Recharge EU trucks: time to act!

A roadmap for electric truck charging infrastructure deployment

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Executive Summary

Trucks account for less than 2% of the vehicles on the road but 22% of CO2 emissions from road transport. The relative share of truck emissions is bound to increase as emissions from passenger cars are driven downwards by the surge in the sales of electric cars. Europe needs a new and ambitious policy and strategy to electrify heavy duty vehicles and decarbonise the freight sector to bring it in line with the EU's Green Deal commitments.

While the European automotive sector was late in the electric car revolution, the nascent days of the shift to electric trucks open up new opportunities for the EU. All key European truck-makers will produce electric trucks in the early 2020s but there are uncertainties over the expected production volumes, partly because of the current lack of a strategic approach to electric truck charging. More generally, lack of clarity on where policymakers want to take trucks - battery electric, electric road system, hydrogen, LNG, synthetic fuels - is a key obstacle in the transition towards a decarbonised road freight sector. What type of infrastructure the EU will support in the coming years is key in this regard.

The new European framework and public funding mechanisms for infrastructure should **prioritise exclusively zero emission technologies**. Using a key EU legislation (covering alternative fuel infrastructure) to promote infrastructure for fossil fuels such as CNG and LNG would not respect the Paris Agreement or the European Green Deal. The revised infrastructure framework planned for 2021 should take electric trucks seriously, include them in the scope of the law, and set appropriate binding targets. It should also propose a realistic and cost-effective strategy to allow hydrogen and dynamically-charged trucks to develop.

The specific recharging needs of electric trucks are classified in **three categories**: depot charging, destination charging (typically at distribution centers), and public charging (along highways or at charging hubs in urban areas). T&E shows that policymakers should address - as of today - all three charging use cases and, if done adequately, **half of the distance driven by trucks in the EU could be covered by electric trucks,** thanks to new models currently coming to the market with about 300 km range (enough to cover nine trips out of ten). It is expected that the range of the electric trucks available will swiftly increase to 500 km, covering about two thirds of kilometers and 19 trips out of 20.

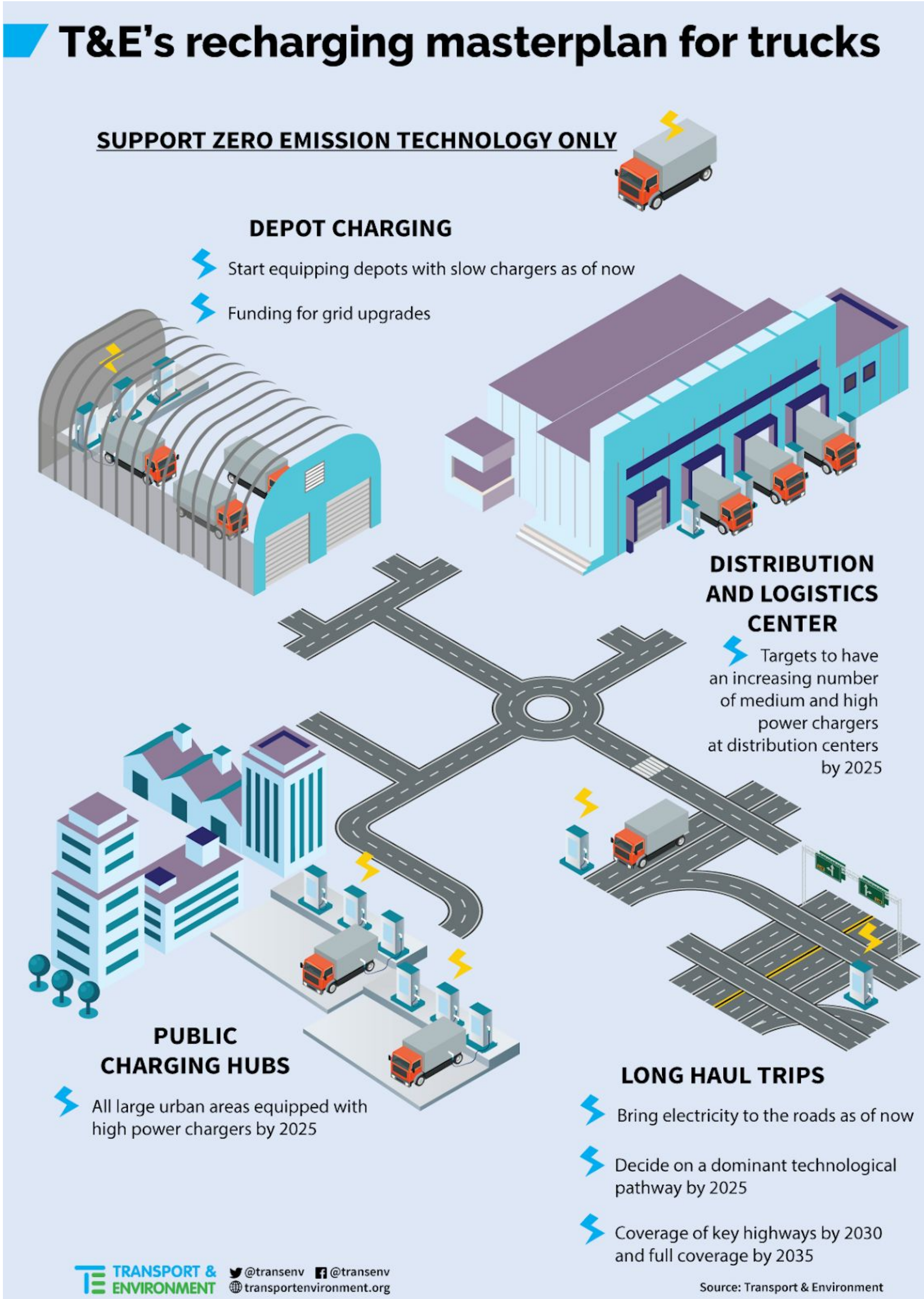
Depot charging will be about 80% of the truck charging needs in the early phases. While the current infrastructure legislation focuses on publicly accessible infrastructure, this paper examines the importance of enhancing well-positioned EU initiatives (e.g. the Connecting Europe Facility, Electricity Market Design Directive) to support the deployment of private chargers at truck depots, starting with urban nodes. Although depot charging will be predominant in the beginning, a base level of **public charging** will be necessary to serve urban and regional deliveries, with increasing dependency on public charging as longer trips are electrified.

To support this shift to electric trucks, policymakers need to use the upcoming revision of the Alternative Fuels Infrastructure Directive (AFID) to introduce the following targets:

- **Focus only on zero emission technologies** by phasing out any infrastructure targets for CNG and LNG as of 2025.
- For both 2025 and 2030, there should be binding targets for the electrification of **distribution/delivery centers and logistic hubs** (starting with the 88 TEN-T urban nodes in 2025).
- Binding Member State targets to install by 2025 high capacity **electric truck public charging stations at all 88 urban nodes of the trans-European transport network (TEN-T)**
- Binding Member State targets to install by 2030 **high capacity electric truck public charging stations along the other main nodes and the TEN-T Core network** to electrify regional delivery journeys. Infrastructure to enable **electric trucks to charge dynamically (i.e. electric road systems)** should become a recognised technology in the revised AFID to allow Member States to meet their binding targets for the TEN-T Core network.
- Binding Member State targets to **deploy a sufficient amount of electricity alongside the TEN-T Core network by 2030 and 2035** to decarbonise long-haul trucks (also necessary to recharge high numbers of electric cars).
- Targets for **hydrogen refueling infrastructure in major EU ports** to maximise the potential of ports as hydrogen hubs.

All of the points above can be prioritised as of today and constitute a 'no regret' direction that the EU can adopt. To further address long haul road freight transport, the EU should elaborate a strategy (as part of the Green Deal and the revision of the AFID and TEN-T regulation) and provide stronger policy direction for **the three zero emission truck types** (electric trucks recharging by plug, electric trucks charging dynamically, and hydrogen fuel cell trucks), vital to fully decarbonise road freight by ensuring pan-European infrastructure coverage by 2035. Whichever the zero emission technology for trucks prevail, they all rely on electricity so the future EU infrastructure laws and funding should focus on bringing the electricity the trucks.

Finally, to ensure consistency and timely application across the EU vehicle market, the AFID revision should be brought forward and become a Regulation on Recharging Infrastructure.


T&E's recharging masterplan for trucks
SUPPORT ZERO EMISSION TECHNOLOGY ONLY
DEPOT CHARGING
Start equipping depots with slow chargers as of now
Funding for grid upgrades
DISTRIBUTION AND LOGISTICS CENTER
Targets to have an increasing number of medium and high power chargers at distribution centers by 2025
PUBLIC CHARGING HUBS
All large urban areas equipped with high power chargers by 2025
LONG HAUL TRIPS
Bring electricity to the roads as of now
Decide on a dominant technological pathway by 2025
Coverage of key highways by 2030 and full coverage by 2035
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Source: Transport & Environment

Introduction

Back in 2014, when the Alternative Fuels Infrastructure Directive (AFID) was adopted, the electric truck market was virtually non existent and policymakers only had limited evidence to determine and support the alternative fuels that would replace diesel. Since then the climate impact of transport has grown bigger and emissions from heavy duty vehicles have grown by 9% over three years[1].

End of 2019, the new European Commission, led by President Ursula von der Leyen, announced in the European Green Deal[2] that it aims for zero emission mobility and a zero pollution Europe. To achieve this, the European Commission has announced the following two levers with regards to infrastructure: the review of the AFID in 2021 to 'accelerate the deployment of zero- and low-emission vehicles' and the deployment of a 'funding call to support the deployment of public recharging and refuelling points' from 2020[3].

In addition to the EU's political commitment to carbon neutrality by mid century, many elements that seemed uncertain in 2014 have become much clearer, in particular the rapid technological maturity of battery and charging technology, and announcements by truckmakers to produce and sell zero emission trucks. The moment is now right for the European Commission to come forward with a plan to deploy a pan-European electric truck charging infrastructure network that will help Europe complete the transition to zero emission road freight.

