DECARBONIZATION OF TRANSPORT SECTOR

Balázs Tóth
Biofuel System Trader
Product & Renewables Supply And Trading

Budapest, 7th December, 2023

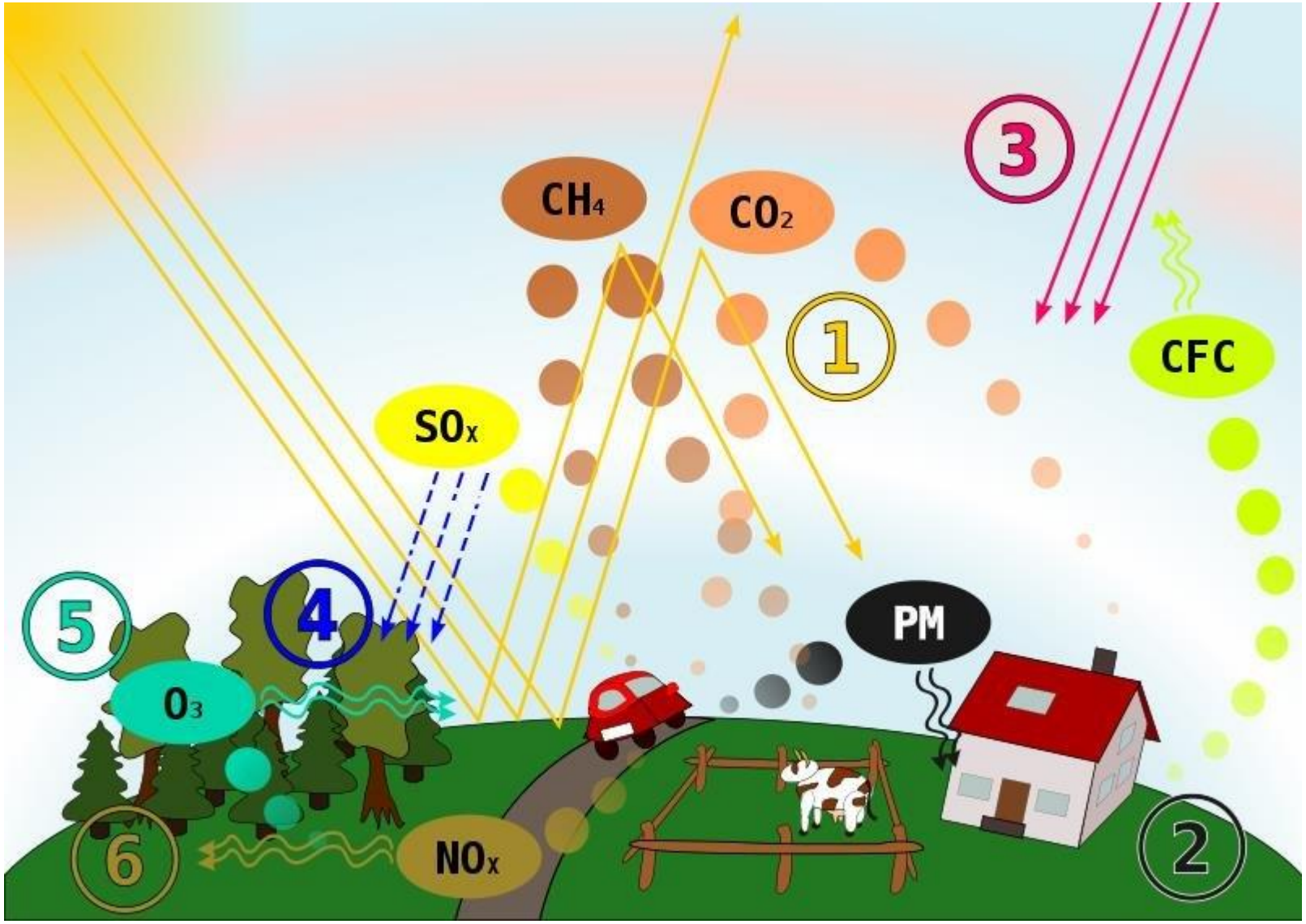
MOLGROUP

OUTLINE

- **Climate change, sources of GHG emission**
- **EU policies**
- **Transport related GHG regulation**
- **Oil industry strategies**
- **Low carbon fuels**

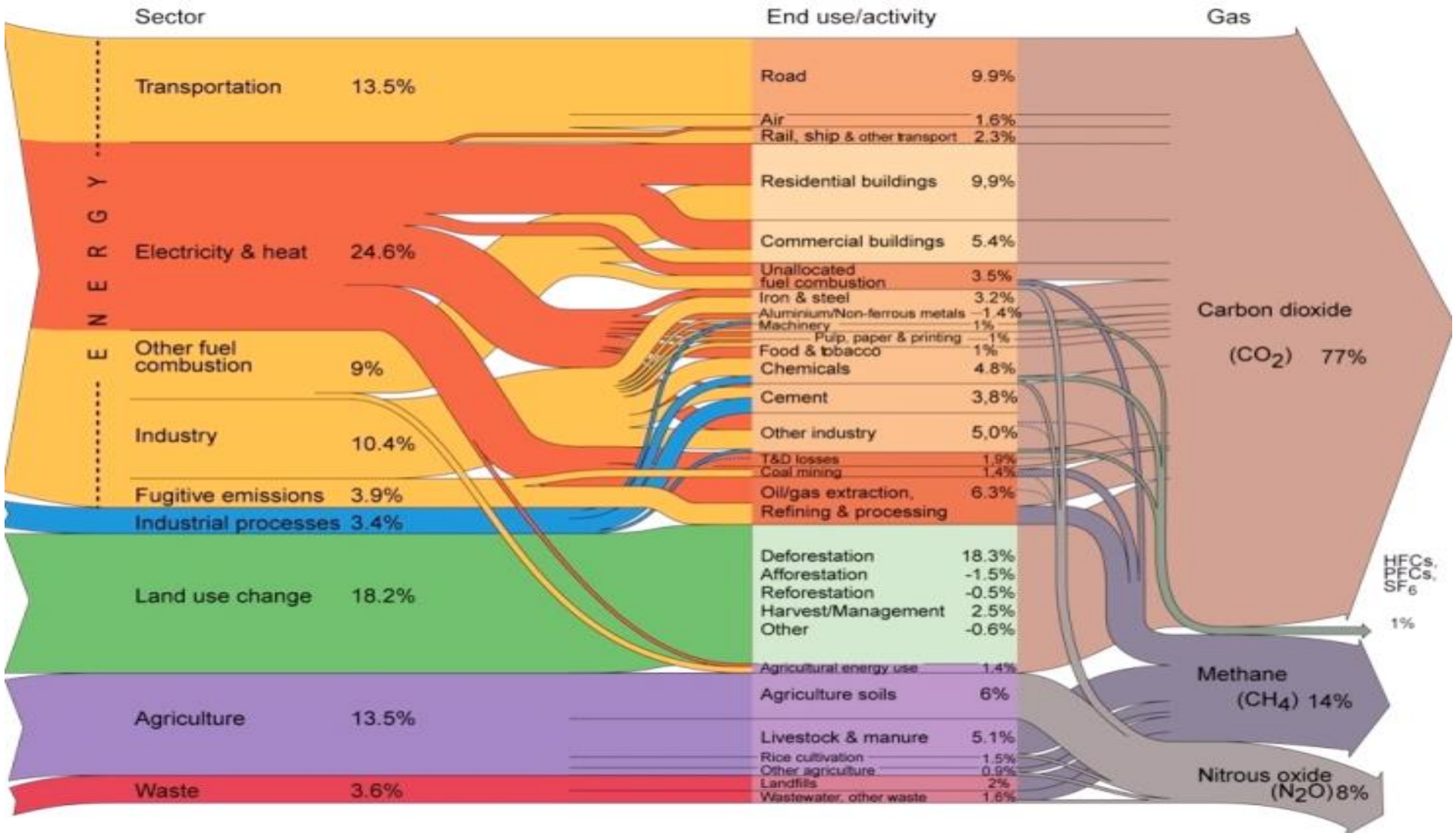
ONE OF THE BIGGEST THREATS OF THE 21ST CENTURY

AIR POLLUTATNTS AND GREENHOUSE GASES



QUIZ 1

GREENHOUSE GAS EMISSIONS FROM SECTORS



OUTLINE

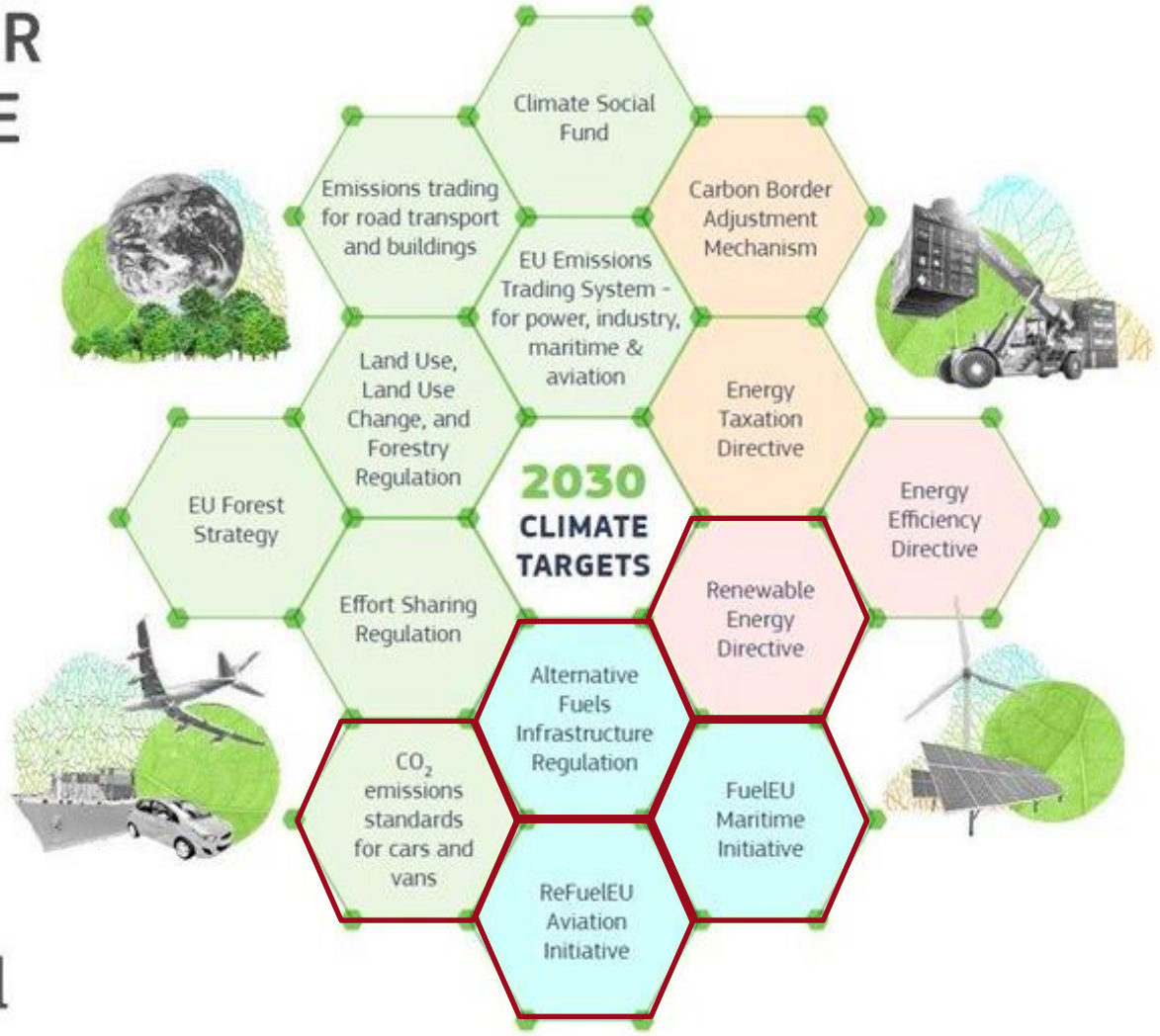
- Climate change, sources of GHG emission
- **EU policies**
- Transport related GHG regulation
- Oil industry strategies
- Low carbon fuels

QUIZ 2, 3

EU GREEN DEAL – BECOMING CLIMATE NEUTRAL BY 2050

EU TARGETS 55% GHG CUT UNTIL 2030

REACHING OUR 2030 CLIMATE TARGETS



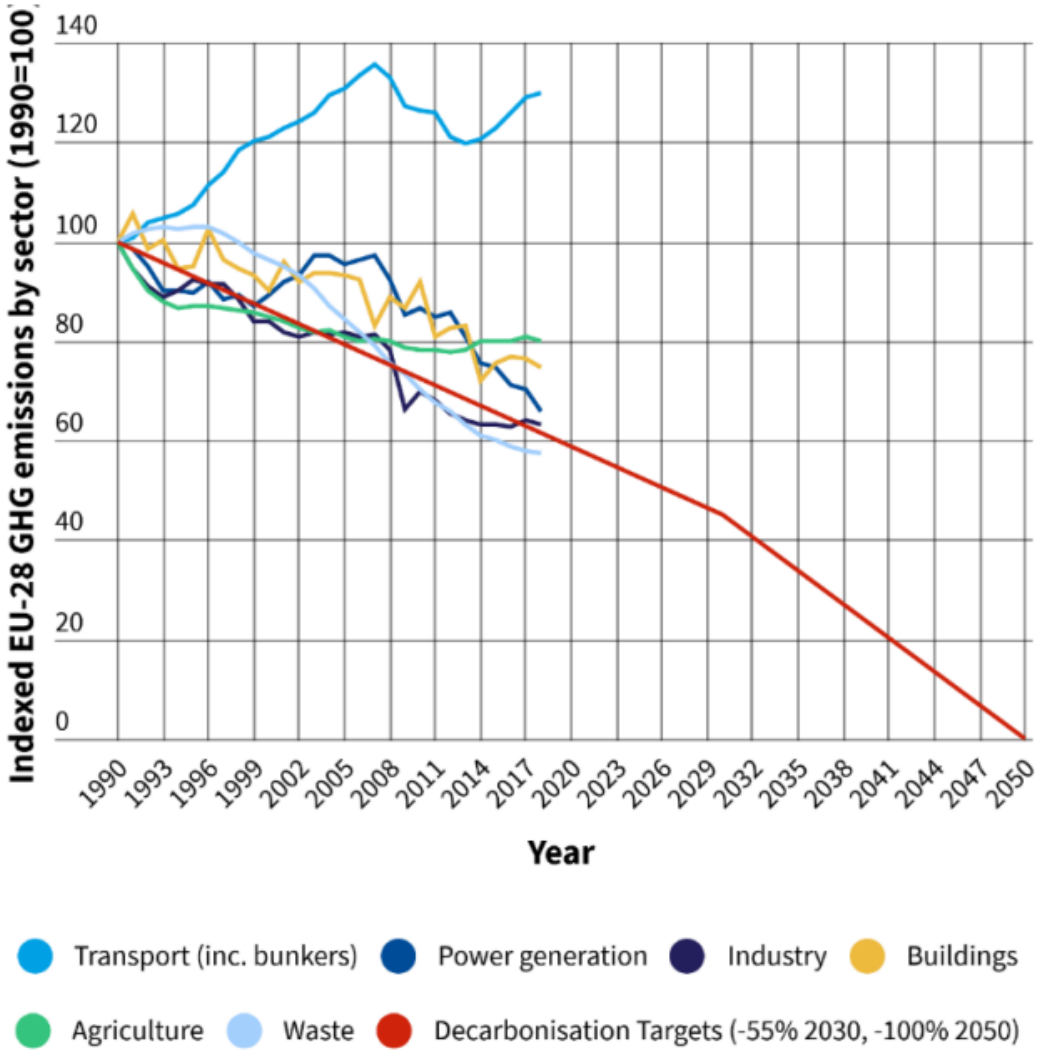
#EUGreenDeal

European Commission

MOLGROUP

QUIZ 4

GHG EMISSION IN DECREASING TREND – EXCEPT TRANSPORT



Source: Transport&Environmetn, Member State's reportot UNFCC

OUTLINE

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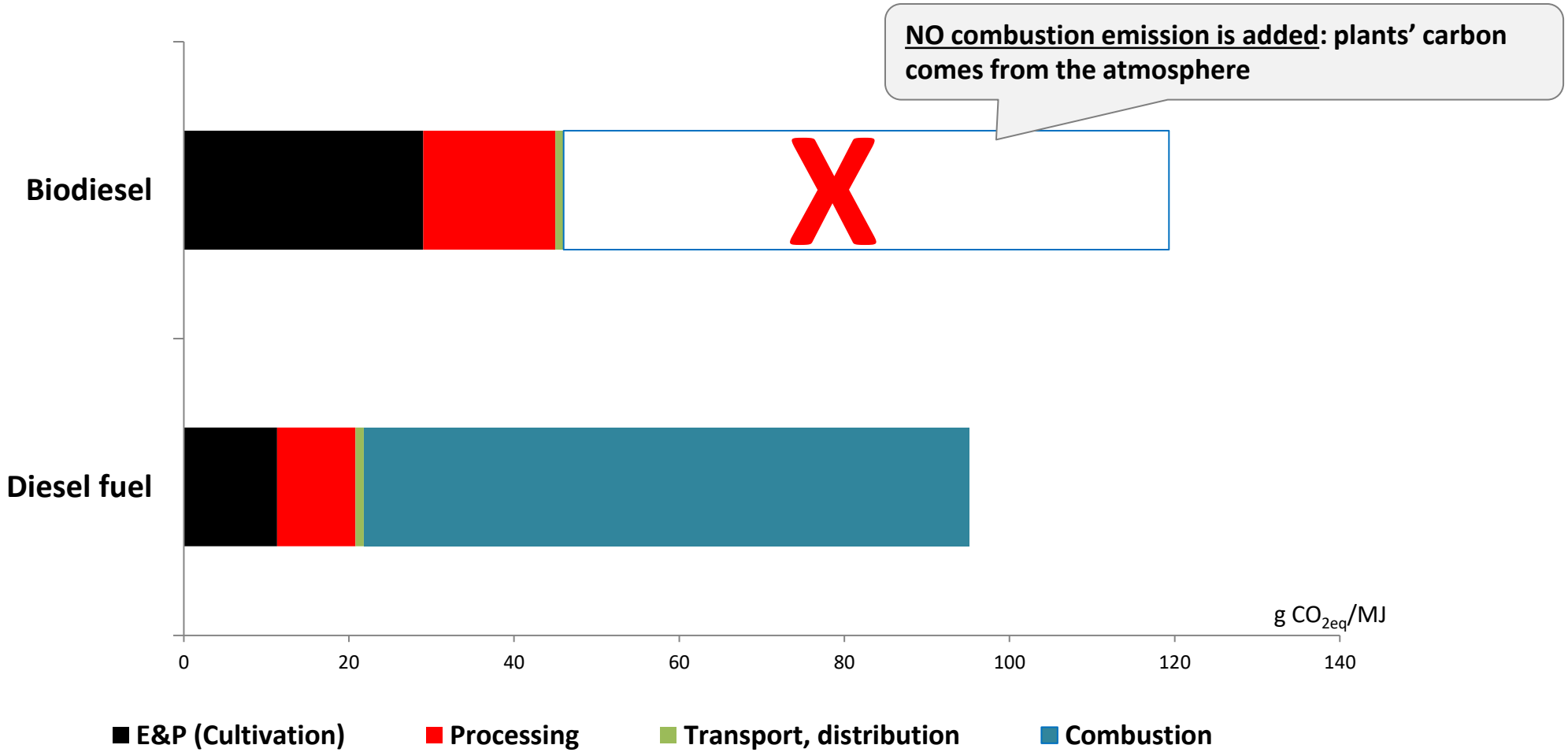
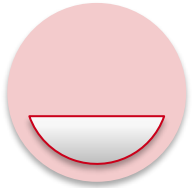
- **Transport related GHG regulation**
- Oil industry strategies
- Low carbon fuels

