Monitoring the shift to zero-emission vehicles in Europe: Key Performance Indicators for light-duty vehicles

Report for: **European Automobile Manufacturers' Association (ACEA)**

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List of abbreviations

AC	Alternating Current
ACC	Automotive Cells Company
ACEA	European Automobile Manufacturers Association
AFIR	Alternative Fuels Infrastructure Regulation
BEV	Battery electric vehicle
CO_2	Carbon dioxide
DC	Direct Current
DSF	Demand-side flexibility
EAFO	European Alternative Fuels Observatory
EEA	European Environmental Agency
EU	European Union
EV	Electric Vehicle
FCEV	Fuel cell electric vehicle
GHG	Greenhouse gas
ICEV	Internal combustion engine vehicle
IEA	International Energy Agency
KPI	Key performance indicator
kW	Kilowatt
LCV	Light-duty commercial vehicle
LDV	Light-duty vehicle
LFP	Lithium iron phosphate
M1	Passenger vehicle with no more than eight seats (passenger cars)
N1	Vehicles used for the transport of goods having a gross vehicle weight not exceeding 3.5 tons
OEM	Original equipment manufacturer
PHEV	Plug-in hybrid vehicle
PV	Photovoltaic Voltage Solar Panel
TCO	Total cost of ownership
TEN-T	Trans-European Transport Network
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
V2L	Vehicle-to-Load

VDA	German Association of the Automotive Industry
ZEV	Zero emission vehicle

Executive summary

On March 5, 2025, the European Commission unveiled the Industrial Action Plan for the automotive sector, aiming to facilitate the industry's transition to electric vehicles (EVs) and achieve full electrification by 2035. The plan contains five key components: innovation and digitalization, demand stimulation, supply chain competitiveness, labour and skills development and regulatory flexibility.

While the plan sets ambitious goals, some industry stakeholders have expressed concerns regarding its sufficiency and timing. For instance, the Automotive Cells Company (ACC), a French battery manufacturer, welcomed the EU's support but feared that it might come too late to address the current challenges faced by the industry. ACC has slowed its battery production expansion due to uncertainties in EV demand and the emergence of more affordable battery technologies.[1]

In this report, we build on the previous gap analysis by introducing a set of key performance indicators (KPIs) designed to track the European automotive's sector progress toward zero-emission mobility. These KPIs will be reviewed quarterly, providing policy makers and industry leaders timely insights to identify challenges and adapt strategies accordingly.

The KPIs focus on four critical roadblocks:

- Electricity grid – can it handle the growing demand for EV charging?
- Consumer perspective – are EVs affordable, accessible, and attractive enough for widespread adoption?
- Charging infrastructure – are there enough charging stations, in the right place and with sufficient capacity?
- Manufacturer perspective – are energy prices competitive and is battery production capacity keeping pace with demand?

The KPIs are calculated at the country level and discussed in detail in the main report. In this executive summary, we focus on European averages for each indicator, which are assessed using a traffic light system – green, orange or red – based on their distance from the target. The targets, along with the methodology used to assign traffic light colours, are explained in Annex 3. The targets align with Europe's objective of ensuring that all new passenger cars and light commercial vehicles (LCVs) are zero-emission by 2035.

Readiness of the electricity grid

The increasing adoption of EVs poses significant challenges to Europe's aging electricity grid. Integrating renewable energy is essential for managing the overall rise in electricity demand – particularly during peak periods. Since EV charging can cause sudden spikes in demand, the widespread implementation of smart charging and time-of-use pricing across Europe is necessary. Additionally, demand-side flexibility plays a critical role in accommodating the variable output of renewable sources, enabling energy storage through vehicle-to-grid (V2G) technology, and supporting grid-balancing services. In this way, EVs become not only consumers of electricity but also valuable assets that enhance grid stability.

[1] https://www.reuters.com/business/autos-transportation/french-battery-maker-acc-welcomes-eu-auto-sector-support-fears-its-too-late-2025-03-06/

Overall, the European electricity grid is not yet prepared to handle the projected increase in electricity demand resulting from the electrification of the light-duty vehicle fleet. All European countries fall short of meeting the requirements for solar panel installations.

Furthermore, the grid is not ready for smart charging. Although smart meter penetration is high in several countries—such as Spain, Italy, and the Scandinavian nations—others, including Germany, Hungary, Poland, and Belgium, still have a very low share of installed smart meters. Only 12% of vehicles available in the European market are V2G-ready, while the target requires a share of 50%. Dynamic electricity pricing is currently widespread only in Norway, Estonia, Finland, and Sweden. In most other European countries, fixed-price electricity contracts remain the standard. Additionally, many countries lack a robust framework for demand-side flexibility. Around half of the countries still apply double taxation on electricity storage, further hindering progress in this area.

The only indicator receiving a green light is the electricity self-sufficiency ratio. On this front, Europe currently has enough electricity production capacity to meet its consumption needs, with some margin to support storage and manage demand fluctuations.

Electricity grid readiness	Key performance indicator	On target?
Grid stress management	Installed solar capacity per light-duty vehicle	Red
Smart charging readiness	Vehicle readiness for bidirectional charging	Orange
	Smart meter penetration rate	Orange
	Dynamic electricity pricing	Red
	Demand side flexibility	Orange
	Double taxation of electricity storage	Orange
Quality of the grid	Electricity self-sufficiency ratio	Green

Consumer adoption

Consumer adoption indicators show that the uptake of zero-emission vehicles remains well below the levels needed to meet the 2035 target. This gap is particularly pronounced for light commercial vehicles, where new BEV registrations still account for less than 10% of new vehicle sales in most countries.

The number of available models with a retail price below € 30,000 remains relatively limited, with 15 models in the first quarter of 2025. Just three of these were priced below € 20,000. The positive news is that the number is increasing. In our previous report, only 7 models were available below the € 30,000 threshold. The share of BEVs in the second-hand market has also grown since the last reporting period, suggesting improved access for lower-income consumers.

While BEV affordability has improved, it continues to pose a significant barrier, especially in light of reduced or discontinued financial incentives in several countries. Affordability concerns are most acute in the mini and small car segments and for consumers who depend on the public charging network. These challenges disproportionately affect low-income households, raising the risk of inequality in access to electromobility. This underscores the need for targeted measures to address mobility poverty, such as widespread adoption of social leasing schemes and capped public charging prices for those without access to home charging.

Consumers	Key performance indicator		On target?
Availability	Share of ZEV passenger cars in new registrations		🔴
	Share of ZEV light commercial vehicles in new registrations		🔴
	Number of available models ≤ € 30 000		↗
	Share of ZEV in second hand market		↗
Affordability	BEV to ICEV energy cost ratio	Private charging	🟢
		Public slow charging	🟠
		Public fast charging	🟠
	BEV to ICEV Total Cost of Ownership	City cars	🟠
		Small car	🟠
		Medium car	🟠
		Large car	🟢
	Battery prices		🟠
	Hydrogen prices		🔴

Recharging and refuelling infrastructure

Key performance indicators for recharging and refuelling infrastructure present a mixed picture. All European countries currently meet the AFIR-based charging capacity targets, as well as the more ambitious and dynamic targets set by the ICCT. Additionally, there are now more public charging stations than gas stations across Europe. However, this figure is heavily skewed by a few countries (the Netherlands, France, and Germany) which have a particularly high number of charging points. In 18 of the EU-27 countries, the number of public charging stations still falls below the number of gas stations.

Despite meeting capacity targets, several consumer surveys show that BEV drivers often perceive the public charging infrastructure as inadequate. Prospective BEV buyers also cite insufficient public charging as one of the main barriers to adoption. This apparent contradiction can be explained by the significant disparities in charging point density. While some regions have high coverage, others, particularly in southern Italy and parts of Eastern Europe, remain underserved.

Moreover, the share of fast-charging stations in Europe is relatively low compared to other major EV markets such as China and the United States. This limited availability of fast chargers results in longer charging times and leads to queues at charging stations, which can discourage potential buyers.

As for hydrogen refuelling infrastructure, most countries remain far from meeting the AFIR target of at least one hydrogen refuelling station every 200 kilometres along the TEN-T network.

Infrastructure	Key performance indicator		On target?
Recharging infrastructure	Public charging capacity per EV	AFIR Target	🟢
		ICCT Target	🟢
	Number of public charging stations		🟢
	Recharging infrastructure deployment disparities		🔴
	AC/DC split	US Target	🟠
		China Target	🟠
Refuelling infrastructure	Number of hydrogen refuelling stations per 200 km TEN-T		🔴

Manufacturing: battery supply chain and energy costs

European automobile manufacturers face two major challenges in the transition to electric vehicles. First, the electricity cost price gap with China and the United States places them at a competitive disadvantage, as higher energy prices in Europe increase production costs, making it harder to compete with manufacturers in lower-cost regions. Second, Europe currently has limited EV battery production capacity, increasing reliance on imports and exposing the industry to supply chain risks and higher costs. Addressing these issues is essential to strengthen the global competitiveness of Europe's automotive sector.

The industrial electricity price gap is assigned a red light because European prices were 151% higher than those in the US and 114% higher than in China. A study by the IMF (2025) highlights the importance of an integrated European energy market. An integrated energy market at European level will not only significantly lower prices, it may also improve EU energy security and help to further reduce CO_2 emissions.

Currently, China accounts for more than three-quarters of global battery production. Chinese batteries are 20% to 30% cheaper than those produced in Europe, which is a key factor behind the lower cost of Chinese EVs compared to their European counterparts (IEA, 2025). European manufacturers are struggling to compete with Asian producers, as highlighted by the recent bankruptcy of Northvolt.

As of 2024, Europe's production capacity for traction batteries remained well below the level needed to equip all light-duty vehicles produced in the region with domestically manufactured batteries. Even when considering planned future capacity, the KPI still falls significantly short of the target.

On a positive note, the European Commission's Industrial Action Plan outlines a clear strategy to strengthen the competitiveness of Europe's battery industry. Its "Battery Booster Package" includes increased financial support for European battery manufacturers and encourages international partnerships to boost production and innovation.

Manufacturing	Key performance indicator	On target?
Energy Costs	Industrial electricity price gap with the USA	🔴
	Industrial electricity price gap with China	🔴
Battery production capacity	Maximum capacity battery production in Europe	🔴

1 Introduction

The European Union (EU) is undertaking an ambitious transition towards zero-emission vehicles (ZEVs) as part of its commitment to achieving climate neutrality by 2050, as outlined in the European Green Deal and the European Climate Law. To meet this goal, the EU aims for all new passenger cars and light-duty commercial (LCVs) vehicles to have zero tailpipe emissions by 2035.

However, as demonstrated in Evers et al. (2024), significant challenges remain in key areas, notably the readiness of the electricity grid, consumer adoption, charging infrastructure and EU battery production. The study provides a comprehensive gap analysis and offers policy recommendations to accelerate the transition to zero emission vehicles. The findings highlight that a successful shift to carbon neutrality for light-duty vehicles requires coordinated action across all four dimensions of the ZEV ecosystem.

This report builds on that gap analysis by identifying key performance indicators (KPIs) to track progress in:

- electricity grid readiness,
- consumer adoption,
- charging infrastructure deployment, and
- European battery production.

Where relevant, clear targets are established for these KPIs, aligned with the EU's objectives of ensuring all new light-duty vehicles are zero-emission by 2035 and achieving climate neutrality by 2050.

Tracking these KPIs is crucial for automakers (OEMs), policymakers, and consumers, as it helps pinpoint areas requiring the most effort and identifies which countries are leading or lagging in the transition to zero-emission mobility. To support timely and effective monitoring, the indicators presented in this report will be updated quarterly.

Unless otherwise specified, the term electric vehicles (EVs) refers to both battery electric vehicles (BEV) and plug-in hybrid vehicles (PHEV). Hydrogen-powered vehicles or fuel cell electric vehicles (FCEV) are considered separately where relevant. The scope of this analysis is limited to light-duty vehicles (LDVs), which include passenger cars and light-duty commercial vehicles (LCVs).

The remainder of this report is structured as follows. Chapter 2 presents the KPIs for assessing the readiness and resilience of the electricity grid. Chapter 3 examines consumer adoption trends for zero-emission vehicles. Chapter 4 provides an overview of the state of the recharging and refuelling infrastructure. Chapter 5 tracks key indicators for the European battery production. The final chapter presents the conclusions.

2 Readiness of the electricity grid

While European grids have generally been reliable and adequate until now, they are increasingly becoming a bottleneck, especially with the emergence of new technologies and shifts in consumer behaviour. Growing grid congestion is making it harder to accommodate new connection requests, and existing infrastructure often lacks the intelligence needed to handle the complexities of digitalized energy consumption and self-production. Furthermore, despite the potential for electrical solutions to be managed effectively, demand-side flexibility and equipment control remain underdeveloped.

We track the readiness of the electricity grid along three lines: grid stress management, smart charging readiness, and the quality of the electricity grid.

2.1 Grid stress management

Installed solar capacity per light-duty vehicle

The co-adoption of electric vehicles (EV) and solar photovoltaics (PV) influences the electric loads of the electricity grid. EVs facilitate the integration of solar generation into the grid by increasing the local consumption of solar electricity and absorbing the solar generation that would otherwise be curtailed (Liang et al, 2022). Additionally, the co-adoption helps with reducing system peak loads because it reduces EV charging during early evening hours.

This means that grid stress will be more manageable if solar panel penetration and EV penetration are growing at a similar rate. When either of these are out-of-balance there risks to be either an overproduction of electricity, or too little production of renewable energy. Especially the latter will become more important during energy transition.

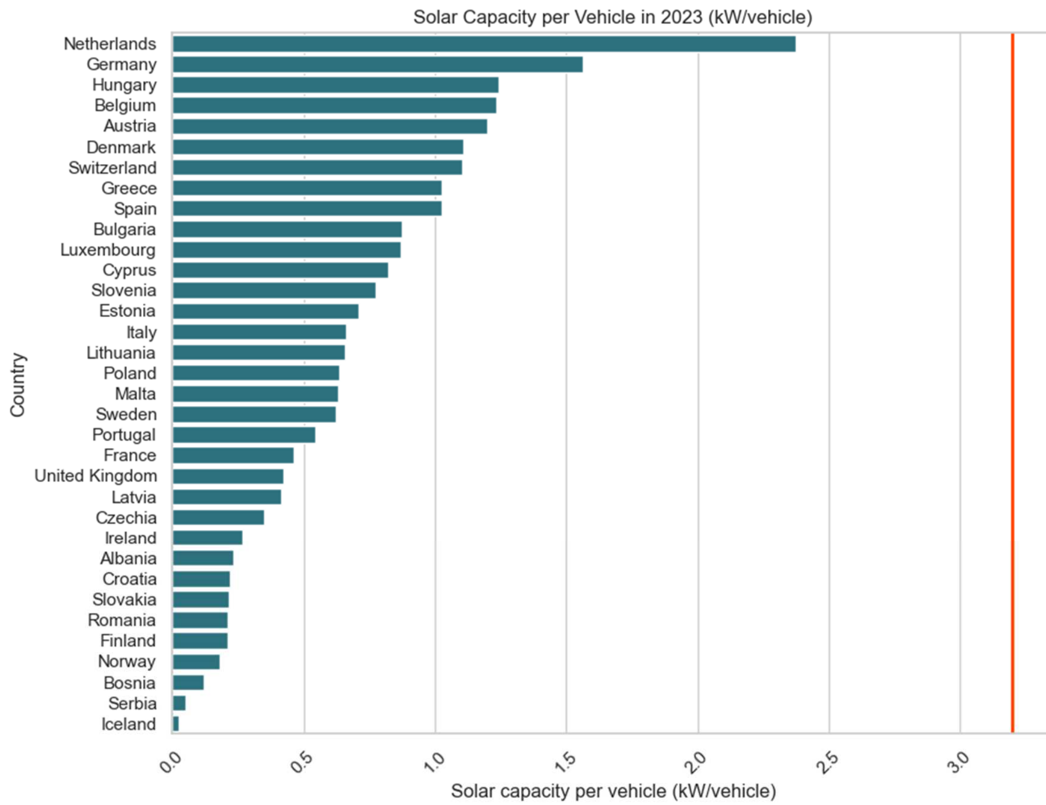
To achieve the net-zero target by 2050, the complete light-duty vehicle fleet should be zero-emission. Therefore, we evaluate the solar panel penetration taking into account each country's light-duty vehicle fleet. The indicator is defined as:

$$\frac{installed\ solar\ capacity\ in\ kW}{number\ of\ passenger\ cars\ and\ LCVs}$$

Based on an annual mileage of 20,000 km per year[2] and an average energy consumption of 160 Wh per km, the average EV requires approximately 3,200 kWh per year to operate. The average solar power generation per year is 1,000 kWh per kilowatt installed capacity in Europe.[3] Therefore, **each car would need 3,200 Watt (3.2 kW) of installed solar capacity to meet its annual energy needs**.

[2] https://www.carvertical.com/en/blog/average-mileage-per-year-in-eu-and-us
[3] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_and_heat_statistics

Figure 2-1 Installed solar capacity (kW) per light-duty vehicle, 2023



Source: Own elaboration based on IRENA and Eurostat

2.2 Smart charging readiness

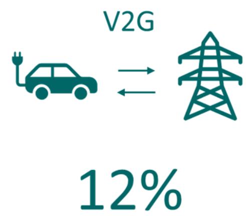
While uncontrolled charging of electric vehicles could stress the electricity grid, implementing smart charging technologies can transform the grid of the future into a more efficient and effective system. We assess the readiness of the European electricity system for smart charging from three key perspectives: vehicle capabilities, charging infrastructure and the legal framework.

Vehicle readiness for bidirectional charging

Vehicle-to-Grid (V2G) enables an EV to send power back to the electrical grid, helping to balance demand and supply. It requires a bidirectional charger and utility company integration. V2G can generate revenue for EV owners through energy trading or incentives.

Figure 2-2 illustrates that by the end of December 2024, **12% of the vehicles supported V2G**. However, the goal is not to equip all vehicles with V2G capabilities. For vehicles with smaller batteries and shorter driving ranges, bidirectional charging is less relevant. Consequently, **the target for this indicator is set at 50%**.

Figure 2-2 Share of the available battery electric vehicles that are V2G ready - December 2024



Source: Own elaboration based on EVdatabase.org

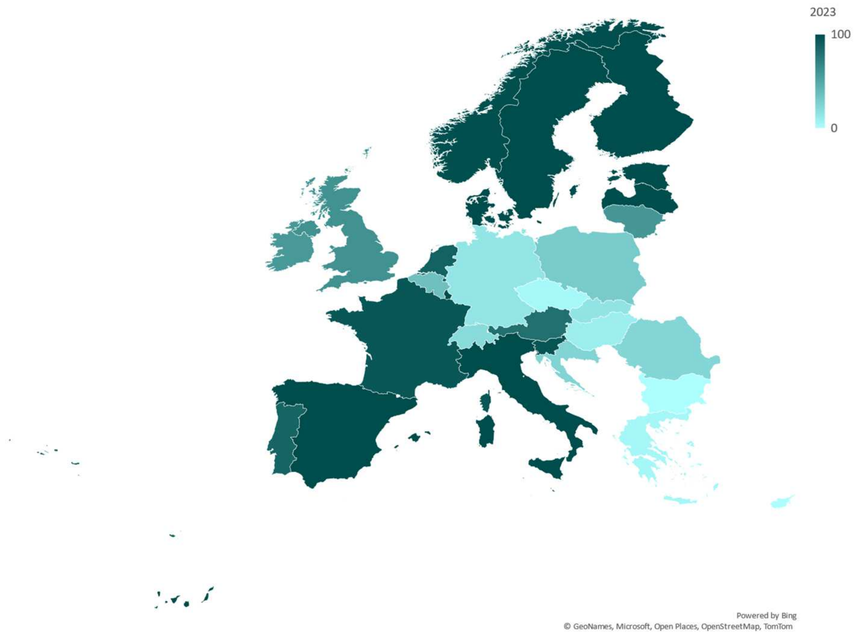
Smart meter penetration rate

Smart meters serve a crucial role in managing the electricity grid with increased low-carbon technology penetration. Therefore, the penetration rate of smart meters is an important indicator of how far EU countries have moved forward on the energy transition. We aim for **a 100% penetration rate of smart meters in Europe**.