This report presents T&E's strategy to deploy charging infrastructure for the electric trucks coming to the European market in the next decade, including novel ideas and recommendations as well as top priorities for the revision of the Alternative Fuels Infrastructure Directive. Section 1 stresses that the existing directive is not fit for electric trucks while giving an overview of the future of the future truck market, Section 2, lays out T&E's roadmap showing how electric trucks would first penetrate within urban trips and later reach the longer haul segments. Each of the identified use cases would have different requirements for each charging pattern (depot charging, destination charging and public charging). Finally, Section 3 presents T&E's policy recommendations for deployment of electric truck charging infrastructure in order to accompany the expected electric truck uptake laid out in the previous section.

T&E is planning an upcoming report that analyses truck flows in Europe based on the roadmap and recommendations set out in this paper.

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[1] UNFCCC data, from 2014 to 2017. Heavy duty vehicles include trucks and buses above 3.5t
[2] The European Green Deal presents key political directions, flagships and funding mechanisms to support decarbonisation, including the deployment of charging infrastructure.
[3] European Commission communication on the European Green Deal on the 11th of December COM(2019) 640 final, Annex.

1. Why the current AFID is not fit for electric trucks

1.1 Electric trucks are coming and need charging

Electric trucks are being embraced by all major European truckmakers. This is driven by the newly adopted heavy-duty vehicle CO2 emission standards (15% average emission reduction by 2025 and 30% by 2030 compared to 2019 levels[4]), improving technological maturity, better cost-effectiveness, city air quality restrictions (e.g. zero and low emission zones), additional maximum permissible weight allowance (zero emission trucks are allowed to carry two extra tons) and the incentive mechanism for zero- and low-emission vehicles (benchmark-based crediting system set at 2% after 2025)[5]. Political pressure is high with the European Commission targeting 90% reduction of transport emissions by 2050 and planning to "ensure a clear pathway from 2025 onwards towards zero-emission mobility". In its recent 2030 Climate Action Programme[6], the German government set the goal that by 2030, one-third of truck traffic shall be powered by electricity (directly and indirectly).

As a result, Daimler Trucks - the world's largest truckmaker - committed in October 2019 to sell only zero emission vehicles by 2039[7] and to abandon the development of natural-gas powered trucks[8] while Volvo and Scania CEOs recently stressed that electrification of HDVs is crucial to reach climate targets[9].

In practice, major truckmakers are starting production of electric trucks in the next couple of years (see Table 1 below). Both Volvo Trucks[10] and Renault Trucks started production in 2019, while Daimler Trucks and MAN plan series production for 2021. DAF has not announced a production date yet but, with its production partner VDL, has already delivered several vehicles[11]. Scania currently only plans a

[4] It is also worth noting that the 2030 truck CO2 standard, currently envisaged as a 30% reduction, can be revised in either direction after a new proposal in 2022: in real political terms, however, the real pressure, both from progressive companies and wider stakeholders, will be for its increase.
[5] The average specific CO2 emissions of a manufacturer are adjusted downwards if the share of ZLEV in its entire new heavy-duty vehicles fleet exceeds the 2% benchmark. The 2030 benchmark level will have to be set in the context of the 2022 review
[6] BMU (2019), Klimaschutzprogramm 2030 der Bundesregierung zur Umsetzung des Klimaschutzplans 2050. Link
[7] Daimler Trucks & Buses targets completely CO2-neutral fleet of new vehicles by 2039 in key regions, Press Release, October 25,2019. Link
[8] Bloomberg, Daimler Dumps Gas-Powered Truck Bid to Build CO2-Neutral Fleet, October 2019. Link
[9] Henrik Henriksson (CEO Scanai Group) and Martin Lundstedt (CEO Volvo Trucks), No more hesitation; take decisions to build electric roads now, September 2019. Link
[10] Volvo Trucks Launches Sales of Electric Trucks for Urban Transport, PRNewswire, November 2019. Link
[11] Jumbo takes delivery of first DAF CF Electric, Press Release, DAF.com, December 2018. Link

hybrid truck with pantograph charging[12]. Iveco's current electric freight vehicle production focuses on the Daily electric van (not shown in the table below) but will, among other initiatives, partner with Nikola to deliver battery electric trucks with a range of about 500 km in 2021[13]. Overall, the new electric trucks from EU OEMs will mainly focus on urban and regional delivery with ranges up to 300 km.

	Model	Stage	Production	GVW	Battery	Range	Source
Daimler Trucks	eCanter	In production		7.5 tonne	83 kWh	120 km	(Mitsubishi Fuso, 2017)
	eActros	Customer tests	2021	26 tonne	240 kWh	200 km	(Daimler AG, 2018)
MAN	eTGM, 6x2	Customer tests	2021	26 tonne	225 kWh	200 km	(electrive.net, 2018)
	eTGM, 4x2	Customer tests	2021	32 tonne	149 kWh	130 km	(eurotransport.de, 2018)
	CitE	Prototype	2021	15 tonne	110 kWh	100 km	(MAN AG, 2019)
Volvo Trucks	FL Electric	Customer tests	2019	16 tonne	300 kWh	300 km	(AB Volvo, 2018a)
	FE Electric	Customer tests	2019	27 tonne	300 kWh	200 km	(AB Volvo, 2018b)
Renault Trucks	D Z.E.	Customer tests	2019	16 tonne	300 kWh	300 km	(Renault Trucks, 2018)
	D Wide Z.E.	Customer tests	2019	26 tonne	200 kWh	200 km	(Renault Trucks, 2018)
DAF	LF Electric	Customer tests	Not announced	19 tonne	222 kWh	220 km	(DAF, 2018a)
	CF Electric	Customer tests	Not announced	37 tonne	170 kWh	100 km	(DAF, 2018b)

Table 1: Electric trucks from main truck makers in the EU (Source: ICCT[14])

On the demand side, users are showing increasing appetite for zero emissions trucks. Big businesses have joined forces several times to ask for more supply of zero emission trucks. In November 2019, on the eve of the European Green Deal, a group of leading companies wrote to the European Commission's president and first vice president asking them to bring forward measures compelling truck-makers to produce and sell zero-emission vehicles.[15] In February 2019, large companies including Nestlé, along with retailers Carrefour and Spar Austria, and transport companies Alstom, Geodis and DB Schenker, asked policymakers and negotiators for strong legislation on truck CO2

[12] Traton (formerly Volkswagen Truck & Bus), the parent company of Scania and MAN claims in an article that "the future of urban transport is going electric". Link.
[13] Reuters, CNH Industrial's Iveco unveils first electric truck in partnership with Nikola, December 2019. Link
[14] ICCT (2019), The future of VECTO: CO2 certification of advanced heavy-duty vehicles in the European Union. Link
[15] Financial Times, Companies say Brussels must help boost green truck production. Link

emission standards[16]. A similar letter was sent in April 2018 by Carrefour, IKEA, Unilever, Heineken, Nestlé, Geodis, national transport associations and other big players[17].

There are today already examples of electric truck operations in Europe with the notable examples of DB Schenker and DHL operating the Daimler e-Canter[18] as well as many consumer tests across Europe with other electric trucks. Cities like Amsterdam and Rotterdam want to reach zero emission urban logistics by 2025 which would for example require all 3,500 trucks and 25,000 vans that drive into the city of Amsterdam to electrify[19].

Thanks to dropping battery prices (from 1,183 $/kWh in 2010 to 156$/kWh in 2019, an 87% drop in 9 years) and technological progress on the energy and power density of batteries, electric trucks are already or will soon become a cost competitive option (compared to diesel). According to McKinsey[20], in Europe, long haul heavy duty electric trucks will be cost-competitive by 2031 at the latest, while for regional haul, heavy duty electric trucks reach price parity by 2029 and medium duty trucks by 2023 (see Figure 1 below). Some light duty and medium duty trucks are already cost competitive today. A T&E cost analysis from 2018[21] showed that battery electric trucks are more cost competitive for long haul applications than previously considered once a number of key enablers are put in place. Scania estimates that battery electric trucks would hit price parity with diesel trucks for long haul in 2027[22].

[16] Transport & Environment (2019), Nestlé, Carrefour and Alstom among businesses calling for strong sales target for cleaner trucks. Link

[17] Transport & Environment (2018), IKEA, Unilever, Carrefour and Nestlé among companies, logistics groups and hauliers asking Juncker to target 24% cut in truck CO2. Link

[18] http://www.efuso.jp/ecanter/

[19] https://frevue.eu/cities/amsterdam/

[20] McKinsey (2018), What's sparking electric-vehicle adoption in the truck industry? Link

[21] Earl et al., (2018). Analysis of long haul battery electric trucks in EU. Link

[22] Scania (2018), The pathway study: Achieving fossil-free commercial transport by 2050. Link

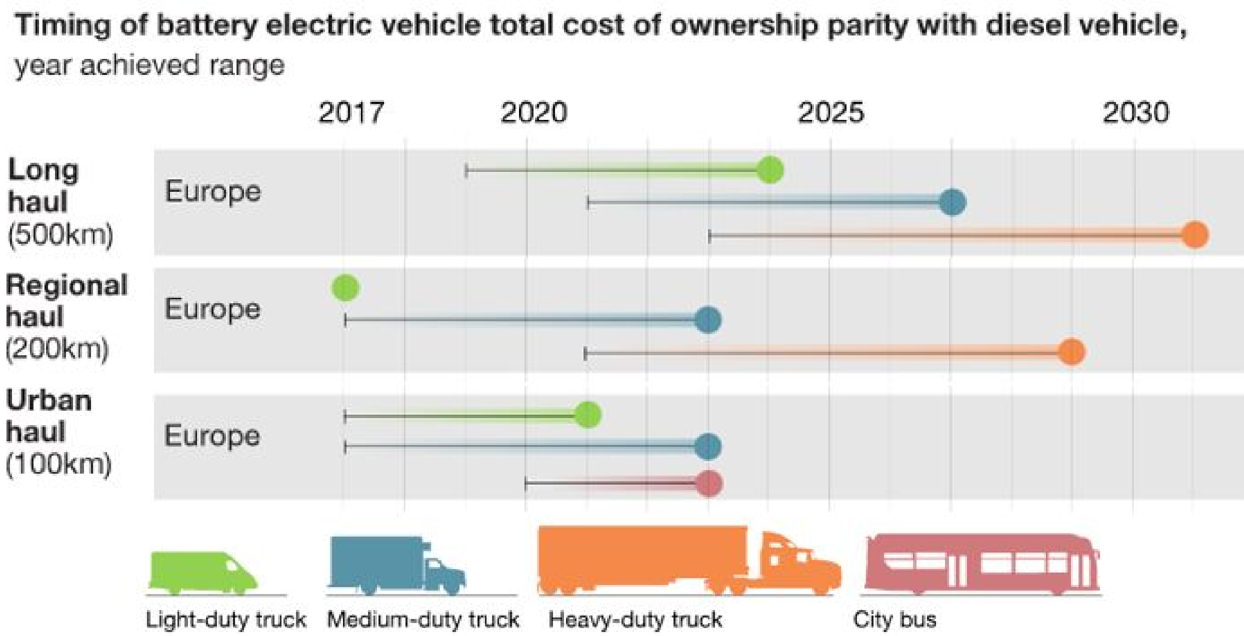


Figure 1: Cost parity timeline of electric vehicles with diesel in Europe

Based on current market trends, it is evident that electric trucks are the preferred technology to decarbonise road freight transport for urban and regional delivery. While there is progress there remains uncertainty over the resulting volume of electric truck sales that we will witness on the road in the 2020s, partly because of the current lack of a strategic approach to electric truck charging. To ensure a speedy uptake of electric truck sales, it is key that the provision of charging infrastructure ramps up in line with the sales of electric trucks. A clear plan on infrastructure will be the game-changer for the future of European trucks.

