EVS27
Barcelona, Spain, November 17-20, 2013

Added Value Services for EV charging management

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Abstract

The deployment of Electrical Vehicles (EV) is not taking place at the expected rate. Consumers' tendency to value losses higher than gains works against electric vehicles when comparing them to traditional solutions. In this context, added value services may support business models with additional incomes, business differentiation or appealing mobility concepts. In the frame of the Green eMotion FP7 project, added value services will be proposed and their implementation in backend systems studied, in order to permit a widespread and sustainable deployment of EVs.

Services and functionalities are delimited by business models defining the overall stakeholder relationship framework. Therefore, the latter will have direct influence, not only at economical level but also in technical aspects of the implementation of added value services. EV services are classified in two main groups: those provided by the EVs to the network and those provided by service providers to end-users. EVs characteristics make them especially suitable for service oriented business, while ICT solutions appear as key enablers of new sustainable mobility concepts. It is very important to decide which services and how these services need to be implemented to allow a wide range of business models to be applied.

Interoperability is another essential aspect when dealing with EVs, since all systems involved in service provision should be able to communicate with each other. This will allow EV users to have transparent and efficient driving experiences, together with lower cost solutions. New advances in communication standards definition and in interoperability assessment (COTEVOS FP7 EU project) are currently going on and will tackle this challenge.

Keywords: EV charging, Added Value Services, Business Models, Interoperability

1 Introduction

Advanced services for electrical vehicles (EV) are believed to be a key element for the development of electrified mobility markets.
For example, a controlled impact of the EV in the electrical infrastructure may achieve a more reliable and vaster development of these technologies. Although this might not be one of the priorities for both EV manufacturers and the public today, it will be needed when the adequate integration within the smart grid management procedures becomes determinant to allow a larger penetration of EVs into the market.

Other services addressed to end users might result a catalysing factor to transform the EV driving experience interesting enough to compete with traditional Internal Combustion Engine (ICE) vehicles.

Business models linked to sustainable transport are arising, fostered by the necessity to reduce the environmental impact of such an energy intensive sector. However, the success of these models might be considered poor up to now. The price, range, uncertainties on the battery performance, etc. make EVs less attractive for vehicle drivers. For this reason, an economic assessment of business models is of maximum importance in order to determine the most appropriate solutions and the conditions leading them to profitability.

In this context, added value services will play a key role by supporting promising schemes with additional incomes, business differentiation and/or appealing new mobility concepts. Information and Communication Technologies (ICT) will be necessary for a suitable implementation of these services in order to optimize the required investments; interoperability and standardization will be a must to obtain scalable and widely applicable solutions; and achieving synergy with smart grid developments will be a way to reduce system implementation costs.

The main objective of the work presented here, which is taking place in the frame of Green eMotion EU project and that will be continued from different perspectives in the recently started PlanGridEV and COTEVOS EU FP7 projects, seeks to give a step forward on current market conditions and to advance towards the development of services and interoperable solutions that might contribute to the sustainable introduction of a high number of EVs into our markets in the following years.

2 Business Models around EVs

2.1 Green eMotion EU project Demo cases

In order to speed up the deployment of EV in Europe, the European Commission selected the Green eMotion (GeM) FP7 project [1] for its Green Cars initiative. The Green eMotion project is based on the conviction that electro-mobility in Europe has to be approached in a systematic and holistic way making use of innovative solutions and involving regional stakeholders at the same time.

Figure 1: GeM EU FP7 project logo

Twelve regional demonstration projects were selected in order to implement and test new developments and functionalities including an EV services market place[1] and a clearing house[2]. The main objective is to demonstrate an interoperable and scalable framework and deploy it as benchmark for further regions and their interconnection in Europe.

Table 1: Location of GeM demo regions

Berlin (Germany)
Stuttgart/Karlsruhe (Germany)
Bornholm (Denmark)
Copenhagen (Denmark)
Barcelona/Málaga (Spain)
Madrid/Bilbao/Valencia/Ataun (Spain)
Strasbourg (France)
Ireland
Italy
Malmö (Sweden)
Kozani (Greece)
Budapest (Hungary)

Each demonstration is willing to test some functionalities and services related to EV deployment. For that purpose, use cases will be implemented targeting the defined objectives. Bellow, there are listed some of the functionalities to be tested:

- Registration at the market place.
- Clearing house service purchase at the market place.
- Roaming charging.
- Central Electric Vehicle Supply Equipment (EVSE) search service for the whole GeM area.
- Load management service.
- Fast DC charging plus storage.
- Inductive charging.
- Assessment of new e-mobility concepts.

[1] ICT platform aggregating the offer of EV related services.

