




Welcome Address to the  
H2020 EU Project GasOn  
Public Final Dissemination Event



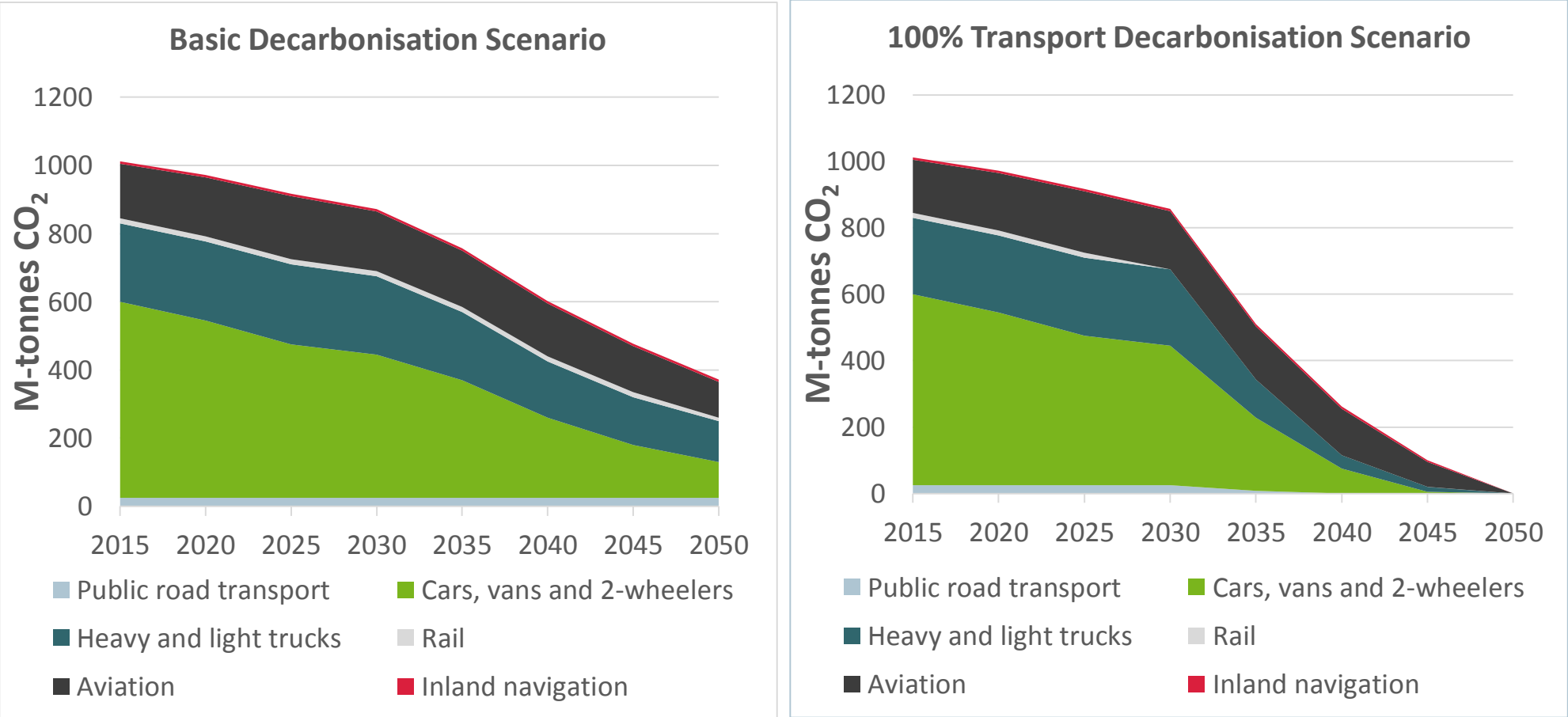
Aachen, 26 March 2019  
Prof. Dr.-Ing. Stefan Pischinger



- CO<sub>2</sub> Scenario and the Role of Methane in it
- Major Challenges and Future Outlook of Drive Train Scenarios
- Boundaries for CO<sub>2</sub> Neutral Mobility
- Summary and Conclusion

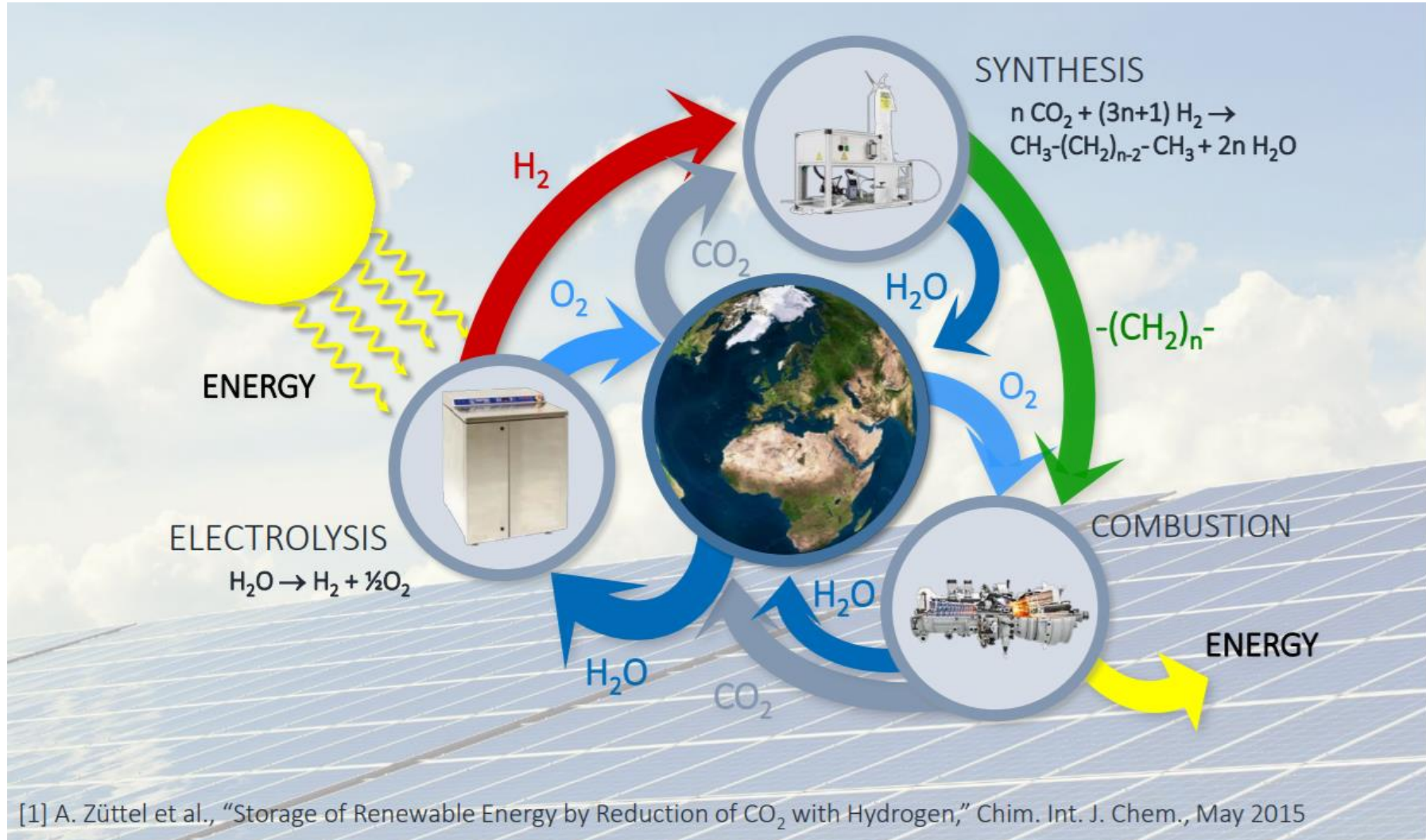
The window to achieving the 1.5 °C target is closing between 2030 and 2040. EU Report recommends more drastic reduction of CO<sub>2</sub> emissions. 