In 2023, the smart meter penetration rate across Europe showed significant disparities among countries (Figure 2-3). Denmark, Finland, Italy, Spain, and Sweden achieved full penetration at 100%, while Estonia, Latvia, and Luxembourg closely followed at 99%. Norway maintained a high rate of 98%, while Slovenia and France demonstrated strong progress, reaching 95% and 94%, respectively. The UK (61%), Lithuania (58%), and Ireland (57%) made moderate gains, whereas Belgium lagged behind at 35%.

Eastern European nations exhibited slower adoption, with Poland increasing from 12% to 29% from 2022 to 2023, while Croatia (24%) and Romania (23%) remained relatively low. Switzerland stagnated at 20%, while Slovakia (15%), Germany (14%), Hungary (9%), and Greece (4%) saw only marginal improvements. Czechia (3%), Bulgaria (0%), and Cyprus (0%) remained at the bottom, indicating significant room for development in these regions.

Figure 2-3 Smart meter penetration rate - 2023



Source: REA and ACER

Legal framework for V2G

When it comes to V2G, simply having a technical solution is not enough. The regulatory environment must enable vehicles to interact with the electricity grid (Hecht et al. 2023). However, the legal and economic structures for V2G in Europe are still being developed.

To monitor the progress of regulatory adoption of V2G in Europe, we use three key indicators:

- the **adoption of dynamic electricity pricing**,
- **advancements in demand-side flexibility**, and
- the application of **double taxation of electricity storage**.

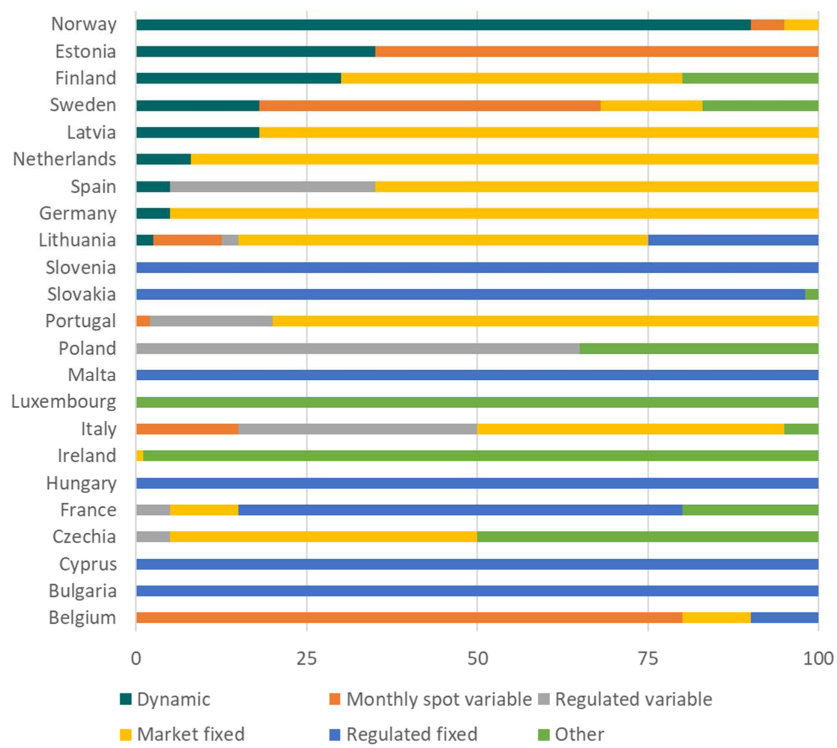
Dynamic electricity pricing

Dynamic electricity pricing, particularly time-of-use pricing, plays a crucial role in promoting the adoption of V2G. Dynamic pricing, offering lower prices during off-peak hours (e.g. nighttime) and higher prices during peak hours (e.g. early evening), ensures EV owners are compensated appropriately, making V2G participation financially attractive.

We assess the progress in dynamic electricity pricing in each Member State by tracking **the share of households that have signed up for a dynamic electricity contract**, as shown in Figure 2-4. Since dynamic electricity pricing relies on smart meter implementation, this indicator is closely linked to smart meter penetration rates.

In 2023, the share of European consumers with dynamic electricity contracts varied significantly across countries. Norway had the highest adoption rate at 90%, followed by Estonia (35%) and Finland (30%). Sweden (18%) and Latvia (18%) also showed notable adoption. In contrast, many countries, including Belgium, Bulgaria, Cyprus, Czechia, France, Hungary, Ireland, Italy, Luxembourg, Malta, Poland, Portugal, Slovakia, and Slovenia, reported 0% adoption, indicating a lack of dynamic pricing options or consumer engagement. Moderate uptake was observed in Germany (5%), Spain (5%), the Netherlands (8%), and Lithuania (2.5%). This disparity highlights differences in market regulations, consumer awareness, and grid flexibility across Europe.

Figure 2-4 Electricity contract uptake of consumers - 2023



Source: ACER Country Sheets

Demand side flexibility

Demand-side flexibility (DSF) refers to the ability of consumers to adjust electricity consumption or supply based on grid conditions, helping balance supply and demand dynamically.

Demand-side flexibility is the foundation for unlocking the full potential of bidirectional charging. It enables smart energy management, maximizes renewable energy use, reduces costs, and enhances grid resilience. Without DSF, the large-scale integration of EVs and V2G would be inefficient, costly, and unsustainable.

Our key indicator tracking demand-side flexibility is based on a comprehensive analysis by LCP Delta and SmartEn, that evaluates the development of DSF in 30 countries based on six quality measures that are scored on a scale from 1 (low score) to 5 (high score):[4]

- Accessibility of DSF in ancillary services
- Accessibility of DSF in Distribution System Operator markets
- Accessibility of DSF in wholesale markets
- Accessibility of DSF in resource adequacy mechanisms

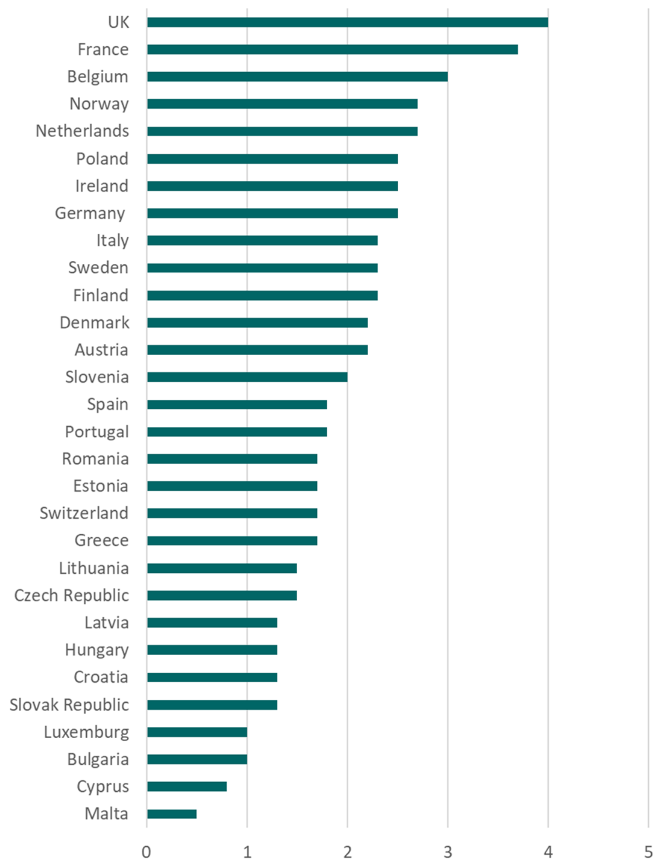
[4] https://smarten.eu/wp-content/uploads/2025/02/Market-Monitor-for-DSF-2024.pdf

- Presence of implicit flexibility
- Future development of the accessibility of DSF.

We aggregate each measure into one DSF indicator. A score of 1 or lower refers to early markets that have not yet established DSF in their electricity system. A score of 3 refers to medium countries that are developing towards more DSF. Countries scoring 4 or 5 are maturing markets that are open to DSF (LCP Delta & SmartEn, 2025).

The ranking of European countries with respect to demand-side flexibility of their electricity markets shows strong disparities between countries (Figure 2-5). The UK and France have the highest accessibility and participation to DSF, while Cyprus, Malta and most Eastern European countries score very low.

Figure 2-5 Demand-side flexibility of the electricity market scored from 1 (low) to 5 (high) - 2024



Source: LCP Delta & SmartEn (2025)

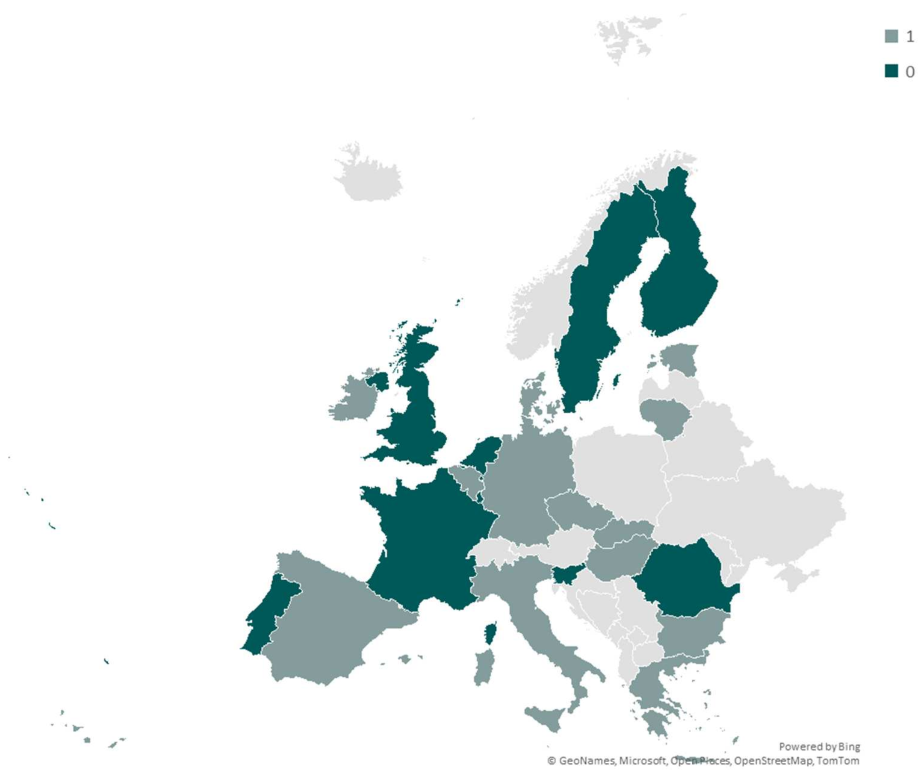
Double taxation of electricity storage

The adoption of bidirectional charging requires a review of the taxation of electricity. In several countries, electricity is taxed when it's drawn from the grid (electricity consumption) and it is taxed again when it is discharged back to the grid (grid usage). Due to this double taxation issue, selling electricity back to the grid is not economically sensible. A possible solution is to reimburse taxes and levies in a way that is proportional to the amount of electricity sold back to the grid. However, this solution is quite cumbersome.

What is actually needed is a reform of electricity taxation to ensure that stored electricity is not taxed twice.

In 2024, double taxation of electricity storage remains a significant issue in many European countries, creating financial barriers for energy storage deployment and bidirectional charging technologies. According to the available data depicted in Figure 2-6, **12 out of 23 countries continue to impose double taxation on stored electricity**. Notably, countries such as Belgium, Germany, Greece, and Spain still apply this form of taxation. Conversely, several European nations, including Finland, France, the Netherlands, Portugal, and Sweden, have removed or avoided double taxation, fostering a more favourable environment for energy storage development. Luxembourg has also taken steps to prevent double taxation, particularly for small-scale photovoltaic installations with behind-the-meter storage. The United Kingdom has recently eliminated VAT on battery storage systems, improving conditions for domestic energy storage.

Figure 2-6 Double taxation of energy storage in Europe - Present (1) or Absent (0) in 2024



Source: European Association of Energy Storage

2.3 Quality of the electricity grid

The quality of a country's electricity network is vital for delivering reliable power and supporting EV charging infrastructure across urban and rural areas. To assess the quality of the electricity grid across European countries, we monitor two KPIs:

- **Electricity self-sufficiency ratio**: measured as the ratio of electricity production to electricity consumption;
- **Transmission network density**: the length of the transmission lines (in km) by population density.

Electricity self-sufficiency ratio

Electricity self-sufficiency, measured as the ratio of electricity production to electricity consumption, indicates how self-sufficient a country is in meeting its electricity demand.

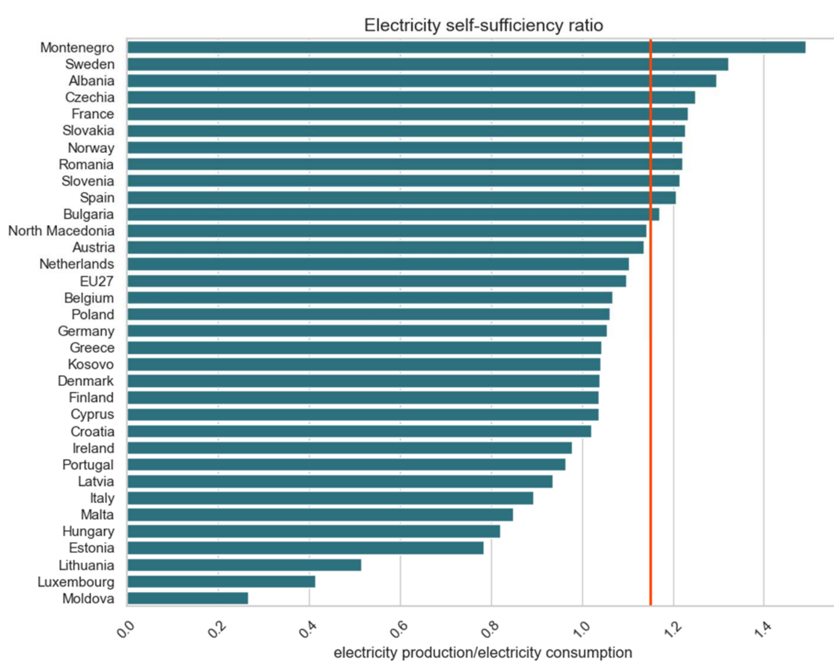
A value close to unity is typically ideal, as it means electricity production is closely matching consumption, ensuring a stable grid without excessive surplus or shortage. A value above 1 indicates surplus production, which can be good for exports or energy security but may also lead to inefficiencies or wasted energy if storage or exports are not possible. A value below 1 suggests that demand exceeds supply, which can lead to shortages, reliance on imports, or potential grid instability.

We determine the **target for this indicator at 1.15**. This allows for fluctuations, storage, and export capacity without excessive waste.

As illustrated in Figure 2-7, electricity self-sufficiency varies across Europe, with some countries exceeding the target of 1.15, while others fall short, indicating a reliance on electricity imports. Overall, the EU-27 is collectively close to self-sufficiency with a value at 1.1. However, several countries fall below self-sufficiency and face a dependence on external electricity source. These countries are Italy (0.9), Malta (0.8), Hungary (0.8), Estonia (0.8), Lithuania (0.5), Luxembourg (0.4) and Moldava (0.3). Heavily import-dependent nations risk energy insecurity, particularly during supply disruptions.

To achieve the 1.15 target, **nations with deficits need to invest in energy production**, particularly renewables and storage solutions, while highly self-sufficient countries should optimize surplus management to prevent excessive waste.

Figure 2-7 Electricity self-sufficiency ratio 2023



Source: Eurostat

Transmission network density

In November 2023, the European Commission published the EU Action Plan to accelerate the roll-out of electricity grids (European Commission COM(2023) 757 final). According to this plan, cross-border transmission infrastructure should double by 2030. An additional 23 GW cross-border transmission capacity will be incorporated in 2025, while a further 65 GW is needed by 2030.

We track the transmission line development by a KPI measuring **the length of the transmission lines in a country relative to its population density**. This KPI highlights the relationship between grid length and population density and helps identifying countries that are underdeveloped.

Setting a universal target for this indicator is challenging because of natural variation in grid lines based on geography. A sparsely populated country (e.g. Norway) naturally needs more transmission lines per capita than a densely populated one (e.g. the Netherlands). Similarly, cities require fewer km of lines per capita due to compact grids, while rural areas need more.

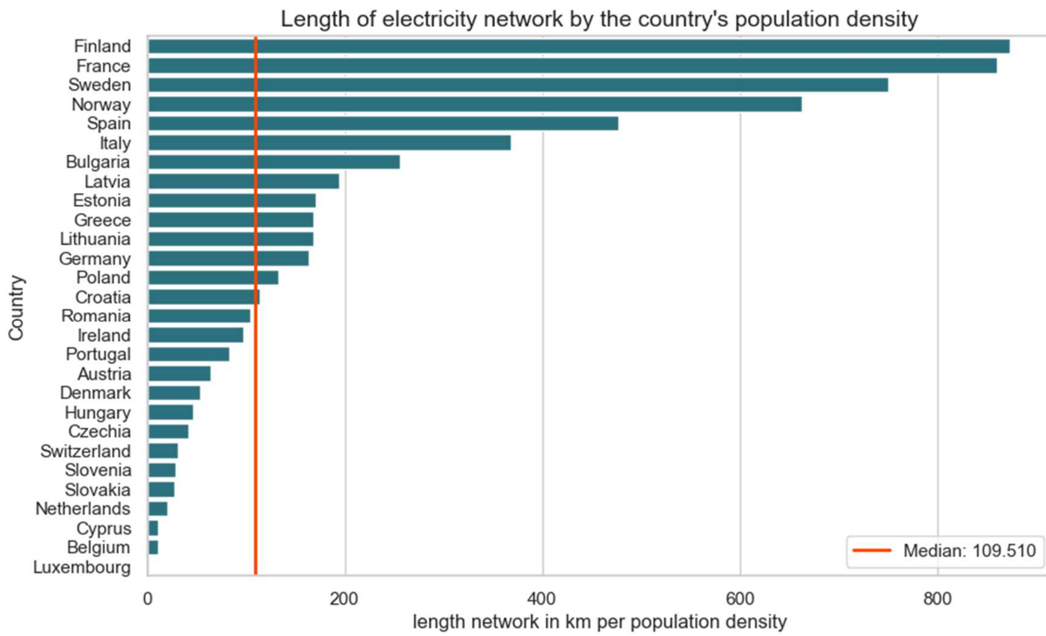
In addition, the length of the transmission network depends on the level of decentralisation of the electricity grid. A highly decentralized grid (with solar power and local microgrids) might require less transmission infrastructure.

