Technical workshop on electrification of heavy-duty vehicles

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Transition to soot-free heavy-duty vehicles and fuels
Zoom workshop
20 April 2022
Paris Agreement aligned CO₂ pathway is possible with accelerated global ZEV transition

- Accelerated ZEV transition reduces CO₂ emissions 73% by 2050
- HDVs account for half of CO₂ mitigation potential and cumulative CO₂ reductions of 47.5 billion tonnes from 2020-2050
- Paris Agreement’s well below 2°C compatibility achieved under the scenario
- Simply transitioning new vehicle sales to ZEVs is not sufficient to align with a 1.5°C pathway
Battery electric and fuel cell electric are the only technologies with potential for near-zero GHG emissions

Lifecycle GHG emissions from a 12-tonne truck in 2021 (left) and 2035 (right) in the EU (preliminary results)
Common characteristics of first-mover HDV segments in ZEVTC countries

Suitable duty cycle
- Predictable route and low variability

Return-to-base operations
- Depot charging

Dedicated parking
- Guaranteed charging spots
First-mover segment for HD ZEVs: Urban buses

- Buses account for about 4.7% of total HDV market in ZEVTC members
- Mature market with widespread commercial availability
- TCO parity with ICE equivalents achievable today, or before 2025
- Recommendation: 100% ZE sales by 2030

Battery-electric urban buses in the US and India

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- https://upload.wikimedia.org/wikipedia/commons/8/8f/Proterra_Electric_Bus_at_Charging_Station.jpg
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First-mover segment for HD ZEVs: Urban delivery vehicles

- Urban delivery vehicles (mostly short-haul medium-duty trucks) account for 27.5% of total HDV market in ZEVTC members
- Small-scale commercialization, orders from major fleet owners will be delivered in the next 3-5 years
- TCO parity with ICE equivalents by 2030, depending on vehicle size and daily driving distance
- Recommendation: 100% ZE sales by 2035
First-mover segment for HD ZEVs: Short-haul tractor-trailers

- Tractor-trailers account for 21.9% of total HDV market in ZEVTC members
- Short- and regional-haul (<250 km/day) ZE products are approaching commercialization in US and EU
- TCO parity within the next decade, as early as 2025 for short-haul tractor trailers
- Recommendation: 100% ZE sales by 2035

Image source: https://californiahvip.org/vehicles/freightliner-ecascadia-battery-electric-truck/
Long-hauler tractor trailers: an important segment for HDV decarbonization

- Long-haul ZE products are approaching range-limited commercialization
- TCO parity will be reached in the next 10-15 years depending on market
- High daily driving distance and large payload requirement require dedicated infrastructure (high-power charging or hydrogen refueling)
- Recommendation: 100% ZE sales by 2040

Image source: https://upload.wikimedia.org/wikipedia/commons/b/b9/Hyundai_Xcient_6x2_tractor_front_side.jpg Ki hoon, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons
To align with Paris Agreement goals of well-below 2ºC, HD ZEV sales should rise to 45% by 2030 and 100% no later than 2040

- Pace of transition varies by HDV segment
- Greater ambition needed for segments where ZEV technologies and market are more advanced

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>7%-30%</td>
<td>75%-90%</td>
<td>90%-100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Medium truck</td>
<td>3%-12%</td>
<td>40%-50%</td>
<td>75%-90%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Heavy truck</td>
<td>2%-9%</td>
<td>30%-41%</td>
<td>60%-75%</td>
<td>90%-100%</td>
<td>100%</td>
</tr>
<tr>
<td>All HDVs (sales-weighted average per country)</td>
<td>3%-12%</td>
<td>40%-56%</td>
<td>69%-83%</td>
<td>94%-100%</td>
<td>100%</td>
</tr>
<tr>
<td>All HDVs (sales-weighted average for all ZEVTC members)</td>
<td>4%</td>
<td>45%</td>
<td>76%</td>
<td>97%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Adopt zero-emission sales and operations targets
Target: 100% HD ZEV Sales no later than 2040

Recommendations

- Adopt ambitious near-term ZEV sales targets
- Adopt long-term 100% ZEV sales and operations targets
- Maintain technology neutral approach

HDV truck phase-out targets around the world (through Dec 2021)

Governments with targets toward phasing out sales of internal combustion engine trucks by a certain date (Status: Through December 2021)

