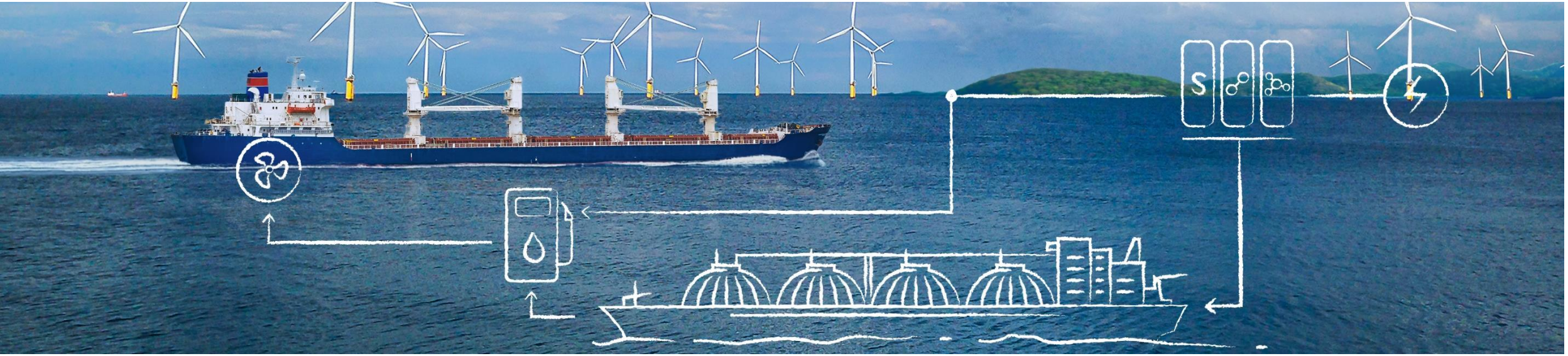
DNV·GL



MARITIME

Alternative fuels and Innovative Technologies

Workshop "Alternative Kraftstoffe II" LEER

Malte Zeretzke

07.November 2018

DNV GL ©

AGENDA

- DRIVERS
- OPTIONS
- CONSEQUENCES
- CONCLUSIONS

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- DRIVERS
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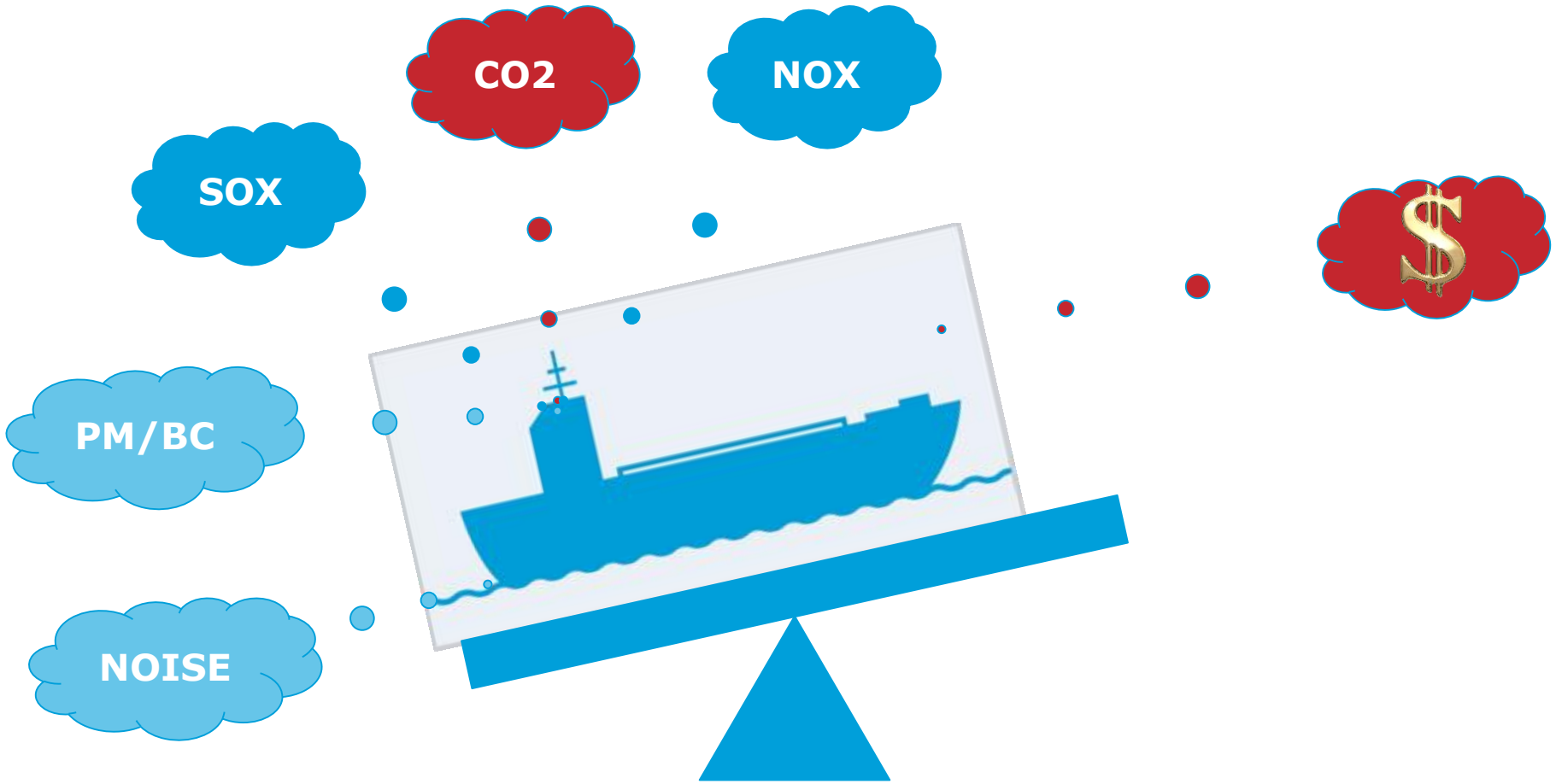
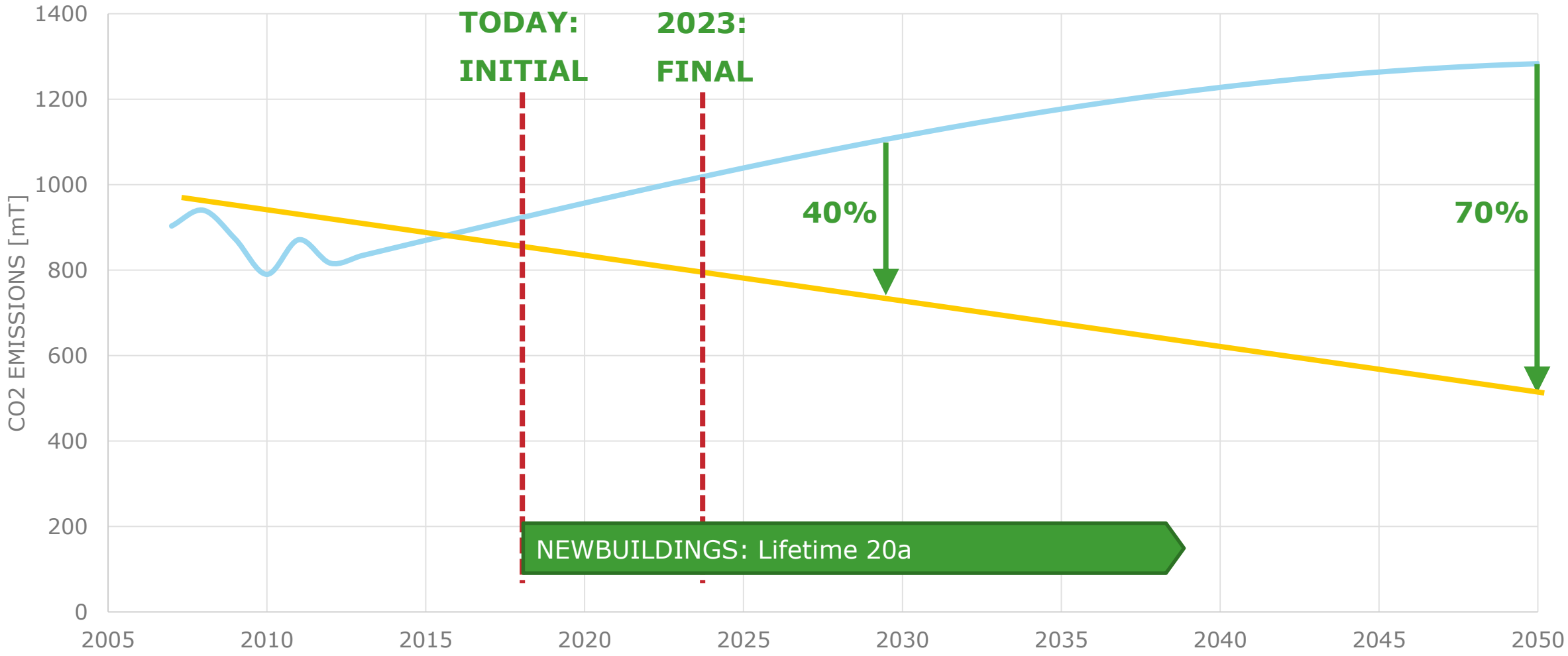
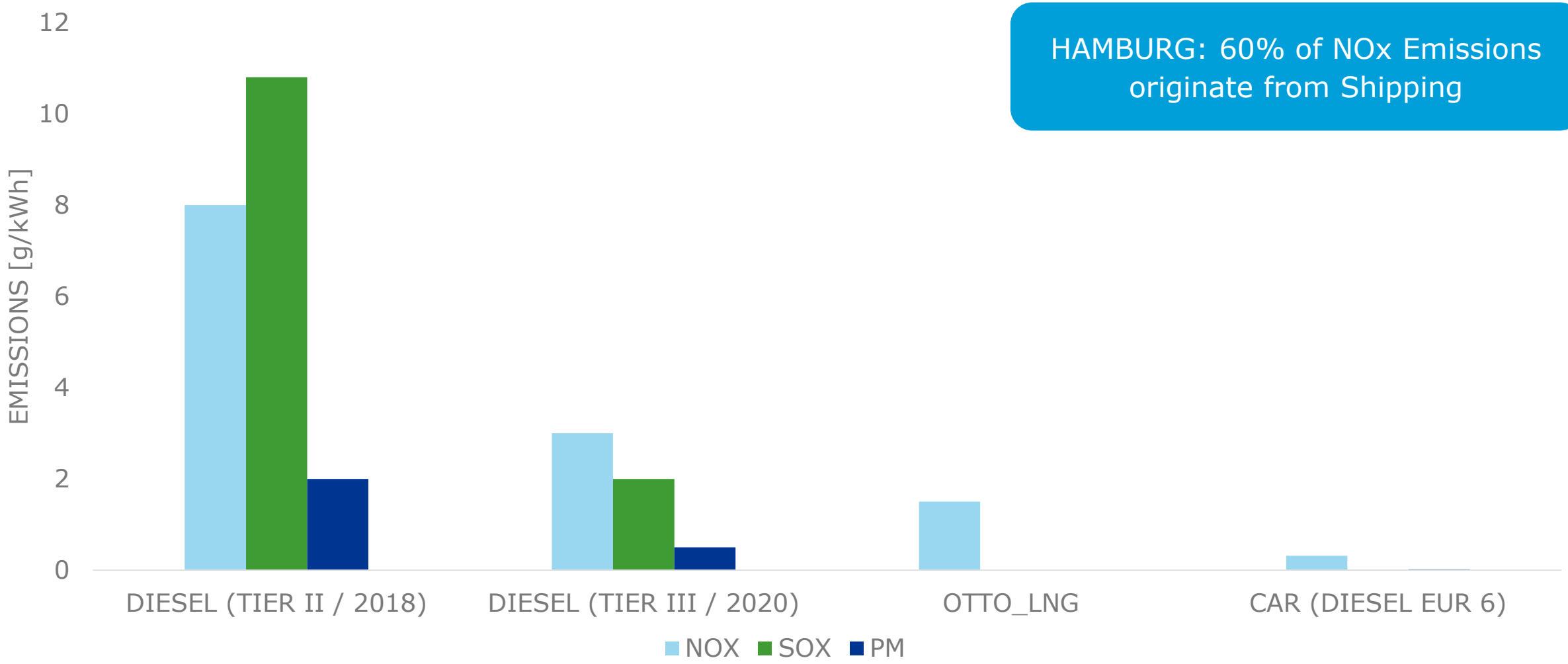
MOTIVATION FOR ALTERNATIVE FUELS AND INNOVATIVE TECHNOLOGY