ACCORDING TO HLP REPORT, TRANSPORTATION MUST BE NOT 60% BUT 100% CARBON-NEUTRAL BY 2050



Source: Final Report of the High-Level Panel of the European Decarbonisation Pathways Initiative, European Commission (DG RTD), Nov. 2018  
[https://ec.europa.eu/info/sites/info/files/research\\_and\\_innovation/research\\_by\\_area/documents/ec\\_rtd\\_decarbonisation-report\\_112018.pdf](https://ec.europa.eu/info/sites/info/files/research_and_innovation/research_by_area/documents/ec_rtd_decarbonisation-report_112018.pdf)

# Synthetic fuels provide a pathway to a carbon neutral energy supply for any application



Source: D. Luisier, N. Mlynek, et al.: "Energy Storage and Synthetic Methane" at SCCER HaE, Oct. 25, 2017

# Methane from renewable resources/energy can be CO<sub>2</sub>-neutral



IN TRANSITION TO FULLY RENEWABLE FUELS, FOSSIL METHANE CAN BE A BRIDGE-TECHNOLOGY



## GHG effect of methane as fuel

### Fossil methane (CNG, LNG)

- H/C ratio and high LHV promise ~ 20% CO<sub>2</sub> benefit over gasoline
- High efficiency of monovalent gas engines → add. Benefit

### Non-fossil methane

- Closing the carbon cycle
- Biogas: in principle CO<sub>2</sub> neutral
- Synthetic methane from CO<sub>2</sub> and H<sub>2</sub> from electrolysis using green electricity

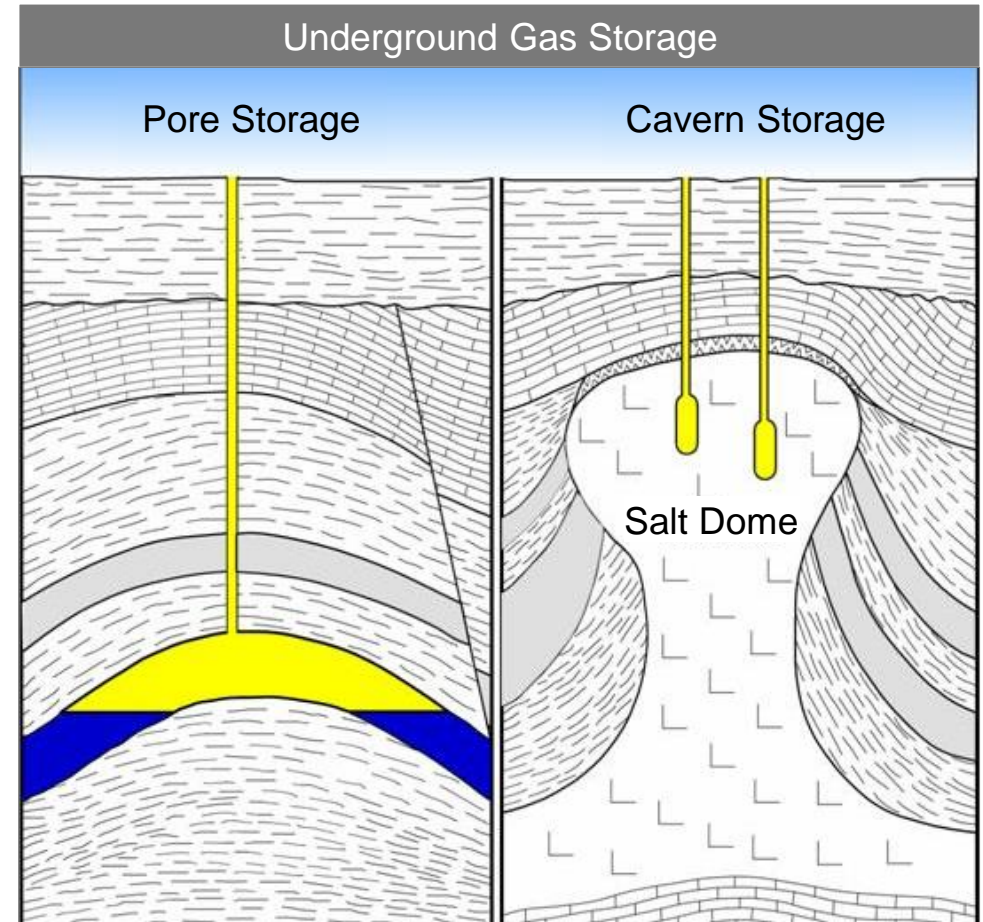
Source: W Casazza, Stadtwerke Augsburg: Carbon neutral public transport in Augsburg – Bionethane buses, 15th International Renewable Mobility Congress, Berlin, 2018



Methane is fully compatible with the gas network infrastructure  $\Rightarrow$  easy energy transport across Europe, easy storage of temporal excess RE



