IBERDROLA

Innovation, Sustainability and Quality Division
Chairman's Office

Infrastructure for ZE-MHDVs

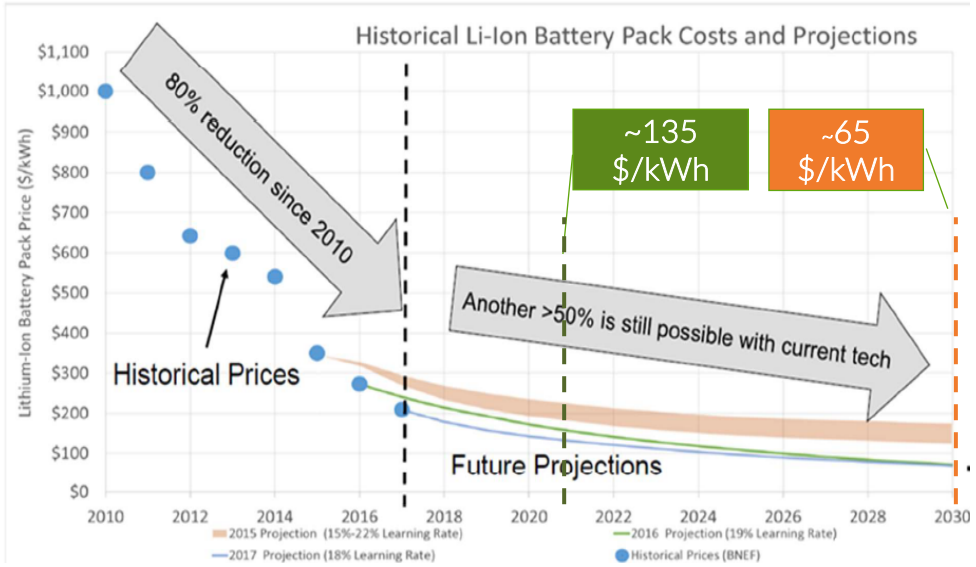


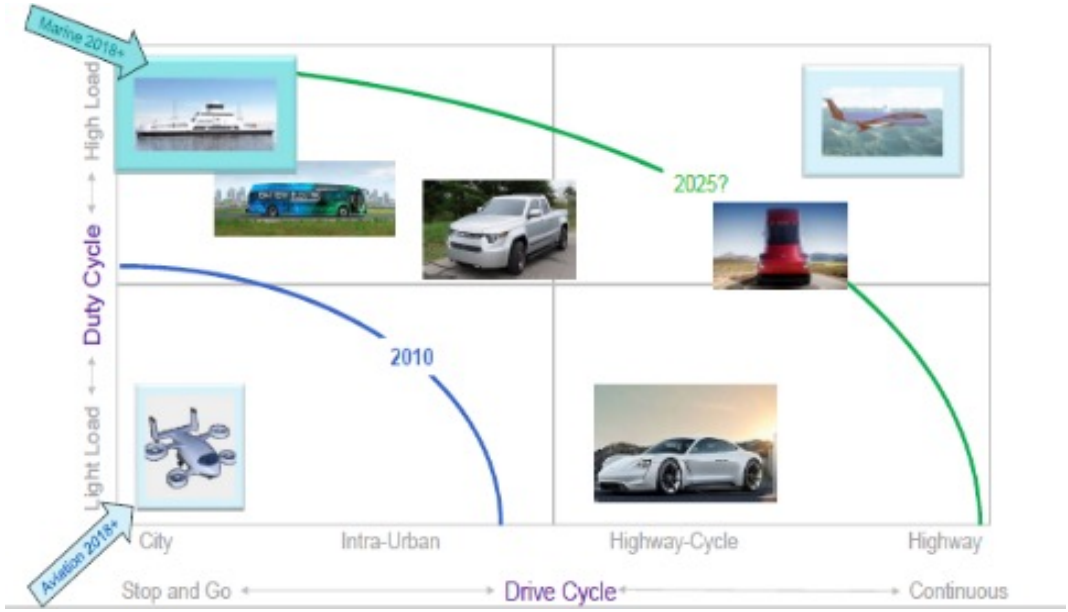
Enrique Meroño,
Head of Quality and New Initiatives

