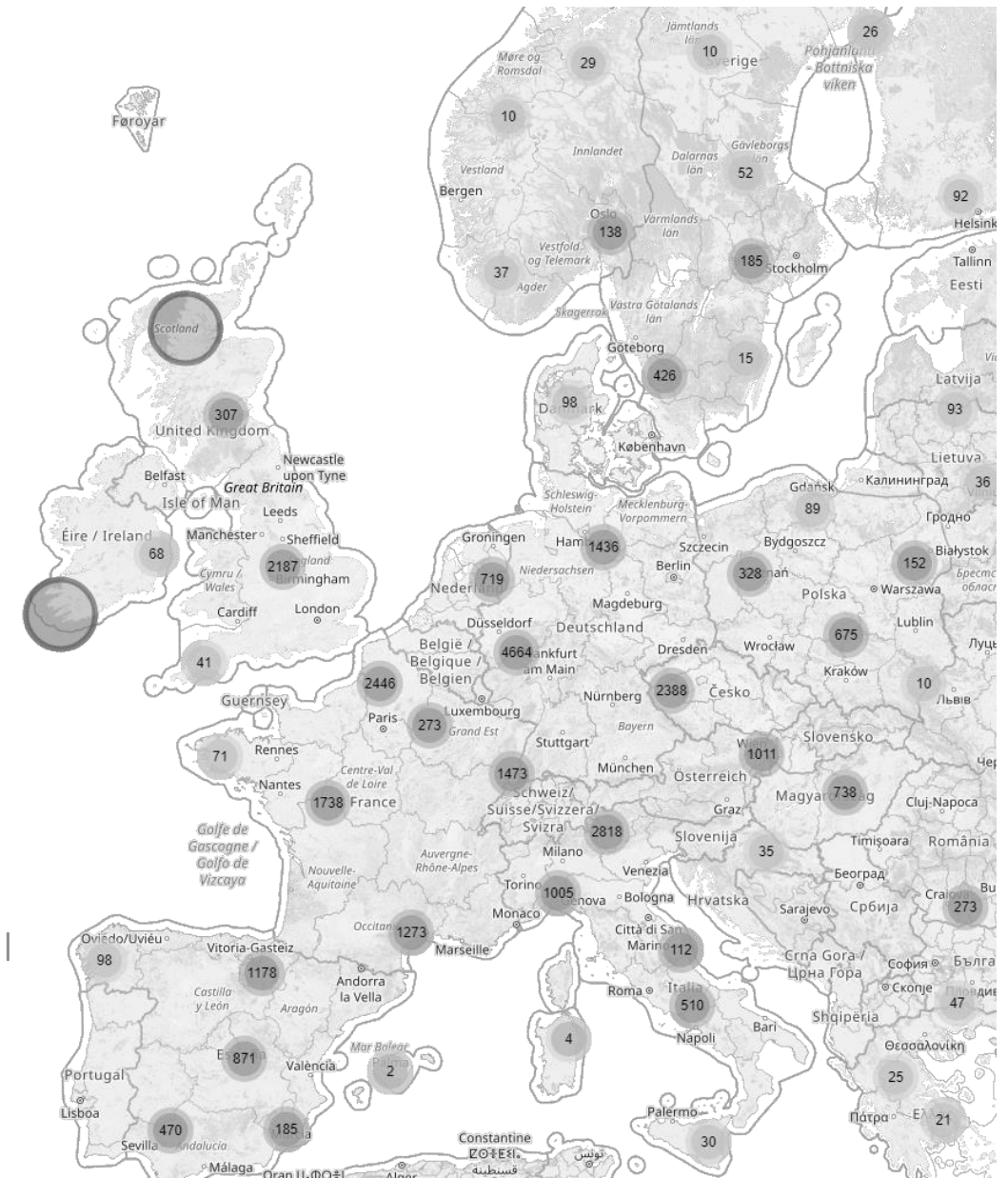


The Future of Charging Infrastructure for Electric Trucks

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SEC Roads to the Future Conference
Uppsala 26.10.2021

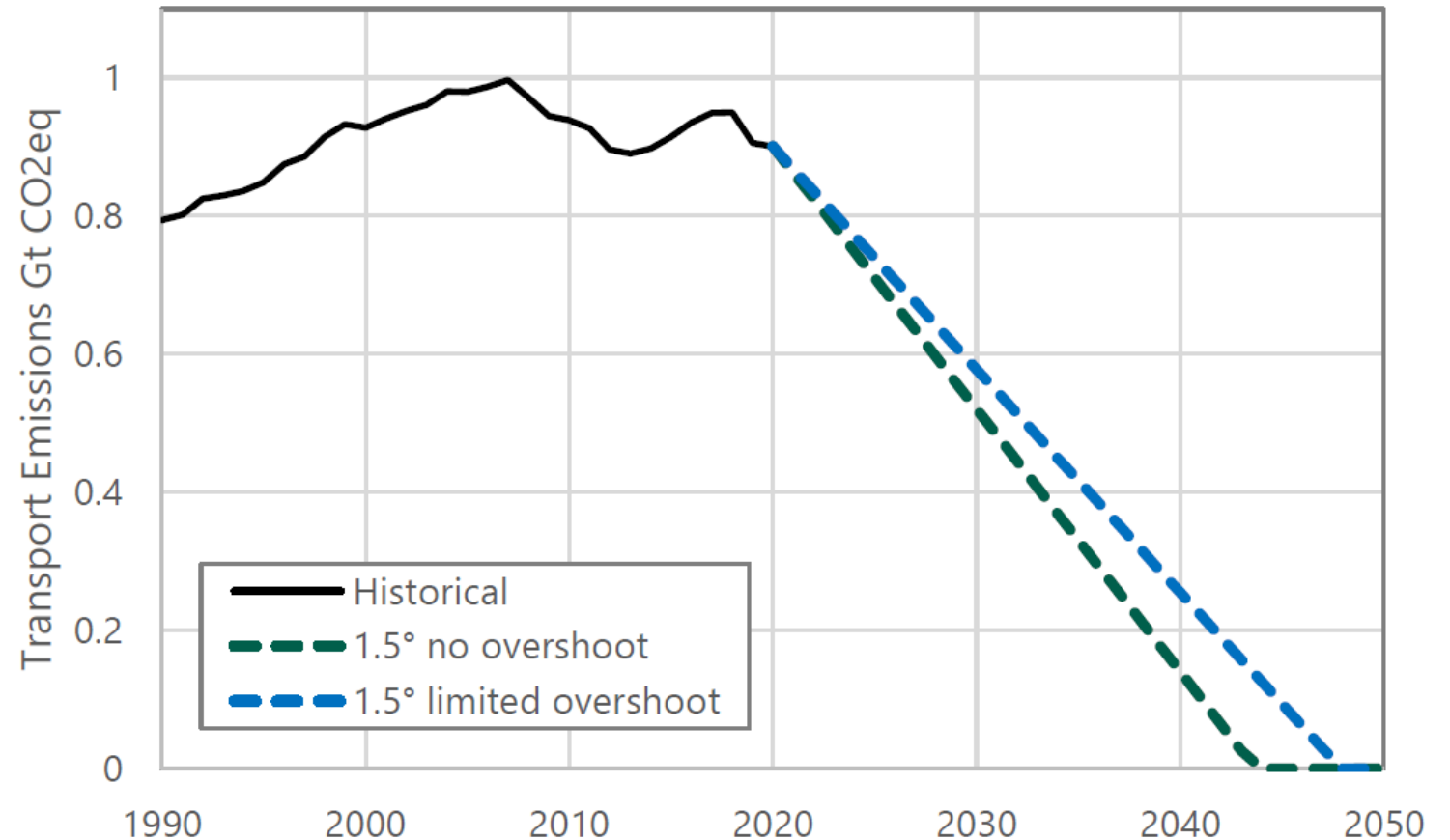


AGENDA

- Motivation
- Market announcements
- Electric truck and charging policies
- Truck charging infrastructure for Europe
- Outlook and Conclusion

