Deploying publicly accessible charging infrastructure for electric vehicles: how to organise the market?

A EURELECTRIC concept paper

July 2013

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Dépôt légal: D/2013/12.105/35

Deploying publicly accessible charging infrastructure for electric vehicles: how to organise the market?

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- The availability of public recharging infrastructure is an important precondition for the success of e-mobility. However, given that the e-mobility market is still under development, business activities in this field do not (yet) deliver any return on investment.
- To avoid serious under-investment in public charging infrastructure, **EURELECTRIC promotes a simple and adequate market organisation** during the market development phase **in order to trigger infrastructure investments** and prepare the ground for a sustainable, balanced and profitable market.
- To that end, EURELECTRIC believes that **it is up to the Member States to decide on the most adequate market organisation according to their national characteristics** (both electricity market and e-mobility needs). In the longer term, the customer will be able to determine the success of the market model and thus the most cost-efficient solution.
- **In this paper, EURELECTRIC presents two possible market models** for deploying publicly accessible charging infrastructure: one in which the infrastructure investment is recovered solely by the e-mobility customers (**independent e-mobility model**) and one in which infrastructure investment is integrated in the grid tariffs, thus spreading the cost between all grid users (**integrated infrastructure model**). EU Member States should rapidly take a decision on the preferred model, thus giving a clear signal to potential investors.

KEY MESSAGES TO E-MOBILITY STAKEHOLDERS

- The identification of **market roles and actors** is indispensable in order to enable a **level playing field for business** initiatives. EURELECTRIC proposes its vision in this paper.

- "Roaming" customers will require setting up a **standardised exchange of data** between the e-mobility service provider and the charging station operator. This can be achieved either with a bilateral contract or through a "Clearing House" or via a combination of both that ensures interoperability.

I. INTRODUCTION

WHAT IS A MARKET MODEL?

A generic market model for e-mobility describes the minimal set of requirements and agreements between all relevant market players that are needed to deliver a well-functioning market in which commercial market players compete on a level playing field, ultimately fostering the mass introduction of e-mobility.

Such a market model describes players' roles in the market, their responsibilities, their relationships and the corresponding interactions. It gives a "top-down" view on the contractual and economic relationships between the actors and their roles throughout the specific value chain. All parties involved have to subscribe to the agreements (including settlements between providers and electricity suppliers) in order to deliver a **customer-oriented market**.

A market model is NOT a "business model": it does not define individual business players, nor does it provide a revenue stream analysis and/or a fully-fledged process analysis.

A market model that aims for a competitive environment for e-mobility must allow for:

- Access of new entrants, competing with a wide range of products and services;
- A stable and long-term investment climate for e-mobility;
- Transparent services and prices, encouraging customer behaviour to reflect the costs involved (e.g. peak demand);
- Revenue creation that reflects value creation and actual costs, avoiding a transfer of costs to other actors.

This paper focuses on market models for public charging infrastructure. Charging in private locations is thus out of scope of this analysis.

In this paper EURELECTRIC proposes a **generic market model** for **charging and e-mobility services**, respecting the regulatory framework for the electricity market in each of the EU Member States. The generic market model is developed with the **large-scale deployment of e-mobility** in mind and taking into account the on-going electric mobility pilot projects throughout the EU Member States. To that extent, the market model is future-oriented.

WHAT IS THIS PAPER'S STARTING POINT?

This paper will build upon work carried out by EURELECTRIC in its 2010 paper "*Market models for the roll-out of electric vehicle public charging infrastructure*"[1]. The document described four possible market models, shown below.

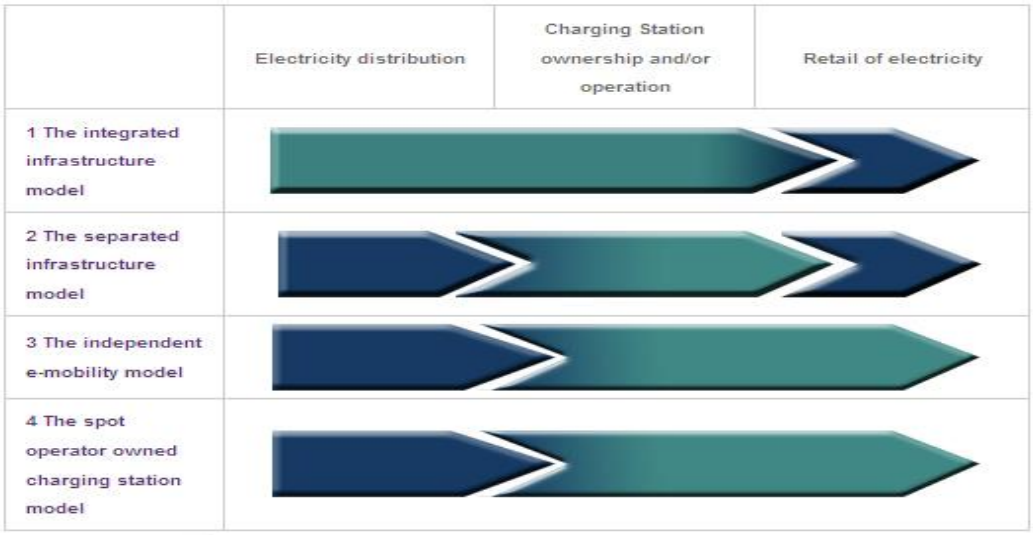

Figure 1: *EURELECTRIC market models for deploying public recharging infrastructure*

The models described in 2010 were limited to a presentation of the value chain to build up the recharging infrastructure, covering the distribution of electricity, the ownership and operation of the charging stations, and the retail of electricity. The models took into consideration the required investment for the infrastructure build-up, but did not include any other service nor identified the relationships between the different market actors. The paper showed that there are different ways to organise the value chain around public recharging infrastructure for electric vehicles.

In this paper EURELECTRIC elaborates on the different relations between market actors in the different value chain models. Similar to 2010, EURELECTRIC does not express a preference for one particular model; we believe that the **choice should be up to each Member State, taking into account characteristics of the national electricity markets, but also characteristics related to mobility behaviour**. Chapter IV describes the two models – the "integrated infrastructure model" and the "independent e-mobility operator model" – in more detail.

IN WHICH POLICY AND MARKET CONTEXT SHOULD THIS MARKET MODEL BE PLACED?

Electricity is increasingly seen as an alternative transport fuel that should contribute to European climate goals, as underscored by the European Commission's White Paper on Transport[2] (2011), the Energy Roadmap 2050[3] (2011), and the Clean Power for Transport Communication and Directive for the Deployment of Alternative Fuel Infrastructure[4] (2013).

[1] http://www.eurelectric.org/media/45284/2010-09-21_market_model_final_for_membernet-2010-030-0808-01-e.pdf
[2] http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm
[3] http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm
[4] http://ec.europa.eu/transport/themes/urban/cpt/index_en.htm

A large variety of stakeholders are currently involved in the development of e-mobility. The large-scale introduction of vehicles fuelled by electricity – either battery electric vehicles (BEV) or plug-in hybrids (PHEV) – implies that private and public charging stations will have to be integrated into the existing low voltage and medium voltage electricity networks. This calls for **cooperation** between a vast variety of stakeholders – both regulated and non-regulated – many of which did not have previous interactions.

