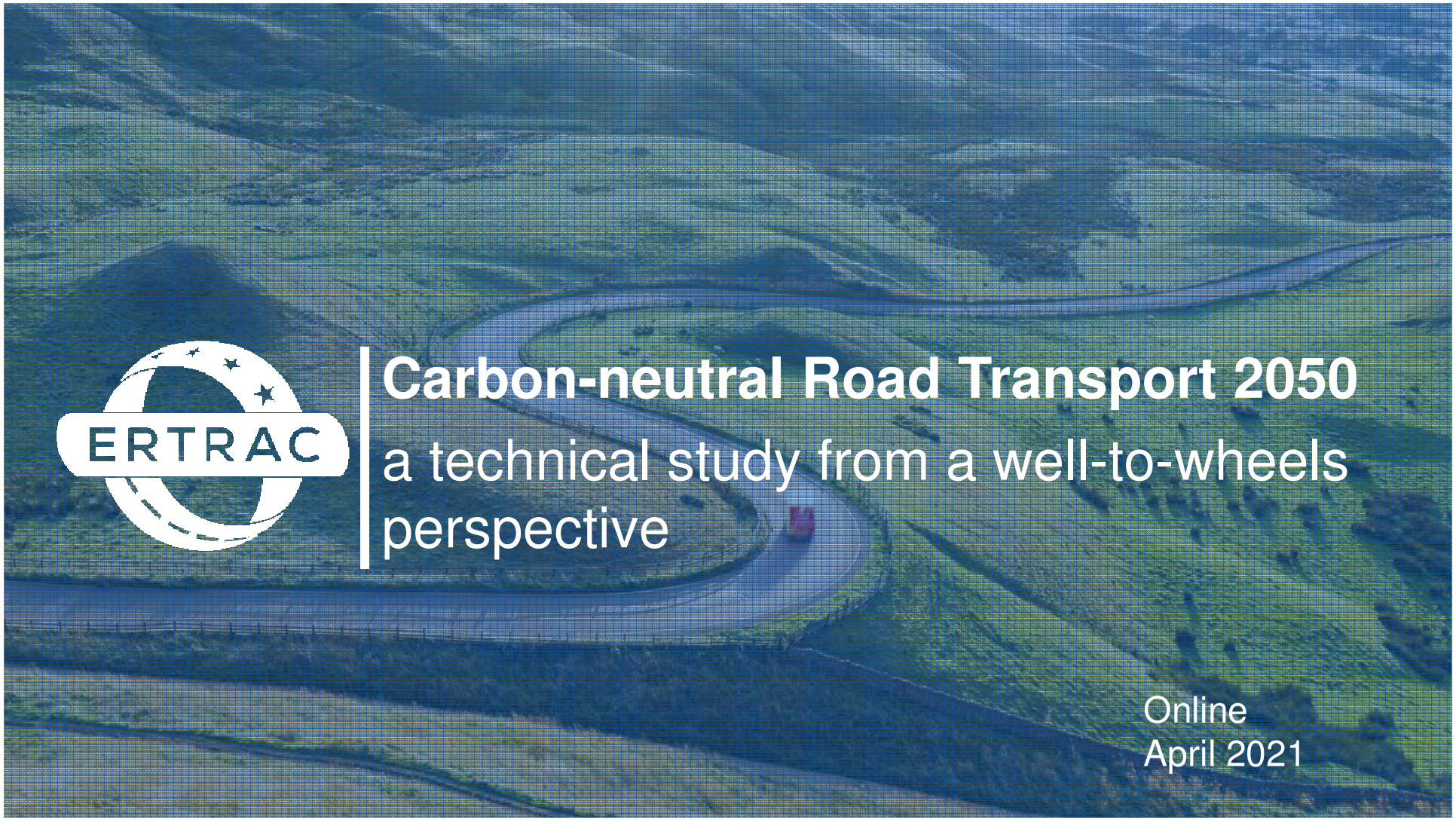


Carbon-neutral Road Transport 2050

a technical study from a well-to-wheels perspective

Online
April 2021

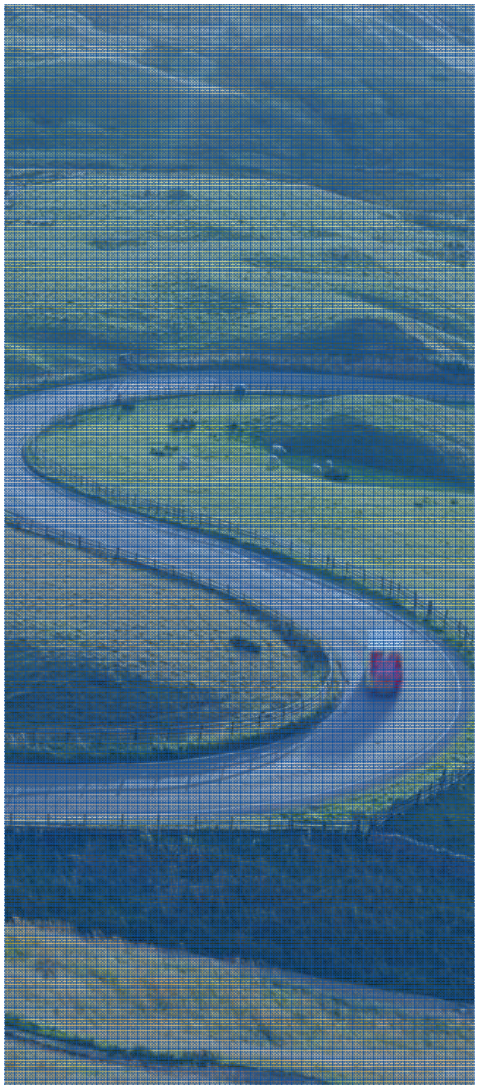