LARGE AMOUNTS OF ENERGY CAN BE STORED BY INCREASING GAS PRESSURE IN PIPELINES AND STORAGES



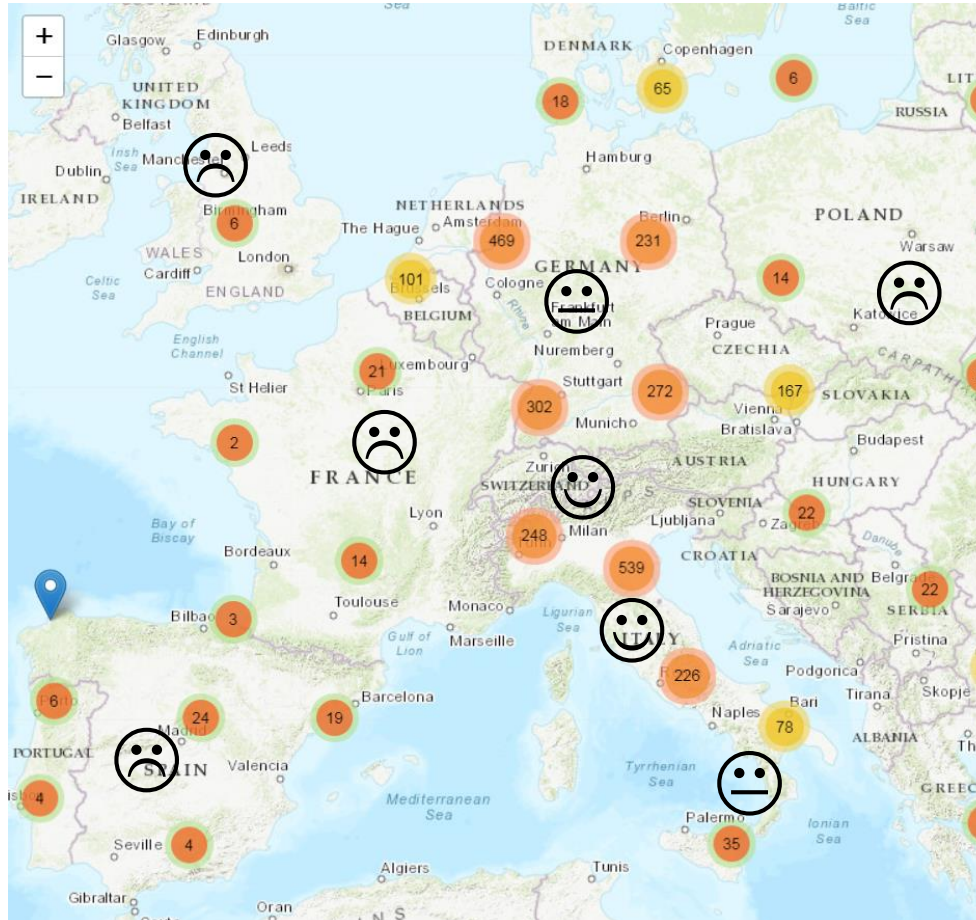
Source: [https://theodora.com/pipelines/germany\\_netherlands\\_czech\\_republic\\_pipelines.jpg](https://theodora.com/pipelines/germany_netherlands_czech_republic_pipelines.jpg),

[https://gruendungsnetz.brandenburg.de/media\\_fast/4058/M%C3%B6glichkeiten%20zur%20gro%C3%9Fvolumigen%20Erdgasspeicherung.jpg](https://gruendungsnetz.brandenburg.de/media_fast/4058/M%C3%B6glichkeiten%20zur%20gro%C3%9Fvolumigen%20Erdgasspeicherung.jpg)

## 2019: in some parts of EU challenging low density of CNG fuel stations



### INFRASTRUCTURE FOR METHANE PASSENGER CARS NEEDS RAMP UP



#### Methane availability

Methane vehicle owners find

- Mostly good supply in Italy
- Acceptable supply in most parts of Germany
- Careful route planning necessary for travelling through France and Spain
- Only local operation possible in UK, e.g. in Swindon and Nottingham, but not in London.

Source of map: <http://cngeurope.com/countries/europe-cng-filling-stations/>; Symbols indicate subjective usability of Gas-Only Vehicles

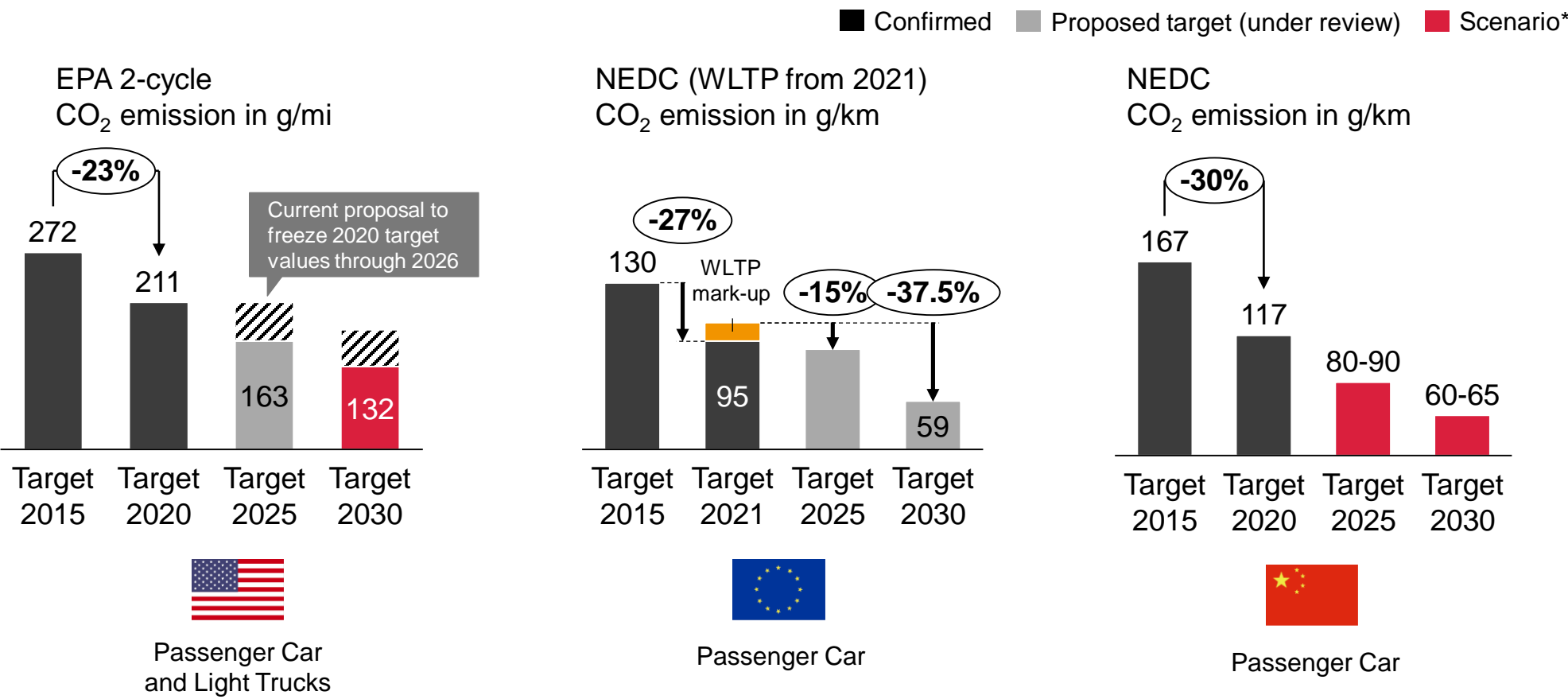
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# Fuel economy respectively CO<sub>2</sub> emission targets will be tightened in all major markets in the upcoming years



