CHARGING POINTS FOR ELECTRIC MOBILITY IN SPAIN

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Executive Summary

Diagnosis of the current situation and proposals to achieve sustainable mobility that guarantees territorial structuring and social cohesion.

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Current situation and analysis

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The promotion of alternative mobility systems to internal combustion engines (ICEs) is one of the most important challenges facing industrial economies to address the problem of climate change. A brief look at the figures illustrates its importance: according to the World Bank, transport accounted for 20.45% of global fuel combustion in 2014[1], and over the last 60 years it has ranged between 18% and 22%. This means that around one fifth of all fossil fuels burned worldwide are due to transport in all its forms.

The most recent data from the European Mobility Atlas show that in the case of Spain 27.5% of greenhouse gas (GHG) emissions correspond to transport. It is the economic sector that contributes the most to the generation of GHG emissions, with 92.83% of that total corresponding to road transport. The Spanish Transport and Logistics Observatory (OTLE)[2] indicated that in 2018 (the last year published) road transport emitted 83.6 million tonnes of CO_2 equivalent, compared to 78.5 million tonnes in 2000. This goes to show that far from reducing emissions road transport is actually increasing them, despite a brief period of reduction between 2002 and 2012.

Meanwhile, the latest greenhouse gas inventory[3] published in March 2022 by the Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITECO) indicates that the transport sector represents 27.0 % of total emissions. This is significantly more than any other sector in the Spanish economy, with industry (20.8 %) and electricity generation (11.8 %) coming in well behind. Road transport alone accounts for 25.4% of total GHG emissions in the inventory, which explains the major importance of analysing emissions in this sector and proposing solutions to achieve its decarbonisation.

