Distribution grid planning and operational principles for EV mass roll-out while enabling DER integration

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Roadmap and recommendations over innovation, regulation and policies

Author: Giovanni Coppola, Enel

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Main Author	G. COPPOLA / ENEL SPA (THIRD PARTY OF ENEL DISTRIBUZIONE SPA)
Project partners involved	EDP ESB RWE AIT RENAULT TECNALIA
Editors	Armin J. Gaul / RWE, Stefan Greve / RWE

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Executive Summary

Two main research and development paths have been performed during PlanGridEV project with regards to the properly management of EVs mass market uptake and the concurrent challenge of renewable sources integration.

The first R&D effort was aimed at evaluating the best planning rules within a Business As Usual (BAU) approach in order to cope with electric vehicles uptake. It leveraged the tool developed in the project and delivered insights to modern Distribution System Operators (DSOs) in order to plan the electricity grid accordingly in the near future. Those insights are available within the outcomes of WP 6 and the deliverables out of that Work Package serve as reference on this.

The second, alternative R&D effort was instead aimed at researching and delivering proof of concept of operational methods which might involve electric vehicles as controllable loads, serving the purpose of implementing supporting services for Distribution System Operators in their operation of large scale infrastructure, minimizing the capital expenditures which are otherwise the only option in the BAU approach.

This document provides an overview of the recommendations useful for the implementation of such a second path, encompassing operational methods by which the DSO could request EVs to be properly managed and controlled in relation to the customer preferences and grid constraints.

Innovation

The R&D performed in this sense during the project allowed the maturity of smart charging to go from TRL 4 to an estimated level of TRL 6, where a series of further innovative actions must be undertaken to bridge the gap until TRL 9 and market reality. Such steps are discussed in the document and are hereby summarized:

To increase EV battery capacity to a minimum level of 44 kWh in order to increase the possibility of monetizing it by using as a controllable asset during the initial transition phase of the market, where in some Member States it will be unlikely to have more than one EV per each low voltage line that can be aggregated in order to provide active demand service.

To establish a common set of interfaces amongst stakeholders, via standardization of EVSE-EVSE back-end system communication protocol and the implementation of a smart charging server-to-server services protocol standard. Such interfaces shall include EV information such as State Of Health, State Of Charge, Remaining Time / Remaining Energy, Time Of Departure, the latter parameters being key in order to derive the flexibility which could be provided to the DSOs for the operation of the service.

To update the EV-EVSE communication and adopt stronger mechanism than what currently available, in order to allow EVs load controllability with the minimum error in terms of time of reaction and EV set points control. This should be implemented by improving IEC 61851-1 with digital communication both for AC and DC charging and by having ISO 15118 protocol implemented in market available EVs.

To allow the possibility of modifying the EV set points during the charging process for DC charging, a possibility which at the moment is not foreseen neither in CHAdeMO protocol nor in DIN specifications 70121-2014 (Combined Charging Systems) communication protocols, but it should be at least taken into account as possibility to combine DC charging and smart charging (e.g. DC home wallbox).

Regulation

An overview has been provided with regards to possible framework regulation to support active demand services and precisely those based on electric mobility. The recommendations were gathered and cross-checked by means of survey to electric mobility and electricity market stakeholders which brought to a common understanding of how a smart charging market should be implemented and under which conditions it shall be regulated by national or international authorities (ref. Chapter 3), in order to assess this service as a possible means of transformation for utilities and precisely modern DSOs.

As demonstrated in this project, a trade-off for DSOs exists between leveraging flexibility of EVs and performing direct grid extensions in order to cope with EVs uptake, therefore regulatory discussions should take into account the possibility of evaluating the DSO's financial participation in the establishment of active demand services market as alternative means to electricity grid reinforcements.

Policies

Smart charging is a set of techniques, or operational methods, that have the potential to save European DSOs significant CapEX costs in electricity grid extension. This was demonstrated in PlanGridEV D7.1 and in several other current studies in this area (see "Smart Charging: Steering the Charge, Driving the Change" – Eurelectric – 2015, to which PlanGridEV researchers contributed).

The costs saved through these techniques could be distributed across the value chain, leading to savings in terms of service fees for consumers.

For this reason, supporting policies might be implemented in each member state that urge the consideration of smart charging as an additional beneficial feature of the EV charging infrastructure under deployment, in accordance with the European Alternative Fuels Infrastructure Directive 94/2014. This could lead to public tendering requirements which recognise the added value of smart charging in terms of tendering evaluation, or public subsidised programmes that specifically request the EV-Grid integration as a mandatory parameter in deployment evaluations, particularly in the uptake of the mass market where the system adoption cost for the electricity system will reasonably be higher.

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Abbreviations and Acronyms

Table 1 Acronyms

BAU	Business As Usual
CBA	Cost Benefit Analysis
CCGT	Combined Cycle Gas Turbine
DER	Distributed Energy Resources
DMS	Distribution Management System
DSO	Distribution System Operator
EC	European Commission
EU	European Union
EVSE	Electric Vehicle Supply Equipment
EVSEO	Electric Vehicle Supply Equipment Operator
EVSP	Electric Vehicle Service Provider
RENs	Renewables
SOC	State Of Charge
WP	Work Package
WPL	Work Package leader
DoW	Description of Work
QO	Quality Objective
KPI	Key performance indicator

1. Introduction

1.1. Scope of the document

European power utilities are experiencing times of deep change due to the concurrency of several pressing forces which their century-old business models are facing:

- The increase of decentralized energy production, which implies a new modelling of energy systems and a deep rethinking of conventional top-down approach with regards to power generation, transmission and distribution

- The lowering of entry barriers for new comers, which implies an increase of market fragmentation and the need of widening the customer services portfolio, in order to keep sustainable levels of enterprise value generation

- The tightening of low-carbon policies and CO2 emissions targets, which implies the de-commissioning of several conventional power plants (CCGT, coal, nuclear) which are not competitive anymore against zero-priced renewable sources being placed at the level of national wholesale markets

All this pressing forces result in a business model transformation which need to be refocused from a conventional profit margin based on commodities volumes transmitted, distributed and sold, into something new which must rely on the principles of value creation and distribution, e.g. de-commoditizing the electricity into a set of services. The implementation of this transformation will leverage a set of new opportunities, amongst them electric mobility is surely promising, in order to deliver a new prospect of growth to the power utilities.

Electric mobility is a multi-disciplinary business, which represents a risk as well as an additional opportunity for electricity utilities in their transition from volume to value, especially with regards to the combination of electric mobility and distributed generation.

PlanGridEV project's research and development effort was conducted along two main paths:

- To understand, by means of specific tool being developed in the project, under which framework conditions the DSOs shall properly invest into network upgrades and how they should pursue the EVs integration in business as usual approach.

- To research and deliver proof of concept of smart charging mechanisms, e.g. the capability of harvesting the time flexibility of EV customers and leveraging it as a grid-supporting service, in order to exploit EVs as manageable loads and create value to be shared between the DSO, EV customers and EV Service Providers.

With regards to the first path, DSOs participating at the project gained a better insights of how to plan their infrastructure for the BAU approach of EVs uptake, which implies not interacting within the market framework with any other actors in order to manage the EVs load curves, whether on medium or low voltage grids.