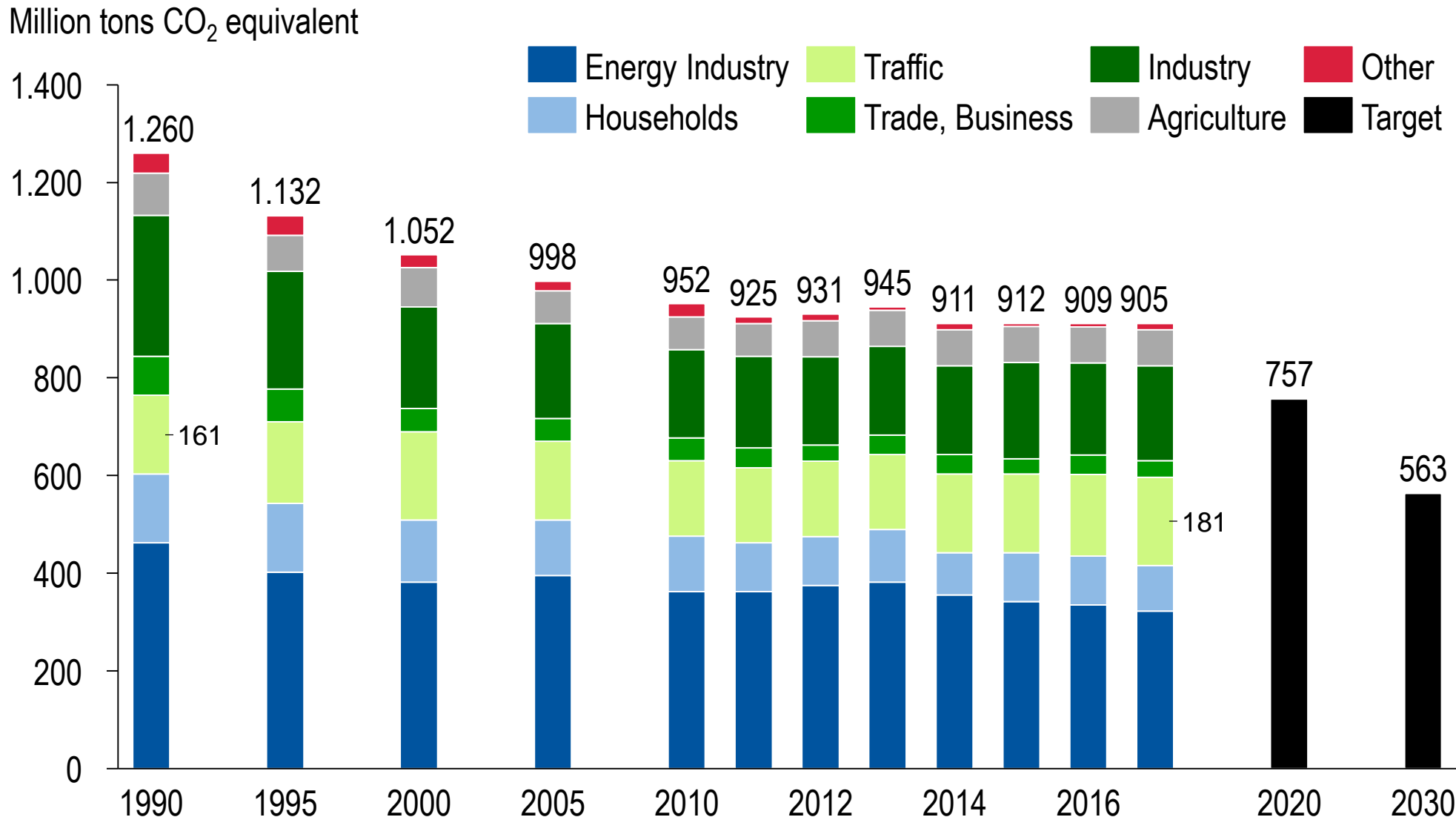
## FUEL ECONOMY / CO<sub>2</sub> EMISSION REGULATION



NEDC = New European Driving Cycle; GHG = Greenhouse Gas  
\* EU: based on GHG reduction targets for transport sector by European Commission; US: 4% annual reduction assumed after 2025; China: convergence with EU targets expected  
// CN figures are converted from l/km  
Source: European Commission, ACEA, FEV

