

# Charging infrastructure for electric vehicles

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A EURELECTRIC position paper

July 2016

***EURELECTRIC is the voice of the electricity industry in Europe.***

*We speak for more than 3,500 companies in power generation, distribution, and supply.*

***We Stand For:***

***Carbon-neutral electricity by 2050***

We have committed to making Europe's electricity cleaner. To deliver, we need to make use of **all low-carbon technologies**: more renewables, but also clean coal and gas, and nuclear. Efficient electric technologies in **transport and buildings**, combined with the development of smart grids and a major push in **energy efficiency** play a key role in reducing fossil fuel consumption and making our electricity more sustainable.

***Competitive electricity for our customers***

We support well-functioning, distortion-free **energy and carbon markets** as the best way to produce electricity and reduce emissions cost-efficiently. Integrated EU-wide electricity and gas markets are also crucial to offer our customers the **full benefits of liberalisation**: they ensure the best use of generation resources, improve **security of supply**, allow full EU-wide competition, and increase **customer choice**.

***Continent-wide electricity through a coherent European approach***

Europe's energy and climate challenges can only be solved by **European – or even global – policies**, not incoherent national measures. Such policies should complement, not contradict each other: coherent and integrated approaches reduce costs. This will encourage **effective investment** to ensure a sustainable and reliable electricity supply for Europe's businesses and consumers.

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## KEY MESSAGES

- Electrification using carbon-neutral electricity will be able to bring important benefits to the transport sector including significant reductions in greenhouse gas emissions from road and rail transport, as well as improvements in air quality and reductions in noise pollution. Electro-mobility is an essential part of the solution to Europe's transport and energy challenges. Electric vehicles (EVs) can play an important role in providing flexibility to the power system and thus contributing to the integration of renewables.
- Public support, standardisation and interoperability as a basis for new services, as well as the deployment of charging infrastructure, are deemed essential to build the foundations for large scale Electro-Mobility Deployment in Europe.
- The limited availability of charging infrastructure, including a lack of adequate business and financing models, is considered to be one of the biggest obstacles to the widespread adoption of EVs by customers who still suffer from 'range anxiety'.
- With the adoption of the Clean Power for Transport Directive (Directive 2014/94/EU), European policymakers have taken important steps to develop national policy frameworks for the market development of alternative fuels and their infrastructure.
- In principle, EURELECTRIC sees the provision of EV charging infrastructure as a market activity. The roll-out of the public EV charging infrastructure can therefore be achieved through public tenders allowing market forces to compete for the provision of the service. However, some countries have given DSOs the responsibility for owning and operating technically the infrastructure as an extension of their regulated role, either for fast or slow chargers.
- In such cases, DSOs may thus be the owner and/or the technical operator of the charging infrastructure especially in public places, and can also provide the metering of the energy while commercial operation of the charging posts could be done by a market party. This is especially an option in those Member States where competition in this area has not yet started and where private investors are hesitant to invest
- Where DSOs own and/or technically operate public chargers, these would be part of the electric distribution assets and the recovery for incurred costs by DSOs must be ensured either via inclusion in the regulatory asset base or it can be financed via public resources. Once markets mature, EURELECTRIC sees the provision of charging infrastructure move towards competition, bearing in mind the need to avoid sunk costs and stranded assets for the DSO.
- When a business case develops, and by order of the regulator, the DSOs can remain the owner of such assets until the cost is recovered, or they can sell the relevant assets to market parties at residual cost. However, the operation would be transferred to a market party (e.g. through auctions).
- EV charging may have a huge impact on demand (kW) at certain times. In order to address local congestion at system peak or to mitigate the need for peak-related network upgrades, DSOs will require a real-time and dynamic response from the charging infrastructure which can be procured through V2G services providers. In order to do this, a fully equipped, remotely controllable and smart charging infrastructure will be required.

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## 1. Introduction

Decarbonising electricity as an energy carrier will make a major contribution to help Europe meet its climate change targets, but it will also open the door for many more positive changes, spill-overs in energy consuming sectors, which currently have no other perspective of becoming fully sustainable. Some of these opportunities, such as electric vehicles (EVs) for example, are already well known.

