Recharge EU: how many charge points will Europe and its Member States need in the 2020s

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Executive Summary

After years of slow progress electric vehicles are finally coming to Europe. Driven by the CO2 standards for 2020/21 - that require carmakers to reach on average 5% EV sales share in 2020 and up to 10% in 2021 or face fines - the offer of better performing and more affordable electric vehicles in Europe will at least double[i]. The number of electric models available on the European market will surpass 200 in 2021, while the European EV production will grow significantly to reach four million vehicles annually by 2025.[ii]

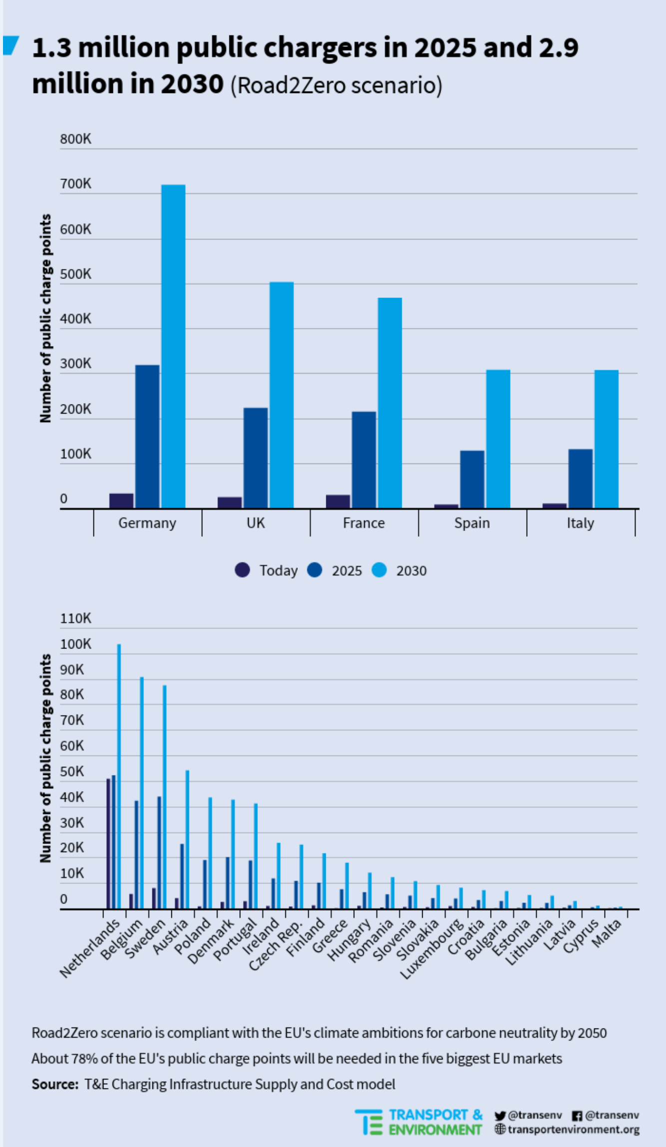
To keep up with this electric surge - estimated to be between 33 million electric cars in the current policy scenario and 44 million in the climate neutral one in 2030 - EU's infrastructure framework needs to prioritise electric charging and be in line with the increasing demand for public and private charge points. This report outlines Transport & Environment's charging masterplan for Europe, including both the numbers of public chargers needed and the funding mechanisms to nudge the market in the right direction. A new EU policy framework for alternative fuels infrastructure (AFID) and the funding mechanisms currently discussed in the European Green Deal are the two cornerstones to deliver an ambitious EU recharging infrastructure masterplan.

As of the end of 2019, there will be around 185,000 public charge points in the EU, or 7 cars for each point, which is enough for the current market. There is a clear preference for slow (AC) public charge points (61% public chargers) but the network of fast and ultra-fast charge points is progressing well with around 9,000 CCS fast charge points and 640 ultra-fast chargers across Europe. Fast chargers are mostly located in the urban corridor stretching from the southern UK to the Netherlands, through German Rhineland, Southern Germany and Switzerland.[1]

But beyond 2020 much more charging infrastructure will be needed to keep pace with the growing e-mobility market. More effort is also needed to ensure seamless and reliable charging within and across countries for drivers. This is why it is crucial to revise the Directive in 2020 and turn it into a European Regulation to guarantee a swift harmonised pan-European deployment of public charge points in line with market developments. The charging deployment should be fairly spread across Europe to ensure all Europeans get the same chance to shift to zero emission mobility.

To set an effective future-proof infrastructure framework, T&E has designed a new methodology - called the Public Charging Supply metric - on how to count and mandate infrastructure deployment across the member states in the new regulation. Instead of simply counting each charge point as one, T&E's Supply Metric proposes to weigh charge points based on how much energy they can provide to the electric vehicle fleet and how available they are to the public. This metric should be used to set the EU public charging infrastructure deployment targets for each country for 2025 and 2030, corresponding to 1.3 million public charge points EU-wide in 2025 and close to 3 million in 2030. In total this would require investment of €1.8 billion in the year 2025, or only 3% of the EU's annual investment in road transport infrastructure.

[1] Also known as the Blue Banana, European Megalopolis or the Liverpool–Milan Axis



While the quantity of charging infrastructure is important, where they are and how they operate, or the quality of the charging infrastructure is equally key.

A European masterplan should ensure:

- The full coverage of all European road networks, or the TEN-T Comprehensive network by 2025 at the latest to guarantee coverage of all of Europe ’ s highway network.

- Recharging an electric car should be as simple and transparent for consumers as refuelling at a petrol station. Prices should be fair, and offered in EUR/kWh, alongside a harmonised automatic authentication system and ability to pay ad hoc using a credit/debit card.

- Charging systems should be smart so they are able to align charging events with the generation of renewable electricity thanks to charge session monitoring and control features (which adapt to flexible electricity pricing). Public charging systems should at the minimum have an intelligent metering system.

Commercial properties such as large shops, leisure and sports facilities with parking facilities, as well as petrol stations are ideal locations for public charging. These are convenient places where many drivers park their cars for some time, and can therefore help alleviate the need for every driver to have a dedicated charge point in urban areas. The new EU Regulation should set minimum targets aiming for a fifth by 2025 and half by 2030 - for chargers on parking spots of medium and large commercial properties.

In making Recharge EU a flagship of the European Green Deal, the cabling and preparation of residential and workplace buildings for charging cannot be ignored. A European ‘right to plug’ should ensure that EV drivers wait no longer than three months to get charging, whether at home or work. This should go hand in hand with a funding programme to cable buildings and upgrade grids where necessary aiming at a fifth of buildings cabled in 2025 and half in 2030.

Finally, the supply of charging infrastructure in cities should be assessed in the light of the need to reduce the dependency on private cars. We need a transition towards fewer vehicles in urban areas so we need to prioritise the deployment of charging solutions for a growing fleet of shared cars, electric taxis and ride hailing services, as well as delivery electric trucks and vans. The latter might require significant investment to upgrade the grid at some locations which the EU and national funds should help with.

This transition will only be successful if it is a just and fair one, which will require social equity concerns to be reflected in EU and national policies, with dedicated shares (up to a third) of public and residential charge points provided in areas of low income or high air. Coupled with incentives to provide shared EV fleets in such areas this can help align mobility and social policy and ensure that everyone, including disadvantaged communities, benefit from zero emission mobility.

Substantial investment will be needed in public charging infrastructure to serve the growing EV market. One-off investments in the deployment of public charge points (includes equipment, installation, and grid upgrades) would increase from about €600 million euros in 2020 to €1.8 billion in 2025 and €2.9 billion in 2030. Cumulatively, this would amount to a total of €20 billion. For private charging infrastructure, the total investment would be about triple that. Combined, about €80 billion will need to be invested up to 2030 for the roll out of public and private charging infrastructure, a small fraction of the €100 billion invested by the EU every year in transport infrastructure. Compared to the current rate of investment in road transport infrastructure (about €53 billion per year), investment in public charging infrastructure would represent a mere 1% of the total in 2020, increasing to 3% of the total in 2025 and 5% in 2030. On the other hand, it would represent in 2025, only 3% of the annual EU spending in fossil fuel subsidies (estimated by the European Commission in 2019 to be €55 billion).

When it comes to deploying charging infrastructure, the EU should support other areas which are not its core field of interest like urban and local level. The use of public money should be limited to key targeted market gaps and to provide a direction to ensure that a little money goes a long way. T&E recommends that the public money is used to prepare the grid, therefore the open tenders to install and operate charging stations should not include any public support (except for some possible level of support for ultra-fast charging in regions with low EV uptake). Importantly, public money should also be used to cofund the cabling of work and residential buildings

The **EU's funding masterplan, called** RechargeEU should make use of existing or planned EU-funding mechanisms like InvestEU, Connecting Europe's Facility (CEF), the Just Transition Fund, the Sustainable Europe Investment Plan as well as structural and regional funds and as much as possible, be combined with private investments in the form of public private partnerships. In particular Member States should take advantage of the new CEF Transport Blending Facility Call (opened in Fall 2019) to support projects on the Core Network and nodes of the core network for electric cars and trucks.

Overall, the shift to EVs will create a multi-billion euro market opportunity for European industry in the grid works and the manufacturing, installation, and maintenance of the charging equipment. The new European Commission and its EU Green Deal has a key role to play in making the transition to e-mobility a success. Not only is this transition essential to face the climate emergency, it will also serve as a building block for the EU's transition towards a zero emission economy while boosting EU competitiveness.

T&E's recharging masterplan for cars

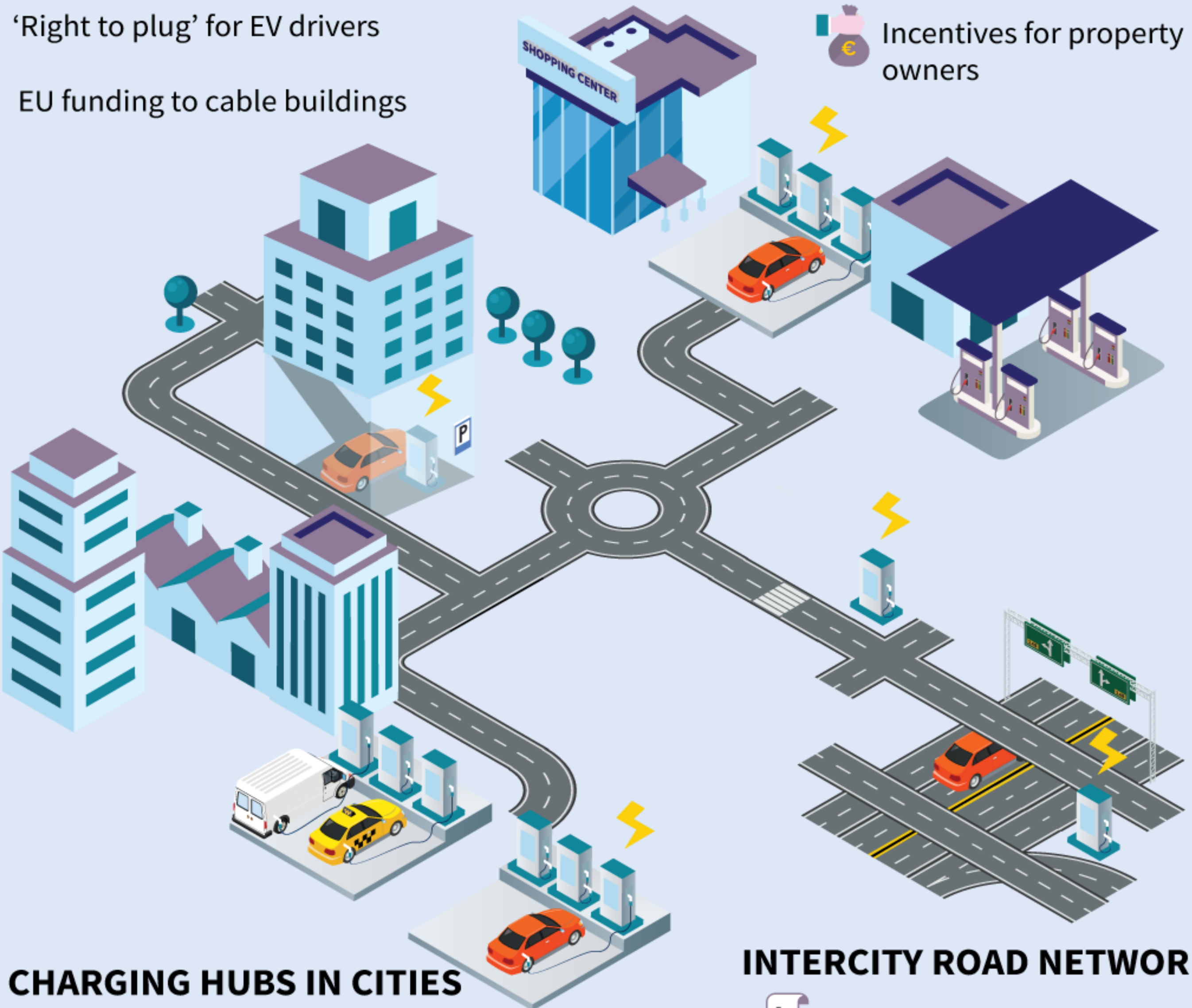
- smart charging
- available 24/7
- easy payment
- social fairness
- fair & transparent prices
- interoperable

HOME & WORK

- All buildings prepared for EV charging by 2035 (EU Legislation)
- 'Right to plug' for EV drivers (EU Legislation)
- EU funding to cable buildings (Public Funding)

COMMERCIAL PROPERTY

- A fifth of parking spots with chargers by 2025 (EU Legislation)
- Incentives for property owners (Public Funding)



CHARGING HUBS IN CITIES

- Prioritise shared & electric mobility: taxis and ride-hailing (EU Legislation)
- Fast chargers for urban deliveries (EU Legislation)
- Grid upgrades (Public Funding)

INTERCITY ROAD NETWORKS

- Full coverage by 2025 (EU Legislation)
- Support charging in towns, villages and remote areas (Public Funding)

: EU Legislation : Public Funding

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Abbreviations

EV	Electric Vehicle. *In this report, this stands for vehicles propelled by an electric motor: battery electric vehicles, fuel cell electric vehicles and plug-in hybrid electric vehicles*
BEV	Battery Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
ZEV	Zero-Emissions Vehicle: BEV and FCEV
PHEV	Plug-in Hybrid Electric Vehicle
ICE	Internal Combustion Engine
OEM	Original Equipment Manufacturer, carmaker
EAFO	European Alternative Fuels Observatory
NPF	National Policy Frameworks
AFID	Alternative Fuels Infrastructure Directive

Introduction

In 2014 the Alternative Fuels Infrastructure Directive (AFID) was adopted. At the time the electric vehicle (EV) market in Europe was in its infancy with only a few models available on the market like the Renault Zoe, Nissan Leaf, BMW i3 and Tesla Model S. At the time policymakers trying to determine the future EV market uptake and infrastructure needs had very limited experience.

Today, the situation is different: battery and charging technologies have progressed at a rapid pace and will continue to do so for many years. With EU car and van CO2 standards in place for 2021-2025-2030, a wave of electric vehicle models is coming to Europe and policymakers now have much more clarity with regards to the expected market uptake. Many elements that seemed uncertain in 2014 have now become much clearer - e.g. the EU's climate commitments, technological development and industrial commitments. The moment is now right for the European Commission to come forward with a plan to deploy a pan-European EV charging infrastructure network that will help Europe complete the transition to zero emission mobility.

In addition to the assessment of the AFID, the new European Commission, led by President Ursula von der Leyen, is currently elaborating a climate strategy, notably the European Green Deal. The European Green Deal presents key political directions, flagships and funding mechanisms to support decarbonisation, including the deployment of charging infrastructure. In the recent European Green Deal communication, the European Commission has committed to review the Directive in 2021 to 'accelerate the deployment of zero- and low-emission vehicles' and to deploy a "funding call to support the deployment of public recharging and refuelling points" from 2020.[iii]

This report aims to contribute to the current discussion on the deployment and funding of charging infrastructure regarding the planned revision of the AFID and the European Green Deal with novel analysis, ideas and recommendations.

In Section 1, T&E shows that while the AFID has been an adequate instrument until 2020, it is no longer fit for purpose for the upcoming ramp up of electric market after 2020. Section 2 assesses in detail the current provision of public charging infrastructure in the EU. Section 3 presents the results from T&E's new in-house model calculating the amount of public charge points required in the next decade for each Member State. Two EV uptake scenarios are modelled: Road2Zero and CurrentPolicies and a new metrics is introduced to enable policymaker to set targets on the supply of public charging infrastructure: the Supply metric - a new counting rule to calculate the weighted supply of public charge points based on their power and service - that goes beyond the current counting of each public charge point indistinctly as one unit. Section 4 sets T&E's blueprint for infrastructure policies and focuses in particular on what the revised Alternative Fuels Infrastructure Regulation should look like in terms of both quantitative and qualitative requirements (as well as infrastructure policies at local and national level). Finally, Section 5 contains T&E's recommendations on how the EU and the Member States can best allocate public funding to incentive the adequate roll out of charging infrastructure and fill market gaps.

1. European rules are no longer fit for purpose

The Alternative Fuels Infrastructure Directive (or AFID) and the roll out of charging infrastructure in general, has been successful in providing an adequate number of public charge points until today (see 2.1 Current Situation). However, the current AFID is no longer fit for purpose and it should be reviewed urgently to set the adequate framework to incentivise and accompany the fast uptake of the EV market.

What is the Alternative Fuels Infrastructure Directive?

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. The AFI Directive required Member States to notify the European Commission by November 2016 on their National Policy Frameworks, or NPFs. NPFs had to set clear national targets and objectives for 2020 and 2025 as well as stipulate adequate support measures and actions for the development of the market as regards alternative fuels, including the deployment of the necessary infrastructure. 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.

With regards to electricity recharging points, the current Directive only requires Member states to have the 'appropriate' number of recharging points by 2020 and if appropriate, it should be revised to ensure that there is good coverage also by 2025.[2] Importantly for the revision, the original European Commission proposal in 2013 contained mandatory minimum requirements for recharging points per Member State totalling 800 thousand chargers by 2020 - which was eventually pushed out of the final regulation.

Not climate compliant

Although, this paper focuses on presenting how EV charging infrastructure should be rolled out and prioritised as the optimal climate-compliant solution, it is important to stress that in its current form the AFID considers fossil gases as valid alternatives and is not compliant with the EU's climate ambitions. A gas pathway is not compliant with a decarbonisation strategy[iv] and initiating a transition to a gas power mobility system would delay the uptake of zero emission technologies and divert limited public and private resources (in addition to perpetuating air quality problems in our cities[v]). Most carmakers have acknowledged this[3] and according to IHS Markit light duty vehicle production forecasts, the planned production of gas cars in Europe plateaus at about 1% in 2025[ii]. This should be reflected in the revised AFID, which should phase out all targets for gas refuelling infrastructure and clearly prioritise zero emission mobility - electricity and hydrogen - as the only pathway compatible with climate ambitions and the Paris Agreement.

Fragmented market with varying commitment and ambition

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[2] Before deciding whether to revise the Directive the European Commission has to assess the effects of its implementation (Articles 10(3) and 10(5)). The process of evaluation started in 2019 and will assess the implementation and effectiveness of the directive 5 years after its adoption as well as provide recommendations and inform any further development of alternative fuels infrastructure policy at EU level. Member States had to report on the implementation of their national plans by 18 November 2019 and the assessment of the NPF implementation reports is part of the assessment. AFID (2014/94/EU), Article 4.2.

[3] *"Openness to other technologies will not help us in our endeavors – it only serves to put off the change in system until further into the future"* Herbert Diess, CEO of Volkswagen Group

NPFs have failed to create a harmonised single market for public charging infrastructure deployment across Europe. The level of ambition for the deployment of e-mobility and in particular for the targets national governments set to themselves for 2020, varies greatly across Member States. According to an analysis from 2017, only 10 out of 28 Member States focused on electricity[vi] while other Member States like Italy and the Czech Republic prioritised natural gas. Many plans have low ambition for deployment targets of all alternative fuels (e.g. Spain, Slovakia, Poland) or lack required targets to assess the ambition (e.g. Sweden, Slovenia, Greece).[4] This high level of inconsistency, jeopardises the possibility for a European harmonized and ambitious policy, as well as climate and industrial strategy for e-mobility.

Scope does not capture the EV charging ecosystem

The AFID focused on public charging and only mentioned that Member States should 'also take measures within their national policy frameworks to encourage and facilitate the deployment of recharging points not accessible to public'. Overall, the enforcement of this recommendation wasn't successful in NPFs as Member States relied on the national implementation of the Energy Performance of Buildings Directive (EPBD) guidelines which set requirements on pre-cabling of new buildings (among other). This has been recognised by the car and electricity industry as a *"missed opportunity to make ECV [Electric Chargeable Vehicles, ed.] charging more friendly in existing buildings*".[vii] These industry players also stressed that new requirements for the installation of charging points should be set for public and private buildings and residential areas.

From a technological point of view, there has also been some advancements and rapid technological progress that are not captured in the current directive. In particular, electric truck charging infrastructure was not considered in spite of the fact that many models are now coming to the market in 2020 and 2021, in particular for delivery applications. Another notable shortcoming is the limited definition of public charging which does not capture the increasing recharging power as ultra-fast chargers (typically 150 kW) are increasingly common (see Section 3 for more). The AFID should be updated in line with the market evolution and the widely used terminologies.

Not aligned with policy and market developments

Because the European EV market is mainly driven by regulation, carmakers have been holding back the sales of EV in the past couple of years[viii] and have suppressed the growth of the EV market. However, the combination of technology, market and regulatory developments have rendered the ambition level of AFID insufficient. The newly approved regulations on vehicle CO2 emissions standards for light-duty vehicles and heavy-duty vehicles, the targets for public procurement of clean vehicles (Clean Vehicles Directive), or the European Commission Long Term Strategy all contribute to new important market developments for e-mobility technologies. European carmakers are starting to offer electric vehicles for the mass market as they have to reach in average 5% EV share in 2020, 10% in 2021 and close to 20% in 2025 to comply with the car CO2 regulation. [i] The number of electric models available on the European market will surpass 200 in 2021 and EV production capacities are being ramped up to about four million EV annually by 2025.[ii] This fundamental market development will rapidly change our transport system and will generate increasing needs for public and private EV chargers.

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[4] A new assessment has been published by the European Commission in 2019 since which included targets from Greece and Slovenia.

2. Public chargers in Europe: Current situation

2.1. From five to seven EVs per public charge point

Definition and differentiation of public charge point

In this report, public chargers were distinguished in several categories:

- Single phase AC chargers (3-7 kW): charges an EV in about 7 to 16 hours
- Tri-phase AC chargers (11-22 kW): charges an EV in about 2 to 4 hours
- Fast DC chargers (50-100 kW): charges an EV in 30-40 minutes
- Ultra-fast DC chargers (above 100 kW): charges an EV in 10-20 minutes or less

The power level (in kW) of a charger represents how many kWh of energy an EV can be charged in one hour.[5] With a tri-phase alternating current (AC) charger, electricity is transferred via three cables (and a neutral) each carrying one phase. A single phase charger is only plugged to one of the three cables (and charging speed is three time lower for a given configuration).[6] The European standard connector for AC charging is Type 2.

With DC chargers the power is direct current and charging speed has the potential to be greatly increased as it powers directly to the battery (no on board conversion). The European standard for DC charging is Combined Charging System (CCS) 'Combo 2', usually referred to as CCS.

A public charger is a charger provides Union-wide non-discriminatory access to users (i.e. everybody is treated equally) according to the 2014 Directive (it can be publicly or privately owned). An improved definition of public and semi-public chargers is presented in Section 3.4).

Public chargin**g infrastructure in line with EU's 1 public charge point to 10 EV guideline**

This metric of number of electric cars per public charge point is used by the European Commission in the current AFID, to qualify the sufficiency of the public charging network and recommended the Member States should be at a ratio of ten electric cars per public charge points.

The EU's current average of one charger per seven EVs and the ratio in most Member States being below 10, indicates that there is still an oversupply of public charging infrastructure, compared to the current number of electric cars on the roads (based on the European Commission's metric). The number of electric vehicles per public charge point has increased from 5 to 7 on average over the past two years. Figure 1 below, gives an overview of the current number of electric cars on the road and available number of public charge points across Europe (normalized by the total population). Three Member States (Netherlands, Norway and Luxembourg) are not shown in the figure as they have very high number of EVs per inhabitant. We can observe that the countries are relatively well distributed between the 10 EVs per public charge point line and the 5 EV per public charge point line.

[5] In reality that amount of energy charged is a bit lower because the charger does not have a 100% and does not reach immediately maximum charging power (especially for fast chargers).