Both paths lead to results which had been published and are available for reading through PlanGridEV deliverables D2.2, D5.3, D6.2, D7.1, whereas related recommendations for future technology, regulatory and policies implementation are hereby summarized.

1.2. Structure of the document

The goal of this document is, however, to derive recommendations out of the project results with regards to the second path of research and development effort run in this project. This is due to the reason that only such a path requires a proactive behavior from DSOs and fits into a general expectation of utilities transformation that will be executed within the next decade, whereas the first path leads to useful insights for the execution of grid planning without role transformation for DSOs. Electric mobility is still at an early market stage, therefore it is hard to guess whether it will be the first business opportunity which will be executed through a new role for DSOs or it will be managed in the business as usual approach. PlanGridEV project derived results and insights for DSOs in both cases, although only the market evolution will tell which path will be market reality: BAU grid planning or smart charging and DSO as a distribution platform optimizer, where electric mobility would be just one of the services run on such a platform.

As a consequence of being somehow an unexplored path, the R&D effort run in PlanGridEV which has been focused on smart charging mechanisms can release recommendations over the innovations which still needs to be implemented in order to increase the Technology Readiness Level of those mechanisms, their market attractiveness and the needed regulatory framework to sustain or enable them.

PlanGridEV partners are even more convinced, at the end of this project, that there exist a huge opportunity to be tapped from DSOs into enabling active demand based business models, such as those relative to smart charging. This opportunity requires utilities, and particularly DSOs, to increase their digital capabilities in order to implement competitive IT-based solutions which can sort out the issues related to EVs uptake as well as renewable sources integration, possibly delivering benefits to both of them: this is what smart charging is about, letting utilities become truly digital and serving electric mobility mass market transition as a first meaningful chance of pivoting the conventional DSO role.

For the reasons above mentioned, Chapter 2 of this document will serve also as a technology roadmap particularly for utilities with regards to the future implementation of smart charging services, whereas Chapter 3 will deliver recommendations on the regulatory framework, integrating answers gathered from EU stakeholders through a specific survey on smart charging topic.

The addressed scenario of this document is the “Smart-Grid Integration” scenario, highlighted in the Figure below, where the techniques of smart charging have been investigated as operational method.

	Conventional	Safe	Proactive	Smart grid
Charge management	No	Soft, fleet-focused	Massive	Massive, local
Type of charge management	None	On/off	On/off	Charge modulation
Expected grid reinforcements				
Non EV-related	Yes	Yes	Minimal	No
EV-related	Yes	Minimal	No	No
Energy flow in EVs that are used to provide services	None	Grid → EV	Grid → EV	Grid (←)→ EV
Provider of the service	None	EVSE Operator (fleet manager)	EVSE Operator/EVSP	EVSP
Remuneration scheme	None	ToU	Regulated contract	Competitive market
Type of power flow control for:				
Emergency constraint mgt.	Centralised	Centralised	Centralised	Centralised
Forecasted constraint mgt.	None	Centralised	Decentralised	Decentralised
Real-time constraint mgt.	None	None	None	Decentralised
Ancillary services for the TSO	None	None	None	Decentralised
Energy trade	None	None	None	Decentralised
DER integration	None	None	None	Decentralised

Figure 1 Demonstration Scenarios of PlanGridEV

The main difference within Proactive and Smart Grid scenario is the availability of the V2G/V2X services as well as a more mature market establishment, where typically the business providing the services to the end-user is different from the business operating the enabling infrastructure (in the case of e-mobility flexibility services, the EVSE or Charging Point Operator). Although the physical demonstration performed in the Project fit in the Proactive scenario, their long-term scope is definitely inspired to the Smart Grids scenario, whereas a mature active demand market exists for LV and MV.

2. Recommendations on framework innovation

2.1. Review of smart charging techniques researched in the project

Out of the Catalogue of Products researched in Deliverable 2.2, only a sub-set class of services where demonstrated throughout the different validation test beds available in the Project.

Although the recommendations included in this document are mainly targeted to overcome technology, regulation and policies barriers for the go-to-market of such services, the framework by which these recommendations were derived is in principle applicable to all of the PlanGridEV envisioned services and similar outcomes can be processed in the other use cases. Smart Grids scenario was particularly demonstrated in Italy and Germany, leveraging assets that in most of the case were already available before the implementation of the project, minimizing the cost intensiveness of PlanGridEV demonstration phase.

Smart Grids scenario implies the possibility to perform a power modulation, which could be either continuous or digital (scheduling ON/OFF) of EVs in response to some extent of grid-supporting or grid-friendly task, constituting a smart charging services. A high-level useful overview of smart charging concept is given in Figure 2.

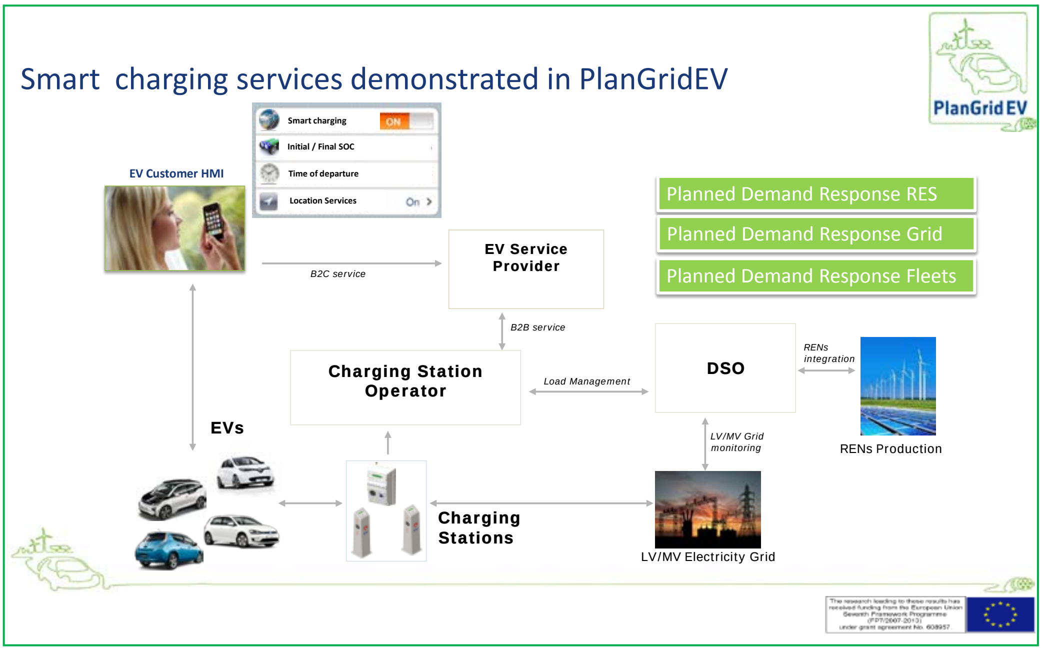

Figure 2 Smart charging services demonstrated in PlanGridEV

The general principle depicted in Figure 2 is that there is a process (a smart charging process) established between the EV customer, who operates the enabling infrastructure (EVSE Operator), the company holding the contractual relationship with the customer (EVSP) and the DSO in order to promote the usage of the customer's EV in accordance to system's boundary conditions, satisfying system performances as well as customers preferences.