Therefore, instead of setting a universal target, we report the **median value** and we will **track changes over time** to ensure the grid expands appropriately with population shifts and energy demand.

France, Finland, Sweden, Norway, Spain, and Italy have extensive transmission networks relative to their population densities (Figure 2-8). These countries generally have large geographic areas and lower population densities, necessitating longer transmission networks. Bulgaria, Germany, Greece, Estonia, Latvia, Lithuania, Croatia and Poland also exceed the median, indicating relatively good transmission coverage.

Czechia, Denmark, Hungary, Slovenia, Slovakia, and the Netherlands have lower transmission network values. This may be due to higher population densities and a compact electricity grid, where long transmission distances are not required. Belgium, Cyprus, and Luxembourg have the lowest values, likely due to small geographic size and high urbanization, reducing the need for extensive transmission infrastructure.

Figure 2-8 Length of the transmission lines (in km) by population density - 2022



Source: Ember and Database.earth

3 Consumer adoption

A successful transition to zero-emission mobility is impossible without a strong consumer demand for zero- and low-emission vehicles. Overall, the consumer adoption of ZLEVs depends on improving availability, affordability, and accessibility, with a need for more diverse and affordable vehicle options, as well as expanded recharging infrastructure.

The progress in the deployment of recharging infrastructure will be covered in Chapter 4. Here, we will focus on the availability of and affordability of ZLEVs.

3.1 Availability

Share of ZEV in new registrations

Regulation (EU) 2019/631 stipulates that all new passenger cars and light-commercial vehicles sold in Europe should be zero-emission by 2035. We track the consumer uptake of ZEVs by monitoring **the market share of BEVs and PHEVs in new vehicle registrations**. The **target for the market share of zero-emission vehicles is 100%,** in line with European Commission's target for 2035.

We classify the EU countries into four groups: [5]

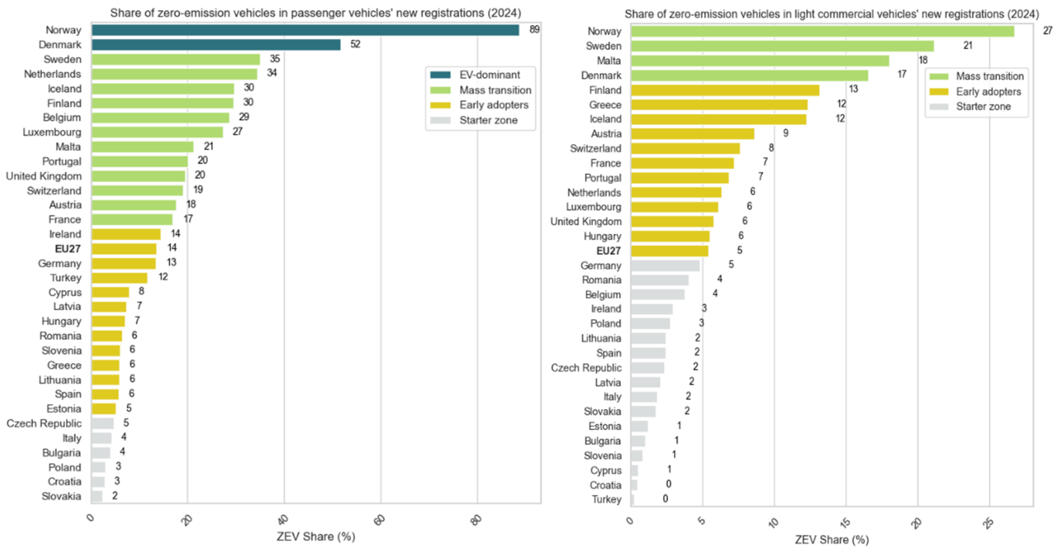
- Starter zone: countries with a ZEV market share in new registrations up to 5%
- Early adopters: ZEV market share between 6% and 16%
- Mass transition: ZEV market share between 16% and 50%
- EV-dominant: ZEV market share above 50%

Figure 3-1 presents the market share of ZEVs in new vehicle registrations for passenger cars (left) and light-commercial vehicles (right) by the end of 2024. For passenger cars, six European countries remain in the starter zone: Slovakia, Poland, Bulgaria, Italy, Czech Republic and Croatia. In these countries urgent action is needed to stimulate the uptake of zero-emission vehicles. In contrast, only two countries– Norway and Denmark – have reached the EV-dominant market phase.

The right side of Figure 3-1 highlights the adoption of ZEVs in the LCV market, which had been significantly slower than for passenger cars. No country has achieved the EV-dominant phase for LCVs, and only four countries have entered the mass-transition phase. In most European countries, the adoption of electric LCVs remains sluggish. This is largely due to challenges such as limited vehicle availability, battery weight constraints, and range limitations, which have been more difficult to overcome compared to the passenger car market.

[5] The International Council on Clean Transportation (ICCT, 2024) demonstrates that the BEV adoption life cycle can be considered as an early market until the new technology reaches a market share of 16%. Above 16% adoption, the technology enters the mainstream market phase.

Figure 3-1 Market share of ZEV in new registrations of light-duty vehicles – end of 2024



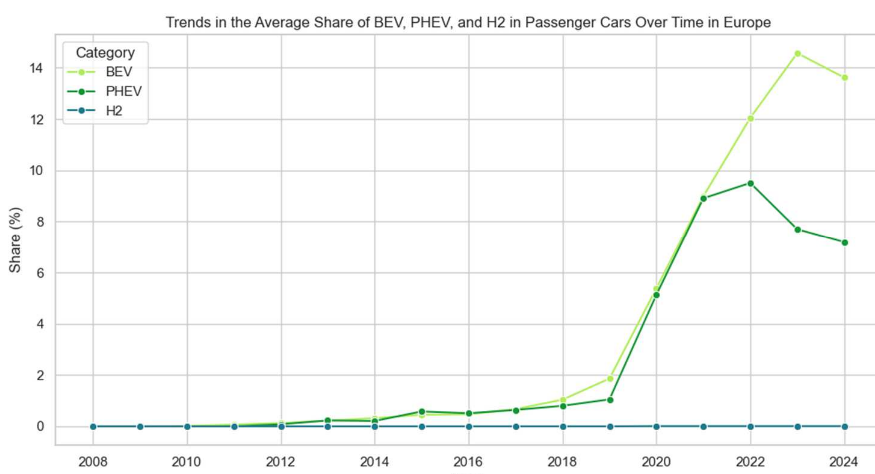
Source: EAFO

Additionally, we track the evolution of BEV and PHEV market shares over time. Time series data and detailed graphs by country can be found in Annex 1.

Figure 3-2 and Figure 3-3 show the evolution of ZLEV adoption rates for passenger cars and light-commercial vehicles in Europe.

For passenger cars (Figure 3-2), two clear trends can be identified. Adoption rates for BEV have increased sharply from 2018 to 2023. As of 2023, the market share of BEV decreased slightly from 14.5% to 13.6%. PHEVs knew a strong increase in market share between 2019 and 2021, but their market share in new vehicle sales declined since then. In 2024, PHEV sales represented a share of 7.2%.

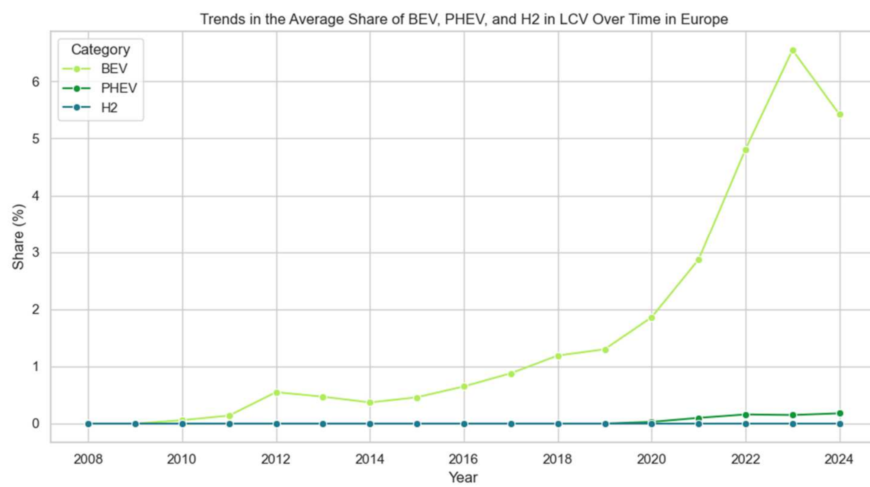
Figure 3-2 Share of ZLEV passenger cars in new car registrations in Europe



Source: EAFO

Figure 3-3 shows that the uptake of zero and low emission light-commercial vehicles in EU-27 countries has been fairly modest. In 2016, BEVs held a modest market share of 0.65%, but this figure steadily increased, reaching a peak of 6.5% in 2023 before slightly declining to 5.4% in 2024. Plug-in hybrid electric vehicles (PHEVs), on the other hand, had no market presence until 2020, when they accounted for 0.03% of the market. Although their share grew marginally to 0.18% in 2024, they remain a minor segment compared to BEVs. Meanwhile, hydrogen fuel cell vehicles (H2) have had no market share throughout the observed period, indicating that this technology has yet to gain traction in the European LCV sector. Overall, market shares for ZLEV LCVs remain well below the EU's ultimate target of 100% zero-emission vehicles by 2035.

Figure 3-3 Share of ZLEV light-commercial vehicles in new LCV registrations in Europe-27



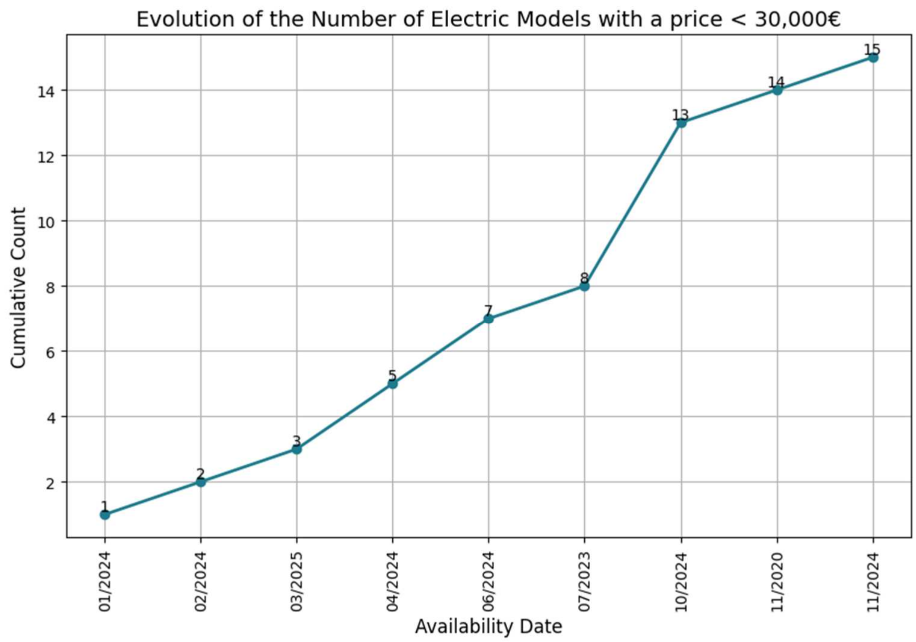
Source: EAFO

Number of available models with a retail price below € 30,000

Numerous surveys indicate that affordability remains the primary barrier preventing consumers from purchasing an electric vehicle. Until recently, the market offered very few budget-friendly BEV models. Evers et al. (2024) report that as of June 2024, only **seven models** priced below € 30,000 were available in Europe.

As shown in Table 3-1 and Figure 3-4, this number has nearly doubled by March 2025, with **15 models** now on the market. Of these, three models are priced below € 20,000, the Dacia Spring Electric 45, Leapmotor T03 and Dacia Spring Electric 65.

Figure 3-4 BEV passenger cars priced below € 30,000



Source: EV-database.org

Table 3-1 Battery electric passenger cars with a retail price below € 30,000 - available in March 2025

Model	Retail Price (approx)	Range (km)
Dacia Spring Electric 45	€ 17,925	165
Dacia Spring Electric 65	€ 19,425	160
Leapmotor T03	€ 19,425	230
Dongfeng Box 42.3 kWh	€ 23,400	255
Citroen e-C3	€ 23,795	260
Hyundai INSTER Standard Range	€ 24,100	250
Fiat Grande Panda	€ 25,500	260
Hyundai INSTER Long Range	€ 25,700	295
Citroen e-C3 Aircross	€ 26,940	250
GMW ORA 03 48 kWh	€ 27,000	260
Renault 5 E-Tech 40kWh 120hp	€ 27,950	250
Renault 4 E-Tech 40kWh 120hp	€ 29,500	245
Opel Frontera 44 kWh	€ 29,750	250
BYD DOLPHIN 44.9 kWh Active	€ 29,990	265
Fiat 500e Hatchback 24 kWh	€ 29,990	135

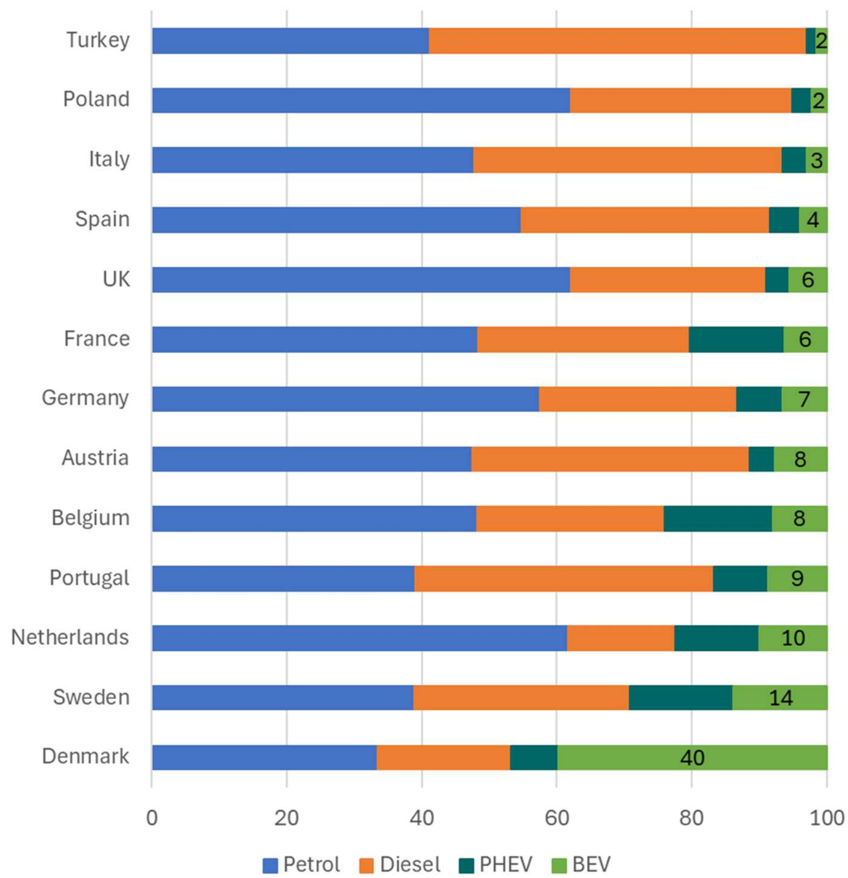
Source: EV-database.org
Note: The approximate retail prices in exclude financial incentives. Actual purchase prices vary across countries due to differences in subsidies, taxes and rebates.

Share of ZLEV in the second-hand market

The development of a robust second-hand market for BEVs is crucial for their mass adoption in Europe. A well-established used BEV market can make electric mobility accessible to a broader segment of consumers who may not be able to afford new models. A thriving second-hand market also helps accelerate fleet turnover, ensuring that early adopters can upgrade to newer, more efficient models while making older BEVs available at lower prices.

Figure 3-5 illustrates the market share of used car sales by fuel type across 13 European countries. Denmark stands out as the only country with a well-established second-hand market for BEVs, where they account for 40% of used car sales. Sweden follows with a market share of 14%. In contrast, Southern and Eastern European countries such as Spain, Italy, Poland and Turkey have particularly low shares of BEVs sales, ranging between 2% and 4%. These low market shares are a natural consequence of the slower adoption of battery electric vehicles in the new car market, as shown in Figure 3-1.

Figure 3-5 Market share of used car sales by fuel type - December 2024



Source: Indicata (2025)

3.2 Affordability

One of the most significant barriers to electric vehicle adoption in Europe is the (perceived) affordability of EVs. While several Total Cost of Ownership (TCO) studies indicate that EVs are as affordable as, or even cheaper than comparable fossil fuel cars (ICEVs) over their lifetime, the high initial purchase price remains a major obstacle for consumers.

The retail price of an EV can differ considerably from the actual purchase cost due to the impact of taxes and purchase incentives. Table 3-2 provides an overview of the incentives and tax benefits for BEVs in 2025.

Compared to the previous year, several incentives have been reduced or discontinued. For instance, the French government ended the scrappage bonus ("prime à la conversion") as of April 2025.[6] Additionally, the maximum purchase subsidy for a BEV ("the eco-bonus") was reduced from € 7,000 to € 4,000.

In Belgium, the € 4,000 purchase subsidy for new zero-emission passenger cars (applicable only in Flanders) was terminated in November 2024, along with the tax reduction for installing charging infrastructure. In the Netherlands, the road tax exemption for BEVs was reduced from 100% to 75%.

At the beginning of 2025, Italy phased out direct incentives for buying electric cars. The long-standing Ecobonus programme, which has supported many citizens in acquiring low-emission vehicles through government subsidies, expired at the end of 2024. Likewise, the 80% purchase subsidy for the installation of private charging infrastructure, available in 2024, was not extended into 2025.

Additionally, the Austrian National Council announced its Budget Restructuring Act on March 7, 2025. Among other measures, it introduced a motor-related insurance tax for electric vehicles and ended the VAT exemption for small photovoltaic systems. These changes came into effect on April 1, 2025.[7]

Conversely, some countries such as Spain have extended or reinforced their financial incentives. Spain recently announced the extension of incentives for electric vehicles and charging infrastructure under its MOVES III programme until the end of 2025.[8]

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[6] https://www.connexionfrance.com/news/one-of-main-aids-to-purchase-an-electric-car-will-end-in-france-in-2025/689653?