Generally speaking, we can distinguish between four categories of charging infrastructure. This classification is important both from a commercial and a technical perspective.

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

This paper elaborates on **publicly accessible charging infrastructure** based on "**roaming**" functionalities – a possible solution to provide e-mobility customers with seamless access to the charging infrastructure and give them the same confidence in infrastructure access that they might have with conventional vehicles. Light has to be shed on the processes and interactions between the various stakeholders (regulated and non-regulated) that are needed to make this "roaming" available. The "roaming" function will be explained in detail in Chapters III and IV.

WHY IS EURELECTRIC PROPOSING THIS PAPER?

In the electricity industry's view, **e-mobility** will become an **integral part** of the **smart energy environment**, a must when electrification of transport should contribute to decarbonising the economy. EURELECTRIC sees "smart charging"[5] as the enabler to develop an economical and sustainable market around charging electric vehicles (both public and private charging). A well-organised e-mobility market is a prerequisite for smart charging.

EURELECTRIC considers smart charging as a **value added service** for:

- **E-Mobility Customers**: economic and ecological value
- **Charging Station Operators**: fulfil contractual commitments and maintain a business economy while taking into account charging requests of other market parties
- **E-Mobility Service Providers:** requests charging access following the request by their e-mobility customers
- **Distribution System Operators**: must maintain voltage within regulated margins and stabilise fluctuating power requests and injections from decentralised renewable generation. In that respect, smart charging enables load management[6] to provide the required flexibility to the system, taking into account multiple physical system constraints without causing severe inconvenience to the electricity customer
- **Energy Supply Retailers and Flexibility Operators:** seek to develop solutions towards energy and capacity markets by trading flexibility for ancillary services to the system (long-term perspective)

[5] EURELECTRIC is aware of on-going discussions to agree on a definition of smart charging, e.g. within the ISO 15118 and the Ad Hoc Group Smart Charging under Mandate 490. Within the context of this paper, EURELECTRIC explains its general understanding of smart charging in order to describe and structure the generic market model.

[6] Load management means the possibility to modulate power and time, switch on/off in emergency situation

- **Society**: smart charging enables distribution grid optimisation (cost efficiency by avoiding excessive network reinforcement costs) and facilitates the integration of renewable electricity

Smart charging with vehicle-to-grid (V-2-G) or rather vehicle-to-home (V-2-H[7]) application generates even more flexibility and will be relevant for future **smart electricity market development**.

The existing electricity market is the foundation of any market for recharging electric vehicles. Therefore, any **possible obstacle that could stem from electricity market models** should be identified and addressed. EURELECTRIC, as the sector association of the European electricity industry, is best placed for such an assessment. Indeed, as the e-mobility market is inherently linked to the electricity market, which has a high degree of different regulations in place across the EU Member States, the interface between both markets has to be streamlined where necessary. For example: the distribution network operators (DSOs) operate in a regulated environment whereas the electricity suppliers operate in a competitive market. Additionally, DSOs may not differentiate their treatment/reaction of demand for network service/capacity, i.e. they must not discriminate against any network users, e-mobility being one of them. DSOs have to reflect, objectively and transparently, specific costs and constraints within their contractual relationship. **This un-discriminatory attitude towards all network users is an important starting point for the development of a new market with new players**.

EURELECTRIC is convinced that it is in the best interest of potential market participants and customers if **transaction costs, stemming from the introduction of e-mobility into the electricity system, are kept low,** i.e. they should increase as little as possible when e-mobility enters the markets. The **generic market model lays the basis for a customer-friendly and cost-efficient solution for charging infrastructure**. In the long term, the recharging infrastructure can be a part of the smart energy environment, with easily accessible and interoperable EV recharging infrastructure, billing and payment for e-mobility customers across Europe. In the next chapters, EURELECTRIC will explain first how a market can be organised in theory by defining market roles and actors and secondly provide practical implementation examples.

II. GENERIC DESCRIPTION OF ROLES, ACTORS AND RELATIONS IN THE ELECTRICITY AND THE E-MOBILITY CHARGING MARKETS

1. IDENTIFICATION OF ACTORS AND ROLE DEFINITIONS

E-mobility across the EU will develop in the existing and on top of the electricity market models. As a first step, market roles are being described that occur in any e-mobility market model. A distinction is made between:

1) "**Primary market roles**" for establishing a market environment, i.e. essential/indispensable roles that have to be fulfilled in any functioning e-mobility market, independent from the market size.

2) "**Secondary market roles**" are roles that may arise in addition due to market scale-up but are not necessary for the basic functioning of the electric vehicle market.

In actual business models, a business player may undertake one role, or a combination of several roles, as long as regulations already in place allow for such a combination.

[7] Or Vehicle to Building application

The table below provides definitions of the different actors and their roles. The definitions have been aligned as much as possible with other publications. For the electricity market, they have been taken from the ENTSO-E harmonised electricity market role model[8]. The model identifies all the roles that can be played for given domains within the electricity market, covering both electricity wholesale and retail markets. For the e-mobility definitions, EURELECTRIC notes that official standardisation committees have not yet reached a common agreement on the definitions, between ISO/IEC 15118, the smart charging ad-hoc group under European standardisation mandate 490 on smart grids, IEC TC8, European projects like Green e-Motion, or the e-Mobility ICT Interoperability Interest Group (eMI3). EURELECTRIC strongly recommends converging to one definition.

Role	Description
Electricity Supply Retailer	These are the present and future companies that hold licences (or are active on the market - not all countries have licences) to sell electricity that they produce themselves or purchase on the electricity markets to end users, with whom they have power contracts with fixed locations for the supply.
Transmission System Operator (TSO)	A party that is responsible for a stable power system operation (including the organisation of physical balance) through a transmission grid in a geographical area. The System Operator will also determine and be responsible for cross-border capacity and exchanges. If necessary he may reduce allocated capacity to ensure operational stability (ENTSO-E's Harmonised Electricity Role Model; p.19).
Distribution System Operator (DSO)	A party that currently holds and manages the assets for low voltage (LV)/medium voltage (MV)/high voltage (HV) (110kV) distribution networks, responsible for connecting all loads to the electric system and maintaining a stable, safe and reliable network for the supply of electricity to all customers. (EURELECTRIC Market Models paper, p. 16)
Balance Responsible Party	A party that has a contract proving financial security and identifying balance responsibility with the Imbalance Settlement Responsible of the Market Balance Area entitling the party to operate in the market. This is the only role allowing a party to nominate energy on a wholesale level (ENTSO-E; p.13).
Balance Supplier	A party that markets the difference between actual metered energy consumption and the energy bought with firm energy contracts by the Party Connected to the Grid. In addition the Balance Supplier markets any difference with the firm energy contract (of the Party Connected to the Grid) and the metered production (ENTSO-E; p.13).
Metering Point Operator	It is the party responsible for metering duties allowing a consumer to purchase electricity on the supply market through the distribution grid. In most countries the role is played by the DSO. The metering information is critical to enable pay-per-use payment models when considered for e-mobility.
Charging Station equipment owner	A party that owns the charging station. *Example: a city owns the public charging stations but outsources the operation to a commercial party. Or in a public parking space a company can both own and operate the charging station.*