# All in all greenhouse gas emissions are stagnating in Germany!

## Increase in GHG for traffic sector since 1990



# The diesel market shares in EU are declining in 2017, ongoing 2018 but diesel necessary for CO2 reduction

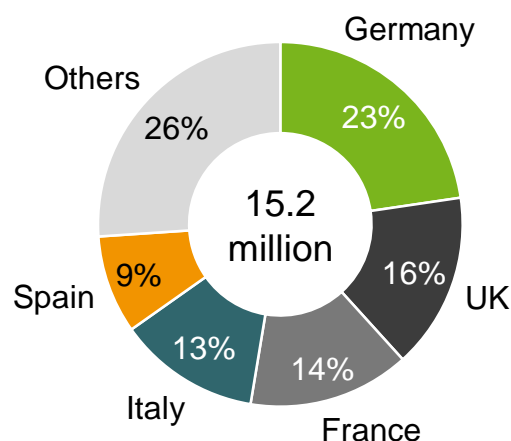


# JANUARY 2019



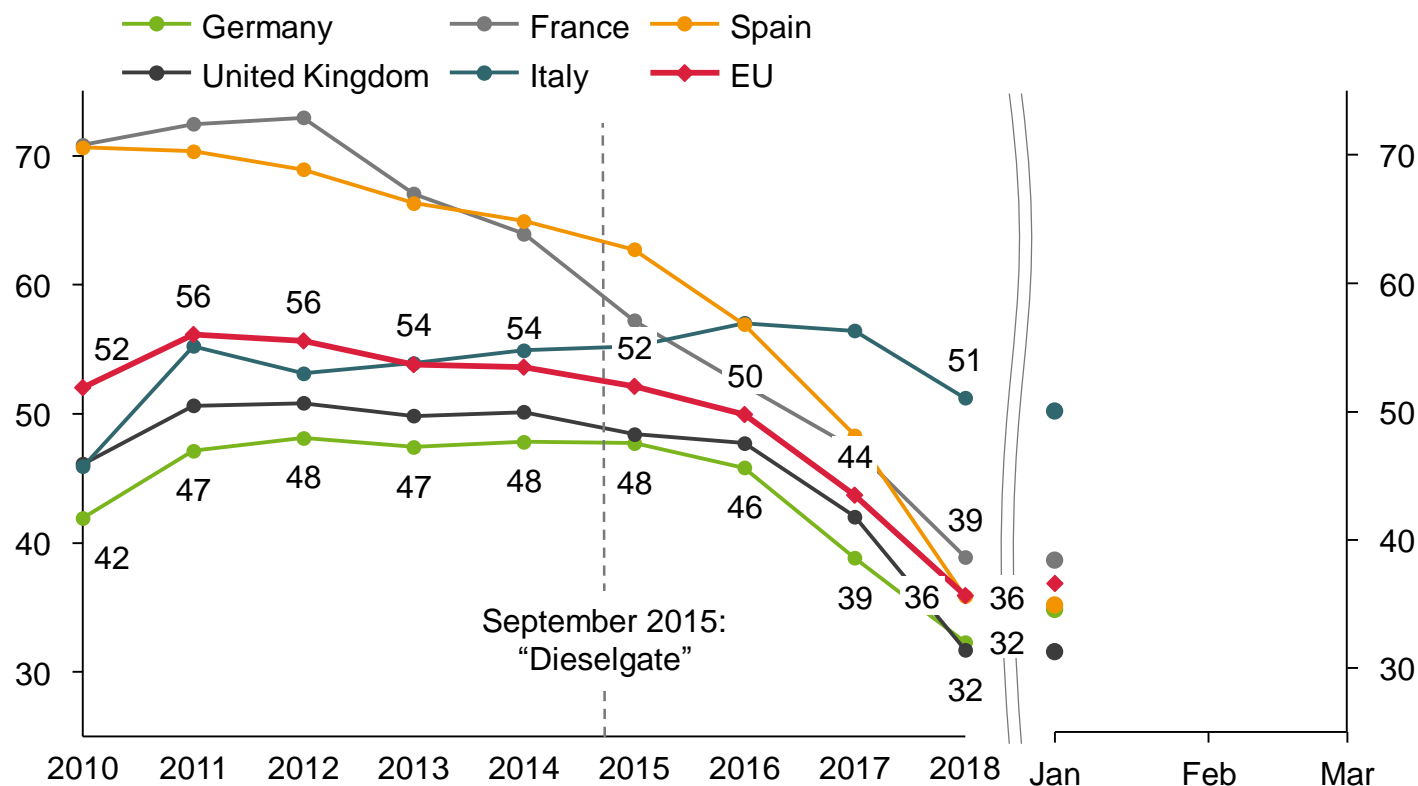
## DIESEL MARKET SHARE DEVELOPMENT IN EUROPEAN PASSENGER CAR MARKET

2018 EU passenger car registration by country



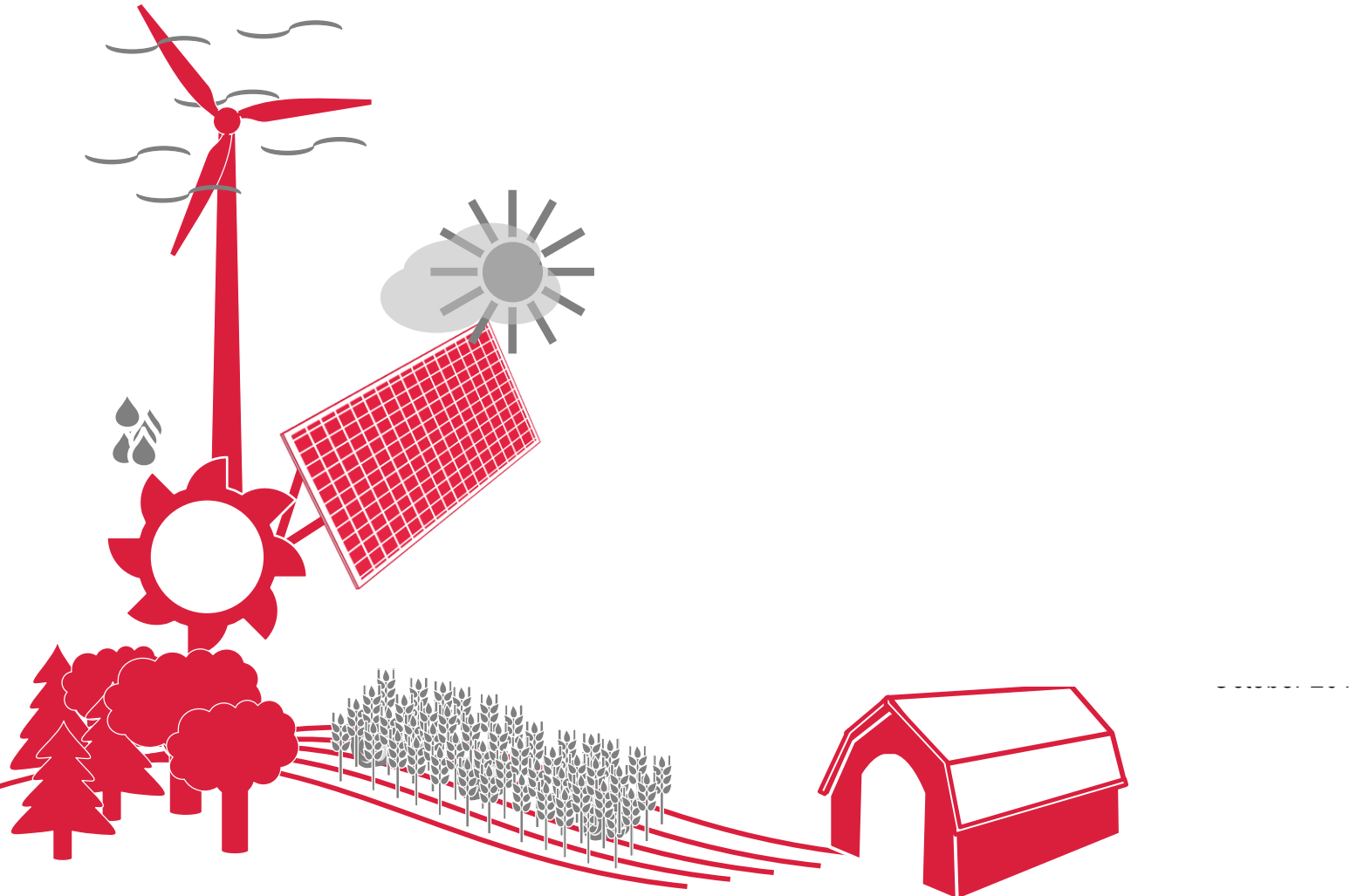
Diesel market share 2010 – 2018 by country in %

12 months moving average diesel market share in %



Source: KBA (Germany), ANFAC (Spain), CCFA (France), SMMT (UK), ANFIA (Italy), ACEA (EU), Statista

