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RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE ET SOLIDAIRE

MINISTÈRE DE L'ÉCONOMIE
ET DES FINANCES

ÉTUDES ÉCONOMIQUES

ANALYSES

Electric vehicle charging infrastructure

Summary

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DGE
DIRECTION GÉNÉRALE
DES ENTREPRISES

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Attention

The methodology used for this study and the results obtained are the sole responsibility of the service provider which conducted it, namely Coda Stratégies. Neither the Directorate General for Enterprise (DGE), the Directorate General for Energy and Climate (DGEC) nor the ADEME (French Environment & Energy Management Agency) are liable in this respect.
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SUMMARY

INTRODUCTION

France's Multiannual Energy Program (MEP)[1] has set a goal of 2.4 million electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEV), both private and commercial, by 2023; a 12-fold increase over the current situation. This deployment must be accompanied by the strong growth of an electric vehicle charging infrastructure (EVCI), being the only way to reassure future owners, and guaranteeing them a comfort of use comparable to that which they are able to enjoy with their internal combustion engine (ICE) vehicle. To support this development, the public authorities have set themselves particularly ambitious targets for the deployment of a charging network with 50,000 charging points (CPs) available to the public by 2020 and 100,000 in 2022 in accordance with a ratio of 10 electric vehicles per CP envisaged in the Strategic Contract of the Automobile Branch (SCA).

Launched in January 2013 and now completed (having come full term), the assistance system set up under the Investments for the Future Program (IFP) has enabled the deployment of nearly 22,000 charging points (August 2018 - Source GIREVE). This effort leads to a greater visibility of this infrastructure, an important factor in the purchasing decision of potential buyers.

In parallel with the development of public charging infrastructure, the regulatory framework is evolving in order to encourage the development of equipment in private spaces: commercial zones, condominiums, company car parks, etc. The Energy Transition for Green Growth Act (ETGGA) has set a target of 7 million private and public CPs by 2030. In this context, it has introduced certain provisions aimed at strengthening the investment dynamic, as for example the obligation to pre-equip parking spaces in new and existing buildings.

The standardisation and normalisation of the EVCI is a prerequisite for their mass development, both for efficiency reasons in their production and for user acceptance. The transposition of Directive 2014/94/EU into French law, notably via the decree of January 12th 2017, has made it possible to set a number of elements concerning charging outlet standards, energy management and control of charging, roaming and interoperability, and the installation and maintenance of infrastructure.

Finally, it is through financial and fiscal incentives that public authorities encourage the development of EVCIs. Thus, a tax credit of 30% is granted to households installing a charging station, while companies, public entities and landlords, under the Advenir program framework, can benefit from additional financing through the mobilisation of environmental "energy saving" certificates.

In an emerging and immature market, the concerted action of actors in the ecosystem is a crucial factor for success. The implementation, by the National Council of Industry initiative, of the SCA, which integrates an action plan for a limited number of high-stakes structuring projects, aims to mobilise all market stakeholders. From a set of reciprocal commitments by the actors involved, a revitalisation of the industrial fabric and service offerings in this area is expected.

In this context of strong commitment from public authorities, the DGE (*Direction Générale des Entreprises*)[2], the ADEME (*L'Agence de l'Environnement et de la Maîtrise de l'Energie*)[3] and the DGEC (*Direction Générale de l'Energie et du Climat*)[4] wanted to carry out a study making it possible to draw up an inventory of the current achievements and, especially, to identify the factors guaranteeing a relevant deployment of the EVCI.

In order to take stock of current achievements, but also to identify areas for improvement, this study is divided into five parts. The first part aims to establish an inventory of the development of charging infrastructure in France. The second part provides an international benchmark through the detailed analysis of three markets (California, Japan, Norway). This has identified several "best practices" in terms of infrastructure deployments. The third part of the study is devoted to a qualitative analysis of stakeholder needs, expectations and positioning vis-à-vis charging infrastructure deployments, and to infer key success factors for France. On this basis, the fourth part of the study focuses on a quantitative assessment of charging infrastructure needs, in particular as a function of the expected evolution of the fleet of electric vehicles. Finally, on the basis of the lessons highlighted by the previous chapters, a series of operational recommendations, addressed to both public authorities and private actors, can be put forth.

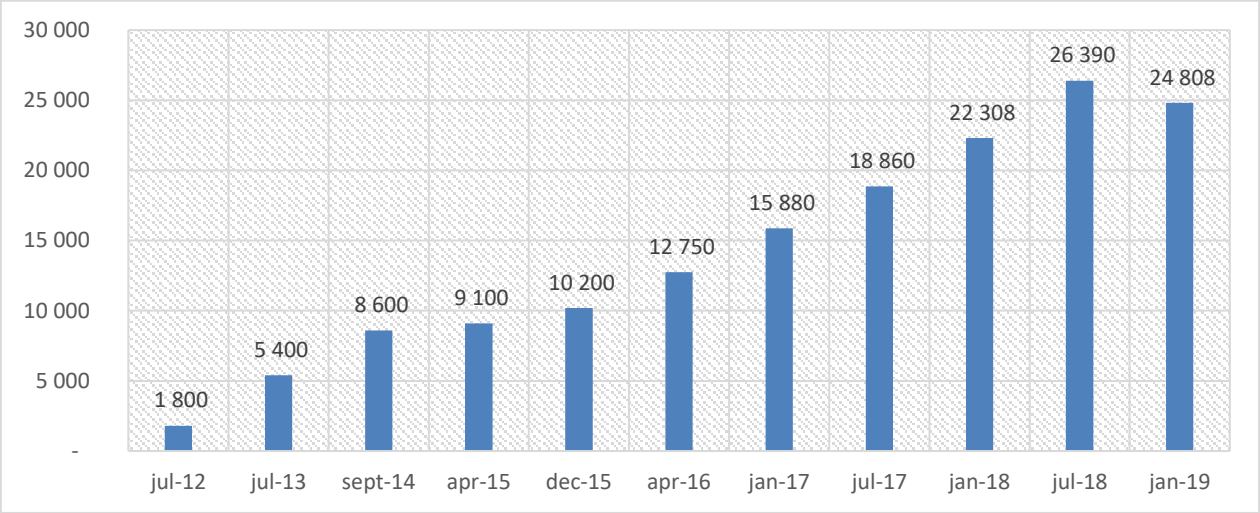
[1] *Programmation Pluriannuelle de l'Energie* in French
[2] General Directorate for Business
[3] The Department for Energy and the Environment
[4] General Directorate for Energy and the Climate

THE DEVELOPMENT OF A CHARGING INFRASTRUCTURE IN FRANCE

Charging infrastructure is developing rapidly, but the goal of universality still remains to be achieved

The financial, fiscal and regulatory incentives put in place by the public authorities and outlined in the introduction of this document, have led to a significant development of the EVCI open to the public in recent years. In the five years from July 2013 to July 2018, the number of charge points has grown fivefold. The closure of the Autolib' network, which occurred in the summer of 2018 has, however, introduced a rupture to this growth, without calling into question the much more favourable availability of this type of infrastructure for electric vehicles used outside the car sharing framework. This growing availability of infrastructure supports solid growth of the electric vehicle market: 39,000 electric vehicles (EVs) and 13,000 plug-in hybrid electric vehicles (PHEV) were registered in 2018, a year-over-year growth of 28%. In January 2019, the fleet of electric vehicles reaches 206,100 units (167,400 EVs and 38,700 PHEV).

Charging infrastructure open to the public: evolution of the number of charging points available, over the period July 2012 - January 2019



Source: GIREVE

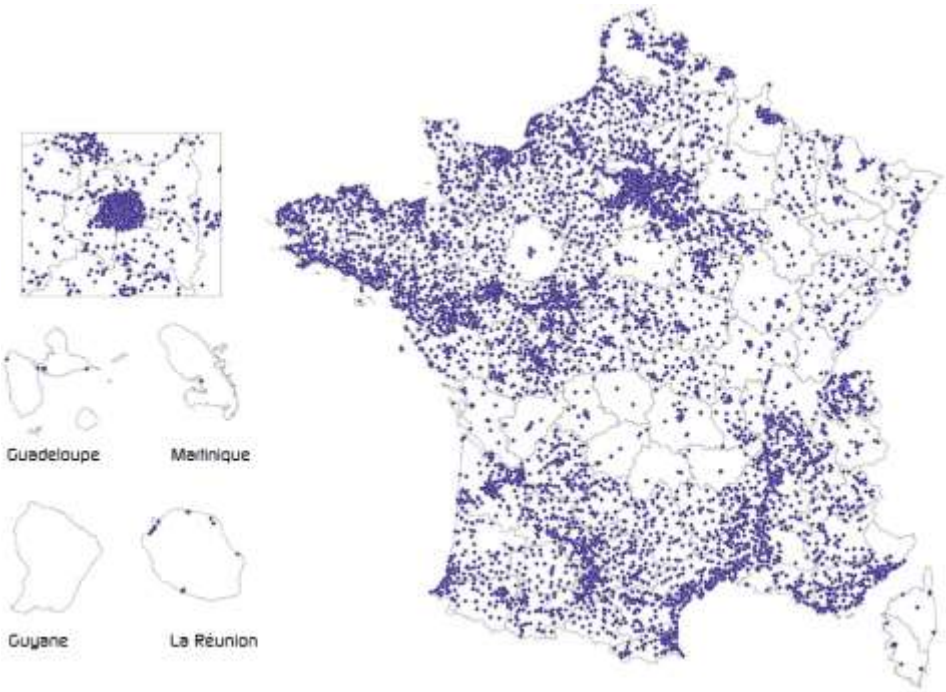
The deployment of charging stations in France is broadly in line, in purely quantitative terms, with the recommendations of the 2014 European Directive (Com 2014), recommending a ratio of 1 charging point for a maximum of 10 electric vehicles. According to the GIREVE[5] data, in January 2019, the national average is 1 CP for 6.7 EVs and 1 CP for 8.3 EVs and PHEVs.

