



# **PKW und LKW Antriebsstrang der Zukunft**

## **The Future PC and HD Powertrain**

Theodor Sams, AVL List Graz

# **The Future Automotive World will be a Different One**

**More different than we  
assumed in the past**

**Financial impacts → OEM change from  
Technology Diversification towards BEV Focus**

# Content

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- 1 Legislation & Market Trends**
- 2 Trends Internal Combustion Engines**
- 3 Trends Electrification**
- 4 Trends Heavy Duty Vehicles**

# Content

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## **1** Legislation & Market Trends

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# Flashlight on PassCar Global Trends



- Intent to become an environmental leader ("Green Deal", "Fit for 55"), focus on Tank to Wheel CO<sub>2</sub>, e-fuels no focus for PassCar
- Political Dogma to push BEV by CO<sub>2</sub> legislation



- Official focus on electrification, but balancing environmental aspects with economy → both BEV+HEV
- Enormous technology catch-up, targeting technology leadership
- Still new ICE under development – Dedicated Hybrid Engines and Transmissions



- Environmental policy is completely changing
- From ignoring environmental aspects towards overemphasize BEV
- Political intention to match electromobility with infrastructure and customer challenges

***Different political priorities***



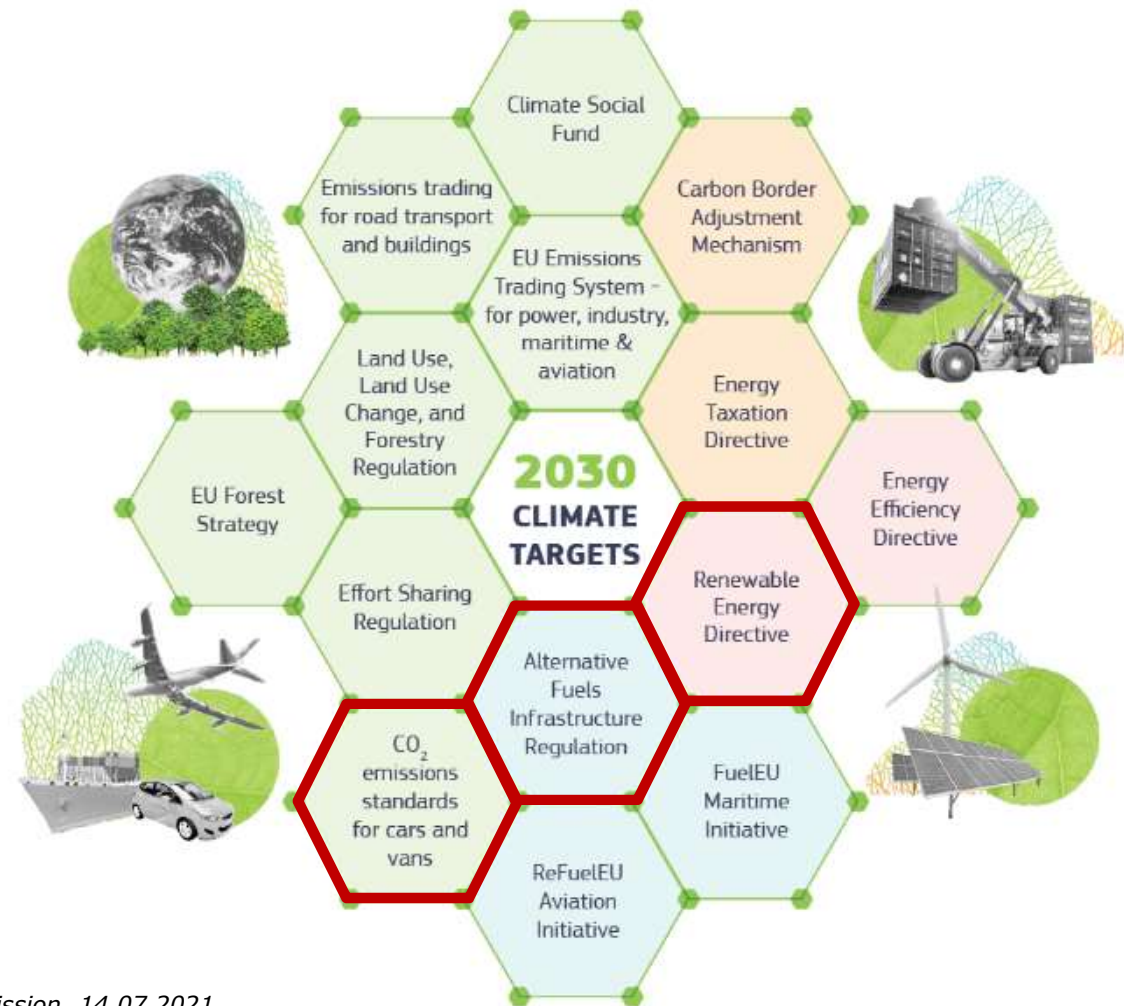
# Delivering the European Green Deal

## The Decisive Decade

The EU will **reduce its net greenhouse gas emissions by at least 55% until 2030**, compared to 1990 levels, as agreed in the EU Climate Law.

➔ A Prize on carbon and a premium on decarbonization.

(Frans Timmermans, Executive Vice-President for the European Green Deal, press conference, 14.07.2021)



Source: Architecture of the package Factsheet, European Commission, 14.07.2021

# Delivering the European Green Deal

## The Decisive Decade

The EU will **reduce its net greenhouse gas emissions by at least 55% until 2030**, compared to 1990 levels, as agreed in the EU Climate Law.

### Proposal of EU Commission 2021-07-14

CO<sub>2</sub> New Pass Car Fleet Average

2030: -55 % vs 2021

2035: -100% vs 2021

➔ A Prize on carbon and a premium on decarbonization.

(Frans Timmermans, Executive Vice-President for the European Green Deal, press conference, 14.07.2021)



Source: Architecture of the package Factsheet, European Commission, 14.07.2021

# The Fit for 55 Package: At a glance

## Pricing

- Stronger Emissions Trading in aviation
- **Extending Emissions Trading to maritime, road transport, and buildings**
- Updated Energy taxation Directive
- New Carbon Border Adjustment Mechanism

## Targets

- Updated Effort Sharing Regulation
- Updated Land Use and Forestry Regulation
- Updated Renewable Energy Directive
- Updated Energy Efficiency Directive

## Rules

- **Stricter CO<sub>2</sub> performance for cars & vans**
- New infrastructure for alternative fuels
- More sustainable aviation fuels
- Cleaner maritime fuels