May 2022

Electrification of transport as a mega-trend

Batteries

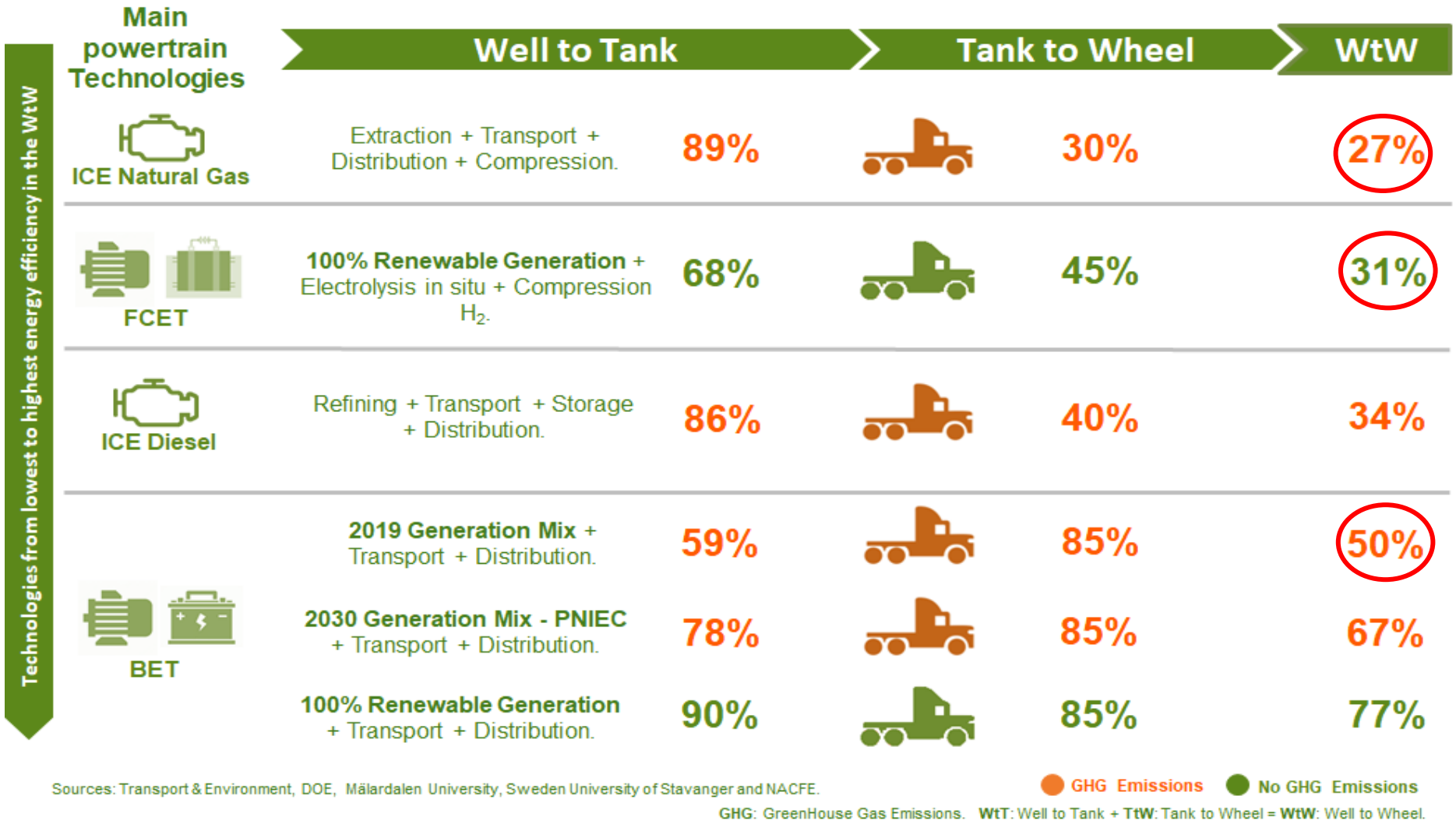




*Source: EPRI.

