

6.2 Deployment of Charging Infrastructures

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In this section, we will introduce the basics to define and understand the deployment of charging infrastructures for electric vehicles. First, we will talk about history before focusing on today's projects, we will finish by studying more specifically the case of France.

Some History

Charging solutions after 1900 Electric vehicles imply charging stations or charging. Before 1900, charging solutions were hand-made. Then, charging stations developed. In those times, they were called "charging columns for electric automobiles". Vehicles could be charged individually at home or collectively within fleets.

Charging column for electric automobiles The 1899 charging column could charge a lead battery with a power ranging from 2 to 6.4 kW with an intensity ranging between 25 and 80 A at 80 V.

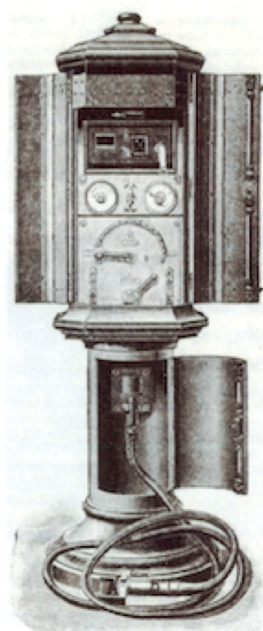


FIGURE 6.1 – The 1899 charging column - Source : <http://www.mobilite-durable.org>

This device was awarded at the July 1899 Show by the Mixed Commission which was in charge of determining the conditions under which automobiles could be charged with electricity. In those times, this model already planned an elegant integration in an urban setting with a format close to that of mailboxes. To charge these accumulators, users had to put a token in the meter, close the internal circuit breakers, the bipolar switch, and choose the charging intensity with the rheostat's switch.

In Europe : Tesla supercharger In Europe, Tesla has already installed about 6 000 Superchargers with a 150-kW power and an intensity ranging from 25 to 150 A at 1 000 V. They are distributed in a little under 900 stations. These chargers can give an additional 270km autonomy in less than 30 mn for an average charging cost of 0.24 euros per kW.

135 years passed between these two devices that almost have the same weight and volume.

In the second part, we will introduce a few exemplary technico-economic projects in California and Norway.

Few exemplary projects

California : its electric infrastructures In California, private vehicles are over-represented. 38 million inhabitants own 35 million vehicles registered in the state. In 2016, the Californian electric vehicle fleet represented 140 000 vehicles, thus 40% of the number of electric vehicles in the US.

California offers 2 500 dollars for the purchase of an electric vehicle as well as a tax credit that can go up to 7 500 dollars. EV users can take carpool lanes. The state of California hopes that electric car sales will represent 15% of the sales of new vehicles by 2025.

In terms of power generation, California produces a quarter of its electricity via renewable energies, solar and wind energy.

Regarding the network, the Californian territory has 7 400 charging stations among which 2 500 fast-charging stations. San Francisco has installed 100 free-of-charge charging stations to incite electric mobility.

Norway : Worldwide reference in electric mobility Here is another example. Norway is a reference in terms of electric mobility development worldwide. This country has 50,000 electric cars for 5 million inhabitants. It is estimated to reach 200,000 EVs by 2020. This country convinced purchasers thanks to several aids : free highways, bridges and parking spaces, driving in bus lanes allowed, VAT aid when purchasing an EV and 500 free-of-charge charging stations.

These numerous favorable conditions allow Norway to achieve record sales since 2015. One new car out of five is electric. Thermal vehicles cost more than electric vehicles and they are severely taxed.

One of the particularities of Norway is that it is the first European oil producer. Its hydraulic resources represent 95% of the electricity produced. But it also develops renewable energies such as wind energy. The use of electric cars in Norway is considered as being clean since the supplied electricity comes from renewable energies. Furthermore, the Norwegian power grid accepting 50,000 charging stations is designed to accept a 2.5 million electric vehicle fleet, just as much as the current thermal vehicle fleet.

Last June, the main Norwegian political parties reached an agreement to prohibit the sale of thermal vehicles as of 2025.