[2] Data and financial clearing processor between involved charging station operators and other e-mobility actors

The next step will be to perform a cost/benefit analysis of some of these functionalities in order to grasp the main concepts making them interesting from a business perspective. Two methodologies will be combined to undertake this task. On the one side, the JRC guidelines for conducting a cost-benefit analysis of smart grid projects [2] will be followed as a general framework. On the other, the e3value methodology [3] will be used in order to understand and calculate economic exchange between agents.
Services and functionalities will be delimited by business models defining the overall stakeholder relationship framework and the general rules of the game, therefore they are of great importance and they will be considered and assessed. This has direct implications not only at economical level but at the technical implementation sphere as well, for example, it may have influence on communications and control systems design.
The existence of an EVSE operator independent from an EV Service Provider (EVSP) may have implications both for procedures and systems definitions.

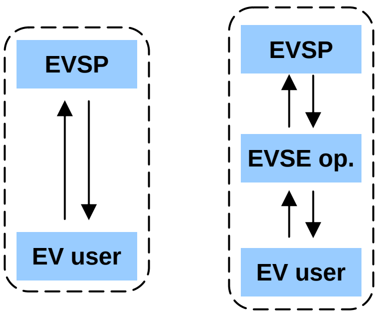

Figure 2: Schemes with and without EVSE operator agent

It is not the same case to have a contract with a unique EVSP or to be able to have access to all EVSPs through an EVSE operator and a market place.

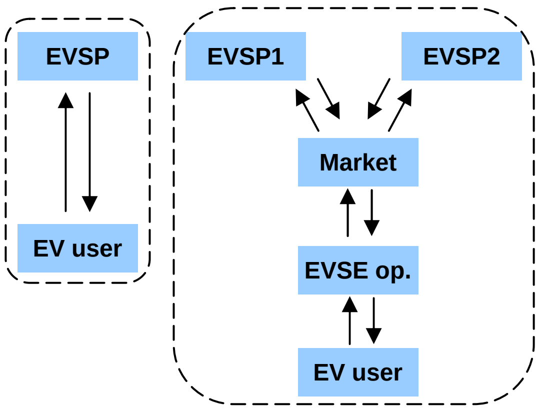

Figure 3: Schemes with and without Services Market

As a last example, load management could be performed through an EVSP, an EVSE operator or a market place. Control systems and communications should be prepared to cope with these possibilities.

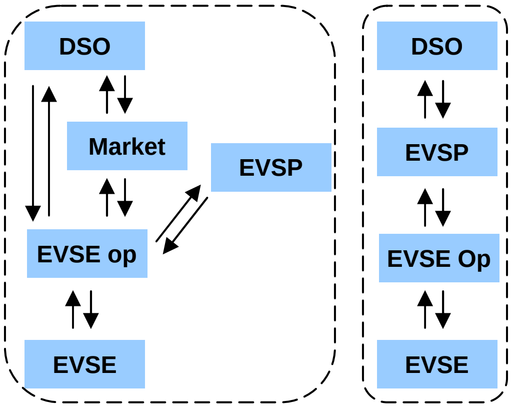

Figure 4: Two different schemes allowing load management

Before going on deeper into value added services, some current business developments involving EVs and sustainable mobility will be described in the following chapter.

2.2 Current developments

Consumers' tendency to value losses higher than gains works against electric vehicles when comparing them to ICE traditional vehicles [4]. This might be faced by means of innovative business models able to make consumers embrace new mobility concepts, revealing the positive aspects inherent in them.
The transport sector, as many others, is suffering the trend to advance more and more towards business models focused on service sale, in comparison to traditional product sale models. For example, today mobility end-users do not need to own a car to drive one; by paying a subscription fee drivers might have a mobility service based on private cars without the need of purchasing one [5].
Although this is not something exclusive of EVs, some of their characteristics make them especially suitable for service oriented business.

2.2.1 Alternatives to vehicle purchase

Due to the high price of batteries and their influence in the final price of the vehicle, the leasing of the storage [6], and even that of the whole vehicle [7], becomes an interesting possibility for private customers.

Other innovative approach was that of *Better Place*, in which service settlement was based on driven km instead of on power usage, following the mobile phone-style contracts [8].

The car sharing concept is one of those services that, even if it is not intended solely for EVs, it highlights some of these technologies' beneficial aspects linked to urban mobility: no pollution, low noise, low energy consumption cost, short distance trips, etc. The concept has been developed beyond the private users sphere to business and university fields, where car sharing might have good business perspectives.