Fleet and Fuel Scenarios for 2050 Carbon Neutral Road Transport in the EU

Aim of the study:

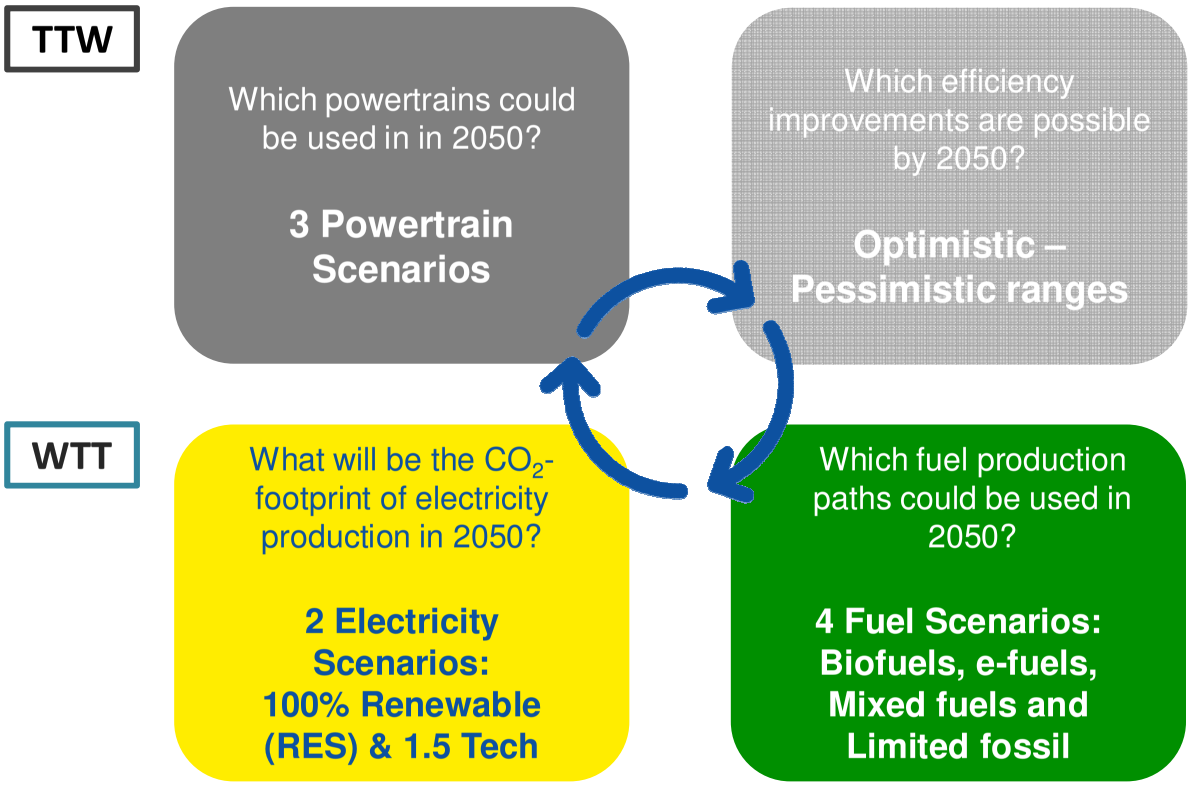
- Explore options for carbon neutral road transport in the EU by 2050, in a WtW perspective

Relevance to EU policy:

