



EU Trends and Legislation on Carbon Neutral Energy Carriers

Waseda Symposium 2022

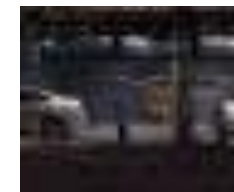
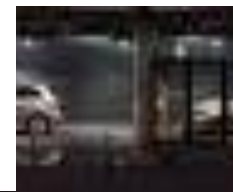
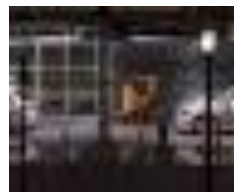
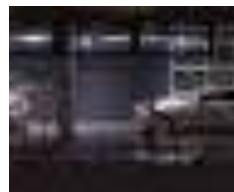
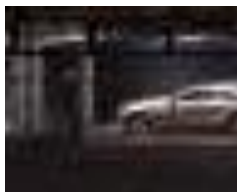
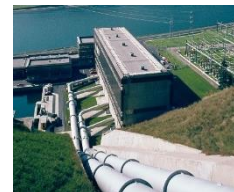
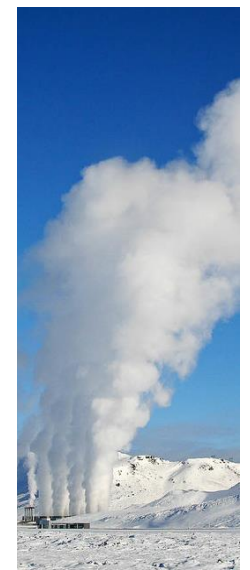
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Efficient & Robust CO₂ Reduction and Energy Supply

1. Primary Energy Supply

2. Energy Carrier / Infrastructure

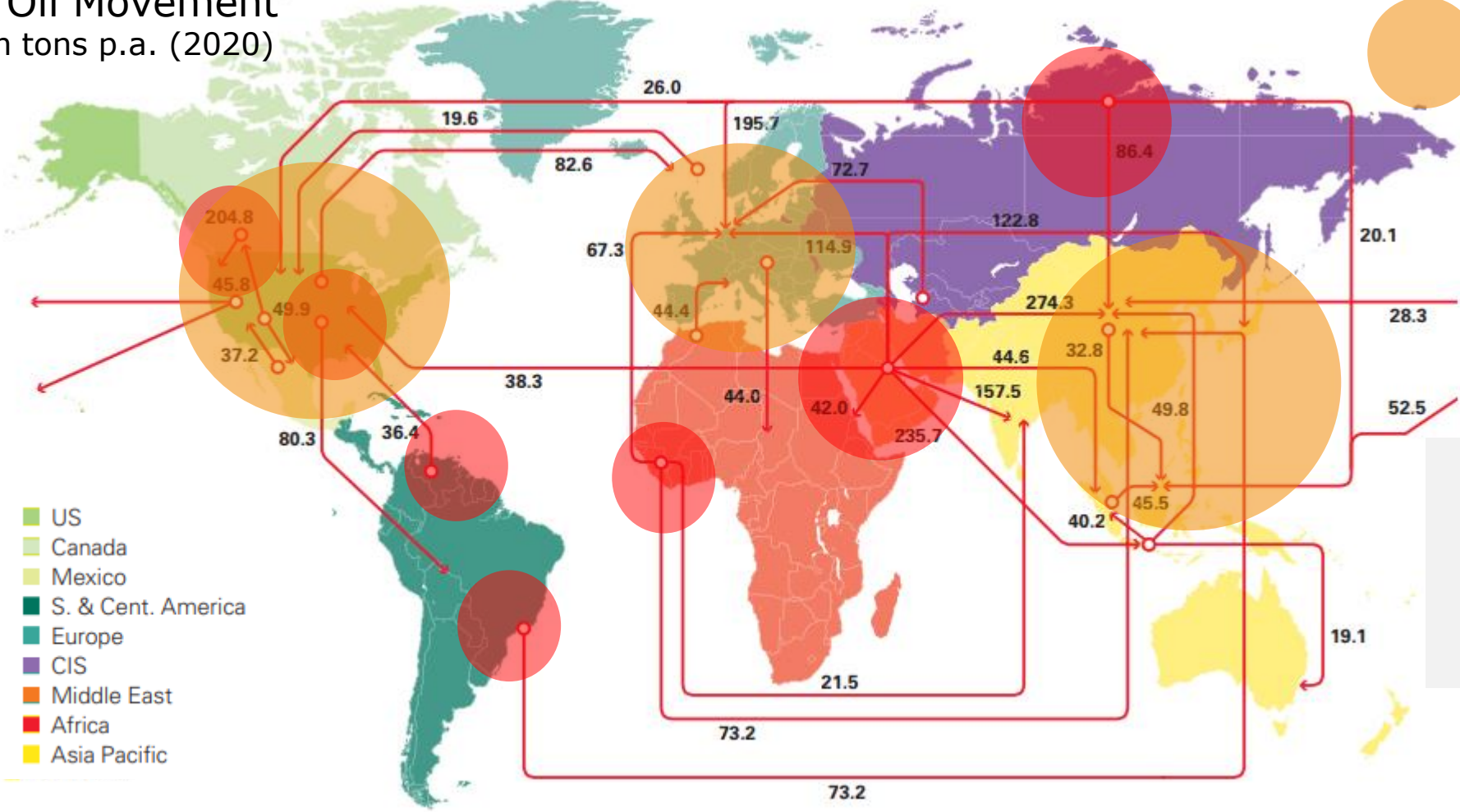
3. Vehicle Portfolio



Today's Fossil Energy Trade System

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

Supply Regions (Red circle)
Demand Centers (Orange circle)



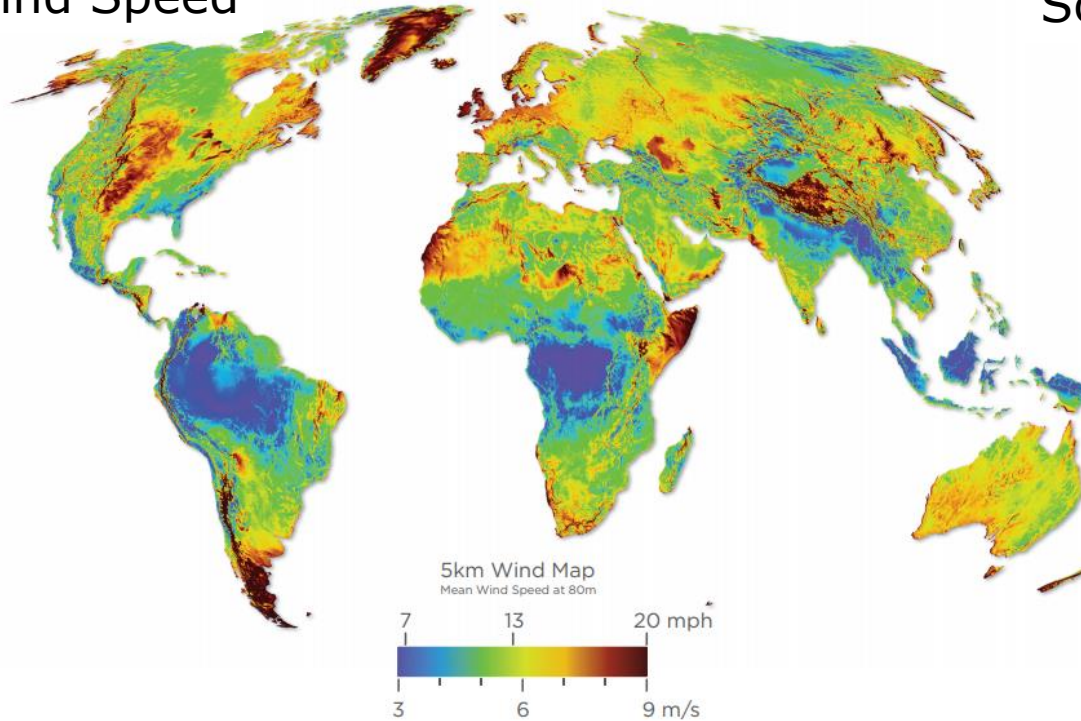
Today's global energy trade is fully based on fossil fuels

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>

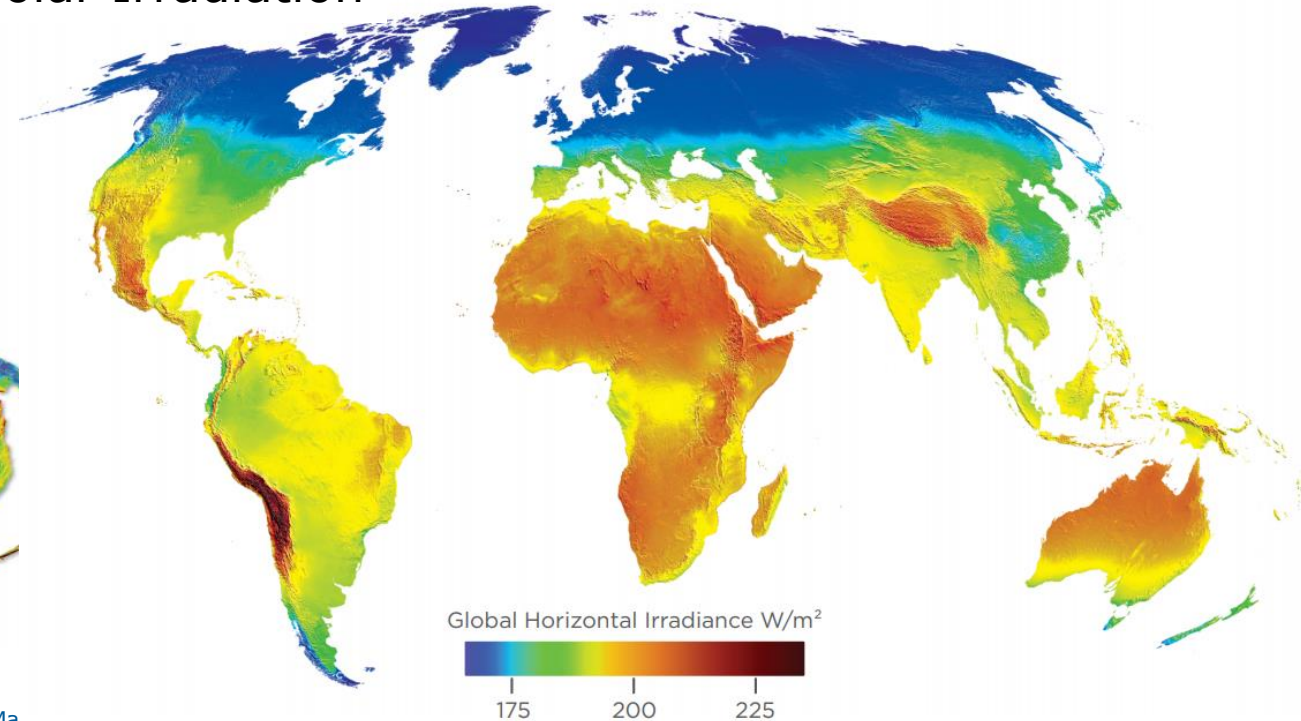


The Challenge: Storage and Transport of Wind and Solar Energy

Wind Speed



Solar Irradiation

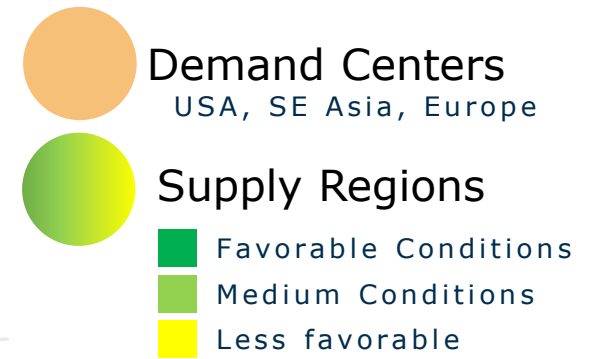


Source:

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_solar_map.pdf?utm_content=Solar-Ma

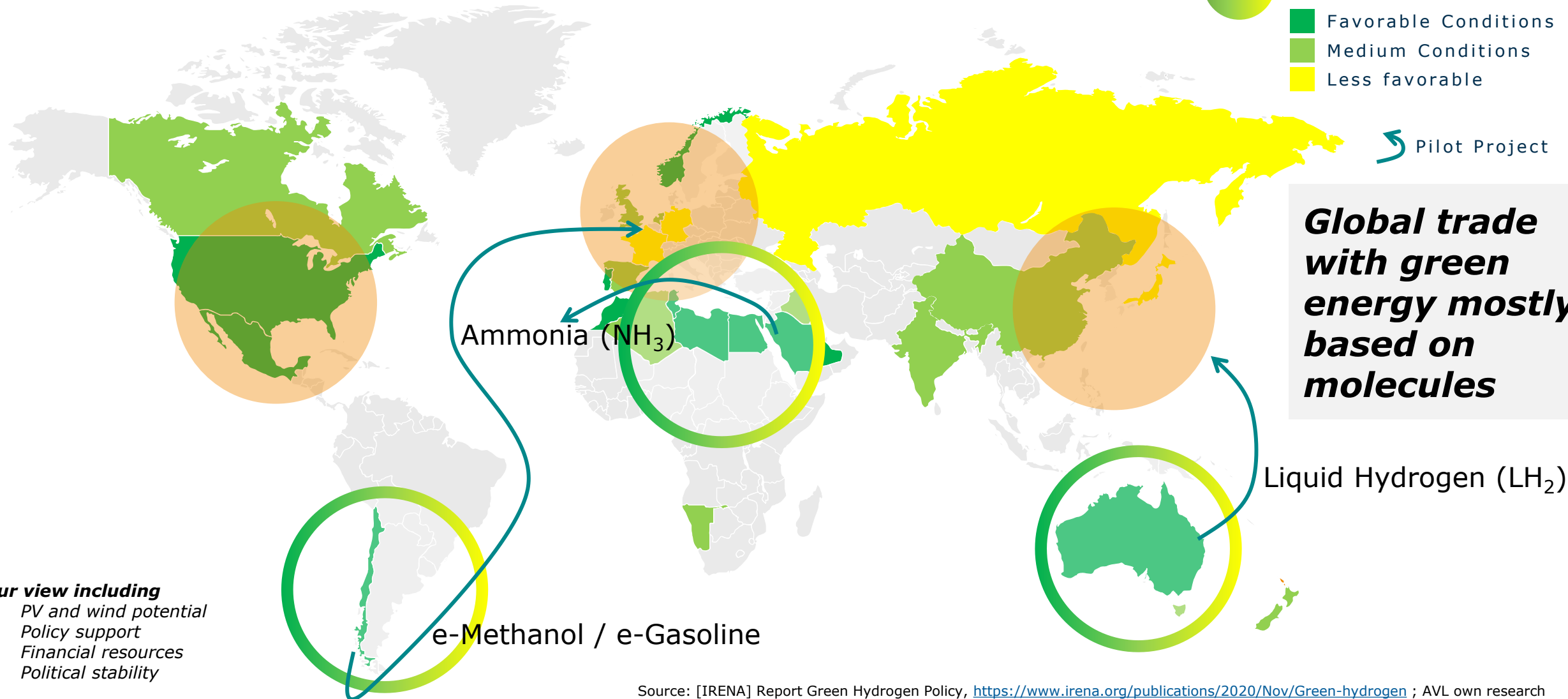
Production Potential is located far away from Demand Centers