1.2 Current AFID is not fit for electric trucks

The Directive on the deployment of Alternative Fuels Infrastructure, or AFID, sets a regulatory framework for the roll out of public recharging and refuelling infrastructure for the following alternative fuels in transport: electricity, CNG, LNG and hydrogen. Ultimately, the goal of the directive is to provide long-term policy certainty for markets and create an interoperable EU backbone infrastructure by 2025 to allow the EU to successfully make the transition to low and zero emission mobility and ensure that vehicles can travel and refuel cross-border.

The current Directive however fails completely to consider charging infrastructure for electric trucks and vans[23] and only sets targets for natural gas refuelling infrastructure which conflicts with the European Green Deal of the Paris climate accord (see Section 1.3 below). The current Directive also includes voluntary targets for hydrogen refuelling infrastructure - but there is no evidence that this provision has had any impact.

1.3 Current AFID sets no pathway for truck decarbonisation

Evidence shows that there are no significant climate benefits in shifting from diesel to fossil gas and that **LNG trucks will not decarbonise road freight.**

ICCT has calculated that the lifecycle benefits of LNG trucks in 2020 in Europe compared to diesel trucks is only 7% for spark ignition or 3% for compressed ignition (see Figure 2 below). T&E analysis shows that on a well-to-wheel basis, gas trucks reduce emissions by 0.4% to 7.2% compared to the average diesel truck. Compared to the best in class diesel, gas truck performance ranges from a reduction of 2% to even an increase of 5.1%[24].

Figure 2: Lifecycle emissions from heavy duty vehicles (Source: ICCT[25])

[23] This paper focuses on both trucks and vans, i.e. road freight vehicles.
[24] Transport & Environment (2018), Natural gas-powered vehicles and ships - the facts. Link
[25] ICCT (2017), Transitioning to zero-emission heavy-duty freight vehicles. Link

There are also some concerns about the level of methane emissions from leakage (occurring through the supply chain) and slips (in the vehicle) and well as upstream emissions which would further worsen the climate performance of gas trucks. Given that methane is a very potent greenhouse gas, major damage is done in the short term, which is the critical period in which emissions must fall the fastest[26]. In addition, recent on-road tests have shown that gas trucks can perform worse than diesel trucks when it comes to air pollution[27].

Finally, the latest evidence shows that volume of renewable gas that can be sustainably and cost-effectively produced is limited, and that it would not be sufficient to meet the relevant demand from transport[28]. As shown in Figure 3 below, the total renewable methane potential in the EU in 2050 is 589 PJ (assuming all available renewable methane potential is supplied to the transport sector and costs are six times higher than the current price level of methane in transport), which is only 11% of the total demand from heavy duty vehicles and ships (5288 PJ in total: 2731 PJ from trucks, 2075 PJ from ships and 482 PJ from buses). This limited amount of sustainable biomethane should be dedicated to harder-to-decarbonise sectors that do not have a clear pathway towards zero (e.g. heavy industry or heating). ICCT stresses further that there is no climate or other benefit in prioritising gaseous over liquid fuels.

[26] Methane is a very powerful greenhouse gas. Over a period of 100 years, it is 28 times more potent than CO2 and 84 times more potent over 20 years. Methane leakage is currently estimated at 2.2% on average of fossil gas produced, with estimates ranging from 0.2% to 10%. Source: T&E (2018), CNG and LNG for vehicles and ships - the facts.
[27] Transport & Environment (2019), Do gas trucks reduce emissions? Link
[28] ICCT (2018), What is the role for renewable methane in European decarbonization? Link

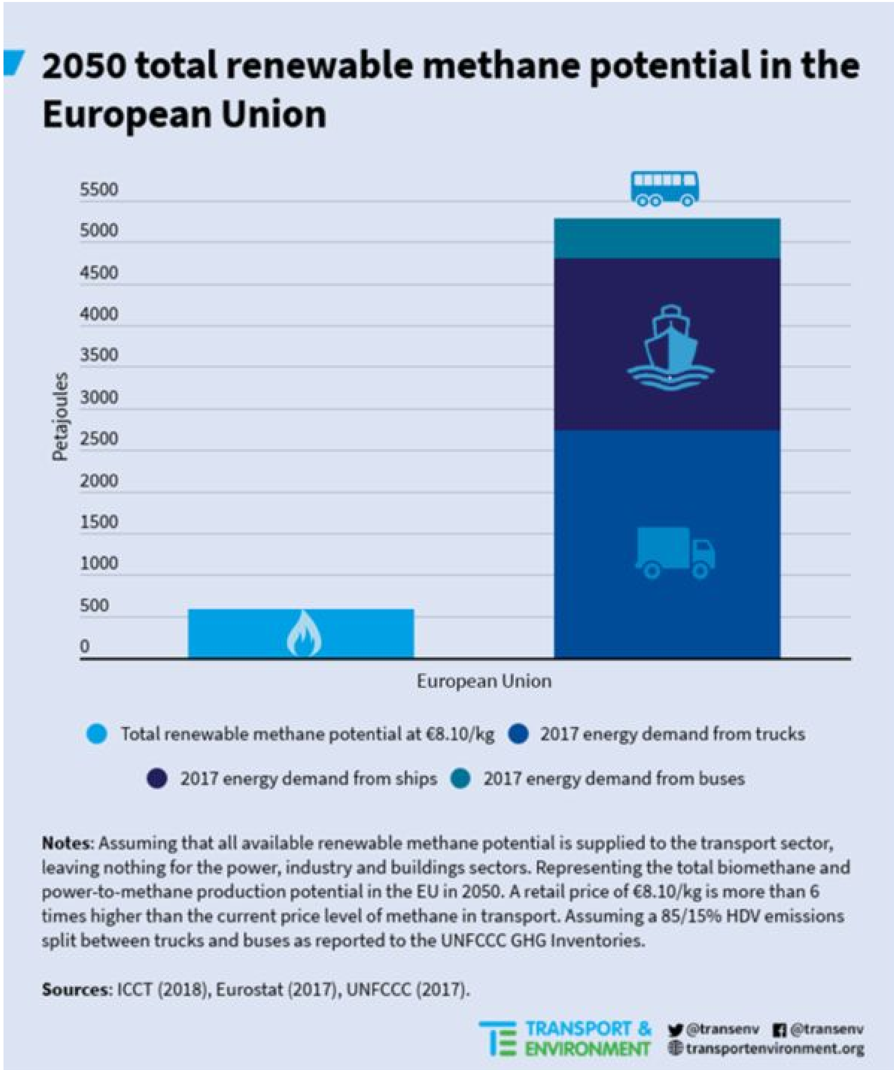


Figure 3: 2050 total renewable methane potential in the EU

Scania made a similar assessment at global level and showed that if exclusively used for commercial transport, biofuels could supply a maximum of 20 percent of 2050 global commercial transport demand. However, the truckmaker notes that "since there will be competing demand from applications that are more challenging to electrify, such as marine and air transport, this maximum is unlikely"[29].

[29] Scania (2018), The pathway study: Achieving fossil-free commercial transport by 2050. Link

This should be reflected in the revised AFID, which should drop targets for gas refuelling infrastructure and clearly prioritise zero emission mobility - electricity and hydrogen - as the only way towards zero emission mobility and a zero pollution EU as laid out by the European Green Deal.

1.4 Going from a Directive to a Regulation for a swift and harmonised adoption

The Directive on Alternative Fuels Infrastructure led to inconsistent national implementation, putting some regions and citizens at risk to be left behind in the e-mobility transition and greatly reducing the business and scaling opportunities for market players across Europe. This led to a fragmented market for the deployment of recharging and refuelling points for cars with countries prioritising different technological pathways[30]. Without a harmonised framework, this is likely to happen again for the roll-out of electric truck charging infrastructure.

The revision of the current Directive should be brought forward to 2020 rather than 2021 as announced on the communication of the European Green Deal and should be turned into a Regulation on Recharging Infrastructure (rather than wider Alternative Fuels Infrastructure), in line with the EU proportionality principle.

Given that series production of electric trucks will start in the early 2020s in Europe, it is key that Europeans have access to an interoperable, comprehensive and functioning charging network across the Union. It is high time that the revised framework starts taking electric trucks seriously by including them in the scope of the technologies and setting appropriate binding targets. This opportunity can not be missed as it would put a halt to the development of a new market where European industry stands a chance for global leadership[31].

[30] Transport & Environment (2020), RechargeEU: How many charge points will Europe and its members need in the 2002s? Link.
[31] E-trucks: European automakers' third and final chance to get electrification right. E-trucks are the third chapter of vehicle electrification – European automakers lagged far behind in the first two: electric cars and e-buses. Link

2. A roadmap for electric truck charging infrastructure deployment

Electric trucks and electric cars have very different recharging needs and these differences should be considered in the scope of future infrastructure frameworks such as the upcoming AFID revision. In this section, T&E outlines the specific recharging needs of electric trucks and how the revision of the AFID can correctly address them.

