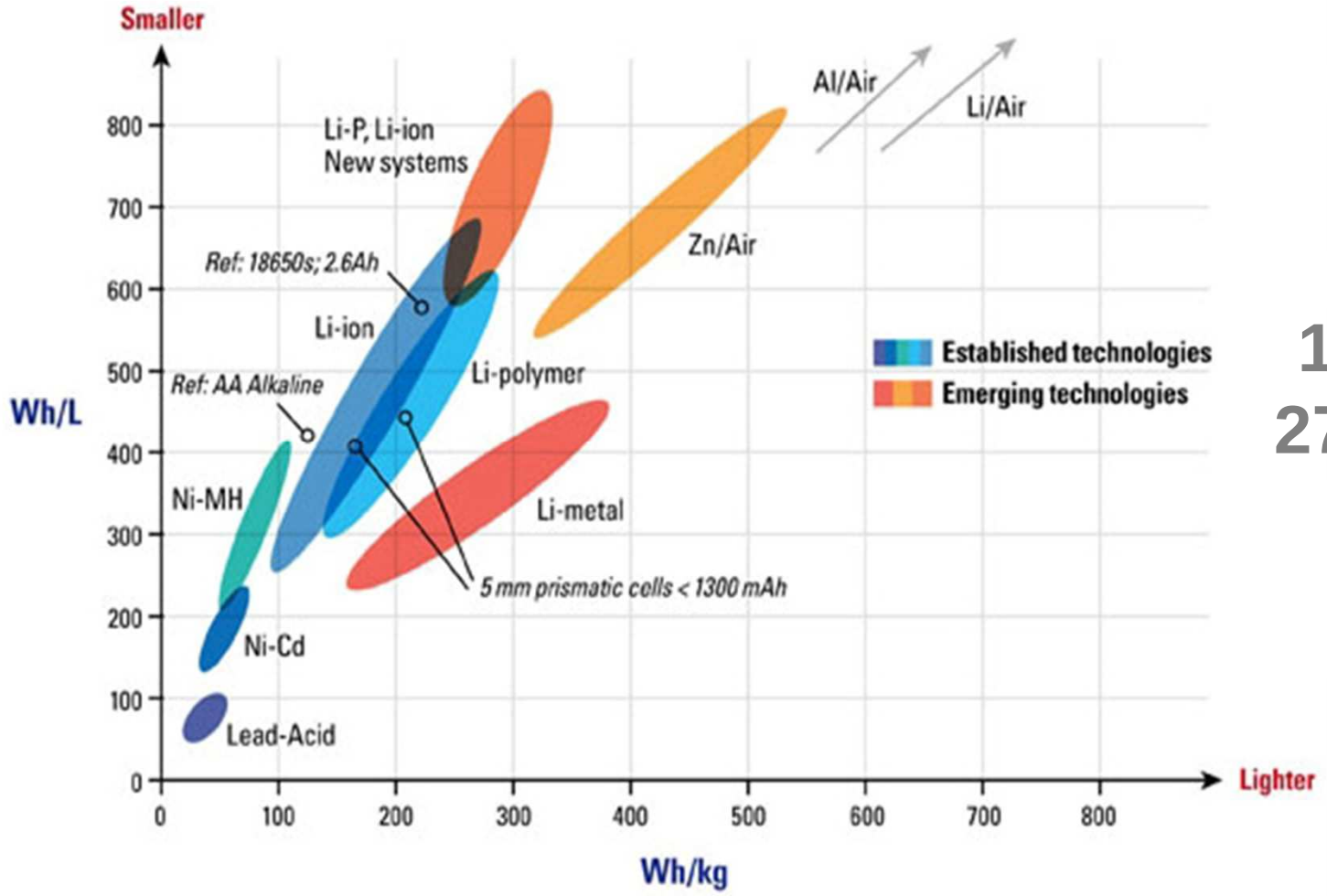
Alternative energy sources



1MJ = 278 Wh

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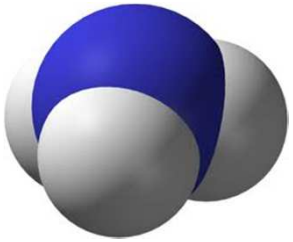
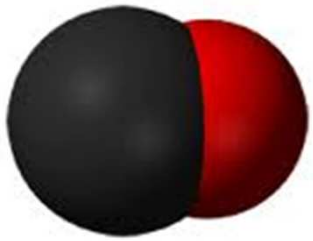
Exhaust gas components

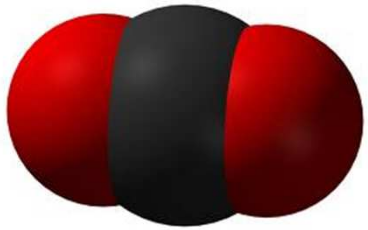
NH_3



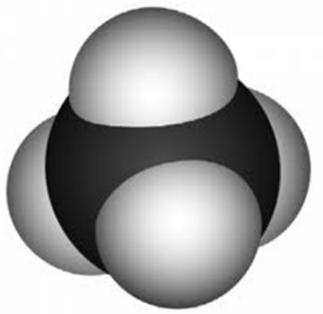
CO



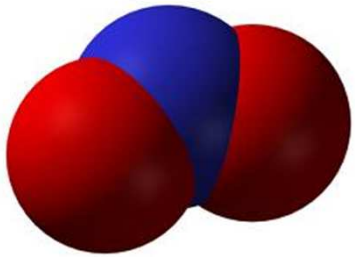
CO_2



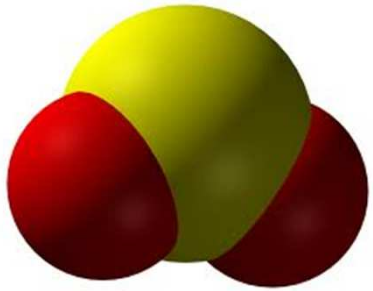
CH_4



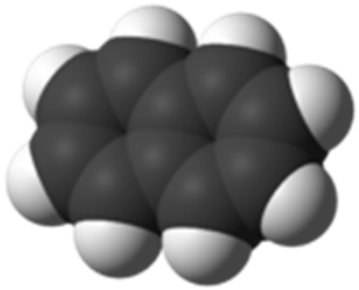
NO_X

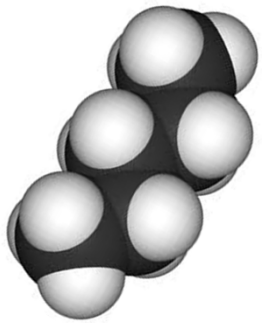


SO_X



VOC’s





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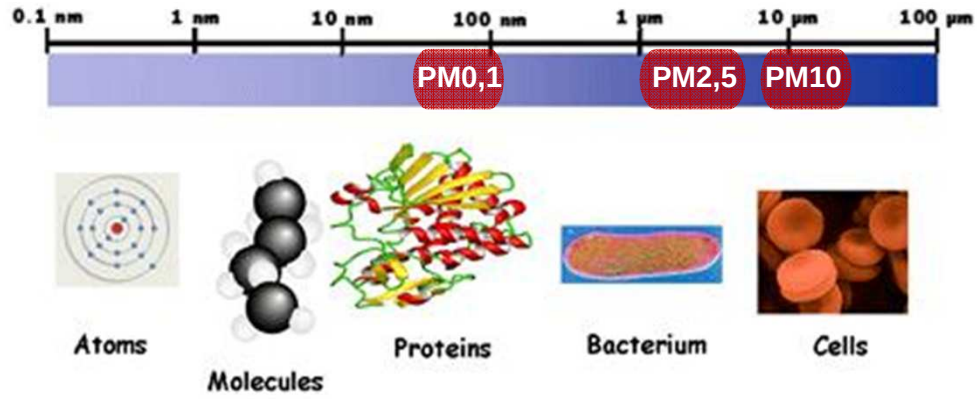
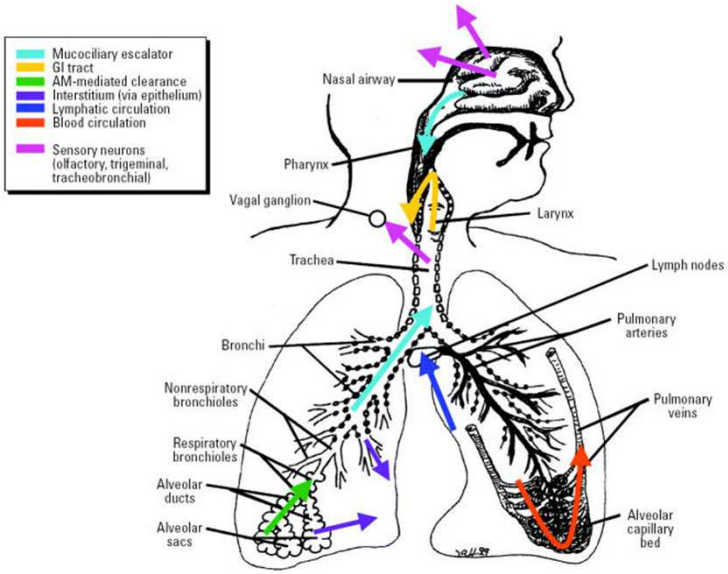
Sustainability:
Environment – Shipping





Particulates

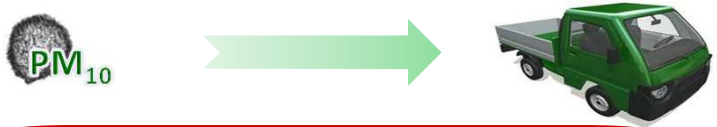
If a nanoparticle was the size of a tennis ball

A virus would be as big as a soccer ball

A $PM_{2,5}$ particle would be te size of a person

A red blood cell would be te size of a big car

A PM_{10} particle would be the size of a small truck



And a tennis ball would range from Gorinchem to Delft

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Harmful emissions related to transport

Diesel LNG

Impact		PM	Lead	SO_x	NO_x	VOC	CO	CH_4	CO_2	N_2O	CFC
Local (health and welfare)		X	X	X	X	X	X				
Regional	Acidification			X	X						
	Photochemical Oxidants				X	X	X				
Global	Indirect greenhouse effect				X	X	X	X			X
	Direct Greenhouse effect	X						X	X	X	X
	Stratospheric Ozone depletion				X					X	X

[*Fiaz A., World Bank (1991)*]

