

Technical workshop on electrification of heavy-duty vehicles

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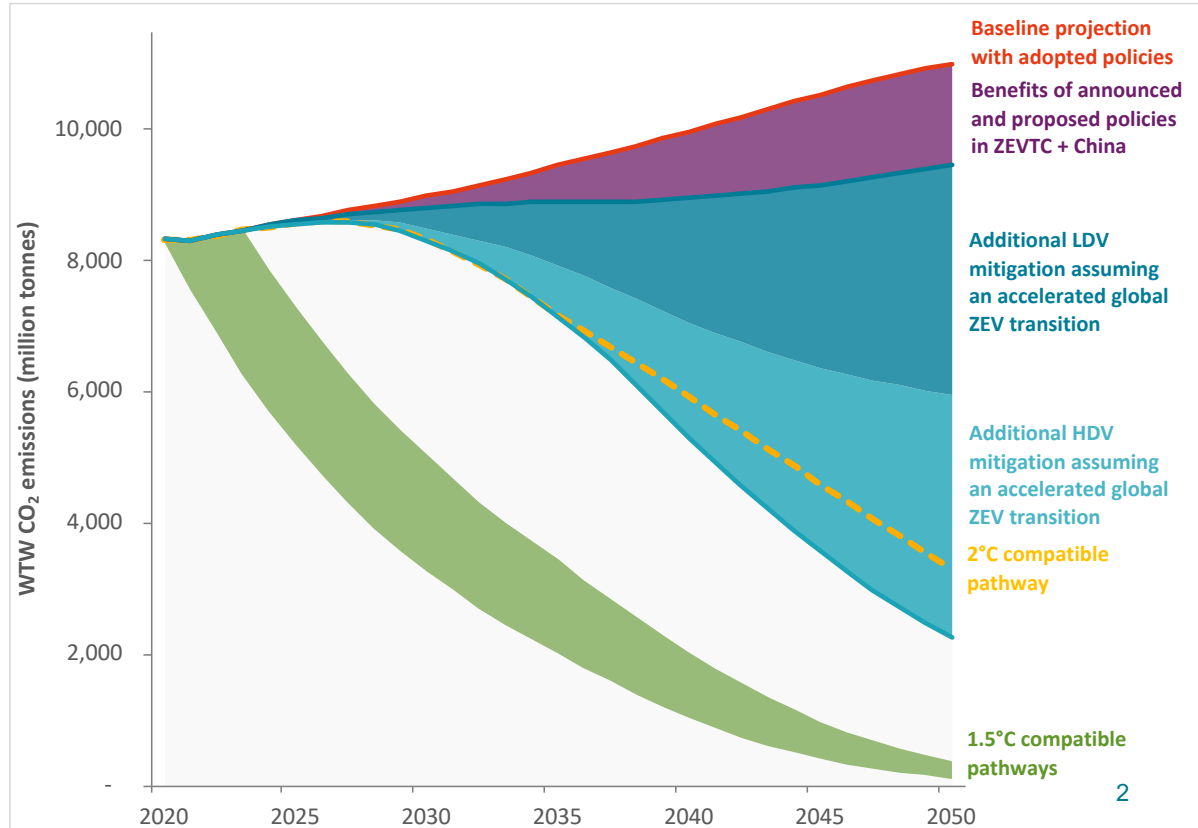
Transition to soot-free heavy-duty vehicles and fuels