CO_2 emissions from road transport

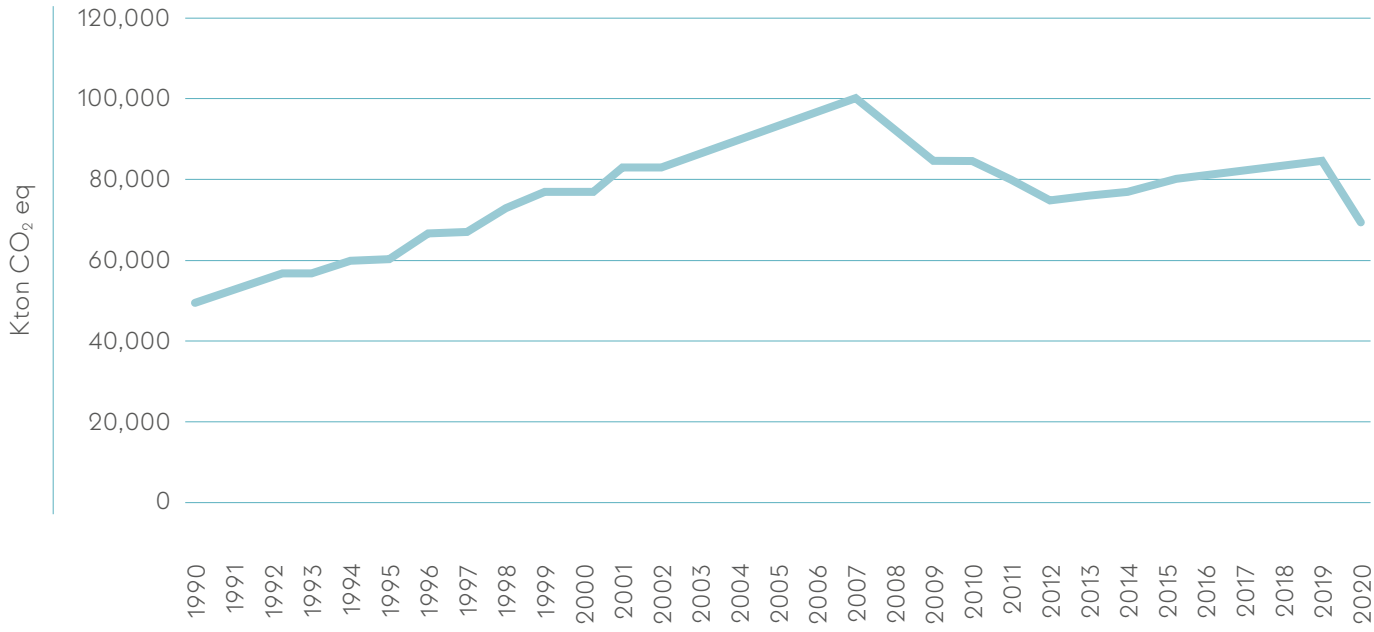

Figure 1.1. Evolution of GHG emissions since 2000 (baseline 100) and 2018.
Based on: OTLE

[1] https://datos.bancomundial.org/indicator/EN.CO2.TRAN.ZS?end=2014&start=1960&view=chart

[2] https://apps.fomento.gob.es/BDOTLE/indicadores/index.aspx?c=26

[3] https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/resumen_inventario_gei-ed_2022_tcm30-534394.pdf

The targets of the Paris Agreement for 2020-2030 contemplate a 55% reduction in GHG emissions for Europe as a whole compared to 1990 and a framework to reach EU climate neutrality by 2050 has been established in the European Climate Law. It is well known that road transport emissions in Spain have been increasing in recent years rather than decreasing, with the exception of 2020 (which had an interannual decrease of 17.5%) due to the restrictions resulting from the COVID-19 health crisis. Accordingly, it is clear that a profound strategic change is needed in this sector.

In Spain, the strategy to achieve the aforementioned target of emission neutrality by 2050 is formalised in the Strategic Energy and Climate Framework. This framework includes the Law on Climate Change and Energy Transition passed on 13 May 2021, which prohibits sale of ICE vehicles from 2040 onwards. This means that electric and hydrogen vehicles will be the only solutions for light road transport from that time on. Issues relating to availability and technological development, together with the potential economic, social, territorial and environmental effects of mass production of hydrogen due to the high electricity requirements, make it more coherent and viable to decarbonise both road and rail transport via electrification. Hydrogen could therefore be reserved as the most feasible alternative for sectors that are difficult to electrify, such as the maritime and aviation sectors.

For this change to be real, the energy source for these vehicles must be fully renewable. Some organisations and groups have voiced their concerns that the 2040 target is not ambitious enough and propose bringing it forward to 2035[4] in line with the European Commission's proposal. **Regardless, it is undeniable that a very broad technological revolution is needed if we are to finally leave ICEs behind. This revolution involves a number of different sectors which will have to be rapidly reshaped in less than 15 years:**

- Light vehicle manufacturers will have to make an irreversible transition to electricity-based technology.

- To ensure true emission neutrality of the new energy sources for these technologies, electricity generation and hydrogen synthesis processes must be carried out using renewable sources. Otherwise, we would merely be changing the GHG emission source. This would improve urban air quality by limiting the emission of solid particles, nitrogen oxides (NOx) and sulphur oxides (SOx).

- There is also a need for rapid changes in the current mechanical services and fuel provisioning sector. Service stations cannot wait until 2040 to focus primarily on supplying new zero-emission vehicles. The technology and infrastructure that will allow their mass entry onto our roads must be developed at the same time. In the same way that years ago all petrol stations switched on a massive scale to unleaded petrol, in the next few years they will have to be converted into electric charging stations.

This study leaves hydrogen technology to one side to focus on the last of the three points mentioned above, namely the development of the network of charging points for electric vehicles in Spain. It takes into account both social and territorial perspectives, which are essential to feasibly achieve decarbonisation of the sector across the country.