CO2: IMO GHG STRATEGY IN SHORT



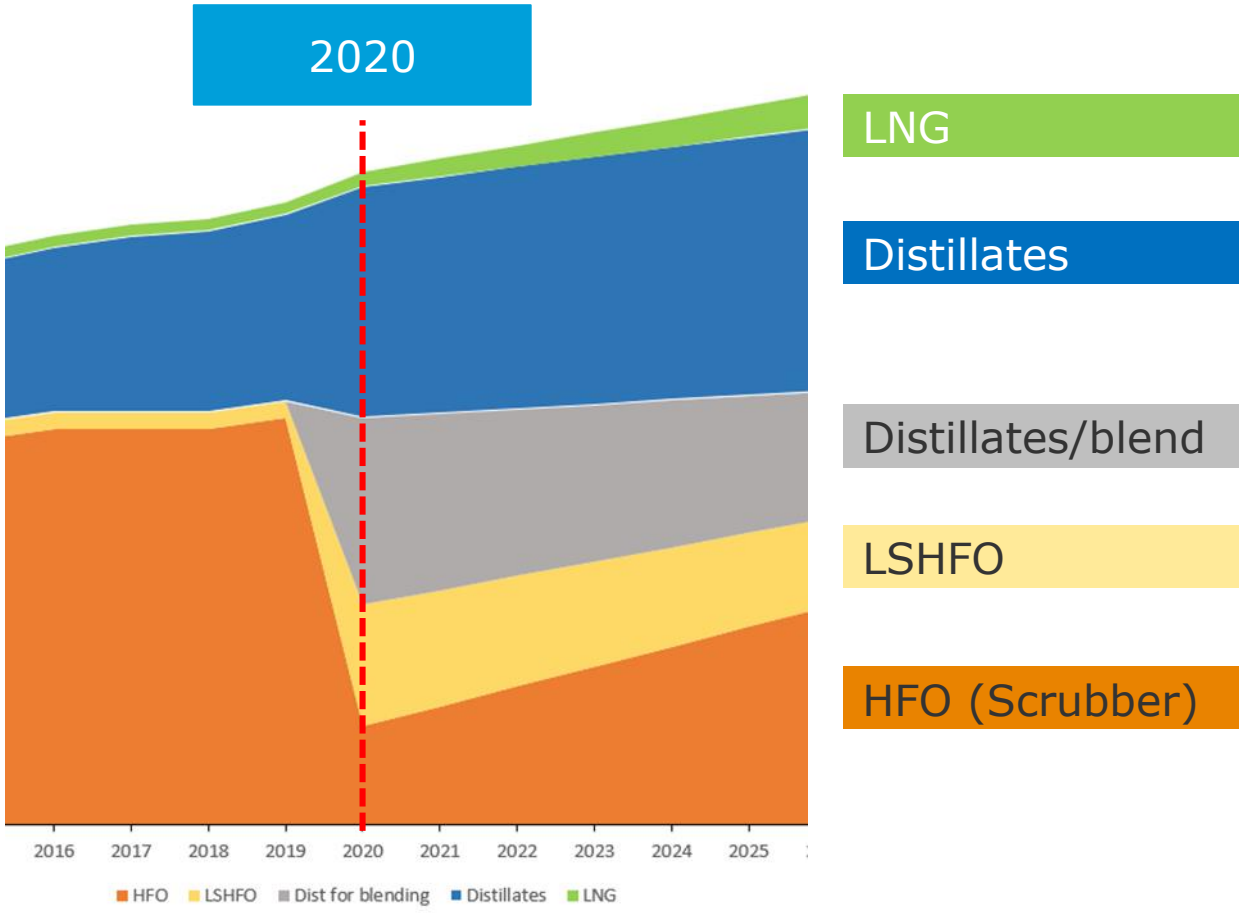
NOx: TODAY KNOWN LIMITS WILL NOT BE THE FINAL ONES



HAMBURG: 60% of NOx Emissions originate from Shipping

SO2: THE 2020 0.5% S WILL HAVE AN EFFECT ON THE MARKET

- High S HFO will drop dramatically
- LNG will not play a major role
- Distillates and LSHFO will take the role of high sulphur HFO
- Uncertain: Development beyond 2020
- Certain: Average bunker costs will increase!
- Allows alternative technologies/fuels to enter the stage



One possible global bunker demand

SOURCE: PIRA Energy.

Demand for high sulphur fuel oil is expected to take a big dive in 2020 with the new IMO sulphur cap.