[7] https://www.deloitte.com/at/de/services/tax/blogs/2025/breaking-news-budget-restructuring-measures-act-2025.html

[8] La Moncloa. 01/04/2025. The Government of Spain extends incentives for electric vehicles and charging infrastructure [Activity of the Council of Ministers]

Table 3-2 Financial incentives and tax benefits for battery electric passenger cars (BEV) in 2025

Country	Purchase subsidy	Infrastructure grant	Acquisition tax deduction	Ownership tax deduction	Company car tax benefit
Austria	✓	✓	✓		✓
Belgium			✓	✓	✓
Bulgaria				✓	
Croatia	✓		✓	✓	
Cyprus	✓ + S		✓	✓	
Czechia		✓	✓	✓	✓
Denmark		✓	✓	✓	✓
Estonia	✓				
Finland			✓	✓	✓
France	✓	✓	✓	✓	✓
Germany				✓	✓
Greece	✓ + S	✓	✓	✓	✓
Hungary	✓		✓	✓	✓
Ireland	✓		✓	✓	✓
Italy				✓	✓
Latvia			✓	✓	✓
Lithuania	✓ + S	✓	✓	✓	✓
Luxembourg	✓	✓	✓	✓	✓
Malta	✓ + S		✓	✓	
Netherlands			✓	✓	✓
Poland	✓		✓	✓	
Portugal	✓		✓	✓	✓
Romania	✓ + S		✓	✓	
Slovakia			✓	✓	
Slovenia	✓		✓		✓
Spain	✓ + S	✓	✓	✓	✓
Sweden	S	✓		✓	✓
Iceland	✓				
Norway			✓		
Switzerland		✓		✓	✓
U.K.	✓	✓			✓

Note: S stands for a scrappage bonus.
Source: ACEA (2025), Tax Benefits and Incentives

We track the progress in affordability based on the following KPIs:

- Total Cost of Ownership (TCO) parity between BEV and ICEV,
- BEV-to-ICEV energy cost ratio,
- Battery prices, and
- Hydrogen prices

Total Cost of Ownership

To assess affordability, we compute the Total Cost of Ownership (TCO) of passenger cars in five European countries: Czech Republic, France, Germany, Italy and Spain. Several factors strongly influence a vehicle's TCO, including electricity prices, public charging costs and residual values. These variables can vary significantly across regions, further shaping consumer perceptions of EV affordability.

We compare the TCO of a battery electric car with that of a comparable petrol car for four segments:

- A-segment: the smallest category of passenger cars, also called city cars
- B-segment: small cars
- C-segment: medium cars
- D-segment: large cars

Models per segment and per country are selected based on vehicle sales and comparability between ICEV and BEV models. The passenger car models considered in the TCO model are shown in Table 3-1.

Tabel 3-1 Passenger car models in the TCO model

Segment	Country	ICEV	BEV
A - city car	Czech Rep	Dacia Sandero	Dacia Spring
	France	Renault Clio	Renault 4E tech
	Germany	Fiat 500	Fiat 500E 23,8 kWh
	Italy	Fiat Panda	Fiat 500E 23,8 kWh
	Spain	Dacia Sandero	Dacia Spring
B - small car	Czech Rep	Skoda Kamiq	Opel Corsa electric
	France	Peugeot 208 II	Peugeot e-208
	Germany	Opel Corsa	Opel Corsa electric
	Italy	Citroën C3	Citroën ë-C3
	Spain	Citroën C3	Citroën ë-C3
C - medium car	Czech Rep	Skoda Octavia	VW ID.3
	France	Renault Capture	Renault Megane E-Tech
	Germany	VW T-Roc	VW ID.3
	Italy	VW T-Roc	VW ID.3
	Spain	Toyota Corolla	BYD Atto 3
D - large car	Czech Rep	Skoda Kodiaq	Skoda Enyaq
	France	Skoda Kodiaq	Kia EV6
	Germany	VW Passat	VW ID.4
	Italy	Volvo XC40	Audi Q e-tron 45
	Spain	Volvo XC40	Audi Q e-tron 45

The TCO is calculated over a holding period of 5 years and an annual mileage of 15,000 km. For BEVs, we consider three charging scenarios: private charging, public slow charging and public fast charging. The TCO model accounts for the specific fiscal context of each country, allowing us to assess the impact of financial incentives and taxation.

For a detailed explanation of the TCO model calculations and the underlying assumptions, please refer to the Technical Report Total Cost of Ownership Models for Light-Duty Vehicles..

Figure 3-6 presents **the ratio of the TCO of a BEV to a comparable ICEV**. A value below one indicates that the BEV is more cost-effective over its lifetime, whereas a value above one signifies higher costs for the BEV. Hence, **the target for indicator is a value below one**.

Spain is the only country where BEVs are consistently more affordable than their petrol counterparts across all three charging scenarios. Unsurprisingly, BEVs are most economical when charged privately. Public charging—particularly fast charging—significantly increases the TCO.

When comparing across vehicle segments, it is noteworthy that smaller vehicles, such as city cars and small cars, generally exhibit a larger TCO gap compared to larger cars. This is especially pronounced in Italy and Germany, two of Europe's largest car markets, where city cars can have a TCO up to 50% higher than that of a comparable petrol vehicle. This is particularly evident in Italy, where small cars are extremely popular. The best-selling car in Italy is the Fiat Panda, while its electric counterpart, the Fiat 500e, struggles to compete on cost—resulting in significantly lower sales volumes.

The D-segment is the only category where the electric model has a more favourable TCO than the petrol version. While this is encouraging, the affordability of larger cars is generally of less concern, as lower-income consumers tend to rely on smaller vehicle segments.

The following subsections provide a more detailed country-by-country comparison of BEV and ICEV TCOs.

Figure 3-6 BEV-to-ICEV TCO ratio per charging profile - Q1 2025

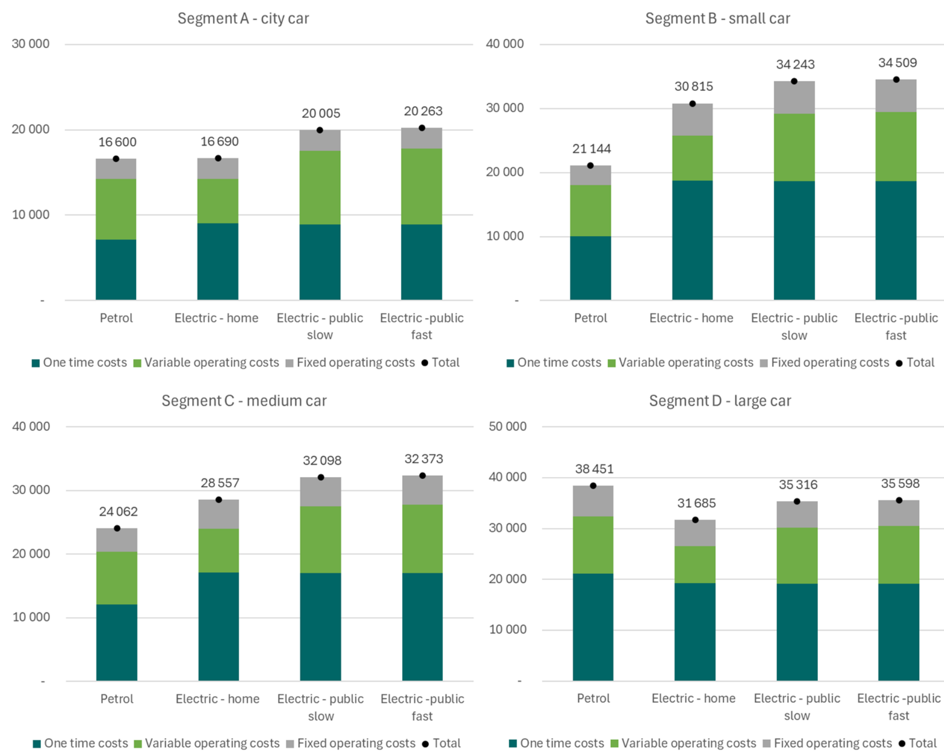
Czech Republic

In the Czech Republic, the TCO of the best-selling A-segment BEVs and ICEVs is nearly equal—provided that the electric vehicle can be charged at home. In this segment, the electric Dacia Spring stands out as one of the most affordable BEVs available on the European market. However, for consumers who rely on the public charging network—which is more commonly the case among lower-income households—the electric A-segment car remains approximately 20% more expensive than its petrol counterpart.

In contrast, BEVs in the B and C segments are consistently more expensive than their petrol equivalents. When charged privately, the TCO of a BEV in these segments is between 19% and 46% higher. If the vehicle must rely on public charging infrastructure, the TCO disadvantage increases dramatically—up to 63% higher than that of a petrol car—rendering the BEV largely uncompetitive in these segments.

For larger vehicles (D-segment), however, BEVs offer a more favourable TCO, with costs ranging from 8% to 12% lower than those of comparable petrol vehicles, depending on the charging method. This advantage is primarily due to the higher energy efficiency of electric vehicles and their lower energy costs.

Figure 3-7 TCO of a petrol car versus a comparable electric passenger car - Czech Republic



France

In France, BEV buyers can benefit from a purchase subsidy that varies according to income. This subsidy, known as the eco-bonus, covers 27% of the vehicle acquisition cost, up to the following maximum amounts:[9]

- € 4,000 for individuals with a reference taxable income of up to € 16,300 per year
- € 3,000 for those with a taxable income between € 16,300 and € 26,200 per year
- € 2,000 for individuals earning more than € 26,200 per year.

However, not all vehicles are eligible for the eco-bonus. Cars with a purchase price exceeding €47,000 are excluded, and there is a clear preference for vehicles manufactured within Europe. A full list of eligible vehicles can be found on the ADEME website.[10]

The median taxable income of buyers of new passenger cars in France is € 29,300.[11] Therefore, in in our baseline calculations, we assume a maximum purchase subsidy of € 2,000.

In addition to the purchase subsidy, BEVs benefit from further tax advantages. They are exempt from both the CO_2 surcharge applied to registration taxes and the vehicle mass tax.

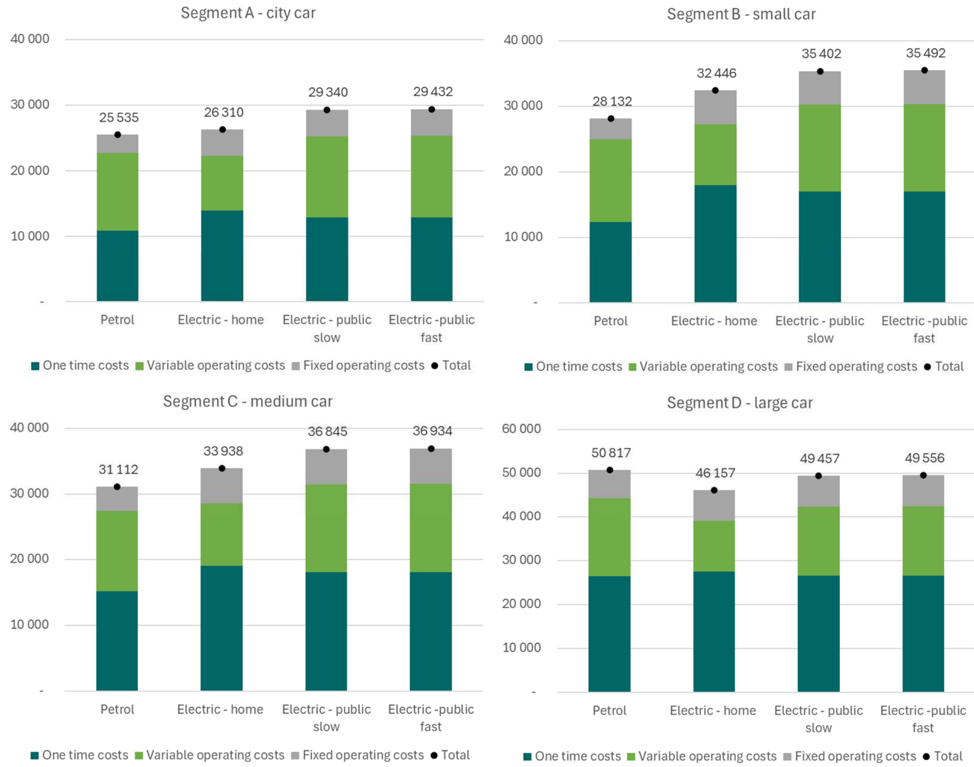
Despite these financial benefits, Figure 3-8 shows that the TCO for mini, small, and medium-sized BEVs still exceeds that of comparable petrol vehicles. In the home-charging scenario, the cost difference is relatively modest, ranging from 3% to 15%. However, in the public-charging scenario, the BEV TCO can be up to 26% higher than that of an ICEV.

That said, for lower-income consumers—those for whom affordability is most critical—the TCO gap is significantly reduced. For instance, a €4,000 subsidy for an A-segment vehicle brings the TCO down to €24,310, which is 5% lower than that of the petrol equivalent.

Moreover, the French government is considering relaunching its social leasing programme, which proved highly successful in 2023. This initiative targeted households with annual incomes of up to €15,400. It received over 90,000 applications within just six weeks, prompting the government to close the programme early. Other studies (e.g., T&E, 2024) have highlighted the significant potential of social leasing schemes to democratize access to electric vehicles across Europe.

[9] https://www.primealaconversion.gouv.fr/dboneco/accueil/media/documents/baremes-bonus-VP.pdf
[10] https://score-environnemental-bonus.ademe.fr/
[11] https://www.statistiques.developpement-durable.gouv.fr/achats-de-deux-roues-et-de-quadricycles-legers-caracteristiques-du-marche-et-des-acheteurs-en-2023

Figure 3-8 TCO of a petrol car versus a comparable electric passenger car - France



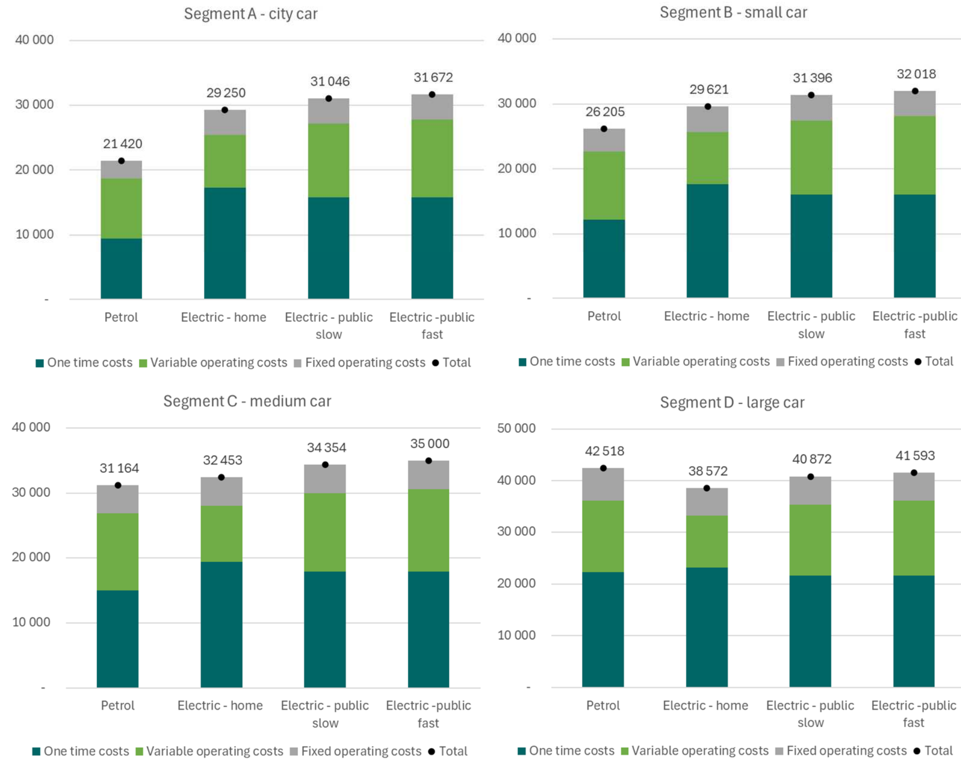
Note: TCO calculations assume a median income of € 29,300, implying a maximum purchase subsidy of € 2,000

Germany

Germany, which had generous subsidies in place for electric vehicles until the end of 2023, now relies primarily on tax benefits and the greenhouse gas (GHG) quota system to support EV adoption. The sudden termination of purchase subsidies, including the environmental bonus ("Umweltbonus"), has significantly affected the affordability of BEVs for many consumers. As a result, there has been a noticeable slowdown in BEV purchases, highlighting the critical role that direct financial incentives play in accelerating the transition to electric mobility (Evers et al., 2024).

As shown in Figure 3-9, an electric car in Germany has a higher TCO than its petrol variant, except for D-segment large cars. This is the case in all charging scenarios, so even when the BEV is exclusively charged at home. This higher TCO is explained by a higher upfront cost for the BEV. The TCO surplus for BEVs ranges from 4% for a C-segment car that is charged privately to 48% for a A-segment car that charges on a public fast charger.

Figure 3-9 TCO of a petrol car versus a comparable electric passenger car - Germany

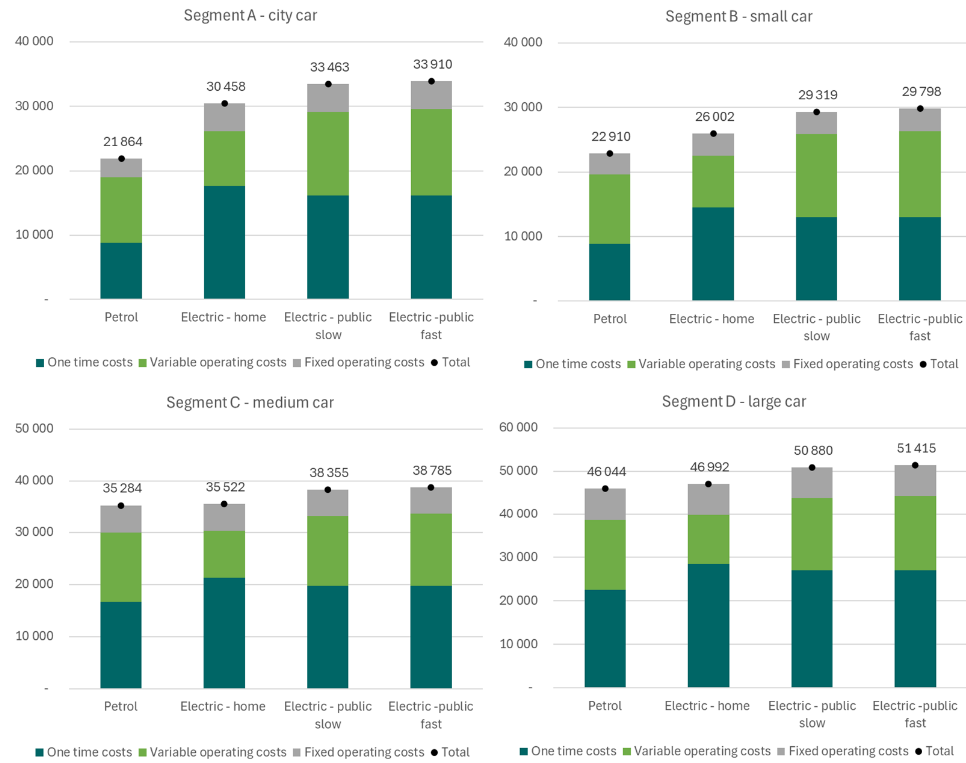


Italy

As of 2025, Italy has replaced its Ecobonus, that provided purchase incentives for electric cars to citizens, with a new programme that directly supports the local automotive sector. The aim of this reform is to reduce the flow of money for the purchase of EVs from non-European countries and to provide targeted support for research and technological development, fostering a long-term growth strategy.

The TCO ratios for Italy, shown in Figure 3-10, demonstrate that BEV passenger cars are more costly over their lifetime than petrol vehicles, across all segments. The TCO gap is most pronounced for the smallest vehicles, the A-segment, where the BEV's TCO exceeds that of the ICEV with 39% to 55%, depending on the charging scenario. For small cars of the B-segment, the TCO-gap is as high as 30%.

