



# EU Trends and Legislation on Carbon Neutral Energy Carriers

Waseda Symposium 2022

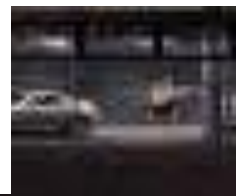
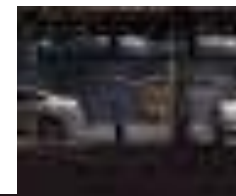
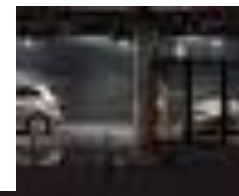
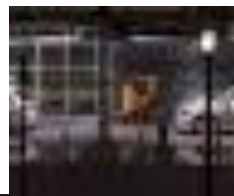
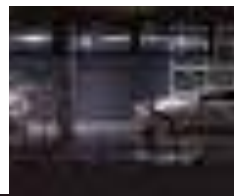
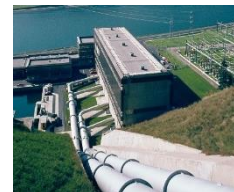
G. Fraidl

# Efficient & Robust CO<sub>2</sub> Reduction and Energy Supply

## 1. Primary Energy Supply

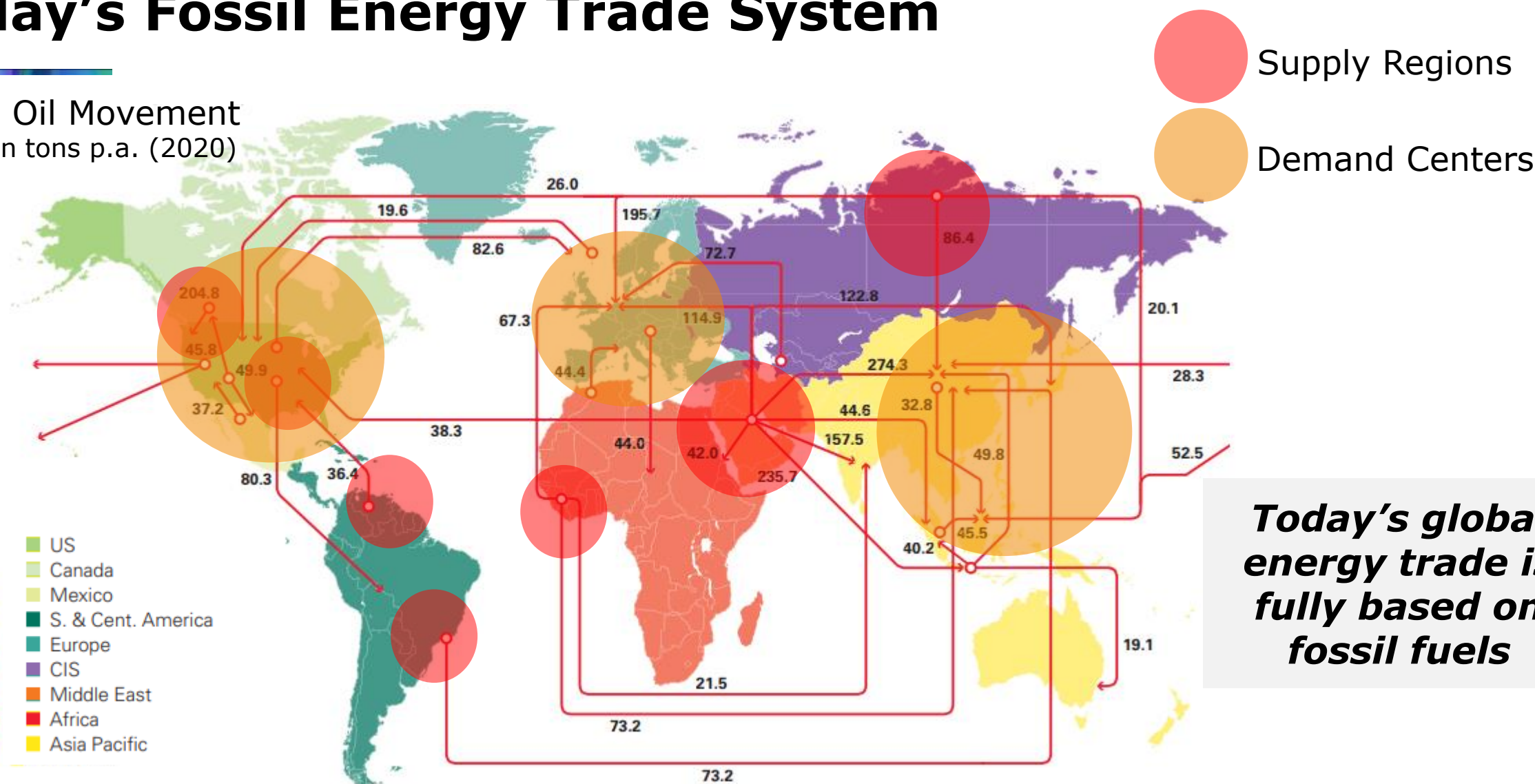
## 2. Energy Carrier / Infrastructure

## 3. Vehicle Portfolio



# Today's Fossil Energy Trade System

Crude Oil Movement  
in Million tons p.a. (2020)

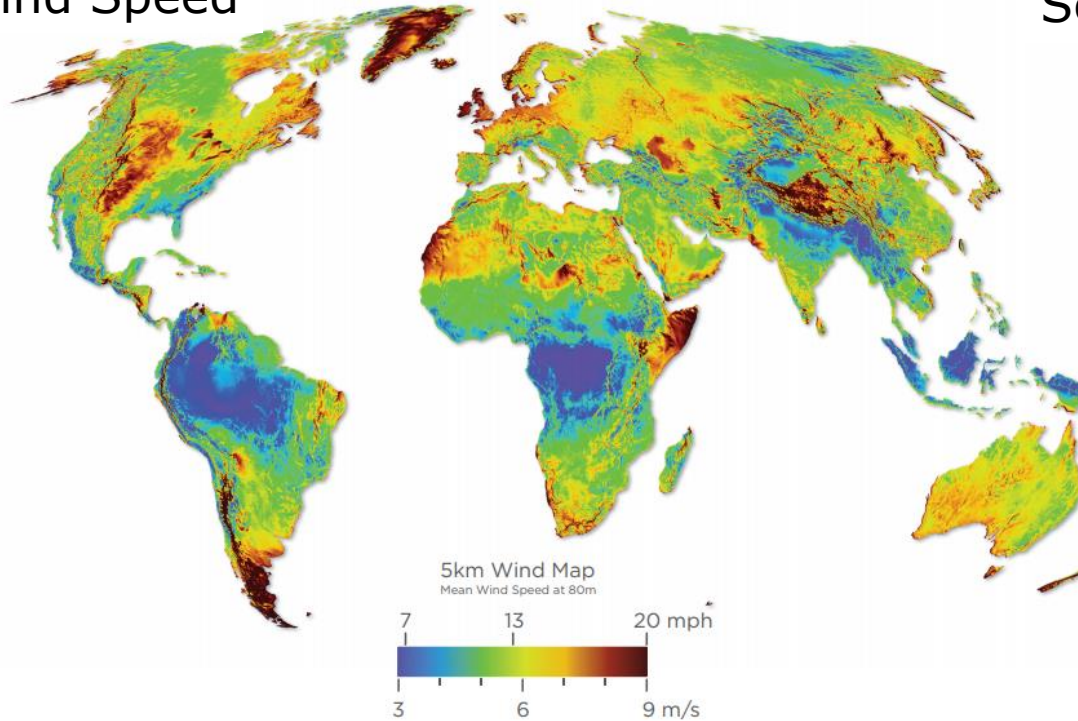


Source: Source: BP Statistical Review of World Energy 2021  
Page 35: <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf>

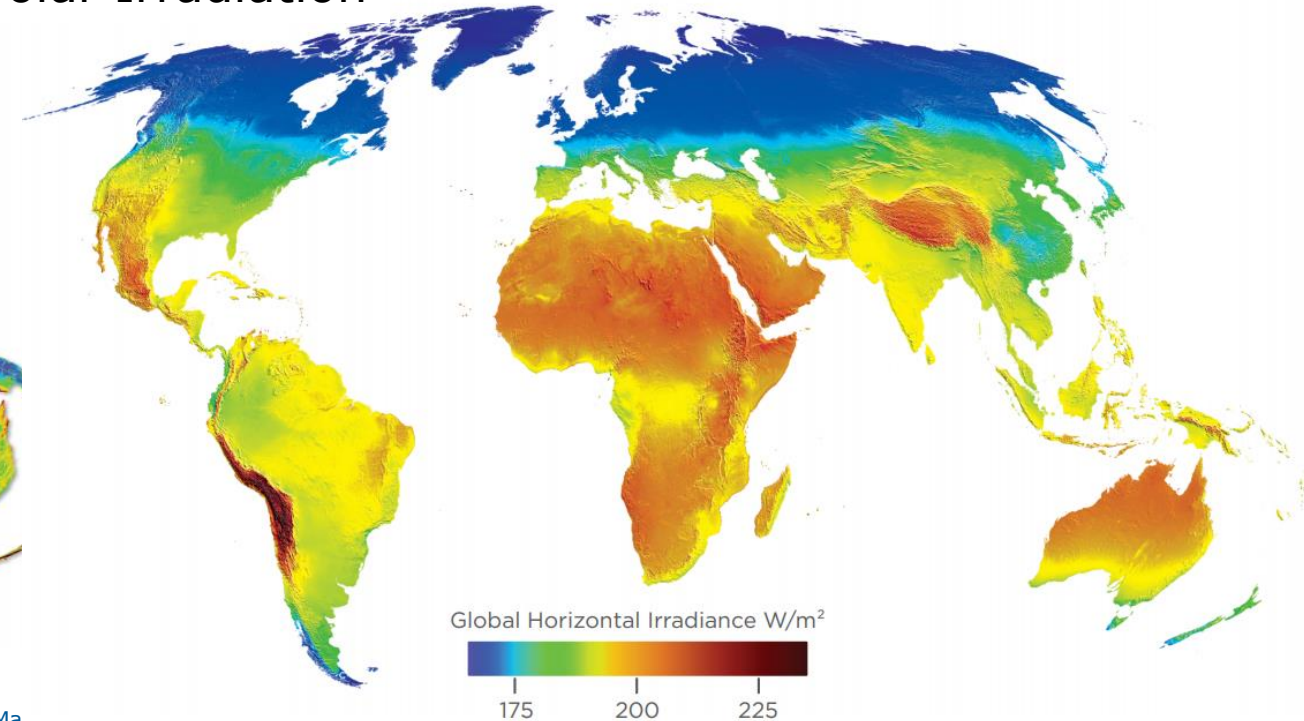


# The Challenge: Storage and Transport of Wind and Solar Energy

Wind Speed



Solar Irradiation

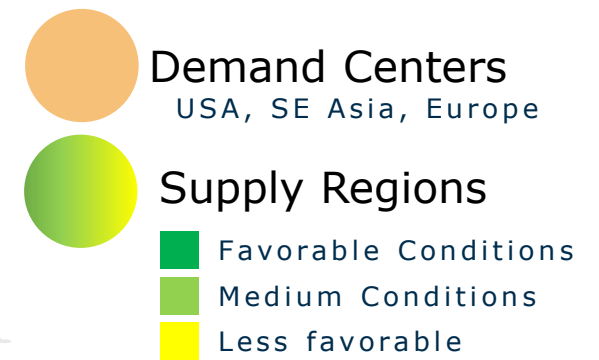


Source:

[https://www.vaisala.com/sites/default/files/documents/Vaisala\\_global\\_wind\\_map.pdf?utm\\_content=Wind-Ma](https://www.vaisala.com/sites/default/files/documents/Vaisala_global_wind_map.pdf?utm_content=Wind-Ma)  
[https://www.vaisala.com/sites/default/files/documents/Vaisala\\_global\\_solar\\_map.pdf?utm\\_content=Solar-Ma](https://www.vaisala.com/sites/default/files/documents/Vaisala_global_solar_map.pdf?utm_content=Solar-Ma)

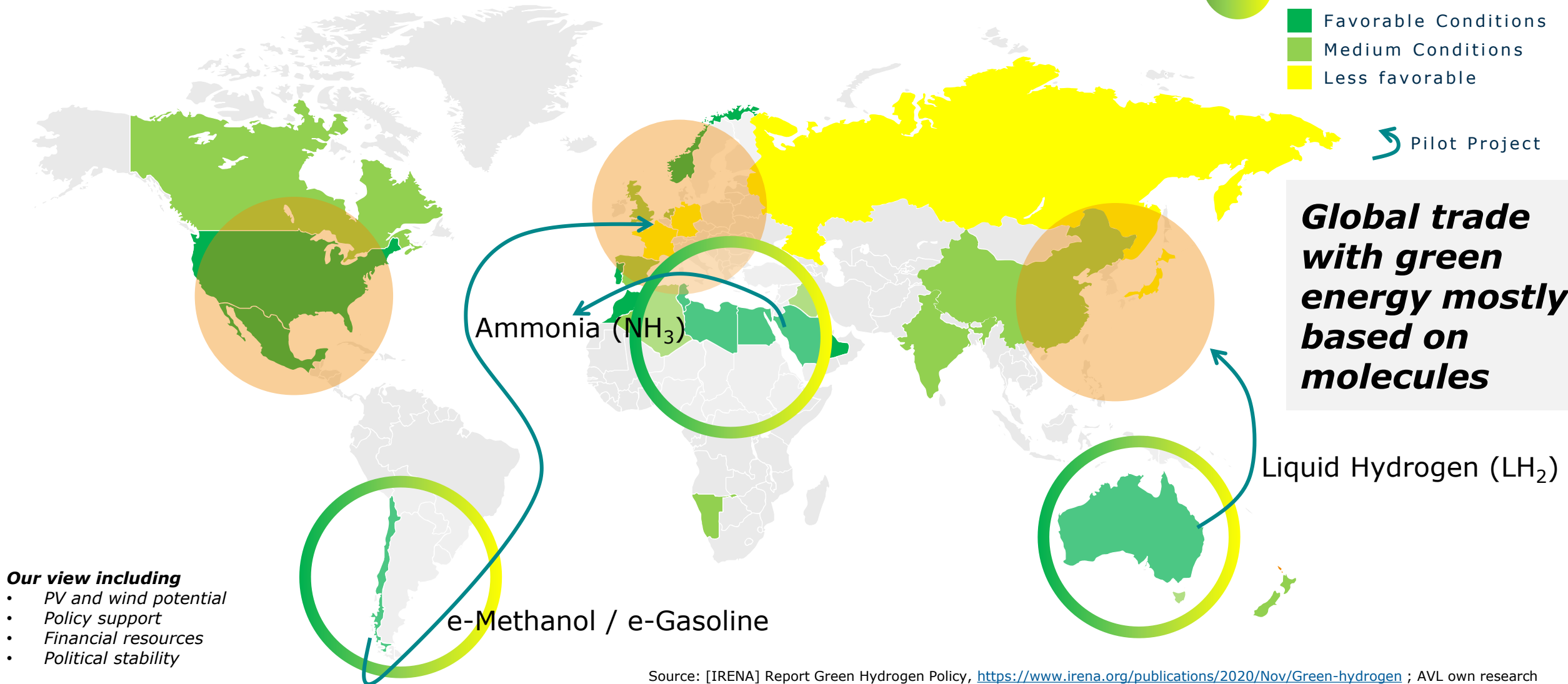
***Production Potential is located far away from Demand Centers***

# Energy Trade Future: Green Hydrogen Production and Demand



 Pilot Project

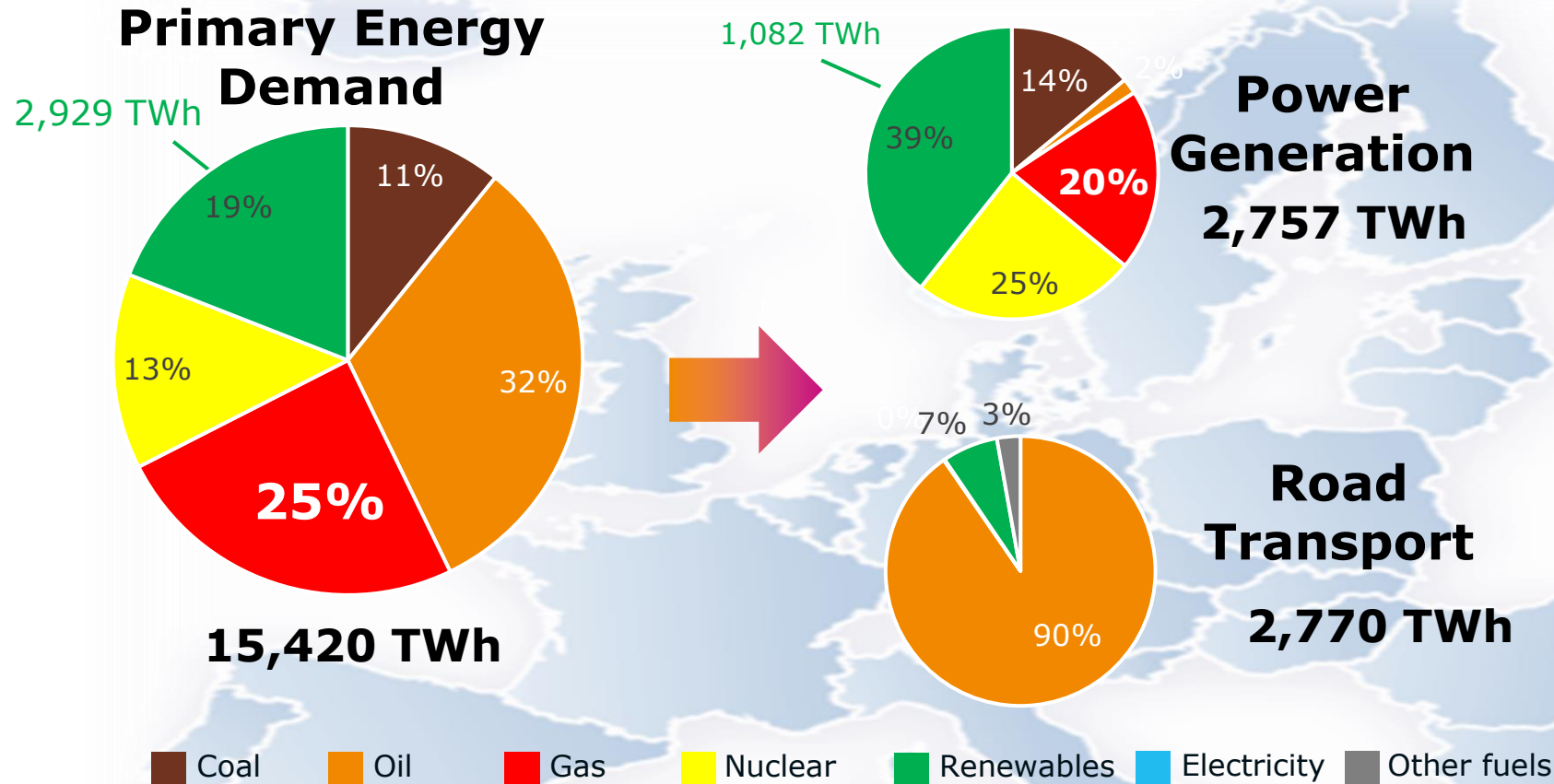
***Global trade  
with green  
energy mostly  
based on  
molecules***