Boundary conditions of this process creates different variations of the smart charging, whether it supports the DSOs, the DER integration, or both. In some cases a TOU tariff is used as pricing signal, or may be the optimization performed within the local home / building energy manager.

Most of the different variations have been described in Deliverable 2.2. The demonstration phase delivered insights over the following services, all belonging the Smart Grids scenario as reported in Figure 1.

- Planned Demand Response: Load Management according to long term minimization of electricity grid investments
- Planned Demand Response: Enhanced RENs integration
- Planned Demand Response: Load Management for fleets

A resume of the services description is provided in the following paragraph, whereas hereby it is useful to detail the specific smart charging techniques that were investigated in the demonstration of such services. All of the three services above mentioned imply the following preliminary hypothesis that constitute the framework of the smart charging techniques and qualify them with regards to the current knowledge in industrial and scientific community. The implications of these technical and demonstration hypothesis are being investigated in this chapter.

Preliminary hypotheses for the services execution in PlanGridEV demonstration

1. IEC 61851-1 standard edition 2014 was used as a reference to communicate variation of power levels in the EV-EVSE communication. This is an analogue communication where the level of currents are quantized based upon the duty cycle of a voltage signal on the pilot wire of the cable / connector, in compliance with the provisions set forth in IEC 62196-3 standard.
   The choice of this communication standard between the EVSE and EV is a consequence of the fact that PlanGridEV demonstration was held by using market-ready EVs which have been available during 2014 and 2015 timeframe, whereas digital communication is currently targeted as feature on shipped vehicles by early 2017 onwards.
2. Customized communication protocol was used for the communication between EVSE and EVSE back-end system (Charging Station Operator of Figure 2). This implies restrictions to the feasibility of services demonstration and its replication potential, which will be analyzed.
3. Customer preferences were selected in the process by delivering inputs over initial SOC, final/desired SOC and time of departure by means of external smartphone application and/or back-end system database.

4. Customers participating at the demonstration phase were within the ranks of employees or subcontractors of the project partners, due to limitation of project scope and budget. This implies a behavioral bias that should be addressed in the scaling-up and exploitation of results.
5. Market access to the services provisioning was simulated. No bid effect was considered to access the Load Management plan typically issued by the DSO or by the DER Operator in case of Planned Demand Response for RES and Grid of Figure 2, or by the home/building energy manager in the case of Planned Demand Response for Fleets. In a realistic case a preliminary bid could take place between the issuer of the Load Management plan (who requests the service to be performed) and the customer of the Load Management plan (who delivers and implement the service to be performed, e.g. the EVSE Operator or EVSP).
6. Market-ready EVs commercially available in 2014 were used in the project demonstration, in order to deliver higher emphasis on the possible replication and scale-up potential of the ideas drafted in the project, particularly with regards to the possibility of building future active demand products tailored to the needs of EV Fleets Operators (e.g. Airport, Port, Hospitals, Small / Medium Enterprises, distributed Large Enterprises).

2.2. Gap analysis between results and use cases

This paragraphs provide further details over the services demonstrated in the project, particularly with regards to the sub-set of expected demonstrable outcomes that were provided in the project against the whole use case description reported in Deliverable 2.2 and Deliverable 3.2.

The first service, Planned Demand Response: Load Management according to long term minimization of electricity grid investments was demonstrated in Italy by using a DMS to generate the initial Load Curve issued by the DSO in order to promote the controlled charging across a specific MV to LV area of L'Aquila city and in Germany by leveraging Smart Operator project. The interaction of the service was direct between the DSO systems (simulated by the DMS) and the EVSE Operator back-end system, controlling several EV charging stations in the city. The Load Management plan was issued and divided per cluster of charging stations, in an augmented reality simulation of 100% EV penetration with the applicable cost figures reported in Deliverable 7.1.

The specific features of this proof of concept are reported in Figure 3, with the relevant features highlighted in green squared boxes close to each key business actor / system.

The high level service description originally designed in Deliverable 2.2 is hereby reported in order to validate the gap analysis with results out of Deliverable 5.3 and put in context the proof of concept within the recommendations effort of this document.

Belonging to the family of Planned D/R services, the load management for minimization of grid investments is amongst the expected core services of PlanGridEV demonstration. With this service, DSO aims at lowering EVs penetration impact by postponing, or avoiding, power assets and wires investments in order to sustain EVs adoption. The final purpose of this product is to enable electric mobility without burdening the national system with additional technological adoption cost for the electricity grid. Customer preferences (Initial SOC, Final SOC and Time of Departure) are traded with power availability at LV level, demanding target load curve to be followed possibly by all charging process within a pre-defined Load Area, as a cluster of EVSEs installed within the same LV (or MV) domain. Such a service could be planned a few hours in advance, especially for low-variation charging behaviors (e.g. home charging, fleet charging).

The proper allocation of controllable charging process within day allows DSO to keep the LV and MV grid with today's design, without changing overloaded transformers due to simultaneous charging.

For what regards the CBA, as demonstrated in Deliverable 7.1, a reasonable expectation would be that turnover happens when 30% overload has to be avoided on transformers, which would lead to 30 EVs out of 90 grid customers simultaneously charging at 3.3 kW for a typical MV/LV substation (Italy's case) or more than 5 EVs charging at 22 kW rated power under the same hypothesis, without improving electricity grid against today's situation. The mechanism by which EVs participates to such a service is by simply applying the desired load curve to each EV. This will be usually leading to a widening of charging process duration and a lower EV bias point, in order to relax power stress for the electricity grid.

In order for such a service to be properly marketed, customer preferences and DSO constraints spread over a selection of EVSEs are not enough. A worldwide repository of EV models as IT Business Objects, whose property and liability belongs to each OEM, can be helpful to be established within the duration of PlanGridEV, in order to speed up Time To Market of such a service and timely exploit a significant innovation effort held within this project. Such a repository would include fundamental parameters of each EV that must be taken into account when allocating a charging process against Customer Preferences (Initial SOC, Final SOC, Time Of Departure) and DSO constraints.

Such a Business Object would be based on the following parameters list:

- EV Model Name
- EV Battery Capacity
- EV Battery Capacity maximum degradation range whilst in operation
- EV maximum incoming power rate

“eMI3”, an established international initiative of the biggest international players in electric mobility, could be the proper driver of such a harmonization (www.emi3group.com).

Such a service would have a reasonable response time of minutes, as part of a planned initiative without needs of quasi-real-time adjustments.

Standards like ISO 15118 also includes these information, like maximum and minimum current/power, required energy content and will also allow to speed up the Time To Market.

Involved stakeholders

Customer, EVSE, EVSE Operator, EVSP, DSO. Expected relationship: DSO/TSO are buyers.

Time To Market

30+EVs within a single area served by a MV/LV substation are expected for positive CBA. Although with current market predictions this is unlikely to be happening before 2020, some areas with higher EV early adopters rate might experienced this kind of opportunity.