One of the main current examples of the car sharing business is the *Autolib* service in the city of Paris [9]. According to [5], this system provides end-users with annual savings amounting about €7.000, compared to car-owning alternative. Even if its acceptance among the public can be considered successful, with around 40.000 subscriptions in 2012, the company operating the business stated that it would take the double amount of customers to break even financially. That is expected to happen in 2018, until then the business will need to be subsidized.

More and more car sharing/rental business can be found in cities around the world: *Car2Go* (several cities in Europe and North America), *City Car Share* (San Francisco, USA), *Zen* (Brussels), *Move About* (North of Europe)…

2.2.2 Interoperability

Mobility makes EVs to be an especial sort of load connected to the distribution network but it involves some technical and economical challenges.

The ability to connect to charging points owned and operated by different service providers could be a way to reduce overall infrastructure costs and to offer a better service to end-users, who would have the ability to charge their EVs in broader areas.

Extensive charging networks could be provided both by big companies able to afford high investments and cover wide areas and by solutions allowing the interoperability of different services and infrastructures.

Examples of the latter are the *Hubject* initiative in Europe, *Clever A/S* in Denmark, *Charge your Car* in UK and *Charge Point* and *Blink Network* in USA, among others. All these networks offer charging services, in which energy price is only a part of the whole fee.

When different charging networks exist, the clearing house service permits those end-users having a contract with a service provider to charge their EVs in other networks.

A future trend might be that of gathering the offer of services, for EV users and drivers in general, at ICT platforms performing the role of service markets (Market Place), similarly to the mobile phones case (*Google Play Store* or *Apple Store*). This aggregation of services would make easier for end-users to access have access to all types of services, including roaming charging.

Other approaches support built-in smart meters inside vehicles or charging cables to avoid some of the problems that the charging point network extension may involve. Mobile metering has advantages and drawbacks but it requires different technical solutions. In this case, for example, the charge socket could be any, therefore it should be identified somehow (QR tag, GPS coordinates…) and probably registered at a clearing house. Some businesses already offer solutions fitting this approach [10].

2.2.3 Impact on the electrical grid

As all other electricity demanding loads, EVs have an impact on the electrical network. This could pose a problem for the system but it could be also an opportunity for service sale.

A low penetration of EVs should not cause major negative impact on networks but, on the contrary, high deployments would require smart charging solutions, in order to ensure an efficient operation and development of the electrical system.

The positive aspect of EVs is that they may offer demand flexibility due to two main reasons:

- They can charge in different locations.
- They can store energy and most of the time they remain parked (95% in the case of Paris [5]).

This fact makes EVs eligible to offer added value services to network operators and planners, permitting them to make a better use of electric system infrastructures and resources.

EV services management requires optimization solutions in the utility side. These should be able to contribute to operation and planning activities by defining and controlling EV charging schedules. The entire infrastructure, from electricity network operators "down" to the EV, including service providers and EVSE operators' backend systems, should be prepared to allow load management in optimum technical and economical conditions.

Some of the EV related communication standards, developed or in current development, make possible smart (ISO/IEC 15118 [11], OCPP [12]) or controllable (IEC 61851-1 [13]]) charging of EVs, but further developments are necessary to find interoperable and optimized solutions.

2.2.4 Part of a sustainable mobility concept

The main reason for the adoption of EVs is the reduced environmental impact that they may involve, which is directly linked to the energy generation mix associated to the charging process.

New mobility concepts arise, especially in urban areas. The before mentioned car sharing solutions may permit a reduction of vehicles in the roads, as well as an improvement of environmental conditions through gas emission reduction, lower noise levels, etc.

ICT solutions helping combine car sharing, public transport, bicycle sharing systems, etc. are starting to be defined. One example is *Toyota*'s *Ha:mo* global mobility service [14].

Control system level solutions seek to perform an assessment and optimization of EVs charging schedules taking into account environmental impact on the top of grid impact analyses.

2.2.5 ICT as a resource

ICT is closely linked to intelligent transport developments. However, all the above described aspects make ICT solutions key in the EV sector. Interoperability, services for the electricity network and new sustainable mobility concepts make both EV and the related charging infrastructure an extremely suitable candidate for the adoption of these solutions.

Among others, ICT solutions are part of:

- EVSE operator and EVSP backend systems: charging schedule control processes, charging point management optimization…
- Services offered to end users, such as charging point location and reservation, state of charge information, vehicle pre-conditioning, vehicle reservation, billing inquiry, etc.
- End-user HMI solutions (vehicle, smart phones…) for service access. For example, the *Ford Sync* platform [15], which deploys the smart phones as HMI inside the vehicle.
- EV services Market Places. GeM project is developing a Market Place solution.
- Adopted communication protocols and technologies, such as PLC, RFID, NFC, etc.