Zoom workshop

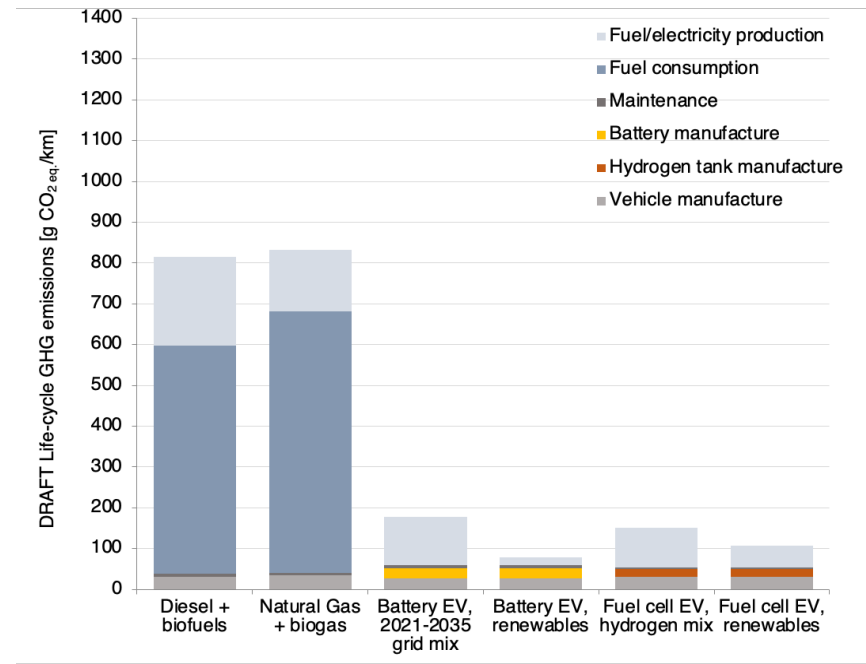
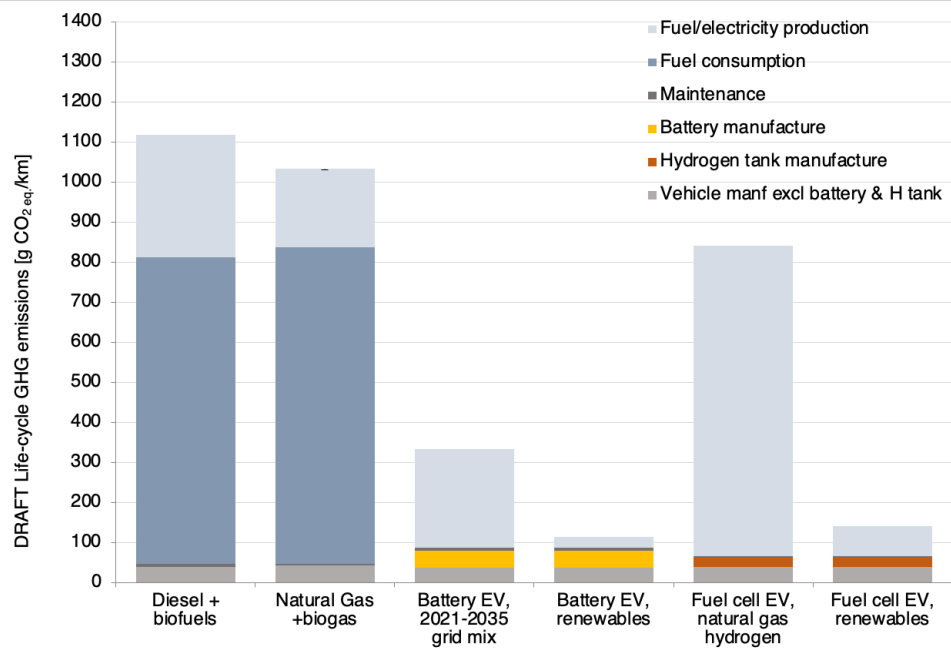
20 April 2022

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

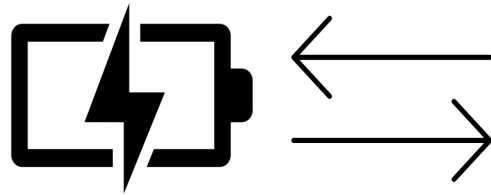


Common characteristics of first-mover HDV segments in ZEVTC countries



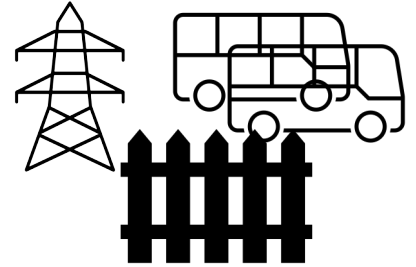
Suitable duty cycle

- 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



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**

A battery-electric UPS delivery van manufactured by Arrival



Image source <https://about.ups.com/be/en/our-stories/innovation-driven/delivering-world-firsts.html>:

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**

A battery-electric Freightliner eCascadia tractor truck



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**

A Hyundai Xcient fuel-cell electric tractor truck



To align with Paris Agreement goals of well-below 2°C, 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