Figure 3-10 TCO of a petrol car versus a comparable electric passenger car - Italy

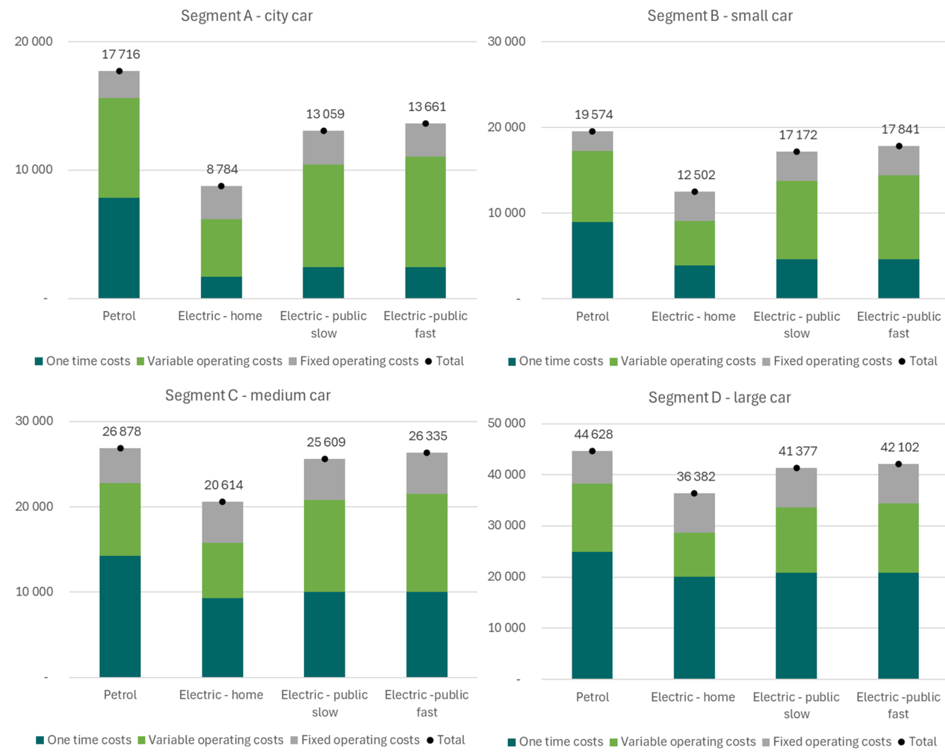


Spain

The Spanish government has extended its MOVES III electric vehicle subsidy programme until the end of 2025. MOVES III provides in subsidies up to € 7,000 for the purchase of a new BEV. Other financial incentives to support EV uptake are also in place, such as a 15% income tax deduction for private EV buyers, incentives for the installation of charging infrastructure and tax rebates.

This generous mix of financial advantages for electric vehicles results in a significant reduction of the TCO of BEVs in Spain, as shown in Figure 3-11.

Figure 3-11 TCO of a petrol car versus a comparable electric passenger car - Spain



BEV-to-ICEV energy cost ratio

One of the main selling points of a battery electric vehicle is its lower running costs compared to a fossil fuel vehicle, but this advantage heavily depends on the user's charging situation. In many countries, public charging infrastructure is more expensive than private home charging, with public fast charging being particularly costly compared to slower alternatives. As a result, people who rely on the public charging network face a major financial disadvantage.

The discrepancy between private and public charging rates can be a significant hindrance to mainstream BEV adoption because it disproportionately affects consumers who lack access to affordable home charging. For those who can install a private charger—especially when combined with solar panels—the cost of charging a BEV is much lower than refueling a petrol car, making the transition financially attractive. However, many urban residents, particularly those in apartments, rely on public charging infrastructure, where electricity costs are often much higher. Public fast charging, in particular, can be so expensive that the cost per kilometer exceeds that of petrol or diesel vehicles. This undermines one of the key economic incentives for switching to electric vehicles, discouraging potential buyers who lack home charging access.

Furthermore, the financial burden falls disproportionately on lower-income households, exacerbating social inequality and slowing down BEV adoption in densely populated areas where charging infrastructure is still limited. Addressing this issue through policies that promote affordable public charging solutions is crucial for ensuring widespread BEV adoption.

We monitor the energy cost gap by comparing the energy costs per 100 km for a BEV with a comparable internal combustion engine vehicle (ICEV). For the BEV, we consider three charging modes: private charging, public slow charging and public fast charging.

The key performance indicator is calculated as **the ratio of the energy cost for the BEV to the energy cost for the ICEV**. If the value is below unity, the BEV has lower running costs. Values higher than 1 indicate higher running costs for the BEV.

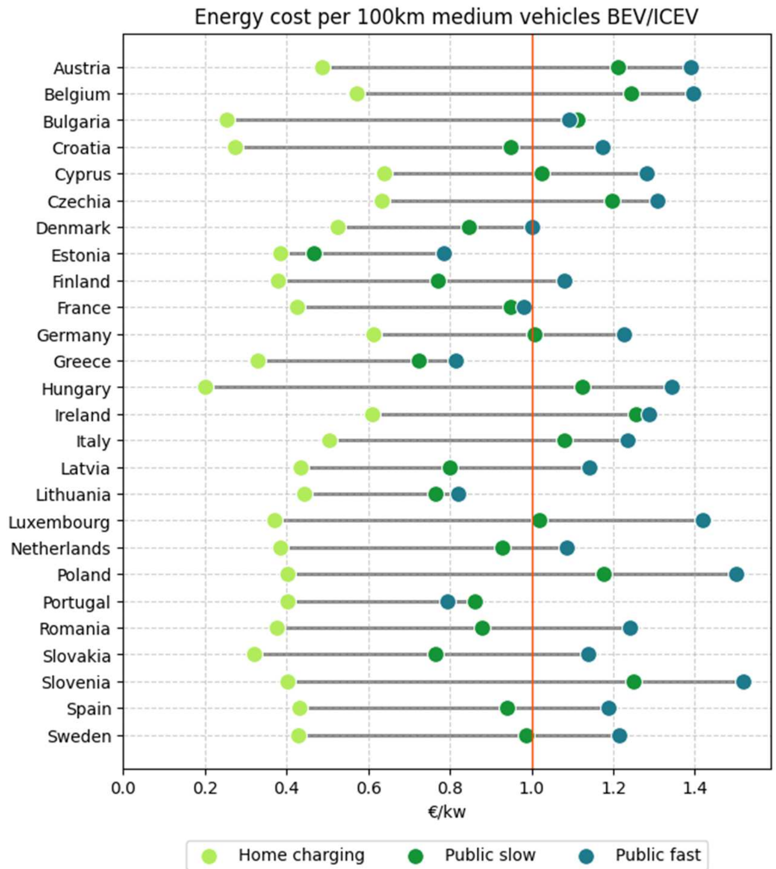
Figure 3-12 illustrates **a significant disparity in BEV energy cost efficiency depending on the charging method** for passenger cars. Figure 3-13 shows the BEV-to-ICEV energy cost ratio for light-commercial vehicles.

BEV users who primarily charge at home benefit from substantially lower running costs compared to ICEV users. However, the situation is reversed for those who rely on public charging infrastructure. In most European countries, the energy costs for a BEV exceed those of a comparable ICEV when charged on the public network – especially with fast charging , which is the most convenient and therefore the preferred option fore many BEV users. This issue is particularly pronounced in Slovenia, Poland, Luxembourg, Belgium, Austria, Hungary and the Czech Republic.

Notably, the cost gap between public and private charging tends to correlate negatively with BEV adoption rates. In countries with a relatively high BEVs uptake, such as Denmark, the Netherlands, Portugal and France, the disparity in charging costs is much smaller, and the overall cost advantage of BEVs over ICEVs remains more favourable.

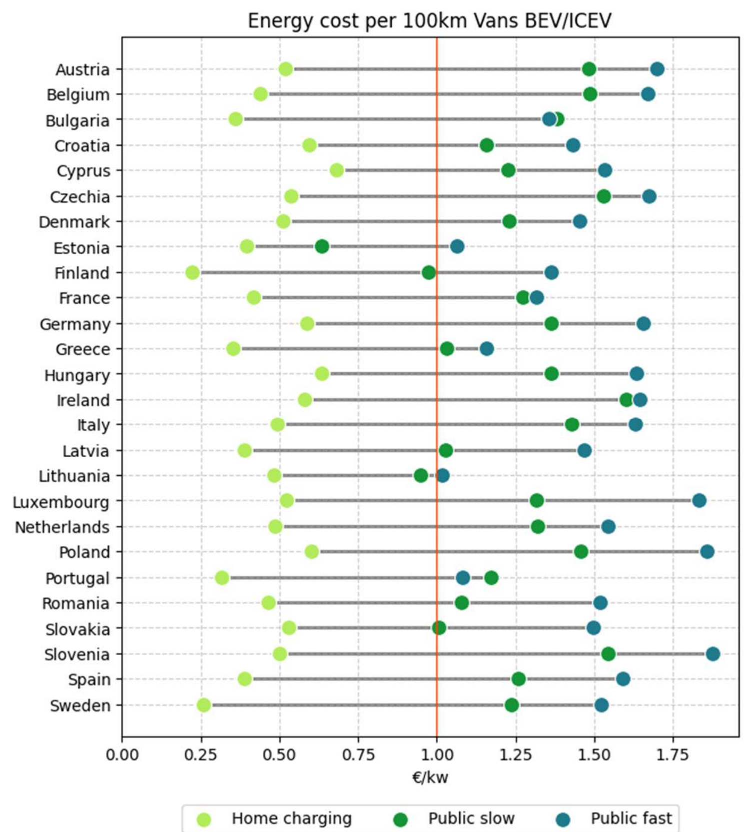
This emphasizes the importance of **monitoring and capping public charging rates** to ensure that BEV adoption remains financially attractive, particularly for those without access to private charging. Without regulatory measures to control excessive public charging costs, a significant portion of the population—especially urban residents and lower-income households—may be discouraged from switching to electric vehicles, ultimately slowing down the transition to sustainable mobility.

Figure 3-12 BEV-to-ICEV energy cost ratio for passenger cars - January 2025



Source: Own calculations based on Eurostat, Charge Price and unleaded petrol prices in the EU
Note: Energy consumption per 100 km for a VW ID.4 (17.3 kW) is compared with that of a VW Polo (5.6 litre)

Figure 3-13 BEV-to-ICEV energy cost ratio for light-commercial vehicles - January 2025



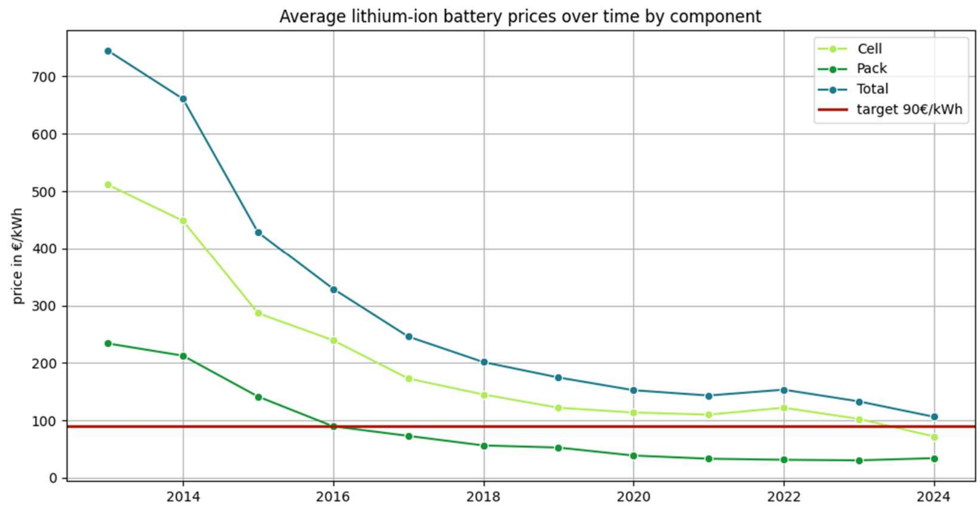
Source: Own calculations based on Eurostat, Charge Price and unleaded petrol prices in the EU
Note: Energy consumption per 100 km for a Renault Kangoo Electric (20 kW) is compared with that of a Renault Kangoo (7 litre)

Battery prices

The battery is the most expensive component of an electric vehicle. Therefore, EV prices are directly related to battery production costs. Under influence of the energy crisis and the shortage of critical materials, battery prices increased significantly in 2022. In 2023, prices for lithium-ion battery packs have dropped with 14 percent compared to the 2022 prices.

Figure 3-14 shows the price evolution for lithium-ion battery packs over the past decade, converted to euro. In 2024, the price of lithium-ion battery packs dropped to a record low of 106 dollar per kWh. Analysis by Bloomberg shows that **$ 100/ kWh (approximately € 90/kWh) is considered as a critical tipping point for EV affordability**. In 2024, lithium-ion battery prices remained above the tipping point, marked by the red line in Figure 3-14.

Figure 3-14 Average lithium-ion battery prices over time



Source: BloombergNEF (2024)

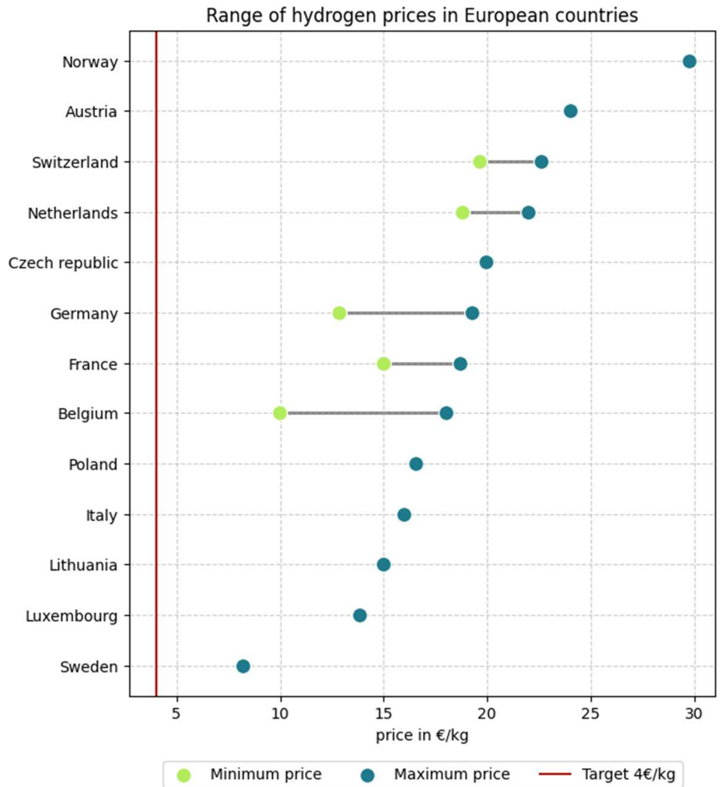
It is important to note that **in Europe, the predominant battery type used in electric vehicles is the lithium nickel manganese cobalt oxide (NMC) battery**. This chemistry is favored for its high energy density and long lifespan, making it particularly suitable for passenger cars. Lithium iron phosphate (LFP) batteries, predominantly used in Chinese BEVs, are about 30% less expensive than NMC batteries (IEA, 2025).

Hydrogen prices

Figure 3-15 depicts the average hydrogen price at refuelling stations in a selection of countries, as of September 2024. Hydrogen refuelling rates differ significantly, with prices as low € 8.2 per kilogram in Sweden to € 29.7 per kilogram in Norway.

Studies on the tipping point for hydrogen prices to set off mass production come with varying figures and are generally focus on hydrogen for heavy duty transport. Hydrogen Observatory determines the break-even price for green hydrogen for heavy-duty trucks in a range of € 2.4 to € 4.4 per kilogram. Therefore, we set **the target for hydrogen prices at € 4 per kilogram**, represented by the red line in Figure 3-15.

Figure 3-15 Hydrogen prices in a selection of European countries – March 2025



Source:https://h2.live/en/

4 Recharging and refuelling infrastructure

As Europe transitions to zero-emission mobility, the demand for recharging infrastructure is rising rapidly. A well-developed charging network is essential to support the shift from internal combustion engine vehicles to zero-emission alternatives.

While most recharging occurs at private charging points (Hardman et al., 2018), public infrastructure remains crucial. It serves individuals without access to private chargers and provides a convenient "top-up" option for those who do, allowing them to charge while engaged in other activities. With nearly two-thirds of Europeans living in urban areas and almost half residing in apartments[12], the need for accessible public charging is clear.

Sufficient public charging capacity also reduces the necessity for automakers to equip vehicles with oversized batteries. To address concerns about long-range travel, manufacturers have leveraged advancements in battery technology and declining costs to increase battery sizes. While this has extended the average range of electric vehicles, most daily trips remain relatively.

To ensure the expansion of recharging networks, the Alternative Fuels Infrastructure Regulation (AFIR) sets fleet-based and distance-based targets for the EU. The fleet-based targets obligate Member States to provide a total cumulative power output through publicly accessible recharging points of at least 1.3 kW per battery electric vehicle, and of at least 0.8 kW per plug-in hybrid electric vehicle in the country. The distance-based targets require the installation of publicly accessible fast chargers at 60 km intervals on the TEN-T network, with each recharging pool providing at least 600 kW of power output.

For hydrogen, AFIR requires hydrogen refuelling stations in all major cities and at least every 200 km along the core Trans-European Transport Network (TEN-T) by 2030.

We monitor the progress in recharging and refuelling infrastructure using the following KPIs:

- Public charging capacity per EV (AFIR),
- Number of public charging stations,
- Recharging infrastructure deployment disparities (charging point density),
- Slow versus fast charging split (AC/DC split), and
- The number of hydrogen refuelling stations per 200 km per TEN-T

Public charging capacity per EV

We monitor the deployment of charging infrastructure by tracking the deployment of **the charging capacity (kW) of the public charging network per electric vehicle**. AFIR requires EU Member States to ensure publicly accessible charging stations offer in aggregate at least 1.3 kW of power output per BEV and 0.8 kW per PHEV. Hence, the AFIR target can be computed as:

Target Output_AFIR = (Number of BEVs×1.3kW)+(Number of PHEVs×0.8kW)

Figure 4-1 shows that most countries meet the AFIR requirements. Nevertheless consumer surveys show that electric vehicle users perceive the currently available public charging network as

[12] https://ec.europa.eu/eurostat/web/interactive-publications/housing-2023#:~:text=In%20cities%2C%2072%25%20of%20the,only%2017%25%20in%20a%20flat.

insufficient. A recent survey by McKinsey (2024) reveals that there is a considerable gap between consumer expectations and the current state of charging infrastructure. Over 80% of potential EV buyers perceive the current availability of public charging as inadequate. This sentiment is echoed by current EV owners, with 70% expressing dissatisfaction with existing charging facilities. Problems are encountered with respect to waiting times, non-operational recharging stations and a too wide distance between the charging station and the EV user's home. Additionally, the survey also shows that many consumers are unwilling to consider buying an EV until the availability of chargers is equivalent to that of gas stations.