AGENDA

DRIVERS

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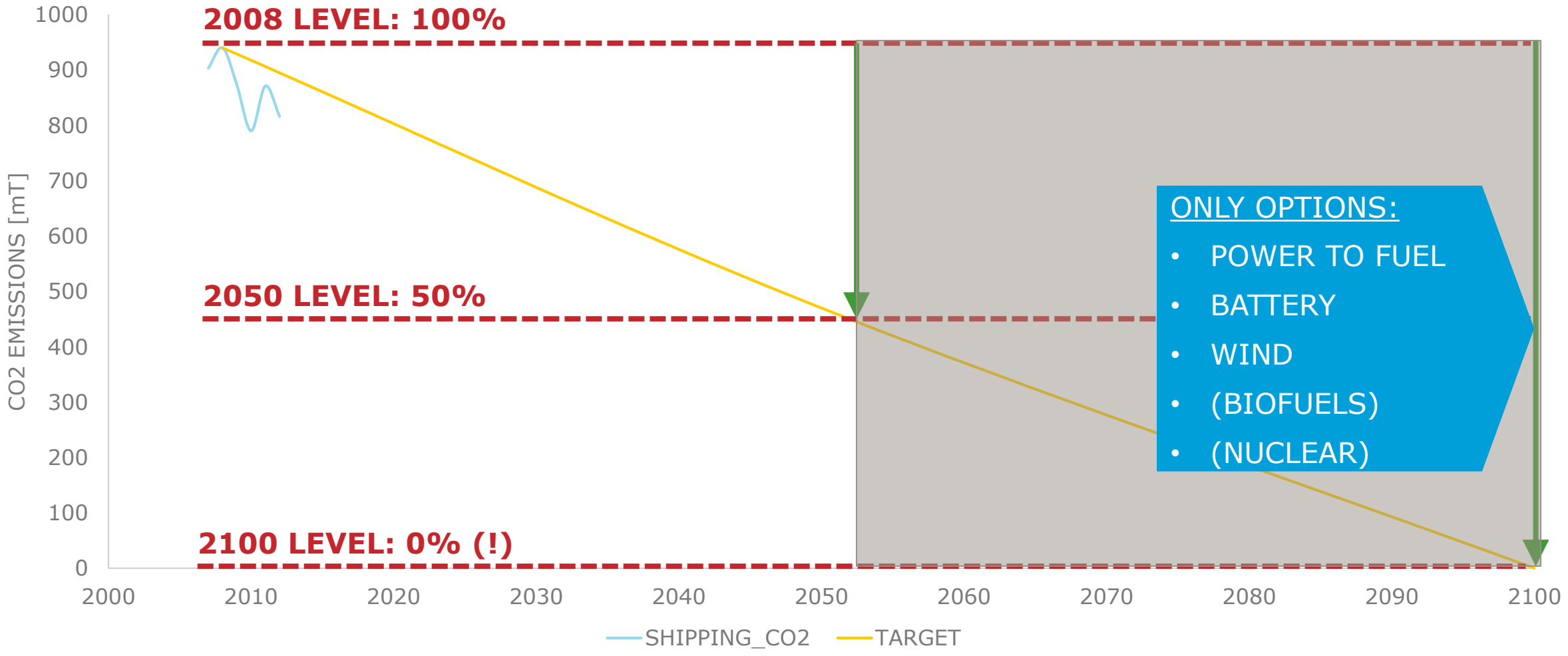
IMO TARGET: PHASE OUT CO2 EMISSIONS IN THIS CENTURY



FUTURE OPTIONS: 4 ACES IN THE GAME

2030 TARGETS: 40%

2050 TARGETS: 70%

LOGISTICS & DIGITALIZATION

- Speed reduction
- Vessel utilization
- Vessel size
- Alternative routes

ca. 20%

HYDRODYNAMICS

- Retrofit (existing)
- Optimize (new)
- Air lubrication
- Cleaning

ca. 15%

MACHINERY

- Machinery improvements
- Waste heat
- Technology

0-100%

ENERGY SOURCES AND CARRIERS

- LNG
- Biofuel
- Power to Fuel
- Wind
- Nuclear

0-100%

TECHNOLOGY AND ENERGY CARRIERES (REASONABLE FOR DEEP SEA)

MACHINERY

- Diesel engines
- Otto engines
- Turbines

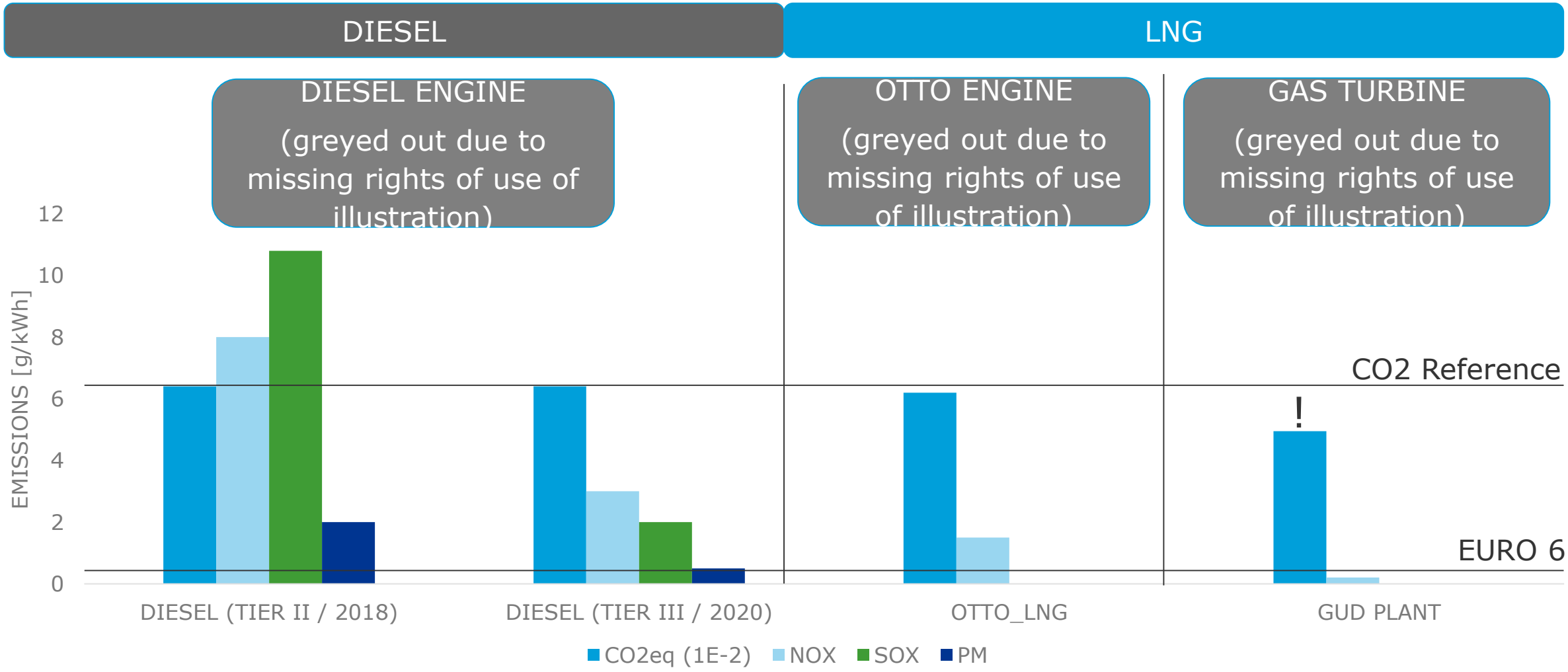
- Fuel cells -> Infancy
- Batteries -> Short Sea Shipping
- Sails -> Potential for slow ships, difficult

ENERGY SOURCES AND CARRIERS

- Diesel
- Natural Gas (LNG or Methanol)
- LPG
- Bio: Diesel / Methanol / Gas
- PTF: Methanol / LG / Diesel / H2

- ~~Electricity~~
- Wind
- ~~Nuclear~~

EMISSION LEVELS OF COMBUSTION ENGINES



TECHNOLOGY AND ENERGY CARRIERES (REASONABLE FOR DEEP SEA)

MACHINERY

- Diesel engines
- Otto engines
- Turbines

- Fuel cells -> Infancy
- Batteries -> Only Short Sea Shipping
- Sails -> Potential for slow ships, difficult

ENERGY SOURCES AND CARRIERS

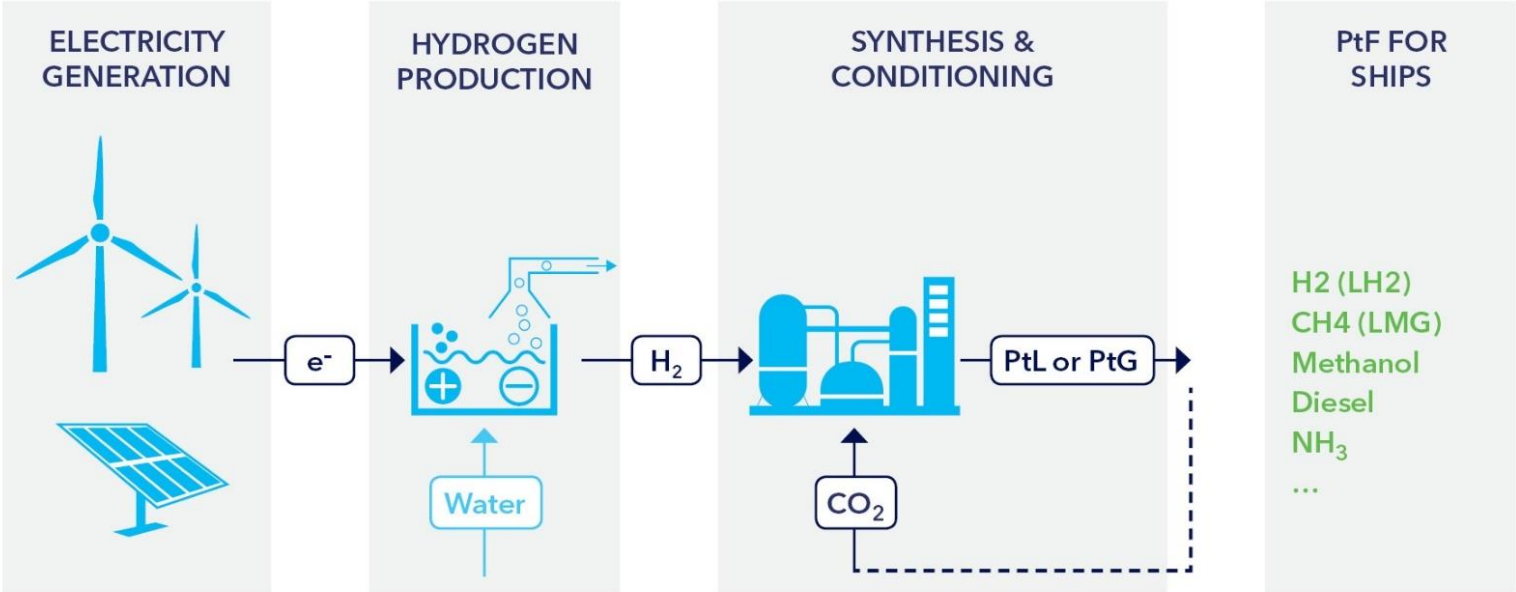
- Diesel
- Natural Gas (LNG or Methanol)
- LPG
- ~~Bio: Diesel / Methanol / Gas~~
- PTF: Methanol / LG / Diesel / H2