Smart grid developments are also characterised by an intensive deployment of ICT solutions. Due to the fact that EVs should become part of the electricity networks of the future, synergies between both systems will lead to cost reductions and efficiency improvement.

Again, communication protocol standardization is a vital ongoing task in this field that should make possible interoperable and economically competitive systems.

3 Added Value Services

Business models rely more and more on services delivery. In cases where an activity is not profitable or attractive compared to other equivalent solutions, service portfolio diversification can help obtain competitive advantages and/or additional incomes.

Services in the frame of EVs can be gathered in two main categories:

- Services offered by the EV to the electric network.
- Services offered to EV users.

Depending on the business model, these groups of services will comprehend specific service relationships between agents, such as EVSE operator and EVSP, different EVSPs, EVSP and market, etc.

3.1 Network services

The EV is a load from the electrical network point of view. It is a load but with own distinctive features that make it special compared to other equipment connected to the grid. On the one side, it is mobile, the charging location may change. This might be usual for smaller loads (phones, laptops…) but not for kW range loads that could even be aggregated in high capacity sets. On the other side, final consumption does not take place while charging, EVs have energy storage in the form of batteries. These both aspects make EVs a highly flexible demand, able to offer network services.

Considering storage characteristics, EVs could not only behave as loads but as energy generators as well. Economical profitability of vehicle-to-grid (V2G) schemes is far from clear and uncertainties are big on the impact that this kind of service may have on batteries' performance. Therefore, the added value of this solution is questionable at the moment [16] and, currently, not a priority on EV market expansion.

Network services can be divided, with respect to their sphere of activity, in the following groups:

- Related to demand response (DR) strategies.

- Related to ancillary/adjustment/balancing services.
- Related to wholesale market.
- Related to power quality services.

Apart from the technical feasibility of these services, the economical assessment is necessary to understand their real value. Framework conditions such as legislative aspects, market competition level, etc. have a far from negligible impact in this analysis.

At a first glance it seems logic that more complex systems require higher investments but, on the other side, it should be assessed if new business opportunities and synergies with smart grid concepts might compensate these.

All these aspects influence directly business models definition.

3.1.1 Demand response strategies

Although most countries implement this type of strategies up to certain level, demand response is principally deployed in electricity systems with tight security margins regarding installed power capacity versus peak demand ratio. This fact makes electricity price variations to be appreciable in those systems, which leads to the profitability of such schemes for final users. At the same time, system operators profit the investment deferral made possible by these strategies. The USA and Australia are countries in which demand response is widely used [17].

These strategies are normally proposed by network operators (TSO, DSO) and offered by end-users through demand aggregators, energy service providers or equivalent stakeholders (demand flexibility providers). Contracts between EV users and EVSPs should be established and demand response characteristics clearly defined.

EVs could participate in ordinary demand management or response strategies such as:

- **Tariff strategies**: time of use tariffs, critical peak pricing and real time price are the most common.
- **Indirect control**: load reduction requests by network operators should be implemented by EV users.
- **Direct control**: the demand flexibility provider or the network operator manages directly the charging settings within agreed contractual terms.
- **Demand markets**: end-users or aggregators could offer their load flexibility at a market under certain conditions.

These strategies are used for different purposes, from load curve flattening to network constraint solution.

Another option currently discussed for the EV case and specifically mentioned by the ISO/IEC 15118 [11] is the possibility of defining a negotiated charging schedule, between EV and EVSP/EVSE operator/DSO, considering EV user preferences, network constraints, energy price, etc.

3.1.2 Ancillary services

Technically speaking, an aggregation of EVs could participate in established ancillary services markets for the network. The most suitable services for EV participation among them are the following:

- Primary regulation
- Secondary regulation.
- Deviation management.
- Intertrips: load or generation disconnection to face events in a specific location.

Other services would require V2G capabilities, implying bidirectional power electronics, higher size and weight, higher losses levels and higher costs:

- Reactive power provision.
- Voltage control: demand increase would reduce voltage in LV networks but generation would be necessary to increase it.
- Voltage dips ride though capabilities: to avoid the disconnection of high amounts of energy generation.

Other services, such as tertiary regulation and black start, do not seem to fit EVs characteristics due to the high capacities needed and the long time involvement required.

3.1.3 Wholesale market

V2G characteristics and a big number of EVs (aggregation) would be necessary to participate in day-ahead and intra-day electricity markets.

In addition to selling electricity, agents aggregating various technologies could benefit from batteries' storage by compensating forecast deviations caused by difficult to predict generation production.