- Examine technical options for a strong contribution of road transport to meeting the Green Deal / Climate Law objectives of carbon neutrality by 2050



Concept of the study



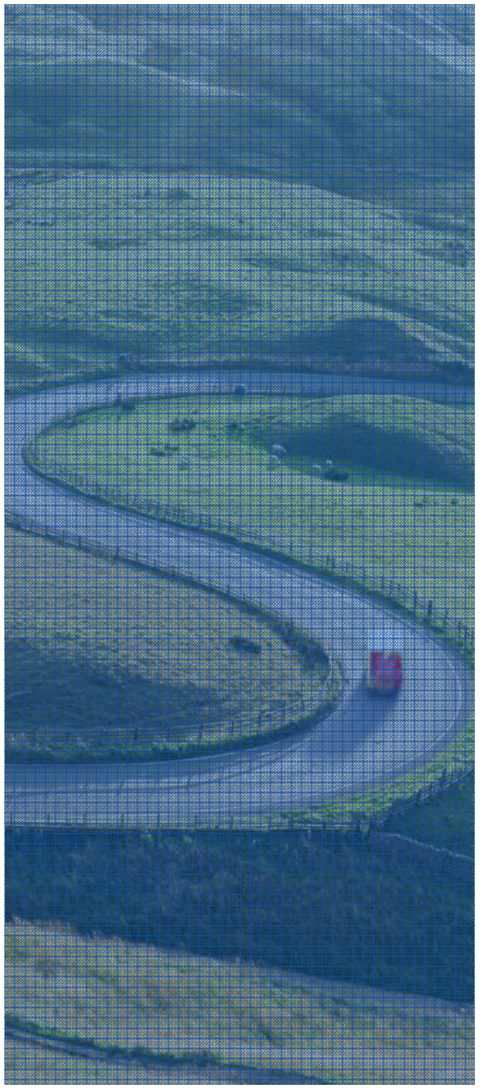
ERTRAC study I has presented fleet scenarios (published 2020)

The present study adds:

- fleet and measure updates
- fuel pathways
- the requirement of carbon neutrality

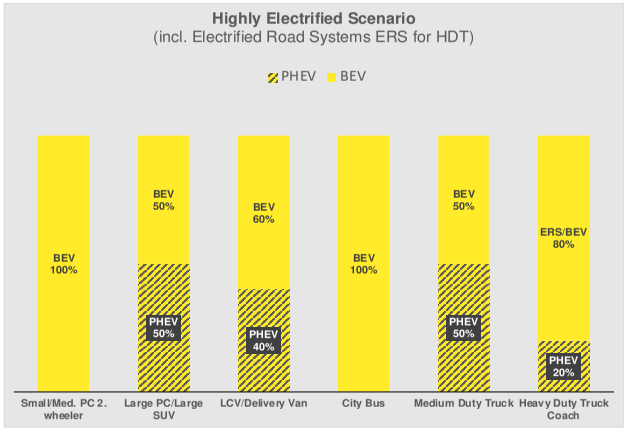
DISCLAIMER

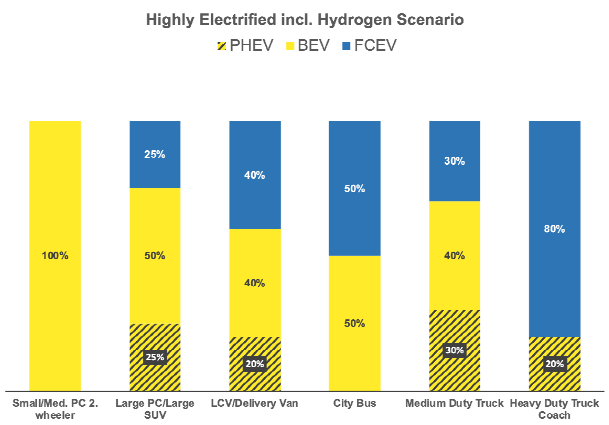
- → **The ERTRAC Carbon neutrality Study 2050 (WTW) analyses different "extreme" scenarios and compares effects**. It does not aim at giving a projection or at describing the way to achieve a carbon neutral road transport.
- → The study only reflects the views of the contributing authors and is not an official European Commission position.
- → **Results:**
  - This study explored different corner scenarios based on a static fuel and fleet modelling exercise.
  - The analysis does not include dynamic modelling or prediction; the results of the analysis should be considered as estimates for comparative purposes.
  - The analysis does not draw conclusions on fuel and electricity availability, competition with other sectors demand, economics, societal acceptance ...