## Support measures

- **Social Climate Fund and enhanced Modernisation and Innovation Funds.**

Source: 'Fit for 55' – Communication, European Commission, 14.07.2021



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## Political View

**Inefficient option to  
elongate  
ICE life**

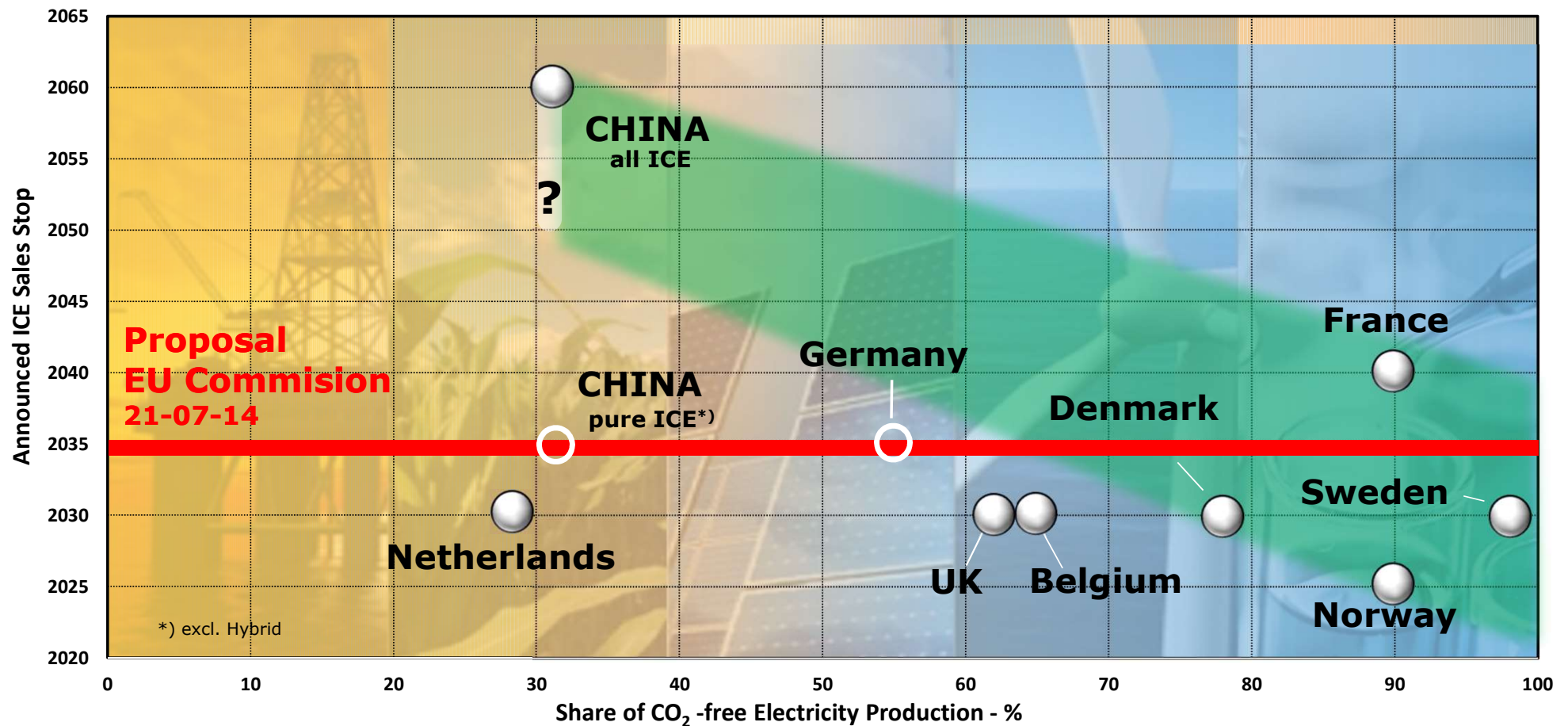
## Technical View

**ICE should be an  
integral part enabling  
access to renewable  
energy sources  
outside EU and large-  
scale storage of energy**

# Chemical Energy Carriers

Source: AVL Energy Consulting Services

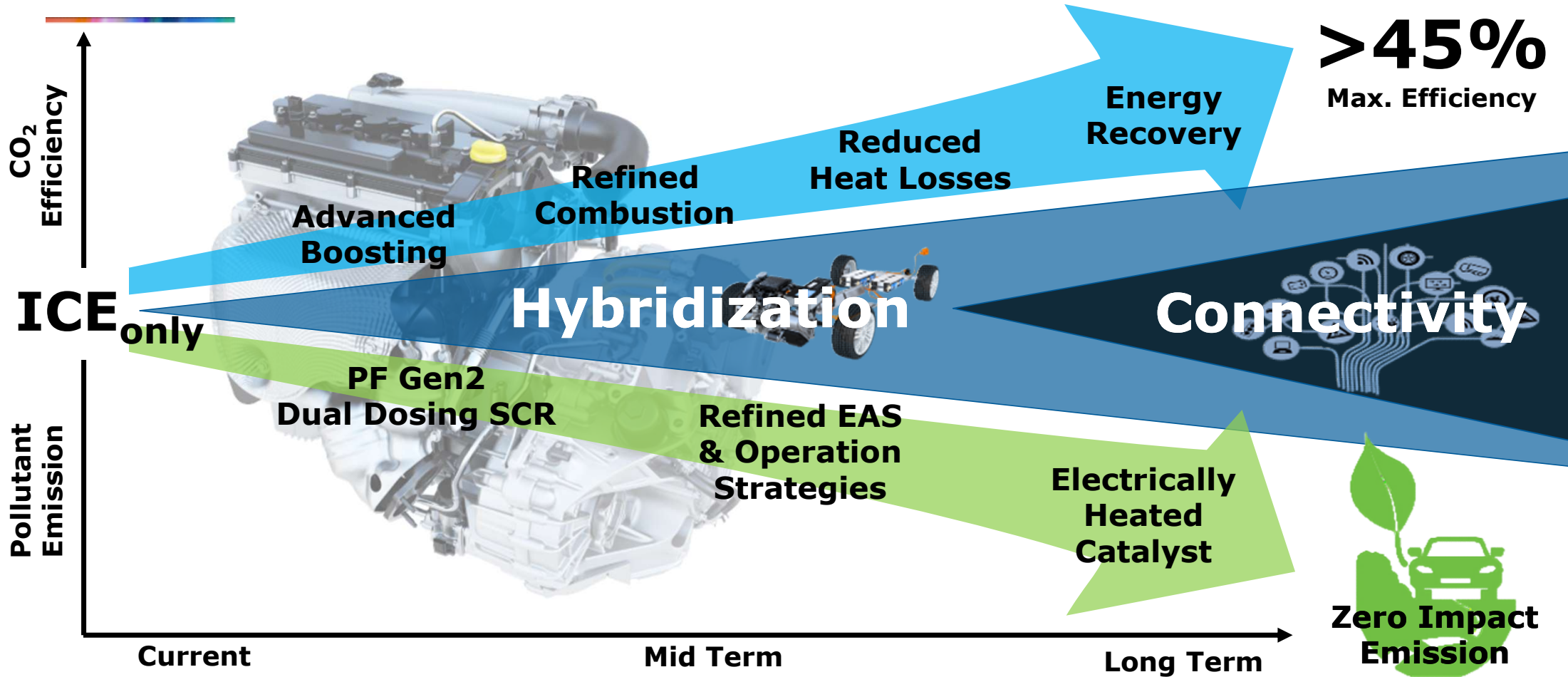
# Announced ICE-Sales Stops vs. Energy Scenarios



