



Green eMotion

Development of a European Framework for Electromobility

Deliverable 3.7

**Implementation of demo prototype
Release 1**

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List of Abbreviations

API	Application Programming Interface
B2B	Business to business
CA	Consortium Agreement
CDR	Charge detail record
CH	Clearinghouse
CMS	Charge management system
DoW	Description of Work (Annex I of Grant Agreement)
DSO	Distribution system operator
EOC	End of charge
ESB	Electricity Supply Board
EV	Electric vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric vehicle supply equipment
EVSP	Electric vehicle service provider
G4V	Grid for vehicle (EU research project)
GeM	Green eMotion
HMI	Human machine interface
ICT	Information and Communication Technologies
ICT	Information Communication Technology
IMS	Infrastructure management system
KPI	Key Performance Indicator
MPO	Metering Point Operator
MSP	Measurement Service Provider
NFR	Non Functional Requirement
NOC	Network Operations Center
NPE	Nationale Plattform Elektromobilität (German initiative)
OEM	Original Equipment Manufacturer, i.e. Electric Vehicle manufacturer
PHEV	Plug-in electric vehicle
RES	Renewable energy source
RFID	Radio frequency identification
SDR	Service detail record
SECC	Supply Equipment Communication Controller
SLA	Service level agreement
TOU	Time of use
V2G	Vehicle to grid
V2H	Vehicle to home
VPP	Virtual power plant
WP	Work Package

1 Executive summary

To enable Europe-wide electromobility in practice, a marketplace was developed within the EU funded demonstration project Green eMotion. The project will demonstrate Europe-wide roaming in an interoperable electromobility system and provide access to new value-added services. Via this marketplace concept users of electric vehicles will be able to access charging infrastructure anywhere in Europe in a convenient way.

In the software engineering process a prototype in general is an early release of an IT system that is used to verify the concepts and processes that are laid out in the software design. This is a crucial step, since it helps to identify problems early in the development process. If these problems would occur in a later phase, it would involve significantly more effort to resolve the issues and might also impact the release schedule.

Within Green eMotion a prototype for an electromobility marketplace was defined in WP3 to verify the functionality of the services before the first release. The development of this base system was finalised in August 2012. The prototype described in this deliverable offers the core functionality of the release 1 (D3.12 – available in February 2013) scope according to the specifications in deliverable D3.5 (Service & transaction design specification), which is required for a basic integration of the partners developing the services. The integration tests starts now and comprises functionalities for a Europe-wide charging point search, clearing charging processes and energy load management. New features will be added for release 2 (February 2014): e.g. reservation of charging points.

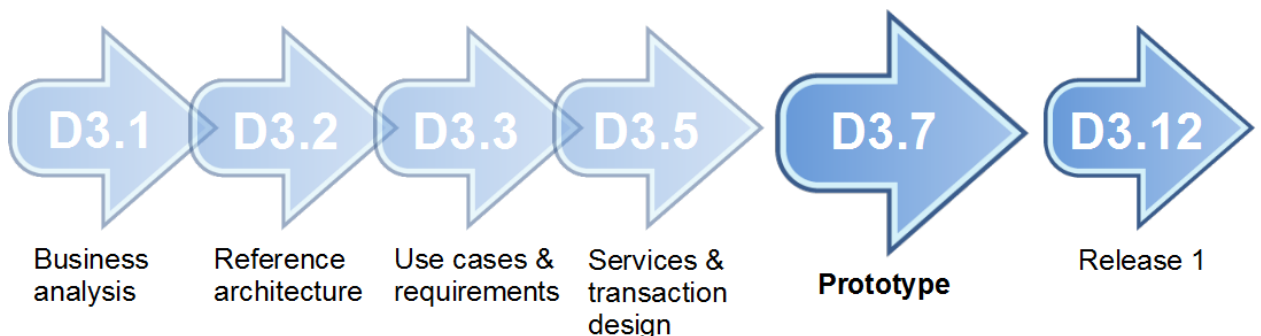


Figure 1: Sequence of deliverables in GeM

In the end the marketplace will have the following functional domains:

Charging: The central Search EVSE component will offer a service interface to query charging spots and battery swap stations from different EVSE operators (release 1). Service interfaces for updates of master data and EVSE status which allow the reservation of charging points will be provided later on (release 2).