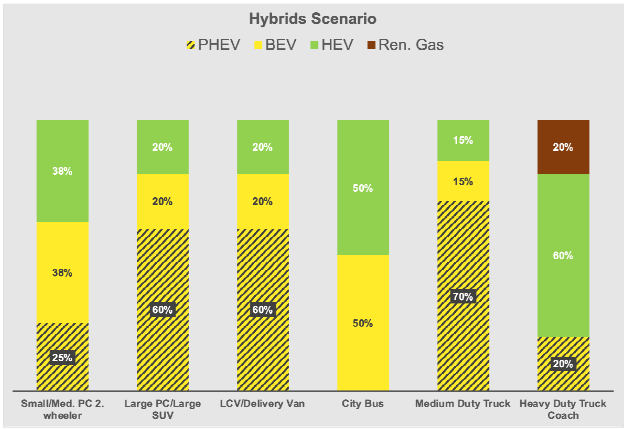


3 Powertrain Scenarios 2050

Scenarios assumptions as input for the study:



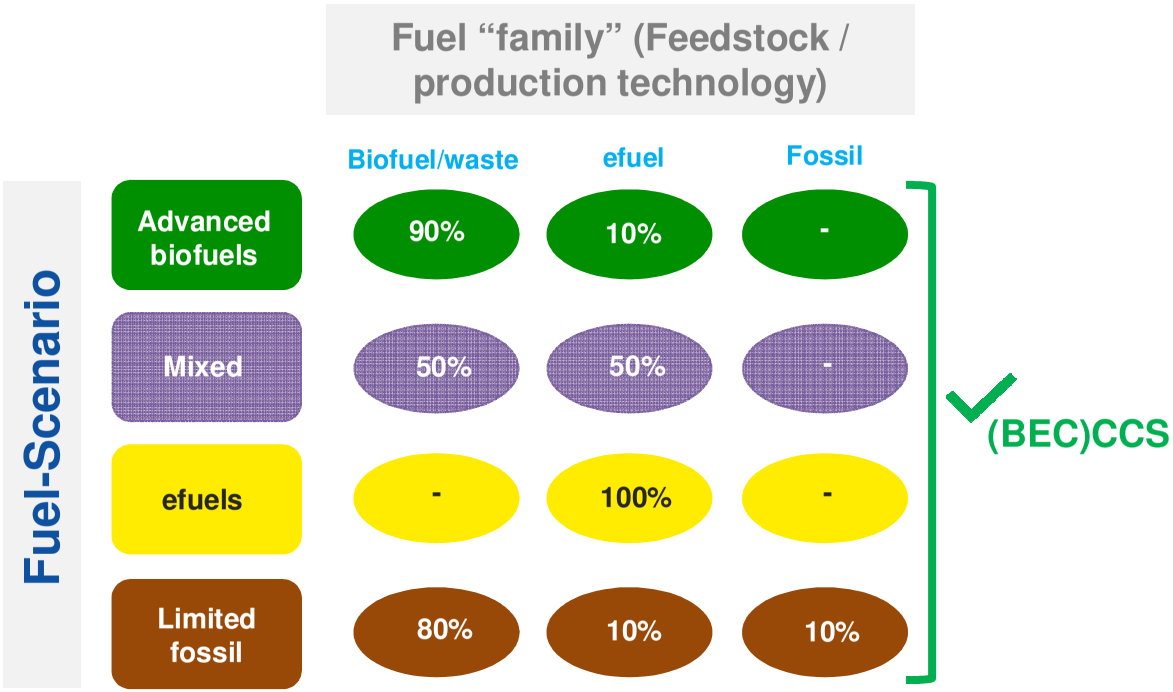




3 different powertrain scenarios analysed (corner-points):

- Highly Electrified incl. Electrified Road Systems (HE-ERS)
- Highly Electrified incl. Hydrogen (HE-H)
- Hybrids Scenario (Hyb)

4 Fuel Scenarios 2050



Note: BECCS refers to biofuel production routes coupled with CCS (allowing negative emissions)

Comparison of different fuel "family" shares being used in the different fuel scenarios (corner-points).

Fuel scenarios have been drafted independently from the powertrains scenarios.

The interactions between these two scenarios will be detailed in the WtW study.