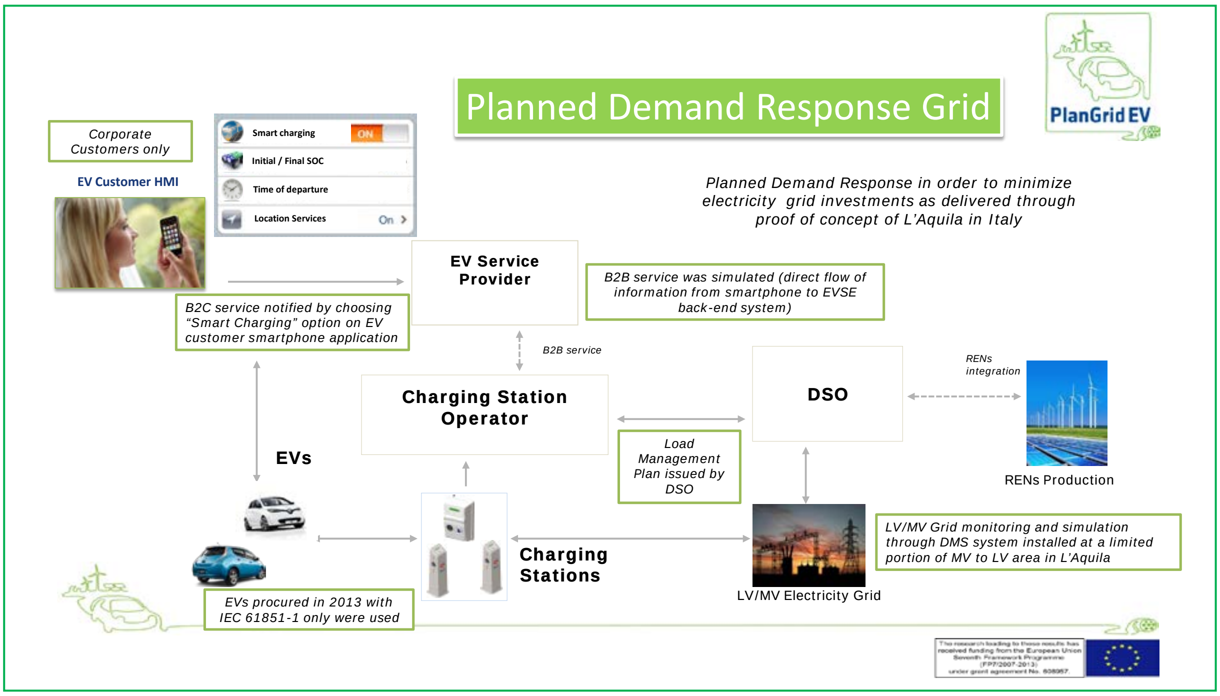

Figure 3 Planned Demand Response: Load Management for minimization of grid investments.

In comparison to the whole use case description, there are several limitations given the context of the proof of concept, in comparison to the expectations set forth in Deliverable 2.2 at the level of service design. The proof of concept delivered only a limited market interaction (one DSO, one MV-LV area and Charging Point Operator collided with EVSP role). Furthermore, the Load Management plan was delivered through a static file exported from DMS system rather than a real time direct uplink communication (e.g. web service based architecture) and there was no EVSP involved in the transaction, as the communication of customer parameters was directly forwarded from the EV customer's smartphone application to the EVSE Operation back-end system.

Therefore the outcome of D5.3, where the results of the demonstration have been included, must be put in the proper scope in order to evaluate recommendations for fulfilling their scale-up potential.

As for the markets interaction, the recommendation which are included in Chapter 3 and 4 reflects the more the expectations of the replication of the demonstration, rather than the effective interaction which was tested in the Project. Nevertheless, useful insights came from the proof concept in relation to the timings of the service request and the information that must be displayed to the customer when accessing smart charging program issued by the DSO.

As for the innovation, the recommendation included in this chapter are mainly to be understood in with the prospect of overcoming the hurdles and the limitations depicted in Figure 3, particularly with regards to the communication protocol available between EV and EVSE as well as the need to input boundary customer preferences through a customer, error-prone HMI rather than autonomous systems like could be allowed by advanced digital communication systems between EV and EVSE.

The second service, Planned Demand Response: Enhanced RENs integration was demonstrated in Italy by using also in this case an augmented reality simulation (where higher penetration of EVs was simulated and then a specific subset of real loads was tested) and in Germany by leveraging the Smart Operator project. The aim was to generate the initial Load Curve issued by renewable operators in order to promote the controlled charging for integrating the distributed sources. The interaction of the service was direct between the DSO systems (simulated by the DMS) and the EVSE Operator back-end system, controlling several EV charging stations in the city. The Load Management plan was issued and divided per cluster of charging stations.

The specific features of this proof of concept are reported in Figure 4, with the relevant features highlighted in green squared boxes close to each key business actor / system.

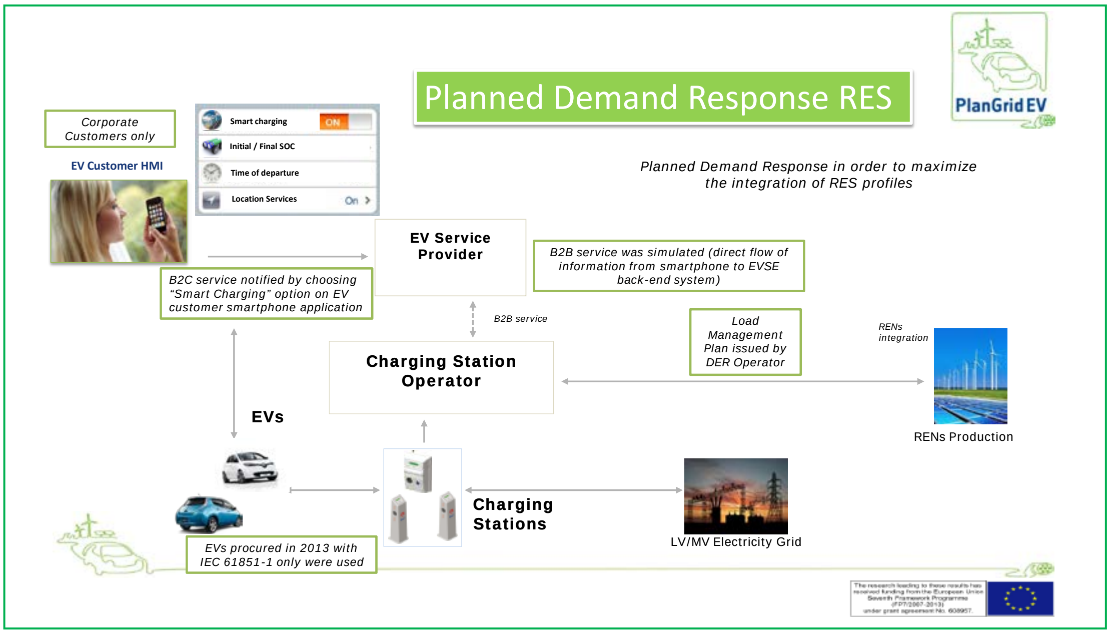

Figure 4 Planned Demand Response: Load Management RES integration

The high level service description originally designed in Deliverable 2.2 is hereby reported in order to validate the gap analysis with results out of Deliverable 5.3 and put in context the proof of concept within the recommendations effort of this document.