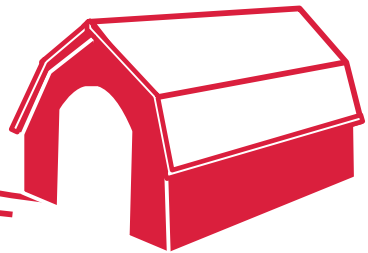
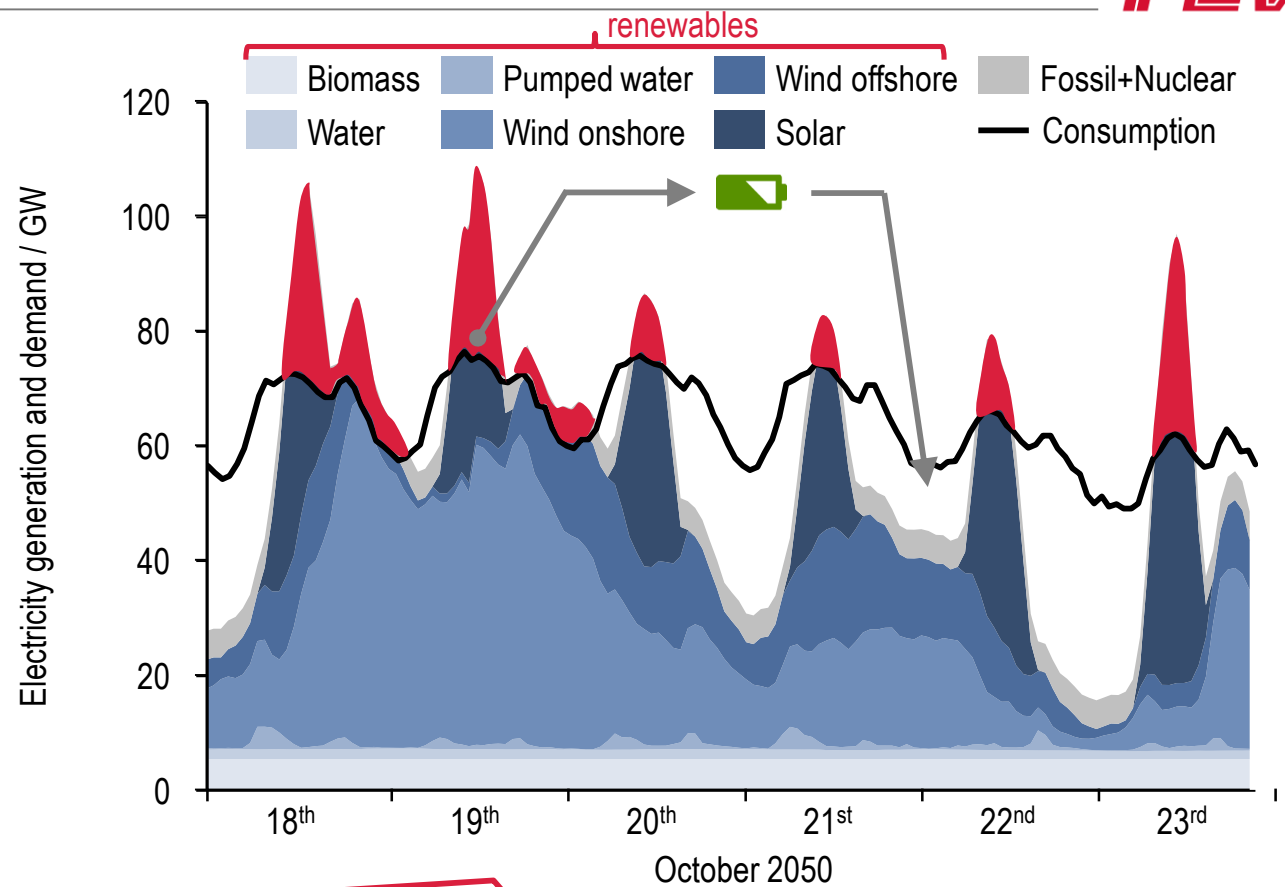
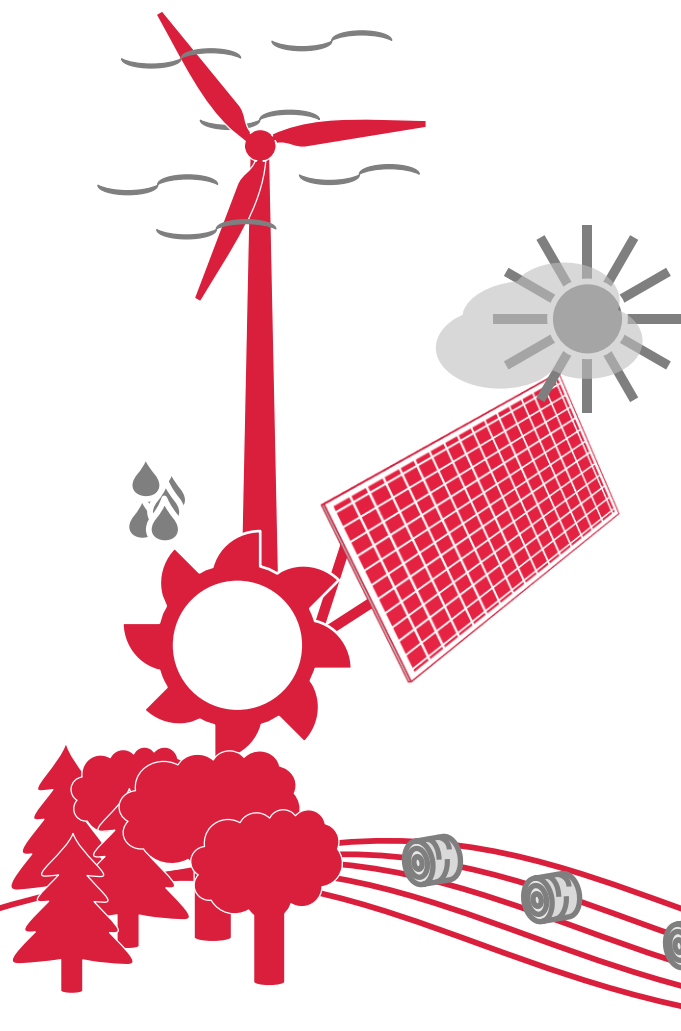
The future mobility will strongly depend on renewable electricity and carbon  
2017\*: 36 % regenerative, fluctuation compensated by fossil & nuclear