Energy Trade Future: Green Hydrogen Production and Demand



Pilot Project

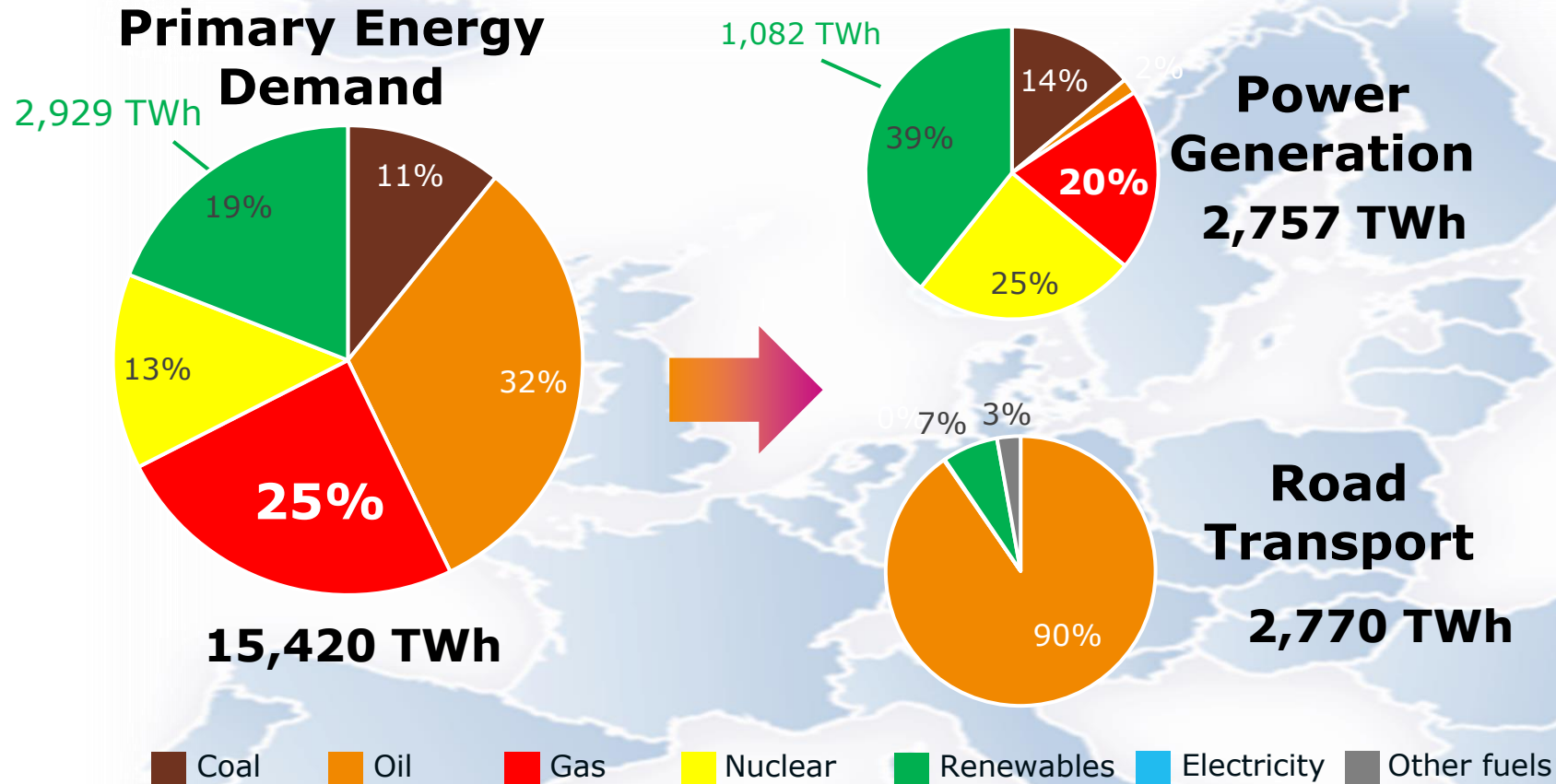
Global trade with green energy mostly based on molecules



- 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



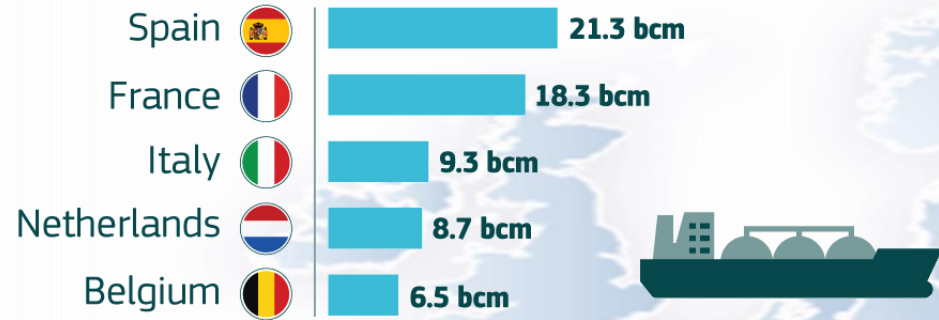
**40% of Gas
and
27% of oil
came from
Russia**

Source: IEA WEO 2021, EUROSTAT

Ukraine War impacts reveal deficiencies of EU energy & CO₂ strategy

EU LNG Imports versus Russian Gas

Biggest LNG importers in the EU in 2021

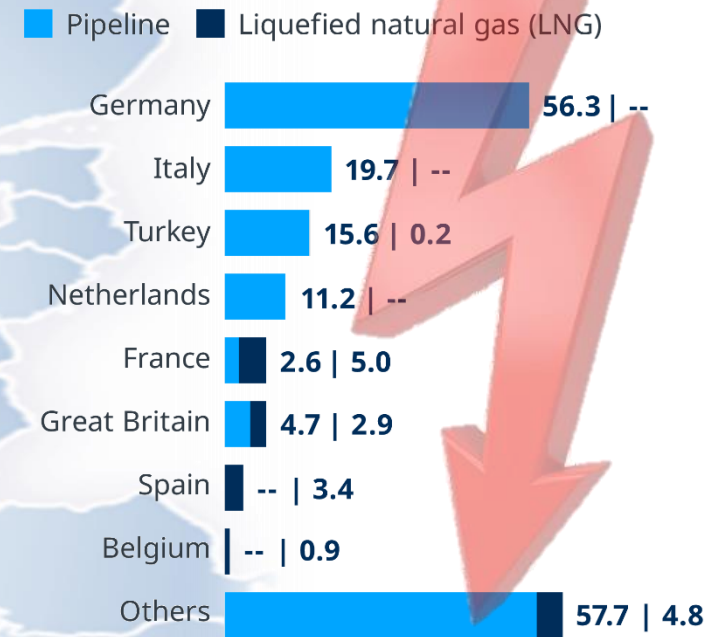


Sources: European Commission, April 2022, [Link](#)

- 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



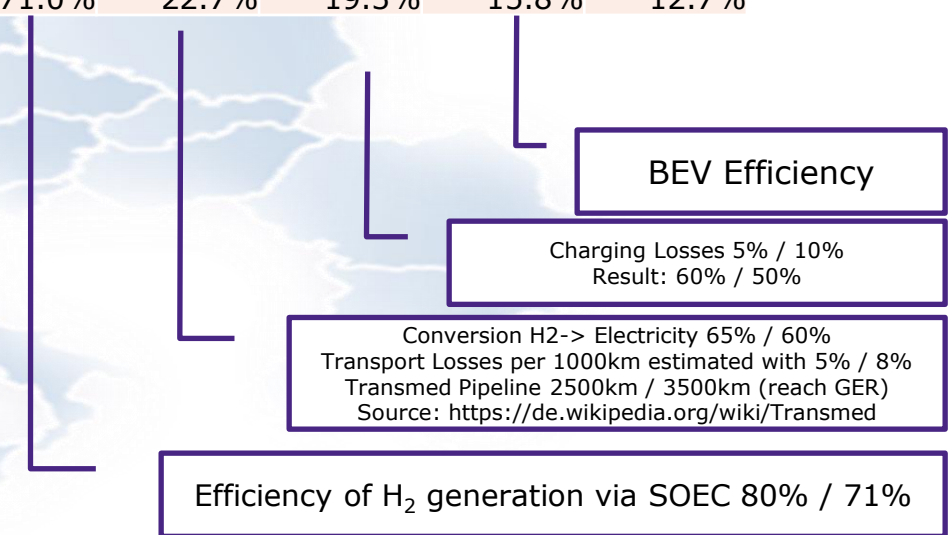
Source: Transmed Pipeline (Algeria-North Italy) 2500km
<https://de.wikipedia.org/wiki/Transmed>

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 (el. from H2)	BEV best case from H2	100.0%	80.0%	42.0%	39.9%	35.1%	31.6%
	BEV worst case from H2	100.0%	71.0%	22.7%	19.3%	15.8%	12.7%



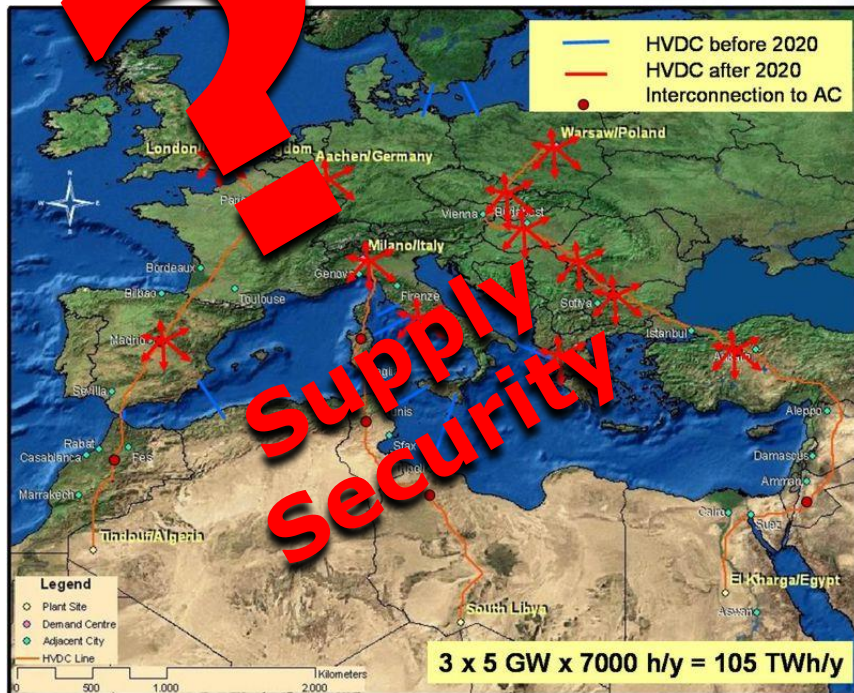
*) MENA ... Middle East and North Africa

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 (\$480bn) with high costs were the main obstacle



Morocco-UK 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](#)



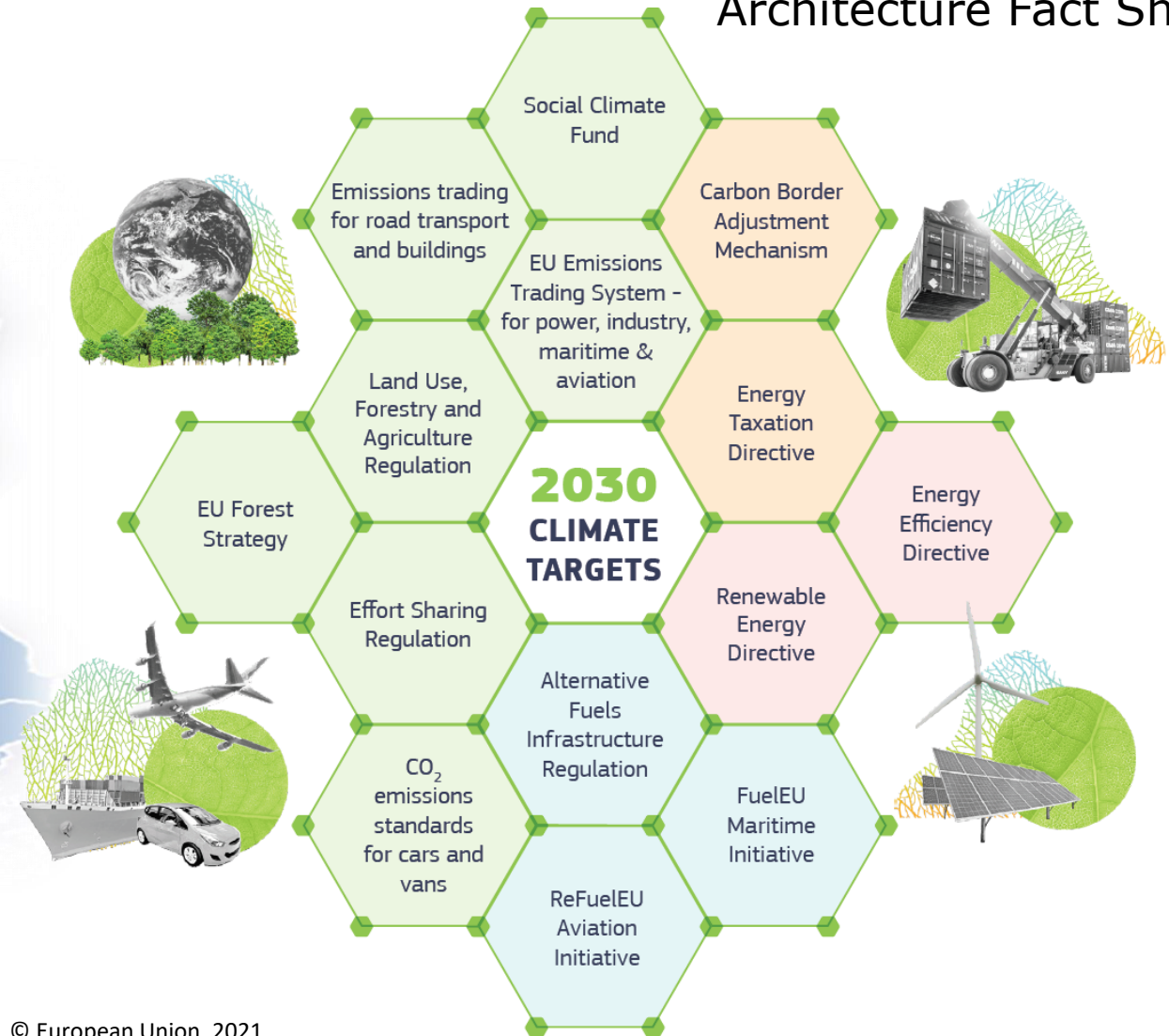
Source: <https://xlinks.co/>

Delivering the European Green Deal - The Decisive Decade

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.*



*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

European Green Deal Tank-to-Wheel

Architecture Fact Sheet

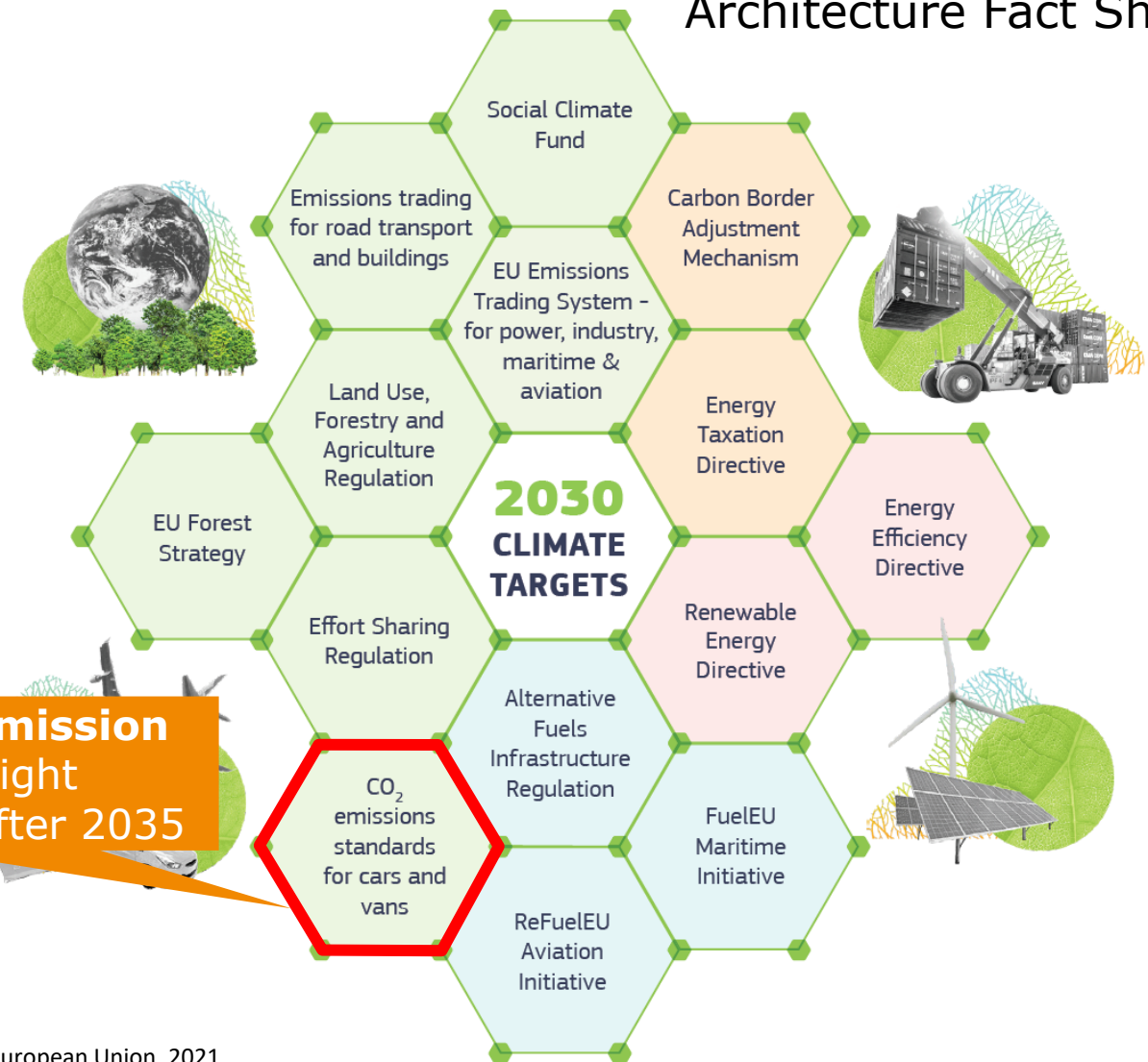
“Fit for 55”

