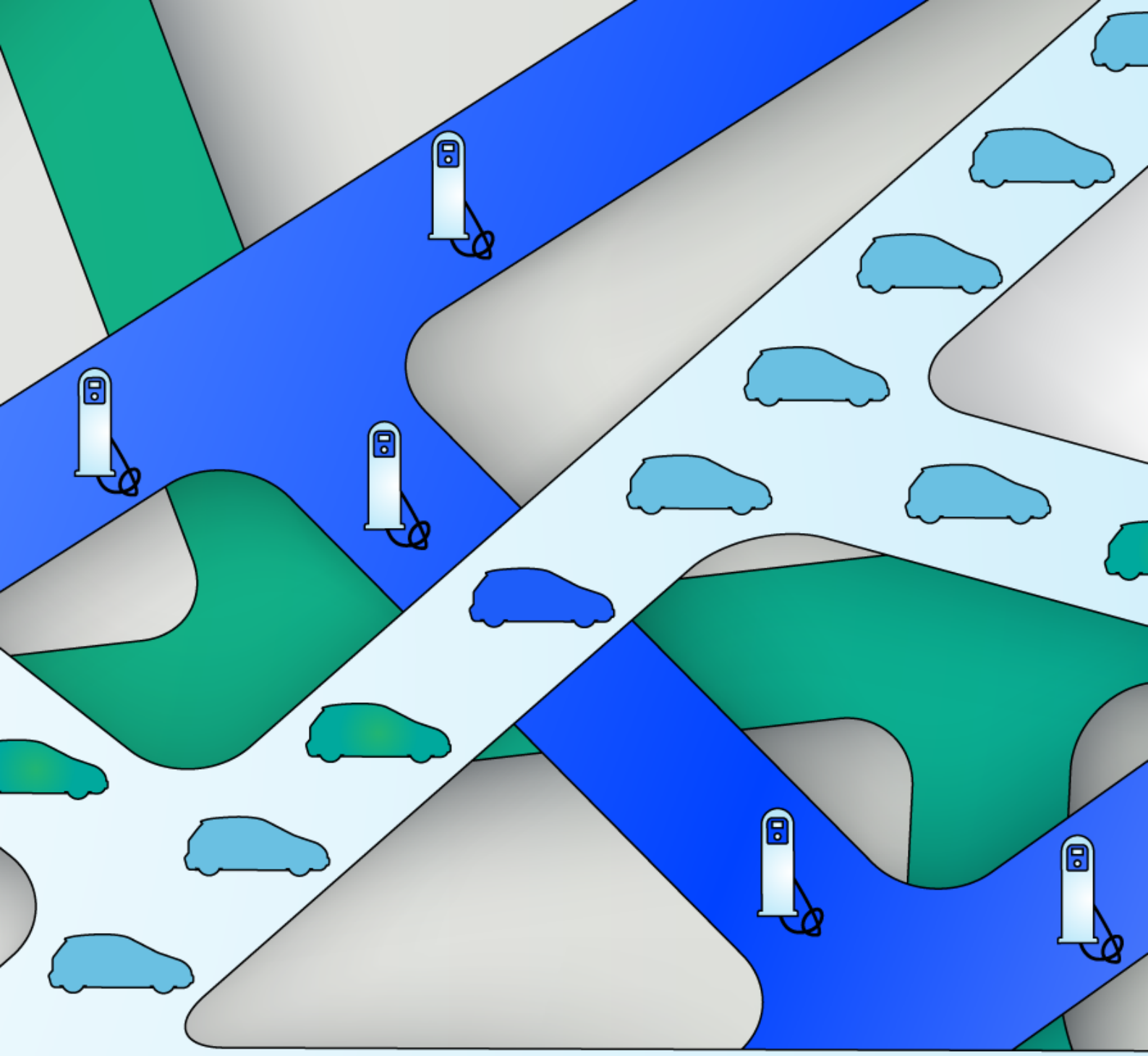

‘Charging’ for phase-out

Why public chargers won't be a block
on EU's combustion car phase-out

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Executive Summary

The lack of charging infrastructure, notably public points for those without private garages, is often raised as a key concern against faster electric car (EV) adoption. As the EU's car CO2 targets propel electric car sales to new highs, with battery electric vehicles accounting for every 10th car sold last year, are the chargers ramping up accordingly? Crucially, as Europe plans to have 100% new car and van sales be zero emission from 2035, will charging be a roadblock? T&E answers these questions in this report and demonstrates how the public charging network will be sufficient.

Public chargers tripled & follow the electric car market

Despite the absence of mandatory targets across Europe today, the public charging infrastructure throughout the EU has grown significantly. In 2021 almost 340,000 public chargers were already in place. This was triple the numbers recorded in 2018; a clear indicator that market dynamics are already gaining momentum as chargers follow the EV market growth.

Furthermore, the infrastructure is ramping up where the uptake of electric cars is highest. While 62% of public chargers in 2021 were located in three countries: Germany, France and the Netherlands. In 2021, 61% of all EVs were registered in those three countries.

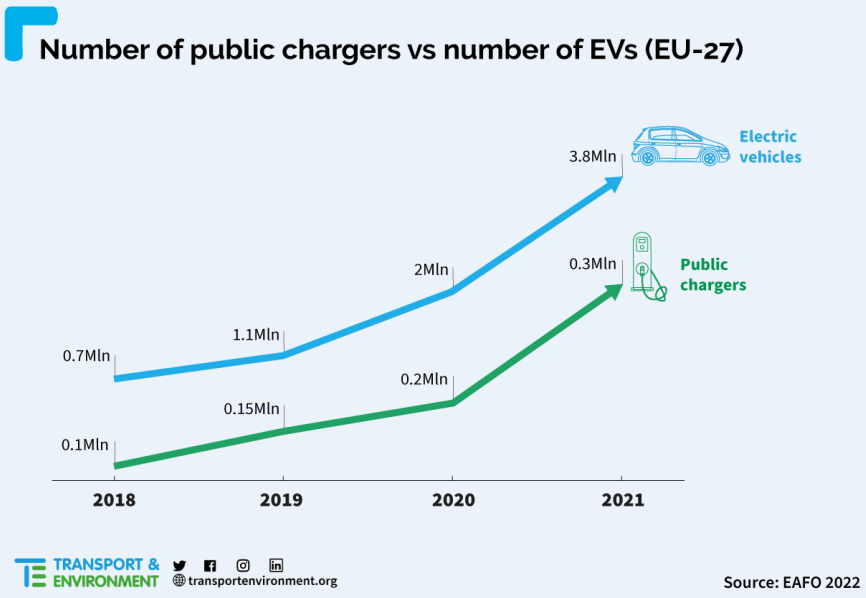

Figure 1: EVs + Number of public chargers 2018 - 2021

But as the electric car market is entering mainstream and growing in all countries, a lot more public charging will be needed in the coming years. To ensure member states ramp up their public networks

on time, the European Commission proposed[1] a regulation on the deployment of alternative fuels infrastructure in July 2021. The draft law obliges member states to always ensure there is a public charging network that is sufficient to fulfill the charging needs of their respective EV fleets. At the very heart of this proposal lies a 'fleet based target' - requiring at least 1 kW of public charging power to be available per each battery vehicle - that increases in line with EVs registered in a country.

Sufficient public chargers for 100% electric sales

To determine the actual public charging demand going forward, three main factors are decisive: (1) the share of public vs. private charging, (2) the utilization rate of the network i.e. the time a charger is used on average per day and (3) the anticipated electricity consumption of future EVs. Public charging will likely play a less important role than often assumed by some, not exceeding 30% of all charging events. Given the ubiquity of the power grid, private charging at home, work or on daily errands will remain the dominant form of charging. This has the added benefit of being cheaper for drivers. The utilization rate of the network will need to increase to enable a sound viable business case; T&E assumes a utilization rate of between 8.6% and 12.5% in this analysis. The energy consumption (or efficiency) of new EVs is constantly improving , e.g. Mercedes recently announced a fully electric vehicle with an average consumption of 10 kWh/100km. T&E assumes a moderately conservative efficiency of 14.8 kWh/100km in this analysis.

Based on the above assumptions and the design of the newly proposed AFI regulation, T&E has modeled the amount of public charging that will be available in the different light-duty EV (cars & vans) uptake scenarios: the Commission Cars CO2 proposal, the scenario consistent with the amendments of the lead MEP in the European Parliament (ENVI draft report) and T&E's Green Deal (Road2Zero) compatible trajectory. Because the AFI public charging parameter is linked to the number of EVs in the fleet, the required public chargers increase accordingly with the ambition on the car and van CO2 side.

Depending on the ambition of the CO2 standards, the results of this analysis show that between 3.6 and 5.1 million chargers will need to be deployed across Europe by 2030. By 2035 - the envisaged phase out date for new cars and vans with an internal combustion engine - this number will rise to 8.2 to 10.4 million chargers. The numbers of chargers are highly dependent on the assumptions around the ratio of normal (<22 kW) and fast chargers (>22 kW): having more fast chargers that provide more power will result in less chargers needed to serve the same fleet. The numbers are therefore indicative and assume a 50/50 split between normal and fast charging. But regardless of this assumption, the actual power and charger numbers increase in line with the higher car CO2 targets in all scenarios. The very regulatory design (or the fleet-based kW targets) ensures that the deployment of chargers in each member state will always follow the uptake of EVs.

[1] European Commission (2021a). Proposal for a regulation on the deployment of alternative fuels infrastructure. Retrieved from: https://ec.europa.eu/info/sites/default/files/revision_of_the_directive_on_deployment_of_the_alternative_fuels_infrastructure_with_annex_0.pdf

Dangers of overbuilding the network

T&E also ran the scenario with the power per EV recommendation from the EU car industry lobby, (ACEA), that wants to see 3 kW per BEV (and 2 kW per PHEV). Based on these targets member states would need to deploy between 9.8 and 14.4 million chargers by 2030, rising to between 24.6 and 31 million chargers in 2035. While more public chargers might be appealing at first glance, the concerns with these high numbers are many fold. It would result in low utilization rates - below 5% - meaning the public charging infrastructure would need to be continuously subsidized. Lower utilization rates can be a necessary side effect for EV markets that are only starting to develop. In the medium to long term, however, the political goal should be to ensure that a charging network becomes economically viable. Thus a network must be able to sustain itself financially. This is only possible if the utilization rates increase significantly over time. A report recently commissioned by ACEA is pointing out that the average utilization rate of the network needs to be at 15% to make a network economically viable. The ACEA AFIR recommendations however would make it impossible to ever reach this rate. It would essentially undercut it by more than three times.

T&E recommendation - link power output to EV-share

The last scenario that was analyzed is the approach T&E is recommending to policy makers on AFI: to keep the 'fleet based' target proposed by the Commission in the long term. But having higher targets for low BEV shares. This entails starting with a higher public charging power share per BEV (3 kW per BEV) if the fleet share is below 1% and gradually decreasing as the market matures to be at 1 kW per BEV once the share hits 7.5%. Following this approach will accelerate the deployment of charging infrastructure in the short and medium term. It would also significantly increase the minimum number of chargers in member states where EV adoption is still slow. At the same time the approach ensures that once a certain maturity of the EV market is reached, an overbuilding of the public charging infrastructure is avoided and higher utilization rates are ensured.

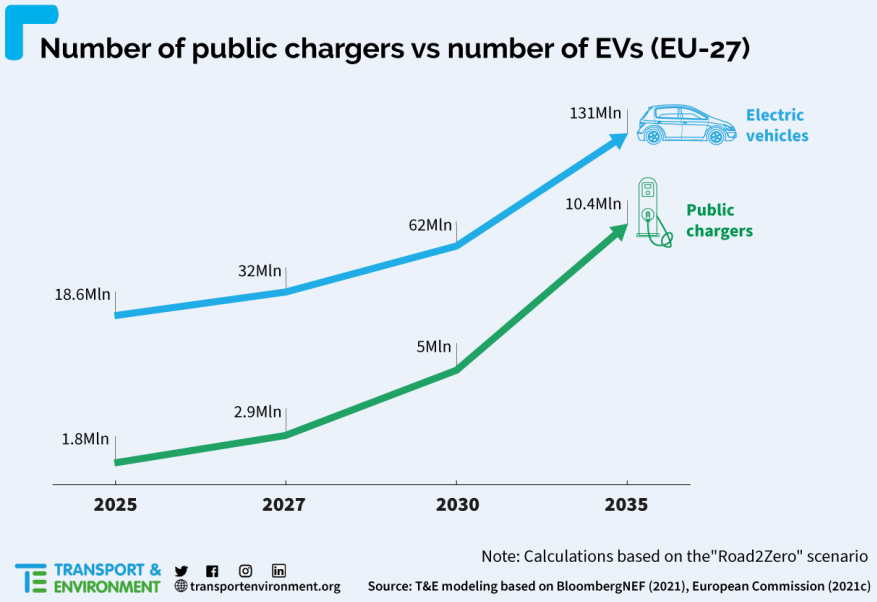

Figure 2: EVs + Number of public chargers 2025 - 2035

The development of the public charging infrastructure in Europe is on track and is largely matching the accelerating uptake of EVs. The mandatory targets proposed in the AFI regulation will ensure at all times that the number of public chargers is on par with the number of EVs.