[6] The power difference within one category (11 kW and 22 kW or 3 kW and 7 kW) is the intensity of the electric current (in ampere). Some AC chargers reach 43 kW and are considered as fast chargers by many. The electricity grid in Europe is largely tri-phase AC

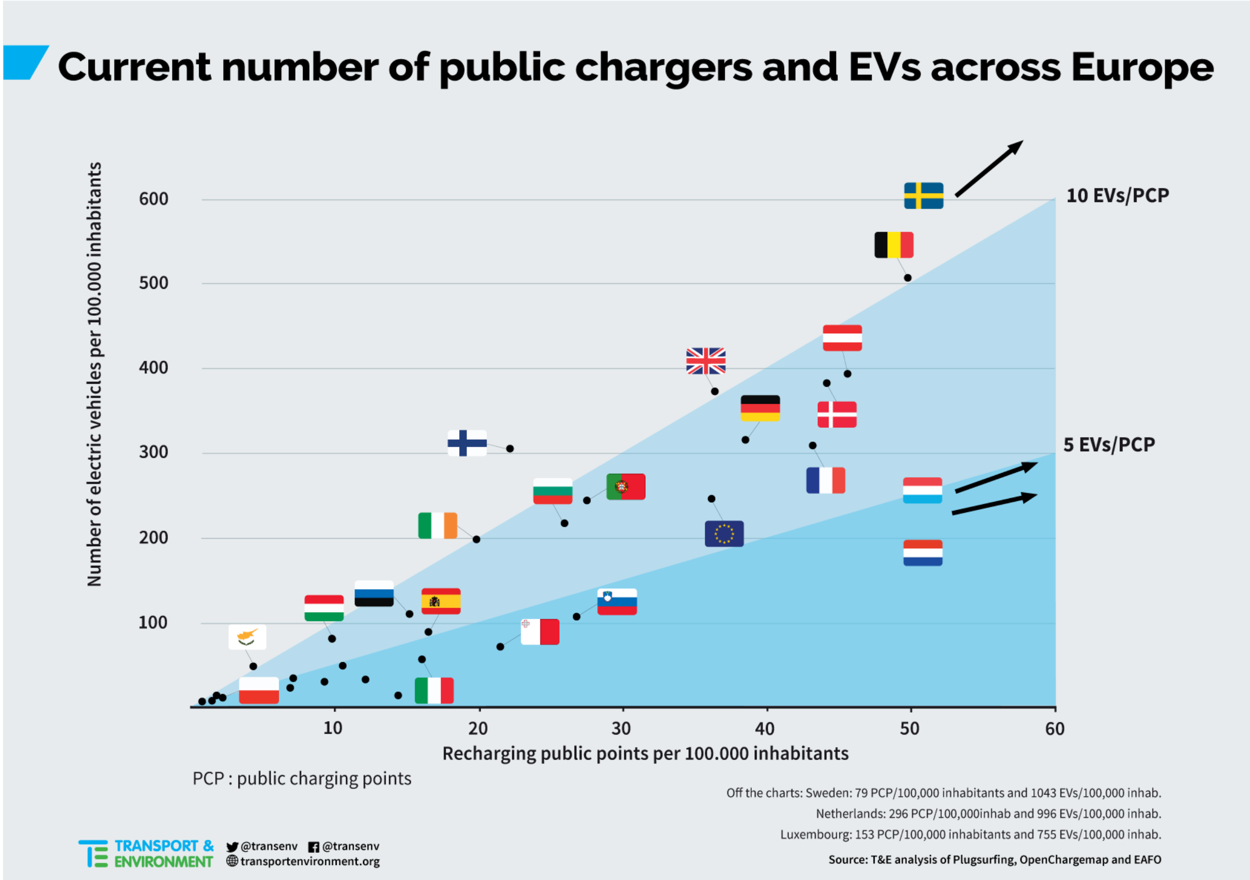


Figure 1: Current supply overview of EVs and public chargers across the EU countries

Currently, only four Member States have more than ten electric cars per public charge point: Cyprus, Finland, Greece, Sweden; while the UK, Belgium and Ireland are at ten, see Figure A1 in Annex 1. On the other hand, the Netherlands - which is one of the most mature EV markets - is one of the countries with the highest number of public charge points per EV (about four electric cars per charger).[7]

Towards a balanced supply of chargers

At the end of 2017, the EU had 132,000 public charge points which increased to 175,000 by the end of 2019 (+32% or 42,000 units), while at the same time the number of EVs on the road increased from 670,000 in December 2017 to 1.3 million in November 2019[8], or a 89% increase in two years according to data compiled by EAFO. The gradual resorption of the oversupply of public charge points demonstrates the growing maturity of the European EV market.

As the oversupply of public charge points is rapidly resorbing, without speedy measures to accelerate infrastructure roll out, the ten EVs-to-one public charge point ratio will be surpassed. If the current pace of

[7] This is explained by the fact that most of the EV drivers in the Netherlands rely on chargers that are located on public premises and provided by local authorities but used as a private charger by only one or two EV drivers. This increases the number of public charge points compared to another country which might rely more heavily on private chargers (that are not accounted for).

[8] On average there are about as many PHEVs as BEVs in the EU but the repartition between PHEV and BEVs is very uneven between Member States as this depends to a large extent on national measures, in particular taxation.

growth of the public charging network persists, there will be about 200,000 public charge points in the EU while at least 2,1 million EVs are expected on the road in the EU by 2020 (based on T&E modelling, see Section 3), which is equivalent to about 11 EVs per public charge point. As carmakers were slow to roll out electric vehicles and sometimes even purposefully kept sales low[viii] it is no surprise that in the last two years governments were slow and rolled-out only 42,000 public charge points. Fortunately recent commitment from national governments mean the deployment of public charge points is likely to accompany this surge. Indeed, if the Member States increase the pace of electric car infrastructure roll out, and deliver on their initial targets from NPFs, then there would be about 220,000 public charge points in Europe by 2020 (based on latest monitoring paper from JRC authors)[ix]. If Member States achieve their targets, the European market would reach on average 9.5 EVs per public charge point.

The data used in this section is from the European Alternative Fuels Observatory (EAFO), which is the official European Commission source for supplying data on alternative fuels vehicles and infrastructure but it does not provide a detailed information on the provision of chargers (e.g. precise power level, location or availability). In addition, this paper also details how the counting method for public chargers can be improved and how the 10 EV-to-1 public charger guideline can also be surpassed.

2.2. Breakdown per charging type

In this section, the report analyses in more detail the supply of public charge points thanks to a combination of two datasets from two different e-mobility service providers: Plugsurfing[9] and OpenChargeMap[10]. Contrary to the public data from EAFO, both Plugsurfing and OpenChargeMap dataset contains detailed information on the type of charger, its availability, the power level and the precise location, which is used in this section to undertake a new analysis (that has not been carried out by other stakeholder) which combines the two datasets (see Annex for more details on the methodology for the combination). When all sources are considered, the final total number of public charge points is calculated to be 185,000 units in the EU in November 2019 and 202,000 units when Norway and Switzerland are included, see Annex 1 for breakdown per country.

Methodology for counting of public charge points

1. Current method (EAFO)

Currently, there are different ways to count the number of public charge points and there is no harmonized methodology at EU level. Member States report the number of public charge points they count to EAFO but do not always provide details on their methodology. In a recent paper, authors from the JRC stressed that *"there is a need for a standardised infrastructure availability (public and private) monitoring system for optimised data collection and to avoid miscalculations"* and called *"for a structured redefinition of infrastructure needs according to technological advances in recharging infrastructure"* which includes an updated classification of charging power categories.[x]
For example, it was reported that countries are not clear whether or not to include semi-public chargers or what type of plugs/sockets are accounted for. In particular, if the Schuko plugs (conventional household plugs) are included or what is the minimum power level of chargers.

[9] Plugsurfing is Europe's largest e-mobility service provider with 130,000 public charge points across Europe and more than 86 thousand drivers in 38 countries. Plugsurfing data shared is not their full database but only a subset relevant to Leaseplan EV drivers, including both private and public charge points

[10] OpenChargeMap is a global public registry of public charging location (https://openchargemap.org/site)

EAFO has recently agreed with the European Commission to harmonise the method to report the number of fast chargers per country and avoid double-counting of CCS and CHAdeMO plugs typically offered on the same charging points but which can not be used at the same time. Currently the number of fast chargers (> 22 kW) are counted as follow by EAFO[xi]: *"(Highest number of CCS/CHAdeMO reported) + Type-2 AC + Tesla Superchargers"*
It has been reported that EAFO is working on an overview of different counting methods of countries and has asked countries to provide the information.

2. **T&E's recommended methodology**

T&E recommends that for more consistency only chargers with the European Commission charging standards should be counted: Combo CCS (for direct current -or DC- charging) and Type 2 (for alternative current -or AC-) and have split them in different charging power (or speed) categories (in kilowatts, or KW) to correctly depict the breakdown in each Member State and avoid duplication. De facto, public charge points below 3 kW should also be excluded. A duo or tri-standard connector (typically CCS, CHAdeMO and Type 2 fast) can be counted as two (one CCS and one Type 2) as long as the two can be used at the same time at their maximum power (with two distinct parking spots).
Semi-public charge points are defined here as chargers that have some kind of access restrictions in terms of availability. For example, these chargers might not be open 24/7 or could be limited to consumers only. However, this excludes chargers that are part of an OEM proprietary charging network (e.g. Tesla Supercharger). These chargers should not be counted as fully public charge points but can be accounted for separately if they are open to the public at least a certain number of hours per day (e.g. 10 hours). The accounting method for these chargers should be harmonised at European level.

Furthermore, counting each charger identically (all count as one) has some limits. In Section 3.4 'New methodology for future targets: Supply metric', T&E presents how a weighting factor should be applied to each charger category and how this can be used to design a new regulation (Section 4).

61% of public charge points are tri-phase AC chargers

Public chargers can have different maximum power ratings (which depend on the available grid connection and the type of connector used). Based on the data available, tri-phase AC chargers (typically 11 or 22 kW) are the most common type of public charge point accounting for 61% of the total supply. Then, one-phase AC chargers (typically 3.7 or 7.4 kW) account for 33%, fast chargers (typically 50 kW), for 4% and ultra-fast chargers (above 100kW) for 0.5% of the total supply. For AC charging tri-phase should be preferred over single phase because on top of providing more energy for a given amount of time, it also puts less stress on the grid (see Section 4.1.3 for more on smart charging).

In Figure 2 below, the current provision of public charging infrastructure in EU's Member States is compared which shows that some countries like Norway, Sweden, Poland, Portugal, Romania, Slovakia and Latvia seem to rely more on fast charging (more than 25% of the total number of chargers). On the other hand, other countries rely to a very large extent on rapid 11-22 kW chargers like Belgium, Bulgaria, Croatia, Denmark, Estonia, Hungary, the Netherlands and Slovenia (more than 85%). Finally, the UK and Spain have a majority of normal 3-7 kW chargers.

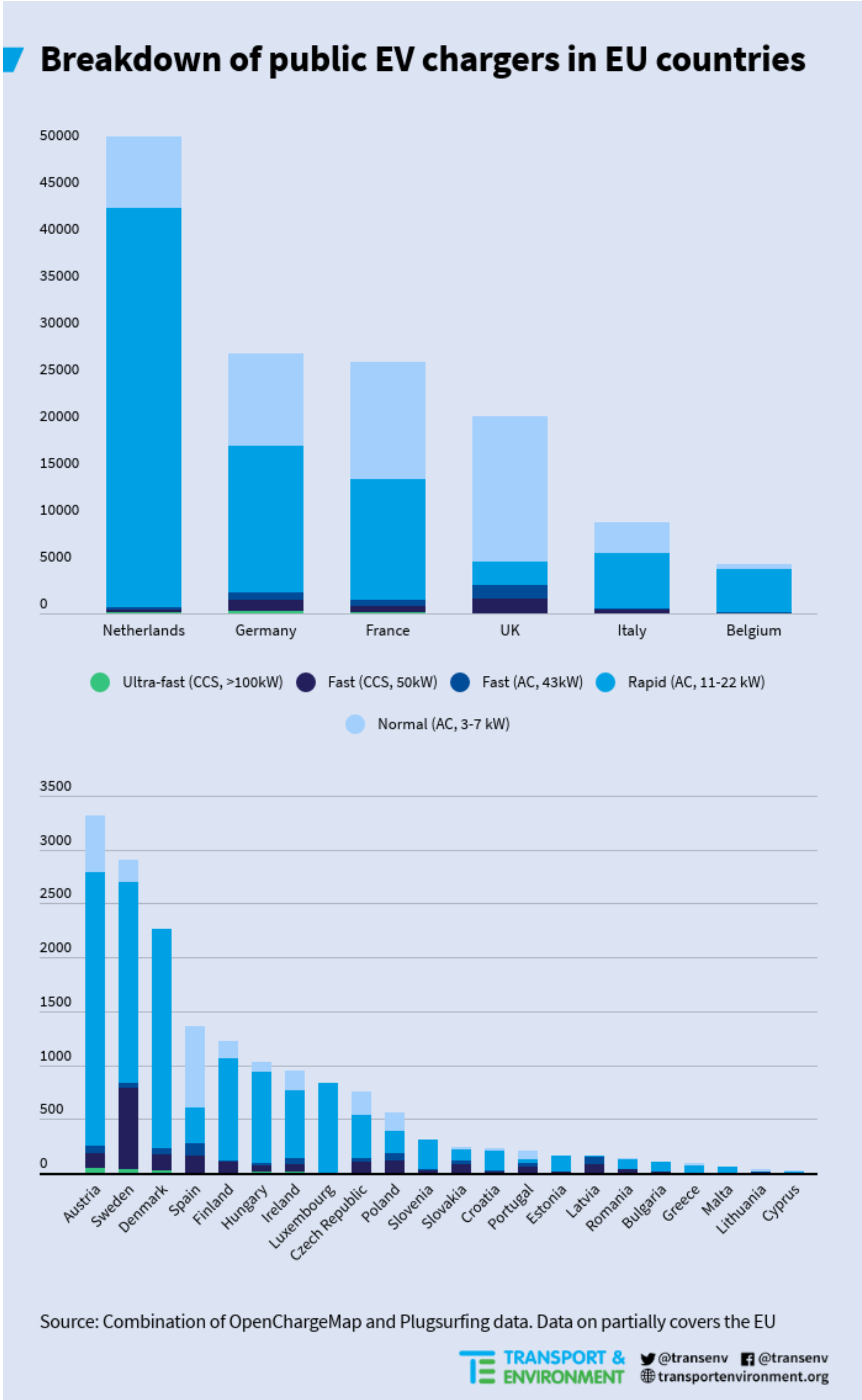
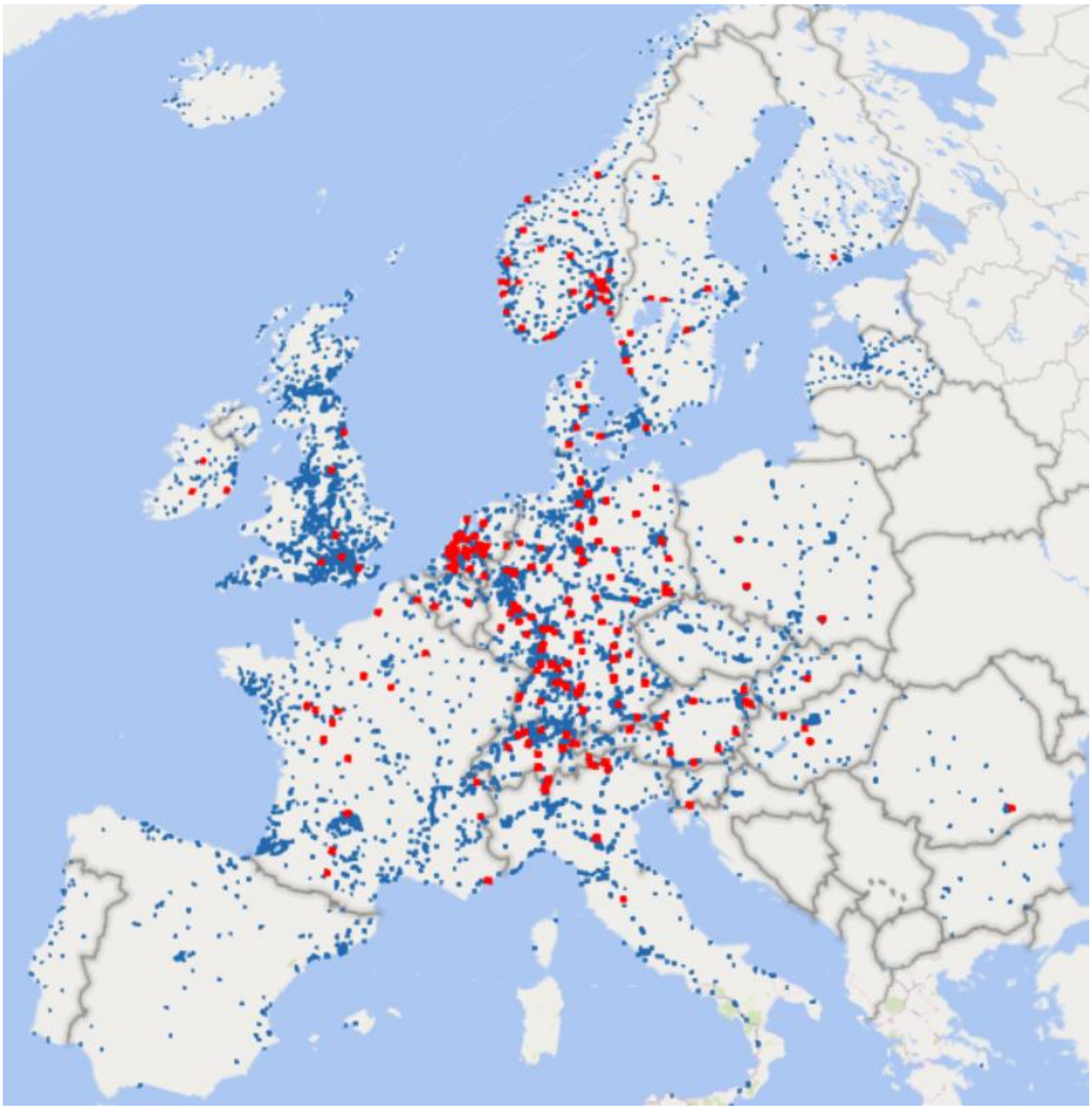


Figure 2: Current breakdown of supply of public charge points in EU countries

2.3. Fast charging: Good fast coverage but still a couple of gaps

There are about 9,000 CCS fast chargers and 640 ultra-fast chargers in the EU (780 and 11,000 with Norway and Switzerland). For example, the Ionity network is rolling out 400 sites in the EU in a couple of years with powers reaching up to 350 kW. In Map 1 below, the geographical coverage of the European CCS fast charging network is shown (based on partly complete datasets from OpenChargeMap and Plugsurfing). It can be seen that a good comprehensive coverage is provided in most Member States (fast chargers are in blue and ultra-fast chargers are in red), and very few gaps persist, for example in Central and Eastern Europe but also in some locations in Western Europe (e.g. Wallonie) or in Southern European countries (e.g. Italy and Spain). Since none of the two dataset used here are exhaustive, some fast chargers could be missing and this map could be considered conservative although it provides a very good overview of the current situation.



Map 1: Distribution of CCS fast (blue) and CCS ultra-fast (red) public charge points
(source: T&E analysis of Plugsurfing and OpenChargeMap data)

The UK, Netherlands, Germany, Sweden, Austria and Denmark, already benefit from very good coverage (more than seven fast charge points for every 100 km) while some other countries (Slovenia, Czech Republic, France, Belgium) have acceptable coverage with four to seven fast charge points per 100 km on average (see Figure 3 below). On the contrary, the density of fast chargers is still relatively low in some Southern countries like Spain, Italy and Portugal, as well as in most Central Eastern European countries such as Poland, Hungary, Greece, Croatia and Lithuania. The metric used here to assess average coverage is the number of fast chargers per distance of the TEN-T Comprehensive network (which is designed to cover all parts of the EU). This allows us to confirm the intuition from the above map where the density of fast chargers is indeed on average much higher in the UK (20 fast chargers for every 100 km along the TEN-T Comprehensive network), the Netherlands (17), Germany (14), Sweden (8), Austria (8) and Denmark (7). This assessment only takes into account national averages and thus doesn't take into consideration geographic distribution and possible gaps within the TEN-T Comprehensive network. It is key that these local gaps are addressed at national level and that the coverage of this European comprehensive network is ensured as soon as possible.

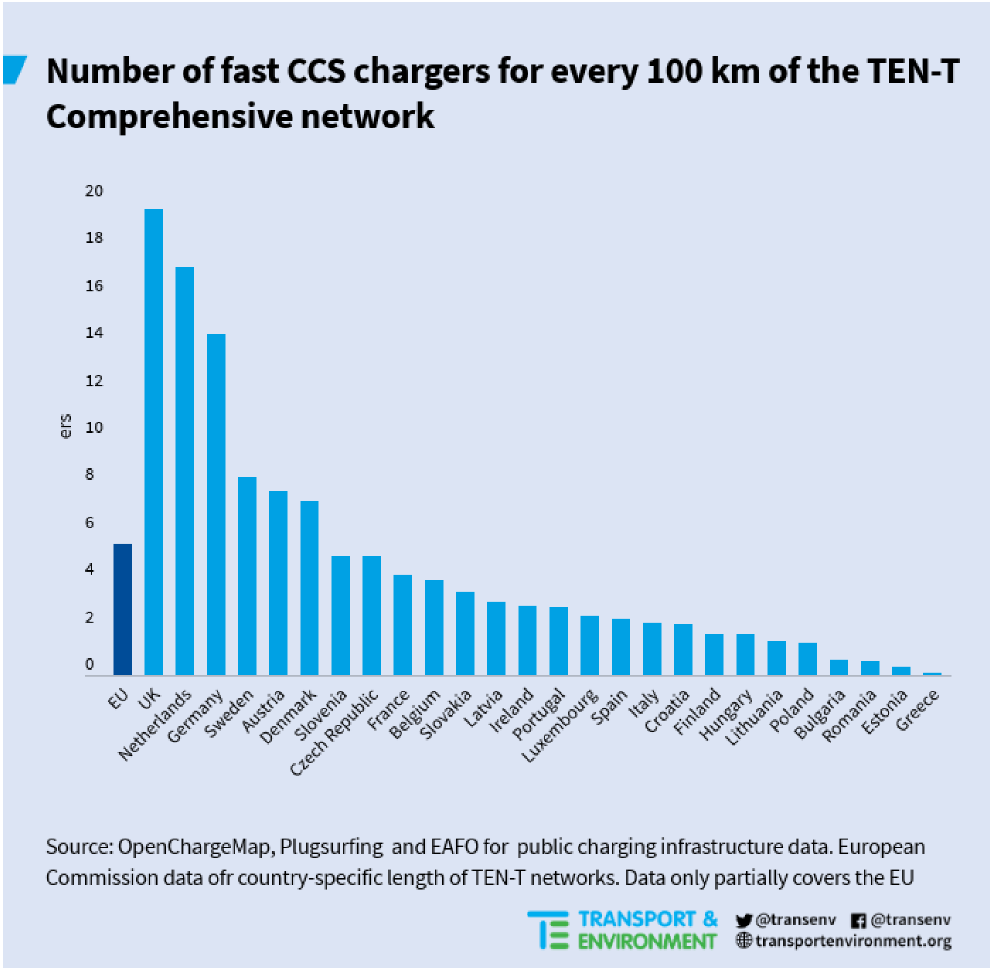


Figure 3: Current availability of CCS fast chargers in the EU per road length

Within the fast charging network are included a growing number of ultra-fast chargers. It has already grown to about 780 ultra-fast chargers[11] (in red in the map above) according to the data in Europe, mostly in Germany (269 charging points), France (88), Norway (85), the Netherlands (98), Switzerland (55), Austria (45), Sweden (31), Denmark (22) and Belgium (20)[12] and is expected to surge in the next couple of years reaching more than 8,000 chargers[13] (or a 16 - fold increase).

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[11] Above 100 kW only. This count excludes Tesla Supercharger network (at least 400 sites and about 4,500 charge points in Europe) because it is a carmaker proprietary network only accessible to Tesla drivers.

[12] Most of the chargers are operated by three CPOs: Allego, Fastned and Ionity

[13] Number of charge points (sites): Ionity: 2,400 (400), Allego: 322+100 (39+25), E.ON: (180+30), Enel: (14), EnBW 2,000 (1000), CEUC: (118), Instavolt: 200, Fastned: (25), Total 1,000 (300), Chargemaster 400, Gridserve/Chargepoint (100), Shell 100 (50), Greenway (40), Fortum, Iberdrola. Assuming 4 chargers per site.

3. Charging the EV uptake: how many public charge points?

3.1. Two EV uptake scenarios: CurrentPolicies and Road2Zero

Thanks to increasing EV sales in Europe, the EV market will be very different in a few years' time. In this section, T&E presents its two scenarios for EV sales up to 2030. The first scenario is aligned with the minimum requirements that carmakers have to comply with, the second one is a higher ambition scenario in line with the EU's objectives to reach climate neutrality in 2050.

CurrentPolicies: EU car CO2 standards
Carmakers will need to comply with the EU CO2 emission reduction targets of -15% in 2025 and -37.5% in 2030, which will result in an increase of EV sales. Based on T&E's in-house model (updated based on recent market developments), it is expected that EV sales will rise to 19% market share in 2025 and 33% in 2030.[14] For more details on the model see the Annex of T&E's Electric Surge report from July 2019.[ii]

Road2Zero: Green Deal-compatible scenario
To be aligned with the Paris Agreement objectives, the European Union should have a zero-emission road transport sector by 2050. The scenario modelled here is based on T&E's 2050 transport decarbonisation strategy, where the last conventional combustion car (including PHEVs and HEVs) has to be sold by 2035 at the latest and the share of ZEVs in new sales would be around 40% in 2030[xii]. This is compatible with the fleet composition considered by the European Commission in their document "Clean Planet for All" on how to achieve a climate neutral economy by 2050 and is more compatible with the European Green Deal and the likely tighter CO2 emission standards that to be revised in 2021 according to the European Green Deal communication from December 2019[xiii].