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Shipping

- Image
- In comparison …
- Regulations
- Room for improvement

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Shipping

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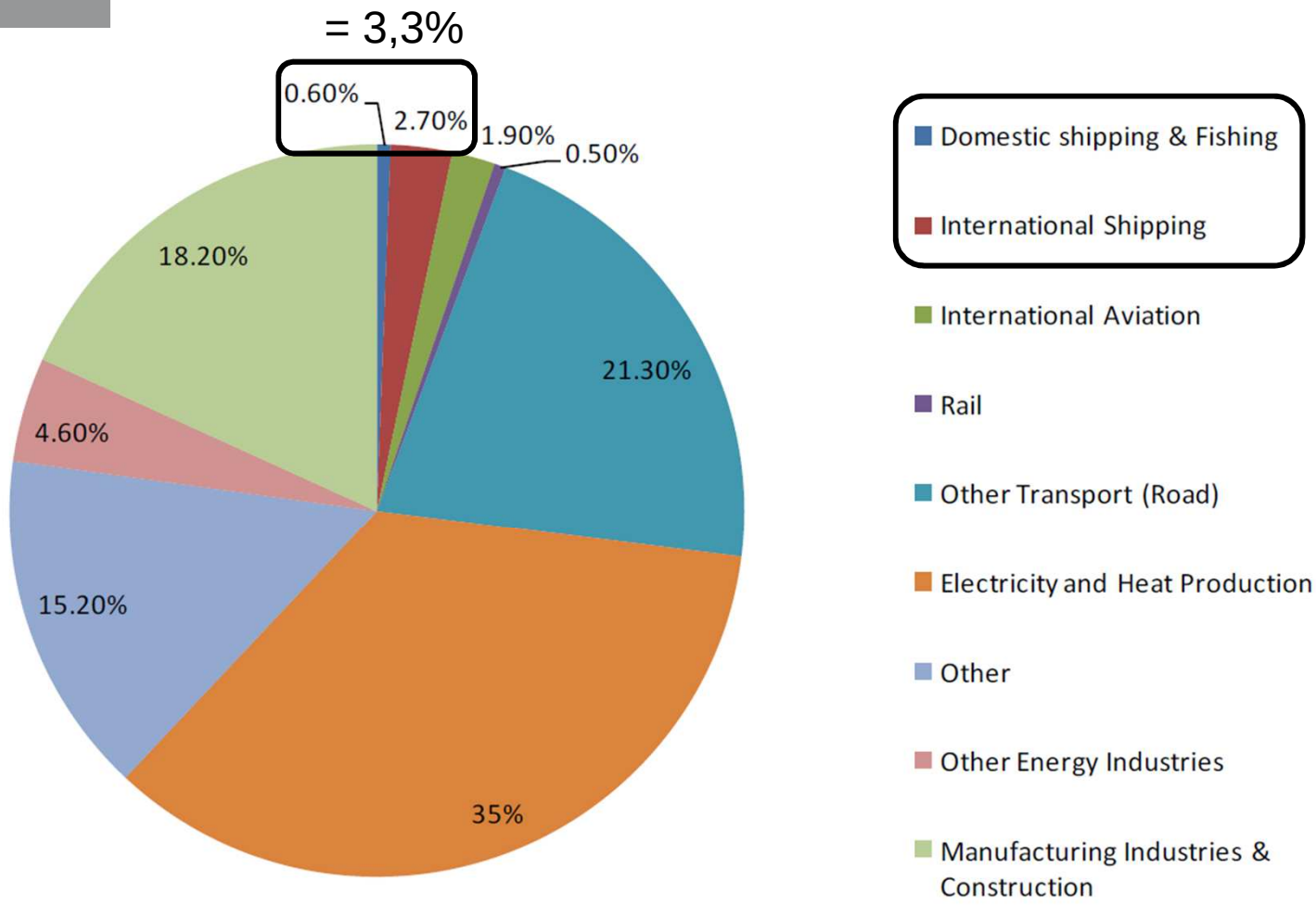
Global CO_2 emission by industry



Ref. 2:nd IMO GHG Study 2009, April 2009, Buhaug Ö et al

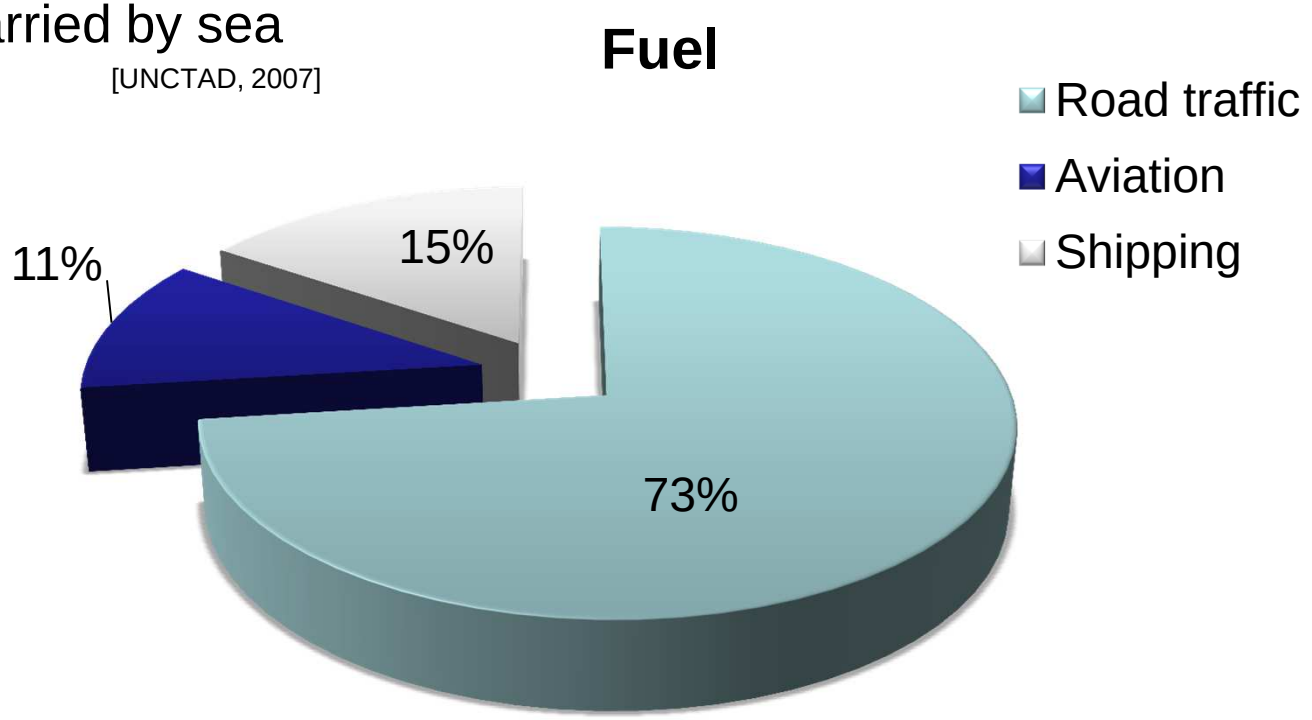
Global CO_2 emission by country

Rank	Country	Annual CO2 emissions[8][9] (in thousands of metric tonnes)	Percentage of global total
	World	29,888,121	100%
1	China[10]	7,031,916	23.33%
2	United States	5,461,014	18.11%
-	European Union (27)	4,177,817.86[11]	14.04%
3	India	1,742,698	5.78%
4	Russia	1,708,653	5.67%
5	Japan	1,208,163	4.01%
6		786,660	2.61%
7		986,308	3,3%
8	Iran	538,404	1.79%
9	United Kingdom	522,856	1.73%
10	South Korea	509,170	1.69%
11	Mexico	475,834	1.58%
12	Italy[12]	445,119	1.48%
13	South Africa	435,878	1.45%
14	Saudi Arabia	433,557	1.44%
15	Indonesia	406,029	1.35%

Transport fuel consumption

80% of world trade by volume is carried by sea

[UNCTAD, 2007]



Data from Eyring et al. J Geophys Res 110 (2005)

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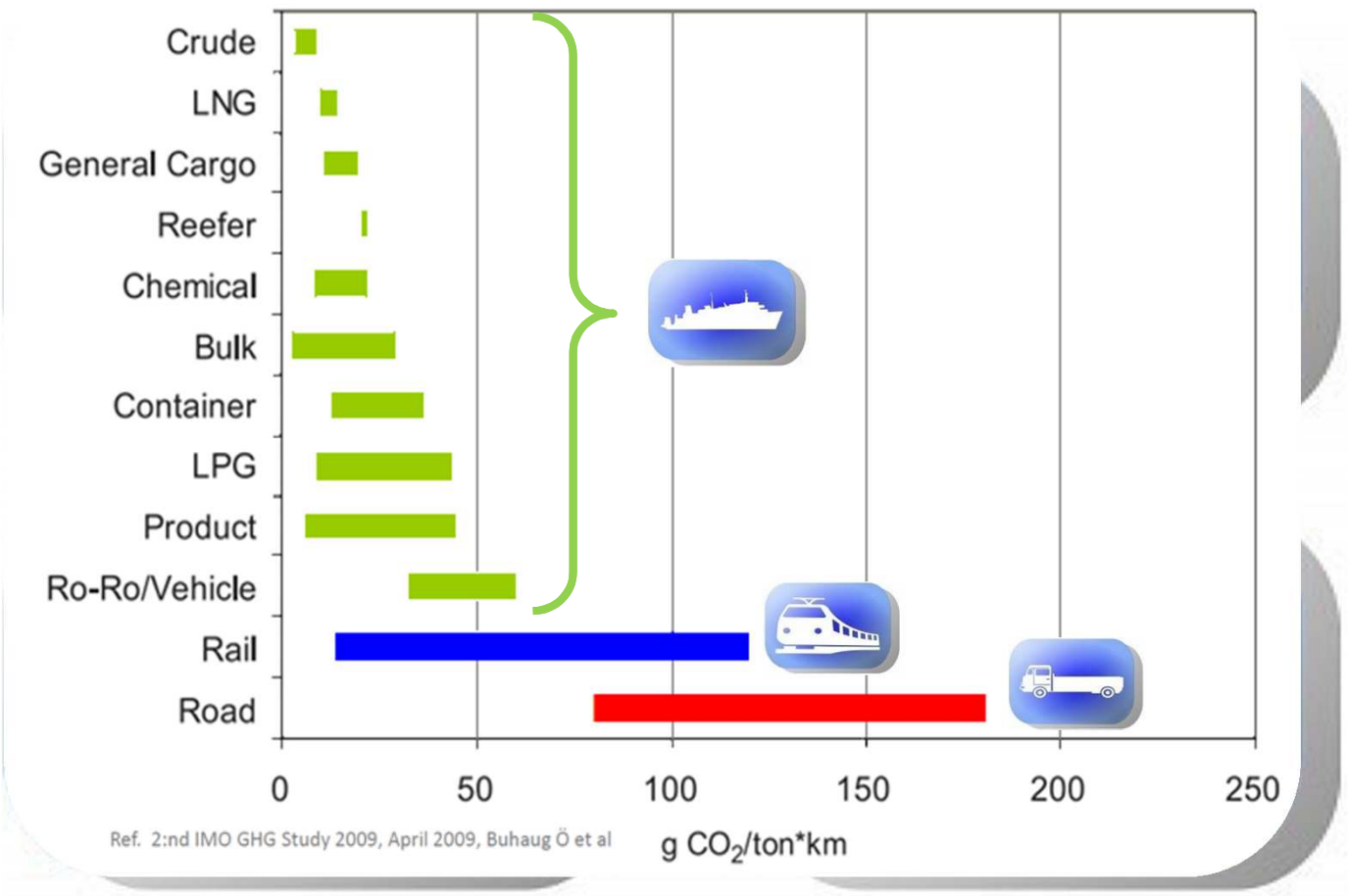
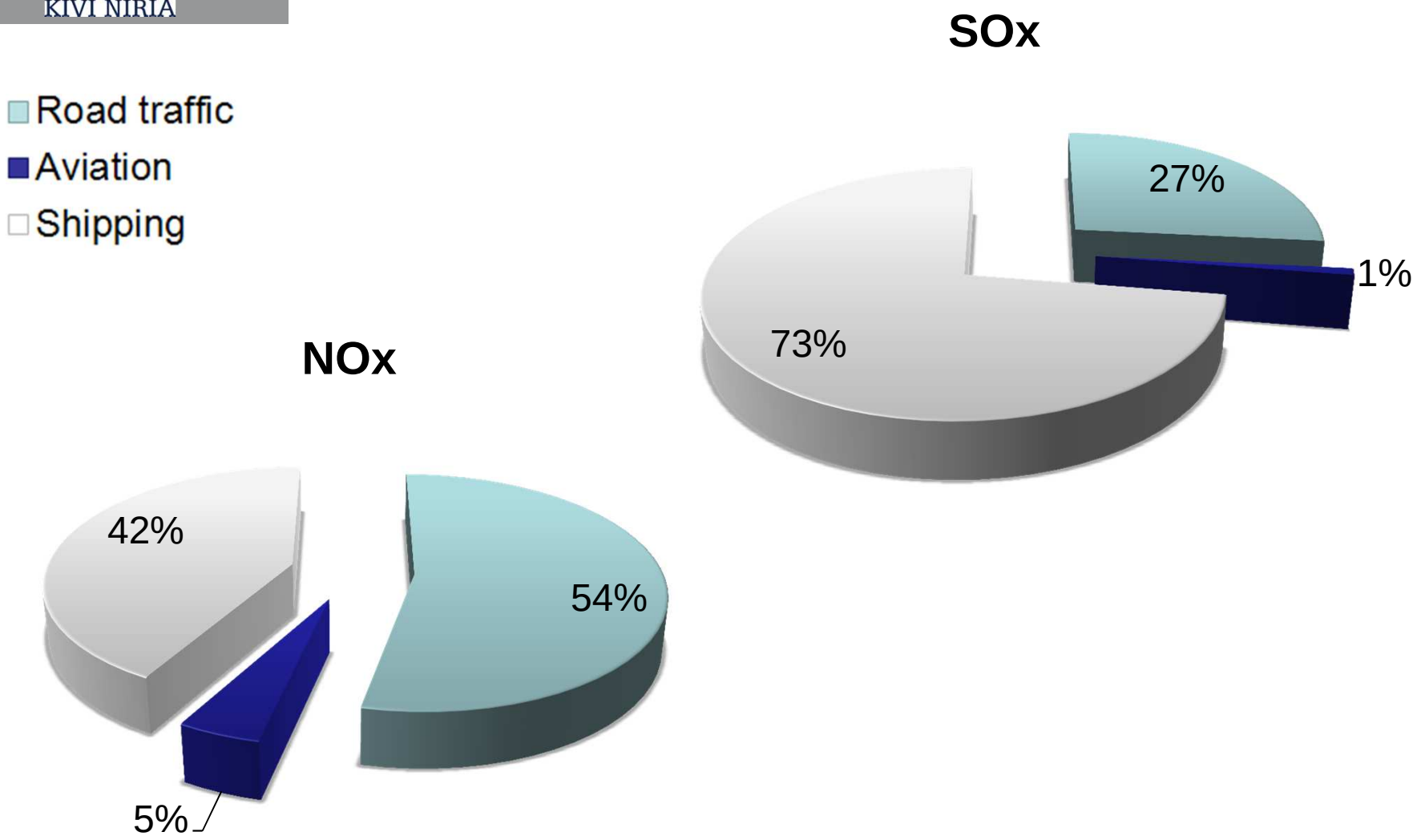
Transport CO2 emission