This overall growth is accompanied by significant disparities at the territory level, both at the departmental and regional levels. The Ile-de-France region, currently penalised by the shutdown of the Autolib' network, appears to be relatively behind in terms of density of charging points. Other regions, such as Brittany, Normandy and the non-coastal areas of Occitania and New Aquitaine benefit, in contrast, from a more intensive deployment.

The risk of "white areas" of publicly available electric charging remains real today. Thus, for example, there are only 2 charging stations in the Creuse *Département*, 5 in Haute Loire, and 6 in Cantal. Such a situation jeopardises the development of the EV market in these areas and, more generally, hinder the use of an EV as the main vehicle, because of potential doubts regarding the possibility of easily recharging a vehicle on long journeys.

[5] Groupement pour l'Itinérance des Recharges Électriques de Véhicules, referencing public charging infrastructure in Europe

Charging stations open to the public (10,491 stations, 24,808 RPs), as of 1 January 2019

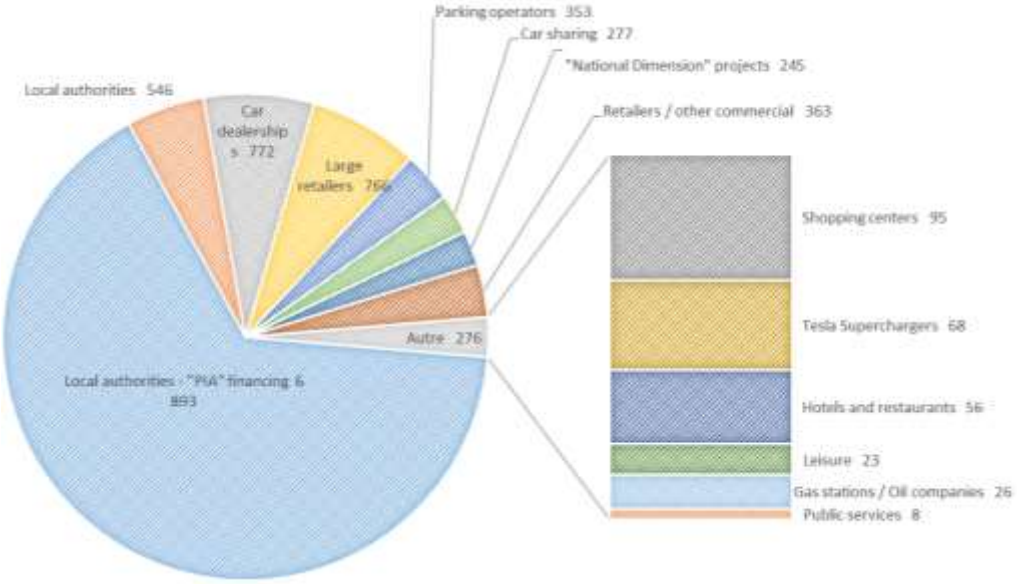


Source: GIREVE

Local authorities play a decisive role in the provision of EVCI in France. According to the information gathered by GIREVE, as of 15 September 2018, local authorities have directly deployed 70% of the charging stations open to the public in France (6,723 stations). Most of these deployments (94%) have received financial support under the IFP, demonstrating the relevance of this arrangement and synergies between the local and the national levels.

Car dealerships and retail chains also play a significant role in the deployment of these infrastructures, as shown in the chart below.

Charging stations open to the public: breakdown by developer category as of January 2019



Source: GIREVE

More than 85% of these stations offer a so-called "normal" charging, up to 22 kVA (of which 53% operate at this power level and 32% at 18 kVA or 3.7 kVA). "Fast" charging stations mainly offer power levels between 40 kVA and 50 kVA and they are largely located, logically, along national roads and highways.

While it can therefore be generally considered that EVCI has, in recent years, been deployed in a manner consistent with the objective of rapidly developing the electric mobility market, the current charging infrastructure remains marked by a high level of heterogeneity in its technical characteristics, its modes of access and in its pricing principles. In this respect, from the point of view of the user, the infrastructure cannot at this stage be considered as a universal infrastructure accessible anywhere and at any time in a simple and transparent manner. Pricing practices, which remain highly differentiated, as well as the limited interoperability of payment methods, are causing real difficulties for users wishing to undertake long journeys. The testimonies collected by CODA Strategies during the realisation of this study show that the pricing and interoperability constraints are at present such that they limit the practice of long-distance travel to owners of high-end vehicles that can rely on dedicated charging networks, or enthusiasts, ready to overcome the heavy burden of long distance EV travel.

Infrastructure Deployment, Financing and Management: Lessons from the Field Survey

In order to better understand the dynamics underlying the current development of EVCI, a specific survey has been carried out by CODA Strategies with both public and private operators.

Public operators and developers

45 public operators, having deployed 2,900 charging pillars (usually with 2 charging points per pillar), to date, responded to the survey. For the record, data published by GIREVE show around 6,700 charging pillars installed directly by local authorities. Under these conditions, with a coverage rate of more than 40%, the sample can be considered as representative of the reality of public EVCI deployment.

The survey carried out demonstrates the pre-eminence of energy federations ("syndicats d'énergie") in the management of EVCI deployment. These actors represent nearly 70% of respondents to the survey. This situation is easily explained by the missions traditionally assumed by these players (development of the electricity network, the public lighting network, etc.), in strong technical synergy with the deployment of EVCIs.

Municipalities and public institutions of inter-municipal cooperation (IMC) tend to rely on the energy federations electrical competence and only take on the tasks of deploying EVCI in less than 30% of cases.

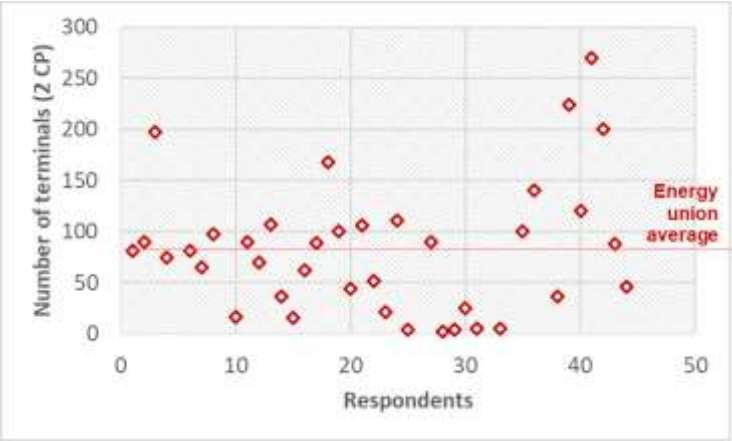
A wide variety of initiatives and usage heterogeneity

The projects mentioned by the public developers are very heterogeneous in size, ranging from a few terminals for smallest to several hundred for the most important ones. As a result, the average of 98 terminals per project is not very representative, as shown in the graph opposite.

Most of the deployed terminals incorporate two charging points.

The nature of the territories under consideration has a very significant impact on the localisation of the terminals. If the highly urbanised territories prefer roadside deployments, the energy federations, operating mostly in rural areas, prefer to deploy EVCI in public car parks.

Number of terminals installed in the projects considered

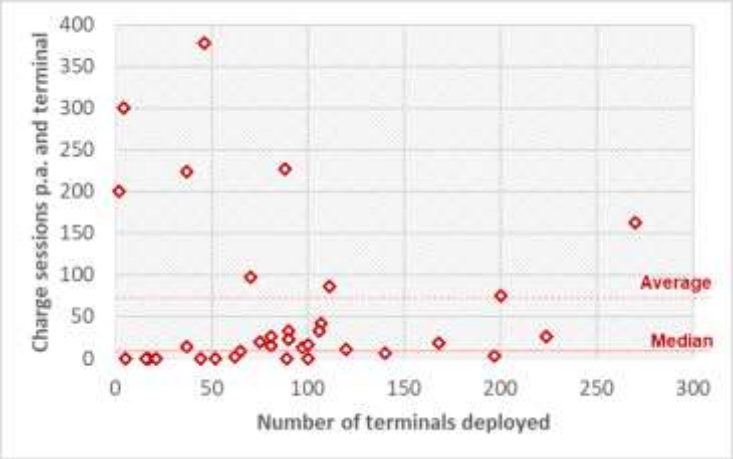


EVCIs are not immune to the traditional issue of critical threshold effects between infrastructure deployment and the usage development. In fact, the average number of charging sessions per terminal and per year remains limited today, with an average figure of 86 charging sessions per year per terminal; a modest number which is inflated by a few cases of much more intensive use. The median of the sample, more representative in this case, remains very low and reflects a situation in which infrastructure availability precedes usage development and is one of its preconditions.

This low infrastructure use must be analysed within a context of recent deployment, and whose technical characteristics are not always stabilised.

In all the cases identified by the survey, the figures are rising and, in most cases, the increases are significant.

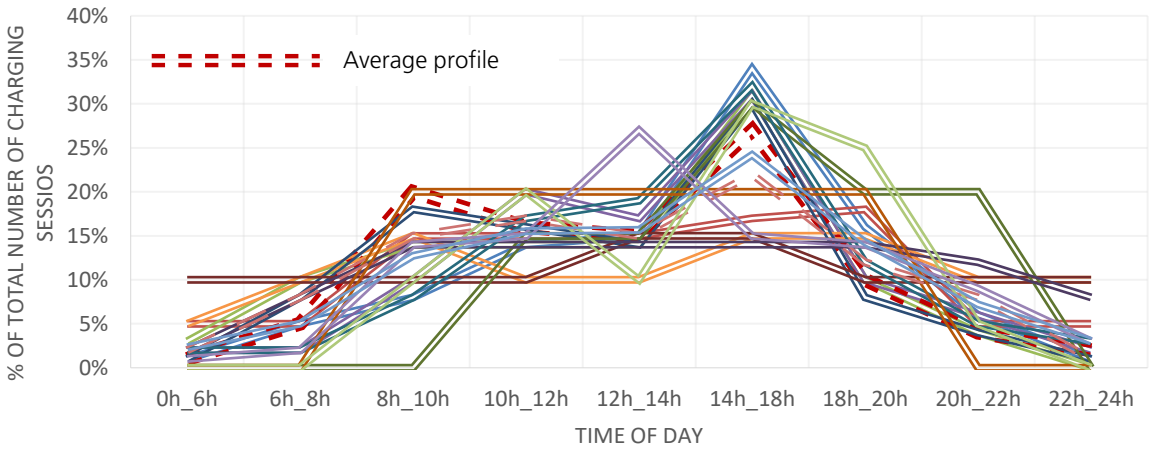
Yearly number of charging sessions per terminal (depending on the number of terminals deployed)



Average utilisation levels show large disparities within the same territory. It thus appears that on average, the upper quartile of the most used terminals generates more than 55% of total charging. Conversely, the least used quartile of terminals generates only around 7% of total charging. Such a disparity is not in itself surprising and corresponds to the willingness of local authorities to implement homogeneous territorial coverage, with the aim of providing a public service.