[8] http://www.ebix.org/Documents/role_model_v2011_01.pdf

Charging Station Operator [9] ***(CSO)***	A party that operates the charging infrastructure from an 'operational technical' point of view, i.e. access control, management, data collections[10], repair etc. There can be a differentiation between the 'technical' operator and the 'commercial operator' that offers services to the electric vehicle driver by using the charging infrastructure. The Charging Station Operators engaged in commercial activities may buy electricity on the supply market and sell a charging service all included, or may sell a charging service not including electricity supply.
Private Network Operator	A party that acts as an electrical infrastructure operator, operating a private network to which charging stations are connected. This network is not managed by the DSO (e.g. home network, building network, shopping malls, etc.). This may be particularly applicable for semi-public locations. In some situations, the Charging Station Operators may also be the private network operator.
E-mobility Service Provider[11]	A party that sells e-mobility service to e-mobility customers. For example, the service can be a fluid and money free access to charging stations from different Charging Station Operators. It may be bundled with other services (EV location, parking etc.), it may include electricity supply and other services.
E-mobility customer	A party that consumes e-mobility services using an electric vehicle, including electricity and charging services.
Data clearing processor	A global platform between Charging Station Operators and e-mobility operators to organise and process their exchange of data for a fluid access to charging stations of any Charging Station Operators by e-mobility customers of any e-mobility service provider. It allows for authorisation of service requests identifying the operators involved, and sends service data summaries to these operators in order to let them invoice their customers.

The following roles have been characterised as "secondary" meaning that their emergence depends on the market scale-up. Their usefulness becomes important under significant market shares. As such, they do not actually exist today due to the limited market development of e-mobility.

Role	Description
Flexibility Operator	A party that aggregates load flexibility from different users of LV and MV grids and trades it with the TSO and/or the DSO in order to provide ancillary services (adjustment mechanism). It may address EV charging through Charging Station Operators and may trade its service to the DSO or to the TSO.
Financial and commercial clearing Processor	Financial and contractual clearing between the involved Charging Station Operators and other e-mobility actors. It's called "e-mobility clearing house" when it is combined with Data Clearing Processor.
Financial Clearing Processor	A platform similar to the preceding one, able to reconcile accounts between operators and process the payments between them.
Secondary Metering Data Operator	A party that may be requested to measure electricity consumption per EV charged, and process the data in accordance with the organisation of electricity purchase. It may be an extension of service of the metering point operator. This role is relevant in a market model in which the DSO is not involved in the charge service operation.

[9] According to ISO 15118 this is called: "**Electric Vehicle Supply Equipment Operator" and according to IEC TC8: "Charging Service Operator"**

[10] In a liberalised metering market, such as in Germany, the data collection is most often done by a third party: the Metering Point Operator.

[11] According to ISO 15118 this is called: **Electric vehicle service provider (EVSP), EURELECTRIC uses there the term of** IEC TC8

2. GENERIC PICTURE OF MARKETS RELATIONS

This section provides a generic picture of how the primary market actors, and corresponding roles, relate to each other. To have a clear understanding on the convergence between the electricity market and the e-mobility charging market, figure 2 below provides a general view of both. It has to be noted that the electricity retail market is not integrated at the European level, so that Electricity Supply Retailers have to be registered within each Member State. Also, specific regulations and contractual organisations with TSOs and DSOs apply within each Member State.

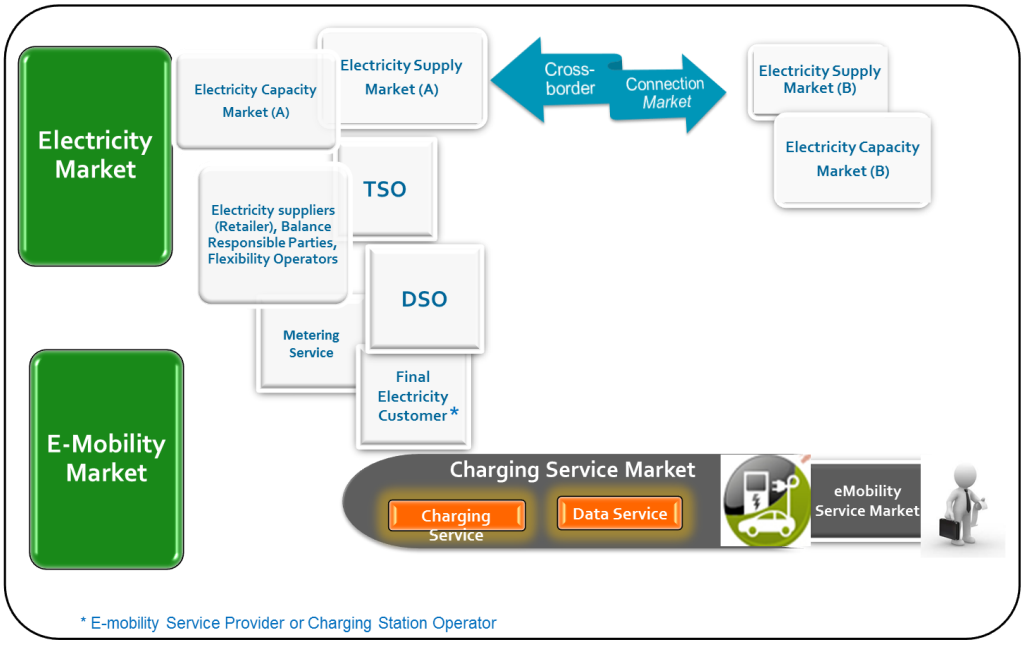

Figure 2: *Generic picture of the electricity and the e-mobility markets*

The e-mobility market is inherently linked to the electricity market. The figure above gives a first hint on the "point of connection" between the overall (national) electricity market and the e-mobility market. Of course, some actors/roles may perform their tasks inside the electricity market only: e.g. the TSO or the electricity supply market, while other actors and roles have a more direct contact, and thus a more direct impact on the market for e-mobility: e.g. DSOs, metering services and retail services.

III. GENERIC MARKET MODELS FOR CHARGING SERVICES IN PUBLIC SETTINGS AND ITS RELATION TO THE ELECTRICITY MARKET

The figures below show a detailed view of the relations between the roles in a charging service market when an e-Mobility customer charges in a location that is publicly accessible. We focus on **charging in public locations** because of the question: how to enable e-mobility customers to use publicly accessible charging infrastructure? Convenient access and customer-friendly usage is crucial for commercial access. Solutions that fit the electricity market function have to be put forward. To enable convenience, interoperability of data models and communication protocols is an absolute prerequisite.

