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INSIGHT

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ROADMAP TOWARDS PUBLIC CHARGING INFRASTRUCTURE IN EUROPE

A STUDY ON THE PUBLIC CHARGING INFRASTRUCTURE ROLL-OUT IN EUROPE

Intro

Electric vehicles (EV) are becoming omnipresent in Europe as improvements in battery technology reduce costs and extend the EV range. A steep increase in the EV sales for the coming years is also expected because of the growing EV offer, regulatory incentives and ambitious targets.

In order to support and foster the EV penetration (share of EV on the road), the availability of a public EVSE (Electric Vehicle Supply Equipment) infrastructure is a must. Public charging stations are essential to the mass rollout of EV by providing a safety blanket and increasing the possibility for intercity traveling.

The aim of this article is to provide an answer to several key questions regarding the installation of public charging infrastructure in Europe: (i) forecasting the future number of EV, (ii) defining the number and optimal mix of slow-medium and fast chargers and (iii) estimating the investment cost to install this charging infrastructure.

Methodology and model

In a pevious study [1], Sia Partners has identified a relation between the coverage degree of the public available EVSE (Electric Vehicle Supply Equipment) infrastructure and the EV penetration degree on a national scale in Europe, in order to predict the required number of public EV charging stations given an EV penetration rate of 1 and 2% (personal vehicles only). With the increasing availability of data, in particular made available by the European Alternative Fuels Observatory [2], the geographical scope of the analysis is extended in this study to almost all European countries and the timespan is further prolonged. In addition, a distinction is made between slow-medium[1] and fast charging installations. Note that this analysis is limited to personal vehicles only and includes battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).

This article aims to answer the following questions:

1. How many EV will be on the road by 2020, 2030 and 2040 in Europe and what share will it represent in the total number of personal vehicles (EV penetration)?
2. How many public charging installations (slow-medium and/or fast) will be required in order to support a given level of EV penetration on a national level?
3. What investment cost will be necessary to meet the required infrastructure coverage?

The future number of EV and the EV adoption degree on a European level are estimated by applying a power growth simulation model. In this model, the different national EV adoption growth rate trends, existing EV fleet number and overall personal vehicle stock for the European countries in scope are taken into account. The prediction of the total EV on the road has herein been based on the total EV sold in the last six years. Further, the required slow-medium and fast EVSE charging infrastructure to meet a given EV penetration degree are determined by a regression model. The EVSE charging infrastructure is herein defined as the EVSE coverage of the road network or the number of charging stations per km of road, while the EV penetration ratio is the total number of EV divided by the total number of personal vehicles on the road.

Figure 1 shows the actual EV penetration, normal and fast EVSE road network coverage for all European countries in scope (2016 values). While the EV penetration and road network coverage are still very limited in the majority of the European countries, Norway stands out with a penetration rate of 4% and the highest fast EVSE road network coverage. The Netherlands comes in second in terms of EV penetration and leads the way regarding normal EVSE road network coverage.

[1] In this article a distinction is made between 'fast' chargers and 'slow-medium' chargers.
'Fast' chargers are defined as DC Type 3 (SCAME).
'Slow-medium' chargers are defined as Level 2 curb side EVSE or other, non-DC EVSE