The way charging infrastructure is used mainly corresponds to extra usage, as evidenced by the concentration of charging made during business hours. The peak of use is observed between 2pm and 6pm, a period which corresponds on average to more than 25% of charges. Such a profile suggests that users, as advised by professional associations or manufacturers, will charge their vehicles as soon as they have the opportunity. It also seems to indicate that these charging points are not, for the most part, used for night charging in the context of residential parking.

Daily usage profile of EV charging infrastructure



Source: CODA Strategies Survey. Question: What is the average daily usage profile of the EVCI (over the entire network), as a % of the total number of charges, according to the proposed timeslots. Key to graph: each curve represents an answer. The breakdown is made by respondents, in % of the total number of charges, on the timeslots indicated. For example, on average, almost 20% of the total number of charges are made between 8:00am and 10:00am.

Average charging time is relatively short, around 2 hours, but the median is also more representative, insofar as some public operators report very long average durations. Thus, half of the charges last less than 1h30, and only 19% more than 3 hours. In general, it seems that infrastructure operators manage to avoid "leech parking".[6]

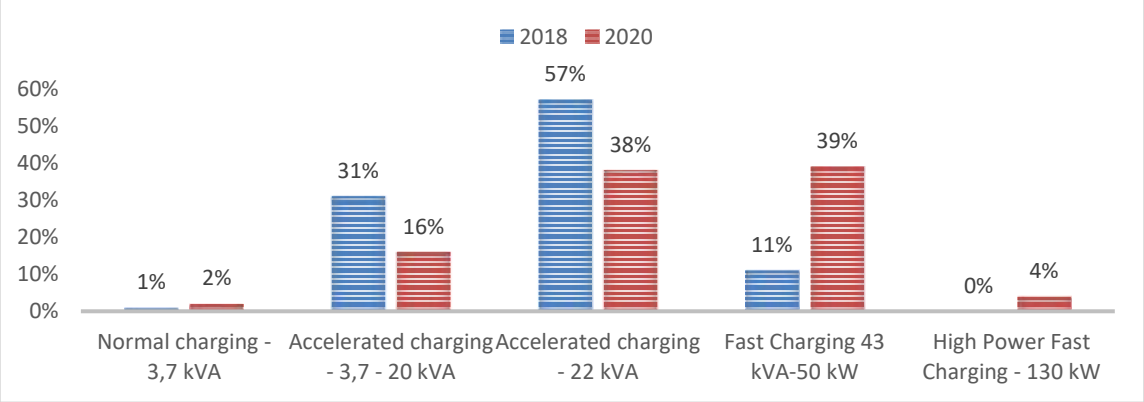
In almost two-thirds of the cases, recharging takes place within the framework of a subscription contract entered into by the user with the territory's EVCI operator. Usage on the spot or with a subscription entered into with another operator corresponds to the remaining third. It can then be used for long trips or shorter ranges (for example home-work commuting or shopping trips). The very wide disparity in the pricing conditions and the payment support used complicates the use of these infrastructures by non-subscribers and, consequently, limits the development of roaming. More specifically, a user wishing to use an infrastructure for which they are not a subscriber will not know in advance the pricing conditions that will be proposed to her, or even if her payment means will be recognised and accepted.

Expected progress in deployments in the short and medium term

Nearly 60% of survey respondents intended to upgrade their EVCI networks by the end of 2018. For the majority of them, these were projects already launched, taking place in 2018. These different projects should lead to an increase of more than 15% in the number of charging points and almost 20% in the number of stations deployed. By the year 2020, the reported projects carry an additional increase of about 10%, both in terms of the number of stations and the number of charging points.

For 2018, more than half of the projects involved the implementation of "accelerated"[7] charging stations, while the deployment of "normal" charging points was almost abandoned. It is important to note that, technically, the 3.7 kVA - 22 kVA charging points can deliver a maximum power of 22 kVA. Intermediate values between 3.7 kVA and 22 kVA correspond to subscribed power choices from the energy supplier and not to the intrinsic performance levels of the charging points. By 2020, a clear evolution of projects is perceptible, with an increase in fast[8] charging at the expense of normal and "accelerated" charging. At the same time, very high-power charging projects are appearing.

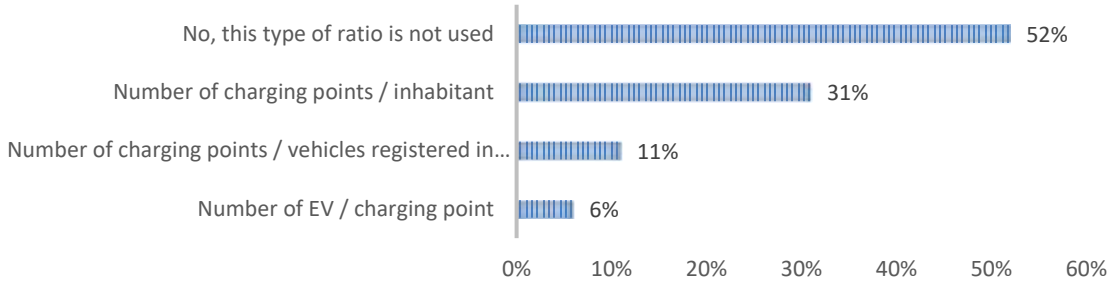
Breakdown of charging point deployment projects by power level, towards 2018 and 2020



The criteria used to define future deployments and determine their location remain very heterogeneous, or do not even exist. About half of the respondents to the survey stated that they did not use specific ratios[9] to measure the effectiveness of their network, or simply integrated the indicators introduced by public authorities as a condition for obtaining subsidies. Some respondents did consider using certain ratios but dismissed this possibility because of either calculation difficulties (for example, lack of information on the number of electric vehicles registered in the area) or because the indicator did not seem relevant (for example the use of "number of charging points / population" or "number of charging points / EV" ratios for territories with a strong tourist or transit activity).

[6] A 'leech' vehicle is a vehicle parked in a place dedicated to electric charging without effectively recharging or long after recharging.
[7] "Accelerated" charging occurs at a maximum power of 22 kVA.
[8] "Fast" charging occurs at power of at least 43 kVA / 50 kW.
[9] For example, "terminal / number of inhabitants in the area" ratios, "terminals / locally registered vehicles", etc.

Ratios used for determining an EVCI of optimal size, in the sample

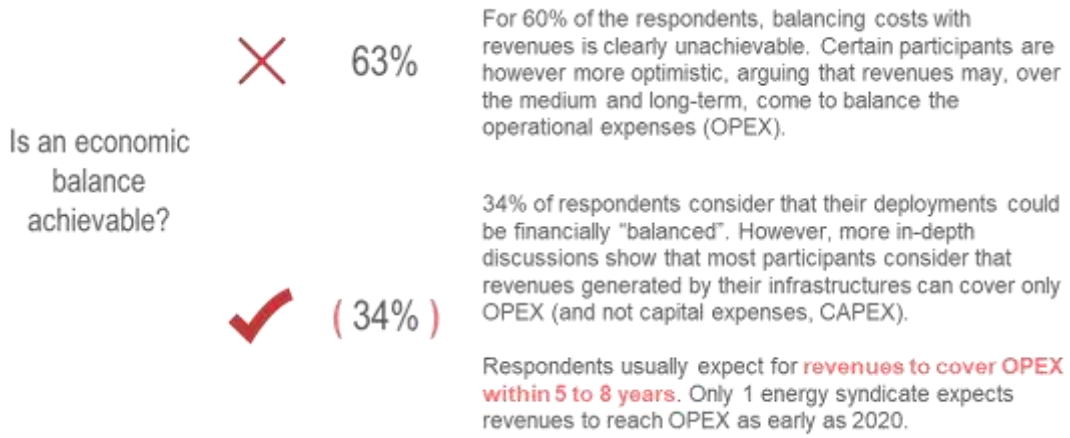


For the purpose of sizing the charging network, the idea of a necessary global coverage of the territory for reasons of ensuring equal access to all citizens is often advanced, and not the level of infrastructure demand, as expressed at time T0.

The business model is still unclear

In the current phase of deploying infrastructure to create / support the future emergence of an EV mass market, an economic equilibrium is generally not feasible in the short term. The relative weight of investments, combined with the current weakness in the use of charging services, necessarily imbalances, at this stage, the economics of public EVCIs. With regards to public infrastructure with strong positive externalities (environmental as well as commercial for EV manufacturers), the economic equilibrium of EVCI operation is not, for some project managers, a relevant objective in itself.

The pursuit of economic balance of EVCIs in the public sample of the survey



Source: CODA Strategies survey

When considering the possibility of a long-term economic equilibrium, the majority of respondents to the survey refer to the coverage of operating expenses by revenue, without considering that these could also cover amortisation costs. Less than 10% of the organisations surveyed said they wanted to achieve total economic equilibrium over the medium term, but without being able to specify the envisaged deadline.