Given that the electricity brought to the market for charging electric vehicles is subject to the rules that go along with the (national) electricity market and related system of balance group management, the starting point for the e-mobility charging market is the established functioning of the national electricity market. This is being presented in the right part of figure 3 below:

- The electricity grid (low and medium voltage)
- The (intermittent) renewable energy sources
- The Distribution System Operator (or Distribution Network Operator)
- The (future) aggregator of flexibility (or capacity market actor)
- The energy market and the energy supply retailer

The left part of the picture represents the e-mobility roles:

- The e-Mobility customer
- The publicly accessible Charging Stations
- The e-Mobility Service Provider
- The Charging Service Operators
- The (future) Clearing House

Figure 3 represents a generic starting point so no business-to-business (B2B) relations are being identified. Only the already established B2B relationships in the electricity market are shown together with the physical connection between the Charging Station and the LV/MV electricity grid.

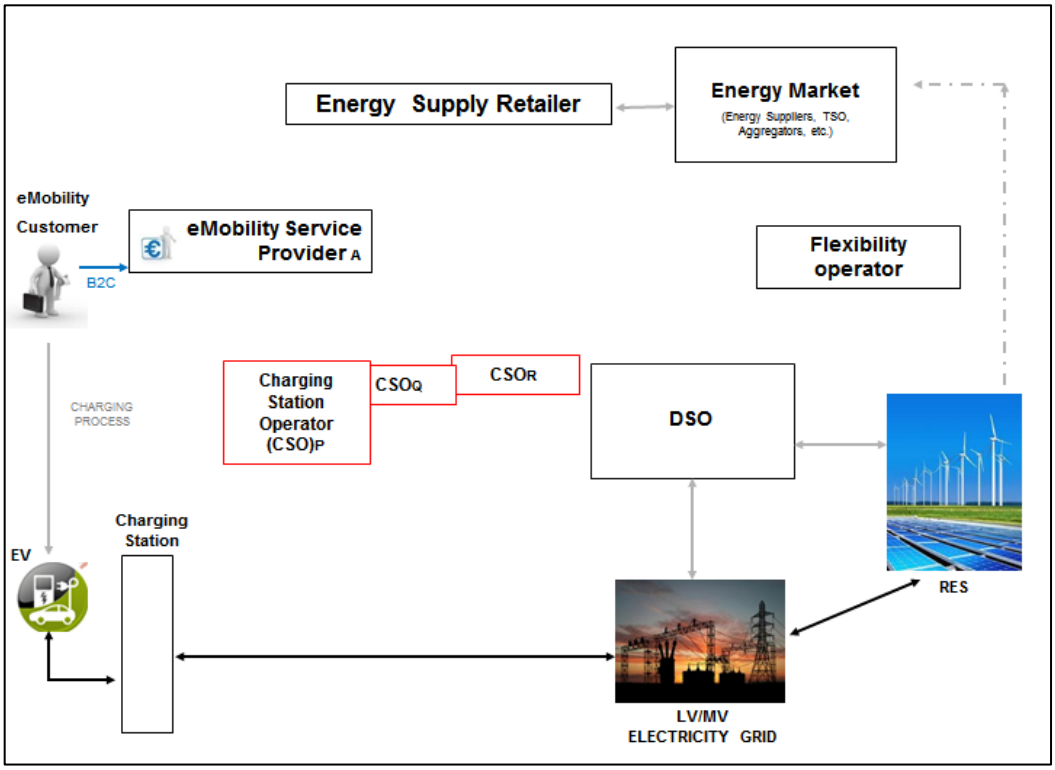

Figure 3: *Generic model for charging in public locations*[12]

Legend:
Blue arrow = B2C contractual relationship
Red-line box: final electricity customer
Black arrow: physical connection

[12] The graphical presentation of the model are inspired upon the work done within the EU funded project Green eMotion, namely the paper "Recommendation regarding requirements for communication protocols and grid-supporting opportunities, published in September 2009 and available on: http://www.greenemotion-project.eu/dissemination/deliverables-infrastructure-solutions.php

Possibilities of access from the **customer's point of view**:

- **direct payment** at the public charging station
- **"roaming" scenarios**

To access public charging stations that are not operated by the e-Mobility Service Provider to which the e-Mobility customer has a contract, two possible "roaming" scenarios are analysed below. To enhance the understanding between them, the scenarios are represented in terms of a generic methodology which makes use of the same symbols, colours and wording.

1. "***Roaming of charging service***": an e-Mobility customer, having a contract with an E-Mobility Service Provider for charging services, is able to charge at a public charging station not operated by his own e-Mobility Service Provider via a B2B roaming agreement between his E-Mobility Service Provider and that Charging Station Operator.
   The Electricity Supply Retailer is chosen by the Charging Station Operator, which sells the charging service including electricity, at a given price condition[13] to the e-Mobility Service Provider.
   This basically means that the Electricity Supply Retailer is fixed at the charging station: it is the Electricity Supply Retailer to which the Charging Station Operator has a B2B contract. This is shown in figure 4 below represented by the grey arrow between the Charging Station Operator and the Energy Supplier. The e-Mobility Service Provider bills his e-Mobility Customer for a "bundled service" (electricity and infrastructure fee) via the business-to-customer (B2C) contract.

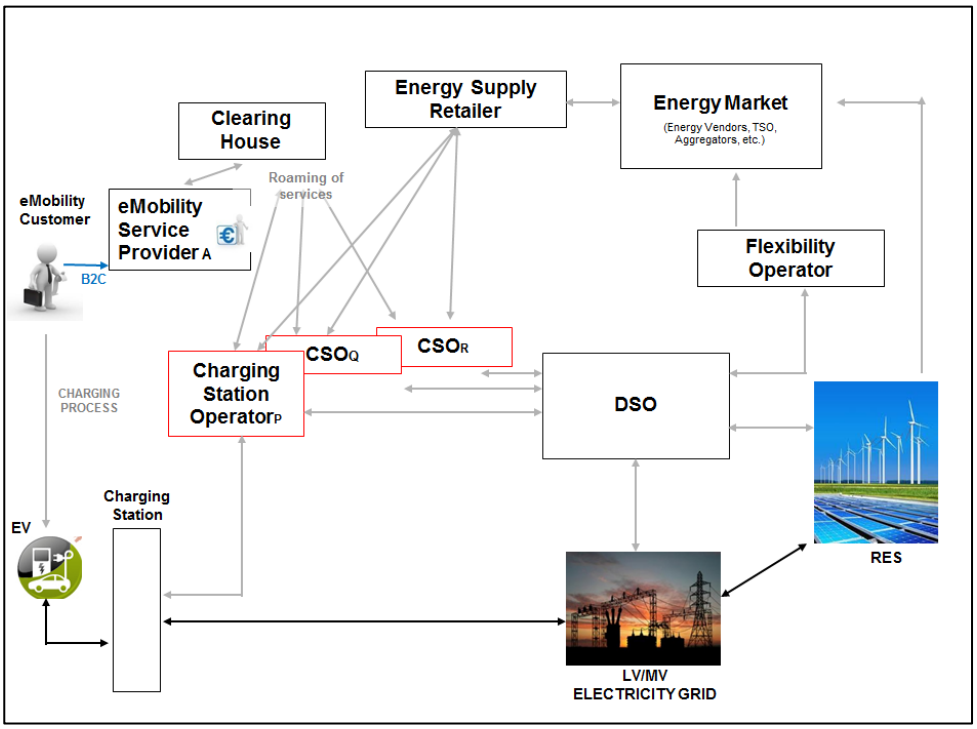

Figure 4: *"Roaming of charging service, including electricity" scenario*

Legend:
Blue arrow: B2C contractual relationship
Grey arrow: B2B contractual relationship
Red-line box: final electricity customer
Black arrow: physical connection