In both scenarios, the share of EVs is 5% in 2020 and 10% in 2021, in line with what T&E has calculated in average for carmakers to comply with the 95g CO2/km emission standard and the split between BEVs and PHEVs is 60%/40% in 2020 and 2021 and 65%/35% in 2025.

Both scenarios are shown in Figure 4 below where the EV uptake is distinguished between BEVs and PHEVs. One interesting takeaway can be drawn from the trend in the curves. Firstly, there is a clear market take up in 2020 and 2021, but the two scenarios diverge mostly after 2025, with only 4% market share difference between the two scenarios in 2025, but up to a 21% difference in 2030. In the CO2 minimum requirement scenario, the rate of adoption slows down after 2025, whereas it should be accelerating as the purchase price of EVs should reach parity with ICE equivalents around the mid-2020s. Technology adoption rates typically follow an exponential s-curve[15] so here the Road2Zero scenario is not only much better for the climate, but it is also more in line with typical market adoption rates.

[14] BEV/PHEV split: 60%/40% in 2021, 65%/35% in 2025 and 70%/30% in 2030.
PHEV average emissions: 43 g/km in 2021, 35g/km in 2025 and 30g/km in 2030.

[15] e.g. color TV, household electrical appliances, cell phones, internet, etc...

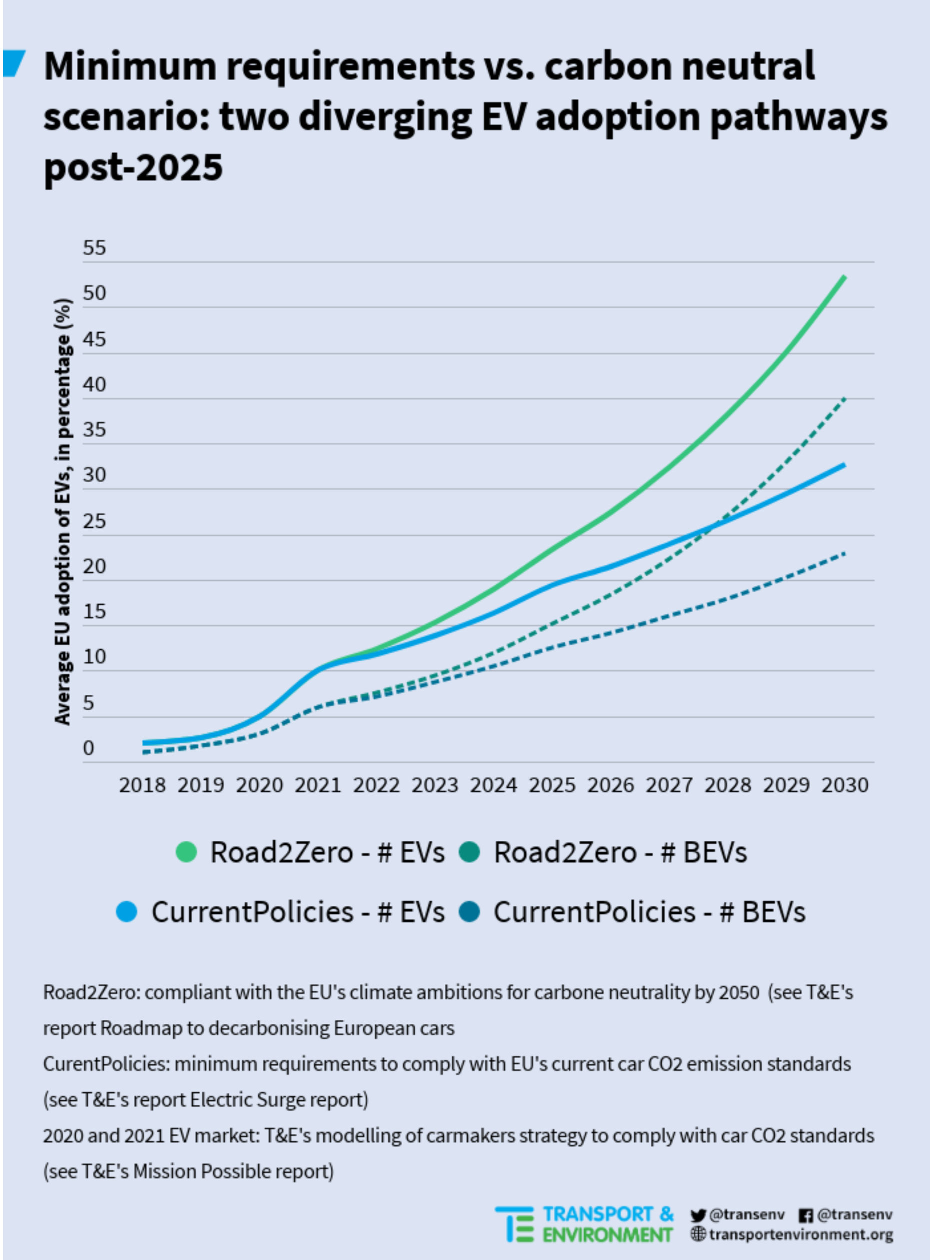

Figure 4: T&E EV sales scenarios (Road2Zero and CurrentPolicies)

3.2. Charging behaviour assumptions

To understand what the actual recharging needs of the European fleet are, T&E has analysed a pan-European EV charging behaviour dataset from LeasePlan EV drivers. The dataset includes over 13,000 charging sessions, covering all the charge sessions of about 300 unique drivers from January 2019 to September 2019 which have charged altogether more than 180 MWh[16]. These charge sessions are done at about 1,500 different charging locations disseminated in eight European countries (Belgium, Denmark, France, Germany, Luxembourg, Norway, Portugal and Sweden).

Today, there is very little evidence on how the average EV user charges his or her car. No previous analysis has been performed on this scale including several countries. Furthermore, existing analyses do not offer a

[16] BEVs charged more than 100 MWh over about 4,300 charge sessions while PHEVs charged about 50 MWh over about 7,300 charge sessions. The remaining energy delivered and charge sessions is performed by EVs that can't be identified.

comprehensive overview from the EV driver perspective (rather from the charging infrastructure perspective) and are prior to 2018 and 2019[17].

LeasePlan is the biggest car leasing companies in Europe and offers cars for personal leases, for small business lease and for corporate business lease. EVs have already become a core part of their fleet for several years already, and they have committed to a 100% zero-emission fleet by 2030. LeasePlan has analysed the total-cost of ownership (TCO) of EVs and shown it is today cheaper than diesel and petrol equivalents in most of the situations (in 56% of the 912 scenarios, EVs had a lower TCO than ICEs).[xiv]

BEV drivers travel long distances

One key finding from this data is that BEVs charge over about 3.7 times more energy than PHEVs over a typical week. Translated into number of kilometers driven on the electric motor, BEVs drive on average about 20,600 km per year while PHEVs about 5,600 km per year on the electric mode[18]. In other words, for the same distance travelled, PHEVs drive only about a quarter of the time on the electric mode, the rest being fuelled by the conventional gasoline engine. This finding on the real-world electric mode is much lower than the utility factor assumed in the EU test procedures[19] that currently significantly over-estimate the amount of time plug-in cars drive in zero emission mode. The European average distance driven per year for conventional vehicles is about 12,000 km[xv], or 42% percent less than the average LeasePlan BEV in 2019, which indicates that BEV company cars travel on average longer distances than the average diesel and petrol equivalent (includes both company and private vehicles) and that high-mileage lease driver can also drive a BEV. These findings will be presented more in depth in a later T&E publication.

Charging behavior indicators

Alongside LeasePlan, T&E has consulted expert stakeholders to validate the assumptions derived from LeasePlan's real-world charging behavior data. Sixteen experts have been contacted and eight experts have provided feedback. The feedback that was provided is treated with strict confidentiality, therefore, the final assumptions for charging behavior used in our analysis are based on a combination of LeasePlan's real-world charging data, T&E internal expertise and expert's feedback. T&E wishes to kindly acknowledge the help of the following stakeholders: Allego, Greenway, Fastned, Enel, Vattenfal, IDO-Laad, Chargepoint and Tesla.

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[17] A couple of academic papers have analysed a larger dataset of EV charging sessions, however these datasets are obtained from charge point operators (perspective from the charger) and do not give a comprehensive view from the EV driver perspective. Two of the most important papers analysing charging data focus on the Netherlands between 2012 and 2016 when the fleet was composed of about 80%-90% PHEVs:

- A. Prettico et al. (2018). Report from JRC authors based on data from 2012 to 2016 from ElaadNL which covers only 16% of the stations in the Netherlands and only tri-phase chargers below 22 kW.
- J.R. Helmus et al. (2018). Also based on ElaadNL data from 2012 to 2016

[18] The analysis of the volume of energy recharged from Leaseplan EV drivers is performed on a weekly basis as done by J.R. Helmus et al., (2018), averaging over the time period between the very first charge session and the last session. Amount of energy delivered is converted into driving distance using the average efficiency of 0.18 kWh/km.

[19] The determination of utility factors for PHEVs in Europe (Annex XXI, Sub-Annex 8, Appendix 5 of WLTP Regulation 2017/1151, amended by Regulation 2018/1832) is based on a 2010 methodology by US SAE, which starting assumptions are: PHEVs are charged every night and PHEVs are always driven with the zero-emission mode used from full to empty battery before switching to the combustion engine, regardless of the total daily trip length.

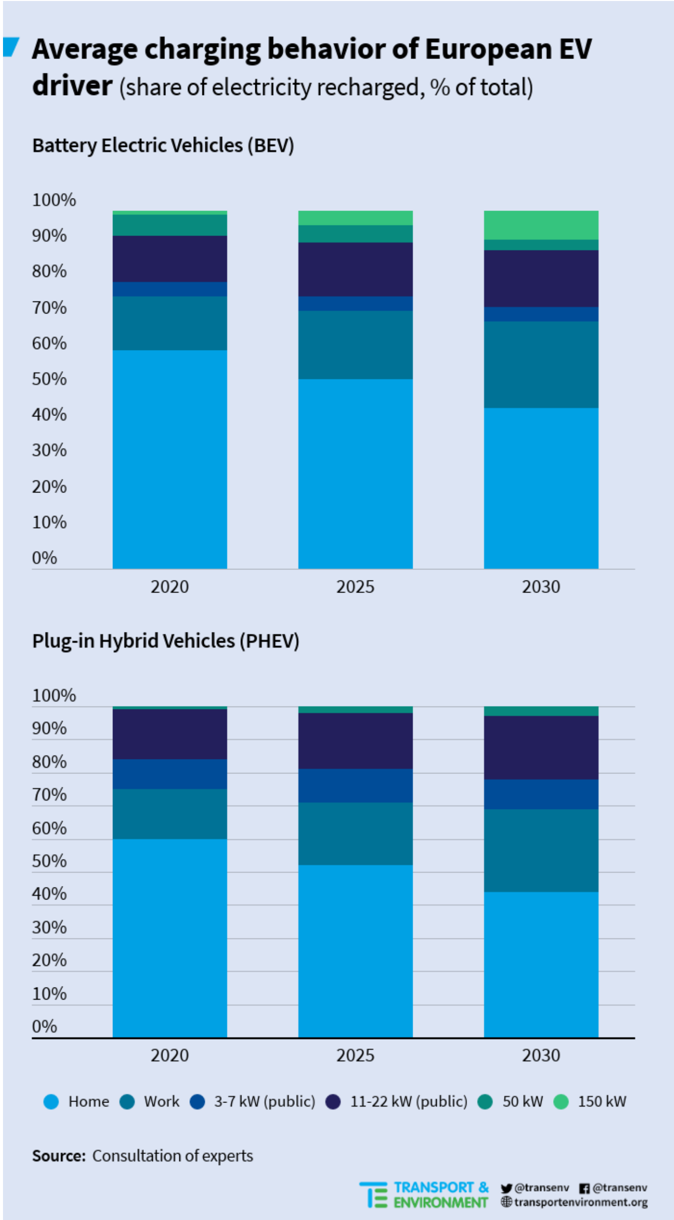

Figure 5: Average charging behavior of European EV drivers

As shown in Figure 5 above, the share of home charging will decrease from 61% in 2020 to 45% in 2030 (the values are expressed in share of total energy recharged, not share of charge sessions). This trend, captured in modelling (see Section 1.3 below) and validated by the experts, reflects the decreasing share of new EV buyers that have access to home charging because more EV drivers will be living shared multi-dwelling buildings with no or limited access to private parking.[20] As a consequence, there's an increase in the need to charge at other locations: public charging and workplace charging. Here, the share of work charging increases from about 15% to 24%, the share of rapid 11-22 kW charging increases from 13% to 17% for BEV while their share of fast (including ultra-fast) increases from 6% to 9% in 2030. In our modelling, the amount of energy delivered with ultra-fast charging surpasses the energy delivered by regular fast (50 kW) chargers around 2026 (in 2019, 90% of the new fast chargers as regular fast chargers vs. only 13% in 2030).

[20] In the model this is captured by treating separately EV drivers with home charging and those without with regards to their charging behavior and to model the increasing share of EV drivers that do not have access to home charging based on housing statistics from Eurostat.

3.3. Supply of public charge points for 2025 and 2030

T&E**'s Public Charging Infrastructure Supply and Cost model**

To evaluate the amount of public charging infrastructure that will be needed to recharge EVs in each European country up to 2030, T&E relies on a bottom-up energy-demand modelling that can be broken down into several steps, with every step addressed at Member State level and for every year from 2019 to 2030:

1. EV uptake scenarios (see section 1.1).
2. Calculate how much energy would be needed to charge the EVs based on real-world charging behaviors observed from LeasePlan data.
3. Distinguish the above energy needs per type of charger: home, work, slow (3-7 kW), normal (11-22 kW), fast (50-100 kW), ultra-fast (above 100 kW).
4. The respective number of chargers needed in each category per year to dispense this energy is calculated.
5. Total costs for infrastructure deployment are assessed based on installation, equipment and grid connection cost for each type

The Figure 6, below gives an overview of the model and presents how the inputs (in particular LeasePlan charging data, EUTRM[21], and the survey/consultation of experts) interact with each other to calculate the outputs (in particular, number of chargers, Supply metric and Sufficiency indicator). Each year between 2019 and 2030 is modelled and the country desired can be selected. For more details of the mode flow chart which includes how national variations between countries are taken into account, please see Annex 2. Both the Supply metric and the Sufficiency Indicator are detailed in the next Section.

[21] T&E's European Transportation Roadmap Model (EUTRM). More information and data sources available: https://www.transportenvironment.org/what-we-do/eu-transport-policy/emissions-modelling

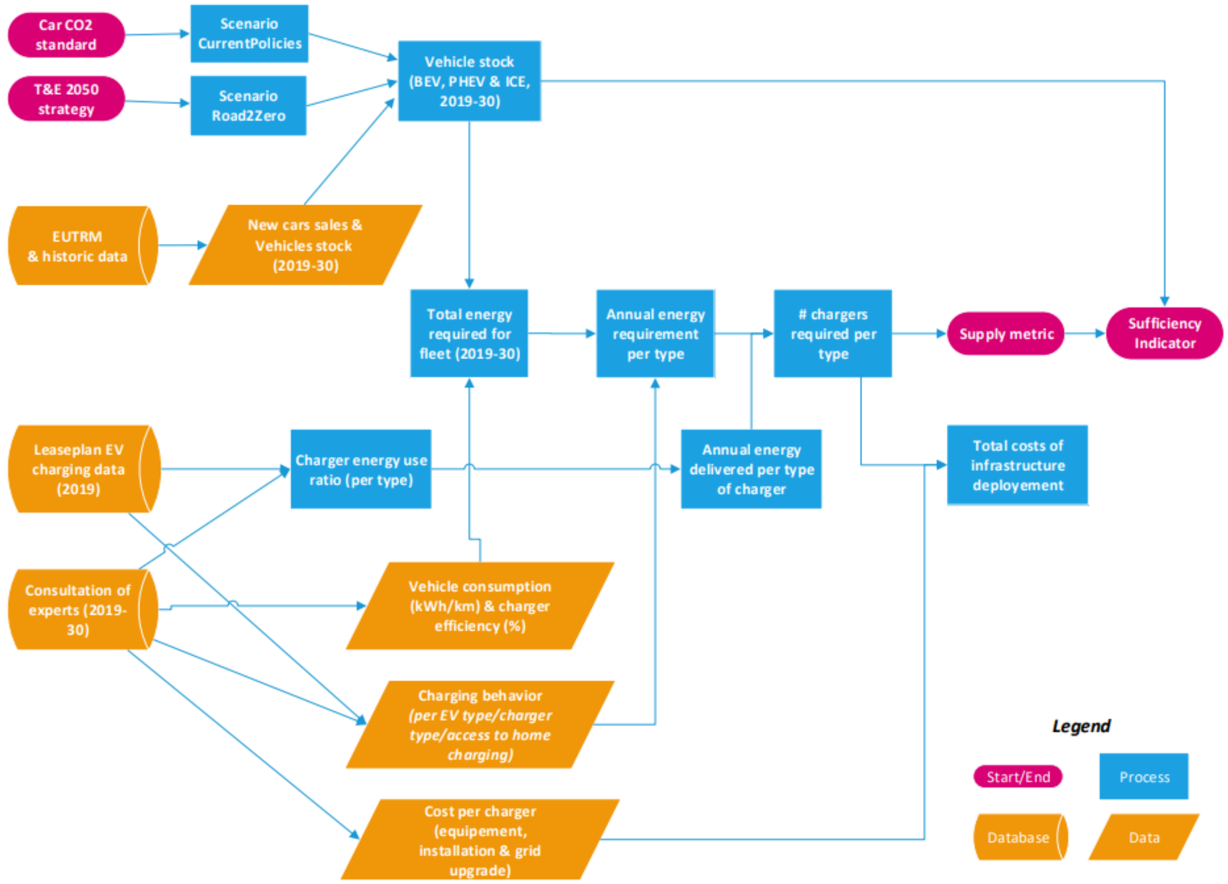

Figure 6**: Flowchart of T&E's Public Charging Infrastructure Supply and Cost model (simplified)**

From 1.3 million EVs today to 13-14 million in 2025 and 33-44 million in 2030

One of the initial steps of the model is to calculate the total EV stock in each country. In the Road2Zero scenario, the number of EVs on the road in the EU would surge from 1.3 million today to about 14 million in 2025 and 44 million in 2030. In the CurrentPolicies scenario, the difference is limited in 2025 (13 million EVs), but greatly increases in 2030 as there would be 11 million less EVs on the road (about 33 million in total). The breakdown per country can be found in Annex 3. The number of ICE cars on the road peaks in 2025 in the Road2Zero scenario and in 2028 in the CurrentPolicies.

1.2 to 1.3 million public charge points in 2025 and 2.2 to 2.9 million in 2030

The total number of public charge points required varies from one scenario to another (along with the total number of EVs). In Section 3.1 above it was stressed that the biggest difference between the two scenarios appear after 2025 which is then reflected in the results of the model. In 2025, in the climate-compatible scenario Road2Zero scenario 1.3 million public charge points would be required, while 1.2 million would be required in the CurrentPolicies scenario. As shown in Figure 7 below, in 2030, the gap between the scenarios increases with 2.9 million public charge points in the Road2Zero and 2.2 million in the CurrentPolicies scenario. In other words, the total number of public charge points has to increase by a factor 6 or 7 by 2025 compared to today's level and by a factor 12 or 16 by 2030. The breakdown per country can be found in Annex 3.

T&E does not call for Member States specific targets on the total number of public charge points calculated from the model here, but rather on a weighted volume of supply of public charging infrastructure (see

Section 3.4 below ‘New methodology for future targets: Supply Metric’). Without any differentiation, there is a risk of market distortion towards very high number of slow charge points.

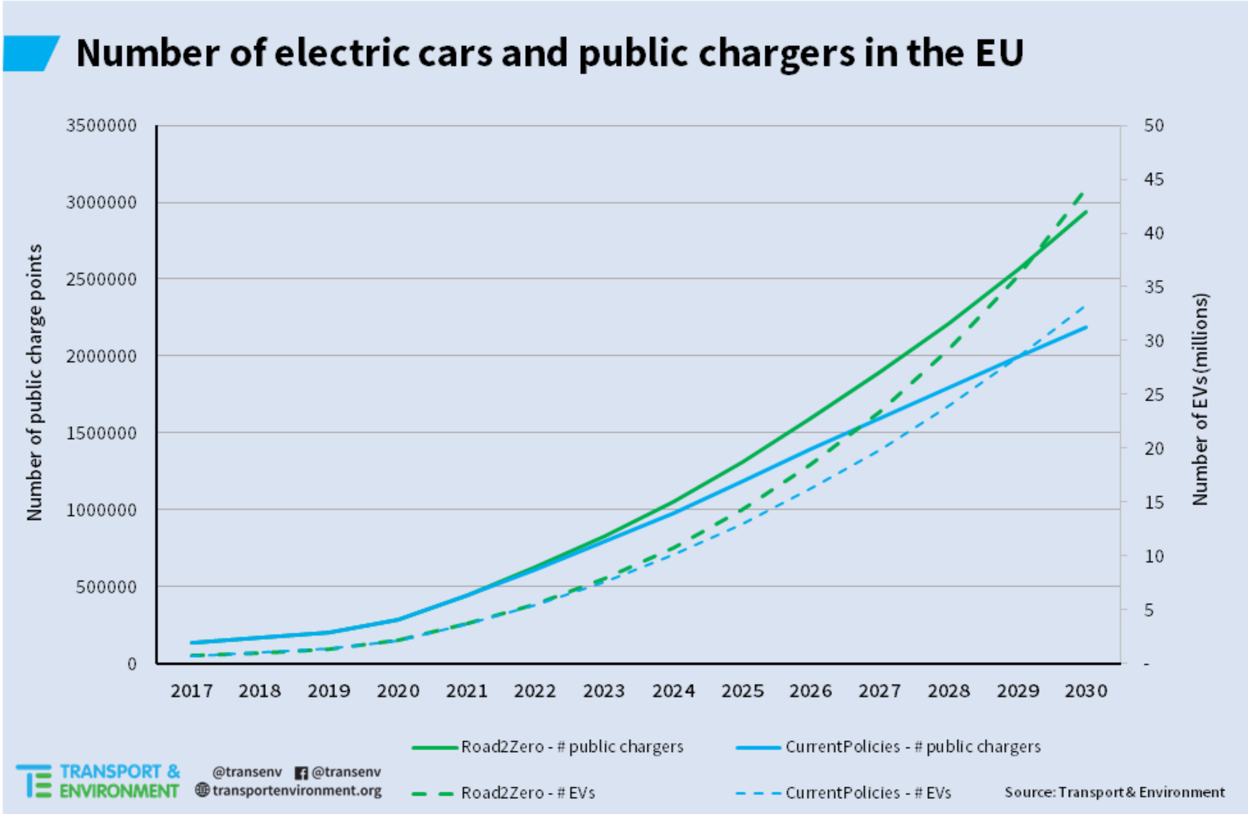

Figure 7: Number of electric cars and public chargers in the EU up to 2030

The findings are aligned with what several EU countries have recently put forward. For example, in Germany, in the Road2Zero scenario, about 720,000 public charge points are required by 2030, whereas Germany has announced in November 2019 a goal of 1 million charge points for the same year (with no precision on the public availability).[22] In France, the government aims at 100,000 public charge points and 1.2 million EVs by 2023[xvi]. T&E’s model calculates 1,150,000 EVs by 2023 and the same amount of EVs on the road in 2023 but the number of public charge points was estimated to be between 130,000 and 140,000 public charge points in that year. In Italy, in the Road2Zero scenario, this would amount to about 3.7 million BEVs and 1.7 million PHEVs.

How will these chargers be distributed across countries?

As the number of required public chargers correlates with the total number of EVs (which itself is strongly correlated with the size of the car market), bigger countries are expected to roll out the lion’s share of future public charge points. The total number of public charge points required per Member State in the Road2Zero scenario is shown in Figure 8 and the one for the CurrentPolicies scenario is shown in Annex 3. All countries have to significantly ramp-up the supply of EV public charge points and the level of effort required for the future charging infrastructure roll out dwarfs the current state of the market. In both scenarios, the top five car markets (Germany, France, the UK, Italy and Spain) will continue to make up the lion’s share of public charge points in the EU, rising to about 78% of the total public charging infrastructure in the EU as of 2025[23]. This is logical because these countries are EU’s biggest economies and the largest car markets, it is not

[22] It should be noted that Germany has today 32,000 public charge points, which is significantly higher than the figure of 20,000 public charge points widely used in media coverage of Germany’s infrastructure plan.
[23] Looking at one scenario or the other implies that all EU Member States are aligned with the same EV uptake

realistic to expect their share of EU's public charge points to be lower than their contribution to the total EU's car market (74% according to ACEA) or to the EU's GDP (70% according to Eurostat). The Netherlands has already made notable progress towards reaching what would be needed to be climate-compliant.