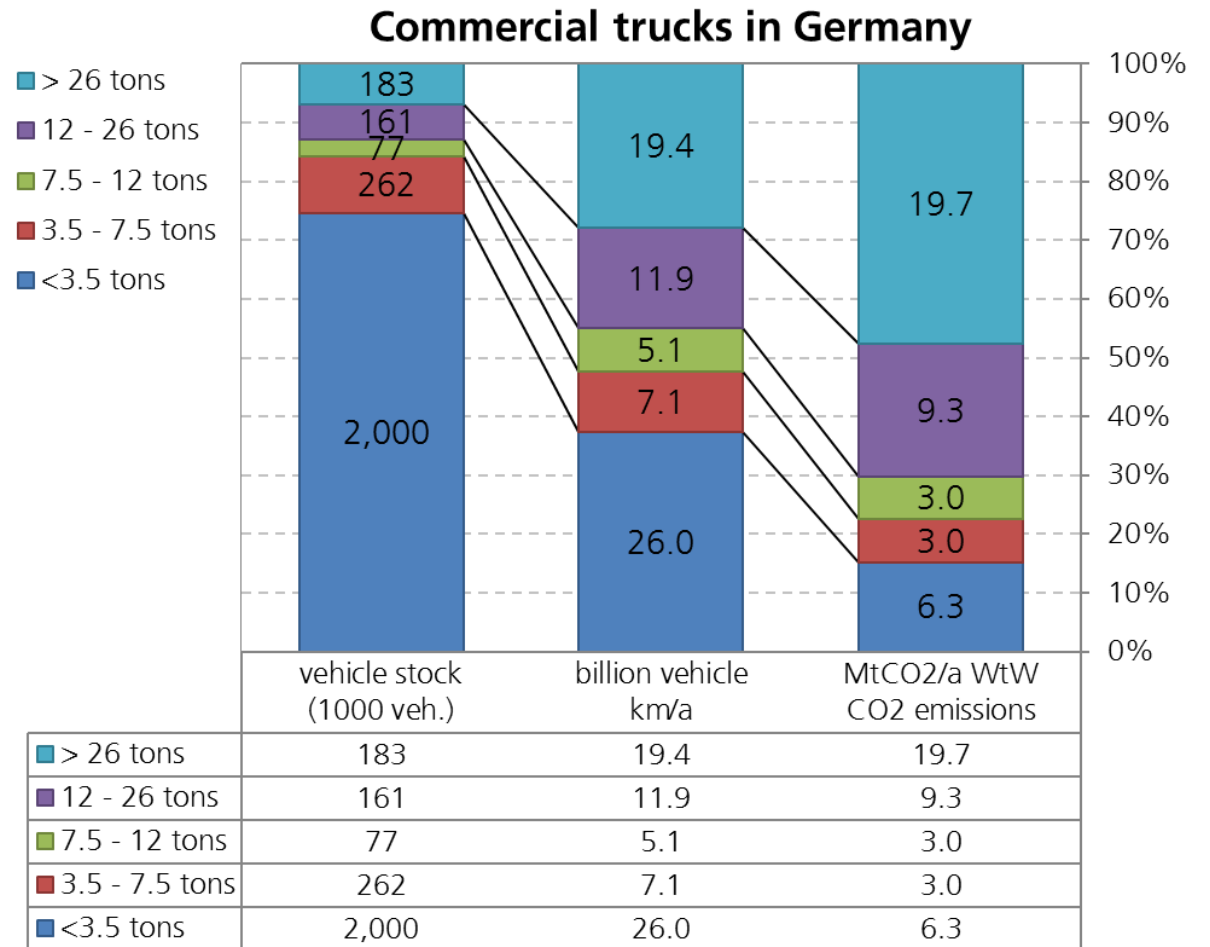
Europe needs to its reduce transport emissions dramatically

- Total transport GHG emissions in Europe around 0.9 Gt/a
- ca. 72% from road transport
- one third of road transport GHG emissions from heavy-duty vehicles (> 3.5t GVW)
- Emission reduction required (compared to 1990):
 - – 35% until 2030
 - –100 % until 2045 / 2050
 - EU target: -90% until 2050