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1. Status quo - is the deployment of public charging infrastructure on track?

One in every 11 cars sold in the EU in 2021 was fully electric as EV sales were boosted by the EU 2020/21 car CO2 targets for the second year running. According to ACEA data[2] for 2021, battery electric vehicles had a 9.1% market share That's up from 1.9% in 2019.

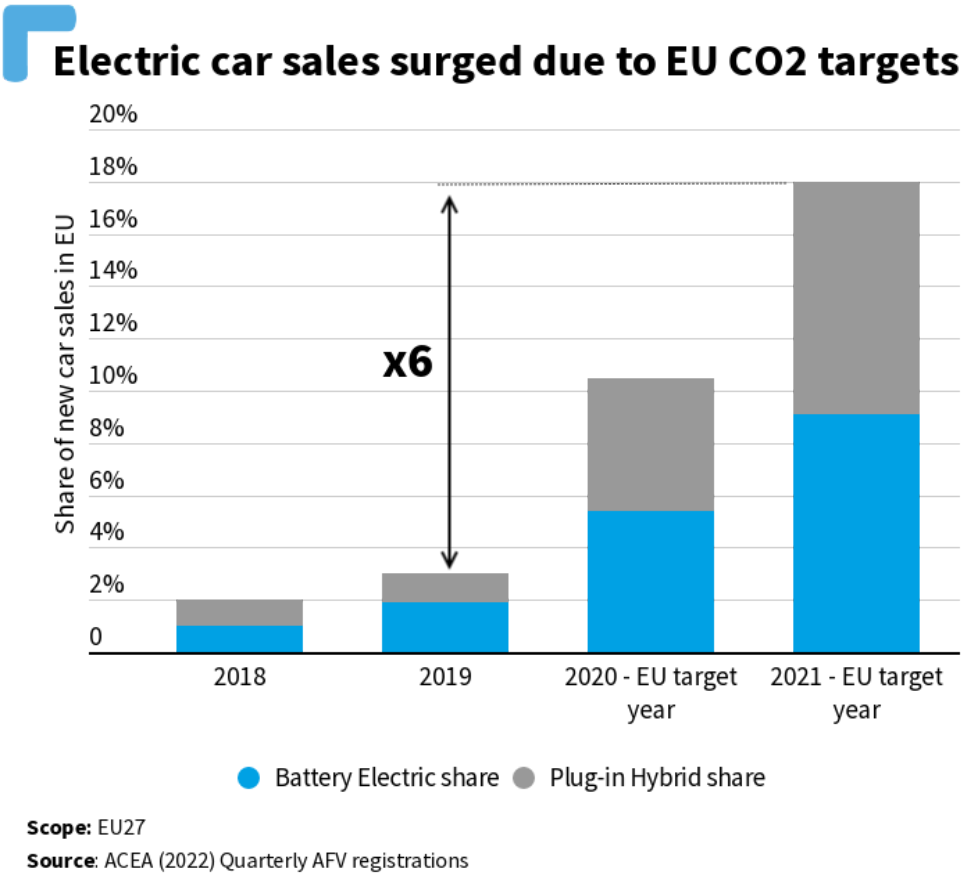


Figure 3: Electric car sales 2018 - 2021

An impressive growth rate that refutes the prophets of doom that have warned for years that a speedy uptake of electric vehicles won't be possible due to a lack of sufficient publicly accessible charging infrastructure. What was really lacking was the supply and the seriousness of car manufactures to shift to e-mobility. Charging of electric cars typically happens at private (at home or at work) chargers and public chargers. It has to be noted that this analysis is focusing only on public charging infrastructure

This does not mean that public charging infrastructure is a negligible factor. Without any doubt, infrastructure is a key variable within the broader electromobility ecosystem, but it has not and it will not

[2] ACEA (2022). New Car Registrations by Fuel Type, European Union. Retrieved from: https://www.acea.auto/files/20220202_PRPC-fuel_Q4-2021_FINAL.pdf

be a limiting factor on the EU's pathway to phasing out the internal combustion engine by 2035 at the latest. We already see today that the market, supported by national and regional policy incentives, is growing and largely satisfying the demand for publicly accessible charging infrastructure. This is demonstrated by the figure below.

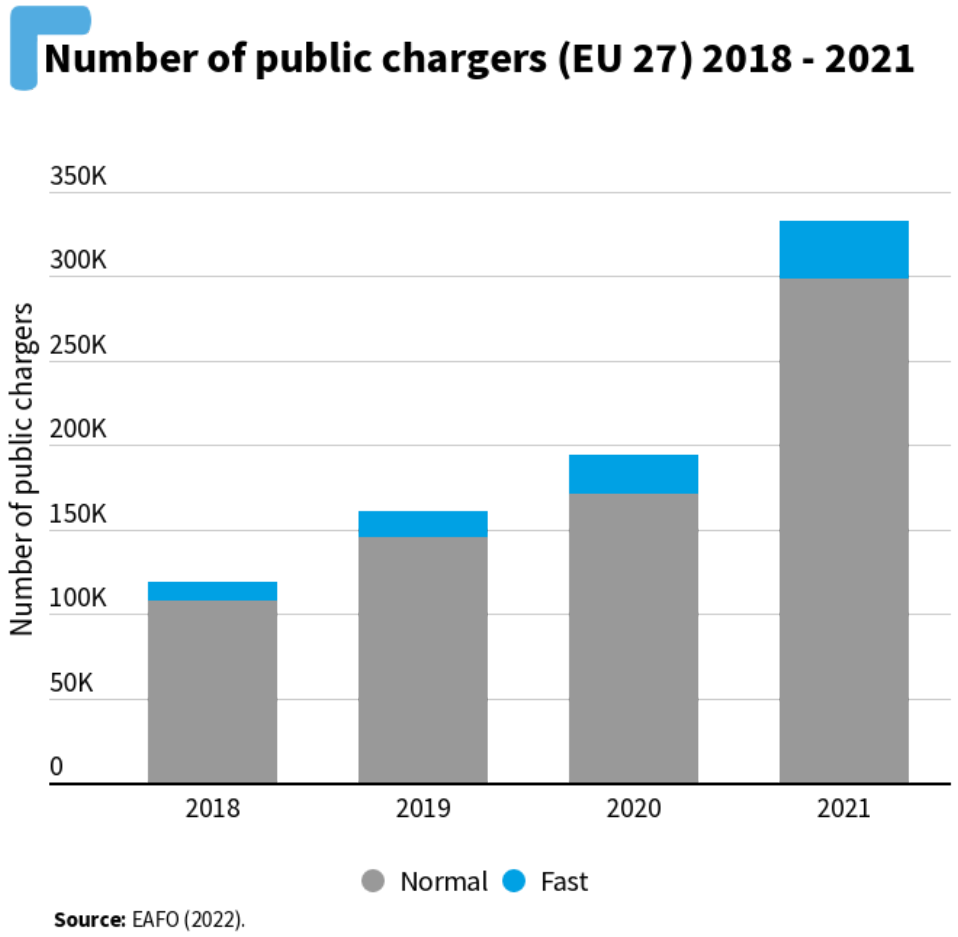


Figure 4: Number of public chargers 2018 - 2021

Despite the absence of clear mandatory targets in the currently in force Alternative Fuel Infrastructure Directive[3] - the main EU law when it comes to public charging - public charging infrastructure has seen staggering growth since 2018. According to the European Alternative Fuels Observatory (EAFO) the total number of charging points within the EU-27 countries tripled to almost 340,000. The number of fast charging points (>22 kW) increased by 350% in the same period[4], reaching more 39,000 in 2021

When comparing the uptake of EVs over the past four years with the deployment of public charging infrastructure over the same time period, we see that both are growing accordingly.

[3] EU (2014). Directive on the deployment of alternative fuel infrastructure. Retrieved from: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094

[4] EAFO (2022). Normal and High power public recharging points (2022). Retrieved from: https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats#

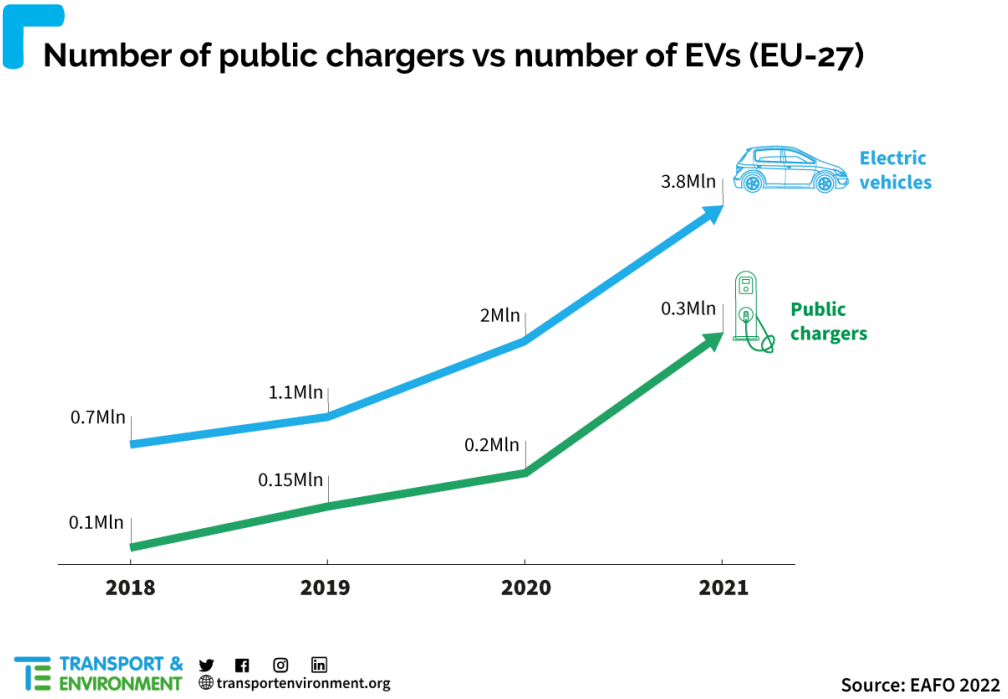


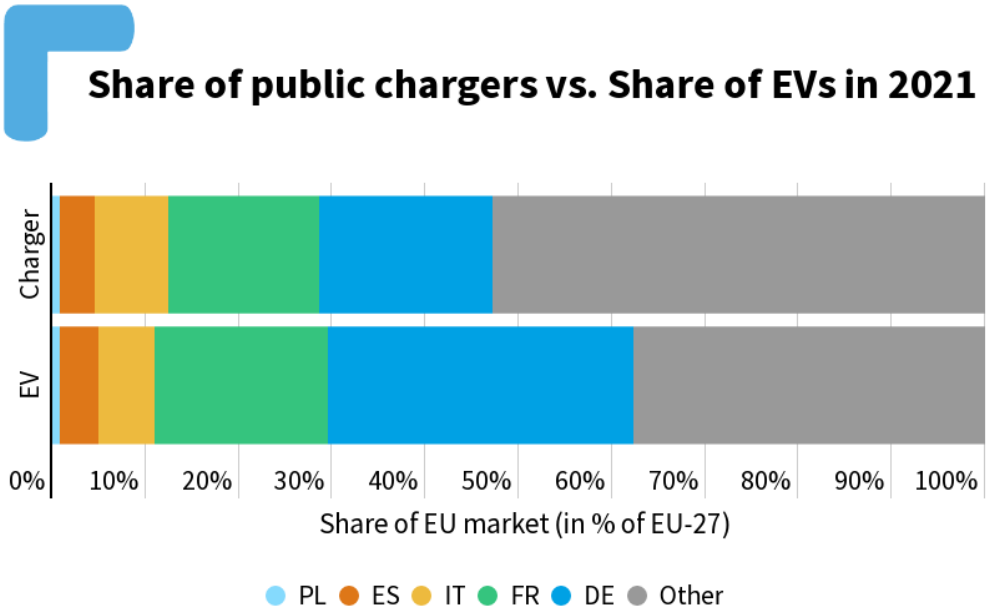
Figure 5: Number of public chargers vs. number of EVs (EU-27)

With regard to the spatial distribution of this infrastructure we also see a clear pattern. In 2021 62%[5] of all public chargers were located in just three countries, namely the Netherlands, France and Germany. This is often depicted as a problematic development as it is allegedly proof that the deployment of charging infrastructure is unbalanced and flawed.[6] On a closer look it is however not surprising as 61%[7] of all EVs registered in the EU, are registered in those three countries. In other words, the present concentration of charging infrastructure is an indicator which demonstrates that the supply and demand mechanism for publicly accessible charging infrastructure seems to work relatively smoothly, with deployment happening where chargers are needed most. We see a similar pattern for almost all member states. This is important as it means that public money can be spent in a targeted manner so as to avoid stranded assets.