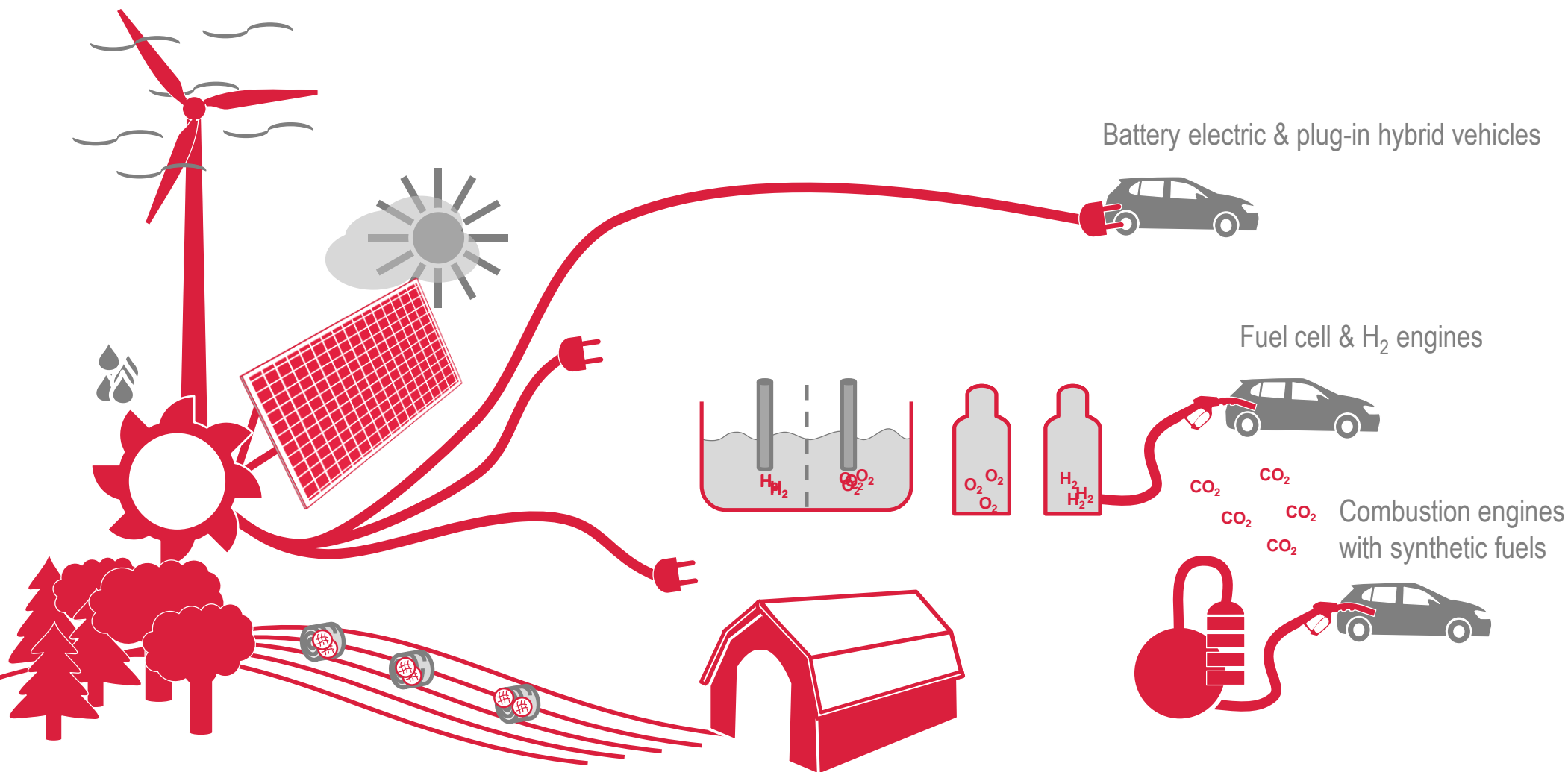
\*Deutschland: <https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#statusquo>



# Extrapolation 2050: 90 % regenerative, over supply to be stored



# Diversified solutions for future Zero CO<sub>2</sub> mobility



# Significant BEV share increase to 2030 – major market for Battery electric vehicles is China followed by EU

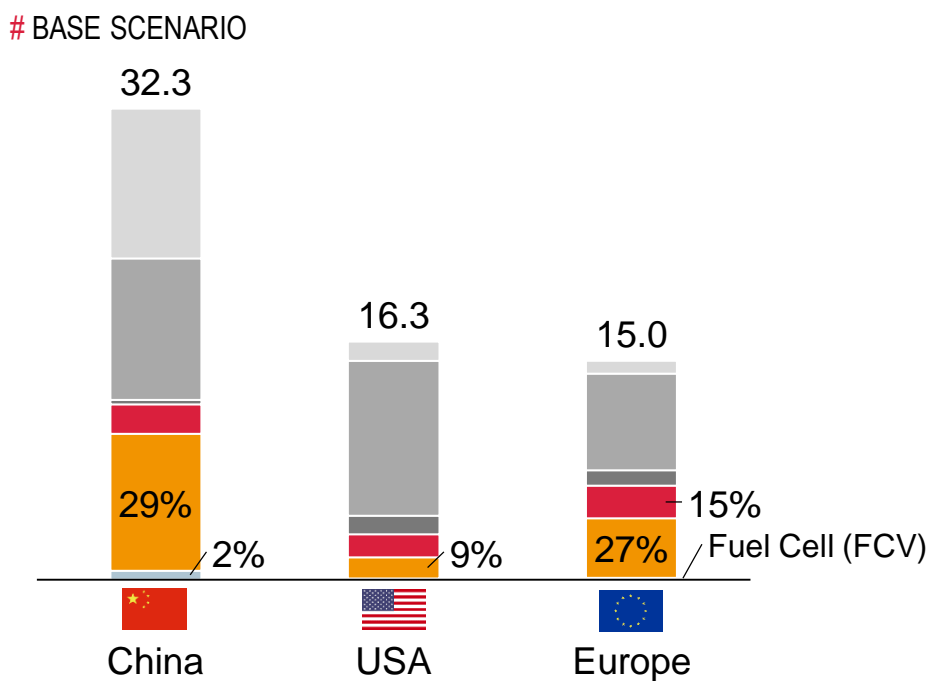
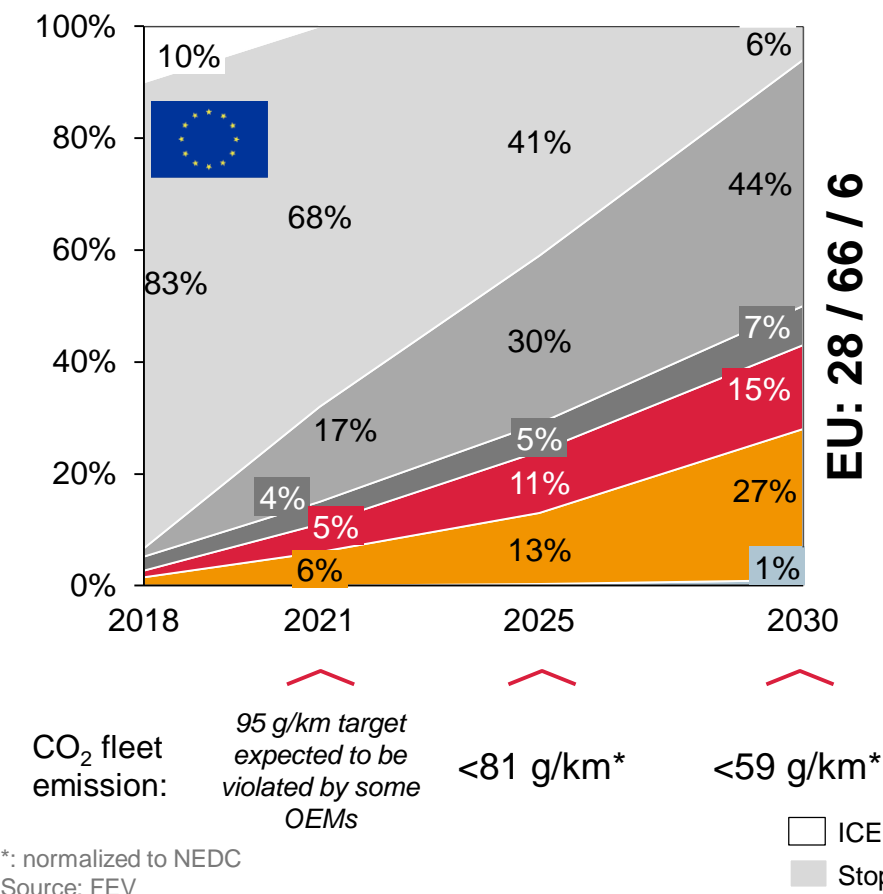