Transport emissions



Data from Eyring et al. J Geophys Res 110 (2005)

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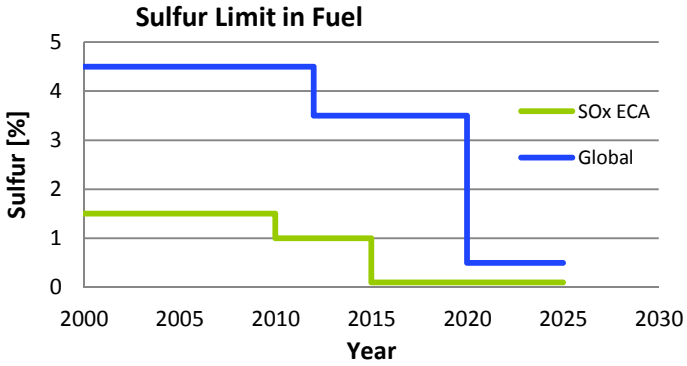
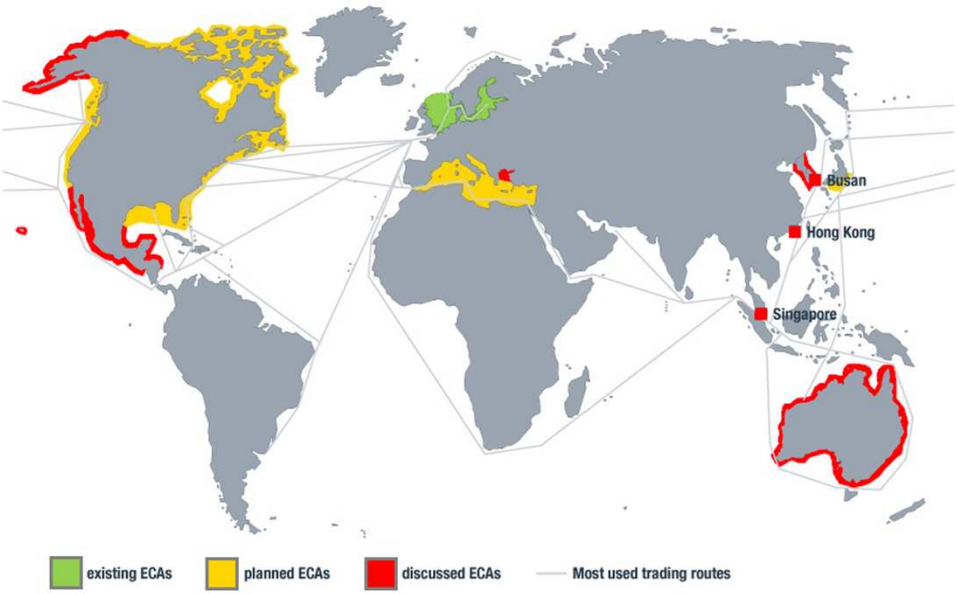
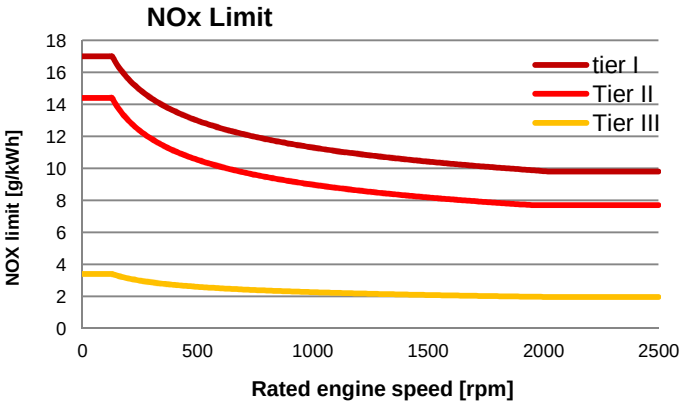
Environmental regulations

Marpol 73/78

- Annex I - Oil
- Annex II - Noxious Liquid Substances carried in Bulk
- Annex III - Harmful Substances carried in Packaged Form
- Annex IV - Sewage
- Annex V - Garbage
- Annex VI - Air Pollution







$$EEDI = \frac{\left(\prod_{j=1}^{\cdots} f_j\right)\left(\sum_{i=1}^{\cdots} P_{ME(i)}.C_{FME(i)}.SFC_{ME(i)}\right) + (P_{AE}.C_{FAE}.SFC_{AE}*) + \left(\left(\prod_{j=1}^{\cdots} f_j.\sum_{i=1}^{\cdots} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)}.P_{AEeff(i)}\right)C_{FAE}.SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)}.P_{eff(i)}.C_{FME}.SFC_{ME}\right)}{f_i.Capacity.V_{ref}.f_W}$$

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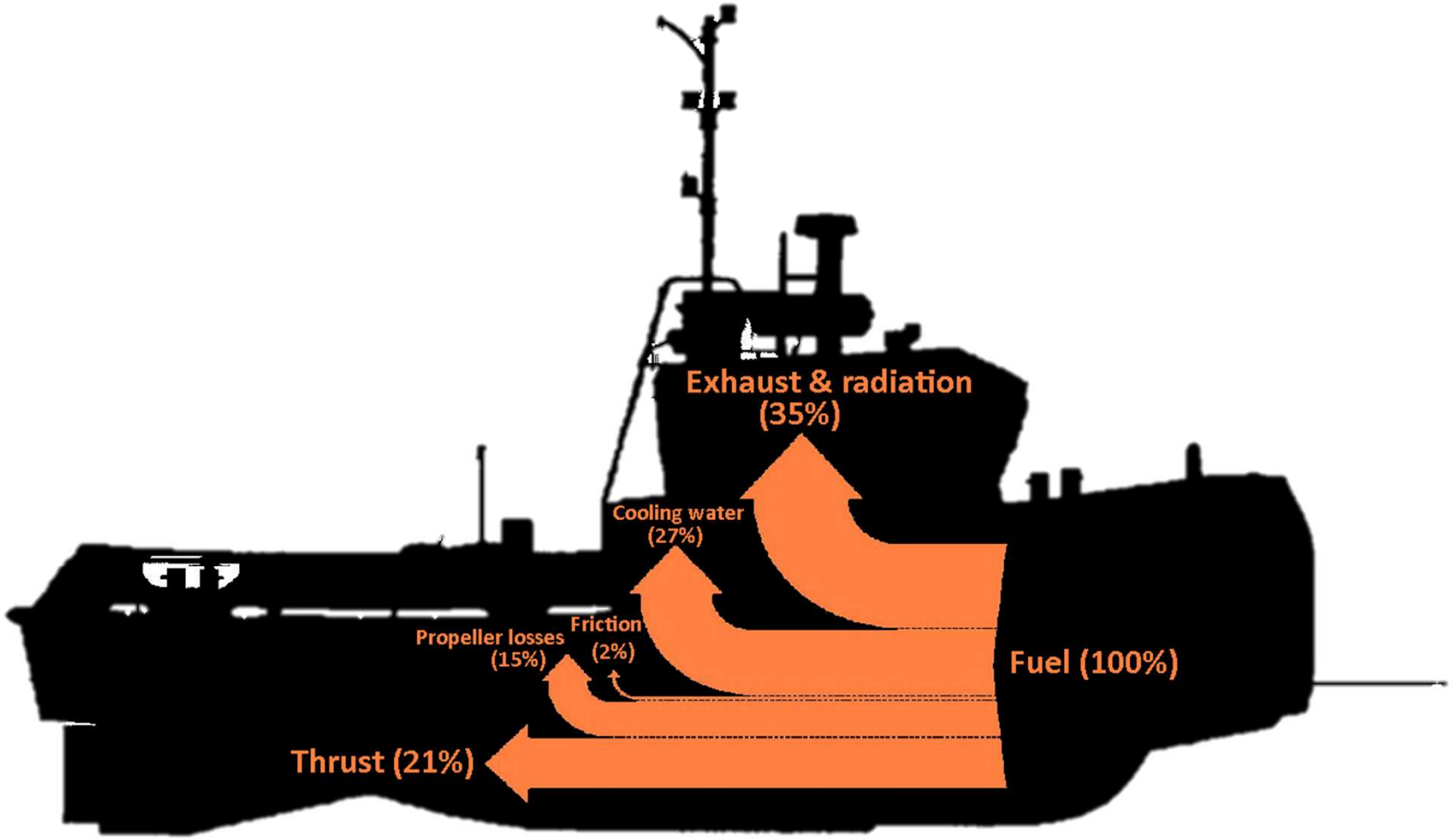
Sankey diagram