<table>
<thead>
<tr>
<th>Country</th>
<th>Target Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>California (United States)</td>
<td>2035 New heavy-duty trucks 75% zero-emission or near zero-emission, 2035 New medium- and heavy-duty vehicles 100% zero-emission</td>
</tr>
<tr>
<td>New York (United States)</td>
<td>2045 New medium- and heavy-duty trucks 100% zero-emission</td>
</tr>
<tr>
<td>Chile</td>
<td>2045 New medium- and heavy-duty trucks 100% zero-emission</td>
</tr>
<tr>
<td>Austria</td>
<td>2030 Medium- and heavy-duty vehicles 100% zero-emission, 2035 Heavy-duty vehicles (&gt; 18 tonnes) 100% zero-emission</td>
</tr>
<tr>
<td>Cape Verde</td>
<td>2035 New medium- and heavy-duty trucks 100% electric</td>
</tr>
<tr>
<td>Pakistan</td>
<td>2040 New heavy-duty trucks 90% electric</td>
</tr>
<tr>
<td>Norway</td>
<td>2030 New trucks 50% zero-emission</td>
</tr>
<tr>
<td>Hainan (China)</td>
<td>2019 New sanitation vehicles 50% electric</td>
</tr>
</tbody>
</table>

Note: Governments with an at least 40% new truck sales target.
* Not necessarily set reflected in an official national state policy document such as a climate or transport strategy/plans, or in a law, or in a similar framework.
Adopt zero-emission performance standards for new vehicles
Zero emission powertrain performance requirement (0 g CO$_2$+NO$_x$+PM/km)

California Advanced Clean Trucks ZEV Sales Requirements, 2024-2035

**Recommendations**
- Align zero-emission requirements with sales targets
- Adopt aggressive timelines for high priority vehicle segments
- Adopt fleet average technology forcing standards
- Limit incentive credits

Provide Fiscal Incentives
VKT road tolls exemption to achieve price parity between battery electric and diesel trucks

<table>
<thead>
<tr>
<th>Country</th>
<th>Current policies</th>
<th>With toll exemptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>2028</td>
<td>2023</td>
</tr>
<tr>
<td>Spain</td>
<td>2025</td>
<td>2022</td>
</tr>
<tr>
<td>France</td>
<td>2024</td>
<td>2021</td>
</tr>
<tr>
<td>Italy</td>
<td>2027</td>
<td>2023</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2023</td>
<td>2022</td>
</tr>
<tr>
<td>Poland</td>
<td>2026</td>
<td>2025</td>
</tr>
<tr>
<td>UK</td>
<td>2025</td>
<td>2025</td>
</tr>
</tbody>
</table>

Germany 100% exemption, 75% in other countries

Recommendations

- Provide both purchase and operating incentives
- Maintain incentives equal to incremental cost
- Support long-term incentives with ‘bonus-malus’ incentive design
Establish Infrastructure Programs and Policies
Long-haul truck stop locations in Europe

Construct a National Zero Emission HDV Charging and Fueling Network

Recommendations

- Establish a national plan for public and private investment in charging and H₂ infrastructure
  - Minimum distances between charging points
  - Minimum installed power at each point
  - Minimum # of chargers at each point
  - Minimum power level of chargers
- Increase investment by 25-35% annually

Expand Fleet Purchase Requirements
Achieve zero emission operations through:
100% fleet purchase requirements

California Proposed Advanced Clean Fleets Requirements (Sep 2021)

<table>
<thead>
<tr>
<th>Zero-Emission Fleet Percentage</th>
<th>10%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box trucks, vans, two-axle buses, yard trucks</td>
<td>2025</td>
<td>2028</td>
<td>2031</td>
<td>2033</td>
<td>2035</td>
</tr>
<tr>
<td>Work trucks, day cab tractors, three-axle buses</td>
<td>2027</td>
<td>2030</td>
<td>2033</td>
<td>2036</td>
<td>2039</td>
</tr>
<tr>
<td>Sleeper cab tractors and specialty vehicles</td>
<td>2030</td>
<td>2033</td>
<td>2036</td>
<td>2039</td>
<td>2042</td>
</tr>
</tbody>
</table>

Recommendations
• Establish national fleet purchase requirements for dedicated fleets
• Expand zero emission areas beyond city centers and including freight corridors

Achieve zero emission operations through: Zero emission zones

Cities with implemented and planned zero-emission zones and variants globally* (Status: July 2021)

*Zero-emission zones grant unrestricted access to battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) only. In addition to BEVs and FCEVs, near-zero-emission zones grant unrestricted access to plug-in hybrid electric vehicles (PHEVs). Zones for freight are defined in different ways, with affected vehicles ranging from urban delivery vehicles to medium- and heavy-duty trucks. Affected areas of zones range from a few streets to an entire city.
Recommendations

Phase out targets
- Adopt target of 100% zero emission sales of HDVs by 2040, with faster targets for key segments

Zero Emission Performance Requirements
- Adopt ZEV regulations to align with ZEV targets and transportation decarbonization goals.

Fiscal incentives
- Adopt fiscal incentives equal to incremental cost across all vehicle classes
- Adopt in-use fiscal incentives such as road tolls

Charging infrastructure
- Develop a national zero-emission charging and H2 refueling plan to shape public and private investment

Market demand
- Adopt national fleet purchase requirements and expand zero emission areas
THANK YOU

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