Introduction to ERTRAC

Towards Scenarios for the Decarbonisation of Road Transport from a Well to Wheels Perspective

27th May 2022

Simon Edwards, ERTRAC Vice-Chairman

Presented at the "Roadmap for Modernisation of Road Transport" conference, Prague

EVROPSKÁ UNIE
Evropský fond pro regionální rozvoj
Operační program Podnikání
a inovace pro konkurenceschopnost

MINISTERSTVO
PRŮMYSLU A OBCHODU

TECHNOLOGICKÁ PLATFORMA
SILNIČNÍ DOPRAVA

Structure

- Introduction to ERTRAC
- Technical Scenarios for the Decarbonisation of Road Transport from a Well to Wheels Perspective

Structure

- Introduction to ERTRAC
- Technical Scenarios for the Decarbonisation of Road Transport from a Well to Wheels Perspective

Introduction to ERTRAC: a Technology Platform

European Road Transport Research Advisory Council

Efficient vehicles

Intelligent traffic management

Better infrastructure

ERTRAC System approach

Public transport and intermodality

Improved logistics

Infrastructure for connected & automated vehicles

Decarbonised Energy & fuels

Flexible and shared mobility services

ERTRAC Organisation

Plenary

Gathering all the ERTRAC members
Establishing the strategic orientations of the technology platform
Endorsing the publications

Working Groups

Gathering experts from the ERTRAC members
Responsible for the preparation of the ERTRAC documents
Co-managed by industry and research leaders

ERTRAC Working Groups

Urban Mobility	**Energy & Environment**	**Safety & Security**
Long Distance Freight Transport	**Global Competitiveness**	**Connectivity & Automated Driving**

Structure

- Introduction to ERTRAC
- Technical Scenarios for the Decarbonisation of Road Transport from a Well to Wheels Perspective

Technical Scenarios for the Decarbonisation of Road Transport from a Well to Wheels Perspective

European Road Transport Research Advisory Council (ERTRAC)
Dr.-Ing. Stephan Neugebauer, BMW AG
Dr. Simon Edwards, Ricardo GmbH

22. Internationales Stuttgarter Symposium
March 2022

DISCLAIMER

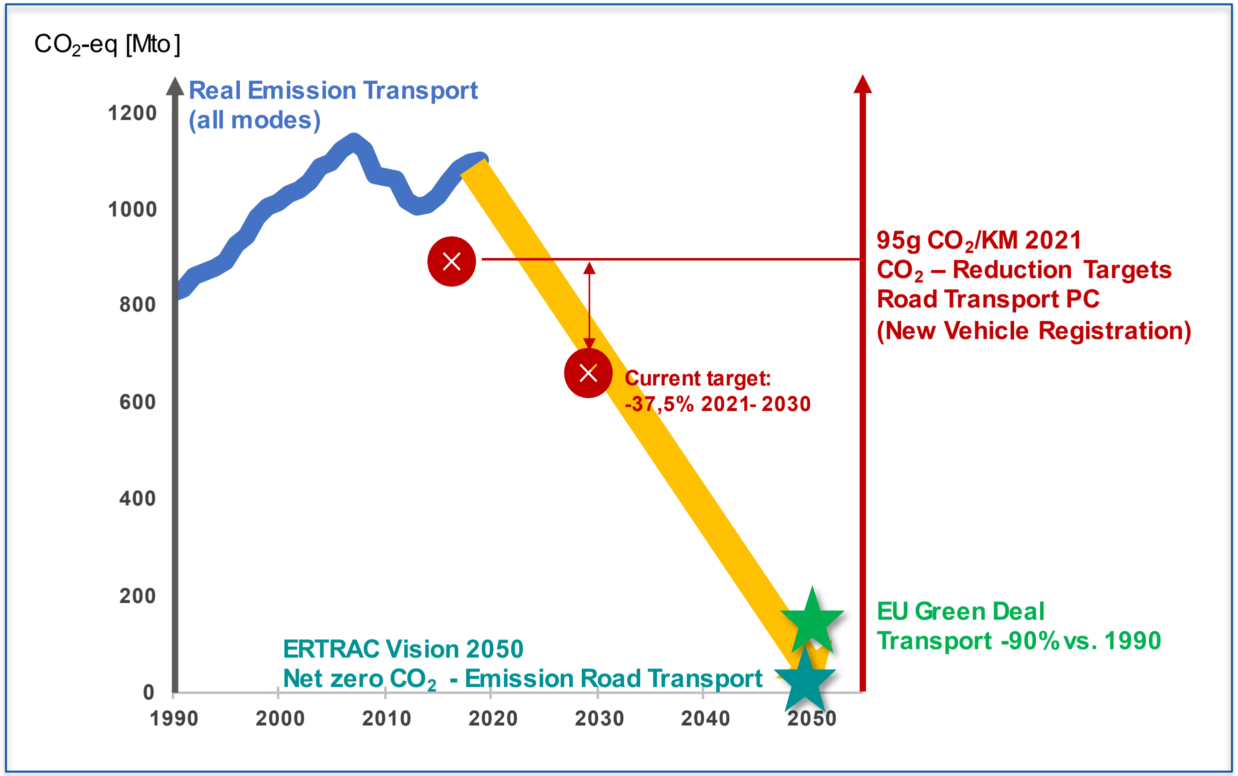
→ **The ERTRAC Carbon-Neutrality Study 2050 (WtW) analyses different "extreme" scenarios and compares effects**. It does not aim at giving a projection or at describing the way to achieve a carbon neutral road transport.

→ 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 ...

European CO_2 targets for transport



To reach the overall European **CO_2 targets for tra**nsport, a **system approach** is needed addressing: Vehicle technologies, Traffic modalities, Infrastructure, Energy production etc.

Initial Questions

? Which technologies can support net **carbon-neutrality in road transport?**[1]

? How large is their **specific effect**?

? What could be the **fleet and fuel impact?**

? **How much energy** and **which energy** is needed for road transport?
(electricity? hydrogen? synthetic fuels?)

? Which **energy paths** do we have and **how much electricity** is needed to produce the different energy carriers?

1. *Technical process that may have GHG emissions (CO_2, CH_4 and N_2O emissions) locally but which are compensated on a life cycle basis by a GHG removal / offsetting mechanism (e.g. growth of biomass, Carbon Capture Use and Storage (CCUS, including from bioenergy), Direct Air Capture (DAC) etc.)*

Concept of the study

TtW

Which powertrains could be used in in 2050?