Trends

- Hybridisation
- Air Lubrication
- LNG

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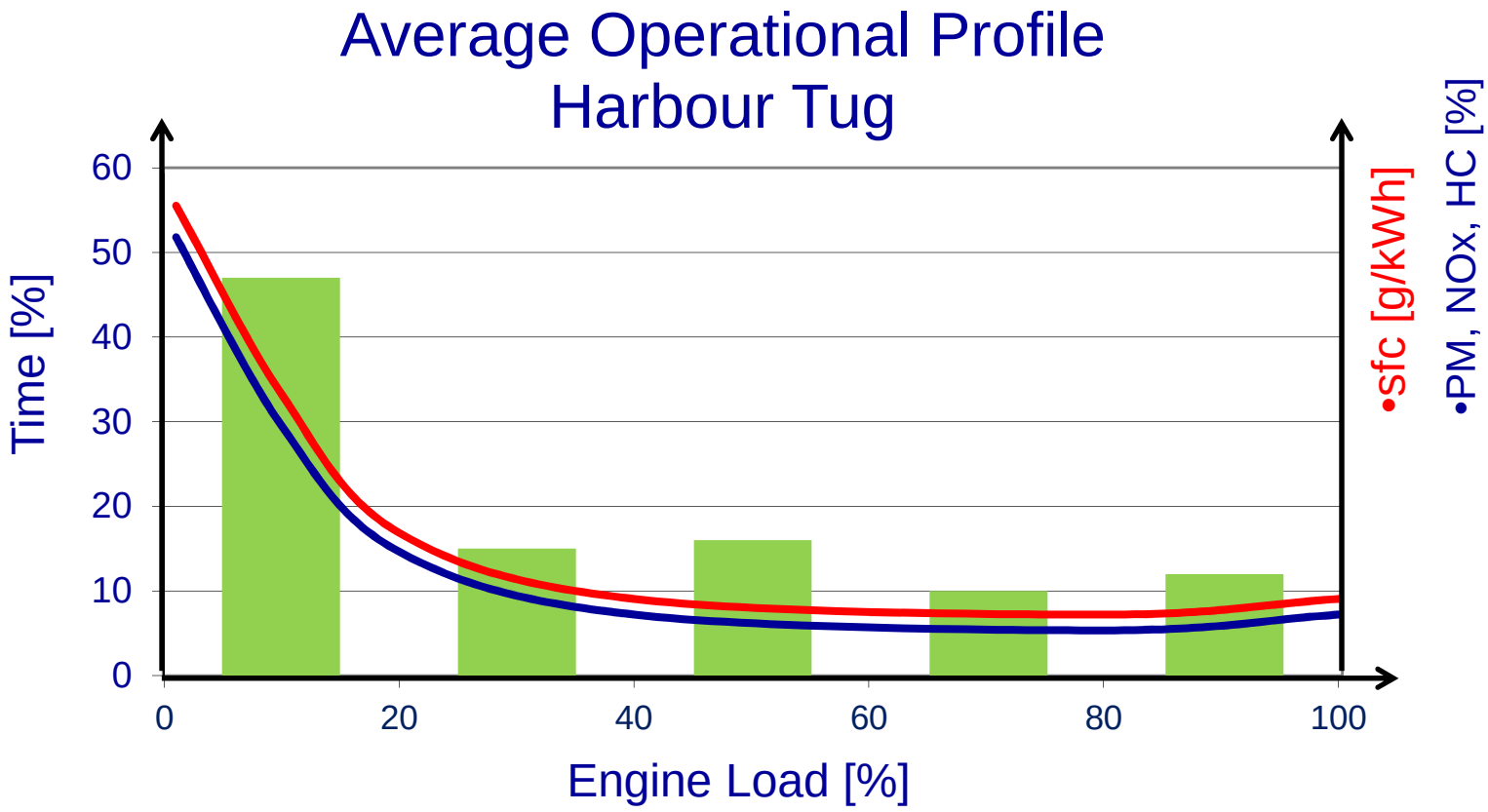
Operational Profile



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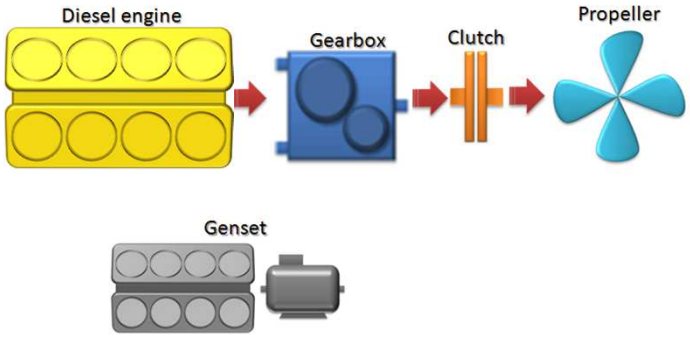
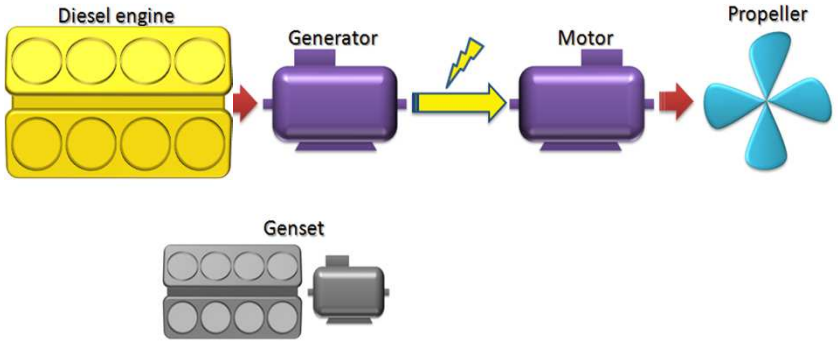
Propulsion Train Concepts

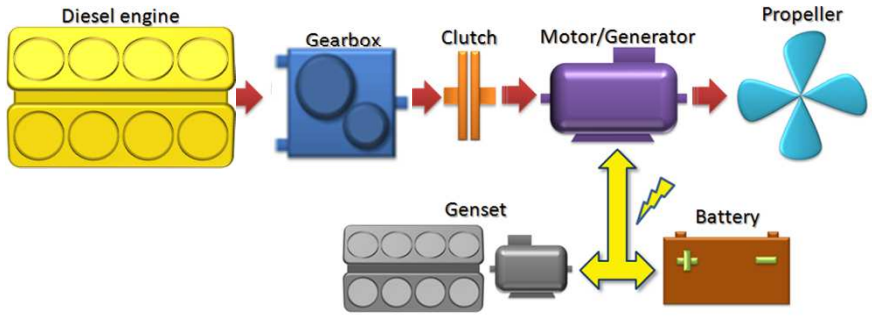
Diesel Direct



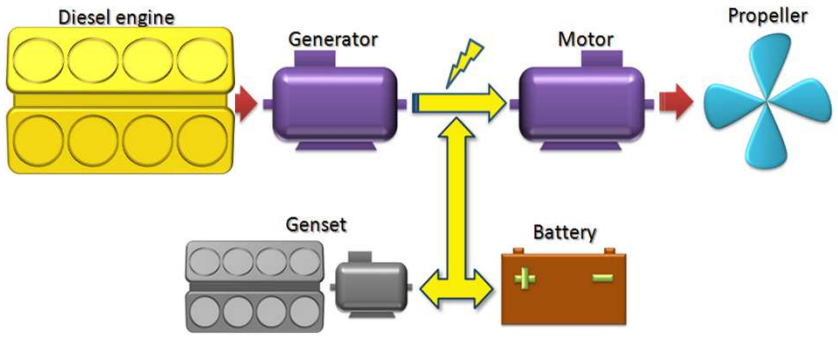
Diesel Electric (Series Hybrid)



Parallel Hybrid



Series-Parallel Hybrid



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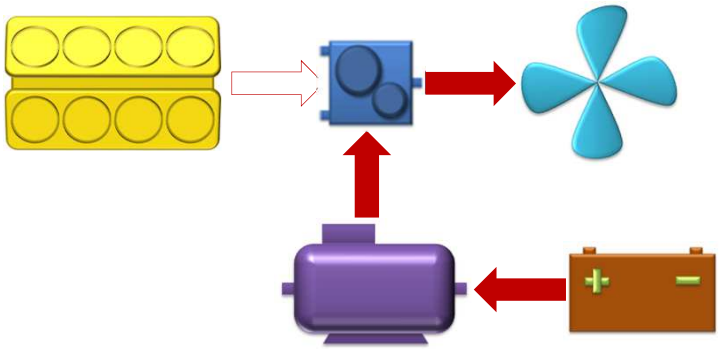
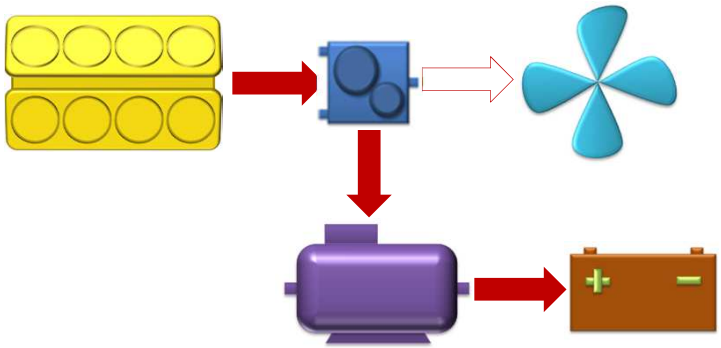
Hybrid Control Modes