3.1.4 Power quality services

An EV equipped with an inverter with phase shifting characteristics could perform phase balancing at an EVSE with multiple phase connection.

V2G characteristics would involve higher costs but, in return, they might provide the following power quality services:

- Harmonic distortion compensation.
- Flicker compensation.
- Voltage dip compensation.
- Uninterruptible Power Supply (UPS) service for the network (aggregated) or home (V2H).

3.2 EV user services

EV user services open wide business opportunities for service developers and providers from two perspectives: service sale and business differentiation. In turn, EV users can benefit from a richer mobility experience compared to that offered by traditional transport means.

Services for the drivers are normally ICT related or supported and best suited to EVs, since some of them become almost necessary, like those related to charge point location and reservation, and to charging process information access. However, many of them could be extended to traditional ICE vehicles, which results interesting from scalability and cost reduction points of view.

Software platforms emulating market places are good candidates to gather and offer services, following mobile phone approaches. They could be marketed separately or as part of a broader service. For example, an EVSP could offer for free the charging point finding service to its customers but charge the queries to external drivers.

Below, there is a list of services that could be offered to EV users according to different aspects [18]:

- **EV specific**: billing access, EV interior preconditioning, charging station location and reservation, state of charge monitoring, load management, charging preference settings, private charging station sharing, sustainability report access…
- **Telematics and navigation**: vehicle diagnostics, real time traffic information, emergency assistance, 3D navigation, search of points of interest…
- **Vehicle access and security**: remote vehicle identification, vehicle locator, vehicle access (smart phone as key)…
- **Mobility**: car sharing vehicle location and reservation, multimodal transport information, car pooling services…
- **Entertainment**: news services, social networking, internet radio, internet purchases (films, music…).

4 Implementation of New Functionalities

Once services are defined within business models, their provision requires technical implementation. This technical implementation must consider among others:

- Software and hardware platforms and applications for back end and front end systems.
- Communication requirements between agents and systems: data flows, protocols, etc.
- Infrastructure and EV capabilities.
- Service access and implementation requirements.

The EV charging process consists in several intermediate steps [11]: communication setup, certificate update and installation, authentication, identification, target setting and charge scheduling, charging, end of charging progress, charging details submission, etc. The message exchange required between all involved agents must be known and systems should be able to transmit and interpret messages when necessary. Interoperability between systems is, therefore, necessary.

It is very important to decide which and how services need to be implemented, mainly in back end systems, to allow a wide range of business models to be applied. For example, how load management can be performed with one phase systems, three phase systems, dc systems, inductive charge systems, etc. The same service might need different implementations depending on the architecture and characteristics of the whole system.

The framework established by the business model should also be considered. For example, the choice of:

- Accessing a service bilaterally with the EVSP or through a market place.
- Choosing different tariff schemes or having just one choice.
- Allowing load management in your vehicle for a charge but not for the next or not allowing it at all.

On the other side, it is also of key importance to understand which requirements are behind each implementation, since this will help assess services economically and validate business models.

For example, scheduling an optimized EV charging curve to offer services to the network might require several data sources in order to cover:

- Environmental and efficiency aspects.
- Grid operation issues.
- Contractual aspects, including energy price, flexibility conditions.
- External updated data base services: weather information, electricity market price, etc.

Following this approach, data provision and communication requirements could be quantified, and associated costs could help assess the service economically.

In general terms, one aspect to consider is that the cost of implementing the new functionalities or services should not become a barrier to EV integration.

These new functionalities implementation analysis will be carried out both in the GeM and in the PlangridEV [19] EU projects. In the first of them, the implementation will be focused on a EVSE operator backend system and in the latter research will target network planning issues. These task are already to be performed so no final results are available yet.

5 The Interoperability Challenge

All systems involved in the service provision to EV and EV users should be able to communicate with each other. In the most comprehensive approach, messages will need to flow from network operators to EVSEs and EV users passing through EVSP and EVSP operator backend systems and the market place. In addition, those messages will have to be interpreted correctly end to end.

Interoperability will provide EV users transparent and efficient processes and, in the case of roaming, higher comfort and tranquillity regarding EV charging and travelling availability.

Apart from this, interoperable and standardized systems will make possible lower cost solutions helping the growth of EV market.

Two interoperability aspects will be addressed below. First, the communication standardization efforts taking place currently in the frame of EVs and, second, the interoperability assessment challenge that will be tackled by a new EU FP7 project initiative.

5.1 Communication Standards

Communications seek to permit the completion of value added services, addressed both to the network and EV users, along the whole involved stakeholder chain. They link network operators and service providers with EVSE, EV and EV users.

EV related communication standards are focused on EV interaction with the rest of the charging infrastructure.