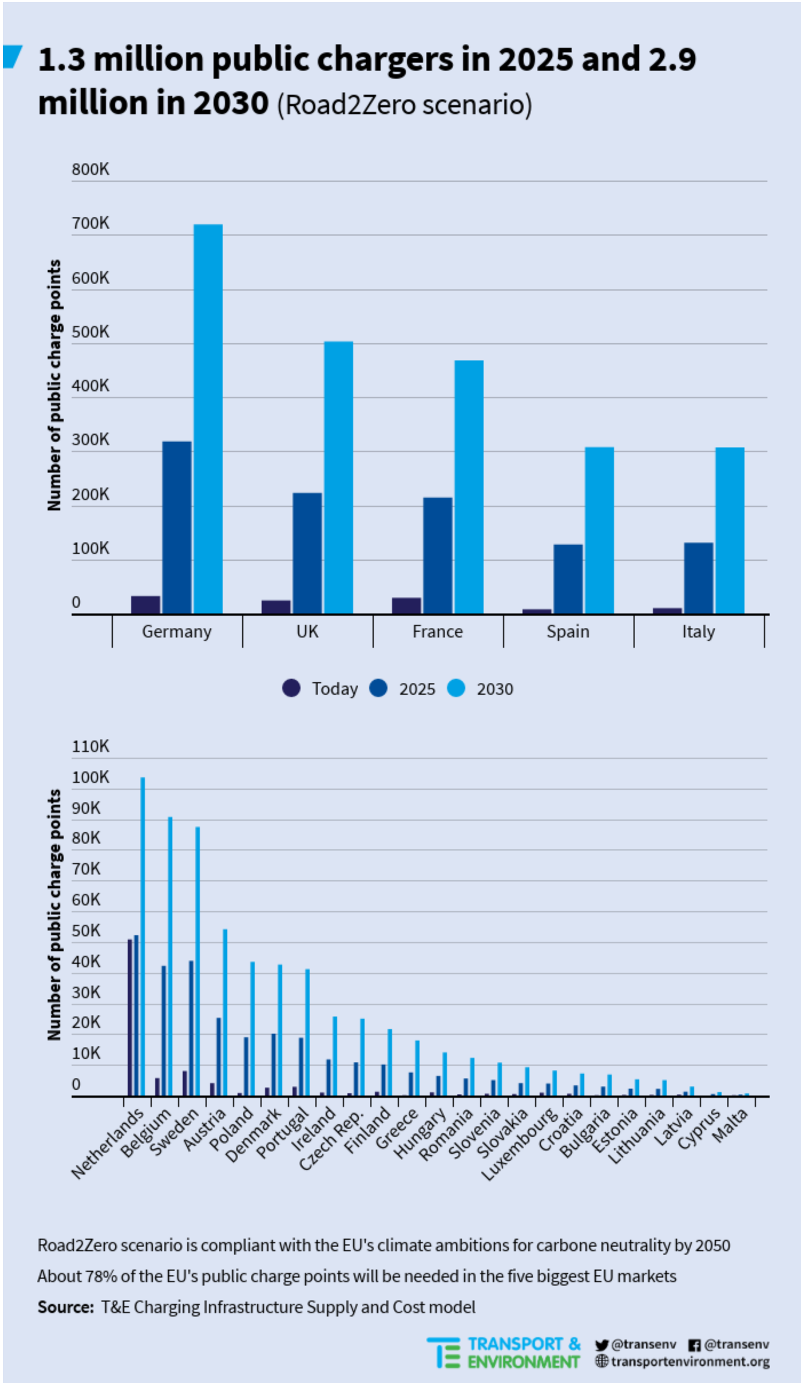

Figure 8: Number of public chargers in EU countries (Road2Zero scenario)

At EU level, there would be on average 5.7 public charge points per capita in the Road2Zero scenario in 2030. As seen in Figure 9 below, most of the EU (all Western and Northern Member States plus Slovenia and Estonia) would need more than four public charge points per 1,000 inhabitants. The other half will need less than three public charge points per 1,000 inhabitants. For example, Romania, Malta, Bulgaria, Cyprus, Poland, Hungary are below 1.5 public charge points per 1,000 inhabitants. On the other hand, only Germany (8.7), Sweden (8.6) and Luxembourg (13.5) are above eight public charge points per 1,000 inhabitants. The amount of public charge points per capita varies from one country to another because of the relative size of the car market in each country (compared to the total population), as well as the access to home charging and the average distance that is driven for each Member State.

Interestingly, although the EV adoption rates are the same across all Member States in our modelling, the deployment of public charging infrastructure per capita is not identical between member states as these countries have many specificities. For example, in some countries where cars drive lower distances annually (e.g. Malta, Cyprus, Czech Republic, Poland, Romania) and are not very urbanised (more access to home charging), the number of public charge points per capita is rather small. This leads to a key take-away: the number of public charge points deployed in each Member State does not need to be harmonised on a per capita basis for an ambitious and harmonised adoption of EVs. It should nonetheless be noted that our modelling does not include second hand vehicle flows (mainly from Western Europe to Central and Eastern Europe) which could lead us to underestimate the amount of electric cars and of public charge points in these countries.

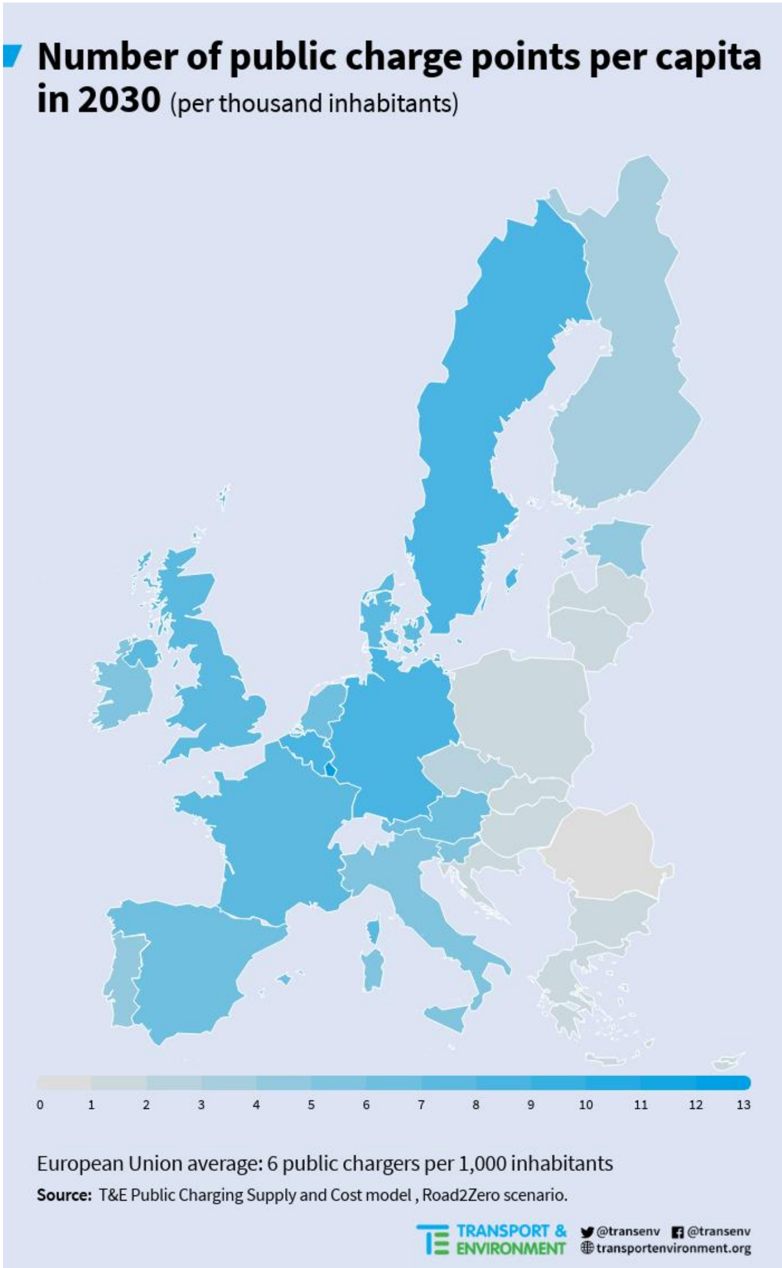

Figure 9: Number of public charge points per capita in 2030

3.4. New methodology for future targets: Supply Metric

The current convention is to count all public charge points equally as one, even though there are many differences from one charger to another according to its availability and maximum power provided, which is what matters for the EV fleet. As shown in the previous section, the availability of chargers and the breakdown between the different charging power categories vary from one country to another, which affects the total amount of power (kW) available to recharge the total EV fleet. Counting all chargers equally can result in some important inconsistencies in the way the public charging network is monitored and the way countries are compared one to another.

To address this, T&E proposes an improved metric to assess the adequacy of the supply, or the quantity of public charging infrastructure, called the EV public charging supply metric, or supply metric which is based on a weighting method. T&E proposed this weighted counting of chargers to set the post-2020 targets for Member States in the review of the AFID. Combined with the results from the modelling presented in the previous Section, we are able to design targets that are Member State specific (based on national housing statistics, vehicle sales and average distance driven) and that are based on our EV uptake scenarios.

The total supply of public charge points is calculated with the following weighting system[24]:

- 1 for single phase (3-7 kW) Type 2 charger *(called here slow charger)*
- 2 for tri-phase (11-22 kW) Type 2 charger *(called here normal charger)*
- 4 for 43 kW Type 2 charger *(called here AC fast charger)*
- 5 for 50 kW (50-150 kW) CCS Combo charger *(called here fast charger)*
- 10 for 150 kW and above CCS Combo charger[25] *(called here ultra-fast charger)*

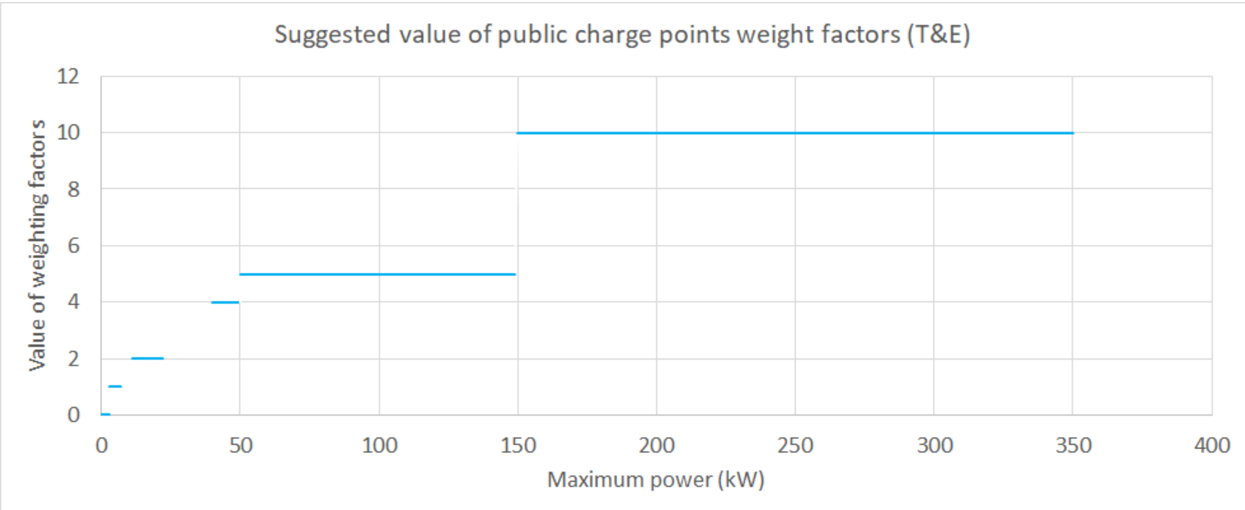

Figure 10: T&E public charge points weight factors

[24] The weighting factors suggested here account for the respective ability of each type of charger to deliver a certain power. The higher the maximum power rating, the more energy can be delivered during a given amount of time and the higher the weighting factor is. The weighting factors are not proportional to the maximum power ratings because that would introduce a risk market distortion towards the higher power charging.

[25] Alternatively, the limit for ultra-fast chargers can be placed at 100 kW rather than 150 kW, and/or and additional fast charging category can be added for chargers of more than 51kW but less than 149kW.

Semi-public charge points or any charger with restricted access should be counted for half their value, e.g. 1 for 22 kW AC fast charger. In practice these semi-public charge points should be available to the public a certain number of hours per day (e.g. 10 hours) and have Type 2 or CCS plugs. This category should be harmonised at European level and seek to include chargers offered on commercial premises, chargers not fully available to all consumers or not available 24/7 as well as public charge points that are de facto private chargers like in the Netherlands (placed on public areas but used as private chargers). However this excludes chargers that are part of an OEM proprietary charging network (e.g. Tesla Supercharger) which should not be counted at all.

The Supply metric for a given Member State is to be calculated based on the following formula:

$$Supply\ metric = \sum_{slow\ charger,i} \frac{1}{availability_i} + \sum_{normal\ charger,i} \frac{2}{availability_i} + \sum_{AC\ fast\ charger,i} \frac{4}{availability_i} + \sum_{fast\ charger,i} \frac{5}{availability_i} + \sum_{ultra-fast\ charger,i} \frac{10}{availability_i}$$

$$Where\ availability_i = 1\ if\ charger_i\ is\ publically\ available\ with\ no\ restriction\ 24/7$$
$$availability_i = 2\ if\ charger_i\ is\ semi-public$$
$$Chargers\ that\ do\ not\ fall\ within\ the\ scope\ of\ the\ above\ are\ not\ counted.$$

A duo or tri-standard connector (typically CCS, CHAdeMO and Type 2 fast) can be counted as two (one CCS and one Type 2) as long as the two can be used at the same time at their maximum power (with two distinct parking spots).

The European Commission's Sustainable Transport Forum (STF) expert group[26] has already published a similar classification to refine the different power levels, which can logically be used to report separately on each type.

A binding target based on the Supply metric

For a given value of the public charging Supply metric, there are countless ways to achieve it depending on the combination of the different charger types. For example, a country could have less public charge points than another country but still have a higher value for their public charging Supply metric thanks to a higher number of fast and ultra-fast chargers and/or a bigger proportion of chargers fully accessible (as opposed to semi-public). In this sense the public charging Supply metric can adapt to different national contexts and is also more resiliant vis-a-vis of future market evolution.

In our model, the average supply value modelled for each country is about the double of the number of public charge points. In reality, this multiplication factor between the number of public charge points and the total amount of supply will vary from one country to another based on the country-specific average charging behavior (in our model the same charging behavior was assumed for all countries). This would introduce an additional variability factor on the optimal number of public chargers and thus reinforces the rational to set a target on the total amount of 'supply'. For example, today some countries have a Supply metric that is about 40% to 60% higher than the number of public charge points (e.g. France, Belgium,

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[26] The STF stakeholders published a report in November 2019, on which many experts collaborated to share views on key policy needs and options for action in Alternative Fuels Infrastructure deployment and consumer services. European Commission, 2019. *Analysis of stakeholder views on key policy needs and options for action in Alternative Fuels Infrastructure deployment and consumer services.* https://ec.europa.eu/transport/sites/transport/files/2019-stf-consultation-analysis.pdf

Spain, UK) while for other countries the Supply metric value is more than two times higher than the number of public charge points (e.g. Denmark, Ireland, Norway, Portugal or Sweden).

The results of the model for the number of public charge points and the associated value of the public charging Supply metric in 2025 and 2030 for both scenarios and for each country are presented in detail in Annex 3 while the suggested target based on the Supply metric and the Road2Zero scenario is presented in Section 4.1.2.

3.5. Two metrics to monitor the public charging and the EV markets

In this Section are presented two complementary indicators to monitor that number of public charge points with regards to the number of EVs on the road: the Sufficiency Indicator and the number of BEVs per fast chargers.

3.5.1. Optimal Sufficiency Indicator

It is key to track how the supply of public charging evolves with regards to the number of electric cars on the road and how much they need to charge. The European Commission's metric (number of electric cars per public charge point, with 10 being the recommended value) is reaching some limits as the EV market matures since it does not capture differences between countries. The energy needs are different for BEVs and PHEVs as BEVs drive only on the electric motor and therefore need to charge more energy. As a consequence, the amount of energy needed for the EV fleet is also affected by the varying split in BEVs vs. PHEVs. To address this, T&E proposes a new methodology to assess the sufficiency of the public charging infrastructure - or how much charging infrastructure is needed for the electric fleets across Europe - the EV public charging Sufficiency indicator, or Sufficiency indicator. This new metric allows to compare how much the overall service provided by one country's total EV public charging infrastructure network can adequately fit the needs of its corresponding EV fleet. Crucially, this Sufficiency indicator should replace the current 10 EVs per 1 charger guideline.

Each country's Sufficiency indicator is obtained by dividing the number of EV, by the Supply metric described above. For this, EVs have different weighting with BEVs counted as two and PHEVs as one.[27]

The Sufficiency indicator for each Member States is to be calculated using the following formula:

$$Sufficiency\ indicator = \frac{\#\ BEV \times 2 + \#\ PHEVs}{Supply\ metric}$$

The derived value corresponds to the number of (weighted) EVs per (weighted) public charge point and gives an assessment of the sufficiency of the public charging network with regards to EVs on the road. The higher the value, the less infrastructure is available for a given number of EVs, similarly to the current 10 in 1 EU guideline.

[27] The respective weight of PHEV vs. BEVs could be adjusted as there is more real-world evidence on average real-world charging behavior. Currently, data suggests that PHEVs recharge about four times less electricity than BEVs (see Section 3.2) but we consider a ratio 2:1 to be more representative for average utilisation in the 2020s. With sufficient data granularity, the weightings could be adjusted at national level.

The advantage of the new Sufficiency indicator is that it is much more representative of the real-world supply-demand balance of the EV public charging market since it takes into account the power delivered/potential of each charger, rather than counting them all equally. In Finland, for example there would be an undersupply of public charge points according to the European Commission metric. However, because they have a very high share of PHEVs (78%) that have lower public recharging needs, there could actually be an oversupply of public charging infrastructure in this country according to our indicator. Thanks to its better representativeness of the real world, the Sufficiency indicator is more suited for policy making, as it creates a harmonized EU framework. This framework also reduces the chances of creating flaws in the regulation. For example, if all chargers and vehicles are counted equally (i.e. current European Commission metric), a country could deploy only slow chargers to easily achieve targets without taking into consideration the needs of the EV fleet such as shared fleets or new high power models.

However, public charging requirements vary from one country to another since the total activity of drivers in the country (or average total distance travelled per year) and access to private (home and work) charging can both influence that requirement. Thanks to the model presented in the previous, we can account for each country's specificities and assesses what would be the optimal value of the Sufficiency indicator for each Member State from today up to 2030 (based on national housing statistics, vehicle sales and average distance driven). The results of the model for the number of public charge points and the associated value of the public charging Optimal Sufficiency Indicator in 2025 and 2030 for both scenarios and for each country are presented in Annex 3. As expected, the Sufficiency indicator is almost identical in the two scenarios since the charging behavior, the amount of energy consumed per EV and the availability of home charging are not scenario dependent. It can be noted that as the market develops, the Sufficiency indicator slightly increases as fewer public charge points are needed per EV as charger utilization and power increases.

By monitoring the actual Sufficiency indicator with real market data it is possible to track a country's progress against the results of the model.[28] This indicator is used mainly for monitoring purposes, where a Member States would track the value of its Sufficiency indicator and would compare it against the value of the 'optimal' Sufficiency indicator (which depends on country specificities).

3.5.2. 80 BEVs per fast charger in 2025

The ideal number of BEVs per fast charger is another indicator that can be used to assess the sufficiency of the provision of the public charging network. It has been widely used and monitored in the literature. It presents a relatively simple assessment that can complement the other Sufficiency indicator presented above if one wishes to investigate in particular the supply of fast chargers. Based on our modelling, the required number of BEVs per fast charger increases from about 40 in 2020, to about 80 in 2025 and 130 in 2030[29]. This value increases over time for two reasons:

- Currently most fast chargers are 50 kW chargers, but in the future, most of the chargers will likely have higher power capabilities (typically 150 kW, with some as high as 350 kW). These chargers are able to charge a car several times faster than a 50 kW, therefore less fast chargers are required per BEV.

[28] A normalised factor could be introduced to compare how Member States perform against the 'optimal' Sufficiency indicator (calculated from the model). This factor would be the ratio of the current Sufficiency indicator divided by the optimal Sufficiency indicator. A value above 1 indicates an oversupply of public charging while a value below 1 corresponds to an undersupply.

[29] If fast chargers with powers above 100 kW are counted double (vs. regular 50kW fast chargers), the number of BEVs per fast chargers increases to about 80 in 2025 and 100 in 2030.

- Average utilisation rates are low in the early phases of the market since the network is rolled-out to ensure a minimum coverage level.

Literature review

Several other studies have also looked into the ideal number of electric vehicles per fast chargers:

- ICCT[xvii]: between 100 and 300 in today's more developed markets, with 100 being more aligned with European context (Norway in particular) and 300 aligned with USA context. In early market, a ratio of 50 could be needed. ICCT notes that as the market develops, fewer fast chargers are needed per BEV as utilization increases, as individual chargers serve more diverse travel schedules and the ideal ratio of electric cars per fast charger in the future is less certain.
- IEA[xviii]: the ratio is assumed to converge towards 130 electric cars per fast charger
- ZeroCarbonFuture[xix]: 125 BEV per rapid charger according to modelling for the UK.
- ICCT calculates between 10 and 20 BEVs per fast chargers in most scenarios when home charging is not available[xx]
- Tesla Supercharger network would translate into an approximate ratio of 37 BEVs per Supercharger (about 4,000 supercharger stalls for more than 150,000 Tesla BEVs in Europe).[xxi]

In the next section, T&E lays out its recommendations for how these metrics should be used to set appropriate targets on the deployment of public charge points at national and local level.

4. T&E blueprint for infrastructure policies

4.1. EU level: Recharging Infrastructure Regulation

4.1.1. Going from a Directive to a Regulation

A new harmonised AFI regulation: AFIĐR

As seen in section 1, 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. If the revised framework stays a Directive, it is unlikely that -due to co-decision and national implementation processes- any target would be set before 2025 even though the Directive states that when and if amended, it should "ensure that an additional number of recharging points are put in place by 2025". Given that more than 13 million of EVs are expected on EU roads by 2025 and more than 33 million by 2030, it is key that Europeans have access to an interoperable, comprehensive and functioning charging network across the Union. 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), which is in line with the EU proportionality principle. In support of this, in 2018, the European Parliament had already called the European Commission to draw up a regulation on roaming on alternative publicly accessible fuels infrastructure[xxii].

4.1.2. Binding targets for Member States

Especially in an early market phase, a low number of charging locations might be a barrier to EV adoption due to psychological effects like range anxiety or a limited acceptance of waiting times. Based on the considerations above, T&E recommends that the new AFI Regulation sets the following binding targets per Member State for 2025.

i) Minimum public charging supply targets

It is of paramount importance to set an overarching 2025 and 2030 target for the deployment of public infrastructure at national level. To be future-proof and foresee a full electrification of sales in mid-2030s, T&E recommends that Member States should roll out the supply of charging points in line with the Road2Zero scenario. The Supply targets per Member State are presented in the Table 1 below.

To guarantee the EV uptake is in line with the provision of public charging, Member States should also measure and report on the Sufficiency indicator as explained in Section 3.5.1. The values of the targets are presented in the Annexes.

Binding 2025 and 2030 targets for the public charging infrastructure in the EU (based on the supply metric, in thousands of units)

Country	2019	2025 target	2030 target
Austria	7.7	51.5	112.0
Belgium	9.2	84.6	186.7
Bulgaria	0.3	5.8	14.1
Croatia	1.3	6.7	14.9
Cyprus	0.1	1.0	2.3
Czech Rep.	1.6	21.8	51.7
Denmark	5.8	40.9	88.1
Estonia	0.4	4.5	10.9
Finland	2.7	20.1	44.4
France	43.6	434.2	965.4
Germany	57.7	640.3	1,480.9
Greece	0.1	15.2	36.9
Hungary	2.2	12.9	29.0
Ireland	2.0	23.8	53.1
Italy	15.7	263.8	632.7
Latvia	1.0	2.5	6.0
Lithuania	0.5	4.4	10.3
Luxembourg	1.8	7.9	16.8
Malta	0.2	0.5	1.3
Netherlands	68.7	103.8	211.8
Poland	1.9	38.3	89.9
Portugal	6.1	37.9	84.8
Romania	0.9	11.2	25.4
Slovakia	1.3	8.1	19.0
Slovenia	1.3	10.2	22.2
Spain	12.6	256.6	632.3
Sweden	18.0	86.4	178.5
UK	34.4	445.2	1,032.6
EU28	299.1	2,640.2	6,053.9

The Supply Index calculates the total contribution of a country's public charging infrastructure by weighting each public charger based on how much charge it can provide (i.e. depending on it's maximum recharging power and it's availability).
Source: T&E Public Charging Infrastructure Supply and Cost model, Road2Zero scenario

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Table 1: 2025 and 2030 targets for public charge point supply metric

T&E recommends that the Commission includes the targets above into the updated Alternative Infrastructure Regulation to ensure adequate supply of public charge points across Europe and seamless market for charging. When setting binding targets, a weighting method (i.e. the Supply metric here) becomes necessary to avoid loopholes in the regulation as the market could be disproportionately balanced towards slow chargers as a result of Member States' incentives put in place to reach their target.