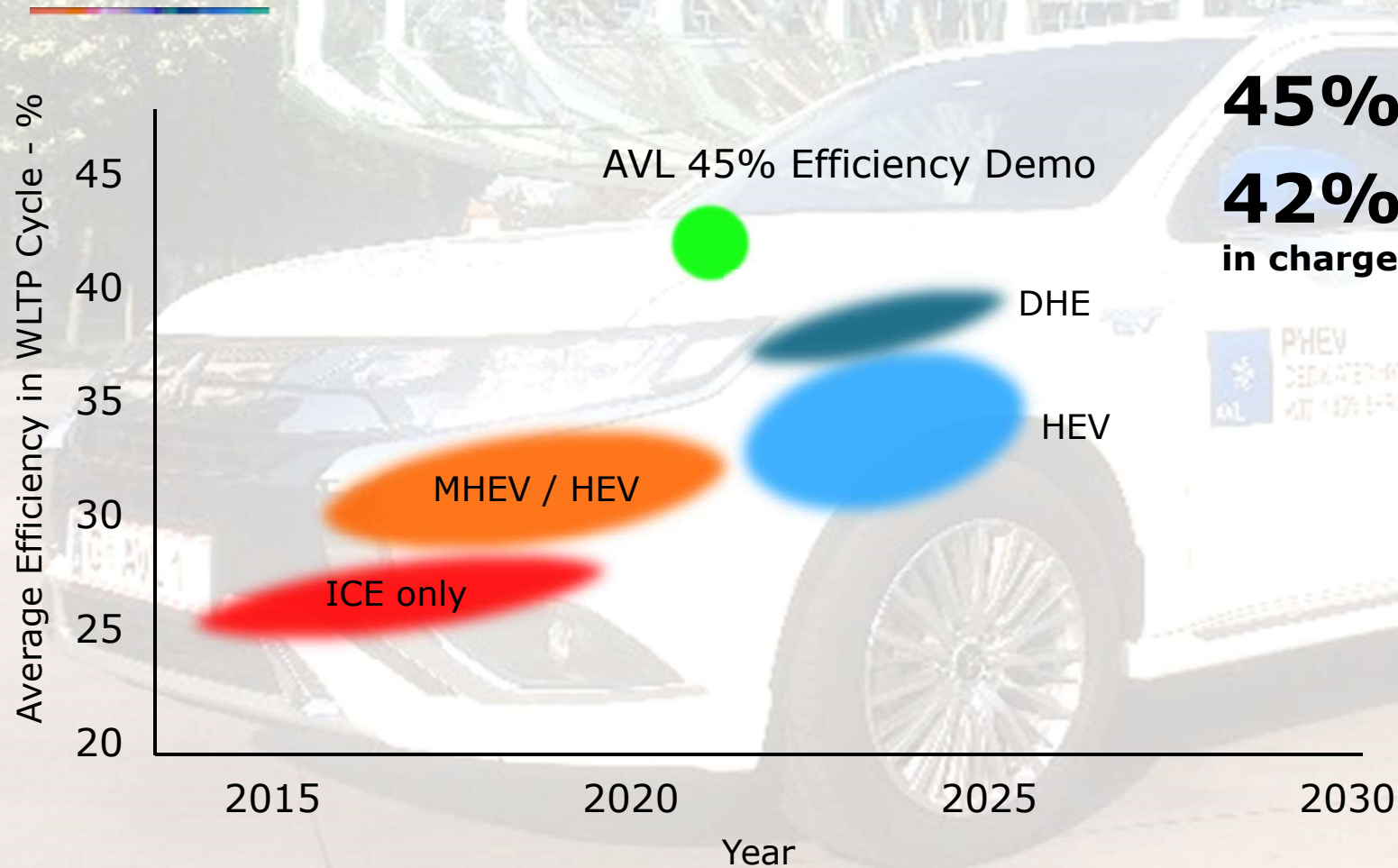
***Partially significant mismatch between announced ICE sales stop and primary energy situation***



# Transformation of the ICE



## Dedicated Gasoline Hybrid Engine - Average ICE Efficiency in WLTP



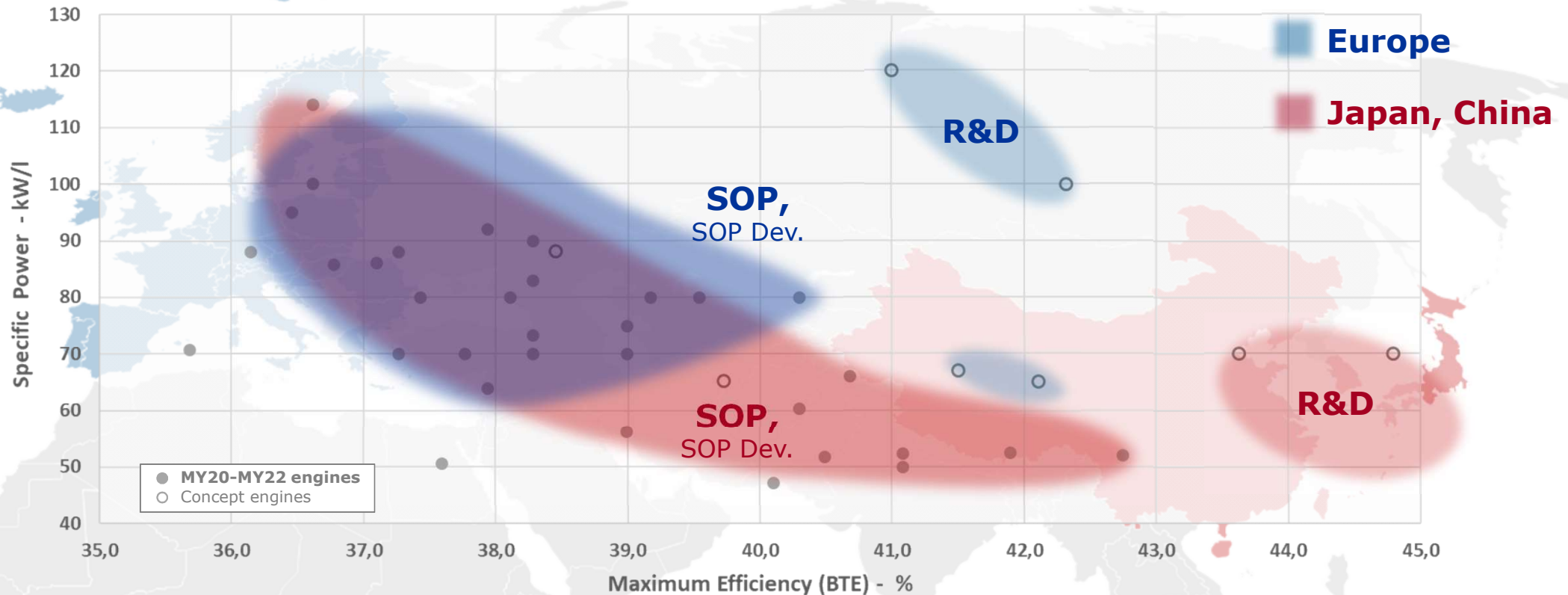
**45%** max. efficiency  
**42%** avg. in WLTP  
in charge sustaining mode\*)