- Our view including**
- PV and wind potential
  - Policy support
  - Financial resources
  - Political stability

Source: [IRENA] Report Green Hydrogen Policy, <https://www.irena.org/publications/2020/Nov/Green-hydrogen> ; AVL own research

# EU Energy Demand 2020



**40% of Gas  
and  
27% of oil  
came from  
Russia**

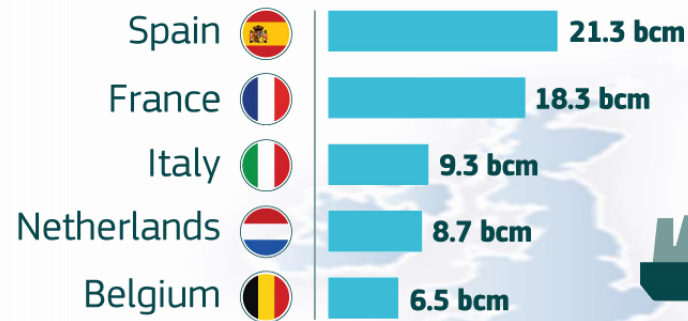
Source: IEA WEO 2021, EUROSTAT

***Ukraine War impacts reveal deficiencies of EU energy & CO<sub>2</sub> strategy***



# EU LNG Imports versus Russian Gas

## Biggest LNG importers in the EU in 2021

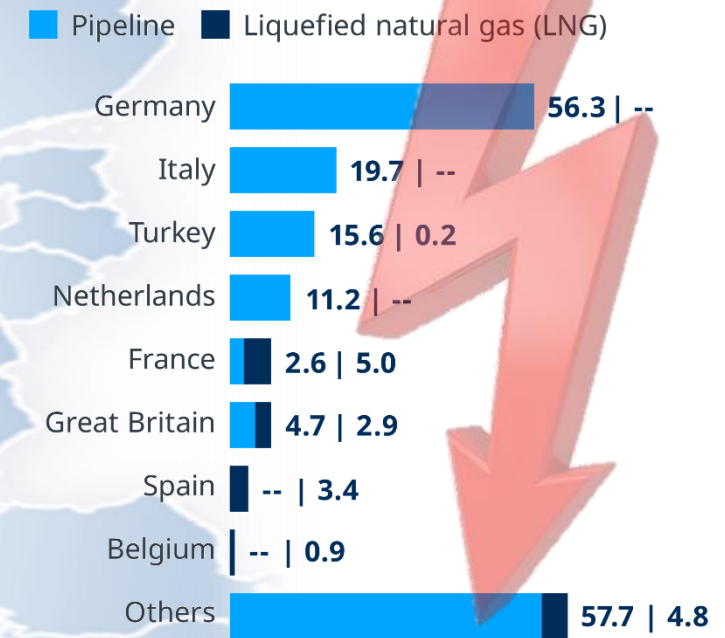


Sources: European Commission, April 2022, [Link](#)

- 20 large-scale LNG terminals now in operation and connected to the grid
- US committed to increase its LNG export volumes for the EU market with an additional 15 bcm this year, and up to 50 bcm annually by 2030

## Volume of Russian gas supply to Europe in 2020

In billions of cubic meters



European total : 167.7 | 17.2



Source: Statista | Daten: BP

**For supply security EU will increase share of LNG to reduce Russian gas via pipeline**

# Primary Energy Path #1

## Hydrogen from Sun – MENA\*) Use Case



Source: Transmed Pipeline (Algeria-North Italy) 2500km  
<https://de.wikipedia.org/wiki/Transmed>

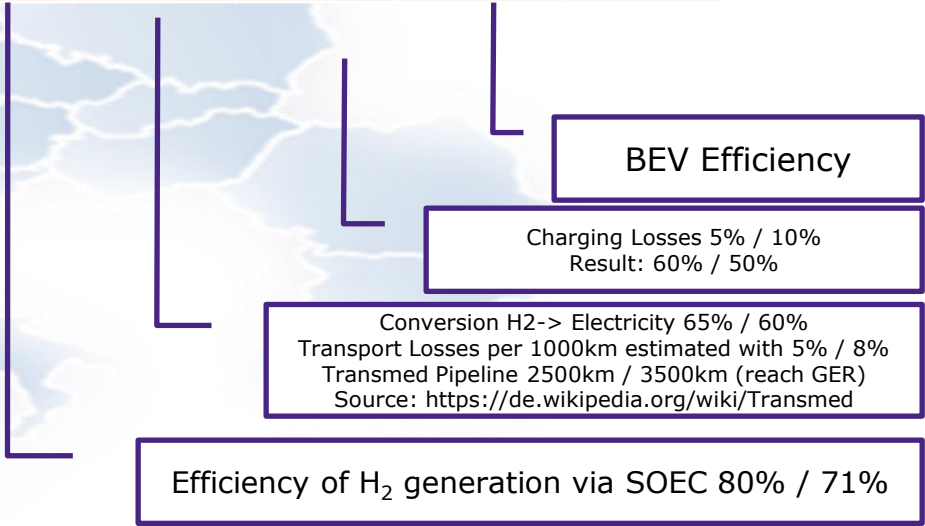
\*) MENA ... Middle East and North Africa

### Assumption:

- H2 generated in MENA (MiddleEast-NorthAfrica)
- transport via pipeline to Europe
- converted back to Electricity

### Wirkungsgradkette / Efficiency Chain

		Plug	Fuel Processing	Transport / Storage	Charging / Refuelling	Tank-to-Wheel	Vehicle efficiency
BEV	BEV best case from H2	100.0%	80.0%	42.0%	39.9%	35.1%	31.6%
(el. from H2)	BEV worst case from H2	100.0%	71.0%	22.7%	19.3%	15.8%	12.7%



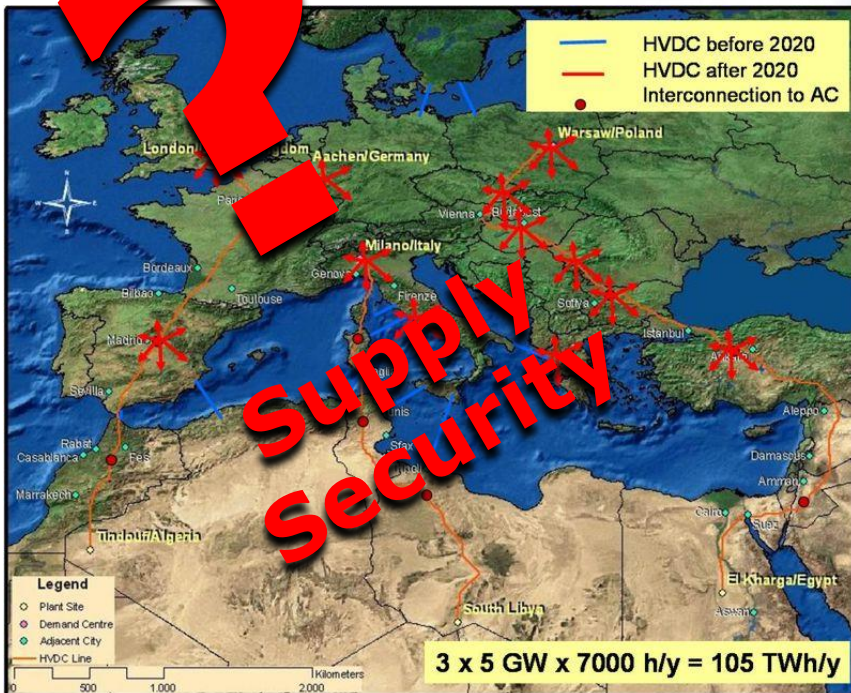


# Primary Energy Path #2

## High-Voltage DC Lines

### Desertec Industrial Initiative (Dii)

- Target: Providing 20% of Europe's electricity by 2050 through solar- and windfarms in Middle East and North Africa (MENA) region.
- Connected to continental Europe via special high voltage, direct current transmission cables.
- Tentative total cost of this project has been estimated at €400 bn (\$400 bn). High costs were the main obstacle



### Morocco-IK Power Project

- 3.6GW solar & wind in Morocco
- Clean power to 7Mio.homes in UK by **2030**
- Four cables, each 3,800km long form the twin 1.8GW High Voltage Direct Current (HVDC) subsea cable systems
- £16bn costs (19bn€)
- Target £48 per MW (57€ per MW)

Depending on voltage level and construction details, **HVDC transmission losses** are quoted at 3.5% per 1,000 km, about 50% less than AC (6.5%) lines at the same voltage. [Link](#)



Source: <https://xlinks.co/>

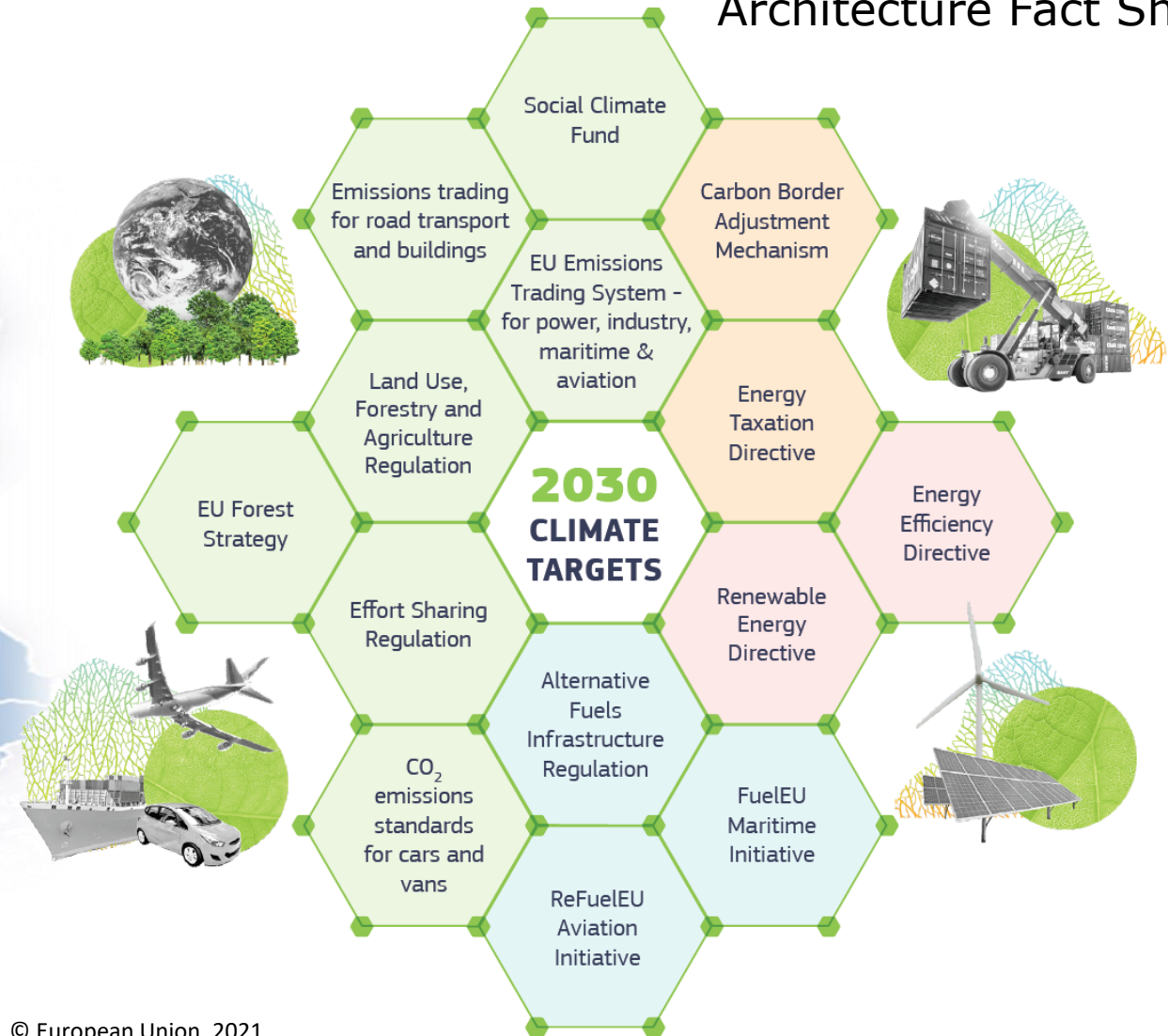
# Delivering the European Green Deal - The Decisive Decade

## "Fit for 55"

The EU will **reduce its net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels.\*

\*As agreed in the EU Climate Law. On 14 July 2021, the Commission presented proposals to deliver these targets and make the European Green Deal a reality.

## Architecture Fact Sheet



© European Union, 2021

# European Green Deal Tank-to-Wheel

## Architecture Fact Sheet

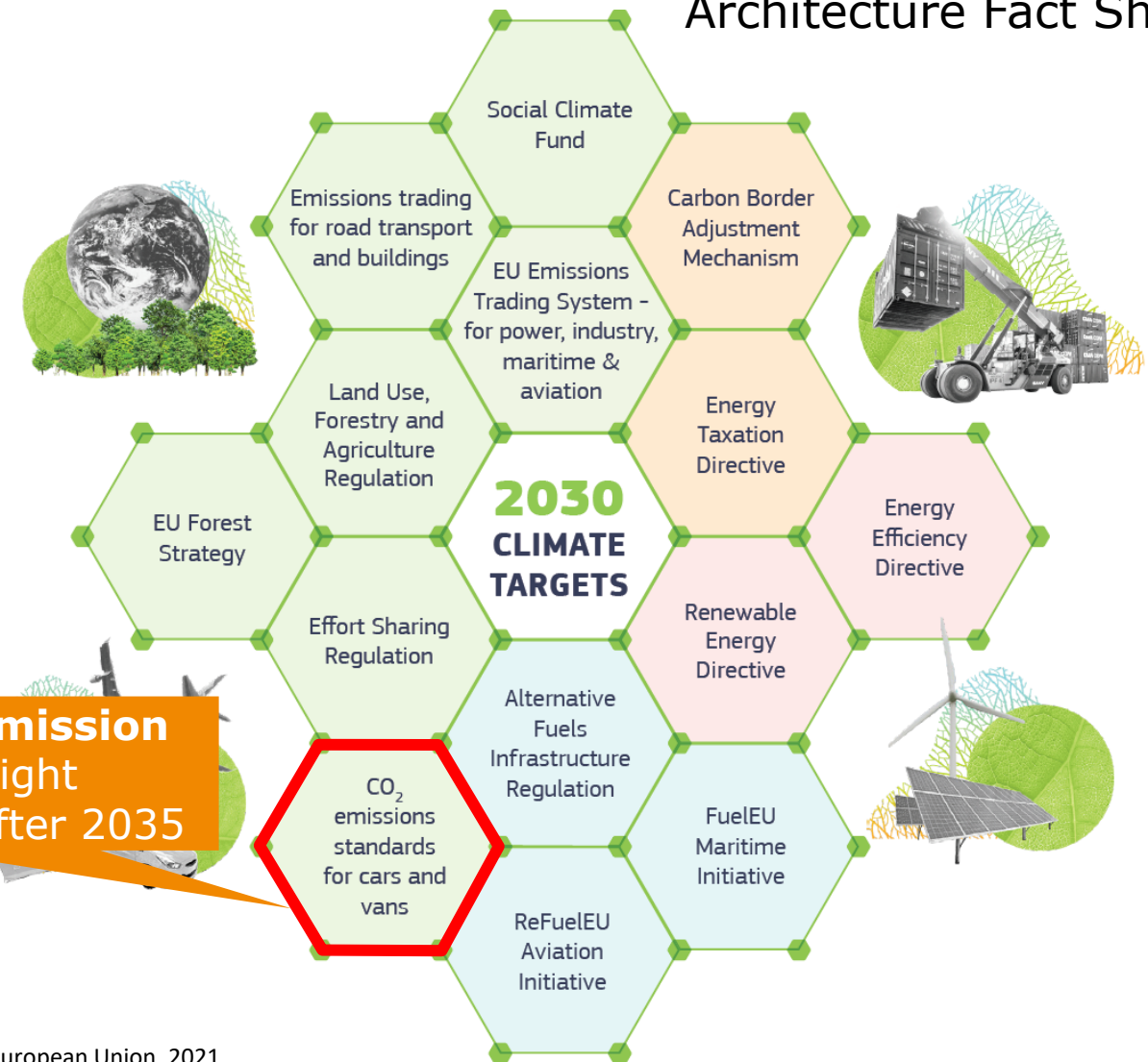
### “Fit for 55”

The EU will **reduce its net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels.\*

**Zero Tailpipe CO<sub>2</sub> Emission**  
for passenger & light  
commercial vehicles after 2035

\*As agreed in the EU Climate Law. On 14 July 2021, the Commission presented proposals to deliver these targets and make the European Green Deal a reality