Roaming: The Clearing House component will provide services to authorize users across EVSE operators and EVSPs and to forward Service Detail Records for charging transactions. In a second step integration with the marketplace will be offered, in order to validate Roaming agreements between the involved parties on the marketplace (release 1).

Energy: The Energy use cases are not in focus for the prototype release, as these do not require integration testing between different partners. Only basic integration tests with the marketplace will be done.

Marketplace: The Service Brokerage component as base system of the marketplace will provide the Dynamic Service Gateway as central integration point for all services. A preview of the Business Services component will provide a first impression of the look and feel of the marketplace user interface. This will be extended and integrated with the Service Brokerage component later on.

The prototype environment will enable the WP3 partners to do cross-partner integration testing of their components and will also give demo regions as part of the WP8 demonstration program the chance to validate the results of their front end adaptations in a test environment. All of this will add to the goal of delivering a solid and thoroughly tested release 1 for deliverable D3.12 that can be used to demonstrate the previously defined use cases and business scenarios in most of the Green eMotion demo regions.

2 Introduction

2.1 Focus of the prototype release

The Green eMotion marketplace eco-system is a complex ICT system of interconnected components offering EV Services which are operated by many different partners. The following figure gives a simplified overview of the involved components, partners and connections in order to show the focus of the prototype release.

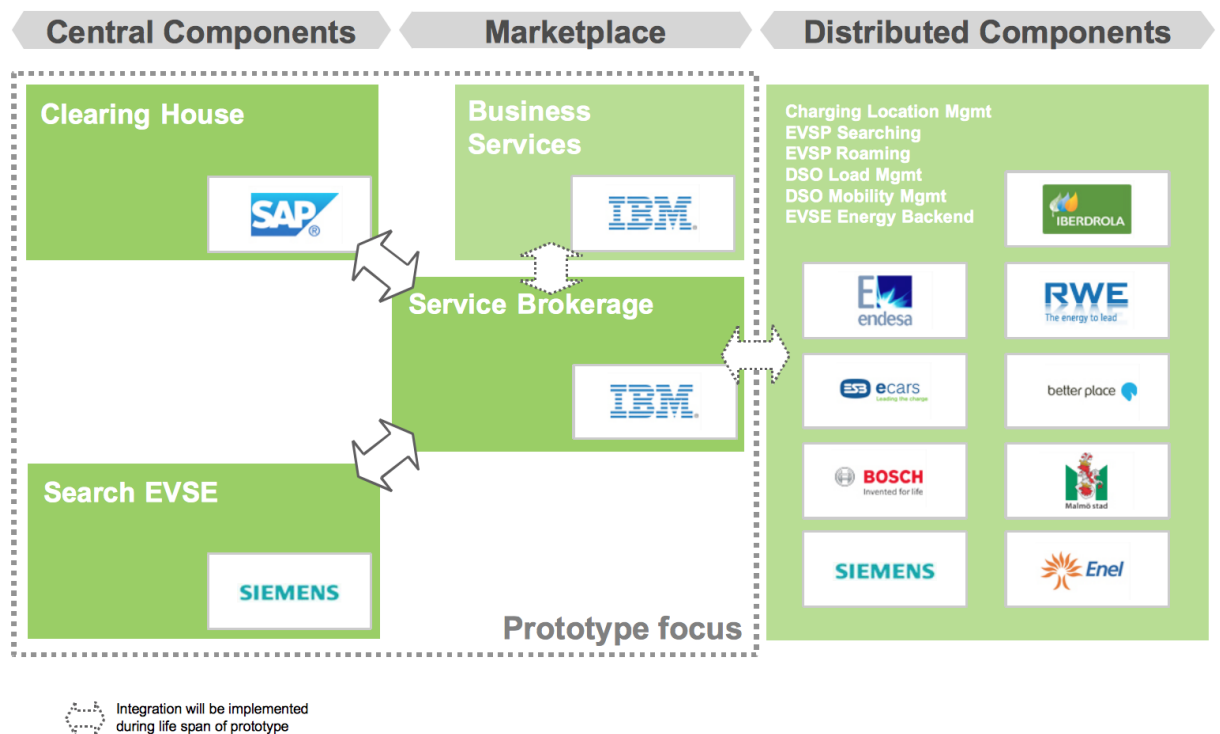


Figure 2: Overview of business components and partners

The components that make up the Green eMotion marketplace eco-system can be separated in three groups:

- **Central components:** Provide functionality that is used by many different partners and is not specific to a specific region. Usually only a few instances would exist for one specific component (prototype focus).
- **Distributed components:** Components that are operated by many different partners and/or regions. These can be components that are used to integrate with a central component (e.g. EVSP Roaming) or components that only integrate with other distributed components (e.g. Energy BCs).
- **Marketplace:** The required components that make up the marketplace act as the central hub for integrating all other components. They provide generic functionality for offering, contracting and using services provided by other components; both central and distributed components.