Electrification using carbon-neutral electricity will be able to bring important benefits to the transport sector including significant reductions in greenhouse gas emissions from road and rail transport (road transport is the second biggest source of greenhouse gas emissions in the EU<sup>2</sup>), as well as improvements in air quality and reductions in noise pollution.

The key to unlocking the potential of electrification depends on our ability to deliver the enabling technologies as soon as possible. The good news is that these technologies are no longer dreams of the future, many of them either already exist on the market or are being prepared for mass deployment. With the support of proper innovation policies these technologies can become cheaper, more flexible and bring more benefits to consumers faster.

This paper will focus on analysing the challenges and opportunities relating to the deployment of EV charging infrastructure one of the three key pillars in the achievement of the large-scale development of Electro-Mobility.

## 2. On the Road towards the Large Scale Development of Electro-Mobility

Electro-mobility is an essential part of the solution to Europe's transport and energy challenges including the objectives of reducing carbon and other greenhouse gas emissions. It is also a key solution to limiting air pollution and noise in urban/suburban agglomerations and other densely populated areas, as well as improving energy security, while providing a new source of revenue. Furthermore, electro-mobility also contributes to maintaining the EU's competitiveness by taking the lead in this new area of technological innovation and development, as well as by contributing to increased efficiency in the European electricity system by shaving demand peaks (provided that the charging infrastructure is smart and responds to price signals or specific demand from DSOs). Electric vehicles (EVs) can also act as a mobile and decentralised storage device, and in this way can play an important role in providing flexibility to the power system and facilitating the integration of renewable energy sources.

The EV industry is working on improving battery efficiency, which has a direct impact on key features such as performance and range. Already today, the range of a typical full battery electric vehicle is around 150-200km<sup>1</sup>, which is particularly relevant when keeping in mind that around 80% of drivers in urban areas cover less than 65km per day. In addition to battery capacity improvement, the EV range can be improved through the availability of a faster charger for occasional longer trips, as most of the charging is estimated to take place at home or at work.

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<sup>1</sup> <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/individual-mobility-conventional-electric-cars>

Figure 1 below shows the total number of electric vehicles and chargers (fast / slow) in a number of European countries. The chart shows a pronounced difference (when considering the number of EVs or chargers on a per capita basis) between the Netherlands and Norway on the one hand, and other European countries on the other. When considering the total numbers of EVs and chargers, as expected, the larger countries (such as France, Germany and the UK) show the greatest numbers, while the Baltic countries (apart from Estonia) and most of Eastern Europe are clearly lagging behind. However, even in those countries featuring higher EV figures, the numbers of available chargers in such countries are still relatively sparse.