\*) simulated based on validated baseline simulation

# Gasoline Engine Development Trends

## EUROPE versus ASIA

Spec. Power versus max. Efficiency



***Europe is applying same base ICE's both for stand alone and with Hybrid, Asia is adding new DHE's***



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# Political Reality

1. Vehicle Portfolio
2. Charging Infrastructure
3. Primary Energy Supply

# Technical Optimum

1. Primary Energy Supply
2. Charging Infrastructure
3. Vehicle Portfolio

**BEV LOW volume**  
**Green Energy LOW**



**BEV HIGH volume**  
**Green Energy LOW**



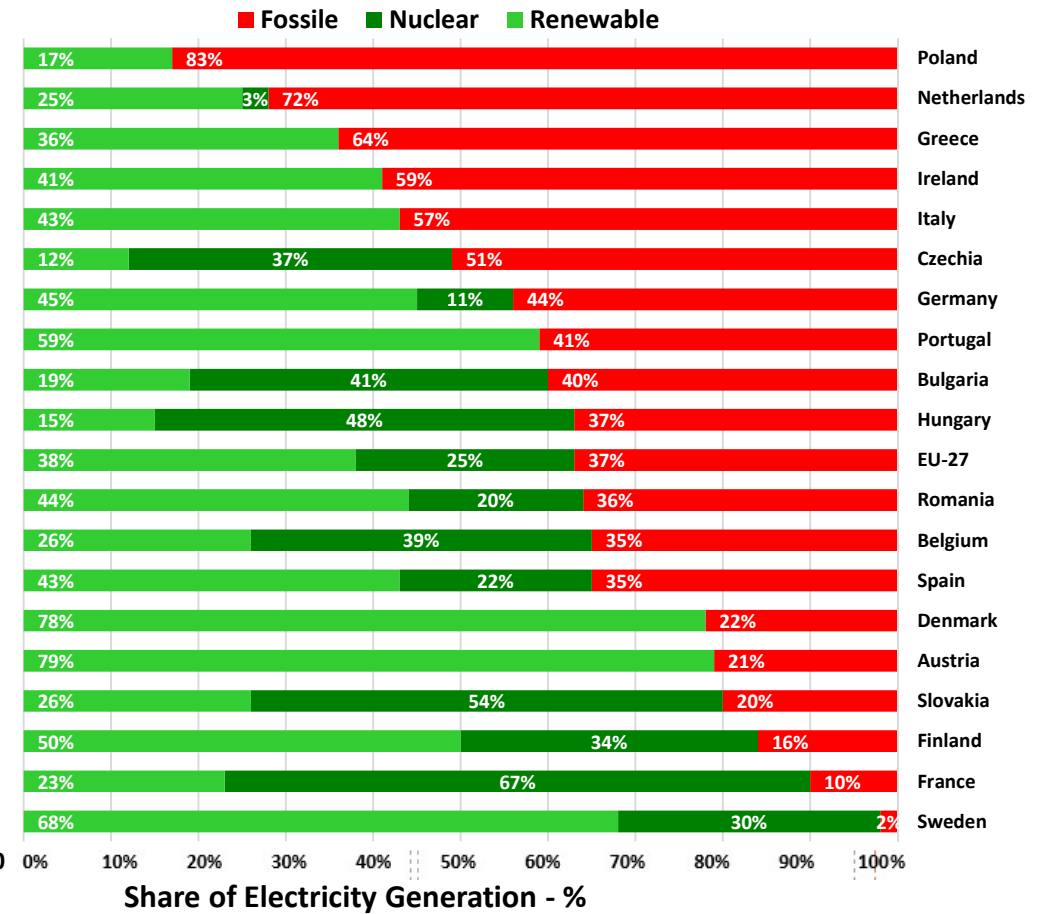
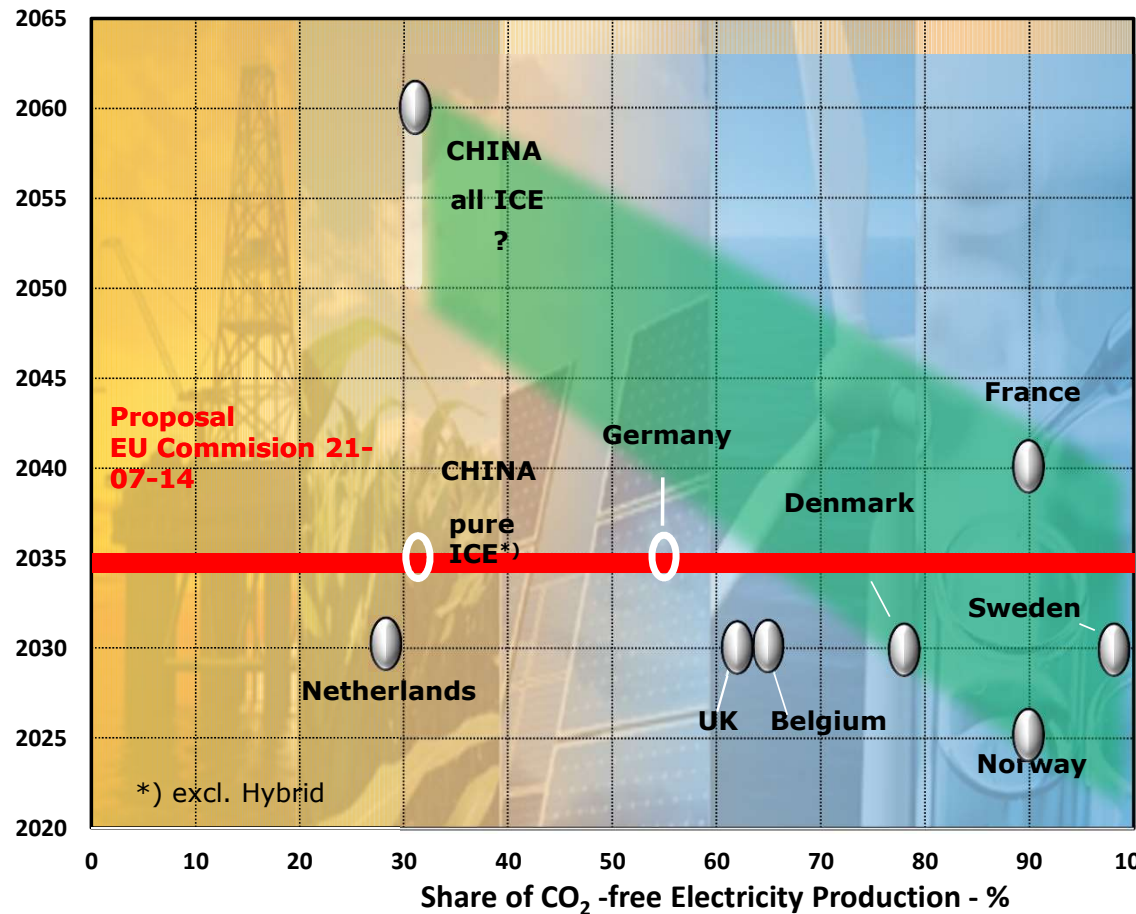
**BEV HIGH volume**  
**Green Energy HIGH**



**Less the amount of BEV's but Primary Energy CO<sub>2</sub> is the REAL LIMITATION**



# Announced ICE-Sales Stops vs. Energy Scenarios



***For global warming reduction of primary energy CO<sub>2</sub> is more essential than ICE ban***

# Make Transport Greener

## CLEANER ROAD TRANSPORT

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

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



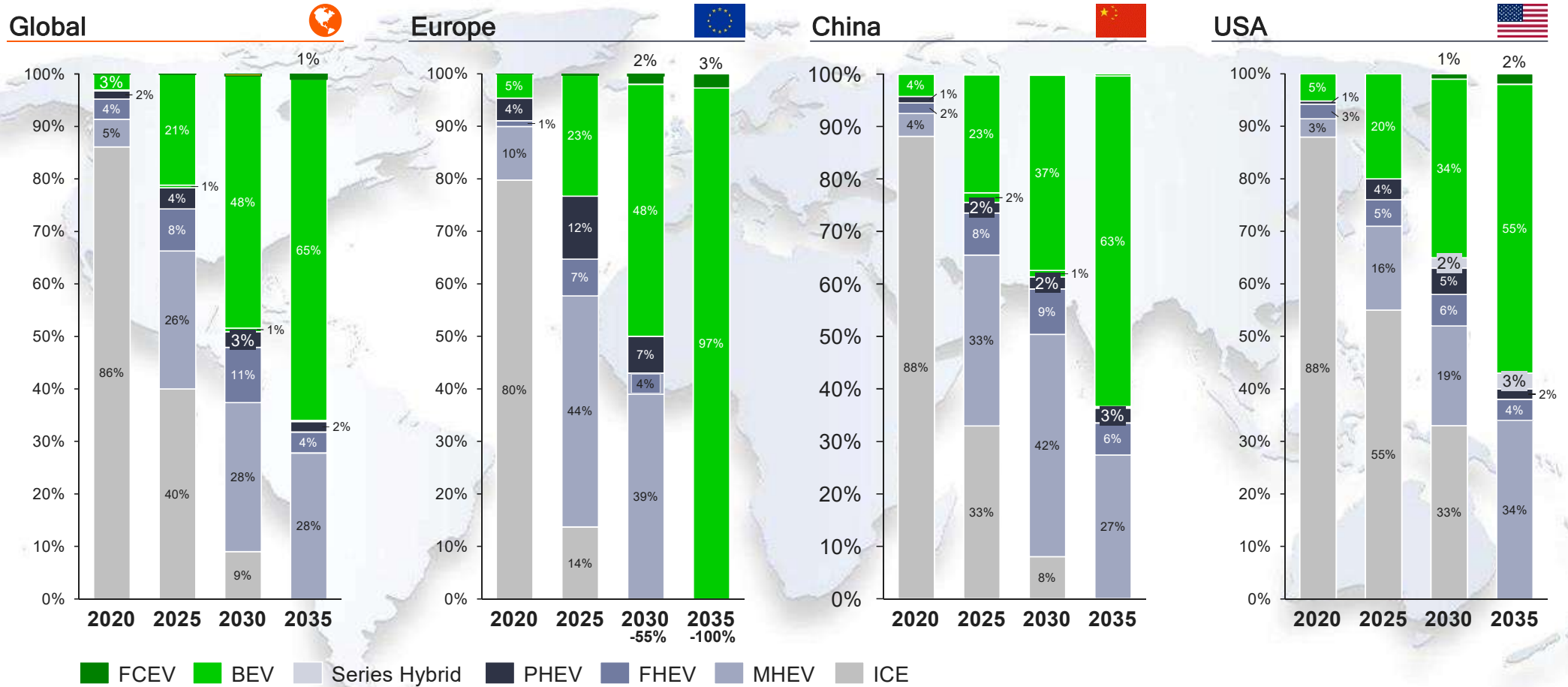
National fleet based targets for charging stations for cars and vans – those could lead to approximately\*:



\*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

# Global Technology Forecast - Net Zero Scenario Status 07/2021







**Electrification does not start with e-Motor and Battery,  
but with the Vehicle BEV Platform Strategy**

**Native EV or Multi Purpose**

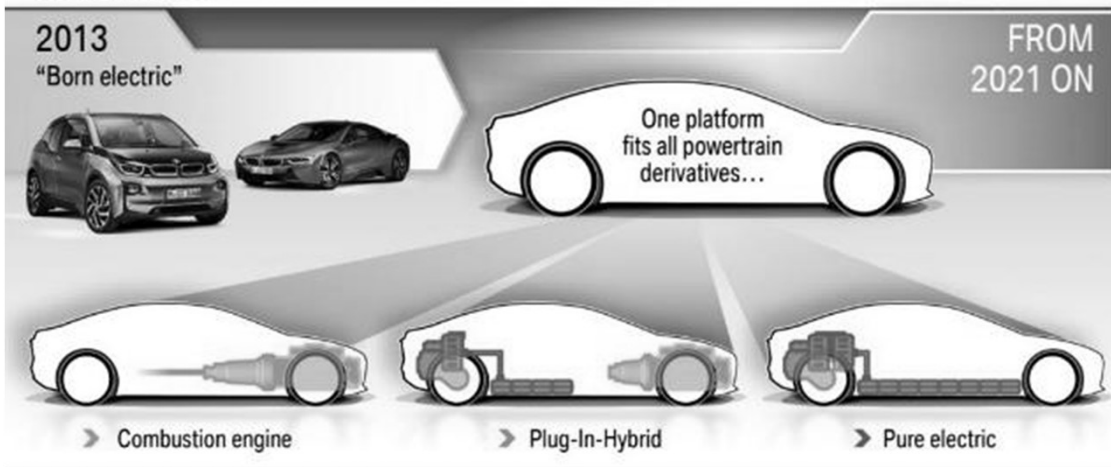
# BEV Platform Architecture

Native EV or Multi Purpose



Multi Purpose

BMW i. FROM "BORN ELECTRIC" TO "ONE PLATFORM SERVES ALL".  
FLEXIBLE VEHICLE ARCHITECTURE TO ENSURE QUICK RESPONSE TO MARKET  
CONDITIONS.



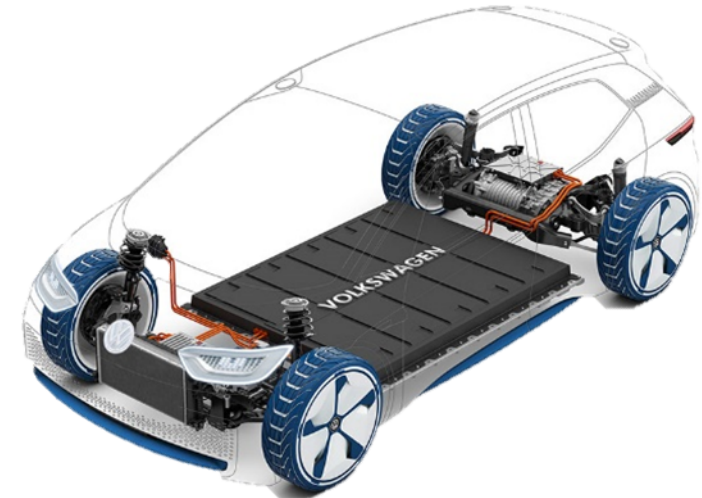
BMW Group Investor Presentation, August 2018

Schematic Illustration

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Native EV



Next Generation

# BEV Challenges

## Cost

- Increased incentives in EU lead to strong volume growth  
→ More than doubling from 2019 to 2020
- Battery costs to further reduce  
~140 to 115 €/kWh (~2030) for smaller batteries
- Power electronic costs drop by 30%

## Range

Cycle Range (WLTP)

On Bord Fuel Consumption Meter for BEV in EU for 2023\*

Cycle Range at low temperature (WLTP @ e.g. -10°C)\*

\*) Under Discussion

## Charging

DC Charging Infrastructure in EU moves towards 150kW and 1000V

EU mainly moving into CCS2

Strong interest to understand how to use 1000V

Beyond 450V (800V) heading for volume?

Real Life GAP

Interoperability



# Charging Future Trends Technology Breakdown



Next 3  
years

- System Robustness & Interoperability
- High Power Charging
- System Security
- Plug & Charge

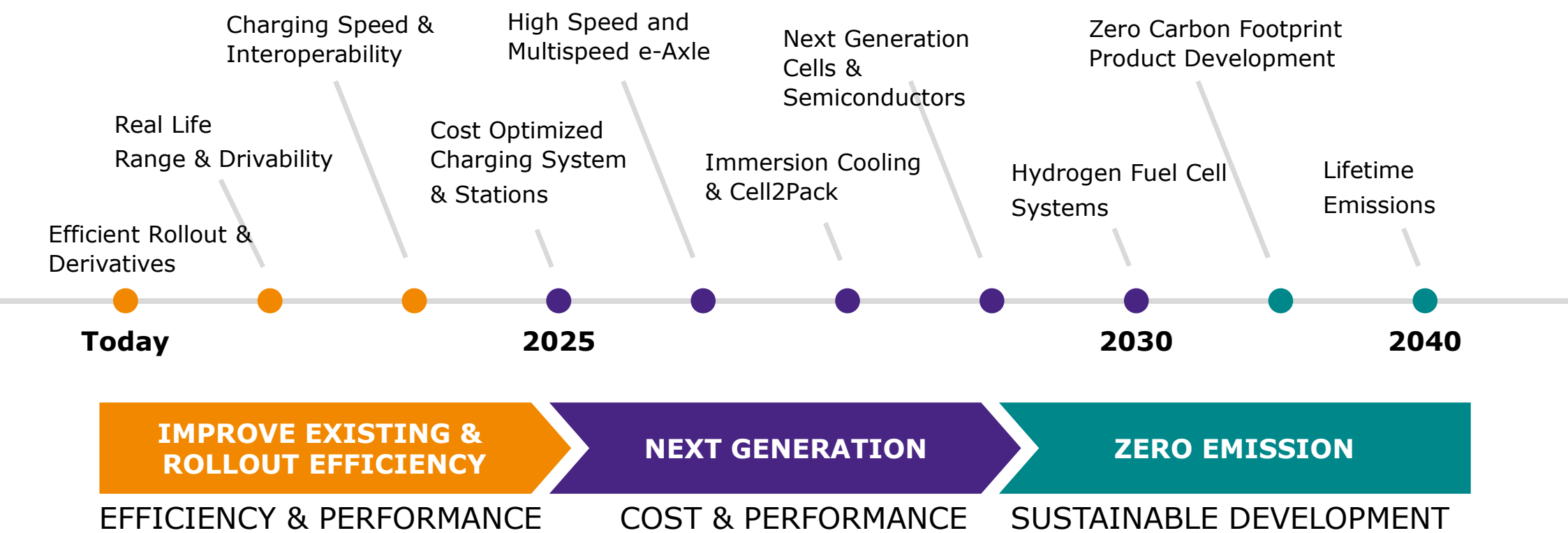
2025

- Advanced Charging Processes: cost optimized / scheduled/ battery life-time optimized
- Galvanic non isolated OBC
- Increased Charging System Efficiency