[5] 74 % in 2020, 72% in 2019, 74 in 2018

[6] ACEA (2021). Correlation between electric car sales and charging point availability (2021 update). Retrieved from: https://www.acea.auto/figure/interactive-map-correlation-between-electric-car-sales-and-charging-point-availability-2021-update/

[7] 61% in 2020 and 2021, 61% in 2019 and 62% in 2018



Source: EAFO (2022).

Figure 6: Share of chargers vs share of EVs

Furthermore, we see that the EV to charging point ratio - the average number of vehicles per publicly accessible charging point - has increased from 6 to 13 from 2018 to 2021. Again this might seem problematic at first, but this is an indicator that the market is maturing: Once a comprehensive network of publicly accessible charging infrastructure is in place, it is inevitable and necessary that the utilization rate - how long chargers are in use each day - of the network increases. We also see this pattern in Figure 5. In member states with a low EV share the ratio is still relatively low, while the ratio increases in member states with a higher EV-penetration. In the long term this is important not only to avoid stranded assets and ensure a business case for charge point operators (CPOs), but also to reduce and eventually phase-out subsidies from public funds (more on that under point 2.2).

This does not mean that there is no room for improvement. It is of crucial importance that with an accelerating EV market, deployment of public chargers must keep pace. In the short to medium term deployment should be further accelerated, especially in countries where EV adoption has not gained enough traction yet. This is especially true when it comes to EU member states where the EV penetration is still significantly below the EU-average. When looking at regulatory measures at the EU but also at the national level, the guiding principles must be to:

- (1) ensure common standards (compatibility, payment etc.),
- (2) ensure the usage of EVs across the entire territory of the EU but
- (3) provide a basic coverage, or a backbone infrastructure.

Wherever and whenever there is more demand for public charging infrastructure this should and will be delivered through a normal market mechanism.

2. Future public charging needs

2.1. The Alternative Fuel Infrastructure Regulation (AFIR) proposal

In the context of the Fit For 55 Package, the European Commission published its proposal[8] in July 2021, turning the existing Alternative Fuel Infrastructure Directive into a Regulation. The goal for the light duty vehicle segment is to provide a comprehensive, EU-wide public charging infrastructure for EVs across the bloc, in every member state. The proposal includes both distance and fleet-based (i.e. linked to the number of EVs) charging targets that each EU member state has to meet. With regard to the distance based targets, a mandatory charging pool every 60 km along the EU's main highways from 2025 and its secondary highways from 2030 onwards is proposed for the EU's most frequently used roads (TEN-T road network). The main target that will determine the number of future public chargers is the so-called 'fleet based target', The proposal requires member states to install publicly available chargers in accordance with the number of vehicles registered in their territory. Accordingly, member states need to provide at least 1 kW of publicly accessible charging power for each BEV and 0.66 kW for every PHEV. Additional provisions on the ease of payment, interoperability and smart charging were also proposed.

2.2. How much public charging infrastructure is actually needed?

For years the discussion of how much public chargers are needed revolved around set in stone dates and absolute numbers of charging points. Both indicators alone are flawed and not really helpful to assess the right amount of chargers. Rather than numbers, what matters is how much power the charging network is providing as there is a difference between a slow 3 kW charger and a fast 50 kW one as to how many electric vehicle batteries a day they can fill up. First of all, the number of chargers gives little indication whether it will be enough to satisfy the growing electricity demand from EVs, without taking into account the ratio between fast and normal/slow chargers. Secondly, aspiring to a fixed amount of chargers in a given year without taking the actual deployment of EVs into account will likely lead to either an over- or under-supply of chargers because the charging infrastructure will either not be sufficient for the size of the EV fleet, or too many chargers could be deployed and thus the network overall might not be used sufficiently. Luckily, the discourse in the industry as well as among policy makers has shifted away from this suboptimal approach.

A flexible, demand based approach is used more and more. The prime example for this is the European Commission's methodology in the AFIR proposal. The 'fleet based' methodology obliges member states to provide public chargers always in direct proportion to the total number of registered EVs in that country. The deployment of chargers will thus always follow the actual charging demand.

[8] European Commission (2021b). Proposal for a Regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0559

But what is the right level of ambition that such a 'fleet based' approach needs to have. It needs to be based on the actual energy that needs to be provided at public charging points. This depends on three main factors that will be discussed below: (1) the share of public vs. private charging, (2) the average utilization rate of the charging network and (3) the anticipated future energy efficiency of EVs.

2.2.1. Public vs. private charging - what is more important?

If an ICE car runs out of petrol or diesel, people go to the nearest gas station and refuel it in a couple of minutes. Naturally many assume that this has to be similar for electric vehicles, i.e. plugging a fast charger into the car and having a full battery again within a short timeframe. While this is possible and necessary, especially for longer trips or while on business or holiday trips, the vast majority of charging will look very different. Charging will not only happen at publicly accessible charging stations but predominantly at chargers that are located either at home (e.g. own garage, private parking facilities) or at work (e.g. parking space at the workplace). Ubiquitous electricity supply means it will always be easiest to charge cars where people sleep, work, shop, stay, etc. On top of that, private charging is more cost effective than public charging. Thus, it is safe to assume that EV-drivers will prefer private charging where it is available. Private charging is also more convenient, as people will charge where they park their car anyway and thus won't have to go to the nearest charging hub.

Looking at the current situation we see this confirmed. According to the European Commission more than 90% of all charging events take place at private chargers.[9] This is already a slight increase from previous years, when public charging accounted only for about 5%[10] of all charging events. The reason why the number is still only in the single digits is due to the fact that the many current EV drivers already have access to private charging and thus only use public charging infrastructure for longer trips. While it is important to have public infrastructure that enables this, most people will only need to use it in a very limited manner, as the average daily driving distance is below 20 km.[11]

It is safe to assume that the market share of public charging is likely to increase in the future as EV adoption gains ground among people who have no or very limited access to private charging - particularly in cities. Nevertheless, this increase will be limited. The Commission expects that post-2030, the rate of private charging will remain as high as 60 - 85%. By 2030 we can expect an already mature EV market and thus it is reasonable to assume that the share will stay relatively constant from 2030 onwards. T&E assumes a relatively high share of 30% for public charging. Other sources such as a recently published

[9] European Commission (2021c). Impact Assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure. Retrieved from: https://ec.europa.eu/info/sites/default/files/revision_of_the_directive_on_deployment_of_the_alternative_fuels_infrastructure_with_annex_0.pdf

[10] T&E(2018). Roll-out of public EV charging infrastructure in the EU. Retrieved from: https://www.transportenvironment.org/wp-content/uploads/2021/07/Charging%20Infrastructure%20Report_September%202018_FINAL.pdf

[11] Bundesministerium für Verkehr und Digitale Infrastruktur (2019). Mobilität in Deutschland. Retreived from http://www.mobilitaet-in-deutschland.de/pdf/MiD2017_Ergebnisbericht.pdf

study by *element energy*[12] concludes that 85% of new car buyers have access to off-street parking with 59% having access to private off-street parking. It is reasonable to assume that those EV drivers will then also have access to private charging infrastructure. ChargeUpEurope, a stakeholder group of CPOs is predictitinc a maximum public charging share of 35%.[13]

The aforementioned AFIR proposal by the European Commission is designed in a way that the minimum infrastructure coverage would enable a public charging share of more than 40%. In taking the highest possible share as a basis, the proposal has an inbuilt safeguard mechanism. This means the outlined targets will provide an infrastructure that would be sufficient for unlikely high public charging shares.

All of the above sources agree that private charging will play the key role in satisfying the growing electricity demand of a rapidly enlarging European EV fleet. One of the few exceptions for this is the assumption taken by parts of the automotive industry. ACEA, is assuming that 60%[14] of all charging events will happen at public chargers. It is unclear where exactly these assumptions are coming from, as the vast majority of other sources are citing numbers way below that. It is also noteworthy that some ACEA member have stated publicly that public charging will only account for a very limited share of all charging.[15]

The above shows that the overwhelming share of charging will most certainly happen at home or at the workplace. Public charging infrastructure is key for long distance travel and to offer charging opportunities to those EV drivers that will not have access to private chargers. This means that public charging infrastructure is an important element of the e-mobility ecosystem, but its role should not be overestimated.

2.2.2. Utilization rate

Another key variable for determining the required amount of charging infrastructure is the utilization rate - the time a charger is in use each day. For markets where the EV share is below the average it is important to achieve a basic coverage with publicly accessible chargers, avoiding gaps in the network and ensuring that public charging is possible everywhere. The negative consequence of this is that the utilization rate of each charger will be relatively low. However, with a growing number of EVs on the road and thus higher utilization of the existing charging network the network wide utilization rate will also increase.

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[12] Element energy (2022). Electric Mobility: Inevitable, or Not? Retrieved from: https://www.platformelectromobility.eu/wp-content/uploads/2022/01/20220110_InevitableEV_Final.pdf

[13] ChargeUpEurope (2021). Charing up Europe through binding capacity targets for publicly accessible charging infrastructure and Member State action plans. Retrieved from: https://static1.squarespace.com/static/5e4f9d80c0af800afd6a8048/t/60d426dda0462c583a9d0353/1624516320310/Charging+up+Europe+through+binding+capacity+targets+for+publicly+accessible+charging+infrastructure+and+Member+State+action+plans+.pdf

[14] ACEA (2021). Position Paper AFIR. Retrieved from: https://www.acea.auto/files/ACEA_Position_Paper-Alternative_Fuels_Infrastructure_Regulation.pdf

[15] Ola Källenius, CEO of Mercedes-Benz has publicly stated that public charging will only account for 10% of slightly more of all charging events. Politico (2022). Online Event: On the Road to Climate Neutrality. Retrieved from: https://charging-infrastructure-climate-neutrality.eu/

Why is this important? For a charging network to become economically viable, the deployed public chargers need to be used in a frequent manner, to allow for the amortization of the investment. There are several assumptions as to how high the average utilization rate will actually be post 2030.

The European Commission estimates that slow and normal chargers (below 22 kW power output) will be in use on average 2 h per day (8.3%). Fast chargers on the other hand will be used 3 hours per day (12.5%). Stakeholders, such as ChargeUpEurope and T&Es own assumptions suggest that utilization rates might have to be even slightly higher. If the ACEA[16] numbers are taken as a basis, the long term utilization rate for each normal charger would be below one hour per day (3.75%). For fast chargers the average utilization would only barely exceed 1,5 h (6.5%) per day.

When looking at these utilization rates it is important to note that they are always representing the average. It is very likely that chargers located along highly frequented highways will be used for several hours a day. In consequence, this means that chargers in remote areas, with relatively low traffic density, might not even be used every day. It is however important to keep in mind that from a business standpoint, and also from a public funding standpoint, it is expedient to aim for a relatively high utilization rate throughout a charging network. To operate a charging network in an economically viable way usually requires a utilization rate of 15% according to a recent McKinsey study[17]. The charging industry itself expects the utilization rate to be 7.2% or 1.72 hours for normal/slow chargers and as high as 17.6% or 4.22 hours for fast chargers[18].

2.2.3. Efficiency of future BEVs

The last variable that influences the amount of public charging is the efficiency of future BEVs. This is an important factor, as higher EV efficiency will likely decrease the total energy demand of the future EV fleet and thus the amount of charging infrastructure needed.

The European Commission assumes that by 2030 the average BEV will consume 14.8 kWh/100 km. While this could be realistic, it seems relatively low from today's perspective. Although, already today VW claims that their ID.3 - representative of an average electric car, along with the Tesla Model 3 – consumes only 13.7 kWh/100 km[19] under ideal test driving conditions (WLTP). Further improvement is expected as efficiency is the focus of many OEMs: Mercedes Benz announced that they are currently developing a

[16] same
[17] ACEA (2022). European EV Charging Infrastructure Masterplan. Retrieved from: https://www.acea.auto/files/Research-Whitepaper-A-European-EV-Charging-Infrastructure-Masterplan.pdf
[18] ChargeUpEurope (2021). A methodology for minimum capacity targets for EV Charging Infrastructure. Retrieved from: https://static1.squarespace.com/static/5e4f9d80c0af800afd6a8048/t/60d420220d01b22d4c24ca42/1624514595669/ChargeUp+Europe+-+methodology+for+minimum+capacity+targets+for+EV+Charging+Infrastructure.pdf
[19] Volkswagen (2022). Der ID3. Retrieved from: https://www.volkswagen.de/de/modelle/id3.html

car[20] that will only consume 10 kWh/100 km. Against this backdrop, ACEA is assuming an efficiency of 20 kWh/100 km until 2030, which seems quite implausible and questionable.

Although significant efficiency gains are likely, T&E is taking a more conservative stance: in this paper it is assumed that by 2030 the average consumption will be around 14.8 kWh/100 km.