3 Powertrain Scenarios

Which efficiency improvements are possible by 2050?

Optimistic – Pessimistic ranges

WtT

What will be the CO_2-footprint of electricity production in 2050?

2 Electricity Scenarios: 100% Renewable (RES) & 1.5 Tech

Which fuel production paths could be used in 2050?

4 Fuel Scenarios: Biofuels, e-fuels, Mixed fuels and Limited fossil

Concept of the study

TtW

Which powertrains could be used in in 2050?

3 Powertrain Scenarios

Which efficiency improvements are possible by 2050?

Optimistic – Pessimistic ranges

WtT

What will be the CO_2-footprint of electricity production in 2050?

2 Electricity Scenarios: 100% Renewable (RES) & 1.5 Tech

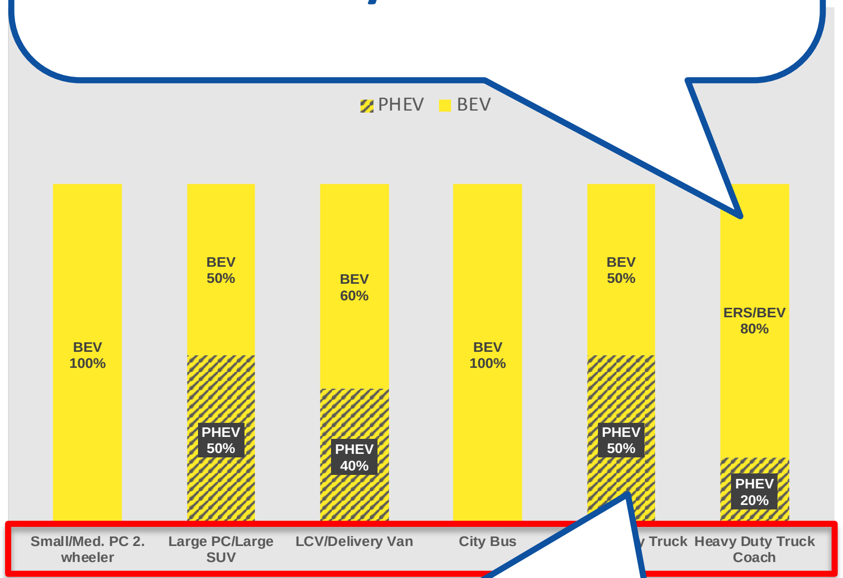
Which fuel production paths could be used in 2050?

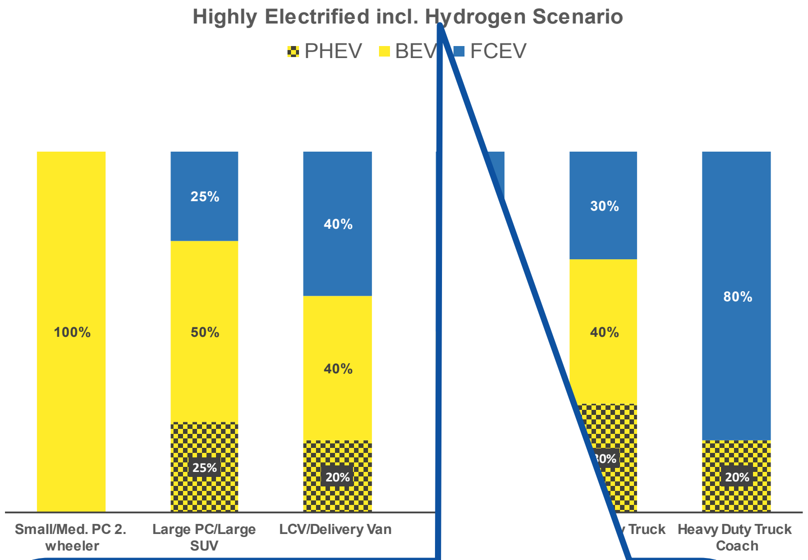
4 Fuel Scenarios: Biofuels, e-fuels, Mixed fuels and Limited fossil

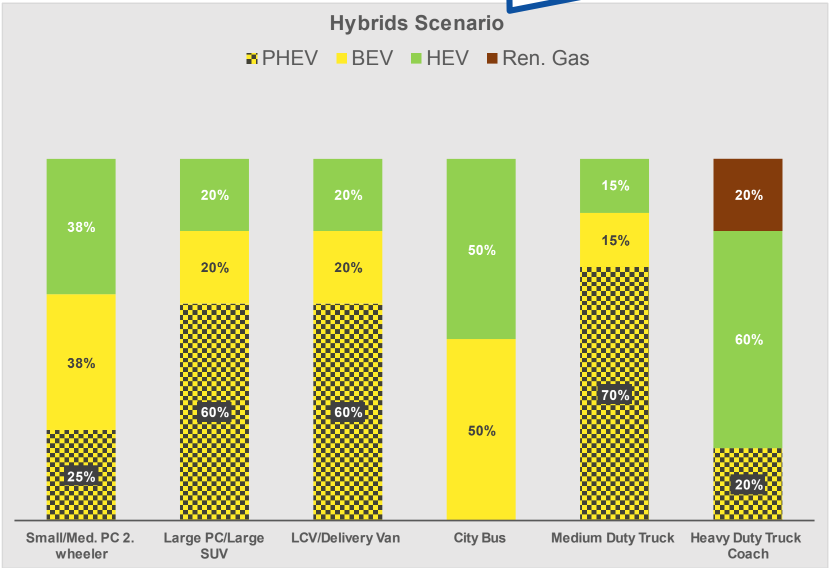
enarios 2050

For heavy-duty trucks, buses & coaches: electrical energy via **Electric Road System and/or battery on-board**

Hybrid Scenario, why?
Maybe the infrastructure will not develop fully for electricity and/or hydrogen







PHEV = ability to run a significant distance purely electrically

In this scenario, the long distance electric vehicles operate with **hydrogen as the energy carrier**

3 di ... lysed (corner-points):

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

Concept of the study

TtW

Which powertrains could be used in in 2050?

3 Powertrain Scenarios

Which efficiency improvements are possible by 2050?