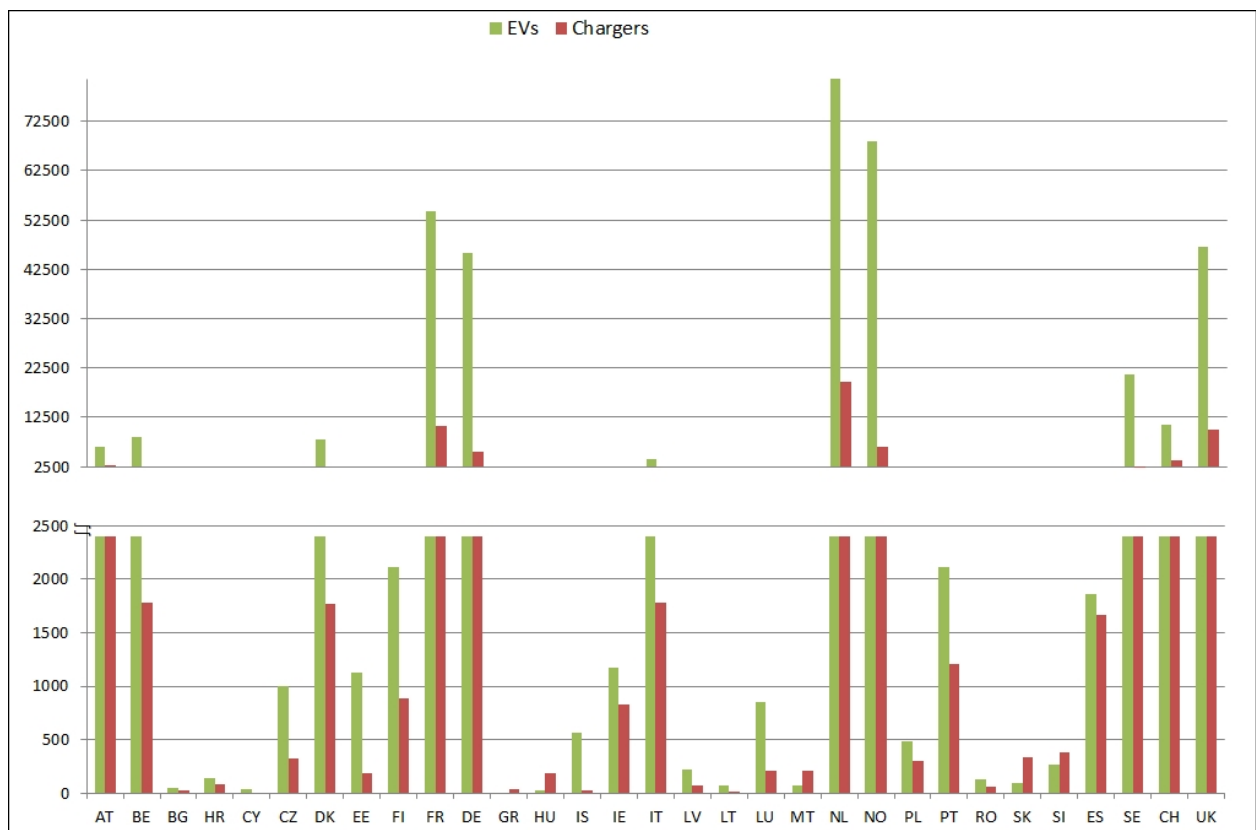


Figure 1: EVs and chargers in European countries (Source: graph by EURELECTRIC using data from EAFO ([European Alternative Fuels Observatory](#)))

### **3. Three pillars to achieve Large Scale Development of Electro-Mobility**

EURELECTRIC considers **the following three pillars as essential to build the foundations for large scale Electro-Mobility Deployment in Europe.**

#### **3.1. Public Support**

Temporary financial and non-financial support from public authorities, governments, climate/energy/transportation funds is needed in order to reduce the economic risks of customers and companies who buy electric vehicles. Such support could take the form of an investment subsidy funding or a fiscal concession. National governments as well as the EV industry should also strive to improve customer awareness regarding the need to change their mobility behaviour into one that is more sustainable, and to remove entry barriers for new entrants. Public support for charging infrastructure is also important in public procurement (examples of best practice include, for example, sustainable transport in fleets and municipalities).

The regulatory framework for reducing greenhouse gas emissions from the transport sector, including more stringent CO<sub>2</sub> emissions standards, represents an additional driver for investment in electro-mobility.

#### **3.2. Standardisation and Interoperability as a Basis for New Services**

For energy and electro-mobility service providers, EURELECTRIC envisages a wide range of business cases that would launch new services and possibilities around the EV industry. These services would either be provided as a supplement to the electro-mobility solution, when buying a vehicle (as a package paying either for the time used or per kWh), or when contracting with them subsequently for the purchase of energy.

As part of the solution in the transition to a low carbon economy, energy and electro-mobility service providers, in cooperation with the EV industry, are expected to strive for the promotion of common open standards, data interoperability and efficient data exchange to pave the way for the necessary behavioural change.