2.2.4. What is the right ambition?

Taking all of the above mentioned factors into account, it seems that the European Commission has proposed solid future proof targets in its AFIR proposal - at least for the medium to long term. As outlined in T&E's AFIR position paper[21], the ambition could be significantly increased for markets where e-mobility is still in its infancy. Long term however, the envisaged ambition of the Commission of 1 kW per BEV will result in sufficient charging infrastructure in all EU member states. The aforementioned assumptions that have led the Commission to the 1 kW target are rather generous: 40% public charging share, relatively low average utilization rates of 2 hours (normal chargers) and 3 hours (fast chargers), as well as a realistic energy consumption.

For all locations with a significantly higher demand, e.g. highly frequented traffic hubs or highway sections with increased traffic volumes during holiday periods - the market will be able to provide additional charging opportunities - as it already does today. In the long run, once sufficiently mature charging markets are established in all countries, it may even be sensible to waive binding targets altogether.

The automotive industry's approach however would lead to a charging network that is not economically viable. The high targets would invariably lead to extremely low average utilization rates of just 3.75% or 0.9 hours per day (normal chargers) and 6.5% or 1.55 hours per day (fast chargers) - even if an unrealistic public charging share of 60% is assumed. This could create a vicious cycle where member states would be legally obliged to massively expand their national charging networks each year way past 2030 without any real additional demand. This in turn would make it ever more impossible for the network to become self sustainable.

To give a better overview, the next section will display the amount of publicly accessible chargers that can be expected once the AFI regulation is in place. It will furthermore give the presumptive numbers for the years 2025, 2027, 2030 and 2035.

[20] Mercedes-Benz (2022). Vision EQXX. Retrieved from: https://www.mercedes-benz.com/en/vehicles/passenger-cars/concept-cars/vision-eqxx-the-new-benchmark-of-effiency/

[21] T&E (2021). AFIR: providing infrastructure to make transport fit for 55. Retrieved from: https://www.transportenvironment.org/discover/afir-how-can-the-eus-infrastructure-law-make-europe-fit-for-55/

3. What is the minimum infrastructure member states need to provide?

To estimate the number of chargers there are three key/important variables: (1) the anticipated number of BEVs (and PHEVs), (2) the required minimum power output per BEV (and PHEV) and (3) the assumed division of chargers with a normal power output (<22 kW) and fast chargers (>22 kW).

The anticipated EV fleet is first and foremost dependent on the ambition of the CO2-standards regulation for cars and vans. It is important to know by how much car makers will have to reduce the CO2-emissions of their newly sold cars and vans and by when. At the moment a number of scenarios are on the table for discussion. These are briefly summarized in section 3.1. The Commission proposal (EC), the European Parliament's lead committee draft-report (ENVI) and T&E's own Green Deal compatible recommendation (Road2Zero).

For the AFIR ambition. how much publicly accessible charging power member states will have to provide for each BEV (and PHEV) registered in their territory is of key importance. The Commission proposal (AFIR-Proposal) as well as the recommendations of car makers (ACEA recommendation) and the T&E recommendation will be presented in section 3.2. Furthermore, the anticipated number of chargers (based on the Commission proposal) for Germany, France, Italy, Spain and Poland will be shown.

In terms of the split between normal and fast chargers, AFIR is not stipulating how member states should distribute the required power output between normal and fast chargers - the only expectation is the requirements for the TEN-T road network. However, the impact assessment accompanying the AFIR proposal is estimating a model-split. It is assumed that 57 % of the delivered public charging energy will be provided through normal chargers with an average nominal power output of 7.7 kW. The remaining 43% will be provided via fast chargers with an average nominal power output of 130 kW.

3.1. Different CO2-standards scenarios

The Commission proposes to increase the CO2 reduction of the entire new car fleet to 55% in 2030 (up from 37.5%) and to 100% in 2035, meaning all new cars will need to be zero emission after this date. For vans a reduction of 50% (up from 31%) is required by 2030, whilst the same target of 100% in 2035 will also apply. The Commission proposal leaves the 2025 target untouched until 2029.

The draft report[22] of the ENVI committee in the European Parliament, the leading committee on CO2 standards, recommends for cars: an increase of the 2025 target to 25% (up from 15%), introducing a 2027 target of 45% and a 75% target for 2030. Additionally they agree with the de facto phase out proposed by the Commission for 2035. For vans the reduction targets are reduced by 5% for each respective year: 20% (2025), 40% (2027) and 70% in (2030).

[22] European Parliament (2022). EP-Draft report AFIR. Retrieved from: https://www.europarl.europa.eu/doceo/document/ENVI-PR-697678_EN.pdf

T&E's recommendation - to have a cost-effective trajectory for road transport to reach zero in line with the EU Green Deal - (Road2Zero) for cars is to increase the 2025 target to 30% and to introduce a new target for 2027 of 45% and significant increase of the 2030 target to 80%. T&E recommends having the same reduction targets for cars and vans except for 2025, where a 25% reduction is suggested.

	2025	**2027**	**2030**	**2035**
EC	15%		55% (50% vans)	100%
ENVI	25% (20% vans)	45% (40% vans)	75% (70% vans)	100%
Road2Zero	30% (25% vans)	45%	80%	100%

Table 1: CO2-standards scenarios

Assumed EV fleet per scenario

Using the aforementioned assumptions for the CO2 standards T&E's own model[23] is able to provide the following anticipated EV fleet sizes for the respective years:

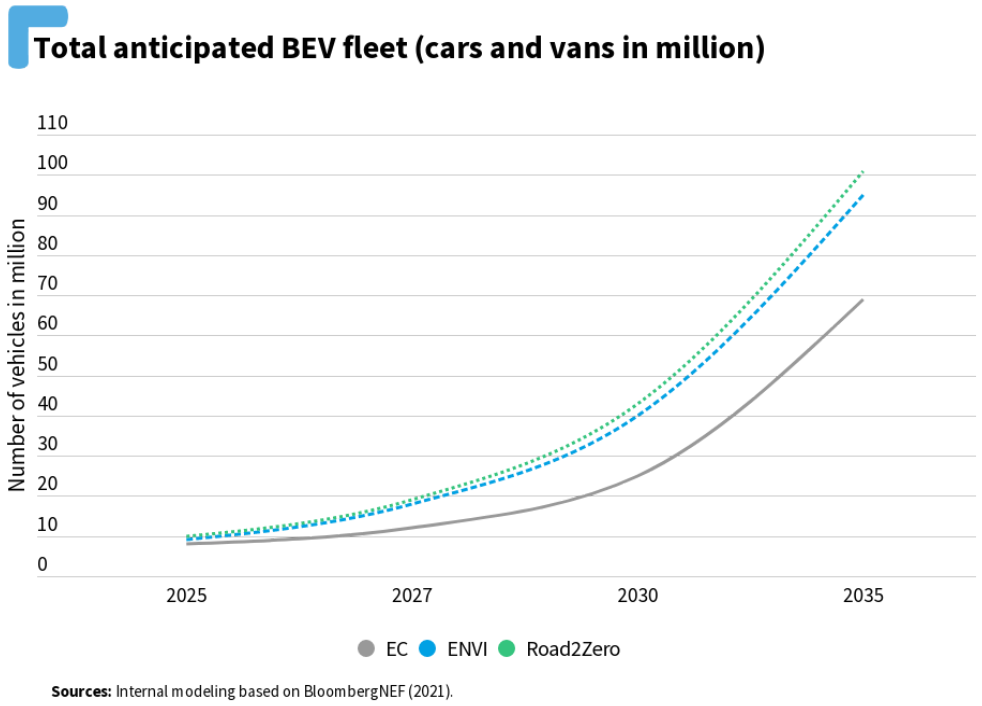


Figure 7: Total anticipated BEV fleet (cars and vans in million)

[23] Internal modeling that computes BEV and PHEV sales required to meet car CO2 standards in different regulation scenarios. Modeling assumes 2021 sales for all projected years and accounts for a country's ambition level as defined by BloombergNEF (2021). Hitting the EV inflection Point. Retrieved from: https://www.transportenvironment.org/publications/hitting-ev-inflection-point&sa=D&source=docs&ust=1648992139464625&usg=AOvVaw3Av4kDCbhmo0qVUDyFES4X

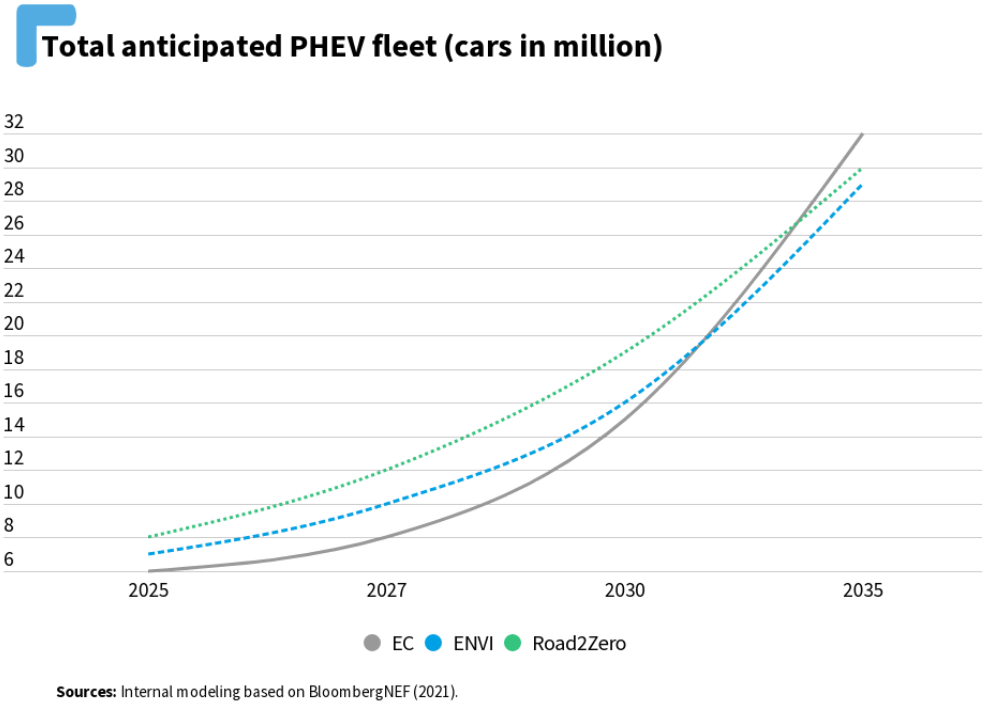


Figure 8: Total anticipated PHEV fleet (in million)

3.2. Different AFIR scenarios

The final parameters needed to make a reliable estimation of the anticipated number of chargers are the requirements in the AFI regulation. In this analysis three scenarios are taken into account the

- **The AFIR proposal with its 'fleet based' targets (AFIR-Proposal)**
  The Commission's proposal would oblige member states to provide provide 1 kW of publicly accessible charging power per BEV and 0.66 kW per PHEV
- **ACEAs recommendation of increasing the targets (ACEA recommendation)**
  In its official position paper ACEA recommends to triple the targets proposed by the European Commission to 3 kW per BEV and 2 kW per PHEV
- **T&E recommendation**
  T&E's recommendation is based on the charging industry's[24] recommendations. Overall the Commission's ambition should be kept in the long term but the power output per BEV should be temporarily increased if the share of BEV in relation to the total LDV fleet is below 7.5%, while also introducing further sub targets for lower BEV shares.

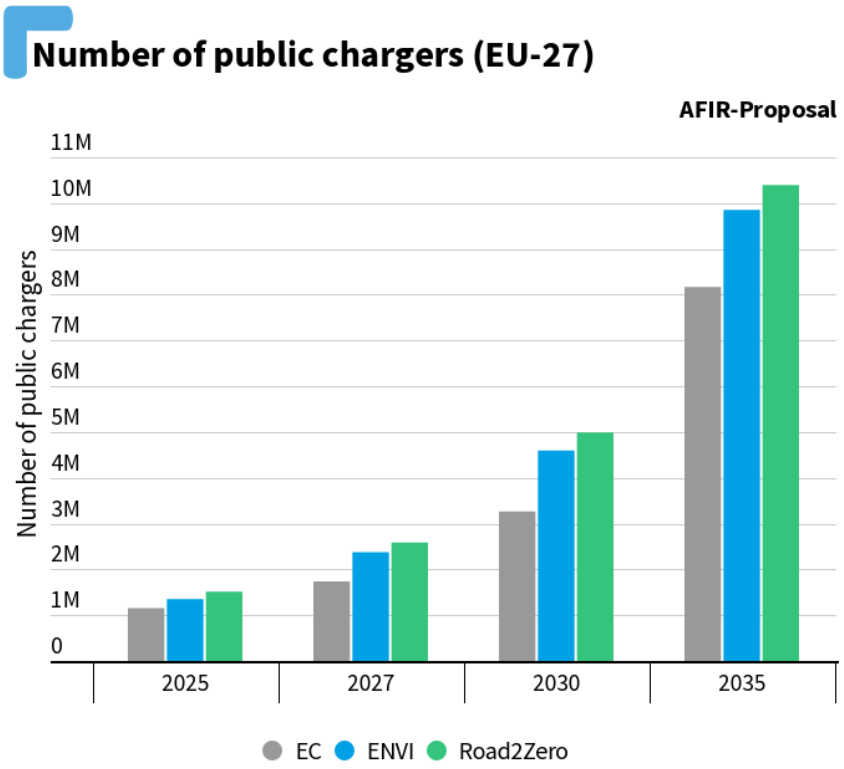
[24] ChargeUp Europe (2021a). ChargeUp Europe's position on the Alternative Fuels Infrastructure Regulation (AFIR) proposal. Retrieved from: https://static1.squarespace.com/static/5e4f9d80c0af800afd6a8048/t/6183a691e794dc2c37309d63/1636017810621/For+Consumers+and+Climate+-ChargeUp+Europe+position+on+AFIR+proposal+%281%29.pdf

3.3. Estimated number of public charging infrastructure for the expected EV fleet

To estimate the total amount of chargers expected this paper is using the assumptions of the Commission's AFIR impact assessment according to which 57% of the installed charging power will be provided by normal chargers (average nominal power output of 7.7 kW) and 43% through fast chargers (average nominal power output 130 kW). It is however important to note that this split can vary greatly from member state to member state. Furthermore, the Commission assumes fast chargers only for BEVs while only normal chargers (<22 kW power output) are foreseen for PHEVs.