[13] According to parameters such as time, power, energy etc. and which may include other services such as parking

2. ***"Roaming of electricity and service":*** an e-Mobility customer, having a contract with an E-Mobility Service Provider for charging services, is able to charge at a public charging station not operated by his own e-Mobility Service Provider via a B2B roaming agreement between his E-Mobility Service Provider and that Charging Station Operator.
   The consumed electricity is purchased from an Electricity Supply Retailer chosen by the e-Mobility Service Provider. The B2B settlement, between the e-Mobility Service Provider and the Charging Station Operator[14], does not include the price of electricity.
   Consequently, the e-Mobility Service Provider will bill his e-Mobility Customer an additional "roaming" fee for using the public charging station, not belonging to the e-Mobility Service Provider. The consumed electricity is part of the already established B2C contract with his e-Mobility Service Provider.

The "***roaming of electricity and service***" scenario shows that the E-Mobility Service Provider buys electricity from an Energy Supply Retailer of its choice for charging its customers' vehicles at all the public charging stations. The Charging Station Operator acts as a "neutral" market player applying "*a multi-vendor approach*": he has an ICT back-end system in place that is able to "identify" the e-Mobility Service Provider that has a B2C contract with the e-Mobility customer, requesting to charge at the public Charging Station, i.e. it "clears" the B2B agreements. A B2B agreement links the Electricity Supply Retailer with the E-mobility Service Provider. Thus, the e-Mobility customer cannot choose any electricity supplier on the charging station as such, as the electricity supplier will be associated (or by itself) to the e-Mobility Service Provider chosen by the customer with his B2C relationship.

The Charging Station Operator still needs a contract with the DSO (grey arrow) for the grid connection point, availability of power and thus the use of the grid system. Yet the Charging Station Operator also needs a contract with an Electricity Supply Retailer for its own consumption of electricity (auxiliaries, losses...) or for e-Mobility Customers without electricity roaming, thus having a direct payment system at the charging station.

[14] Not to further increase the complexity, the graphs assume that the Charging Station Operator is also operator of the network to which the charging stations are connected (Private Network Operator). This is generally the case in public areas.

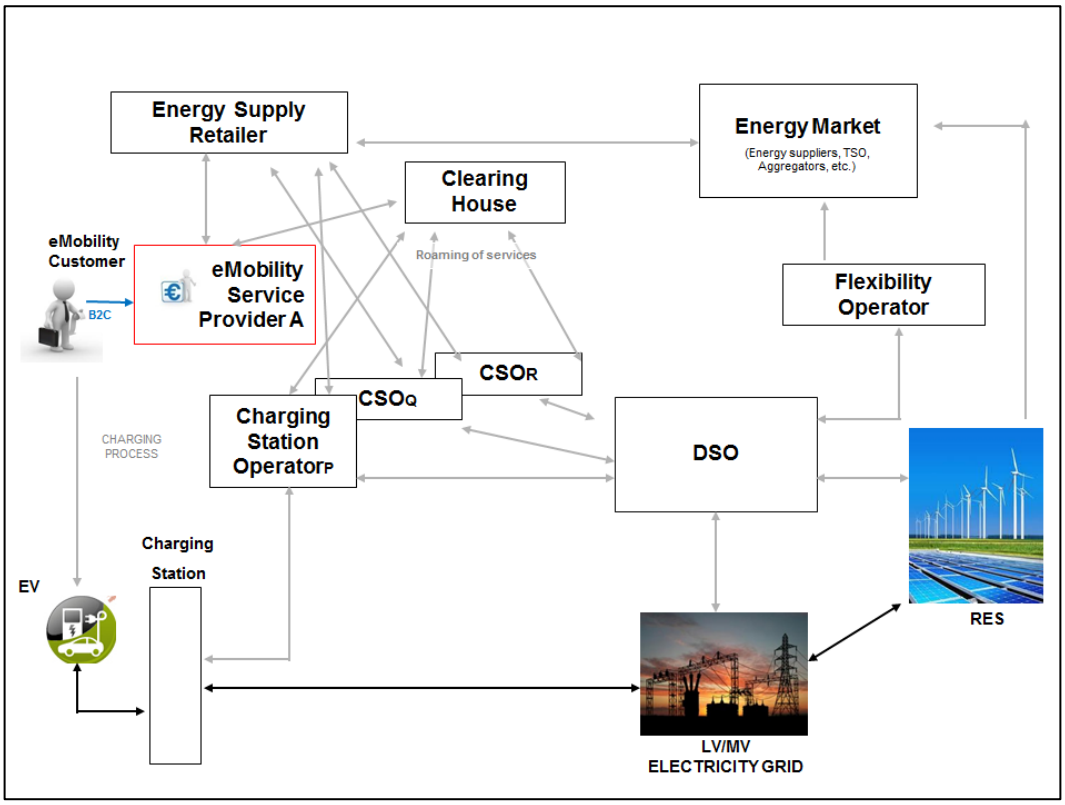

Figure 5: *"Roaming of charging service and electricity" scenario*

Legend:
Blue arrow = B2C contractual relationship
Grey arrow: B2B contractual relationship
Red-line box: final electricity customer
Black arrow: physical connection

In this theoretical description of both "roaming" scenarios, the Charging Station Operator always has a contract with the DSO for the grid connection and power availability from the grid. The difference between the two "roaming scenarios" relates to the question of **who has a direct relationship with the Electricity Supply Retailer**. Either the electricity supplier is fixed at the public charging station, chosen by the Charging Station Operator, or the electricity supplier "comes along with the electric vehicle" through a B2C contract with the e-Mobility Service Provider. Interoperability of the data exchange for "roaming" customers is indispensable in both scenarios.

In reality the two "roaming" scenarios described above are mostly not discussed or implemented in their pure form because national solutions/market models do always reflect additional (national) characteristics.

IV. National Case Studies of implemented market models

In the examples below, EURELECTRIC describes national implementations of e-mobility market structures in some Member States (both planned and already in operation). In practice, several roles can be performed by a single actor, for instance: e-Mobility Service Providers might also be Charging Station Operators, a DSO in charge of deploying the infrastructure thus acting as a Charging Station Operator. Or an Electricity Supply Retailer might also act as an e-Mobility Service Provider. Many other combinations may exist.