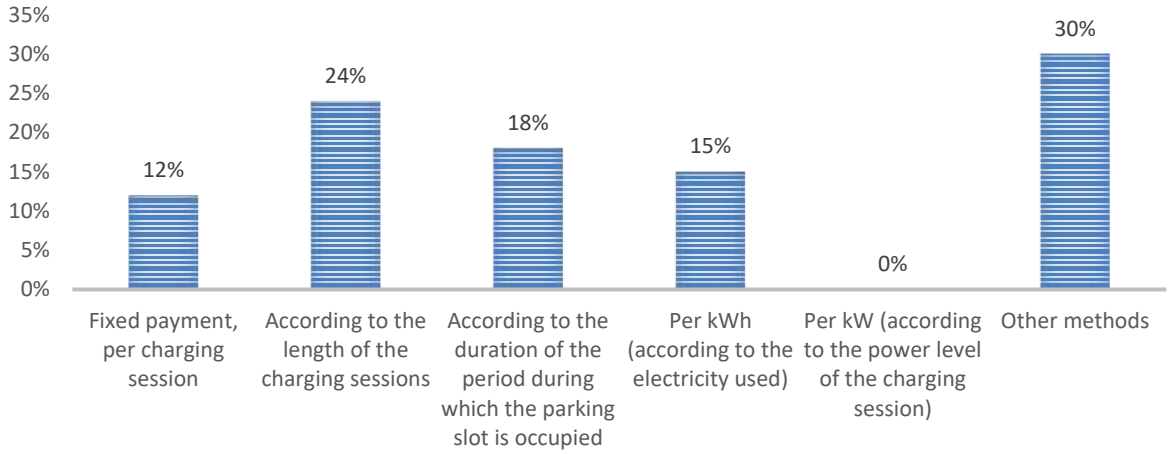
The importance of investment costs associated with charging points' deployment is worth noting. The survey carried out shows an average cost of between €10K and €12K, for terminals with two charging points whose maximum power delivered per CPs is between 7 kVA and 22 kVA. The cost of the terminal itself tends to represent only about 40% of the total costs, the civil engineering, installation, connection fees and other costs representing the rest.

In any case, in the current phase of deployment, and even excluding amortisation charges, the revenues cover only a small part of the operating costs incurred. In the few cases for which this data has been communicated, the ratio is often in the order of 10% and can rise up to 30% to 40% for operators who have deployed their network earlier.

There is no consensus on the level of activity required for the economic equilibrium of the networks, with some respondents reporting 300 to 400 charging sessions per year per terminal, while others cite a much higher level of 900 charges annually. The very different installation and maintenance costs depending on the type of area (urban/rural), the electrical connection work envisaged, the power of the charging points, can explain these differences of appreciation.

The lack of maturity of economic models is also reflected in the diversity of billing methods currently adopted. Free charging is still observed in some cases, even if it tends to regress. However, considering the diversity of billing methods currently in place, it is clear that operators of these infrastructures have not at this date reached a consensus on the appropriate way to bill their services.

Availability of the different means of payment for a charging session

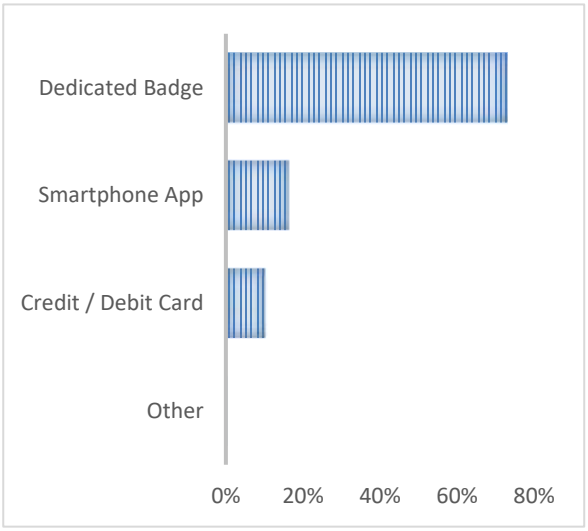


In fact, none of the billing methods currently used receive unanimous support.

The means of payment used also remain very diversified. The use of a dedicated IC card / badge is the most common practice, but payment by smartphone application is growing rapidly and, when proposed, quickly becomes the dominant method. Payment by bank card is also growing significantly and, in cases where it is proposed, often represents more than a third of payments.

The pre-eminence of dedicated IC card payment focuses on the issue of roaming. According to the actors involved, roaming is developing rapidly and the user should eventually be able to use his current payment method throughout the national territory, in full transparency. However, the testimonials gathered show that this goal is still far from being achieved. Users interviewed said that the management of badges to organise long-distance travel is still very problematic and some, familiar with this type of travel, do not hesitate to acquire impressive collections of badges of various origins.

Relative use of the different methods of charging session payment



Private operators

Private operators intervene on the EVCI market, either by assuming, on behalf of public actors, the operational management of their infrastructure, or by directly deploying charging networks in their own name.

More than a dozen organisations are currently active on the market. Sodetrel (which has now become Izivia, has 3,000 supervised charge points and 200 fast charging stations deployed on the motorway network), Blue Solution (a subsidiary of the Bolloré group which ran the Autolib' network in Paris until 2018 and is the owner of concessions in Lyons and Bordeaux), Driveco (50 stations and 150 terminals managed mainly in Corsica and the south of France) are some examples of actors involved in EVCI deployment. Other private actors do not deploy their own infrastructure but are very active in delegated management on behalf of public developers.

The results of the survey conducted among private operators do not differ radically from those obtained from public developers. This observation was expected since, in a number of cases, reference is made to identical infrastructures, perceived sometimes from the developer's point of view and sometimes from the operator's point of view.

The most significant differences are observed in terms of geographical deployment, with a significant presence of the networks of these operators on the national communication channels, in particular the motorway network (mainly Sodetrel via its "Cori-door" network). This particular positioning of certain private actors is reflected in the weight they attach to accelerated charging (thus all terminals installed by the Compagnie Nationale du Rhône (CNR) or by Sodetrel offer charging powers of 43 kVA-50 kW).

According to their statements, the private operators stand out clearly by unanimously displaying a goal of overall economic equilibrium of their network in the medium term, integrating the coverage of infrastructure depreciation costs. In the current phase, however, none of these actors has yet managed to balance its operation and the losses are very important.

LESSONS FROM THE INTERNATIONAL BENCHMARK

At the end of a process of ranking different countries active in EVCI deployment, three geographical areas appeared particularly interesting to study, in order to identify their best practices and the opportunities for replication of these in the French context. Norway, where the market share of electric vehicles is the largest, has emerged as a key reference. The State of California, home to one of the world's largest EV fleets, has very ambitious short- and medium-term goals, while managing the coexistence of private players and regulated monopoly power companies, presents some similar problems to those encountered in France. Finally, Japan attracted our attention because of its extremely dense network of charging stations and a mode of organisation resting largely on the mobilisation of partnerships between the public sector and the private sector. Best practices observed in each of these three parts of the world are highlighted in the following paragraphs.

In California: vast deployment of capital, carried out by numerous actors

The Californian market has developed in a number of phases. The first customers mainly used home charging, most often in individual homes. Charging in the workplace has progressively been adopted, encouraged by significant public incentives and the activity of infrastructure providers and developers. From now on, specific efforts are being made to promote the development of charging along major roads and in commercial zones.

The Californian state and local authorities are actively engaged in this development. Faced with the disengagement of federal authorities, the Californian government has chosen to strengthen its own means of action, notably through the Alternative Renewable Fuel Vehicle Technology Program (ARFVTP), the amount of which will increase to nearly $230 million for the period 2018-2019 (against $80 million raised since its inception). About half of the funds in this program will be devoted to the development of EVCIs. Municipalities and "air districts" also finance the development of EVCIs, based on a system similar to that of energy saving certificates in France. These incentives made it possible to generalise charging infrastructure at the workplace, in commercial zones and, more rarely, on roads.

In addition, and in order to address some of the shortcomings still observed, the public authorities requested the contribution of energy experts. In a situation of regulated monopoly, these actors proposed the first investment plans, aiming to set up more than 12,500 CPs for a budget of around $200 million, financed by an increase in electricity tariffs. The stated priorities concern the development of infrastructure in apartment blocks, on the public domain, where infrastructure is insufficient, as well as on tertiary and service sites (both public and private). Unveiled in May 2018, the energy companies' full program will finally raise $738 million for the electrification of transportation.

The expected developments are based on different economic and legal models proposed by the different state operators. In some cases, the ownership of the installation is the responsibility of the energy company who makes it available to its customer in exchange for a one-off fee. In another model, the customer reclaims ownership of the charging point and receives financial assistance from her energy supplier who also takes care of the work. Some energy suppliers come up with different models depending on the type of customer envisaged.

The infrastructure development in California will also benefit from the major contribution of Electrify America, a subsidiary of Volkswagen created under the agreement between the car manufacturer, the United States and the State of California to repair the damage related to "Dieselgate". Under the agreement, Volkswagen is committed to investing $2 billion in the development of a national electric charging infrastructure, of which $800 million will be invested exclusively in California and dedicated to the development of a fast charging network and a network of "community charging".

The adequacy of charging infrastructure with the development objectives of the electric vehicle fleet is regularly assessed, through annual analysis to determine infrastructure needs and to reorient public action according to the growth of the market.

For the coming years, the priorities are focused on the development of fast charging corridors, with the desire to legitimise the status of main vehicle for EVs. Collective housing is also subject to specific attention, as its residents are currently discouraged from using EVs because of the difficulty of managing their charging. Finally, the development of EVCI in urban and peri-urban areas, especially in commercial areas, is also favoured, particularly through the mobilisation of specific funding for these targets.

Beyond the expansion and densification of the network, qualitative improvements are now targeted, both for charging at work and at home. The replacement of conventional domestic outlets, still used for the most part by households, with controllable charging points is strongly encouraged to limit energy peaks and allow the development of new services for controlling energy consumption.