Some of the vehicles and infrastructures currently available on the market permit a “mode 3” type charging (as defined by the IEC 62196[20]), which allows one-direction communication, from the EVSE to the EV, by means of a control pilot function which is defined by IEC 61851-1 [13] (basic signalling). According to this specification, load managing options are linked to the dynamic limitation of power, i.e., depending on electrical system conditions the DSO could set a maximum supply current limit to the EV charging, through the EVSE.

The ISO/IEC 15118 [11] set of standards takes a step forward on EV intelligent charging, through the definition of two-way communications (high-level communication) and the possibility to negotiate with the vehicle a time dependent charging schedule. The series consists of several standards, most of them under development currently.

Apart from the EV-EVSE level, the communication upstream, towards network operators and services providers, is something to be defined through standardised solutions. The Open Charge Point Protocol (OCPP) [12] is one of the first attempts addressing this need but it is not completely in line with the ISO/IEC 15118 smart charging protocol and the capability to perform some interesting features is missed. In parallel, other manufacturers have developed private protocols for EVSEs control (RWE, Bosch…) and currently there is an activity going on, pushed by GeM EU project and supported by the EMI3 (eMobility ICT Interoperability Interest Group), with the objective of gathering efforts and experience in order to issue a common standard that will allow the interoperable implementation of value added services in the framework of the EVs.

Another interoperation level is that of the smart grid. Developments in the EV field should be aligned with those taking place in the smart grids since EVs will become part of it. On March 1st 2011, the European Commission issued a Mandate (M/490 [21]) for Smart Grids standards to the European Standardization Organizations. Through this mandate, the EC requested CEN, CENELEC, and ETSI to develop or update a set of consistent standards within a common European framework of communication and electrical architectures and associated processes, that will enable or facilitate the implementation in Europe of the different high level Smart Grid services and functionalities, as defined by the Smart Grid Task Force, that will be flexible enough to accommodate future developments. The mandate stated that “a set of consistent standards”, which will support the information exchange (communication protocols and data models) and the integration of all users into the electric system operation shall be provided. A reference architecture (SGAM framework) and a first set of standards (including newly delivered technical specifications) is already available.

Other attempts made by the commission in this direction of promoting standardization for the sake of interoperability and affecting EVs are reflected by the following two other mandates:

- M/468 concerning the charging of electric vehicles [22] was principally focused on the connectivity between charger and EV, smart charging and safety aspects.
- M/453 in the field of ICT to support interoperability of co-operative systems for intelligent transport [23].

5.2 COTEVOS EU project

One of the most challenging aspects about EV services interoperability is testing: how to assess that different systems are able to interoperate under some particular conditions.

The COTEVOS EU project proposal aims to develop optimal structures and capacities to test the conformance, interoperability and performance of the different systems to be included in the infrastructure for smart charging of EVs, based on a well known network of smart grid test beds. The project will address key issues such as the cross-national transparency, the interaction between grid infrastructure and vehicles and the operational reliability. In order to achieve this, the assessment of different systems, standards, communications and protocols will be performed and the infrastructure for their validation will be implemented.

The following chapters describe the main activities shaping the project proposal.

5.2.1 Alignment of testing methods with standards

The main objectives of this work are the following:

- Analysis and alignment of new tests and conformance test procedures with existing standards, regulations, standardization activities and standardization needs at European level concerning the interaction between EVs and grid infrastructure.
- Definition of priorities for new tests and conformance testing methods.

5.2.2 Communications and information management

The scope of this part of the project is to analyse, define and develop the reference architecture to assess that EV/EVSE systems can interoperate and be used by the smart grid actors, as defined in M/468 and M/490.

The considered actors are the following:

- eMobility actors: EVSP, vehicle manufacturer (OEM), EVSE operator, EV user, EV, market place/Clearing house operator.
- Power system actors: DSO, TSO, energy supplier, Balancing Responsible Party (BRP).
- Other relevant actors: energy Meter Operator (MO), building efficiency manager, flexibility aggregator.

5.2.3 Development of test and procedures

The creation and proposal of cost effective conformance test procedures based on laboratory capabilities, standard analysis and communications assessment is key in this project. These test procedures should be commonly accepted and agreed among EV manufacturers, EV infrastructure manufacturers and power utilities. As result, this work will offer the EV OEM’s and power utilities an adequate set of test procedures to assess the performance of the different systems and implementations.

Cost effectiveness will be taken into consideration as well as quality assurance methods like benchmarking and round robin tests. A future outcome could be a Pan-European certificate.