Optimistic – Pessimistic ranges

WtT

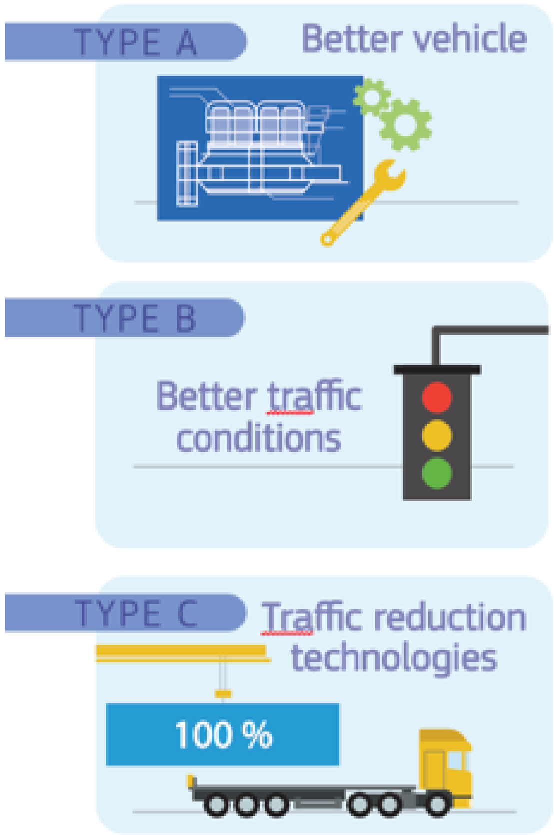
What will be the CO_2-footprint of electricity production in 2050?

2 Electricity Scenarios: 100% Renewable (RES) & 1.5 Tech

Which fuel production paths could be used in 2050?

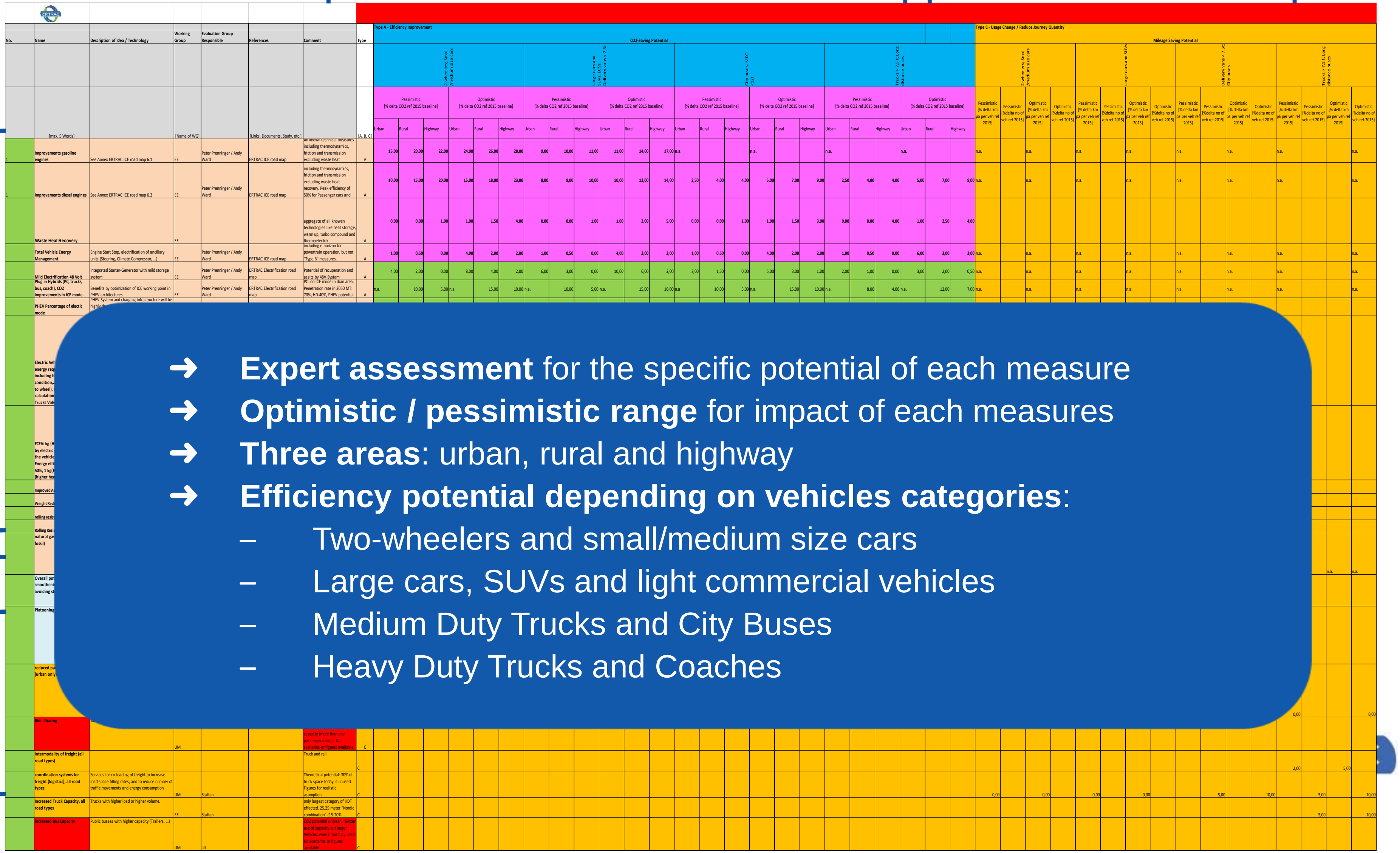
4 Fuel Scenarios: Biofuels, e-fuels, Mixed fuels and Limited fossil

“CO_2 measures sheet” for the different type of technical improvements



CO_2 reduction potential

Mileage saving potential



- ➜ **Expert assessment** for the specific potential of each measure
- ➜ **Optimistic / pessimistic range** for impact of each measures
- ➜ **Three areas**: urban, rural and highway
- ➜ **Efficiency potential depending on vehicles categories**:
  - – Two-wheelers and small/medium size cars
  - – Large cars, SUVs and light commercial vehicles
  - – Medium Duty Trucks and City Buses
  - – Heavy Duty Trucks and Coaches

Concept of the study

TtW

Which powertrains could be used in in 2050?

3 Powertrain Scenarios

Which efficiency improvements are possible by 2050?

Optimistic – Pessimistic ranges

WtT

What will be the CO_2-footprint of electricity production in 2050?

2 Electricity Scenarios: 100% Renewable (RES) & 1.5 Tech

Which fuel production paths could be used in 2050?