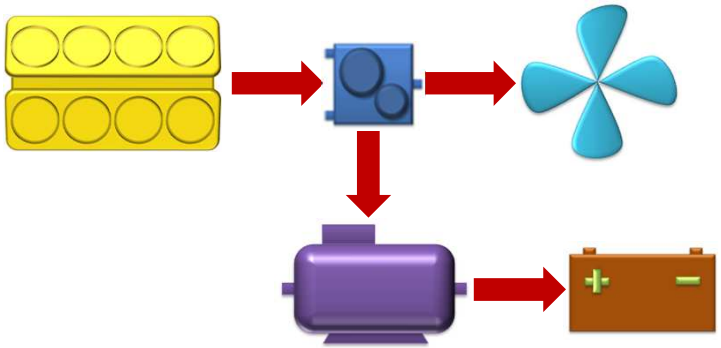
•Mode 1: Low Speed Transit, Standby



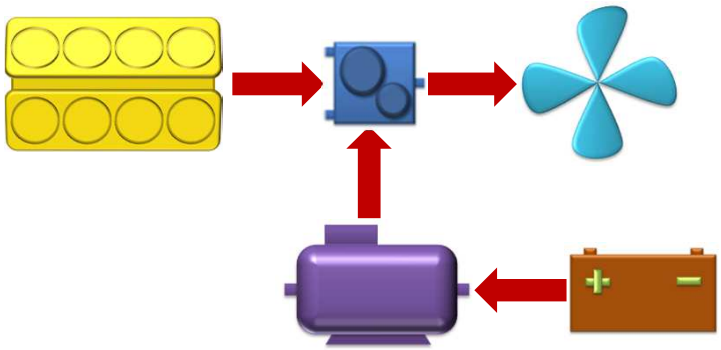
•Mode 2: Standby With Low Battery



•Mode 3: Low Power Assist, Low Speed Transit



•Mode 4: High Speed Transit, High Power Assist



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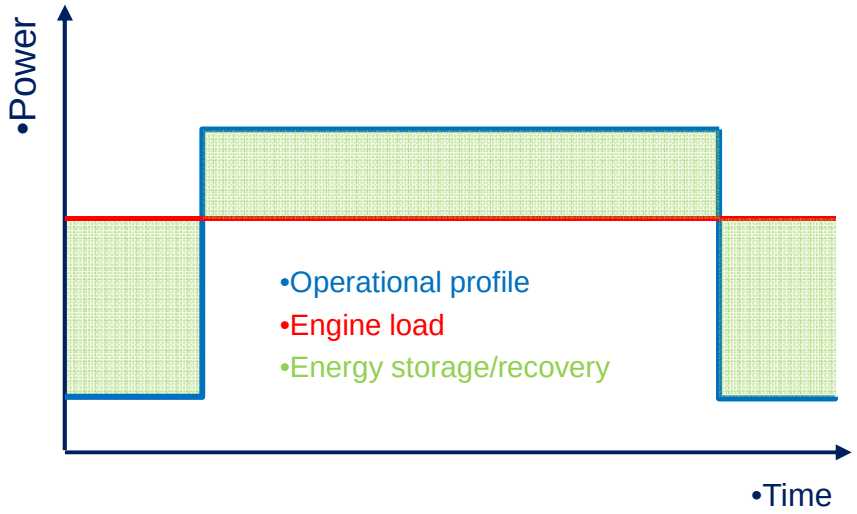
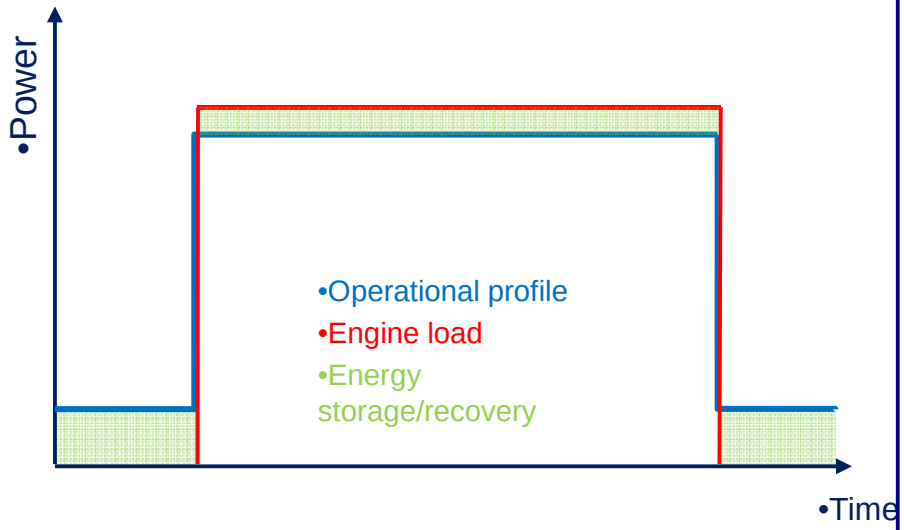
Hybrid Strategies

•Strategy 1



- Small engine = low weight & cost
- Big battery = high weight & cost
- No start-stop

•Strategy 2



- Big engine = high weight & cost = high efficiency
- Small battery = low weight & cost
- Start-stop, but engines off when power- demand is low

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Sustainability:

Environment – Shipping

One Sold, One for Stock!

Trends

- Hybridisation
- Air Lubrication
- LNG

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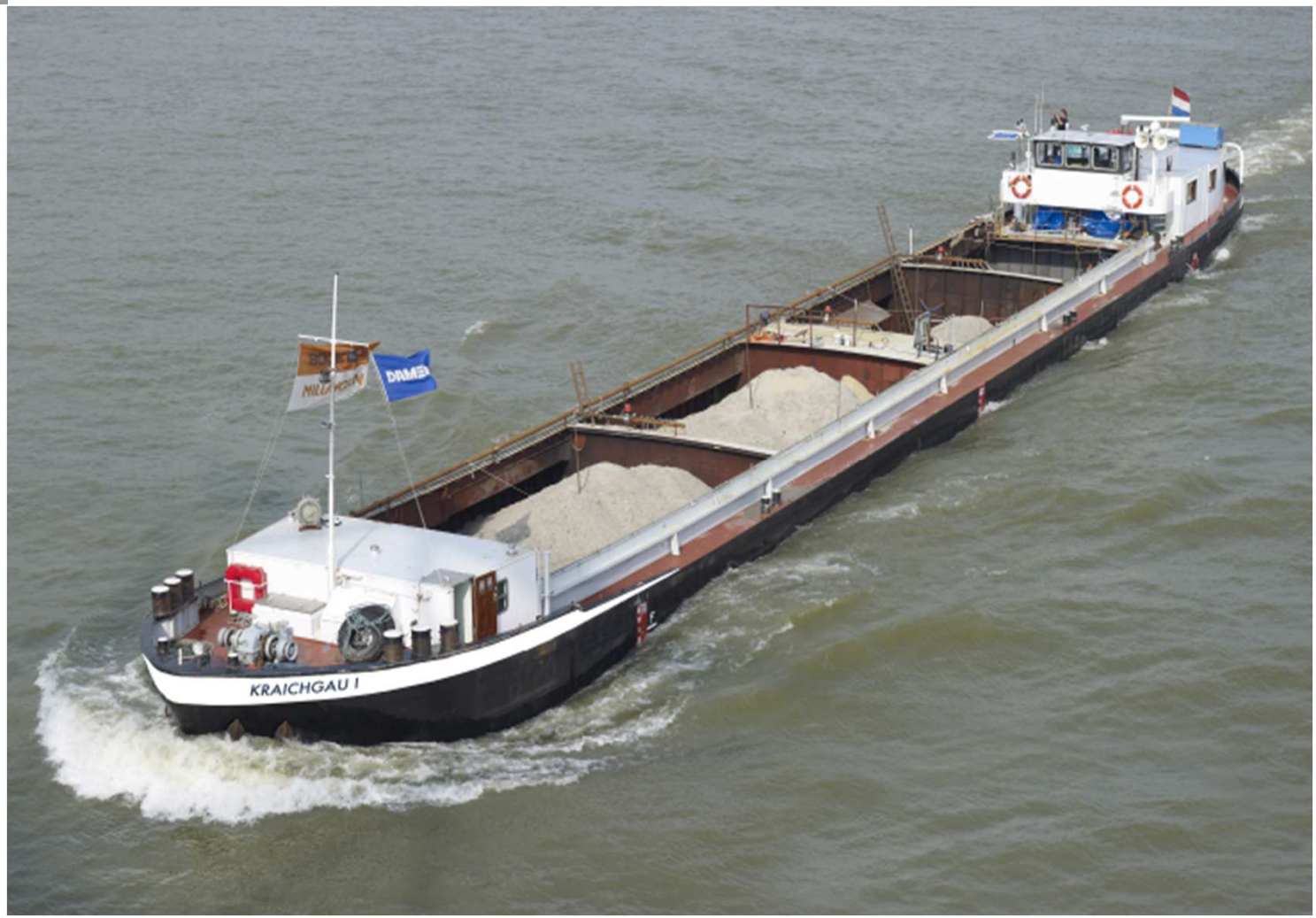
Air Lubrication



Length : 10,0 m
Speed : 21,0 km/u
Deadweight : 2,858 kW

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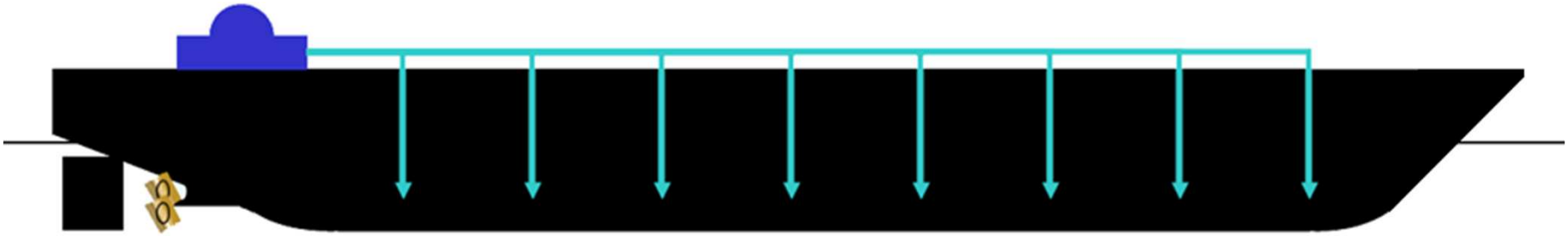
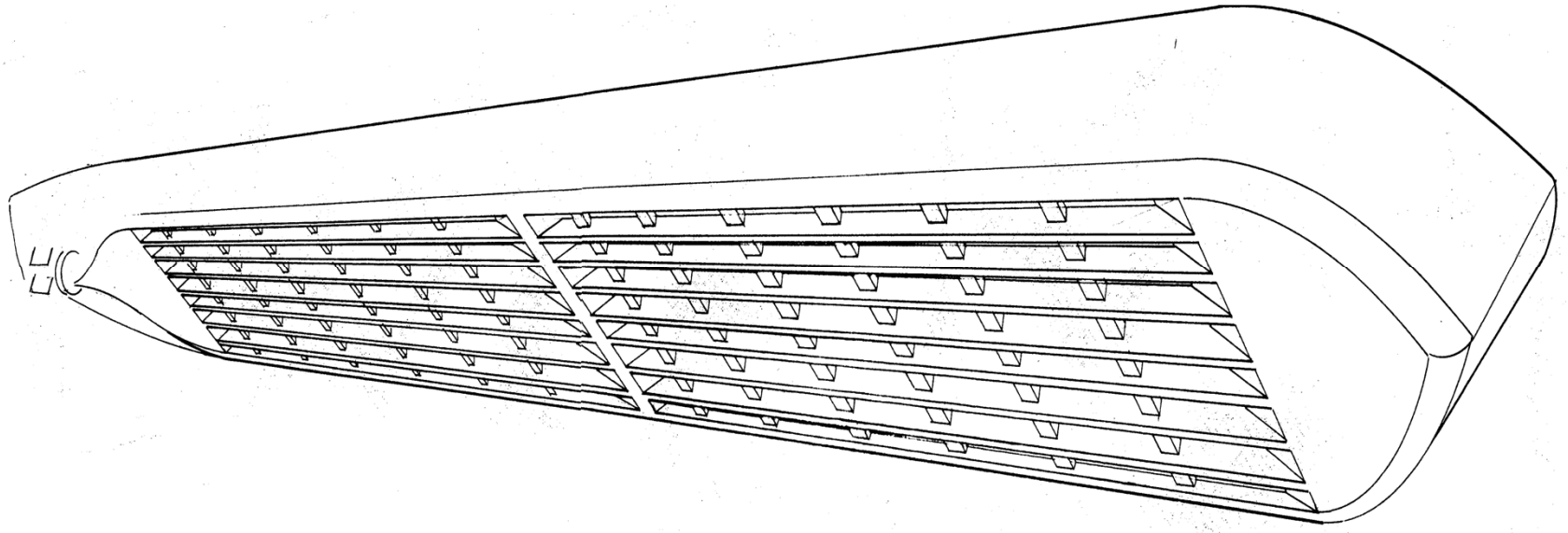
Air Lubrication: concept