Before going into more detail, it is important to underline that there are three different use cases for electric truck recharging: depot/private, destination and public charging. These terms are increasingly used among industry experts and accurately depict the situations where an electric truck can be expected to charge:

- **Depot charging:** Overnight charging at the transport operator's depot.
- **Destination charging**: Charging at distribution centers during the day while loading and unloading.
- **Public charging:** During the day or night at locations that are publically accessible for trucks that are aligned with existing parking times. For example hubs for mid-day breaks, resting areas and ports when trucks queue.

In the following section, T&E makes the case that based on the future market development, Europe should first focus on the roll-out of depot and destination charging for urban and regional delivery applications although also a small level of public charging will be necessary for these applications. In the next stage, public charging should be tackled more as electric trucks will cover longer distances and will need to recharge within urban areas as well as along the key highways.

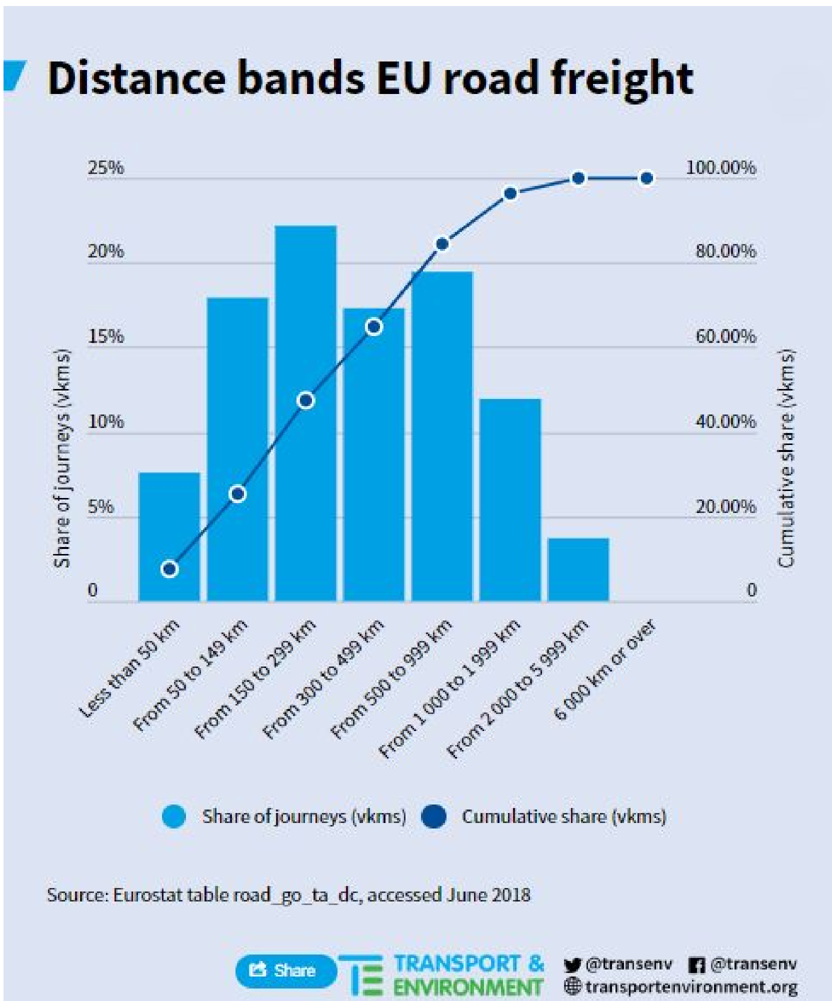
2.1 First step: Urban and regional deliveries (return-to-depot applications)

As noted above, and backed up by market developments and techno-economic considerations, for urban and regional delivery applications, the most promising technology is battery electric trucks and vans. Battery electric freight vehicles will penetrate first these urban and regional delivery applications. These vehicles are expected to electrify at a fast pace as the demand for electric freight vehicles is driven by competitive total-cost of ownership[32], better driver comfort, much lower noise levels (8 times lower according to Renault Trucks), reduced congestion[33] and air quality benefits in cities.

[32] ICCT (2019), Estimating the infrastructure needs and costs for the launch of zero-emission trucks. Link
[33] According to Renault Trucks, electric trucks lower congestion in cities because they can silently make deliveries at night time, thus shifting deliveries outside of peak hours. Link

While urban delivery applications only cover one city or urban area, regional delivery trucks perform inter-city trips. Urban and regional applications have in common that they return home overnight and typically have pre-established routes and operations during the day. This allows transport operators to plan trips and charging needs in a very similar way to electric buses.

Trucks with 200 to 300 km of range can cover most of the urban and regional delivery requirements. **In the EU, almost half (47%) of road freight kilometers are trips of less than 300 km and represent 90% of the transport operations** (see Figure 4 below and Annex 3 for more charts). For urban deliveries only, trucks with 200 km or 300 km range would cover a high share of applications. For example, Renault Trucks estimates that an electric truck with a 200 km range would be sufficient to cover 76% of city deliveries[34]. This means that by providing the infrastructure for urban and regional trucks, Europe could already tackle a major share of truck emissions.



[34] https://switch-to-electric.com/

Figure 4: European road freight transport by distance class, 2017[35]

According to a truckmaker's ongoing project[36], it is estimated that about 80% of the energy recharged by electric trucks will be done while charging at the depot, while destination charging covers 15% of the total energy, and public charging about 5% (this covers preliminary findings for trucks that have a 'return-to-base' application, i.e. urban and regional deliveries). CE Delft found some very similar results in a study on charging demand for trucks within Greater Amsterdam where depot, destination and public charging would respectively account for 78% (64% during the night and 14% during the day), 16% and 6% of total energy demand, see Table 2 below. This illustrates that electric truck recharging needs are three-fold and a comprehensive approach on all three charging use cases is necessary to address all urban and regional delivery applications.

	MWh/year	Share of total (%)	Average daily energy per truck per day (kWh)[37]
Depot	369,081	78%	215
Destination	73,554	16%	43
Public	28,143	6%	16
Total	470,778	-	274

Table 2: Charging demand for trucks within Greater Amsterdam. Source: CE Delft[38]

The vast majority of energy is charged at the depot chargers but both destination chargers and public charge points are also needed. Firstly destination charging at logistics centers is a logical way to add up to several hundreds of kilometers of range per day while not altering the use case of the truck since all trucks stay immobile typically for more than 30 minutes for each loading or unloading. With charging provided at the loading or unloading dock, a cost effective and business friendly approach to charging is provided to parked trucks with charging solution of 350 kW or more.

Secondly, evidence that urban and regional delivery also rely on public charging confirms existing and previous projects (e.g. FREVUE[39] and ASSURED[40]) that have pointed to the role public

[35] To find country-specific information on road freight transport by trip distance class, see: transenv.eu/trucktransportbydistanceclass or here.
[36] Preliminary findings from a major truckmaker on 'return-to-base' applications only.
[37] The number of trucks that (regularly) visit the Amsterdam environmental zone is estimated at 4,700 vehicles by CE Delft. These trucks drive an annual distance of about 70,000 km,
[38] CE Delft (2019), Charging infrastructure for electric vehicles in city logistics. Link
[39] Experience shows that drivers of commercial electric vehicles are frequent users of fast chargers in Stockholm in Oslo during the FREVUE project (017). Link

electric truck charging infrastructure needs to play in urban areas to reduce range anxiety, save time and provide flexible charging. Volkswagen Commercial Vehicles is also showing the necessity to deploy public charge points as it is already deploying 50 public charge points on public parking lots around its site in Hannover.[41]

To be effective, legislation on infrastructure for trucks should tackle all depot, destination and public charging with effective tailored measures (see more in Section 3 below).

2.2 Second step: Public charging infrastructure at urban nodes and along the TEN-T

As electric truck range grows with improvements in battery technology, trucks will become more flexible and increasingly cost-competitive (Figure 1) allowing electric trucks to go from urban and regional logistics with a maximum of a couple hundred kilometers per day, to long haul operations covered by larger electric trucks. As journey profiles increasingly reach beyond the range of the vehicle, public charging (e.g. during driver's breaks) is increasingly necessary in order to reach the next destination or get back to the depot.

Therefore, public charging hubs at urban nodes along the main European corridors should be built to allow deliveries between cities for trucks driving beyond the range of the vehicle over a given day. As the network of public chargers grows, the maximum distance possible on a single charge will diminish in relative importance. This will effectively enable truck operators to switch to electric trucks for most of their operations as only 5% of truck trips are more than 500 km (Figure 4).

Truck manufacturers are already planning this next step with adapted products. For example, Daimler is planning to bring a larger and heavier electric semi tractor-trailer to Europe[42], which could be similar the Daimler eCascadia 36-40t electric truck with 400 km range[43] and Nikola will be producing the Nikola Tre BEV (range up to 483 km)[44].

In Table 3 below, the two electric delivery truck use cases described in 2.1 and 2.2 are illustrated in more detail. It shows that with the adequate electric trucks, already 64% of the vehicle kilometers as well as 95% of the trips in Europe can be electrified.