3.3.1. AFIR-Proposal

Following the trajectory of the AFIR-Proposal of 1 kW per BEV and 0.66 kW per PHEV would require member states to deploy an approximated total of 1.15 to 1.51 million public chargers by 2025, 1.74 to



Sources: Internal modeling based on BloombergNEF (2021), European Commission (2021c).

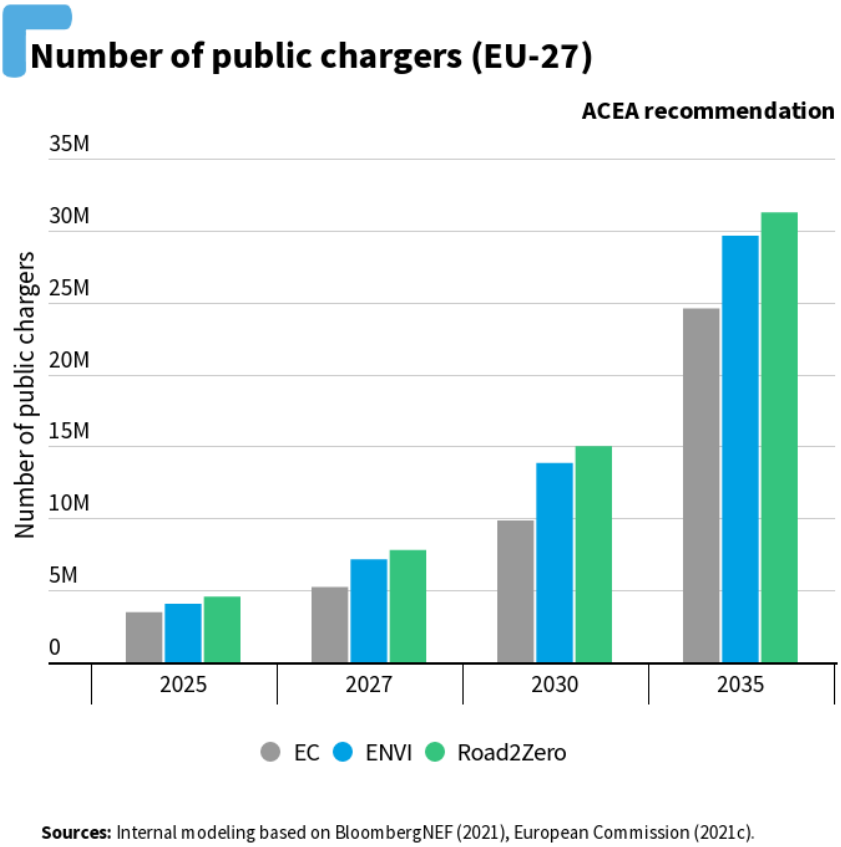
2.59 million by 2027, 3.27 to 5 million by 2030 and 8.17 to 10.4 million by 2035 - all subject to the different CO2-standard scenarios discussed above.

Figure 9: Number of chargers (AFIR-Proposal)

An increasing number of EVs on the road will significantly increase the cumulative target all 27 EU member states have to achieve together. Since the 'fleet based target' is static the average utilization rate remains the same at all times. While the total number of charging points is sufficient from an EU-27 perspective, the distribution between member states could be improved as member states with very low EV shares would have to fulfill certain targets. Due to the low number of EVs, those might not be sufficient to ensure a comprehensive network everywhere. However, after 2030 this will not be an issue anymore, as the EV markets in almost all member states will be relatively mature already.

3.3.2. ACEA recommendations

If policy makers would follow the ACEA recommendations of 3 kW per BEV and 2 kW per PHEV, member states would already need to provide between 3.5 and 4.6 million public charging points across Europe in 2025, between 5.2 and 7.8 million in 2027, 9.8 and 15 million in 2030 and 24.6 and 31.3 million in 2035. Essentially this would mean triple the number of charging points when compared to the Commission proposal.



Sources: Internal modeling based on BloombergNEF (2021), European Commission (2021c).

Figure 10: Number of chargers (ACEA recommendation)

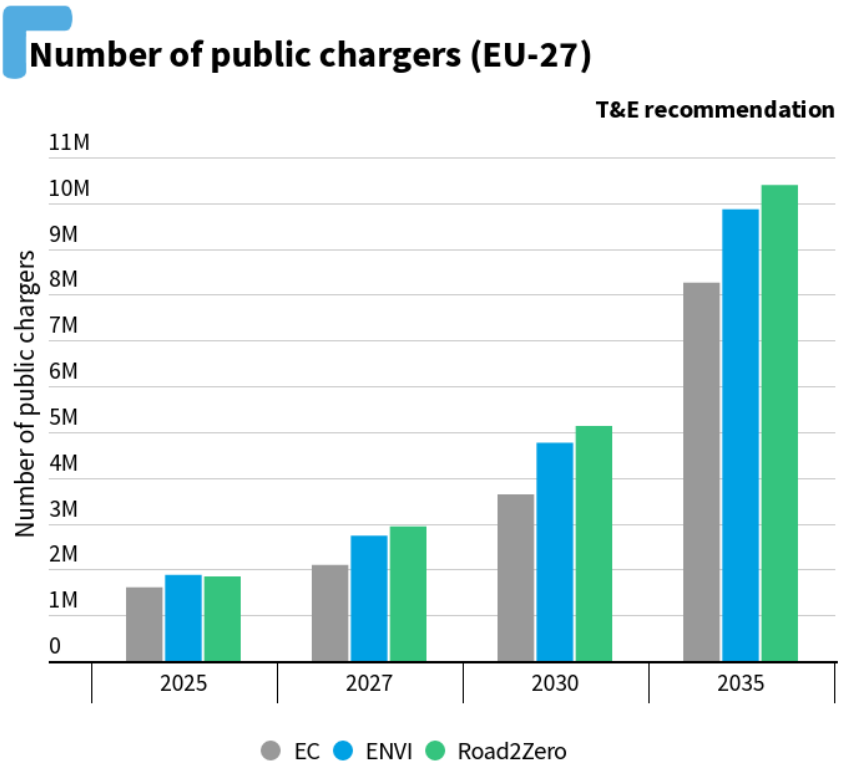
Higher targets can be helpful in the near future in select member states to ensure a minimum coverage and to accelerate deployment. For the vast majority of member states however, and for all member states after 2030, such high targets will lead to a massive over-deployment of public chargers and therefore a

large number of stranded assets. Essentially providing a publicly financed charger for every four EVs on the road.

Moreover, these high legal targets would make it almost impossible for private CPOs to operate charging points in an economically viable way as the high targets would keep the average utilization rate of the charging network below 3.75% (and 6.5% for fast chargers). This is significantly below the utilization rates of 15% that the aforementioned McKinsey study says is required to achieve sound economics, meaning the public will be required to financially support the chargers. The result will be that large parts of the EU charging network would need to be built, maintained and operated by the public even past 2030.

3.3.2. T&E recommendations

The last scenario analyzed would result in 1.6 to 1.9 million public charging points in 2025[25], between 2.1 and 2.9 million in 2027, 3.6 and 5.1 million in 2030 and 8.3 and 10.4 million in 2035. From 2030 onwards the numbers are largely congruent with the numbers in the AFIR-Proposal.



Sources: Internal modeling based on BloombergNEF (2021), European Commission (2021c).

Figure 11: Number of chargers (T&E recommendation)

[25] The reason why the number of public chargers in 2025 for the Road2Zero scenario is slightly below the ENVI scenarios is due to the fact that the charging market in Germany would reach a higher BEV share (in relation to the whole LDV fleet) already in 2025 and the power requirement per BEV would those be only 1 kW.

However, they are significantly higher in the years leading up to 2030. This is due to higher targets in member states with very low EV adoption rates. While the EV share in many member states - in particular in Northern- and Western Europe - will be relatively high in the later half of this decade, the uptake will be most likely delayed in some Southern- and Eastern European member states. Tying the power output to the BEV-share thus prevents a two speed Europe when it comes to charging infrastructure.

This is helpful, as it is likely that the number of used EVs will significantly increase in the later half of the decade and more and more will arrive in countries where the EV share is still relatively low. To date it is, however, difficult to properly assess to what degree second hand EVs will stay within the same country or will be transferred to others. Hence, a moderately overbuilt charging infrastructure, can help to account for this uncertainty.

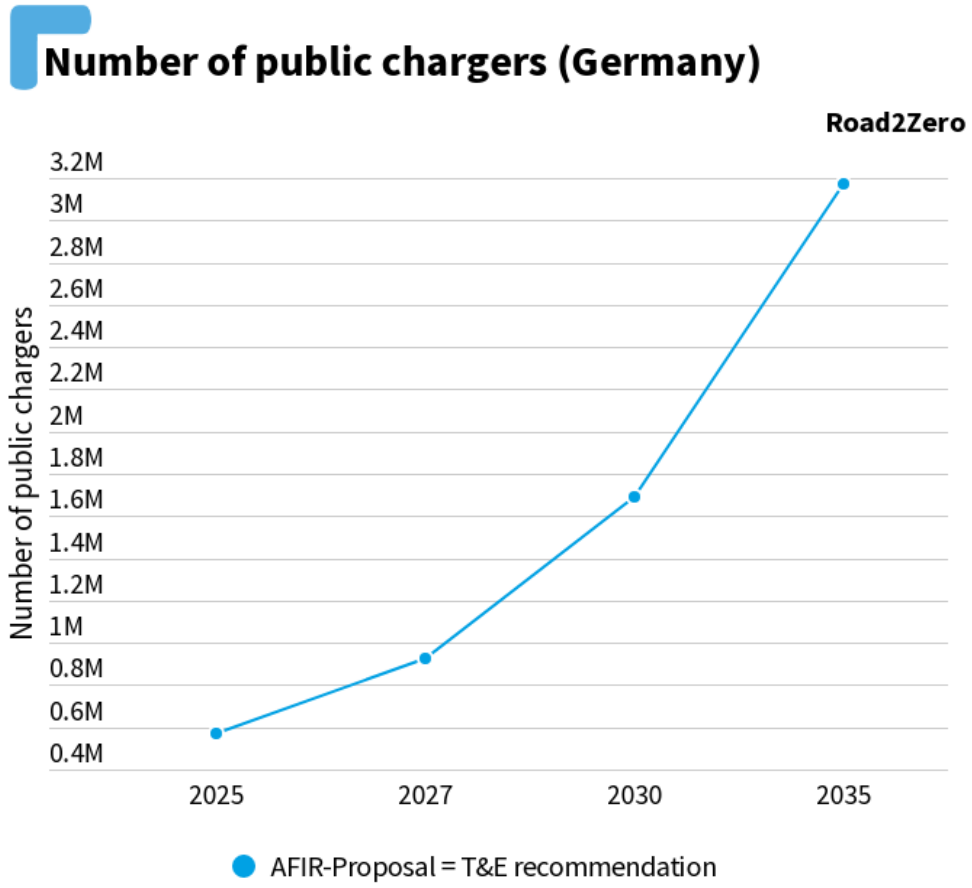
3.3.3. Expected Developments in member states

In this final section of the analysis T&E looked at what the combination of increased CO2-standards and the AFIR proposal would mean for the deployment of public chargers in individual member states. The five countries with the biggest populations in the EU have been chosen: Germany, France, Italy, Spain and Poland. They are also accounting for different EV markets. Countries where the EV uptake is happening relatively fast: Germany and France, countries where the uptake of EVs is on track but not as fast: Italy and Spain and finally Poland as an example of a member state where it is expected that the uptake of EVs will be slower than the average for the the time being. For the purpose of clarity the analysis below only compares the targets as outlined in the AFIR-Proposal and T&E's recommendation. Furthermore only the ENVI CO2-Standard scenario will be analyzed.