[4] ECODES (2022): 2035: Commitment to the phase-out of ICE vehicles in Spain. Online at https://ecodes.org/images/que-hacemos/01.Cambio_Climatico/Incidencia_politicas/Movilidad/ECODES_PeticinCCAA_ICE_Phase_Out_2035.pdf

An earlier study by Transport & Environment[5] with collaboration by ECODES estimated the number of new charging points needed to reach the target of the Integrated National Energy and Climate Plan (PNIEC) 2020-2030, which aims to reach a fleet of 5 million electric vehicles by 2030[6]. This study identified the need for 3 million private charging points and between 222,901 and 289,130 public charging points under two alternative scenarios. With nine years to go, there is still much to be done. Currently, Spain has barely achieved 5% of the 2030 target and reaching this objective will require a heavy investment budget of €12.248 - €13.231 billion. Conversely, although this amount may seem very high it represents less than a third of the annual expenditure on fossil fuel imports.

This study does not focus on the investments or the number of charging points needed, but rather on evaluating their distribution in light of the nature of the territory and social cohesion factors. As in many other aspects, inland areas of the Spanish mainland have lower population densities and are often disconnected from the main communication corridors. In addition, these areas face particularly complex difficulties due to the limited investment attractiveness of a sparse and dispersed population for economic agents, who view these people less as citizens and more as a potential market.

When approaching climate change as a global problem which the whole of society must contribute to locally, it is essential to ensure that economically, socially or geographically disadvantaged groups are not left behind in the solutions. **If solely investment and profitability criteria are applied when developing infrastructure, there is a risk of creating a situation where sustainability becomes a luxury world** of high-end electric vehicles and expensive home geothermal installations and energy storage batteries which are beyond the reach of the majority of the population. **The transition must be by and for everyone.**

In this context and in light of the firm commitment to electric mobility as a fundamental axis to achieve decarbonisation of the transport and mobility sector, the electric vehicle charging infrastructure must be developed to eventually allow charging of electric vehicles throughout the territory. **This study evaluates whether the current development of this infrastructure network follows a strategy that favours more densely populated urban areas to the detriment of rural Spain.** If that is the case, corrective measures must be introduced in the investment strategy. **The study offers an overview that will lay the groundwork for subsequent more specific and transversal analyses.**

It defines specific areas for evaluation of the availability of public charging points, using **Geographic Information System (GIS)** tools to generate results with cartographic images and numerical indicators. This allows an assessment as to whether rural (inland) areas in Spain are lagging behind in the early stages of the process to develop the electric vehicle charging network.

The development of the charging infrastructure on the islands is considered to be subject to unique conditions specific to their situation, with greater reliance on availability of domestic charging points and especially infrastructure for tourism, the economic sector that places the most vehicles on the roads of both archipelagos. Moreover, the distances and topography influence mobility very differently in these territories. To avoid mixing different realities, this study focuses solely on the Spanish mainland, differentiating three study areas:

- Territories close to the national road network
- Urban areas
- The rest of the territory: rural areas far from national roads.

To define the first zone and main object of the study, we relied on data from the National Geographic Institute (IGN) through the download centre of the National Centre for Geographic Information (CNIG)[7]. The entire **State Road Network (RCE)** was selected, which covers the entire peninsula with the exception of Navarra and the Basque Country.

In order to include Navarra and the Basque Country in the study, the main roads were selected from the transport GIS of the CNIG for these provinces, treating them as the equivalent of the national roads in these territories.

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[5] https://ecodes.org/hacemos/cambio-climatico/incidencia-en-politicas-publicas/seguimiento-de-politicas-de-transporte-y-movilidad/estudio-sobre-el-despliegue-de-la-infraestructura-de-carga-del-vehiculo-electrico

[6] According to the Spanish Directorate General of Traffic (DGT), there are currently around 24.5 million light vehicles on the road in Spain.

[7] http://centrodedescargas.cnig.es/CentroDescargas/catalogo.do?Serie=REDTR

Taking into account the above considerations, the study defines a road network for the Spanish mainland which links the traffic between the main population hubs and the surrounding countryside, locating the positions of each of the charging points with great accuracy. The availability and frequency of these charging points is compared with those present in urban areas and in rural areas distanced from main roads, where the positioning is not as precise. For this purpose, a database was created with the number of charging points and connectors and the types of installations in urban areas, although their exact position on the urban road network is not specified. The reasoning is that once within an urban area its charging points are always widely available. The aim of the study is not to determine the accessibility of urban charging points within each city but rather to compare urban availability as a whole with rural territories, which may or may not be crossed by main national roads.