It has to be noted that the increasing penetration of EVs will push the market players to install chargers fast and will result in the above targets largely being met by market forces, and eventually become obsolete. For more details on the market-driven opportunity in the charging infrastructure, see Section 3.1 below. Such market-driven approach is important and has proven to work -for example in places like the Netherlands- authorities should nonetheless monitor and influence where chargers are installed to secure the smart and cost-effective coverage.

Both the Supply metric and Sufficiency indicator can be visualised in Figure 11 below. In green is the "sweet spot" where the country's supply of public charging infrastructure is in line with the target while its the sufficiency value is close to what its optimal value should be, meaning that the number of public chargers is in line with the number of EVs on the road. The figure also details the situation in each of the four quadrants and the measures that should be taken by the Member States to adequately develop their EV charging infrastructure.

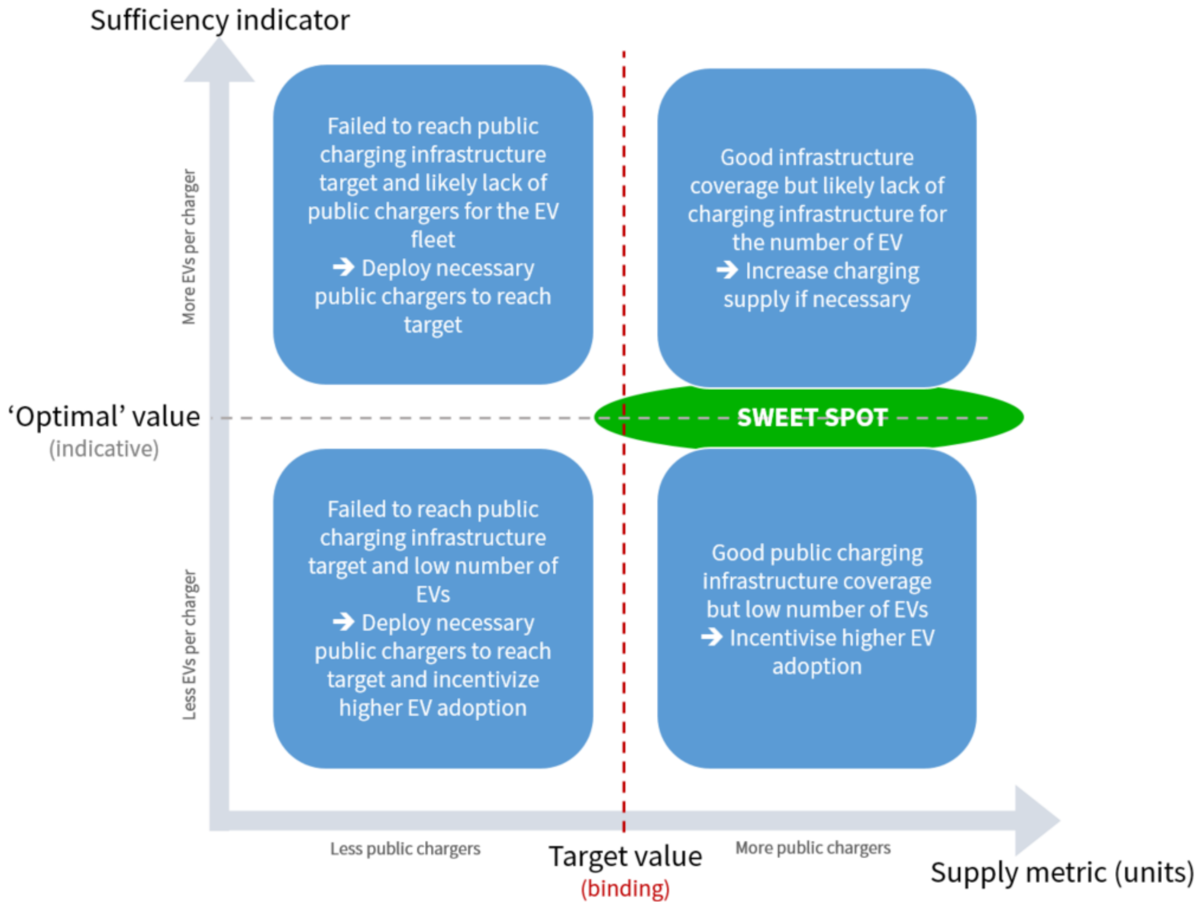

Figure 11**: Overview of T&E's metrics and how they can be used by policymakers to monitor the market**

ii) Comprehensive coverage of European highways

Coverage along the main corridors that have a lot of traffic has already progressed relatively well (see Section 2). Private companies like Fastned in the Netherlands are profitable installing fast chargers in locations with high demand and/or high population density[xxiii]. The priority for this regulation is to address the 'market gaps' to ensure that all EV drivers are able to access every region, even the most remote ones. As a first step, the European Commission should assess the progress with regards to the target of at least one site every 60 km on the TEN-T Core network. But more importantly, to guarantee the coverage of the highway network, the future AFI Regulation should:

- Mandate that the gaps are speedily identified and closed within two or three years of the application of the regulation.[30]
- Target coverage of the remaining TEN-T Comprehensive Network[31] and/or the entire highway road network with at least one site every 100 km by 2025 at the latest.
- By 2025 it is recommended that the TEN-T Core network should be adequately covered with ultra-fast chargers.

With increasing demand from cars and trucks along the highways, the total energy and power requirements will rapidly reach maximum capacity of the network at the rest areas where vehicles park on a long journey. In this situation, where the grid needs to be extended to the site, the connection is very costly. For example, there are some examples where it costs 20,000 to 30,000 euros per MW at premises close to existing buildings like malls or hotels, while on the highway it can be ten times more when the grid needs to be brought to site. In France, for 70% of the highway rest areas, the connection cost would be below €40,000 for 2.5 MW.[xxiv]

Public authorities and grid operators should plan together to bring electricity to the highways by deploying future-proof rest areas along highways where the electricity supply has been upgraded to the medium voltage grid or using innovative solutions such as batteries as buffers to save costs. This can be undertaken as of today when new fast charging sites are created, in particular when they are a greenfield project.

National and/or regional authorities together with private stakeholders should carefully monitor the usage of the network (in particular events of congestion) and increase the number of fast chargers available along the highways to go beyond the minimum requirements.

iii) BEVs per fast charger at national and local level

To complement the targets above, T&E recommends that the Member States and the European Commission should monitor closely the provision of fast chargers. Member States should aim to have at most 80 BEVs per fast charger in 2025 and 130 BEVs per fast charger in 2030.

This metric is also very relevant at local level as it allows to take into account shared EVs, electric Transport Network Companies (TNCs)[32] and electric taxis, which are all vehicles with high mileage that would have a higher usage of public fast chargers. Cities have very different needs and ambitions for urban and mobility planning. It is thus difficult to set a benchmark at a local level but large cities that want to see taxi, TNC and shared fleets go electric, should also support the deployment of these mobility services with a high level of provision of fast chargers (low number of BEVs per fast charger). For example, in London where all new taxis have to be zero emission capable since 2018, the city is deploying fast charging stations for electric taxis and private hire electric vehicles and had 72 fast charging points dedicated exclusively for electric taxis (out of 200 fast chargers)[xxv].

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[30] Two or three years is a feasible time frame to fill the gap in the network. For example, the Ionity network is deploying 400 sites over Europe in this time period. The coverage of the network should be both directions of the highways with a site on every side at least every 60 km.

[31] The total TEN-T Comprehensive network is 164,000 km (including about 50,000 km of the Core network)

[32] A TNC (also known as ridesharing company or a mobility service provider) is a company that matches passengers with vehicles, via websites and mobile apps. Uber is the most notable example today.

4.1.3. Quality not (only) quantity

Numerical targets are key for the roll out of public charging infrastructure and the number of public charge points available -together with the number of EV on the road- are good first approximation of the state of the public charging supply for a given location. However, sheer quantitative requirements alone are not sufficient to guarantee the most effective roll out of charging infrastructure, so quality requirements are necessary to ensure the quantitative requirements are put to best possible use.

The Supply metric and Sufficiency indicator presented earlier in this paper allow policymakers to distinguish the contribution of the various charging powers and availability to the public, as well as the requirements from BEV and PHEVs by weighting. In this section, T&E presents what are the other key requirements that should be enacted in the new AFI Regulation.

i. Definition and conditions for public charge points

The definition of a 'public' charger should be refined in the new regulation in order to harmonise the market around a set of best practices that would balance the needs of consumers (seamless, fair and transparent charging) with the obligations of charge point operators and manufacturers (identical requirements across the national markets and creation of a level playing field).

To be considered and counted as a public charge point, there should be a number of conditions and requirements on new chargers placed on the market. All new public charge points should:

- Be available 24/7 on an open and non-discriminatory basis to all users (applied retroactively to all existing chargers).
- Provide fair and transparent prices, including for ad-hoc payment
- Up-time requirement of 97% (which can be audited and verified by independent third parties)[33].
- Rely on standard interoperability protocols for communication between the EV, the charger and the central management system.
- Comply with 'smart charging' and other 'smooth grid integration' minimum requirements (see Section 4.1.3 below).

All the above requirements should be harmonised at European level to create a single market for charging.

Chargers that have restricted access to customers only or that are not available 24/7, but more than a given number of hours per day (e.g. at least 10h per day, 7 days a week), should be counted as semi-public (and count towards half their value for the public charging Supply metric). Because they are typically located on commercial grounds, they do not serve the same use-case scenario and benefit mostly the owner which can attract new customers. No additional technical requirements should be placed on semi-public charge points to qualify as such and the above requirements on payment, up-time and grid integration should apply.

ii. Consumers: Seamless payment & fair and transparent prices

Payment services with unfair, untransparent or unjustifiably high prices (e.g. higher than conventional refuelling) risk deterring potential EV users and slowing down transition to e-mobility across Europe. To solve this, the new Regulation should enable, seamless, interoperable and harmonized ad-hoc charging,

[33] In cases where public tendering takes places, down-time requirements should be included in the processes.

notably transparent and non-discriminatory pricing to ensure charging is as simple as refuelling at a petrol station.

Current cumbersome authentication requirements and limited payment options allow charge point operators to dictate the terms of their relationship as consumers have no credible alternative than to sign a contract with them in order to be able to charge. This should change and consumers should always have the possibility to charge without contracting with the operator - ad hoc charging via simple card payment should be standard across all publically accessible charging points in Europe. California recently approved regulations that will require credit card readers at charging stations after 2023 (2020 for DC charging and 2023 for AC charging).[xxvi] Furthermore, it introduced new innovative taxation regimes designed specifically for EVs to ensure that electricity rates should be designed to reflect the unique flexible nature and costs of EV charging and guarantee fuel cost savings to customers who charge EVs in a manner that supports the electric grid.[xxvii]

The new regulation should also set proportionate, transparent and fair pricing to prevent acessibility discrimination and excessive prices. The price component structure should be transparent and, non-discriminatory, in particular for ad-hoc and roaming services (either e-roaming platforms or peer-to-peer connections). The preferred solution is to price the charging per volume of electricity (or kWh)[xxviii] but a time-based fee component is usually necessary to encourage drivers to move their EV when it is charged and to reduce idle time.[34]

iii. Social equity

Social considerations are a key aspect of the transition to a low carbon society and transport system. No one should be left behind as part of a just transition to zero emission economy and this should be reflected in the planning for deployment of charging infrastructure, notably by prioritising roll out in lower income and non-urban areas across EU regions.

Publicly developed charging plans must all have an equity component where a certain percentage of public charge points must be sited in areas of low income. Although some case-by-case assessment is required to adapt to local requirements and specificities. T&E recommends that about 20% to 30% of the chargers are placed in disadvantaged neighbourhoods, which is aligned with existing best practices from the United States.

In the United States, utilities and charge point operators are mandated to install a percentage of infrastructure in low income areas and neighborhoods. Most of the utility plans in California include at least a 30% threshold to be installed in disadvantaged areas. Another example, Electrify America plans to have 25% of the fast charging stations to be sited in communities representing the bottom quartile of income and environmental exposure. An EVgo plan coordinated with the US government sets a minimum of 20% of stations in disadvantaged communities. While it is difficult to recommend one percentage across Europe, Member States should endeavour to place at least 20% of public chargers to be sited in disadvantaged areas (which alongside smart incentives for EV purchase or provision of shared EV fleets would enable those communities to benefit from transition to zero emission mobility).

Beyond public charging, the equipment of chargers in apartment buildings should also include public measures in low income areas to promote equal access to e-mobility and to favour slow charging (which is the primary source of cheap energy). Indeed, thanks to affordable electricity (in particular though

[34] In terms of public policies, idle time was observed to be one parameter to negatively impact the infrastructure size and use according to J.R. Helmus et al., (2018)

increasing supply of 2nd hand EVs), e-mobility will benefit most to those that drive long distances to their workplace, which includes lower income citizens that live in sub-urban areas and outside of urban areas.

iv. Smooth grid integration

The AFI regulation should put in place requirements to support public and private EV charging flexibility and 'smartness' while not placing an excessive burden on the development of new EV charging market players. Smart charging functionality should optimise EV recharging, while providing benefits to the electricity system and consumers when technically, economically and environmentally suited.

Currently, there are no ISO or CEN/CENELEC standards on smart charging agreed. These standards should be established as soon as possible to aid the development of smooth EV charging market.

The key requirements below are set on the charging system level and not the individual charger level. They include:

- Intelligent metering systems as a minimum for public charging

All public charge points should be equipped with an 'intelligent metering system[35] that should be able to accurately measure and communicate information both ways (send and receive information) and receive information on costs and prices[36] to both the system operators (or aggregators) and drivers. The current condition that it is 'technically feasible and economically reasonable' should be removed and metering requirements should be harmonised across countries.

- **'Smart charging systems' for private chargers**

Private chargers have different applications and requirements than public charge points as they are typically with lower power and are used for longer charging periods (when the vehicle is left parked during the day or night). Because there are less constraints on when and how the energy should be delivered, a higher level of flexibility or 'smartness' can be included for these chargers. While not in AFI scope, Member States should within their national legislation require smart metering systems that include an intelligent metering system[37] (see above) and that react and control the charging power by stopping or modulating the power to recharge at 'off-peak' periods during times of low general electricity demand, low energy prices and/or high renewable electricity production. Overall, the right balance should be struck between the cost of the meter, accuracy, technicality and features of the meters to avoid unnecessary stringency that would increase the cost of the charger too much.

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[35] 'smart metering system' or 'intelligent metering system' means an electronic system that can measure energy consumption, providing more information than a conventional meter, and can transmit and receive data using a form of electronic communication; (as defined in EED Directive 2012/27/EU).

[36] Send messages (e.g. energy delivered or time charged) and receive information on electricity costs and distribution and tariff costs (which can be received in the form of commands or setpoints, e.g. frequency signal). Communication can be local (with the building energy management system) and/or not locally defined (an e-mobility provider, aggregator).

[37] The requirements on intelligent metering should be tailored to private charger applications and could be different to requirements from public charge points (in particular for the display of information, the in-site storage of the data or the billing based on variable electricity prices).

Ultimately, national regulations and smart charging provisions should transpose as fast as possible the recently agreed "Clean Energy for All Europeans", notably the new Electricity Directive (DIRECTIVE (EU) 2019/944) and the new electricity market design rules that would enable smart charging and vehicle to grid and provide consumers with more accurate price signals that reflect real costs. These provisions include creating a framework for smart pricing, both for electricity and network tariffs as intelligent metering, dynamic electricity retail prices and dynamic grid tariffs. A charging regime should ensure costs are distributed fairly, and EV users face charges that reflect the costs (or benefits) they are imposing on the system.[38]

EV battery information should not be proprietary

To make smart charging a reality, data on the State of Charge (SoC) of the EV battery should be open to other market actors as well.[39] OEMs should be regulated to open the information of the SoC of the battery to the electricity suppliers and grid managers. If OEMs were to withhold this information, the grid companies and independent service providers and aggregators would not be able to effectively manage the demand-response of the EVs. For more details on the parameters to be provided, please see T&E paper on sustainable batteries.[xxix]

Tri-phase charging over single phase charging

The electricity grid in Europe is largely tri-phase alternating current and when charging on all tri-phases, the vehicle would charge three times faster.[40] The increase in cost for going from a one phase charger to a tri-phase charger is rather limited (several hundred euros). From the vehicle side, the carmakers also have the possibility to design the on board charger to withstand tri-phase charging. To maximise the potential of public AC chargers and to provide the best and most appropriate service to EV drivers, all public charge points should preferably be installed via a tri-phase connection and all electric cars should come standard with a tri-phase on board charger. This will avoid system inefficiencies where consumers would be capped or limited in the charging speed they effectively get. In addition, this is also beneficial for the electricity grid as a whole.[41]

4.1.4. Planning for infrastructure beyond national targets

The current AFID's requirements for charging infrastructure address "urban/suburban and other densely populated areas" although Member States focused on measures and targets at national level in their reports to the Commission (NPFs)[42]. It is key to preserve the approach at national level but some further requirements or guidelines could be set to address the specificities of different typologies of urbanism (urban, suburban and rural areas). In particular the European Commission together with JRC could elaborate a definition of each type of area that would be relevant for the deployment of charging

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[38] The importance of the national implementation of the revised Electricity Directive is underlined in the Sustainable Transport Forum's report.

[39] The point is highlighted in the Sustainable Transport Forum's report.

[40] The limiting factor for charging power is usually the amount of ampere provided on the tri-phase.

[41] When more electricity is distributed on one phase than on the other, this can lead to unbalance between the phases' voltage, harmonics or higher return currents which can cause problems with the electricity supply. For example, in Germany, and the Netherlands, there are requirements to distribute the capacity over the tri-phases beyond 4.7 kW or 2 kW.

[42] Some regional and local measures were also reported and assessed. In the current guidance documents for the NPF implementation reports, Member States can even choose for "application level" from local, regional, national.

infrastructure (in particular urban and suburban)[43] and develop a charging infrastructure allocation model adapted for local level. This could provide a harmonized framework for public charging infrastructure deployment at local level and would thus build upon and complement the work presented in 2.1.1 on the binding targets for Member States.

The above recommendation could take the shape of an open and harmonised EU tool to support cities in planning infrastructure roll out. The European Commission should develop jointly with business and local authority partners a tool to help municipalities assess the expected uptake of EVs, and how the allocation of the chargers should be best planned. In the USA, the tool EVI-Pro Lite[44] is publicly available and allows to plan for the expected uptake of electric cars. Based on several inputs such as the number of parking spots, availability of private charging, city demographics and dimensions, electricity grid constraints and amount of shared electric vehicles, one should be able to assess the future charging requirements[45]. This tool could also complement the guidelines and recommendations for tendering that the European Commission is currently working on.

Finally, the electricity sector (DSOs), charge point operators (CPOs) and the public authority should jointly plan to accelerate the speed of deployment of charging infrastructure. Indeed availability of space and power is one of the main challenges that charge point operators face when expanding the network and it has been reported that it can be very lengthy to get a response on the request to get a grid connection or to install chargers are one location. By planning ahead, public authorities' could provide both the space and power for the CPOs (based on previous assessment with other stakeholders), while these private companies should be able to easily take initiative for infrastructure deployment by having some visibility on which areas could be favoured and for example not too expensive to open a grid connection.

Local and regional authorities should select the locations with private players in particular with charge point operators (which have the experience of the charging usage) and grid operators to ensure that the two following conditions are addressed:

1. The location has to be user-friendly, easily accessible, visible and in adequacy with the local authority's plans for transportation, mobility building and land-use.
2. The location should be planned by taking into account the electricity system (e.g. possible areas of overcapacity, flexibility of the grid). To this end, grid and network maps should be shared by DSOs with municipal authorities (and with CPOs when relevant) to plan for charging infrastructure.

4.2. Local and national level

4.2.1. Charging in residential, workplace and public buildings

The European Union and the Member States urgently need to create favorable conditions for charging in residential, workplace and public buildings, for both new and existing stock. The scope of the revised AFI

[43] In 2018, European Commission DG Regio has worked on a global definition of urban area with the help of JRC, see for example: Joint Research Centre, Atlas of the Human Planet 2018 – A World of Cities

[44] The National Renewable Energy Laboratory (NREL) released a the EVI-Pro Lite Tool to assist state and local governments to prepare for expansion of the charging infrastructure. The model uses detailed data from personal vehicle travel patterns, electric vehicle attributes, and charging station characteristics to assess the quantity and type of charging infrastructure necessary to support regional adoption of electric vehicles. Thanks to this tool local authorities can estimate how many charging stations need to be installed to support a particular number of plug-ins in different scenarios. Available at: https://afdc.energy.gov/evi-pro-lite

[45] When a municipality plans to investigate further the deployment of the network, it can contract a private company for Geographic Information System (GIS) assisted tools that are able to model the configuration of the city.

should be enlarged and address charging in buildings as failing to do so could create a bottleneck for the future uptake of e-mobility.

Residential buildings: the 'right to plug'

The new regulation should assist the fast and easy installation of charge points in all shared buildings. Currently procedures are too complex, too long and discourages drivers to purchase electric cars. In many countries, drivers have to wait for the general assembly of the tenants to have formal approval and start installation work, or pay for the whole building to be rewired if they are the first to get an EV. In many countries this can take up to more than a year. Improved and faster infrastructure planning and permitting is essential in meeting customer demands.

The revised AFI Regulation and renewed national regulations and frameworks should ensure that all European have the right to plug:

- The time from the initial request from an EV user to the installation of the plug should take no longer than 3 months.
- Procedure must be as easy as subscribing to an internet provider. For example, Member States could seek to establish a one stop shop or web portal combining services of various building and parking providers and streamlining permit and installation procedures.
- Ensure that cost is not prohibitive to the installation and the use. Charging infrastructure in less wealthy areas and for disadvantaged social groups shall be provided free of charge.
- Allow users to choose their own charging provider no matter who sets up the collective infrastructure.
- Create a framework for the 'right to plug' at work for people that do not have private parking at home. This means that employees have the right to ask for a dedicated or shared charger at their workplace and be granted permission, in cases where they park their EV there (especially if the EV is provided by the company).

Minimum infrastructure requirements for all public and private buildings

Strong requirements for the cabling (or pre-equipment) of buildings and for the installation of chargers in buildings should be a key target of the new EU regulation. The opportunity was missed during the last EPBD discussions[46] and it would be too late to fix this in the 2024 review - therefore the AFI framework should be expanded to become an enabling tool for charging infrastructure deployment beyond public infrastructure only and focus where it is most needed - all buildings with parking space. The European Union should impose for buildings with more than 10 parking spaces the establishment of a collective recharging infrastructure plan, including:

[46] Member States have to implement the following minimum requirements from the EPBD provisions into national law by 10/3/2020: The EPBD mandates that national government implement the following as minimum requirements in their national policy: (i) ducting of all new or heavily renovated residential building with more than ten parking spaces, (ii) new or heavily renovated non-residential buildings: ducting of at least one in every five parking space and at least one recharging point for buildings of more than ten parking spaces (iii) Member States should lay down requirements for the installation of a minimum number of recharging points for all non-residential buildings with more than twenty parking spaces, by 1 January 2025. These obligations do not apply if the cost of recharging and ducting installation exceeds 7% of the total cost of the renovation. Directive (EU) 2018/844

- Comprehensive cabling of all buildings by 2035 to enable any tenants to connect at a later date at minimum cost by only having to install a wallbox[47] with intermediate targets of 20% in 2025 and 50% in 2030[48].
- All parking spots in new buildings or in buildings undergoing major renovations should be either equipped with EV charging or cabled for future installation.
- Specific attention should be paid to hard-to-reach buildings or less wealthy residential areas, with specific public programmes to ensure no EU citizen is left behind.
- A focus should be placed on companies that have private parking spaces for their employees as company EV already have a cost advantage compared to their diesel and petrol equivalents (see Section 3.2, on LeasePlan TCO analysis) and offering EV charging at workplace is well suited to incorporate renewable electricity from solar energy during the daytime as well as offering convenient charging for employees that do not have easy access to home charging.
- Deployment of chargers at parking spots on commercial properties should also be prioritised (see below Section 4.2.2.)

Section 5 outlines how EU-funding mechanisms should be designed and used to prepare buildings for EV transition.

4.2.2. Commercial properties & petrol stations: increasing value by providing new services

All commercial parking spots[49] in places where drivers spend time for leisure, shopping or other activities should be mandated to offer a certain number of electric car chargers. Commercial parking lots are a logical place for EV charging as they serve customers who plan to park for some time while engaged in nearby activities. Focusing on commercial property owners is key as they own most residential, office and leisure buildings in cities. This will vastly help the coverage sufficiency across densely populated areas since many people tend to agglomerate around commercial services and spend enough time there to recharge their EV batteries. This will play a crucial role in the future as cars get longer range and can be charged in shorter timeframes, while taking pressure of densely populated cities to provide each driver with a designated charging spot.