1. The independent e-mobility market model

This model is currently being implemented in **Germany**, **France**, **Spain**, **Denmark** and **the Netherlands**. Indeed some minor variations to the market organization may exist but the general market structure fits to the **"*roaming of charging service*"** scenario as described above. It goes along the following interactions.

The public charging stations are being deployed independently from the "regulated" DSO/grid business. The „provision" of charging stations (building, owning, and running it) is a **competitive activity** that can be carried out by „any market participant" – so actually more than one party might install charging stations in a town or on a single street.

From a **DSO's point of view**, the new connection points for these charging stations are treated as any other new connection points to the distribution grid[15]. The DSO either provides a "network" meter for the charging station or in liberalized metering market[16] a third party may perform the duties of the Metering Point Operator and provide relevant data to the DSO for the networks fees calculation.

If certain capacities limitations occur in the distribution network, a **smart charging process** has to be considered. Two possibilities may exist (depending on the national frameworks):

1. The DSO requests flexibility through the market i.e. finds an aggregator through the Flexibility Operator that "sells" him, all or part, of the flexibility that might be included in a single recharging process.

2. The DSO has a direct contract with the owner of the network connection to which the charging stations themselves are connected (e.g. using a private network inside a building etc.) in relation with its electricity distribution role, which allows him to send technical signals requesting power reduction, or power increase, according to the local situation of the network.

Given the competitive structure of this market model, it is possible that a single party "owns" the charging stations, "runs" it and "serves" customers as an E-Mobility Service Provider at the same time (grey shaded areas in figure 6). Providing the service through one company may also be understood as a means to cover the costs that stem from the provision of charging stations and that are "uncovered" today. The e-Mobility Service Provider either runs a balance group himself or is a sub-balance group, or buys electricity from the market i.e. from a supply company, for its own charging stations operation. It is clear that also a supply company itself may act as an e-Mobility Service Provider, Charging Station Operator and owns the charging stations.

However, the Charging Service Operator must be neutral, i.e.: granting charging service access, to any e-Mobility Service Provider that is willing to develop e-mobility business by offering e-mobility services. In

[15] The connection is to be introduced via minimum technical requirements or special connection conditions if applicable according to the regulatory framework

[16] Germany has a liberalised metering market.

most relevant cases the e-Mobility Service Provider and the Charging Stations Operator is also the final customer of the electricity i.e. the e-Mobility Service Provider "sells" a recharging service that might include a kWh component but must not necessarily ("time of charging" might also be a measure of price). This will depend on the electricity market model of each EU Member State.

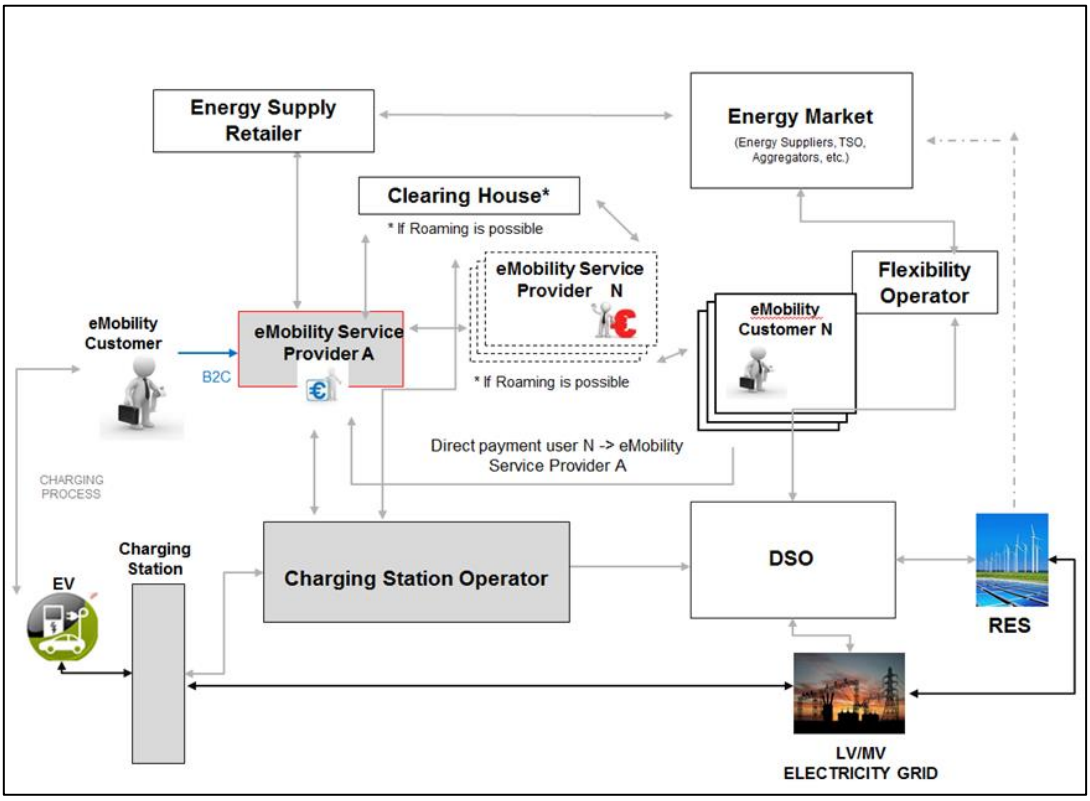

Figure 6*: The independent e-mobility market model*

Legend:
Blue arrow: B2C contractual relationship
Grey arrow: B2B contractual relationship
Grey boxes: roles may be performed by the same market actor
Red-line box: final electricity customer
Black arrow: physical connection

Figure 7 shows the elements that enter into the calculation of a charging service fee that (in the absence of any public subsidies etc.) must be borne by the e-Mobility customers in the independent e-mobility market model.

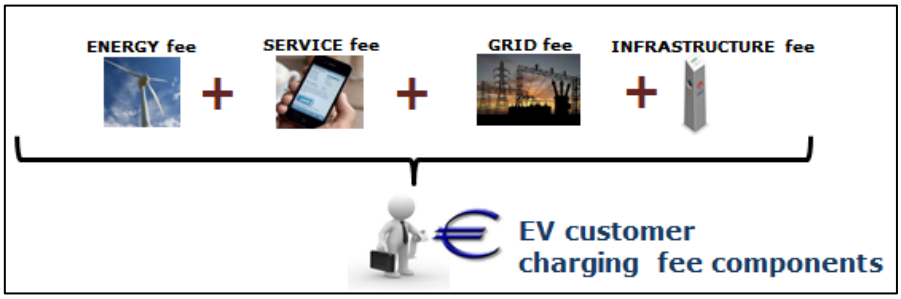

Figure 7: *Components of e-mobility service fee*

From the **e-mobility customers' point of view**, they may access the charging stations via different means:

1. When the customers want to charge at a public charging station operated by his e-Mobility Service Provider: the customers have a (long-term) **contract** with their e-Mobility Service Provider that runs the charging stations i.e. **subscription model** – the subscription model may also be understood as a means to cover the costs involved in setting up the public recharging infrastructure.