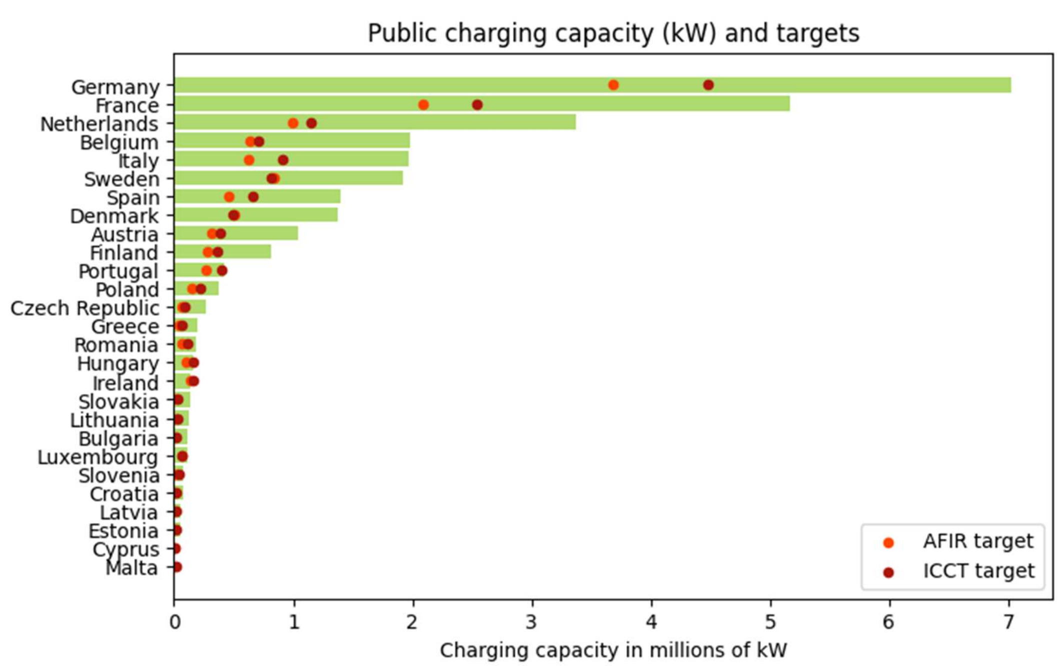
A study by Bernard et al (2022) from the ICCT states that while AFIR targets are sufficient in the long term, higher targets that vary according to the electric car and van stock share are necessary in the short term. Because of lower expected charge point utilization in the early stage of market development, higher charging targets are necessary for markets with less than 15% electric vehicle stock share. Therefore, ICCT proposes a dynamic target that depends on EV penetration rates as shown in Table 4-1.

Table 4-1 ICCT (2022) target for public charging capacity per vehicle

	BEV	PHEV
market share < 2%	2.1 kW	0.95
2% < market share < 5%	1.6 kW	0.75
5% < market share < 10%	1.3 kW	0.65
10% < market share < 15%	1.1 kW	0.60
market share > 15%	1.0 kW	0.55

Figure 4-1 shows that public charging capacity per EV is highest in Germany, France, the Netherlands and Belgium. These countries all meet the AFIR and ICCT targets. Public charging capacity is the lowest in Malta, Cyprus, Estonia, Latvia, Croatia and Slovenia.

Figure 4-1 Public charging capacity (kW) per EV - Q4 2024



Source: EAFO

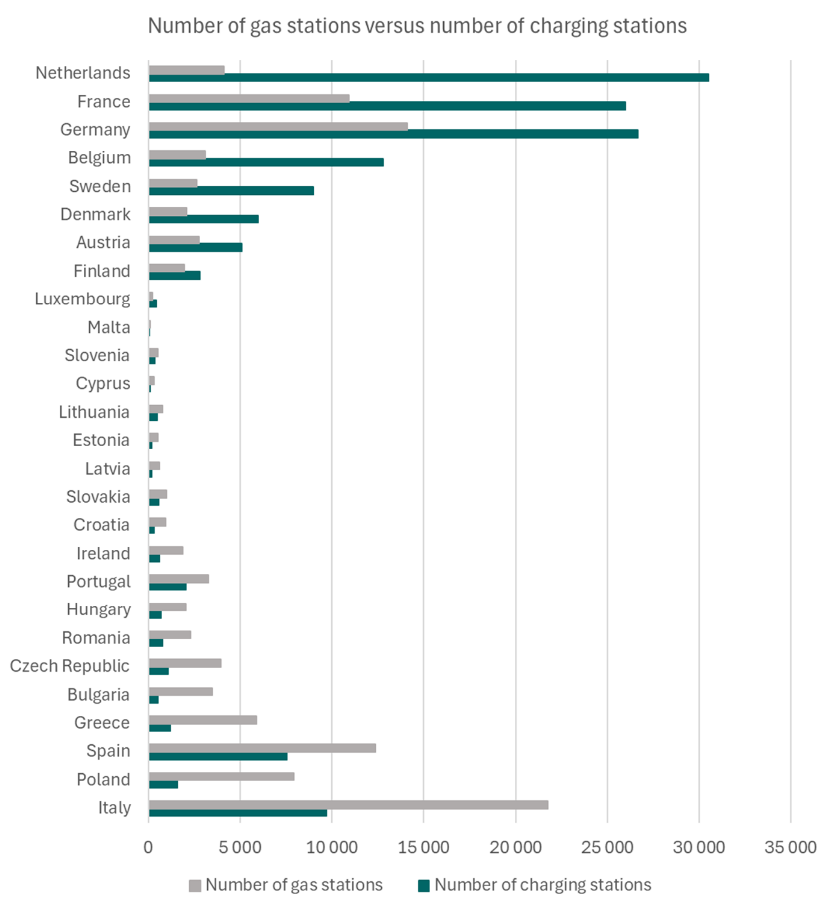
Number of public charging stations

A comprehensive consumer survey conducted by McKinsey (2024) reveals that prospective EV buyers expect the same convenience they enjoy with ICEVs. More specifically, no less than 42% of the survey respondents identified as "skeptical EV buyers" state than they will only consider buying an EV if the availability of public chargers is equivalent to that of gas stations.

Therefore, our second KPI to track the deployment of charging infrastructure focuses on **the number of public charging stations**. **The target for this indicator is the number of gas stations per country**.

We estimate the number of charging stations by the average number of charging points per station. A study by PWC finds that, on average, public charging stations host between six to eight charging points, though this can vary depending on the specific network and location.[13] In Europe, the IONITY network's stations have an average of about 6.4 charging points each.[14] Therefore, we assume an average of 6 charging points per charging station.

Figure 4-2 Number of gas stations compared to estimated number of EV charging stations in Europe - 2024



Source: EAFO and fuelseurope.eu

[13] https://www.pwc.com/us/en/industries/industrial-products/library/electric-vehicles-charging-infrastructure.html
[14] https://www.ionity.eu/network

Figure 4-2 shows that the number of EV charging stations across European countries varied significantly compared to the number of ICEV gas stations. The goal is to have an equal number of EV charging stations as gas stations, but most countries still have a gap to close. Countries like Italy, Poland, and Spain have thousands fewer EV charging stations than gas stations, with gaps of 12,052, 6,323, and 4,811, respectively. However, some countries, such as the Netherlands, France, and Germany, already have more EV charging stations than gas stations, surpassing their targets by 26,369, 15,069, and 12,576 stations, respectively. This data highlights the varying levels of EV infrastructure development across Europe, with some nations still needing significant expansion to match traditional refuelling networks, while others have already exceeded them.

Overall, **there were 882,020 publicly accessible charging points in EU-27 countries at the end of 2024**. The European Commission targets **3.5 million charging points by 2030** to support the level of vehicle electrification necessary to reach her CO_2 emission reduction targets. According projections made by ACEA (2024), the requirement for charging points is significantly higher. No less than **8.8 million charging points are required by 2030**. In any case, both targets indicate that there is an urgent need for accelerating the charging infrastructure deployment in Europe.

Recharging infrastructure deployment disparities

The AFIR target for public charging infrastructure capacity is typically computed at the country level, which presents a significant limitation: it does not account for **regional disparities within individual countries**. While this approach ensures that each nation meets a minimum infrastructure requirement, it overlooks **potential gaps in charging point density** between urban and rural areas.

In many European countries, charging infrastructure is heavily concentrated in major cities, leaving less densely populated regions with inadequate coverage. This results in significant disparities, where EV drivers in some areas enjoy abundant fast-charging options, while others face long distances between charging stations. For example, the Netherlands and Germany have some of the highest numbers of charging points in Europe, yet access varies greatly between metropolitan hubs and peripheral regions. Addressing these imbalances requires a more granular approach to infrastructure planning, ensuring that EV adoption is not hindered by uneven charging availability.

We monitor discrepancies in charging point density is five key markets, France, Italy, Germany, the Czech Republic and Hungary by tracking **the number of charging points per 100,000 inhabitants**. Because AFIR requires at least 1.3 kW of charging power per BEV, this translates to approximately 200 public charging points per 100,000 inhabitants. However, in densely populated urban areas, a higher density (300-500 charging points per 100,000 inhabitants) is needed due to limited home charging. Therefore, we set **the target for this indicator at 300 charging points per 100,000 inhabitants**.

Figure 4-3 shows that charging point density is the highest in France, ranging from 189 charging points per 100,000 in habitants in the Pays de la Loire to 314 charging points per 100,000 inhabitants in Corsica.

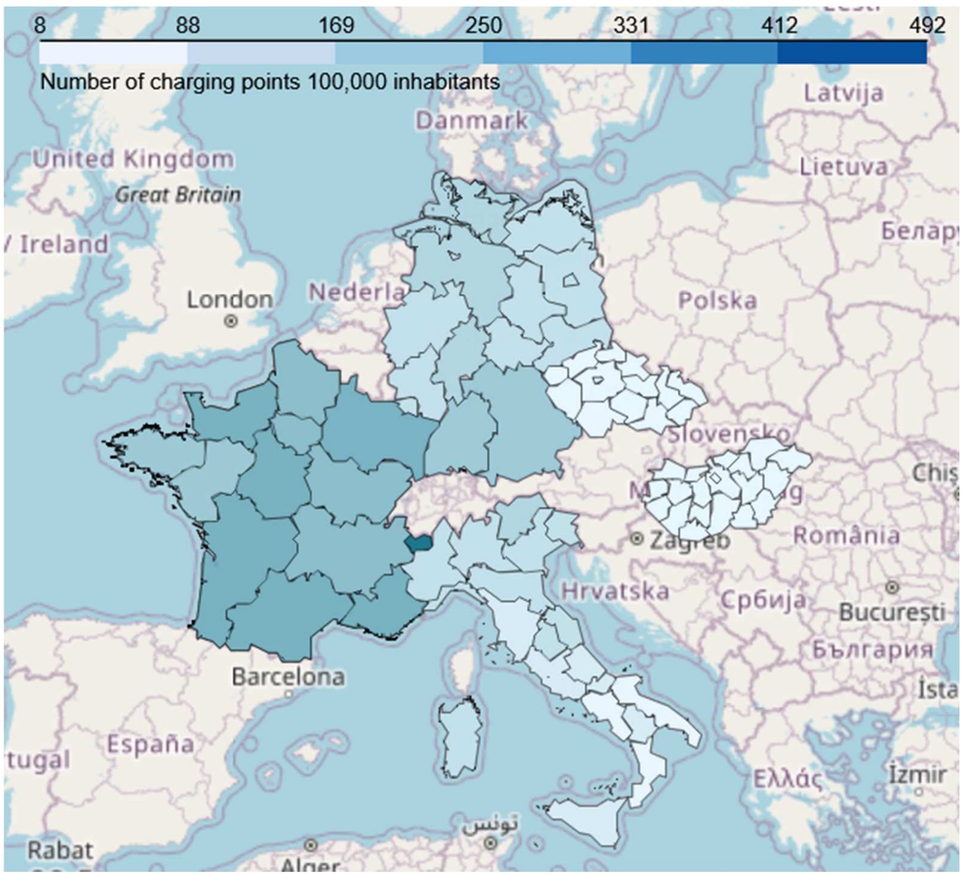
In Germany, public charging point density is especially low in the Sachsen-Anhalt region, with only 94 charging points per 100,000 inhabitants. The region with the highest public charging point density in Germany is Baden-Württemberg, with 199 charging points per 100,000 inhabitants.

In Italy, there are important disparities in charging point density. In Valle d'Aoste, a mountainous region in northwestern Italy, with a relatively small number of inhabitants but many tourists, charging point density is high, with 492 charging points per 100,000 inhabitants. However, in most Italian regions, charging point density is significantly below 100 points per 100,000 people, especially in the southern Italy.

In eastern Europe charging point density is extremely low. In most regions in the Czech Republic and Hungary charging point density is only around 20 charging points per 100,000 inhabitants or even lower. However, it is important to note that the data for Hungary and the Czech Republic stems from 2022.

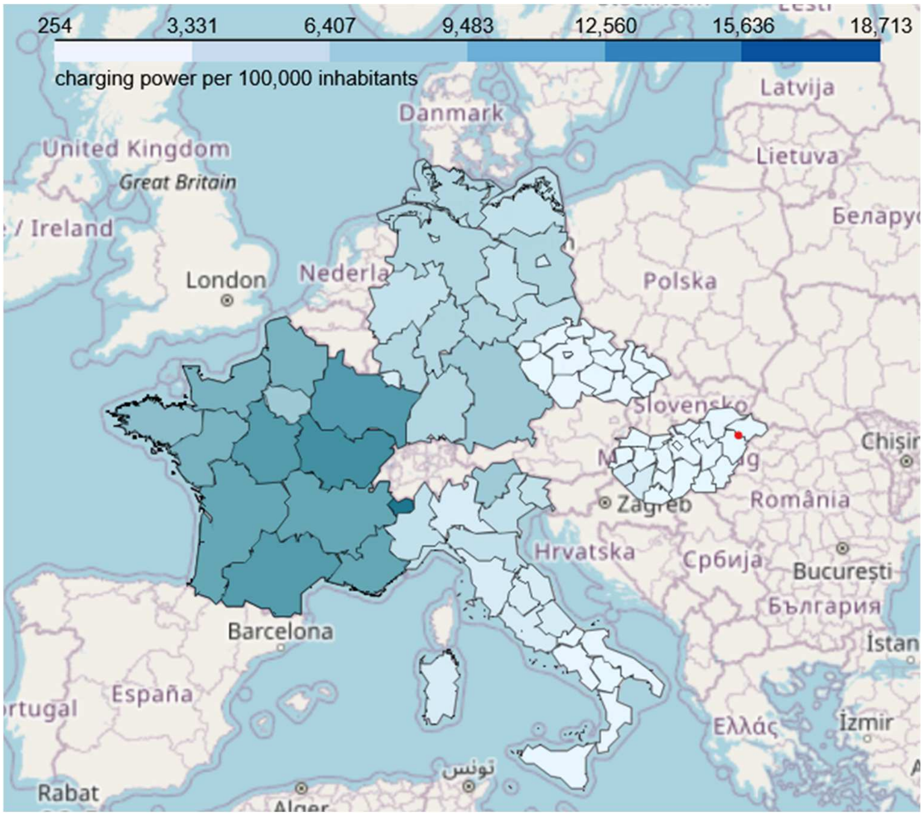
Figure 4-4 depicts public charging density as the public charging capacity (kW) per 100,000, leading to similar conclusions about charging point density as Figure 4-3.

Figure 4-3 Number of public charging points per 100,000 inhabitants



Sources: Standorttool.de, AVERE, Piattaforma Unica Nazionale dei punti di ricarica per i veicoli elettrici, Ministry of Industry and Trade Czech Republic
Note: Charging point data for France, Germany and Italy are from March 2025, data for the Czech Republic is last updated on March 31st 2022.

Figure 4-4: Public charging power (kW) per 100,000 inhabitants



Sources: Standorttool.de, AVERE, Piattaforma Unica Nazionale dei punti di ricarica per i veicoli elettrici, Ministry of Industry and Trade Czech Republic
Note: Charging point data for France, Germany and Italy are from March 2025, data for the Czech Republic is last updated on March 31st 2022.

AC/DC split

EV chargers come in various types catering to the diverse needs of electric vehicle users. In the European Union, recharging points are classified into two main categories, based on their power output and speed. Category 1 is recharging via AC, while Category 2 is recharging via DC (EAFO, 2024). AC chargers use alternating current to charge electric vehicles. DC chargers, or faster chargers, use direct current to charge electric vehicles. AC chargers are most commonly used for at home recharging or recharging at the workplace. DC recharging is typically used for fast public recharging or recharging on highways.

Table 4-2 Categorisation of chargers in Europe

Category	Sub-category	Maximum power output
AC	Slow AC recharging point	P<7.4kW
	Medium AC recharging point	7.4kW<P<22kW
	Fast AC recharging point	P>22kW
DC	Slow DC recharging point	P<50kW
	Fast DC recharging point	50 kW <P<150kW
	Level 1 -Ultrafast DC recharging point	150kW<P<350kW
	Level 2 -Ultrafast DC recharging point	P>350kW

We monitor the composition of charging speeds in Europe by tracking the share of slow (AC) and fast (DC) charging infrastructure in each Member State. Defining an optimal AC-DC mix is challenging, as it depends on context: highways require (ultra)fast charging, while residential and urban areas need a balance of slow and fast charging options. Instead of setting an arbitrary target, we compare Europe's share of DC charging points with other major markets such as China and the US.

In China, nearly half (47%) or all charging points are DC chargers (ICCT, 2024), while **in the US, 26% of all charging points are DC chargers**.[15]

Figure 4-5 illustrates the distribution of AC (light green) and DC (dark green) charging points across Europe, compared to China and the US. No European country – except Turkey – matches China's DC share, though Turkey has a relatively small charging network. In most countries, DC chargers account for less than 20% of the total, highlighting **inadequate charging speeds**. This issue is particularly pronounced in the Netherlands, Belgium, Cyprus, Greece, Luxembourg, Denmark, Sweden and Italy.

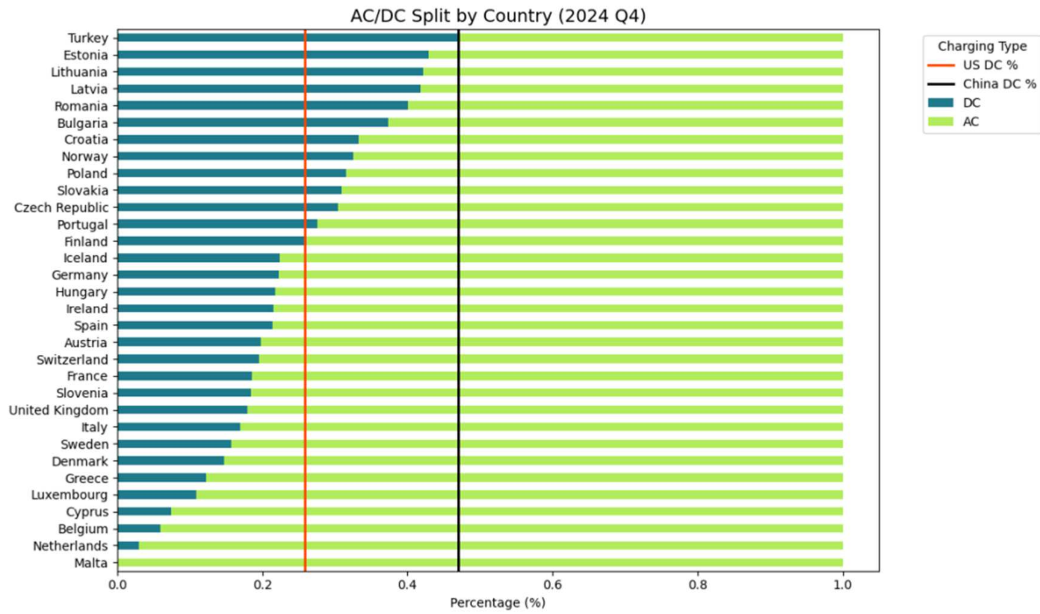
Consumer surveys indicate a strong preference for faster charging speeds among both current and potential EV users (e.g. EAFO Consumer Monitor)[16]. The gap between infrastructure availability and user expectations could slow EV adoption, as slower charging options may not meet mobility needs.