2030

- GaN/SiC Technology for Charging Components
- Bi-directional Charging/ virtual power plants
- Robotic/"hands-free" charging

# xEV Electric Trends and AVL Activities



# Content

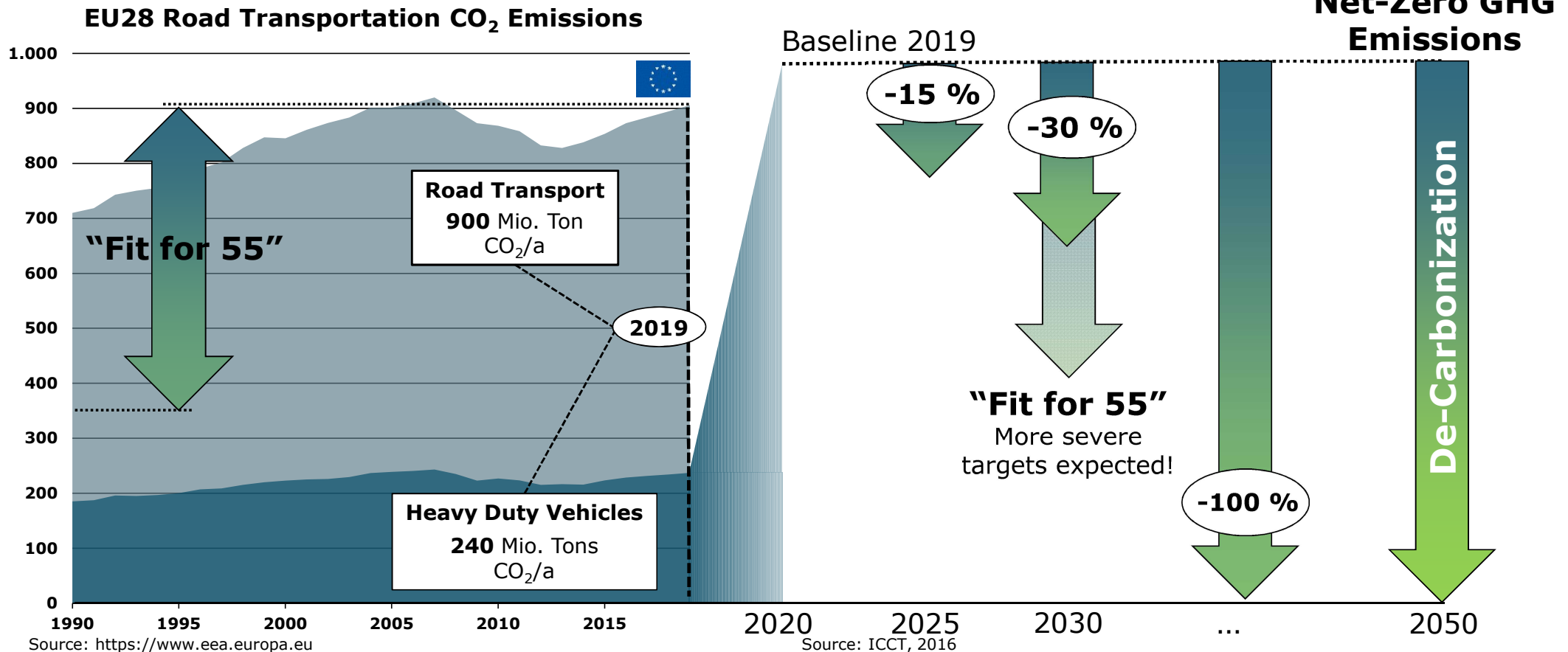
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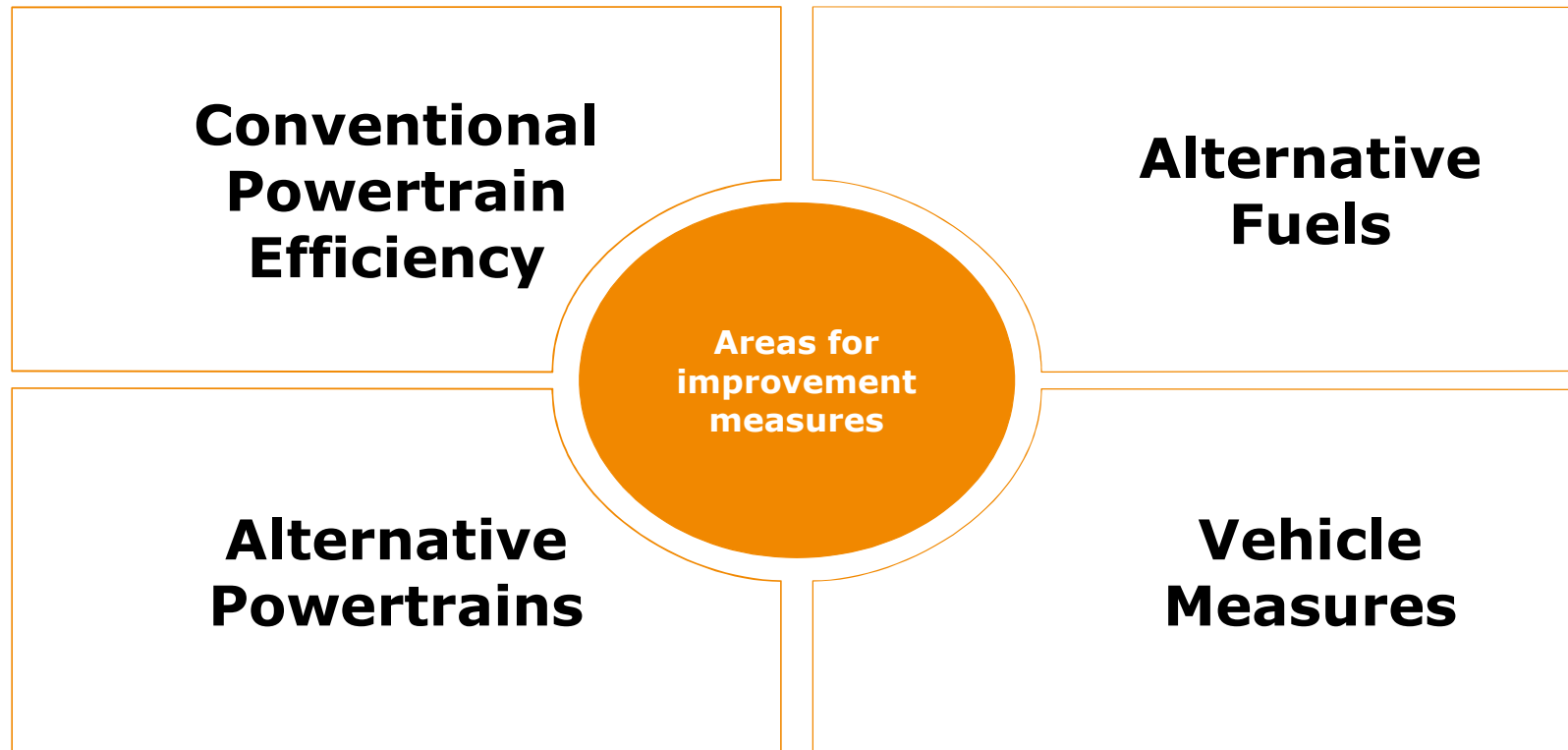
# Global Trends CO<sub>2</sub> Footprint