4 Fuel Scenarios: Biofuels, e-fuels, Mixed fuels and Limited fossil

Fuel Scenarios 2050

Fuel “family” (feedstock / production technology)

Fuel Scenario	Biofuel/waste	E-fuel	Fossil
Advance biofuels	90%	10%	-
Mixed	50%	50%	-
efuels	-	100%	-
Limited fossil	80%	10%	10%

✓ (BEC)CCS

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

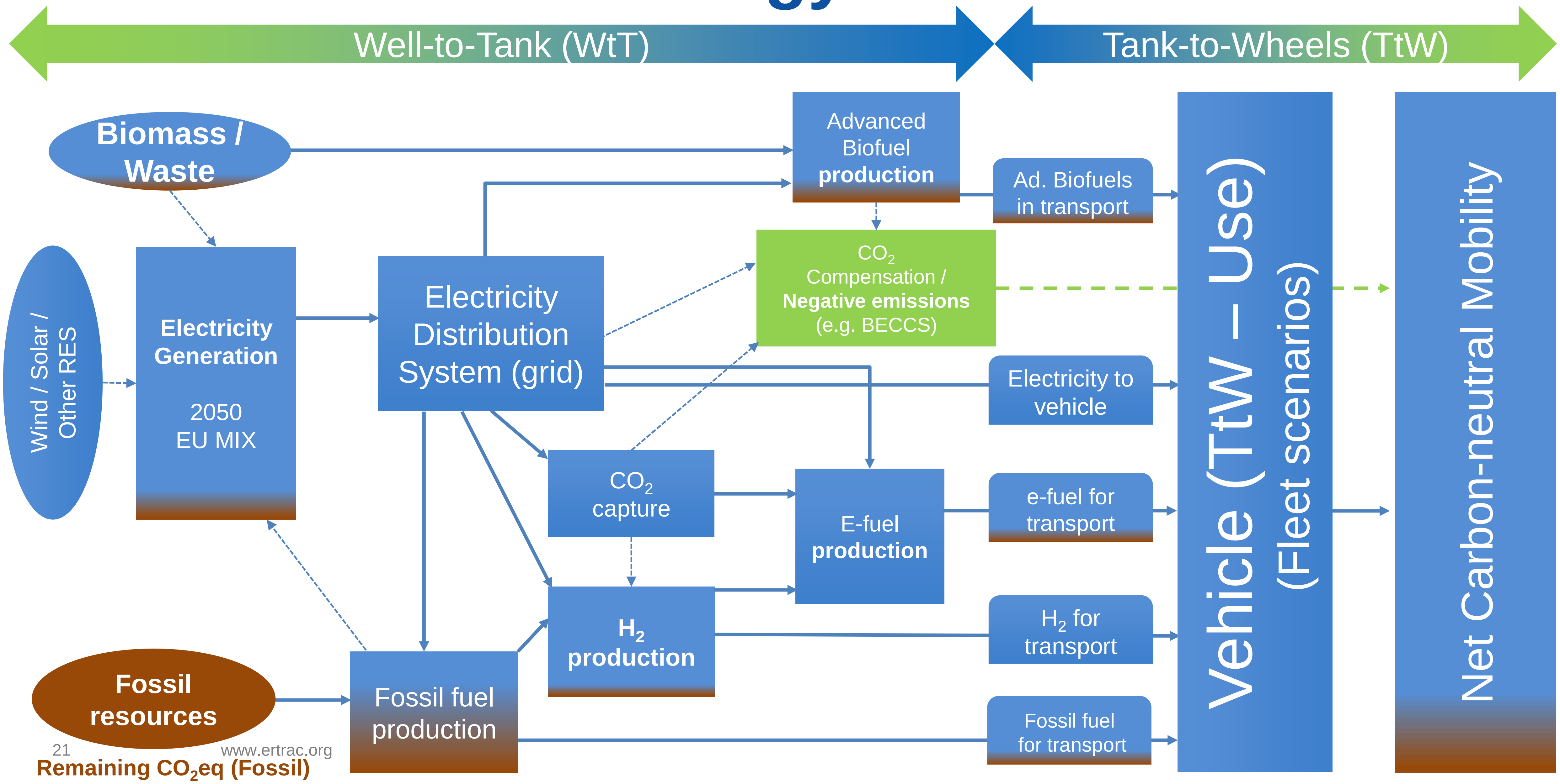
The interactions between these two scenarios is detailed in the WtW study

Note:

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

Overview of the WtW study

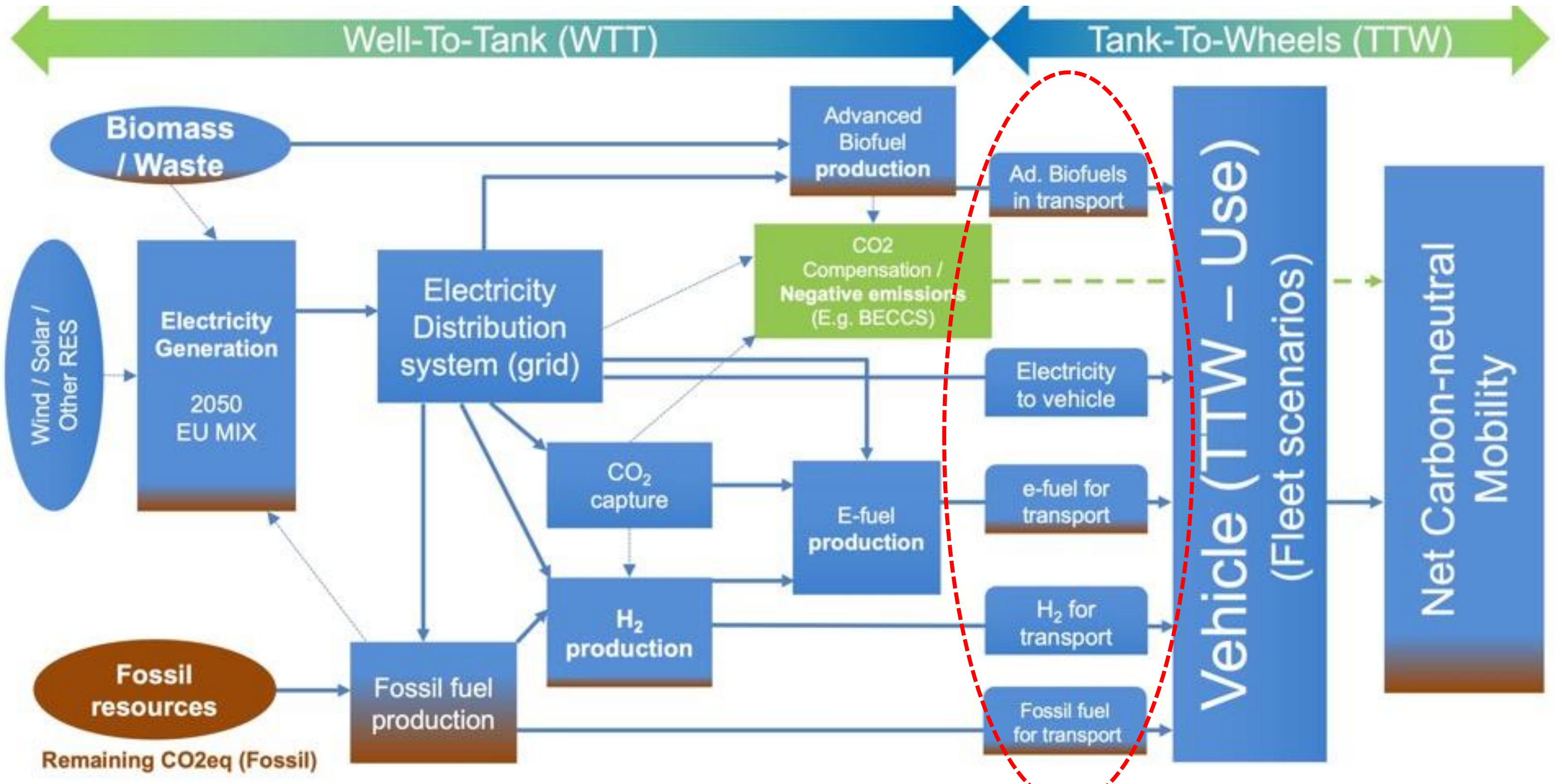
Results Fleet & Energy scenarios



Results Fleet & Energy scenarios

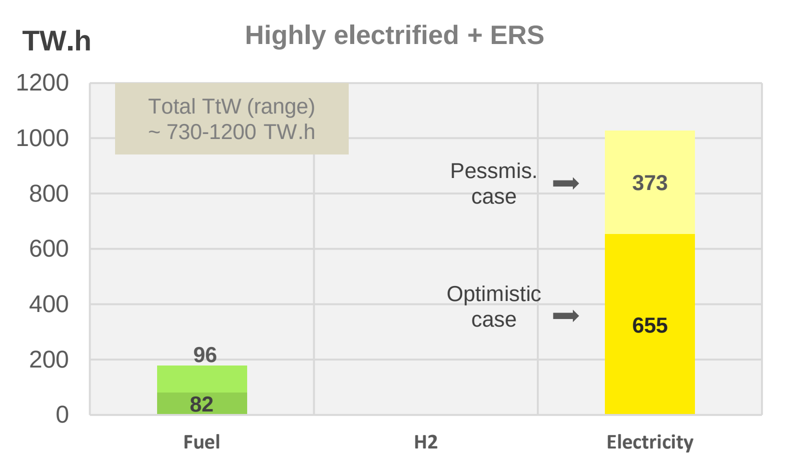
Question 1:
How much
- **fuel**
- **hydrogen**
- **electricity**

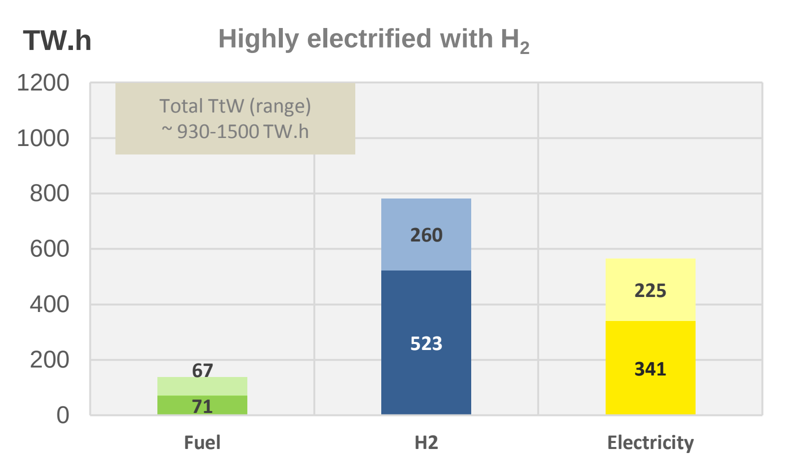
could be required (used) in EU Road Transport by 2050? (TtW, TW.h).

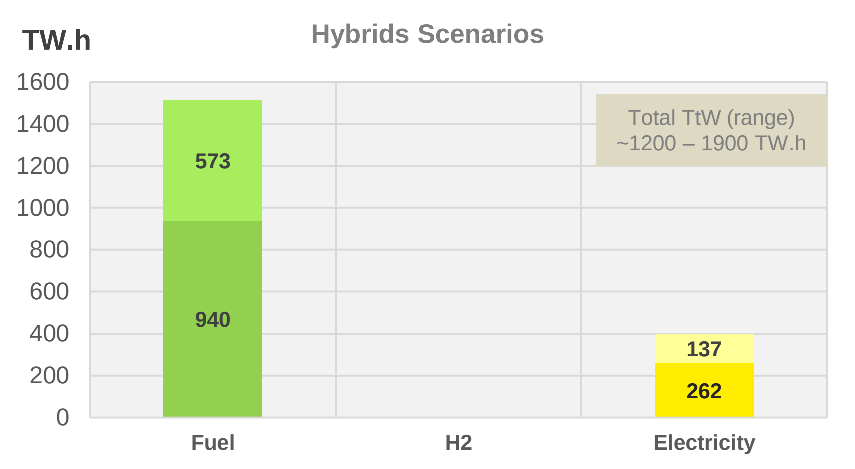


Question 1:

How much **fuel, hydrogen, electricity** could be required (use) in EU Road Transport by 2050? (TtW, TW.h)







Significant reduction in the fleet-averageTtW energy consumption:

The total TTW energy consumption could range between ~730 and 1900 TW.h. A significant reduction is shown in all scenarios considered **(20% to 70% savings)** in total energy requirement versus 2015. (As a reference, 290 Mtoe consumed in the EU road transport 2015 <> 2400 TW.h).

Fuel: **significant reduction** compared to EU road transport sector in 2015.

In the highly electrified scenarios the savings in fuel consumption are up to 95%.
The highest use of fuel (Hybrids-Scenario) varies between 940 and 1510 TW.h
→ 40% to 60% savings

Hydrogen:

The use of hydrogen ranges between 520 and 780 TW.h (Highly electrified with H_2 scenario).