This service, alongside Load Management for minimization of grid investments, is also one of the core services of PlanGridEV project and at key root of electric mobility success in the long term future. The purpose of this service is to plan EV charging processes within MV and LV domain in accordance with the planned (forecasted) availability of RENs/DERs. DSO or DER Operator is supposed to behaving as buyer of this service, as DSO would have interest in enhancing DERs hosting capacity without necessarily designing the electricity grid for the worst case (Business As Usual approach) but maximizing the controllability of active appliances like EVs. DER Operator on the other side might invest in such service in order to access proper remuneration schemas. Regardless who is buying such a service, the customers might participate as long as their preferences are satisfied.

Home charging and low to medium speed public and semi-public charging is home turf for such a service, which needs a minimum amount of 10% penetration rate to properly allocate enough EVs charging processes below a HV/MV transformer to match a significant production coming from cluster of some PV or Wind DER plants. This would mean, with 10,000+ customers served by HV/MV substation, 1000 EVs to be properly programmed.

The mechanism by which EVs participate at such service is the same of the 6.3, 6.4, 6.5. Response time and time depth of service execution are equal too.

As RENs integration is mainly relying on DSO assets, this service is always involving DSO (different from Load Management for fleets, where the value distribution might even not involve DSOs).

Reliability of DERs forecast should be mandated, whenever possible, to DER Operators.

Involved stakeholders

Customers, Fleet Owners, EVSE Operators, EVSP, DSO, DER Operator. DSO/DER Operators are buyers.

Time To Market

1000+EVs within a single area served by a HV/MV substation are expected for positive CBA against a cluster of 5 to 10 typical DER plants. Although with current market predictions this is unlikely to be happening before 2025, some areas with higher EV early adopters rate might experienced this kind of opportunity, especially where there is a simultaneous increase of DER penetration.

In comparison to the whole use case description, there are several limitations given the context of the proof of concept, particularly with regards to the expectations set forth in Deliverable 2.2 at the level of service design. The proof of concept delivered only a limited market interaction (one DSO, one MV-LV area, Charging Point Operator collided with EVSP role). Furthermore, the Load Management plan was delivered through a static file exported from the available data of renewable plants operated by project partners rather than a real time direct uplink communication (e.g. web service based architecture) and there was no EVSP involved in the transaction, as the communication of customer parameters was directly forwarded from the EV customer's smartphone application to the EVSE Operation back-end system.

Therefore the outcome of D5.3, where the results of the demonstration have been included, must be put in the proper scope in order to evaluate recommendations for fulfilling their scale-up potential.

As for the markets interaction, the recommendation which are included in Chapter 3 and 4 reflects the more the expectations of the replication of the demonstration, rather than the effective interaction which was tested in the Project. Nevertheless, useful insights came from the proof concept in relation to the timings of the service request and the information that must be displayed to the customer when accessing smart charging program issued by an operator of renewable production or an aggregator.

As for the innovation, similarly to the previous service, the recommendation included in this chapter are mainly to be understood in with the prospect of overcoming the hurdles and the limitations depicted in Figure 3, particularly with regards to the communication protocol available between EV and EVSE as well as the need to input boundary customer preferences through a customer, error-prone HMI rather than autonomous systems like could be allowed by advanced digital communication systems between EV and EVSE. Furthermore, in this specific service the availability of data from nearby RES plants (operating below the same HV/MV substation) are taken in a static way and without any forecasting algorithm: the day ahead curve, used for the execution of Load Management plan, is matching the actual production of the day before, in a low accuracy estimation which produces a significant error signal between the real curve and the expected one.

The third service, Planned Demand Response: Fleets was demonstrated in the Italian testbed by using internal EV corporate fleet and it is reported in Figure 5. The aim was to generate the initial Load Curve issued by a third party (DSO or Renewables Operator) in order to promote the controlled charging for DSO's operational needs as well as for integrating the distributed sources, by producing a benefit in terms of costs of charging of the fleet operator. The interaction of the service was direct between the DSO systems and the EVSE Operator back-end system, controlling several EV charging stations in the city. The Load Management plan was issued and applied to a specific cluster of charging stations at corporate premise of Enel in Rome.

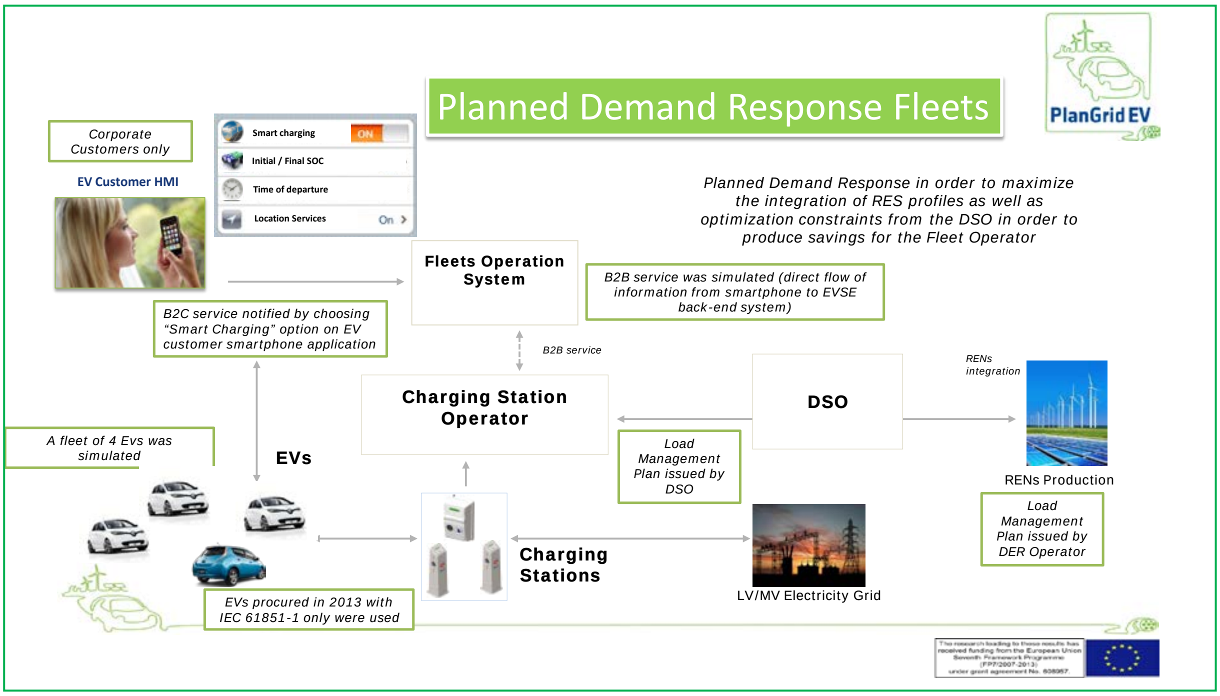

Figure 5 Planned Demand Response: Load Management for fleets

The specific features of this proof of concept are reported in Figure 5, with the relevant features highlighted in green squared boxes close to each key business actor / system.