© European Union, 2021





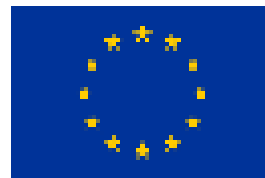
# Make Transport Greener

## Current Situation in Europe – **Fit for 55**

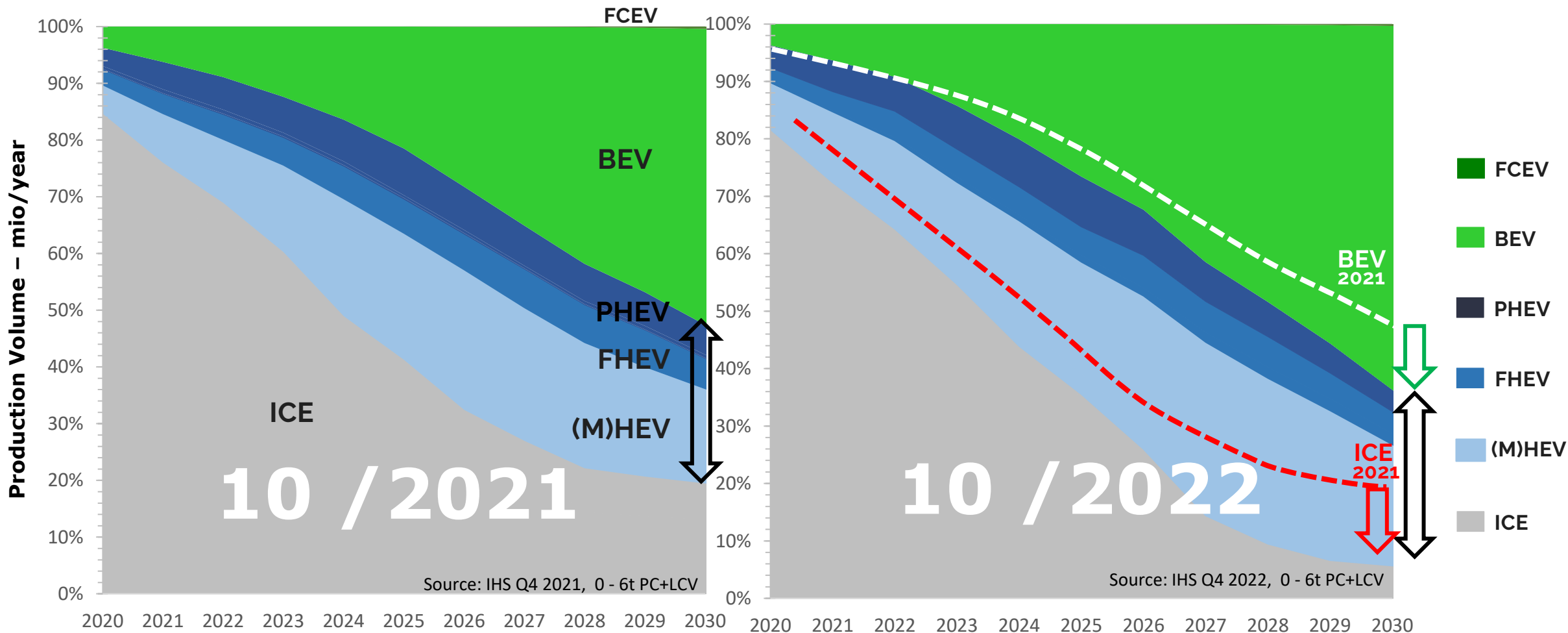
7/2021

More ambitious CO<sub>2</sub> emissions standards for new cars and vans to help grow the number of zero- and low-emission vehicles on European roads.



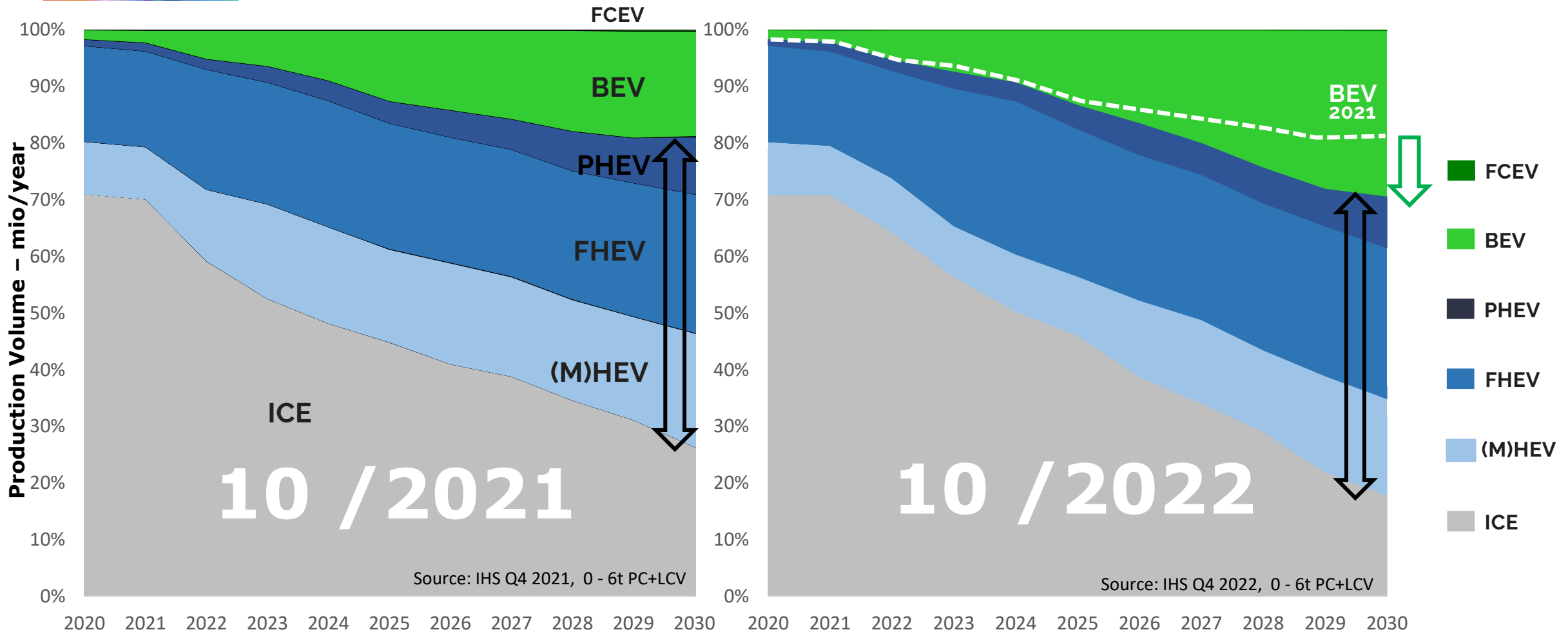
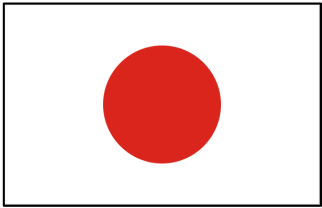


# Technology Outlook **EUROPE** - IHS Prediction 10/2021 vs. 10/2022



**Prediction 2022 vs. 2021: 2030 BEV 53% → 62%, ICE<sub>only</sub> 20% → 8%, Hybrid 30%**

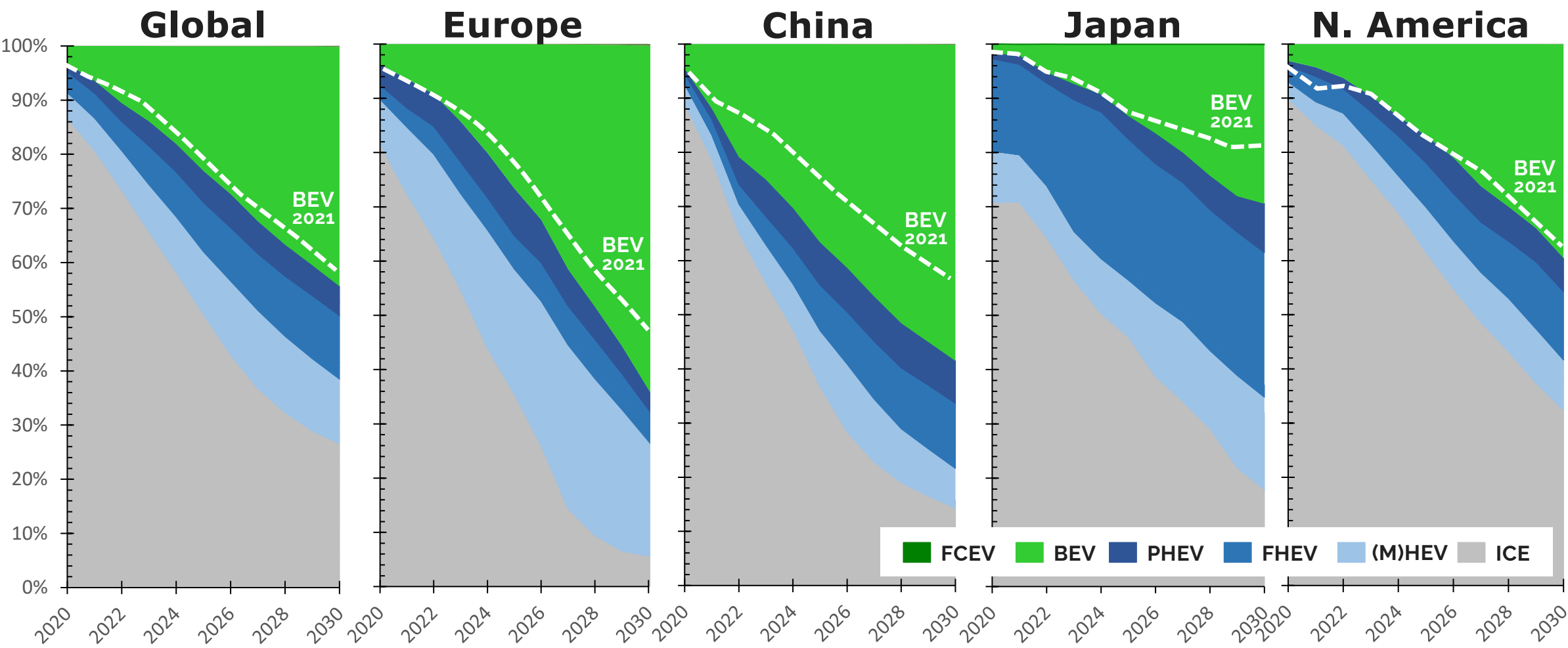
# Technology Outlook **JAPAN** - IHS Prediction 10/2021 vs. 10/2022



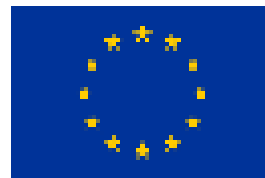
***In spite increasing BEV share, XHEV remains dominating beyond 2030***



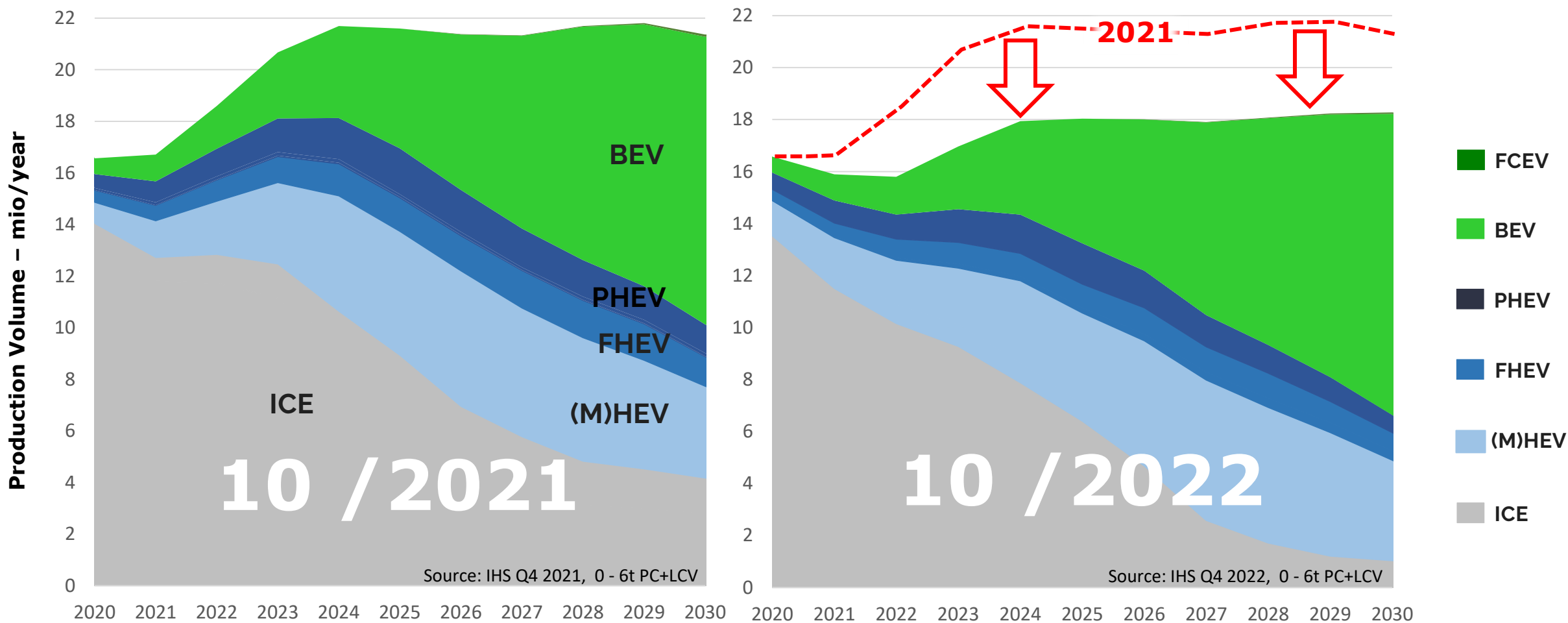
# Technology Outlook **GLOBAL** - IHS Prediction 10/2022



***Most significant growth of BEV share in Europe and China***

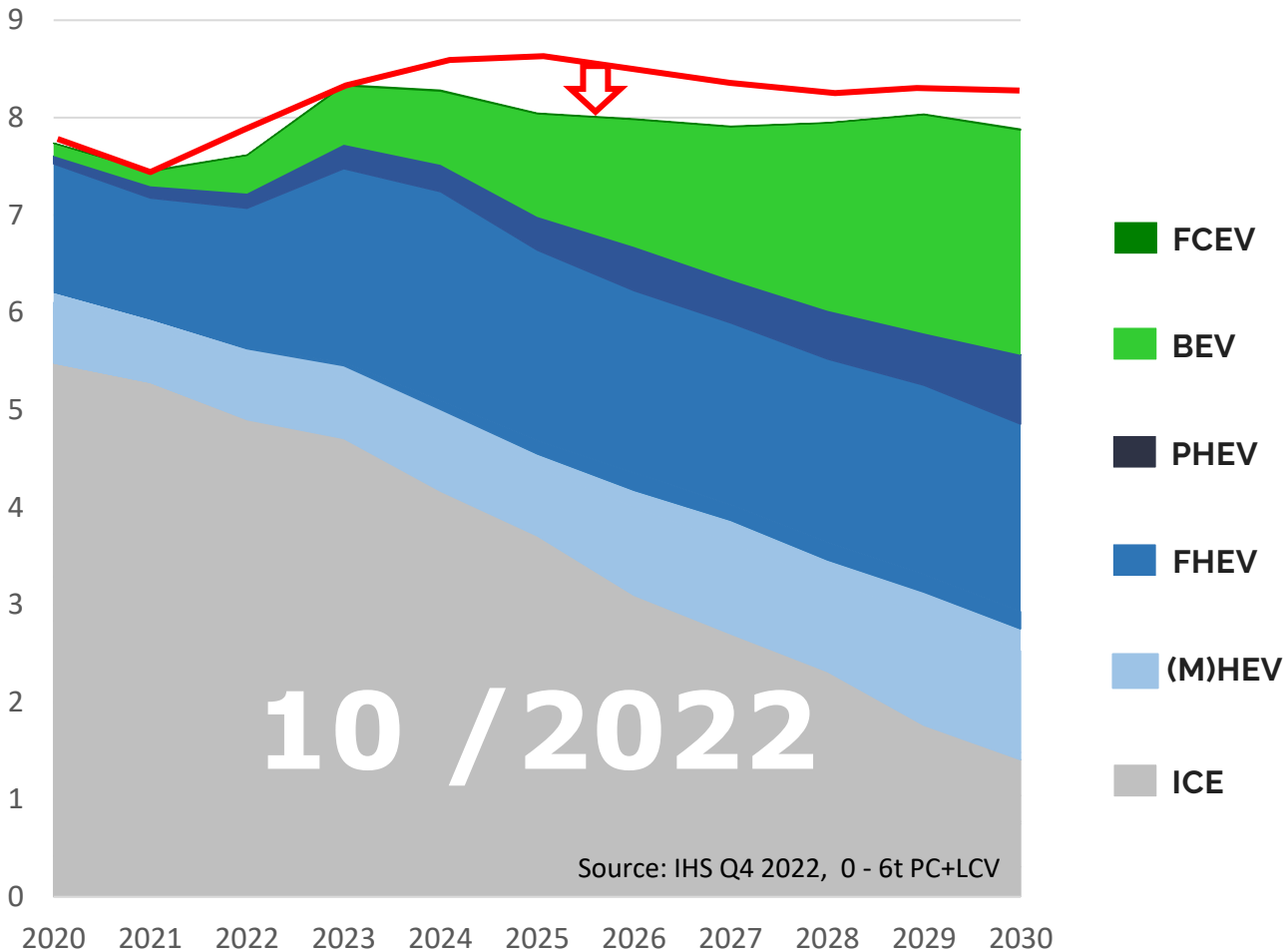
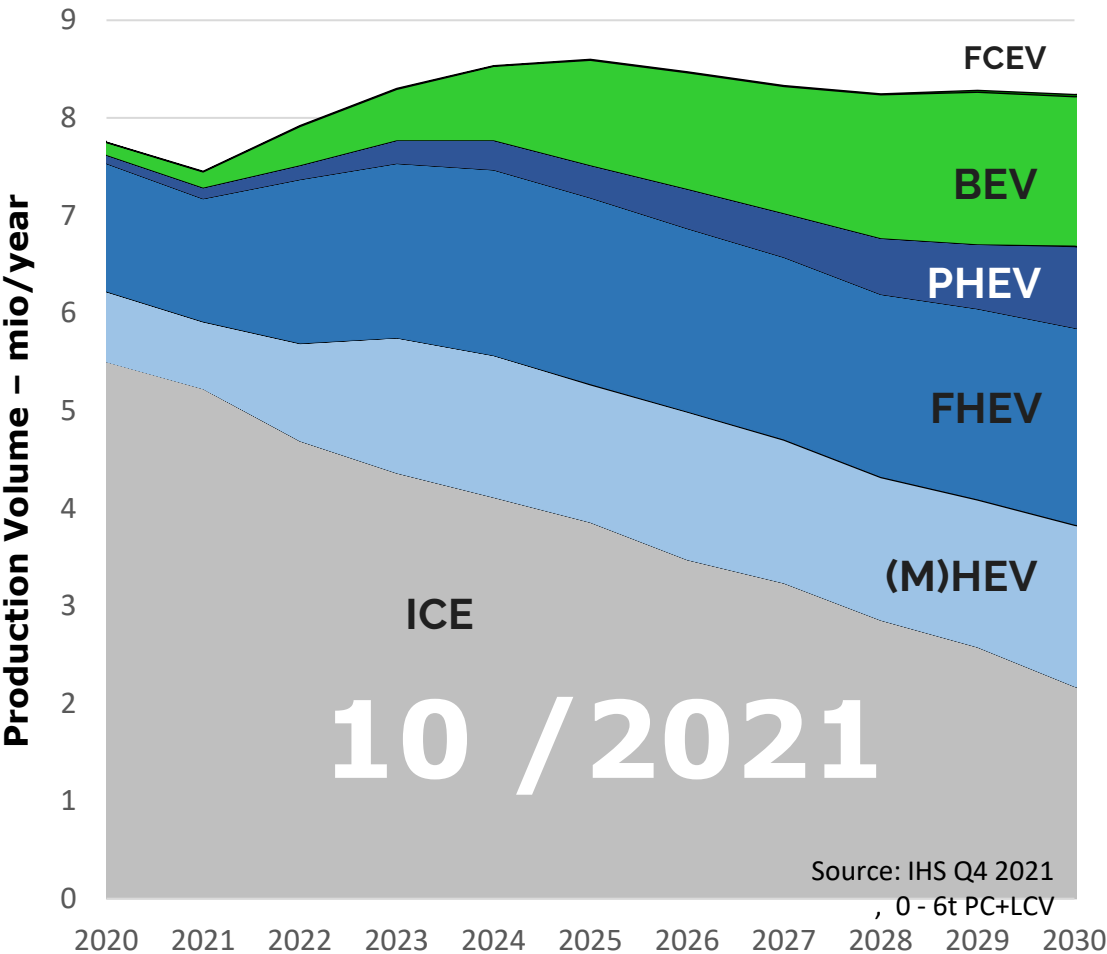
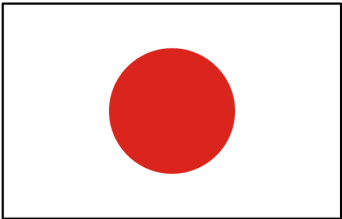