Germany

Germany is the biggest vehicle market within the EU. With roughly 50 million light-duty vehicles (cars + vans) registered in 2018 the country accounts for 19% of all LDVs in the EU[26]. While initially not one of the front-runners when it comes to EV adoption, registrations have accelerated significantly in the past years. According to our calculations, following the Road2Zero CO2-reduction pathway, 66% of all LDVs will be BEVs in 2035. According to this scenario Germany would need to install 572,500 public charging points by 2025, around 928,500 by 2027, 1.69 million by 2030 and over 3.17 million in 2035.

[26] Eurostat (2022). Road transport equipment - stock of vehicles. Retrieved from: https://ec.europa.eu/eurostat/web/transport/data/database



Sources: Internal modeling based on BloombergNEF (2021), European Commission (2021c).

Figure 12: Number of public chargers (Germany) - Road2Zero

As EV adoption in Germany is expected to happen fast and T&Es recommendation would thus fully match the Commission's AFIR proposal from 2025 onwards the basic charging infrastructure will be mature enough - if very ambitious CO2-standards (Road2Zero) are adopted.

France

With almost 38 million LDVs registered in 2018, France is home to 14% of all cars and vans registered in the EU. The EV uptake in France is expected to be very similar to that of Germany[27]. The number of charging points required by AFIR would be between 257,000 (following the AFIR-Proposal) and 327,500 (following the T&E recommendation)in 2025, 428,000 in 2027, 836,000 in 2030 and 1.83 million in 2035.

[27] Eurostat (2022).

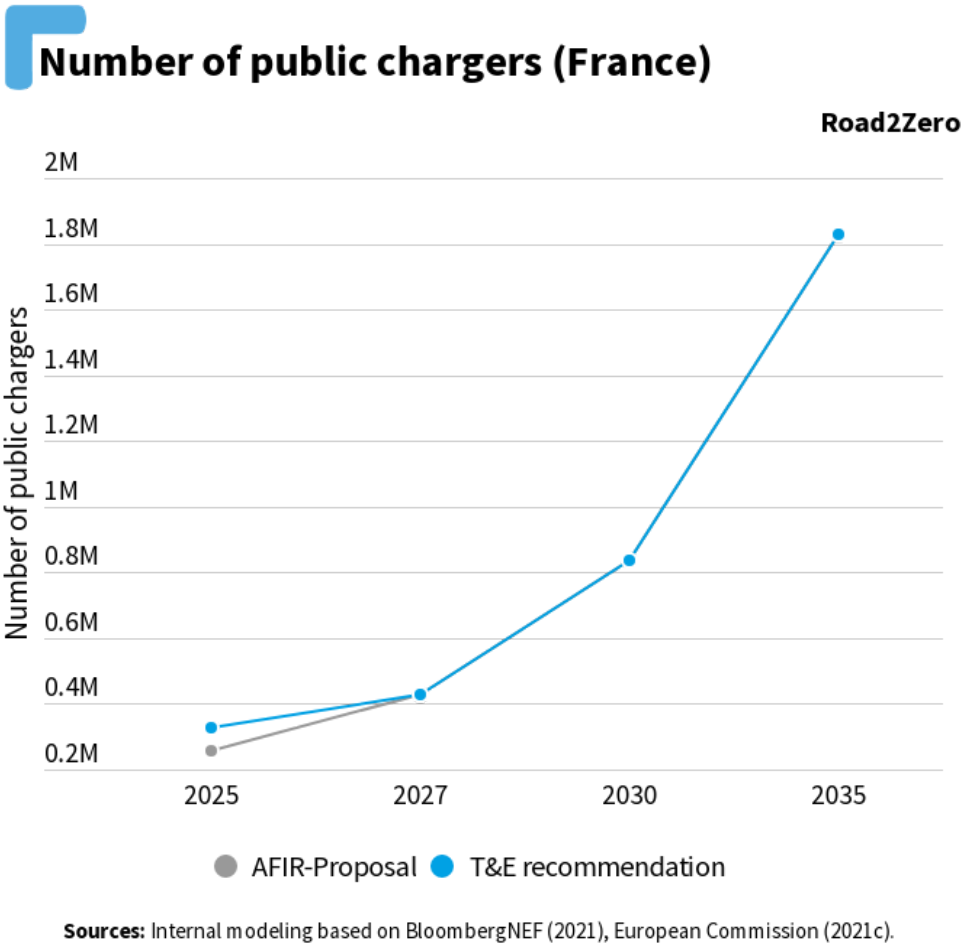


Figure 13: Number of public chargers (France) - Road2Zero

Very similar to Germany, France is one of the countries where EV adoption will happen comparably fast and a mature charging market is to be expected from 2027 onwards, T&E's recommendation and the AFIR-Proposal would thus be aligned after 2027.

Italy

With more than 43 million LDVs Italy accounts for 16% of all registered LDVs in the EU and is thus behind Germany, the country with the biggest fleet of cars and vans.[28] However, the EV share in Italy is expected to grow at a slower pace than that of France or Germany. Hence, Italy is expected to deploy, under the Road2Zero CO2 standard scenario, 119,500 (AFIR-Proposal) to 207,500 (T&E recommendation) public charging points in 2025, 225,000 (AFIR) to 345,500 (T&E) by 2027, 496,000 by 2030 and 1.24 million by 2035.

[28] Eurostat (2022).

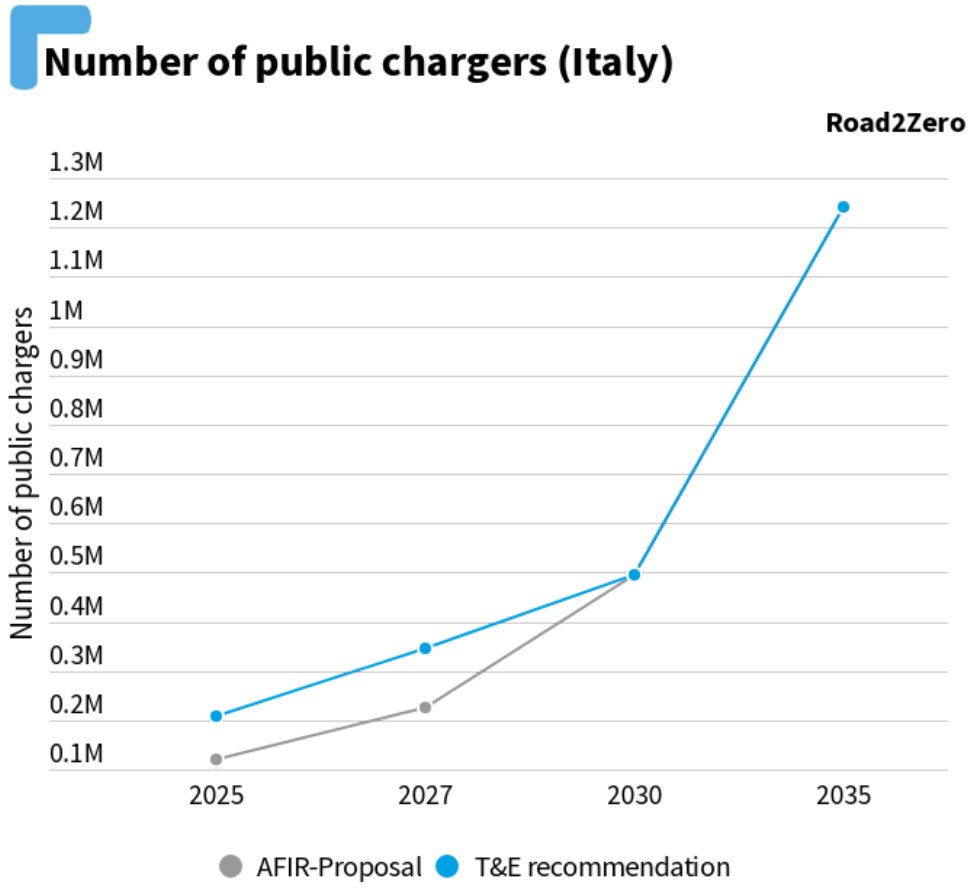


Figure 14: Number of public chargers (Italy) - Road2Zero

Due to a slightly slower EV adoption rate compared to the frontrunners, T&E's recommendation for AFIR would lead to significantly more public charging points for the years leading up to 2030. From there onwards the charging market will be largely mature and T&E's recommended targets would be the same as those proposed by the European Commission.

Spain

Close to 28 million cars and vans were registered in Spain in 2018, or about 10% of the EU's total LDV-fleet.[29] Along with Italy, Spain is part of those countries where EV adoption is already happening on a larger scale but significantly slower than in the Northern European markets. According to our calculations Spain would need to deploy between 97,000 (AFIR-Proposal) and 147,500 (T&E recommendation) public chargers by 2025, 192,000 (AFIR) to 269,000 (T&E) by 2027, 420,500 by 2030 and 978,500 in 2035.

[29] Eurostat (2022).

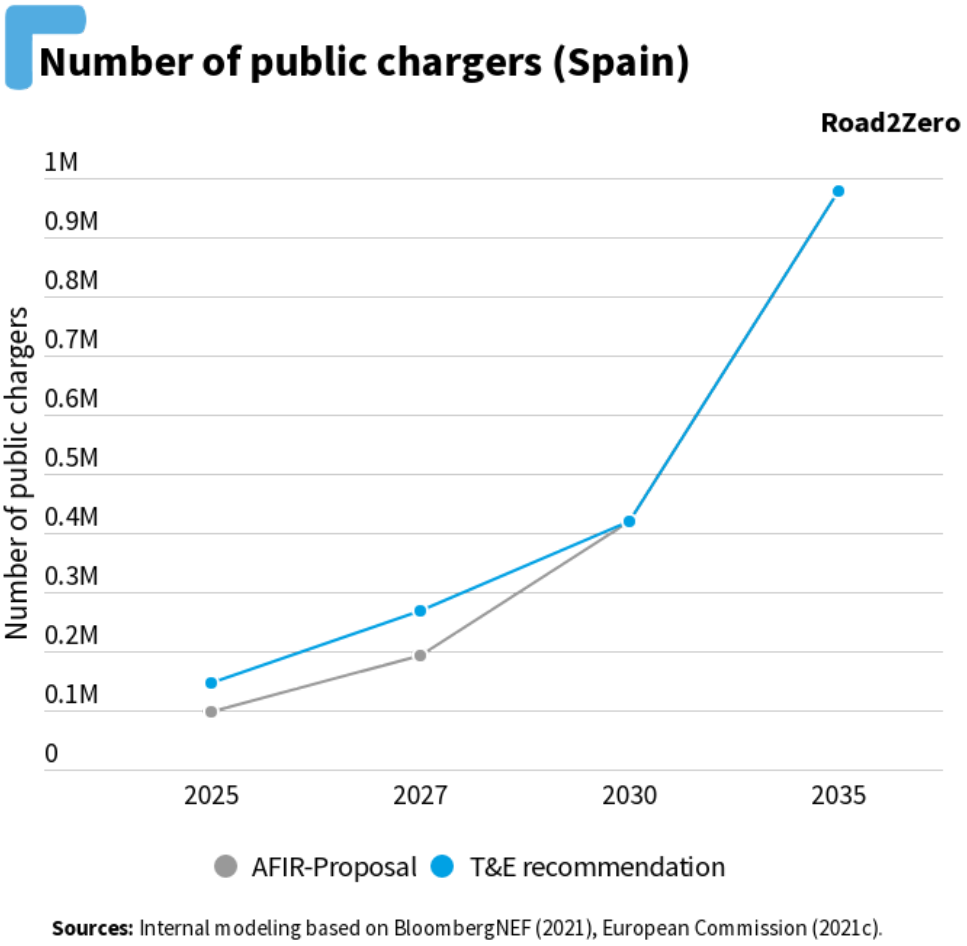


Figure 15: Number of public chargers (Spain) - Road2Zero

Similar to Italy, Spain would need to provide more public charging infrastructure under T&E's recommendation up until 2030 and would only fall back to the AFIR-Proposals targets after that.

Poland

With more than 26 million cars and vans Poland has almost the same amount of LDVs registered in its territory as Spain and accounts for another 10% of the EU's total LDV-fleet.[30] However, according to T&E's estimations the uptake of EVs will be significantly slower in Poland than in the other analyzed countries. According to our estimations Poland would, following the CO2 reduction pathway as recommended by T&E (Road2Zero), need to deploy between 27,000 (AFIR-Proposal) and 48,500 (T&E recommendation) public chargers in 2025, between 59,000 (AFIR) and 101,500 (T&E) in 2027, 139,500 (AFIR) to 221,000 (T&E) in 2030 and 355,500 in 2035.