- *Batteries' costs decrease has been underestimated in the past*
- *Battery pack price reduction* 2010-2020: ÷ 6
- *Estimated battery pack price reduction* 2021-2030: ÷ 2
- ***The development of batteries is continuously moving the electrification frontier.*** *With the current trend, electrification of heavy-duty transport is going to be a reality in the following years.*

Heavy Duty Trucks- Energy Efficiency

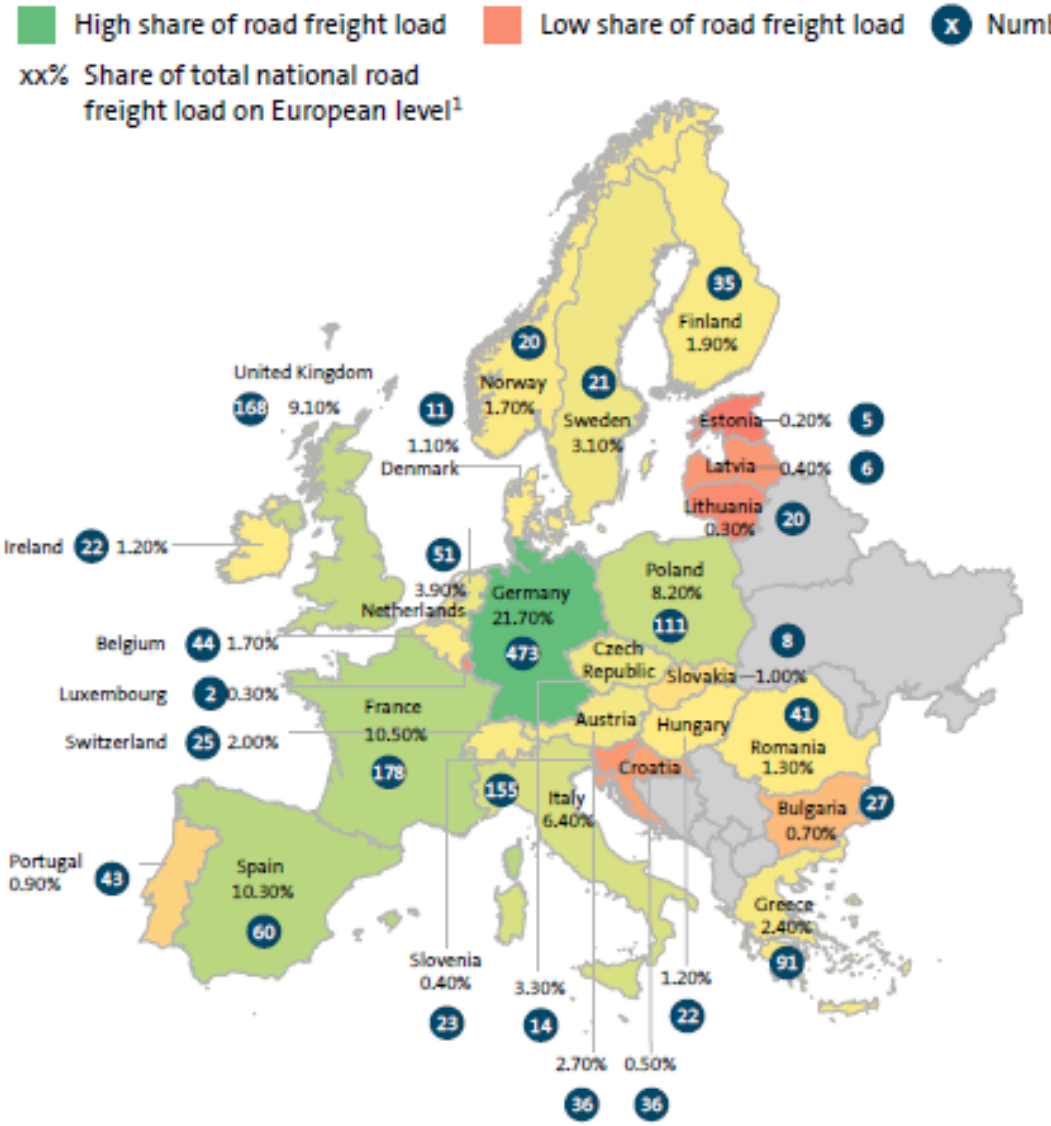


Sources: Transport & Environment, DOE, Mälardalen University, Sweden University of Stavanger and NACFE.