# Technology Outlook **EUROPE** - IHS Prediction 10/2021 vs. 10/2022



**App. 20% lower production volumes 2023-2030 expected than 1 year ago**

# Technology Outlook **JAPAN** - IHS Prediction 10/2021 vs. 10/2022

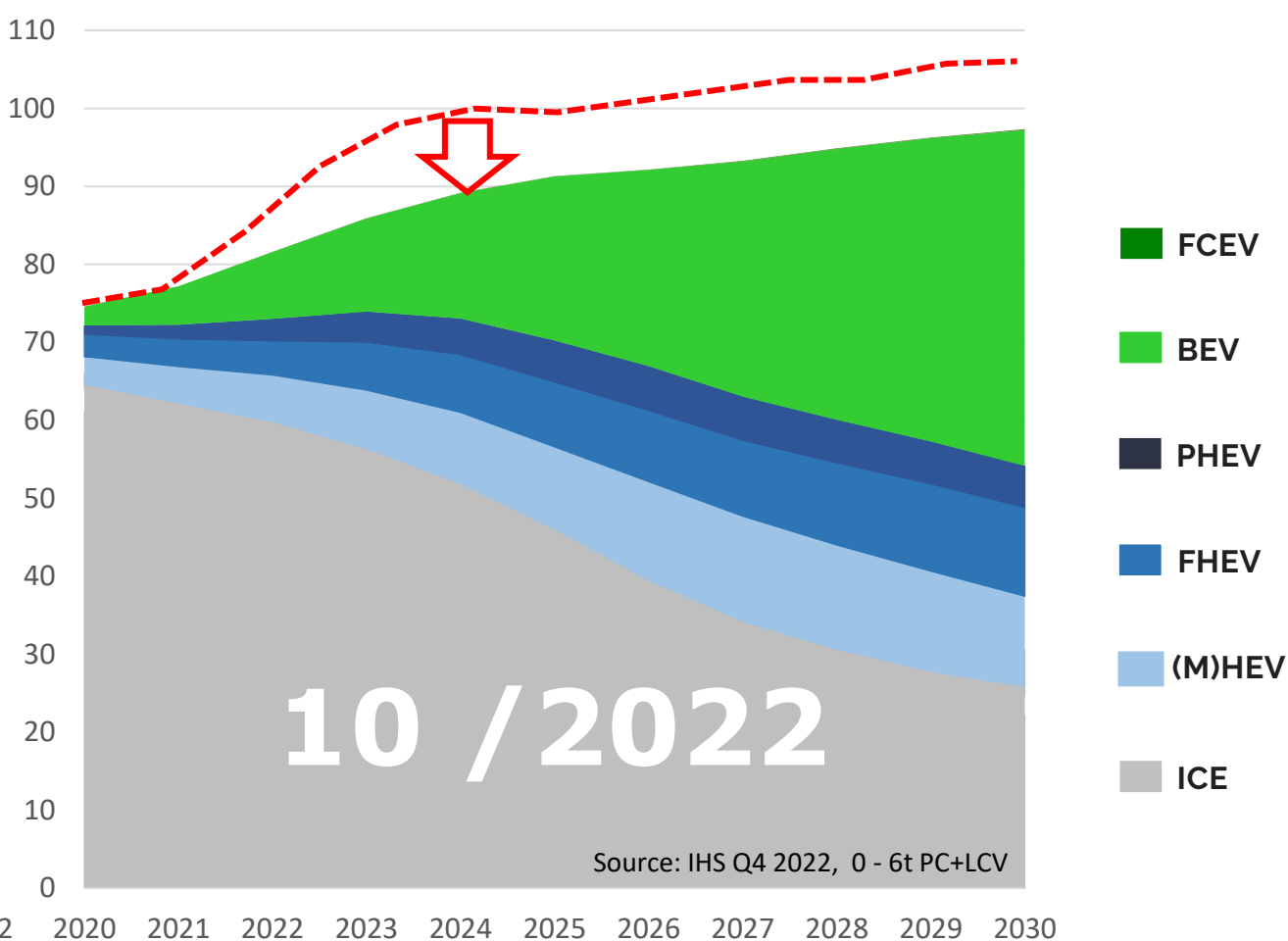
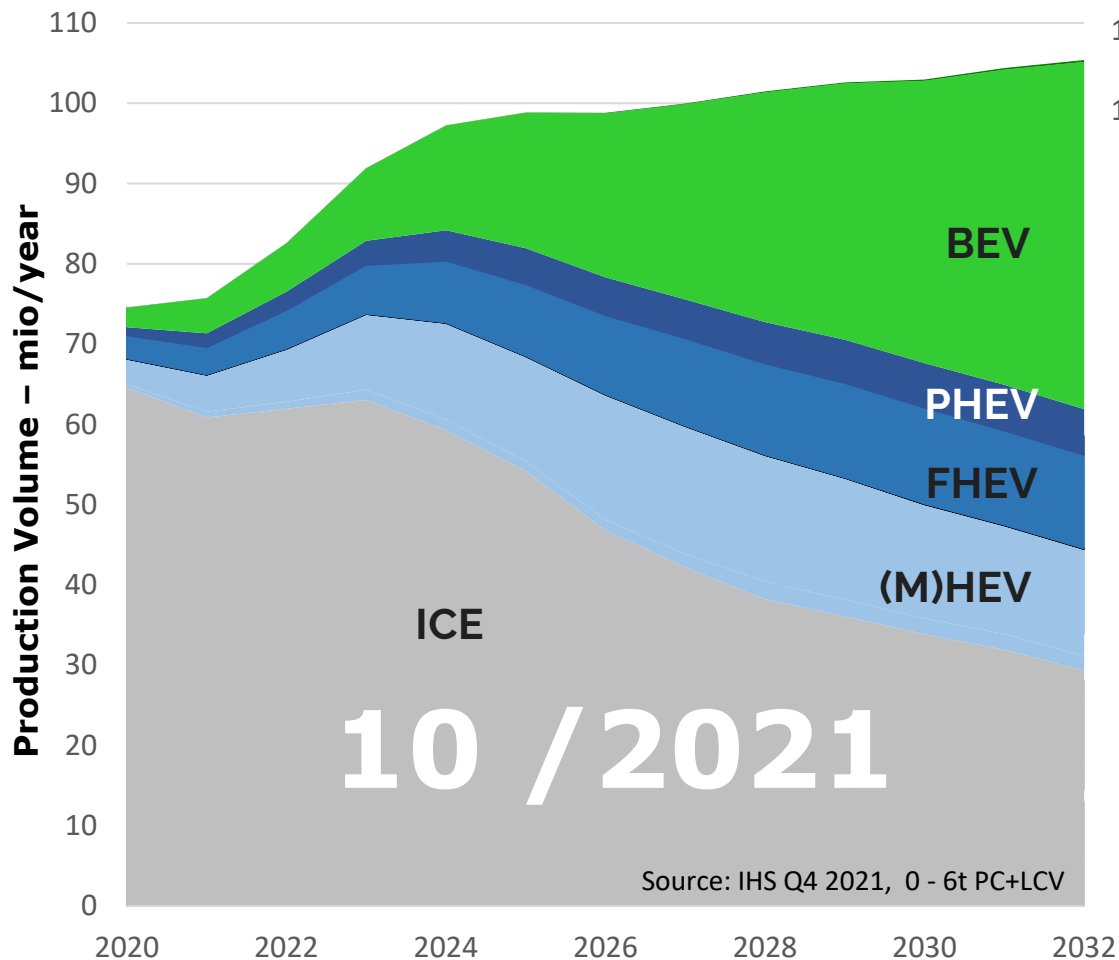


**App. 5% lower production volumes 2024-2030 expected than 1 year ago**





# Technology Outlook **GLOBAL** - IHS Prediction 10/2021 vs. 10/2022



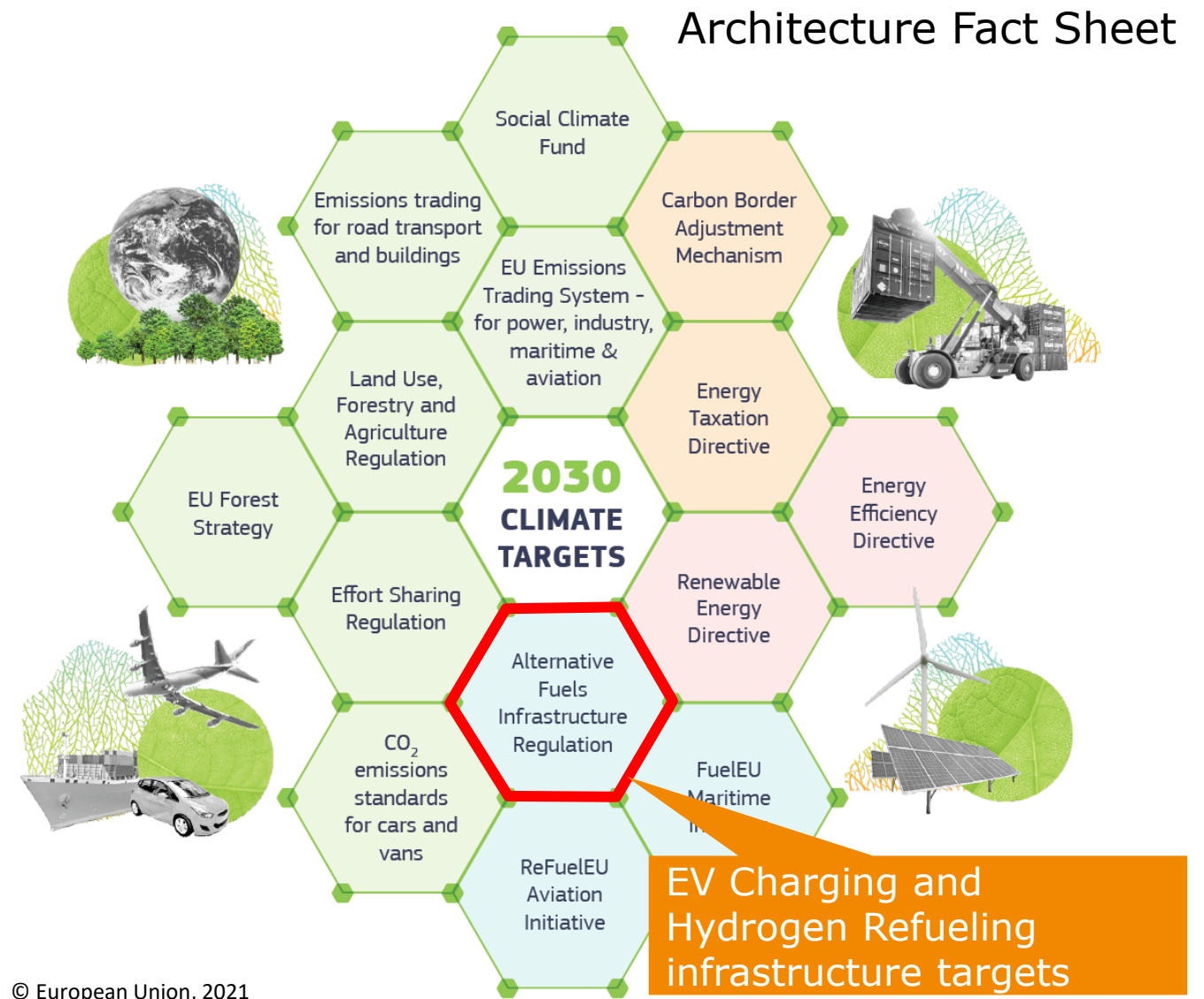
**App. 10% lower production volumes 2024-2030 expected than 1 year ago**

# European Green Deal Infrastructure

## “Fit for 55”

The EU will **reduce its net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels.\*

\*As agreed in the EU Climate Law. On 14 July 2021, the Commission presented proposals to deliver these targets and make the European Green Deal a reality.

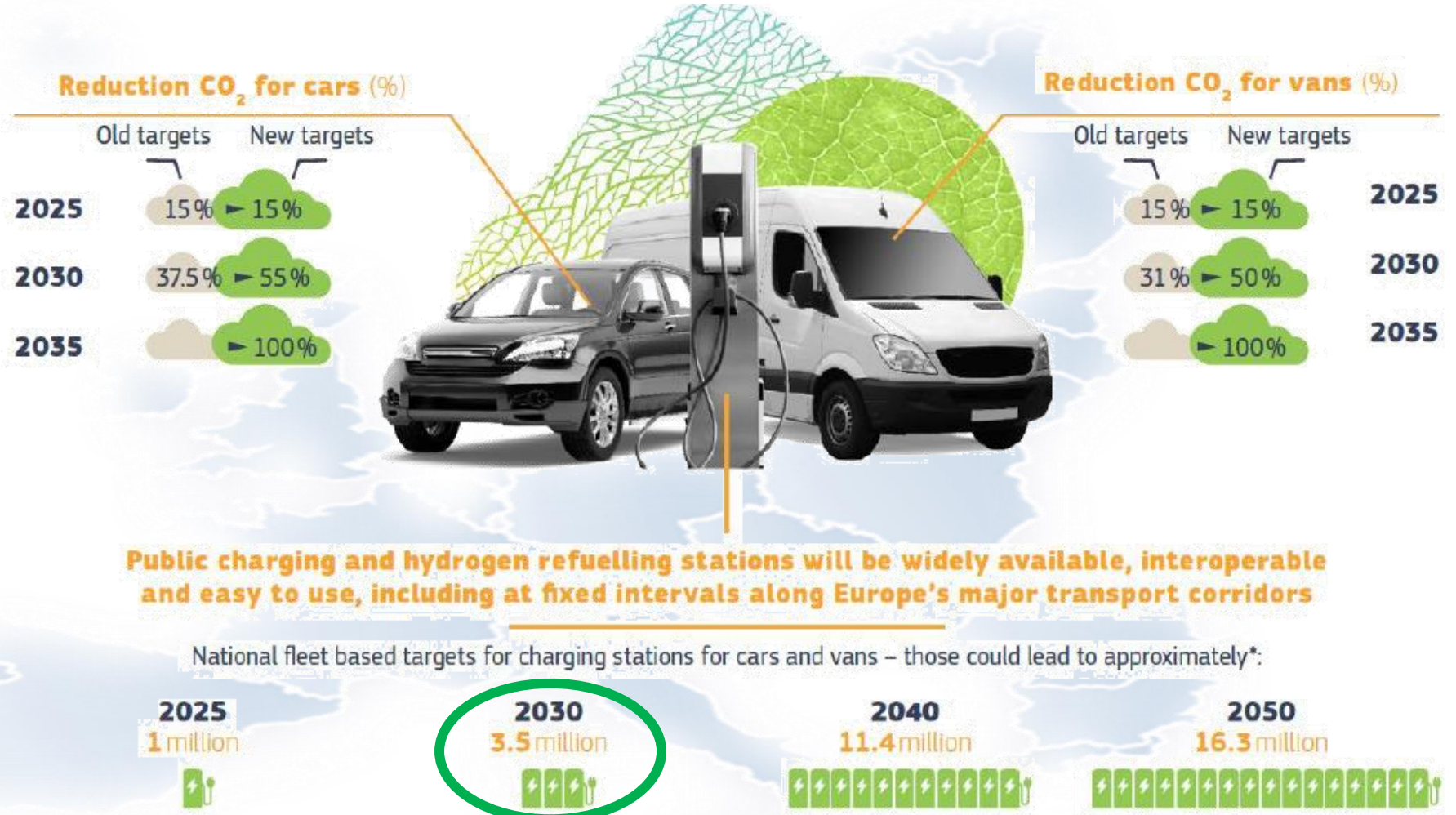


# Make Transport Greener

## Current Situation in Europe – **Fit for 55**

More ambitious CO<sub>2</sub> emissions standards for new cars and vans to help grow the number of zero- and low-emission vehicles on European roads.