WHY TO USE BIOFUELS



FUELS SHOULD FIT FOR PURPOSE



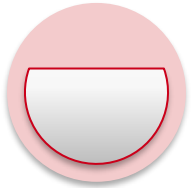
Alternative fuels

Biogas for CNG cars

Renewable electricity for road and non-road transport

Hydrogen

LIMITED



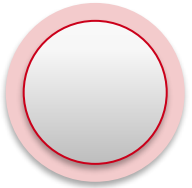
High blends

E85 – min. 70% ethanol + gasoline

B30 – 70% diesel+ 30% biodiesel

B100 – 100% biodiesel for trucks

LIMITED



Blending with fossil fuels

Car producers' (ACEA) statement:

Existing cars designed for fuels E5/E10-B7

All new European car models produced after 2010 run on B7 or E10

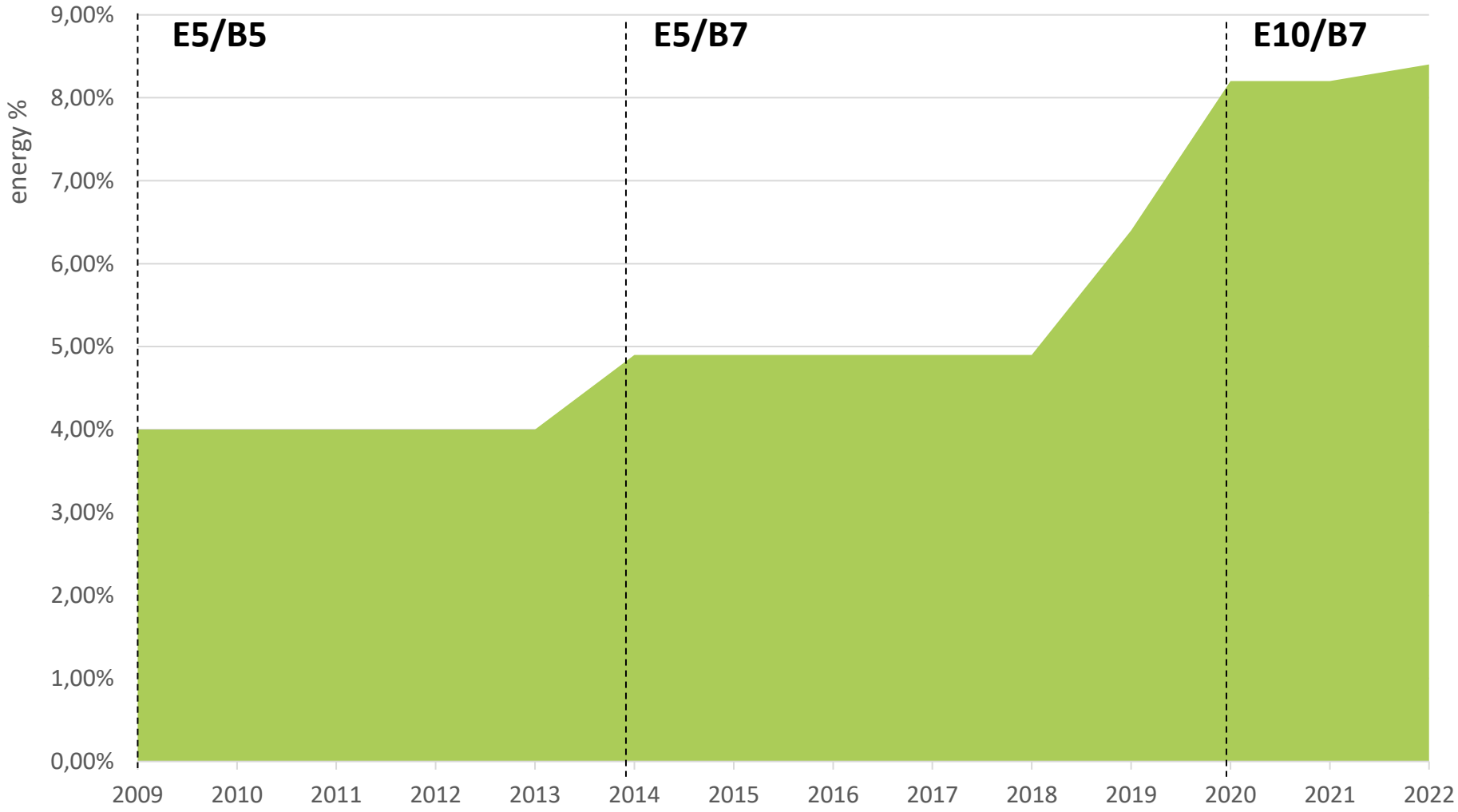
Different lists of older E10 compatible cars

BLENDING WITH FOSSIL FUELS is the main option to replace fossil fuels with biofuels, but it has technical limitations (blending wall)

E10 and protection grade

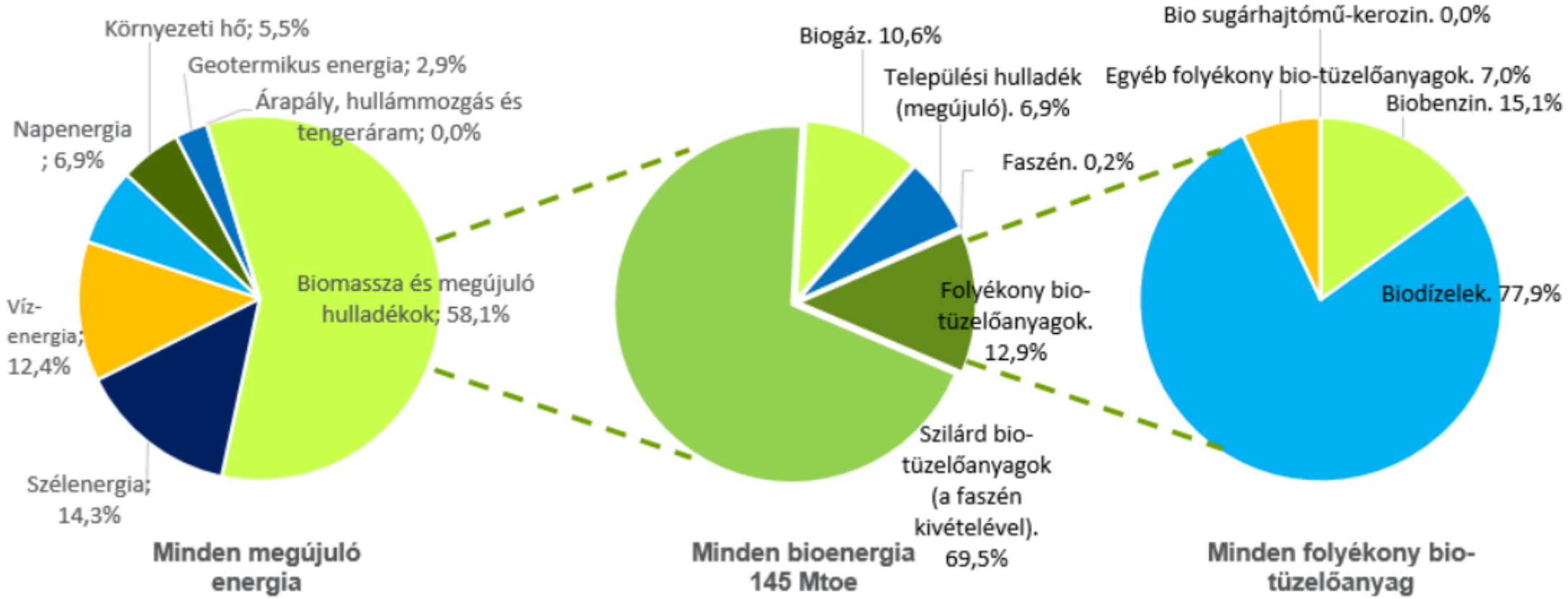
- Ethanol content from 0 to 10 v/v%
- Marketing obligation of **protection grade** (guaranteed that petrol contains no more than 5% ethanol)

BIO SHARE OF LIQUID FUELS IN HUNGARY



BIO SHARE OF LIQUID FUELS IN HUNGARY

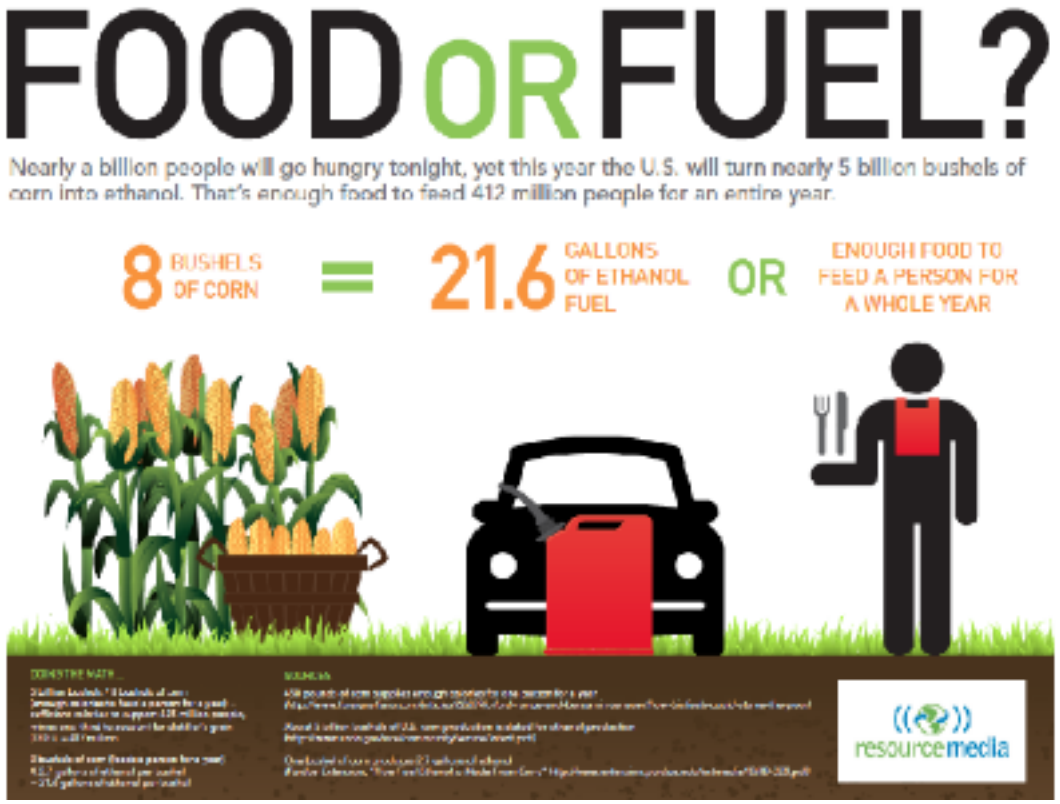
2. ábra: Bruttó uniós megújulóenergia-fogyasztás típusonként (2020, % és Mtoe). Forrás: Eurostat



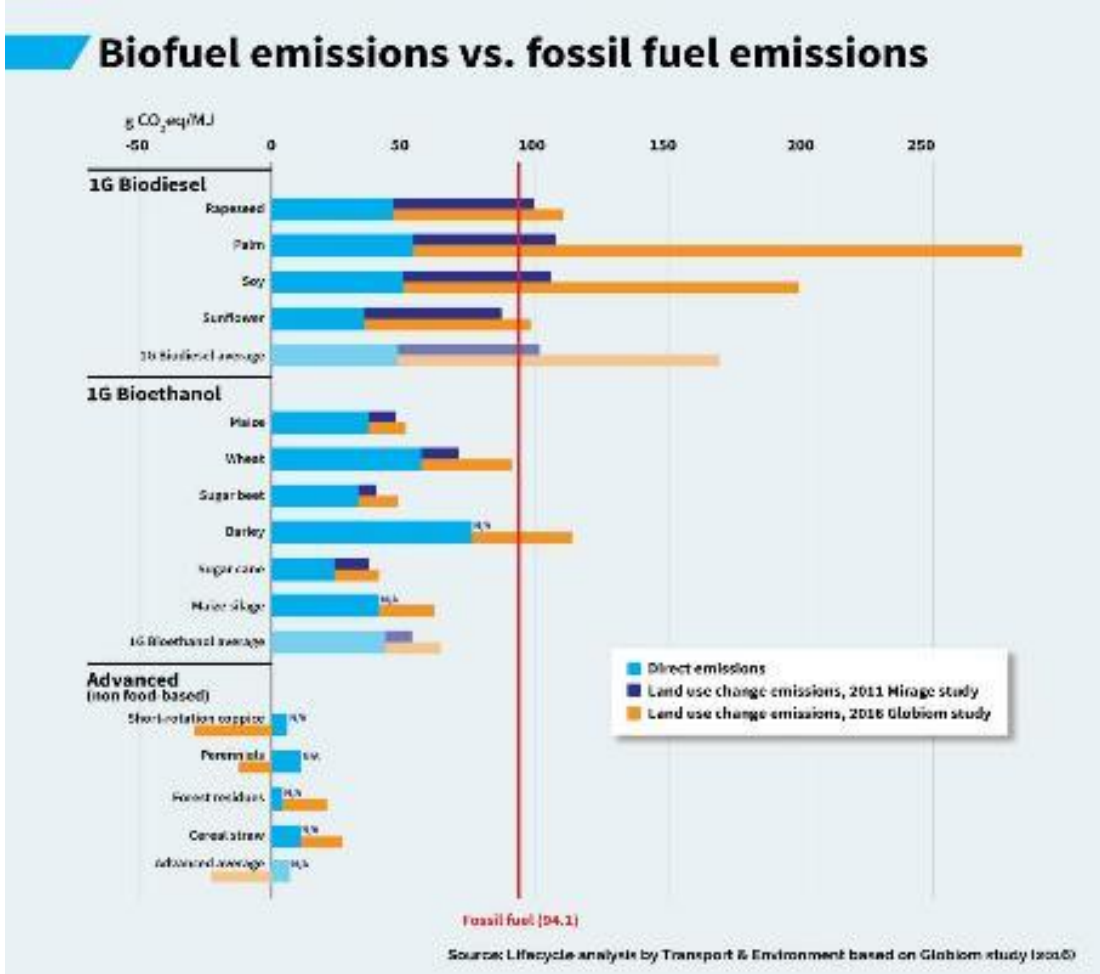
EU Commission 2022 Report on the Achievement of the 2020 Renewable Energy Targets