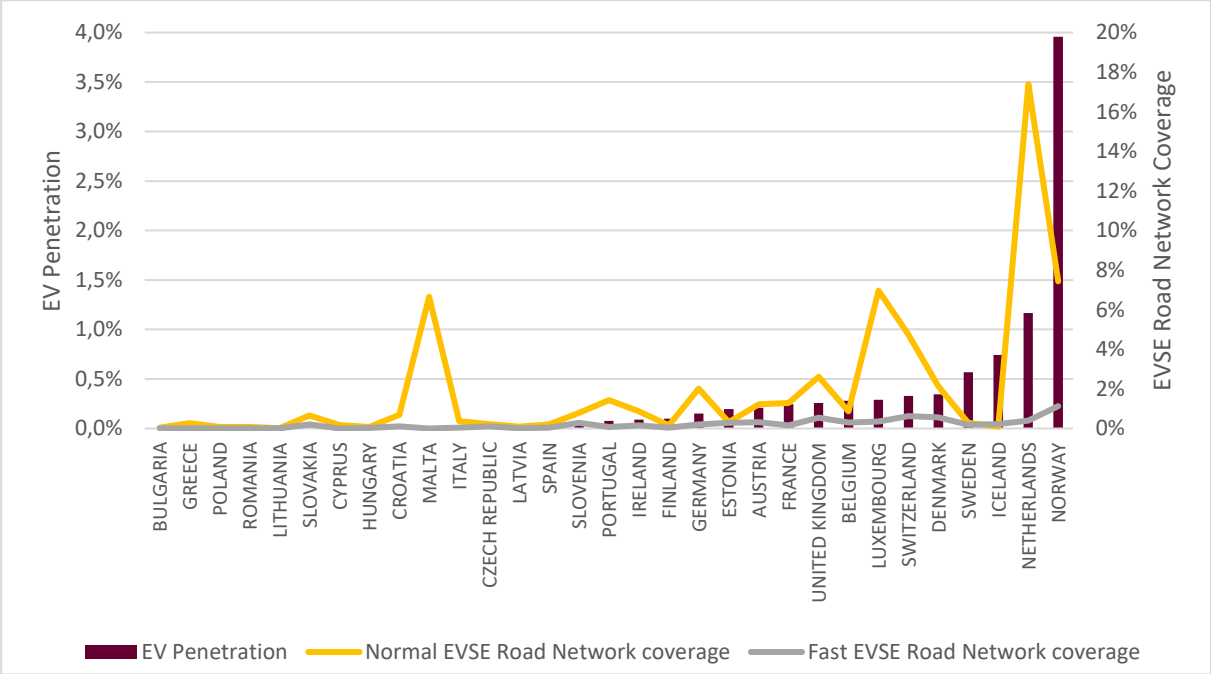

FIGURE 1: ACTUAL EV PENETRATION AND EVSE ROAD NETWORK COVERAGE (2016 VALUES)

Although the advantages of fast EVSE chargers outweigh those of small-medium EVSE chargers, its very high installation and maintenance costs still hinder a massive adoption. Historically mainly slow-medium chargers have been installed because it was the only technology available or to rapidly enroll a country-wide charging infrastructure in the most cost-efficient way. Currently a trade-off is made between slow-medium and fast chargers.

In the following Results section the elements to which this article aims to find an answer are further investigated: the EV penetration ration in Europe, the required EVSE infrastructure and the investment costs.

Results

EV penetration in Europe

Figure 2 visualizes the predicted amount of EV on the road and and the corresponding EV penetration degree in Europe, estimated via power regression. A growing EV adoption rate is estimated due to increasing efficiency and downward cost trend of batteries, a lower total cost of the vehicle and an expanding and improving EV road infrastructure

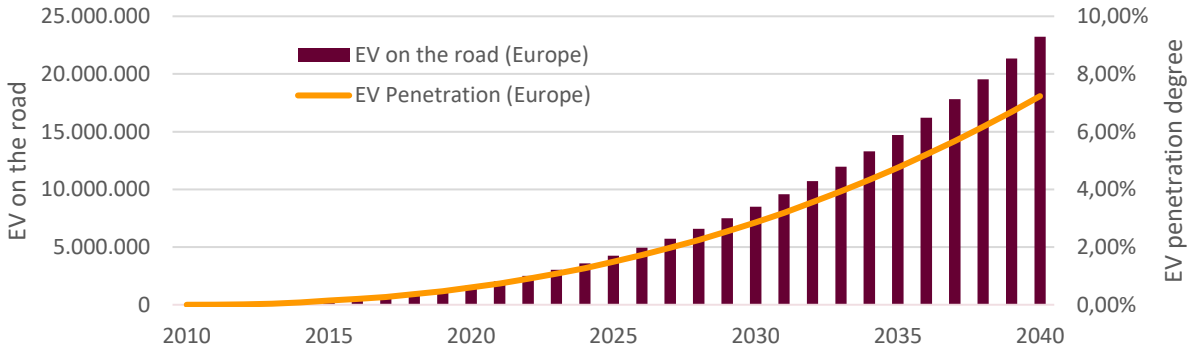

FIGURE 2: TIMELINE EV GROWTH AND EV PENETRATION

Table 1 gives an overview of the EV stock situation today and the milestones which will be reached the coming years. It can be observed that by 2020 the total EV stock will more than double while by 2040 the EV potential

may almost thirtyfold. Today the EV stock limits to 750 000 cars, resulting in a EV penetration degree of less than 0,5% of the total vehicle park. By 2040, following the current tren,d European countries would be able to reach a total EV stock of 25 million cars or an EV penetration degree of 7,5%.

	2017	2020	2030	2040
EV on the road	750 000	1 600 000	8 500 000	25 000 000
EV penetration	<0,5%	<1%	3%	7,5%

TABLE 1: MILESTONES EV GROWTH AND EV PENETRATION IN EUROPE

Required EVSE implementation in Europe

From analytical observations it has been noted that the EV penetration is more sensitive towards fast EVSE compared to slow-medium speed EVSE. The distribution between fast and slow-medium charging infrastructure may depend on different components such as appropriate grid infrastructure, installation and exploitation costs. Therefore this study introduces two scenarios which represent the EVSE speed distribution and the impact on the total installation required.