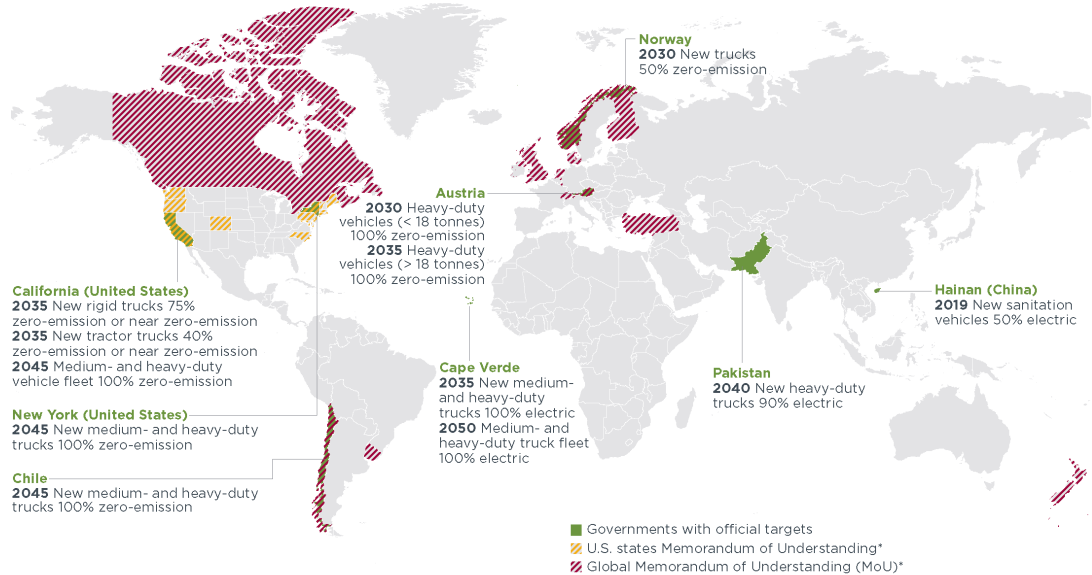
Vehicle type	2025	2030	2035	2040	2045
Bus	7%-30%	75%-90%	90%-100%	100%	100%
Medium truck	3%-12%	40%-50%	75%-90%	100%	100%
Heavy truck	2%-9%	30%-41%	60%-75%	90%-100%	100%
All HDVs (sales-weighted average per country)	3%-12%	40%-56%	69%-83%	94%-100%	100%
All HDVs (sales-weighted average for all ZEVTC members)	4%	45%	76%	97%	100%

Adopt zero-emission sales and operations targets

Target: 100% HD ZEV Sales no later than 2040

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)



U.S. states Memorandum of Understanding (MoU)

California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont and Washington and the District of Columbia

2030 New medium- and heavy-duty vehicles 30% zero-emission
2050 New medium- and heavy-duty vehicles 100% zero-emission

Global Memorandum of Understanding (MoU)

Austria, Canada, Chile, Denmark, Finland, Luxembourg, Netherlands, New Zealand, Norway, Scotland, Switzerland, Turkey, United Kingdom, Uruguay, Wales

2030 New medium- and heavy-duty vehicles 30% zero-emission
2040 New medium- and heavy-duty vehicles 100% zero-emission

Note: Governments with an at least 40% new truck sales target.

* Not necessarily yet reflected in an official national/state policy document such as a climate or transport strategy/plan, in a law, or in a similar framework.

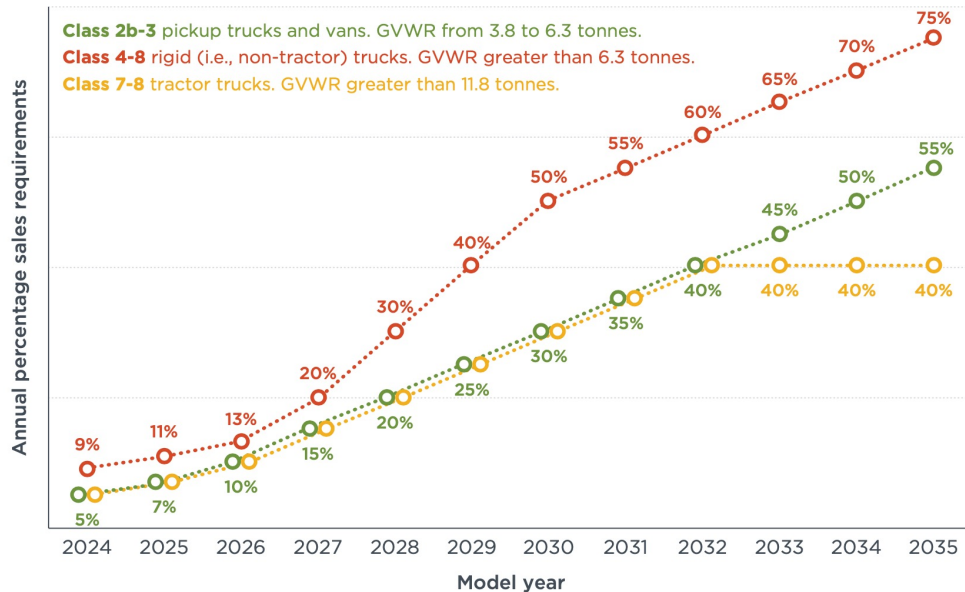
Recommendations

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

Adopt zero-emission performance standards for new vehicles

Zero emission powertrain performance requirement (0 g CO₂+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