DAMEN

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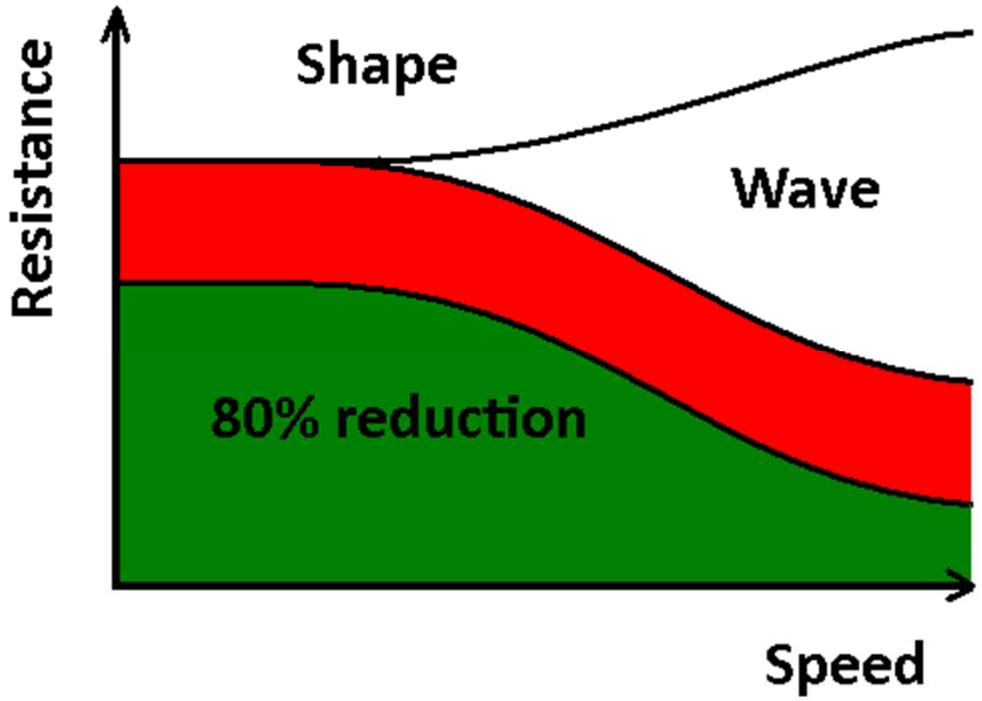
Air Lubrication: reduced friction



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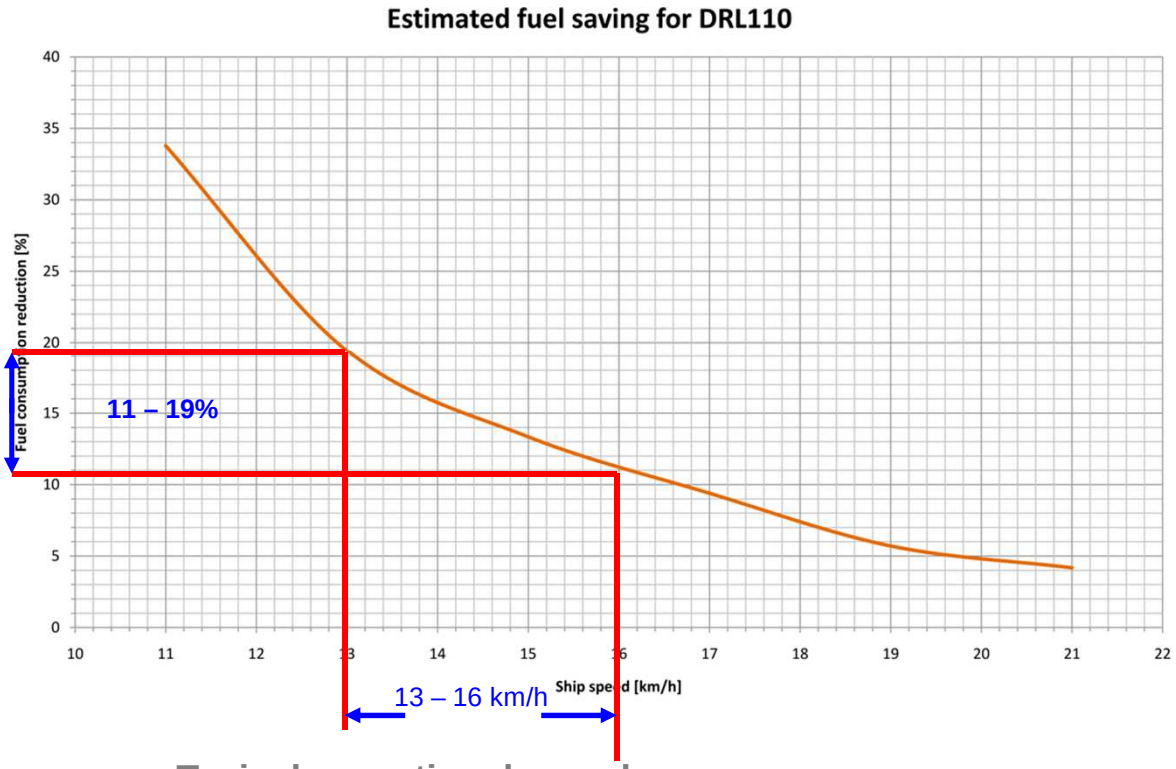
Air Lubrication: full scale

Applied to a Damen Ecoliner 110



Typical operational speed range

Length o.a.	110.00 m
Breadth moulded	11.45 m
Depth	3.65 m
Draft, design	3.55 m
Deadweight	2858 ton
Cargo hold capacity	3280 m^3
Container capacity	120 TEU
Main engine	1307 kW
Speed	21 km/hr
Airdraft	6.70 m