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

Zero Tailpipe CO₂ 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

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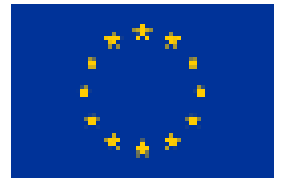
Make Transport Greener

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

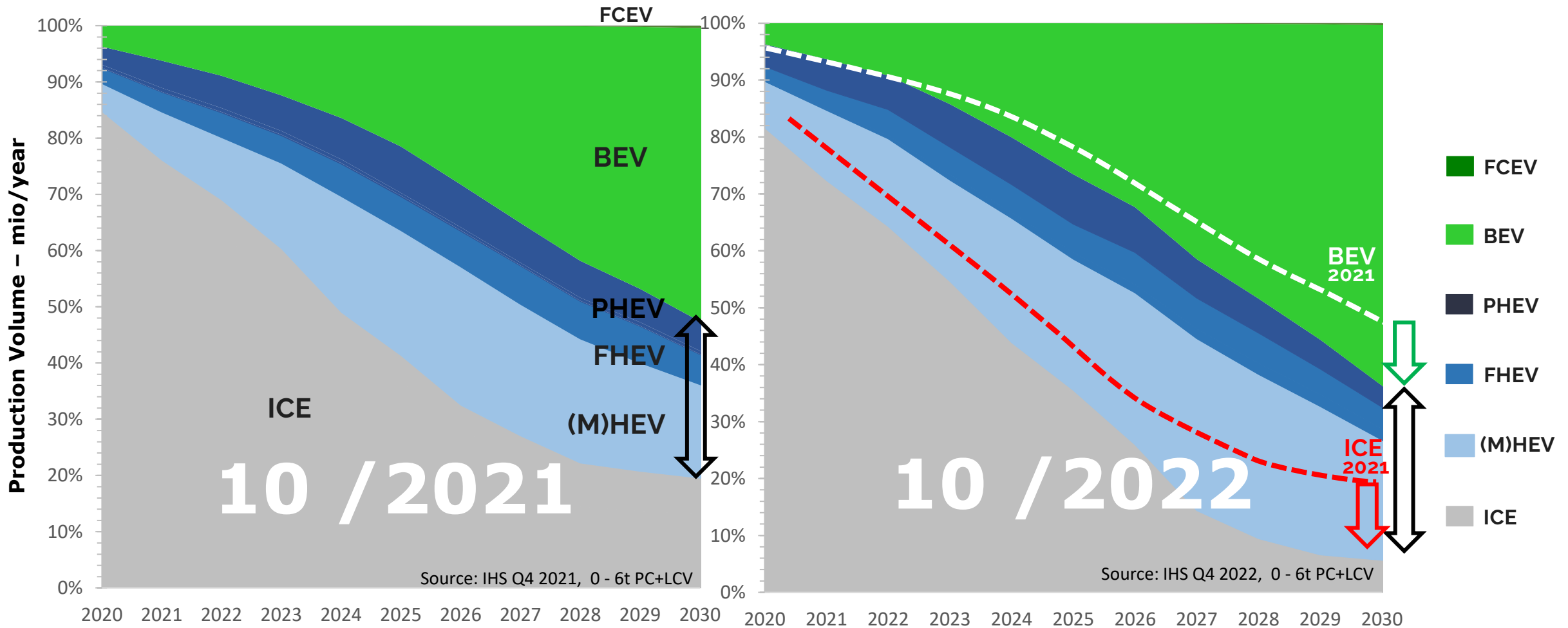
7/2021

More ambitious CO₂ emissions standards for new cars and vans to help grow the number of zero- and low-emission vehicles on European roads.



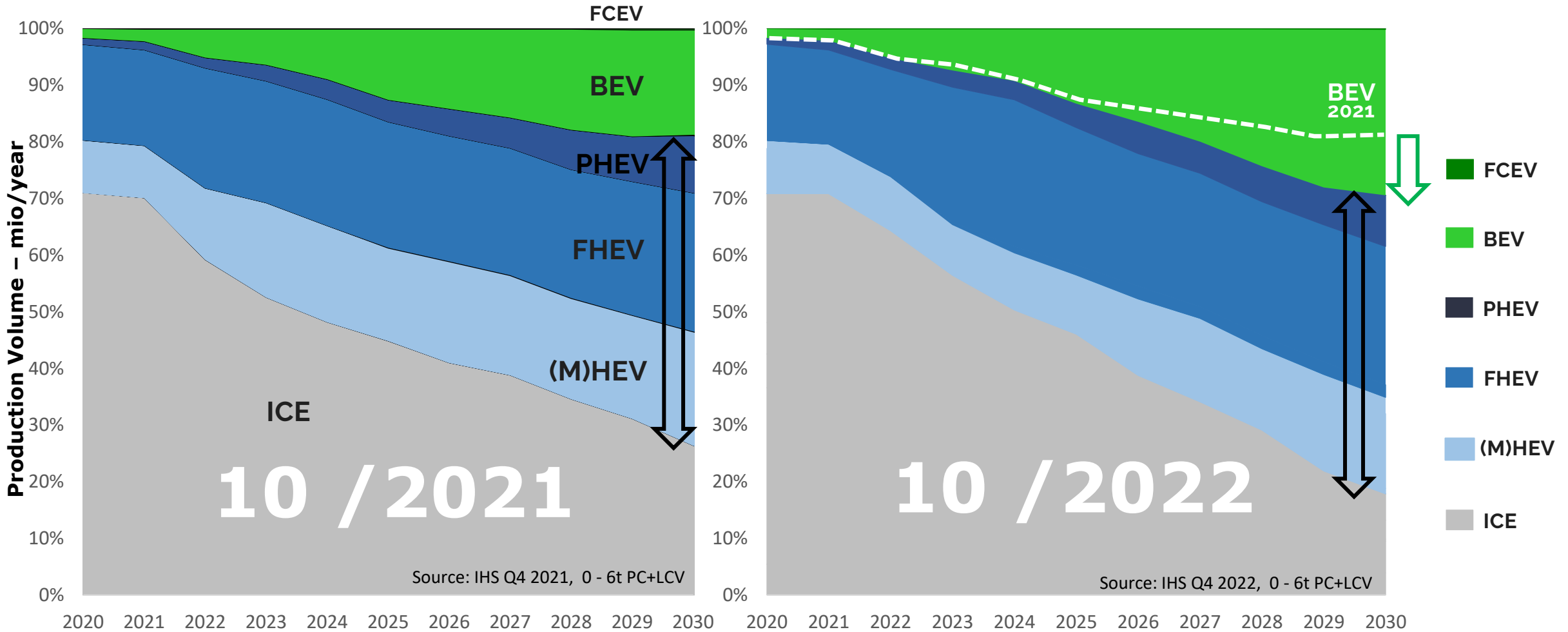
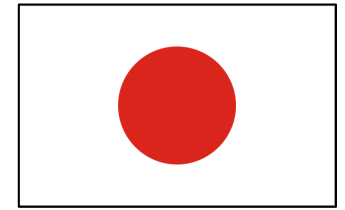


Technology Outlook **EUROPE** - IHS Prediction 10/2021 vs. 10/2022



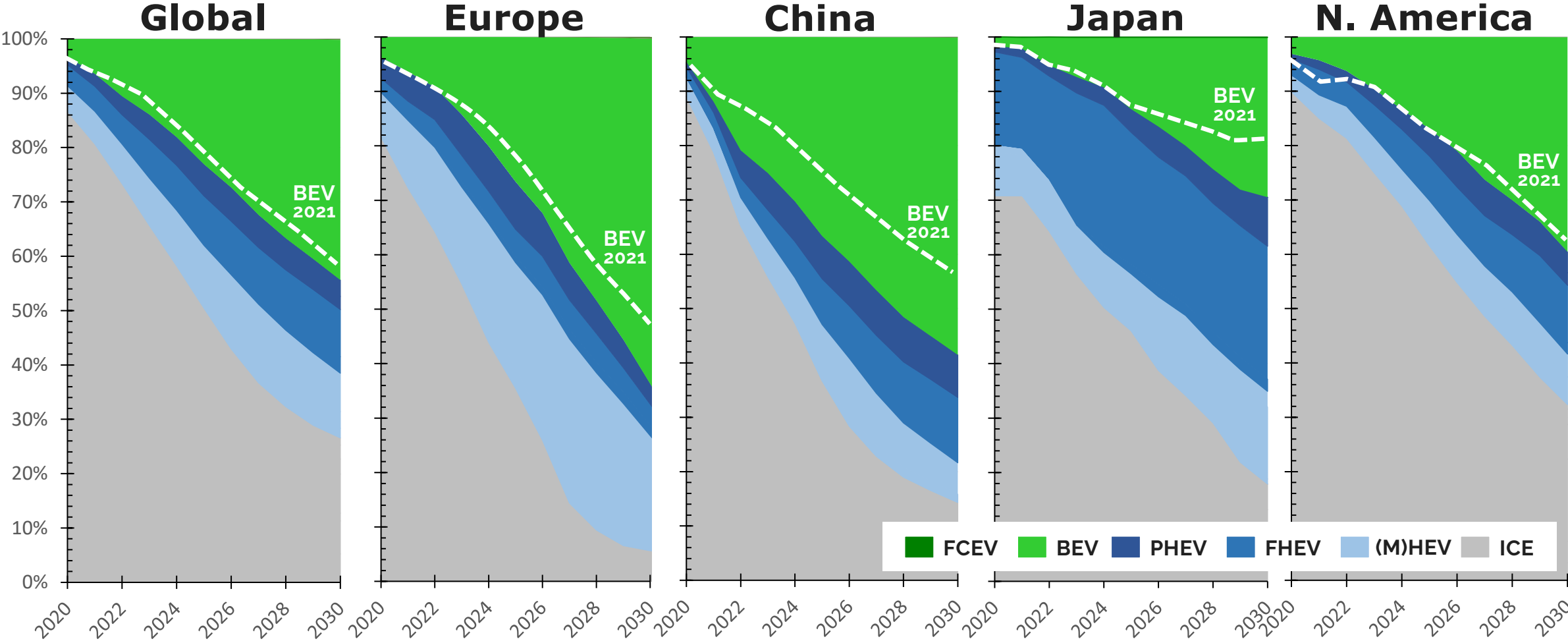
Prediction 2022 vs. 2021: 2030 BEV 53% → 62%, ICE_{only} 20% → 8%, Hybrid 30%

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

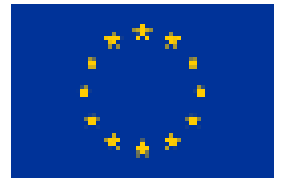


In spite increasing BEV share, XHEV remains dominating beyond 2030

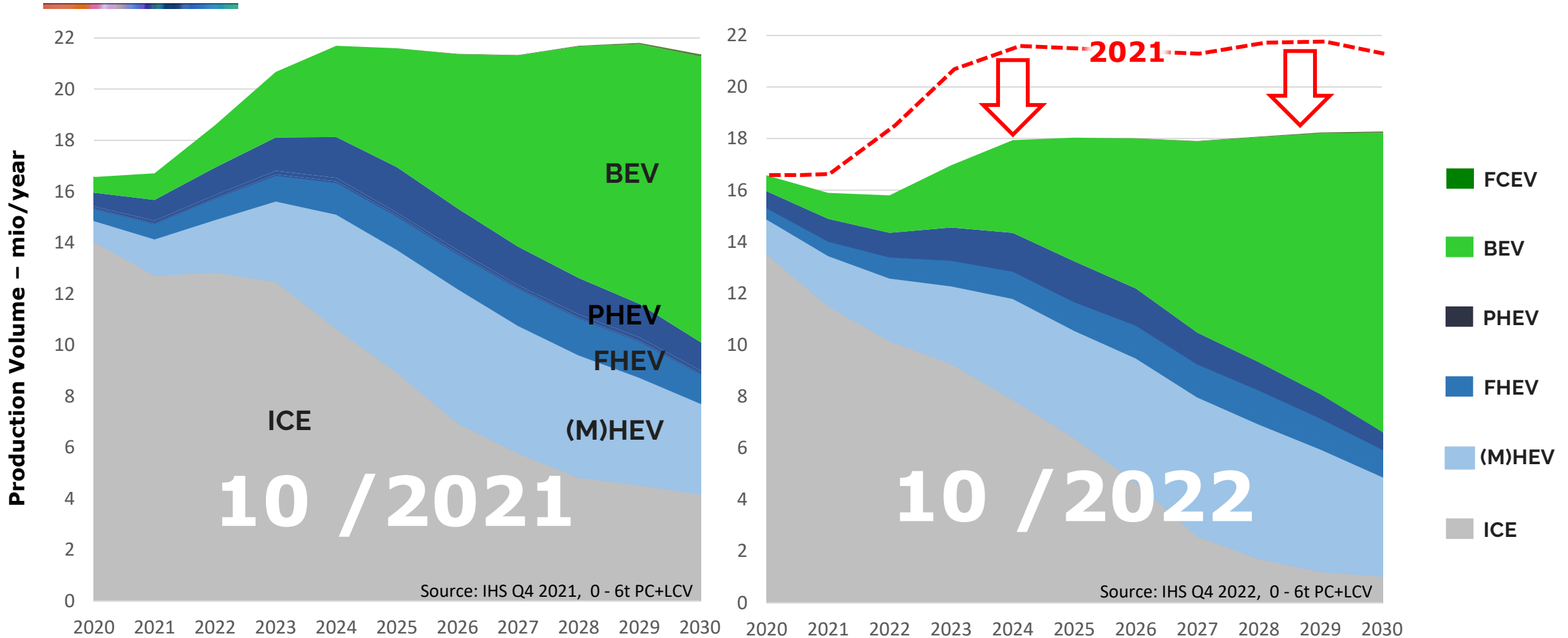
Technology Outlook **GLOBAL** - IHS Prediction 10/2022