France

A different situation In France, the situation is different. The French fleet consists of 38.5 million thermal vehicles and 76% of the electricity comes from nuclear power. The remaining 24% come from other resources : fossil fuel, hydraulic energy, wind energy, solar energy and bioenergy.

In 2015, France has adopted a law on energy transition for green growth. One of its aims is to deploy electric mobility. This goes through the installation of 7 million charging stations on the whole territory, the obligation to install charging stations in every new facility and construction, in existing business premises and shopping malls, but also in housings in the event of works.

With 7 million electric vehicles, the electricity production would be enough but would require an optimized management of demand. Should we go over 15 million EVs, the equivalent of the production of 5 EPRs would be necessary to supply the required electricity.

The different actors involved are thinking about the grid, the production of electricity favoring renewable energies, and the integration of electric vehicles. It is the vehicle to grid concepts associated with smartgrids, V2G related to smartgrid.

To this day, 16,000 charging stations are available on the territory. By the end of 2017, there should be 38,000.

Project BlueSolutions The Bolloré group, with the agreement of the government, is going to install 16,000 charging stations by 2019 for a 150-million-euro investment. They aim at offering users charging stations every 40 km. Note that these stations will not offer fast charging, since they have a 3 to 7 kW power. It must be noted that this installation is behind the initial development plan.

Project Corri-Door Corri-Door is a private consortium which gathers Sanef, EDF and its subsidiary Sodetrel, automotive manufacturers such as Renault-Nissan, BMW and Volkswagen, as well as ParisTech. On a national level, the Corri-Door project aims at being the backbone of the charging networks in France by connecting already equipped cities and regions. It has been acknowledged as being of national scale via a ministerial decision on January 29 2016. This project is integrated in the Trans-European Transport Network program established by the European Commission which finances 50% of the investments. The installation of fast-charging stations for a total cost of 10 million euros is done along highways and in city suburbs. Eventually, the Corri-Door network will provide a 200-charging-station network, meaning every 80 km.

Example of territorial deployment : Nord-Pas de Calais regional project

Before the January 1 2016 merger, the former Nord-Pas de Calais regional council had launched a regional plan to develop electric mobility in partnership with 19 EPCIs in order to implement a charging station network over 250 km from Maubeuge to Dunkirk. In order to observe a territorial meshing, each EPCI joining the program agreed to install one outlet for 3 000 inhabitants over 3 years. The mobility plan has been organized via a corridor system, mainly along major roads, with the goal of

installing a semi-fast-charging station every 50 km. The first installation phase saw the implementation of 233 charging stations out of the 2 500 planned stations.

Exemple of territorial deployment : Valenciennes Métropole The Valenciennes métropole project is part of a state call for projects via the ADEME and the regional council which financed up to 80% of a charging station installation until January 20 2016. 16 municipalities are affected. 37 semi-fast-charging stations built by G2 mobility were planned every 20 km and one fast-charging DBT station at the junction of the two highways. The global installation and operation budget is about 650,000 euros. The average cost to install a station was 12,000 euros minus public aids : 50% by the ADEME, 30% by the regional council. Local authorities were to finance the remaining 20% and finance operation costs. Regional use fares were also defined. They are described in the table of Figure 6.2.

• Accelerated charge				Full charge Registered price
		Registered	Unregistered	
Day	Barèmes BLEU*	0.70€ / 20min	0.75€ / 20min	3,15€
21h-7h	Barèmes VERT*	0.10€ / 20min	0.15€ / 20min	0,45€
• Fast charge				
		Registered	Unregistered	
	Barèmes ROUGE*	4.50€ / 20min	5.50€ / 20min	4,50€

FIGURE 6.2 – Valenciennes Métropole : Regional use fares

Conclusion

To conclude, to this day France is not able to offer operating conditions similar to that of Norway. However, our model is close to that of the one offered in California but we suffer from an important delay in terms of the number of electric vehicle in circulation and the development of electric networks.