DAMEN

KIVI NIRIA

Ecoliner 3

Trends

- Hybridisation
- Air Lubrication
- LNG

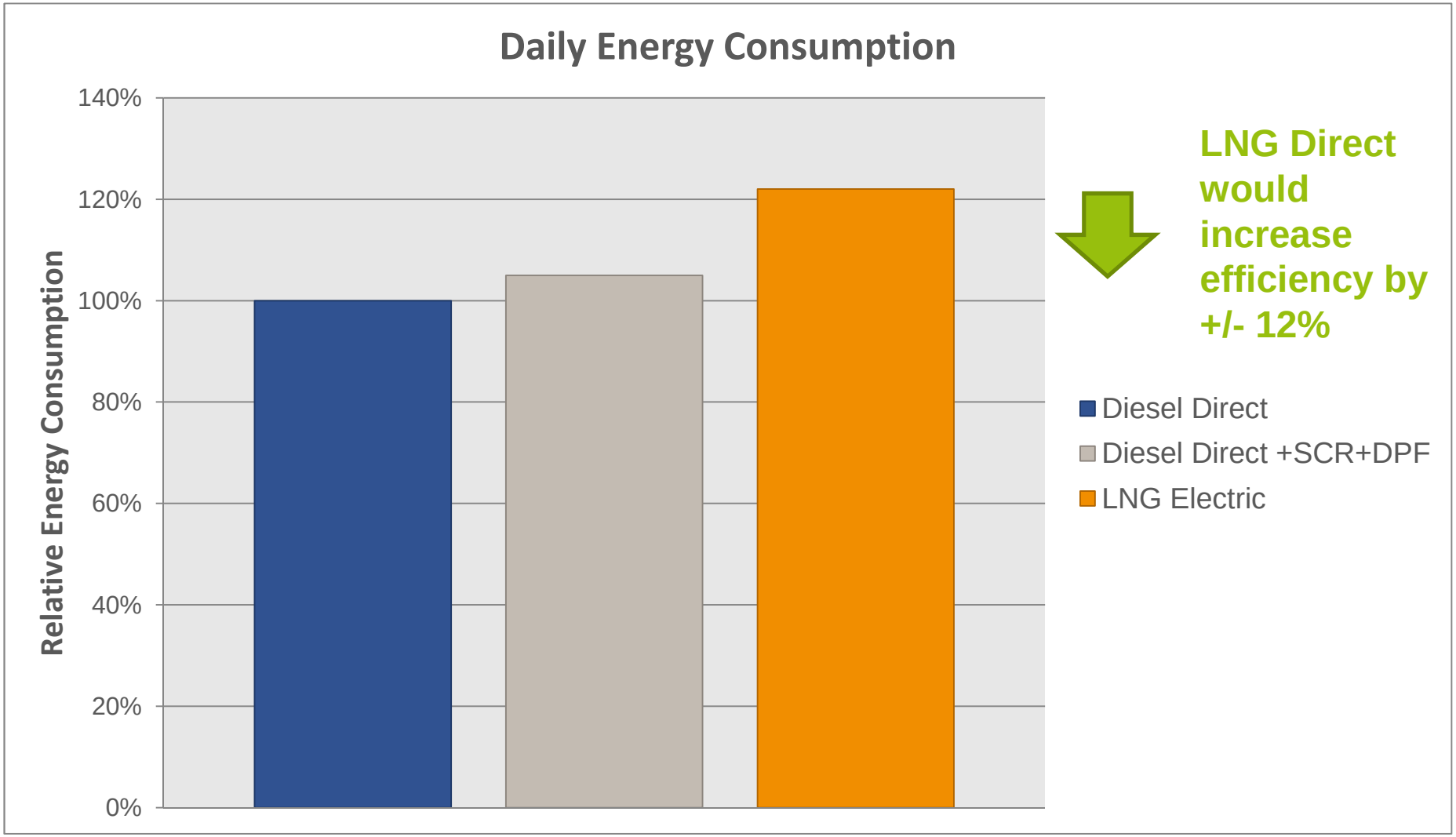
KIVI NIRIA

E3 Ferry

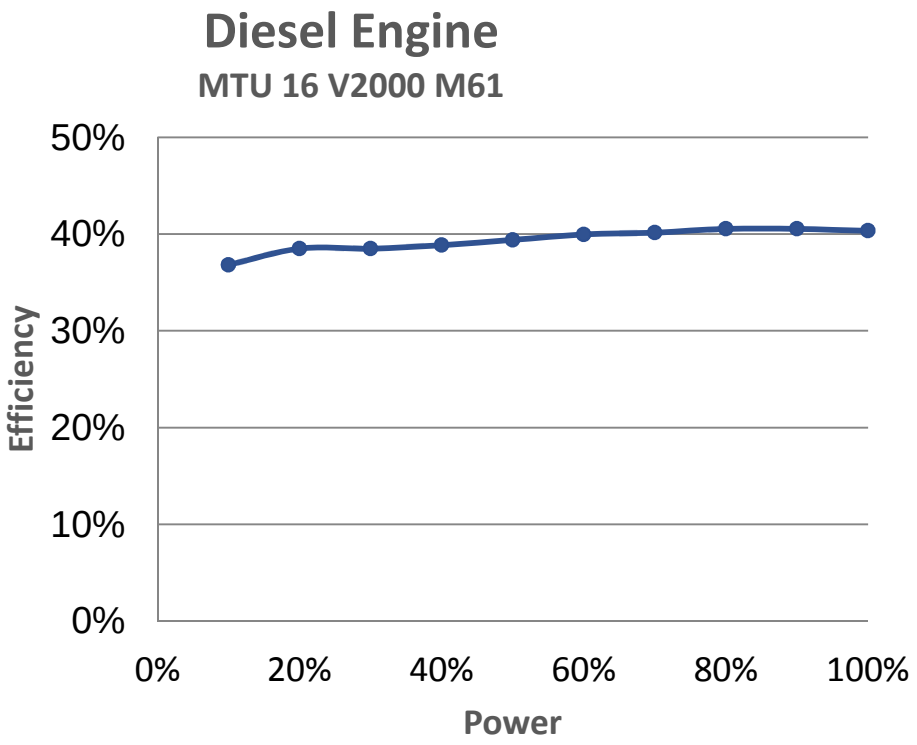
Alt. 1:
Diesel Direct + SCR + DPF

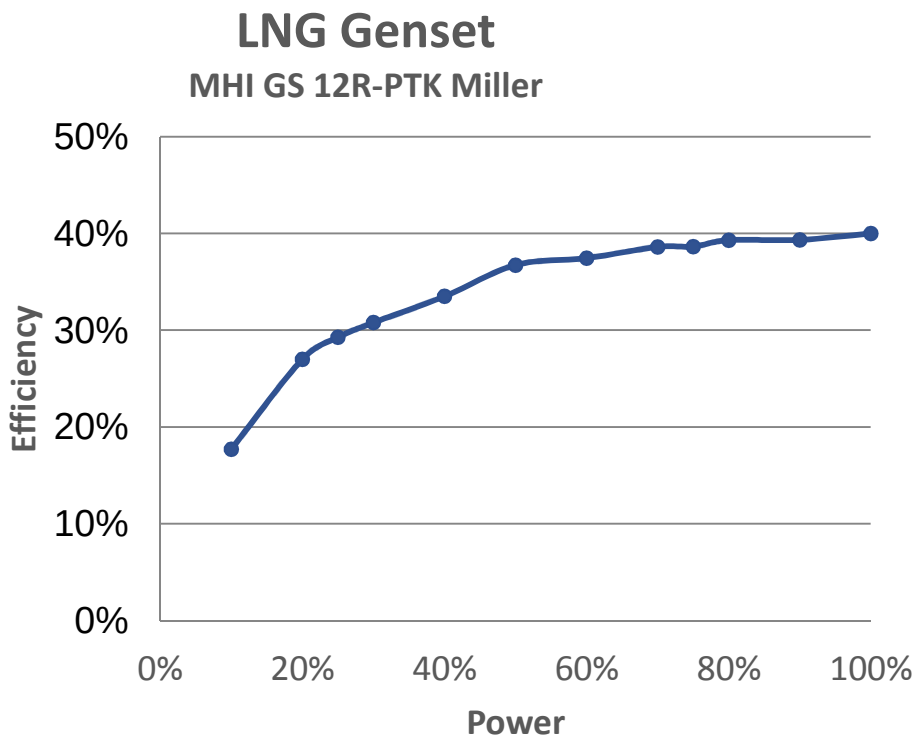
Alt. 2:
LNG - Electric

Energy Consumption Comparison



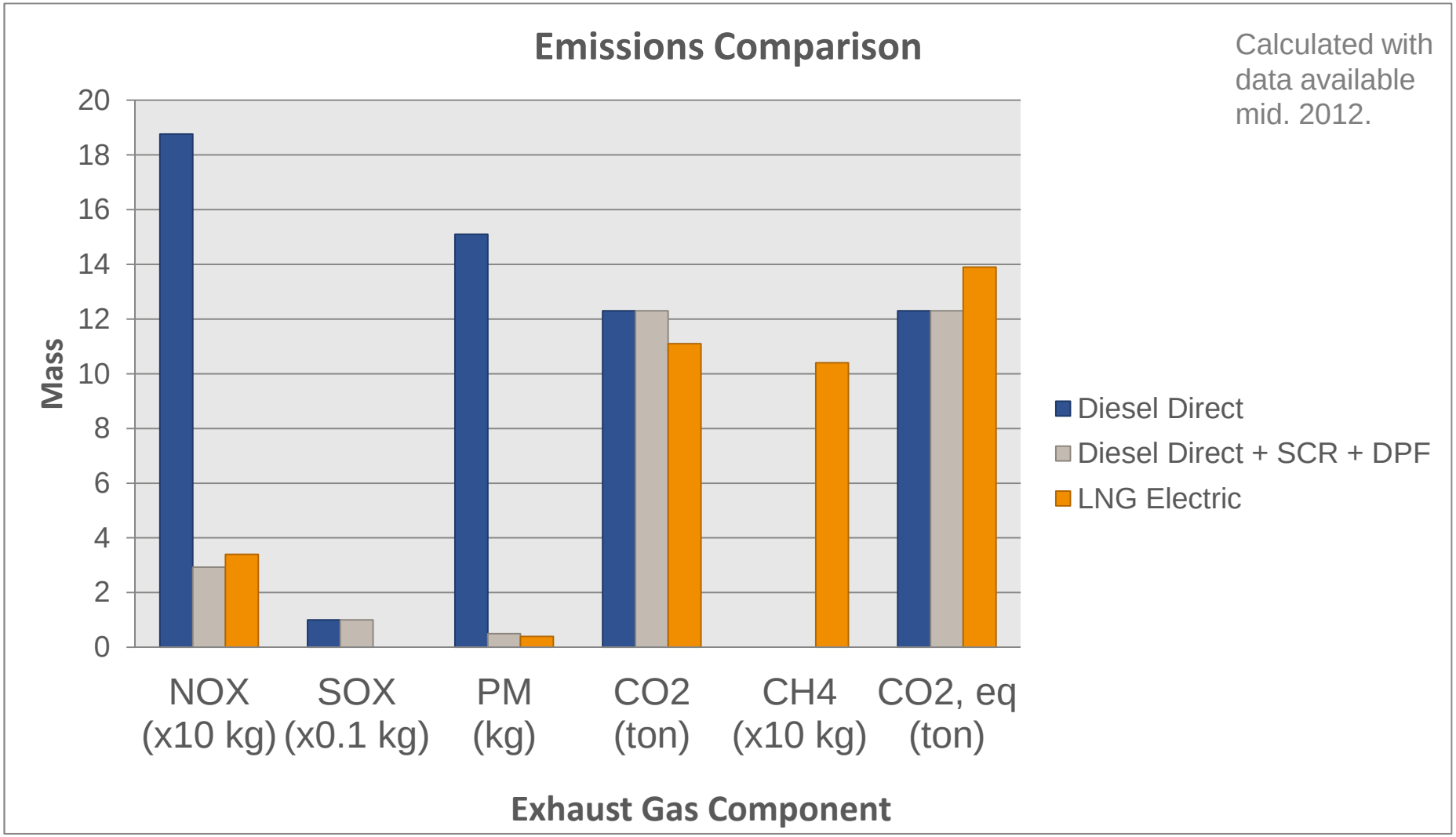
LNG Genset vs Diesel Engine Efficiency



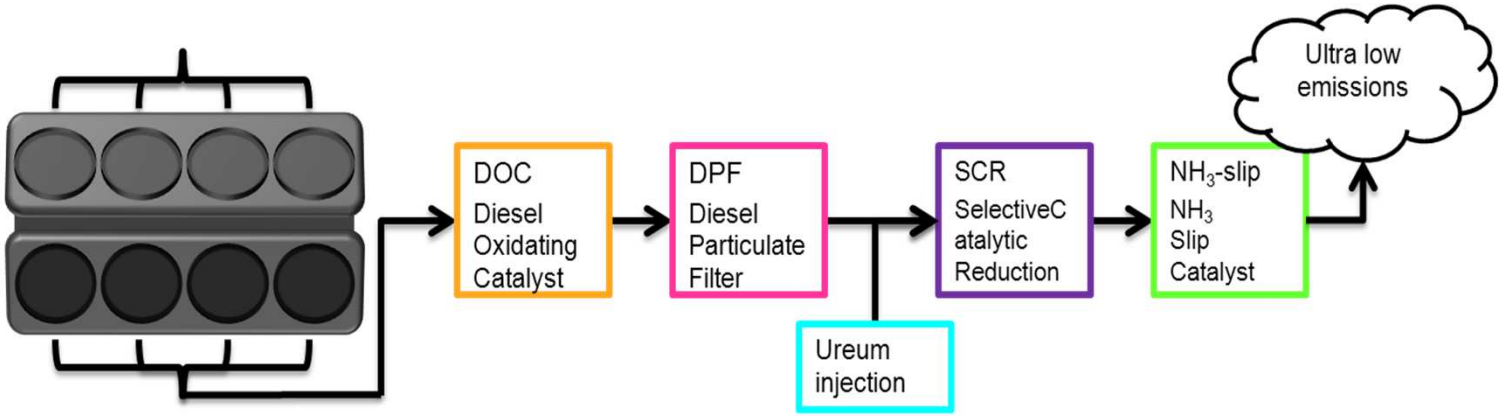


No LNG engines available for Gas-Direct at the time of this project (mid. 2012)