Most significant growth of BEV share in Europe and China

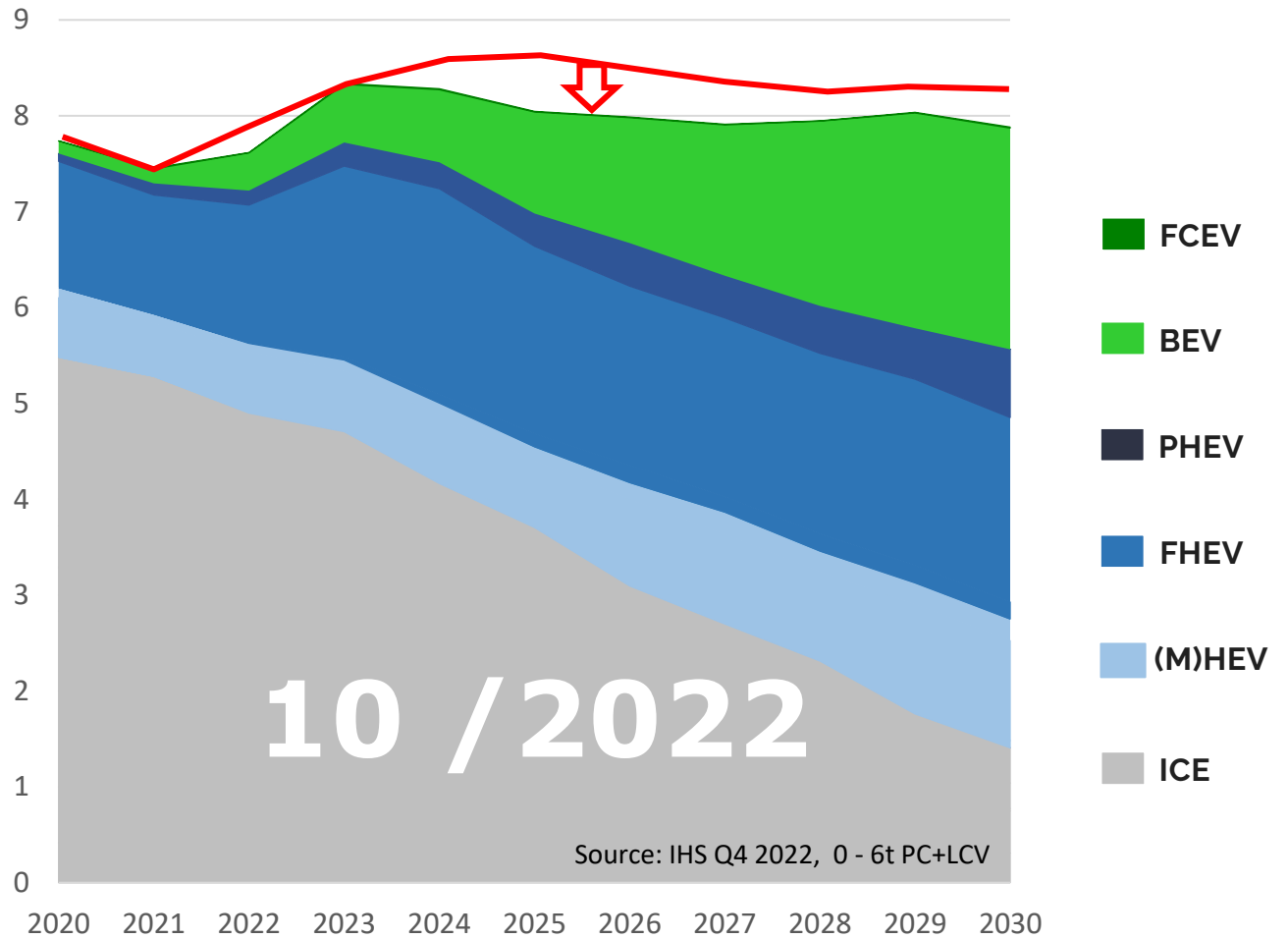
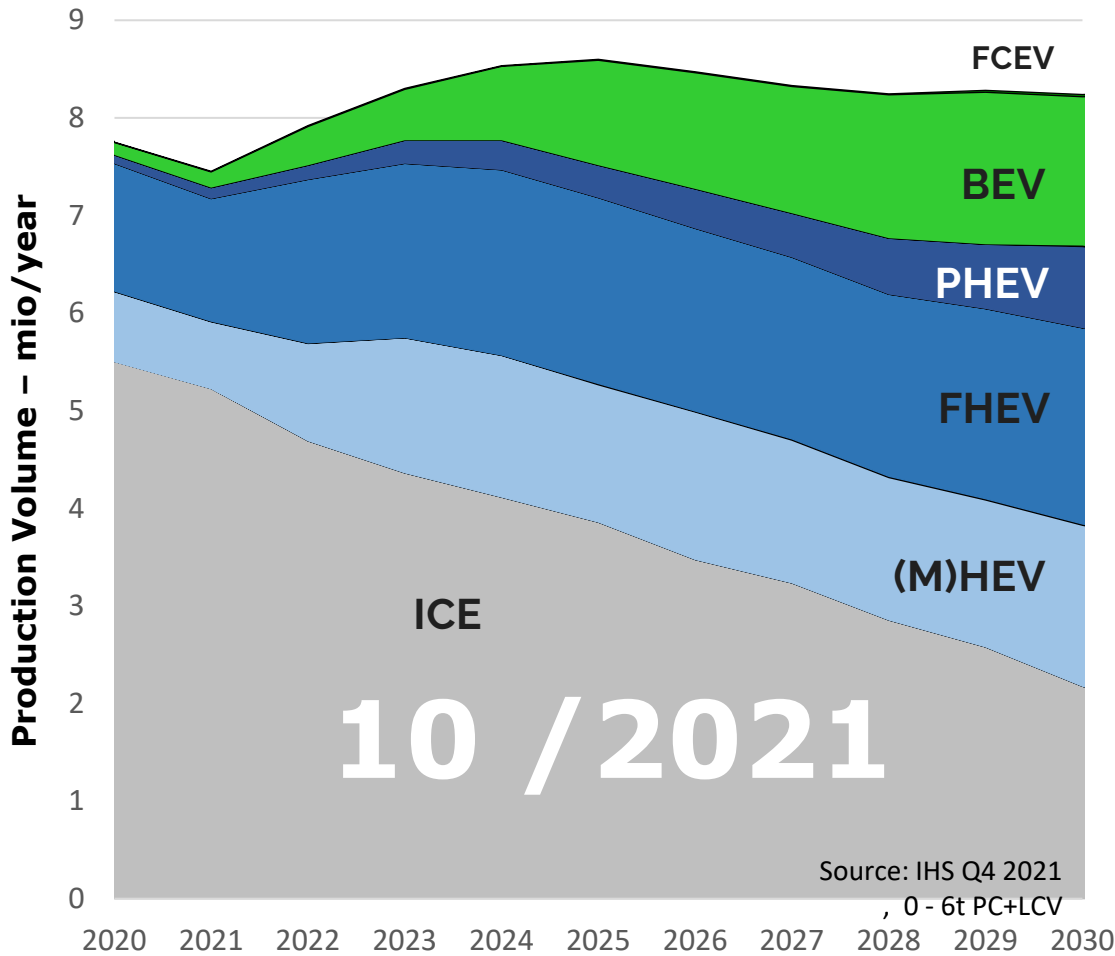
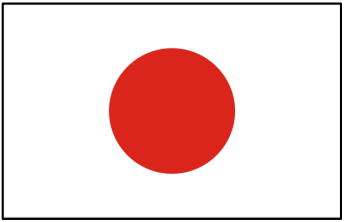


Technology Outlook **EUROPE** - IHS Prediction 10/2021 vs. 10/2022



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

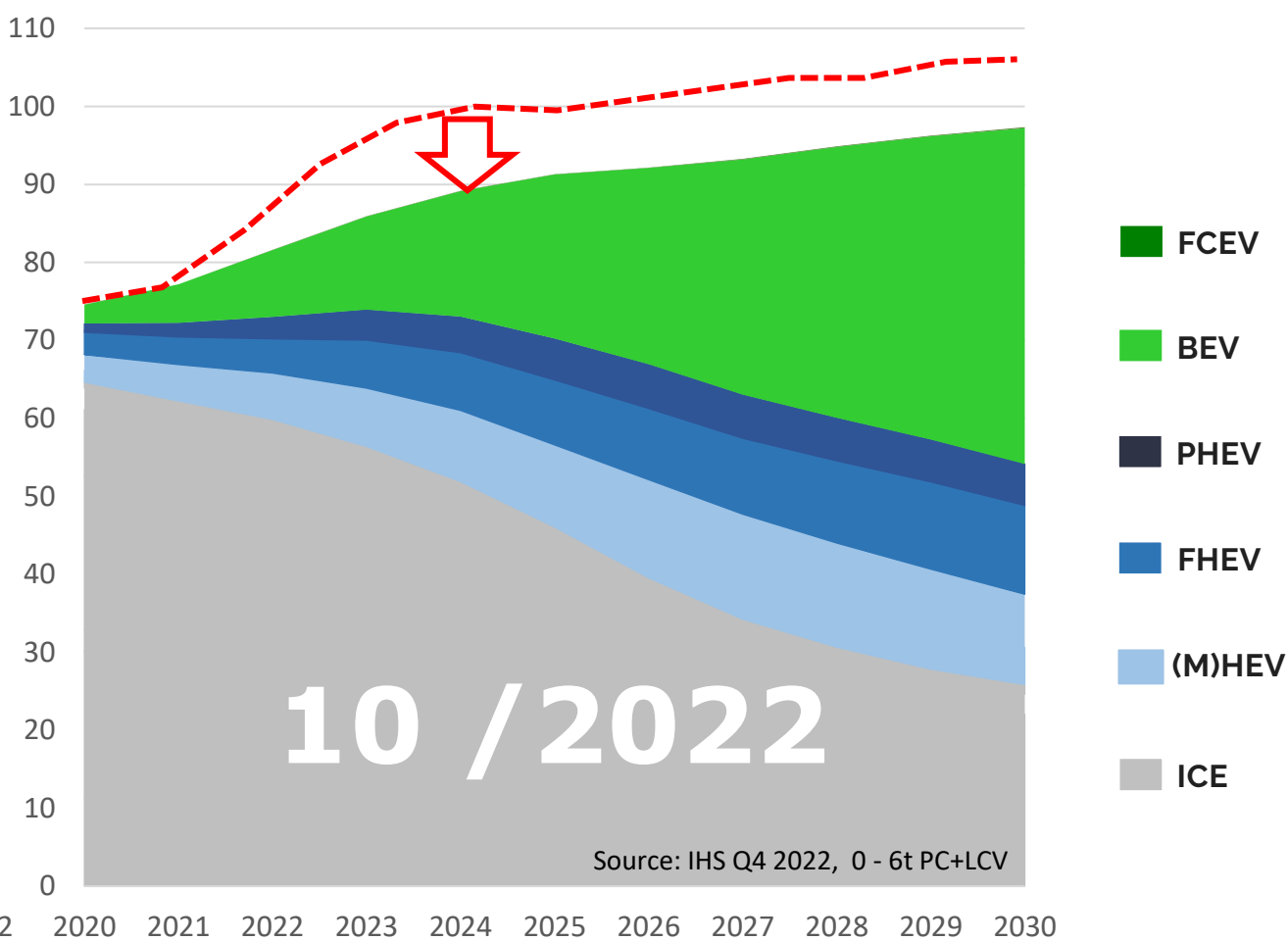
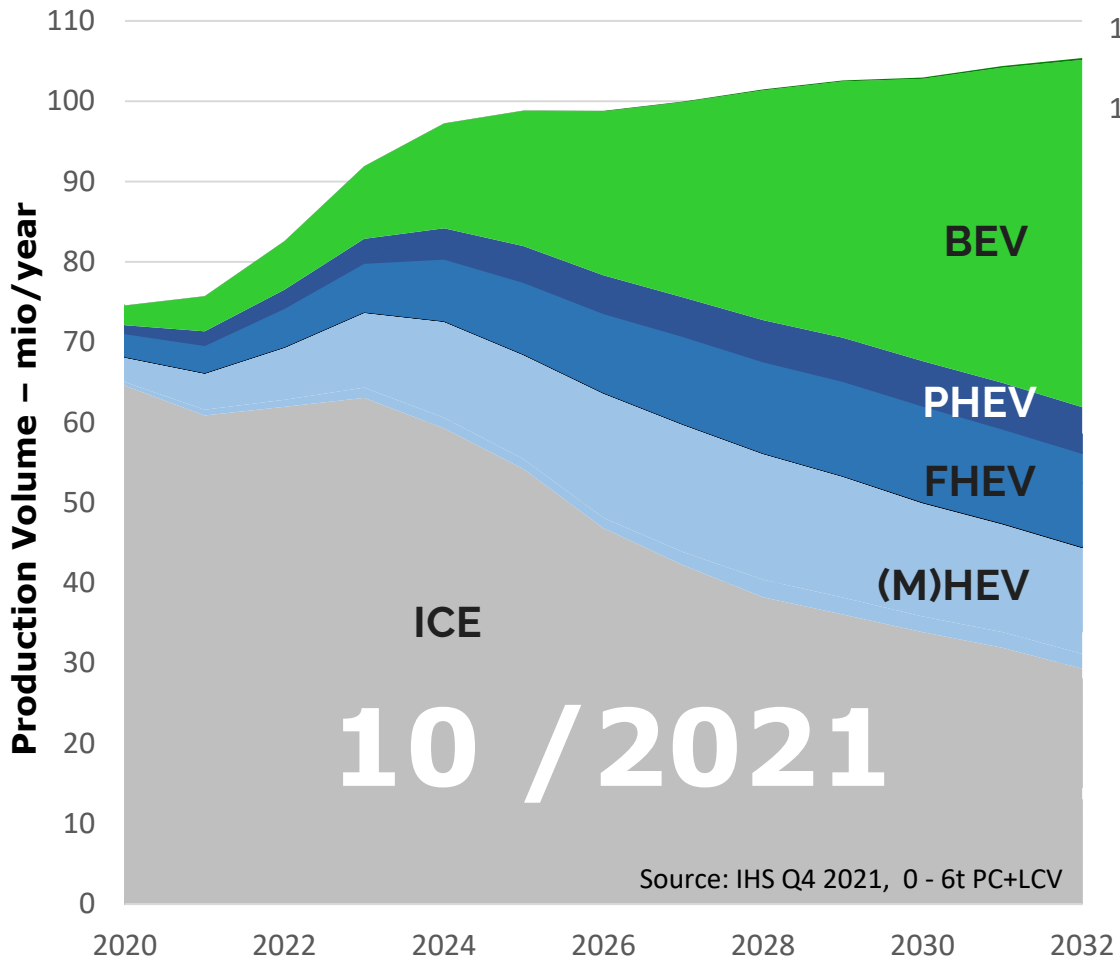
Technology Outlook **JAPAN** - IHS Prediction 10/2021 vs. 10/2022



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



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



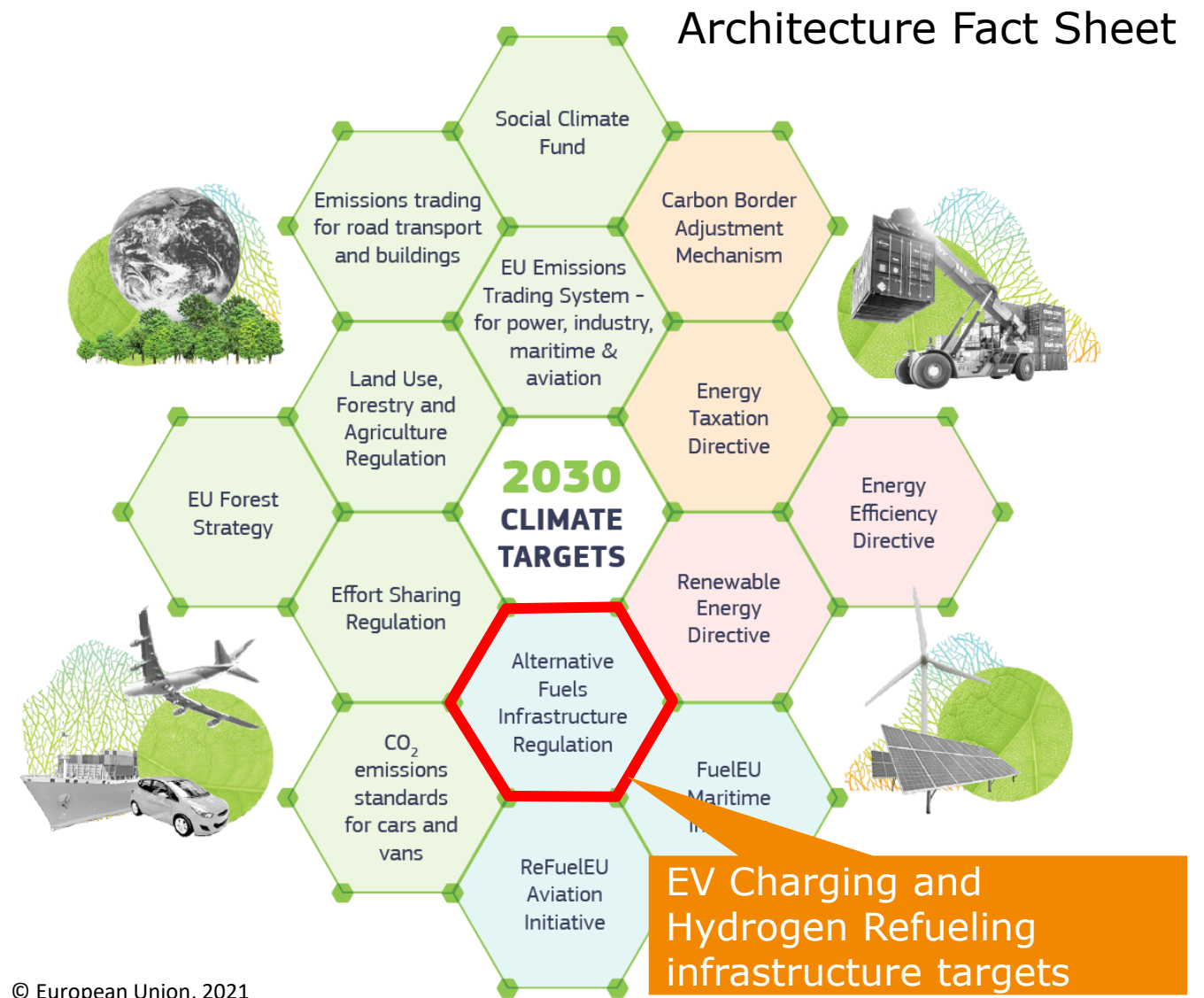
App. 10% lower production volumes 2024-2030 expected than 1 year ago

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.



© European Union, 2021

Make Transport Greener

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

More ambitious CO₂ 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.