- ~~Electricity~~
- Wind
- ~~Nuclear~~

PRODUCTION PATHWAYS OF POWER TO FUEL

PRINCIPLE PRODUCTION PATHWAY

Power to Liquid (PtL), Power to Gas (PtG) = Power to Fuel (PtF)



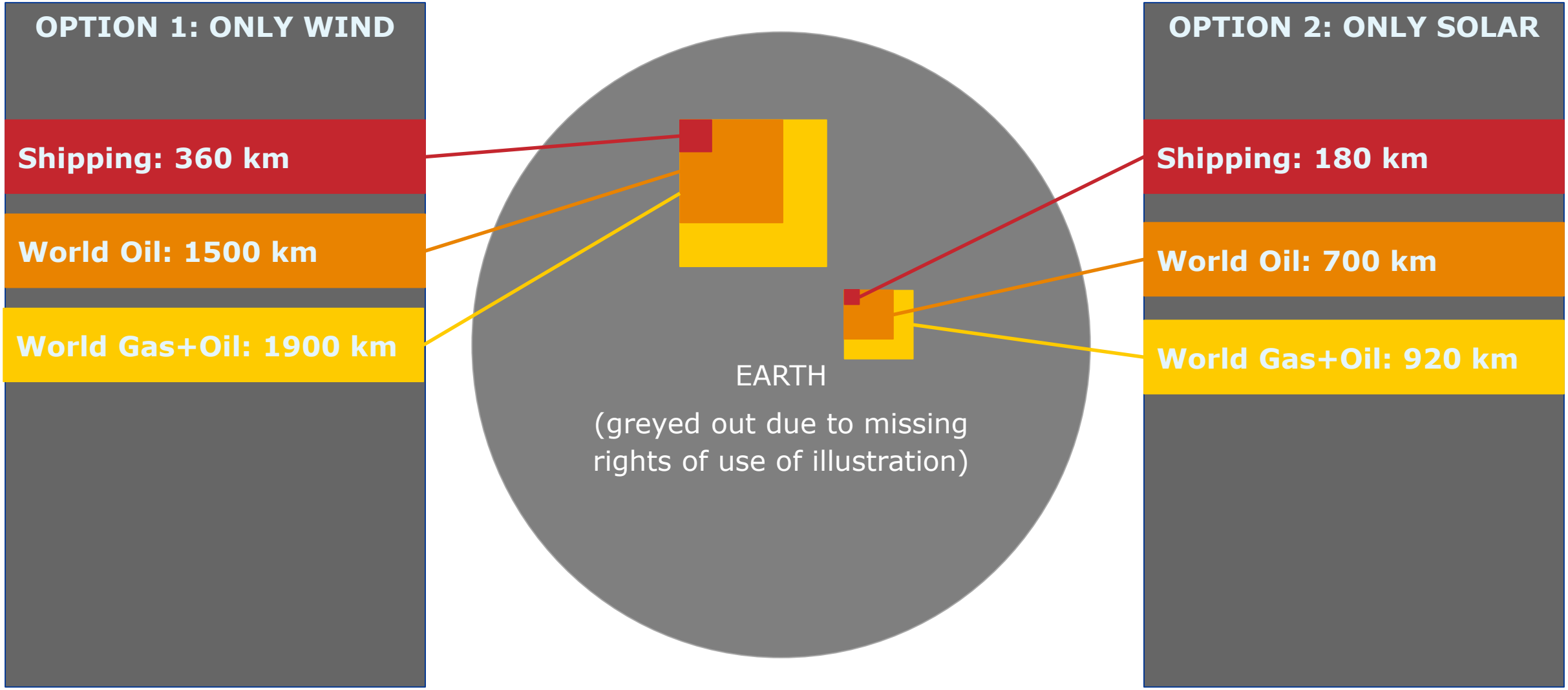
PTX	Electrolysis	PTG process	Liquefaction	PTL process	Production
CH4	71%	75%	96%	x	51%
Diesel	71%	x	x	75%	53%
Methanol	71%	x	x	75%	53%
H2	71%	x	83%	x	59%

GRAPHIC

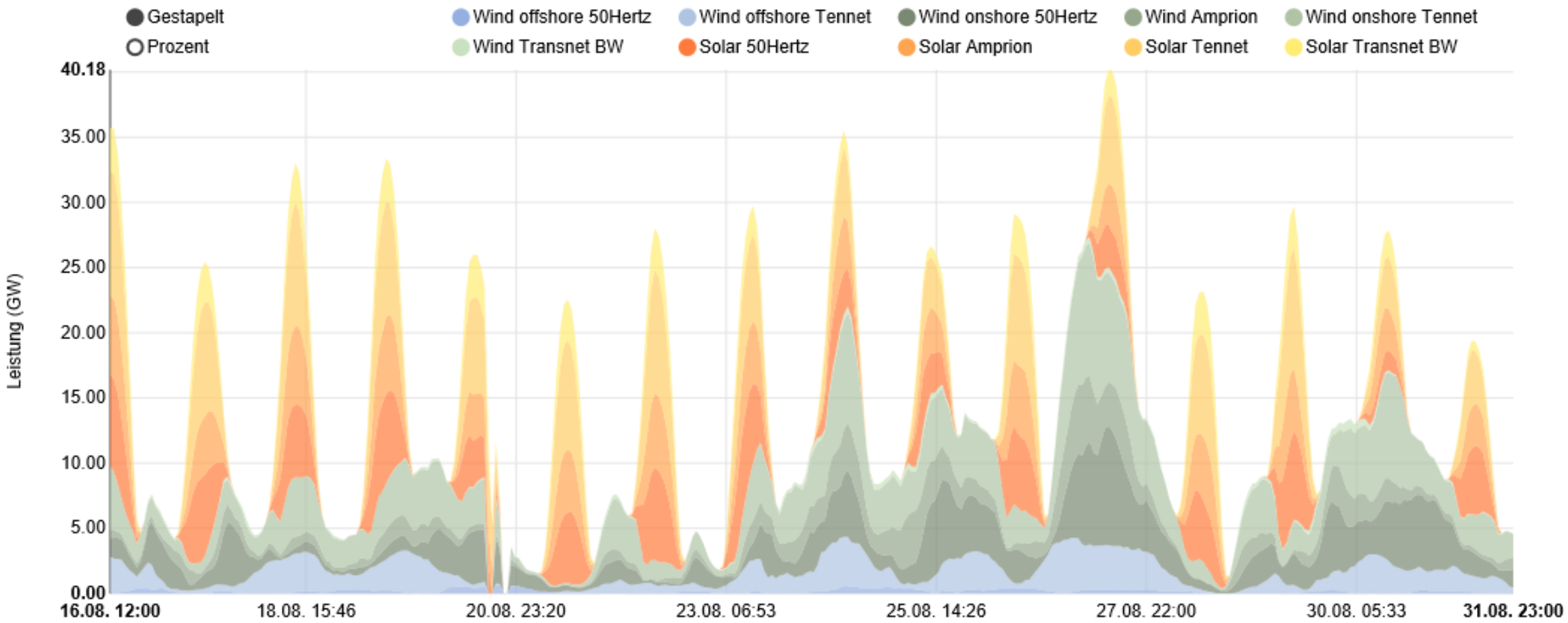
(greyed out due to missing rights of use of illustration)