Emissions comparison

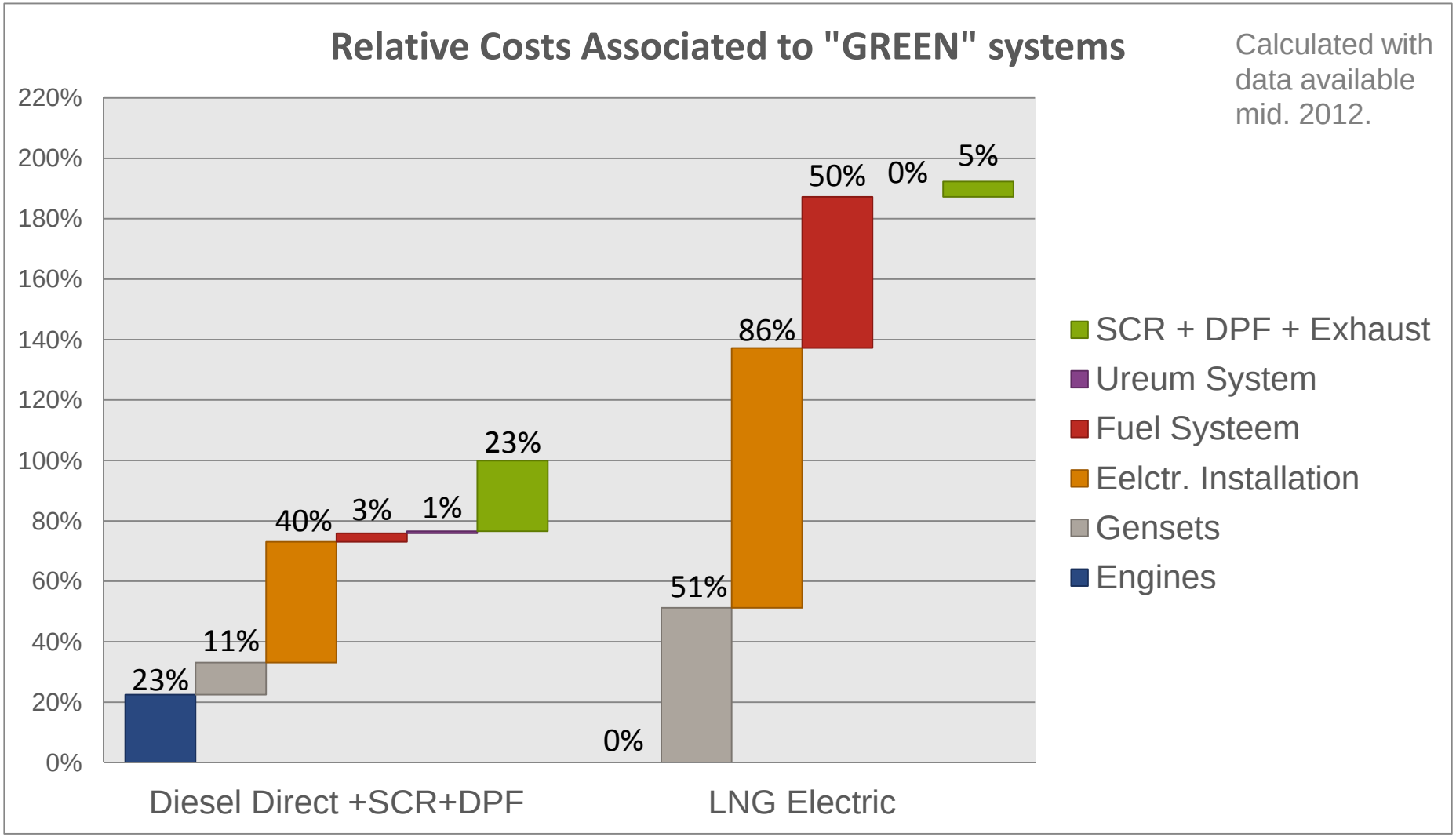


Exhaust Gas Aftertreatment

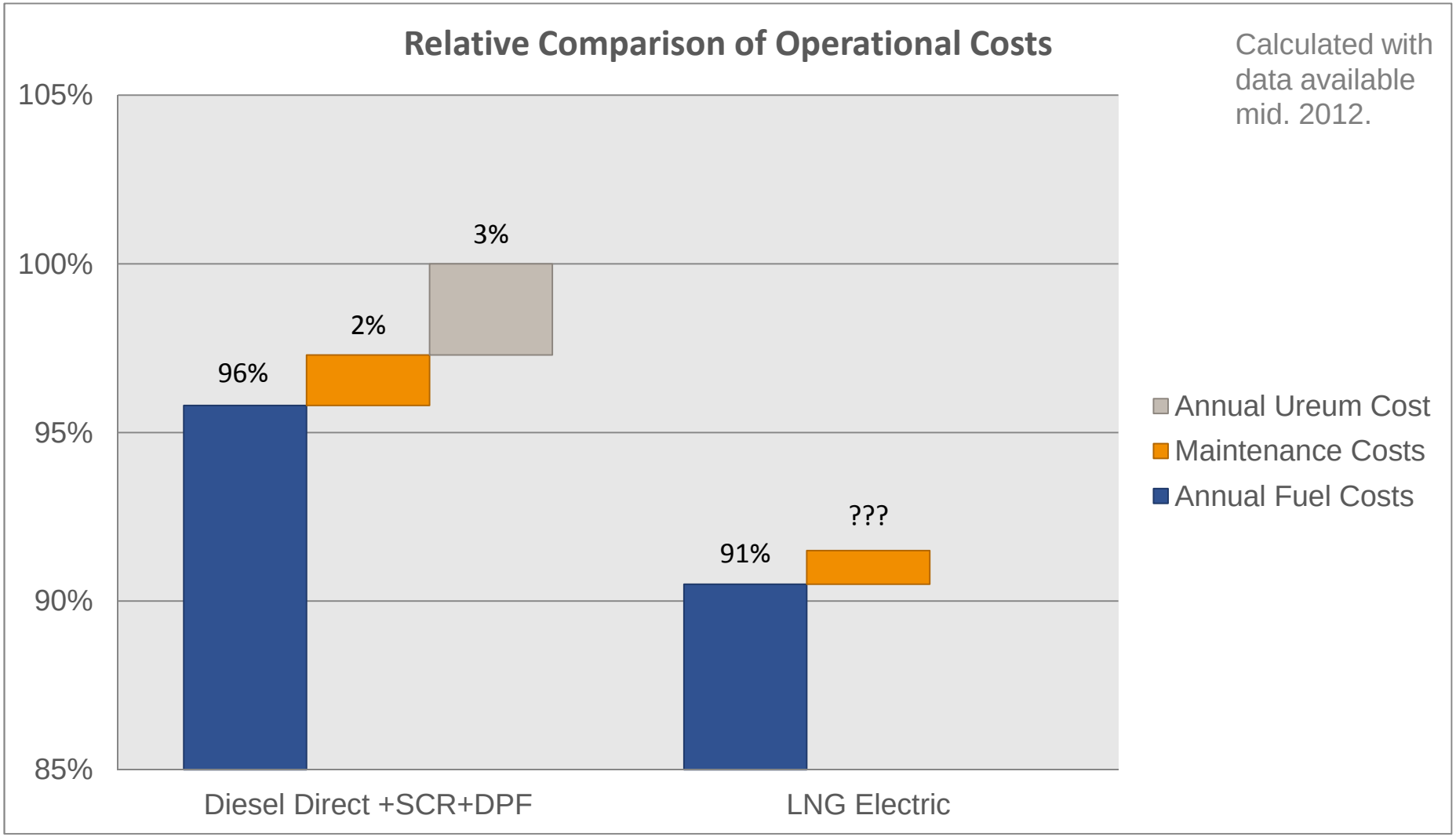


NO_2 formation:	$NO + O_2 \longrightarrow NO_2$
PM reduction:	$C + HC + O_2 \longrightarrow CO_2 + H_2O$
NH_3 generation:	$[NH_2]_2CO + H_2O \longrightarrow N_2 + CO_2$
NO_X reduction:	$NO + NO_2 + NH_3 \longrightarrow N_2 + H_2O$
NH_3 slip elimination:	$NH_3 + O_2 \longrightarrow N_2 + H_2O$

Relative CAPEX comparison



Relative OPEX comparison



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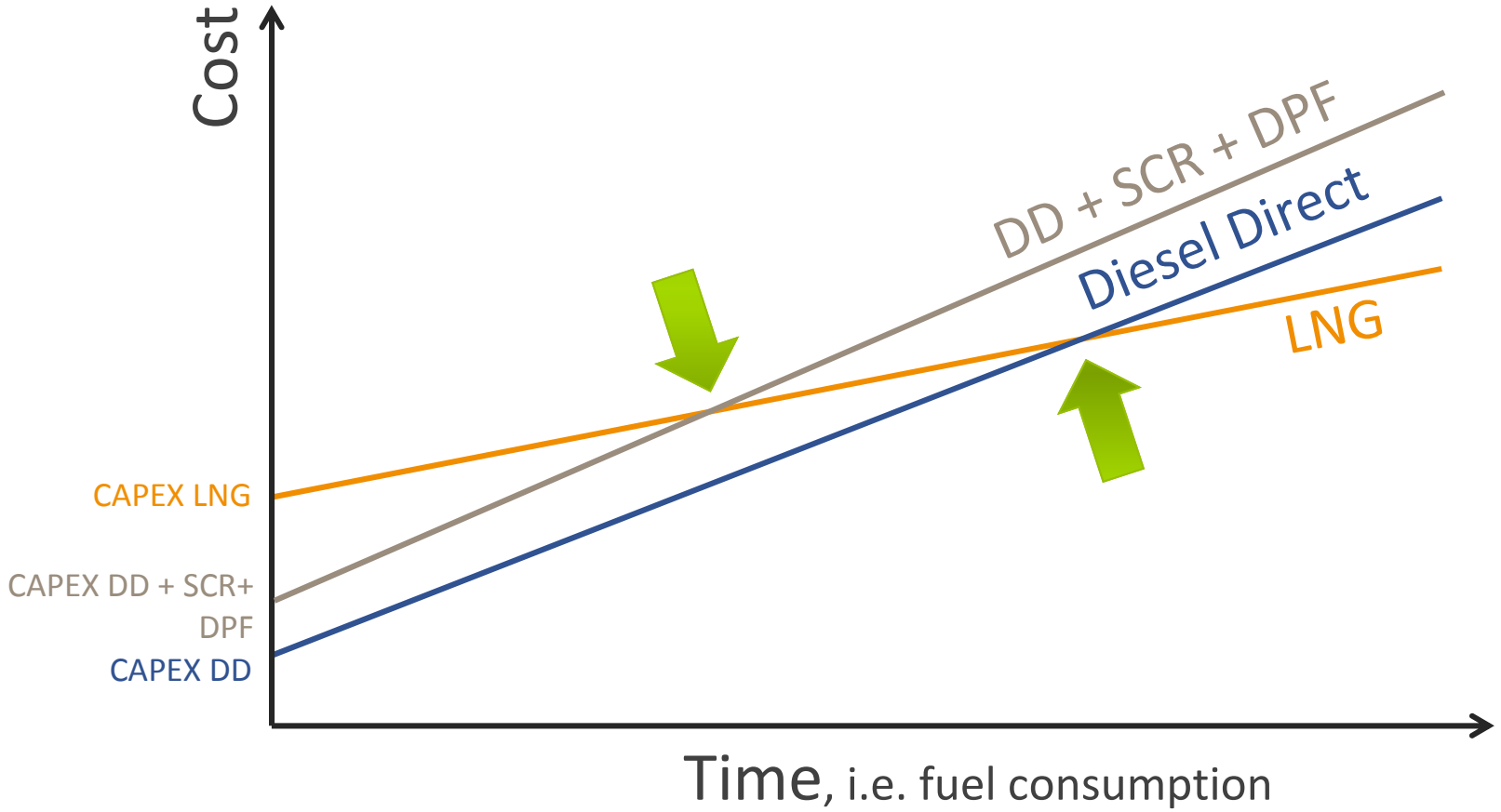
Life Cycle Cost



Three parameters influence the economical feasability:

(1) Add. investment cost LNG system, (2) Price difference LNG and fuel oil, (3) Operational profile of the vessel.


... It is not easy being green...