Public charging and hydrogen refuelling stations will be widely available, interoperable and easy to use, including at fixed intervals along Europe's major transport corridors

National fleet based targets for charging stations for cars and vans – those could lead to approximately*:



*according to Commission Impact Assessment of vehicle uptake following the 'Fit for 55' proposals and assuming an average power output of approx. 15 kW per recharging station

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

Current rate of installation of new charging points per week

2,000
per week

Balances the average network utilization of charging points and consumer- as well as customer needs

6,000
per week

average number of charging points needed for a smooth transition until 2030

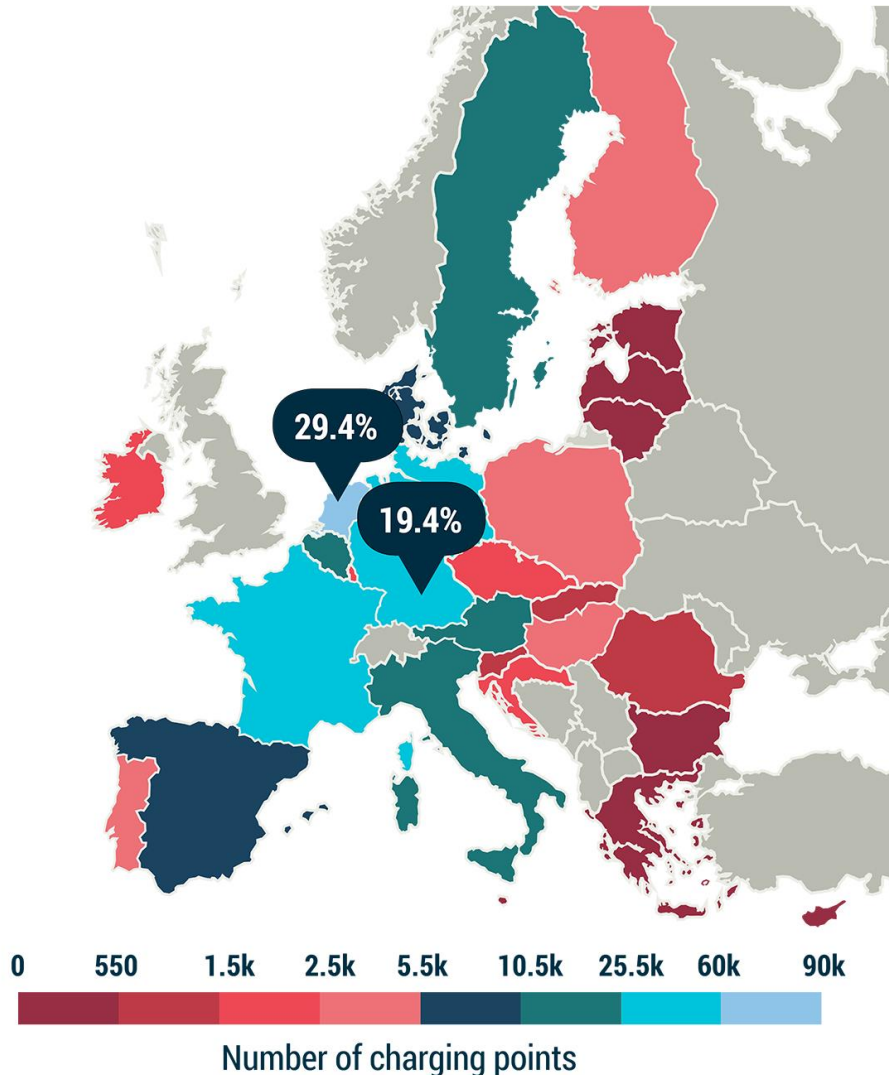
14,000
per week

only 11% of needed charging points

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

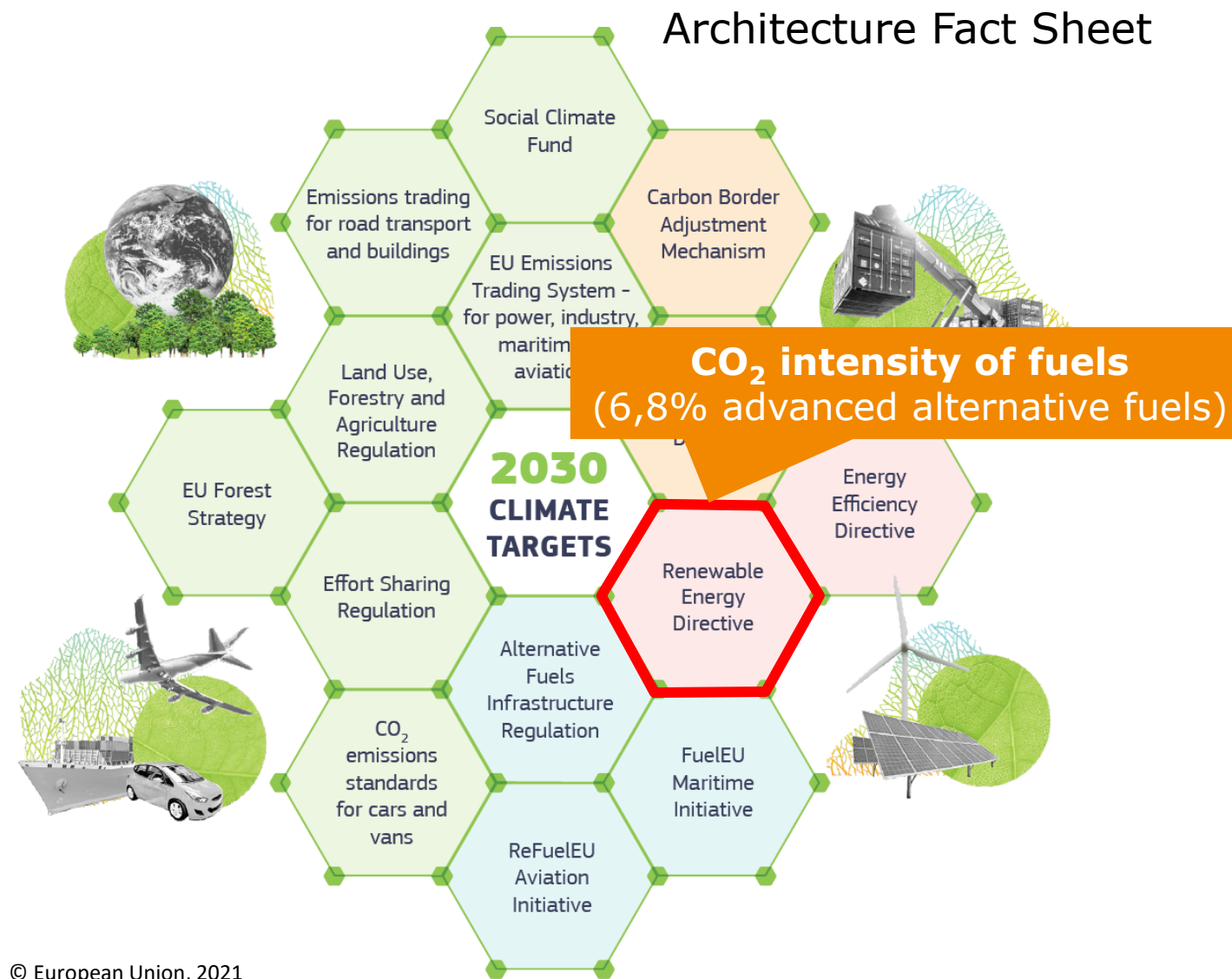
Source: ACEA, June 2022, [Link](#) // European Alternative Fuels Observatory (EAFO), 2021, [Link](#)

European Green Deal Well-to-Wheel

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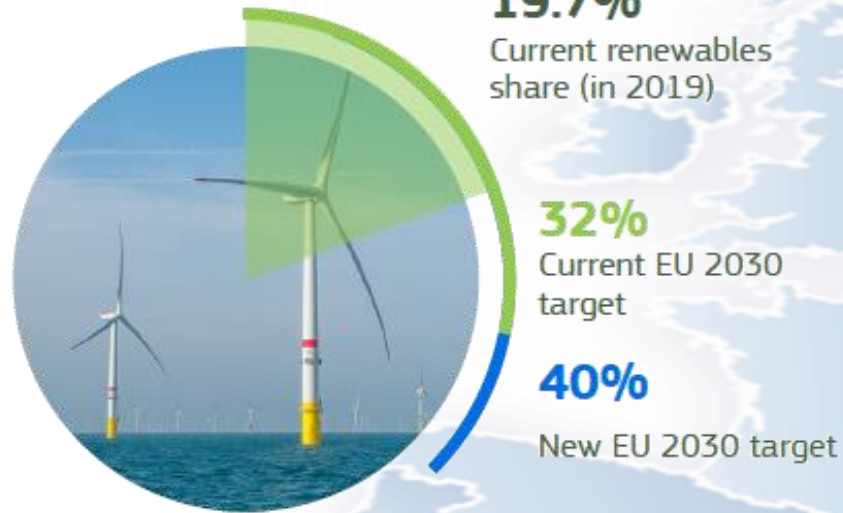


Proposal to Amend RED III

Status: June 2022

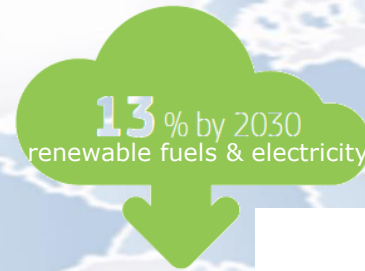


Renewables in the EU energy mix

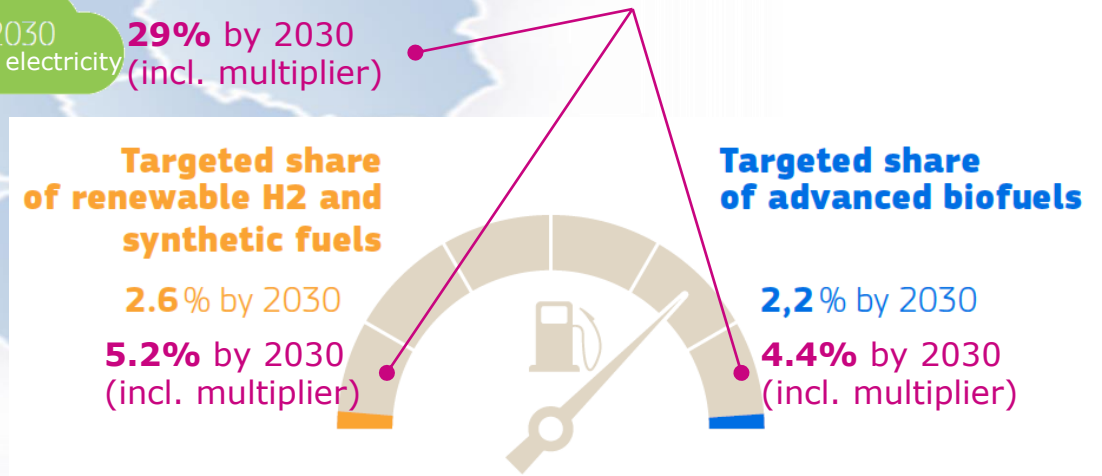


- New targets on greenhouse gas emissions of transport and use of innovative fuels;
- Strengthened criteria and certification for sustainability and greenhouse gas savings.

Targeted reduction in transport GHG intensity



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



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



19.7%
Current renewables share (in 2019)

~~**32%**
Current EU 2030 target~~

~~**40%**
New EU 2030 target~~

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

~~**13%** by 2030
renewable fuels & electricity~~

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_1Uph8Levh2e5moxmPczKGT1LpSBdlSsmgvQW4ZkqbHPXZw

European Green Deal Lifecycle CO₂

Recovery,
CO₂ footprint

Battery
directive

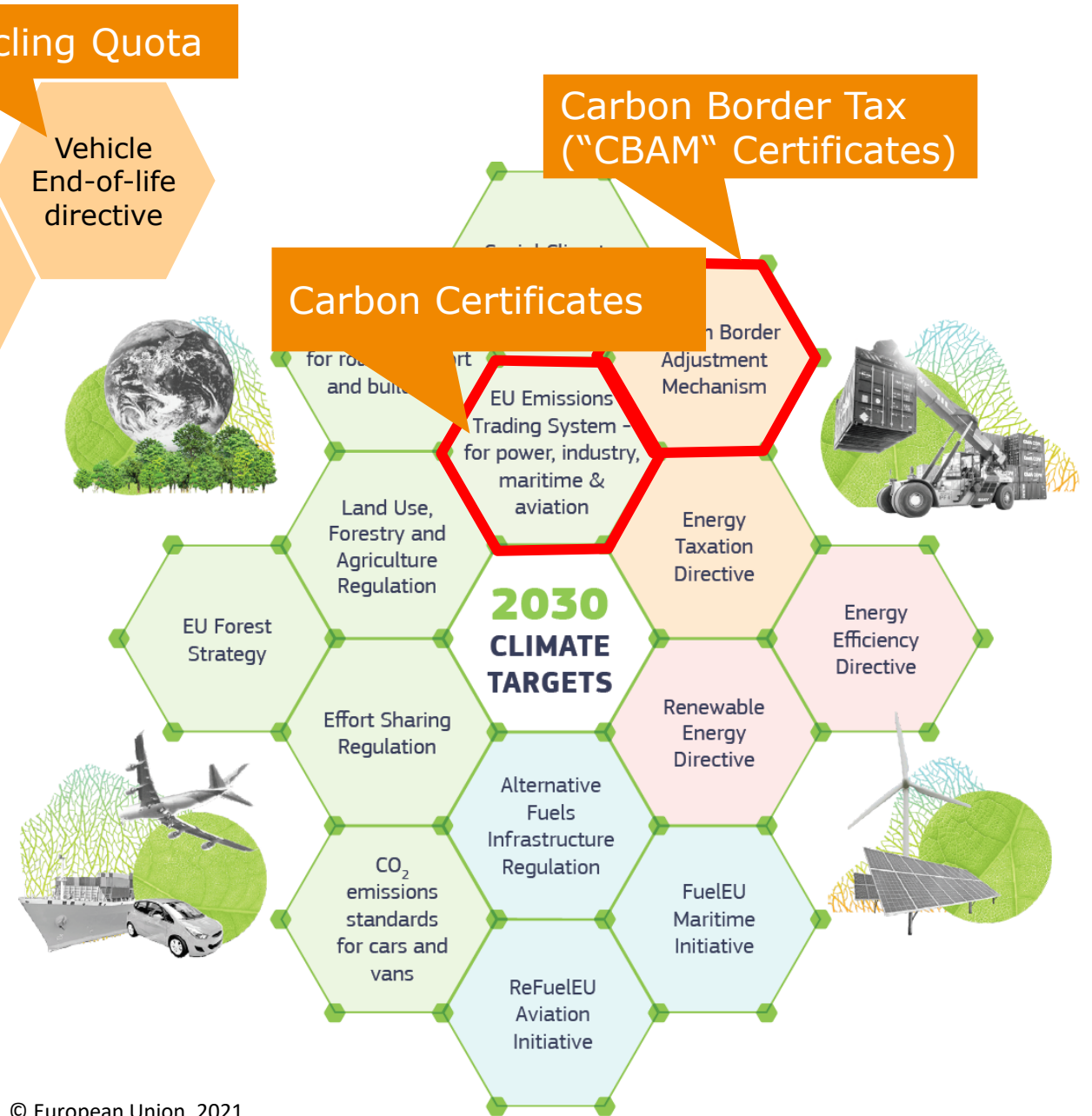
Recycling Quota

Vehicle
End-of-life
directive

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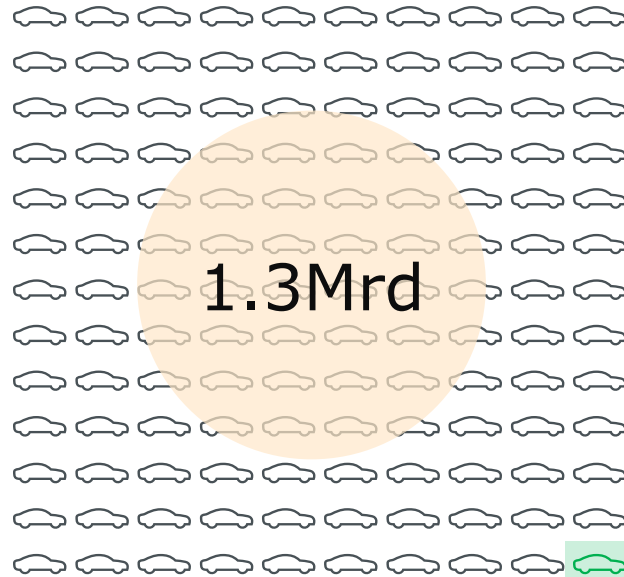
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Global Passenger Car Fleet Today and Tomorrow

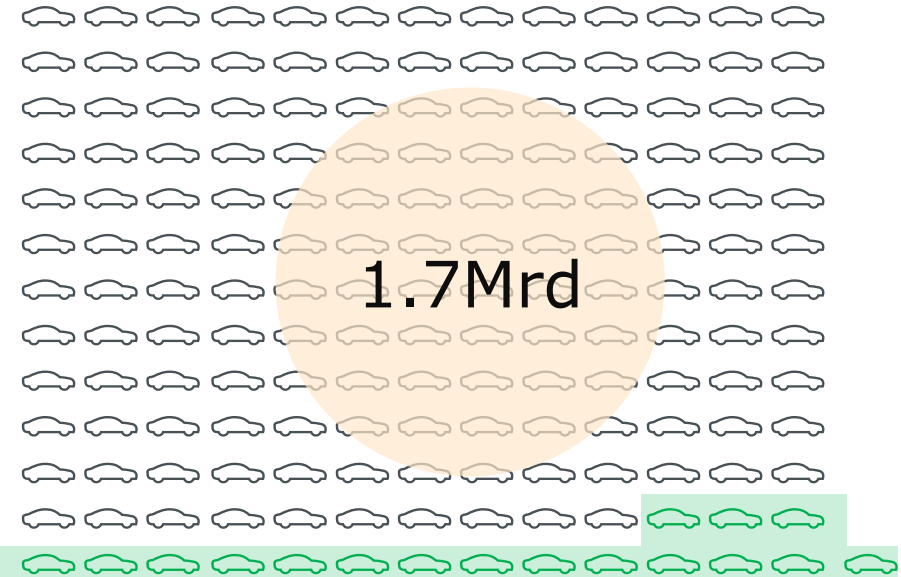
2020



Fleet life-time:
approx. 17 years
3% growth p.a.
6-7% renewal p.a.