## PASSENGER CAR POWERTRAIN ELECTRIFICATION SCENARIOS – VEHICLE SALES

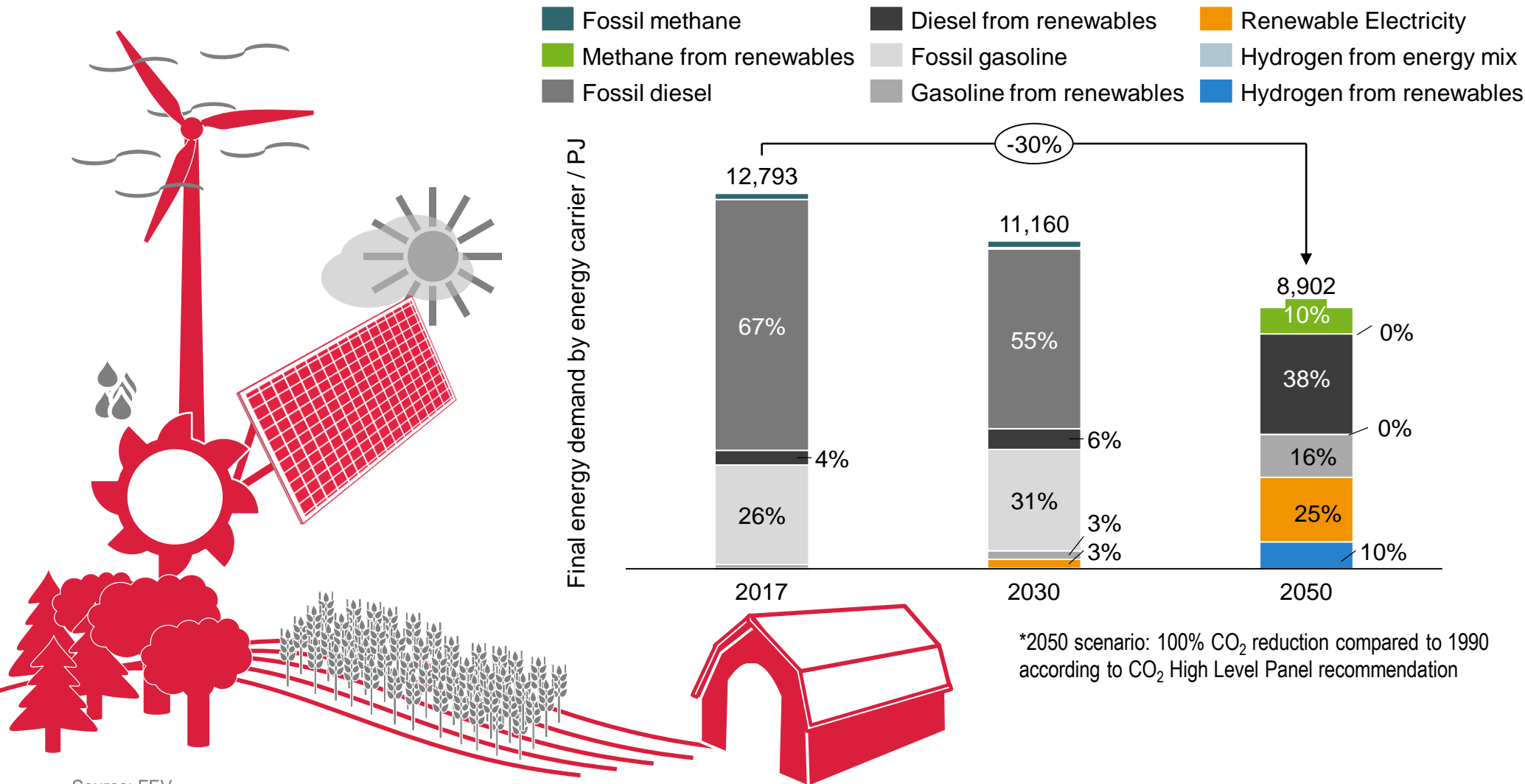


FEV Base Scenario

Pass. car powertrain type forecast 2030 in mio. units



# Energy supply scenario Europe 2050: 100% renewable energy in road transport



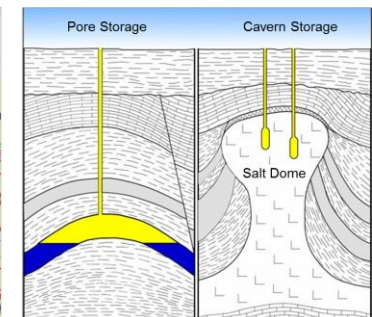
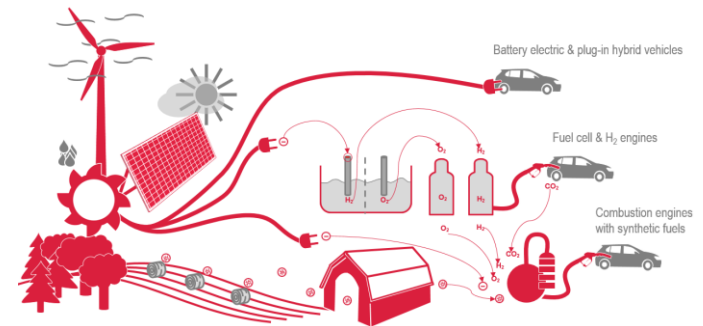
Source: FEV



# Conclusion: A carbon-neutral society in 2050 will depend on using and storing renewable energy in multiple ways and forms



- CO<sub>2</sub> emission targets worldwide are getting more and more challenging
- CO<sub>2</sub> emissions can be reduced effectively with using PtX fuels, hybridization and battery electric vehicles
- Methane (and to some extent Hydrogen) from renewable resources and renewable energy can be stored and transported in existing gas infrastructure
- Mixture of BEV and hybrid vehicles with e-fuels for different use cases are able to reach the defined targets
- Further technologies for ICE efficiency increase up to 50% are available



$\eta_e$  ↗