Binding requirements for the rollout of public charging and hydrogen refuelling stations for cars, vans and trucks.



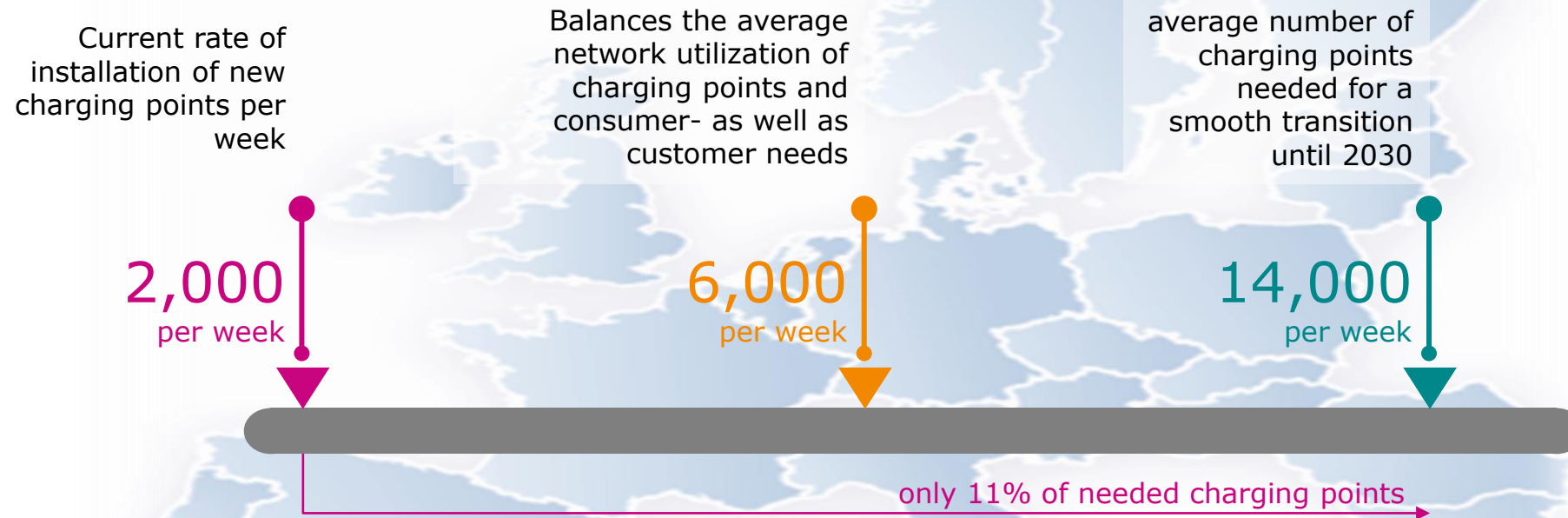
Source: Make Transport Greener Factsheet, European Commission, 14.07.2021



# Challenge: Charging roll-out EU

## Current vs required weekly public charging point rollout, 2021-30

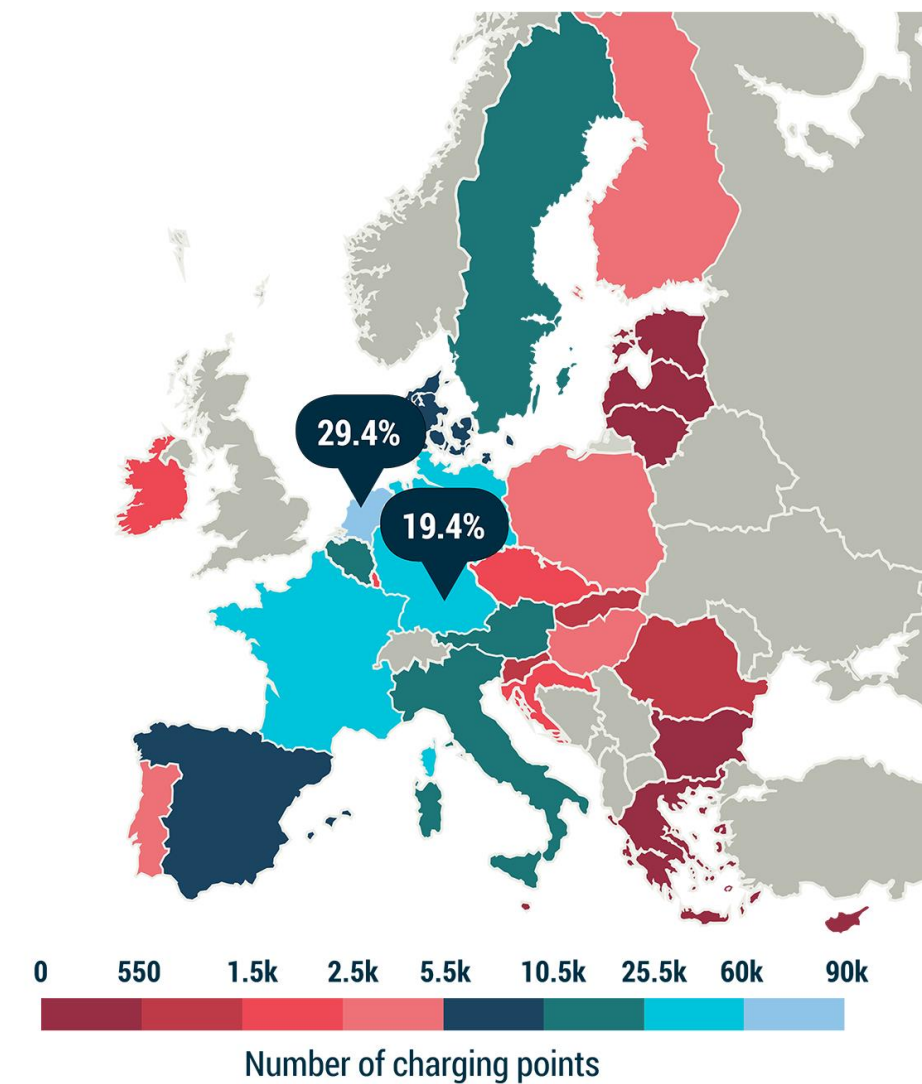
Number of public AC and DC charging points per week, thousands



Source: European EV Charging Infrastructure Masterplan, acea, March 2022, [Link](#)

***A significant acceleration in installation speed is required to reach required charging points by 2030***

# Distribution of Electric Car Charging Points in the EU



## Top 5: Countries with MOST chargers

	Charging Stations	EVs	Vehicles per charging station
Netherlands	90,284	390,438	4
Germany	59,410	1,310,081	22
France	37,128	785,245	21
Sweden	25,197	334,565	13
Italy	23,543	247,188	11

***Charging Infrastructure might become a bottleneck in the scale-up of BEV's***

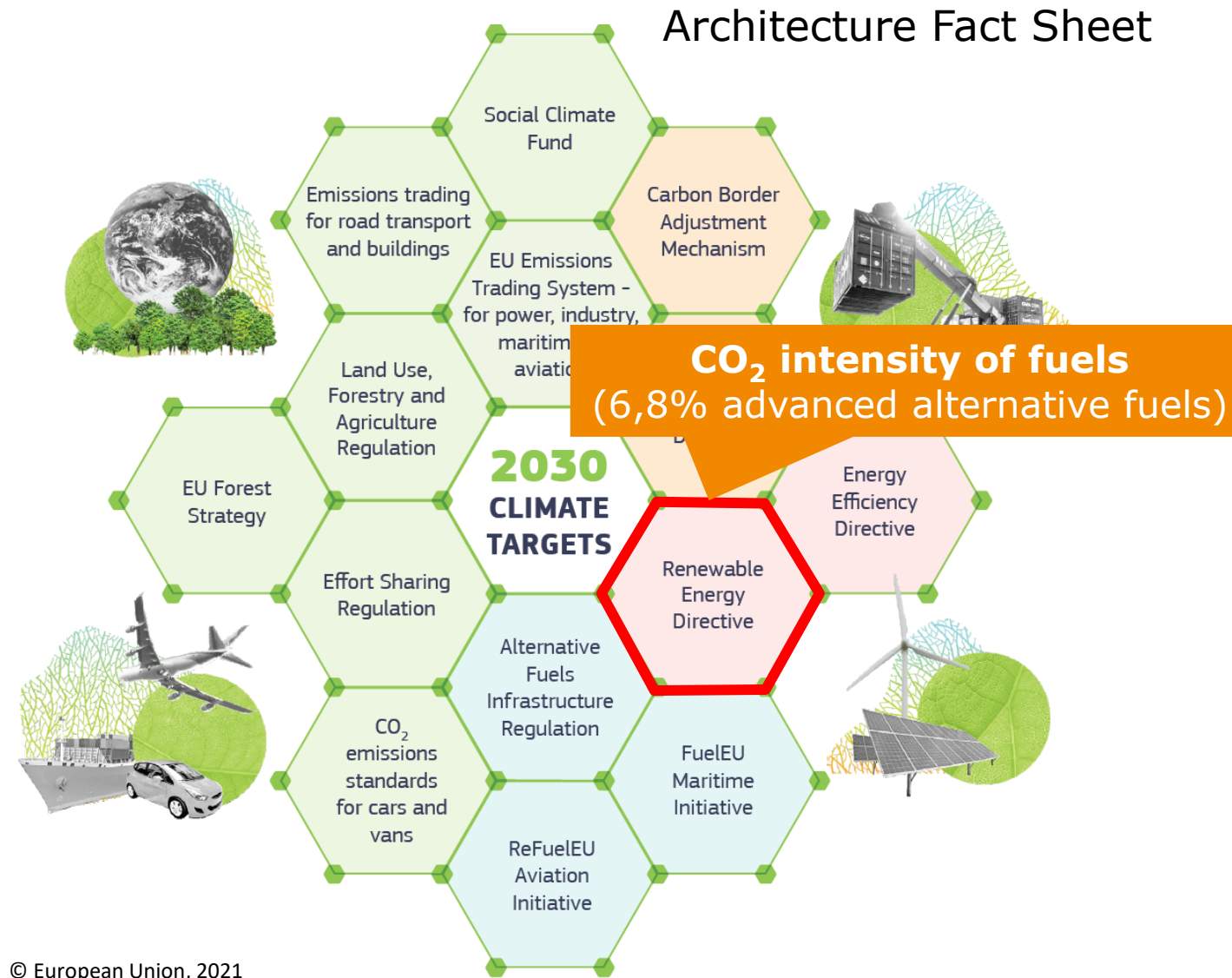
Source: ACEA, June 2022, [Link](#) // European Alternative Fuels Observatory (EAFO), 2021, [Link](#)

# European Green Deal Well-to-Wheel

## “Fit for 55”

The EU will **reduce its net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels.\*

\*As agreed in the EU Climate Law. On 14 July 2021, the Commission presented proposals to deliver these targets and make the European Green Deal a reality



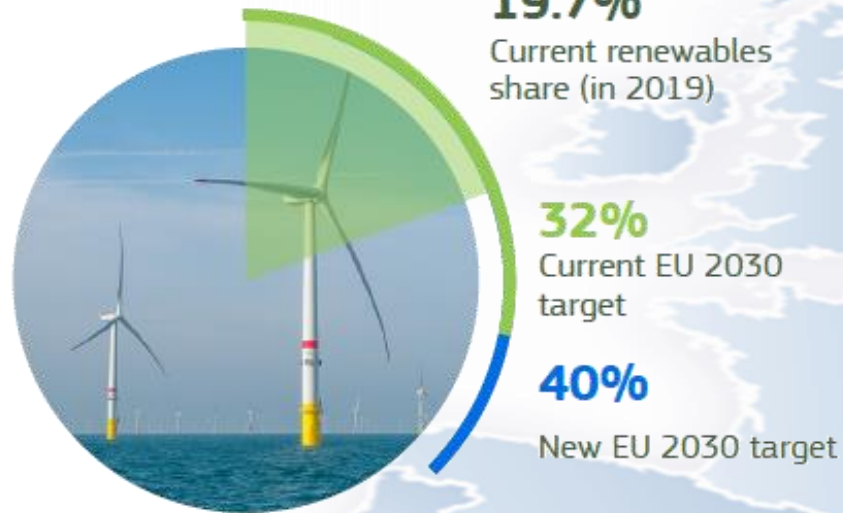
# Proposal to Amend RED III

## Status: June 2022

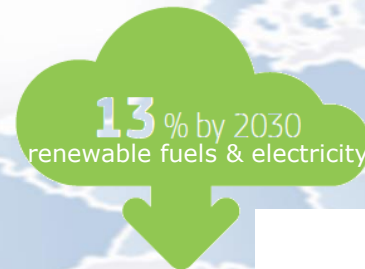


- New targets on greenhouse gas emissions of transport and use of innovative fuels;
- Strengthened criteria and certification for sustainability and greenhouse gas savings.

### Renewables in the EU energy mix



### Targeted reduction in transport GHG intensity



### Proposal June 2022 (Council) Parliament Position in Sep. 2022

#### Targeted share of renewable H2 and synthetic fuels

2.6% by 2030

5.2% by 2030  
(incl. multiplier)

#### Targeted share of advanced biofuels

2.2% by 2030

4.4% by 2030  
(incl. multiplier)

Currently on the market: B7 (7% Biodiesel) and E5 (5% Ethanol)

Source: Proposal Amendment to the Renewable Energy Directive to implement the ambition of the new 2030 climate target, Factsheet - Decarbonising our Energy System to meet our Climate Goals, Factsheet - Make Transport Greener, European Commission, 14.07.2021

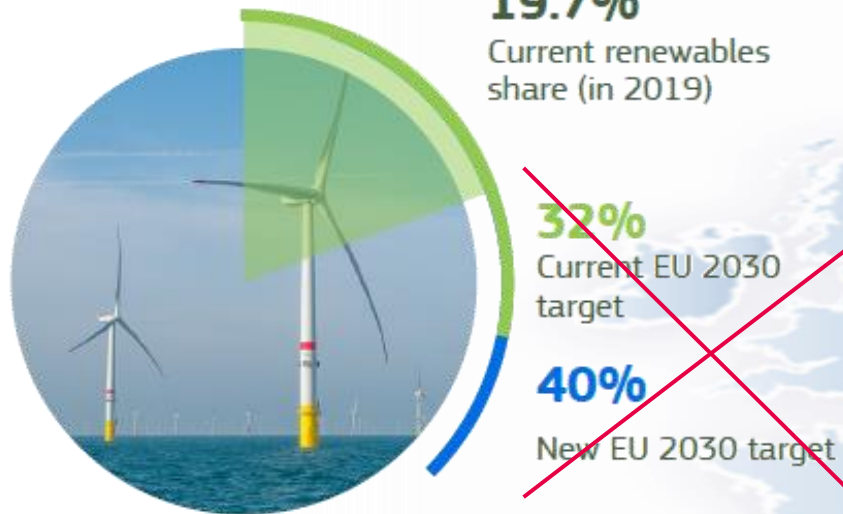


# Proposal to Amend RED III

Status: September 2022



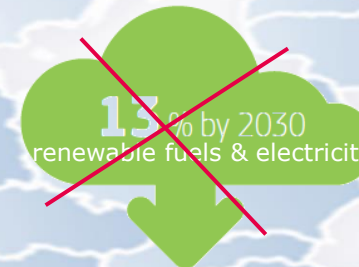
Renewables in the  
EU energy mix



The Parliament has made a commitment to an overall renewable energy contribution of 45% to the total energy mix by 2030.

- New targets on greenhouse gas emissions of transport and use of innovative fuels;
- Strengthened criteria and certification for sustainability and greenhouse gas savings.

