Scenarios and Technologies for Decarbonization of Road Transport 2050

Peter Prenninger - AVL List GmbH
There is a need to significantly reduce transport CO$_2$ whilst demand is projected to increase.

To reach the overall European CO$_2$ targets for transport, a system approach is needed.
Better infrastructure
Improved logistics
Decarbonised Energy / fuels
Public transport and intermodality
Flexible and shared mobility services
Efficient vehicles
Intelligent traffic management
Infrastructure for connected & automated vehicles
ERTRAC System approach
KEY QUESTIONS

1. Which technologies can support the **decarbonisation** (TTW)?

2. How large is the **specific effect**?

3. What could be the **fleet impact on CO₂**?

4. How much energy and which energy is still needed for road transport: electricity? alternative fuels (Btx, Ptx, H2)?

5. What are the **research needs**?

(X (out of ERTRAC scope): Are we able to produce this energy in a **renewable** or **CO₂ neutral way**?)
ERTRAC CO\textsubscript{2} Evaluation Group

- Only technical measures are addressed
- Fleet calculation is done by simulation tool \textit{“DIONE”} by JRC
- Effects are based on \textit{reduction factors} (WLTP, RDE etc.)
- Ranges (optimistic and pessimistic approach)
- 3 main types of measures:
  - Type A: “better vehicle” (powertrain, aerodynamics, weight,...)
  - Type B: “better traffic conditions” (“green traffic light,...)
  - Type C: “traffic reduction technologies” (load optimization,...)
TYPE A: “BETTER VEHICLE”

- Light weight chassis
- "50% efficiency engines"
- FCV with improved efficiency
- Auxiliaries on demand
- Super low CD-aerodynamics
- Extended 48V mild hybrids
- Reduced rolling resistance
- Long range plug in hybrids
- High efficient EV- auxiliaries
- Exhaust waste heat recovery
# ERTRAC CO2 Evaluation Experts

*Nominated by the ERTRAC Executive Group*

<table>
<thead>
<tr>
<th>Category</th>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>Stefan Schmerbeck</td>
<td>Volkswagen (cars)</td>
</tr>
<tr>
<td></td>
<td>Staffan Lundgren</td>
<td>Volvo (trucks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier</td>
<td>Christophe Petitjean</td>
<td>Valeo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Provider</td>
<td>Peter Prenninger</td>
<td>AVL</td>
</tr>
<tr>
<td></td>
<td>Andy Ward</td>
<td>Ricardo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academia</td>
<td>Zissis Samaras</td>
<td>Aristotle University</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cities and Regions</td>
<td>Thierry Cosemanns,</td>
<td>VUBrussels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Member States</td>
<td>Günther Lichtblau,</td>
<td>Umweltbundesamt (AT)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Rob Hofman</td>
<td>RWS Netherlands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chair</td>
<td>Stephan Neugebauer</td>
<td>BMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>assisted by Peter Kropf, BMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 assessment for the fleet</td>
<td>Christian Thiel</td>
<td>JRC</td>
</tr>
<tr>
<td></td>
<td>Jette Krause</td>
<td></td>
</tr>
</tbody>
</table>
**CO2-MEASURE SHEET**

- **Expert assessment** for the specific potential of each measure.
- **Optimistic / pessimistic range** for all measures.
- **Three areas**: Urban, rural and highway
- **efficiency potential depending on categories**:
  - Two-wheelers and small/medium size cars
  - Large cars, SUV’s and light commercial vehicles
  - Medium Duty Trucks and City Busses
  - Heavy Duty Trucks and Coaches
Projected Fleet Composition in 2050

Fleet mix similar to today (DIONE Baseline)

Passenger Cars are dominating the fleet 2050
Projected Fleet Activity by Vehicles  2050
(Vehicle km, DIONE Baseline)

- Small/Medium Size Cars: 62%
- Large Cars/large SUV's: 11%
- Light Commercial Vehicles: 12%
- Delivery Vans: 2%
- Mild Duty Trucks: 1%
- Long Distance Busses: 1%
- City Busses: <1%
- Two-Wheelers: 4%
- Heavy Duty Trucks: 7%