[30] Eurostat (2022).

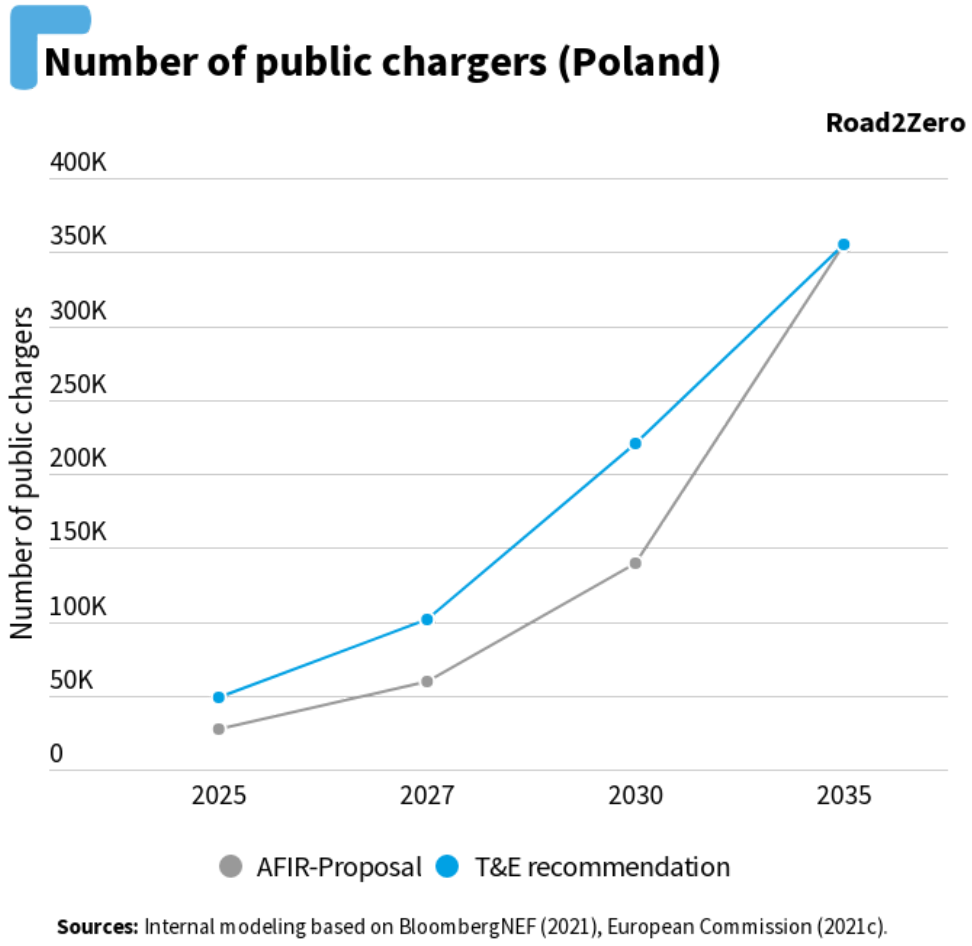


Figure 16: Number of public chargers (Poland) - Road2Zero

Since the EV share in Poland will only start to significantly increase past 2030, T&E's recommendation would require the country to build significantly more public charging infrastructure than would be required by the Commission's AFIR proposal. The Polish charging market is thus expected to reach maturity only in the mid of the next decade. However, it has to be acknowledged that it is to date difficult to estimate how many used EVs will leave the country of their first registration and end up in other countries. Hence, it maybe possible that the number of EVs in Poland could be significantly higher already towards the end of this decade . In any case the 'fleet based target' approach will make sure that enough public chargers will be available to supply the required energy of any given EV fleet.

3.3.4. Different fast/slow charger split - sensitivity analysis

As noted earlier the assumed split between fast and slow chargers is based on the assumptions of the Commissions AFIR Impact Assessment, resulting in a long term share of fast chargers of around 5% (long term: only assuming charging infrastructure for BEV). In the actual proposal there is however, no specification as to where member states should put the infrastructure - apart from the distance based targets for the TEN-T road network. Not being too prescriptive is sensible given that the public charging

needs and user profiles can be very different across the member states. Different factors such as the size of the country, the population and/or traffic density, access to private charging etc.

In more mature EV markets we already see a stark difference today. While in the Netherlands and Belgium the share of fast chargers (>22 kW power output) is around or slightly below 5%, it is at 9% in France and 17% in Germany.[31]

T&E has thus conducted a further analysis on how the number of public chargers would develop using assumptions T&E has used in previous works on charging infrastructure. This scenario is assuming that only 52% (vs. 57%) of charging energy will originate from normal chargers and 48% (vs. 43%) from fast chargers. Furthermore, a higher nominal power output for normal chargers of 10 kW is assumed along with a significantly lower nominal power output for fast chargers of 100 kW. Using these numbers would result in a long term share for fast chargers of 8.5%.

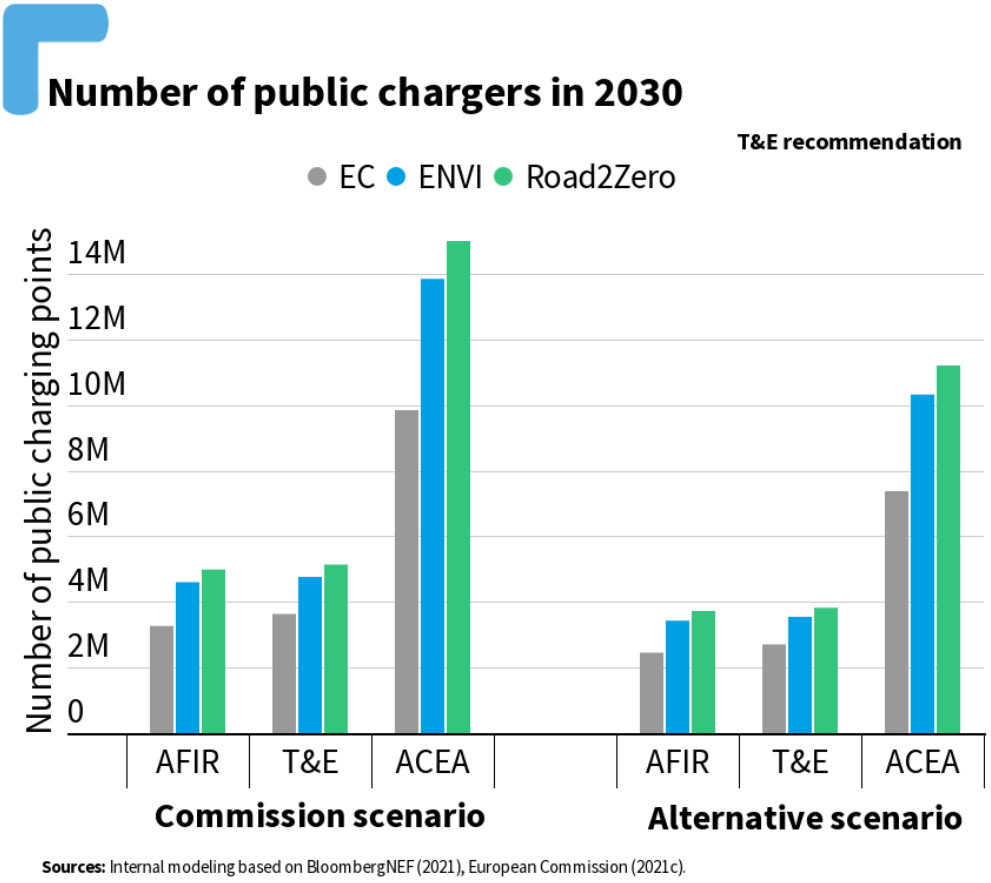


Figure 17: Number of public chargers in 2030 - alternative scenario

[31] EAFO (2022).

4. Conclusions and Recommendations

The accelerating market penetration of EVs and the deployment of public charging infrastructure is happening almost everywhere in Europe at the same pace today. 62% of public chargers are located in those three countries (Netherlands, France, Germany) where 61% of all EVs are currently registered. In member states where EV adoption is happening the fastest we also already see that the utilization rate of the charging network is increasing - a promising development that will ensure that in the long term the public charging networks in all EU member states will eventually be self-sustaining systems that will not require any additional public support.

The 'fleet based' target proposed in the AFIR is a solid way to ensure that the uptake of public charging infrastructure is always in line with the increasing numbers of EV registrations. However, it is important to ensure the right level of ambition. This ambition must ensure that the infrastructure deployment provides a sufficient minimum network in each EU member state. It must however also ensure that public charging networks can eventually be operated in an economically viable way. Evidence shows that the role of public charging is often exaggerated, as private charging will account for the lion's share (60 - 85%). It can also be expected that the efficiency of EVs will increase over time and the average energy consumption per 100 km will decrease. Aggregating these factors shows that the 1 kW per BEV target, proposed by the European Commission, is sufficient for public charging markets that have reached a certain level of maturity. It would however be sensible to increase the targets in the short to medium term.

The recommendations of the automotive industry however, would most likely produce a vast number of stranded assets as they would essentially triple the public charging infrastructure in the EU. While this is also a waste of resources it impedes the development of the charging industry and could transform public charging into a business that would need to be financed and indirectly operated by member states.

The pathway of the EV uptake will be largely determined by the level of ambition of the CO2-standards for cars and vans. In this paper T&E has modeled different pathways and what they would mean in terms of the total number of public charging points. What this analysis has shown is that the methodological design of the AFIR will guarantee a sufficient number of charging points for whatever amount of EV's will be on EU-roads in this and the coming decade. The analysis also shows that the Commission's AFIR ambition is sufficient for a phase out. However, to ensure that the uptake of EVs is as smooth as possible and to ensure that EV usage is equally simple throughout the EU T&E advocates for targeted modifications of the proposal.

T&E recommendations for AFIR

T&E recommends linking the 'fleet-based' charging infrastructure targets to the BEV-share in a country's fleet in a more differentiated way than the Commission proposes, as well as adding an absolute minimum target as a safeguard mechanism in countries with low EV penetration to enable growth. This will make sure that member states with a relatively low EV-share in their total vehicles fleet are obliged to provide sufficient infrastructure until their public charging markets reach a certain maturity:

- The minimum power output per BEV in the fleet-based targets should be set as follows:

    - If the share of battery electric cars in the fleet is less than 1%, member states should guarantee 3 kW per BEV of public charging;
    - If the share is
    - <1 - 2.5% ➜ 2.5 kW;
    - < 2 - 5% ➜ 2 kW;
    - < 5 - 7.5% ➜ 1.5 kW;
    - above 7.5% ➜ 1 kW.
- Regardless of the BEV share, each member state should provide the minimum charging infrastructure sufficient for at least 2% EV-share in 2025, 5% in 2027 and 10% in 2030.

A final compromise on the law should also ensure that the distance based charging targets, which are subordinate to the 'fleet-based' targets, should apply for the entire TEN-T road network (TEN-T Core and Comprehensive) to ensure seamless travel throughout the EU from 2025 onwards.

Furthermore, AFIR should enable cars to charge where they park and especially enable people in urban areas without any access to private charging to charge their EV by making it mandatory for medium and large commercial properties to equip 15% of their parking spaces with publically accessible chargers.

Private charging - Energy Performance of Buildings Directive (EPBD)

This paper is analyzing public charging needs. However, charging will happen predominantly at private chargers. The EPBD proposal is the key law to address private charging. T&E sees a clear improvement in the Commission's new proposal when taking into account the requirements of the directive that is currently in force, namely ambitious requirements for new buildings and buildings undergoing major renovation – with all parking spaces having to be 'EV-ready' and pre-cabled for possible future charging points.

The proposal is however, weak when it comes to requirements for existing buildings - especially existing residential buildings - which make up the vast majority of all buildings in the EU. T&E thus recommends to have pre-cabling requirements for all parking spaces for all existing buildings (>3 parking spaces) at the latest by 2035 with intermediate targets of 15% in 2027 and 30% in 2030. For publicly owned or occupied buildings all parking spaces should already be pre-cabled by 2030 at the latest.

Furthermore, for all existing non-residential buildings (>10 parking spaces) at least 15% of all parking spaces should have an installed charging point by 2030 and 30% by 2035. New non-residential buildings and those undergoing major renovation should have a charging point for every second parking space as a minimum.

Last but not least, to lower the entry barriers to e-mobility, the EPBD should guarantee a 'right to plug' that would ensure that the latency between the application for a private charging point and the actual installation is no longer than three months.

EV-charging infrastructure, public and private, is an important variable on the way to a zero-emission road transport sector. Private charging will, however, play a more important role than commonly assumed policy makers should ensure that the deployment of private chargers can happen as smoothly as possible. For public charging the expected approach of the AFI regulation will always ensure that the deployment of chargers will always happen in line with the uptake of EVs.