European electricity companies, distribution system operators (DSOs) and national electricity sector associations support the deployment of pre-standards and further development of existing standards (ISO 15118) when implementing infrastructure and vehicle connections. In doing so, they gain early experience with business models and are better able to assess the impact on the electricity grid when standards are approved officially by ISO and IEC. This approach was supported in the Declaration on Standardisation of Electric Vehicle Infrastructure<sup>2</sup> adopted by the European electricity industry.

#### **3.3. Deployment of EV Charging Infrastructure**

In order to reap the benefits that electric vehicles (EVs) have to offer, the efficient integration of EVs into the European electricity system is required. The limited availability of charging

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<sup>2</sup> 'Standardisation of Electric Vehicle charging infrastructure', Declaration by the European Electricity Industry, (2009)

infrastructure, including a lack of adequate business and financing models, is considered to be one of the biggest obstacles to the widespread adoption of EVs by customers, many of whom still suffer from 'range anxiety'.

From a service provider viewpoint, this entails a circularity problem for market operators who are wary of investing in the needed infrastructure without having any visibility as to what its actual utilisation will be in view of the uncertain adoption rates of EVs, as well as potential interoperability issues. Generally speaking, we can distinguish between four categories of charging infrastructure<sup>3</sup>:

1. Public charging station on public domain (e.g. roadside/sidewalk);
2. Publicly accessible charging station on private domain (e.g. commercial areas such as shopping malls);
3. Semi-public charging station on public or private domain (e.g. car sharing CS, hotels or business parking for visitors and customers);
4. Privately accessible charging station (e.g. home or office locations).

The classification is important both from a commercial and a technical perspective.

This paper will focus on analysing the challenges and opportunities relating to the deployment of EV charging infrastructure particularly on the public domain as a key pillar in the achievement of the large scale development of Electro-Mobility.

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<sup>3</sup> As explained in "Deploying publicly accessible charging infrastructure for electric vehicles, how to organise the market?", EURELECTRIC concept paper (July, 2013)

## 4. How to achieve the deployment of EV Charging Infrastructure

### 4.1. Policy framework and deployment models

With the adoption of the Clean Power for Transport Directive (Directive 2014/94/EU), European policymakers have taken important steps to develop national policy frameworks for the market development of alternative fuels and their infrastructure by November 2016. The Directive states that the establishment and operation of recharging points for EVs should be developed as a competitive market with open access to all parties interested in rolling-out, operating recharging infrastructures or offering charging services for customers.

At the moment, due to the low deployment of EVs, low charging point manufacturing scale and the relatively high deployment costs, public charging stations on public and private domain and semi-public charging stations can only be operated profitably with public and private support.

Another option to achieve the roll-out of the **public charging infrastructure** (generally, AC charging points with medium and high power up to 22 kW, several countries offer up to 50 kW) is to issue a public tender which would allow market forces to compete for the provision of the service. The municipality organises a tender in which all investors can participate and an annual fee, for example, may be defined through this tendering process.

Several countries have chosen a different model, fully compatible with the previous one, whereby DSOs are given the responsibility of **owning and technically operating** the infrastructure as an extension of their regulated role. This option enables that commercial operation of the charging posts could be done by a market party. This is the case in Austria, Luxembourg, Slovenia (only on highways) and Ireland. Furthermore, in a number of Member States, municipalities can also be in charge of deploying public chargers.

The DSO model described above is consistent with:

- Directive 2014/94/EC, which states: *“Distribution system operators play an important role in relation to recharging points. In the development of their tasks, the distribution system operators, some of whom may be part of a vertically integrated undertaking owning or operating recharging points, should cooperate on a non-discriminatory basis with any other owners or operators of recharging points, in particular providing them with the information needed for the efficient access to and use of the system.”*
- The CEER Conclusions Paper “The Future Role of DSOs”, which states: *“When there is the potential for competition to develop new activity areas, the default is either to prevent DSOs from undertaking the activity completely, or allow the DSO to undertake the activity under special conditions imposed by the regulator.”*

**As markets mature and a business case develops, EURELECTRIC sees the provision of EV charging infrastructure move towards competition**, bearing in mind the need to avoid sunk costs and stranded assets for the DSO. Furthermore, in the cases where Member States have decided that in the initial stages of development of electro-mobility, the DSO should be the owner and technical operator of EV charging infrastructure and there should be an exit strategy

so that a competitive market can be established once the market reaches the necessary level of maturity.