2030

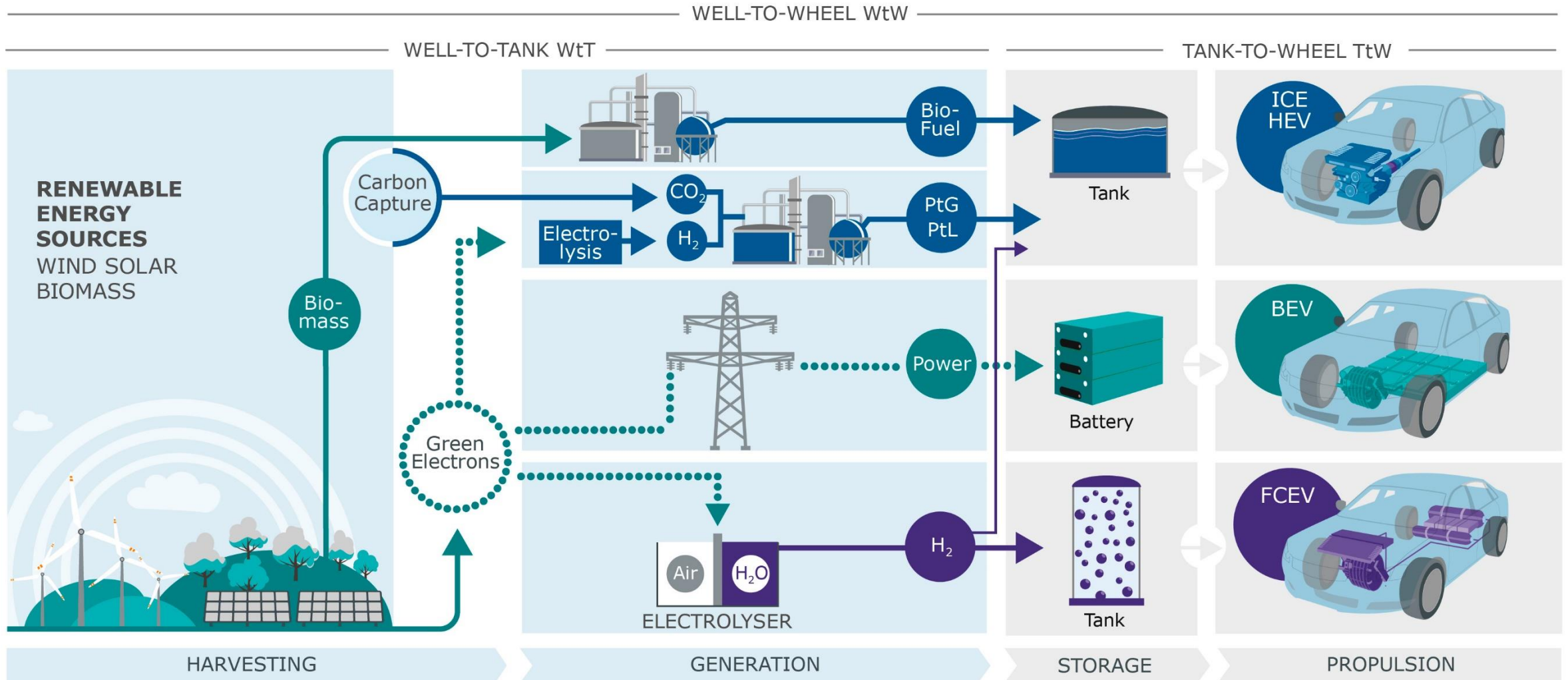


10 mln. Veh. with combustion engine 10 mln. Veh. battery electric

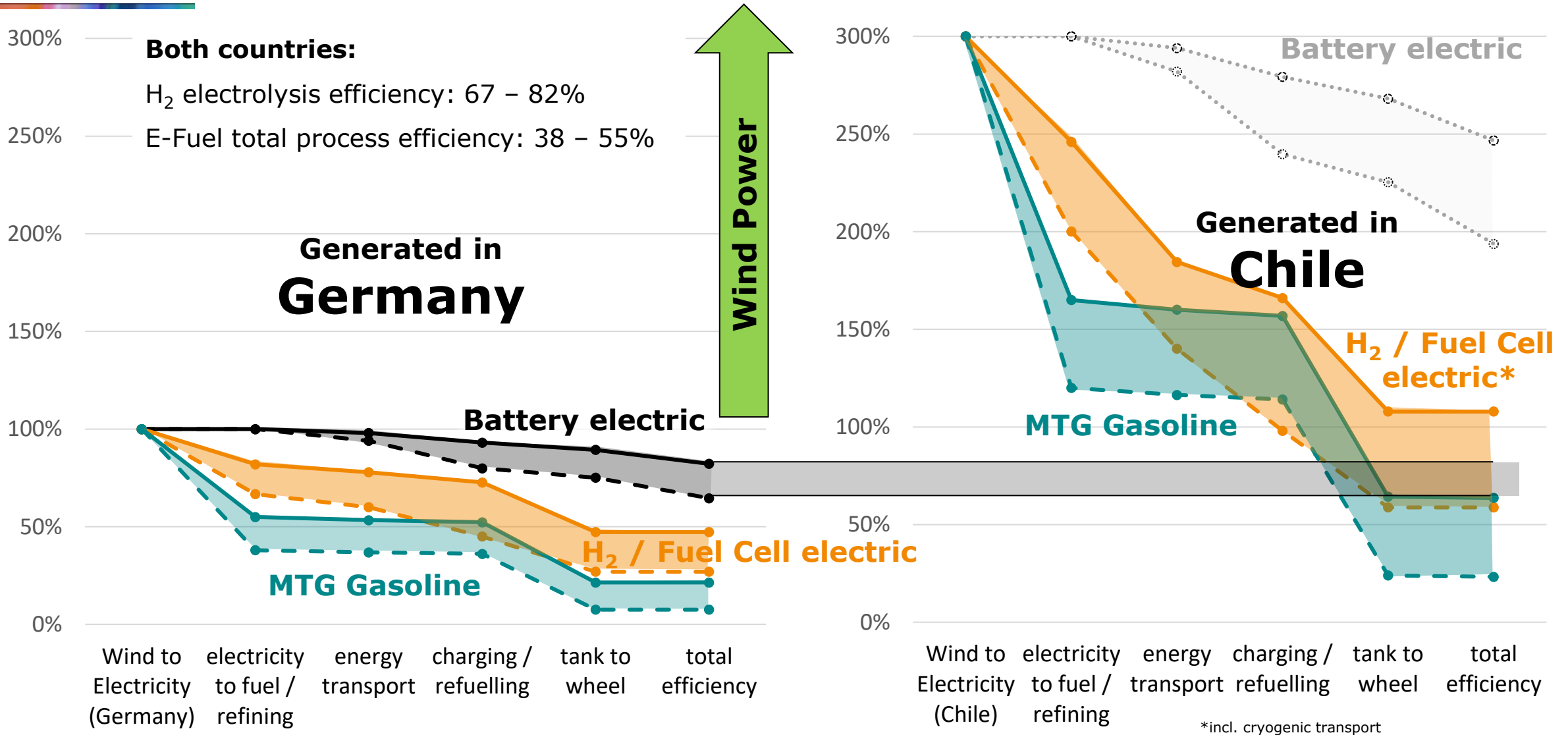
Source: EIA, 2021, [Link](#) ; IEA, 2022, [Link](#)

For an effective CO₂ 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

E-Fuel

1 avg. Filling Station (FS)
supplying 5 Mio. Liter fuel per year
(Germany: 14000 stations, 56 Mln. tons fuel cons./yr)

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*

10_{FS}
100_{FS}

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

Saudi Aramco (2020-2023)

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

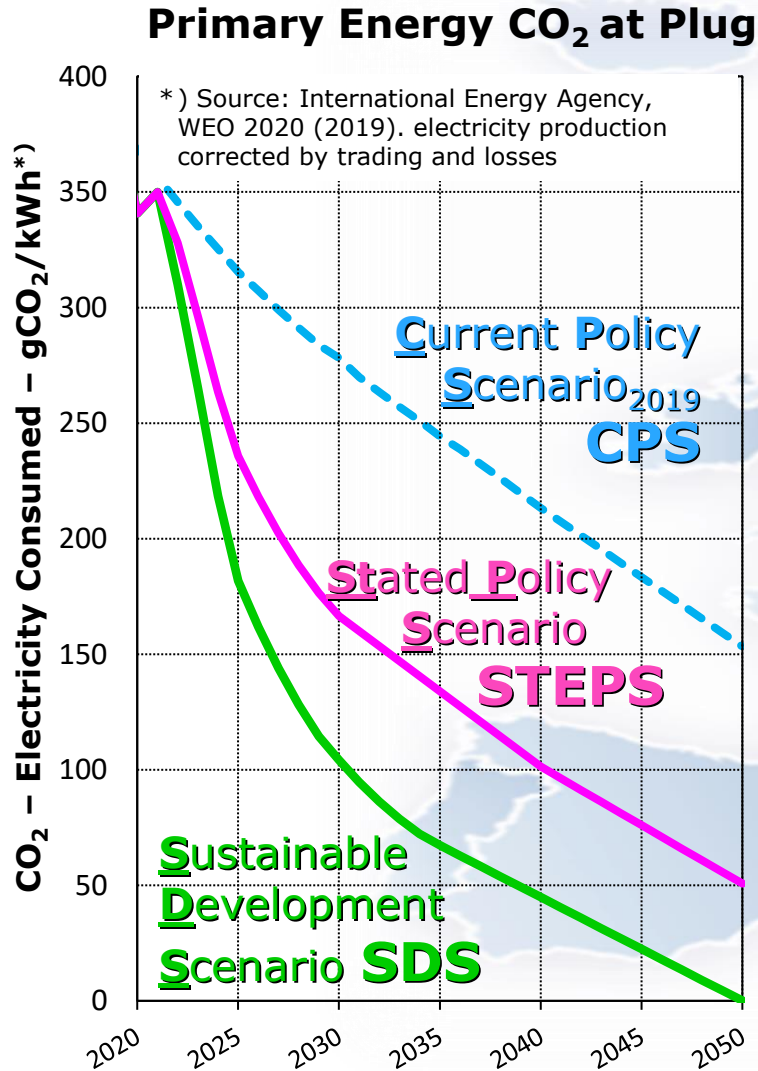
1_{FS}

Project	Location	Operational Date	Project Capacity	CO ₂ Abatement
Bilbao	Spain	2024	2.3 Kton/y	6.9 Kton/y
Neom	Saudi Arabia	2024	12 tpd Methanol / 35 bpd gasoline	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 & CO₂ Scenarios EUROPE



Current Policy Scenario ₂₀₁₉ **CPS**

Worst Case Scenario

Stated Policy Scenario **STEPS**

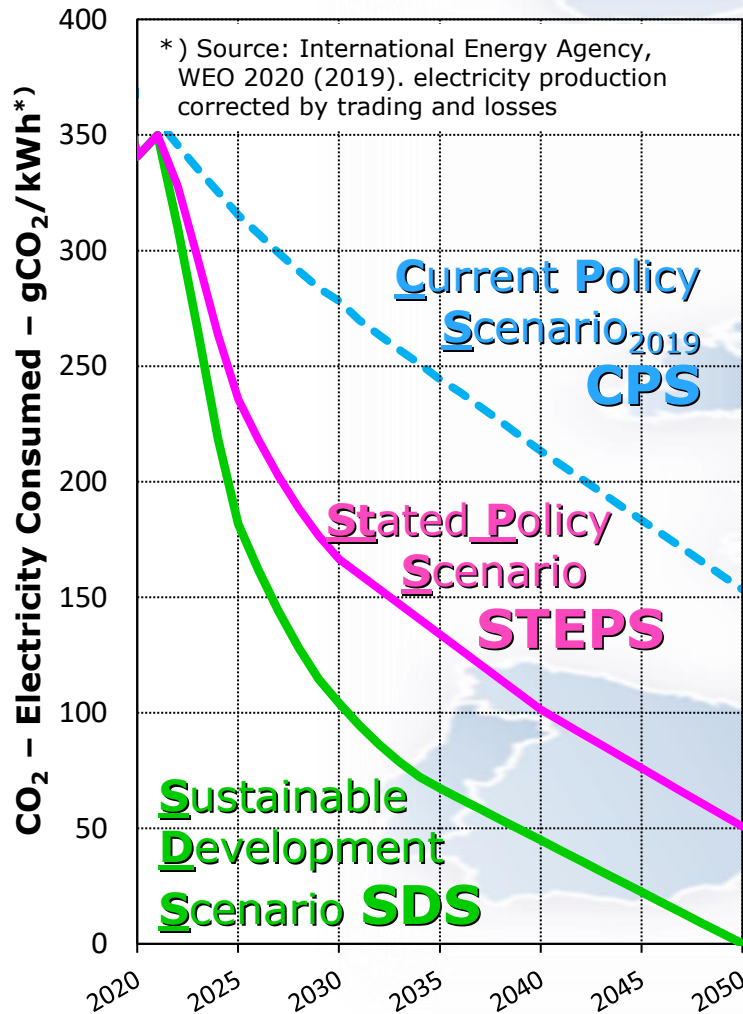
Reflecting all announced policy intentions and targets

Sustainable Development Scenario **SDS**

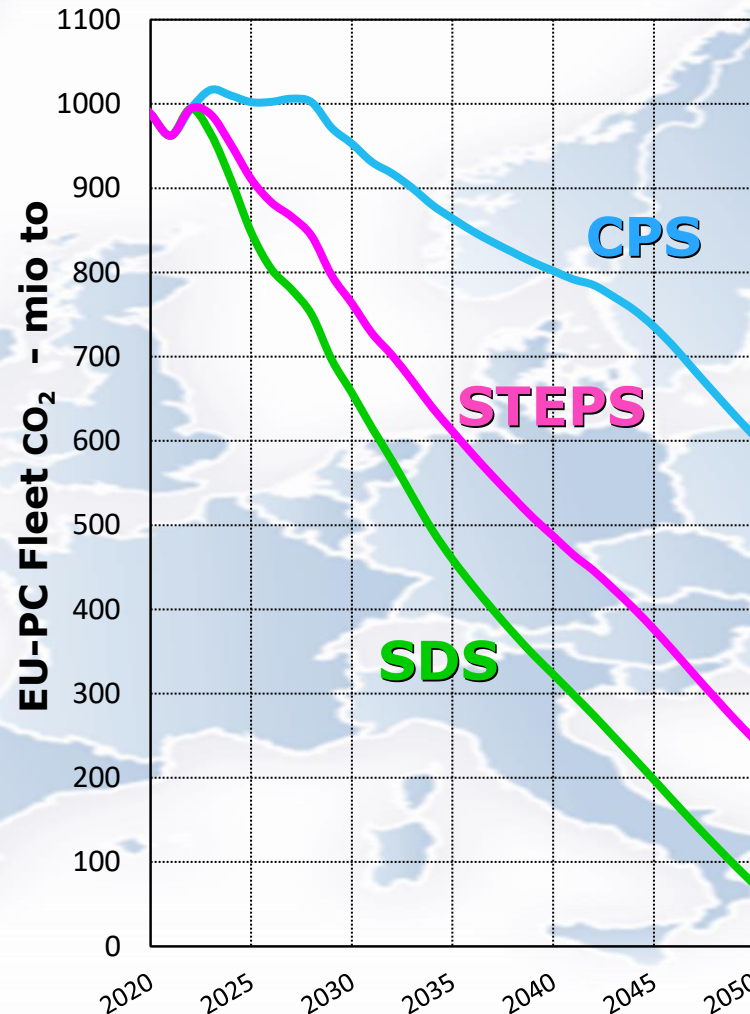
Theoretic scenario to put energy system back on track with Paris Agreement