Note:
- *Basis: JEC WTT v5 – 2030 extended towards 2050*
- *Drop-in fuels compatible with existing powertrains*

Results Fleet & Energy scenarios TtW

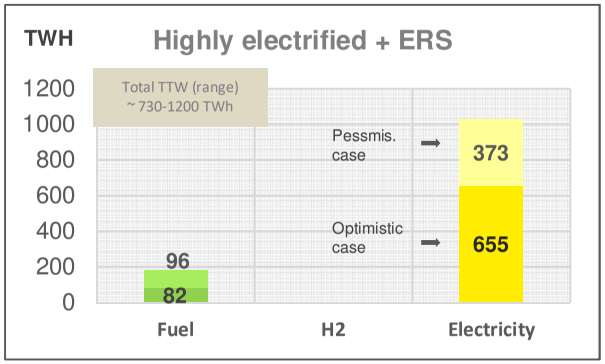
Question 1:

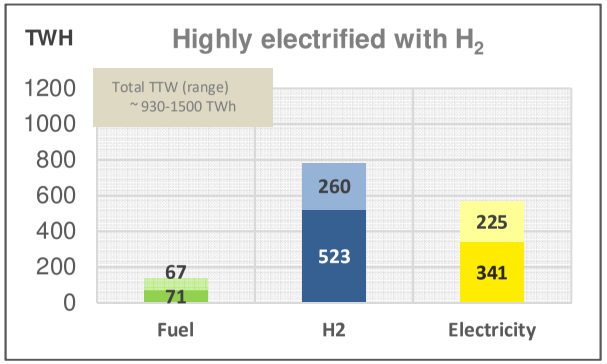
How much

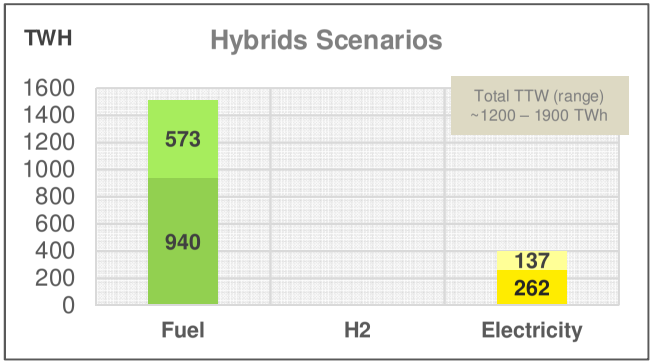
- **fuel**
- **hydrogen**
- **electricity**

could be required (use) in EU Road Transport by 2050? (TtW, TWh).

Question 1:
How much **fuel/hydrogen/electricity** could be required (use) in EU Road Transport by 2050? (TtW, TWh).







Significant reduction of fleet-average TTW Energy Consumption:
The total TTW energy consumption could range between ~730 and 1900 TWh. A significant reduction is shown in all scenarios considered **(45% to 80% savings)** in total energy requirement versus 2015.
(As a reference, 290 Mtoe consumed in the EU road transp. 2015 <> 3400 TWh).

Fuel: **Significant reduction** compared to EU road transport sector in 2015.
In the highly electrified scenarios the savings in fuel consumption are up to 98%.
The highest use of fuel (Hybrids-Scenario) varies between 940 and 1510 TWh
→ 55% to 70% savings

Hydrogen:
The use of Hydrogen ranges between 520 and 780 TWh (Highly electrified with H2 scenario).

Electricity: Road Vehicles consume directly up to 35% of total 2015 EU final electricity consumption.
The use of electricity ranges from ~260 up to 1000 TWh (the latter in the highest electrified scenario (HE + ERS scenario) which represents ~35% of total EU-wide electricity consumption in 2015).

Efficiency is paramount (Delta "Optimistic-Pessimistic")
Technical measures (A,B and C) targeting efficiency improvement
- Vehicle
- Traffic condition
- System improvements