In order to pave the way towards a unified laboratory, as accessible as possible, COTEVOS will also analyse how to open its plans for new testing procedures to other laboratories not directly involved in the project, including the participation in round robin tests, when possible.

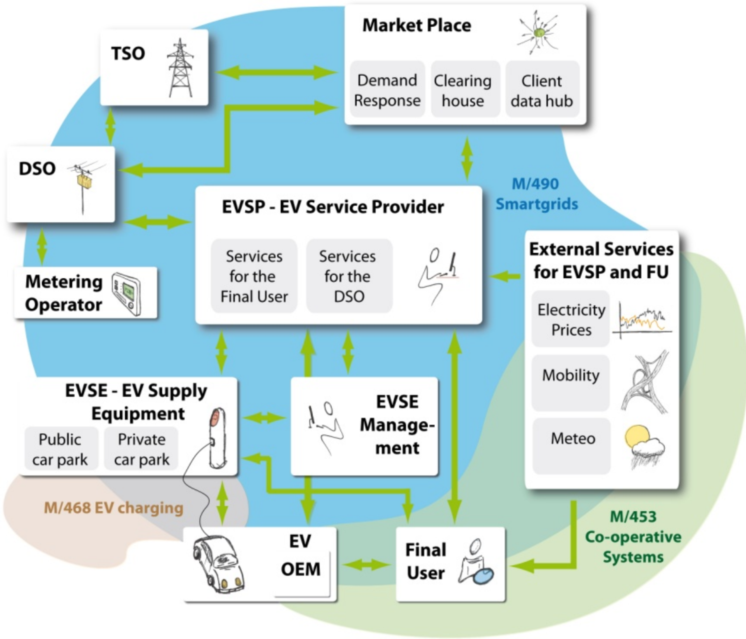

Figure 5: EV charging infrastructure and COTEVOS concept

It is necessary to define procedures and experiments to demonstrate the full transaction chain from the moment of physical plug-in, to the confirmation of financial clearing. Compulsory functionalities such as roaming, seamless interoperability and smart charging should be highlighted. A minimum requirements-procedure can be defined allowing full charge and transaction payment.

However, advanced transaction scenarios may also be suggested taking into consideration additional steps in the charging process such as advance notice of driving range, status of market prices, information on the availability of charging stations and service providers, GPS guiding, etc.

Round robin tests will be designed including financial roaming. The test procedures will specify what should be tested and the relevant boundary values. It will not dictate exactly how the laboratory should carry out the tests, since this may be best decided at each test site.

Having defined the requirements for interoperability, both in terms of the basic compatibility, financial roaming and smart charging concepts, this task will make a general description of the test procedures that COTEVOS partner laboratories should carry out. These descriptions will, to a large extent, refer to a selected set of standards relevant to the tests.

The ability to perform different test methods will increase the need for well-designed round robin tests, which main objectives are twofold:

- Ensure that the methods used at different laboratories yield the same results for the same equipment.
- Allow the OEM and power utilities to double-check equipment by having testing redundancy.

5.2.4 New and unified test facilities

Appropriate capacities for testing within the COTEVOS partnership must be created. The objectives are the following:

- Setting up a unified infrastructure for conformance testing according to ISO/IEC 15118.
- Specifying unified tests for wireless charging and proposing measurement setups for EMC tests.
- Setting up a unified infrastructure for integrated functional testing of EV and EVSE power and communication interfaces.

5.2.5 Business models and exploitation

As part of activities devoted to setting up new and harmonized test facilities, a plan is proposed in order to implement the adequate infrastructures for assessment, validation and certification at the short, medium and long terms. This plan will take into account economic aspects according to business models analysis. This approach will be supported by two main issues:

- A joint COTEVOS idea for an interoperability centre that can be developed in parallel with other European Centres and Laboratories, in agreement with the individual strategies and investment policies of the different COTEVOS' laboratories.
- A deployment plan for assessing the interoperability of the different systems and actors.

Taking this common basis, business models for exploitation of individual laboratory deployment and project results will be developed. For each business model a market plan will be prepared, including the following key elements:

- Value creation, providing an overall view of the product / service that represents a new, distinctive benefit for the addressed customers.
- Stakeholders, meaning the market potential for that value and the way to target and reach customers.
- Management of the resource combination necessary to deliver the value to each stakeholder.
- Networking, addressing the range of envisaged collaborations with other actors on the market to deliver the value.
- Financials, focusing on the revenue and profit generation and on the required investments to reach the market.

6 Conclusions

The importance of innovative business models and value added service implementation has been presented in the article, as a way to make progress in the EV market development.

This work will be carried out in the frame of several FP7 EU projects from different perspectives such as EVSE operator/EVSP backend systems, network operator planning solutions and interoperability assessment: Green eMotion, PlanGridEV and COTEVOS.