Norway: the deployment of EVCI supports the development of a market driven by regulatory and tax incentives

Electric and hybrid rechargeable vehicles now account for more than 40% of all vehicles sold on the Norwegian market, placing the country in the position of world leader on this criterion. This favourable position is the result of very important tax incentives, coupled with an effort to develop EVCIs and simplify their access. The Norwegian market is now in a phase allowing the development of EVCIs by private actors without recourse to public aid.

The Norwegian government's tax incentives have played a major role in the development of a mass market for electric vehicles. Since 1990, there have been eight incentives, mostly fiscal and cumulated over time, to support this sector. Tax exemptions, in particular registration tax (which is a major component of the cost of acquiring a vehicle), tax on company cars and VAT, have contributed to making the cost of electric vehicles more competitive than that of their ICE competitors (for example less than 10% for an average sedan). To these tax incentives were added various advantages granted to the owners of EVs: exemption from tolls, free municipal parking, free access to ferries, access to lanes reserved for buses, and carpooling.

The development of EVCI accompanied the rise of this market but did not precede it. In fact, the observation of the available statistics indicates that the ratios commonly used to measure the density of charging infrastructures are not particularly high in Norway.

If the EV fleet has grown rapidly without requiring an exceptional deployment of public charging infrastructure, it is partly due to the size of Norway and, further, the place of home charging. Surveys conducted in Norway indicate that 97% of EV owners living in houses charge their cars at home on a daily or weekly basis. Only 11% resort to the same conditions at public stations. Public authorities are now trying to simplify access to charging for residents in collective housing. Housing cooperatives are accompanied in the process of installation of charging infrastructure, municipalities create structures simplifying the appropriate deployment of on-demand charge points, etc. Access to home charging is thus undoubtedly one of the key factors in the success of the Norwegian market.

The transition to the real "mass market" nevertheless depends on the development of a fast charging network. This allows the adoption of the electric vehicle as the main vehicle of the household.

In this area, a virtuous circle seems to be engaged between the growth of the fleet of EVs, the economic sustainability of fast charging stations encouraging their development and, consequently, the reassurance of potential buyers as to the possibility of using an EV as the main vehicle.

The business model for fast charging is beginning to be sustainable in the absence of subsidies, especially for the stations with the highest usage. The Norwegian model suggests that from 3% EV penetration in the total fleet, some fast stations can operate without public support. In addition, private operators reason about the overall economic equilibrium of their network and integrate cross-subsidies to finance the development of the network from the cash flow generated by the most profitable stations.

Gradually, higher charging power levels should be proposed and differentiated charging rates depending on the charging speed will also appear. While these stations usually offered two charging points, they gradually integrate four to six. The adequate sizing of the stations is considered a key factor in their frequentation.

Nevertheless, public support is still needed for stations on highway corridors in areas of low population density, with very low traffic. The targeting of subsidies for this type of installation makes it possible to ensure a satisfactory network on the territory, conditional on the development of a mass market, while limiting the expenses supported by public finances.

In Japan, a proactive national strategy to deploy EVCI

Japan is an interesting case of political will to make the national deployment of electric vehicle charging infrastructure (EVCI) consistent. This is identified as one of the key factors to achieve the ambitious objectives of the public authorities (40% of EV sales by 2030).

The Japanese strategy is built with the desire to federate public actors (Ministry of Economy, Japanese Development Bank, Prefectures) and private actors (car manufacturers, energy companies, manufacturers of charging equipment). This desire was notably concretised by the establishment of the Nippon Charge Service LLC, a consortium of four major car manufacturers, two national energy companies and the Japanese Development Bank (whose missions are close to those of the Caisse des Dépôts et Consignations in France).

The reference framework of the Japanese policy is the national plan developed by METI[10], which estimated the infrastructure needs and the corresponding financial resources to be raised. These objectives were defined at the territorial level by the 47 prefectures, which further determined the relevant localisation of the network.

The financial resources have been significant, with a total allocation of 58.3 billion Yen, or approximately €460m over the period of the national plan (2013 - 2017). In particular, these amounts were used to subsidise up to two-thirds of the costs of installing charging stations. Greater incentives are reserved for fast charging stations, which can benefit from grants of up to €63,000. Different funding levels are also provided depending on whether or not the stations fit into the local master plan and whether they are installed on the public domain (category 1) or on a private site accessible to the public (category 2, for which the level of subsidy is about 30% lower).

The role of Nippon Charge Service (NCS) in the deployment and management of charging stations is a key feature. NCS has been deploying, operating and maintaining public and private third-party charging stations for eight years. NCS acquires the rights of use of the stations and then provides IC cards to the EV manufacturers who transmit them to their customers (private owners of electric vehicles or fleet managers). Private customers can also contact NCS directly for an IC card. The main advantage of the NCS monopoly is to guarantee users perfect roaming throughout Japan.

Charging fees are low in absolute value and close to cost price. The objectives of the consortium are not primarily linked to the economic model of the charging network but are of an industrial nature (for car manufacturers) or for general interest (for public authorities)

The plan put in place has come to fruition, with more than 27,000 charging stations installed by the end of 2016 against approximately 7,500 five years ago. This deployment has accompanied the growth of sales of electric vehicles, which during the same period passed from 40,000 to 165,000.

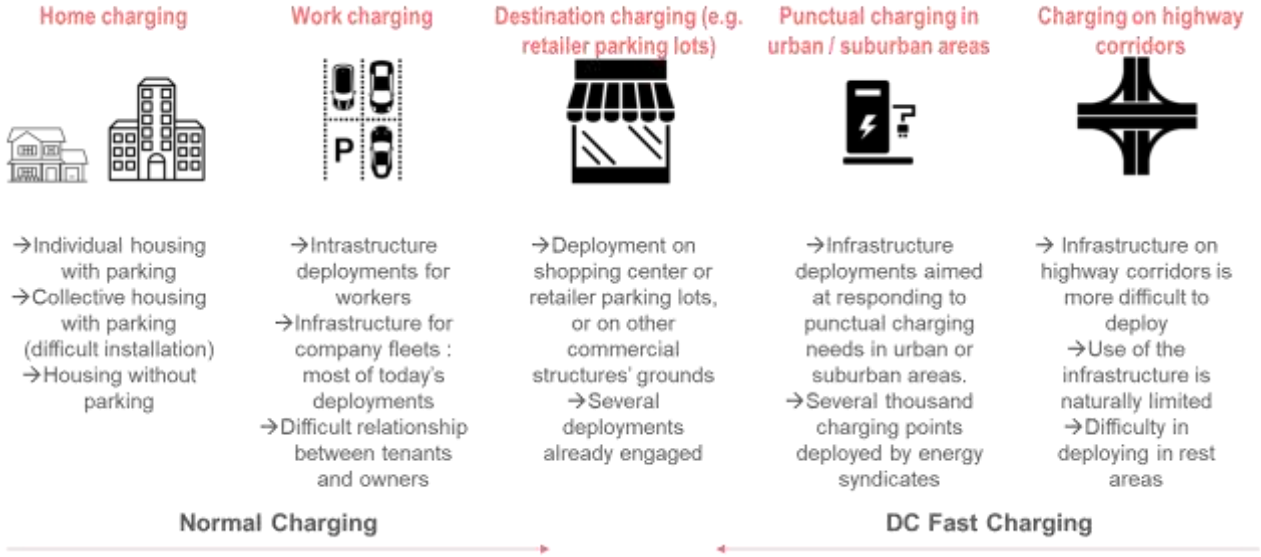
The average national ratio of 1 charging point for 4,125 EVs and/or PHEVs is now considered satisfactory. In urban areas there is at least one station for an area of 10 km², while on the highway corridors, the average maximum spacing between two stations is 30 km. In this context, the priorities of the public authorities for the current period relate in part to the densification of the network in certain areas still not well covered, an objective requiring the establishment of 5,000 additional CPs. This objective will go hand in hand with the encouragement of the deployment of stations on the rest areas of highways and national roads, notably favoured by a regulatory evolution facilitating the installation of EVCI within service stations. Finally, the public authorities intend to promote the development of EVCIs in private car parks, particularly in collective housing (which houses 40% of the population). In addition to publishing technical and legal guidelines for property developers/managers, this goal will be supported by grants of up to 100% of the cost of installation.

[10] Ministry of Economics, Trade and Industry

THE DEMAND FOR FUTURE EVCI: NEW CHALLENGES, NEW SOLUTIONS

According to the figures by GIREVE, France has largely exceeded the recommendations in terms of EVCIs of the AFI (Alternative Fuels Infrastructures) directive of the EU (10 vehicles per CP). If the objectives of homogeneous territorial coverage remain relevant, the development of a mass market for EV is now more or less prioritised by matching the available infrastructure to the needs of users, in order to reassure them and simplify the charging process as much as possible. The deployment needs analysis must therefore consider the five major types of recharging and the associated infrastructures identified during the realisation of this study.