Targeted reduction  
in transport GHG intensity



**14/09/22: New 2030 target: 45%**

**14/09/22: New 2030 target: 16%**

Currently on the market: B7 (7% Biodiesel) and E5 (5% Ethanol)

Source: Proposal Amendment to the Renewable Energy Directive to implement the ambition of the new 2030 climate target, Factsheet - Decarbonising our Energy System to meet our Climate Goals, Factsheet - Make Transport Greener, European Commission, 14.07.2021; <https://www.europarl.europa.eu/news/en/press-room/20220909IPR40134/parliament-backs-boost-for-renewables-use-and-energy-savings>  
[https://www.euractiv.de/section/energie-und-umwelt/news/eu-parlament-stellt-sich-hinter-45-ziel-an-erneuerbaren-bis-2030/?utm\\_source=piano&utm\\_medium=email&utm\\_campaign=12114&pnespid=uLJ6CCVMLa8Xx6DD.S.kEJaeoQ\\_1Uph8Levh2e5mokxmPczKGT1LpSBdISsmgvQW4ZkqbHPXZw](https://www.euractiv.de/section/energie-und-umwelt/news/eu-parlament-stellt-sich-hinter-45-ziel-an-erneuerbaren-bis-2030/?utm_source=piano&utm_medium=email&utm_campaign=12114&pnespid=uLJ6CCVMLa8Xx6DD.S.kEJaeoQ_1Uph8Levh2e5mokxmPczKGT1LpSBdISsmgvQW4ZkqbHPXZw)

# European Green Deal Lifecycle CO<sub>2</sub>

Recovery,  
CO<sub>2</sub> footprint

Battery  
directive

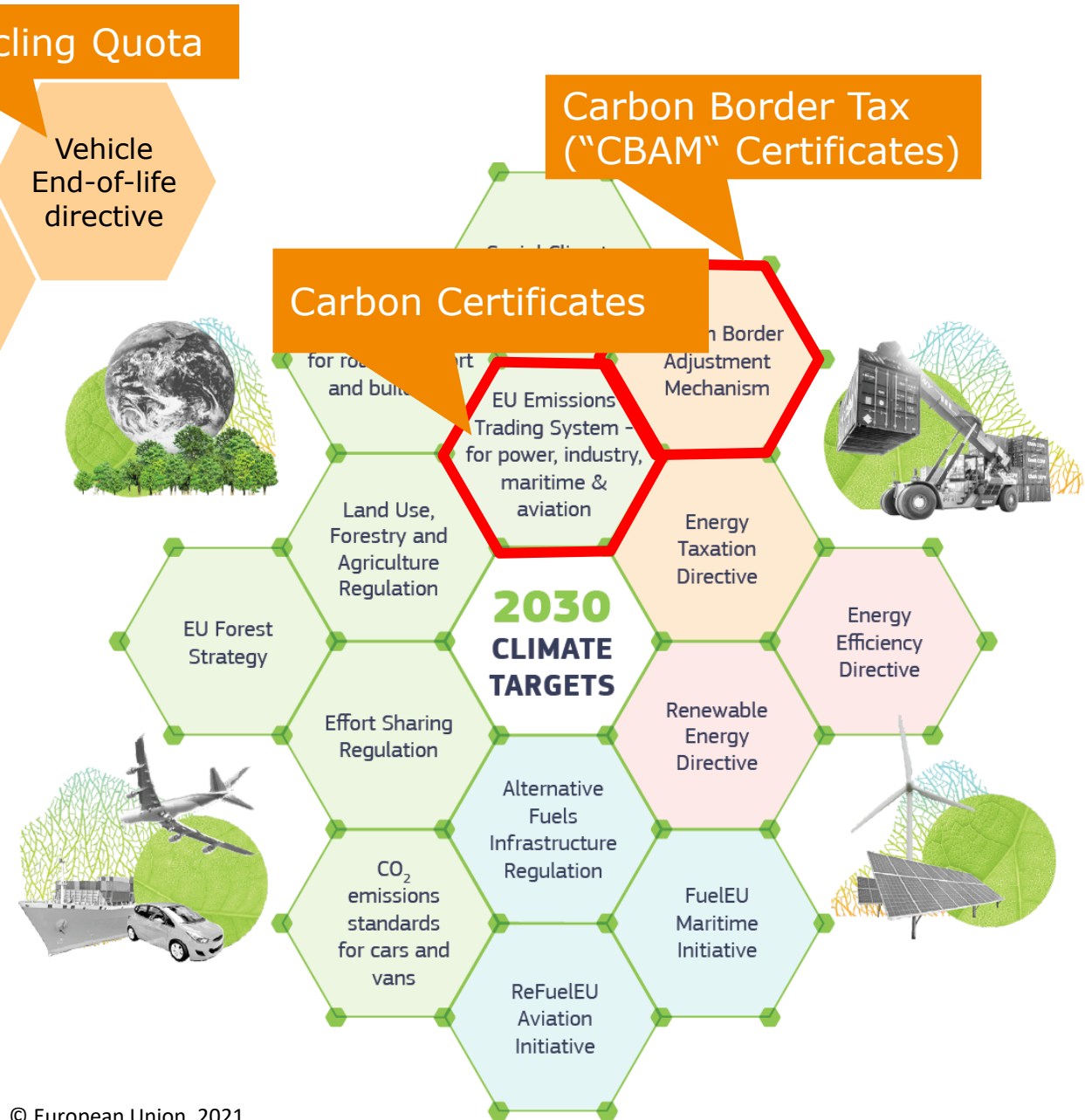
Recycling Quota

Vehicle  
End-of-life  
directive

## "Fit for 55"

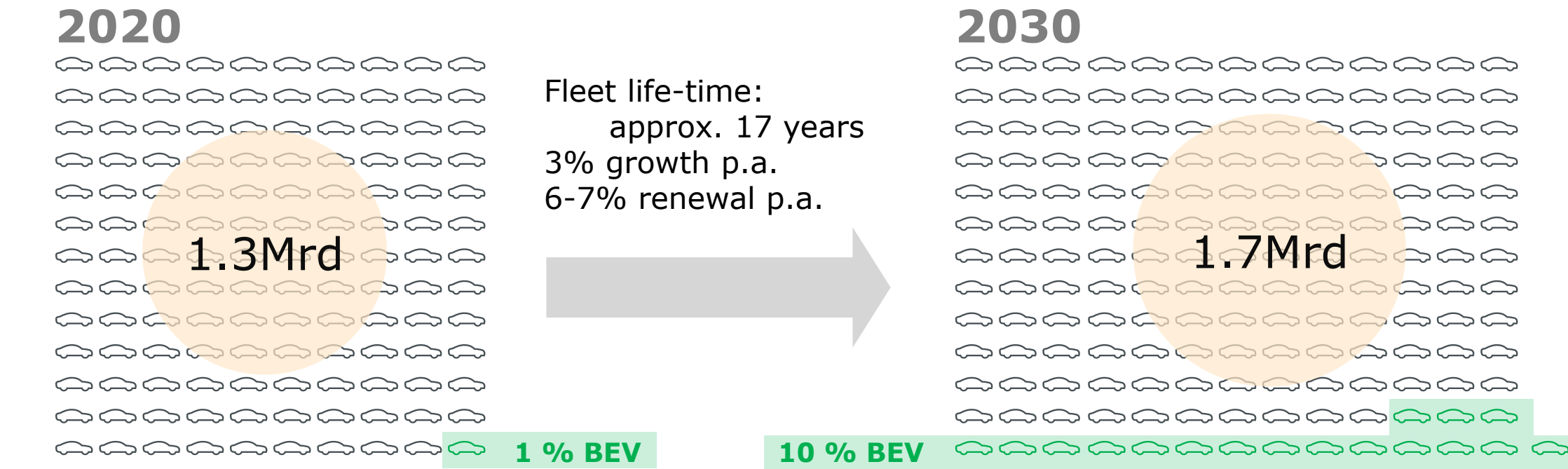
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# Global Passenger Car Fleet Today and Tomorrow

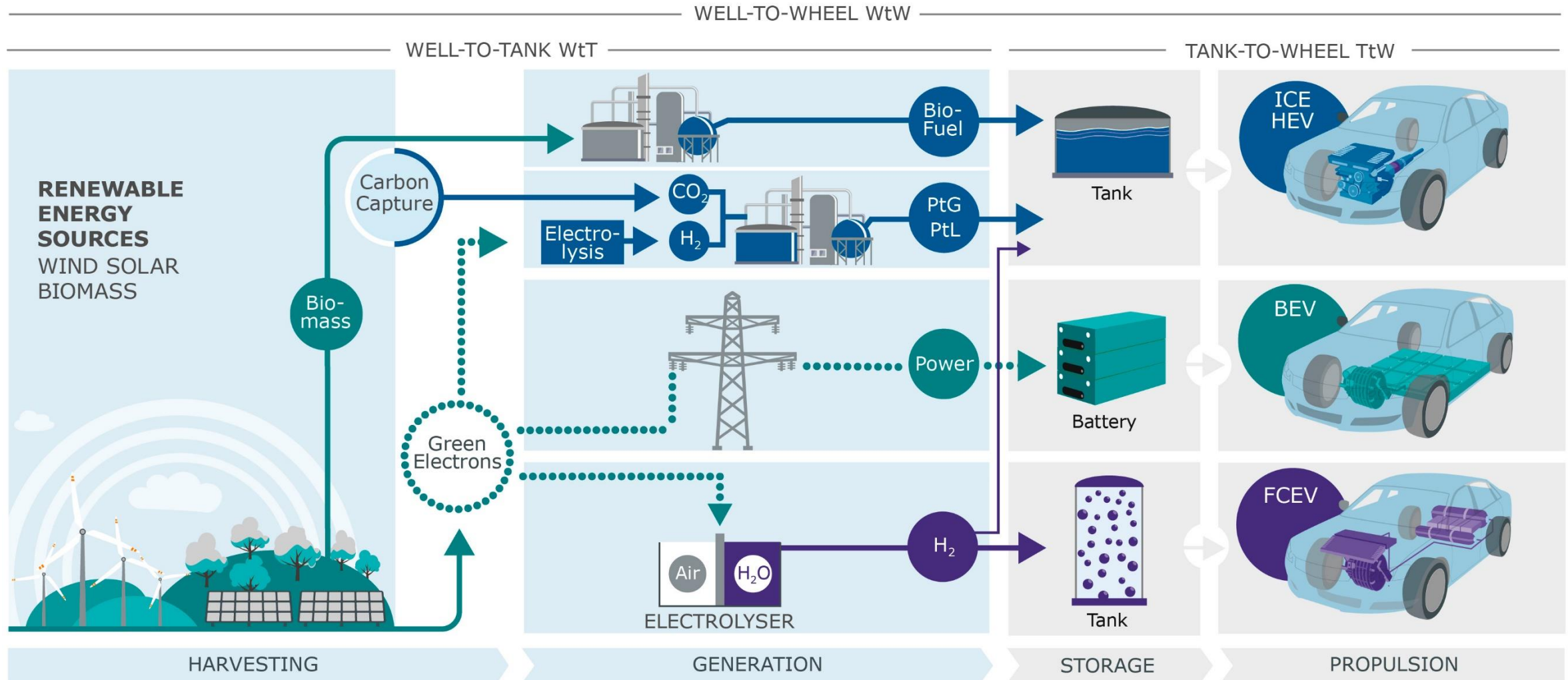


 10 mln. Veh. with combustion engine     10 mln. Veh. battery electric

Source: EIA, 2021, [Link](#) ; IEA, 2022, [Link](#)

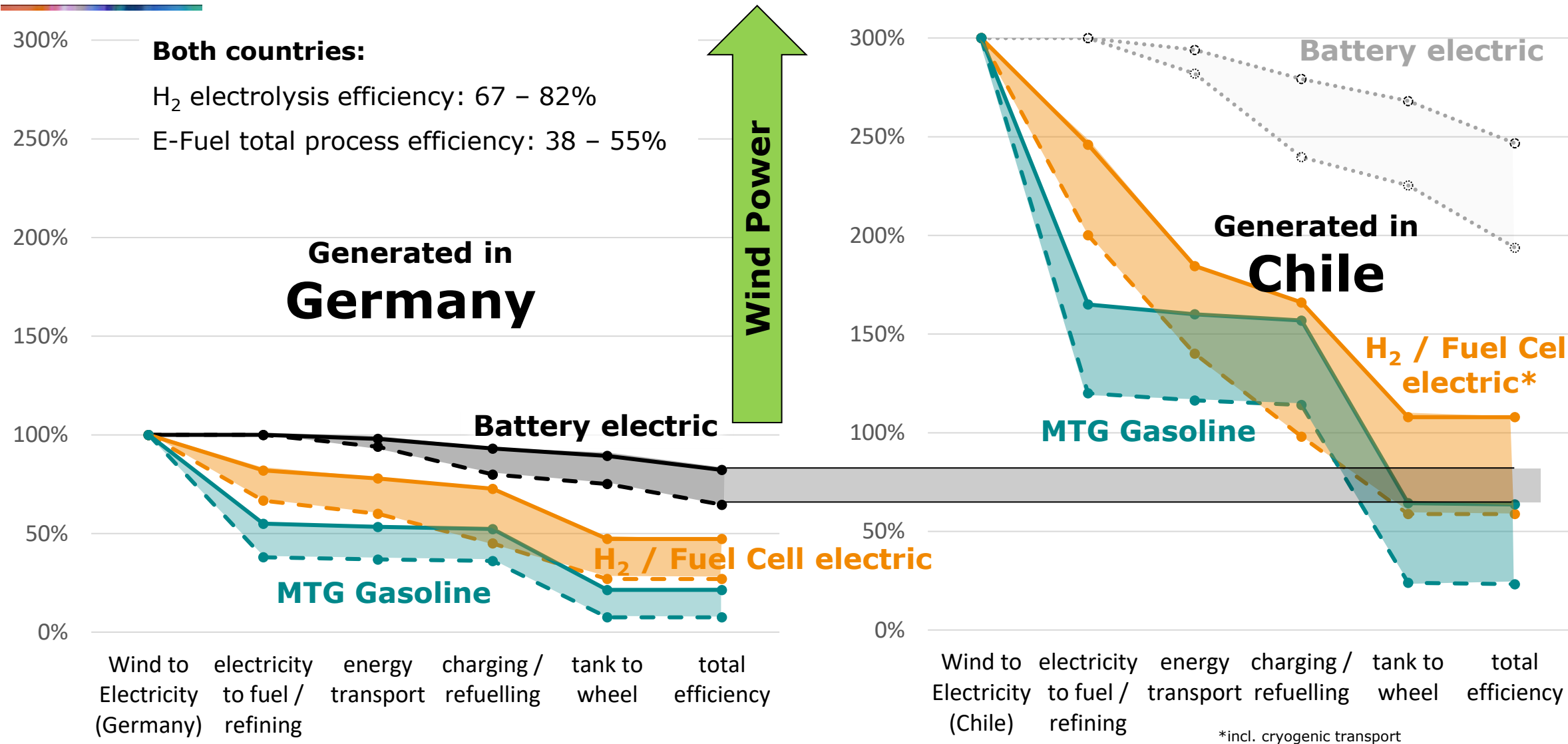
***For an effective CO<sub>2</sub> Strategy de-fossilizing the existing fleet is essential !!!***

# Pathways to Clean and Sustainable Propulsion Systems

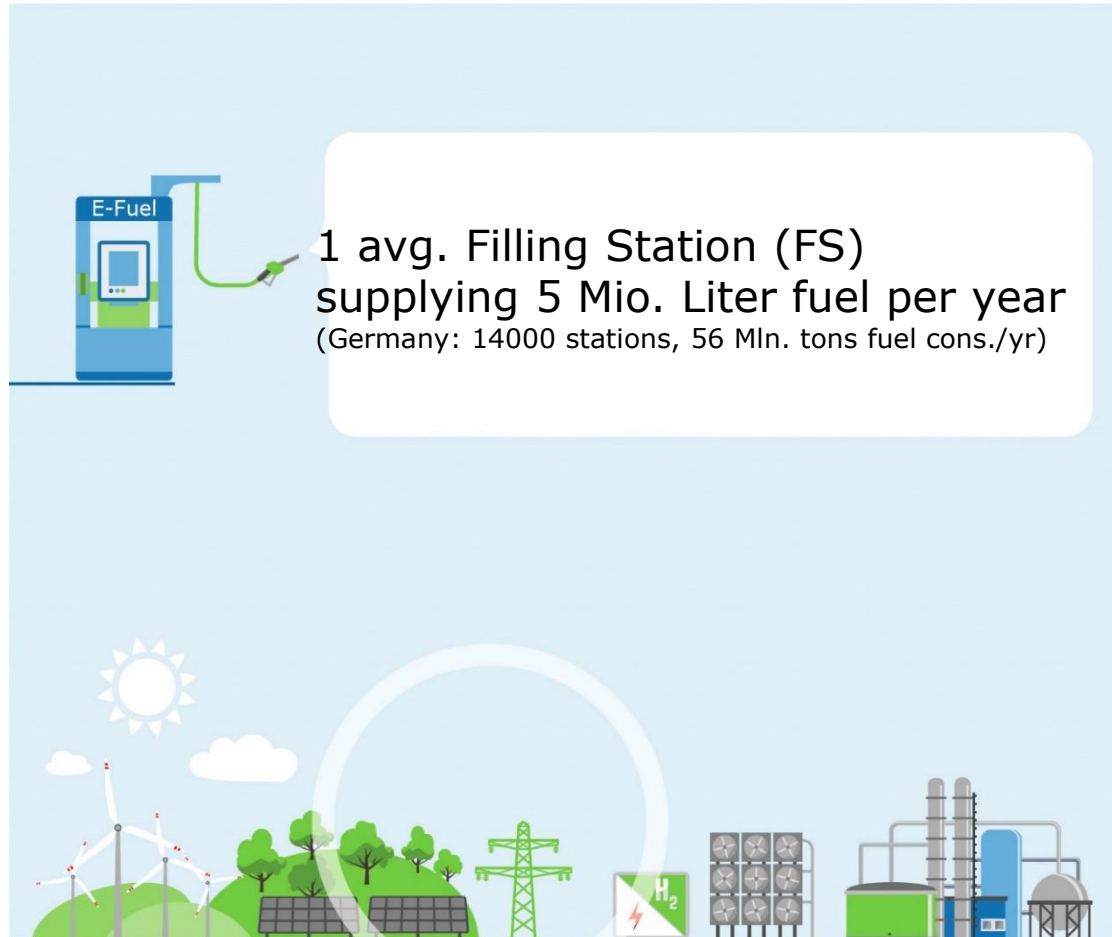




# Efficiency in Energy Conversion of Renewable fuels Germany vs Chile



# Upscaling of Solutions for New Fuels



## Renewable Synthetic Fuel Production Projects:

### Porsche & Exxon (start 2022)

2022 - 130.000 l/year - 1 MW\*  
2024 - 55 Mln. l/year - 150 MW\*  
2026 - 550 Mln. l/year - 1.5 GW\*

\* Plant sizes are own assumptions based on announced e-Fuel volume

10<sub>FS</sub>

100<sub>FS</sub>



### Saudi Aramco (2020-2023)

Bilbao: 2.9 Mln.Liter pa (2.3 kton/year)  
Neom: 2 Mln. Liter pa. gasoline (35 Barrel/day)