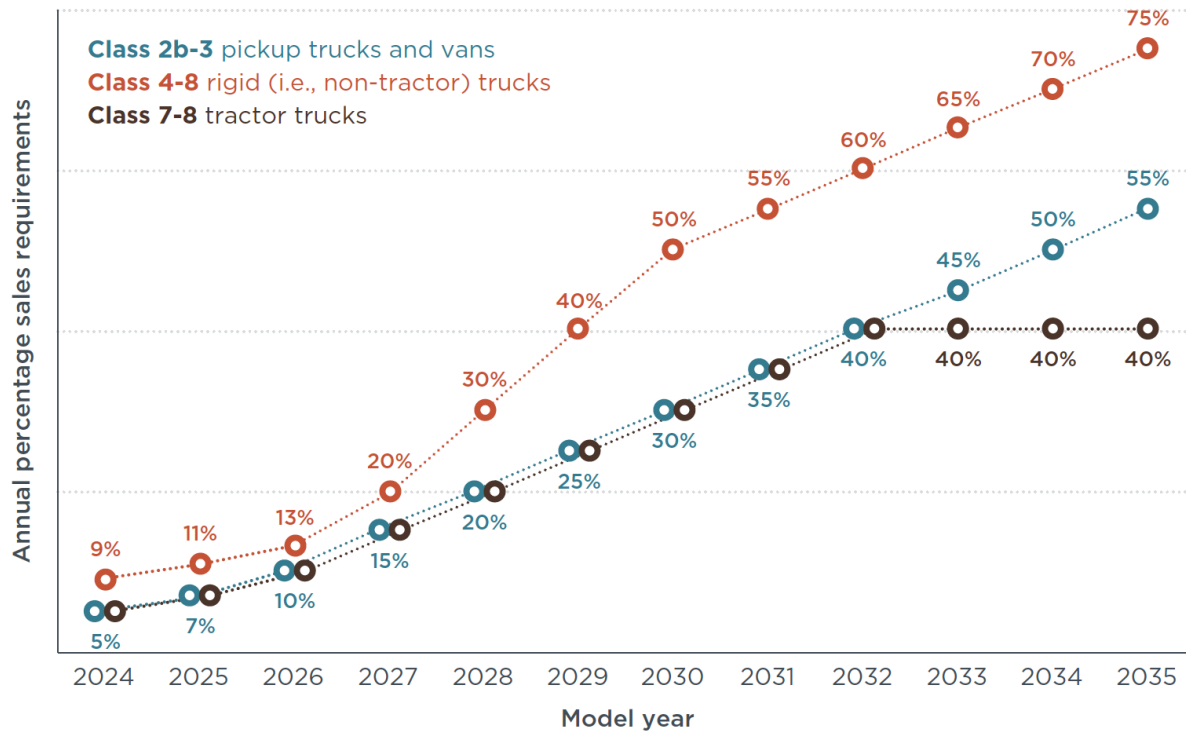


Heavy duty trucks make up only 5% of truck stock but 50% of truck CO₂ emissions

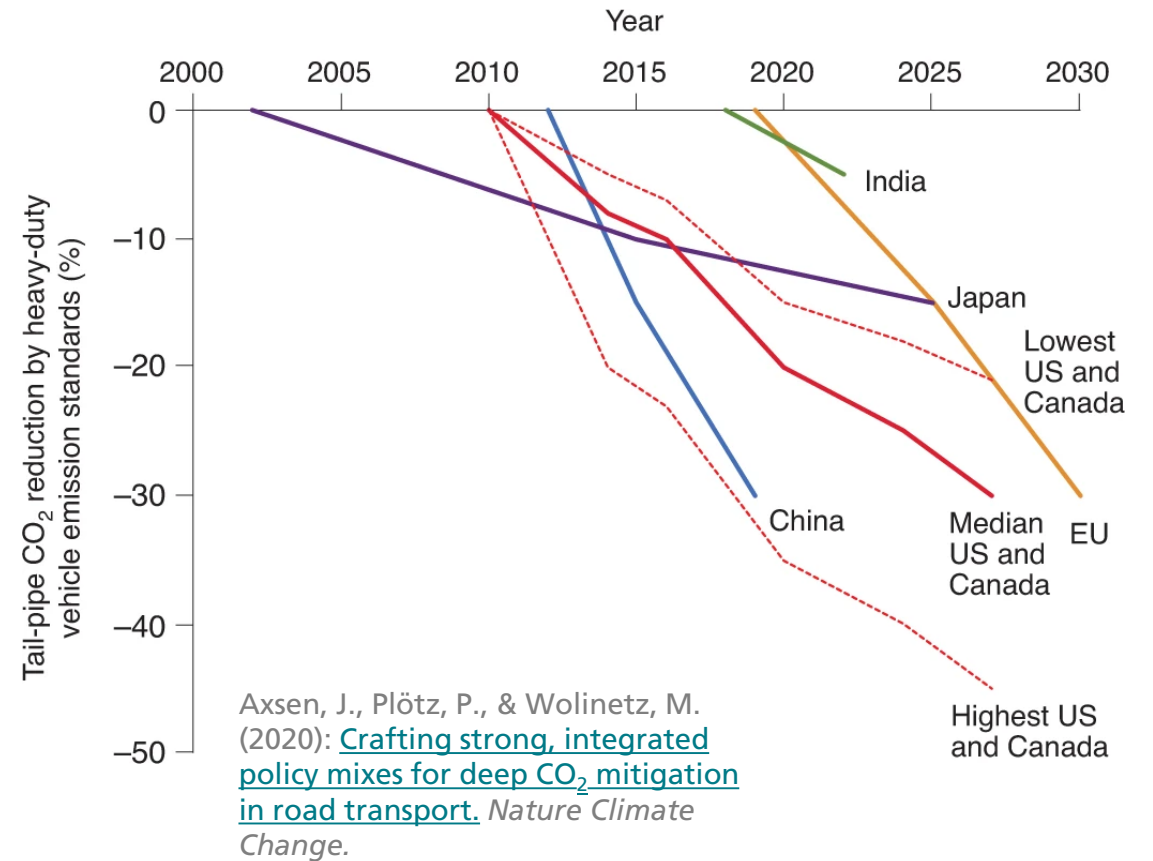
- Heavy trucks have high annual mileage and high energy consumption
- For long-term CO₂-neutrality in the transport sector, we need solutions for the heavy truck transport (today Diesel only)
- Possible solutions:
 - Battery trucks
 - Electric road systems
 - Hydrogen Fuel cell trucks
 - Power to gas, e.g. renewable LNG



Main driver for commercial electrification of trucks: CO₂ reduction policies worldwide

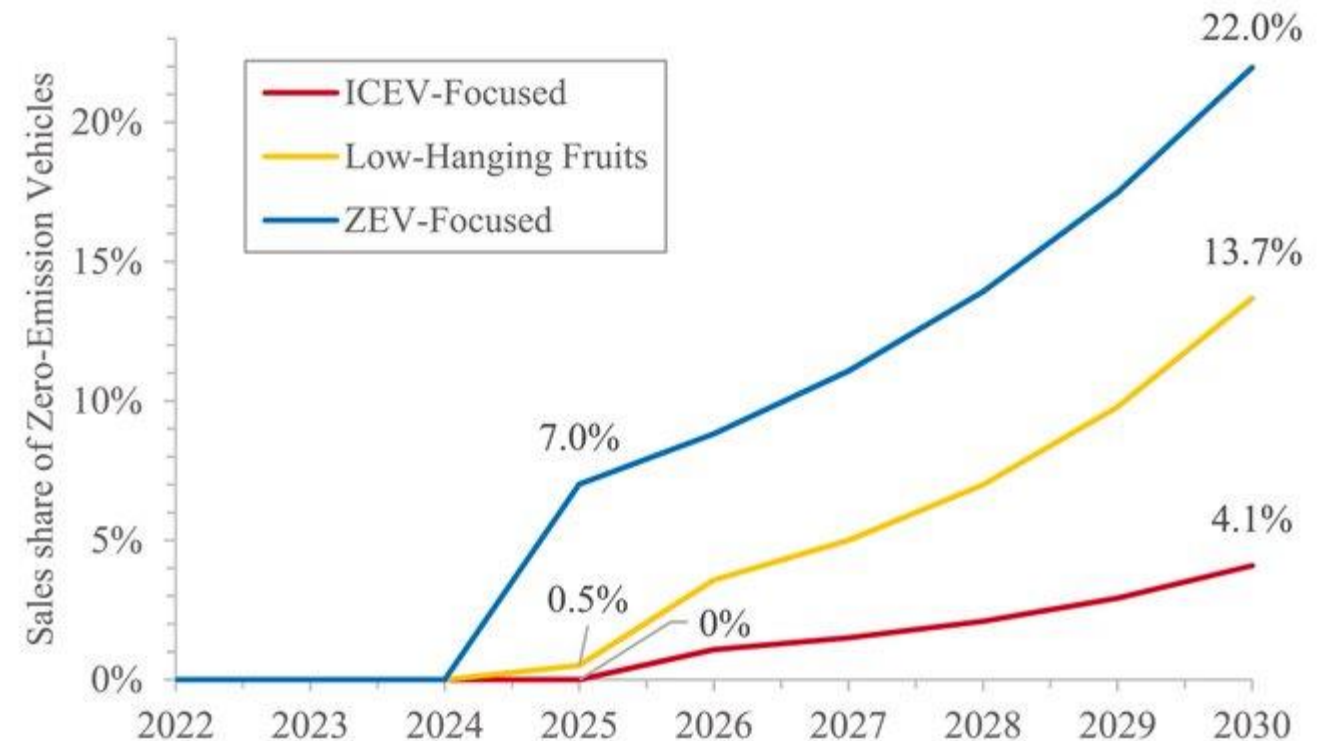


<https://theicct.org/publications/california-hdv-ev-update-jul2020>



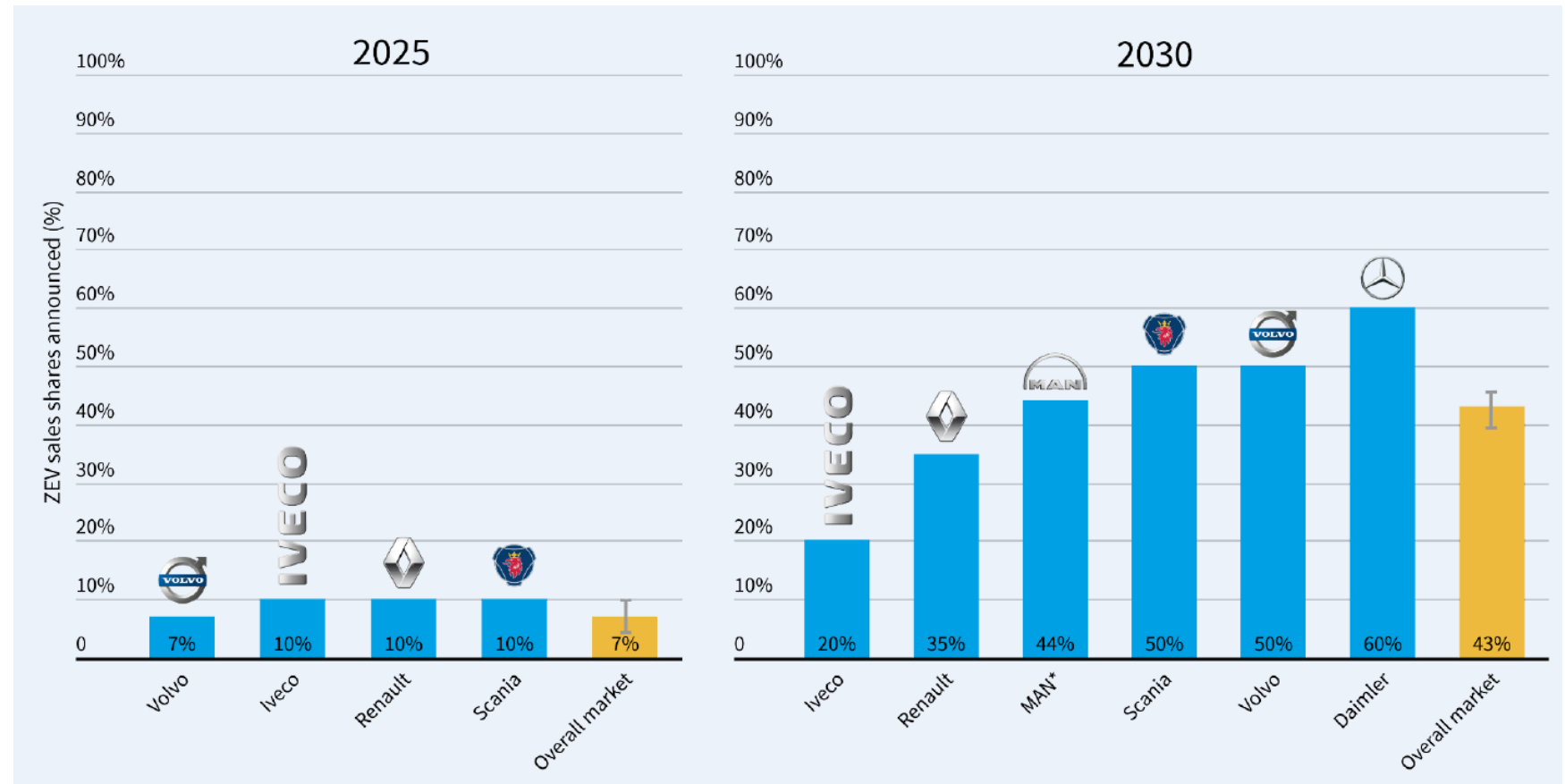
Manufacturers will sell electric trucks to meet EU targets