The focus of the prototype release is the deployment of the central and marketplace components. These are required to go forward with the development and integration of the distributed components. The goal of the prototype is therefore to provide a platform for integration and testing, so that a solid platform for demonstration purposes can be delivered with release 1.

In the first version of the prototype only the core functionality that is required for a basic integration of regions and partners will be provided. This functionality will be extended in consecutive prototype releases leading up to release 1.

2.2 Development and test schedule

Since the prototype will not provide all of the defined functionality from day 1, it is required to have an aligned development schedule for WP3, so that involved partners outside of WP3 can adapt their development schedules and plan the testing activities.

The following table offers a quick overview of the planned versions for each component. More details on the scope of each release are provided by the next chapters.

	08/12	11/12	12/12	02/13
Service Brokerage	v1	v2		
Business Services	v1	v2		v3
Search EVSE	v1	v2	v3	
Clearing House	v1	v2		
Energy BCs				v1

Table 1: Development and Test Schedule for Prototype

Note: Each version is made available at the end of the month listed in the table.

3 Charging Domain

The central Search EVSE component will offer a service interface to query charging spots and battery swap stations from different EVSE operators.

The requesting business partner can combine several search criteria, which can be grouped roughly into the following sections:

1. Technical equipment
2. EVSE operator
3. Management
4. Address
5. Proximity search

In the current Search EVSE prototype only EVSE master data added manually into the search component will be available. None information about the current operational status of an EVSE will be provided.

By the end of November 2012 (v2) the search component will be able to request EVSE master data from Charging Location Management systems, if these systems provide the specified service ProvideEVSE-MasterData.

By the end of December 2012 (v3) the search component will be able to request Operational status data from Charging Location Management systems, if these systems provide the specified service ProvideEVSEStatusData.

4 Roaming Domain

The Clearing House enables roaming in the electric mobility domain. For that Green eMotion partner SAP will provide two service interfaces. The first one handles the authorization requests from EVSE Operators which have to deal with an unknown customer, so that the operator can decide if he allows the unknown customer to charge or not. The second interface forwards the service data record to the responsible EVSP after charging took place, so he can bill his customer in the end.

The validation of roaming agreements between Business Partners will be added at the end of November 2012 (v2) when the Business Services component of the Marketplace can be used to store these agreements. Until then, the Clearing House will assume that all partners in the Green eMotion context have valid agreements among themselves.

In order to do the B2C contract validation, which means that the Clearing House checks if the customer has a valid contract with his provider, the Clearing House offers the storage of a list of customers from each provider directly, or asks the EVSP each time his customer wants to charge at a foreign EVSE Operator. For the latter one, the EVSP has to implement the authorization interface as well.

5 Energy Domain

The energy domain is in charge of demonstrating B2B services that enable value creation and value transfer among stakeholders with regards to the integration of EVs in to the LV/MV grid.

The aim of these services is to demonstrate a Large Scale Load Management (LSLM) scenario, as stated in D4.2 of Green eMotion, through the use of a dedicated set of features implemented by EVSP, EVSE Operator and DSO. The LSLM scenario shows off load management requests published on the marketplace from the DSO to multiple stakeholders, either EVSP or EVSE Operators according to the specific business / regulatory framework. This load management requests are made up of load curves that should be followed by each EVSE Operator in a specific load area, in order to achieve remuneration targets. The fulfillment of load management requests causes a power modulation forwarded to a set of charging points whose points of delivery do belong to the targeted load area.

The usage of load management practices according to the DSO needs might help the DSO in achieving high quality of service and avoiding penalties to RENS distributed producers, thus leading to a “Charge For Free” use case, where the EV driver might receive a warning on his own EVSP smartphone application that he could charge his EV for free in a certain timeslot, thanks to the B2B services infrastructure that enables value transfer between DSO, EVSE Op, EVSP and EV driver all along the chain of load management business process.