Electricity: road vehicles consume directly at least 20% of the total 2015 electricity consumption

The use of electricity ranges from ~260 up to 1000 TW.h (the latter in the highest electrified scenario (HE + ERS scenario) which represents ~20% 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

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

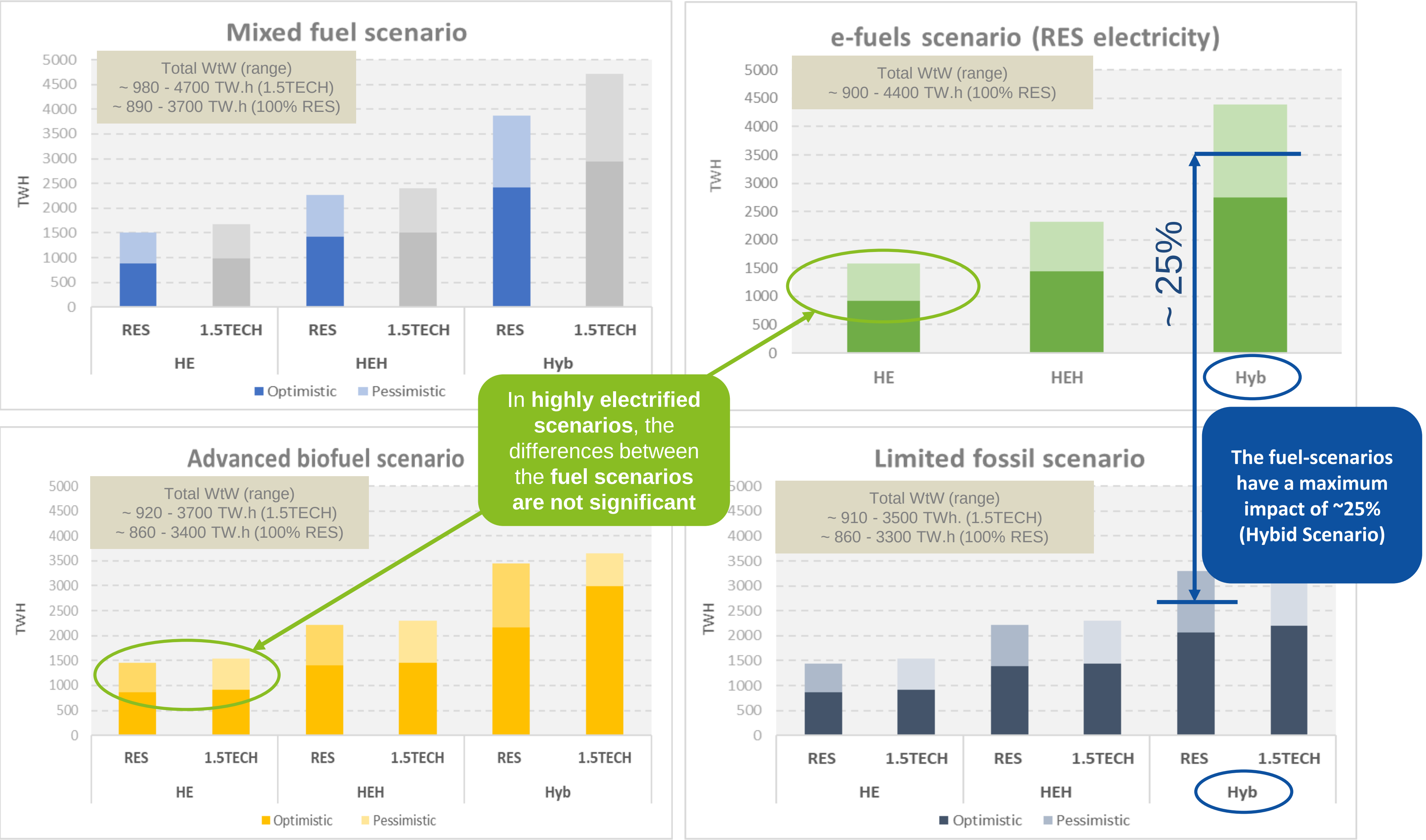
Results Fleet & Fuel scenarios

?

Question 2:

How do the fuel-scenarios influence the energy request in a net CO_{2eq} neutral road transport?

(WtW, TW.h, CO_2 neutral)