## Transport emission and reduction target in Europe



**2020 Daimler/Volvo announced to have 2039/2040 100% CO<sub>2</sub> free truck fleets**

# Possible Measures



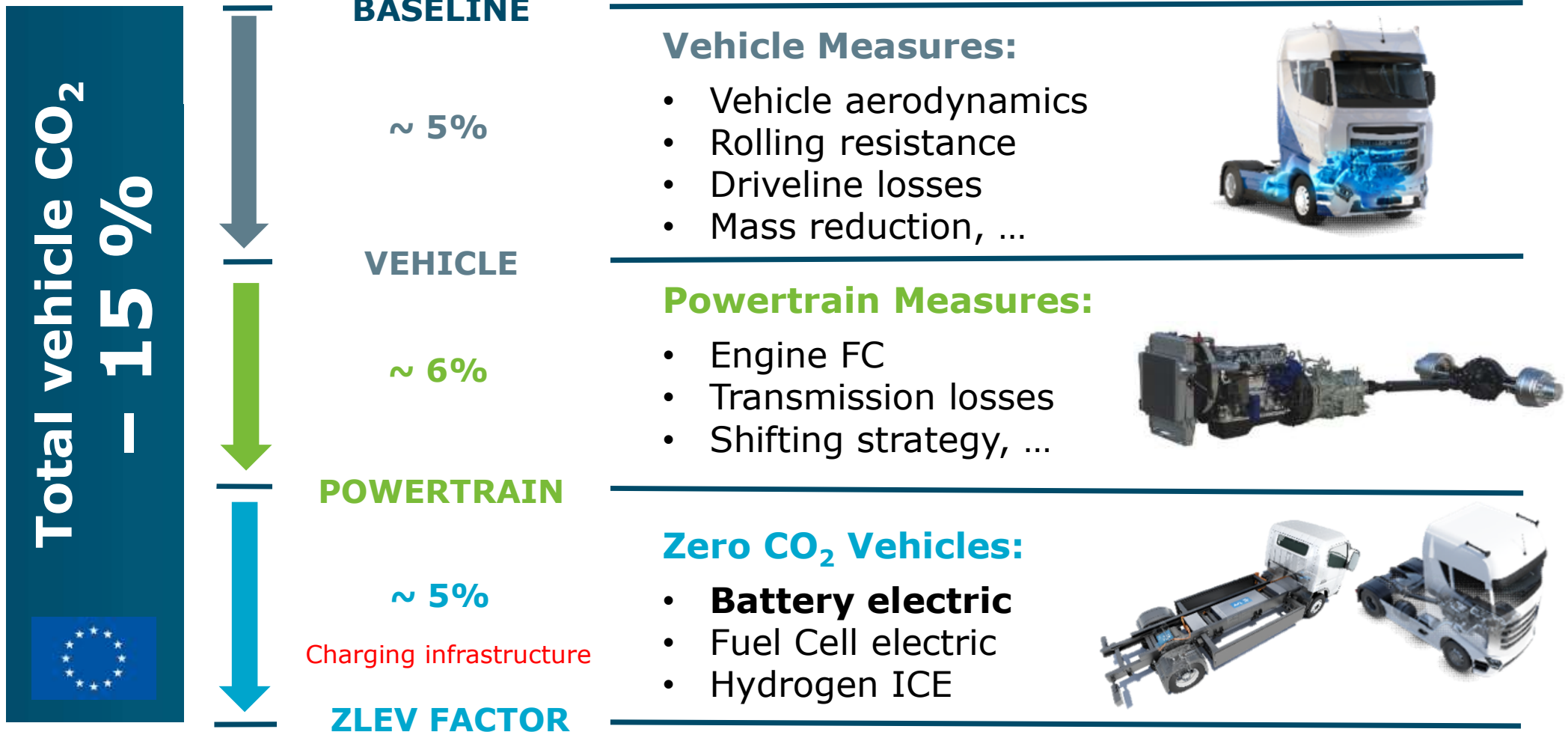
Measures will depend on external and internal factors (e.g. demand from customers, push from legislation, position of e.g. vehicles on the product life-cycle, expected competitors' activities ...)

# Overview of Possibilities for CO2 Reduction (tank-to-wheel)

Conventional	Natural Gas	Hybrid
MY27 50% BTE, long-term w/WHR up to 55% $\triangleq$ <u>16% CO2 reduction</u> (long-haul)	Between <u>10 to 23% CO2 reduction</u>	Between <u>6 and 10% CO2 reduction</u>
Battery-Electric	Fuel-Cell	H2-ICE
<u>No CO2 emissions</u>	<u>No CO2 emissions</u>	<u>97% and more CO2 reduction</u>

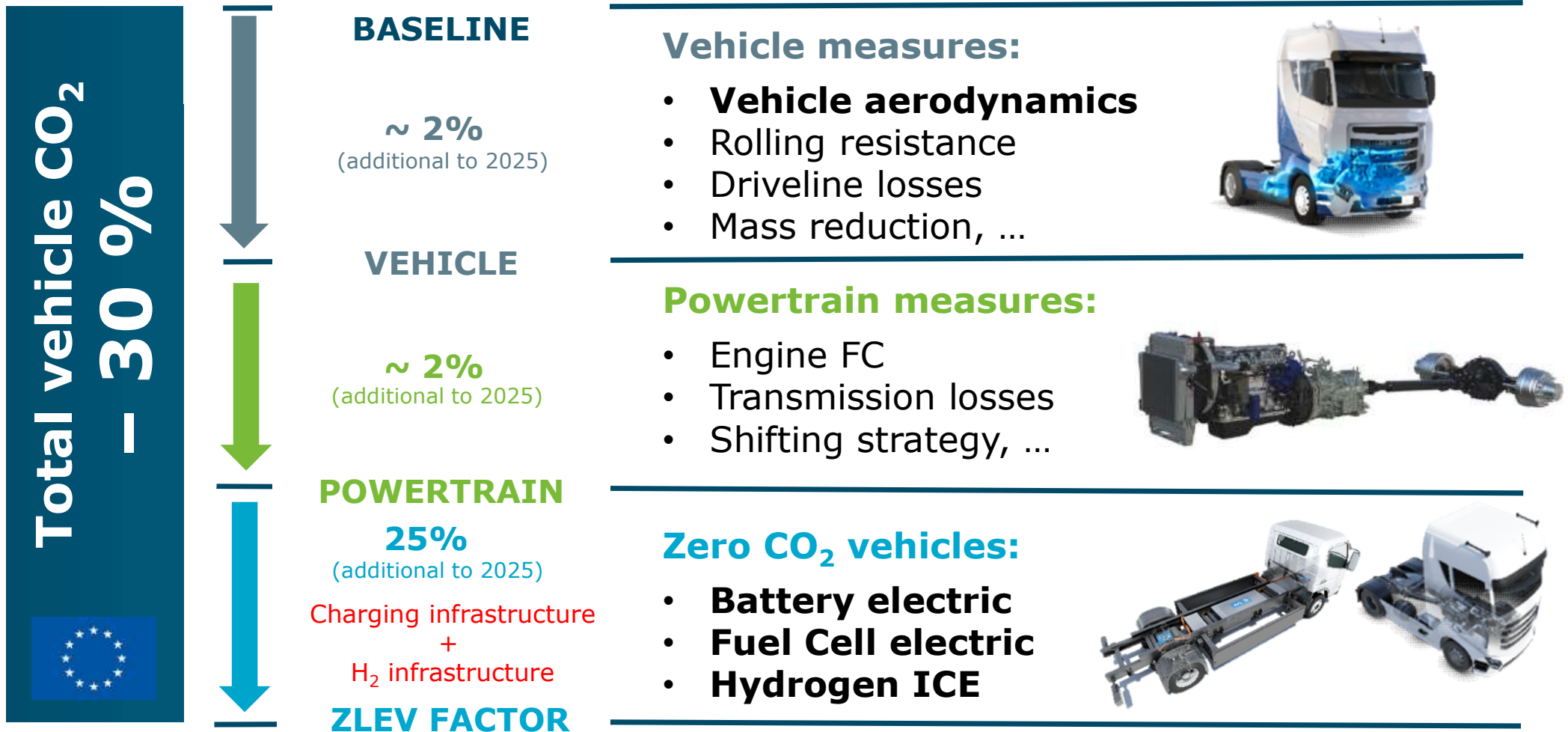
# Global Trends CO<sub>2</sub> Footprint