Energy & CO₂ Scenarios EUROPE

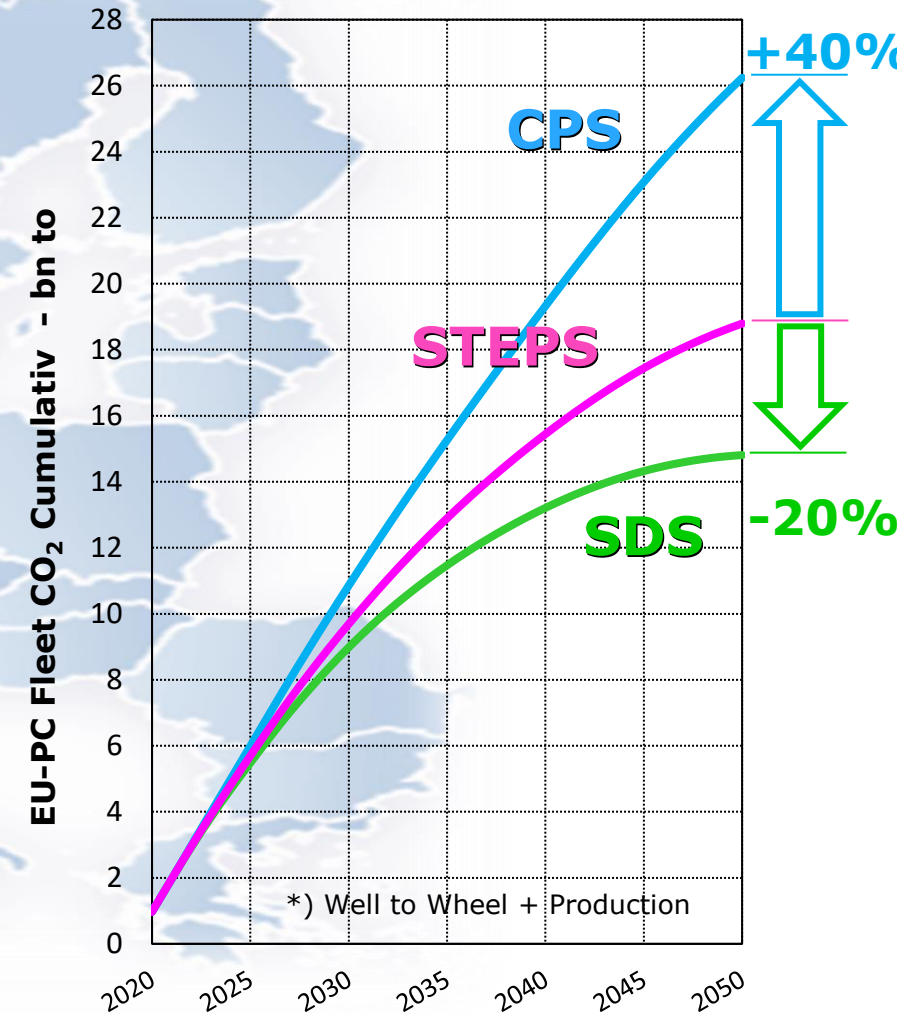
Primary Energy CO₂ at Plug



Annual EU-PC Fleet CTG-CO₂



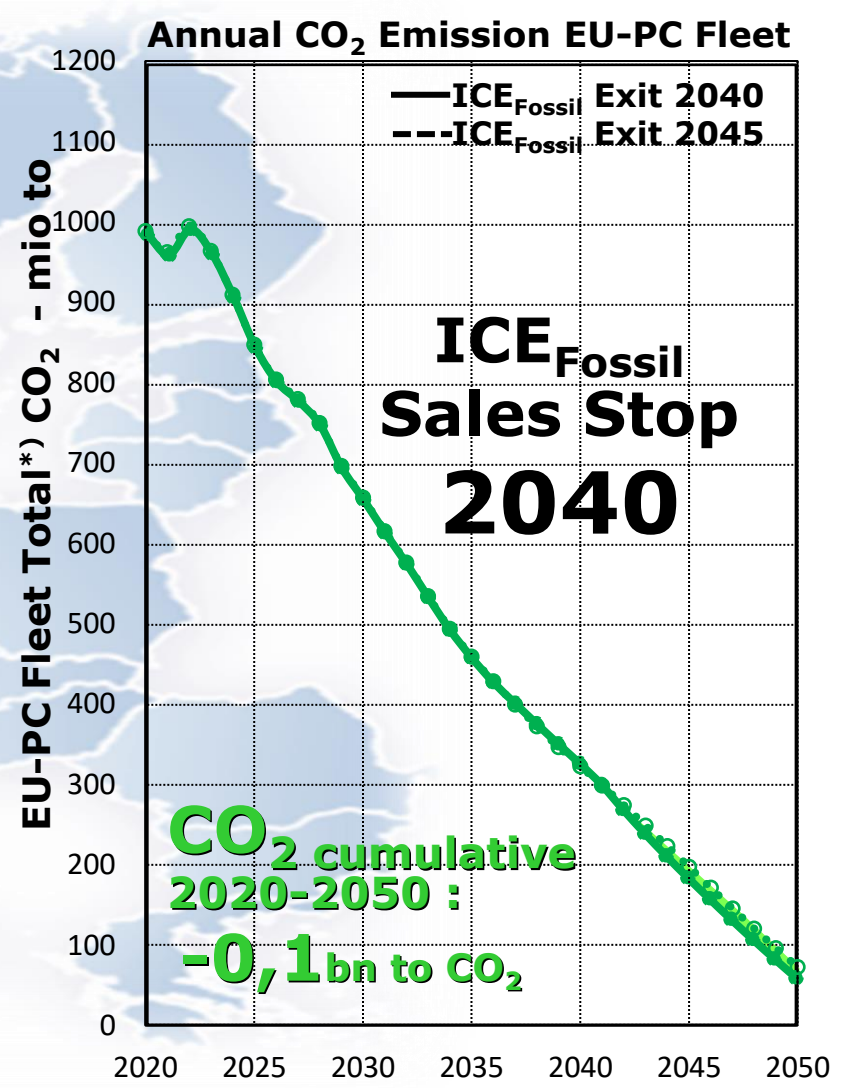
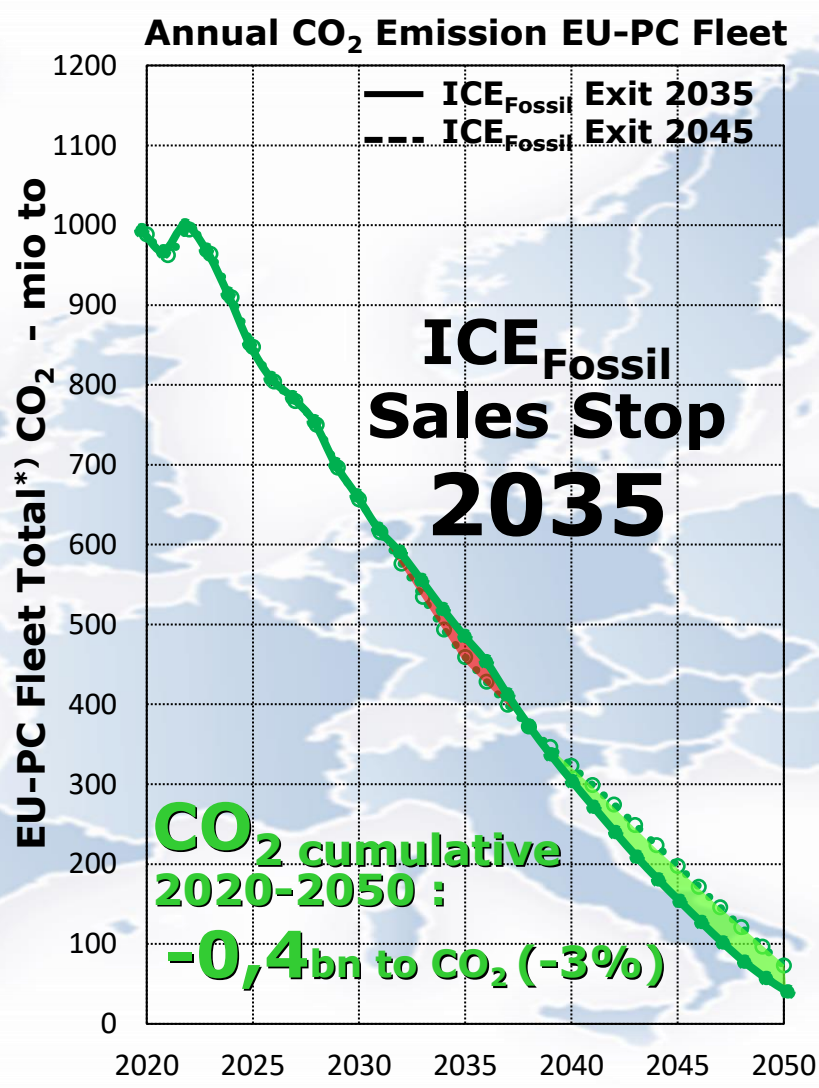
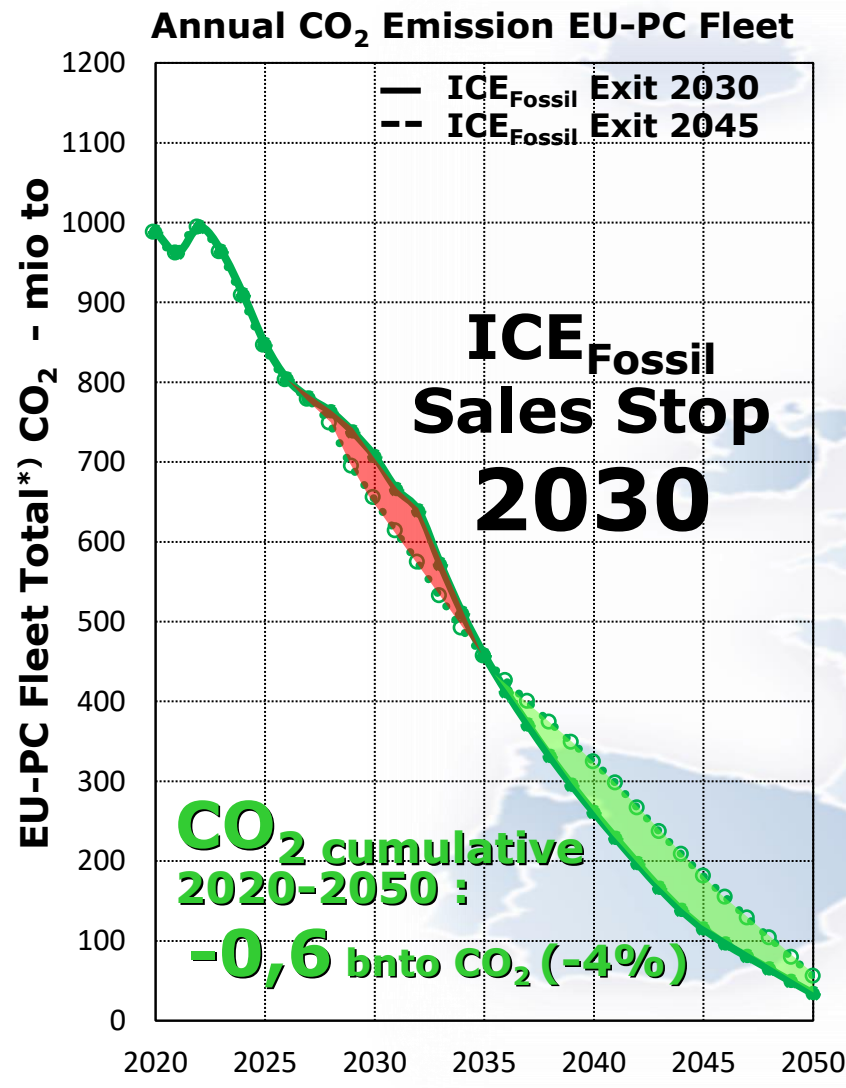
Cumulative EU-PC Fleet CTG-CO₂



EU CO₂ Emission^{*)} with Different ICE_{Fossil} Sales Stops

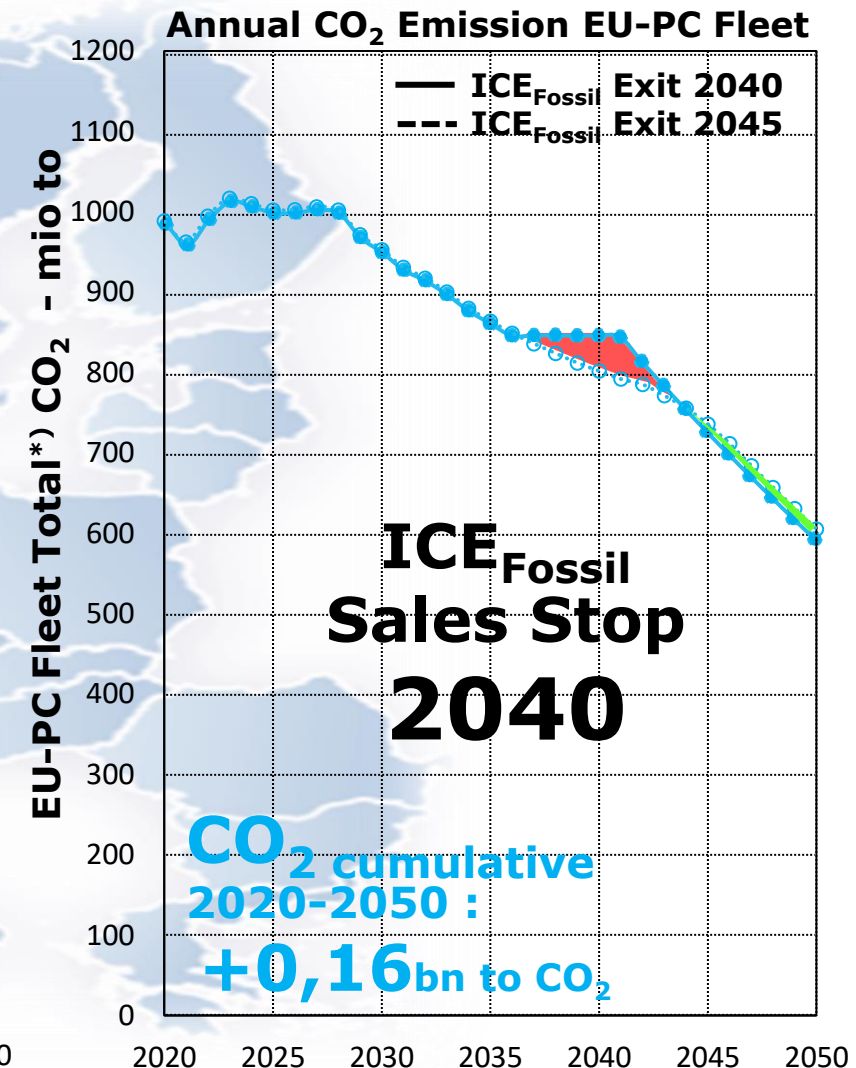
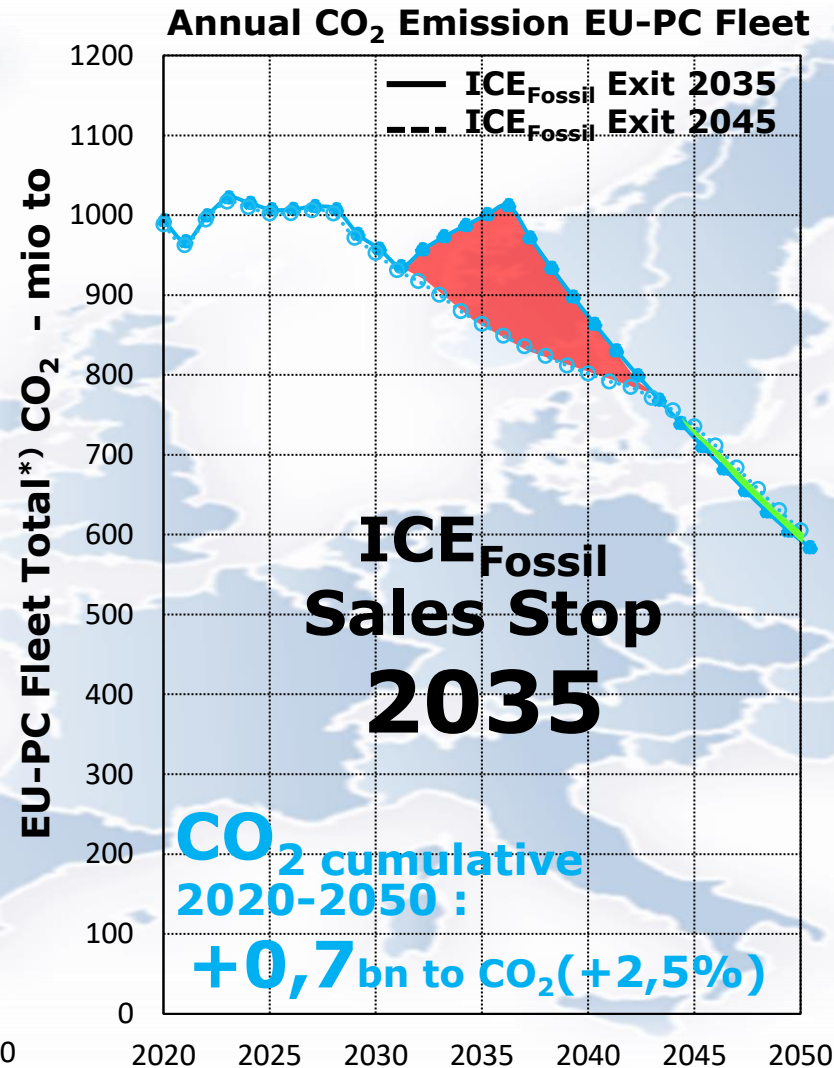
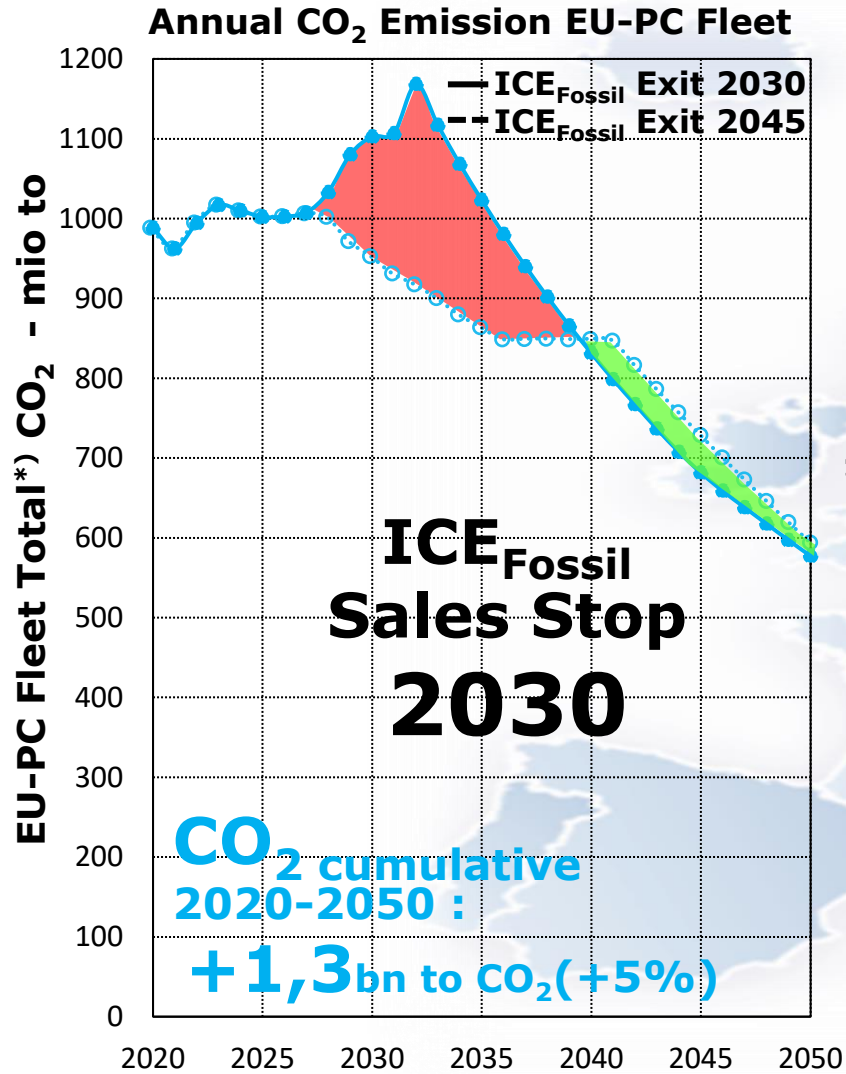
SDS Energy Scenario

