EU Green Trucks Summit
12 October 2022
Maarten Verbeek & Iddo Riemersma
PROJECT GOAL & SCOPE

PROJECT GOAL

To assess the techno-economic market uptake potential of zero-emission trucks for the European Union (EU) and the United Kingdom (UK) over the timeframe 2020 – 2040

SCOPE

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Truck type</th>
<th>Mission profile</th>
<th>BEV medium range</th>
<th>BEV large range</th>
<th>FCEV range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid truck</td>
<td>Urban delivery</td>
<td>150 km</td>
<td>200 km</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Tractor trailer</td>
<td>Regional delivery</td>
<td>300 km</td>
<td>400 km</td>
<td>NA</td>
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<tr>
<td>Tractor trailer</td>
<td>Long haul</td>
<td>500 km</td>
<td>800 km</td>
<td>800 km</td>
<td></td>
</tr>
<tr>
<td>Tractor trailer</td>
<td>Construction</td>
<td>150 km</td>
<td>300 km</td>
<td>300 km</td>
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</tr>
</tbody>
</table>
METHODOLOGY

Feasibility for replacing ICEV by ZEV is evaluated on:

Affordability (Total Costs of Operation - TCO)
- Energy costs (energy consumption & energy prices)
- Investment cost (glider & drivetrain components)
- Other costs (e.g. maintenance)

⇒ ZEV affordable if TCO are same or better than diesel equivalent

Applicability
- Average daily distance (average daily mileage in 25 km bins)
- Daily distance variation (assumed 30% lower as in current situation due to adaptation in vehicle deployment)
- 90% of the trips for BEVs can be performed with one full charge plus 45 minutes fast charging

⇒ ZEV is applicable when operational constraints are fulfilled
DISCLAIMER: ACTUAL UPTAKE ≠ UPTAKE POTENTIAL

The actual uptake of ZEVs will likely differ from the uptake potential, depending on:

- Sufficient production and availability of ZEVs
- Sufficient infrastructure for charging/refuelling
- Acceptance by transport operators
- Other policies that assessed not in this study (e.g. zero-emission zones)
- Public awareness and social responsibility

Conclusions are only valid within the assumptions made for this study on energy costs, energy consumption, component costs, vehicle deployment etc.

Truck deployment differences between countries, temperature influences on energy consumption, mark-up factor in retail price etc. are all accounted for.
TCO RESULTS

CALCULATED TCO FOR ARTICULATED LONG HAUL TRUCK IN EU+UK

BEVs will become the most cost-effective drivetrain for many applications even before 2030.

FCEVs only become more cost-effective than diesel equivalents for very limited applications in a few countries.
UPTAKE RESULTS

TECHNO-ECONOMIC ZEV UPTAKE POTENTIAL FOR ARTICULATED REGIONAL DELIVERY TRUCK

- Uptake potential depends on lowest TCO and average daily mileage distribution in the fleet
- For regional delivery truck the BEV drivetrain reaches >99% uptake potential by 2030
Considerable ZEV uptake potential already present for trucks today.

For all truck types (excluding construction truck) the BEV drivetrain reaches >99% uptake potential by 2030.
OTHER RESULTS

- Limited payload penalty for the long range BEV only (3 tons in 2020, none by 2030)
- Uptake curves are not significantly different between countries in EU+UK

Sensitivity analysis

- In the combined worst-case scenario the uptake will be delayed and the maximum uptake potential reduced
- Reduction of maximum uptake potential is mainly related to the battery size, not TCO

Policy driven scenario

- Effect of tolling, CO$_2$ pricing & purchase subsidies on the uptake potential of ZEVs:
  - towards 2030: advanced up to 4 years
  - beyond 2030: equal to situation without these drivers (close to 100% uptake)

Towards 2030: battery price +31%, diesel price -12%, electricity price +26%, average yearly mileage +25% & current daily distance variation (without 30% reduction)
Main takeaways from this study:

- Overall uptake potential for the vehicles in this study reaches 99.6% in 2030 in the central scenario (2033 for construction truck).
- Even if battery prices do not come down as fast as expected, diesel prices would be relatively low or electricity prices relatively high, the uptake potential of BEVs is close to 100% by 2030.
- A more demanding deployment scenario for ZEVs will delay the uptake potential in the 2020s, but hardly lower the maximum uptake potential (since TCO of BEVs will often still be lower than for diesel, even with higher range/larger battery).
- FCEVs are not cost-competitive for trucks in scope, but may be in certain other (niche) applications.
- The actual uptake of ZEVs can only materialise if important boundary conditions are met (e.g. availability of ZEVs and charging/refuelling infrastructure).
THANK YOU FOR YOUR ATTENTION
ELECTRIC TRUCKS TAKE CHARGE

THE TECHNO-ECONOMIC UPTAKE POTENTIAL OF ELECTRIC TRUCKS AND RECOMMENDATIONS FOR EUROPEAN POLICYMAKERS

URS MAIER, AGORA VERKEHRSWENDE SENIOR ASSOCIATE ENERGY AND INFRASTRUCTURE

TRANSPORT & ENVIRONMENT’S GREEN TRUCKS SUMMIT IN BRUSSELS ON 12 OCTOBER 2022
TNO, T&E AND AGORA VERKEHRSWENDE ON ZERO-EMISSION TRUCKS AND REACHING CLIMATE NEUTRALITY
1 Total cost of ownership (TCO) and operational requirements – i.e. driving range, charging or refuelling time and payload – are no barriers to the rapid up-take of zero-emission trucks.
SHARE OF SALES WHERE ZERO EMISSION TRUCKS BEAT DIESEL TRUCKS

Note: Fuel cell electric trucks were included in the analysis and represent up to 0.02% of cases in 2040.
AVERAGE DAILY DISTANCES DRIVEN BY TRUCKS IN EUROPE

97% of trucks drive up to 800 km per day.

Agora Verkehrswende (10/2022) | in cooperation with: T&E; source: TNO
DAILY DRIVING PATTERNS OF ELECTRIC LONG-HAUL TRUCKS

Mandatory 11h rest break
Battery fully charged overnight

Mandatory 45min rest break
Fast charge if needed

Mandatory 11h rest break
End of daily trip

4.5h of driving

0 km

~350 km
Range on a single charge with newest truck generation

500 km
Average driven per day by tractor trailers

530 km
Range on a single charge with future truck generation

800 km

Agora Verkehrswende (10/2022) | in cooperation with: T&E; source: T&E
PAYLOAD LOSSES OF ELECTRIC LONG-HAUL TRUCKS

<table>
<thead>
<tr>
<th>Year</th>
<th>Payload Loss</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>+1.55 t</td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>0 t</td>
<td></td>
</tr>
</tbody>
</table>

- +5.1 t Battery pack
- +0.7 t Electric powertrain
- -2.0 t ZEV weight allowance
- -2.2 t ICE powertrain

Note: All urban and regional delivery trucks have higher payload capacity than diesel
Zero-emission trucks are primarily battery-electric trucks. Fuel cell trucks are suitable for special uses, for example when very long ranges are required.
The EU should significantly increase its CO₂ targets for freight trucks to 100% zero-emission from 2035 and say no to fuels crediting. This is needed to reach climate neutrality in time.
ZEV UPTAKE POTENTIAL COMPARED TO CURRENT POLICIES AND RECOMMENDATIONS BY T&E AND AGORA VERKEHRSWENDE

Note: Assumes ZEV uptake across all freight trucks, including currently regulated and unregulated vehicle groups
ZERO EMISSION TRUCK FLEET IN 2030 DEPENDING ON THE CO₂ TARGETS

Agora Verkehrswende (10/2022) | in cooperation with: T&E; source: T&E
Ambitious emission standards are needed for the rapid expansion of the production capacities of zero-emission trucks. The EU and its member states are required to rapidly roll-out charging and refuelling infrastructure.
Policy instruments on the demand side like purchase incentives, a CO\textsubscript{2} based truck toll and a CO\textsubscript{2} price on fuels speed up the transition particularly before 2030. As planned, Germany should add a CO\textsubscript{2} surcharge on the road toll.
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