The high level service description originally designed in Deliverable 2.2 is hereby reported in order to validate the gap analysis with results out of Deliverable 5.3 and put in context the proof of concept within the recommendations effort of this document.

Although the same principle of the above for trading off customer preferences and time availability against target power load curve holds true, this time the target power load curve generation could be driven by purposes different than DSO requirements.

For example, such a smart charging service could be run in order to minimize electricity bill (target load curve compiled against the contracted energy price schedule), enhance the usage of local distributed energy resources that might be installed at the premises of the fleet owner (target load curve matching medium-term DERs forecast), or both at the same time (maximization of local DERs plants whilst minimizing the power requested to the electricity grid, lowering the global service bill).

The mechanism by which EVs are used in this services is the same of Load Management for minimization of grid investments, although the purpose generating the target load curve is a different one.

As EV fleets are expected to be great contributors to global EV shares within the next few years, due to supporting policy in terms of CO_2 certificates and corporate taxes discount, such a service looks the one with most realistically short Time To Market. The number of EVs participating in the service does not depend on the EVs penetration rate as the previously described services, but on the capability to gather enough EVs to locally counter-peak the production of household/building DER or the pricing time schedule that the fleet owner (customer) has contracted with its Energy Vendor.

Typically, fleet owner could simultaneously be final customer and driver of this service. The service could either be provided third party, acting as a Virtual Utility in the combination of minimization of electricity consumption from the grid and maximization of DERs production, the same entity possibly holding the DERs installed at the local premise, the EVSEs and the EVSE Operator back-end.

Involved stakeholders

Fleet Owners, EVSE Operator, Virtual Utility. Expected Relationship: Fleet Owners are buyers.

Time To Market

Below 5 years.

In comparison to the whole use case description, there are several limitations given the context of the proof of concept, particularly with regards to the expectations set forth in Deliverable 2.2 at the level of service design. The proof of concept delivered only a limited market interaction (one DSO, one MV-LV area, Charging Point Operator collided with EVSP role which on its end collided with the Fleets Operator). Furthermore, the Load Management plan was delivered through a static file exported from the available data of renewable plants operated by project partners rather than a real time direct uplink communication (e.g. web service based architecture) and there was no EVSP involved in the transaction, as the communication of customer parameters was directly forwarded from the EV customer's smartphone application (in this case DSO workers) to the EVSE Operation back-end system.

Therefore the outcome of D5.3, where the results of the demonstration have been included, must be put in the proper scope in order to evaluate recommendations for fulfilling their scale-up potential.

As for the markets interaction, the recommendation which are included in Chapter 3 and 4 reflects the more the expectations of the replication of the demonstration, rather than the effective interaction which was tested in the Project. Nevertheless, useful insights came from the proof concept in relation to the timings of the service request and the information that must be displayed to the customer when accessing smart charging program issued by a local energy management system in relations to the execution of optimization program for reducing EV fleet's OpEX.

As for the innovation, similarly to the previous services, the recommendation included in this chapter are mainly to be understood in with the prospect of overcoming the hurdles and the limitations depicted in Figure 5, particularly with regards to the communication protocol available between EV and EVSE as well as the need to input boundary customer preferences through a customer, error-prone HMI rather than autonomous systems like could be allowed by advanced digital communication systems between EV and EVSE. Furthermore, in this specific service the availability of data from nearby RES plants (operating below the same HV/MV substation) are taken in a static way and without any forecasting algorithm (see also previous gap analysis) and there is no other buffering system (such as electric storage) that has been used in order to maximize the capabilities of integrating load management plans from local energy management system.

2.3. Targeted actions for framework innovation

The specific services as reviewed in Paragraph 2.1 to 2.2 were demonstrated in the project and provided useful insights for the design of recommendations for enabling their delivery to the market. This paragraph build on such a review and the subsequent gap-analysis (also provided in Paragraph 2.2) in order to understand the technical hurdles ahead for the implementation of market-ready services inspired to the R&D effort of PlanGridEV, in the wider business concept of leveraging performances flexibility of EVs as power controllable loads.

This paragraph provides a deep dive into the gap analysis between services description and their demonstration, with regards to the innovation that must be executed across the whole value chain

A global innovation roadmap is given in Figure 6.

2.3.1. Innovation recommended for OEMS.

Adoption of digital communication protocols for EV-EVSE communication

All Load Management plans performed in the EV-Smart Grids integration scenario during PlanGridEV relied on IEC 61851-1 communication protocol (PWM based) and AC charging only, using Type 2 connector as defined in IEC 62916-3.

These represent severe limitations to the accuracy of load management (which has a granularity of more than 1.5 A) as well as a significant inertia in response timing of the EVs (Which is typically above 6 seconds) as well as the minimum allowed current (around 6 A).

Furthermore, the usage of an analog communication protocol is forbidding the delivery of additional information from the EV to the EVSE, like EV’s SOC, Remaining Time and Needed Energy or similar Business Objects that are useful for the service execution.

Although prototype usage of digital communication protocol such as ISO 15118 are already available, its adoption is highly recommended and constitutes a recommendation of this project in order to increase the effectiveness and the reliability of a Load Management plan executed between DSO, DER Operator, EVSP, Building Energy Manager and the EV.

But even beyond its adoption for AC charging, the possibility of changing power modulation level should be foreseen in the near future also for the communication protocols based on DC charging, which at the moment do not fully comply (at least not in all its available standardized versions) with such a possibility. This could be particularly relevant in the near future to allow the execution of Load Management plans by using low to medium power DC charging, which is linked to the hypothesis of using home or fleet DC charging wallboxes as currently envisioned by some of the key players in the automotive industry.

Increase of battery capacity

Smart charging is also about battery monetization and the capability to use the time that the EV is typically parked in its lifetime as a supporting flexibility for the whole energy ecosystem, including but not limited to serving the DSO needs in terms of grid optimization and minimization of grid reinforcements as a consequence of EVs uptake. The technical and business depth of leveraging battery as a monetization tools is straightforwardly linked to its capacity. Furthermore, there is a trade-off between battery lifetime and number of cycles could be executed due to smart charging. Increasing battery capacity reduces the number of cycles needed with regards to the trading of the same kWh bundle between the EV and the Third Parties (EVSP, DSO, DER Operator).

Innovation effort must be put in providing a doubling of battery capacity every 5 years in the next 15 years in order to properly monetize batteries for value added services such as smart charging. There has been reportedly discussed at OEM Forums of PlanGridEV projects that the automotive industry is already working in this direction and that double-density, 35-40 kWh batteries should be embedded in EVs available in the market in 2017-2018 timeframe, with the additional core benefits of providing 200 to 250 km range autonomy.

Value added services in the B2C relationship

Smart charging, with all variations discussed in the Catalogue of Products produced in Deliverable 2.1, could be a significant value added service provided by OEMs innovating the B2C relationship and widening it beyond the procurement of the equipment and its operation and maintenance services. This is somehow also related to the adoption of digital communication protocols, which allows plug & charge functionalities and customer identification and services access directly from the EV.