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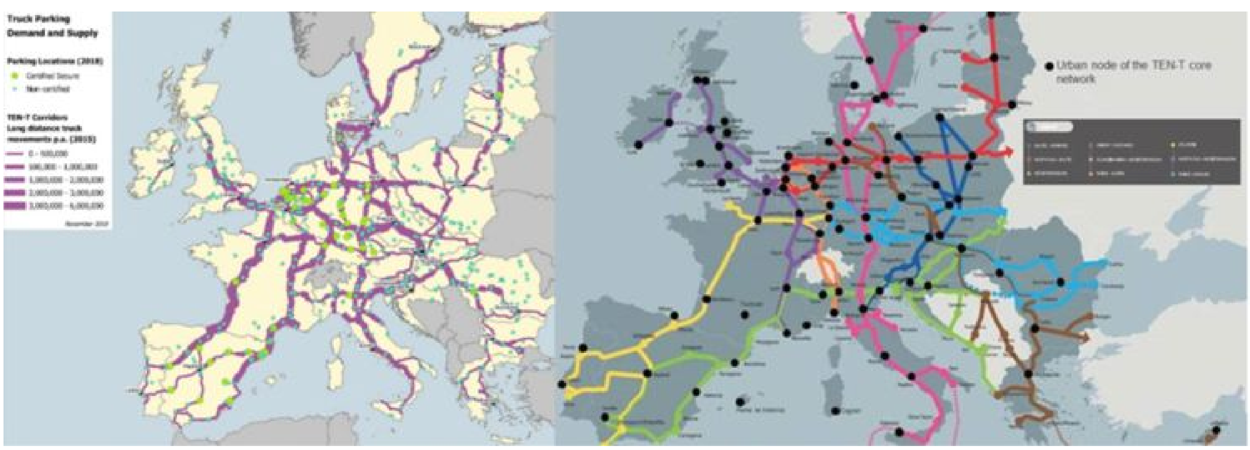
[40] Experience from ASSURED shows that electric buses and different types of electric trucks could share fast charging infrastructure during the day as their charging peaks are not concomitant.
[41] Volkswagen Commercial Vehicles has commissioned 50 public charge points on public parking lots around its site in Hanover and 50 others at its plant. Link
[42] Daimler plans the next step in electrical development with a tractor-trailer, Boarse.de, February 2019. Link
[43] Electrive.com
[44] Electrive.com

Range	Applications	Battery size	Recharging time (overnight)[45]	Recharging time (opportunity)[46]	Share of v.km covered[47]	Share of trips covered	Example
200 - 300 km	Urban deliveries and predictable regional deliveries	200 - 300 kWh	3-5 h @ 50 kW	30-45 min @ 400 kW	47%	90%	Volvo FL/FE Electric, Daimler eActros
400 - 500 km	Regional deliveries and predictable long haul	550 - 750 kWh	5-7 h @ 100 kW	30-45 min @ 1 MW	64%	95%	Daimler eCascadia, Nikola Tre

Table 3: Illustration of typical electric truck use cases

To work most effectively, these public charge points should be used via a pre-booking system and be convenient for lunch stop and other breaks. To maximise utilisation rates of the chargers and thus improve the business case, chargers should be placed in strategic high traffic locations. The urban nodes are an evident choice as a very high share of the truck traffic flows circulate through these nodes. Importantly, public chargers located along key TEN-T Core networks would also be necessary to enable trips between key urban areas that are too distant from each other (see Figure 5 below).



[45] Assumptions: charging 80% of the battery with a 90% charging efficiency
[46] Assumptions: charging 80% of the battery with a 80% charging efficiency
[47] Share of total EU road freight kilometers driven by trucks that are undertaken over trips that are less than 300 km and 500 km.

Figure 5: Truck movement on the TEN-T Corridors[48] (left) and TEN-T Core network and urban nodes (right)

2.3 Third and final step: Long haul: different electrification pathways

Battery electric trucks have the possibility to charge statically with a plug or dynamically while moving with a catenary system, a rail or by induction. These two solutions (static and dynamic charging) offer different sets of advantages and disadvantages and will serve different applications.

Figure 6: Examples of electric truck charging (from left to right): dynamic via catenary, dynamic via induction, static via plug, dynamic via rail

Several studies find that the deployment of a **pan-European dynamic charging system** is the most cost-efficient and climate-friendly. However, the roll out of such a network will be challenging as it requires strong policy commitment and wide action across all European Member States and industry partners. There are currently several companies that are competing to impose their technology as the widely accepted standard. For example, Siemens and Scania champion the catenary electric road with a existing pilot projects in Sweden and Germany[49] while Alstom advocates for a ground-based electric rail charging system. In the recommendations below, T&E stresses the need for a single dynamic charging system standard set by EU authorities by 2023. Standardisation of dynamic charging within 3 years by the EU is a critical step for the large scale roll-out of interoperable dynamic charging. Without an EU-backed standardisation process, dynamic charging will make little progress as Member States either await standardisation, sponsor non-interoperable systems, or some combination of both.

On the other hand, battery electric trucks can charge statically at '**megacharger' (also called HPCCV or High Power Charging for Commercial Vehicles)** sites along the main highways and placed at truck rest areas and natural stops on the roads. Truck drivers are mandated to take a 45

[48] European Commission (2019), Study on Safe and Secure Parking Places for Trucks. Link

[49] Other countries such as France, the UK, Netherlands, Austria and Hungary are also showing interest. A third field trial will be located in Baden-Württemberg, about 1h from Strasbourg.

minute break every 4.5 hours (EU Regulation (EC)561/2006), and this time period could be used to recharge the trucks' batteries.

Both static and dynamic charging may co-exist in the future. Far from being mutually exclusive, they would both reinforce the potential of battery electric trucks to rapidly and effectively decarbonise road freight transport. An initial deployment of static charging would kick-start the electric truck ecosystem in urban and regional deliveries up to the 'critical mass' required to effectively roll out dynamic charging infrastructure. Indeed, dynamic charging systems require a minimum number of electric trucks on the roads to be deployed to guarantee a business case when about 16,000 km would be sufficient to have coverage of the TEN-T Core network[50]. As stated by Volvo and Scania, fortunately, electric trucks can be quite simply adapted to varying technologies[51].

Hydrogen fuel cell electric trucks could be part of the solution in particular for long distance applications where a combination of range and flexibility is necessary. A system fully relying on hydrogen would need to overcome challenges associated with the need to produce hydrogen on a very large scale and the costs associated with that (including for the end user: the trucking companies). The production of hydrogen through electrolysis and renewables (green hydrogen) requires much more renewable electricity than directly charging a battery. The overall efficiency of the direct electrification pathway is about 77% while it is 33% for hydrogen, or about 2.3 times less efficient, see Annex 2 for details. Several studies have also identified the hydrogen pathway for heavy duty vehicles as a less cost-effective pathway compared to direct electrification[52]. Hydrogen will also be required for other applications such as industry, shipping, as a source for efuels for aviation, and potentially for heating. In other words, the challenge would rest on supplying all of these all of these sectors with green hydrogen, whilst simultaneously shifting a major part of the road transport sector to it. However, in a scenario where renewable electricity becomes very cheap and can be deployed rapidly and at enormous scale, i.e. imported from outside Europe, some stakeholders expect the efficiency and cost challenges that hydrogen currently faces can be overcome.

Direct electrification is the most energy-effective solution to reach zero emissions by 2050[53] which is the priority of the new European Commission. However, hydrogen and battery electric trucks solutions are not mutually exclusive and could co-exist. For example, some applications for hydrogen where there is a surplus of renewable energy generated can be envisaged or, as identified by the ICCT, hydrogen trucks could have some promising applications for drayage trucks around ports.

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[50] European Climate Foundation (2018), Trucking into a greener future. Link

[51] Henrik Henriksson (CEO Scanai Group) and Martin Lundstedt (CEO Volvo Trucks), No more hesitation; take decisions to build electric roads now, September 2019. Link

[52] ICCT (2017), Transitioning to zero-emission heavy-duty freight vehicles. Link
European Climate Foundation (2018), Trucking into a greener future. Link
Scania (2018), The pathway study: Achieving fossil-free commercial transport by 2050. Link

[53] Transport & Environment (2017), Roadmap to climate-friendly land freight and buses in Europe. Link

Box: future proof charging infrastructure and autonomous trucks
Autonomous trucks are likely to become a reality at some point in the future and these trucks would have the ability to drive without having to stop for mandatory breaks. An autonomous truck that stops to charge would harm its business case compared to a truck that can drive 24/7 and charge while moving. Under this logic, dynamic charging infrastructure could be considered the most future-proof solution.

Furthermore, it should be noted that all electric trucks could benefit from a dynamic charging system as the charging solution and the technologies are not mutually exclusive. In particular hydrogen trucks have a small battery (for assisting the fuel cell when needed and for regenerative braking of the electric motor), which could be combined with dynamic charging systems effectively making the hydrogen fuel cell serve as a range extender with most of the operation running on direct electricity.

2.4 Planning electricity grid integration to reduce costs

The power requirements for electric truck chargers, in particular high power opportunity charging (HPCCVs), can be significant and will entail grid upgrades in many cases. At megawatt capacity, electricity grid infrastructure can be costly as the charging site needs to be connected to a medium voltage electricity grid which can require important civil engineering work to deploy the cables. Nonetheless, installation of connections of up to several dozens of MWs are common for grid operators, especially when connecting industrial sites. Grid operators - Distribution System Operators and in some cases Transmission System Operators - and transport companies using electric trucks will need to cooperate on smart infrastructure planning to reduce network and installation costs by relying on an ‘optimisation by location’ strategy for HPCCVs in particular. In other words, planning of HPCCVs needs to take into account the pre-existing grid infrastructure, including the location of high or medium voltage lines, which would help reduce the distance over which the new grid has to be deployed. Consideration must also be given to combining grid upgrade works with future-proof infrastructure deployment plans (i.e. preparing the grid capacity to be EV-ready), with such master-planning to ensure that local authorities and the electricity sector plan ahead.

Companies could also reduce the grid impacts of electric trucks thanks to ‘behind the meter optimisation’ by balancing the charging load between several charging applications which would smoothen the power demand curve. Also, stationary batteries could charge at a slow rate when there is an excess of renewable electricity and redistribute the energy to supply electricity when there is high charging demand. Dynamic time-of-use pricing of electricity[54] will strengthen the interest in

[54] Implementing the provisions of the Electricity Market Design Directive and Regulation on dynamic time-of-use pricing, the role of aggregators, flexible network tariffs will give a financial incentive for companies to use off-peak charging, provided the necessary smart functionalities are present.

integrating smart functionalities and enable companies to adjust charging by responding to price and grid signals or local renewable electricity generation. This would be most effective for slower depot charging where there is more flexible charging demand.

2.5 Industry's call for action

T&E's roadmap for the deployment of charging infrastructure in the EU is aligned with industry calls for the roll out of charging infrastructure. ACEA, the association of the European cars and truck makers recently published their '10-point plan to help implement the European Green Deal' in January 2020. Point #4 calls for an urgent deployment of an 'EU-wide network of charging points and refuelling stations suitable for passenger cars and commercial vehicles'. ACEA also calls for an 'ambitious review of the Alternative Fuels Infrastructure Directive' which would set 'mandatory targets for charging points'[55]. The industry calls further for that the 'AFID review should take account of the specific requirements of the heavy-duty segment, as their needs in terms of charging/fuelling capacity and location of infrastructure differs greatly from cars'.