1. **Scenario '15% fast'**: a situation wherein the EVSE national charging infrastructure consists of 15% fast charging stations compared to 85% slow-medium charging stations
2. **Scenario '30% fast'**: a 30% fast chargers situation

A growing trend can be idenftified in the share of fast-charging stations in each European country, although none of them has reached a share of 15% fast chargers yet. Only the actual situation in Norway is approaching this scenario, as they have a relative share of 13,4% fast-chargers. The '30% fast' scenario is an extreme case in the analysis.

Given the EV penetration rates for Europe, estimated above, Figure 3 represents the required total number of EVSE, in the scenario of 15% fast chargers and 30% fast chargers, to support this identical EV penetration degree. It can be observed that an increase in fast EVSE compared to slow-medium EVSE has a significant impact on the required total charging points.

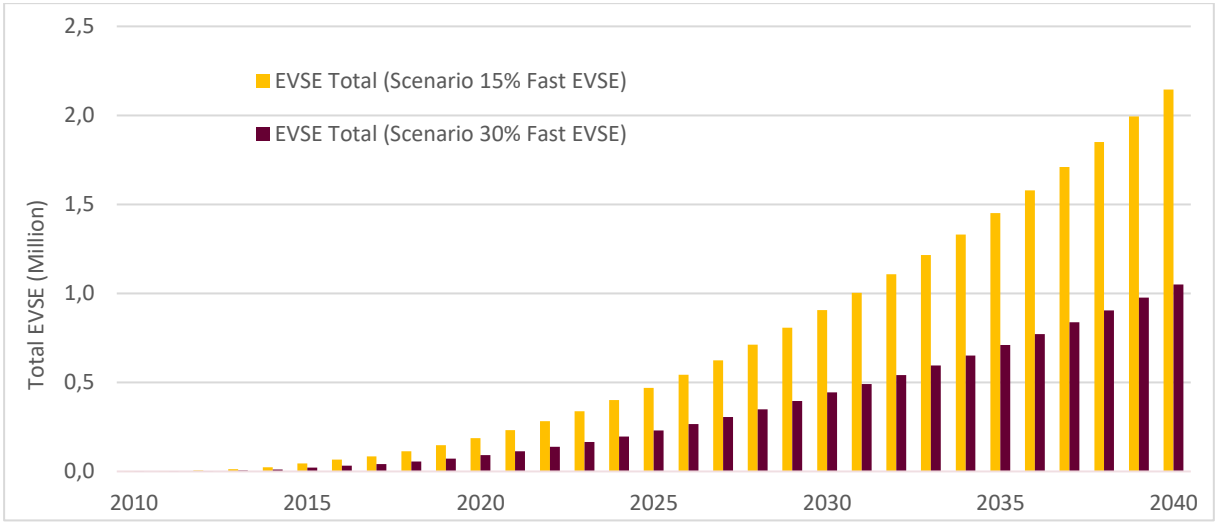

FIGURE 3: EVSE ADOPTION RATE IN EUROPE

Table 2 specifies the EVSE milestones, in both scenarios, which should be reached in order to assure the needed EV penetration in Europe in 2020, 2030 and 2040. Currently, the total amount of EVSE represents 90 000 charging points and required a steep growth in both scenarios to support the expanding EV base. The total number of charging installations is, however, remarkbly different as more than the double of total EVSE is required as of 2020 in case of the '15% fast'-scenario compared to the '30% fast'-scenario. Practically, it is sufficient to replace

existing slow-medium chargers with fast chargers (until these represent 30% in the total EVSE stock) by 2020 to support the EV penetration.

	2017	2020	2030	2040
Scenario 15% fast	90 000 (<13% Fast EVSE)	190 000	900 000	2 150 000
Scenario 30% fast		90 000	450 000	1 000 000

TABLE 2: MILESTONES REQUIRED EVSE (TOTAL EVSE IN EUROPE IS 90,000

What does the additional EVSE implementation cost?

The other side of the coin is that the investment in a single fast EVSE is significantly higher compared to the slow-medium speed EVSE[2] [3]. Nevertheless, the simulation model indicates that the EV adoption rate is much more sensitive to the fast EVSE implementation, compared to the implementation of slow-medium EVSE. This makes the investment in fast chargers more atractive in order to support the EV adoption. Figure 4 represents the required total yearly investment costs of the EVSE on European level in the scenarios of 15% and 30% fast chargers. The analysis indicates that proportional bigger investment in fast EVSE, not only requires less public charging stations, but will also result in a lower total investment cost and a higher gain for society.