- Manufacturers can increase efficiency of new diesel trucks and introduce low emission vehicles
- Depending on choice of Diesel efficiency strategy, at least 4 – 22 % zero emission trucks sales are required in 2030
- These are minimal values, real values likely to be higher

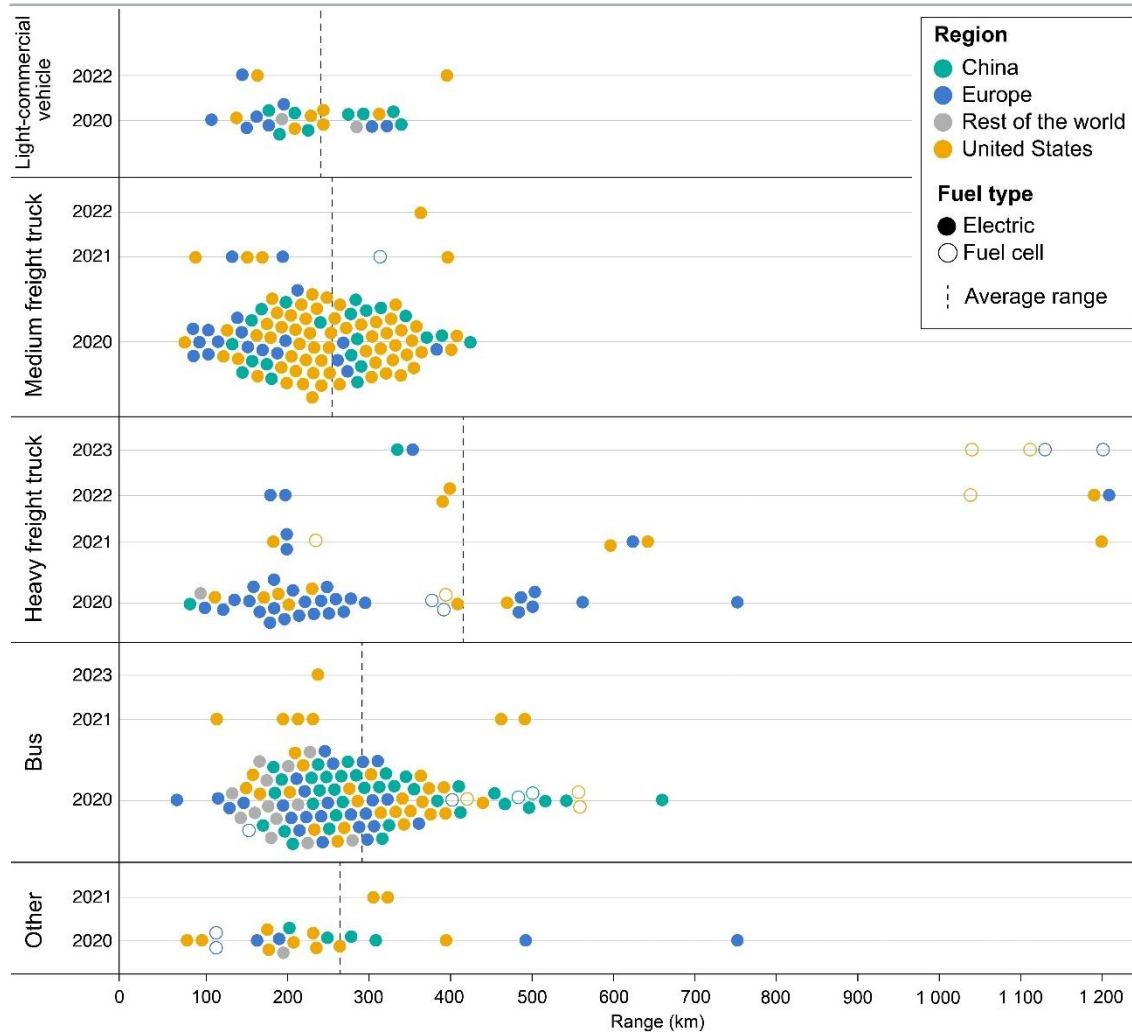


Manufacturers have announced 20 – 60 % zero emission truck sales in 2030 and 100 % zero emission sales in 2040

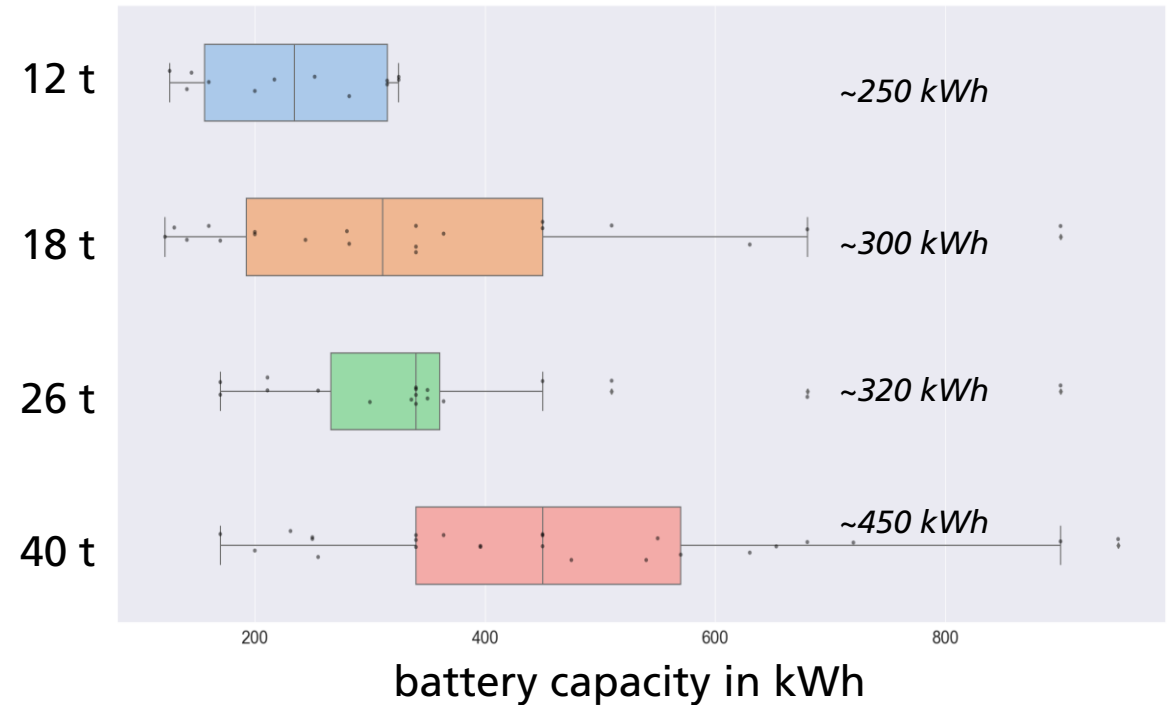
- ZEV sales targets for OEM in Europe:
 - 2025: ~ 7 %
 - 2030: ~43 %
- ACEA announcement of 100% zero emission sales in 2040 (possibly including liquid renewable fuels)



Manufacturers have announced many battery electric trucks



Heavy-duty trucks



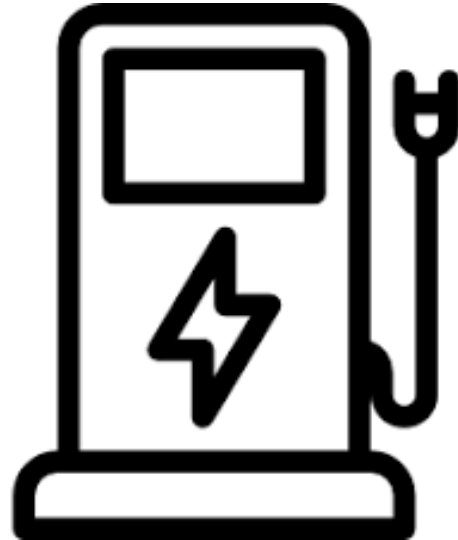
Source: Global EV Outlook 2021 (IEA) and Link, Plötz, Moll, & Griener (2021): Machbarkeit Emissionsfreier Lieferverkehr. Karlsruhe: Fraunhofer ISI

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Truck charging: where and how?