T&E shares the view that an ambitious AFID revision is indeed one of the most important enablers to achieve carbon neutrality, including for commercial vehicles.

Individual CEO and companies have also put forward a more specific call for action. In their joint letter[56], Volvo and Scania CEOs have asked for a large-scale expansion of both e-roads and charging infrastructure for trucks insisting that both static and electric road technologies are "already sufficiently mature to be implemented as soon as there is an established charging infrastructure". They point out there's "no reason to delay the first steps" of infrastructure deployment, and that "in order to make the greatest climate contribution, we propose as a first step that charging stations should initially be built adjacent to common rest areas by roads with large transport flows". The next section presents T&E's recommendations on how to address these first steps (as well as the following ones) in the upcoming revision of the AFID.

[55] ACEA (2019), Paving the way to carbon-neutral transport. Link
[56] Henrik Henriksson (CEO Scanai Group) and Martin Lundstedt (CEO Volvo Trucks), No more hesitation; take decisions to build electric roads now, September 2019. Link

3. Policy recommendations

The sections above map out today's landscape for zero emission trucks and T&E's roadmap for future electric truck charging needs. Some areas are particularly ripe to be served with charging infrastructure (e.g. urban and regional distribution), whereas for others, standardisation is a prior requirement for a single European approach. This section details what the EU should do first and foremost and provides clear policy measures to accompany and deliver on the above roadmap.

It is key that the European Commission plans for charging infrastructure for all heavy-duty vehicles (such as trucks, buses, coaches, and large delivery vans) and for all applications (urban delivery, regional delivery and long haul) with an initial focus on private charging infrastructure. Supporting adequate charging infrastructure deployment will give vehicle-makers and transporters visibility to plan accordingly the transition to electric, which will improve the business case of transport operators, and facilitate the uptake of electric heavy duty vehicles across the continent.

3.1 Revision of the Alternative Fuels Infrastructure Directive

Revision of the Alternative Fuels Infrastructure Directive (AFID) should ensure that the uptake of the electric truck market is accompanied by a rapid, adequate and harmonised ramp up of charging infrastructure. To achieve this, the European Commission should adopt the following recommendations in the upcoming revision of the AFID. The policy recommendations and their interaction with the roadmap described above are summarised in the timeline in Figure 7 below.

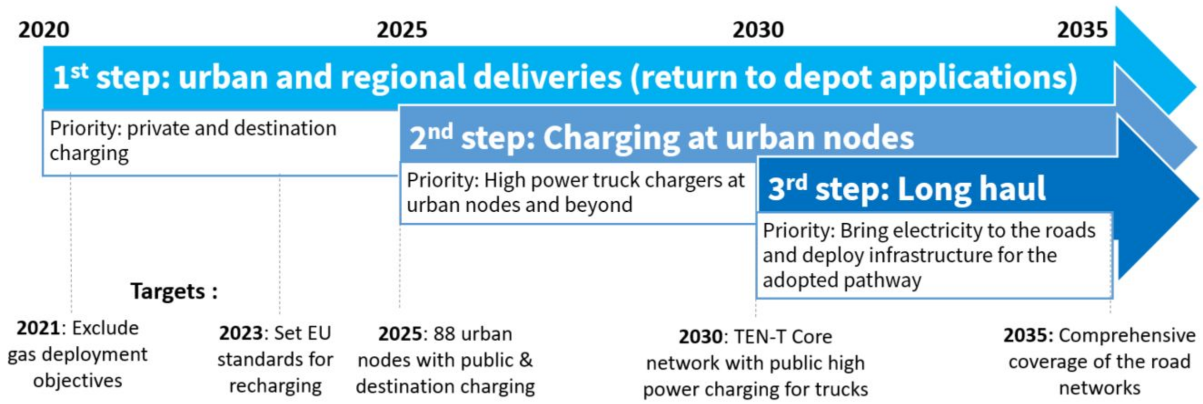

Figure 7: Summary of T&E vision for electric truck infrastructure deployment

3.1.1. No more targets for CNG and LNG infrastructure

Currently the AFID set targets for the deployment of LNG refuelling infrastructure for heavy duty vehicles with the aim of having the 'appropriate number of points along the TEN-T core network' by 2025. Targets on gas refuelling infrastructure should be taken out of the revised legislation as they are not a solution to decarbonise road freight transport. The focus needs to shift exclusively to zero emission technologies, in line with the Paris Agreement and the zero pollution objective of the European Green Deal.

3.1.2. Adopt definitions for electric truck charging infrastructure

The definition of a public charge point as considered by the AFID should be adopted based on the specific use cases of trucks. Currently the definition of recharging points accessible to the public means that it should provide non-discriminatory access to users (which may include different terms of authentication, use and payment though means of subscription)[57]. The definition of chargers should be further tailored for electric truck chargers and extended to cover fully public charge points, destination chargers and depot (private) chargers in order to cover them adequately and separately in the revised infrastructure framework:

[57] "A recharging or refuelling point accessible to the public may include, for example, privately owned recharging or refuelling points or devices accessible to the public through registration cards or fees, recharging or refuelling points of car-sharing schemes which allow access for third party users by means of subscription, or recharging or refuelling points in public parking. Recharging or refuelling points which allow private users physical access with an authorisation or a subscription should be considered to be recharging or refuelling points accessible to the public." Directive 2014/94/EU

- **Public chargers for trucks**: A public truck charger is a charger that is accessible to all, which should respect the following to be counted as such: (i) non-discriminatory access to all transport operators, (ii) include a pre-booking system, (iii) available 24/7 with strict uptime requirements, (iv) interoperable and be (v) safe and secure for trucks. Alternatively, public charge points could be called 'shared' chargers to be distinguished with the current definition of public which is tailored for light duty vehicles.
- **Destination chargers:** Destination chargers are located on private premises at distribution/logistics centers or industrial premises and are used during loading or unloading of trucks. The use of the destination chargers should be shared between the transport operators operating at the premises on a non-discriminatory basis. Some sort of identification is usually required for the trucks to access these premises (e.g. a badge or simple sign-in) but the premises are open to the relevant transport operators (similar to an electric car semi-public charger open to customers of a shop).
- **Depot / private chargers:** Private truck chargers are located on private premises and are not shared by any transport operator. Typically, these chargers are overnight chargers at depots. Here a parallel can be drawn with the residential or workplace private chargers for passenger EVs.

For all truck charging categories, and in particular for public and destination chargers, there should be some granularity on the power categorisation of the infrastructure with chargers being differentiated based on their power categories (e.g. below 350 kW, between 350 kW to 600 kW, between 600 kW and 1 MW and above 1 MW).

3.1.3 Set EU-wide public charging standards

The new infrastructure framework should adopt Union-wide common connectors for electric vehicles within the European regulation by 2023 (or sooner when possible) on the following:

- **Static CCS recharging** for heavy duty vehicles with power reaching at least 600kW.
- **Static High Power Charging for Commercial Vehicles (HPCCV) for long haul** for power level reaching at least 1 MW[58].
- **Dynamic electric truck recharging:** one single option between the current existing technologies (overhead catenary recharging, ground rail recharging and inductive charging). It is recommended that the European Commission carries out the necessary assessment to compare and select the best technology and begins by convening stakeholders for a common initiative.

[58] CharIN is currently developing technical criteria for HPCCV chargers of up to 2 MW, which is supported by several stakeholders (from Europe and the USA) and is likely to become the most common high power charging standard at global level. This new standard would be based on CCS communication protocols but the charging plug would be larger.

The European Commission should - within the revised framework - be empowered to adopt by delegated act, new charging technology standards which should become binding within 24 months for the infrastructure deployed or renewed.

The new framework should be reviewed again in the mid 2020s to give further policy direction on the respective roles - in long haul road freight - of **static charging, dynamic charging and hydrogen fuel cell trucks.** Total costs to users, taxpayers and society as a whole must be at the centre of analysis work that compares all three zero emission truck types.

3.1.4 Set binding Member State targets for charging infrastructure

Destination charging at delivery centers (2025)

The scope of the revised AFID should be widened to address destination charging of electric trucks. The European Commission should propose binding Member State targets to electrify logistic hubs and delivery centers, installing an **increasing number of medium and high power chargers with intermediate targets in 2025, 2030 and 2035**. This allows for Member States to plan with transport operators and logistic centers to identify and incentivise opportunities to install destination chargers at these centers (minimum power level recommended is 350 kW) which should - when relevant- be shared between the different transport operators accessing the delivery center.

T&E recommends that Member States start planning for the destination chargers within the main urban areas, in particular focusing on the 88 urban nodes. A comprehensive strategy for road freight electrification should be set up for these urban nodes addressing private charging (see 3.2.1), destination charging and public charging (see below).

Public charging at all 88 urban nodes (2025)

The European Commission should introduce binding Member State targets for the deployment of HPCCV charging sites at all the 88 urban nodes of the TEN-T network by 2025 (see Annex 1 for the list of urban nodes).

Each of the 88 urban nodes should be equipped with high power public charging sites available for electric trucks, each with the appropriate power to recharge several electric trucks at the same time with at least 350 kW of minimum power capacity per charger[59]. All sites should be easily accessible to all heavy duty vehicles - including the biggest trucks and buses - and offer high power charging coupled with a prebooking system (as suggested by the FREVUE projects).

The 88 urban nodes as defined in the TEN-T Guideline Regulation (EU) 2013/1513 (see Figure 9) are the starting point, final destination or transfer point for much of the freight moving on the trans-European transport network. In the EU, 88 urban nodes are identified with at least one per Member States and up to 13 in Germany[60]. Electrification of these sites help strongly reduce the issue of "range anxiety" among truck drivers and should serve all applications: urban and regional deliveries as well as recharging for long haul journeys repeated between the same urban hubs (sometimes called line haul).