QUIZ 5

FOOD VS. FUEL DEBATE



NOT ALL BIOFUELS ARE GOOD

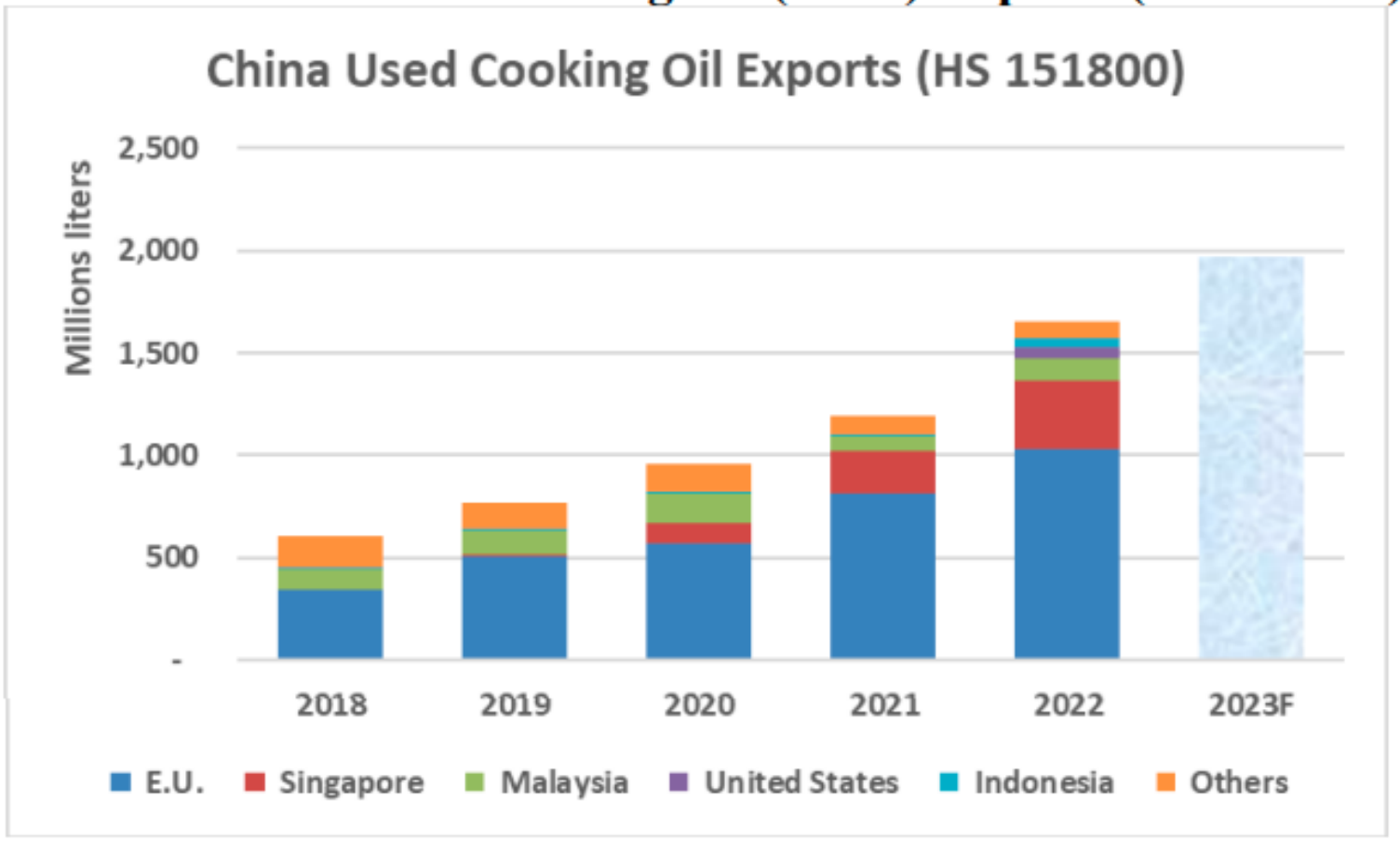


QUIZ 6

EU TRANSPORT RENEWABLE POLICY

USED COOKING OIL IMPORT TO EU

Chart 4. China: Used Cooking Oil (UCO) Exports (HS 151800)

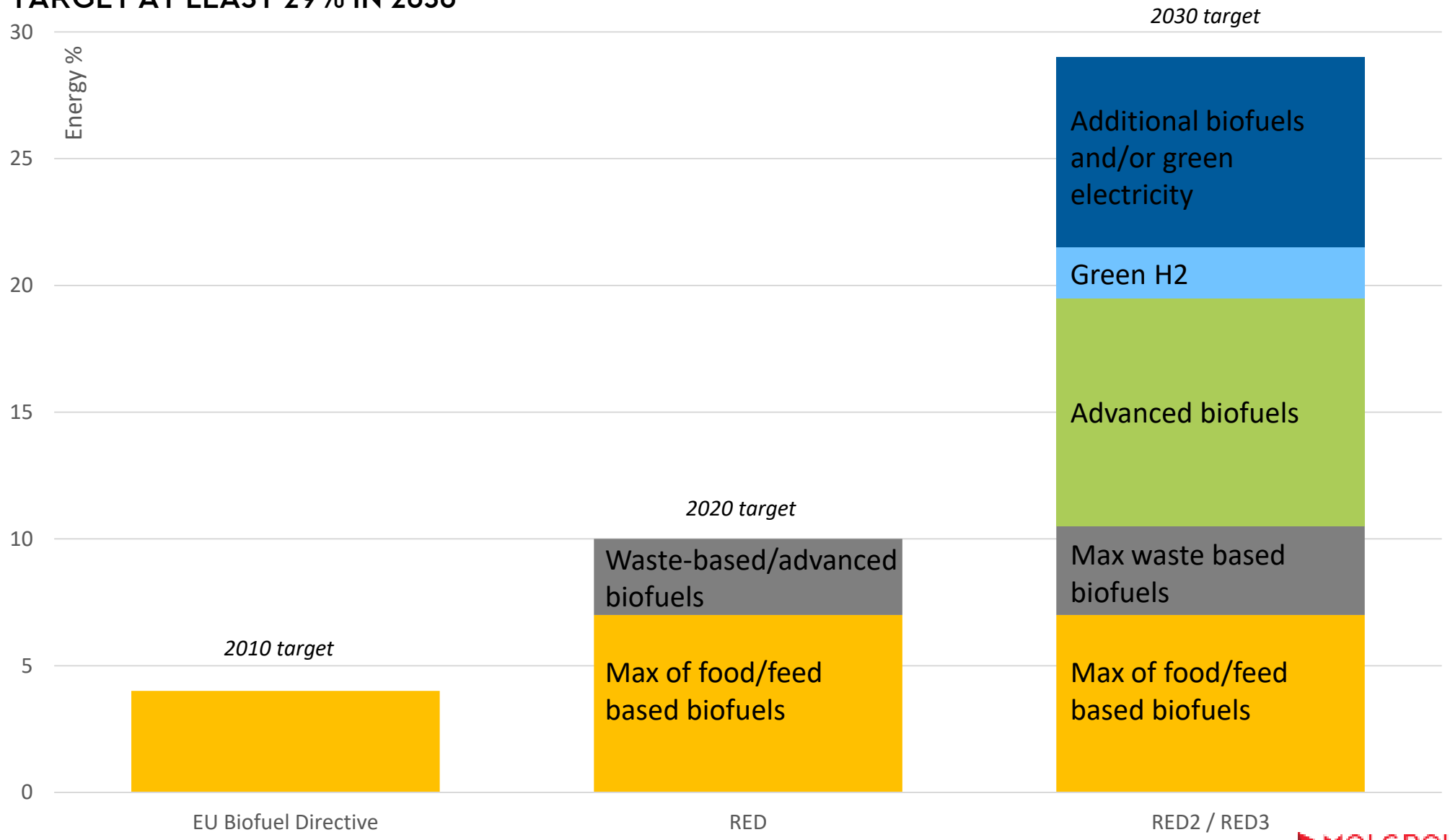


Sources: Trade Data Monitoring and General Administration of China Customs

Note: Used cooking oil (UCO): 1 MT = 1,043 liters of UCOME (UCO methyl ester)

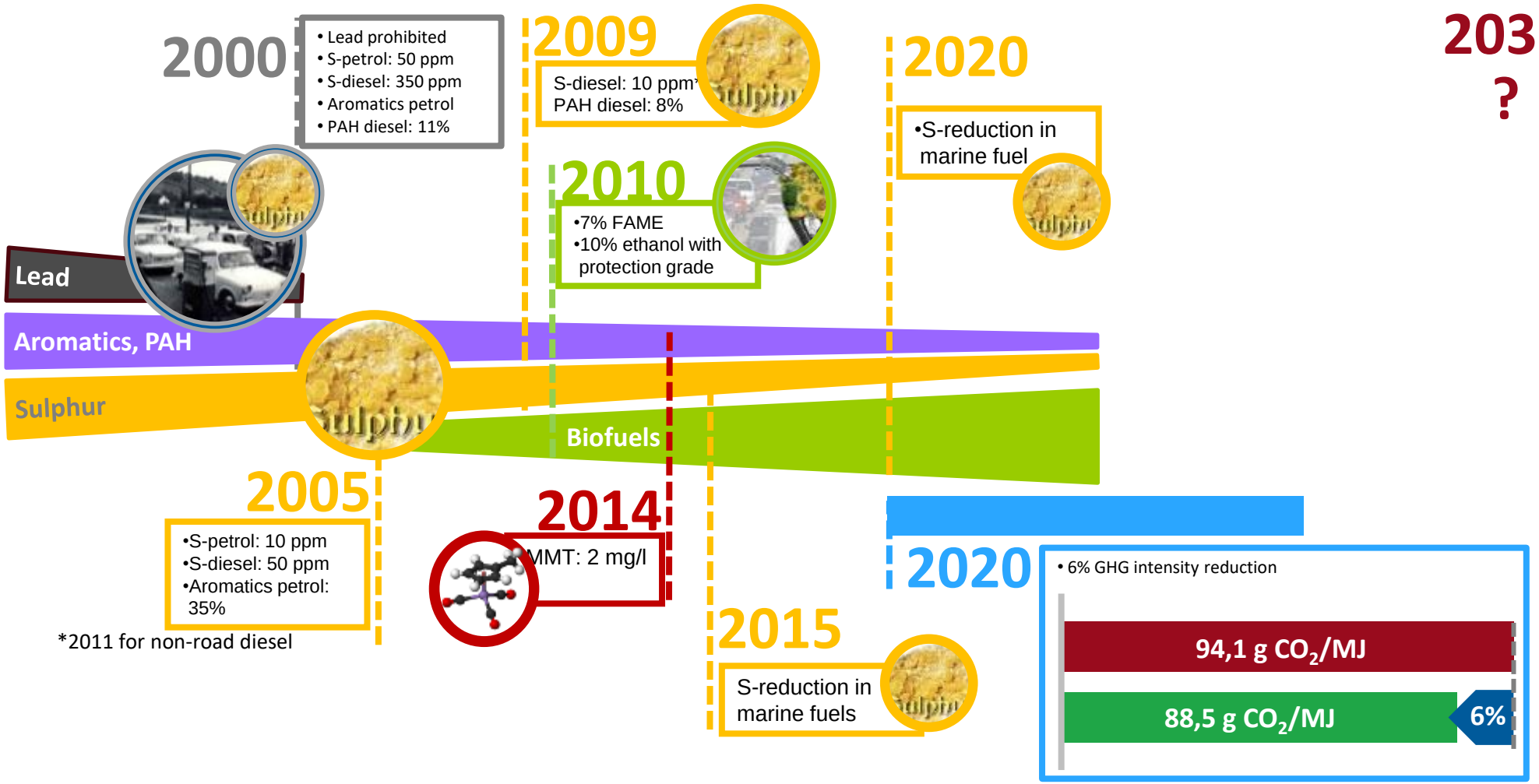
EU TRANSPORT RENEWABLE POLICY

RES-T TARGET AT LEAST 29% IN 2030



TRANSPORT FUEL REGULATION HISTORY

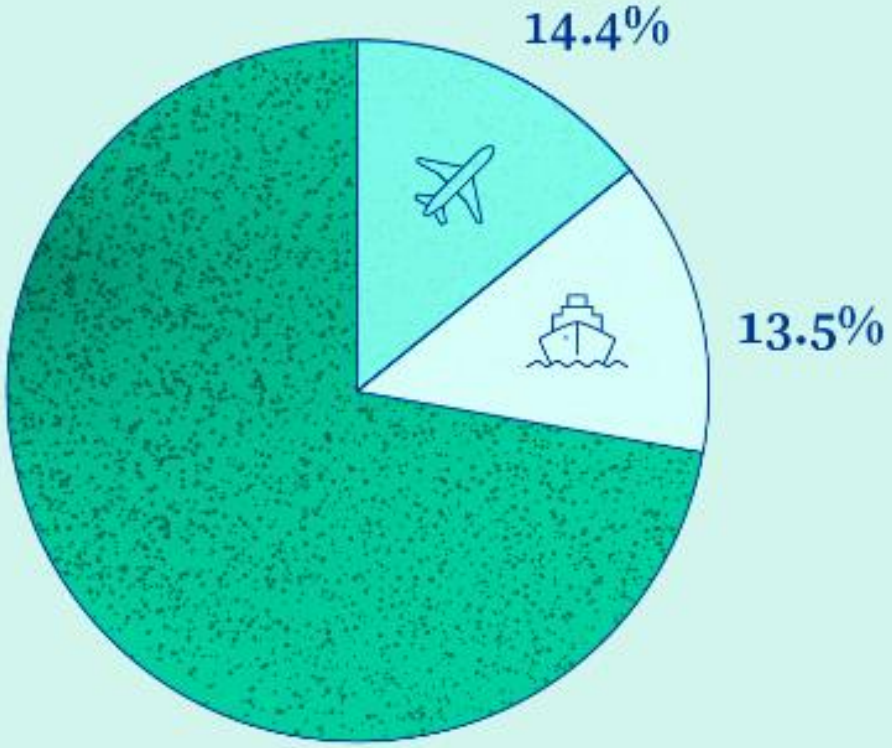
FUEL QUALITY DIRECTIVE



REASON FOR REGULATING AVIATION AND MARITIME

Why these regulations are needed

Aviation and maritime transport account for 14.4% and 13.5% of EU transport emissions, respectively.



EU transport emissions
(based on latest available data from 2018)

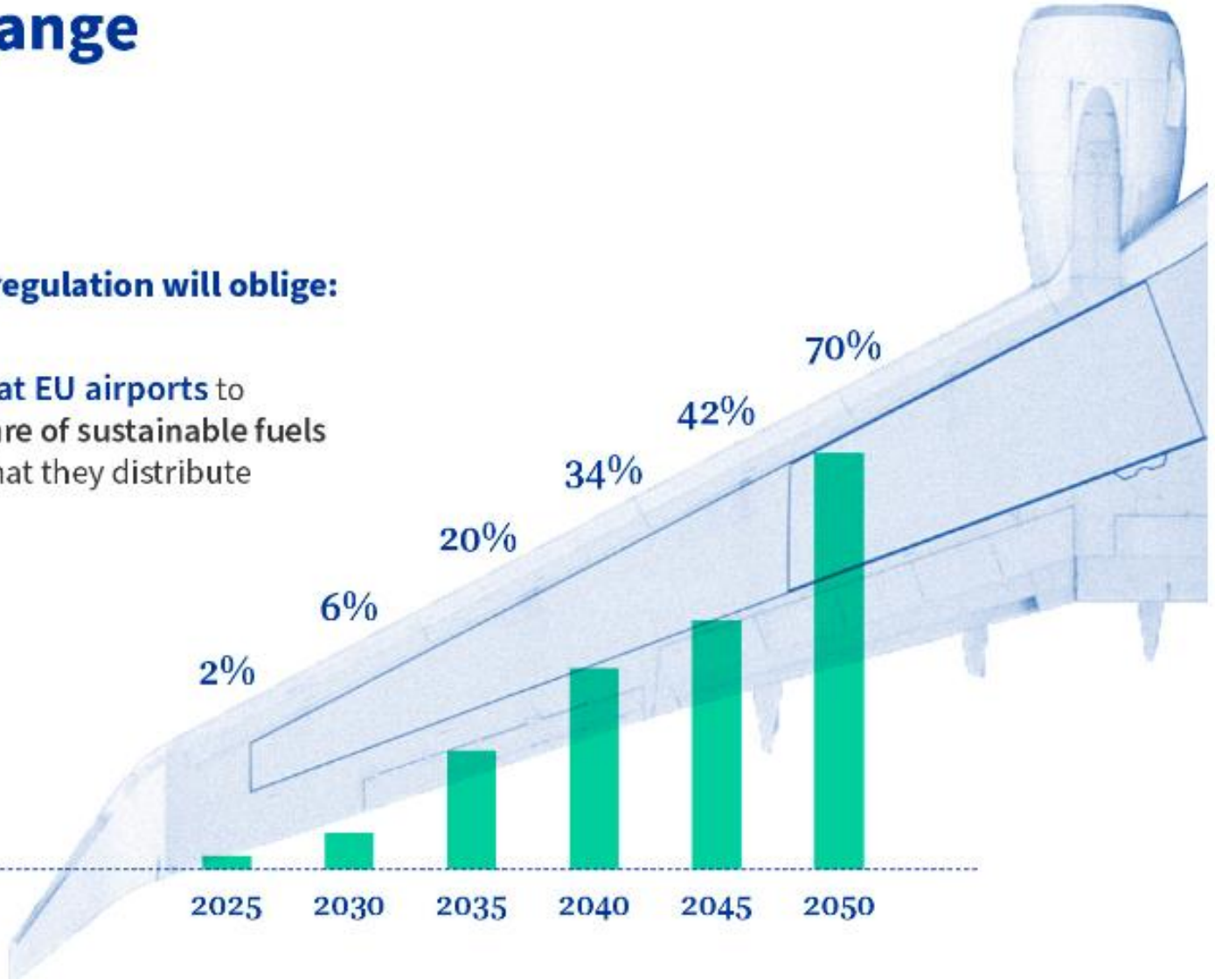
AVIATION FUELS

What will change

The ReFuelEU aviation regulation will oblige:

1. aircraft fuel suppliers at EU airports to gradually **increase the share of sustainable fuels** (notably synthetic fuels) that they distribute

Minimum share of supply of sustainable aviation fuels (in %)



SUSTAINABLE AVIATION FUELS:

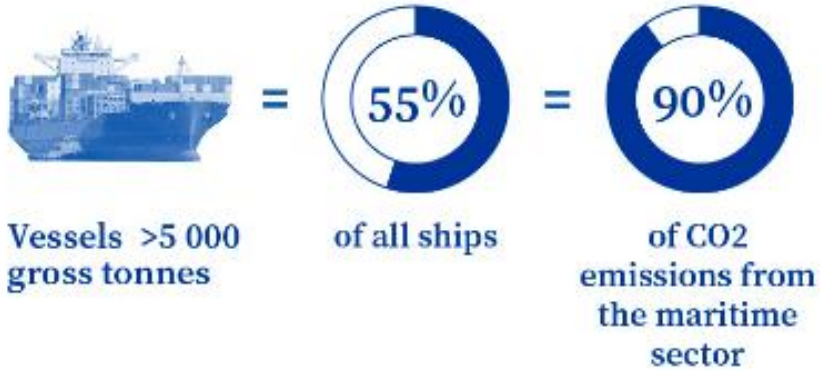
- synthetic fuels produced from green power
- advanced or other non-food based biofuels

MOL-WIZZAIR BIOJET TEST FLIGHT

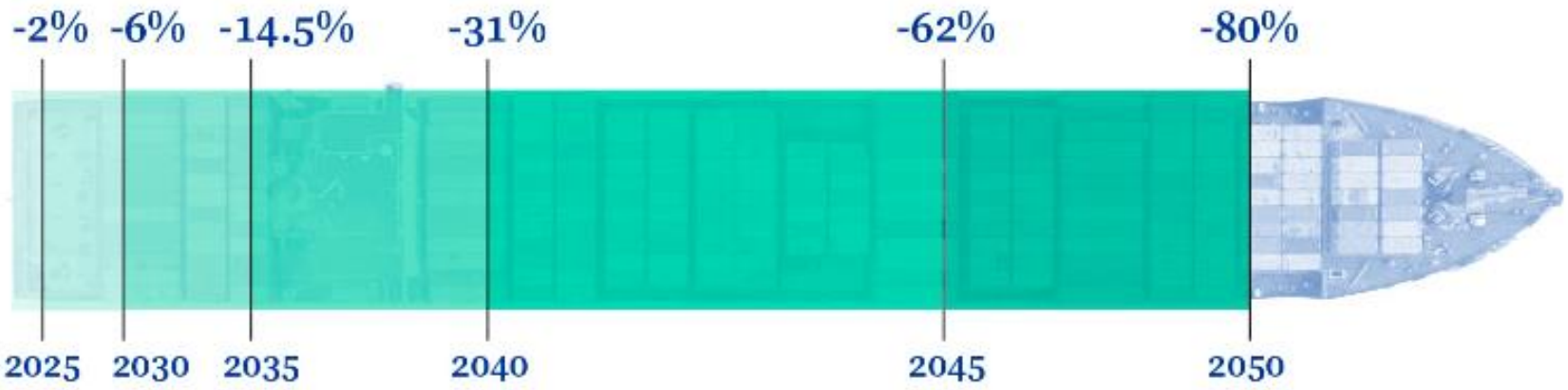
MARITIME FUELS

The FuelEU maritime regulation will oblige vessels above 5 000 gross tonnes calling at European ports (with exceptions such as fishing ships):

→ to **reduce** the **greenhouse gas intensity** of the energy used on board as follows



Annual average carbon intensity reduction compared to the average in 2020



CO2 REDUCTION CAN BE MET BY USING:

- Liquid biofuels,
- E-liquids,
- Decarbonised gas (including bio-LNG and e-gas),
- Decarbonised hydrogen and
- Decarbonised hydrogen-derived fuels (including methanol, and ammonia),
- Electricity

DILEMMA

EU Regulations

Vehicle industry

- Reduce gCO_2/100km emission
- Reduce pollutant emission

Oil industry

- Reduce CO_2 emission from fuels
- Use more and more bio and low carbon fuels

Electrification

Emissions measured at tailpipe

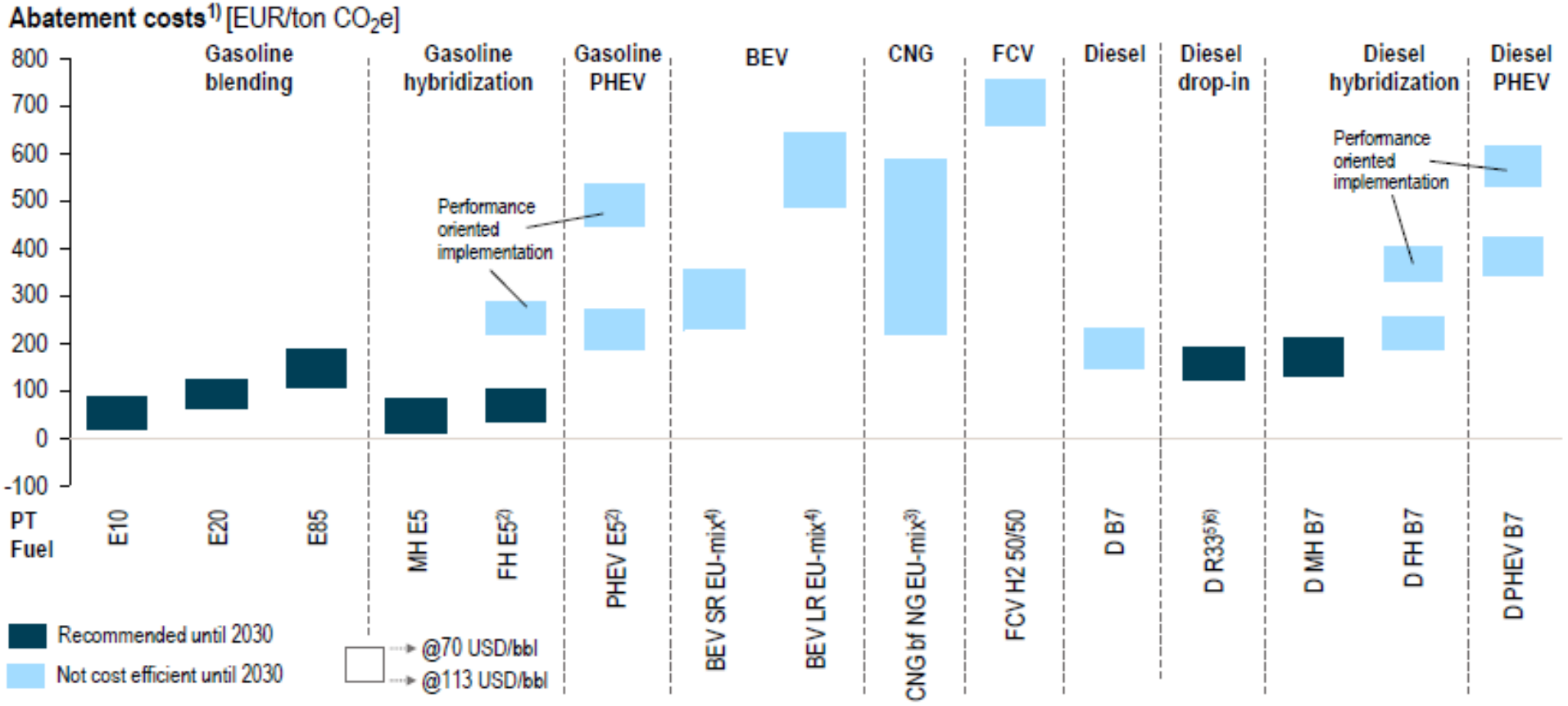
Decarbonise liquid fuels

Life-cycle emissions measured

QUIZ 7

COST OF GHG REDUCTON OPTIONS – PASSANGER CAR

WTW GHG abatement costs for society, new C-segment PC 2030 [EUR/ton CO_2e]

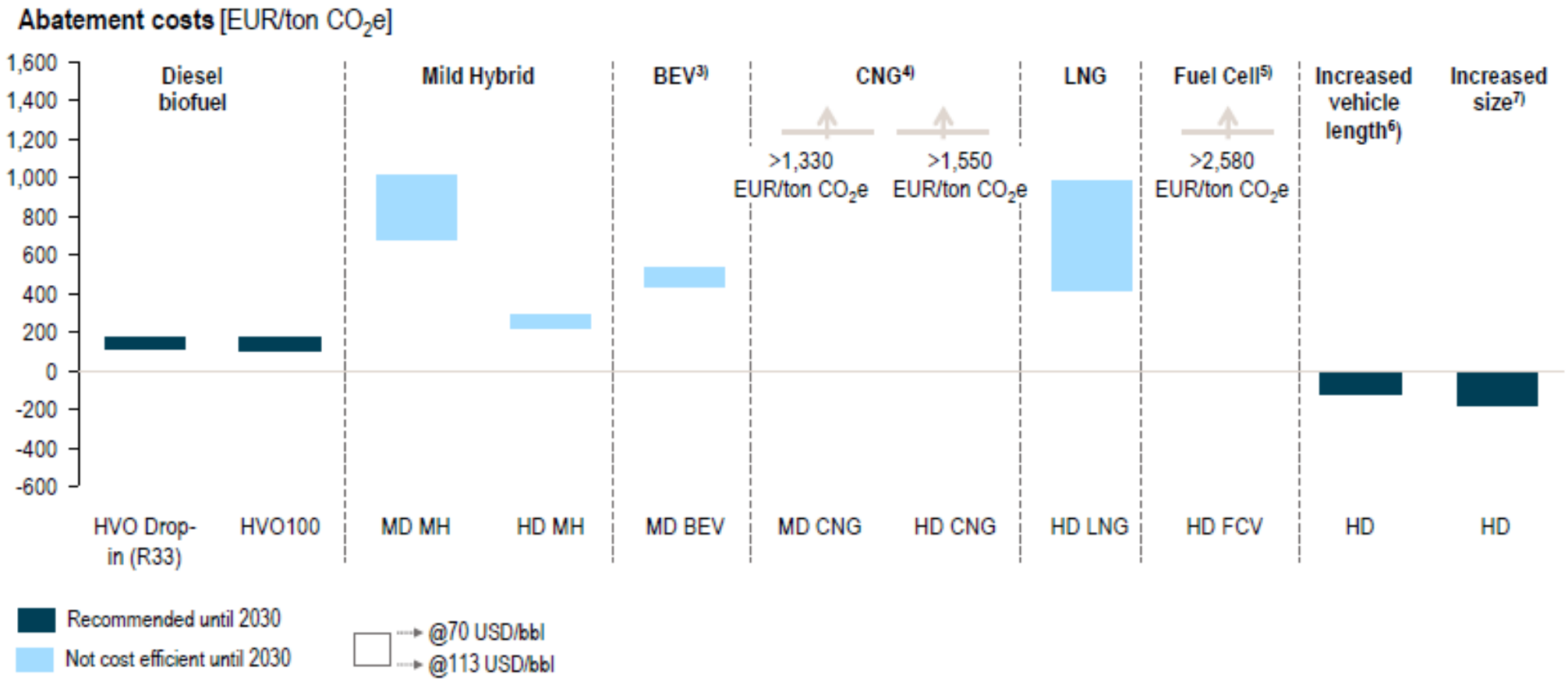


1) Compared to optimized Gasoline powertrain 2030 using E5, all technologies with 250,000 km lifetime mileage 2) 30% e-driving, higher e-driving share reduces abatement costs
3) Large range between scenarios driven by decoupling effect of natural gas price 4) Risk of higher abatement costs due to need of second battery over lifetime,
SR – short range with 35 kWh battery capacity, LR – long range with 65 kWh battery capacity, both using 2030 EU mix electricity, 5) Diesel fuel with 7% FAME and 26% HVO
6) Abatement cost in existing vehicle: -67 EUR/ton CO_2 (high oil price), 7 EUR/ton CO_2 (low oil price)

Source: Roland Berger

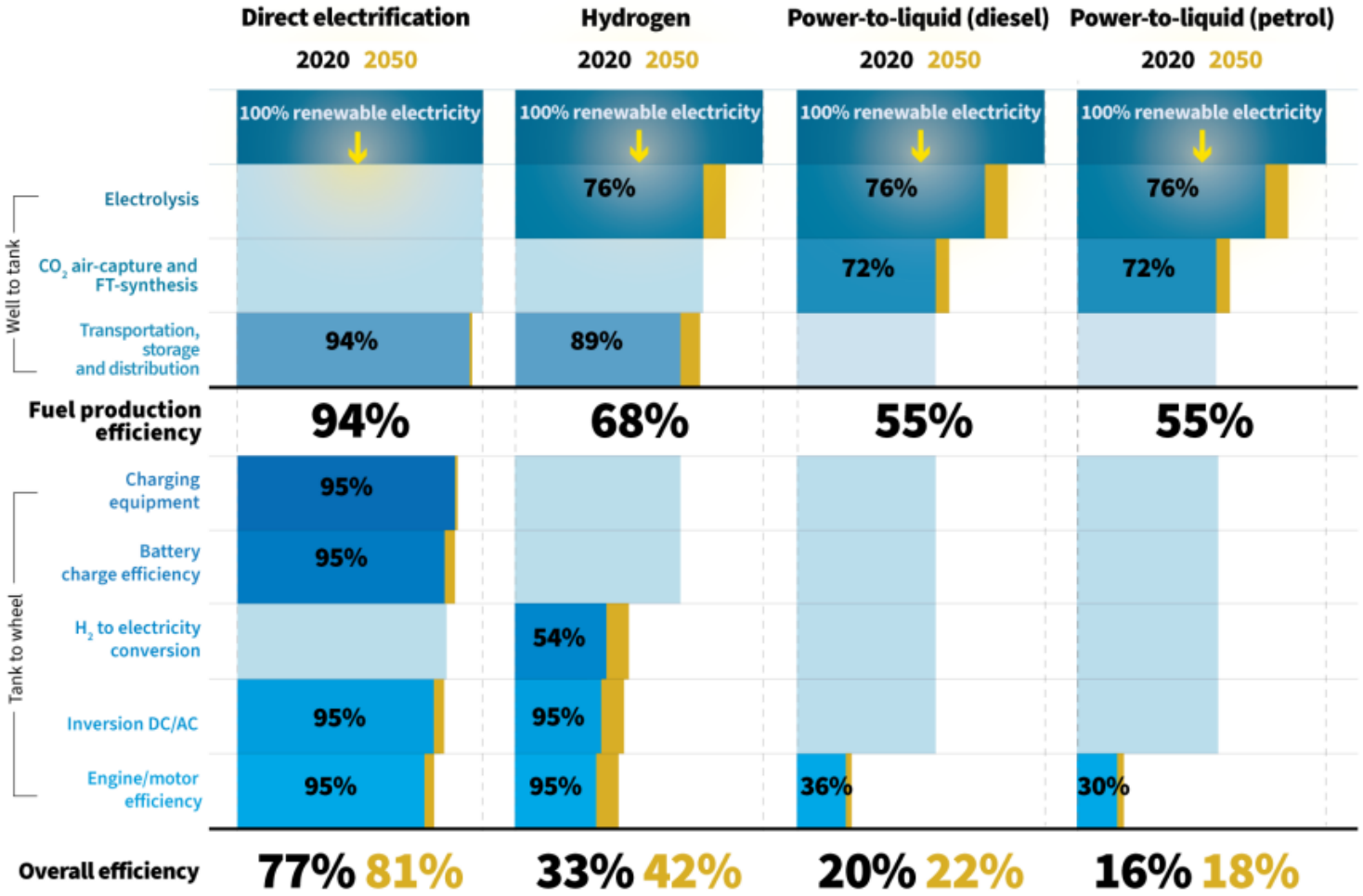
COST OF GHG REDUCTON OPTIONS - TRUCKS

Figure 46: WTW GHG abatement costs of MD and HD commercial vehicle 2030 [EUR/ton CO2e]



1) Medium duty 2) Heavy duty 3) Exclusion of HD BEV due to incompatibility of BEV range with long haul requirements 4) High CO_2 abatement costs for CNG and LNG within MD/HD/City Bus s result from low quantities of vehicles (missing economies of scale) and CO_2 abatement potential compared to Diesel is small (<5% savings/km) 5) High system cost and low lifetime mileage in medium duty trucks causes very high abatement cost , therefore incompatibility 6) Increased efficiency due to aerodynamic measures to reduce drag 7) Length and gross vehicle weight increase, increased transport efficiency by 10%

Cars: direct electrification most efficient by far



Notes: To be understood as approximate mean values taking into account different production methods. Hydrogen includes onboard fuel compression. Excluding mechanical losses.