When defining the urban areas to be considered we used the Statistical Atlas of Urban Areas of the Ministry of Transport, Mobility and Urban Agenda (MITMA), more specifically the document 'Urban Areas of Spain 2021'[8], which identifies 84 urban areas and their corresponding municipalities. Before applying this list of municipalities directly, it needs to be taken into account that urban areas or cities are not necessarily the same as the municipalities in which they are located. Applying this correction, 78 effective mainland urban areas were established with a total surface area of 15,459 km^2, compared to the total surface area of these municipalities of 45,292 km^2.

[8] https://apps.fomento.gob.es/CVP/handlers/pdfhandler.ashx?idpub=BAW087

Main results

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This report is the most comprehensive study to date regarding the current situation of electric vehicle charging points in relation to surface area and population. It proposes where to locate charging points and of what charging level in order to achieve balanced territorial development and dynamise rural areas in Spain through electric mobility. Currently, electric vehicles cannot replace ICE vehicles due to the absence of a public charging infrastructure equivalent to the petrol station network.

The Integrated National Energy and Climate Plan approved by the Spanish government set a target of 5 million electric vehicles in Spain by 2030, including cars, vans, motorcycles and buses, without including specific targets for the connectors or the actual charging points themselves. It is evidently vital to have adequate public and private infrastructure where these vehicles can recharge their batteries in order to achieve this target.

Meanwhile, the Law on Climate Change and Energy Transition passed in May 2021 mandated the Spanish Government to make information on charging points available to the public within one year of its enactment. In addition, section 15 obliges service stations to install charging points based on their aggregate annual volume of petrol and diesel sales. Those with higher volumes are required to install at least one 150kW charging point, while for those with lower volumes (5-10 million litres) the required capacity is 50kW. As for the rest, no requirements have been established at all. These are clearly insufficient targets which reaffirm the conclusions of this study, since the charging points will be located where there is more traffic without taking into account social aspects and territorial structuring.

To sum up, this report reaches the following **conclusions**:

1 Various estimates have been made of the infrastructure needed to guarantee the transition to electric mobility. According to the report by EVERIS for T&E , in collabotarion with ECODES, on public charging for electric vehicles, between 222,901 and 289,130 connectors will be needed by 2030. Meanwhile, FACONAUTO - ANFAC estimates a total of 340,000. These targets seem far-fetched, with an estimated current total according to our report of only 5,950 charging points and 16,014 connectors on the Spanish mainland eight years from that date[9]. In order to reach even the lowest of the above figures in only eight years, 25,861 connectors would have to be installed each year, **multiplying the current rates by more than 1.5 per year.**

2 **The current distribution of charging points is strongly conditioned by the commercial supply and demand strategies** of mainly privately-owned entities (93%), meaning that there is a strong preference for their location in the most densely populated areas.

3 **Less than 5% of the distances on the main road network** currently meet the criterion of 60 km between high-capacity charging points.

4 **The current distribution of charging points is mainly located in urban areas**, where market actors consider that the demand is concentrated. There is much lower availability along the main road network and a token presence in rural areas, which account for more than four-fifths of the territory. The 'high' relative availability of charging points in relation to population in rural areas is largely an illusion, given that it is of no use to rural inhabitants if they have to travel long distances to reach them. The surface area per charging point is highly unbalanced, currently standing at 349 km^2 in rural areas and 4.11 km^2 in urban areas.

[9] The methodology applied in this study considers that when several connector support structures are located in the same place they are considered as a single charging point. This criterion may not have been applied in other studies. In addition, this study solely considers the mainland charging network, excluding charging points in the Canary Islands, the Balearic Islands and the autonomous cities in North Africa.