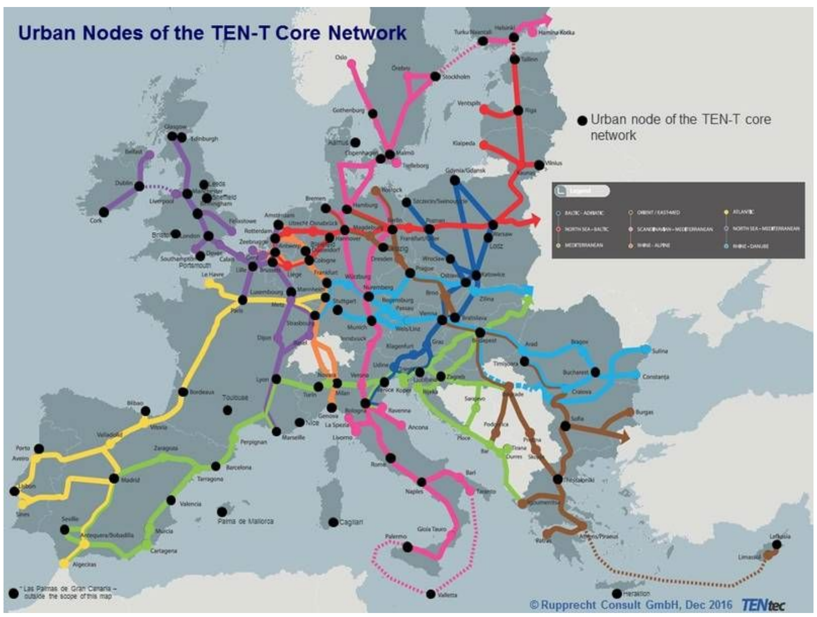

Figure 8: Urban nodes of the TEN-T Core Network (in black)[61]

Coverage of the TEN-T Core network and main urban area: 500 sites (2030)

[59] Urban and regional delivery trucks with about 300 km range would be able to recharge more than half the battery in about 30 minutes.
[60] According to the TEN-T guidelines, Member States also need to ensure the interconnection of passenger transport and freight transport with other transport modes as well as to ensure promotion of efficient low-noise and low-carbon urban freight delivery.
[61] European Commission, Trans-European Transport Network (TEN-T). Link

The EU should propose binding Member State targets for HPCCV additional charging sites by 2030 along cities of the TEN-T Core network and at key locations of the TEN-T Core network to bring the total to 500 (relevant locations to be decided by the European Commission and the Member States).

The static charging infrastructure network should have a sufficient level of redundancy to enable all inter-city operations. With a network coverage of at least one site every 100 km, it requires about 500 sites to cover the TEN-T Core network. The charging power should be at least 600kW by 2030[62].

T&E will undertake in 2020 an analysis of road freight movements across the EU to provide further recommendations on the required number of high power public charge points necessary in each urban node, and how the TEN-T Core network can best be covered by starting with the 88 TEN-T urban nodes.

Hydrogen refuelling infrastructure in major EU ports by 2025

The European Union should adopt a targeted hydrogen strategy with deployment targets around ports by 2025. Hydrogen (and ammonia) refuelling infrastructure at ports will be required to decarbonise ships (see T&E brief, *AFID and shipping: Shore-side electricity for ships*) when battery electric ships would not be suitable. This hydrogen refuelling infrastructure could also be made available for hydrogen fuel cell trucks that need a combination of range and flexibility and perform long trips. Because the refuelling infrastructure would be necessary for ships in any case, such objectives for long haul freight are a lower-risk investment (with regards to the uncertainties for the large scale deployment of hydrogen road vehicles), and would benefit from economies of scale. With this approach, the EU can make maximum use of the potential of ports as hydrogen hubs. Given that most of the main ports are also urban nodes, high power electric charging infrastructure would also have to be deployed around these locations and the two technologies would coexist serving different purposes: electric truck charging infrastructure for urban and regional deliveries around the ports with predictable operations, and hydrogen trucks would be used for longer trips and/or applications that require much greater flexibility.

Dynamic charging infrastructure as a recognised pathway to meet AFID targets

[62] 600 kW would be sufficient in most cases to recharge the truck in 45 minutes. Indeed, truck drivers have to stop every 4.5 hours for at least 45 minutes. Therefore, close to 500 kWh would have to be recharged at maximum during two stops. According to real world effective charging speed, 600 kW chargers could be the level of the minimum requirements that should be simultaneously available to all trucks. Load management and power split between chargers can be an effective way to manage and reduce power demand requirements.

The revised regulation should enable MSs to meet the targets for the coverage of the TEN-T Core corridors with dynamic recharging infrastructure (connecting two or more urban nodes). Put simply, roll-out of dynamic recharging infrastructure by a Member State, or states, would proportionately reduce their binding target to provide static HPCCVs. To benefit from the flexibility, the project should be aligned with European standards and ideally be cross-border.

The European Union should approve as soon as possible (not later than 2023) a European standard for the dynamic charging of electric trucks. The AFID framework has a key role to play with regards to deployment of dynamic recharging infrastructure. Dynamic charging systems suffer from higher upfront costs but benefit from lower system costs compared to hydrogen (which has lower upfront costs but much higher system and operating costs). Recognising this, and the challenge to gather funding commitments from several Member States, dynamic recharging infrastructure should have priority towards EU funds like CEF Transport Blending Calls with higher co-funding rates than apply for electric vehicles and charging infrastructure.

3.1.5 Bring the electricity to the roads to plan beyond 2030

The European Commission should adequately plan for road freight transport to reach carbon neutrality by 2050 as required by the Paris Agreement[63]. Based on T&E's climate modelling for 2050, by 2035, 80% of all new trucks should be zero emissions. By that year, the coverage of recharging infrastructure should be mature and enable almost any truck operator to buy a new electric truck and use it seamlessly for any operations.

To achieve this, the European Commission and Member States should focus on bringing electricity alongside the main roads as part of the upcoming AFID revision. It should be noted that the access to electricity alongside the main roads will, in any case, also be required to recharge high volumes of electric cars.

Regardless of which charging technology will achieve the dominant position, both static and dynamic recharging will require important amounts of electricity alongside the roads. The European Commission should assess the supply of electricity along key selected corridors and nodes and set, for 2030, binding Member State targets for the roll-out of sufficient electricity infrastructure at these locations (in close cooperation with the Member States and the electricity sector). Volvo and Scania's CEOs also identify 'expanding the electricity supply to roads' as the first priority[64].

[63] Transport & Environment (2018), How to decarbonise transport by 2050. Link

[64] "1. Expand the electricity supply to roads - Regardless of which technological solution is ultimately selected, a clear decision on providing electricity to roads should be taken now. A strategy outlining which

The requirements for the provision of electricity to the roads should aim to have the sufficient amount of electricity supplied alongside the TEN-T Core network by 2030. The requirements should be based on a metric that takes into account the density of road freight traffic flows along the key corridors and the total amount of available recharging power per kilometer (see example below).

Example: 1 MW per km to cover a flow of up to one electric truck every 4.5 seconds
In the scenario of an electric truck powered by a dynamic charging system, about 100 kW/km would be enough for one truck[65]. Scaling up to 1 MW, there could be 10 electric trucks at the same time over a distance of one kilometer, which would translate into 13.3 trucks per minute or one truck every 4.5 seconds. In the case of static charging, the energy consumed (and thus the recharging requirements) are the same, the notable difference is however that the trucks are forced to stop (for 45 minutes every 4.5 hours at 600 kW) while the dynamic charging trucks theoretically do not need to stop to charge[66].

3.2 Create the right frameworks

3.2.1 Private charging at depot

Depot private charging of electric trucks is an essential component of truck electrification, in particular in the early phase. Two measures should be prioritised:

Funding support for private depot charging. Financial support and incentives should be granted to transport operators that need electric recharging at their depot and for costly grid upgrades, where required. This is the first necessary step to support the uptake of the initial wave of electric trucks in delivery operations. Financing the high infrastructure and grid upgrade costs

government agency holds responsibility for ensuring that selected areas are supplied with electricity, deciding on route segments as well as the financing the boosted power grid. A swift approach to expanding electricity to roads is most likely with a financing model that is similar to that for railways." [No more hesitation; take decisions to build electric roads now]

[65] Assumptions: 1.25 kWh/km and 80 km/h and no transfer losses for dynamic or static power delivery.

[66] In the scenario that autonomous trucks do not stop, about 17% more trucks would be needed if the trucks have to stop to charge to cover the same freight activity. With 1MW chargers, the breaks can be reduced to half an hour every 4.5h and the activity losses are then 11%.

of private chargers at depots to offer the adequate overnight charging to the electric trucks can prove very expensive[67] and current EU funding instruments like the Connecting European Facility (CEF) programme are not adapted to financially support this type of undertaking as they are limited to public charging stations. The European Commission should adequately address this within new funding mechanisms such as the Sustainable Europe Investment Plan (supporting €1 trillion of investment over the next decade), and the Just Transition Fund (supporting the people and regions most affected by the climate transition), as well as better targeting existing mechanisms starting with CEF itself.

"Right to plug" at truck depots. Hauliers that are not the owner of the depot or garage should have the right, on reasonable access terms and conditions, to install a charger and undertake the necessary construction on-site. Furthermore, there should be a European harmonisation of depot and parking charging safety rules and all new and/or renovated parking facilities should have all parking spots pre-equipped with the necessary grid connection to recharge electric trucks overnight.

3.2.2 Destination charging

Similar to private depots, there's a need for clearer procedures to govern requests made by transport operators to logistic hubs and freight delivery centers to install charging. The procedure should aim to facilitate the roll out of charging and be aligned by each Member State to achieve its charging targets for destination centres proposed above. The revised AFID (see Section 3.2) should offer templates to Member States in this regard to enable them to achieve the required penetration levels.

3.2.3 Align 'Safe and Secure parking areas' regulation

In 2017, the European Commission commissioned a study on 'safe and secure truck parking areas' (SSTPAs), which has identified that the lion's share of the existing 300,000 truck parking spaces available in Europe need to be upgraded[68] and that 100,000 new safe and secure truck parking places need to be created[69]. When upgrading truck parking spaces to the new standard or deploying new ones, the European Commission should logically ensure recharging points are provided.

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[67] For example, in the case of bus depots in Paris, the electrification of a bus depot costs about 20 to 30 million euros (based on the experience of the electrification of 17 bus depots). Link

[68] Only 7,000 of these 300,000 parking spots can be considered "safe and secure"

[69] European Commission (2019), Study on Safe and Secure Parking Places for Trucks - Final report . Link.

The recently agreed regulation on minimum requirements on maximum daily and weekly driving times[70] already sets 'power supply' as a basic service to which certified parking should comply. Electric trucks will soon be on European roads and, as upgrading the grid capacity can be very costly, it is essential to think ahead and incorporate the needed ducting infrastructure and grid capacity for future truck charging needs.