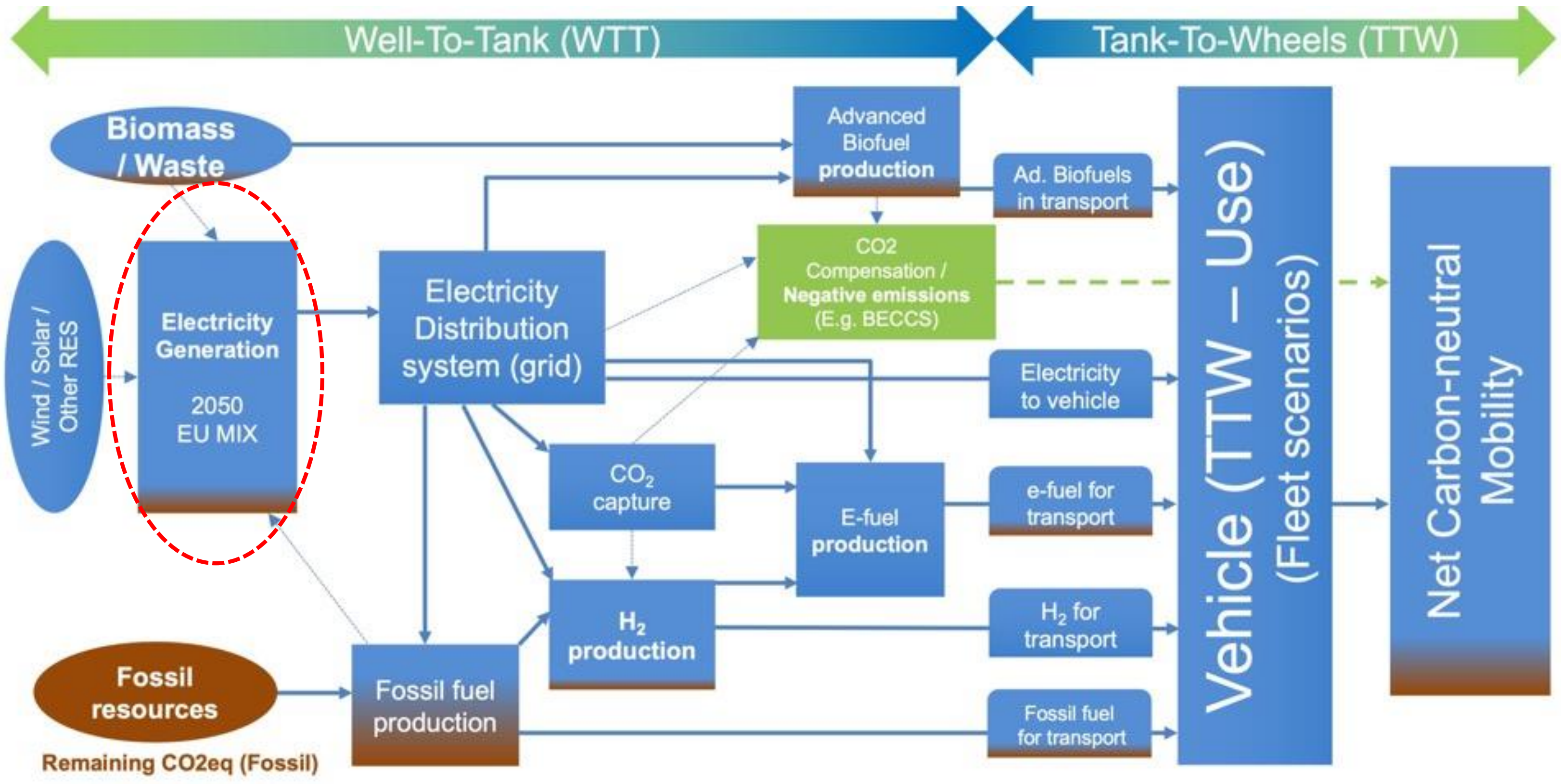


Results Fleet & Energy scenarios

?

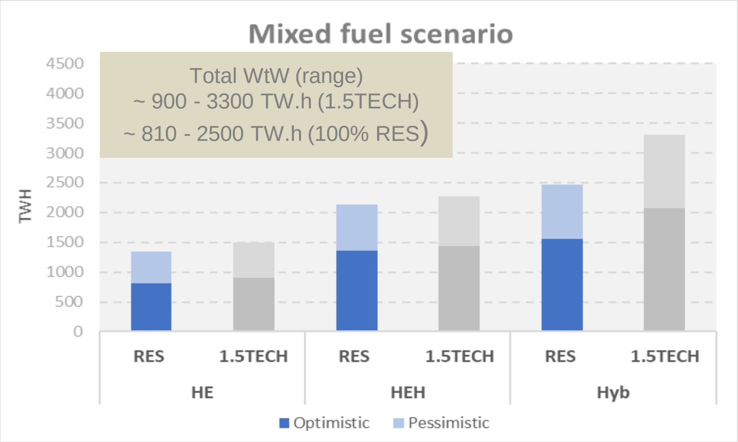
Question 3:

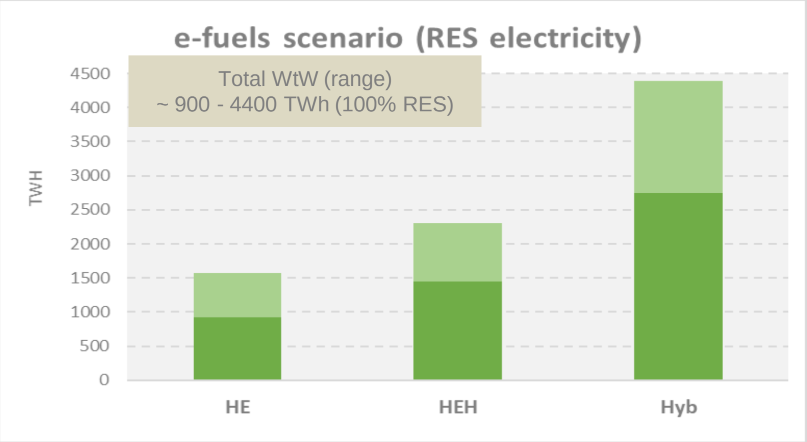
How much electricity is needed in the scenarios overall?

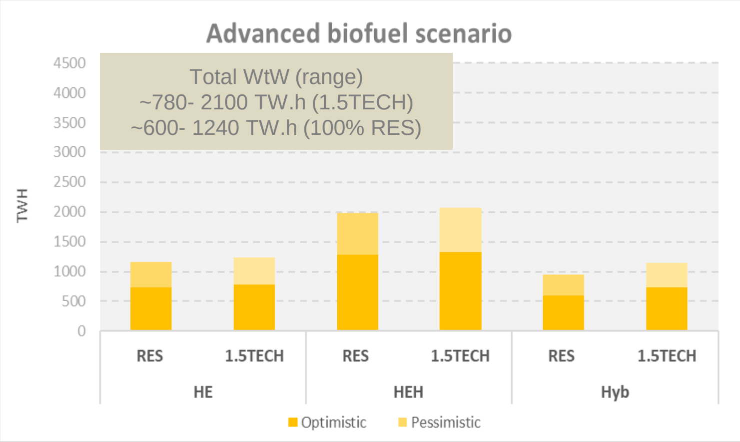


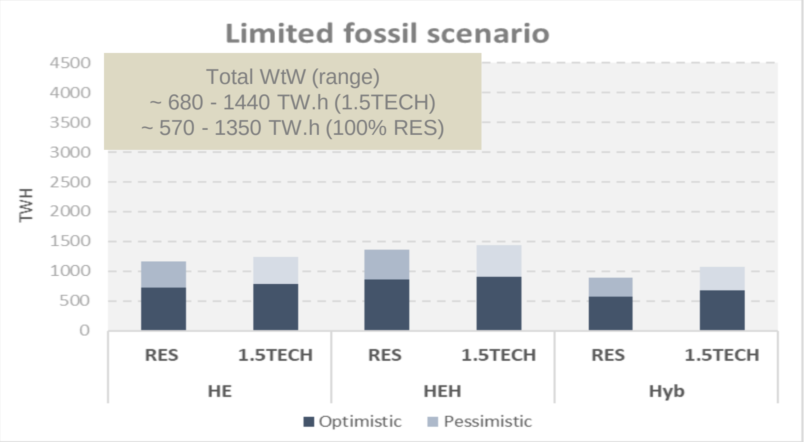
Results Fleet & Energy scenarios

Question 3:
How much electricity is needed in the scenarios overall?