1. Is it feasible?
2. Does it make sense?
3. Is it economical?

FEASIBLE?
SURFACE AREA DEMAND TO MEET GLOBAL FOSSIL FUEL DEMAND BY PTX



DOES IT MAKE SENSE?
FLUCTUATION OF POWER OF RENEWEABLE ENERGY SOURCES

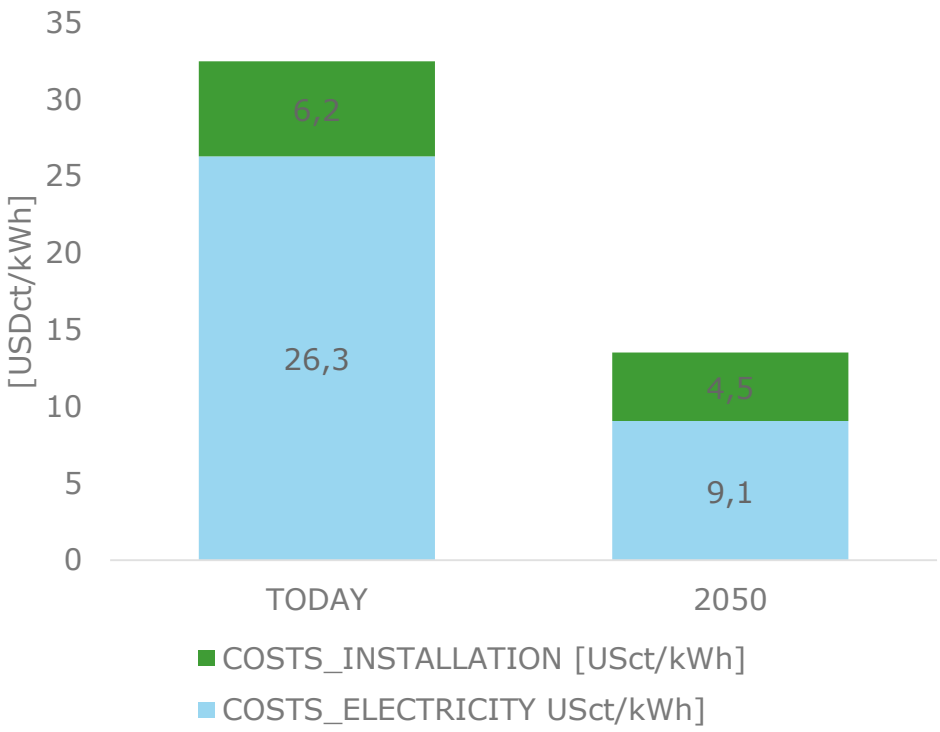


SOURCE: ISE Fraunhofer www.energy-charts.de

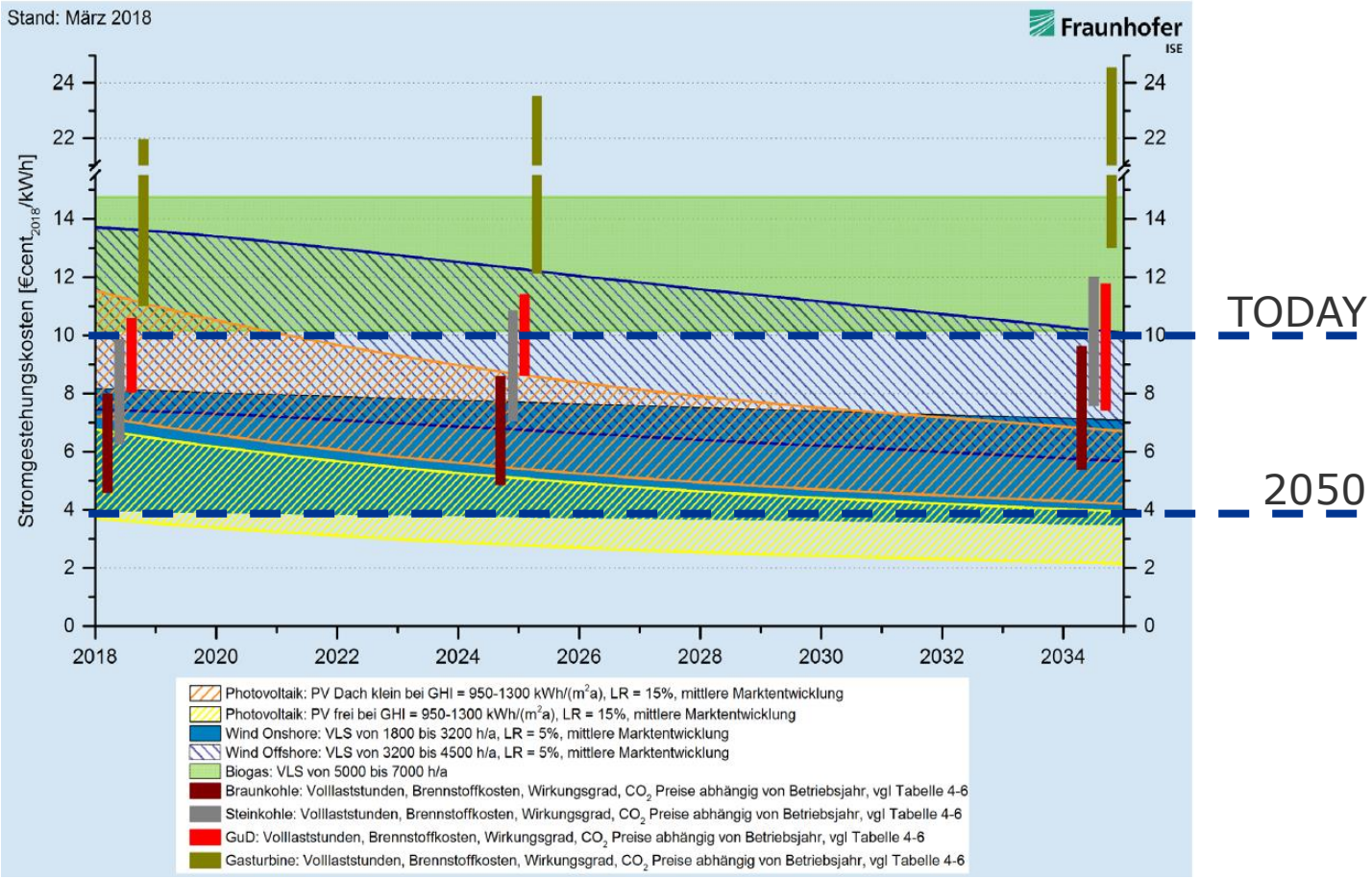
IS IT ECONOMICAL?
COSTS OF PTF (EXAMPLE DIESEL // CONCENTRATED SOURCE)

ELECTRICITY: 10 EURct/kWh

ELECTRICITY: 4 EURct/kWh



Based on CIT,2018 [LBST]

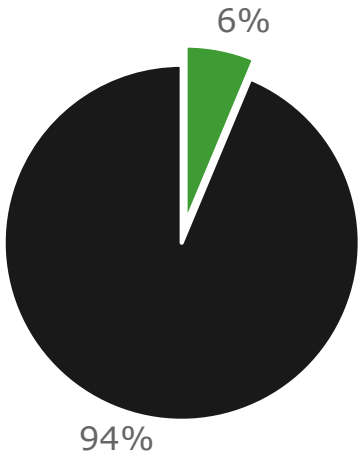


SOURCE: Fraunhofer ISE, March 2018

WILL PTF TAKE UP?

Desert + PV Plant

(greyed out due to missing rights of use of illustration)