Source: Transport&Environment

OUTLINE

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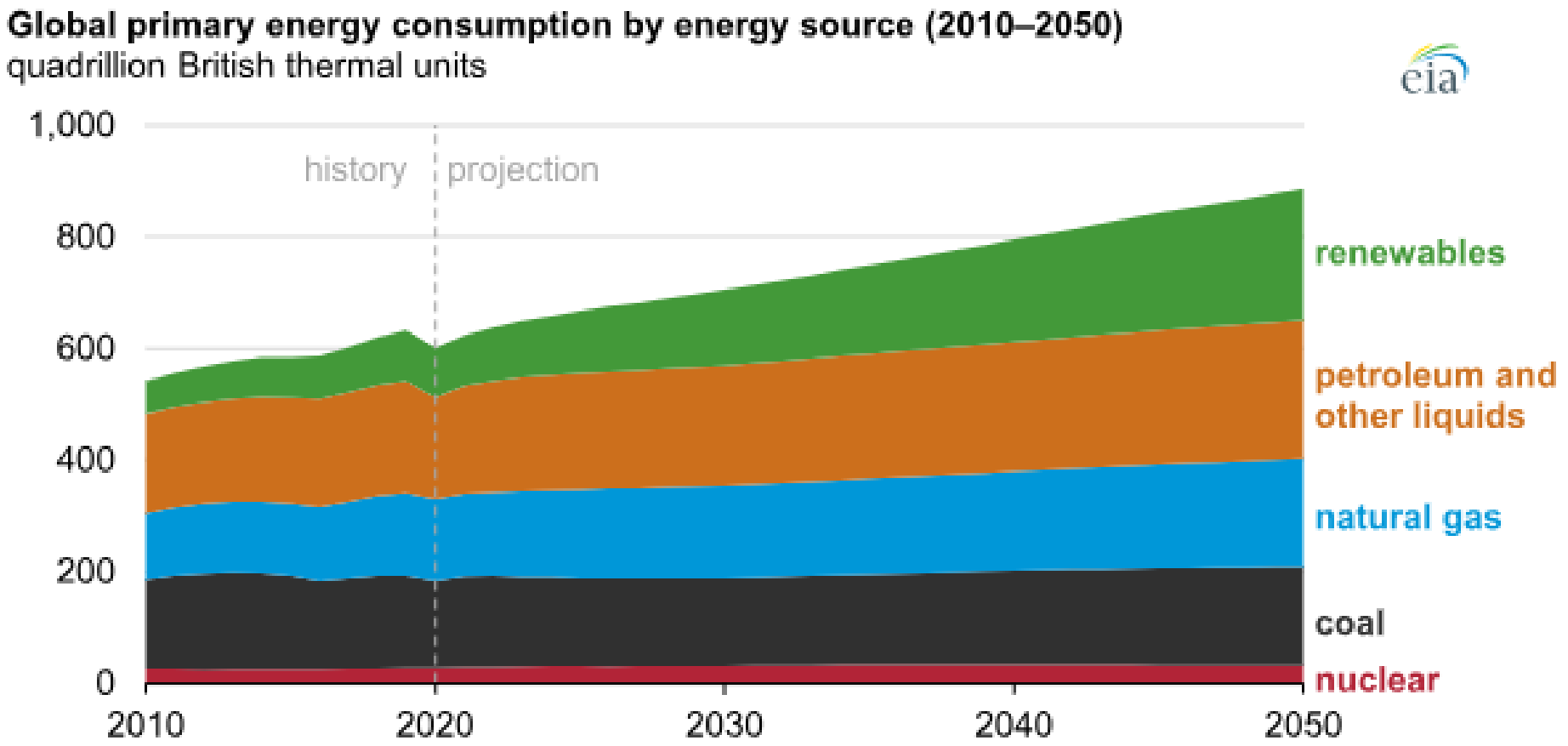
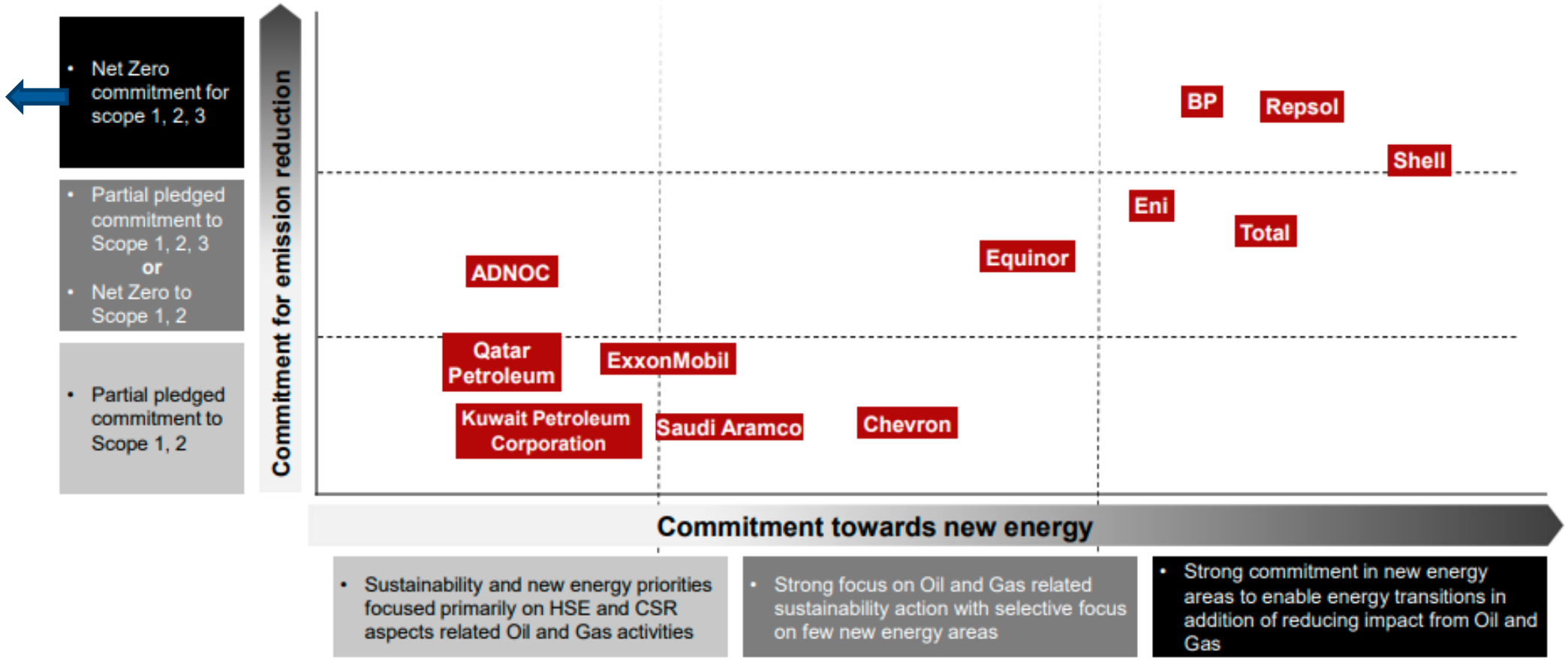
ENERGY TRANSITION OR SATISFYING GROWING DEMAND BY NEW SOURCES?



Source: U.S. Energy Information Administration, *International Energy Outlook 2021* Reference case
Note: *Petroleum and other liquids* includes biofuels.

CLIMATE CHANGE – OIL&GAS COMPANY ACTIONS

Oil and Gas company sustainability positioning



Sustainability strategies for Oil and Gas
Strategy&

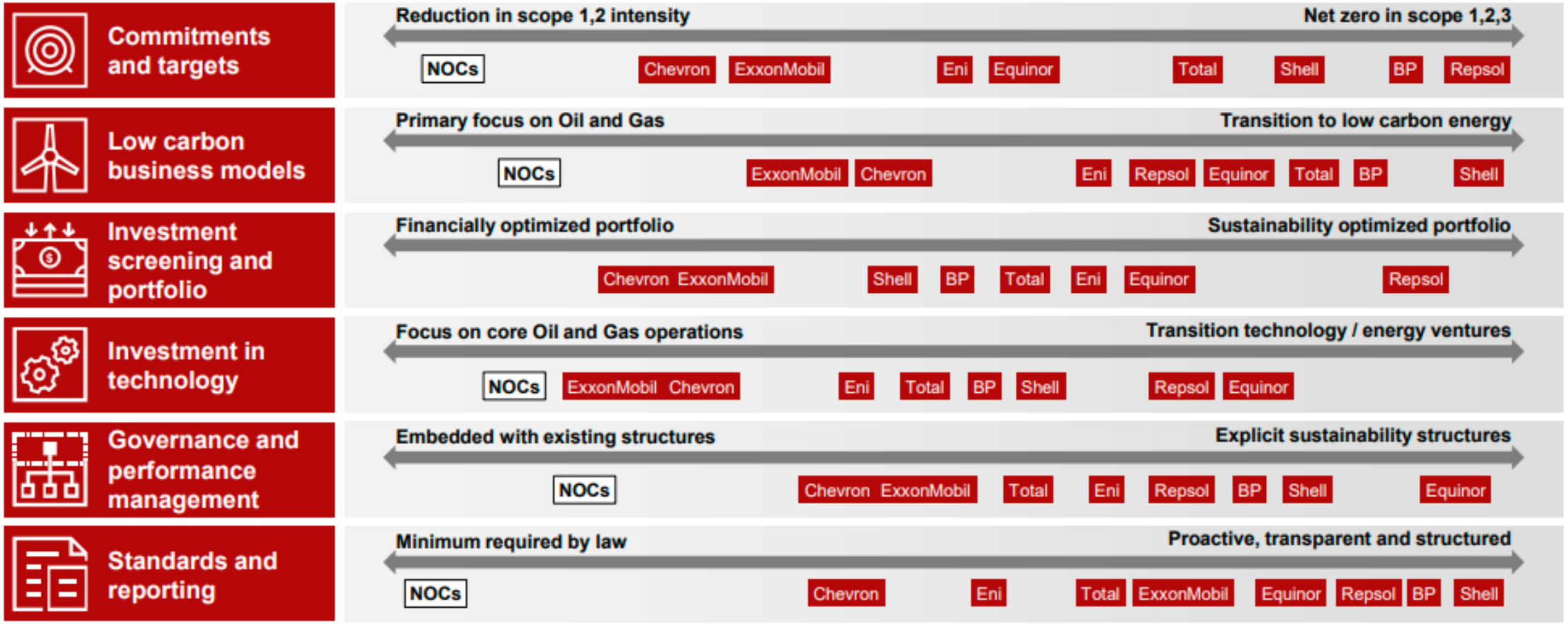
Source: Strategy& analysis

CLIMATE CHANGE – OIL&GAS COMPANY ACTIONS

	Emissions scope covered in announcements			
Company	Scope 1	Scope 2	Scope 3	GHG emissions or fossil fuel-related public ambitions or "targets"* (*renewables or forestry not included)
bp	✓	✓	✓	▪ Achieve net zero GHG emissions by 2050 across entire operations (scope 1 & 2) ▪ Net zero carbon oil & gas production by 2050 (scope 1, 2, 3) ▪ Reduce GHG intensity of all products it sells by 50% by 2050 ▪ Methane intensity target
Chevron	✓	✗	✗	▪ Reduce upstream oil net GHG emissions intensity by 5-10% ▪ Reduce upstream natural gas net GHG emission intensity by 2-5% by 2023 ▪ Methane intensity target
ConocoPhillips	✓	✓	✗	▪ Reduce GHG emissions intensity between 5% and 15% (CO_2 eq/boe) by 2030 vs. 2017
eni	✓	✓	✗	▪ Reduce upstream CO_2 intensity by 43% by 2025 vs. 2014 ▪ Reduce upstream fugitive methane emissions by 80% by 2025 vs. 2014 ▪ Net zero carbon footprint upstream by 2030 (Scope 1, on equity basis) ▪ Methane reduction target
equinor	✓	✓	✓	▪ Reduce intensity of Scope 1, 2 & 3 emissions by 50% by 2050 vs. 2020 ▪ Reduce GHG emissions incl. methane (Scope 1 & 2) in Norway by 40% by 2030, 70% by 2040 and to near zero by 2050 (reduce CO_2 eq/boe produced to 8kg by 2030) ▪ Methane intensity target
Exxon	✓	✗	✗	▪ Reduce methane emissions by 15% by 2020
REPSOL	✓	✓	✓	▪ Reduce absolute emissions by 3 Mt by 2025 (incl. Scope 3) ▪ Reduce methane emissions by 25% by 2025 ▪ Reduce carbon intensity by 10% by 2025 vs. 2016 (/GJ), 20% by 2030, 40% by 2040 ▪ Reduce net carbon emissions to zero by 2050 (scope 1, 2, 3)
Shell	✓	✓	✓	▪ Ambition to reduce the net Carbon Footprint of its energy products (scope 1,2,3) by 20% by 2035 and by 50% by 2050 (~40gCO_2e/MJ) ▪ Reduce carbon intensity by 2-3% by 2021 ▪ Methane intensity target
TOTAL	✓	✓	✓	▪ Reduce Scope 1 & 2 emissions to below 40 Mt by 2025 ▪ Routine flaring elimination by 2030 ▪ Reduce carbon intensity of energy products sold (scope 1, 2, 3) by 15% by 2030 vs. 2015 ▪ Methane intensity targets

CLIMATE CHANGE – OIL&GAS COMPANY ACTIONS

Strategic choices for Oil and Gas sustainability strategies



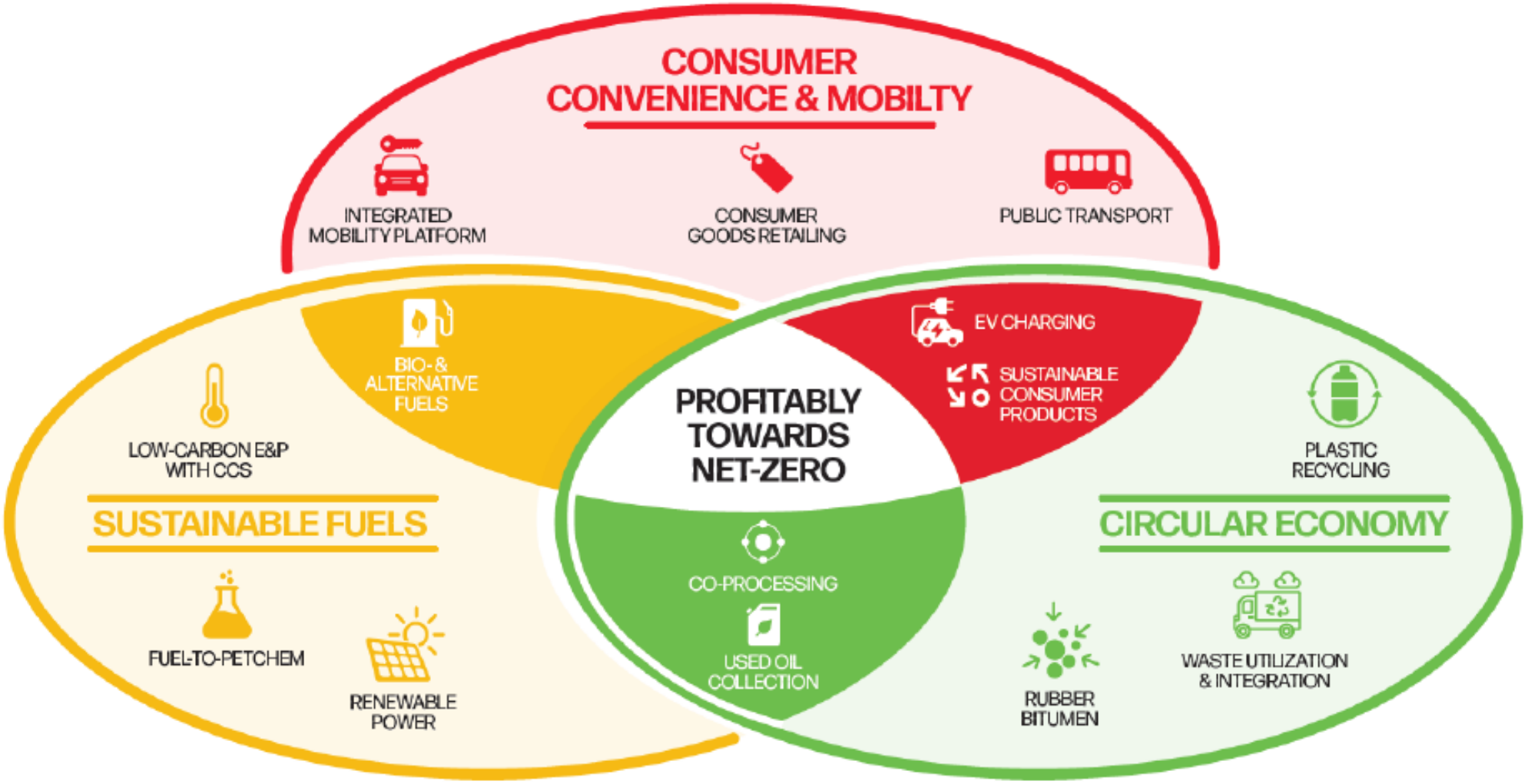
Sustainability strategies for Oil and Gas