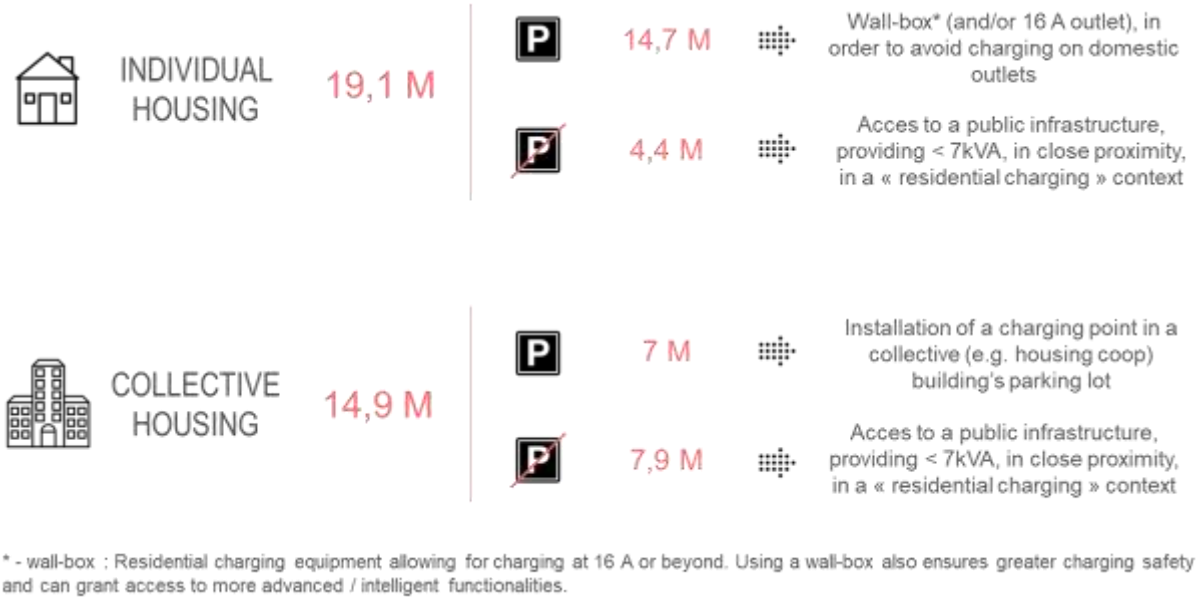
The main types of electric vehicle charging



The essential role of home charging

French housing is divided between individual housing (19 million of which nearly 15 million have a private parking space) and collective housing (15 million, of which nearly 8 million have no parking space). The issues pertaining to the development of home charging are therefore very different between these cases.

Breakdown of the French housing park



* - wall-box : Residential charging equipment allowing for charging at 16 A or beyond. Using a wall-box also ensures greater charging safety and can grant access to more advanced / intelligent functionalities.

Informing users in individual households is key

The installation of an outlet in an individual home is available at reasonable costs (less than 1,000 euros for a high-end installation, a few hundred euros for simpler but nevertheless secure outlets). The decision process is obviously quick and controlled by the potential purchaser of an electric vehicle that will be able to ensure that they have a charging solution at the time of delivery of their vehicle (which is often not the case in collective housing). In these conditions, the main challenges of this solution are to inform users both on a technical and economic level.

Technically, it is a matter of guiding users towards dedicated solutions offering an optimal level of security (for example, the majority of conventional domestic outlets in Norway and California occasionally experience incidents such as overheating). In the perspective of significant growth of the fleet of EVs, the possibilities of piloting, or at least those of subscribing to a "peak / off-peak hours" device are important points to take into account for enhanced savings and an additional level of comfort for the end user, while guaranteeing the safety of the electricity network.

Regarding savings, the study shows that potential users have very poor knowledge of the relative costs of different energies. According to the general feeling expressed, electricity would cost more than traditional fuels (no doubt this is in reference to what is observed with regards to home heating). This misconception, which leads to the elimination of home charging solutions, needs to be fought. Under current conditions, the fuel for an ICE vehicle is about 11 cents per kilometre against about 3 cents for an electric vehicle charging at home.

The challenges of simplifying charging in collective housing

The steps for residents of collective housing with dedicated parking spaces are complex, long and often prohibitive for installing a charging point for electric vehicles. Yet the "right to plug" has been recognised and allows collective-housing residents to demand the implementation of a charging solution.

Moreover, the costs to be borne by collective-housing residents, if the pre-equipment does not exist, are important and often dissuasive. In effect, if the existing electricity network can offer charging solutions for initial users, when the number of them increases, important re-work of the internal electrical network should be considered. The total costs then become prohibitive, especially if they must be borne by a limited number of co-owners.

Moreover, the body corporates, who could guide the residents in the process of deploying the most appropriate charging infrastructure, do not currently assume an active prescribing role in this area due to lack of sufficient information.

Some of these encumbrances are in the process, or expected to be in the process, of being lifted in the near future. In particular, the next evolution of the "right to plug" should better frame timeline issues, as well as the organisational constraints.

On the financial level, grants are available (the Advenir program or subsidies from certain local authorities) and can reduce the level of investments to be made. Moreover, the rate of reduction (the assumption of a part of the connection costs by the energy distributor), which is currently 40%, could increase during the next period.

The development of the EVCI operators' proposals, who bear the initial cost of investment and then earn a monthly subscription system, is likely to reduce the investment cost and especially facilitate access for initial users at the level of collective housing. These offers are still little-known to potential beneficiaries. In some cases, their economic competitiveness often appears to be insufficient and is likely to negate the economic advantage available to EVs in terms of fuel costs.

In new buildings, the regulatory framework in force imposes pre-equipping, which allows the later installation of charging points, at the request of the occupants, under economically-satisfactory conditions. The application of this regulation will thus gradually improve the situation directly, but also by gradually renewing the network.

On-demand charging points: a solution for 12 million households without parking space?

The availability of public CPs is essential for the development of EV usage in homes without access to private parking. This population is over-represented in urban areas due to the nature of housing. The municipalities concerned are therefore often unable to stimulate electric mobility, as they cannot ensure that potential users have access to electric charging under satisfactory conditions (regular charging, close to home charging, comfortable, and above all inexpensive).

On the basis of this observation, a number of European municipalities (Oslo, Amsterdam, Rotterdam, etc.) have put in place "on-demand CP" installation programs, the aim of which is to enable the deployment of public EVCIs in areas where there is a need and where, as a result, their sufficient use is guaranteed. In this context, an EV user, faced with the lack of a charging solution near their home, can file a deployment request. After verifying that the request is justified, the infrastructure operator will initiate an installation procedure which guarantees reasonable delays between the submission of the application and the actual installation. Such shortening of the delay time generally requires a coordinated effort between the various stakeholders (expert services, utilities, companies responsible for civil engineering and installation). In some cases (e.g. Amsterdam) this may lead to some larger missions being delegated to certain companies (for example, the completion of the connection to the electricity grid by the company in charge of setting up the charging points).

The advantages of such a system concern all market stakeholders. For end users, even if they do not have the exclusive use of the installed charging point, this system makes it possible to have an available charging point, close to their residence and thus inducing no additional constraint compared to the parking of a traditional road vehicle. For infrastructure operators, demand-generated installation ensures the existence of significant and consistent revenue. For the public authorities, this type of approach may eventually reduce the amount of financial incentives to put in place since these charging points, a priori heavily used, should naturally find their economic equilibrium.

Technically, these charge points can provide normal charging for night charging, where fast charging is not required, or even unsuitable in the perspective of load management of the electricity network. Synergies are possible with the public lighting grid, some of which could support this type of charging point while significantly reducing deployment and connection costs.

An Opportunity for Social Housing

Today, social housing landlords, who manage a stock of 4.5 million homes, including 1.7 million with parking spaces, face significant vacancy rates of their parking spaces, resulting in a significant loss of revenue. Under these conditions, the development of charging points within this context can serve a dual purpose.

This approach is firstly part of the desire to offer more services to residents. By promoting their residents' access to electric mobility, social housing landlords would help reduce their overall energy bill. If residents in social housing are not generally considered as pioneering users of electric vehicles, the development of a second-hand market and the gradual reduction of purchase costs are likely to call into question this finding. In addition, this enhanced offer of services is also a factor of attractiveness for this type of housing, an important criterion for social housing landlords wishing to preserve the social mix within their stock.

Increasing the occupancy rate of parking spaces is another potential financial benefit. Some social housing landlords are effectively considering scenarios for the provision of parking spaces equipped with charging points for non-residents. Such an offer makes sense when the dwellings are located in dense urban centres, for which a shortage of parking is observed.

Social housing landlords are currently reluctant to offer parking rental to external users because of the perception of a risk of requalification of their buildings to the status of Institution Receiving Public (IRP)[11], creating safety constraints with regard to fire and specific access. Being rented out within a "residential" logic, these constraints should not however be applicable. A clarification of the regulatory framework would therefore be likely to reassure these actors and encourage them to put in place proactive policies in this area.

For parking operators, real opportunities are still not often taken into account

Public car parks, especially those generally located in dense metropolitan areas, could provide answers to charging infrastructure needs. Parking operators have already deployed charging points, hosting nearly 3% of nationally-available charging stations. These are usually stations containing several CPs inferior to 22 kVA which, according to the National Federation of Parking Trades (NFPT)[12], would be used very little.

In this context, car park operators don't seem willing to intensify their investments in the short term. Apart from the low usage rate observed, they mention the significant technical and safety constraints that apply to the installation of charging points on managed sites, notably fire regulations.

Nevertheless, it is clear that the supply of charging solutions is undeniably a medium-term opportunity for these players, faced with a steady decline in attendance at their facilities. Such an offer could be addressed both to users on the move wanting to recharge during a professional meeting or while shopping. It could also target neighbourhood residents where the car park is located to offer a residential parking solution.

Beyond certain technical constraints, related for example to the need to simultaneously offer fast charging (for supplementary charging) and a normal one (residential), the proposed financial conditions must necessarily adapt to the different members of the public. User feedback on this point clearly indicates that the cost of the services currently offered is considered too high.

Workplace charging: growing but with unanswered questions

In the Norwegian and Californian examples, workplace charging is the second method used by electric vehicle owners after residential charging. This is starting to develop in France, in a context where certain questions still remain and where the options chosen by its promoters do not always seem the most relevant. A number of obstacles to the development of this type of solution are perceived by companies and the building owners renting out professional premises.

Thus, in the case of charging being free to employees, the question of the existence of a benefit-in-kind was raised. The current system is unfavourable to EVs or PHEVs and is complex with respect to "electric" fuel costs. In effect, the company must install a meter on its installation in order to establish the actual costs of charging at work, which leads to superfluous complexity.

Tenants of business premises are faced with landlords with very different attitudes. Some are very willing because they see the opportunity to increase the attractiveness of their premises, while others are very cautious, focusing on significant technical constraints and are worried about having to apply the regulatory framework dedicated to PABs (with strong constraints related to fire safety), which would result in significant costs. The evolution of the regulatory framework, with the introduction of the "right to plug" for tenant companies will ease this process.