1<sub>FS</sub>

aramco

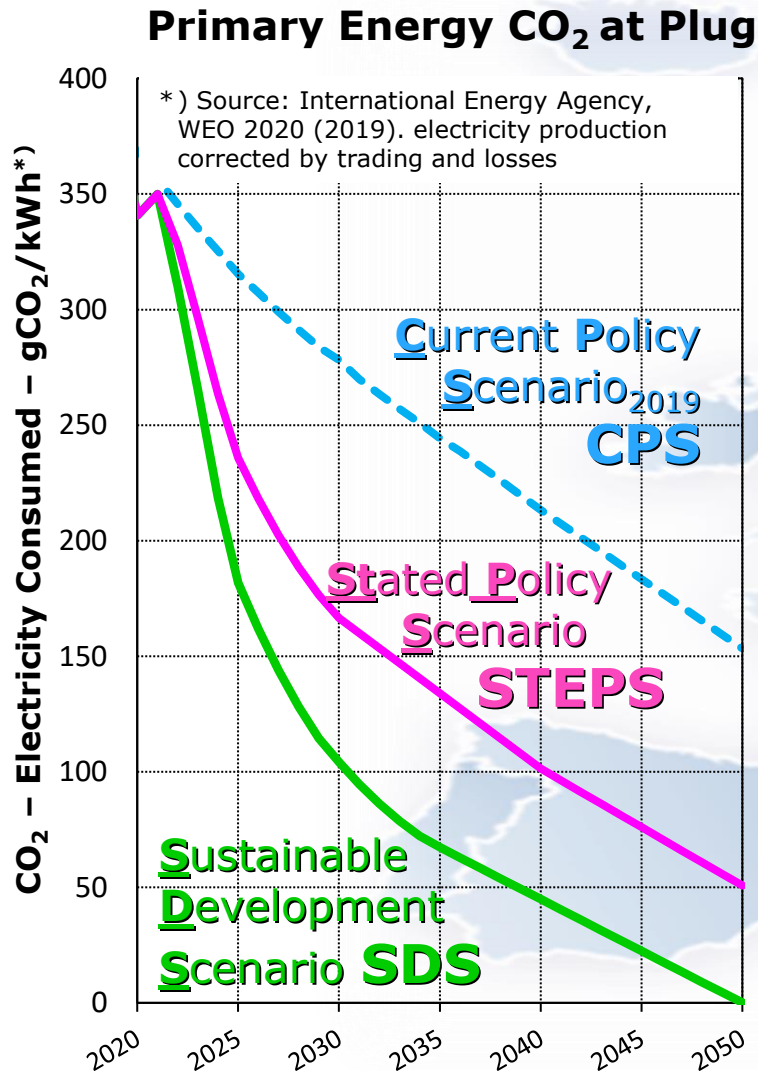


Bilbao	Neom
SPAIN	SAUDI ARABIA
OPERATIONAL DATE 2024	OPERATIONAL DATE 2024
PROJECT CAPACITY 2.3 Kton/y	PROJECT CAPACITY 12 tpd Methanol 35 bpd gasoline
CO <sub>2</sub> ABATEMENT 6.9 Kton/y	CO <sub>2</sub> ABATEMENT 5.6 Kton/y

\*\* Fuel Stations turnover, Germany: avg. station 5 Mln.l pa, ranging from 300.000 to 10 Mln.l pa, across 14.000 stations countrywide

**Significant upscaling is needed**

# Energy & CO<sub>2</sub> Scenarios EUROPE



Current Policy Scenario <sub>2019</sub> **CPS**

Worst Case Scenario

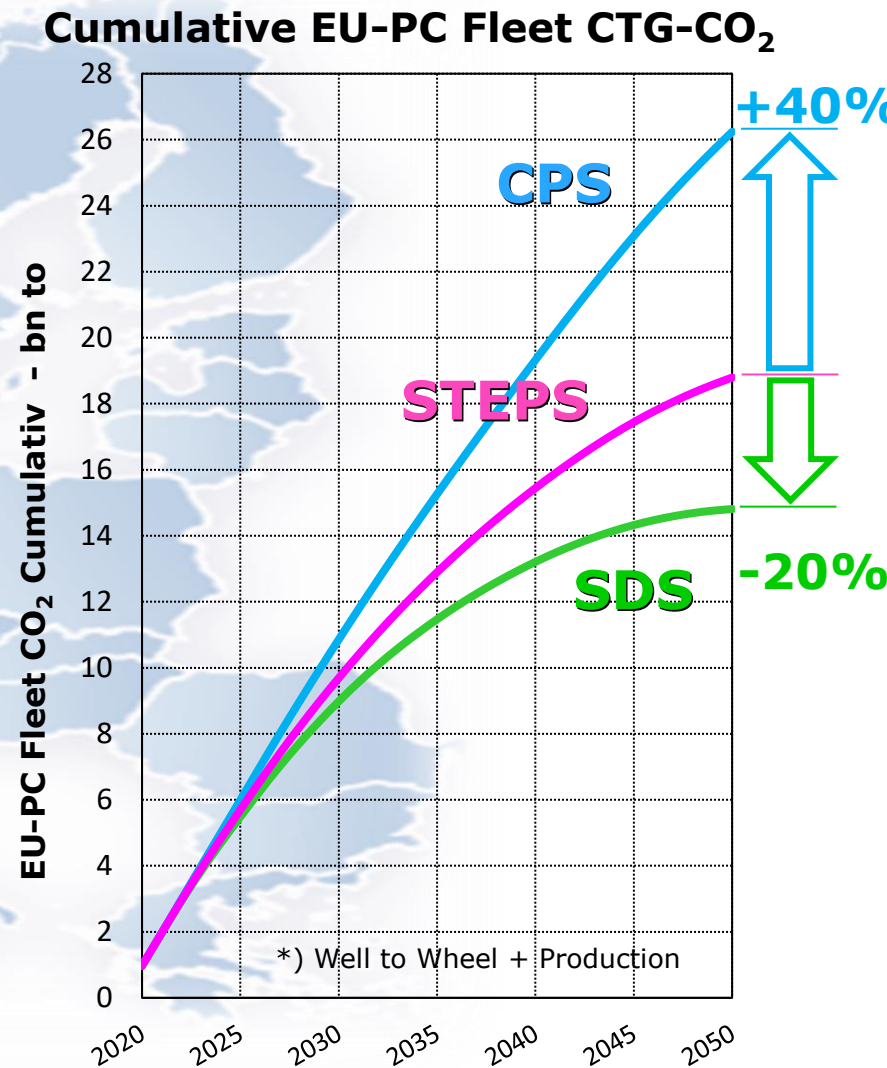
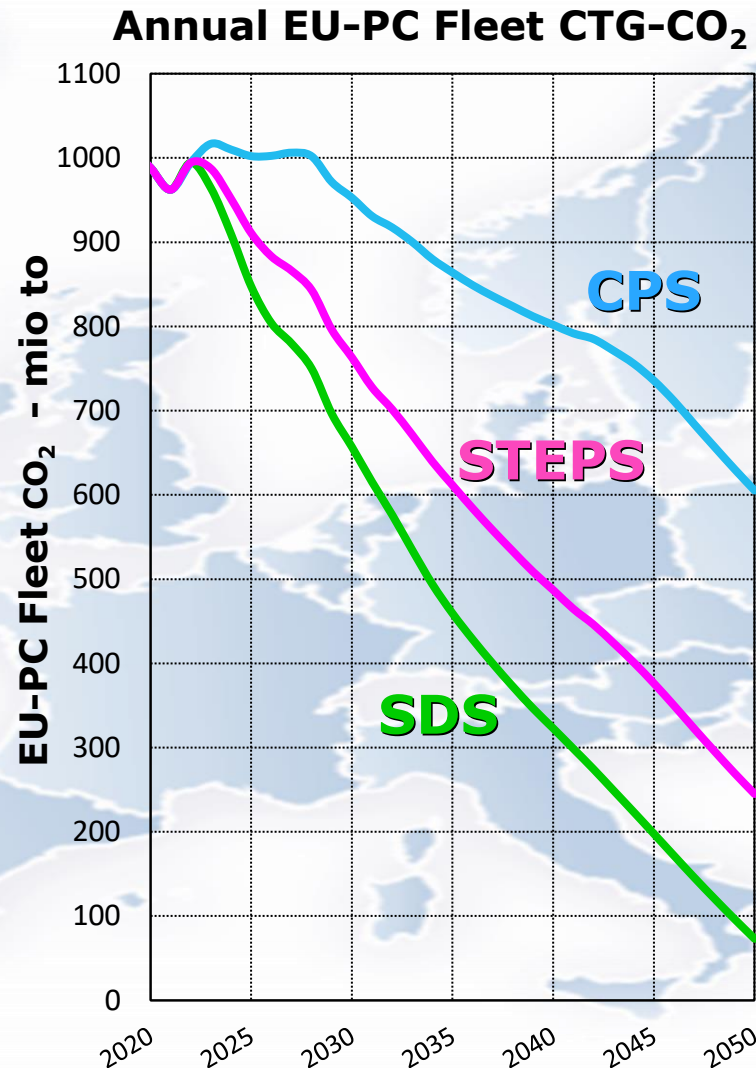
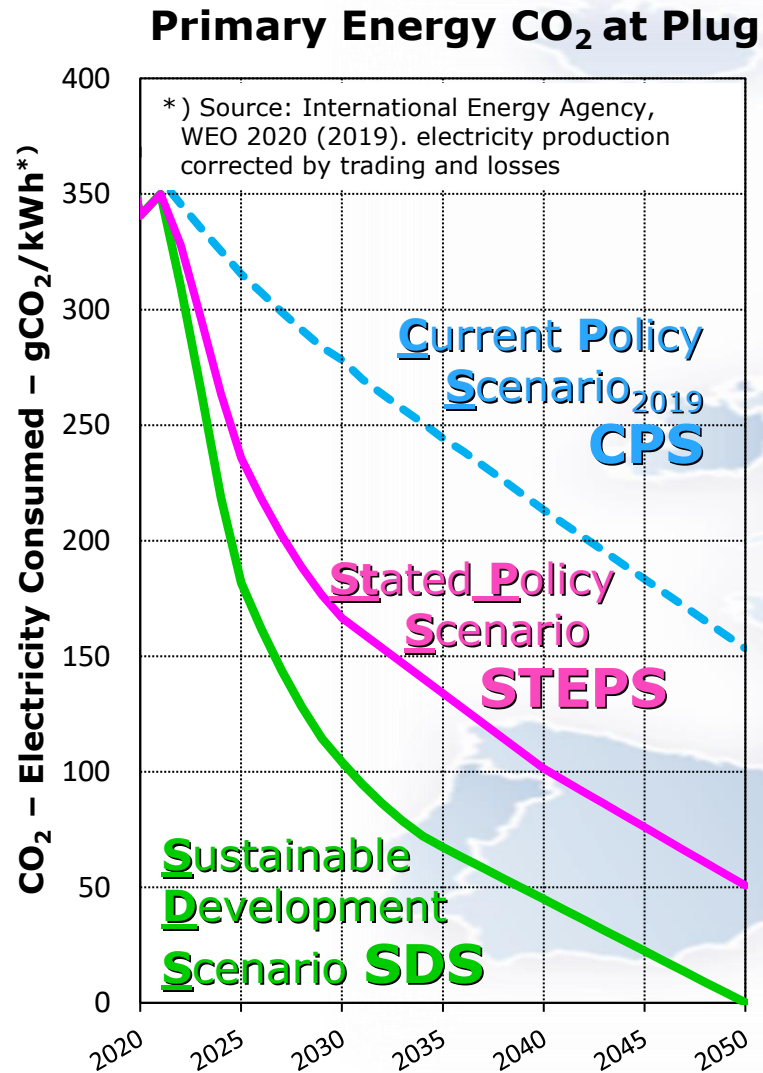
Stated Policy Scenario **STEPS**