If the DSO model is selected, the recovery of the cost can be done either via inclusion in the regulatory asset base, or it can be financed via public resources. The latter option is preferable in order to share the burden of the costs of decarbonisation of transport sector equally within society, rather than allocating it to electricity consumers (as this could lead to increase in retail bills and hampering of electrification, namely transport).

In all models, we believe public charging infrastructure should follow the EU mandates for standardisation and technology developments, ensuring that all the logical needs of EV users are met in a timely manner. The infrastructure should therefore be installed following customers' needs and the progressive deployment of EVs. Charging points should also be located at the "right place" and embed the adequate technology, hence avoiding stranded investments.

The situation is somewhat different for **private and semi-public infrastructure** (usually, AC charging points up to 22 kW (excluding devices with a power less than or equal to 3.7 kW) which are installed in private households or the primary purpose of which is not recharging electric vehicles, and which are not accessible to the public), as customers themselves (e.g. wallboxes in private garages) or building managers/owners (e.g. who can install charging stations in parking lots located nearby in case of apartment buildings or at offices) can own and operate the charging points. In such cases, the retail company or electro-mobility service provider usually rolls-out and operates the charging infrastructure.

Customers who own a garage where they can install a private charging point are more likely to buy an electric vehicle than those who park their cars on the street. However, the majority of the inhabitants of large European cities park their vehicles on the street. Deployment of public charging infrastructure does not provide a solution in the case of this example since it does not guarantee the possibility of charging one's EV every night. Additionally, in those locations where public charging infrastructure exists, its use is frequently restricted by the lack of interoperability standards or mechanisms to easily pay for the charge. EURELECTRIC believes that Member States should therefore implement mechanisms to guarantee the possibility of charging EVs on the street for those citizens who do not own a garage.

It is also worth noting that in order to address local congestion at peak loads (not system wide), or to mitigate network upgrades for coping with peaking loads, DSOs may require dynamic charging technology that allows real-time and dynamic response from the charging infrastructure or charge point operator (CPO). In order to do this, the ability to communicate indirectly with the abovementioned equipment will be required. In this context, the network may take advantage of EVs equipped with vehicle-to-grid (V2G) technologies dealing with network congestion management issues through V2G service providers. EVs may alleviate the congestion increasing or decreasing their battery energy level, stop their charging or even inject energy to the grid aiming for the secure state of the system. V2G technologies may be key to provide local services that DSOs may procure in the market that at the same time may provide additional revenues to support the infrastructure development.

In a fully liberalised e-mobility market, new roles of e-mobility providers (EMP) and charge point operators (CPO) should be established. This is for example the situation in Austria, where vertically integrated EMPs and CPOs offer their services.

#### **4.2. Role of the DSOs in cases where they are mandated to deploy/operate Public Charging Infrastructure**

As mentioned in section 4.1 above, one option to achieve the roll-out of the **public EV charging infrastructure** is to issue a public tender which would allow market forces to compete for the provision of the service. A few countries have chosen a different model, which can coexist with public tenders for deploying charging infrastructure in other locations or regions, whereby DSOs are given the responsibility of **owning and technically operating** the infrastructure as an extension of their regulated role. This is especially an option in those Member States where competition in this area has not yet started and where private investors are hesitant to invest. In this case, DSOs may be the owner and/or the technical operator of the charging infrastructure on AC (lower power) and DC (higher power) levels, especially in public places, and can also provide metering services. As previously mentioned, a market party, if deemed so by Regulatory Authorities, could do the commercial operation of the charging posts. It is important to note that as far as public and semi-public areas are concerned, public access to the charging infrastructure should always be possible. We believe that public charging stations should enable free access to all citizens.