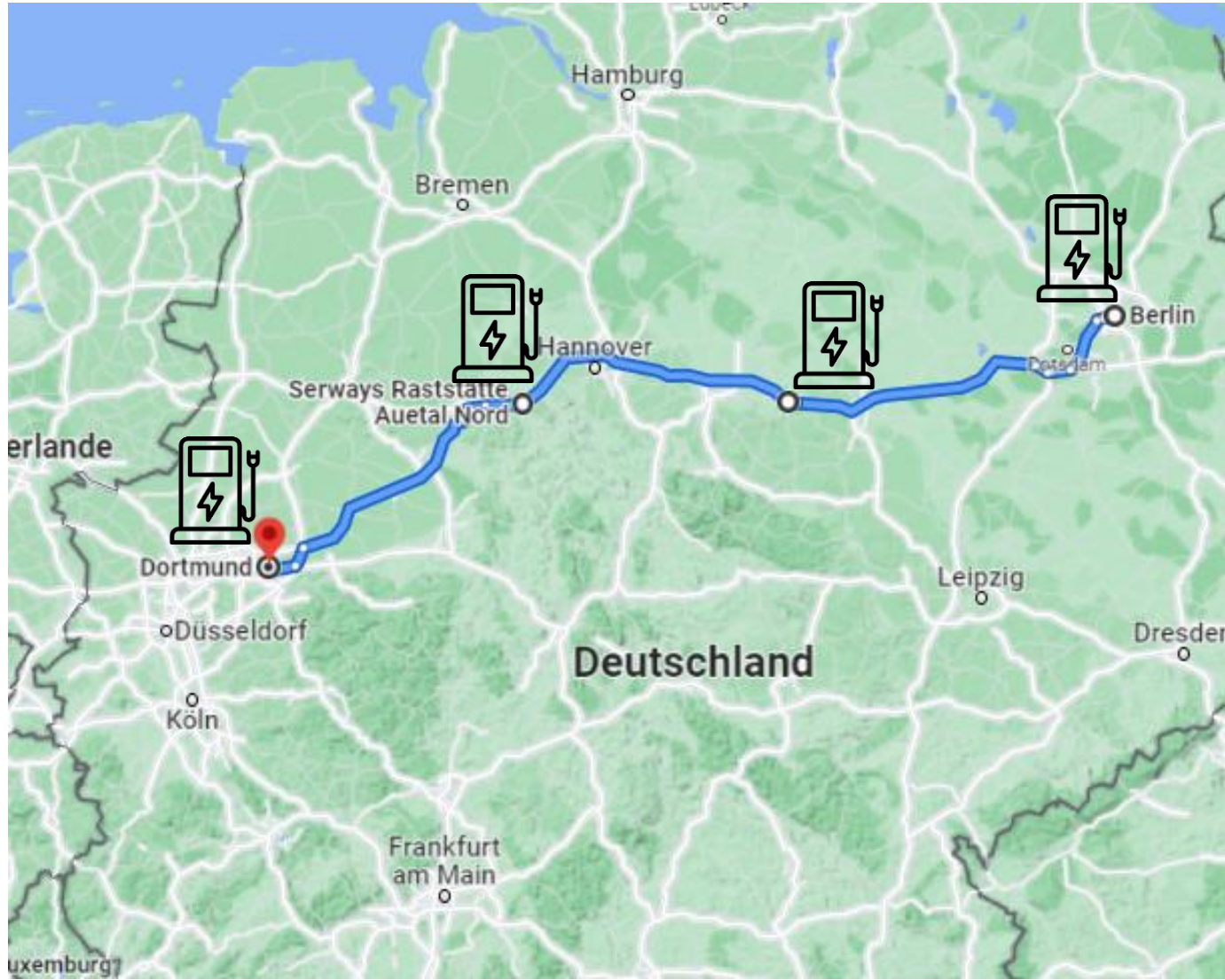
- Most important is depot charging as many trucks are in regional operation return to depot
- Battery trucks cheaper in TCO by 2025
- charging in long-haul operation
 - slow: over-night (50 – 100 kW)
 - mega-watt charging: during 45 min break after 4.5 h of driving
→ 400 km / 600 kWh in 45 min
imply about 800 kW
 - comprehensive fast charging network enables long-haul battery electric trucks



Technical standards for truck charging:

- **Combined Charging System (CCS)** allows 350 kW charging
→ sufficient for over-night charging and fast charging in 1.5 h
- **Mega-watt Charging System (MCS)** standard is under development and should be finalized approx. 2023
- Start public locations with CCS and expand to MCS when ready