Reflecting all announced policy intentions and targets

Sustainable Development Scenario **SDS**

Theoretic scenario to put energy system back on track with Paris Agreement

# Energy & CO<sub>2</sub> Scenarios EUROPE

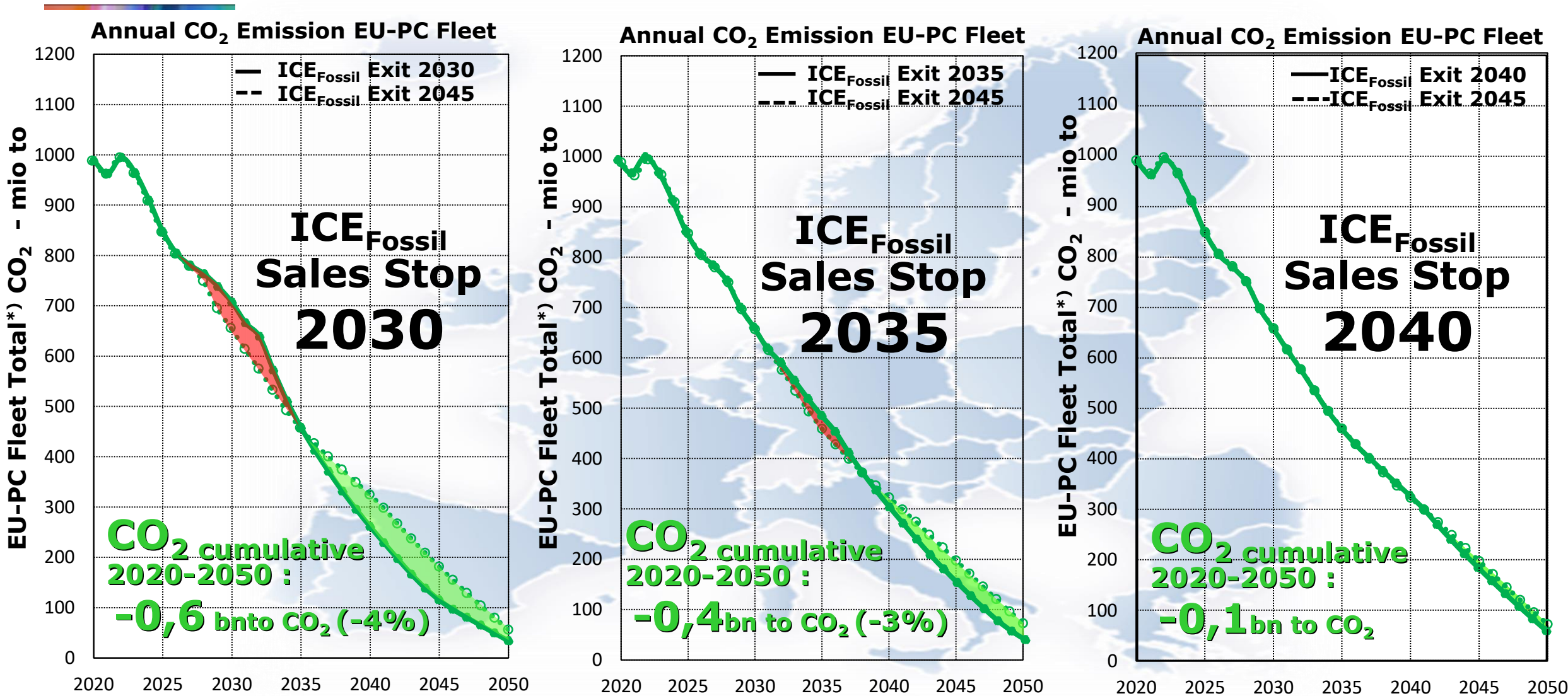




# EU CO<sub>2</sub> Emission<sup>\*)</sup> with Different ICE<sub>Fossil</sub> Sales Stops

## SDS Energy Scenario

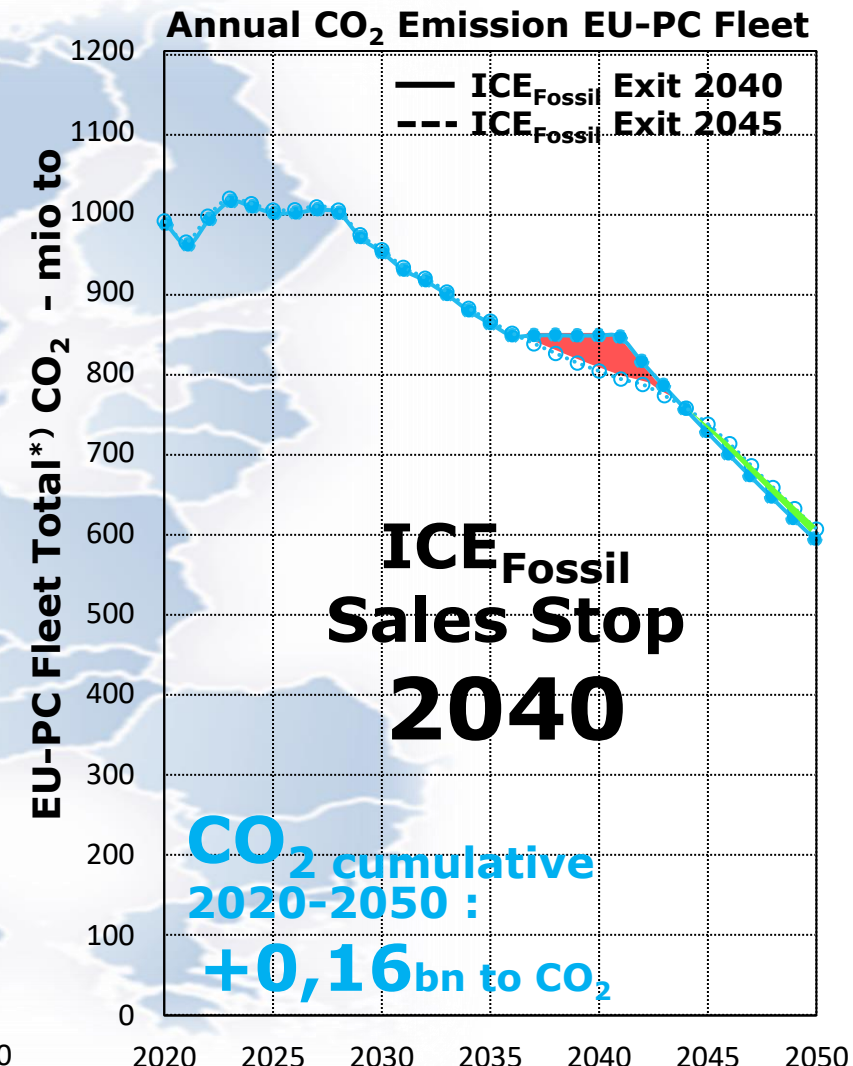
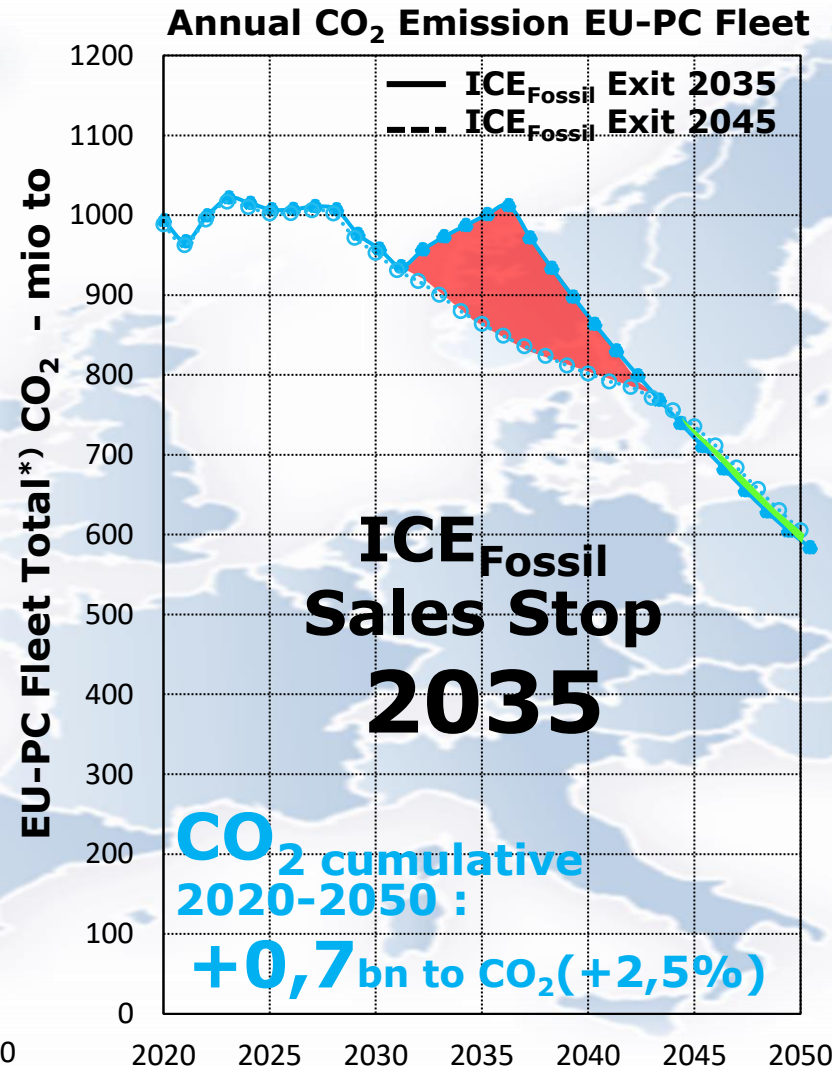
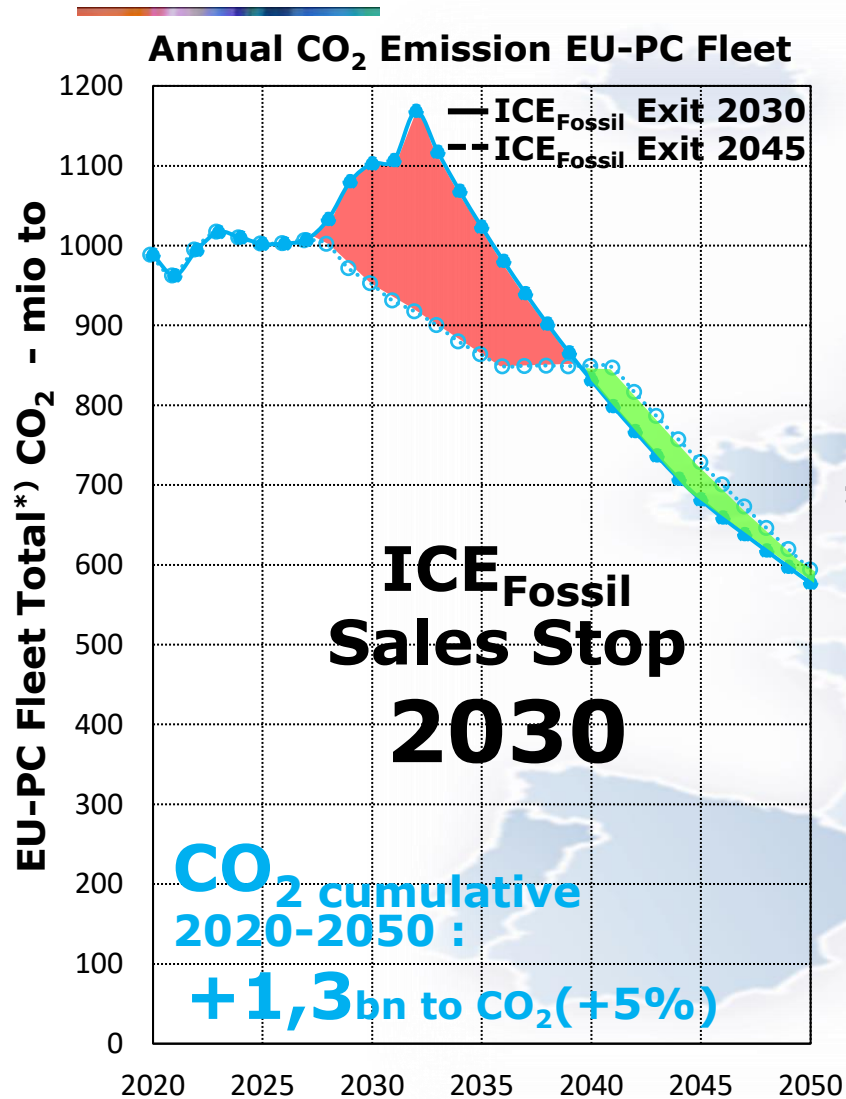
\*) EU PC Fleet Well to Wheel + Production



# EU CO<sub>2</sub> Emission<sup>\*)</sup> with Different ICE<sub>Fossil</sub> Sales Stops

## CPS Energy Scenario

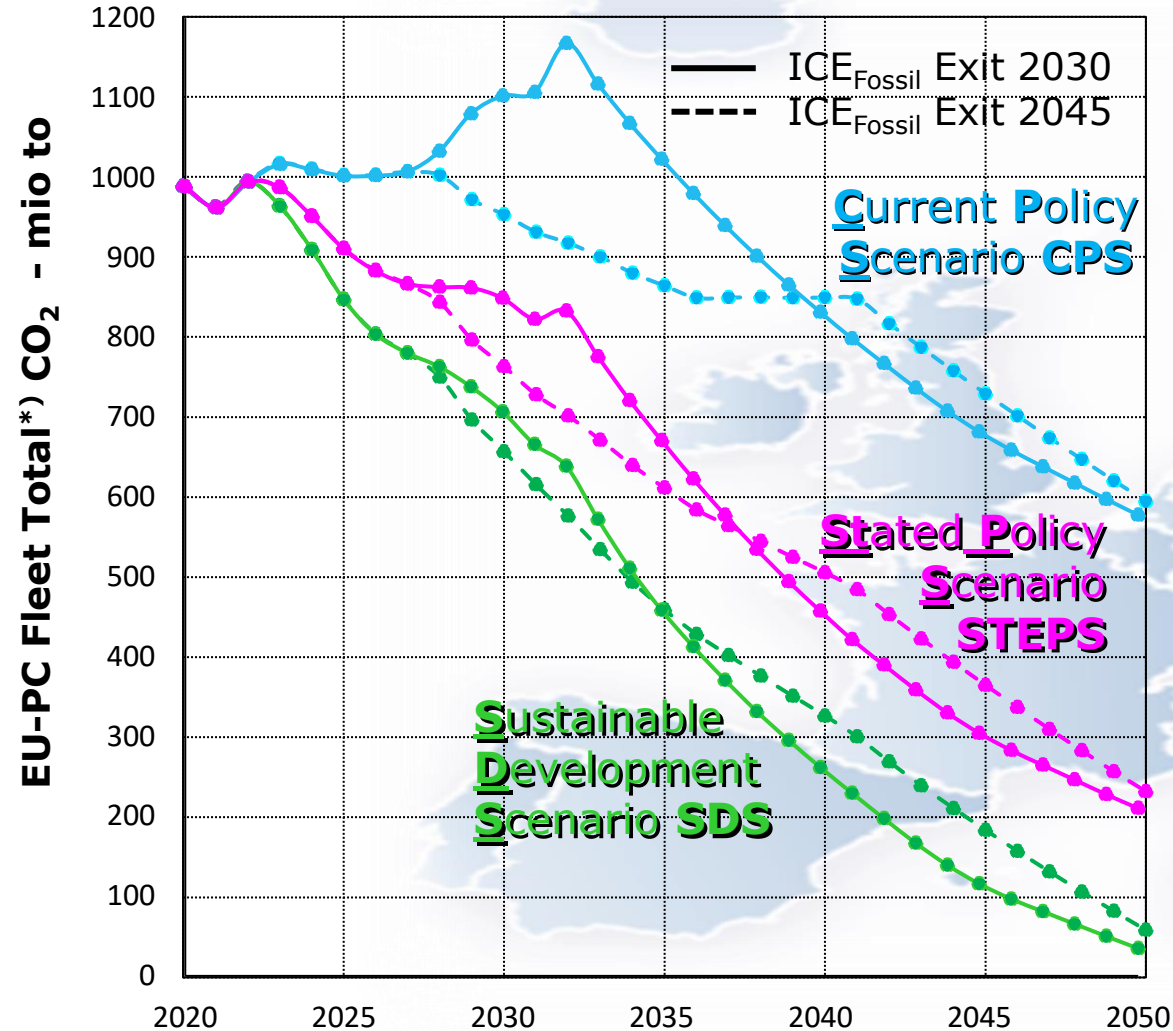
\*) EU PC Fleet Well to Wheel + Production



# EU CO<sub>2</sub> Emission<sup>\*)</sup> - Impact of ICE<sub>Fossil</sub> Sales Stops with Different Energy Scenarios

\*) EU PC Fleet Well to Wheel + Production

Annual CO<sub>2</sub> Emission EU-PC Fleet



**CPS: 2045 → 2030:**  
**CO<sub>2</sub> cum : +1,3 bn to CO<sub>2</sub> (+5%)**

**STEPS: 2045 → 2030:**  
**CO<sub>2</sub> cum : + / 0 bn to CO<sub>2</sub>**

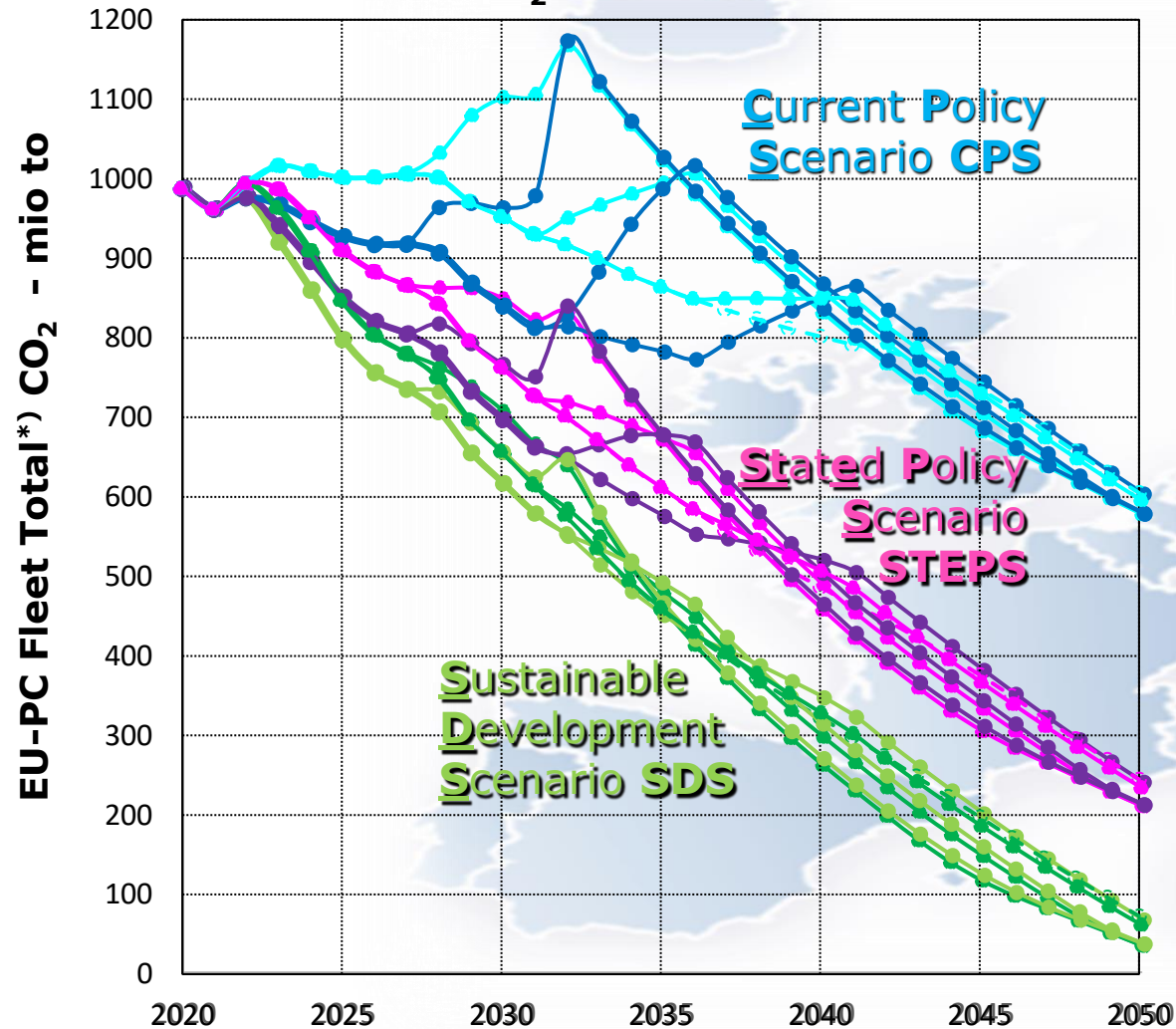
**SDS: 2045 → 2030:**  
**CO<sub>2</sub> cum : -0,6 bn to CO<sub>2</sub> (-4%)**



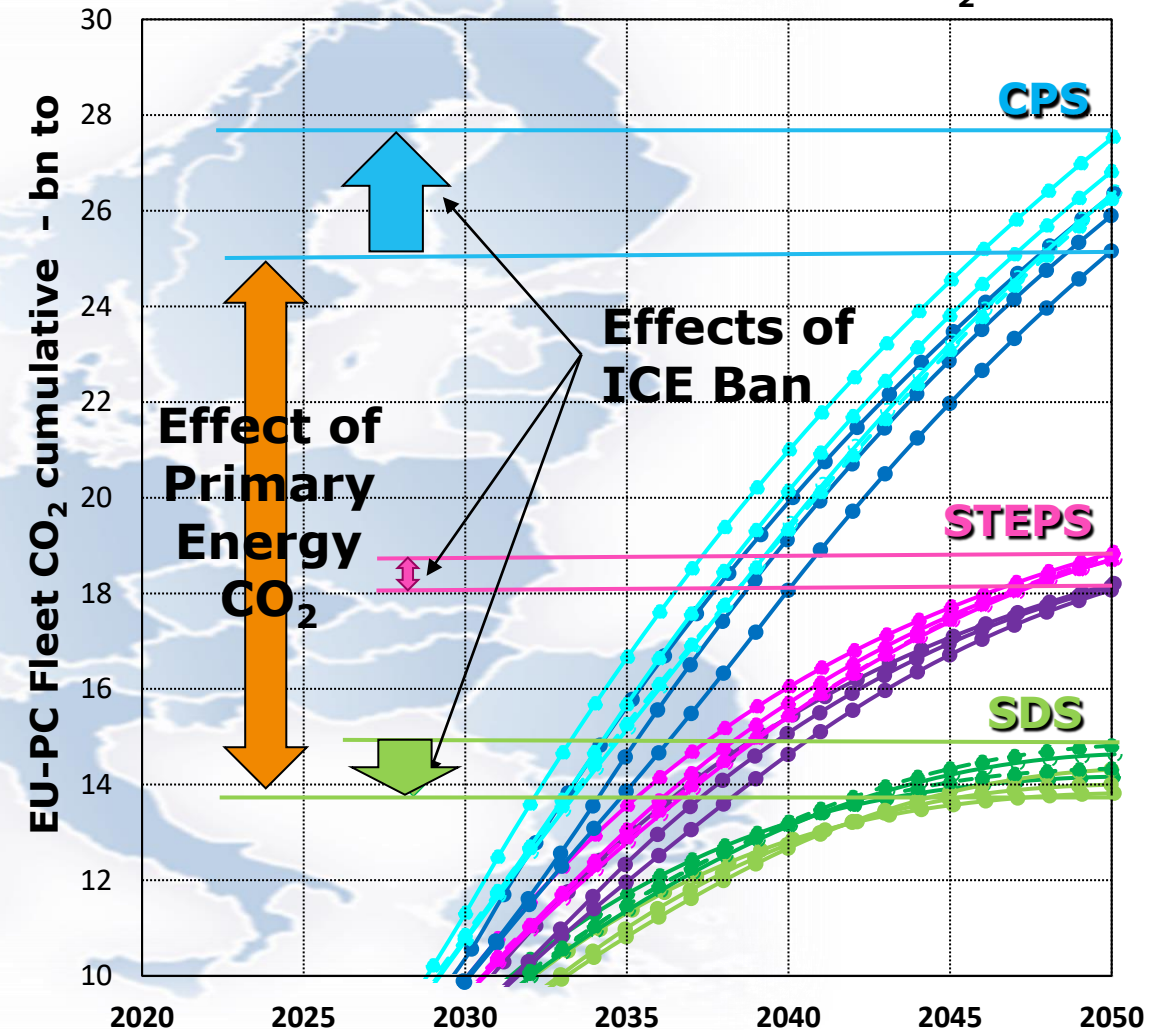
# Effect of Primary Energy CO<sub>2</sub> vs. ICE<sub>Fossil</sub> Sales Stop 2030/2035/2040/2045

\*) EU PC Fleet Well to Wheel + Production

## Annual CO<sub>2</sub> Emission EU-PC Fleet



## Cumulative EU-PC Fleet CTG-CO<sub>2</sub>





# Efficient & Robust CO<sub>2</sub> Reduction and Energy Supply

## Logic Approach

**1. Primary Energy Supply**

**2. Energy Carrier/  
Infrastructure**

**3. Vehicle Portfolio**



## European Way

**3. Primary Energy Supply**

**2. Energy Carrier/  
Infrastructure**

**1. Vehicle Portfolio**

# Summary

- **Actual energy crisis reveals deficiencies of EU energy and CO<sub>2</sub> policy**
  - **Energy supply & energy carriers not diversified enough**
  - **No proper matching primary energy / infrastructure / propulsion technologies**
  - **Dogmatic focus on BEV → most effective means for short term CO<sub>2</sub> reduction – e-Fuels – not emphasized sufficiently**
- **High risk that current PassCar–CO<sub>2</sub> legislation will increase lifecycle CO<sub>2</sub> emission versus an optimized, technology open approach**
- **Adaptation of current PassCar CO<sub>2</sub> legislation required for cost effective CO<sub>2</sub> reduction**

# Thank you



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