When DSOs are mandated to develop such public charging infrastructure, they can take the knowledge advantage of the grids' behaviour, which allows them to take direct measures in the planning and operation processes. DSOs should also aim at keeping costs in check.

In terms of DSO involvement, two existing approaches are possible:

- The DSO is in charge of developing EV charging infrastructure and metering, contracting out the commercial and technical operation of the assets to a market player (e.g. in Austria, Luxemburg and Slovenia (only on highways)).
- The DSO is in charge of developing EV charging infrastructure and metering. The DSO is also the technical operator of such assets. Billing services are provided by a third party (e.g. in Ireland), meaning the commercial operator.

The process for the involvement of DSOs may fall under the control of the energy regulator, which would apply cost efficiency criteria in the same way that it does for all other assets. It should nevertheless be recalled that efficiency is also linked to the way the infrastructure is deployed and operated, such as location of the charging points, choice of the technology and the way it is used, which will be more demanding for regulators to find the best way to drive efficiency.

Where **DSOs are responsible for owning and/or technically operating charging infrastructure**, public stations would become part of the electricity distribution assets until technological maturity is reached. As long as ownership and/or technical operation is under the DSO's control, the energy regulator will be responsible for setting cost efficiency criteria that are similar to those used in other pieces of grid infrastructure. In the specific case of charging infrastructure, the

regulator may determine the number of charging points. In any case, cost recovery (subject to cost efficiency testing) must be ensured.

When the **DSO is the only owner** of the charging post, and once the markets mature and a positive business case develops, EURELECTRIC sees the need for EV charging infrastructure to move towards unrestricted competition, while bearing in mind the need to avoid unjustified sunk costs and stranded assets for DSOs. Market testing should be performed by the energy regulator and/or the competition authority. DSOs may either keep asset ownership until they recover their total investment, or can sell the relevant assets to market parties at residual cost.

On the other hand, in those cases where Member States decide from the start that the **DSO should be the owner and also the technical operator** of EV charging infrastructure, there should be a clear exit strategy so that a competitive framework can be established once the market reaches the necessary level of maturity.



There may be two levels of involvement in the role of the operator depending of the roaming service:

- DSO can be the general operator of those charging infrastructure with roaming of electricity and services. This is because in this type of roaming, the B2B settlement between the e-Mobility Service Provider and the Charging Station Operator (DSO in this case), does not include the price of electricity. The role of the DSO will be the access control, management, data collections, etc.
- However, in those charging infrastructures with roaming of charging service, the DSOs will be only the technical operator (i.e. access control, management, data collection), while the commercial operation will be done by a market party. It is important to make this distinction due to in this type of roaming; the Electricity Supply Retailer is chosen by the Charging Station Operation and the commercial operator will sell the charging service including electricity at a given price condition to the e-Mobility Service Provider.

In this case, as in the previous, DSOs may either keep asset ownership until they recover their total investment or can sell the relevant assets to market parties at residual cost. However, the technical operation would be transferred to a market party (e.g. through auctions) while the maintenance should be under the owner's responsibility.

The owner of the charging infrastructure will receive the fee infrastructure through the e-Mobility service provider or through the operator of the charging infrastructure, who will have a B2B roaming agreement with the e-Mobility Service Provider.

In case of software updated and other measures which will help to provide better services to the customer and which exceed usual maintenance, the cost will be paid by the commercial operator of such assets.

It should be noted that, in certain cases, markets may be considered as mature overall but not necessarily mature at the local level. For example, there may be situations where the development of EV charging infrastructure could be non-profitable for individual market players notwithstanding significant rates of global EV penetration. In such cases, DSOs could act as “last resort EV charging infrastructure operators”.