As EV market share keeps growing, EV charging will become a key investment for commercial property owners that want to attract EV drivers. Offering EV charging will allow commercial properties attracts more customers, which will spend more time on the commercial property, thus increasing spending. According to Chargepoint, one major retailed found that by offering EV charging, shops were able to triple customer spendings.[xxx] As e-mobility reaches high adoption rates within city dwellers that do not have access to private parking this will be all the more beneficial to property owners. In China, many provincial and local governments require that residential building owners provide EV charging spaces and mandates for a percentage of commercial parking spots to have EV charging.[xxxi]

The new regulation should set the following charging infrastructure deployment targets:

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[47] A wallbox is a wall-mounted charging points for electric vehicles that provides power at a higher rate than normal sockets (which offer a maximum of 3kW).

[48] The recommendation is the triple of the EV share in the total average European on-road car fleet in the years 2026 and 2031 (the one year delay is introduced to take into account that the provision of chargers needs to be adequate during the period 2025 up to 2030 and 2030 to 2035 even though there are no intermediate annual targets). About half of EU inhabitants are estimated to have access to home charging (based on analysis of Eurostat housing statistics, see Annex).

[49] Commercial properties include for example shopping malls, grocery stores, parking facilities, cultural and sport facilities, etc

- All existing and new commercial real estate companies with more than 10 parking spots should equip -at the minimum- a 20% of parking spots with a public or semi-public charge point by 2025 and 50% of the parking spots by 2030[50].
- By 2030, commercial properties with less than 10 parking spots should have at least one charger.
- Member States should put in place, as appropriate, some level of public support to incentivise the deployment of chargers on commercial properties, in particular for the connection to the adequate grid capacity.
- Similarly, all petrol stations in cities and suburban areas which have concessions/lease contracts for at least 5 years should be mandated to install publicly accessible charging stations, equivalent to at least 25% of their refuelling stations.

Petrol stations are incumbent players that usually benefit from the best available locations for vehicle accessibility. Replacing petrol stations in urban areas with charging hubs will favour the uptake of electric taxis, electric TNCs and electric shared vehicles who are important users of such charging hubs (see 2.2.3 below) while also limiting the number of diesel and petrol cars in the city looking for a petrol dispenser. Depending on concession conditions, petrol stations could be mandated to provide a certain percentage of fast chargers vis a vis of the total number of petrol dispensers.

Setting requirements on commercial properties is not included in the original scope of the current AFID, but T&E recommends that the AFI Directive should become a Regulation (see Section 4.1.1). This will enable the EU to set requirements on commercial properties as part of this EU legislation.

4.2.3. Cities: Charging hubs for new and shared e-mobility services

The new framework for infrastructure deployment should require national and local authorities to elaborate joint energy, transport and telecoms plans and incorporate the deployment of smart charging infrastructure. Such plans should jointly map both the drivers' needs to identify best charging locations and the urban and pan-national energy grids to create synergies with the energy sector[51]. The best locations following such mapping should be selected and turned into charging hubs for different charging needs, notably in cities. Additionally combining charging infrastructure installation with grid reinforcements and/or with other works planned is a good practice (as done in Stockholm for example).

Charging hubs can provide an effective way to address the increasing charging needs from existing and new e-mobility services while reducing the impact on public space. Such charging hubs would combine multiple charging solutions to answer the needs of many: from slow chargers for park & ride, to fast charging for long distance travelers, to city dwellers topping-up and finally for high utilisation EVs like taxis and ride-hailing/ride-sharing services or small delivery vehicles. In addition, the business case for charging hubs is much more evident thanks to a more predictable energy load, a higher utilisation rate, and a reduced grid connection cost.

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[50] The recommendation is the triple of the EV share in the total average European on-road car fleet in the years 2026 and 2031 (the one year delay is introduced to take into account that the provision of chargers needs to be adequate during the period 2025 up to 2030 and 2030 to 2035 even though there are no intermediate annual targets). About a third of inhabitants in EU cities and towns are estimated to have access to home charging (based on analysis of Eurostat housing statistics, see Annex).

[51] The grid costs can be very high if only the low voltage distribution is available in the surroundings of the site, so cities should favour locations where the appropriate medium-voltage distribution grid is available

Because Uber and other ride-hailing companies add traffic and air pollution to cities, all rides from TNCs and taxis across large EU cities should be electric by 2025[xxxii], therefore T&E recommends that all medium and large cities should plan several charging hubs by 2025 at the latest in order to answer these new charging requirements. In particular, the hubs should address the following:

- Incentivise shared vehicle use

Mobility hubs represent a crucial step towards the adoption of shared and electric mobility services. They can vary in size, type of location and type of offer but the idea is to give a diverse offer of shared electric (and micro) mobility services to dissuade citizens from owning private cars, resulting in cleaner, more livable and less congested cities. These dedicated locations, where citizens can choose from different sustainable electric transport options for shared use (e-bikes, e-cargo bikes, e-scooters, EVs) will represent a real alternative to the use of a private car, by providing opportunities and road space to increase shared and electric mobility. Placing these hubs in the outskirts of cities and/or at mobility nodes such as public transport hubs with attractive pricing would limit the incentive for drivers to enter often congested city centres and reduce congestion resulting from parking space search. For example, the project eHUBS[xxxiii] will make available shared mobility for citizens though 92 eHUBS, with almost 2,400 shared light electric vehicles in six cities from five countries. Two notable examples of cities that are part of the project are the city of Leuven in Belgium which plans to have 50 eHUBS and the city of Amsterdam which plans 15-20 eHUBS. Another good example of this is the MEGA-E[xxxiv] project by Allego, which also aims to bring multimodal charging hubs including ultra-fast chargers to metropolitan areas. In light of the currently unequal distribution of (shared) electric mobility we would recommend significantly expanding eHUB style projects but focusing them on towns and cities in Southern and Eastern Europe.

- Fast charging for shared EVs

Charging hubs at easily accessible locations, with dedicated parking spots for electric taxis, shared EVs, and Transport Network Companies (TNCs) EVs, would are key to provide fast charging on an adequate scale for the growing fleet of electric ride hailing and electric shared vehicles. These vehicles will be more dependent on fast charging infrastructure than regular EV drivers because they have higher utilisation rates and drive longer distances, for example in Amsterdam, taxis are responsible for more than 60% of all fast charging[xxxv]. A recent T&E report[xxxvi] has shown that electric, shared and autonomous vehicles should be integrated holistically with other mobility options such as public transport and new (micro)mobility to avoid exacerbating the current mobility system's failure on air pollution, carbon emissions and congestion. These charging hubs are a future proof solution to charge future electric, shared (possibly autonomous) vehicles in cities where the use of private cars has been eliminated or greatly reduced. The Commission should create a dedicated fund devoted to taxi and ridesharing electrification. This fund should support the roll out of dedicated charging infrastructure for cities seeking to electrify their for-hire fleets.

- Flexible uses

Charging hubs can also be made available for delivery and logistics applications. For example, the cities of Stockholm and Oslo have installed fast charging stations to allow for 'opportunity charging' during operational hours of delivery vans and it has proven to be an operationally and economically viable solution[xxxvii]. In China, several large stations also serve highly diversified use cases[52]. Within the ongoing Assured[xxxviii] project, several players, including Volvo truck claim that there are many benefits of

[52] For example the Qian Hai charging station can charge 60 vehicles simultaneously (maximum capacity of 3 200 kW), the charging station is populated by taxis (50%), LCVs (30%), passenger cars (10%) and buses (10%), highlighting the diversified use of the chargers.

interoperable charging solutions for both e-buses and other electric vehicles as, for example, multibrand usage, enabling completion of business case, lower TCO, scale of economy and lower development cost.

Public parking: the 'right to plug' at a public parking spot

Installing slow chargers on existing parking spots is one solution among others to address urban charging needs. Although, it is key that some public charging is offered in cities for the residents that do not have access to home charging and for other EV drivers entering the city. Simply rolling out slow public charging on existing public parking spots would not solve cities' congestion problems. Cities should adopt a wider systemic approach of mobility in their city and also reduce the number of on-road parking spots to limit the number of cars in cities and to free up space for other usages, including cleaner new (micro) mobility services, e.g. electric scooters and bikes. For example, national, regional or local authorities could set minimum deployment targets for the share of public parking spots to be equipped with chargers. To reach the target, cities can install more chargers but are also encouraged to reduce the number of parking spots, which will de facto increase the ratio of public charge points per parking spot. Once the EV market reaches 8-10%, a more coordinated approach becomes necessary as seen in cities like Oslo and Amsterdam.

Nonetheless, when appropriate, T&E recommends that cities grant tenants that do not have access to a private parking the right to ask the municipality to install a public charge point in their area in the early market phase. The effectiveness of the demand-driven strategy has been proven in cities like Amsterdam and is supported by recent research[xxxix] which shows that a demand driven approach is very effective in the early adoption phase, whereas the strategic roll out (local government places charging points near strategic locations) becomes more important as user numbers grow to facilitate EV use in general (but also including this is a wider thinking about clean air and urban mobility).

5. Funding for Recharge EU

5.1. A multi-billion market opportunity

In Section 3, we've assessed the need for additional EV charging infrastructure across the EU though 2025 and 2030. Based on that analysis, around 1.3 million public charge points are required by 2025 and close to 3 million in 2030. This section now analyses the capital costs incurred with the deployment of EV charging infrastructure needed for public and private charging in the EU (based on one-off cost assumptions for the deployment of each charger type presented in Figure A5 in Annex 2).

Substantial public charging infrastructure investments will be needed to serve the growing EV market. One-off investments in the deployment of public charge points (includes equipment, installation, and grid upgrade) would increase from about €600 million euros in 2020 to €1.8 billion in 2025 and €2.9 billion in 2030 (see Figure 12 below). Cumulatively, this would amount to a total of €20 billion. For private charging infrastructure, the total investment would be about triple. Combined, about €80 billion will need to be invested up to 2030 for the roll out of public and private charging infrastructure, a small fraction of the €100 billion invested by the EU every year in transport infrastructures.[xl] Compared to the current rate of investment in road transport infrastructure (about €53 billion per year), investment in public charging infrastructure would represent a mere 1% of the total in 2020, increasing to 3% of the total in 2025 and 5% in 2030. On the other hand, it would represent in 2025, only 3% of the annual EU spending in fossil fuel subsidies (estimated by the European Commission in 2019 to be €55 billion)[xli].

By dividing annual costs by the total number of new electric cars on the market every year, the total investment can be estimated for each individual new EV. Here, the average amount of investment in public charging infrastructure per vehicle sold steadily decreases from about 800€ in 2020 to less than 400€ in 2030. This is due to equipment cost reduction as the market grows and the charging infrastructure becoming more heavily utilised thus serving more vehicles per unit.

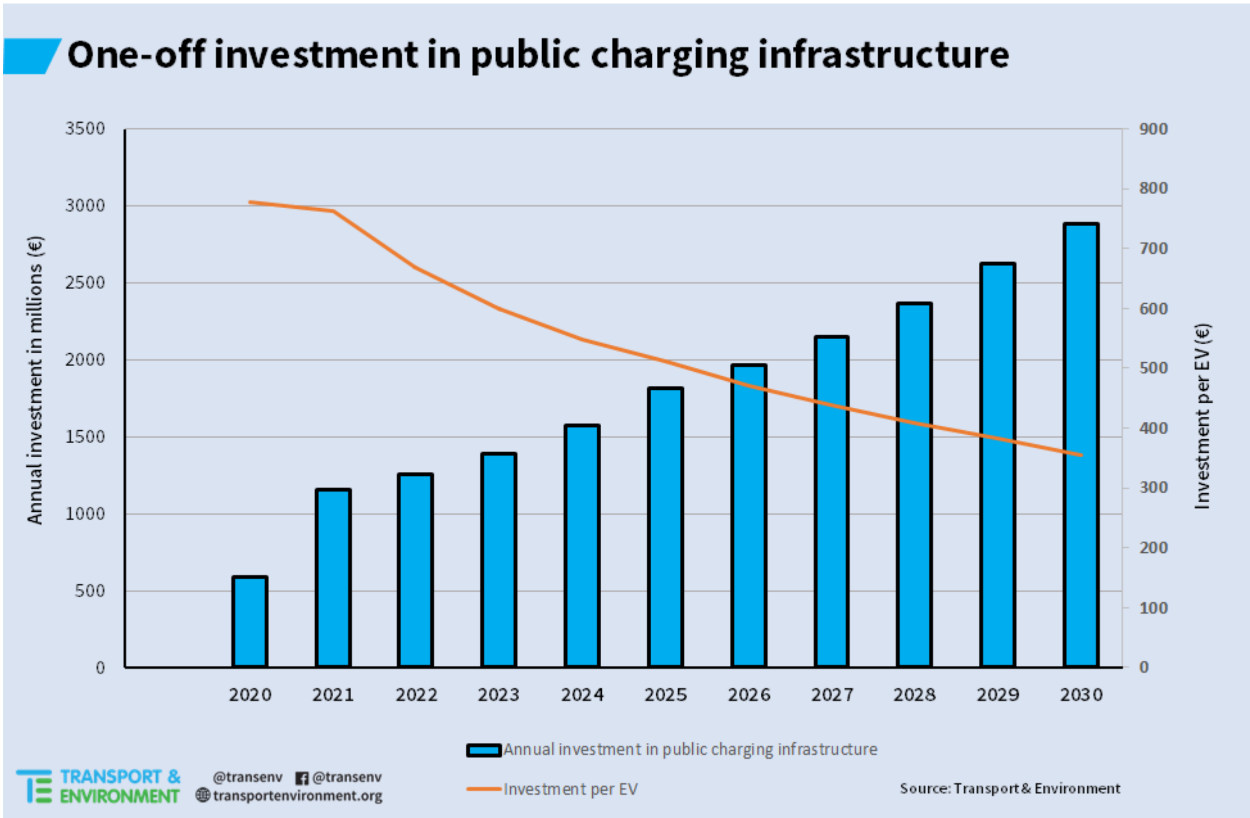

Figure 12: Investment in public charge points installation (one-off investment only)

This large part of the required investments will be driven by the private market, as companies are already seizing market opportunities and investing solely with their own means (currently most cities are not investing any public money). In the future, we could expect licensing of public charging networks to operators to be a source of revenue for public authorities (as it is for telecommunication networks for example) granted that the right concessions conditions are provided (e.g. long term concessions with guarantees on EV uptake).

This new economic activity creates great business opportunities for a wide number of professions including electrical contractors, charging infrastructure equipment manufacturers and installers as well as electricity suppliers and distributors. This was underlined in a 2018 study showing that electric cars will directly create 200,000 new permanent jobs by 2030 in the EU (more than twice the number that could be lost in car manufacturing).[xlii] Nonetheless in some particular situations, there would be a need of public support in the short to medium term to finance infrastructure deployment where there is a market gap.

5.2. Making 'RechargeEU' a pillar of the European Green Deal

In the previous section T&E has detailed how the deployment can be mandated through regulation and in particular through AFID. In this section T&E details how public money should be used to encourage the right deployment of charging infrastructure, or the *carrot*.

European Commission President Ursula von der Leyen's first priority is for Europe to become the first climate-neutral continent. Alongside her climate lead Timmermans, she will propose the European Green Deal in her first 100 days in office which will include the first European Climate Law to enshrine the 2050 climate neutrality target into legislation along with a Sustainable Europe Investment Plan which will support €1 trillion of investment over the next decade, as well as the Just Transition Fund to support the people and regions most affected by the transition and a "funding call to support the deployment of public recharging and refuelling points" from 2020[xliii].

The European Green Deal should set clear objectives for the deployment of public charging infrastructure granted that they are aligned with the recommendations in section 3. More importantly, the European Green Deal should put into place new funding mechanisms or better target the existing ones to tackle market gaps in the current and expected deployment of EV chargers in the EU. All EU citizens should have the opportunity to benefit from e-mobility (including lower mobility costs and better air quality) and the new European Commission should ensure that the transition to e-mobility "leaves nobody behind". This funding mechanism is called here RechargeEU and is presented below through T&E's three priorities for EV charging infrastructure.

The EU and its various tools and funding mechanisms typically focus on EU and national level. When it comes to deploying charging infrastructure, the EU should support other areas which are not its core field of interest like urban and local level.

RechargeEU should make use of existing or planned EU-funding mechanisms like InvestEU[53], Connecting Europe's Facility (CEF), the Just Transition Fund, the Sustainable Europe Investment Plan as well as structural and regional funds and where feasible, be combined with private investments in the form of public private partnerships. In particular, Member States should take advantage of the new CEF Transport Blending Facility Call (opened in Fall 2019) to support projects on the Core Network and nodes of the core

[53] InvestEU (starts in 2021), has earmarked €11.5 billion for sustainable infrastructure and expect a multiplier effect of 13.7. By allocating a reasonable share of this budget to recharging infrastructure where there's a market gap.

network for both electric cars and trucks[xliv]. RechargeEU and other infrastructure funding schemes should complement existing or planned infrastructure programmes like in Germany[54] and fill the gaps between Member States, in particular covering cohesion countries that should have the same strong focus on EV charging infrastructure roll out as Western and Northern countries.

5.3. Priorities for Recharge EU funding program

5.3.1. Priority #1: Cabling buildings and offices

Costly grid connections for parking lots in buildings is currently one of the biggest barriers to faster EV adoption. The economic burden for the tenant - whether an individual or a company - can be very heavy as neither the building owner nor the other tenants are usually willing to contribute financially. In some situations, the first tenant to install a charger would have to pay for expensive grid work and even pay for the ducting or cabling of all the parking spaces in order to have his/her parking spot equipped. Separate ad-hoc installation every time a tenant wishes to install a charger is very expensive, lengthy, ineffective, cumbersome and costly for society[55].

Alternatively, the optimal solution for these buildings is for the parking or building owner to cable all parking spots at once when there is a first request for a charger or a building is undergoing a renovation. With pre-equipment, chargers can easily be installed once the tenant wishes and he/she would only pay the price of the equipment and very light installation to connect to the pre-equipped cables (typically around €1,000 for the wallbox and connection to cables, sometimes covered by the carmaker). This greatly reduces the societal costs and the burden on the tenants, and even eliminates the complex and lengthy process through which tenants have to go through as they do not need to undertake any construction work. The cabling of a building can however still be very costly for the owner and tenants who usually do not have a pressing need to undertake such work.

The European Commission should develop a long-term funding programme (about 10 to 15 years) for local authorities and governments to support the cabling of residential and office buildings' in all parking spots (funding programme channeled through Member States). The EU-fund could cover a certain percentage of the total cabling costs and vary between more developed and less developed regions in line with the EU cohesion policy and be used as co-financing (e.g. EU to provide 20% and Member States 80%). A maximum threshold could be set according to the size of the building based on the total number of parking spots. The cabling and electrical infrastructure should be smart as a condition.

Importantly, this programme should be combined with a simultaneous efforts of building renovation in Europe, to refurbish and improve the efficiency of the existing buildings across Member States. Similarly to the installation of charging infrastructure, the financial incentives for renovation are not properly aligned. A renovated building with an EV charger significantly benefits the tenant by making heating and mobility cheaper while significantly reducing the EU's two largest sources of CO_2 emissions (transport and buildings). By combining construction work and funding support, the EU can help owners that have less incentives to make the costly upgrades.

In the short term, this programme should be a means for the European Union to kick start wide adoption of e-mobility beyond early adopters that usually have access to a home charging location. In the longer term, the European Union should aim to have all parking spaces in buildings cabled for charging

[54] Germany has recently announced their charging masterplan, aiming for one million public charge points by 2030 and investing 3 billion euros in infrastructure deployment by 2023.

[55] According to a paper by AVERE France, the additional cost can reach €6,000 if a tenant wishes to install a charger (and is the first to do so)

infrastructure by 2035 as new sales of petrol and diesel cars should be phased out by that year at the latest for the EU to be in line with its climate ambitions.

Example: Good practices for funding charging infrastructure in buildings

- France: the ADVENIR programme funds 50% of the cabling (excludes the installation of the charger) with a maximum of €4,000 per building below 50 parking spots and €75 per parking spot above 50 spots with a maximum of €15,000 for the building.
- Finland: Subsidy for housing companies for building EV charging infrastructure with a total budget of 1.5 million euros per year. The subsidy covers 35 % of the costs incurred from building electrical system surveys, wiring installations and charging equipment. The minimum requirement is to build readiness for five charging points.

5.3.2. Priority #2: Grid upgrades in urban areas

Charging hubs

In Section 4.2.3 is explored the importance of charging hubs in urban areas in addressing the different charging needs while also reducing the use of private cars through shared e-mobility services. The RechargeEU programme should be aligned to support local authorities in the development of public charging infrastructure, in particular upgrading grids for charging hubs where needed.

It can be challenging for cities, companies or shared service operators to foot the bill for the costly grid reinforcements and connection required to build a charging station. Many locations and parking lots, especially in central urban locations would only have readily access to the low voltage grid, which is often not capable to take fast DC charging and therefore municipal authority and grid operator need to seek to connect to a medium voltage grid somewhere else or pay for the upgrades.

The EU and other public authorities should focus on the grid reinforcement for the creation of multi-user charging hubs in cities. Similar to the funding proposed above for buildings, the European Commission should offer local authorities the possibility to benefit from a dedicated funding mechanism to upgrade the grid in urban areas and roll out charging hubs. These hubs could include several normal (11-22kW), fast (50kW) and ultra-fast chargers (150 kW) and have charging spots that can be booked and prioritised for shared EVs, and urban logistic vehicles (vans and small trucks).

The EU should support local authorities in the roll out of these hubs though the CEF MAP programme which sets urban areas as one of the priorities for the funding. This finding should be fairly split between different cities and regions to ensure all benefit equally. A precondition to get the public money should be for the city to undertake a thorough assessment and planning of its transport and energy needs to identify best locations. Priority should be given to cities that plan to introduce shared electric cars services or publicly supported fleets for their residents and have programmes in place to reduce private car use[56].

T&E recommends that the public money is used in the first place to prepare the grid, therefore the open tender to install and operate the station should not include any public support (except for some possible level of support for ultra-fast charging in regions with low EV uptake).

[56] For example, the combined hubs should total a minimum level of power (in MW) that is in line with the city's population and the number of high-mileage shared vehicles.

Electrification of road freight depots

Preparing the depots of heavy duty vehicles to enable charging during the night time is also a challenge due to the high level of power that is usually required. Currently, existing funding mechanisms like Connecting Europe Facility (CEF) are only designed to fund public charging infrastructure and are not suited for the current need to electrify truck depots. The European Commission should also rely on the above described mechanism to address truck operators and public bus transport authorities that need to electrify their depots.

5.3.3. Priority #3: Vouchers for (fast) charging

While fast chargers do not represent the bulk of EV drivers' recharging needs and slow private charging should stay the predominant solution to supporting tomorrow's e-mobility, some provision for fast charging is necessary to ensure comprehensive coverage of fast charging infrastructure over the whole EU. Currently, the regions where there are gaps in the fast charging network are also the less wealthy regions and countries, especially outside the big cities. Moreover, in many cases for remote areas, the coverage and capacity of the existing grid infrastructure is not adapted to intermittent electricity demand from EVs which makes create a bottleneck for the deployment of fast charging infrastructure.

To tackle jointly both the social justice of the transition to e-mobility and providing a comprehensive coverage of fast charging infrastructure as soon as possible, the EU should dedicate a part of the RechargeEU programme for granting one-off standardised vouchers for regional authorities in more remote areas. Supported by this mechanism, the EU should aim to cover the TEN-T Comprehensive road network of the EU by 2025 while at the same time ensuring no regions suffer from EV charging gaps.

This mechanism based on vouchers -and inspired by the European Commission's ongoing Wifi4EU[57] programme- are lump sum payments intended to cover the full cost of the equipment and installation of fast DC chargers. Small towns under 50,000 inhabitants[58] should be targeted as these usually have less capacity to access funding mechanisms and typically see less EV traffic, while aiming at ensuring comprehensive coverage of their territory with fast chargers as soon as possible. To get the full €50,000 grant, there should be some simple conditions on the location of the charger to ensure the money is put to best use. The mechanism should have a strong focus on the TEN-T Comprehensive network (or within the vicinity of), on disadvantaged neighborhoods or on towns and cities where there are not already fast chargers installed close by. To ensure the conditions above, the charging site has to be located in one of the following:

- In a town of less than 50,000 inhabitants with the closest public fast charger located at 60 km or more
- Along the TEN-T Comprehensive network (or within 10 km of it) with the closest public fast charger located at 60 km or more
- In a disadvantaged neighborhoods with the closest public fast charger located at 30 km or more

Similarly to Wifi4EU, a minimum number of vouchers to be attributed per country should be established and the number of vouchers per country may not exceed 15% of the call budget.

Why set a condition on the distance to the closest fast charger?

[57] Wifi4EU consists in 8,000 vouchers of 15,000€ each running from 2017 to 2019.

[58] The programme #RechargeEU originally presented only targets towns (under 30,000 inhabitants) and has a total budget of €500 million (10,000 x €50,000).

Setting a condition on the distance to the closest fast chargers ensures that public money is not allocated to municipalities that already have fast charging sites and where any further growth of the network would already be market-driven. It is important that this public money is used strategically to ensure that it benefits the coverage of the continent by addressing market gaps. Currently, there is a guideline for the coverage of the TEN-T Core network in 2025 of at least on site every 60 km which serves only an information purpose (non-binding recommendation from the European Commission's Assessment of NPFs). However, this is too late and not aligned with the market uptake as all EV drivers need to be able to fast charge their EV when travelling between any two places. Therefore, this voucher system is a good way to ensure swift coverage to bring forward the completion date of the full TEN-T Comprehensive network to 2025 (date of the expiration of the #RechargerEU vouchers)[59].