Construction of the first four public MCS chargers underway



HoLa

<https://www.hochleistungsladen-lkw.de/hola-en/>

Partners



Bauhaus-Universität Weimar



Associated Partners

TRATON



Verband der Automobilindustrie



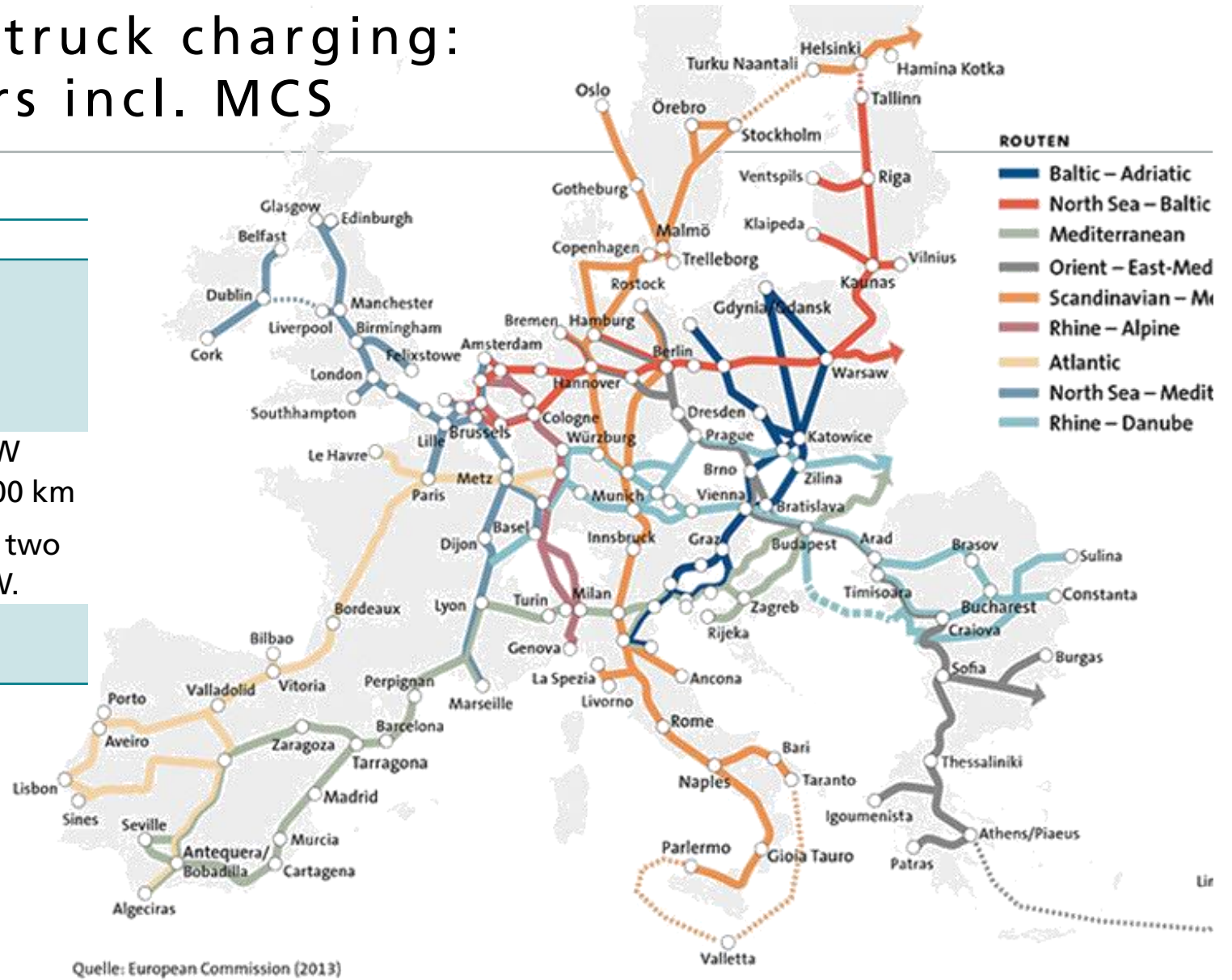
MEYER&MEYER

EU proposal for public truck charging: > 15,000 public chargers incl. MCS

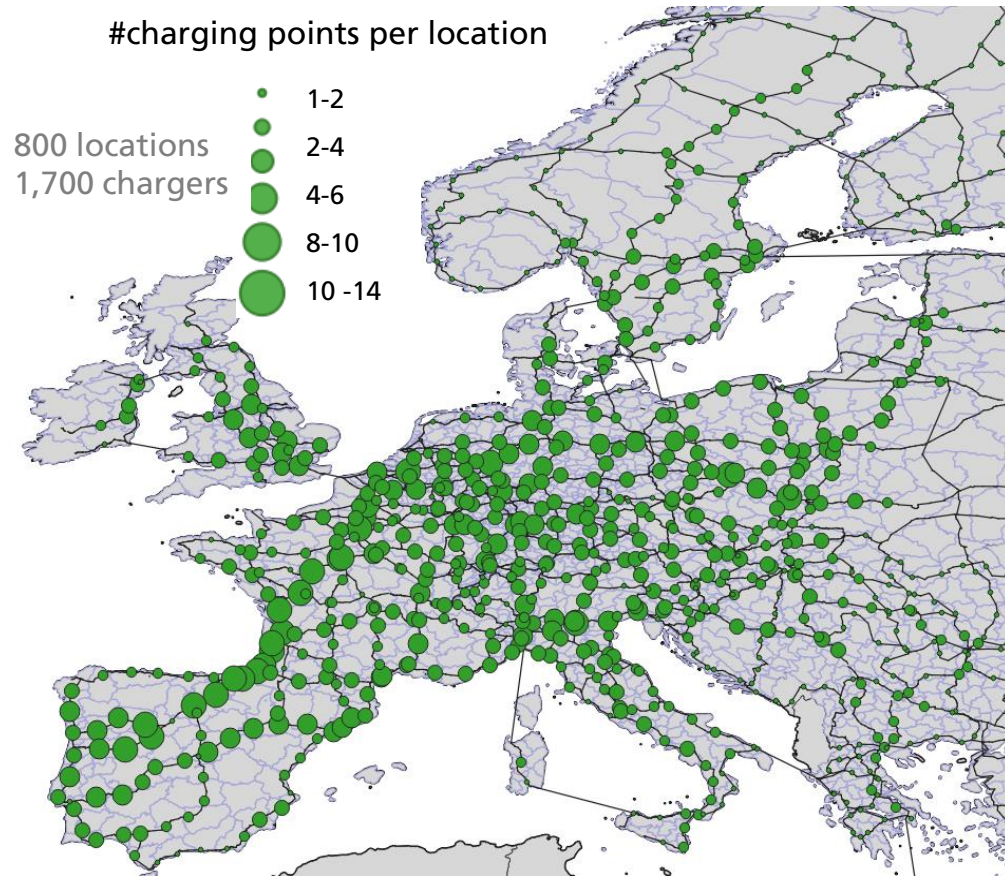
	2025	2030	2035
TEN-T core network	1,400 kW every 60 km At least one ≥350 kW	3,500 kW every 60 km At least two ≥350 kW	
TEN-T comprehensive network		1,400 kW every 100 km At least one ≥350 kW.	3,500 kW every 100 km At least two ≥350 kW.
88 Urban nodes	600 kW @ ≥ 150 kW	1200 kW @ ≥150 kW	

CP by 2030

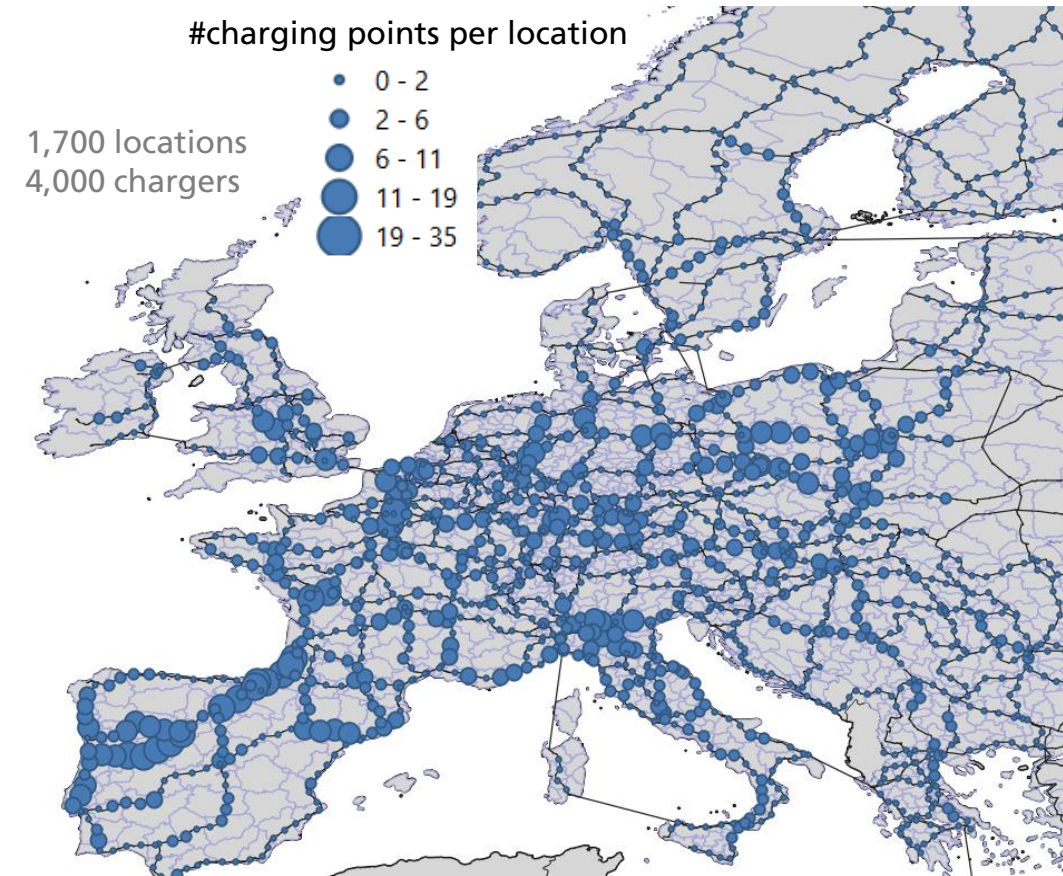
Core network	12,000
Comprehensive network	4,000
Safe & secure parking	700
Urban nodes	700
Total	Ca. 17,400