5 Urban areas account for most of the charging points in mainland Spain (69%), with the remainder being distributed relatively evenly between the other two territorial areas. **Nearly 7 out of every 10 charging points in mainland Spain are located in large and medium-sized urban areas.**

6 **Only 2% of the connectors currently operating have a capacity of 150 kW or more**. On the main road network the imbalance is somewhat less pronounced (5%) while in rural areas it is even higher, with only a token 0.7% having this capacity.

7 Even though the rural population is much smaller at fewer than 5 million inhabitants, they should not be deprived of the same level of services as urban areas. **Failure to develop the charging network throughout the territory would condemn the rural environment to reliance on ICE vehicles.**

8 If we consider the map of the total length of main road sections between total charging points, it can be seen that **the longest sections are generally located in the inland areas of the mainland, while the Mediterranean and South Atlantic coastal zone has much better coverage.** Virtually none of the provinces along this coastline have road sections between charging points longer than 60 km.

9 In absolute terms and in terms of the relative distribution of charging points per surface area, there is also **a clear preference for location of charging points on the south-eastern coast of the Spanish mainland** and in larger urban areas, with inland areas and the northern coast lagging well behind.

10 The current outlook is particularly bleak for high-capacity charging points, as can be seen on the map. Except in the vicinity of large urban areas, especially on the Mediterranean coast, it is very difficult to find road sections between high-capacity charging points with a length of less than 60 km. **Nearly 8 out of every 10 km of the main road network consists of sections of more than 60 km between fast charging points.** This makes it impossible to develop electric vehicles as a regular means of intercity transport.

11 **The current development of the high-capacity network is negligible and merely token in nature**. Currently, only one out of every 50 public connectors has a capacity of more than 150 kW, and although for strategic reasons of the service providers they are generally located on the main road network, the absolute figures are abysmal. The situation is even worse in rural areas far from the main roads, which theoretically account for more than four-fifths of the mainland surface area and only have 17 connectors: practically as if there were none at all.

12 **The deployment of high-capacity connectors is conditioned by two main factors**. On the one hand, more than two thirds of charging point installation initiatives are undertaken by corporate or public entities, where achieving a long customer dwell time on the company's premises forms part of the business strategy. The installation of charging points is therefore seen as an additional service provided as a courtesy to customers/users, however high charging capacities would in principle not be in the immediate interest of the business due to the reduction in dwell times.

13 There is a second aspect relating to capacity/charging speed which will likely prove to be fundamental for the transition to an electric vehicle fleet: for a charging point to be able to offer a high power output, **the electricity grid must have adequate transformation facilities.** This poses a challenge in terms of investment in the electricity grid, and it is essential to ensure that less densely populated areas are not left behind, given that initiatives to provide fast charging points in rural areas will only succeed if the connectors have access to the necessary power.

14 Looking at the availability of connectors in relation to population, it can be seen that the south-east coast has the best coverage of the four regions, although surprisingly the overall ratio of the other regions is better, possibly because of the smaller population as a whole and the relatively low coverage of the three large urban areas in the interior. The coverage of connectors on the south-east coast is clearly better than in the rest of the regions as a whole. The poor situation in inland areas is gradually improving, while the north coast has the worst coverage. This latter circumstance is confirmed by the distribution of connectors according to capacity. Apart from identifying the privileged situation of the south-east coast in the case of low-capacity connectors, it also confirms the **very poor situation of the north coast in terms of high-capacity connectors.**

15 **The very limited coverage of high-capacity charging points is very much due to strategic reasons**. It reflects the recharging needs for long-distance movement of electric vehicles between Madrid and the surrounding territory, the reason why these charging points are located halfway between.

By Autonomous Communities

There are two indicators that clearly reflect the different situation in Spain according to autonomous communities (which ones are less backward than others: none may stake a claim to being advanced in this area).