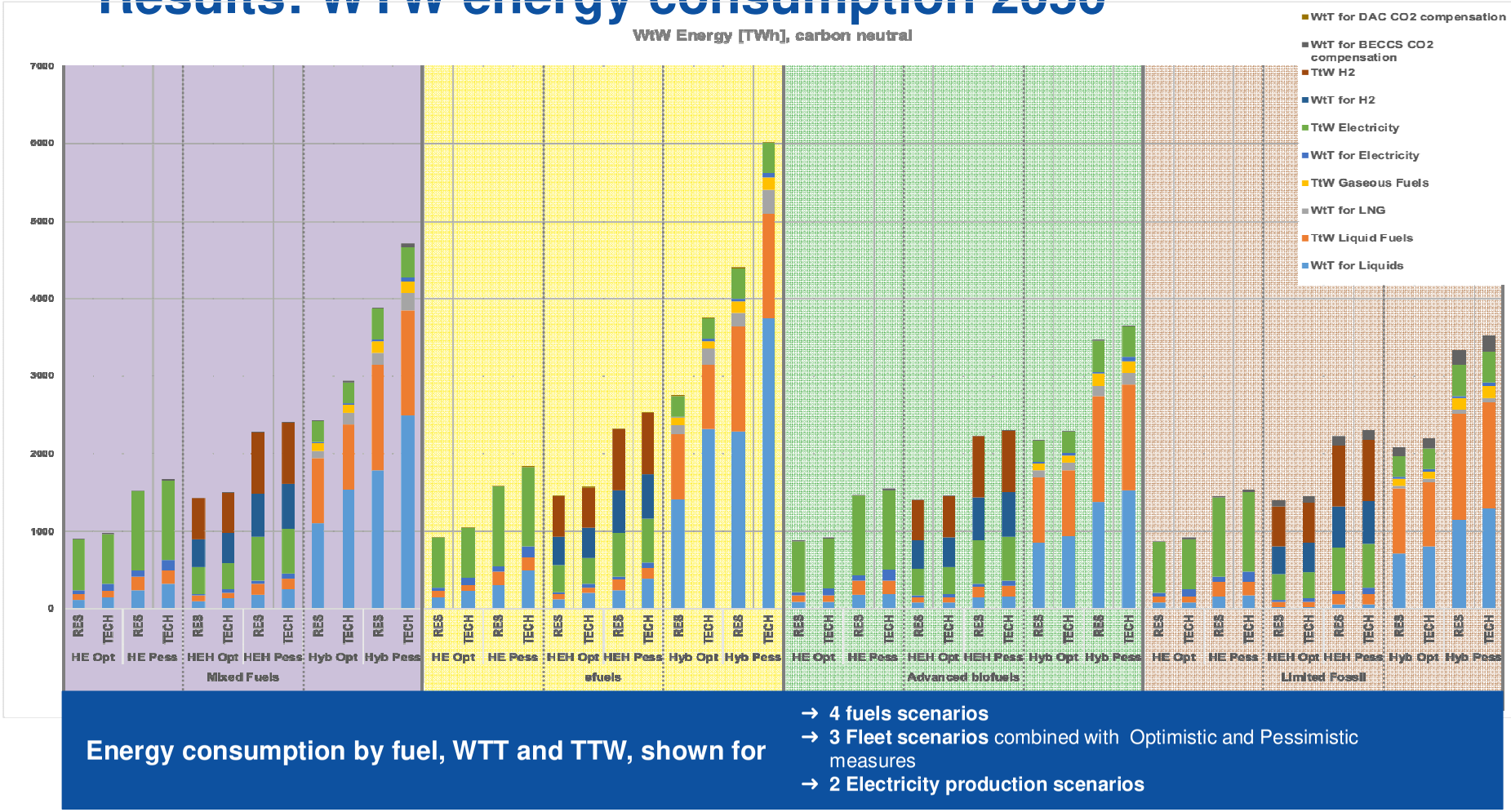
Potential to reduce the energy consumption by ~35-40%, showing the importance of boosting R&D in these areas.

Results Fleet & Energy scenarios WtW

Question 2:

How much energy could be required to reach a net CO_{2eq} neutral road transport in Europe? (WtW, TWh)

Results: WTW energy consumption 2050



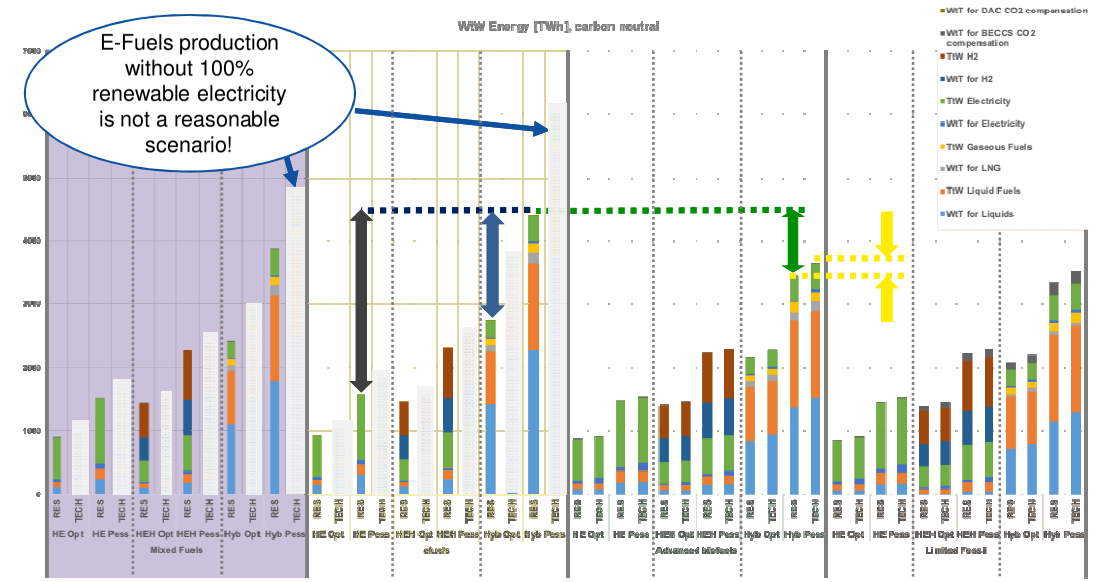
Energy consumption by fuel, WTT and TTW, shown for