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Annex

Table 3: Number of public chargers - AFIR-Proposal[32]

EC	2025	2027	2030	2035	ENVI	2025	2027	2030	2035	R2Z	2025	2027	2030	2035
Austria	33000	50500	99500	237500		38500	68000	139000	282500		42500	71000	141000	284500
Belgium	47000	69500	124000	335000		52500	90500	175000	407000		57500	101000	203000	442000
Bulgaria	500	1000	3000	12000		1000	2500	6000	18000		1000	2500	7000	20000
Croatia	1500	2500	5000	20500		2000	4500	10500	29500		2000	4500	11500	32500
Cyprus	500	500	1500	5000		500	1000	2500	7000		500	1000	3000	7500
Czech Republic	7000	13000	31000	116000		11500	25500	56500	149500		12500	28000	65500	164000
Denmark	37500	55500	103000	203000		41000	68500	121500	220000		48000	76500	129000	227000
Estonia	500	1000	2000	9500		1000	2000	4500	13500		1000	2000	5500	15000
Finland	15500	23000	42000	87000		17000	28500	52000	98000		19500	31500	55000	101000
France	204500	307000	567000	1439000		231000	398500	777000	1730500		257000	428000	836000	1828000

[32] Energy delivered normal chargers: 57%, average power output normal charger: 7.7 kW, energy delivered fast chargers: 43%, average power output normal charger: 130 kW

Germany	448500	668000	1226000	2661000		492500	843000	1603500	3072000		572500	928500	1690000	3170000
Greece	5000	8500	19000	62000		8000	15500	32500	79000		8500	17500	38000	85500
Hungary	5000	8000	17000	62500		7500	14500	31500	84500		8000	15500	35500	91500
Ireland	9000	14000	28000	77500		10500	18500	39000	91000		12000	21000	42000	95000
Italy	85000	127000	251500	866500		113500	210500	435000	1143500		119500	225000	496000	1242000
Latvia	500	500	1500	5500		500	1000	3000	8000		500	1500	3000	9000
Lithuania	1000	1500	3500	13500		1500	3000	7000	20000		1500	3000	8000	22000
Luxembourg	5000	8000	14500	35000		6000	10000	19500	41500		6500	10500	20500	43000
Malta	500	500	1000	4000		500	1000	2000	5000		500	1000	2500	5500
Netherlands	64000	95500	177500	355000		74000	128000	227000	403000		81500	136500	235000	411000
Poland	15500	27500	65000	247500		25000	54000	121000	325000		27000	59000	139500	355500
Portugal	20500	30500	54500	140500		23000	38500	74000	166500		26000	42000	79500	175000
Romania	5500	8500	16500	58500		6500	13000	28500	79500		7000	13500	32500	87000
Slovakia	2500	4500	11000	43500		4000	9500	21000	58000		4500	10000	24000	63500
Slovenia	1500	2500	6500	25500		2000	5000	12500	35000		2000	5000	13500	38000
Spain	61000	96000	208500	699000		90000	174000	362500	900000		97000	192000	420500	978500
Sweden	76500	113500	191000	345500		87500	144500	235000	388000		98500	160000	251500	404500

EU-27	1154000	1737500	3269000	8167000		1349500	2373500	4600000	9855500		1514000	2587500	4988500	10398000

Table 4: Number of public chargers - ACEA recommendation[33]

EC	**2025**	**2027**	**2030**	**2035**	**ENVI**	**2025**	**2027**	**2030**	**2035**	**R2Z**	**2025**	**2027**	**2030**	**2035**
Austria	99000	151500	299500	713500		116500	205000	417500	847500		127500	214000	423500	853500
Belgium	142000	210000	374500	1011000		158500	273000	528500	1226500		174000	304500	612500	1332000
Bulgaria	1500	3500	8500	36500		3000	7500	18500	54000		3000	7500	21000	59500
Croatia	4000	7000	15000	61000		6000	13500	31000	88000		6500	14000	35000	97500
Cyprus	1000	1500	4000	15500		1500	3000	7500	21000		1500	3500	8500	23000
Czech Republic	21500	39000	93000	349500		35500	77000	170500	450500		38500	84500	197000	493500
Denmark	113500	168000	310000	610500		124000	207000	366500	662000		144500	231000	389000	683000
Estonia	1500	3000	6500	28500		2500	6000	14000	41000		2500	6000	16000	45000
Finland	46500	69000	126000	262000		52000	86000	157500	294500		58500	94500	166000	304000
France	616500	924500	1708000	4331000		696500	1199500	2338000	5205000		773500	1289000	2516000	5498500

[33] Energy delivered normal chargers: 57%, average power output normal charger: 7.7 kW, energy delivered fast chargers: 43%, average power output normal charger: 130 kW

Germany	1351000	2012000	3692000	8010000		1484500	2537500	4825500	9235500		1724000	2796500	5084500	9528500
Greece	15500	25500	57500	187000		23500	47000	98500	238000		26000	52500	114500	258000
Hungary	15500	24000	51000	188500		22500	44000	94000	254000		24000	47000	107500	276000
Ireland	28000	42500	84000	233500		32000	56000	116500	273000		36000	62500	126500	286000
Italy	255500	382500	757500	2608500		342500	634000	1309500	3440500		360500	677500	1492500	3737500
Latvia	1000	2000	4000	17000		1500	3500	8500	24500		2000	4000	9500	27000
Lithuania	2500	4500	10000	40500		4000	9000	21000	59500		4000	9000	23500	65500
Luxembourg	16000	23500	43500	106000		18000	30500	58500	124500		19500	32500	62000	129000
Malta	1000	1500	3500	11500		1500	3000	6000	15000		1500	3000	7000	16500
Netherlands	192000	286500	533000	1066000		223000	385500	682500	1210500		245500	411000	706000	1234500
Poland	46500	82500	195500	746000		75000	163500	364500	978500		81500	178500	420500	1069500
Portugal	62000	92500	164000	423500		70000	115500	222000	501500		78000	127000	239500	527000
Romania	16500	25500	49500	176000		20000	39500	86000	239500		21000	41000	97000	262000
Slovakia	7500	14000	33500	131000		12500	28000	63500	175000		13500	30500	73000	190500
Slovenia	4500	7500	19000	76500		6500	14500	37000	105500		7000	15000	41000	114000
Spain	183500	290500	629000	2106500		271500	525500	1093500	2710500		293500	579000	1268000	2946500
Sweden	230500	342500	575000	1040000		263000	435000	707500	1166500		296500	481500	757500	1216500

EU-27	3477500	5235000	9847000	24587000		4067500	7148500	13843500	29642000		4563000	7796000	15015500	31272500

Table 5: Number of public chargers - T&E recommendation[34]

EC	**2025**	**2027**	**2030**	**2035**	**ENVI**	**2025**	**2027**	**2030**	**2035**	**R2Z**	**2025**	**2027**	**2030**	**2035**
Austria	44500	50500	99500	237500		52500	68000	139000	282500		57000	71000	141000	284500
Belgium	63000	82000	124000	335000		70500	108500	175000	407000		76000	101000	203000	442000
Bulgaria	1500	3000	6000	22000		2500	6500	14000	25500		2500	6500	13000	20000
Croatia	3500	5000	9000	20500		4500	8000	14500	29500		4500	8000	16500	32500
Cyprus	500	1000	2500	6500		1000	2000	4000	7000		1000	2000	4500	7500
Czech Republic	12500	21000	45000	116000		21000	38000	72500	149500		20000	40500	65500	164000
Denmark	45000	55500	103000	203000		41000	68500	121500	220000		48000	76500	129000	227000
Estonia	1500	2000	4000	9500		2000	3500	6500	13500		2000	3500	7500	15000
Finland	23500	31500	50000	87000		26500	40500	52000	98000		29500	43500	55000	101000

[34] Energy delivered normal chargers: 57%, average power output normal charger: 7.7 kW, energy delivered fast chargers: 43%, average power output normal charger: 130 kW

France	317000	394500	567000	1439000		363000	398500	777000	1730500		327500	428000	836000	1828000
Germany	569000	668000	1226000	2661000		628500	843000	1603500	3072000		572500	928500	1690000	3170000
Greece	8000	14000	29000	77000		12500	24500	48000	79000		13500	26500	55000	85500
Hungary	10500	14500	26500	62500		13500	23500	41500	84500		14000	24500	35500	91500
Ireland	14500	22000	28000	77500		16500	24500	39000	91000		18500	27000	42000	95000
Italy	148000	226500	387500	866500		200500	330500	435000	1143500		207500	345500	496000	1242000
Latvia	1000	1500	3000	5500		1500	2500	5000	8000		1500	3000	6000	9000
Lithuania	2500	3500	6500	13500		3000	7000	10000	20000		3000	7000	11500	22000
Luxembourg	5000	8000	14500	35000		6000	10000	19500	41500		6500	10500	20500	43000
Malta	500	1000	2000	4000		1000	1500	3000	5000		1000	2000	3500	5500
Netherlands	86000	95500	177500	355000		74000	128000	227000	403000		81500	136500	235000	411000
Poland	27500	52500	112500	317500		46000	96500	193000	325000		48500	101500	221000	355500
Portugal	35500	46000	68500	140500		40500	59500	74000	166500		38000	64000	79500	175000
Romania	13500	17500	34500	58500		16000	28000	51500	79500		16500	28500	57500	87000
Slovakia	5000	8000	17000	43500		7000	14500	27500	58000		7500	15500	24000	63500
Slovenia	3500	5500	9500	25500		5000	9000	12500	35000		5000	9500	13500	38000
Spain	93000	152000	293500	699000		139500	250000	362500	900000		147500	269000	420500	978500

Sweden	76500	113500	191000	345500		87500	144500	235000	388000		98500	160000	251500	404500
EU-27	1611000	2095000	3636500	8263000		1883000	2739500	4765000	9863000		1848000	2940000	5134500	10398000

Table 6: Number of public chargers - T&E recommendation (alternative scenario)[35]

EC	**2025**	**2027**	**2030**	**2035**	**ENVI**	**2025**	**2027**	**2030**	**2035**	**R2Z**	**2025**	**2027**	**2030**	**2035**
Austria	32500	37500	74000	176000		38500	50500	102500	208000		42000	53000	104000	209500
Belgium	47000	61500	93500	252000		52500	81000	132000	305000		56500	76000	153000	331000
Bulgaria	1000	2000	4500	16000		1500	4500	10000	18500		2000	4500	9000	14500
Croatia	2500	3500	6500	15000		3000	6000	10500	21500		3500	6000	12000	24000
Cyprus	500	500	1500	5000		500	1500	3000	5000		500	1500	3500	5500
Czech Republic	9000	15500	33000	87000		15500	28000	53500	112000		14500	30000	49000	122500

[35] Energy delivered normal chargers: 52%, average power output normal charger: 10 kW, energy delivered fast chargers: 48%, average power output normal charger: 100 kW

Denmark	33500	42000	77500	151500		31000	51500	91000	163500		36000	57500	96500	169000
Estonia	1000	1500	3000	7000		1500	2500	5000	10000		1500	2500	5500	11000
Finland	17000	23000	37500	65500		19500	30000	39000	73000		21500	32000	41500	75500
France	232000	291500	424000	1074000		266000	297500	578500	1286000		242000	320000	623000	1359000
Germany	421000	500500	917000	1985500		464500	630000	1194500	2279500		429000	695000	1259000	2350000
Greece	6000	10500	21500	57000		9500	18000	35500	59000		10000	19500	40500	64000
Hungary	7500	10500	19500	47000		9500	17000	30500	63000		10000	18000	26500	68000
Ireland	10500	16000	21000	58000		12000	18000	29000	67500		13500	20000	31500	70500
Italy	108000	165000	284500	647500		146500	242000	324500	852000		151500	253500	370500	925500
Latvia	500	1000	2000	4000		1000	2000	4000	6000		1000	2000	4000	6500
Lithuania	2000	2500	4500	10000		2500	5000	7500	14500		2500	5000	8500	16000
Luxembourg	4000	6000	11000	26500		4500	7500	14500	31000		5000	8000	15500	32000
Malta	500	500	1500	3000		500	1000	2000	3500		500	1500	2500	4000
Netherlands	63000	71000	131500	262500		55000	95000	168000	297500		60500	101500	174000	303500
Poland	20000	38000	82000	234500		33500	70500	141000	242500		35500	74500	161500	265000
Portugal	26000	34000	51000	105000		29500	43500	55000	124000		28000	47000	59500	130500
Romania	9500	12500	25000	43500		11500	20000	37000	59000		12000	20500	42000	64500

Slovakia	3500	6000	12500	32500		5000	10500	20500	43500		5500	11000	18000	47000
Slovenia	2500	4000	6500	18500		3500	6500	9000	26000		3500	7000	10000	28000
Spain	68500	112000	217000	525000		103000	184500	272500	673500		109000	199000	316000	732000
Sweden	57500	85500	143000	257500		65500	108000	175000	287500		74000	120000	188000	300000
EU-27	1187500	1554500	2706000	6166500		1387000	2033000	3545500	7332500		1371500	2186500	3824500	7729000