Most of the CEF Multi Annual Programme (MAP) funding[71] to truck parking is closely tied with the ability to claim it is 'safe and secure'. However, currently the requirements for 'safe and secure' truck parking areas do not cover any environmental aspects. In the face of the urgency to decarbonise road transport, it is of paramount importance that CEF funding for truck parking should be used wisely to prepare the parking spots for electric charging.

T&E asks the European Commission to:

- Enlarge the scope of the new 'safe and secure' standard to include environmental criteria (perhaps amending it to 'safe, secure and sustainable parking') to include electric commercial vehicle charging.
- Select new truck parking locations based on the availability of the electricity grid to offer a very high capacity connection using techno-economic criteria .
- The EC Expert Group on Safe and Secure Parking Areas for Trucks should mandate all new or renovated truck parking areas to be connected to the medium voltage electricity grid with a capacity of several MWs[72] (no cabling or ducting of chargers has to be undertaken but the service infrastructure siteworks must allow this to be done at reasonable cost subsequently).

[70] Political agreement for the Regulation of the European Parliament and of the Council amending Regulation (EC) No 561/2006 as regards on minimum requirements on maximum daily and weekly driving times, minimum breaks and daily and weekly rest periods and Regulation (EU) 165/2014 as regards positioning by means of tachographs (23/01/2020). Link.

[71] 2019 CEF Transport MAP Call. Link

[72] Minimum capacity requirements could be set based on the number of parking places. For example, there could be a requirement to have at least 600 kW per parking spot, at least for the first ten parking places. 600 kW would be sufficient in most cases to recharge the truck in 45 minutes (truck drivers have to stop every 4.5 hours for at least 45 minutes). For large parking areas, a lower requirement on the available capacity per additional spot can be set. This is supported by the fact that some large parking areas (e.g. up to 100 spots or more), do not require high capacity opportunity chargers during the day but slower powers would be sufficient to recharge the totality of the trucks during the night. Additionally, load balancing of the power between all the parking spots allows for more flexibility on the grid.

3.2.4 European Commission strategy to decarbonise road freight and reach climate neutrality

The European Commission should adopt a road freight long haul decarbonisation strategy to ensure comprehensive coverage by 2035.

The European Commission should investigate how static and dynamic electric trucks recharging technology, and hydrogen trucks, can be encouraged, financed and mandated in order to set the most effective framework to reach the coverage targets and achieve cost-effective decarbonisation with electric trucks by mid-century at the latest.

As part of the impact assessment of the revision of the AFI Directive, a study should be carried out to analyse different technological pathways to decarbonise long haul road freight. Given that a road freight system relying entirely on hydrogen would require very high volumes of renewable electricity (that would be better allocated to other more efficient applications), the scenarios explored should focus on the following two pathways: a) dominant direct electrification recharged via high power chargers and targeted roles for hydrogen trucks and dynamic charging, and b) dominant dynamic charging electric trucks with lower deployment of high power charging infrastructure and a targeted role for hydrogen truck refuelling (at major EU ports).

In both scenarios electric trucks recharged via a plug would cover all urban and regional applications. Based on this analysis the European Commission should outline the respective roles of the three zero emission truck types (electric trucks recharging by plug, electric trucks charging dynamically, and hydrogen fuel cell trucks) and should, as of now, set a strategy for pan-European coverage of all the TEN-T networks by 2035 with zero emission infrastructure.

In the mid-2020s, when the AFID framework is revised again, the standards should be set, the respective roles of the different long haul technologies (electric truck charging via plug or via dynamic infrastructure and hydrogen fuel cell) made clearer, and the comprehensive coverage of all the EU should be targeted for 2035 with clear binding member state targets for each zero emission infrastructure. There needs to be sufficient infrastructure to enable fully electric operations to ensure the coverage of the network increases in line with the number of electric heavy-duty vehicles on the road[73].

[73] Alongside, local and national authorities should monitor the increase in the number of e-trucks to ensure that the charging networks meets the demand.

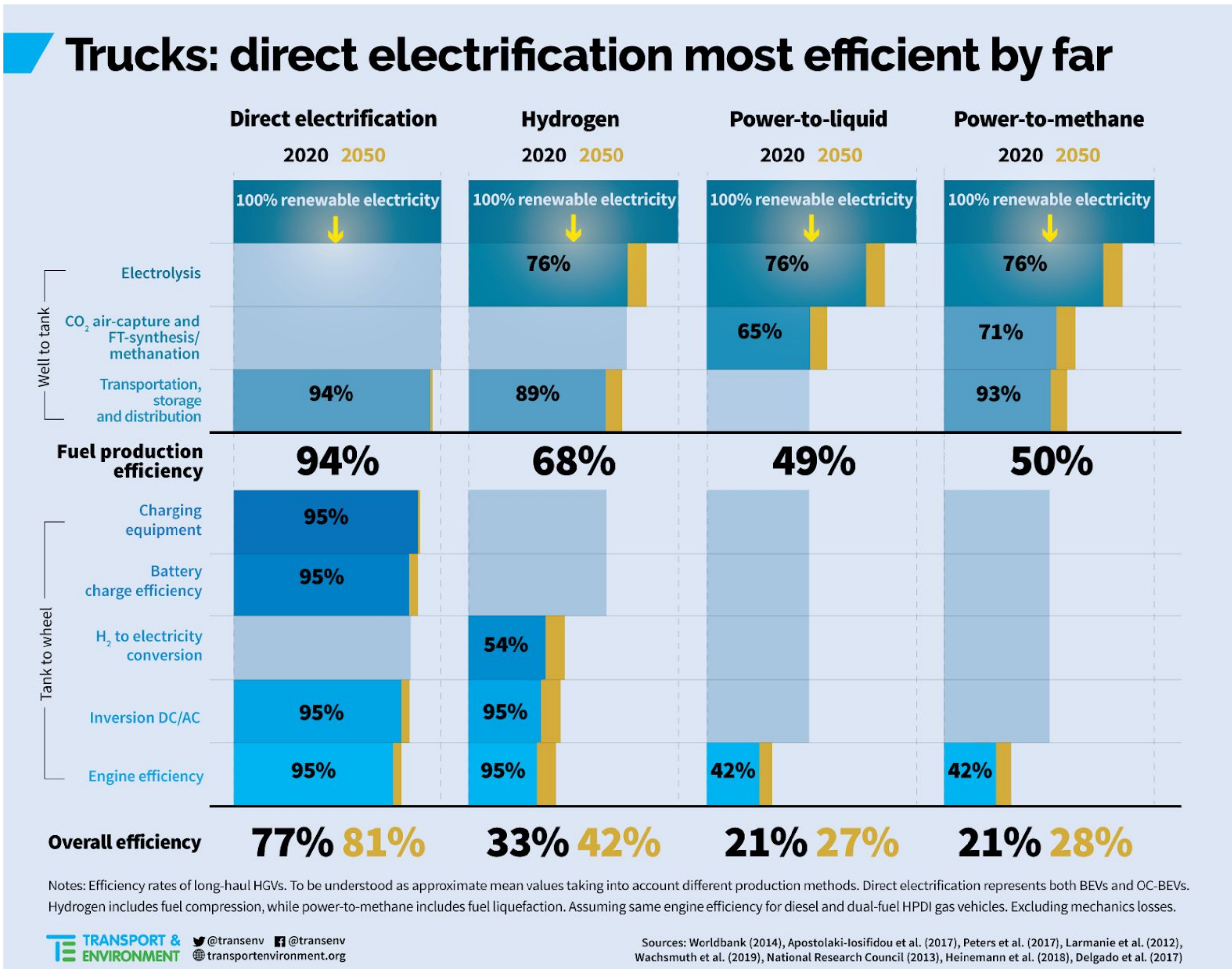
Annex 1: TEN-T urban nodes

Country	# Urban nodes	Cities
Austria	1	Wien
Belgium	2	Antwerpen, Brussel
Bulgaria	1	Sofia
Croatia	1	Zagreb
Cyprus	1	Lefkosía
Czech Rep.	2	Ostrava, Praha
Denmark	2	Aarhus, København
Estonia	1	Tallinn
Finland	2	Helsinki, Turku
France	8	Bordeaux, Lille, Lyon, Marseille, Nice, Paris, Strasbourg, Toulouse
Germany	13	Berlin, Bielefeld, Bremen, Düsseldorf, Frankfurt am Main, Hamburg, Hannover, Köln, Leipzig, Mannheim, München, Nürnberg, Stuttgart
Greece	3	Athína, Heraklion, Thessaloniki
Hungary	1	Budapest

Ireland	2	Dublin, Cork
Italy	9	Bologna, Cagliari, Genova, Milano, Napoli, Palermo, Roma, Torino, Venezia
Latvia	1	Rīga
Lithuania	1	Vilnius
Luxembourg	1	Luxembourg
Malta	1	Valletta
Netherlands	2	Amsterdam, Rotterdam
Poland	8	Gdańsk, Katowice, Kraków, Łódź, Poznań, Szczecin, Warszawa, Wrocław
Portugal	2	Lisboa, Porto
Romania	2	Bucureşti, Timişoara
Slovakia	1	Bratislava
Slovenia	1	Ljubljana
Spain	7	Barcelona, Bilbao, Santa Cruz de Tenerife, Madrid, Palma de Mallorca, Sevilla, Valencia
Sweden	3	Göteborg, Malmö, Stockholm
UK	9	Birmingham, Bristol, Edinburgh, Glasgow, Leeds, London, Manchester, Portsmouth, Sheffield

Annex 2: Efficiency of different technological pathways

The infographic below shows the overall system efficiency of four pathways: direct electrification (battery electric vehicle), hydrogen pathway (fuel cell electric vehicle), power to liquid or synthetic fuels (conventional internal combustion engine vehicles) and power-to-methane or synthetic gas (conventional gas vehicles).



Annex 3: European road freight transport by trip distance class (2017)

European road freight transport statistics on distance travelled (v.km), activity (t.km) and number of trips are available per trip distance classes with the following link: transenv.eu/trucktransportbydistanceclass
In the table below are the average EU statistics which are also available for the following countries: Germany, France, the UK, Poland, Italy, Spain, the Netherlands and Belgium.