Potential future European public mega charger network



Distance	BEV stock share	Avg. CP / station
100 km	5 %	2,6



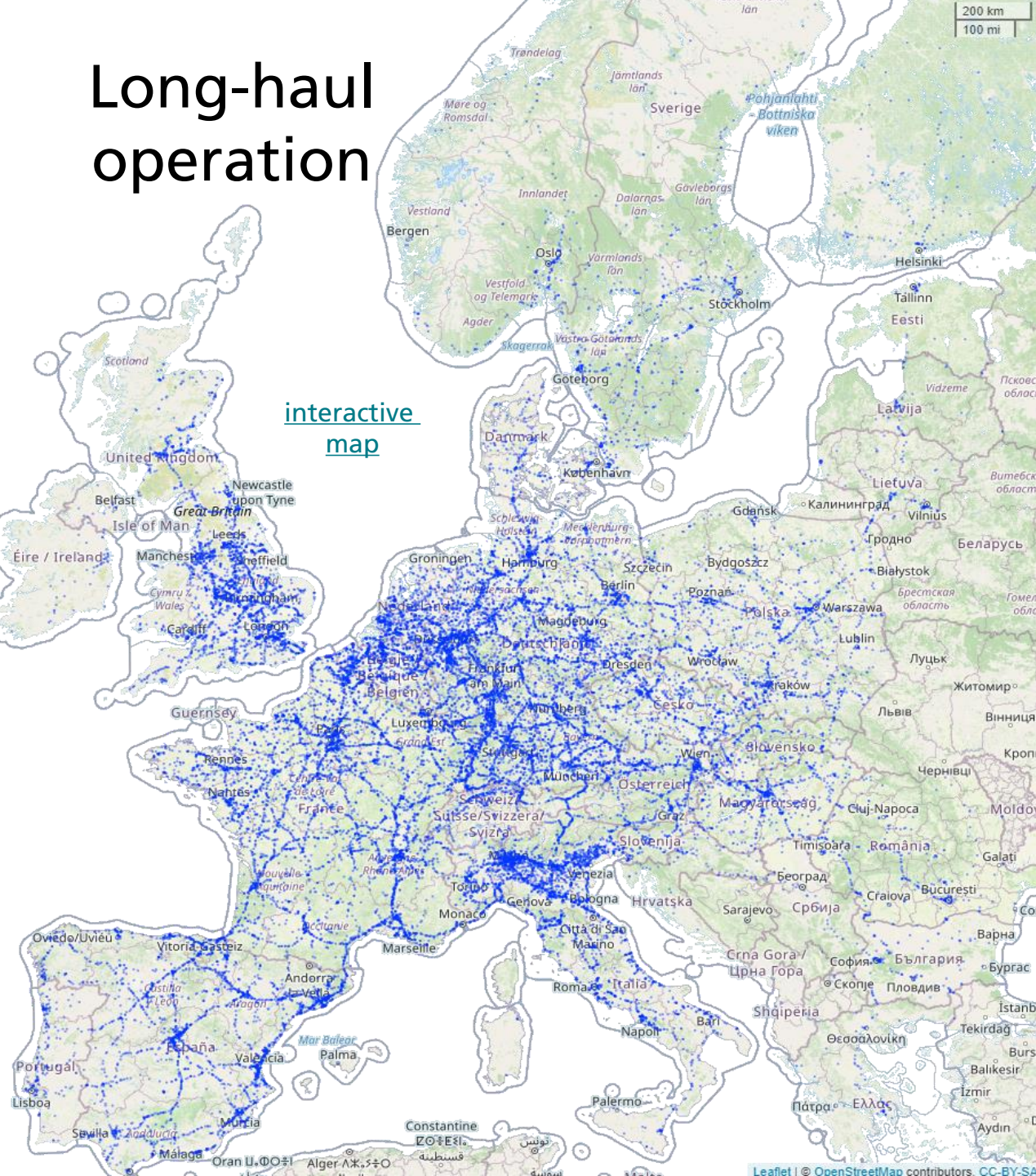
Distance	BEV stock share	Avg. CP / station
50 km	15 %	2,9

Sauter, Speth, Plötz, & Signer (2021): [A charging infrastructure network for battery electric trucks in Europe](#), Fraunhofer ISI Working Papers Sustainability and Innovation No. S 02/2021, Karlsruhe 2021

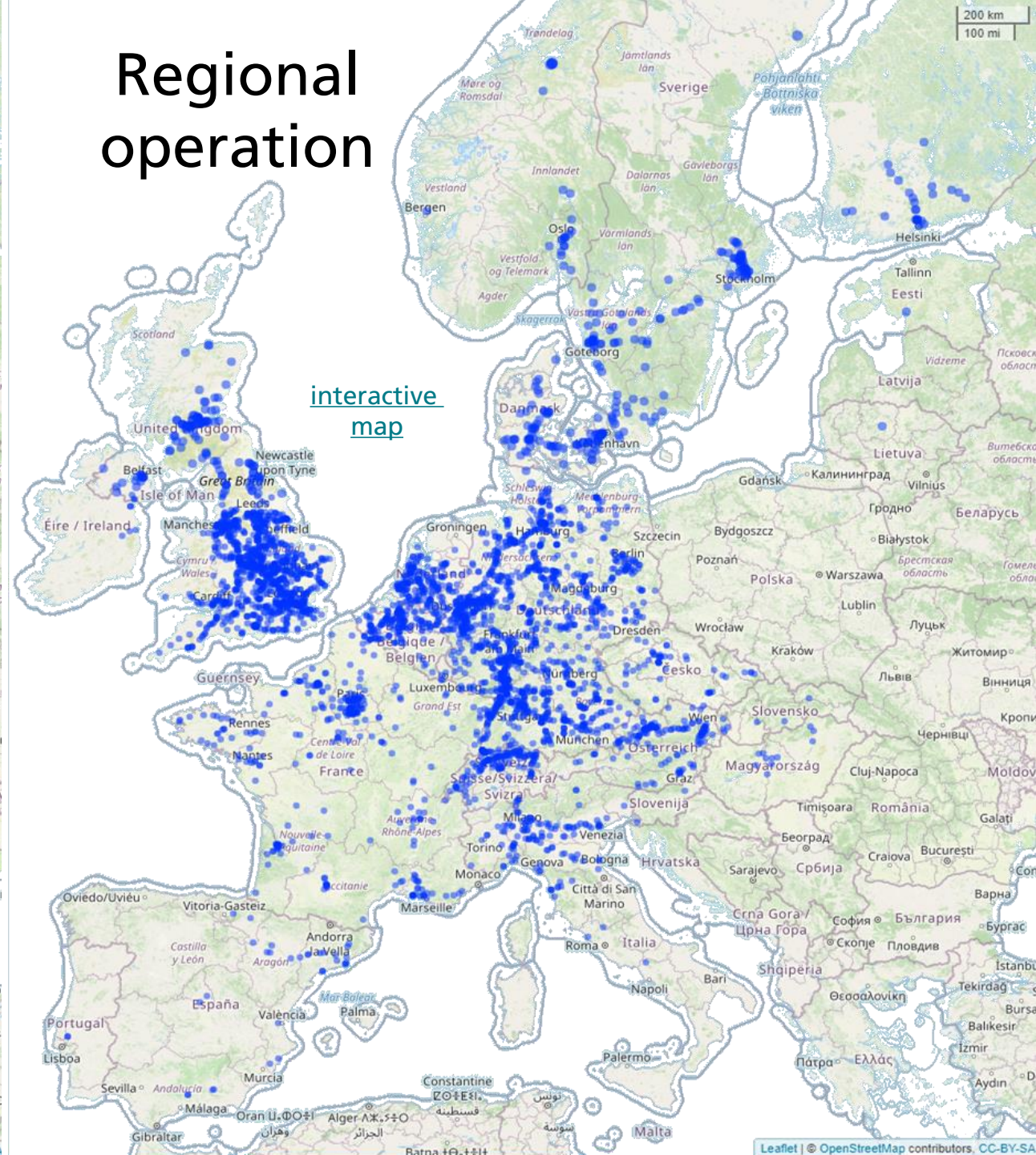
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Long-haul operation