Strategy&

Source: Strategy& analysis

MOL 2030+: PROFITABILITY TOWARDS NET ZERO

ACCELERATED LOW-CARBON TRANSITION



INVESTMENTS FOR FUEL QUALITY IMPROVEMENT

2000 2001 2002 2003 2004 2005 2006 2007 2008

HDS reconstruction

Residue Uprading project

Delayed Coker

Product Yield Improvement

EU 2005 Project

Product Quality Improvement

Production of exclusively 10 ppm S motor fuels 4 years before EU regulation

New Sulphur recovery unit

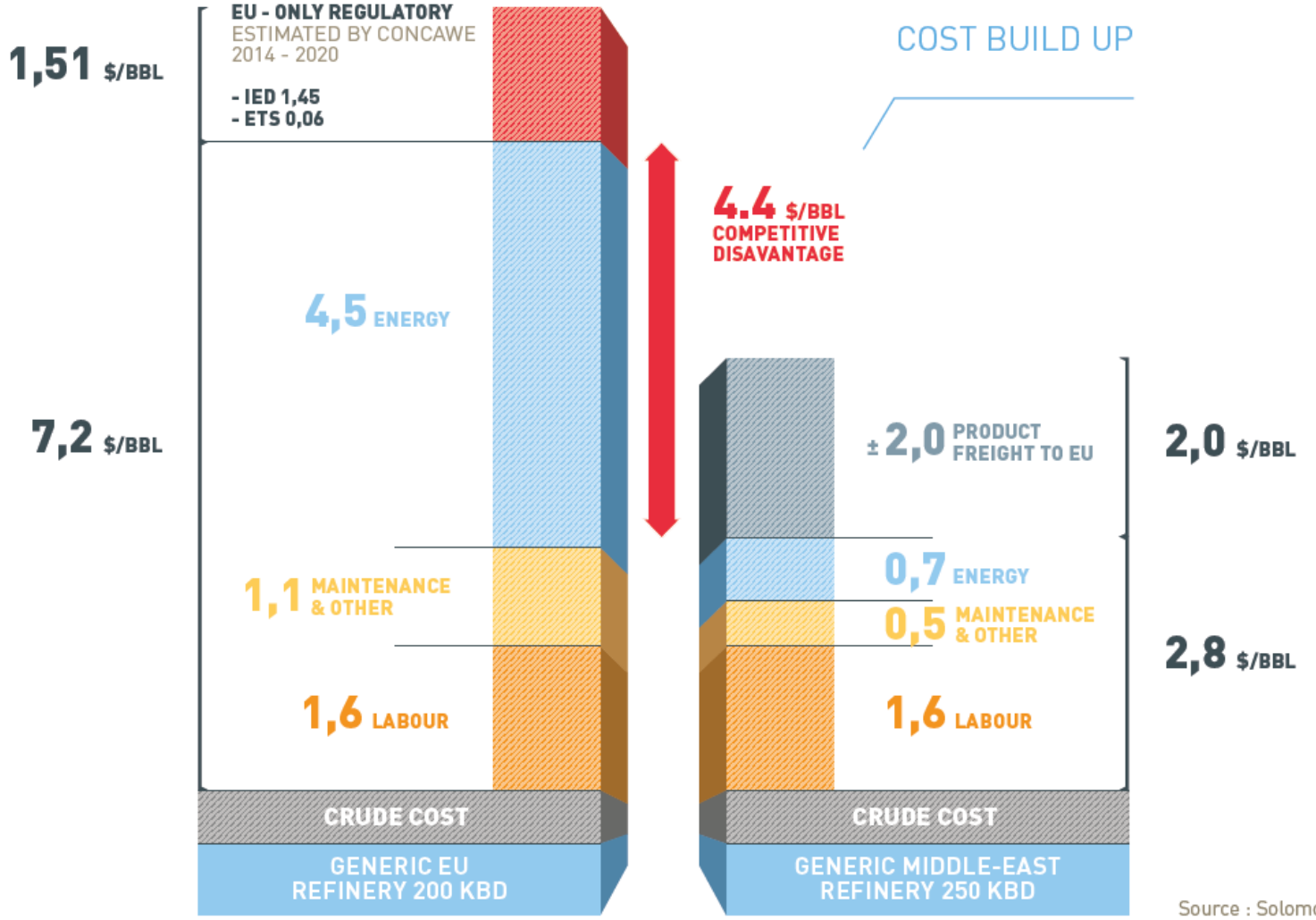
Direct Environmental Protection

Reconstruction of Waste incinarator

Waste Water Treatment

FCC flue gas filter

EFFECT OF „TOO MUCH" REGULATION



Source : Solomon 2014

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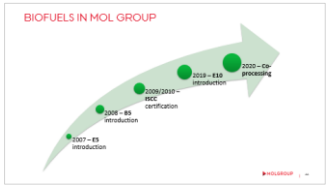
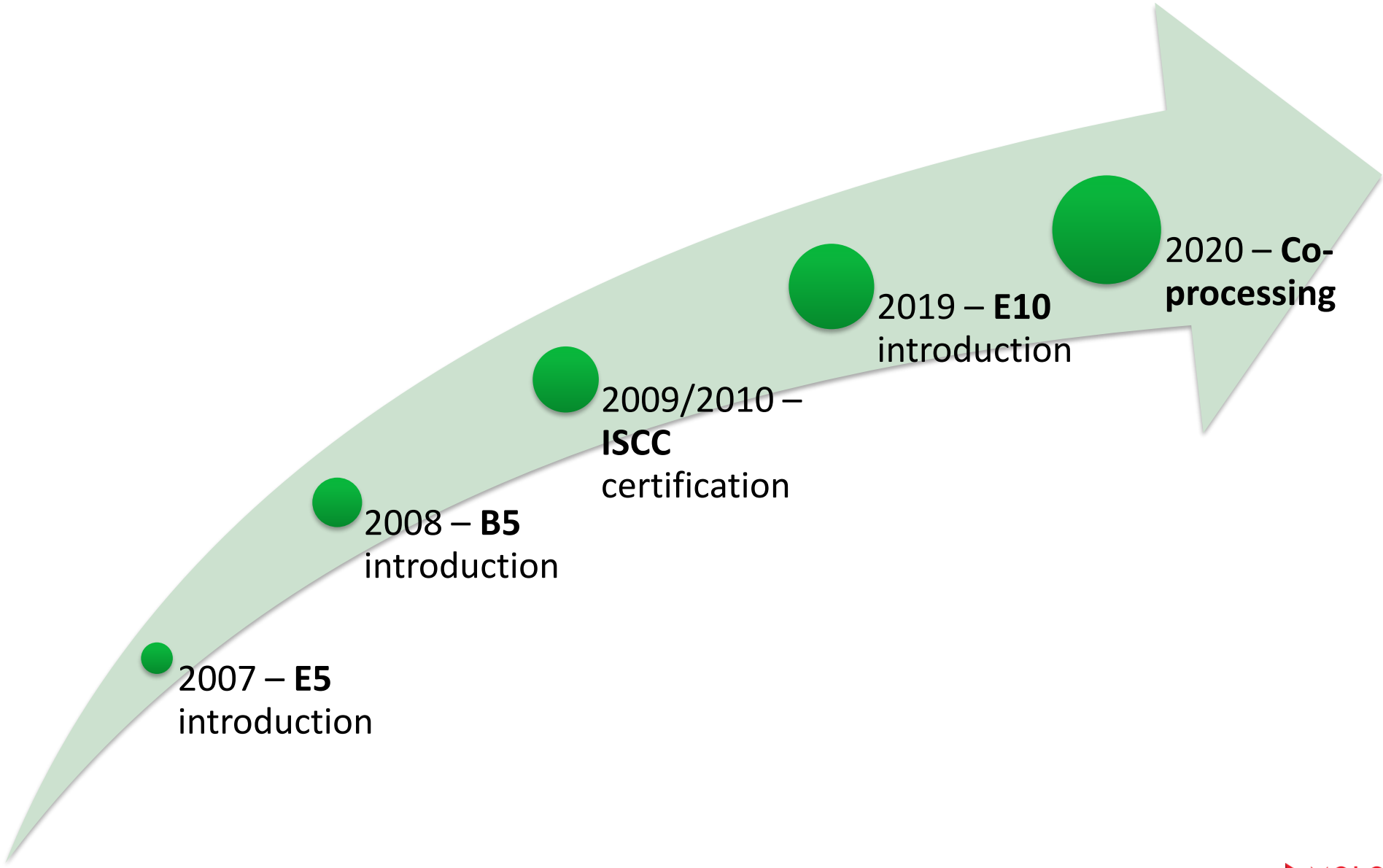


BIOFUELS IN MOL GROUP

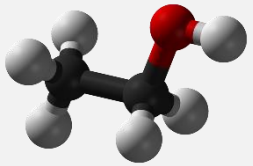


MAIN BIOFUELS USED IN MOL GROUP

Corn, wheat, sugarbeet…

Fermentation

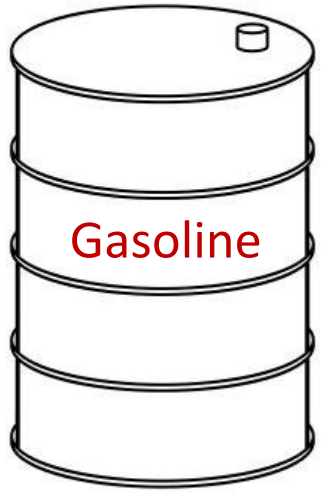
Bioethanol



~70% GHG saving

Max 10 v/v%

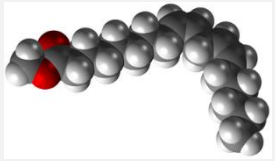
Max 5 v/v%



Sunflower seed oil, rapeseed oil, used cooking oil

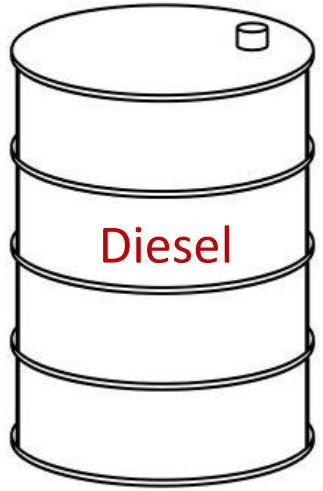
Transesterification

Biodiesel



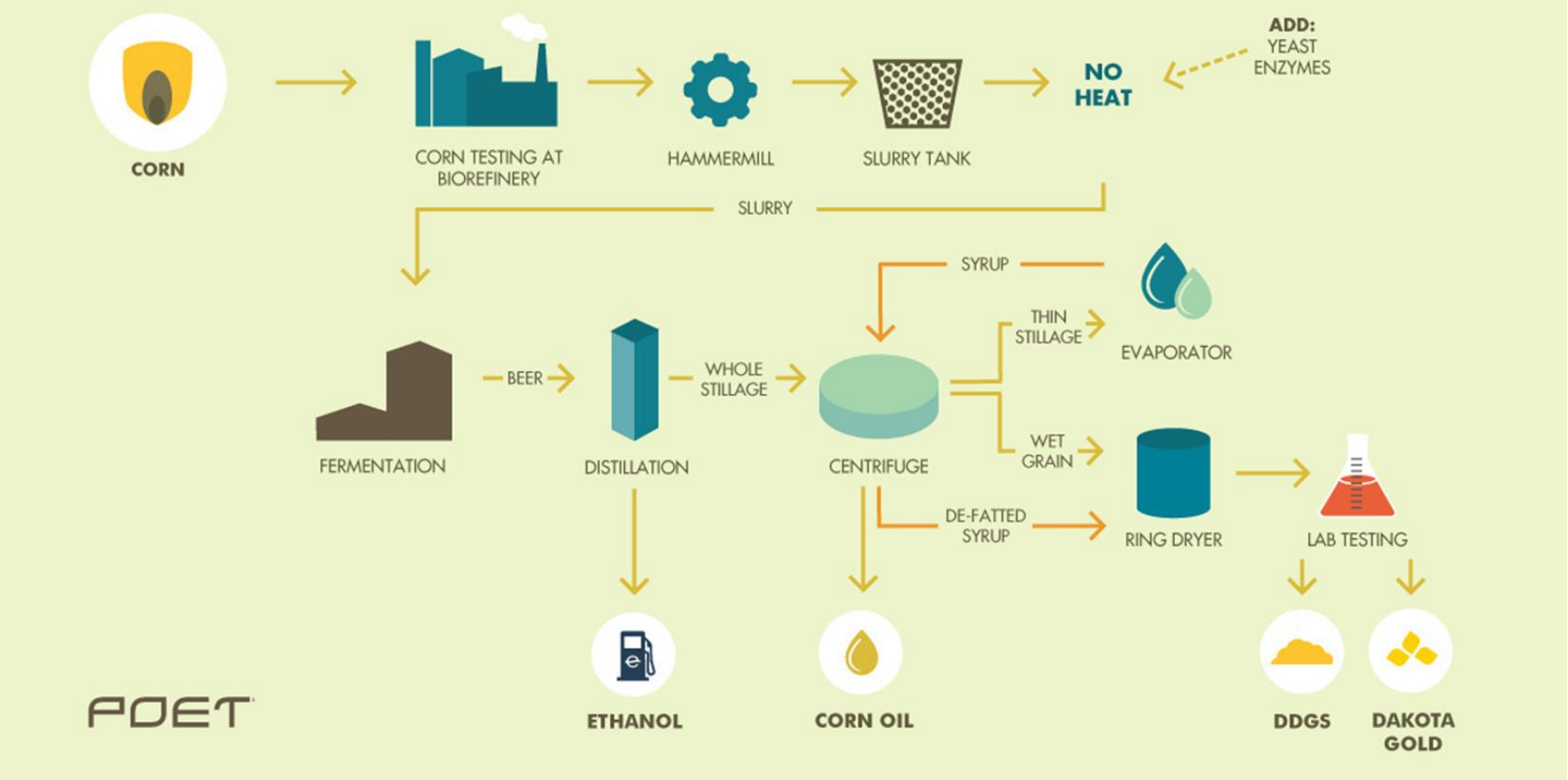
~60-90% GHG saving

Max 7 v/v%



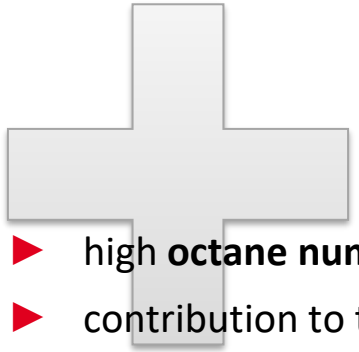
BIOETHANOL

- Ethanol is one of the oldest motor fuel – applied since 1887
- Ethanol blended into gasoline since 1976 in Brazil
- „Bioethanol” in terminology means fuel grade ethanol produced from bio origin



QUIZ 8

BIOETHANOL PROPERTIES

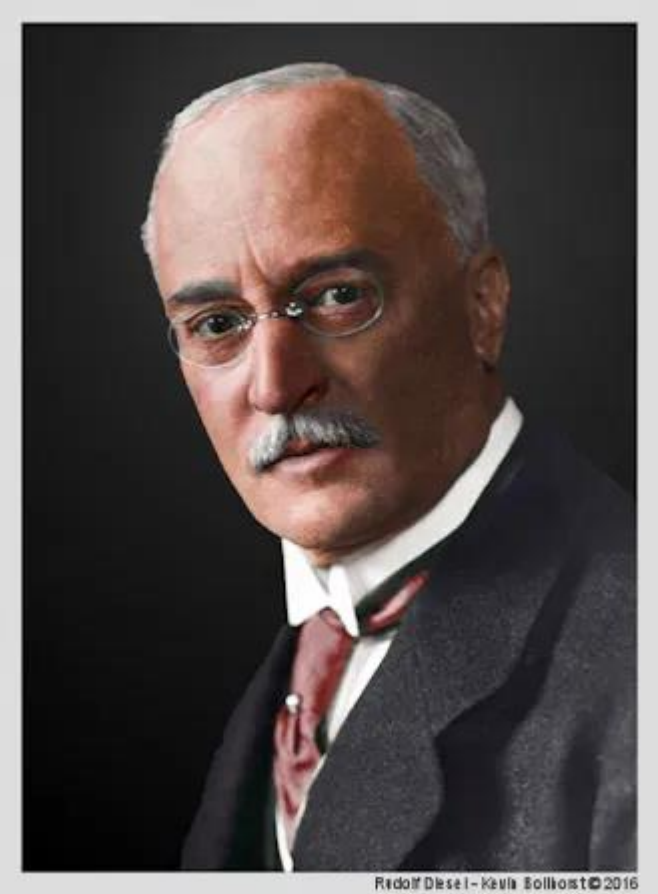


- high **octane number** (octane number increasing additive),
- contribution to the **reduction of the aromatic content** of gasolines,
- more **perfect combustion** (oxygen containing compound),
- **higher compression ratio**, efficiency and total performance,
- performance and torque increasing,
- the mixture has a higher volumetric energy content,
- lifetime of engine increases as a result of lower operating temperature,
- numerous **environmental advantages**,
- biodegradation,
- it is less toxic than methanol

- lower **energy content** relative to weight,
- in case of operating with pure ethanol the **consumption is higher** and the mechanical performance declines,
- new gasoline blending recapture must be applied because of high blending **vapour pressure**,
- high **evaporization emission**,
- **poor lubrication** (damages),
- **corrosion** (iron, steel, zinc etc., needs more corrosion inhibitor),
- phase stability problem if water is in the gasoline mixture,
- it can damage the blindings (elastomers), plastics,etc.