→ **Wide variation in total electricity request:**
Range between **600 TW.h up to 4400 TW.h** (representing from ~**20% up to ~140% of** total EU-28 electricity consumption in 2019 (3220 TW.h).

→ **The limited fossil and advanced biofuel scenario result in the lowest electricity needs (between ~20% to 30% of EU-28 electricity consumption 2019)**

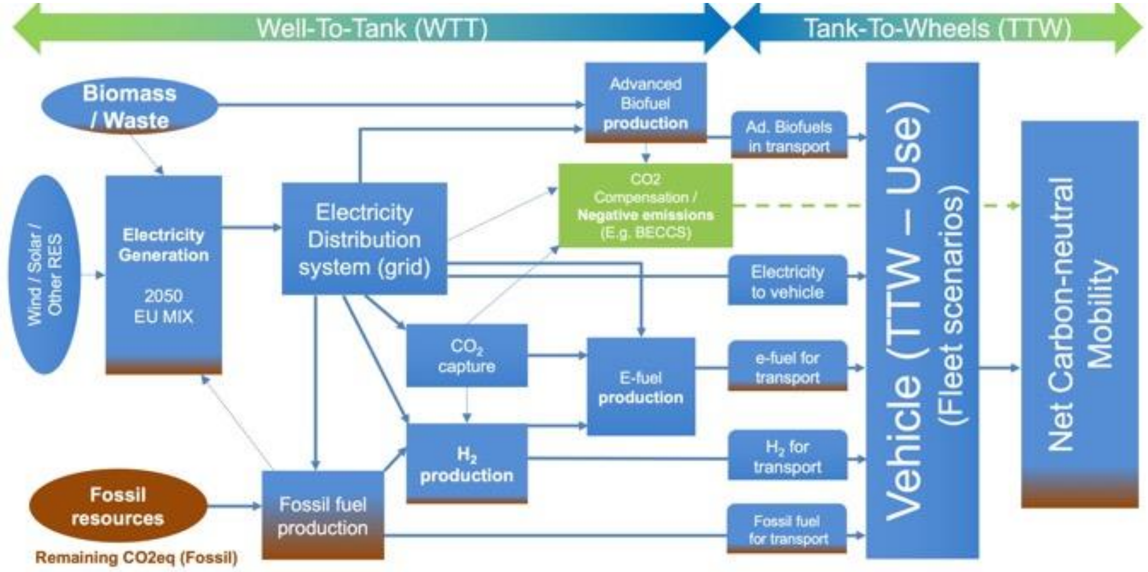
→ **The absolute extreme values for electricity request are always linked with the Hybrid Fleet: in combination with e-Fuels the absolute maximum is reached, in combination with “adanced biofuels” or “limited fossil” the absolute minimum is reached**

→ **In the highly electrified scenarios, the electricity demand is towards the lower-end of the different explored scenarios (~35% to 50% of EU28 electricity consumption in 2019)**

Results Fleet & Energy scenarios

Question 4:
What is the best fuel and/or fleet combination?

This question cannot be answered relying on this study alone.



System optimization cannot be based on an extreme scenario approach
Further research, innovation and development work is needed to assess and establish the optimal solutions, on the basis of various criteria.

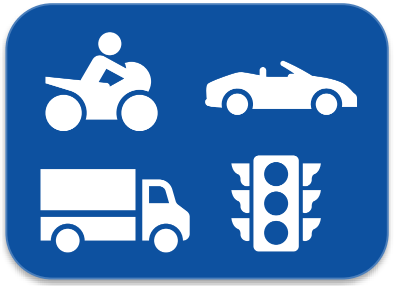
Such criteria might be those listed below (out of the scope of the CO_2 Evaluation Group):

- Production and storage capacity
- Life Cycle Assessment (LCA) to account for the emissions and energy required for infrastructure and vehicle production
- Investments in infrastructure and energy production facilities
- Cost of energy production and distribution as well as vehicle technology development
- Land use, water use and needed resources; and their allocation between different sectors
- Different locations for energy production (EU or MENA-Region)
- Customer acceptance of specific vehicle types and fuels
- Acceptance of CCS

CONCLUSIONS

Conclusions

➜ To achieve “carbon-neutral” road transport (WtW) in 2050, **drastic changes** are needed in all three areas:



➜ **The complete and robust carbon-neutrality** of road transport could be achieved with a **mix of technologies, where electrification** is the **key element** for the reduction of the CO_2 emissions.

BEV (possibly with ERS)

PHEV

FCEV

Note: the mix of these powertrain options ***will depend*** *on the development of the infrastructure (charging infrastructure, ERS, hydrogen filling stations, production capacities for renewable fuels etc.)*

Conclusions

- ➜ The **energy efficiency measures identified** (A, B and C) **reduce the energy / fuel consumption in all scenarios in a very significant way**
- ➜ The **demand for fuels decreases in all scenarios** (in highly electrified scenarios up to 95%)
- ➜ **In strongly electrified scenarios**, the **WtW differences in energy consumption** between the fuel scenarios are quite **small**
- ➜ The total **demand for electricity** in road transport will **increase** (energy production + use in vehicle)

Relative to the total EU28 electricity consumption in 2019:

- **20%-30%** in advanced biofuels or limited fossil scenarios combined with hybrid fleet
- **35%-50%** in highly electrified scenarios
- **up to 1.4 times** 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

Besides road transport:

➜ Renewable electricity generation capacity (inside and outside of Europe)

➜ Net carbon-neutral H_2 and fuel production (inside and outside of Europe)

➜ Technology and capacity of CCS and DAC

➜ Availability of raw materials and sustainable feedstocks (appraised from a life-cycle analysis perspective)

ERTRAC CO_2 Evaluation Group*

Marko Gernkus
Volkswagen(cars)
OEM

Staffan Lundgren
Volvo (trucks)
OEM

Christophe Petitjean
Valeo
Supplier

Peter Prenninger
AVL
Research Provider

Simon Edwards
Ricardo
Research Provider

Zissis Samaras
Aristotle University
Academia

Gaetano de-Paola
IFPEN
Cities and Regions

Holger Heinfelder
Umweltbundesamt (AT)
Member States

Stephan Neugebauer
BMW
assisted by Peter Kropf, BMW
Chair

Georgios Fontaras
JRC
CO_2 assessment for the fleet

Jette Krause
JRC
CO_2 assessment for the fleet

Marta Yugo
Concawe
Energy / CO_2 assessment for the WtT / fuel scenarios

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

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

Thank you!