## **5. Insight on some technical issues and EV impact on the grid and on smart charging**

### **5.1. Some technical issues regarding EV Charging Infrastructure**

There are also technical reasons that should be considered when deploying an EV charging infrastructure:

- **EV charging infrastructure location:** A retail company or electro-mobility service provider usually rolls out and operates private or semi-public infrastructure (typically, AC charging points of 3.7 kW and up to 22 kW). Private customers or commercial buildings can have EV charging stations installed in their private garages or parking lots.
- **Control Equipment:** It is worth noting that in order to address local congestion at peak loads (not system wide), or to mitigate the need for peak-related network upgrades, DSOs, or the relevant operator of the charging station, may require dynamic charging technology that allows real-time and dynamic response from the charging infrastructure provided by the respective charge point operator (CPO). This means that a fully equipped, remotely controllable and smart charging infrastructure may be needed. When the DSOs have been mandated to take this roll, it is good to consider that they are able and experienced to fit these devices out.
- **Driving range:** Fast chargers (DC charging points above 22 kW, typically 43 kW but possibly up to 300 kW in an hour) can draw a significant amount of power over a short time span. Assuming an average consumption of 20 kWh per 100km, this provides a driving range of more than 100km per hour of charge. Today, a wide range of market players, from car manufacturers (e.g. Tesla’s network of ‘superchargers’, 120 kW DC) to other electro-mobility service providers provide such a service. However, we believe that DSOs can also invest in these assets, under the same conditions explained above in terms of ownership and technical operation of public chargers. DSOs can install as much as needed charging poles so as to reduce this driving range to the right length.
- **Distribution network impact optimization:** Regardless of whether or not the DSO is the owner and/or the operator of these assets, DSOs are capable of connecting this load infrastructure at the technically optimal connection point to minimise power fluctuation grid impact for both fast and slow chargers.
- **Infrastructure deployment and task fulfilment:** Government or local authority would allow DSOs to access to the places where the public and semi-public charging infrastructure would be located. The DSO (either as a market facilitator in the beginning or as supplier/service provider, depending on the country), will take care of energy billing,

which can be done either directly or on a roaming basis. It is possible to offer time-based tariffs in order to set the right pricing incentives to shave the demand peak. These assets and operations may be delivered to competitive market players upon the request of the national regulatory authority once the market is mature, as explained in section 5 above. In order to facilitate competition and enable cross-border travel, it is necessary to have pan-European roaming in place. As mentioned before, any costs for the DSOs (especially if not fully state-owned) initiated by the regulator or policy, must be recovered.

## 5.2. EV Impact on the Electricity Grid and Smart Charging



The electricity system should become robust enough to cope with a fully electrified fleet in Europe, with small requirements of further investments in power system assets, provided that this cars' fleet would be charging in a smart way<sup>4</sup>, i.e., during off-peak hours. It is estimated that in 2035 a hypothetical share of 10% EVs will have an impact of up to 82TWh<sup>5</sup> on the electricity demand in the EU.

While EV charging is feasible in terms of the total amount of consumed energy (kWh), it could nonetheless have a huge impact on demand (kW) at certain times in certain areas. Charging will therefore need to be smartly coordinated by means of smart ICT systems in order to prevent foreseen evening peak loads and resulting in either transformer or cable overloads. While DSOs are temporarily responsible for this activity, they should be able to build their own ICT tools to monitor their infrastructure in order to mitigate network constraints. Smart charging could not be implemented in some business cases and therefore optimisation would not be the main target especially regarding fast charging (both AC and DC) because EV drivers could be under stricter time constraints (such as in the case of medical emergency vehicles, doctors, public order vehicles etc.). In such cases, EV availability is the main driver.

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<sup>4</sup> **Smart charging** has been defined by EURELECTRIC as “a controlled charging process that optimises the use of the grid and the available electrical energy to minimise additional investment in the grids and facilitate the integration of RES”. What are the benefits of smart charging? [EURELECTRIC position paper](#): European electricity industry views on charging EVs.

<sup>5</sup> Ten percent is equal to an estimated 25 million of EVs by 2035. See: [EURELECTRIC's Smart Charging paper, March 2015](#)

EURELECTRIC pursues in all its activities the application of the following sustainable development values:

Economic Development

▶ Growth, added-value, efficiency

Environmental Leadership

▶ Commitment, innovation, pro-activeness

Social Responsibility

▶ Transparency, ethics, accountability



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