## Contributors to EU CO<sub>2</sub> fleet target achievement 2025

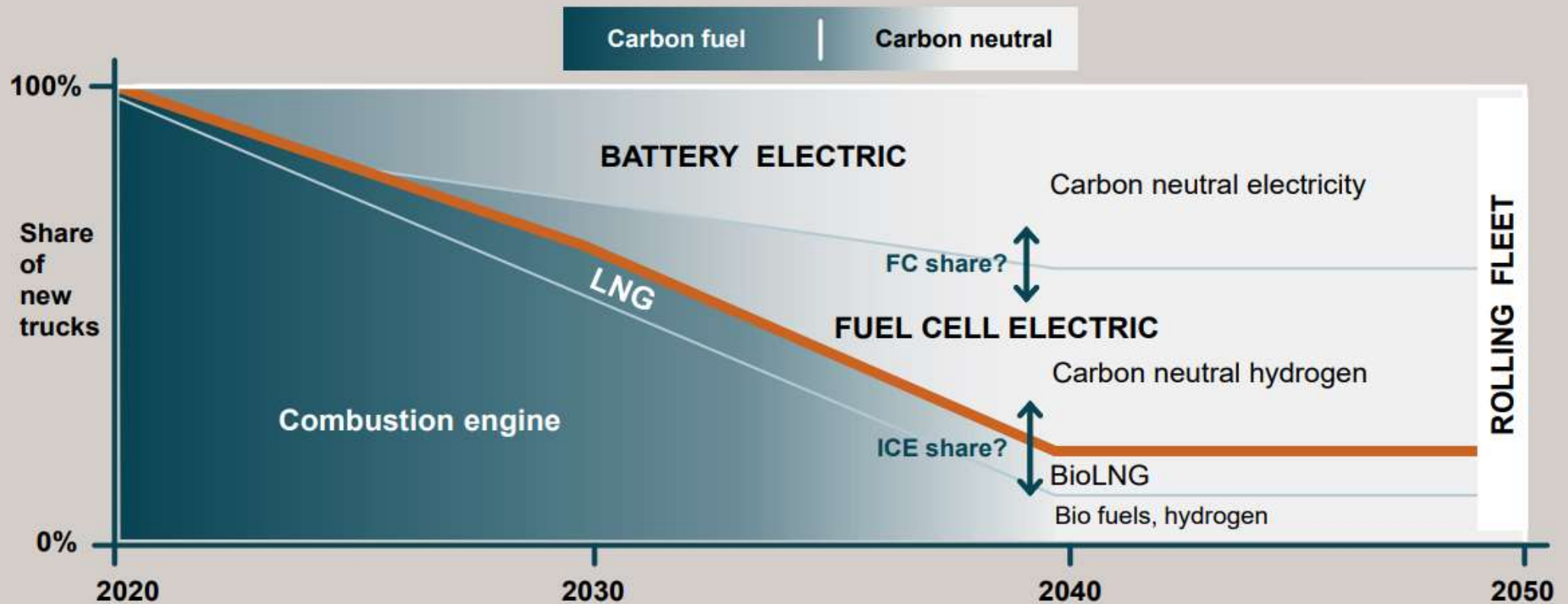


# Global Trends CO<sub>2</sub> Footprint

## Contributors to EU CO<sub>2</sub> fleet target achievement 2030



# 100% fossil free Volvo Group vehicles from 2040





# Global Trends CO<sub>2</sub> Footprint

## Daimler Truck: HD Electric Vehicle Platform

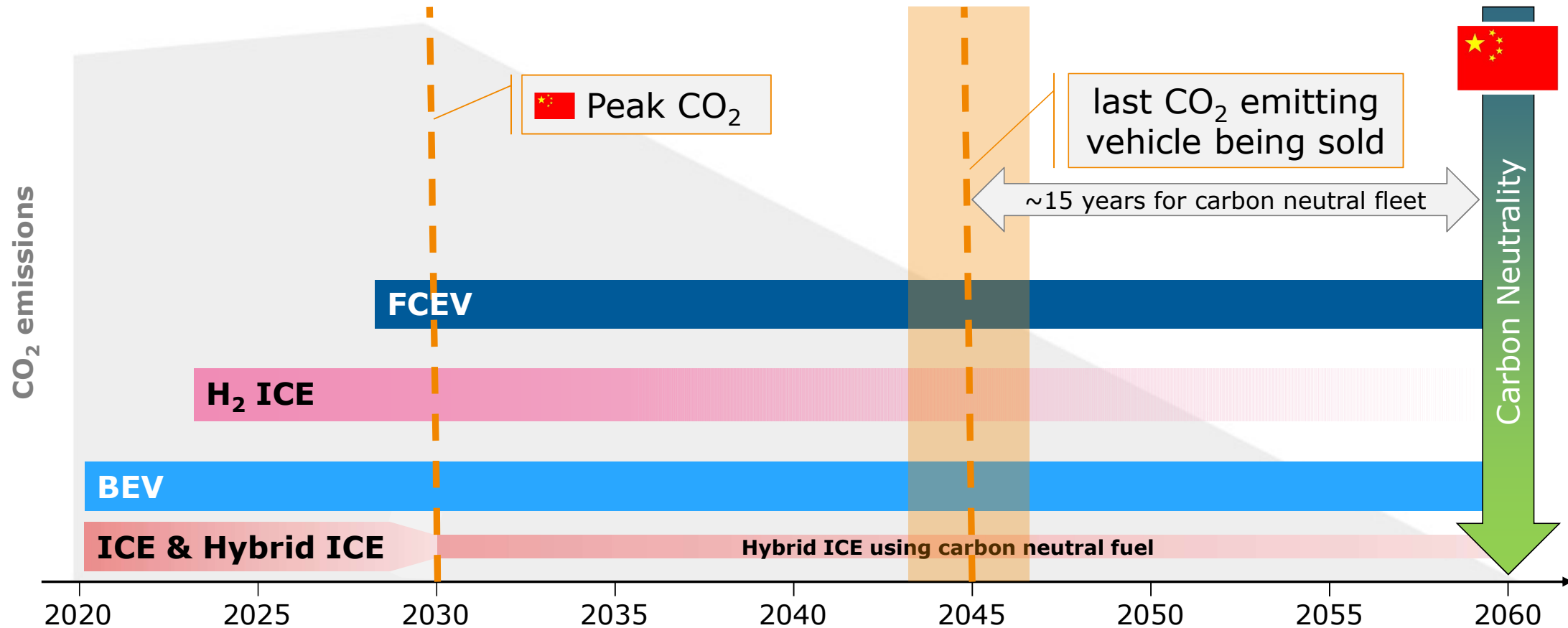


**DAIMLER Fuel Cell  
Concept Truck**  
2x 150kW FCS



# Global Trends CO<sub>2</sub> Footprint

## China's way to CO<sub>2</sub> free transportation





# Some Thoughts

- **For most effective CO<sub>2</sub> reduction, each primary energy CO<sub>2</sub> level requires a tailored technology portfolio → SECTOR COUPLING DECISIVE**
- **With current visible CO<sub>2</sub> legislation, the further CO<sub>2</sub> reduction will be largely determined by the PRIMARY ENERGY CO<sub>2</sub> level**
- **Sustainable design of components and powertrain → DESIGN to CO<sub>2</sub>**

Thank you



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