- → **4 fuels scenarios**
- → **3 Fleet scenarios** combined with Optimistic and Pessimistic measures
- → **2 Electricity production scenarios**

Results Fleet & Energy scenarios

Question 2:

How much energy could be required to reach a net CO_{2eq} neutral road transport in Europe? What leverage have the different scenarios? (WtW, TWh, CO_2 neutral)



The **variation in the WTW Energy** demand between

the fleet scenarios is up to	~3000 TWh
the optimistic–pessimistic case is up to	~1500 TWh
the fuel scenarios is about	~1000 TWh
electricity production scenarios up to	~250 TWh

Growing leverage

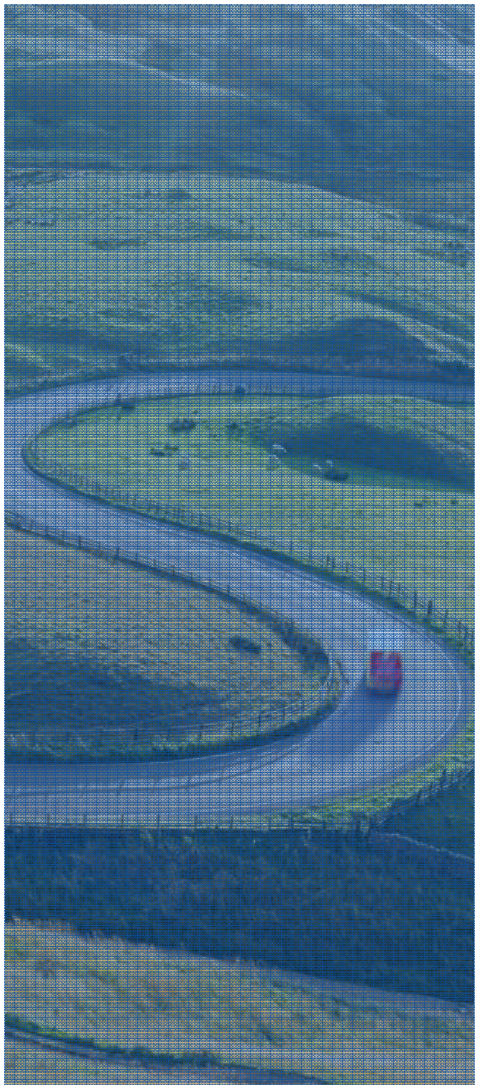
The share of TTW in the whole WTW energy consumption varies between **~50% up to 90%,** increasing with the level of fleet electrification.

DISCLAIMER
ERTRAC 2050 CO_2-Study
RESULTS

→E-Fuels production without 100% renewable electricity is not a resonable scenario!
→In the following slides we mainly focus on the 100% renewable electricity scenario (RES), combined with all fleet and fuel scenarios.

Conclusions

- **The complete and robust carbon-neutrality** of road transport could be achieved with a **mix of technologies**
- The **demand for fuels decreases massively in all scenarios** (in highly electrified scenarios up to 95% savings).
- The overall **WtW energy demand decreases drastically with fleet electrification**
- **In strongly electrified scenarios**, the **WtW differences in energy consumption** between the fuel scenarios are quite **small.**
- The **energy efficiency measures identified** (A, B and C) **reduce the energy / fuel consumption in all scenarios in a very significant way.**
- The total **demand for electricity** in road transport will **increase** (energy production + use in vehicle) (up to 1.6 time of total EU28 el. cons. 2019 if e-fuels are used along with a hybrid fleet)
- The largely **Carbon-Neutral production of electricity** is a prerequisite for “carbon-neutral” road transport in all fleet and fuel scenarios.