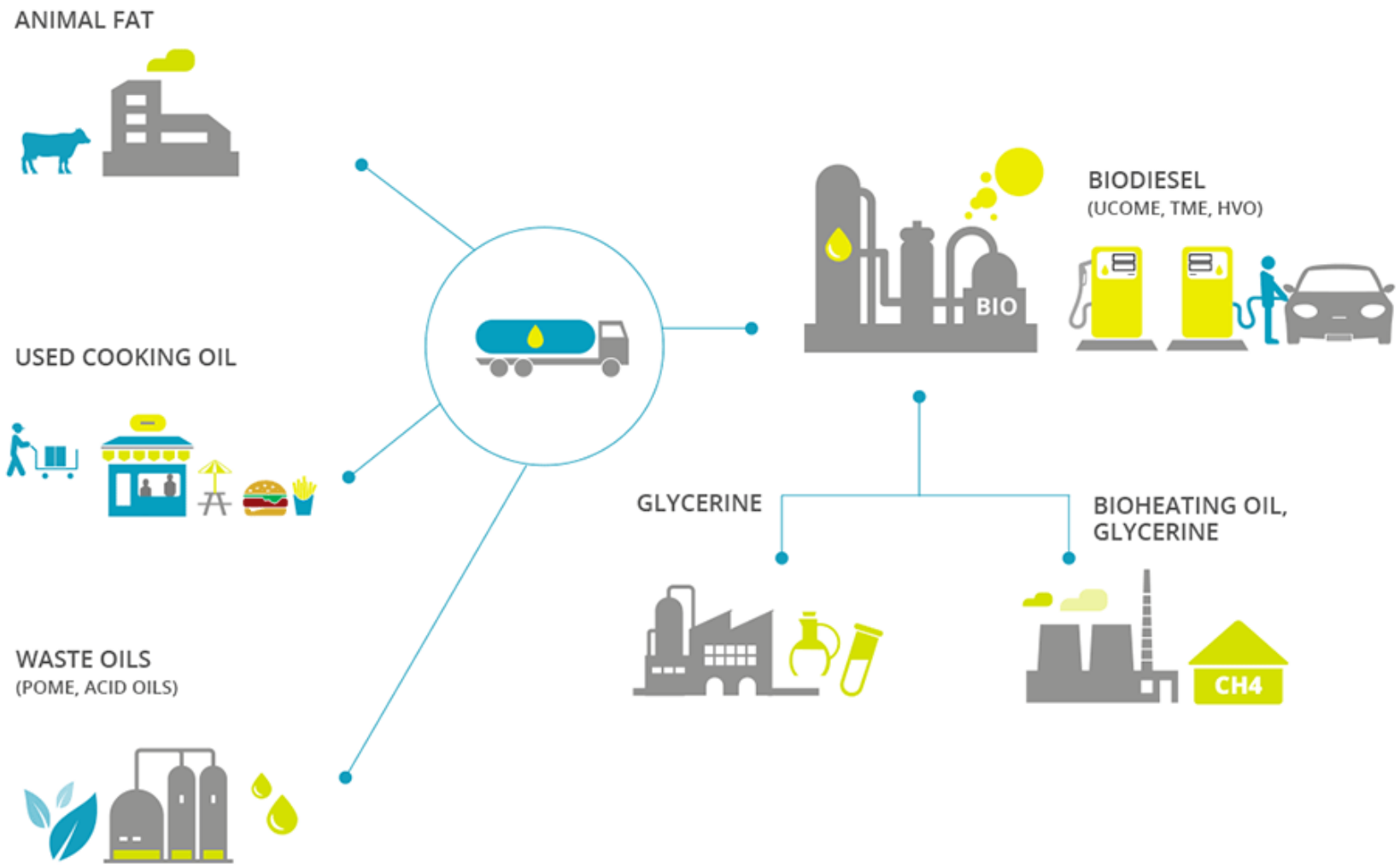
BIODIESEL

The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in course of time as important as petroleum and the coal tar products of the present time." **1912**



The concept of using vegetal oil as an engine fuel dates back to 1895 when **Rudolf Diesel (1858-1913) developed the first engine to run on peanut oil**, as he demonstrated at the World Exhibition in Paris in 1900. Unfortunately, R. Diesel died 1913 before his vision of a vegetable oil powered engine was fully realized.

BIODIESEL PRODUCTION PROCESS



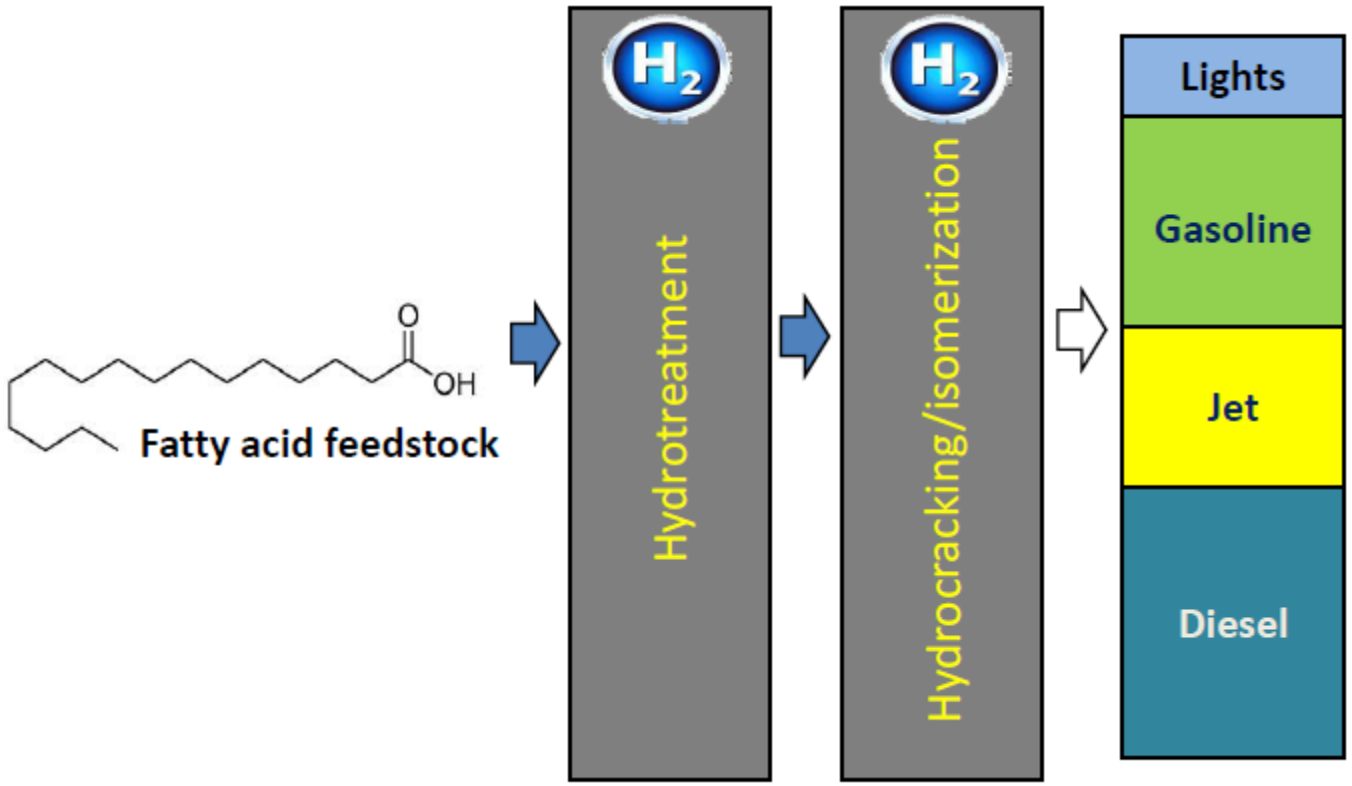
QUIZ 9

BIODIESEL PROPERTIES

- Produced from **renewable materials** – eco friendly / closed CO2 cycle.
- Local & self production – **less reliance on foreign oil**.
- Contains practically **no sulfur** (0.001%) – non toxic.
- Considerably decreases emissions (up to 50%).
- Easily decomposes – does not harm soil or ground water.
- Increased **lubricity**
- Biodiesel is **not hazardous** material (flashpoint above 110C).
- Eligible as fuels under international standards & specifications (world-wide).

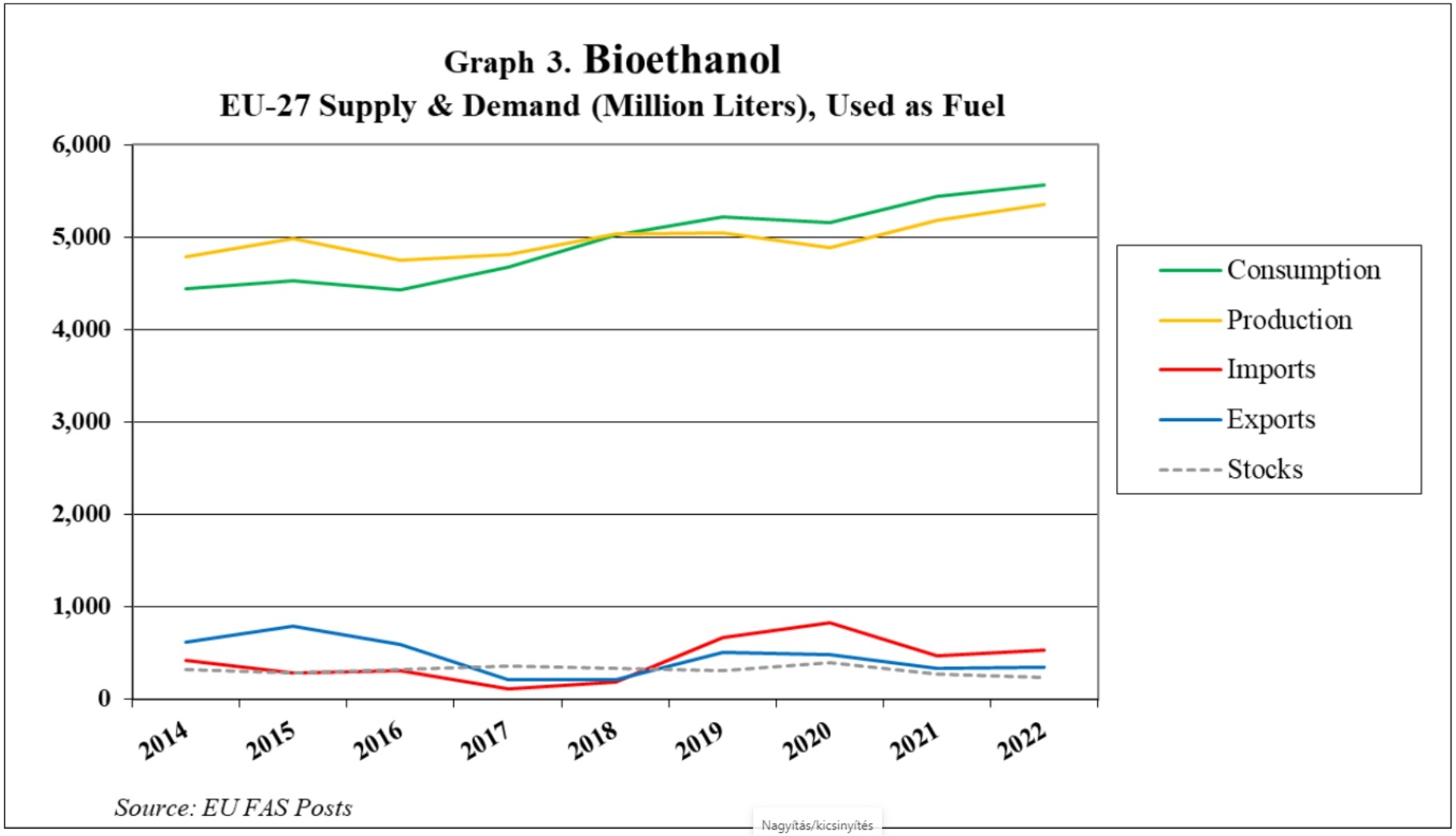
- high unsaturated content (causing bad thermal-, oxidation-,and thus **storage stability**),
- high **water content** (corrosion problems),
- ester bond sensitivity to hydrolysis (poor storage
- stability),
- unfavorable cold properties (**CFPP**),
- **low energy content**,
- methanol content (toxic),
- higher cost compared to the conventional, crude oil based gas oil etc.

HYDROTREATED VEGETABLE OIL



- HVO fulfills EN590 standard except density
- No blending limit defined in fuel standard
- High cetane number
- Energy density higher than diesel (44 MJ/kg)
- Can potentially use same feedstock as Biodiesel production
- Has high market price

BIOETHANOL SUPPLY & DEMAND

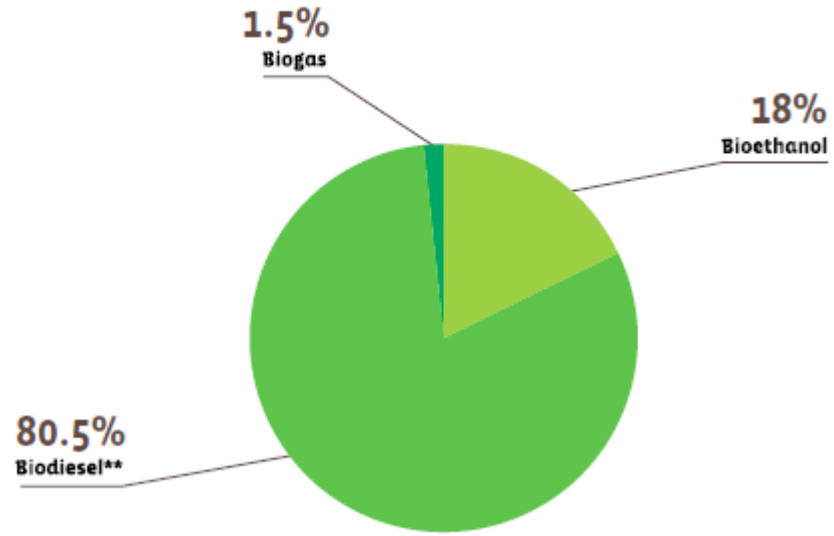


EU BIOFUEL CONSUMPTION

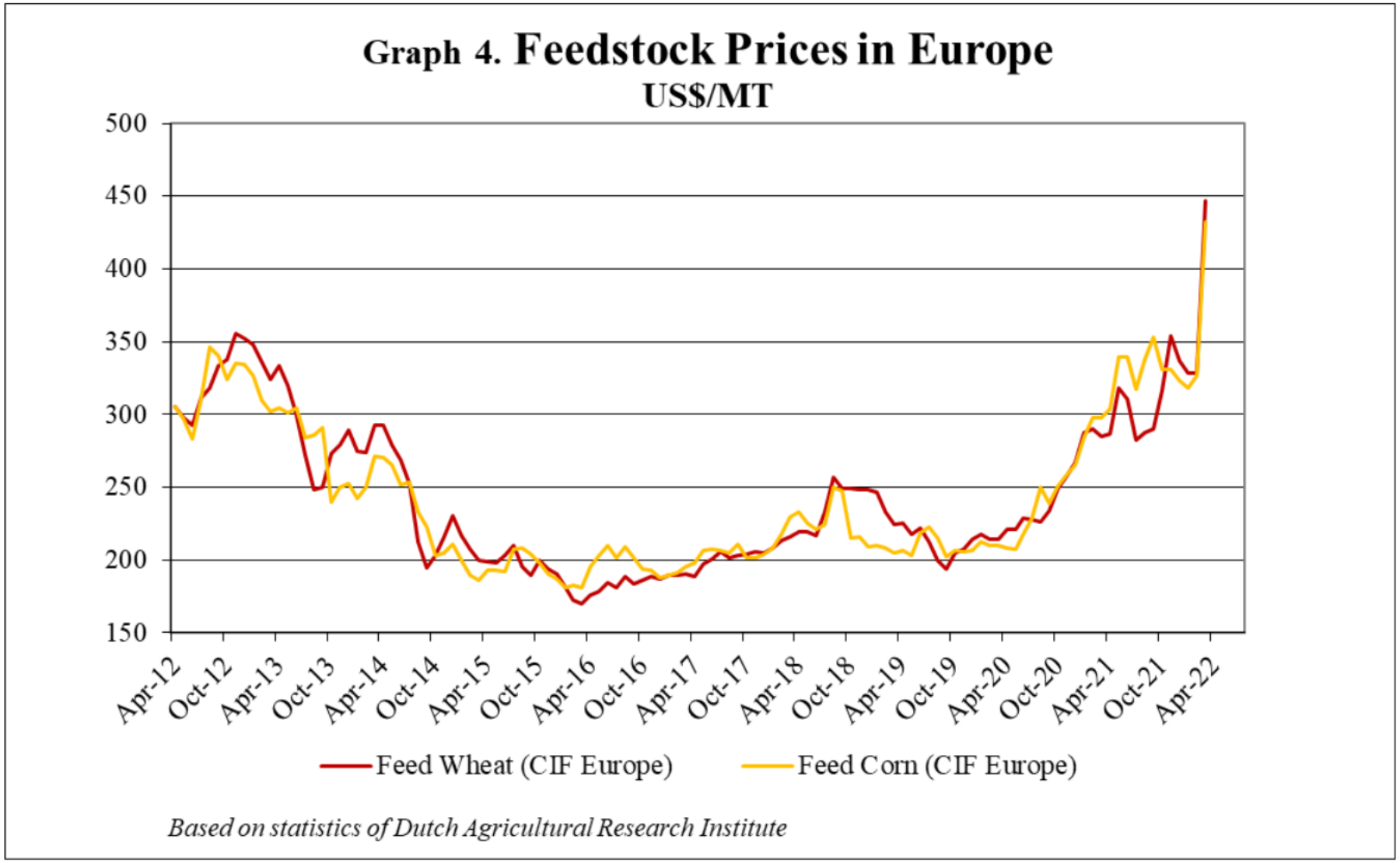
European Union (EU-28, EU-27) biofuel (liquid and biogas) consumption trends **for transport in ktoe.**

Estimation. **Compliant and no compliant biofuels.* **Sources : data from 2004 to 2017 (Shares 2020); 2018-2019 (EurObserv'ER 2020)