Some flexibility should be provided to municipalities to do slow charging

Municipalities know best what type of charging would be required for their inhabitants and for the wider e-mobility system and should be given flexibility to choose how best to spend the money. They should not be obliged to install only fast charging when they see a slow AC charging more relevant. Slow charging is much cheaper than fast charging (cheaper equipment and more easily integrated into existing grid infrastructure) and therefore allows the municipality to equip itself with up to 20 times more chargers with the same amount of money.

A smaller - for example €15,000 - grant could be claimed by any town below 50,000 inhabitants to install any type of public charging. This funding is limited to one per municipality and is intended to stimulate any kind of public-private partnerships granted as long as it allows EV drivers to charge without discrimination in the municipality.

[59] Comprehensive network is 164,000 km long: about 5,000 sites could be sufficient whereas the European Commission has suggested a programme of 10,000 fast charging sites

Conclusion

The analysis presented in this report shows that the coverage of charging infrastructure has progressed in line with the electric vehicle market until now. But now more than ever, it is key to have the right regulatory and funding frameworks, indispensable for lowering the barriers for EV adoption for the charging infrastructure deployment to continue progressing in the right direction.
Both the revision of the Alternative Fuels Infrastructure Directive and the European Green Deal, will be under fierce discussion in the year 2020 and should constitute the two cornerstones of the masterplan to recharge EU's electric cars. As e-mobility becomes accessible to all and enters the mass market, the EU has a responsibility to ensure that no one is left behind and to lift existing market gaps where private investment does not naturally flow to meet drivers' needs. The roadmap to recharge EU's cars and trucks presented in this report shows that we need a clear and ambitious orientation from EU policymakers on both legislation and funding instruments. Importantly this orientations should only give priority for zero emission road transport and acknowledge natural gas is a dead-end for decarbonising the EU's transport sector.

Firstly, the current Alternative Fuels Infrastructure Directive (AFID) policy framework should be swiftly revised in 2020 and turned into an EU Regulation (AFIR) for a more harmonized and rapid implementation. This time round mandatory electric car and truck charging infrastructure targets for Member States are necessary to keep up with the upcoming surge of electric cars and to be aligned with mid-century carbon neutrality objective. T&E calculates that about 1.3 million public charge points would be needed for cars in 2025 and close to 3 million in 2030 to adequately translation EU's climate policy into the new regulation. It is also high time to address the particular recharging needs of electric trucks in the new regulation by deploying measures for private depot charging and setting objectives for public and destination charging. T&E has shown that future regulation and targets should rely on an improved categorisation, counting and monitoring system for all types of charging infrastructure, combined with a number of more qualitative requirements.

Secondly, charging infrastructure needs to become a flagship of the European Green Deal to create the cross-industry synergies of tomorrow's decarbonised economy and craft tomorrow's e-mobility ecosystem. Here public resources should be put to best use to target current market gaps and leverage investment in the cabling of buildings and the strengthening of the electricity grid, especially in urban areas where local distribution grid will need to be reinforced to provide sufficient power capacity for tomorrow's charging hubs, electrified buildings and depots of trucks and buses. In particular the Just Transition Fund and the Sustainable European Investment Plan should target Cohesion countries and less wealthy European regions so the transition to e-mobility benefits all Europeans in terms of deployment of charging infrastructure but also to help retrain, upskill and adjust industrial workforces. The deployment, operation and maintenance of chargers will create multi-billion market opportunities where hundreds of thousands of jobs will be created. The use of public money will stay limited to very specific use cases were the market does not deliver and the licensing and exploitation of public charge point networks would even provide additional resources to cities and public authorities.

A harmonised future-proof infrastructure policy is necessary to recharge the dozens of millions of EVs due to hit the roads in the next decade and finally curb the increasing trend in road transport emissions. But beyond charging infrastructure, the EU and the Member States need to set other ambitious and supportive measures such as taxation and sustainable battery value chains to accompany the car industry transformation and ensure it is fast, fair and benefits all Europeans. Agreeing an EU-wide phase out of internal combustion engine vehicle sales by latest 2035 is crucial to provide long-term strategic direction and planning certainty. All of this is a future opportunity for a prosperous and emissions free Europe.

Annex 1: Supplementary material Section 2

Number of electric cars per public charge point: 2019 vs. 2017

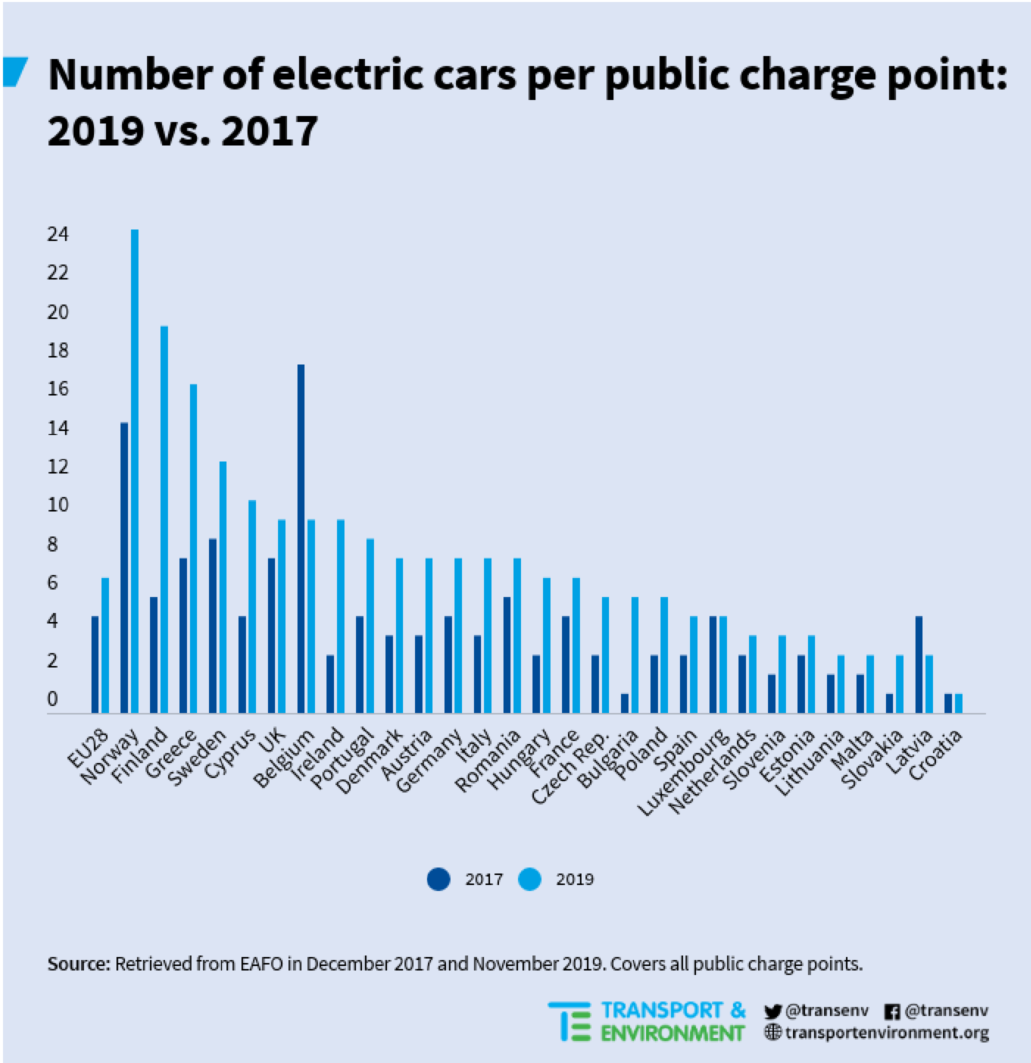

Figure A1: Number of electric cars per public charge point 2019 vs. 2017

Better progress for fast charging according to CCS Map

Between 2019 and 2017, Member States have made better progress on the number of available public fast chargers. According to CCS Map[60], the total number of CCS connectors[61] has increased by 57% since the end of 2017, from 4909 CCS connectors up to 7690 today. Germany and the UK have by far the largest number of fast chargers available, together, they capture about half of that growth in the number of CCS connectors. This is further explored below though other data sources which show that the number of CCS fast chargers is actually today at about 9,000 units in the EU.

[60] http://ccs-map.eu/

[61] The EU standard for DC fast charging, compatible with all BEVs on the market besides Nissan Leaf which relies on CHAdeMO.

Combination of the different datasets

Neither of the datasets from Plugsurfing or OpenChargeMap is exhaustive (and the data shared by Plugsurfing does not cover 100% of their public charging network) but together they complement each other to a reasonable extent (it is estimated that the combined dataset cover about 80% of the total EU public charging network). Because both OpenChargeMap and Plugsurfing dataset only cover part of the total number of chargers, T&E selected, for each country, the highest value among the two data sources. Because of the lack of consistent information on chargers, some chargers with missing information on the plug are counted in the respective power category described above and semi-public charge points or chargers with limited availability are counted as public (see below how this can be improved). Chargers marked as Schuko plugs and with powers above 3.7kW were assumed to be Type 2 chargers marked as error. A similar assessment was made for Type1, TypeE, T23 plugs (chargers in very limited numbers).

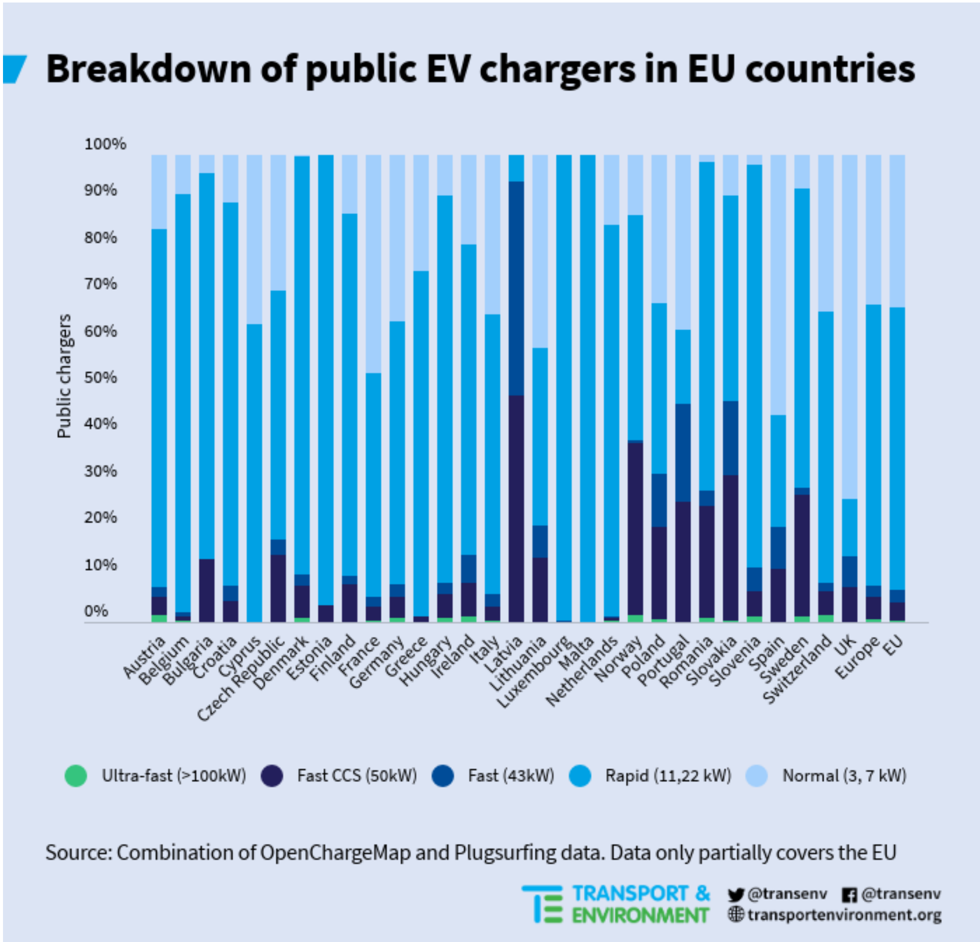

Figure A2: Current breakdown of public EV charge points in the EU

Breakdown of public EV charge points in EU countries

In Figure A3 below, a precise overview of the total number of public charge points in each country is offered by combining the information for PlugSurfing and OpenChargeMap with the numbers from EAFO, and selecting the highest value[62]. CHAdeMO and Tesla Superchargers are not counted (only fully public charge

[62] The counting method applied to the Plugsurfing and OpenChargeMap data is more conservative than the EAFO counting method (some plug types are excluded, including CHAdeMO and chargers below 3kW are not included).

points with European standards). The final number of public charge points is taken as the maximum between the two datasets a) the combination of OpenChargeMap and Plugsurfing dataset b) EAFO.

It can be noted that the countries with the highest number of public charge points are also the countries with the highest number of EVs on the road, in other words these two numbers tend to increase hand in line. It is natural that countries with high number of electric cars are also the ones with high number of public charge points, although this hides some different approaches between countries. Germany, France and the UK, seem to be rather aligned with respectively 32,000, 29,000 and 24,000 public charge points and similar ratio of number of EVs per public charge points (7 for France, 8 in Germany and 9 in the UK). On the other hand, Norway and the Netherlands have very different approaches to public charging. The Netherlands has a much higher number of public charge points per EV (many of which are semi-public, see below), while Norway has less public charge points per EVs but has many fast chargers among them.

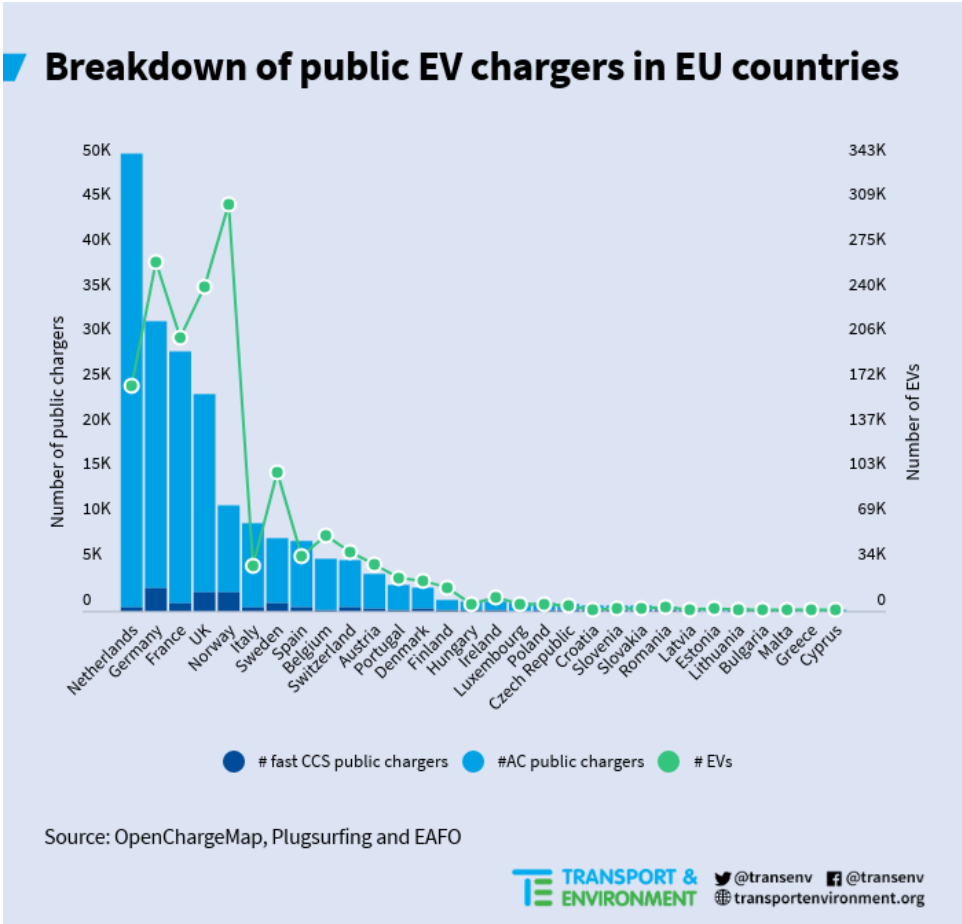

Figure A3: Current number of EVs and public charge points in the EU

More than a third are not publicly accessible 24/7

About 38% of the public charge points in the dataset from Plugsurfing are not open to the public on a 24/7 basis on average at EU level. These chargers are usually located on private commercial premises (e.g. supermarket, mall, gym, etc...) and would correspond to what is called a 'semi-public' charger. The business case for these chargers is driven commercially by the business owner that wishes to attract clients. Because

Therefore if the value obtained for this method is higher than EAFO values, then this value was considered more accurate than the EAFO value it is not open 24/7, it does not provide the same ‘charging service’ as an equivalent fully public charge point open 24/7.[63]

The Netherlands has the highest share of public charge points not open 24/7 with 61% of the total public charge points, while Belgium (44%) and the UK (42%) are the only other two countries that have a share that is higher than the EU average.

Annex 2: Charging Infrastructure Supply and Cost model

The methodology of the Charging Infrastructure Supply and Cost model is developed around the principle that energy demand induced from EV recharging should be used to quantitatively assess indicators and metrics on the charging infrastructure requirements. This follows the key recommendation from the authors of the European Commission’s Joint Research Center (JRC) on charging infrastructure[64].

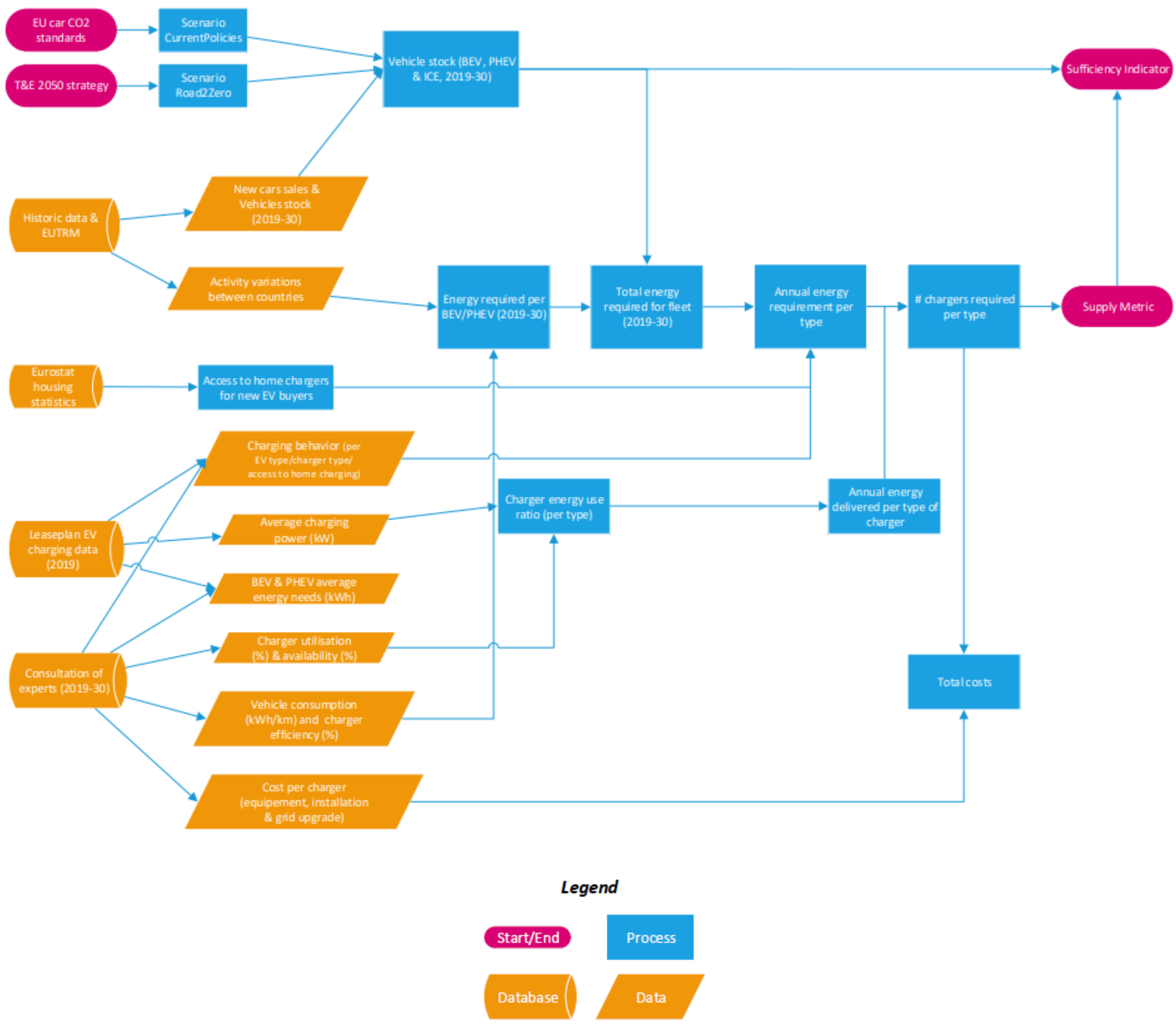

Figure A4: T&E’s Public Charging Infrastructure Supply and Cost model flow chart

[63] In other words, the maximum total amount of energy dispensed by this semi-public charge points is lower than what an equivalent charger could provide if it was available 24/7.

[64] Report from JRC authors: A.; Prettico et al, 2018: Indicator-Based Methodology for Assessing EV Charging Infrastructure Using Exploratory Data Analysis.

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The following assumptions and inputs to the model are country-specific.

Vehicles sales are kept constant at the same level as in 2018. This is supported by current stagnation of the passenger car market and the expectation that a shift away from passenger car ownership to a shared vehicle model would balance the increase in vehicle sales that has historically been aligned with economic growth. Vehicle stock is based-on 2017 vehicle stock from Eurostat calibrated to the forecast in vehicle activity per member state from T&E's in-house transport emission modelling tool EUTRM (European Transportation Roadmap Model, is a model owned and maintained by T&E[65]). The fleet replacement rate and turnover are modelled through these constraints. The larger impact of the transition to shared mobility (and possible lower car sales) and the transfer of second hand cars between countries is not modelled within the scope of this project.

Availability of home charging: Based on Eurostat housing statistics, T&E estimated the share of inhabitants in each country that would have access to home charging[66]. We assumed that in 2030, the access to home charging for the average new EV buyer was representative of the country's average. In 2019, we assumed that about 80% of EV drivers have access to home charging based on Fuelling Europe's Future assumption of 0.8 home chargers per EV.

Average distance travelled: Based on EUTRM's average distance travelled per car in each country, the average distance travelled by EVs from the LeasePlan dataset were adjusted to national context. The average from LeasePlan was assumed to be representative of the average in the countries these vehicles operate (Germany, Belgium, Norway, Portugal, Sweden, France, Denmark and Luxembourg) which was then used to normalised to each other country. Two factors were introduced to correct the amount of energy delivered to LeasePlan EVs which are representative of company car fleets only: for BEVs the mileage was lower by 10% in 2019 up to 25% in 2030 to account for the reduction of the vehicle activity linked to the ageing of the fleet. The distance electrically driven by PHEVs on the other hand was increased by 10% in 2019 and was calibrated to have PHEVs driving electrically two thirds of the distance that BEVs drive. This is assumed to be more representative of the average EV driver behavior and corresponds in practice to values ranging from about 18,200 km per year in 2019 down to 16,400 km on average in 2030 for the BEV fleet and from 6,100 km per year in 2019 up to 11,000 km on average for the PHEV fleet (distance driven on the electric motor only).

Lifetime of EVs: The model runs for the years 2019 up to 2030 and during this time period, the survival rate of EVs was assumed to be 100% (i.e. not scrapped at all). This is supported by findings from Element Energy[xlv] that shows that the survival rate of EVs after 10 years would be as high as 88% (vs. 77% for ICEs). This is based on the discussion within expert groups showing that EVs already show increased reliability and reduced maintenance compared to ICE and are expected to be leading in terms of lifetime in the future. T&E has estimated that the inclusion of scrappage of EVs according to the survival curve from Element Energy would lead to a reduction of 1%-2% of the EV fleet in 2030. In addition, EVs are retained in the EU stock for longer, with no EU exports as neighbouring non-EU importing countries (e.g. Turkey, Russia, North Africa) will lack charging infrastructure in the short and medium term future.

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[65] More information and data sources available: https://www.transportenvironment.org/what-we-do/eu-transport-policy/emissions-modelling

[66] Eurostat house categories are broken down between detached houses, semi-detached house, flat in building with less than ten dwellings and flat in building with more than ten dwellings. For each category the share of inhabitants in cities, towns and rural areas is provided (12 categories in total). Generic probability of access to home charging was provided for each country which -when combined- provide an estimate of the provision of home charging in each country. The EU average is 54%, with values ranging from Malta (22%), Spain (41%), Estonia (42%) or Netherlands (43%) to Slovenia (74%), Croatia (72%), and Luxembourg (71%).

Assumptions

In the table below please find the main assumptions to the model.