GHG Emissions No GHG Emissions

GHG: GreenHouse Gas Emissions. **WtT**: Well to Tank + **TtW**: Tank to Wheel = **WtW**: Well to Wheel.

1: An estimated EUR 108bn of investment is required to roll-out the infrastructure for all 1'800 European urban and regional HDT hubs



Country	Charger need, total # '000	Total investment need per country, bn EUR
Germany	79.9 - 80.0	23.8 - 23.9
France	38.8 - 38.9	11.5 - 11.6
Spain	38.0 - 38.1	11.3 - 11.4
United Kingdom	35.7 - 35.8	10.6 - 10.7
Poland	30.3 - 30.4	9.0 - 9.1
Italy	22.8 - 22.9	6.8 - 6.9
Netherlands	14.4 - 14.5	4.3 - 4.4
Czech Republic	12.2 - 12.3	3.6 - 3.7
Sweden	11.4 - 11.5	3.4 - 3.5
Austria	9.9 - 10.0	3.0 - 3.1
Greece	8.8 - 8.9	2.6 - 2.7
Switzerland	7.3 - 7.4	2.2 - 2.3
Finland	6.8 - 6.9	2.0 - 2.1
Norway	6.2 - 6.3	1.8 - 1.9
Belgium	6.1 - 6.2	1.8 - 1.9
Romania	4.9 - 5.0	1.5 - 1.6
Hungary	4.5 - 4.6	1.3 - 1.4
Ireland	4.4 - 4.5	1.3 - 1.4
Denmark	4.2 - 4.3	1.2 - 1.3
Slovakia	3.7 - 3.8	1.1 - 1.2
Portugal	3.4 - 3.5	1.0 - 1.1
Bulgaria	2.4 - 2.5	0.7 - 0.8
Croatia	1.7 - 1.8	0.5 - 0.6
Latvia	1.5 - 1.6	0.5 - 0.6
Slovenia	1.4 - 1.5	0.4 - 0.5
Lithuania	1.1 - 1.2	0.3 - 0.4
Luxembourg	1.0 - 1.1	0.3 - 0.4
Estonia	0.6 - 0.7	0.2 - 0.3
Total	360 - 365	108 - 109

1. Loading national road freight data (2019, Eurostat) extrapolated to 2030 based on country GDP growth 2018-19 and adjusted for regional and urban HDTs