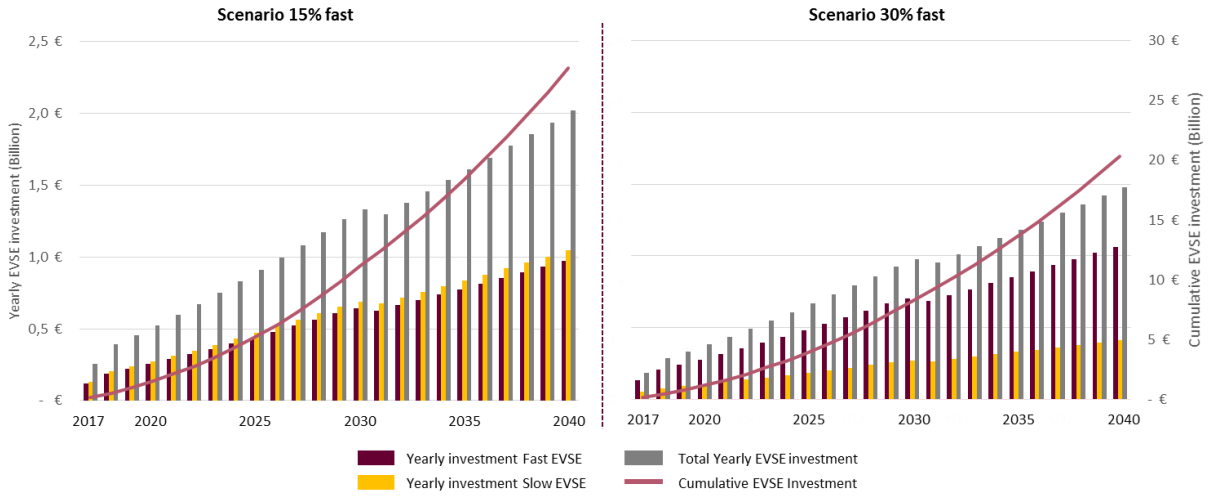

FIGURE 4: TOTAL EVSE INVESTMENT COST IN EUROPE

Table 3 sumarises these cumulative total investment cost required for the different milestones in time. The table shows the additional investment into the EVSE in addition to the current publicly available EVSE (in 2017). For example, in order to reach an EV penetration of 7,5% by 2040 a total amount of 2,15 million EVSE with an additional investment cost 27,8 billion Euro is required in the '15% fast'-scenario. The same goal will be reached by providing a total of 1 million EVSE, with a cost of 20,3 billion Euro, following scenario '30% fast'.

	2017	2020	2030	2040
Scenario 15% fast	0,25 €	1,6 €	11,2 €	27,8 €
Scenario 30% fast	0,20 €	1,2 €	8,2 €	20,3 €

[2] The cost of fast and slow-medium speed EVSE have been estimated respectively 48 000 and 8 000 Euro

TABLE 3: TOTAL EVSE INVESTMENT MILESTONES (IN BILLION €)

CONCLUSION

In this study the total number of electric vehicles on the road until 2040 is estimated, together with the total number of charging points required to support this growing EV penetration ratio, and the investments that will be needed to install these charging points.

The scenarios of a 15% and 30% fast chargers share in the total number of charging installations are analysed in this study. A statistical analysis based on the historical data of EV penetration versus deployment of public fast and slow-medium chargers shows that fast chargers have a significantly higher contribution towards promoting EV penetration. Comparing both scenarios, the model suggests that the investment in fast public EVSE will not only lead to less EVSE required in total, but also to a lower overall cost.

The prediction shows that in order to achieve an EV penetration of 7,5% (25 million EV by 2040), the European countries will require between 1 and 2 million EVSE in public space, which corresponds to an estimated total investment between 20,3 and 27,8 billion euro. The analysis shows that by focusing on the fast EVSE implementation, the European region can save up to 7.5 billion euro.

Therefore, Sia Partners recommends to increase the investment in fast EVSE relative to the slow EVSE on the European and the national level in order to support the future EV penetration at a lower cost to society.

References

[1] Sia Partners, Energy Blog, 2016, http://energy.sia-partners.com/20160927/public-charging-infrastructures-essential-mass-adoption-electric-vehicles

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[3] U.S Department of Energy, 2015, https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf

[4] The Charging Point 2011, Is it easy to charge an electric car? Do you need special equipment? http://thechargingpoint.azurewebsites.net/knowledge-hub/hot-topics/hot-topics-charging.html

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ABOUT SIA PARTNERS

Founded in 1999, Sia Partners is an independent global management consulting firm with over 800 consultants and an annual turnover of USD 140 million. The Group has 19 offices in 15 countries, including the U.S., its second biggest market. Sia Partners is renowned for its expertise in the Energy, Banking, Insurance, Telecommunications and Transportation sectors.

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