Conclusions

Research Recommendations and Priorities:

1. Enable fleet mix change by

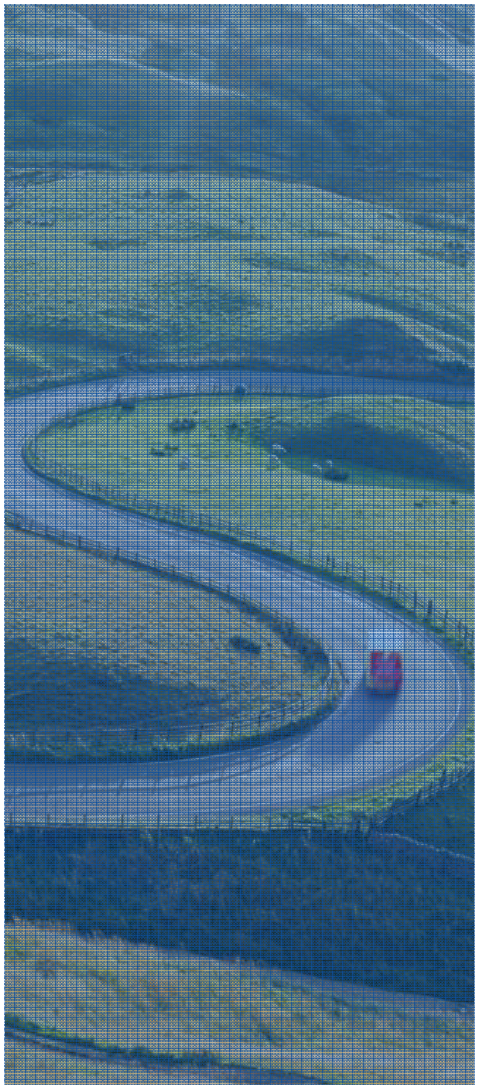
- ➜ Improving powertrain technology: cost, range, functionality, …
- ➜ Adapting infrastructure technology and concepts

2. Efficiency improvements by

- ➜ Measure A: Vehicle
- ➜ Measure B: Traffic conditions
- ➜ Measure C: Traffic Reduction Technologies

Beside Road Transport:

- ➜ Renewable electricity generation capacity (inside and outside of Europe)
- ➜ Net carbon-neutral H2 and fuel production (inside and outside of Europe)
- ➜ Technology and capacity of CCS and DAC
- ➜ Availability of raw materials and sustainable feedstocks (appraised in a life-cycle analysis perspective)

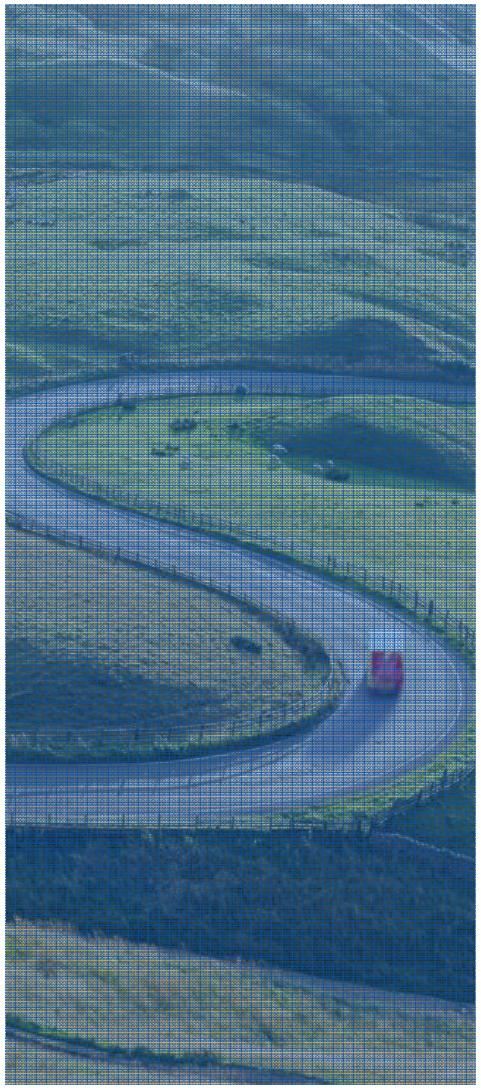


Next steps

➜Stay tuned for the detailed presentation to ERTRAC members (tentative date: 29th April)

➜The publication is under finalization.

In the meantime, you can find the previous publication online: *EU road vehicle energy consumption and CO2 emissions by 2050 – Expert-based scenarios*



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CO_2 assessment for the fleet

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CO_2 assessment for the fleet

Marta Yugo
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Energy / CO_2 assessment for the WTT / fuel scenarios

Roland Dauphin
Concawe
Energy / CO_2 assessment for the WTT / fuel scenarios

ERTRAC

** Each Member of ERTRAC Executive Group nominated specific experts*

Thank you!