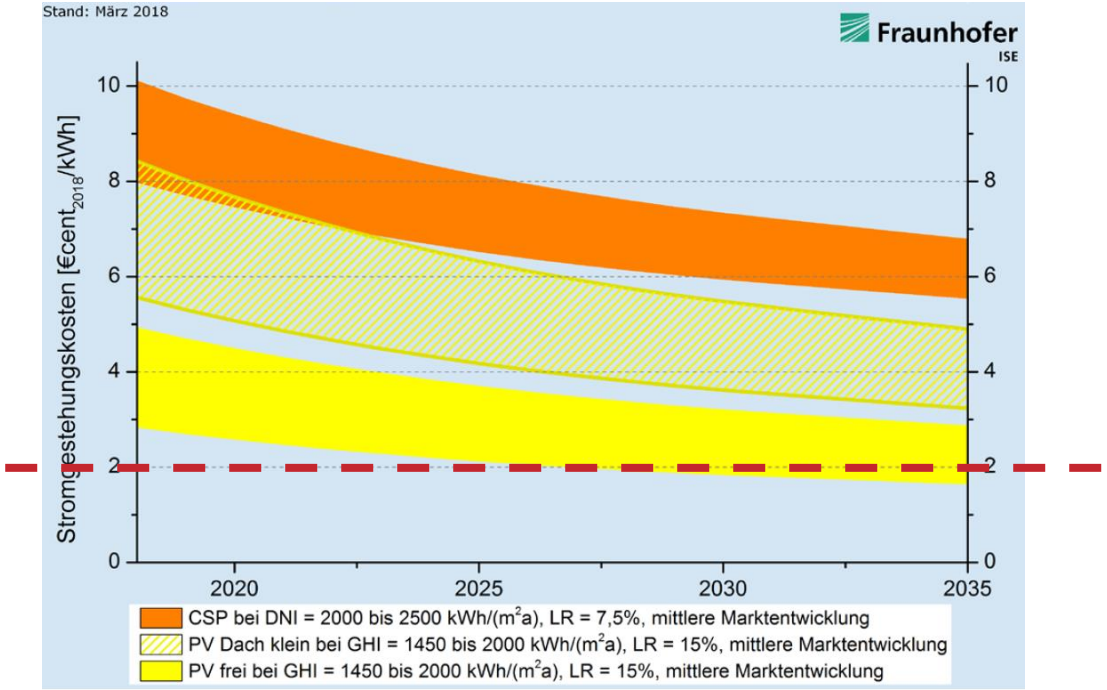
COVERAGE OF SHIPPING FUEL DEMAND

- PRODUCTION_PLANT
- FOSSIL_REMAINING

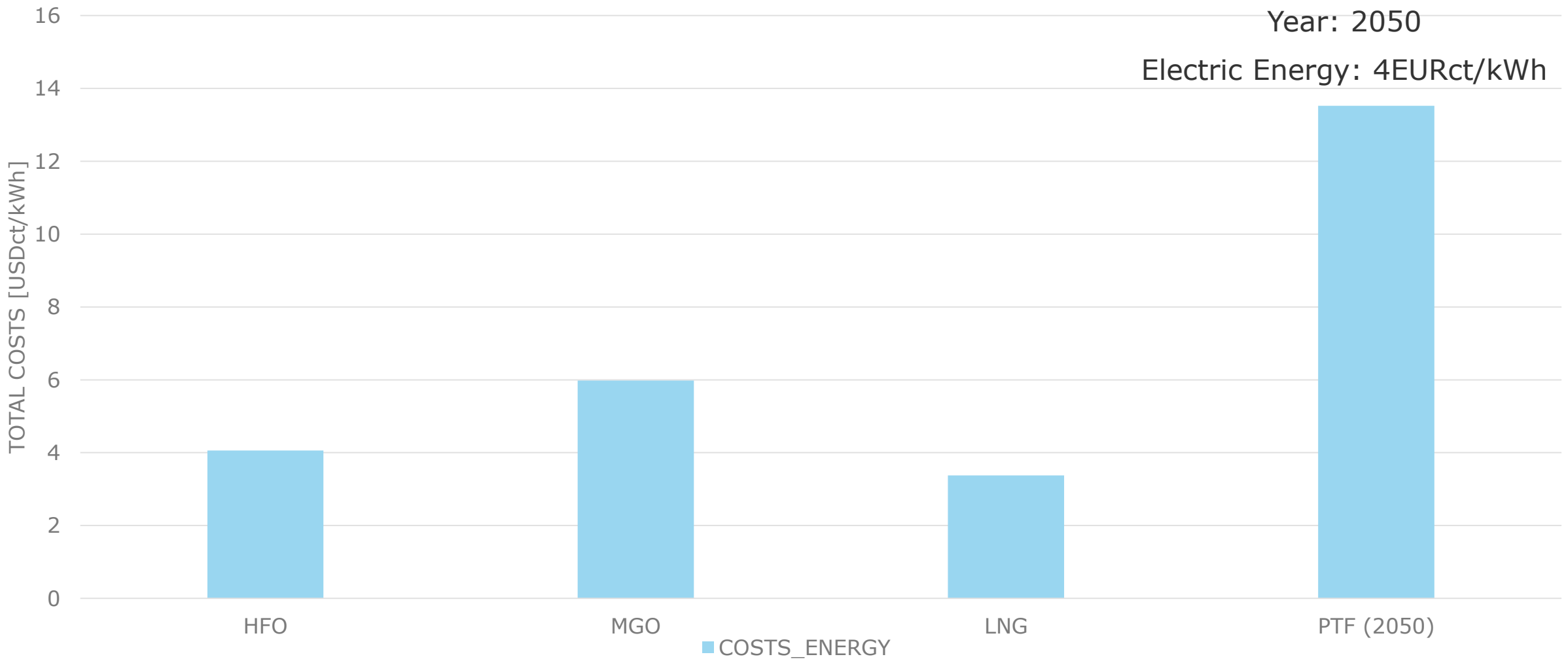
March 2018:

Saudi Arabia signed a MOU with Japanese Banks to build a **200GW** solar power plant (200bnUSD)

Expected electricity costs: **2.5 USDct/kWh**



TOTAL COSTS OF FUELS



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ALTERNATIVE PERSPECTIVE: SOCIO-ECONOMIC COSTS OF CO2

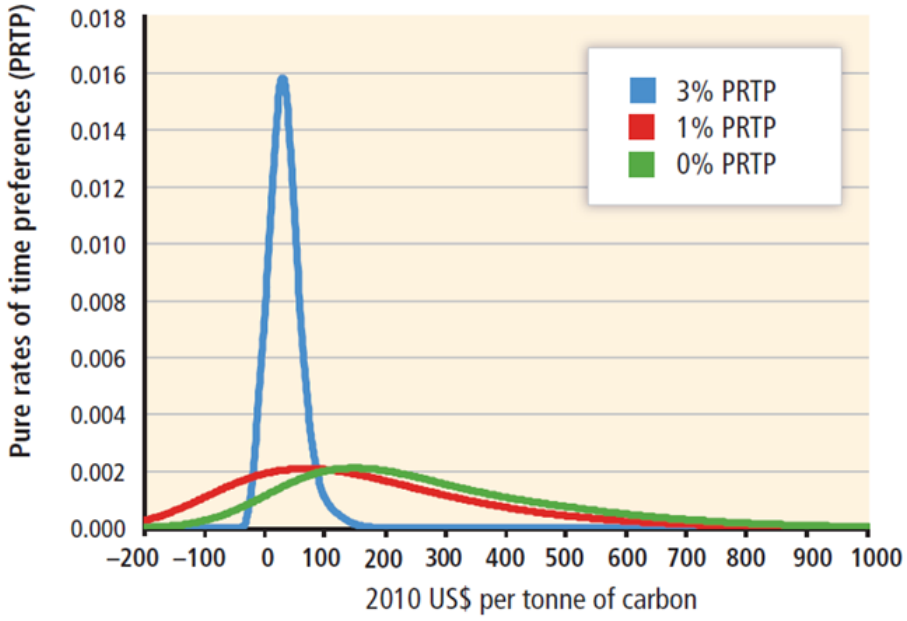
Photos – consequences of global warming

(greyed out due to missing rights of use of illustration)

UBA-Empfehlung zu den Klimakosten

Klimakosten in $Euro_{2010}$ pro Tonne Kohlendioxid	Kurzfristig 2010	Mittelfristig 2030	Langfristig 2050
Unterer Wert	40	70	130
Mittlerer Wert	80	145	260
Oberer Wert	120	215	390

Quelle: Umweltbundesamt 2013, Best-Practice-Kostensätze für Luftschadstoffe, Verkehr, Strom- und Wärmeerzeugung (Anhang B der Methodenkonvention 2.0)