In the prototype version of the GeM Marketplace, no energy related services will be provided. They are scheduled to be available from Q1 2013, around Release 1 of the GeM Marketplace and they will be demonstrated for both DSO and EVSE Operator side from Enel.

The services that will be provided for Release 1 do embed basic functionalities (see D3.5) and they will serve as proofs of concept for future advanced services to be published for Release 2, including V2G and RES integration related services.

6 Marketplace Domain

In the Green eMotion Reference Architecture that was defined in deliverable D3.2 the GeM Marketplace was divided into 3 domains, which are shown in the figure below.

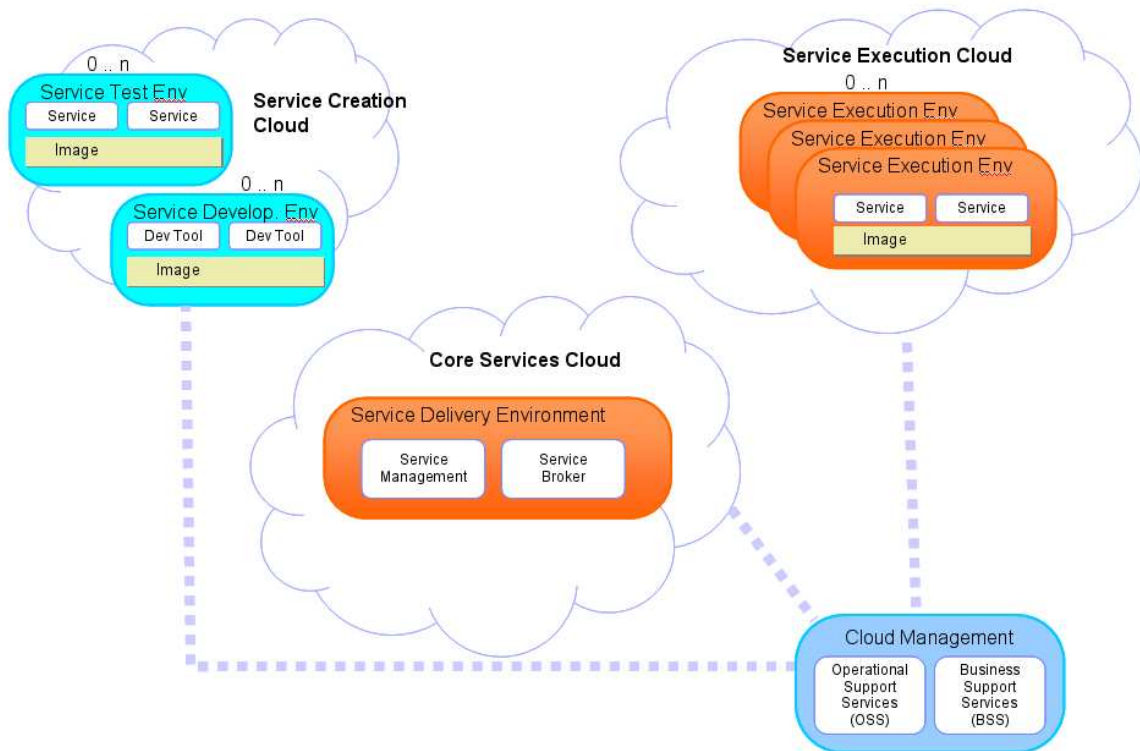


Figure 3: Overview of marketplace domains

The Prototype and Release 1 focus on the Service Delivery Environment (or Core Services Cloud), which provides the functionality that is required for the demonstration of the Green eMotion marketplace ecosystem and will be deployed in the IBM Cloud environment (IBM SmartCloud Enterprise).

Of course also other partners are able and invited to deploy their services in the IBM Cloud environment, following the approach outlined in the Reference Architecture with the Service Execution Cloud. This allows them to use the same Cloud management tools that are also used for the management of the marketplace itself. An integration of these tools with the Service Management of the Service Delivery Environment is not currently planned for Release 1. For the prototype Siemens will be the first WP3 partner to deploy its services (Search EVSE) in the IBM Cloud environment.

A Service Test Environment (part of the Service Creation Cloud) could also be instantiated easily in the IBM Cloud environment, so that new versions of services can be tested without impacting the existing services. Once Release 1 will go live, IBM will offer a separate Service Delivery Environment, which can be used by these Service Test Environments in the cloud or other test systems of the partners, in order to test the integration of services in a separate environment.