Rising activity with rising vehicle size
Powertrain Scenarios 2050 (stock): Highly Electrified Scenario (HE)

- Small / med. PC / 2 wheeler: BEV 100%
- Large PC / Large SUV: BEV 50%
- LCV / Delivery Van: BEV 60%
- City Bus: BEV 100%
- Medium Duty Truck: PHEV 60%
- Heavy Duty Truck / Coach: CNG/LNG 20%, ICE 40%, PHEV 40%
Powertrain Scenarios 2050 (stock): Partly Electrified Scenario (PE)

- Small / med. PC
- 2 wheeler
- Large PC / Large SUV
- LCV / Delivery Van
- City Bus
- Medium Duty Truck
- Heavy Duty Truck Coach

**BEV**
- Small / med. PC: 75%
- Large PC / Large SUV: 40%
- LCV / Delivery Van: 40%
- City Bus: 100%
- Medium Duty Truck: 30%
- Heavy Duty Truck Coach: 20%

**PHEV**
- Small / med. PC: 25%
- Large PC / Large SUV: 60%
- LCV / Delivery Van: 60%
- City Bus: 70%
- Medium Duty Truck: 20%
- Heavy Duty Truck Coach: 20%

**ICE**
- Small / med. PC: 60%
- Large PC / Large SUV: 40%
- LCV / Delivery Van: 60%
- City Bus: 30%
- Medium Duty Truck: 80%
- Heavy Duty Truck Coach: 60%

**CNG / LNG**
- Small / med. PC: 25%
- Large PC / Large SUV: 20%
- LCV / Delivery Van: 25%
- City Bus: 20%
- Medium Duty Truck: 80%
- Heavy Duty Truck Coach: 20%
Powertrain Scenarios 2050 (stock): Mixed Scenario (MIX)

- **Small / med. PC 2 wheeler**
  - ICE 37.5%
  - PHEV 25%
  - BEV 37.5%

- **Large PC/Large SUV**
  - ICE 20%
  - PHEV 60%
  - BEV 20%

- **LCV / Delivery Van**
  - ICE 20%
  - PHEV 60%
  - BEV 20%

- **City Bus**
  - ICE 50%
  - BEV 50%

- **Medium Duty Truck**
  - ICE 15%
  - PHEV 70%

- **Heavy Duty Truck Coach**
  - CNG / LNG 20%
  - ICE 60%
  - PHEV 20%
2050 Fleet Activity by Powertrain

* Remark PHEV: First 50 km of driving-cycle always in electric mode
Conclusions:
1. The change of the fleet mix has the most important effect.
   Remark: R&I is needed to develop the functionality of electrified vehicles and to create customer acceptance (Range, Charging, Costs, …).
2. The partial electrified and mixed scenario without further efficiency measures will not achieve the CO2-Targets.
Conclusion:
1. In combination with all efficiency measures also scenarios with lower electrification can achieve the CO₂-reduction. 
   Remark: economical/societal impact is not considered!
2. With lower electrification the influence of efficiency measures is more important.
3. The “Mix Scenario” only offers a critical chance to achieve the CO₂ targets (TTW)
4. With lower electrification or lower system efficiency the need for decarbonized fuels is becoming more important (Well to wheel, WTW)
Conclusion:
1. Even in scenarios with high electrification more than ~ 50% of total energy demand is for chemical energy carrier (Fuels, Gas, Hydrogen).

2. Improvement of combustion engine efficiency is important even in highly electrified scenarios.

Question (out of ERTRAC scope):
“Are we able to produce these energy carriers in a renewable way?”
MAIN OUTCOME 2050 (so far)

- We are able to reduce the TTW CO₂ Emissions in the order of 60% vs. 1990 baseline *(Social or economical impact not considered!)*.

- Huge investment in R&I is needed to improve the functionality of e-mobility *(costs, range, charging, ...)*

- Electricity has to become zero carbon

- Fossil transport fuels have to be replaced by renewable PtX, Biofuels or Hydrogen

"Are we able to produce these energy carriers in a renewable way?"
Thank you!