AVERAGE: 241 USD/t

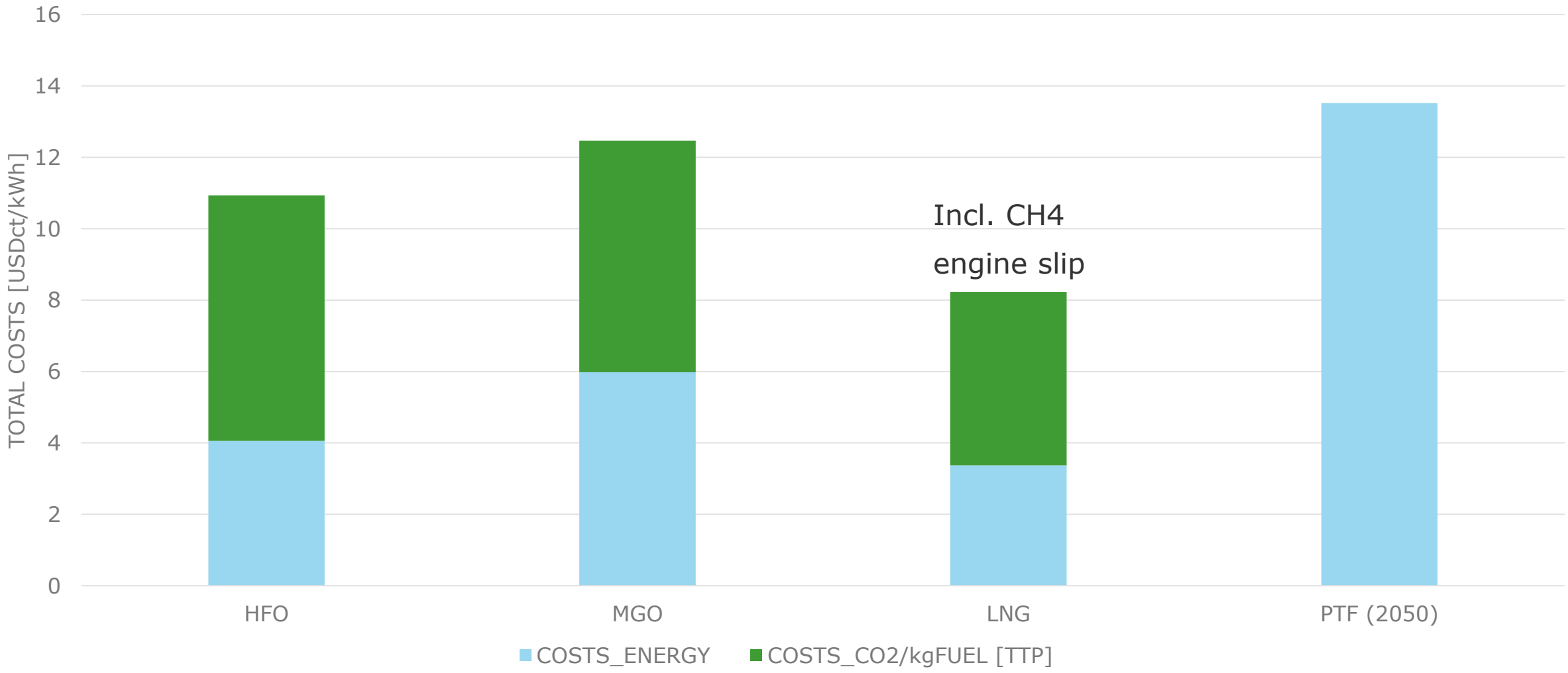
Number of Studies: 35

SOURCE: 5th IPCC Report (Climate change 2014) Page 691

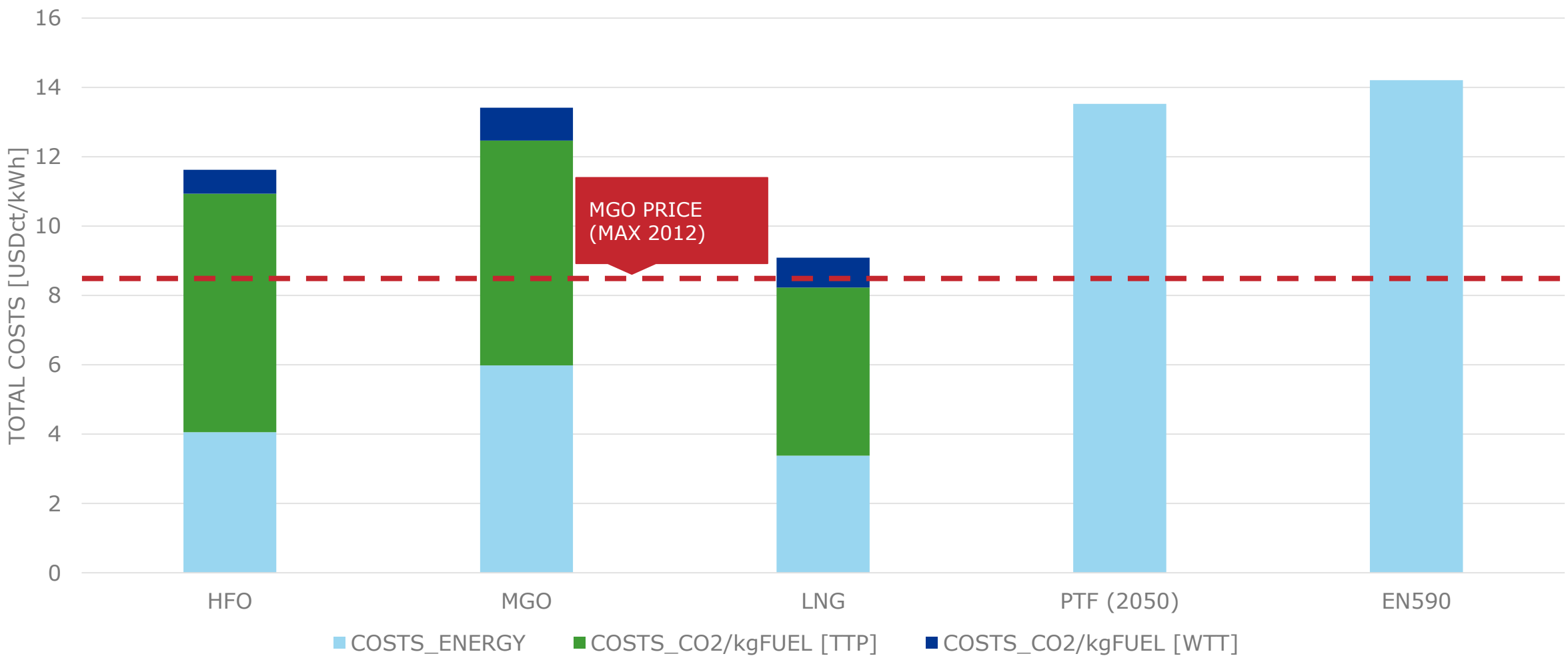
Average taken for further assessment:

240 USD/tCO2

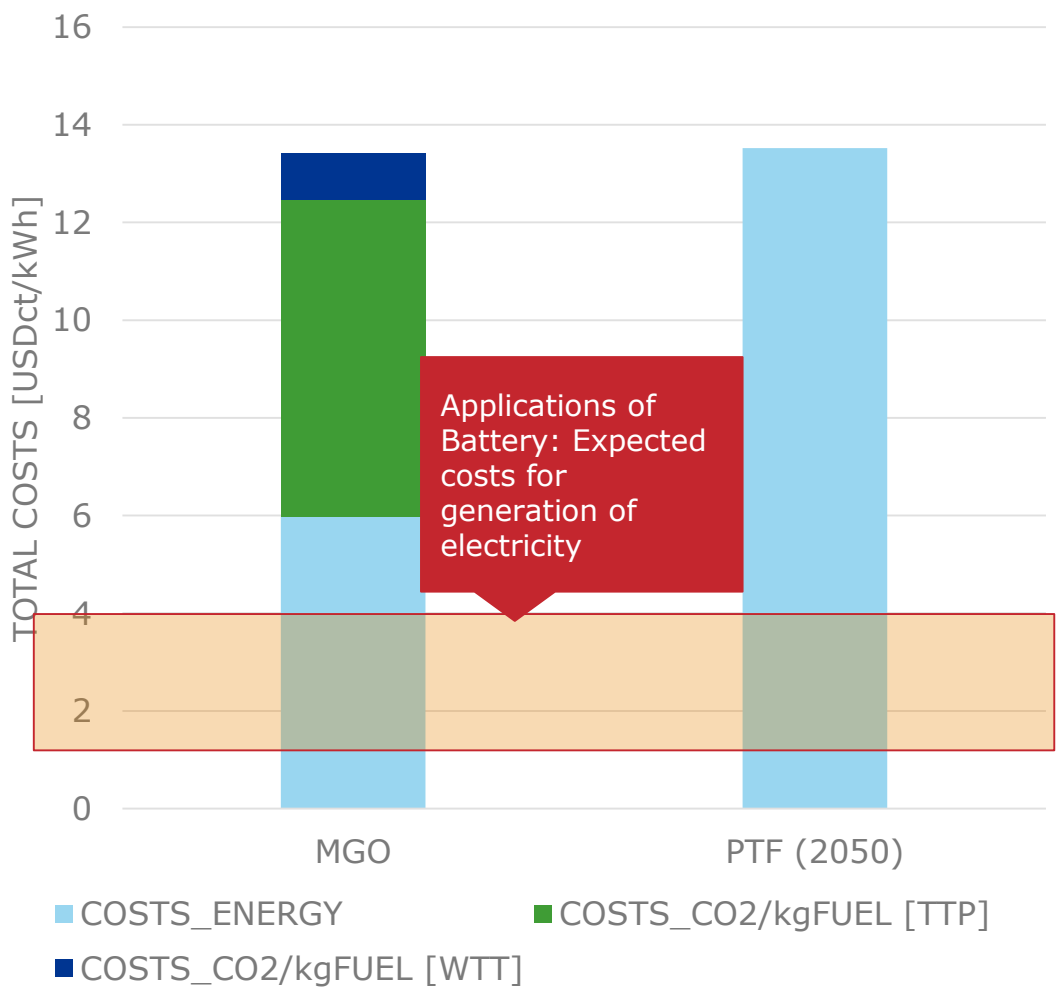
TOTAL COSTS OF FUELS (INCL TTP CO2 COSTS)

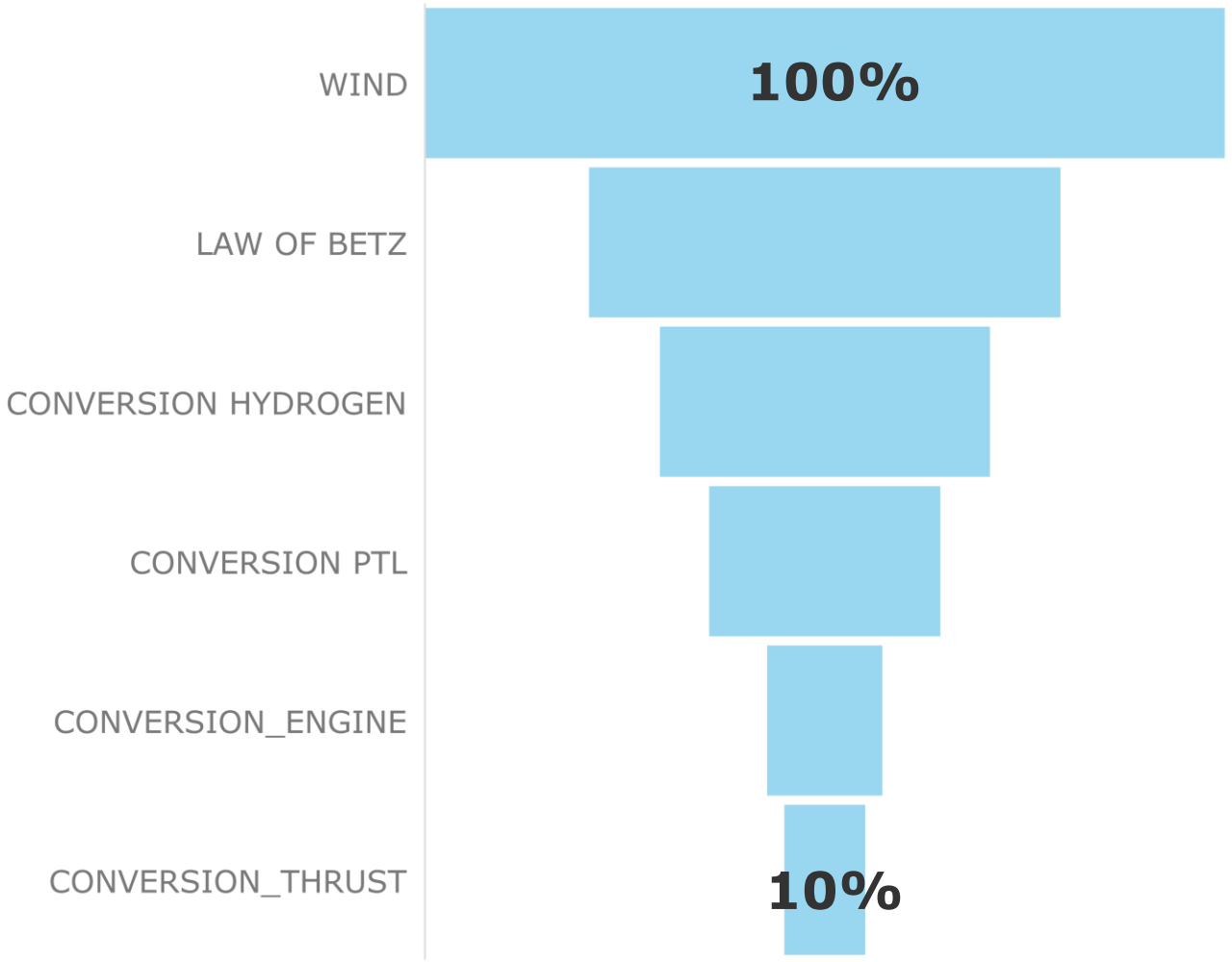


TOTAL COSTS OF FUELS (INCL WTT CO2)