Additional details on the deployment of the marketplace can be found in deliverable D3.11 Deployment Plan.

The Service Delivery Environment is made up of two components: Service Brokerage (BC 1965^{*}) and Business Services (BC 1966^{*}; also "Service Management" in the Reference Architecture).

The Service Brokerage component will provide the Dynamic Service Gateway (SRV 1968^{*}) which allows services to be called via the marketplace and is therefore the most crucial part for a first integration of partner systems. The first version of the Dynamic Service Gateway will not validate contracts between Business Partners on the marketplace but will forward any requests for a set of predefined services. In a second version this validation will be enabled.

The Business Services component will provide the user interface required to buy, sell and manage services on the marketplace. The first version will only offer a preview of the look and feel of the user interface. It will be possible to register new Business Partners and to browse a catalogue of predefined services. In the second version Business Partners will be able to create contracts. This will also allow the integration with the Service Brokerage component in order to validate these contracts during service calls. Additionally this version will offer the Contract Validation service interface (SRV 1967^{*}) that will be used by the Clearing House to check for Roaming Agreements between EVSPs and EVSE operators on the marketplace.

^{*} Refers to numbering scheme from deliverable D3.5 (BC: Business Component, SRV: Service Interface)

7 Glossary

Authentication

Authentication is the validation of an Identity on a predefined level.

Levels may be differentiated to provide different security gradations for different functions, or a system may be designed to use one single Authentication level.

Examples of authentication means are:

- *Automatically readable Certificates*
- *Passwords*
- *Iris-scans, fingerprints, etc.*
- *Dynamic challenge/response algorithms*
- *Pre-existence of a GUID*

Authorization

Authorization determines if a specific authenticated identity is given access to a specific function or resource.

Examples: Authorization can be based on many principles, e.g. :

- *Validate the combination of Identity and Requested Function (existing contract)*
- *allow, unless explicitly listed*
- *Deny, unless explicitly listed*
- *Calculate access based on Identity Properties (Providers only)*
- *Calculate access dynamically, based on system properties (max concurrent users)*
- *Include validation of time-window, connection type, multiple access, and any number or combination of aspects*

Basic End User Service

A Basic End User Service is a business service that will have to be supported discrimination free to every involved actor. Basic End User Services are a "MUST" in order to provide the minimum functionality for electric mobility.

Business Partner

Any party that is registered at the GeM Marketplace acts as Business Partner. They can act as Service Provider and/or as Service Requester.

Buying

The term Buying refers to a complex process. In the context of the GeM Marketplace the term Buying includes the following independent actions:

- *Acceptance of the Service Contract Offering of the EV Service by the Service Requester*
- *Call of the EV Service by the Service Requester.*

Call of a Service

A call occurs when a Service Requester "consumes" the EV Service based on the conditions of a Service Contract.

Note:

Selling and Buying includes the whole commercial process.

Clearing House

A Clearing House within the Green eMotion context of electric mobility provides a couple of services which enable roaming. Two scenarios are reflected, the contractual clearing and the financial clearing, which can be on top of the contractual clearing. Clearing services can be consumed by EVSE operators when asking for validation of customers (contract clearing) and forwarding CDRs. EVSPs can register, update and delete new contracts of their customers via the Marketplace.

The B2B contract information can be stored in the clearing house directly or in the Marketplace.

The B2C contract information can be stored in the clearing house directly, in the Marketplace or can be requested each time from the corresponding EVSP.

Note:

The availability, traceability and access security of this service must be implemented at a very high quality level.

Congestion Management

This is about the efficient use and allocation of Power Transmission capacity.

This is a task of Distribution System Operators (DSO's) for the Mid/Low Voltage domain, and Transmission System Operators (TSO's) for the High Voltage Domain.

Recent developments such as local generation from windmills and large scale PV have complicated this task. EV complicates this even more, for several reasons:

EV generates significant additional E-usage

EV power usage is discontinuous because it draws power from the Grid during battery charging, not while in use.

Grid Operators have little experience in predicting the Power Usage of EV

EV deployment through society is unpredictable, and different regions may show different usage patterns

In addition to this, technology to use EV batteries to feed power into the Grid is expected to be deployable in the near future.

This provides a valuable tool for Congestion Management and Load Balancing, but it increases the complexity of the task.