Madrid tops the ranking in terms of ratio of surface area to high-capacity connectors, which is not surprising given the urban nature of much of the region. The other autonomous communities where each high-capacity connector has a ratio of less than 1,000 km^2 clearly coincide with the most urbanised regions, perhaps with the exception of Murcia. The autonomous communities with the highest proportion of rural territory generally exceed 2,000 km^2 per connector, and in four of them there are none at all. All of the above reinforces the conclusion that market forces have so far encouraged positioning of the best charging points in the most densely populated areas, to the detriment of a more homogeneous territorial distribution.

Autonomous Community	km^2/connectors > 150 Kw
Madrid	309
País Vasco	556
Comunidad Valenciana	597
Cataluña	671
Murcia	870
Aragón	1,989
Andalucía	2,190
Extremadura	2,316
Castilla-La Mancha	2,836
Castilla y León	2,945
Asturias	5,305
Galicia	No high-capacity connectors
Cantabria	No high-capacity connectors
Navarra	No high-capacity connectors
La Rioja	No high-capacity connectors

Table 5.1. Surface Area / High-capacity connectors.
Source: prepared by the authors based on *Electromaps*.

When considering the distribution of the sections of the main road network, the conclusions are different due to the fact that only roads outside urban areas are considered in these sections.

Autonomous Community	% sections > 60 km without high capacity
Castilla y León	74.11%
País Vasco	76.74%
Comunidad Valenciana	76.81%
Aragón	80.88%
Madrid	86.44%
Murcia	94.01%
Andalucía	94.04%
Castilla-La Mancha	96.14%
Cataluña	98.81%
Extremadura	99.17%
Asturias	99.93%
Navarra	99.95%
Galicia	100.00%
Cantabria	100.00%
La Rioja	100.00%

Table 5.1. Surface Area / High-capacity connectors.
Source: prepared by the authors based on *Electromaps*.

1 **Only Castilla y León has at least a quarter of the length of its main roads (according to the criteria defined in this study) in sections of less than 60 km between high-capacity charging points, with the Basque Country and the Valencian Community having similar values.** It seems that the presence of charging points in cities is more influential in this respect than the distribution on interurban roads. The other 10 autonomous communities do not even have 10% of their road network within the 60 km limit, and in the case of three of them they have none on their entire national road network.

2 **In Galicia, Cantabria, La Rioja and Navarra there is not a single high-capacity connector in their entire territory.** These 4 regions are joined by 9 provinces: Castellón, Guadalajara, Guipúzcoa, Huesca, Jaén, Palencia, Segovia, Soria and Teruel. In total, there are no (super) fast charging points in 16 zones. It should also not be forgotten that taken together these zones comprise 140,0002 km of the national territory. In other words, on 28% of the surface area of mainland Spain there are no high-capacity charging points at a provincial level.

3 **The availability in term of connectors reflects similar values, with six times more presence on the south-east coast than in rural provinces, which lag well behind the other three regions.** It has also been confirmed that while large urban areas have fewer charging points in relation to the population, they are very highly concentrated in terms of territory. While on the south-east coast there is a connector every 13 km^2, in the provinces of Madrid, Seville and Zaragoza there is a connector every 14 km^2. The north coast is not far behind in terms of total and low-capacity connectors, but the deficient situation of high-power connectors is confirmed in this region, where there is only one connector for a little over 14,000 km^2, twice the entire surface area of the Basque Country.

4 **The availability of charging points in relation to surface area confirms that the situation of the south-east coast is the best of the whole territory** and modulates the apparently good results of rural areas in terms of population. The low population of the inland provinces may suggest good relative availability for the population, however in practice the dispersion over such a large territory results in very low effective availability. There is only one charging point every 200 km^2, while on the south-east coast and in the big cities there is one every 31 km^2 and 43 km^2 respectively.