To address this, policymakers and industry stakeholders must **accelerate the deployment of fast charging stations**. Aligning infrastructure with consumer demand will be key to enhance the appeal and practicality of electric vehicles.

[15] https://driveelectric.gov/stations-growth

[16] https://alternative-fuels-observatory.ec.europa.eu/consumer-portal/consumer-monitor

Figure 4-5 Share of slow (AC) charging and fast (DC) charging public charging points



Source: EAFO

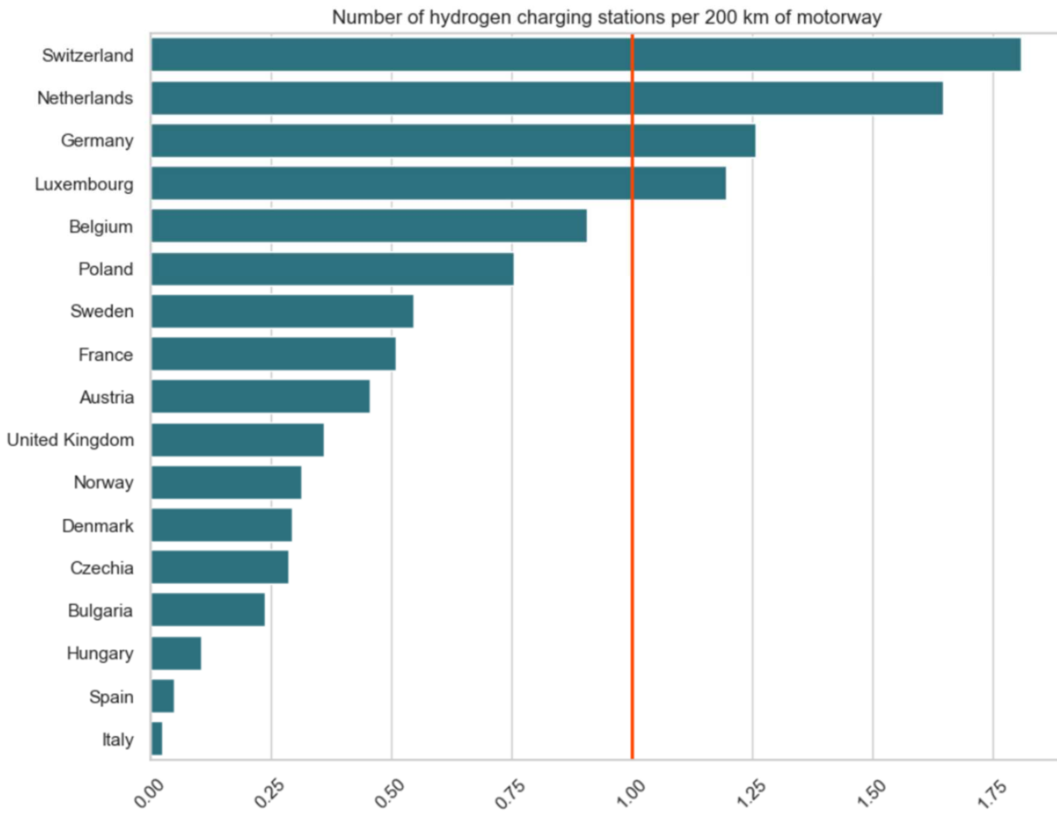
Hydrogen refuelling stations per 200 km TEN-T

For Hydrogen, AFIR requires at least one hydrogen refuelling station per 200 km of highway on the TEN-T network by 2030. We compute this indicator based on the locations of hydrogen refuelling stations available at H2-map.eu.[17] We group the number of stations by city and compute for each stations the number of refeulling points in a 200 km radius and compare this with the length of the highway network. This approach leads to an estimate of the number of hydrogen refuelling stations per 200 km of highway, but it might lead to an overestimation.

Figure 4-6 shows the number of hydrogen stations per 200 km of highway for a selection of European countries. Switzerland, the Netherlands, Germany and Luxembourg meet the AFIR target. All other countries underperform, with the lowest number of refuelling stations in eastern Europe and Southern Europe (Hungary, Bulgaria, the Czech Republic, Spain and Italy).

[17] https://h2-map.eu/

Figure 4-6: Number of hydrogen refuelling stations per 200 km TEN-T



Source: Own calculations based on H2-map.eu and Eurostat

5 Manufacturing: Energy costs and battery production

A successful transition to zero-emission passenger cars and light-commercial vehicles (LCVs) depends not only on consumer adoption and infrastructure deployment but also on the ability of European manufacturers to produce these vehicles competitively. To remain viable in the global market, Europe must ensure that its production costs are on par with major competitors such as China and the United States.

A key factor in cost-competitive manufacturing is energy pricing (Draghi, 2024a, 2024b). The production of electric vehicles, particularly battery manufacturing, is highly energy-intensive. If energy prices in Europe remain significantly higher than those in other regions, manufacturers could face a competitive disadvantage, making European-made EVs less attractive compared to imports. Ensuring stable and affordable energy costs is therefore critical to maintaining a strong domestic production base.

Additionally, a reliable battery supply chain is essential for securing Europe's position in the global EV market. Batteries are the most expensive component of an electric vehicle, and reliance on imports creates supply risks and cost uncertainties. Developing a robust European battery industry—spanning raw material processing, cell production, and recycling—will not only enhance supply security but also support local economies and reduce dependence on foreign markets.

This chapter examines key manufacturing KPIs, focusing on energy costs and battery production capacity, to assess Europe's readiness for large-scale zero-emission vehicle production.

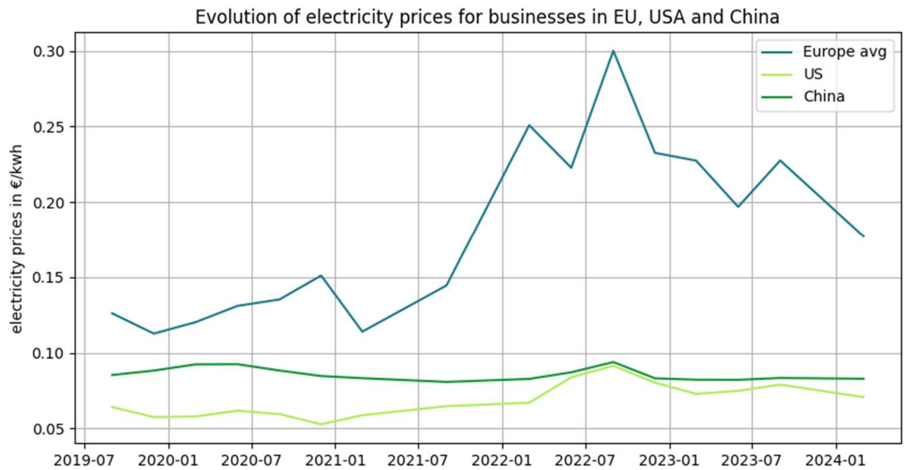
Energy costs

The production of battery electric vehicles is highly energy-intensive. Therefore, assessing the relative competitiveness of the European automobile industry requires careful monitoring and management of the **structural energy price gap** (Draghi, 2024a, 2024b).

Figure 5-1 presents the industrial electric prices in Europe, the US and China. In March 2024, **European industrial electricity prices were 151% higher than those in the US and 114% higher than in China**. Although the energy cost gap with the US and China has narrowed somewhat since its peak in 2022, it remains significantly wider than in 2019, when European electricity prices were 97% higher than in the US and 48% higher than in China.

This persistent energy price gap highlights the challenging environment for European manufacturers, who must compete with their Chinese and US counterparts. Without decisive action to address this cost disparity, Europe's ability to attract investment and maintain a strong position in the global electric vehicle market will be increasingly at risk.

Figure 5-1: Retail electricity price (in €/kWh) for the industry – up to March 2024



Sources: Eurostat, Ember, EIA, gobalpetrolprices

Battery production capacity

Batteries are the heart of electric vehicles, playing a crucial role in their performance, range, and cost. The lithium-ion battery is the most widely used type in EVs today. As the global phase-out of diesel and petrol cars and light duty commercial vehicles progresses, the demand for lithium-ion batteries is expected to surge over the next decade. Therefore, it is crucial for Europe to ensure sufficient domestic battery production to manage both the availability and price developments of these critical components.

The European battery industry has been striving to establish a robust domestic manufacturing base to reduce reliance on Asian producers. In 2024, Europe had a **total battery production capacity of 343 GWh**, with Poland, Sweden and Hungary leading the production (IPCEI, 2024). When combining both operational production capacity and capacity currently under construction, Europe's maximum potential battery production amounts to 997 GWh.

The target for battery production capacity is based on projected light-duty vehicle production in Europe. Assuming that by 2035 all vehicles produced (excluding those exported outside Europe) will be zero-emission, and aiming for battery production self-sufficiency, the goal is to align battery production capacity with vehicle production. Based on an average EV battery capacity of 71.9 kWh,[18] **the target for European EV battery production capacity is set at 1125 GWh**. This target is an underestimation of total required production capacity because it only accounts for the required battery production for passenger cars and LCVs. Battery production for heavy duty vehicles is not included in the target.

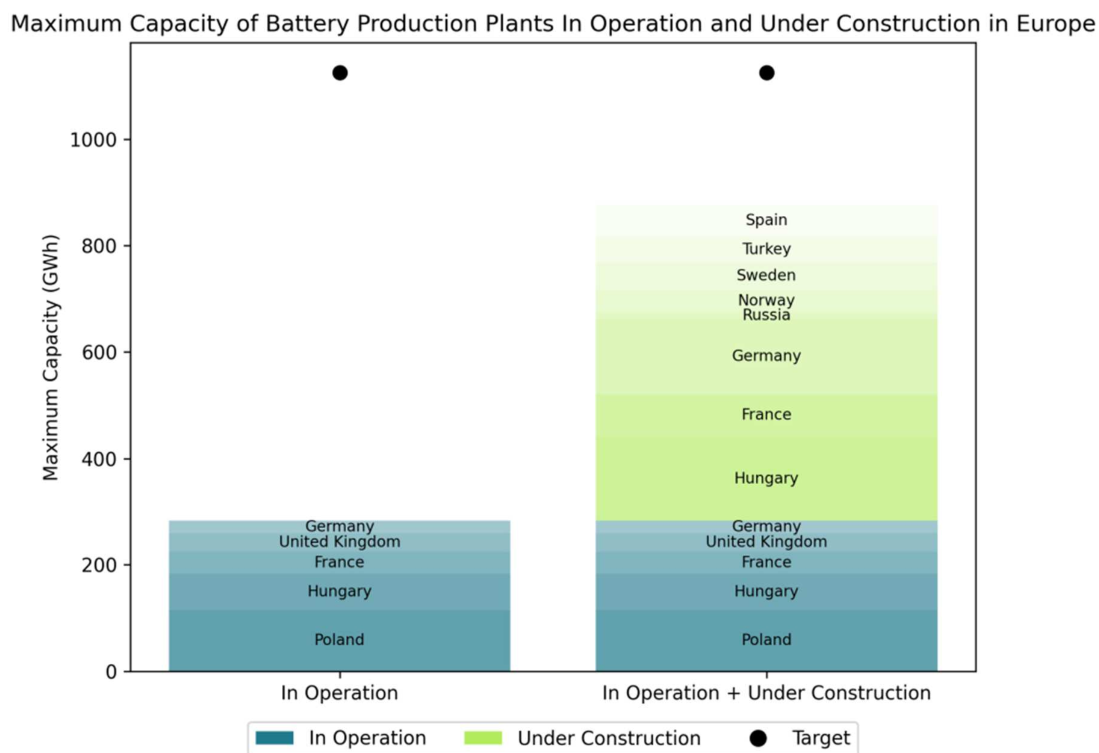
Figure 5-2 shows the current and expected maximum battery production capacity in Europe. The figure illustrates that significant addition capacity is being planned in Germany, Hungary, France and Spain.

[18] https://ev-database.org/cheatsheet/useable-battery-capacity-electric-car

Despite these efforts, the recent bankruptcy of Northvolt, once Europe's largest investment in a homegrown battery maker, highlights significant challenges in scaling up production to compete with established Asian manufacturers. Northvolt's collapse underscores the difficulties smaller manufacturers face in achieving economies of scale and maintaining competitiveness.

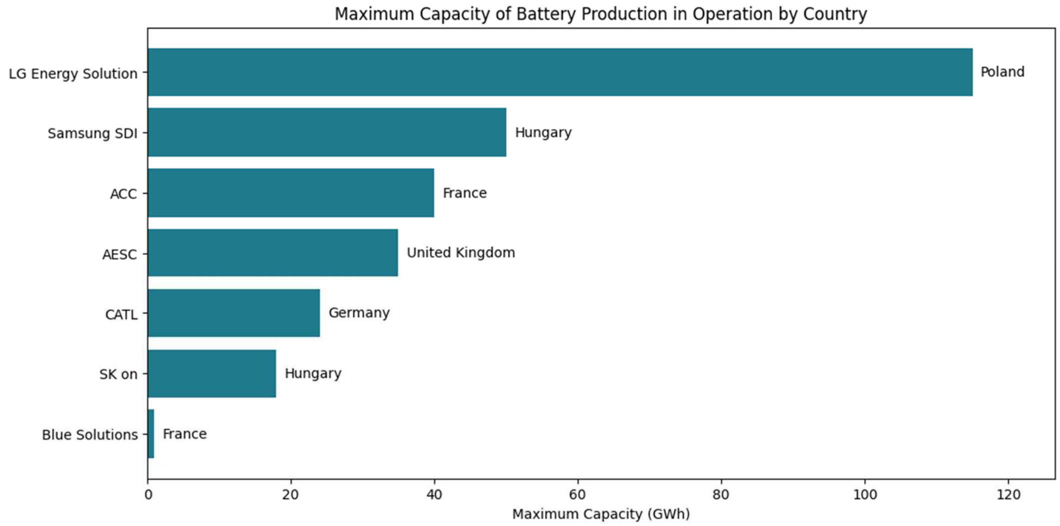
The European Union has announced plans to boost domestic battery manufacturing capacity, aiming to increase its global market share to about 15% by 2030. However, Northvolt's bankruptcy serves as a cautionary tale, emphasizing the need for substantial financial support, strategic planning, and sustained investment to build a competitive battery industry capable of rivalling dominant Asian producers.

Figure 5-2 Maximum traction battery production capacity in Europe as of 2024



Source: IPCEI (2024)

Figure 5-3 Maximum battery production capacity in operation - 2024



Source: IPCEI (2024)

Conclusion

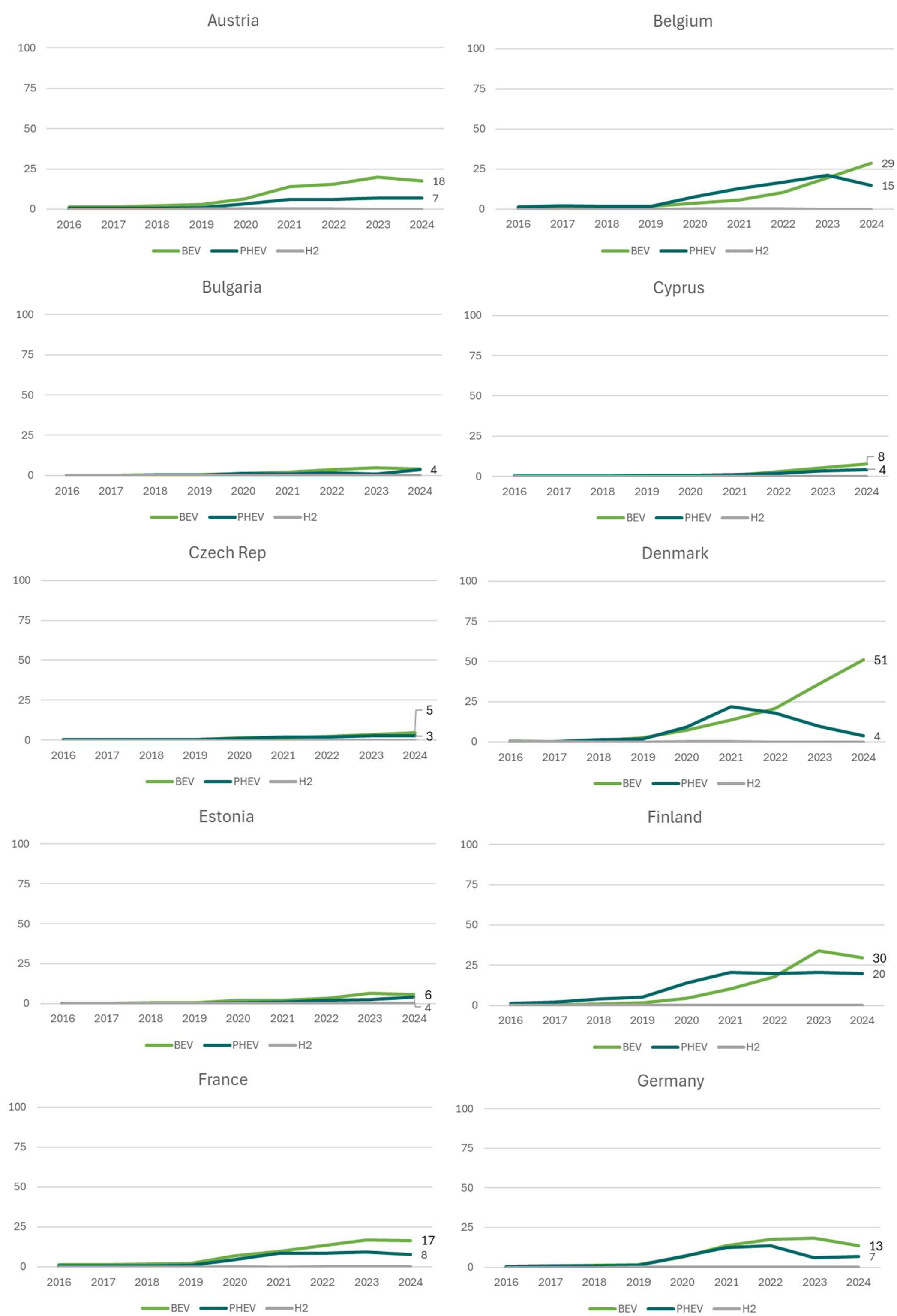
This report highlights the complexity and urgency of the European automotive sector's transition to zero-emission mobility, as outlined in the European Commission's 2025 Industrial Action Plan that was announced on March 5, 2025. While the plan provides a clear framework and direction, the current status of the sector shows that significant gaps remain across several key areas. The performance indicators developed in this report underscore that progress is uneven, and critical roadblocks—particularly in grid readiness, consumer affordability, and battery manufacturing—threaten to delay or derail the transition if not addressed promptly.