Connection Window

A connection window is a continuous period that an EV is connected to the e-Grid. The Connection Window may contain any sequence of

- charging, drawing power from the grid

- discharging, supplying power to the grid
- passivity

The Connection Window is different from the Minimum Charging Period.

The assumption is that for Home Charging, the common Connection Window is much larger than the Minimum Charging Period, since most of the EV will be connected upon homecoming in the afternoon / evening, and will only be disconnected upon departure for work in the morning.

For on-the-road charging, the connection window is defined by incidental circumstances.

Contracting

A Business Partner can accept a Service Contract Offering from a Service Provider, which generates a Service Contract.

This contract will then be the basis for usage of the EV Service.

Contractual Clearing

1. Validation of customer
 - a) Authentication on a charge point triggered by an EV driver or its EV
 - The EVSE operator forwards the identification information to the Clearing House. The information consists at least of EVSEID (Electric Vehicle Supply Equipment ID) and Contract ID.
 - The Clearing House first checks if the EVSE operator and the EVSP of the customer have an agreement. Therefore the Clearing House can check its own database or retrieve information from the marketplace.
 - The Clearing House additionally checks if the customer is entitled to charge at that particular charge point. Therefore the customer data can be checked in the Clearing House database or can be retrieved from the customer's EVSP.
 - The result of the check is delivered back to the EVSE operator so that he can react accordingly (start charging or deny charging).
 - b) Validation of customer and its purchased services
 - Any EVSE operator can check the services which a currently connected customer is entitled to consume.
2. Routing of charge data (CDRs) between roaming partners
 - The foreign EVSE operator sends the CDR to the Clearing House after the charging process is finished.
 - The Clearing House forwards the CDR to the "Home" EVSP (directly, daily, weekly, monthly etc.).

Note:

Both processes are triggered only if the EV driver is not a direct customer of the EVSP which also acts as EVSE operator of the used charge point.

Core Service

A Core Service is a basic service that is required to run the GeM Marketplace and a service that is shared and used by the Value Added Services, Clearing House Service and End User Services.

Examples:

- *Business Partner Registration*
- *Service Contract Offering Creation*
- *Service Contract Creation*
- *Service Registration*
- *Service Monitoring*
- *Service Lifecycle Management*
- *Service Deregistration*
- *Service Billing*

Delivery

Service Provider provides an EV Service based on an existing Service Contract.

EV Marketplace

EV Marketplace is a marketplace within the EV Service Market which serves as a semi-open environment for offering services by Service Providers to Service Requesters.

The GeM Marketplace is an instance of an EV Marketplace.

EV Roaming

Roaming of EV related services will occur when a service is contracted between consumer A and provider B, but is delivered to consumer A by provider C, based on a contract between provider B and provider C.

Roaming both between EVSE operators and between countries/regions:

EV driver can use the EVSE infrastructure of those EVSE operators that his EV Service Provider has signed a roaming agreement with. The Marketplace provides the service of providing a record of all roaming agreements so that it can be verified what EVSE infrastructure an EV driver is allowed to use and also which services he is allowed to consume. The Marketplace facilitates the data exchange between the roaming partners. The most common type of roaming is the international travel. When contract party from the homeland will not have any facilities abroad, he can enable his clients to use local facilities based on a Roaming Contract with a local provider. Since terms and conditions will usually be different, any Roaming Service will most likely result in a surcharge to the Roaming consumer.

Roaming of EV within the EV Marketplace considers the following information tasks: Authentication, validation of contracts, Service indication, Generation and routing of Charge Detail Records (CDR)

EV Service

EV Services are all the service related to Electric Mobility.

Examples:

- *Find Charging Point*
- *Reserve Charging Point*
- *Reduce grid load from charging vehicles (Congestion Management)*
- *CO2 Reporting*

EV Service Market

The EV Service Market is a virtual domain comprising all the services related to Electric Mobility. It describes the whole ecosystem for EV Services. The EV Service Market consists of End User Service Providers (Service Requesters), Service Providers and any number of Marketplaces. If there are several marketplaces, they can be completely independent or interconnected and can be organized in any type of structure.