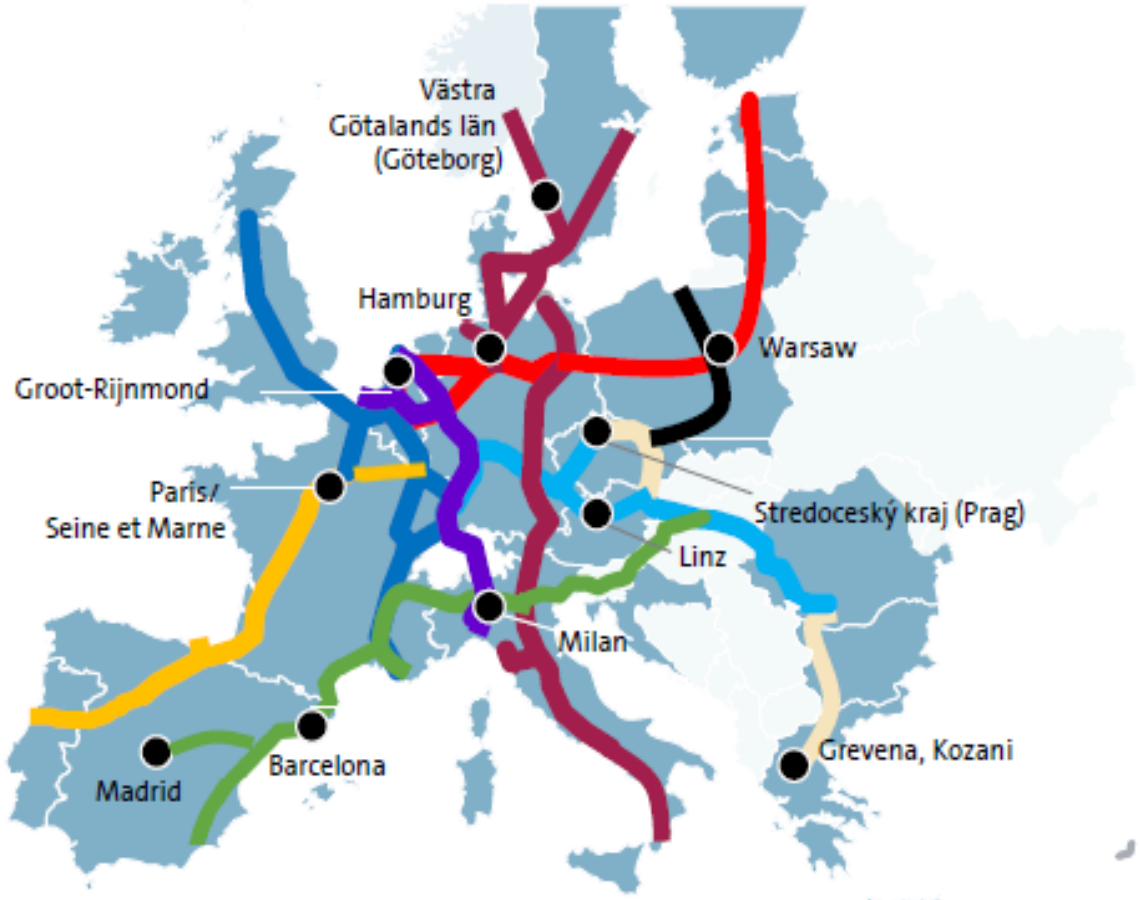
Source: Eurostat, Industry experts and team analysis

Key insights

Germany, France, Spain and the UK **represent more than 50%** of the aggregated national road freight load and require **over EUR 55 bn investments**

Highest national investment needs are found in **Germany with EUR 24bn** to be split among a large number of hubs (473) in contrast to **Spain**, where **EUR 11bn investment** are concentrated to 60 hubs

2: Long-haul HDT journeys concentrate along 9 main core TEN-T corridors across Europe, covering up to 20,000 km (20% of TEN-T roads network)[1] and connecting main European hubs



The 9 main corridors crossing Europe (3 W-E and 6 N-S) cover over 20,000 km of length, which corresponds to 20% of TEN-T (road) network and have a forecasted movement of up to 1100 BEV HDT per day