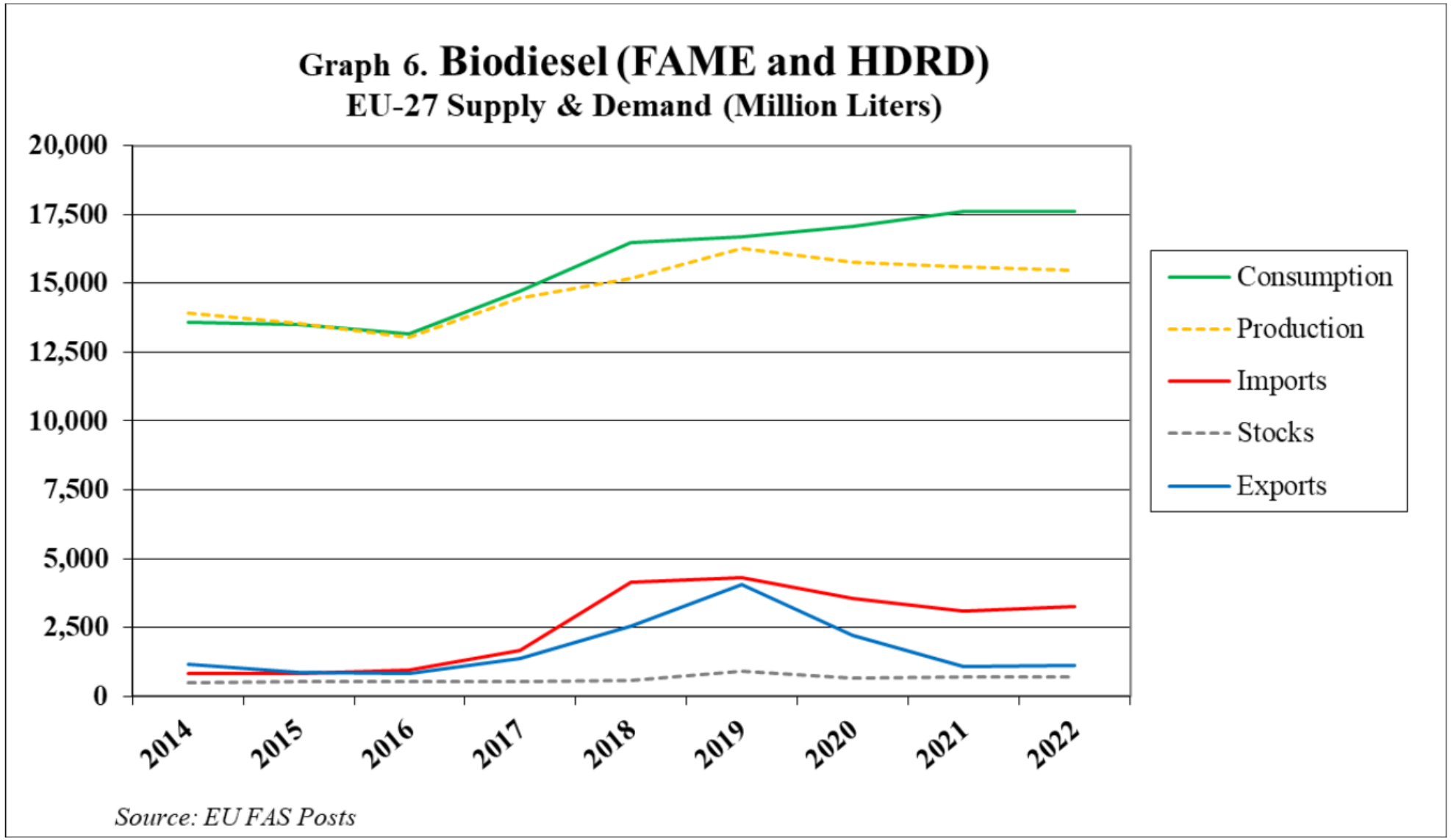
Breakdown of total EU 2019 biofuel consumption*
in energetic content for transport by biofuel type in EU28



BIOETHANOL FEEDSTOCK PRICES

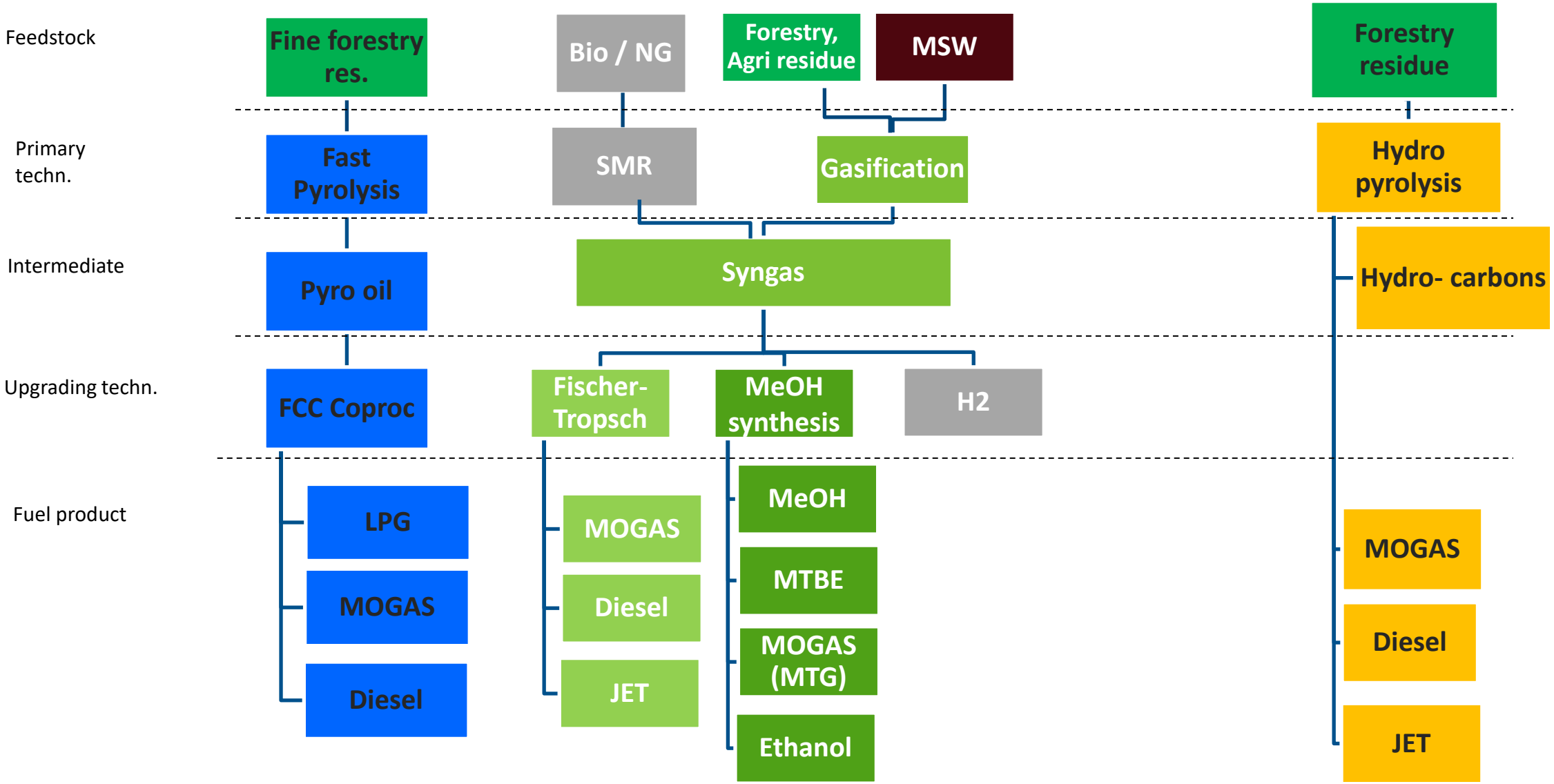


BIODIESEL SUPPLY & DEMAND

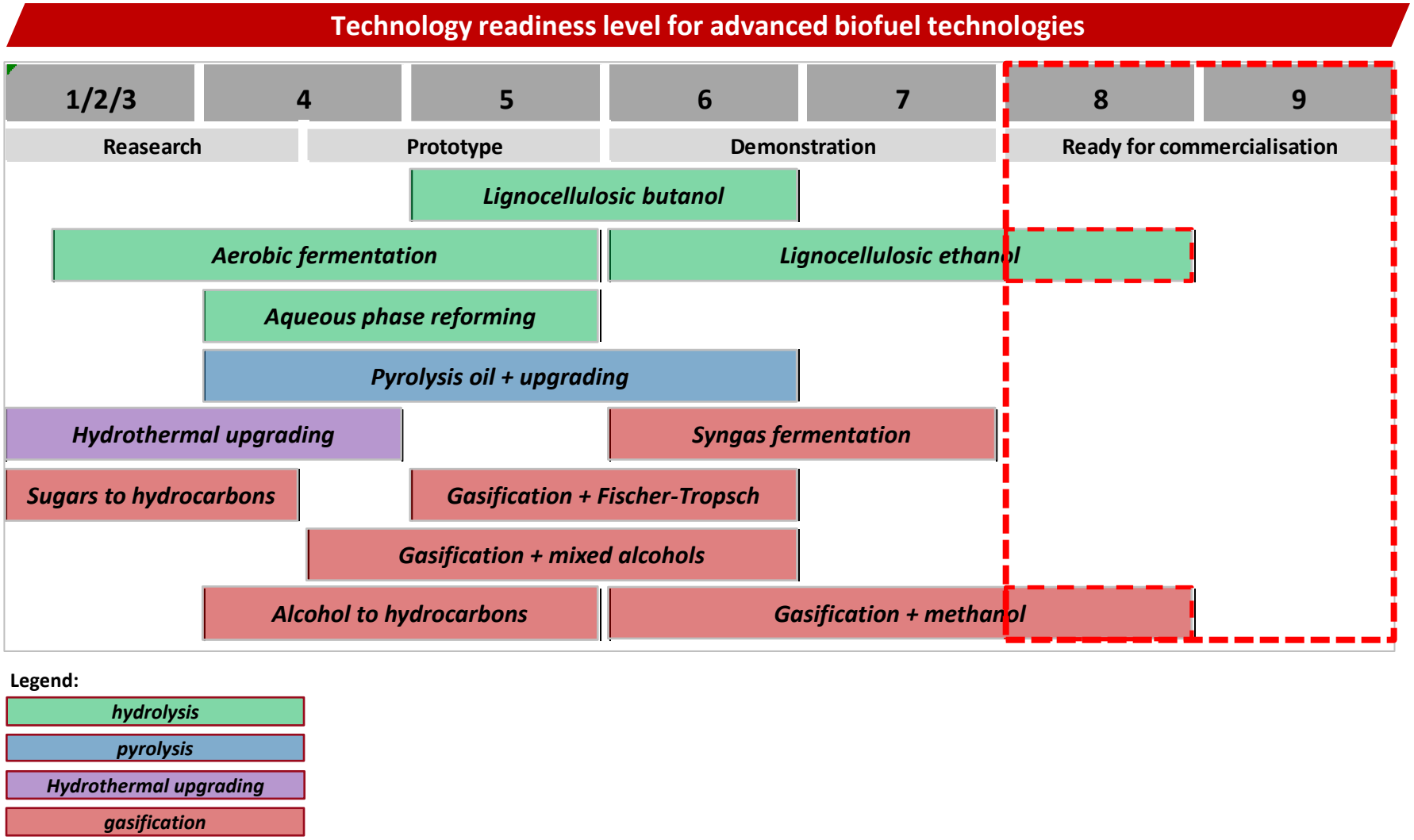


QUIZ 10

GHG EMISSION TREND BY SECTOR



ADVANCED BIOFUEL TECHNOLOGIES



Source: CONCAWE & International Renewable Energy Agency (IRENA) – Innovation outlook advanced liquid biofuels

CHALLENGING FEEDSTOCK LOGISTICS

CONVENTIONAL ETHANOL

~150kt feedstock

50kt ethanol

ADVANCED ETHANOL

~250kt feedstock

50kt ethanol
(advanced)

CO-PROCESSING

- Biofuel mandates are increasing (2020: 10 e%; 2030: 14 e%)
- Compliance is limited in fuel blending (max. level: 10 v% Ethanol; 7 v% Biodiesel – FAME/UCOME)
- Solutions over blending limit: Co-processing or pure Hydrotreated Vegetable Oil (HVO)
- Co-pro started in Danube Refinery in Q1 2020

Biofuel blending

Refinery

Crude oil →  → **Products blended with bio**

Biofuel

Co-processing

Refinery (hydrotreater unit)

Crude oil →  → **Product with bio (HVO) content**

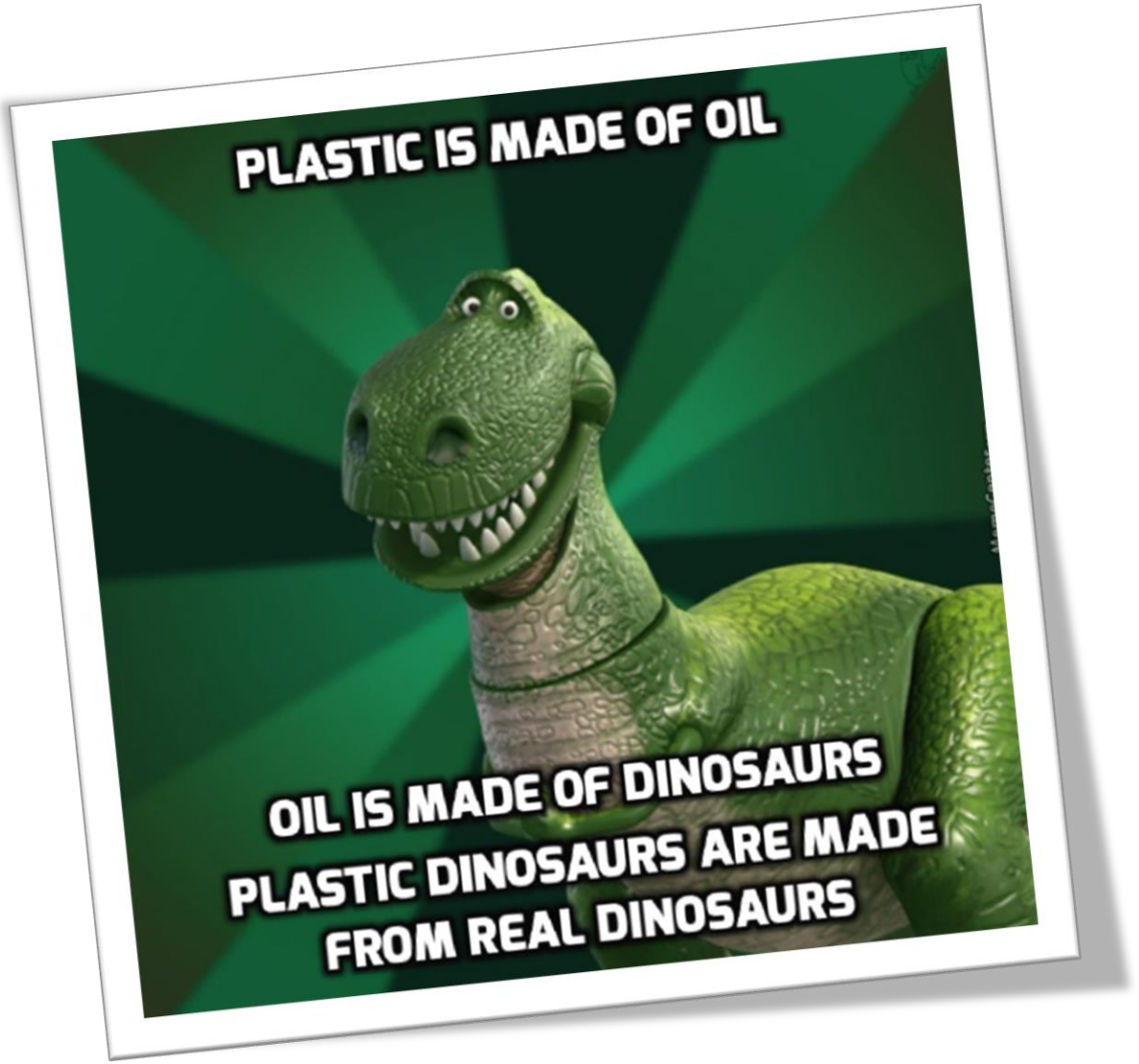
Bio-feed

- Feedstock options: vegetable oil, waste oil, animal fat or advanced oil
- Production capacity: ~20-70kt of Co-pro HVO

Co-pro feedstock unloading

QUIZ 11

THANK YOU FOR YOUR ATTENTION!



BACK-UP

what are the scopes of carbon emissions?

scope 1

PFCS SF6 CH4 CO2 HFCS N2O

GREENHOUSE GAS EMISSIONS

Scope 1 emissions are direct greenhouse (GHG) emissions that occur from sources that are controlled or owned by an organization (e.g., emissions associated with fuel combustion in boilers, furnaces, vehicles).

SOURCE: EPA.GOV

SCOPE 1
Direct Emissions from Reporting Company

scope 2

CH4 CO2 PFCS SF6 N2O HFCS

GREENHOUSE GAS EMISSIONS

Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling and are a result of the organization's energy use.

SOURCE: EPA.GOV

SCOPE 2
Indirect Emissions from Upstream Activities

scope 3

CO2 CH4 SF6 PFCS HFCS N2O

GREENHOUSE GAS EMISSIONS

SCOPE 3
Indirect Emissions from

Upstream Activities
Purchased Goods & Services
Capital Goods
Fuel & Energy Related Activities
Transportation & Distribution
Waste Generated in Operations
Business Travel
Employee Commuting
Leased Assets
and...

Downstream Activities
Transportation & Distribution
Processing of Sold Products
Use of Sold Products
End-of-Life Treatment of Sold Products
Leased Assets
Franchises
Investments

Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

SOURCE: EPA.GOV

greenworldwide SHIPPING