Assumptions: EU-wide EV fleet average values			2020	2025	2030
EV new car sales scenarios	CurrentPolicies	BEV	3%	13%	23%
		PHEV	2%	7%	10%
	Road2Zero	BEV	3%	15%	40%
		PHEV	2%	8%	13%
Energy use ratio (%)		3-7 kW (public)	7%	10%	14%
the ratio of total energy actually delivered with the total max energy capability (charger at max. power 24/7)		11-22 kW (public)	3%	5%	8%
		50 kW	2%	4%	7%
		150 kW	1%	3%	5%
Availability (or uptime)			97%	98%	99%
Recharge Efficiency (losses from plug to battery)			95%	95%	95%
Average vehicle efficiency (kWh/km)		BEV	0.18	0.17	0.16
(real world driving of EV fleet average)		PHEV	0.18	0.17	0.17
Charging behavior (EU average)	BEV	Home	61%	54%	45%
		Work	15%	19%	23%
		3-7 kW (public)	4%	4%	4%
		11-22 (public)	13%	15%	16%
		50 kW	6%	5%	3%
		150 kW	1%	4%	8%
	PHEV	Home	61%	52%	44%
		Work	15%	19%	25%
		3-7 kW (public)	9%	10%	9%
		11-22 kW (public)	15%	17%	19%
		50 kW	1%	2%	3%
		150 kW	0%	0%	0%
Total		Home	1,100	1,195	1,200
includes installation cost, equipement cost and grid connection		Work	1,745	1,973	2,200
		3-7 kW (public)	3,400	3,400	3,400
		11-22 kW (public)	4,500	4,500	4,500
		50 kW	31,000	27,727	25,000
		150 kW	75,000	69,545	65,000

Figure A5: T&E's modelling assumptions

Annex 3: Supplementary material for Section 3

Number of public charge points in 2030

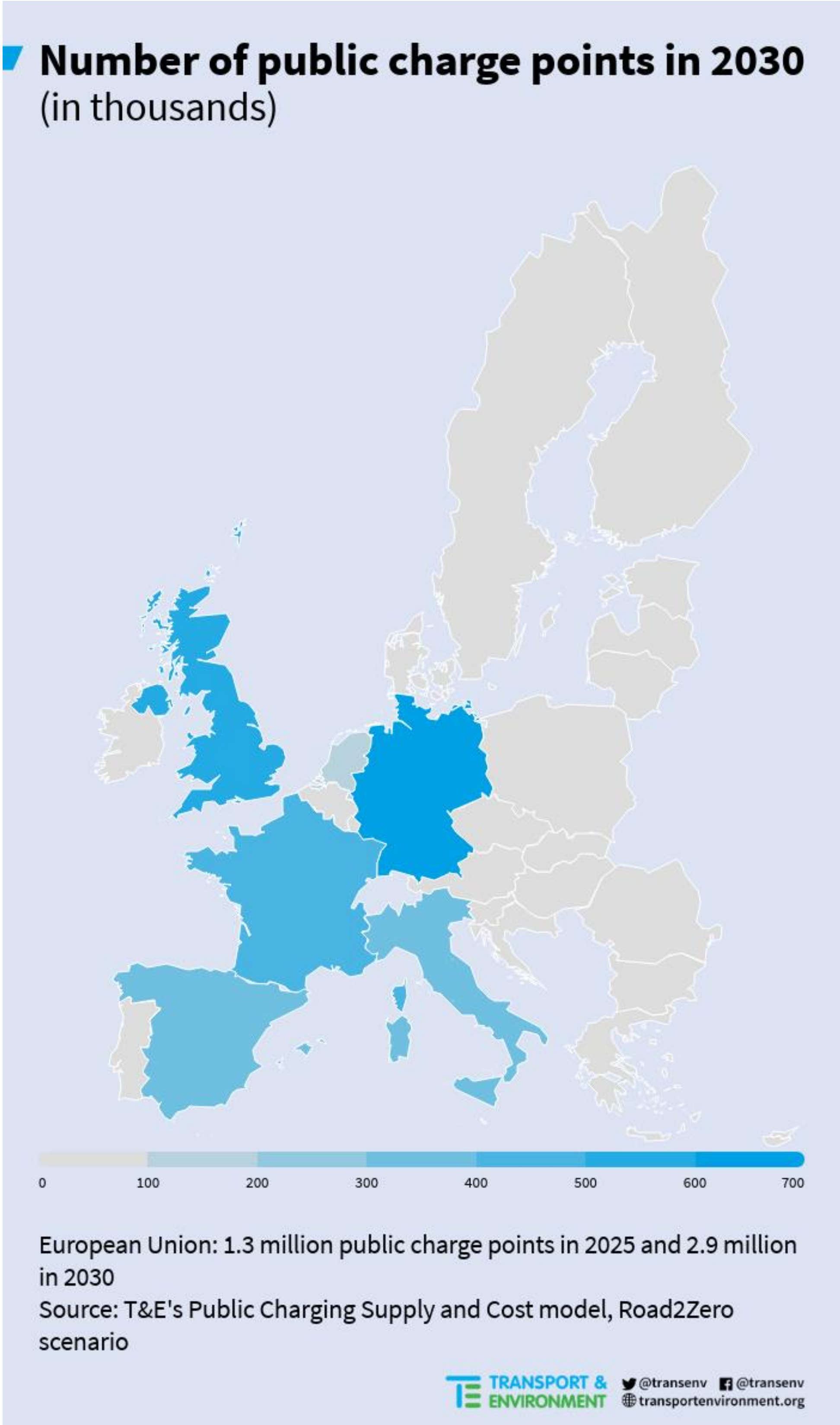

Figure A6: Map of public charge points in the EU in 2030

Current Supply metric and Sufficiency indicator

In Figure A7 below, the supply of public charge points (based on the Supply metric) of EU countries are compared. It appears that the Netherlands is leading the way with Germany, France and the UK. In Germany, the high number of fast and ultra-fast chargers boosts the value of their Supply.

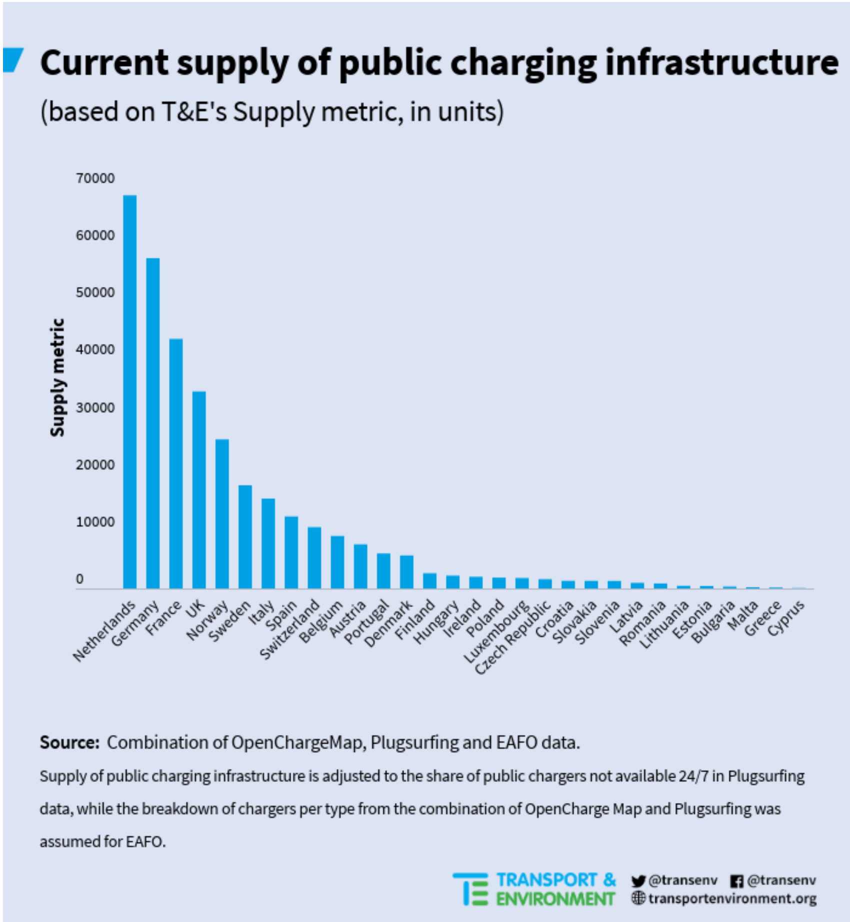

Figure A7: Current public charging Supply metric in EU countries

Based on available data, the current sufficiency of infrastructure for EU Member States can be estimated, assuming the data gathered from Plugsurfing and OpenChargeMap is representative of the current provision of charging infrastructure (see Figure A8). There are seven countries where the total number of public charge points in our combined dataset is less than half of what is counted by EAFO and have been marked by an asterix in the Figure below (Croatia, Lithuania, Portugal, Romania, Slovakia, Spain and Sweden).

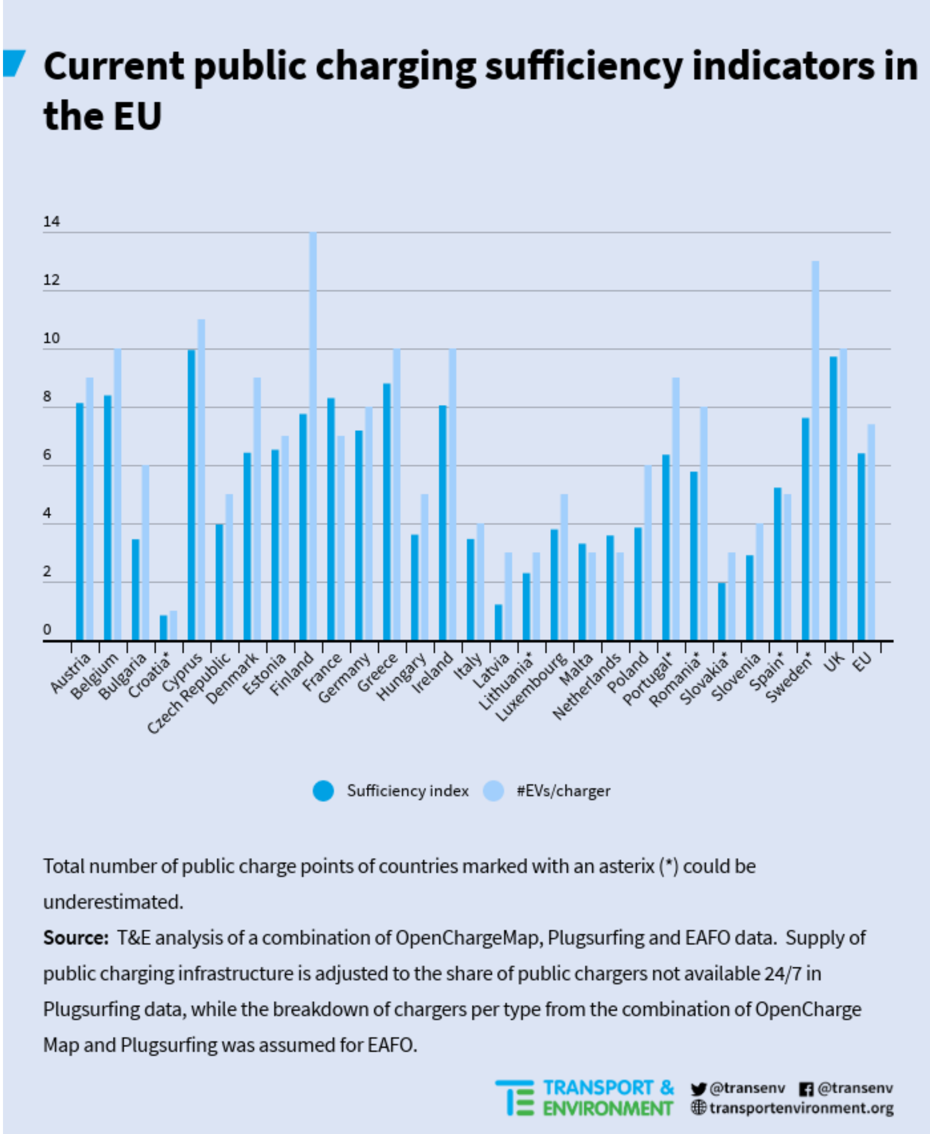

Figure A8: Current public charging sufficiency indicator in the EU

Modelling results: CurrentPolicies scenario

In the graph below, the number of public charge points required in 2025 and 2030, in the CurrentPolicies scenario is presented. See Figure 8, Section 3.3 for modelling results for the scenario Road2Zero.

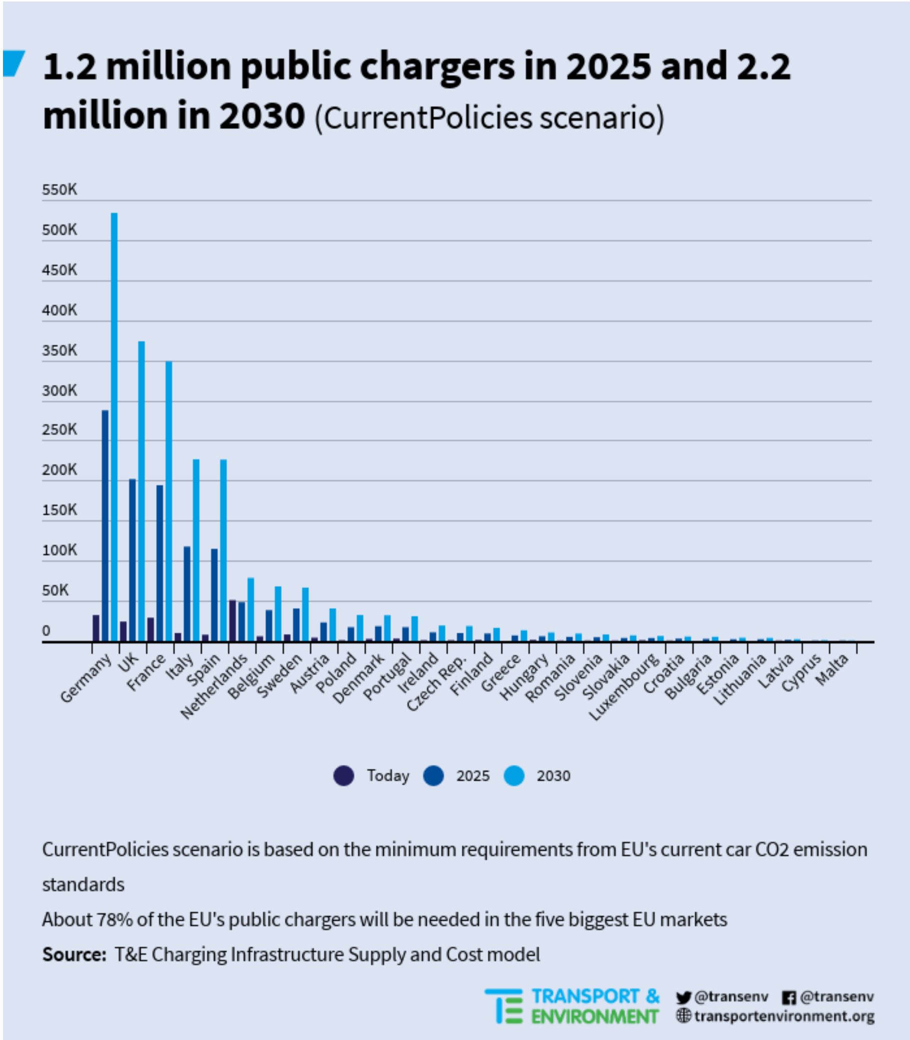

Figure A9: Number of public chargers in EU countries (CurrentPolicies scenario)

Optimal Sufficiency Index

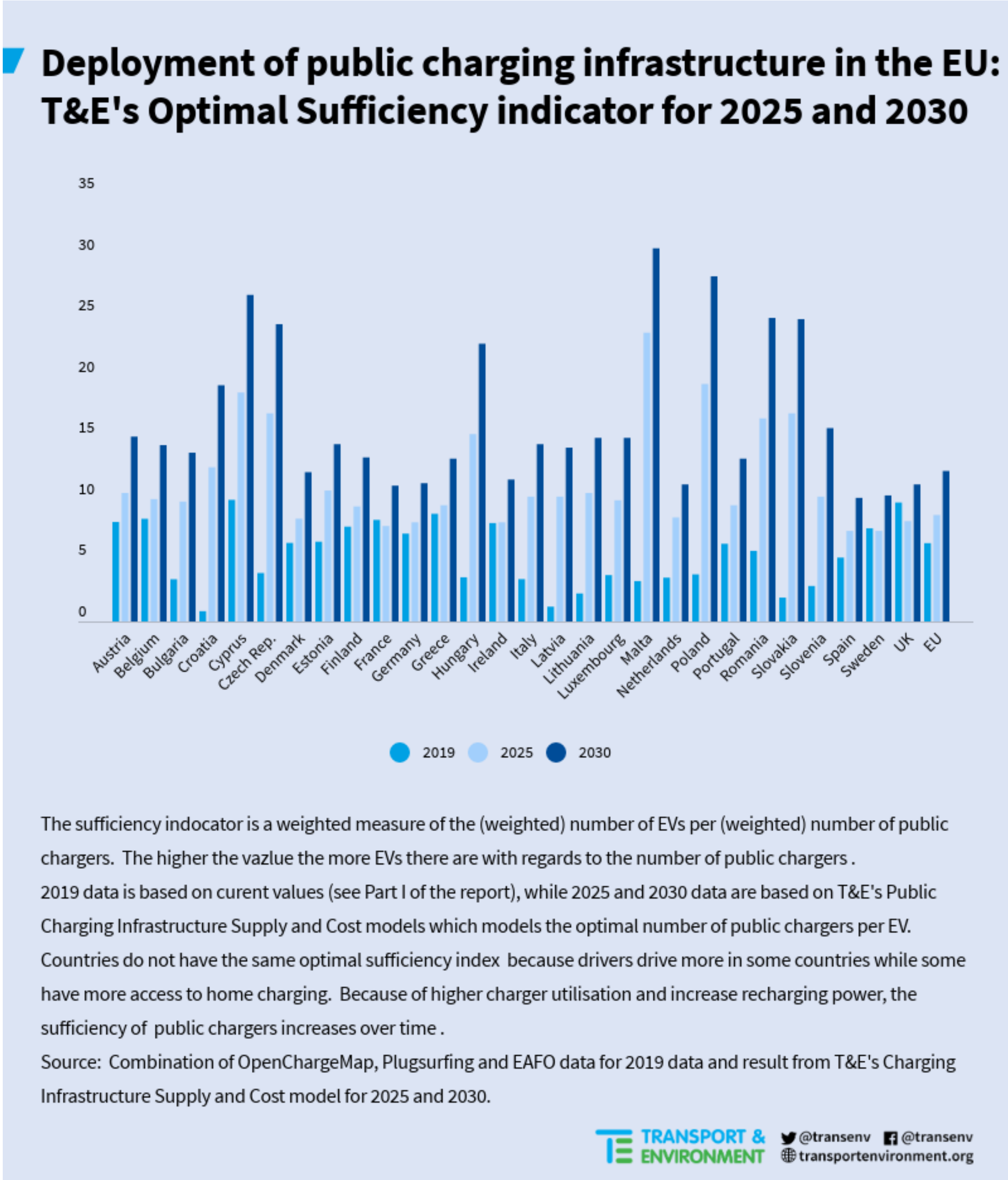

Figure A10: Optimal Sufficiency indicators in EU countries in 2025 and 2030

Road2Zero: Modelling results

	Total Public Chargers thousands)			Supply metric (thousands units)			Number of EVs (tousands)			Optimal Sufficiency indicator		
Country	2020	2025	2030	2020	2025	2030	2020	2025	2030	2020	2025	2030
Austria	7	25	54	15	51	112	55	328	998	7	10	15
Belgium	10	42	91	19	85	187	89	529	1,609	7	10	14
Bulgaria	0	3	7	1	6	14	3	35	115	7	10	14
Croatia	0	3	7	1	7	15	4	52	170	7	13	19
Cyprus	0	0	1	0	1	2	1	11	36	12	19	27
Czech Rep.	1	11	25	3	22	52	17	227	743	11	17	24
Denmark	5	20	43	11	41	88	35	210	639	5	8	12
Estonia	0	2	5	1	4	11	3	29	93	7	11	15
Finland	3	10	22	5	20	44	25	121	358	7	9	13
France	53	214	467	112	434	965	331	2,069	6,341	5	8	11
Germany	64	318	719	132	640	1,481	463	3,210	9,963	6	8	11
Greece	1	8	18	2	15	37	6	89	291	6	9	13
Hungary	1	6	14	2	13	29	12	122	390	9	15	23
Ireland	3	12	26	6	24	53	17	118	364	5	8	12
Italy	15	131	307	31	264	633	134	1,662	5,416	7	10	14
Latvia	0	1	3	0	3	6	2	16	50	7	10	14
Lithuania	0	2	5	1	4	10	2	28	92	7	11	15
Luxembourg	1	4	8	2	8	17	7	48	150	6	10	15
Malta	0	0	1	0	1	1	1	7	23	18	24	31
Netherlands	25	52	104	51	104	212	206	561	1,433	6	9	11
Poland	2	19	44	4	38	90	32	457	1,502	12	19	28
Portugal	5	19	41	10	38	85	39	222	671	6	9	13
Romania	1	6	12	2	11	25	10	114	372	10	17	25
Slovakia	0	4	9	1	8	19	7	85	278	11	17	25
Slovenia	1	5	11	2	10	22	6	64	207	6	10	16
Spain	16	128	307	34	257	632	112	1,169	3,765	5	7	10
Sweden	18	44	87	34	86	178	133	415	1,111	5	7	10
UK	48	223	503	93	445	1,033	382	2,275	6,927	6	8	11
EU28	**281**	**1,312**	**2,941**	**571**	**2,640**	**6,054**	**2,133**	**14,274**	**44,108**	**6**	**9**	**12**

Table A1: Modelling results from scenario Road2Zero

CurrentPolicies: Modelling results

	Total Public Chargers			Supply index			Number of EVs			Optimal Sufficiency indicator		
Country	2020	2025	2030	2020	2025	2030	2020	2025	2030	2020	2025	2030
Austria	6.79	22.97	40.48	15	47	83	55	299	756	7	11	15
Belgium	9.80	38.34	67.95	19	77	139	89	483	1,220	7	10	14
Bulgaria	0.32	2.60	5.04	1	5	10	3	32	86	7	10	14
Croatia	0.38	2.95	5.35	1	6	11	4	47	127	7	13	19
Cyprus	0.06	0.44	0.83	0	1	2	1	10	27	12	19	27
Czech Rep.	1.22	9.70	18.52	3	20	38	17	205	557	11	17	24
Denmark	5.30	18.31	31.97	11	37	66	35	192	485	5	8	12
Estonia	0.34	2.00	3.89	1	4	8	3	26	70	7	11	15
Finland	2.59	9.20	16.23	5	18	33	25	111	272	7	9	14
France	52.70	194.16	348.57	112	394	714	331	1,887	4,800	5	8	11
Germany	64.26	287.50	533.71	132	579	1,089	463	2,922	7,527	6	8	11
Greece	0.73	6.76	13.21	2	14	27	6	80	218	6	10	13
Hungary	1.02	5.76	10.46	2	12	21	12	110	293	9	15	23
Ireland	2.66	10.65	19.17	6	22	39	17	107	275	5	8	12
Italy	15.15	117.61	226.66	31	237	463	134	1,501	4,062	7	10	15
Latvia	0.18	1.11	2.14	0	2	4	2	14	38	7	10	14
Lithuania	0.26	1.94	3.71	1	4	8	2	26	69	7	11	15
Luxembourg	0.89	3.54	6.12	2	7	13	7	44	113	6	10	15
Malta	0.03	0.22	0.46	0	0	1	1	7	17	18	24	31
Netherlands	25.48	48.21	78.50	51	96	159	206	524	1,119	6	9	11
Poland	2.00	17.04	32.25	4	34	66	32	413	1,125	12	19	28
Portugal	4.75	17.07	30.69	10	34	63	39	203	509	6	10	13
Romania	0.76	4.99	9.13	2	10	19	10	103	279	10	17	25
Slovakia	0.47	3.63	6.83	1	7	14	7	77	208	11	17	25
Slovenia	0.79	4.54	8.02	2	9	16	6	58	156	6	10	16
Spain	16.40	114.77	226.10	34	231	461	112	1,057	2,829	5	7	10
Sweden	18.00	40.36	66.38	34	79	134	133	386	860	5	7	10
UK	47.80	201.73	373.59	93	403	760	382	2,076	5,249	6	8	11
EU28	**281**	**1,188**	**2,186**	**571**	**2,391**	**4,460**	**2,133**	**12,998**	**33,345**	**6**	**9**	**12**

Table A2: Modelling results from scenario CurrentPolicies

Alternative Charging Infrastructure metric: Total power supply

An alternative metric to quantify the total contribution of the public charging infrastructure ecosystem could be used to calculate the total available power supply for a given Member States. In short, the total amount of kW of each individual charger would be counted separately.

This method was not selected for two reasons: i) higher complexity as Member States would have to report on the precise charging power of each charger while the European Commission is currently elaborating a classification of charging power/type according to a similar method ii) This method would give a disproportionate contribution to ultra-fast chargers, in particular to the ones above 150 kW, where only a small proportion of the EV fleet would be able to charge. For example, this method would assume that a 350 kW charger counts for about 100 times more than a 3.7 kW charger.

T&E recommends that the feasibility and effectiveness of this option should be assessed in the Impact Assessment of the revision of the AFID.

Endnotes

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