2. When the customers want to use a charging station operated by a different e-Mobility Service Provider: **access can be granted via a roaming agreement**[17] if the e-Mobility Service Provider$_N$ of the customer holds a roaming agreement with the e-Mobility Service Provider$_A$ that runs and services a particular charging station (this is a similar situation to the mobile phone market)

    - This roaming agreement is generally a private contract that may be administered through a (data) clearing house[18] (the clearing house is needed to provide authentication services etc.), or through a bilateral agreement, or a combination of both.

    - The clearing house could serve as a financial clearing house as well

    - Depending on the actual relation between the e-Mobility Service Provider and the Charging Station Operator there may also be a need for direct communication between the Charging Station Operator and the clearing house (e.g. for customer authentication)

3. Possibility of **direct payment** systems (credit cards, sms etc.)[19]

    - The model therefore works for customers "holding" a contract with an e-Mobility Service Provider as well as for e-Mobility customers who do not hold such a contract when they want to use the charging stations

2. THE INTEGRATED INFRASTRUCTURE MARKET MODEL ("DSO MODEL")

This market model is already being implemented in **Italy** as part of early market phase tests, mandated by the Italian authority for electricity and gas; in **Ireland**, following a decision by the Irish government as part of the national roll-out plan for recharging infrastructure; and in **Luxembourg**. In relation to the "theoretical approach" described in chapter III, this implementation strategy is inspired by the ***"roaming of electricity and service"* scenario** by establishing a multi-vendor platform that allows for competitive offers between e-Mobility Service Providers while having access to the public charging infrastructure. However, the practical implementation, as detailed below, demonstrates that it is **not an actual supplier switch** (from the contractual point of view) at the public charging station managed by the DSO, thus the process is not similar to the one for household electricity supplier switching. In fact, the DSO has an ICT back-end system that is able to "link" the customer to an e-Mobility Service Provider with whom the customer has a contract that includes electricity. The market models have been implemented for this scenario that may slightly

[17] It is important to note that in a roaming solution it must be clear whether the roaming customer becomes a customer of e-Mobility Service ProviderA serving the Charging Station or whether he "stays" the customer of his e-Mobility Service ProviderN that "resells" the service provided by the e-Mobility Service ProviderA

[18] With a Clearing House we mean an ICT system that is able to "clear" B2B settlements (financial, authorisation, information, billing, etc.). Already today initiatives for such a clearing house exist: e.g. the EU funded project Green eMotion is demonstrating such a Clearing House on a European level but also national, commercial initiatives are already emerging such as Hubject in Germany and Gireve in France.

[19] In Germany, the National Platform for e-mobility decided to offer direct payment possibilities via credit card or sms payment at the load infrastructure. In France, the "Livre Vert" for public infrastructure does the same.

differ depending on whether a country has one DSO or several DSOs active that deploys publicly accessible charging points.

The integrated infrastructure market model is characterized by a charging service market working upon the DSO business model. This implies that the publicly accessible charging infrastructure (charging stations) is part of the **regulated business** of operating and managing the LV and MV electricity grid and its deployment is therefore included in the expected activities performed by the DSO. Thus the **remuneration** of the **necessary investment** to provide the public infrastructure and the service upon it is also (at least partly) **provided through** the general **network fees**.

In this case, the **DSO acts as the Charging Station Operator:** installing and managing the public Charging Stations and allowing different eMobility Service Providers to compete by providing Business to Customer (B2C) services (e.g. basic and smart charging) to their customers on the charging stations.

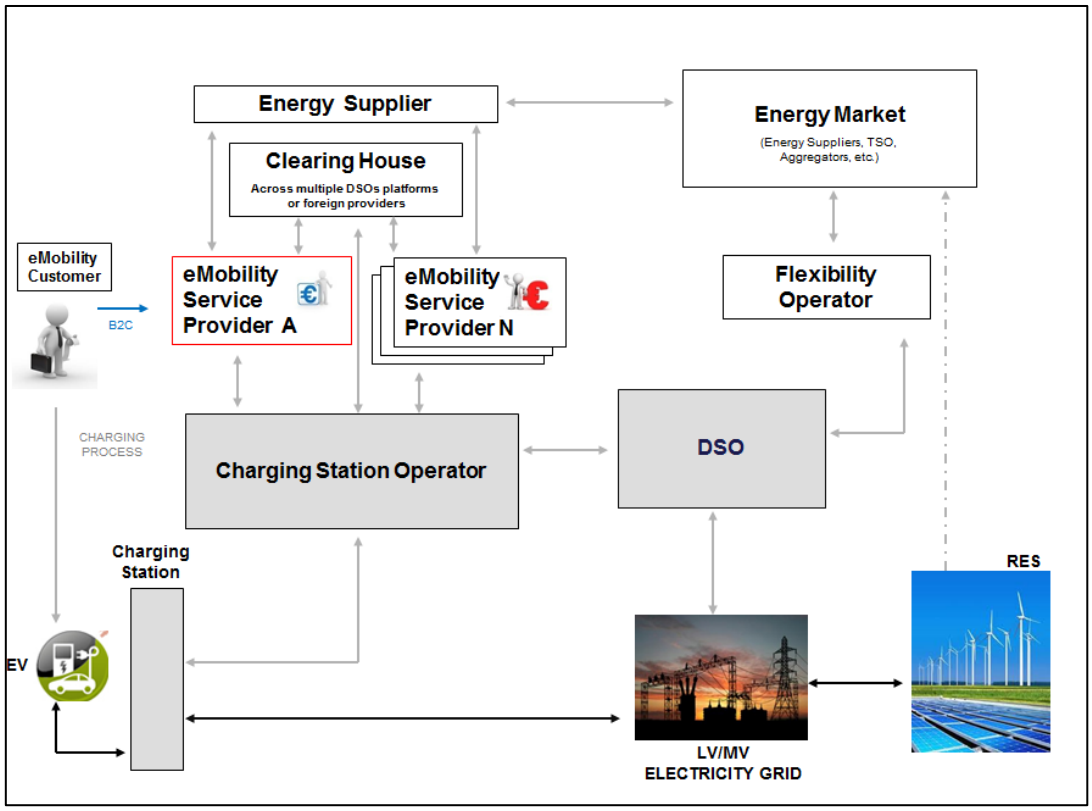

Figure 8*: The integrated infrastructure market model*

Legend:
Blue arrow: B2C contractual relationship
Grey arrows: B2B contractual relationship
Grey boxes: roles performed by the DSO
Red-line box: final electricity customer
Black arrows: physical connection
Clearing House acts across multiple DSOs platforms and foreign providers

By playing the role of a Charging Station Operator, the **DSO** applies a **multi-vendor approach** and allows **access to all e-Mobility Service Providers** under **non-discriminatory conditions**[20] because the charging infrastructure is part of the DSO's regulated activity, in addition to the provisions set forth in the Directive 2009/72/EC.