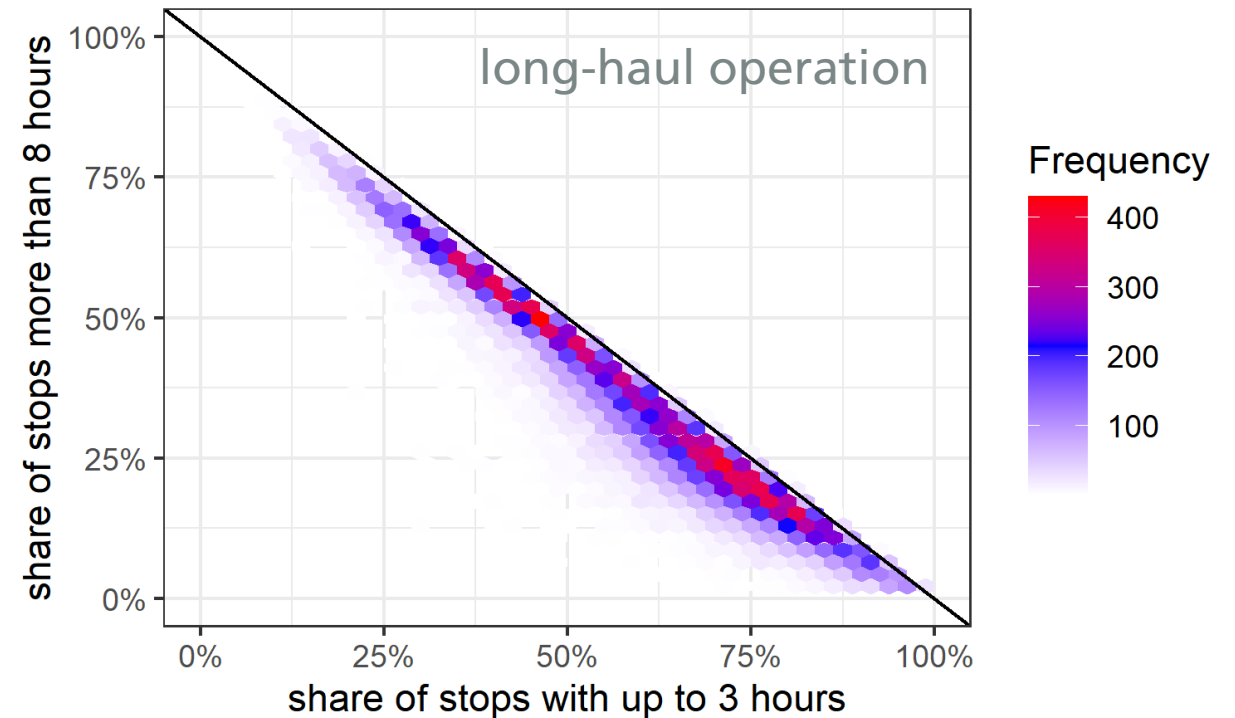


Regional operation



Limited range requires re-charging during stops. Most important: depot charging followed by public charging

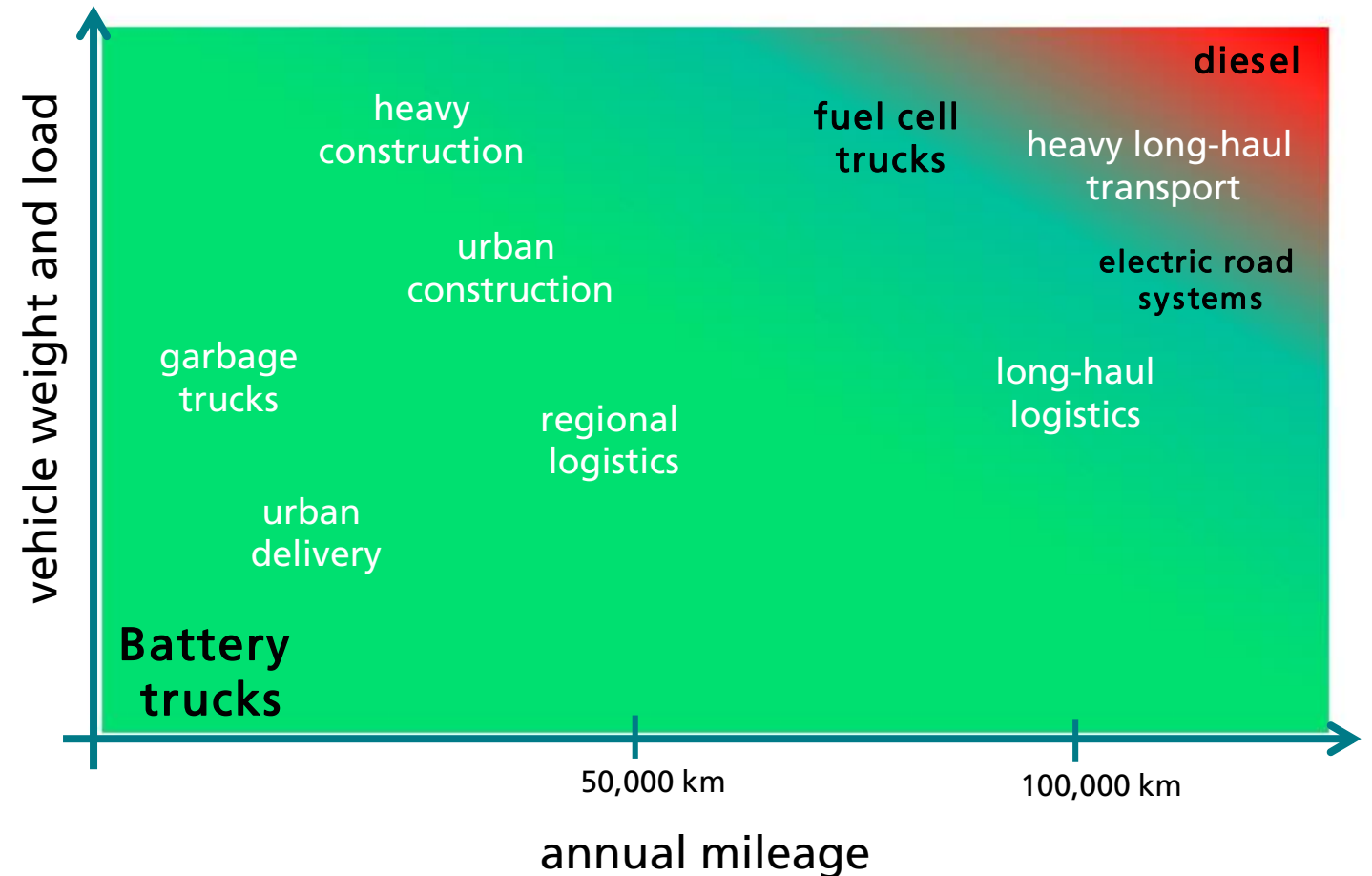
- Most stops are probably at home depot of truck → depot charging most important
- But trucks in especially in long-haul operation need public charging
- Analysis of 0.75 million truck stops from 400,000 trucks:
 - about 2/3 of public stops < 3 hours
 - about 1/3 of public stops > 8 hours



Duration:	½–1 h	1–3 h	3–8 h	8–23 h	23–44 h	>44 h		<3 h	3–8 h	>8 h
Long-haul	35%	24%	6%	31%	2%	2%		59%	6%	35%
Regional	44%	23%	6%	24%	1%	3%		67%	6%	27%

What about fuel cell trucks and electric road systems?

- **Battery trucks** can cover urban, regional and (with MCS) long-haul, 2nd and 3rd generation battery trucks will have ranges to cover >80 % of trips
- **Fuel cell trucks** more expensive than battery trucks in purchase and operation → niche for fast refueling irrespective of costs
- Extremely demanding cases with renewable and bio fuels
- Fuel cell niche too small for scale effects and infrastructure invest?
 - No future for fuel cell trucks?



Summary and Conclusion

The future of trucks is electric with ubiquitous charging

The future of trucks and charging

- Fast electrification of trucks to come (~ 20% sales in 2030)
- Most important charging powers
 - 50 – 100 kW at depot (everywhere)
 - 100 – 800 kW in public with CCS and MCS (about 1,000 locations in Europe)
- First use case: urban & regional logistics
- long-haul needs MCS network with mega chargers every 50 km along highways

Discussion and outlook

- Grid expansion will be important for high power charging → could be bottleneck for fast roll out
- Future role of hydrogen in trucking uncertain
- Share of public vs. depot charging unclear