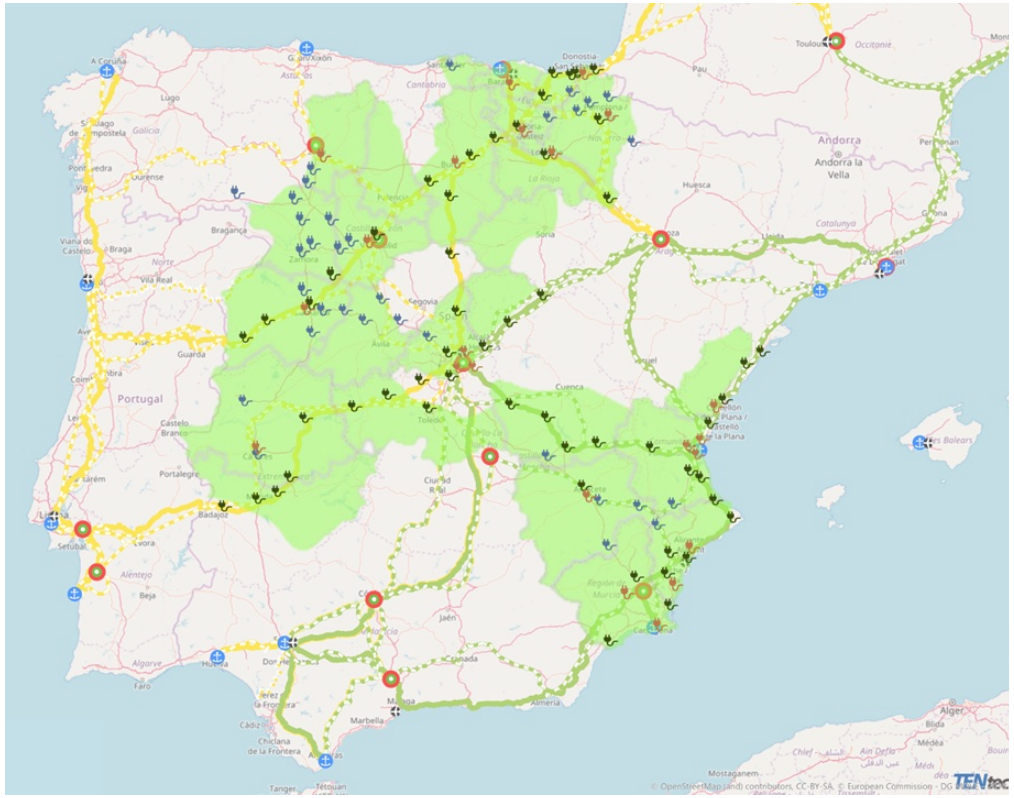
	Length, km	HDT movements per day, #	BEV HDT movements per day, #[3]
1 Scandinavian-Mediterranean	~4,650	11,500 - 12,500	950 - 1,000
2 Mediterranean	~3,370	9,500 - 10,500	790 - 840
3 North Sea-Baltic	~2,500	9,500 - 10,500	790 - 840
4 North-Sea Mediterranean[2]	~2,480	13,000 - 14,000	1,110 - 1,160
5 Rhine Danube	~2,070	11,500 - 12,500	950 - 1,000
6 Atlantic	~1,900	9,000 - 10,000	790 - 840
7 Rhine Alpine	~1,600	13,000 - 14,000	1,110 - 1,160
8 Baltic-Adriatic	~960	6,500 - 7,000	470 - 520
9 Orient – East Med	~690	9,500 - 10,500	790 - 840
Total	~20,200		

1. Based on long-haul daily HDT movement intensity > 6k per day; 2. Although the UK is not part of the EU and of the TEN-T network anymore, the corridor was kept on the map as it draws a very high density of long haul HDTs. 3. Based on BEV HDT overall penetration of 7.9% by 2030

Source: Trans-European Transport Network (TEN-T); industry experts and team analysis

HDT Interurban charging development plan 2030

HDT Charging stations-Spain



Ten-T Core
(3,6 MW, ~ 4M€/station)

Ten-T Comprehensive
(1,5 MW, ~ 1,7M€/station)

Spain 2030	Energy consumption	Installed Capacity	Investment M€
Hubs	70%	47%	46%
Urban Nodes	14%	11%	11%
Interurban	16%	42%	43%

- Hubs: -Certainty of charging demand.
- Interurban: -Charging infrastructure is needed in advance and it won't be profitable until ~2035.

GOVERNMENT SUPPORT

(In Spain 51% of the logistic operators own from 1 to 2 HD trucks and they have a short trip one day and a long-haul trip the next day)

To accelerate aspired HDT BEV infrastructure expansions in Europe, we identified 7 potential hurdles to overcome (1/2)