Investment costs can hinder the development of these infrastructures, but the Advenir program significantly reduces this barrier and is also widely used to finance this type of installation.

Solution providers in this field are evolving quickly. Some companies offer conventional charging point installation solutions, supplemented by maintenance contracts, leaving the user company to determine the pricing conditions and the billing terms. Other players offer integrated service bundles, releasing the client company from any formality and taking direct responsibility for billing the service to the end user.

The technical solutions and billing methods selected do not always appear relevant. Charging at work can indeed accommodate, without problem, normal charging and its billing should focus on the criterion of the amount of energy provided and not the time of occupancy of the charging point (employees of companies do not wish to have to move their vehicles during their working day). These principles are not always respected.

[11] In French, Etablissement Recevant du Public (ERP)
[12] In French, Fédération Nationale des Métiers du Stationnement (FNMS).

Charging infrastructure for one-time charging: a logic of reassurance

The development of extra charging stations, allowing an electric vehicle user to restore, in a short period of time, a charge level sufficient to complete a journey, adds supplementary charging with residential charging.

Public authorities have already contributed to the establishment of a supplementary charging network: the network developed by local authorities / energy federations exceeds, according to figures from GIREVE, 6,700 stations spread over 70 departments.

These stations can be installed in any type of place where potential users park for at least 30 minutes and never for more than two hours. In this respect, car parks for commercial and cultural facilities are natural targets. But stations totally dedicated to this function, aimed in particular at the needs of certain professionals (taxis, CDVs ...) can also find their technical and economic justification.

Charging on commercial business sites

In the case of commercial businesses, a charging station is undeniably a "loss leader" by increasing the attractiveness of stores that have them. This explains the free charging currently provided by most shopping centre operators. However, these conveniences are temporary and should gradually be replaced by cost-based invoicing. In fact, the increase in the number of EVs should gradually increase the associated investment needs and therefore the costs borne by these operators. In addition, the maintenance of a totally free offering would probably involve the development of undesirable practices for these operators, such as the development of parking "leeches".

If the free offer eventually disappears, the economic model of deployment of these infrastructures will not rely solely on the marketing of access to the charging point, but more on the commercial effects of the attractiveness of stores.

In France for the moment, it is essentially the operators of large shopping centres who deploy EVCIs, independently or with a certain number of partners. A generalisation of partnerships with "pure player"[13] operators, already observed on the Norwegian market for example, is likely to occur in the French context: the mall operators would make land available, while the operators of EVCIs would ensure the deployment and the use of the charging points, motivated by their desire to be present on the most relevant and profitable sites. This would also make possible the installation of charging equipment beyond the parking lots of the biggest operators.

Given the business model of these stations, with revenues partly related to the use of shops, cultural venues, etc., and for periods of 30 to 120 minutes, a charging load in the order of 50 kW per CP seems sufficient in the medium and long term.

Charge hubs

Beyond installation on shopping sites, the creation of "charging hubs" by private operators is starting to be observed, in particular in Norway and in the Netherlands. The feedback is very favourable with frequent attendance rates and important revenues, often among the best in the EVCI network of these operators.

These hubs have two roles: to reassure users about the availability of a quick charge when it is needed (similar to using an urban service station), and allow shared vehicles to recharge (see next paragraph).

In the absence of real services or a reason to occupy the charging point for longer periods, the CPs associated with these stations should deliver the highest power level possible, in line with the fleet of vehicles (50 kW now, but scalability to 150 kW or more if necessary). The examples of Norway or the Netherlands show the relevance of the development of these stations by private actors, searching for locations which allow the best profitability of the station.

The case of taxis and CDVs

The existence of these hubs will also send favourable signals to professionals who have chosen to use electric mobility. From this point of view, the limitations of the use of ICE vehicles envisaged in urban centres could have a powerful driving effect on this type of installation.

Among the targeted professionals, taxi and chauffer driven vehicles' (CDVs[14]) drivers offer significant development potential. For the latter, the use of an EV is a marketing argument vis-à-vis their customers but also and above all

[13] Companies whose main activity is solely the development and operation of the EVCI.
[14] VTC in French, being « voiture de tourisme avec chauffeur ».

an important lever to reduce their operating costs: their typical fuel budget is €400/month for a distance travelled of about 5,000 km, being the case especially in large cities. If these economic arguments are not yet fully taken into account, it is often due to lack of information, but also for fear of not being able to easily assume the constraints associated with recharging.

Stations dedicated to shared vehicles (taxis and CDVs) could be particularly attractive for the adoption of electric mobility for this class of user (this type of infrastructure is already used successfully in Amsterdam). The development of these few stations, in addition to the hubs and charging points deployed on retail sites, should dispel these fears, while the enrichment of the vehicle offers (design, range) could remove the final obstacles.

This study has also shown a real interest by operators of this type of service who are ready to recommend electric vehicles to their employees and to participate in reflections on the deployment of charging infrastructure, including using the geolocation data available to them (for the identification of the most relevant locations, for example). As far as these professions are concerned, railway stations and airports appear to be privileged places to deploy this type of charging hub.

As in the case of urban hubs, stations dedicated to shared vehicles should offer the highest possible charging power, in line with the car fleet (50 kW in the short term, 150 kW minimum in the medium and long term).

The development of infrastructure on highway corridors

For the majority of households, the inability to use an electric vehicle for "long-distance" travel greatly reduces its attractiveness, especially when only one vehicle is owned. Arguments on the total cost of ownership, which could raise awareness particularly among low-income households, are hampered in this case by the difficulties in conceiving the use of EVs in all contexts, in particular that of a long road trip, even if these trips represent a negligible part of the total use of the vehicle.

The specifications of an ideal charging station within a highway corridor are known, thanks in particular to the feedback from already-deployed networks: enough CPs to guarantee a level of redundancy and avoid queues, sufficient power to reduce charging times (in line with the vehicle fleet, the scalability of these stations is paramount), simplified access to the station in full transparency for the user (type of outlets, means of payment, billing level ...) and associated services allowing to use the time spent at the recharging area to relax, eat and so forth.

But this desire of potential users to have a charging infrastructure along the highway corridors at conditions close to those offered by existing gas stations (space, recharge time, and associated services) is fraught with difficulties in relation to developing this type of infrastructure.

The first difficulty faced by this type of installation is economic. The development costs of these stations are on average higher than in urban areas because of the distance from the electricity grid, as are the operating and maintenance costs, while the attendance is necessarily lower and the associated revenues implicitly limited.

This constraint obviously impacts the economic models associated with the setting up of these stations, which are carried by actors for whom it constitutes a commercial incentive (Tesla, Ionity), or by some operators (e.g. Total) who can also benefit from additional revenues (sales of services, food products, etc) and synergies with their traditional activity (mutualisation of maintenance costs for example). "Pure player" operators approach these facilities through partnerships.

In France, the Corri-Door network, the result of a project led by EDF, comprising Sodetrel, Renault, Nissan, BMW and Volkswagen and co-financed by the European Commission to the tune of 50%, includes 200 fast charging terminals (1 CP per terminal), located every 80 km along highways. At present, Ionity also provides 4 stations in France for about twenty charging points and is building eight other stations.

The increase in the number of EVs should lead to an increase in the use of these infrastructures, which remains limited today. Guarantees of redundancy and availability must be provided to users to convince them to integrate this type of network into their travel plan. The recent announcements of the operator of the Corri-Door network (Sodetrel became Izivia) meet this constraint and prefigure a significant densification of the network. Ionity is already developing its network in this direction.

More generally, the development of an EVCI along highway corridors implies that a certain number of barriers are overcome.

On the economic front, and unlike other types of EVCIs, it seems difficult to envisage a financial equilibrium in the short and medium term. Under these conditions, public financial support of various kinds is likely to continue, in particular through a better support of rate reduction (as provided for in the "LOM", the draft law on the orientation of mobility), making it possible to limit costs for connection to the electricity network.

Much more important than the economic barriers, the obstacles to the development of the EVCI are also organisational and relational. Thus, the specifications issued by the highway concessionaires for the implementation of EVCIs on highway service areas are often considered too demanding, thus increasing installation costs without any real technical justification. The transposition of the constraints imposed on the fuel distribution stations ("through route", shade, etc.) does not necessarily have a technical justification and considerably increases installation costs. In addition, on certain highway areas, concessions will evolve in the next 2-3 years. This instability tends to delay any investment in EVCIs, as the future status of the infrastructure is not yet clearly perceived by investors. An improvement of the regulatory framework on this point seems particularly appropriate.

WHAT LEVEL OF DEPLOYMENT TO ACCOMPANY THE RISE OF THE EV FLEET?

The objectives of the SCA are ambitious regarding the development of the fleet of electric vehicles. Thus, the objective of a fleet of one million EVs and PHEVs is posted for 2022. By 2030, this fleet should grow more than fivefold and represent more than 15% of the fleet of light vehicles (private and commercial). Such a boom cannot be conceived without a significant growth of associated charging infrastructure. This study focuses on evaluating the growing needs of the EVCI stock, based on a model integrating the evolution of vehicle range, the deployment location, types of travel, and current and expected charging practices. The following table summarizes the results achieved by the model by the years 2022, 2025 and 2030 (in number of charging points).

Number of Charging Points by 2022, 2025 and 2030

Number of charging points (in thousands)	2022	2025	2030
CPs in individual housing	422	1 112	2 012
CPs in collective housing (incl. social housing)	204	586	1 541
CPs in social housing	*16*	*65*	*247*
CPs in business	75	227	595
CPs on demand			
CPs for EVs optimal optimisation scenario	*13*	*29*	*75*
CPs for EVs average scenario (1 CP for 2 EVs)	*97*	*273*	*942*
CPs for PHEVs	*116*	*358*	*800*
CPs Urban Hubs	0,45	1,55	2,108
CPs Public Access Buildings (commercial businesses, cultural spaces etc)	8,7	10,2	10,6
CPs National Highway Network	1,8	3,6	4,2

The EVCI for daily needs should incorporate CPs available in public spaces for EV and PHEV users without private charge points. The sizing of this infrastructure strongly depends on the objectives pursued by the on-demand charging policies that could be adopted, namely a systematic provision of a CP or a modulation taking into account the flexibility provided by the increase in vehicle autonomy and the progressive use of hubs.