The adoption of smart charging in the OEM services portfolio could improve OEM business in terms of revenues diversification and customers redemption, however it requires innovation at the level of products marketing management, broader technical and business cooperation with utilities in the long term, particularly with regards to the possibility of OEMs behaving in the role of power flexibility aggregators at LV and MV level in order to support grid-oriented services or customer-oriented services, such as the energy optimization of EV fleets.

2.3.2. Innovation recommended for DSOs

Real time monitoring needs of O&M

At the source of all considered Load Management plans for the smart charging services there are grid optimization constraints. Within the limited scope of PlanGridEV demo, such constraints were derived from the usage of decentralized autonomous agents (such as in the case of Germany test bed run by RWE) or by the means of general distribution management systems at LV level. The penetration of this instruments at LV level is still limited and typically subject of R&D project. However, without a full exploitation of these systems at scale level there could be no sensing of operational needs of the electricity grids as it is, even without taking into account a deeper LV monitoring and control by means of distributed sensors and IoT approach. Without a real time sensing of operational needs and IT based systems (decentralized or not) dedicated to this, no concrete Load Management plan could be cross checked against the real operational constraints of the system operator.

Load Forecasting algorithms

Moving beyond the monitoring of operational needs, the adoption of load forecasting algorithms should enable DSOs to promote the usage of active demand products, where flexibility services are requested through Load Management plans, such as the services envisioned in Deliverable D 2.1. Such algorithms must be using data coming from a wide set of sources, including distributed energy resources operators, charging point operators and EVSPs.

LV Monitoring & Control

Low Voltage Monitoring and Control by means of IT systems focused on sensing O&M needs as well as a diverse set of new sensors installed at LV level is a key technology to be rolled out in order provide DSOs with the capabilities of defining meaningful active demand products based on smart charging and Load Management through EVs and reacting at LV system level in case of need to integrate the execution of active demand product.

Active demand market & products

Once the enabling IT systems and LV sensors are in place to provide DSO with the capability of performing operational duties by means of supporting third parties as flexibility aggregators, DSO must equip themselves with skills and competences in order to design active demand products offered at B2B level in the marketplace. In same specific regulatory framework, DSOs might be requested even to operate such a marketplace, which involves the deployment and operation of complex real time IT systems and competences close to those of trade exchange and energy wholesale market business operations.

2.3.3. Innovation recommended for Technology Providers

Digital Communication Protocols

As for the EV-EVSE communication, all technology providers including Charging Stations manufacturers, EVSP service smartphone application developers and systems component (modem manufacturers, chip makers, software designers) should exploit the capabilities of digital communication and include coherent business objects in their products development.

This could also be applied to the harmonization of EVSE-EVSE Back-end communication, which currently is implemented by means of different customized solutions and some of them might not comply with the capabilities of digital communication at EV-EVSE level, particularly with regards to the propagation of the smart charging-relevant information such as SOC, Time of Departure, Remaining Energy and some behavioural characteristics of EV, e.g. State Of Health of the battery.

Hardware Design-To-Cost

This is a general product optimization problem in relation to the scale effect of charging stations. Economic simulation run in this project typically required a CapEX of 500 € (ref. Deliverable 7.1) per charging stations in order to comply with the service requirements defined in Deliverable 2.1. This additional cost has an impact on the overall CapEX investment to enable smart charging techniques and might be mitigated by hardware design-to-cost effort of technology providers to drop the unit cost of the charging stations and the additional equipment needed for smart charging. This topic would have a huge side benefit in easing the deployment of charging stations and facilitate the technology adoption by granting a higher rate of access to a wider distributed charging station network, where smart charging services might be deployed in order to provide support to grid operational needs.

2.3.4. Innovation recommended for EVSPs and DER Operators

Real time data of plants operation for aggregators

Similarly to increased effort from DSO in LV monitoring at the source of Load Management plans to be applied to cluster of charging stations, also DER Operators would need to interface information from operational needs with third parties. In order to provide information to aggregators, DER Operators should at first promote the operation of data platform where each power plant is monitored and relevant information is aggregated and channelled to nearby energy management systems (in the case of Planned Demand Response for Fleets), DSOs (in case of Planned Demand Response for grid optimization) or directly to Charging Stations Operators (in case of Planned Demand Response for RES integration, e.g. service station area with fast charging stations and PV / Wind plant).

Active demand markets & products

Similarly to DSOs, also DER Operators must equip themselves with the capability of designing active demand products and managing them within a secondary balancing marketplace, where they could leverage their own assets for providing ancillary services to the DSO or supporting the integration of the power produced by their plants in controllable loads such as those represented by EVs.

2.4. An agenda for EV-Smart Grids integration

All innovation recommendations provided in Paragraph 2.3 have been grouped into the following chart, summarizing the overall innovation roadmap recommended by PlanGridEV to the whole electric mobility ecosystem in order to unlock the potential of EV-Smart Grids integration.