These are some of the conclusions that may be drawn from this study. As noted at the beginning, this report is intended to provide an overview, meaning that it will be necessary to determine the actual situation and its evolution following subsequent developments which place a focus on more specific key areas or interests for the promotion of electric mobility in Spain, with the ultimate goal of developing the charging infrastructure as the fundamental pillar of this process. Moreover, it will also need to be assessed in view of the scenario existing at that time. It should not be forgotten that significant investments are contemplated under the Recovery, Transformation and Resilience Plan, and they must be used to address this situation. However, it must also be borne in mind that public and private investment need to complement each other, for that is the only way to guarantee territorial structuring and social cohesion when extending electric mobility across the country.

Recommendations 3

1 Spain must give **a huge boost** to the deployment of recharging points, especially high-powered ones on the National Road Network. Petition also for the road network that falls under the competence of the regions. A joint effort by public administrations, the private sector and civil society organisations that are interested. This requires a huge effort, as there are currently only 49 charging points with high-capacity connectors, the equivalent to current petrol stations. More than 9,000 service stations in Spain[10] need to be converted to electric vehicle charging points with an adequate number of connectors and, above all, adequate power supply.

2 It is **essential to ensure that less densely populated territories are not left behind**, given that any initiative to provide fast charging in rural areas will only be successful if the connectors have access to the necessary power supply. If the market is not complemented by public investment in more sparsely populated territories, especially in terms of power transformation capacity, the so-called 'empty Spain' will be left behind and the decarbonisation and transformation of the transport and mobility sector will follow two different paths, one 'fast' and the other 'slow', thereby further widening the gap between the 'two Spains'. This situation leads to clear economic disadvantages and social inequalities which ultimately also contribute to depopulation.

3 **The energy/fuel distribution sector must assume a decisive role** to offer a specific service that replicates the experience of travelling in an ICE vehicle.

4 The **electricity grid** must be **boosted** and equipped with adequate transformation facilities, given that the secondary aspect of capacity-charging speed will likely prove to be fundamental for the transition to an electric vehicle fleet. Investments must be made in the electricity grid so that charging points can offer high power outputs. In this sense, it is essential to ensure that less densely populated areas are not left behind, given that any initiative to provide fast charging points in rural areas will only be successful if the connectors have access to the necessary power supply.

5 **This network is urgently needed** (with the targets set being only 8 years from now) and the stakeholders most directly involved, particularly companies in the energy sector, must lead the way for the construction of this network so that electric vehicles can replace ICE vehicles.

[10] https://www.dieselogasolina.com/buscador-gasolineras.html

6 All the above entails a need for **major investment**. The public contribution towards this amount should assume as a priority objective the development of a fast charging network that covers the whole territory without leaving behind less densely populated rural areas. A significant part of public investment should therefore be oriented towards this objective, given that private investment will obviously focus on the territories where it is most profitable.

7 **The authorities must regulate and prioritise the development of the fast charging network** so that it covers the whole territory. For example through a funding scheme for the installation of recharging points in municipalities with more than 1,000 inhabitants. Through the Next Generation funds, establish a programme aimed at promoting the installation of, at least one ultra-fast public access recharging point in a suitable location within the urban core.