The EV Service Market is open:

- Any party offering an EV related services is considered as a part of the EV Service Market.
- EV Services can be offered via a Marketplace or directly on a bilateral basis between Service Providers

Financial Clearing

We can imagine of two different clearing strategies. For both strategies the EVSPs have to reveal more contractual details to the Clearing House than in the Contractual Clearing. To be concrete, the EVSPs have to send the applied price plan for each customer to the Clearing House, so that the later can calculate a weekly or monthly amount for the charging at one particular EVSP. Alternatively, the EVSPs built up bilateral contracts which define the amount which has to be paid if a customer of one EVSP charges at the other EVSP. The result is the same in the end. The Clearing House has to know how much one EVSP charges for the foreign charging of another EVSP's customer.

The first strategy calculates the total amount of a specified time frame, which one EVSP, the debtor, has to pay another EVSP, the creditor. The total amount and the information to which the money has to be paid are then transferred to the EVSP who is the debtor.

The second strategy does additional calculations. In that case the total amount is not sent to the debtor. After the calculation of all total amounts which have to be paid between the different EVSPs, the difference of the debts, which two EVSPs have among each other, is calculated. Only the one EVSP which still has a debt by the other EVSP gets informed by the Clearing House with the information to whom the difference has to be paid.

The second strategy produces less data flow and less effort for the EVSPs, because two financial transactions are reduced to one. It has to be checked, if that kind of information flow is still enough to fulfill all legal requirements. For example, it could be that for administrative accounting all individual items have to be accounted. If that is the case, all foreign chargings are already in the EVSPs system and they can do the calculation with their own accounting system.

As soon as financial clearing is in place, the EVSPs have to publish more contract details. At the moment it is not clear if the EVSPs want that.

GeM Marketplace

The GeM Marketplace is semi-open B2B Marketplace within the EV Service Market. All Business Partner in the eco system may offer their EV Services on the GeM Marketplace that can be bought by any Business Partner. The EV Services may be created and hosted at the GeM Marketplace (Service Creation and Service Execution).

It consists of 4 service categories:

- Core Services

- Clearing House Services
- Basic End User Services
- Value Added Services

The GeM Marketplace will offer additional functionality, such as:

- Authentication and Authorization
- Linking and Aggregation of EV Services
- Collect Transaction Data
- Monitoring and Reporting
- Business Analytics

for all EV Services routed through the GeM Marketplace. EV Services, that offer well defined, preferably standardized service interfaces, can be embedded in higher level services to provide additional functionality.

Identification

Identification is the basic step of connecting a Business Object, Actor, Event and Service with a technically valid Unique Identifier.

Identification can be the result of human or automated action, such as reading an RF-TAG, reading a vehicle license-plate, or typing in a user ID.

Note:

Identification does not include validation of the identity: "Authentication".

Minimum Charging Period

The Minimum Charging Period is the time required to achieve a specified battery charging level. This period is never defined explicitly; it is the result of a calculation which includes:

- available charging speed, defined by the Charging Point
- required charge level, as defined by the EV Operator (driver or Fleet-Manager)
- initial charge level, which is not final until the moment of connection to the Grid

When the Minimum Charging Period is smaller than the expected Connection Window, the opportunity exists to use the EV for congestion management, either by time-of-use control or even by supplying power to the Grid.

Selling

The term Selling refers to a complex process. In the context of the GeM Marketplace the term selling includes the following independent actions:

- Provide a Service Contract Offering of an EV Service by the Service Provider
- Acceptance of the Service Contract Offering of the EV Service by the Service Requester
- Call of the EV Service by the Service Requester

Service Broker

A Service Broker is a software infrastructure component that connects Service Requester and Service Providers by:

- routing messages,
- transforming message protocol,
- transforming message content,
- providing publish/subscribe mechanisms,
- securing message transfer.

Service Contract

A Service Contract is bilateral contract between the Service Provider and the Service Requester. It is created if a Service Requester accepts the Service Contract Offering of a Service Provider.

Service Contract Offering

A Service Contract Offering is created by the Service Provider during a service registration process. The provider chooses all the required modules and additional optional modules from the service contract framework. The service contract offering is the base for a Service Contract between Service Provider and Service Requester.

Service Provider

Any Business Partner of the EV Marketplace that offers and sells EV Services on the EV Marketplace.

Service Requester

A Business Partner of the EV Marketplace that consumes EV Services on the EV Marketplace.

Value Added Service

Value Added Service (VAS) is not absolutely necessary in order to realize electric mobility, but they will make life easier. Value Added Services are designed in order to generate value for a stakeholder in the system and might be charged.