So far, results cover the concept definition phase but, from now on, technical and economical aspects will be developed, leading to specific implementation proposals.

Acknowledgments

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007-2013 under Grant agreements no. 265499, 608957 and 608934.

References

[1] *Green eMotion project*, http://www.greenemotion-project.eu/

[2] V. Giordano, I. Onyeji, G. Fulli, M. Sánchez, C. Filiou, *Guidelines for conducting a cost-benefit analysis of smart grid projects*, JRC Reference Reports, European Union, ISSN 1831-9424, 2012

[3] *e3value methodology*, http://e3value.few.vu.nl/e3family/e3value/

[4] *Chalmers, Systems Perspectives on Electromobility* 2013, ISBN 978-91-980973-1-3, Göteborg, Chalmers University of Technology, 2013 [Available at: http://www.chalmers.se/en/areas-of-advance/energy/cei/Pages/Systems-Perspectives.aspx]

[5] C. Weiller, *E-mobility services*, Cambridge Service Alliance, 2012 [Available at: http://www.cambridgeservicealliance.org/uploads/downloadfiles/emobility%20121210HQPspread.pdf]

[6] *The Electric Vehicle, A Global Strategy*, Renault Group web site: http://www.renault.com/en/CAPECO2/vehicule-electrique/Pages/vehicule-electrique.aspx, accessed on 2013-06-25

[7] *Nissan Leaf*, Clever web site: https://www.clever.dk/elbiler/nissan-leaf/, accessed on 2013-06-25

[8] T. Hazeldine, S. Kollamthodi, C. Brannigan, M. Morris, L. Deller, *Market Outlook to 2022 for battery electric vehicles and plug-in hybrid electric vehicles*, AEA Group, 2009 [Available: http://www.ricardo-aea.com/cms/assets/Uploads/Papers-and-Reports/Sustainable-Transport/AEA-Market-outlook-to-2022-for-battery-electric-vehicles-and-plug-in-hybrid-electric-vehicles-1.pdf]

[9] *Autolib*, https://www.autolib.eu/en/, accessed on 2013-06-25

[10] *Ubriticity*, http://www.ubitricity.com/en/, accessed on 2013-06-25

[11] *ISO/IEC 15118 Road Vehicles – Vehicle to Grid communication interface*, ISO, http://www.iso.org

[12] *Open Charge Point Protocol (OCPP)*, http://www.ocpp.nl/, accessed on 2013-06-25

[13] *IEC 61851-1: Electric vehicle conductive charging system - Part 1: General requirements*, IEC, www.iec.ch

[14] *Ha:mo*, Toyota web site http://www.toyota-global.com/innovation/intelligent_transport_systems/hamo/, accessed on 2013-06-26

[15] *Ford Sync*, http://www.ford.com/technology/sync/, accessed on 2013-06-26

[16] TU Dortmund University, *D2.3. Cost-benefit-analysis and recommendations for Business models*, G4V EU FP7 project, [Available: http://www.g4v.eu/datas/reports/G4V_WP2_D2_3_cost_benefit_and_business_models.pd]

[17] R. Rodríguez, I. Cobelo, A. Díaz, D2.3 *Demand Response and Demand Side Management*, Solid-DER EU FP6 project, October 2008

[18] S. Singh, *360 Degree perspective of the gloval EV market*, Frost & Sullivan, [Available: http://www.arengufond.ee/upload/Editor/events/Kohvihommik/Sarwant_Estonia%20-%20New%20Business%20Models.pdf]

[19] *PlanGridEV* EU FP7, Grant agreement no: 608957

[20] *IEC 62196: Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles*, IEC, www.iec.ch

[21] *M/490 EN Smart Grid Mandate - Standardization Mandate to European Standardisation Organisations (ESOs) to support European Smart Grid deployment*, European Commission, Directorate-General for Energy, B.2 – Electricity and Gas, Brussels, 1st March 2011

[22] *M/468 EN Standardization Mandate to CEN, CENELEC and ETSI Concerning the Charge of Electric Vehicles*, Ref. Ares(2010)386919, European Commission, Enterprise and Industry Directorate General, Brussels, 4th June 2010

[23] *M/453 EN Standardization Mandate Addressed to CEN, CENELEC and ETSI in the field of Information and Communication Technologies to Support the Interoperability of Co-operative Systems for Intelligent Transport in the European Community*, European Commission, Enterprise and Industry Directorate General, Brussels, 6th October 2009

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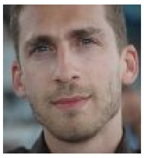

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