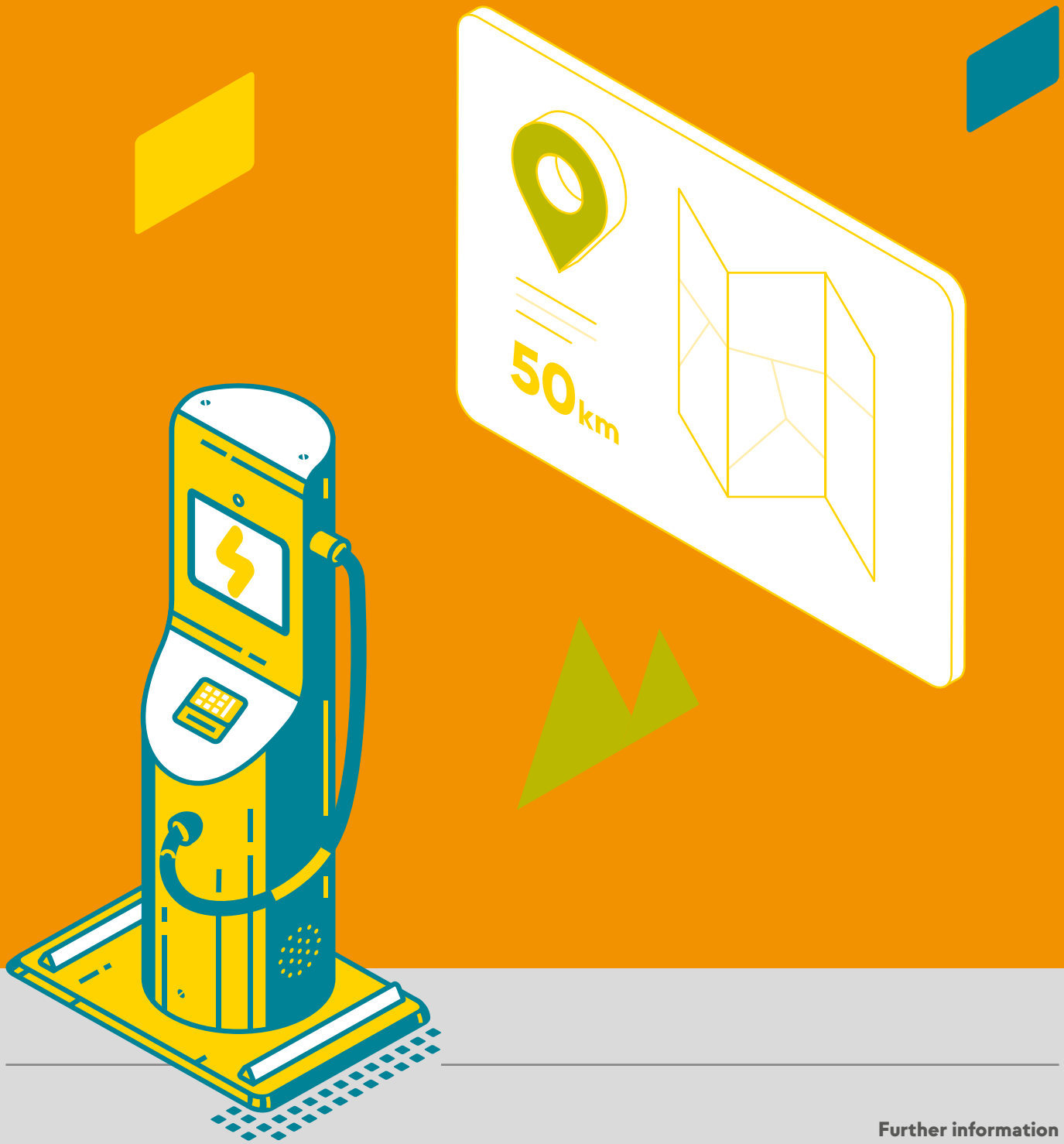
8 **It is necessary to hybridise renewable energy installations in Spain with new charging points**. As these installations will mostly be located in rural Spain, they should have very advantageous prices for the inhabitants of these territories and also for users of certain routes that are considered by public authorities to be a priority.

9 **Aid and tax benefits** should be promoted for individuals and companies related to points of interest in Spain — especially areas with less traffic density — so that they commit to the implementation of charging points both in homes and establishments located in urban areas and/or on roads of all kinds.

10 It is essential that both the government and energy companies establish concrete measures to eliminate **the barrier effect** for the implementation of electric mobility in general and charging points in particular **deriving from high electricity prices**.

11 **Launch of a nationwide information campaign on the installation of recharging points in homes:** requirements, subsidies, procedures and direct contacts. Creation of virtual spaces on the websites of municipalities and regions websites where the available information is centralised and easily accessible.

12 **As soon as possible, the Ministry for Energy Transition and Demographic Challenge should launch a database and interactive map with information about the availability, location and typology of connectors, among other relevant.**



Further information

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