The traffic light system reveals that, although Europe meets some infrastructure and self-sufficiency benchmarks, broader readiness is still lacking. The electricity grid remains ill-prepared for the demands of large-scale EV adoption, and while public charging infrastructure is expanding, it is not perceived as sufficient or equitably distributed. Consumer uptake is improving but remains far from the trajectory needed to reach the 2035 goals, especially among vulnerable groups. Meanwhile, European manufacturers continue to face global competition due to high energy prices and limited battery production capacity, posing a long-term risk to the region's automotive competitiveness.

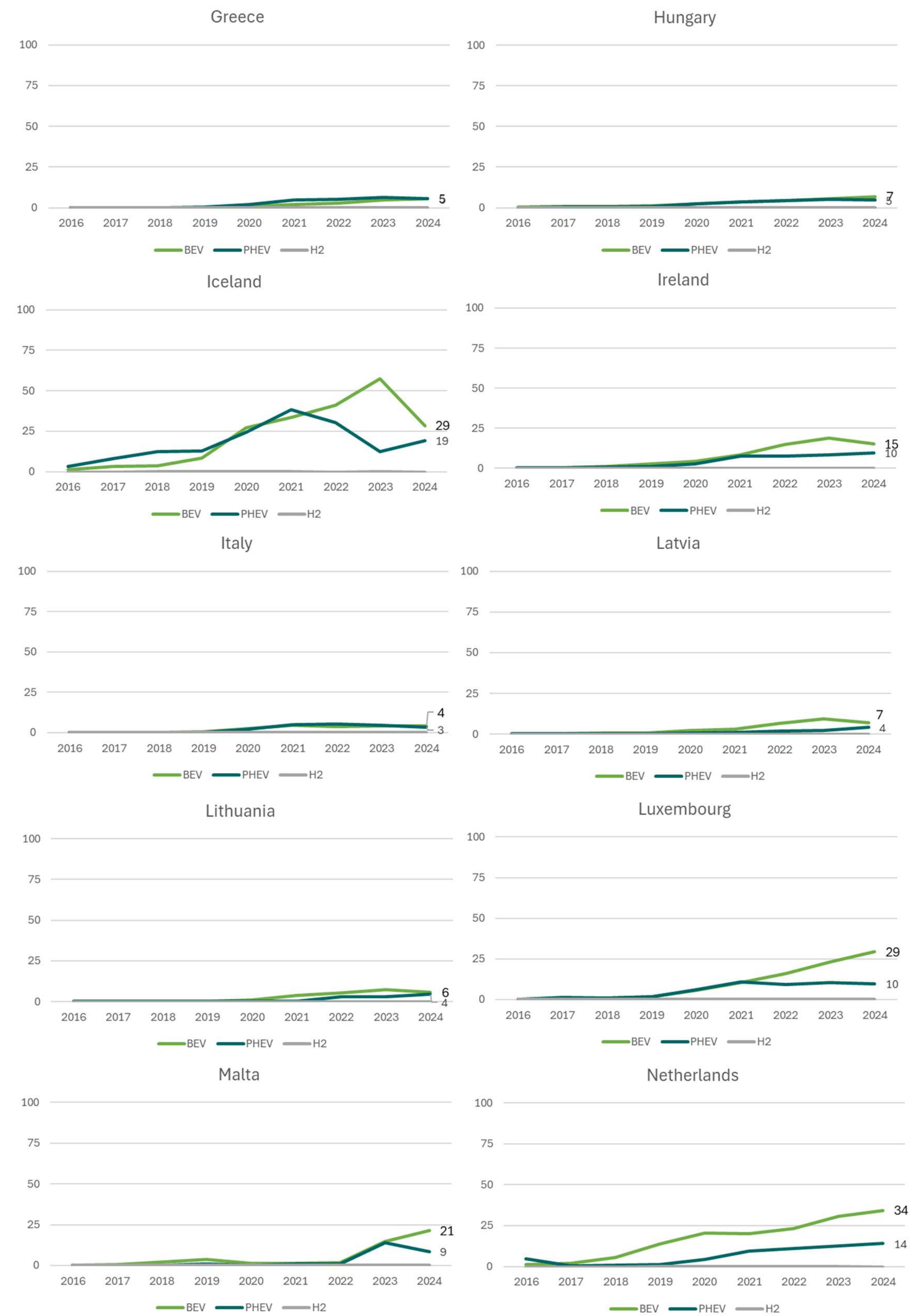
To close these gaps, coordinated action is essential. Quarterly monitoring of KPIs will support more agile and responsive policymaking, helping to identify bottlenecks early and adjust strategies accordingly. Ultimately, achieving a successful transition will require targeted investment, regulatory flexibility, and strengthened cooperation between governments, industry, and civil society. With sustained commitment, Europe can still lead the global shift to clean mobility—provided that implementation keeps pace with ambition.

![TML Transport & Mobility Leuven logo]

1 Annex: Market share of ZLEVs passenger cars in total registrations



Source: EAFO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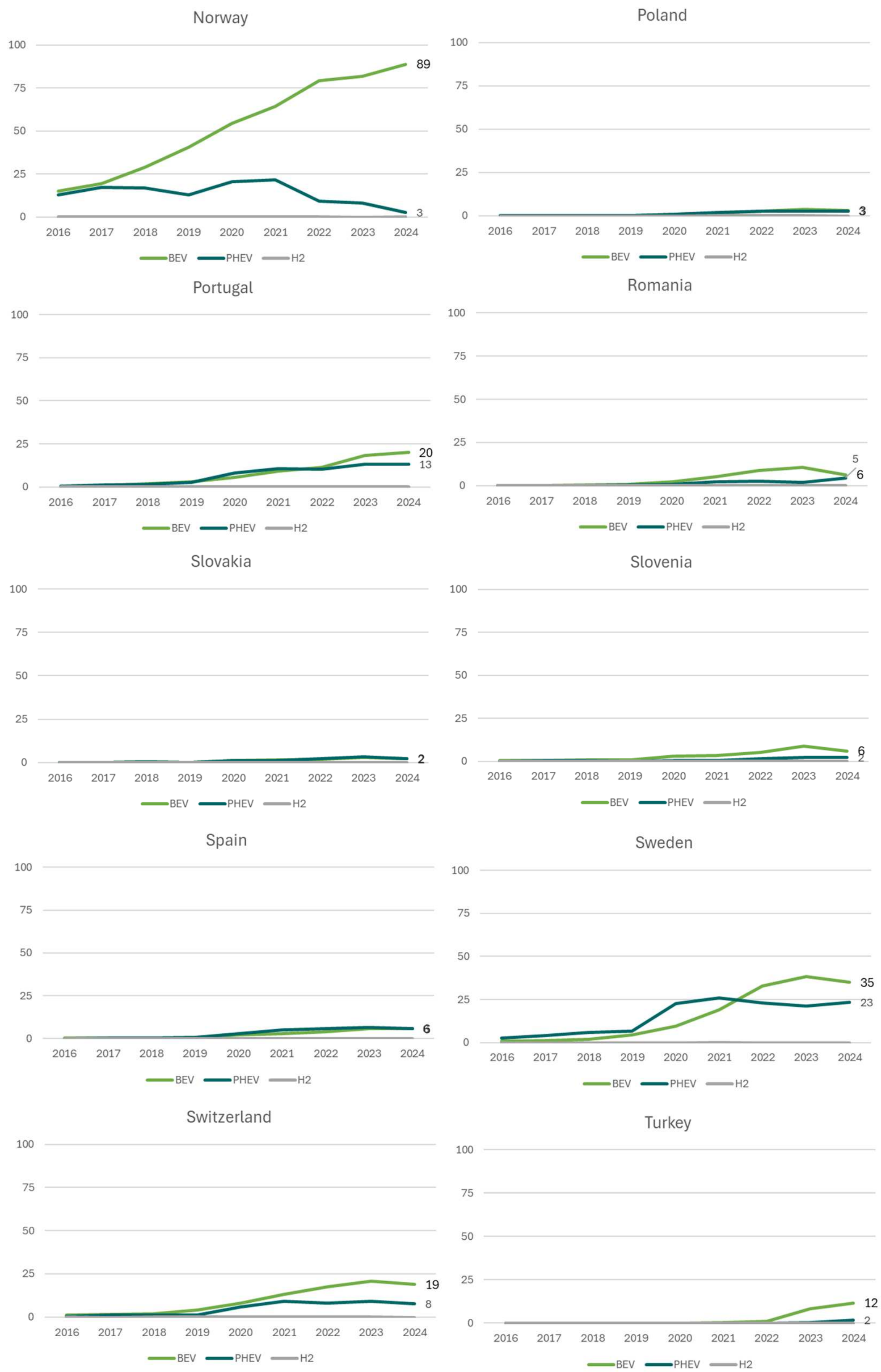
Source: EAFO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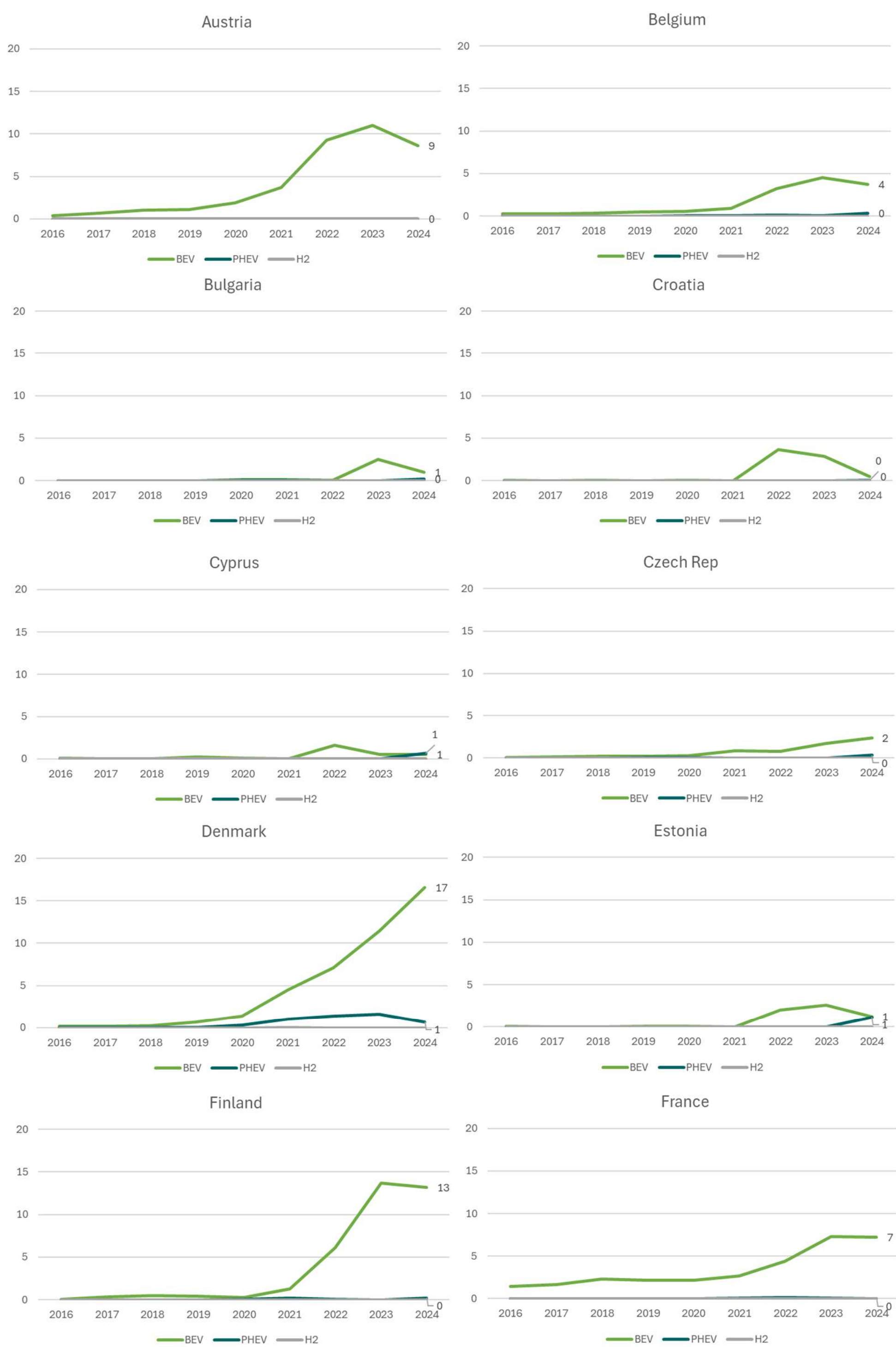
Source: EAFO

2 Annex: Market share of ZLEVs light-commercial vehicles in total registrations



Source: EAFO


Germany
Greece
Hungary
Iceland
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
2016
2017
2018
2019
2020
2021
2022
2023
2024
BEV
PHEV
H2

Source: EAFO


Netherlands
Norway
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
UK
BEV
PHEV
H2

Source: EAFO

3 Annex: Methodology for assigning traffic lights

KPIs and Targets

The table below provides an overview of the different key performance indicator per category, as well as the assigned target.

Electricity grid indicators	Target
Solar energy capacity per LDV	3.2 kW per vehicle
Share of EVs that are V2G ready	50%
Smart meter penetration	100%
Dynamic electricity contract uptake	100%
Demand-side flexibility	5
Countries with double taxation of energy storage	0
Electricity self-sufficiency	1.15
Consumer adoption indicators	**Target**
Share of ZEV in passenger vehicles	100%
Share of ZEV in light-commercial vehicles	100%
Available models < € 30,000	upward trend
Share of ZEV in second hand market	upward trend
BEV-to-ICEV TCO - A-segment	< 1
BEV-to-ICEV TCO - B-segment	< 1
BEV-to-ICEV TCO - C-segment	< 1
BEV-to-ICEV TCO - D-segment	< 1
BEV-to-ICEV energy cost ratio - private charging	< 1
BEV-to-ICEV energy cost ratio - public slow charging	< 1
BEV-to-ICEV energy cost ratio - public fast charging	< 1
Battery prices	€ 90/kWh
Hydrogen prices	€ 4/kg
Charging infrastructure indicators	**Target**
Public charging capacity per EV	AFIR
Public charging capacity per EV	ICCT
Number of public charging stations	equal to gas stations
Charging infrastructure deployment disparities	300 per 100,000 inhabitants
AC/DC split	China and US values
Hydrogen refuelling station per 200 km highway	1
Manufacturer indicators	**Target**
Industrial electricity price difference with US	≤ 0
Industrial electricity price difference with China	≤ 0
Battery production capacity	1125 GWh/year

Methodology for assigning traffic lights

The KPIs related to electricity grid readiness are bidirectional, meaning they can deviate from the target in either direction. As such, the traffic light system is defined as follows:

- Green: The European average is within ±25% of the target.
- Orange: The average deviates between 25% and 75% from the target.
- Red: The average deviates by more than 75% from the target..

For the remaining, generally unidirectional KPIs, the traffic light system is applied as follows:

- If the KPI meets or exceeds the target, the light is green,
- If the KPI is up to 25% below the target, the light is orange,
- If the KPI is more than 25% below the target, the light turns red.

References

ACEA (2024). Charging ahead: accelerating the roll-out of EU electric vehicle charging infrastructure. https://www.acea.auto/files/Charging_ahead-Accelerating_the_roll-out_of_EU_electric_vehicle_charging_infrastructure.pdf

ACEA (2025). Tax benefits and incentives – Electric cars Electric-cars-Tax-benefits-purchase-incentives-2025.pdf

BloombergNEF (2024). Lithium-Ion Battery Pack Prices See Largest Drop Since 2017, Falling to $115 per Kilowatt-Hour, December 10, 2024. https://about.bnef.com/blog/lithium-ion-battery-pack-prices-see-largest-drop-since-2017-falling-to-115-per-kilowatt-hour-bloombergnef/

Draghi, M. (2024a). The future of European competitiveness – A competitiveness strategy for Europe. https://www.europeansources.info/record/the-future-of-european-competitiveness/

Draghi, M. (2024b). The future of European competitiveness – In-depth analysis and recommendations. https://www.europeansources.info/record/the-future-of-european-competitiveness/

European Commission COM(2023) 757 final. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Grids, the missing link - An EU Action Plan for Grids. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2023:757:FIN

Evers, R., Heyndrickx, C., Mayeres, I. Peduzzi, E., Vanpée, R. (2024). Accelerating Change: Closing the Gaps in Europe's Shift to Zero-Emission Vehicles, Report for the European Automobile Manufacturers' Association (ACEA). https://www.tmleuven.be/en/project/Gap-analysis-of-a-zero-emission-automotive-industry

Hardman, S., Jenn, A., Tal, G., Axsen, J., Beard, G., Daina, N., Figenbaum, E., Jakobsson, N., Jochem, P., Kinnear, N., Plötz, P., Pontes, J., Refa, N., Sprei, F., Turrentine, T., & Witkamp, B. (2018). A review of consumer preferences of and interactions with electric vehicle charging infrastructure. Transportation Research Part D: Transport and Environment, 62, 508-523. https://doi.org/10.1016/j.trd.2018.04.002

Hecht, C., Figgener, J., & Sauer, D. U. (2023). Vehicle-to-Grid Market Readiness in Europe with a Special Focus on Germany. Vehicles, 5(4), 1452–1466. https://doi.org/10.3390/vehicles5040079

ICCT (2024). Moving past the early market: how to get battery electric vehicles to the mainstream. https://theicct.org/how-to-get-bevs-to-the-mainstream-sept24/

ICCT (2024). Charging up China's Transition to Electric vehicles: A dive into China's public charging infrastructure deployment and comparison with Europe and the United States. ID-93-–-China-charging-Report-A4-70131-v6.pdf

IEA (2025). The battery industry has entered a new phase. March 5, 2025. The battery industry has entered a new phase – Analysis - IEA

IMF (2025). Integrating the EU Energy Market to Foster Growth and Resilience. International Monetary Fund. https://www.imf.org/en/News/Articles/2025/01/13/sp-integrating-the-eu-energy-market-to-foster-growth-and-resilience

Indicata (2025). Market Watch – January 2025, https://indicata.com/market-watch/indicata-market-watch/

IPCEI (2024). Battery cell production in Europe: Status quo and outlook. 2024-05-BZF_Kurzinfo_Marktanalyse_Q2_engl.pdf

LCP Delta & SmartEn (2025). 2024 Market Monitor for Demand Side Flexibility, https://smarten.eu/reports/2024-market-monitor-for-demand-side-flexibility/

Liang, J., Qiu, Y. (Lucy), & Xing, B. (2022). Impacts of the co-adoption of electric vehicles and solar panel systems: Empirical evidence of changes in electricity demand and consumer behaviors from household smart meter data. *Energy Economics*, *112*, 106170-. https://doi.org/10.1016/j.eneco.2022.106170

McKinsey & Company (2024). Exploring consumer sentiment on electric-vehicle charging. https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/exploring-consumer-sentiment-on-electric-vehicle-charging

T&E (2024). Social leasing: a key measure for national Social Climate Plans. A targeted support to promote access to electric vehicles for middle and low income households. https://www.transportenvironment.org/uploads/files/2024_10_Social_leasing_briefing.pdf