[20] Within reasonable conditions, example: solvability, business track record etc

The **customer** generally has a **service contract** with one (or possibly more) e-Mobility Service Providers and is able to charge at each public charging station of the charging network deployed by the DSO. Therefore the back-end of the Charging Station Operator - performed by the DSO - is able to execute "Clearing House[21]" functionalities resolving B2B relationships between e-Mobility Service Providers on the public charging stations deployed by the DSO. In case several DSOs have deployed publicly accessible infrastructure, there is a need to have also a "Higher Level Clearing House" that is able to deal with multiple integrated infrastructures managed by those different DSOs. These "higher clearing house functionalities" are also needed in the situation in which an "international" e-Mobility Customer thus having a contract with a "foreign" e-Mobility Service Provider wants to use the public charging station deployed by the DSO.

In this model, the electricity consumed at the charging station by the e-Mobility Customer it is not linked to the electricity supply contract of the DSO, acting as the Charging Station Operator. The electricity supply "comes along" with the e-Mobility customers through his B2C contract with his e-Mobility Service Provider. The e-Mobility Service Providers can either buy the electricity from an Electricity Supply Retailer thus they act solely as e-Mobility Service Providers or they can play both roles.

Indeed, this "integrated infrastructure model" implements "roaming of electricity and service" due to the fact that the Charging Station Operator (the DSO) provides access to all possible e-Mobility Service Providers and is able to "identify" their electricity retailer through the Clearing House functionality that resolves the B2B relationship between the E-Mobility Service Provider and the Electricity Retailer. Hence the billing settlement is guaranteed by the Charging Station Operator (DSO): he sends the relevant transaction data of the charging process to the e-Mobility Service Provider and to his associated Electricity Retailer. The e-Mobility Provider settles the entire transaction, so including the electricity consumed, in the B2C contract with the e-Mobility Customer. The "fee" for the access and usage of the Public Charging Station can be traded as a general service by the e-Mobility Service Provider to the e-Mobility Customer: e.g. pay per minute, pay per parking spot, flat rate, etc. depending on the conditions of the B2C contract.

The clearance of B2C relationship between the customer and the E-Mobility Service Provider (which has a B2B relationship with Electricity Supply Retailer) is still the only enabler for enabling a charging process. Such B2C relationship could be established through a previously valid contract or through a direct on-the-spot and contract-less access (e.g. direct payment via credit card or sms), with the customer choosing his e-Mobility Service Provider right at the time of accessing the Charging Station. Once the B2C contract is acknowledged, the DSO is able to send metering data to the specific Electricity Supply Retailer which is beyond the B2C relationship between the e-Mobility Service Provider and the final customer.

An additional feature of this market model is the ability to implement differentiated and incentivised e-Mobility tariffs. The following assumptions are then made:

i. e-Mobility Service Provider encompasses the role of the Electricity Supply Retailer,
ii. DSO acts as the Metering Point Operator
iii. public charging stations are equipped or are in communication with electricity meters on the Point of Delivery (meaning the public charging station).

Then, the e-Mobility charging process can be traded as a "pure" electricity sale because the billing information is provided directly from the Point of Delivery by the Meter Point Operator. This is only

[21] With a Clearing House we mean an ICT system that is able to "clear" B2B settlements (financial, authorisation, information, billing, etc.). Already today initiatives for such a clearing house already exists: e.g. the EU funded project Green eMotion is demonstrating such a Clearing House on a European level but also national, commercial initiatives are already emerging such as Hubject in Germany and Gireve in France.

possible because in this case, the DSO performs also the role of Meter Point Operator in addition to the Charging Station Operator. Hence the DSO is able to send certified information of the consumed electricity to the e-Mobility Service Provider. In this specific case, the "integrated infrastructure model" could allow an e-Mobility pricing as a direct derivation from the electricity markets. It is important to note that the electricity sale always happens through a relationship between an Energy Supply Retailer (linked to an e-Mobility Service Provider or acting as the e-Mobility Service Provider) and the final customer. Billing is enabled through the infrastructure managed by the DSO and using revenue-grade metering.

Therefore the integrated infrastructure market model enables both service and electricity sale to the final e-Mobility Customer which allows for a level-playing field for Electricity Supply Retailers to directly handle B2C relationships in e-mobility market.

All the technology of the publicly accessible charging infrastructure becomes part of the Regulated Asset Base of the DSO and is recovered by the charging infrastructure's regulated return on investment. This means that the **costs for deploying the public recharging infrastructure are being spread over the grid customers (also non EV users), as part of the grid fee.**

From the e-Mobility Customer perspective, this market model allows for access and service transaction as previously described. The integrated infrastructure model implies a specific structure of the customer charging fee components. By including the infrastructure investment in the Regulated Asset Base of the DSO, the mark-up over infrastructure investments is generalised over the grid customer base rather than just the e-mobility customer base. Thus, the specific e-Mobility customer is not paying each time an additional infrastructure cost component to let the Charging Station Operator to recover its investment i.e. the deployment of charging infrastructure is cross-subsidized via an (albeit probably small) increase in the grid tariff. Additionally, this model could contribute, on the medium term, to a reduced grid and service fee because smart charging products might have a quicker "Time-to-Market" due to the synergies that may arise when the DSO acts as the Charging Station Operator by enhancing load allocation and integrating renewable capacity.

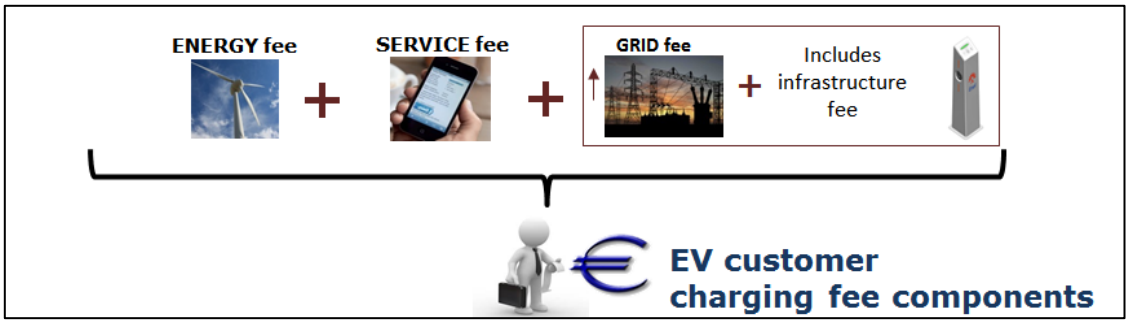

Figure 9: *Components of e-mobility service fee*

From a technology adoption perspective, the deployment of public recharging infrastructure in this model provides a "guarantee" that the infrastructure investment is done, even in the absence of a mass market since the charging stations are installed upon profitless rationale. This approach can be strategic to overcoming "the chicken and egg" effect of the early adopter phase for e-mobility: a critical mass of EVs is needed to recover infrastructure investment. Simultaneously, potential customers need to be reassured that they get decent infrastructure network coverage. The implementation of an "integrated infrastructure model" is a governance decision that can only be taken by national governments and mandated to local DSOs.

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