Country	Current policies	With toll exemptions
Germany	2028	2023
Spain	2025	2022
France	2024	2021
Italy	2027	2023
Netherlands	2023	2022
Poland	2026	2025
UK	2025	2025

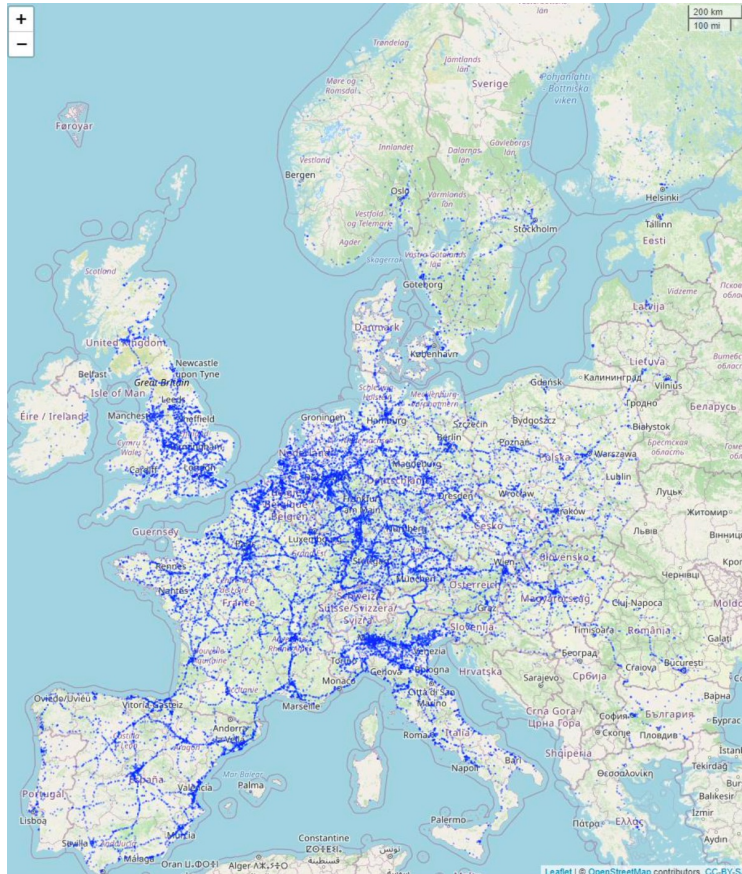
Germany 100% exemption › 75% in other countries

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)

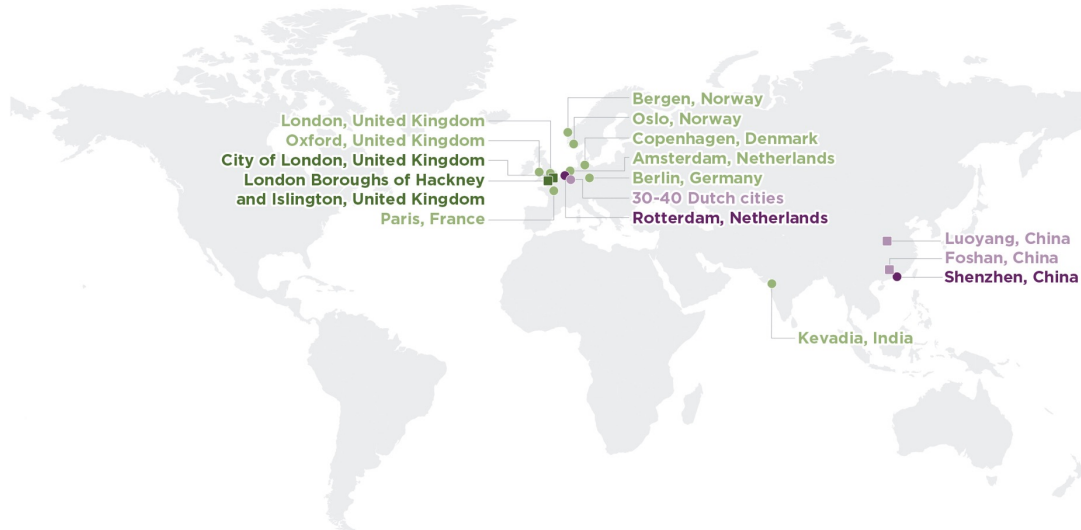
Zero-Emission Fleet Percentage	10%	25%	50%	75%	100%
Box trucks, vans, two-axle buses, yard trucks	2025	2028	2031	2033	2035
Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

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 zone	Near-zero-emission zone		Zero-emission zone for freight	Near-zero-emission zone for freight
Implemented	—	■	Implemented	●	—
Planned	●	—	Planned	●	■

*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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