*) EU PC Fleet Well to Wheel + Production



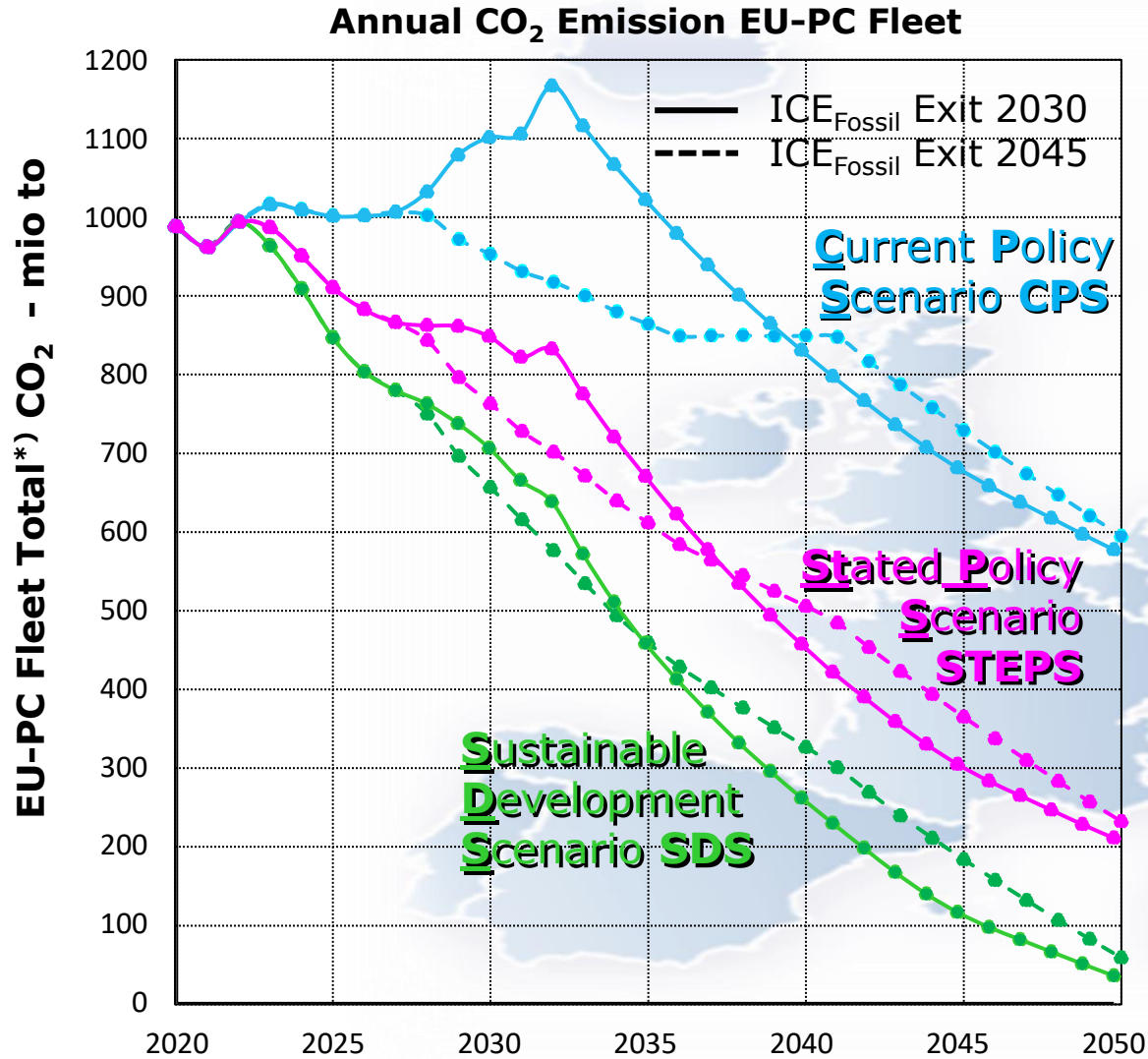
EU CO₂ Emission^{*)} with Different ICE_{Fossil} Sales Stops CPS Energy Scenario

*) EU PC Fleet Well to Wheel + Production



EU CO₂ Emission^{*)} - Impact of ICE_{Fossil} Sales Stops with Different Energy Scenarios

*) EU PC Fleet Well to Wheel + Production



CPS: 2045 → 2030:
CO₂ cum : +1,3 bn to CO₂ (+5%)

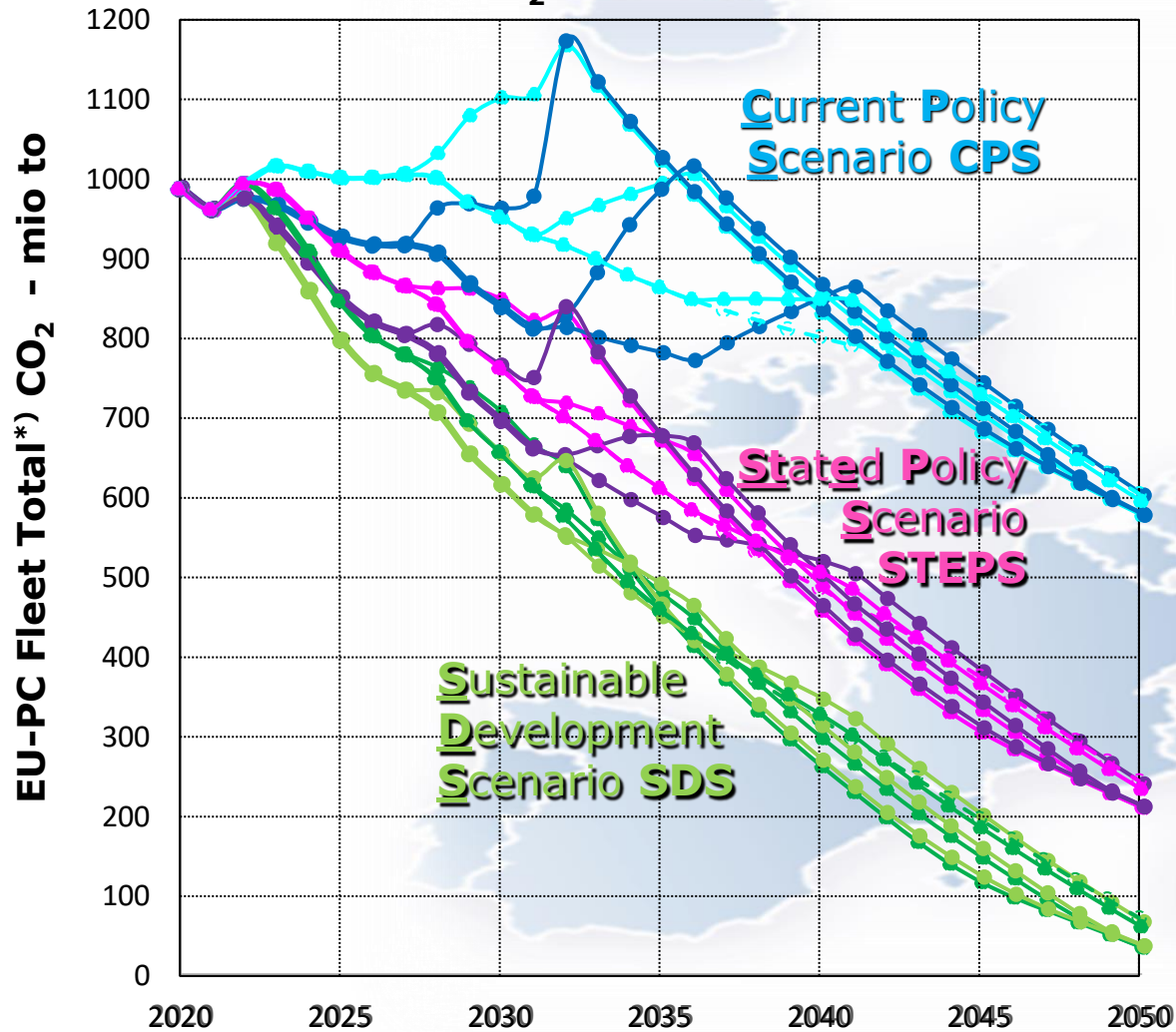
STEPS: 2045 → 2030:
CO₂ cum : + / 0 bn to CO₂

SDS: 2045 → 2030:
CO₂ cum : -0,6 bn to CO₂ (-4%)

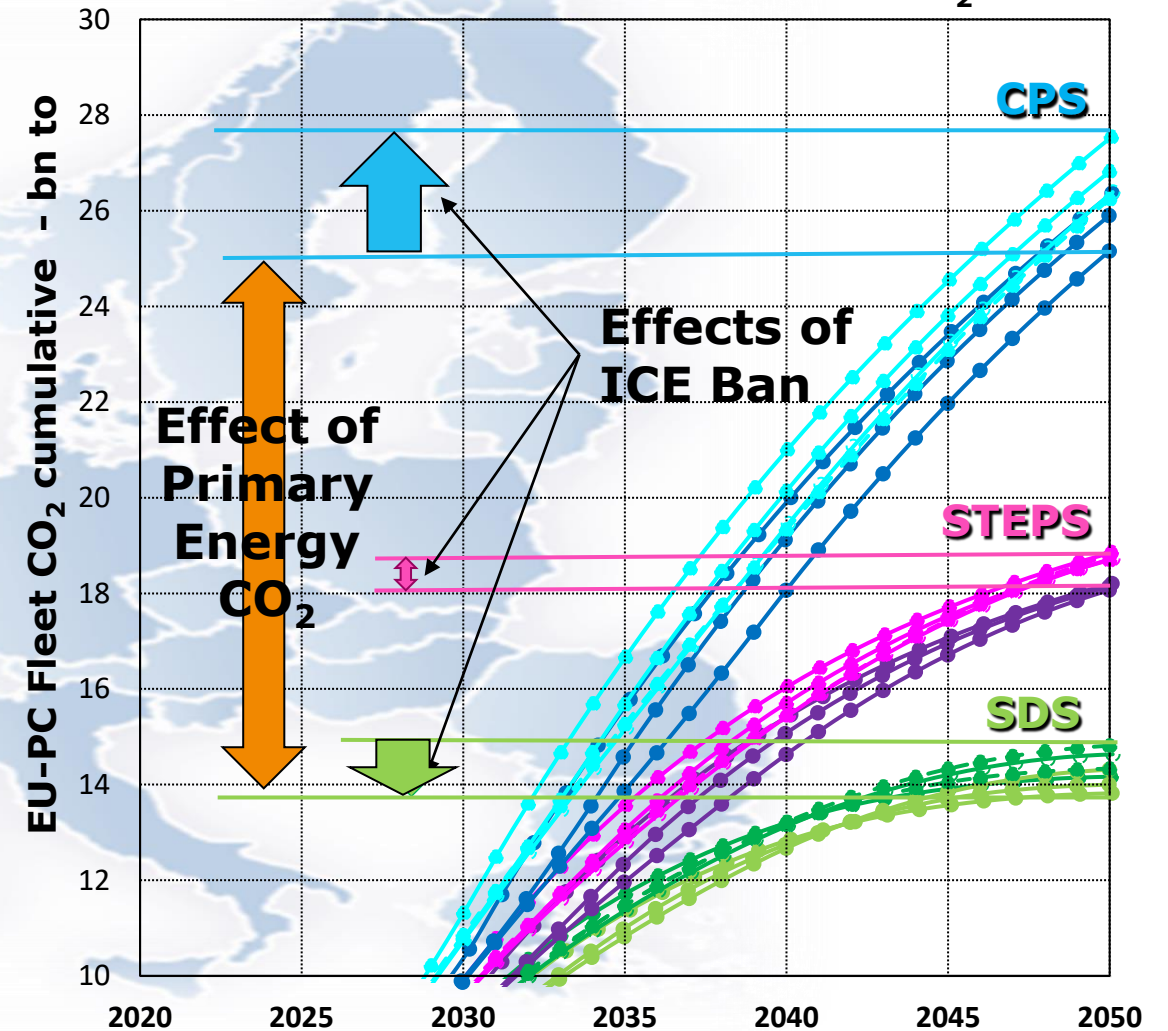
Effect of Primary Energy CO₂ vs. ICE_{Fossil} Sales Stop 2030/2035/2040/2045

*) EU PC Fleet Well to Wheel + Production

Annual CO₂ Emission EU-PC Fleet



Cumulative EU-PC Fleet CTG-CO₂



Efficient & Robust CO₂ 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 CO₂ 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 CO₂ reduction – e-Fuels – not emphasized sufficiently**
- **High risk that current PassCar–CO₂ legislation will increase lifecycle CO₂ emission versus an optimized, technology open approach**
- **Adaptation of current PassCar CO₂ legislation required for cost effective CO₂ reduction**

Thank you



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