In addition to this on-demand infrastructure and private infrastructure, a fast CP network is necessary for several reasons: the guarantee of always having a backup solution for users in case of unusual use of their vehicle, the needs of users in transit around the zone, those of light utility vehicles with occasional needs ... Such infrastructure could be deployed indifferently on public roads (urban hubs) or on sites situated in commercial or cultural zones.

Contrary to daily usage, trips when the distance covered is greater than 100 km, require rapid charging infrastructure on all the networks concerned, regardless of the importance of the fleet of EVs, to guarantee travel equivalent to that offered by ICE vehicles. If the corresponding infrastructure is mainly installed on the conceded motorway network, the coverage of all road networks is necessary.

CONCLUSIONS AND RECOMMENDATIONS

The study of the deployment of the EVCI on the national territory shows the existence of a real dynamic, resulting both from initiatives of public origin and private offers. It also shows that, following the territory's grid phase, which has almost been completed, the public policies and players' strategies must now focus on fine-tuning the equipment deployed, their characteristics and location, and the needs of current and future users. This implies, particularly with regard to public authorities, the implementation of a set of measures aimed at fostering the development of infrastructures where they have been expected and will be used. Three areas of progress have thus been identified.

Regulatory Framework

At the regulatory level, important work has already been carried out and has led to significant progress, such as the assertion of the "right to plug" for residents in collective housing or the obligation for new buildings to integrate, at minimum, pre-equipment allowing the subsequent installation of charging points at a limited cost. It is desirable that this work be completed by facilitating the steps to be taken by EV owners wishing to have a charging solution, for example by simplifying the right for collective housing residents and creating a favourable framework for the deployment of "on-demand charging points". It is also necessary to resolve the issue of PAB (Public Access Building)[15] classification of social housing and increase the rate of rebate, through the LOM (Legislation on mobility)[16], to encourage the investment of private operators for the installation of EVCI in the charging hubs and corridors along major highways.

In order to allow potential users of EVs who do not have private parking to access economically-interesting charging, a program to deploy on-demand charging points should be developed. This program should be managed in a decentralised way by local authorities. Access to the infrastructure must be open to users without private parking and most importantly, a new charging point should be installed only when the existing infrastructure is insufficient. Public authorities should encourage an organisation that allows for relatively rapid deployment of EVCIs, especially concerning connection and public works. The participation of private actors must be supported; initiatives can be granted to private operators who are attracted by the guarantee of a predictable level of use. To improve its business model, the installation of CPs on public lamp posts should also be included in this program. Finally, on-demand charging points should be installed only on existing parking spaces, with the view of not increasing congestion locally, while encouraging the replacement of an ICE vehicle with an EV/PHEV.

Improvement of the **"right to plug"** for collective-housing residents is also necessary. In the first place, a simplification of the procedures should be targeted. In the next step, public authorities should educate the actors in the sector—with body corporates as a priority—to the necessary reduction of the costs of development of the EVCI in the parking spaces of collective housing. Body corporates must be encouraged to submit the various technical and commercial options available to landlords and their tenants.

The diffusion of EVCIs within the social housing stock should also be sought. Highlighting and possibly eliminating the issue of reclassifying car parks in PABs (when leasing out more than 10 places to external users) would free up the investment of the public housing providers. More generally, these providers should be encouraged to pay more attention to the issue of EVCI. In this sense, the Social Union for Housing (SUH)[17] is a pertinent interlocutor.

To meet the need for extra charging, high power CPs will be needed. Faced with this imperative, the role of public authorities is essentially to encourage the investment of private operators in charging hubs, through a favourable market framework. On the financial side, the increase in the rate of rebate, foreseen in the LOM, should be realised, while other financial incentives do not seem necessary, for the urban and peri-urban zones. At the organisational level, local authorities and public actors must encourage the investment of private operators by facilitating access to public land in certain key zones of their territories (railway stations and intermodal zones, etc.). For non-attractive zones for medium-term private development and subject to the existence of demand, public authorities could encourage the development of a minimum EVCI. For those receiving public support, minimum architectural and functional specifications should be imposed.

Finally, in order to allow the EV to be used as the main vehicle for households, the existence of a fast charging network at highway level should be ensured. With this in mind, the creation of a regulatory and support framework, taking into account the specificities of highway EVCI development, and encouraging private players

[15] In French, ERP (Etablissements recevant du Public)
[16] In French, Loi d'orientation sur les mobilités
[17] USH, or L'Union sociale pour l'habitat

to invest, is necessary. Engaging the move to a higher discount rate as provided for in the LOM is relevant, but not sufficient to offset the economic barriers to the development of these EVCIs. In particular, it is advisable to dissuade highway concessionaires from issuing specifications that are too drastic and unsuited to the specificities of the EVCIs deployed in the corridors of the main highways. The most profitable architectures should then be able to develop naturally, without public financial support. The adoption of a minimal architecture and associated functionalities should be strongly encouraged (each station should integrate at least 2 CPs, preferably 4, with maximum deliverable loads adapted to usage and be able to scale). EVCIs should be located near services and amenities, and allow access for any type of vehicle by ensuring easy roaming for the user.

Structural Actions

At the initiative of market stakeholders, their professional organisations and with the participation of public authorities, an effort to structure the ecosystem must be maintained and deepened. This should notably lead to improving solutions for charging at work or in business parks and developing high-performance additional charging solutions, offered as part of urban hubs (some of which would be reserved for taxis and CDVs) but also on spaces managed by shopping centres, transport operators or cultural venues.

First of all, charging at work warrants improvement. The current benefits-in-kind system is complex and unfavourable to EVs and PHEVs and should therefore be reviewed, for example through the introduction of an annual electricity consumption subscription. In order to allow businesses renting their premises to access EVCI, the "right to plug" provided for in the LOM project should be introduced, obliging the owners of professional buildings to respond favourably to the EVCI needs expressed by their professional users. A best practice guide, presenting the favourable impacts on both landlords and tenants, of the development of EVCI at work should be carried out. This guide should also communicate the relevance of the Advenir program and popularise a series of best practices in billing and station architecture, allowing to take into account all the specificities of charging at work (vehicles parked during the day).

The development of EVCIs in business parks should also be encouraged, particularly by encouraging the creation of tripartite projects between local authorities, representative bodies of companies and EVCI operators. The implementation of pilot projects would bring a better visibility on the technical and organisational architectures to be favoured.

Public authorities should also encourage the creation of dedicated taxi and CDV infrastructures to facilitate the adoption of electric mobility by these professions. For large cities, the creation of charging hubs dedicated to taxis and CDVs, to supplement the private EVCI of transport companies and home charging, should be stimulated. Major stations and airports in the major urban areas should be provided with a few charging points in zones reserved for taxis. The development of these hubs should be accompanied by a communication campaign to show the relevance of electric mobility for taxis and CDVs.

Charging on PAB sites is relevant and should be encouraged. The establishment of an incentive framework encouraging the development of infrastructures by these actors (shopping centres, cultural places, etc.) on their own funds or through partnerships is necessary. These investments could be stimulated by the existence of Advenir and the increase of the rate of rebate proposed in the LOM. Partnerships between these actors, providing land and EVCI operators developing infrastructure, should be encouraged, inter alia through the presentation of a series of best practices. The best practices highlighted should also concern the conditions linked to billing for charging and access to infrastructure / roaming.

The Role of Communication

Finally, this study has shown that communication towards not only end users, but also prescribers (utilities, energy federations, landlords ...), as well as investors and providers, remains necessary. This work should aim to explain a certain number of points that remain poorly known by decision-makers today.

Firstly, a communication campaign to demystify electric charging in general, and home charging in particular, should be carried out. A guide to show the economic benefits and comfort associated with this form of charging, and to indicate the preferred technical architecture, should be published. A dedicated internet platform should present this information and also aim to provide potential users with better visibility of good charging practices, at home, but also in other contexts. The Association for the Development of Electric Mobility (ADEM)[18], because of its representativeness, would be a logical candidate for the creation of this platform.

[18] In French, L'Association pour le développement de la mobilité électrique (AVERE)

Dissemination of best practices of the right to outlets in collective housing must also be stimulated. In this sense, a formalisation of the position of the grid operators, and more generally of other players, with respect to charging infrastructure, should be encouraged. The use of existing infrastructure, where possible, should be supported as a transition solution in a take-off phase of the market. Low-scalability deployments should be discouraged. Clarification of billing principles (responsibilities, billing principles, costs, etc.) would also be useful. All of this information should be included in a best-practice guide with examples of relevant facilities and actively communicated to landlords and body corporates of collective housing.

All of these considerations have given rise to the formulation of specific detailed recommendations for professionals and public authorities.

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Low emission mobility and in particular electric mobility development is one of the major challenges of the energy transition. The launch of new generations of electric vehicles, more efficient in terms of associated services and autonomy, suggests the possibility of a significant development of the market. One of the crucial factors in its growth is undoubtedly the availability of charging infrastructure allowing users, regardless of their living conditions (individual homes, collective housing, with or without parking ...), to consider their use in conditions of comfort and peace of mind similar to those offered by traditional vehicles.

On the basis of this observation, this study presents an overview of the current development of electric vehicle charging infrastructure (EVCI) resulting from public and private initiatives. The prospects and development conditions of the three main types of infrastructure («proximity», «extra», «long-distance») are specifically studied.

In the light of a program of interviews conducted with stakeholders in the sector, but also a benchmark of three leading markets (Norway, California, Japan), good practices are identified and recommendations are brought to the attention of private actors and public authorities.

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