Bottleneck/Barrier		Mitigation measure
1 Network concessions & permits	Prolonged processes from first application to the final permit to build a line (e.g. 3-5 years in Germany), esp. important for public charging, where obtaining a concession proves to be more difficult due to environmental concerns and property questions • Concession: General mandate to build the grid • Permits: Legal validation to build that exact grid – incl. environmental concerns, expropriation, etc., which takes much longer	Fast-track permit process for charging-related grid extension projects Change regulation to allow operation of battery storage for DSOs to bridge time gap until network capacity is fully ramped-up
2 Regulation (of network operators)	Investment done by DSO bear the risk not being refunded by the regulatory authorities if sufficient assets utilization is not in place. DSOs cannot invest proactively in anticipation of future demand in some countries (and instead are focusing on "safer" options to invest into the grid where demand already exists). Thus losing valuable time, which is esp. important for fleet hubs because grid extension in cities is less popular, usually leading to long construction times incl. traffic implications etc.	A supportive regulatory framework to guarantee appropriate regulated return (e.g. by defining these types of investments as "non-controllable", or allowing for inclusion in the RAB[1]) Incentivization of proactive grid extension for charging hotspots (e.g. some European countries have introduced a bonus to the WACC for certain types of investments)
3 Grid stability & congestion	Grid capacity issues arise in depots in cities during peak hours & cold days, and in rural / recreational areas with lower network resilience (e.g. by simultaneously using high power chargers at same location)	Load leveling where charging rates can be changed to balance out intermittent solar and wind generation Peak shaving / Voltage- / Frequency control: Re-enforcement of grid with stationary batteries or Vehicle-to-Grid (V2G) technology using EV battery to balance load on the grid
4 Financing / Business case	High one-off upfront costs to put charging infrastructure in place combined with still higher TCO for BEV than diesel, especially during early and mid 2020s (low ramp up of penetration) does not incentivize potential investors (e.g. fleet owner)	Funding or politically secured off-balance financing mechanisms completed by regulations pushing BEV HDT adoption and charging infrastructure requirements (e.g. grid upgrades)

1. Regulatory Asset Base

Source: Industry experts, team analysis & refinement with CEO Alliance

To accelerate aspired HDT BEV infrastructure expansions in Europe, we identified 7 potential hurdles to overcome (2/2)



Bottleneck/Barrier		Mitigation measure
5 Land concession (for CPOs)	Charging related land concession requirements/restrictions hinder installation of charging infrastructure esp. for on-the-go charging (e.g. safety requirements & getting agreement from multiple involved parties)	Policy changes from the national governments combined with EU-wide land use concession policy changes
6 Parking space	HDT parking infrastructure to host future charging stations along main corridors is scarce/not sufficient (shortfall of 100k HDT parking spaces) especially for overnight charging stops along the European highways[1]	Additional creation of areas for HDTs along the main corridors to ensure sufficient and balanced on-the-go charging infrastructure, with focus on countries with highest need first (e.g. France, Spain, etc.) or using a 'per corridor' approach
7 Lack of unified standard	Globally more than a dozen plug types & communication protocols to link batteries to chargers meeting different local standards leading to higher costs, range anxiety and incompatibility. Highly relevant for seamless cross-country public charging Different charging networks with different backend solutions incl. charging services (e.g., payment, billing) and connectivity platforms (access to multiple charging networks), requiring multiple subscriptions with various providers to ensure cross-country coverage	Accelerating streamlining processes of standards Open charging HW & SW, with connected platforms and roaming agreements between remaining players in the market to provide seamless EV driver experience In-vehicle software with on-board controller that allows chargers to determine power needs and billing requirements[2]

1. EU report on Study on Safe and Secure Parking Places for Trucks, 2019; 2.Tesla already has similar software installed, with pre-charge battery warmup, and direct billing to credit card of the EV owner;

Source: Industry experts, team analysis & refinement with CEO Alliance

Electrification of transport-Context



Oil & Gas Companies



Traditional OEMs



Transport & logistic companies

short-medium term business impact



In disrupted changes, most of the industry endures a negative impact on their business, at least, in the short-medium term





Excessive noise-conflict of interests

Similarities with the **stages of grief**:

Status quo bias (present continuous approach)

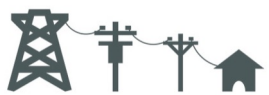
- **Denial** - "BEVs have low range, it takes many hours to recharge the batteries even on the highway and you have to change the battery at least once in the lifetime of the car"
- **Anger** – "All batteries are made in China with a generation mix full of coal"
- **Bargaining**- "We support technological neutrality" or "we have a carbon neutral approach"
- **Depression** – "We have invested huge amount of money in PHEVs and now you are planning to ban them as well"
- **Acceptance**



TESLA

New OEMs





Electric Utility Companies