DIFFERENT PERSPECTIVE ON WIND PROPULSION + BATTERY





AGENDA

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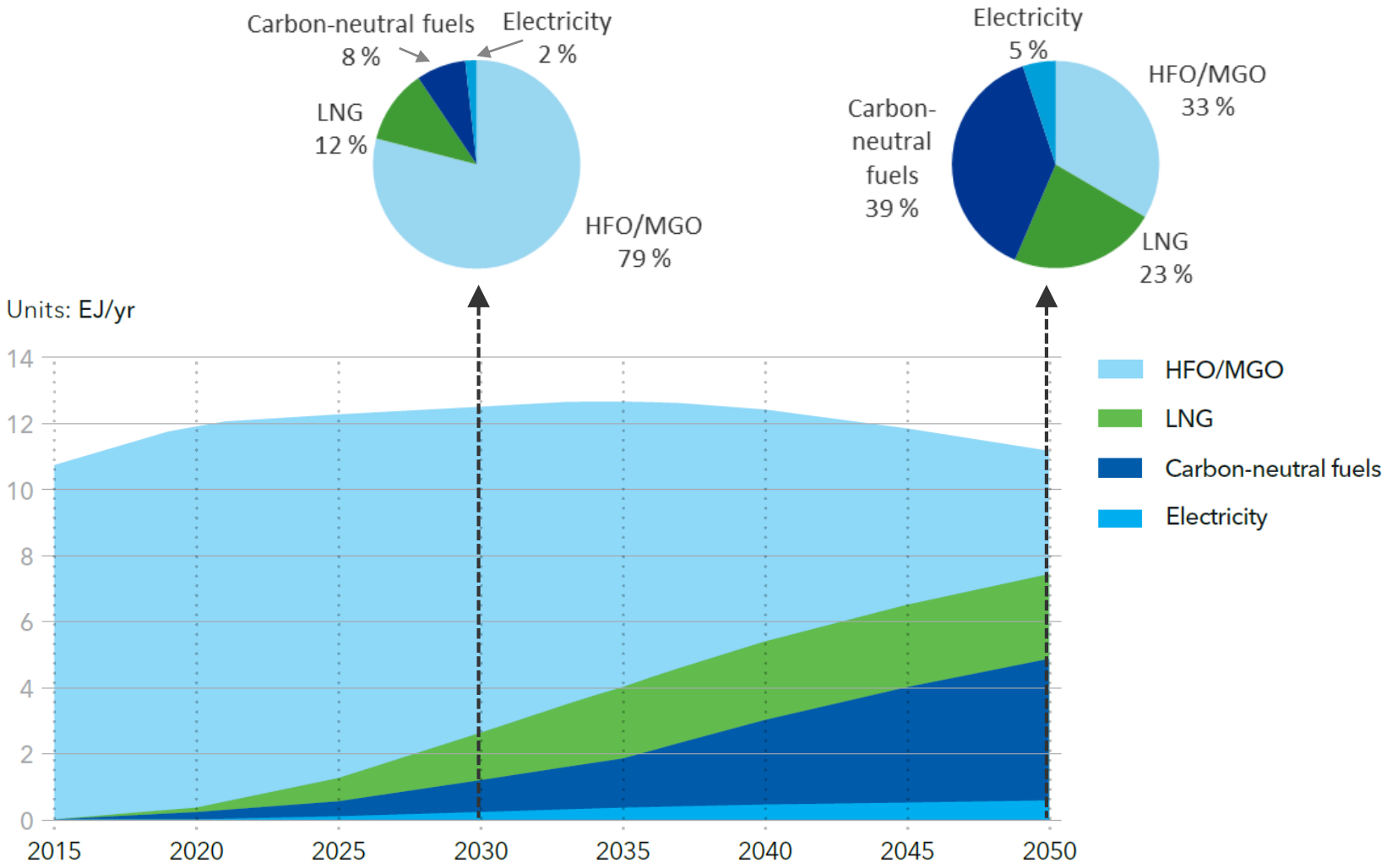
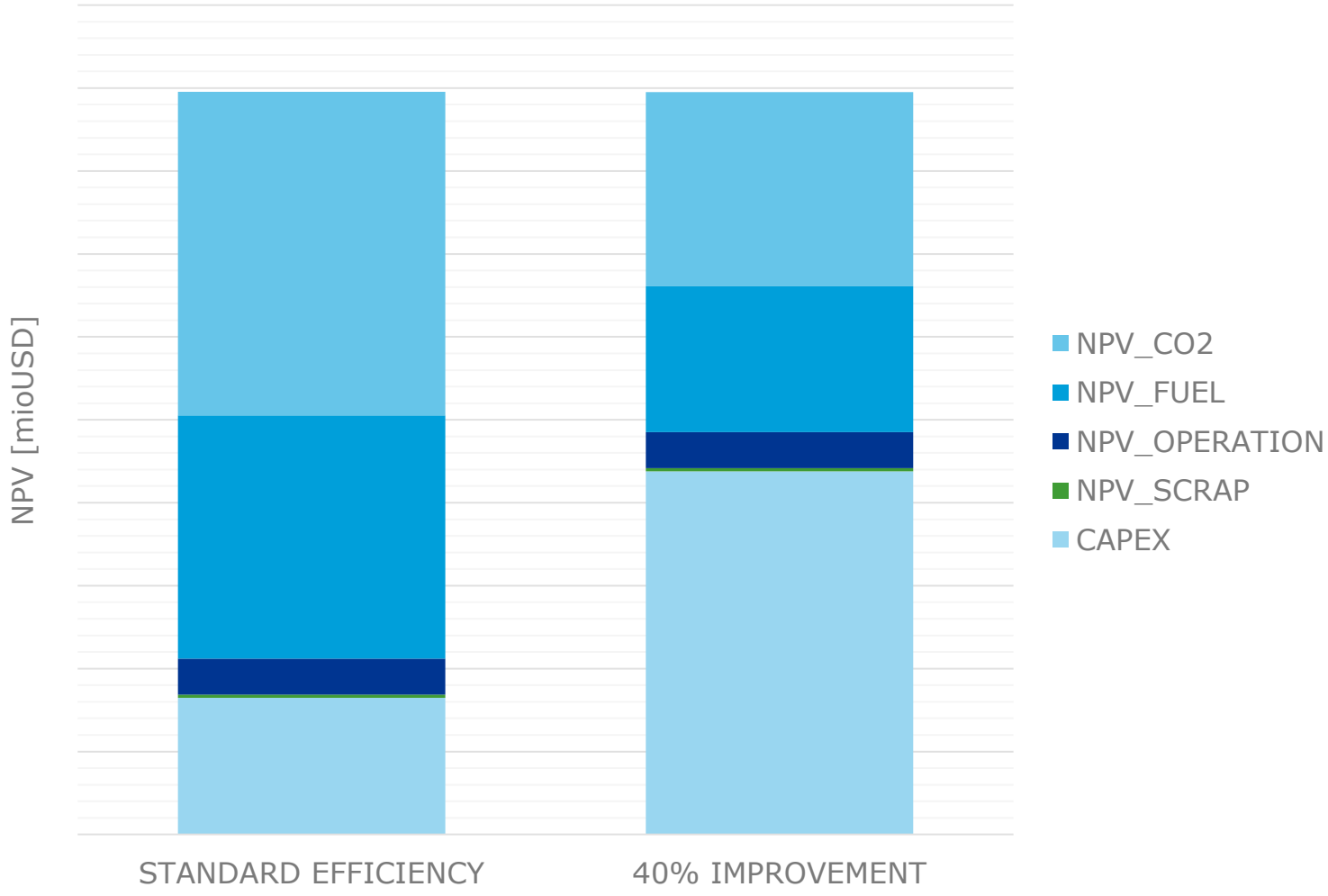
DNV GL ENERGY TRANSITION OUTLOOK

- Total energy use in international shipping will be 11 EJ/270 Mtoe in 2050:
  - 33 % (90 Mtoe) HFO/MGO
  - 23 % (60 Mtoe) by LNG
  - 39 % (100 Mtoe) carbon-neutral fuels
  - 5 % (160 TWh) of electricity
- 11 % of energy in short sea and non-cargo supplied by electricity



Source: Maritime Forecast to 2050, DNV GL 2018

CONSEQUENCE: FUEL WILL GET MORE EXPENSIVE



Average taken for further assessment:

240 USD/tCO2

AGENDA

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CONCLUSIONS

- PTF is **expected to come**
- **Fuel price will rise** (But: Total economic costs of fossil fuel and PTF are almost the same only the party paying the bill is expected to change)
- To damp the effect of rising fuel costs it is essential to consider **efficient + cleaner technology** for todays orders
- Already with today available technology **future proof designs are possible**
- **Wind assistance** gets interesting again
- **LNG is a suitable bridge to PTF** (no blind end) and offers fast emission reduction (CO2 but also NOx, SOX and PM)

THANK YOU!

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SAFER, SMARTER, GREENER

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