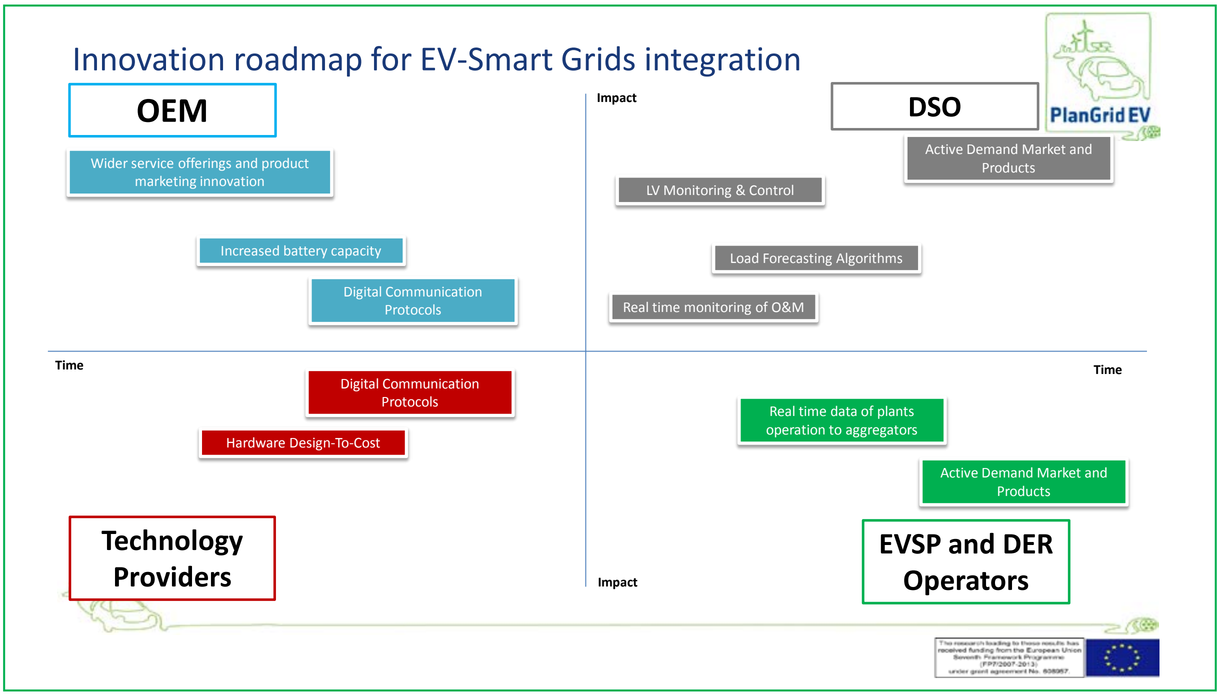

Figure 6 Innovation roadmap for EV-Smart Grids integration

3. Recommendations to regulatory bodies and policy makers

3.1. Smart charging as key technology for EVs mass adoption

Smart charging market won't reasonably happen by itself and without a supporting regulatory framework as well as supporting policies. This is somehow a consequence of being smart charging still a value added services on top of electric mobility market, which is currently at niche level in Europe and still far from 2020 targets (4 million of EVs in Europe) that were considered at the beginning of the design process of the Alternative Fuels Infrastructure Directive EU 94/2014.

However, smart charging is a powerful tool to facilitate EV mass market uptake for several reasons.

- It enables an extended customer experience, integrating transport and energy management needs into one service, particularly in the case of small medium enterprises (ref. Deliverable 2.1 and Deliverable 5.3)
- It provides DSOs with a significant alternative to copper-only based CapEX investments, promoting the evolution of DSO role towards system platform optimizer and simultaneously lowering the EV technology adoption's cost at system level, by maximizing the investments efficiency in other topics which are relevant for EVs mass market uptake, rather than conventional and BAU grid investments (ref. Deliverable 7.1)
- It provides OEMs with the possibility of enriching their B2C relationships as well as monetizing the assets beyond the sale of the equipment, by leveraging the battery in order to provide flexibility service to the DSOs
- It supports DSOs within its duty of DER integrator, establishing a value chain by which smart charging services might be traded to sustain DSOs needs avoiding curtailment penalties
- It has a positive impact on TCO for the EV driver, as he/she benefits from flexibility trading in terms of service fees, thus having an impact on the OpEX components of EV TCOs.
- It provides EVSP with a possible new source of revenue, enriching their services portfolio and strengthening their B2C relationship, serving as a potential bridge to nearby markets such as energy retail.
- It stimulates the development of an entire new software industry at the meeting point of energy, transport and operation and maintenance industries, promoting the adoption of optimization algorithms running at local level, in systems such as home or building energy managers, or centralized platforms, in systems such as EVSE Operation Back end, DSO distribution management systems, DER plants SCADA.

This chapter provides therefore an overview of the possible regulatory framework by which smart charging services might be adopted at mass level in Europe, understanding smart charging as a means of reducing the EV technology adoption cost at system level. EV adoption is currently lagging behind the expectations in Europe, accounting for less than 0.5% of new sales, with some degrees of deviation amongst Member States. For example, although Italy is the 4th market in terms of ICE vehicles sales in the first 9 months of 2015, it is clearly lagging behind in terms of EVs adoption as it is only the 7th market within EU market (reference Figure 7). Therefore there is a general technology adoption problem, which produces a 255x average downgrade in volume of EV market compared to ICE market (accounting for new sales only) but also specific lags in some Member States which might widen and cause a technological divide, similarly to previous technology adoption in the recent past (e.g. broadband). Such a technology divide, which in the case of Italy produces an unrealistic uptake to the expected EVs mass market goals of 2020 (reference Figure 8), has technology adoption's cost as one of the major hurdle to be overcome, together with range anxiety due to limited battery capacity and availability of EV Charging infrastructure.

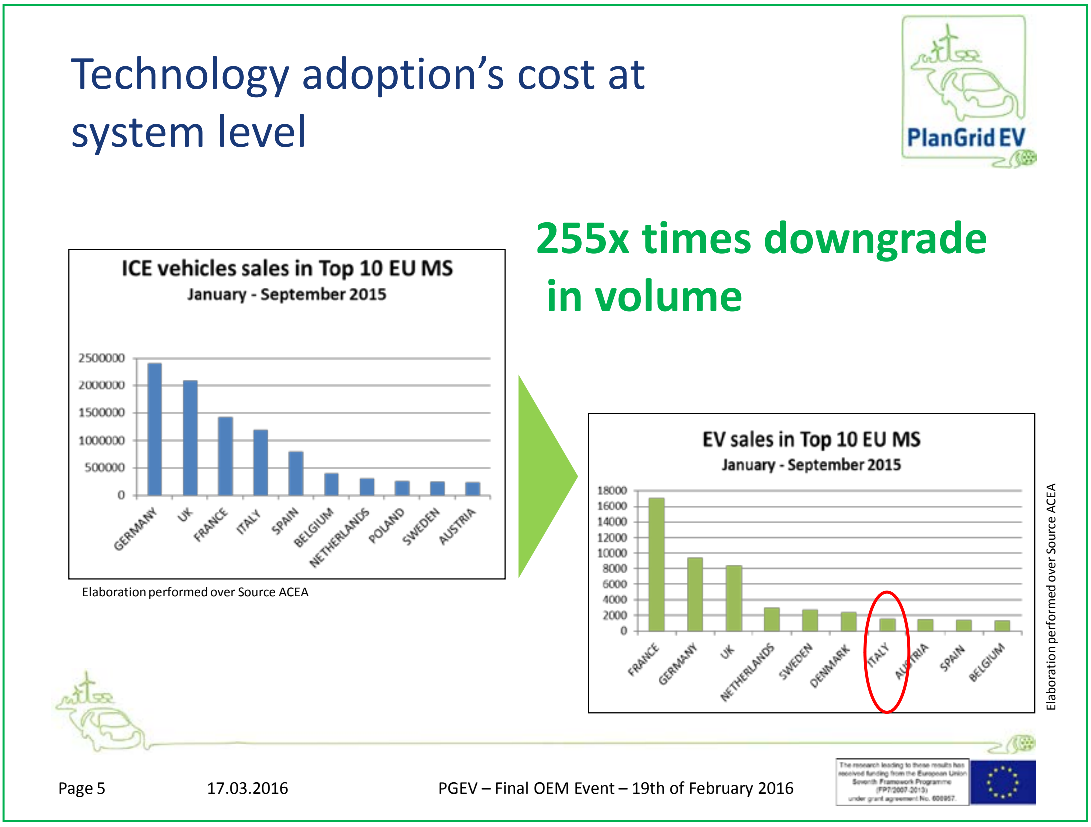

Figure 7 EVs market in 2015 and technology adoption cost

The breakdown of technology adoption cost has not been investigated throughout this project, however Deliverable 7.1 provided with the raw figure of 1 B€ per million of EVs for the electricity system, with an uncertainty of 20% depending on the specific Member State. Such a figure seems to be clearly dominating the technology adoption cost in comparison to the change in after sales industries from ICE to EV sales, deployment of slow public charging stations or other source of technology adoption cost that might have an impact for the whole national economy, without taking into account the private or corporate equity investments in this business.

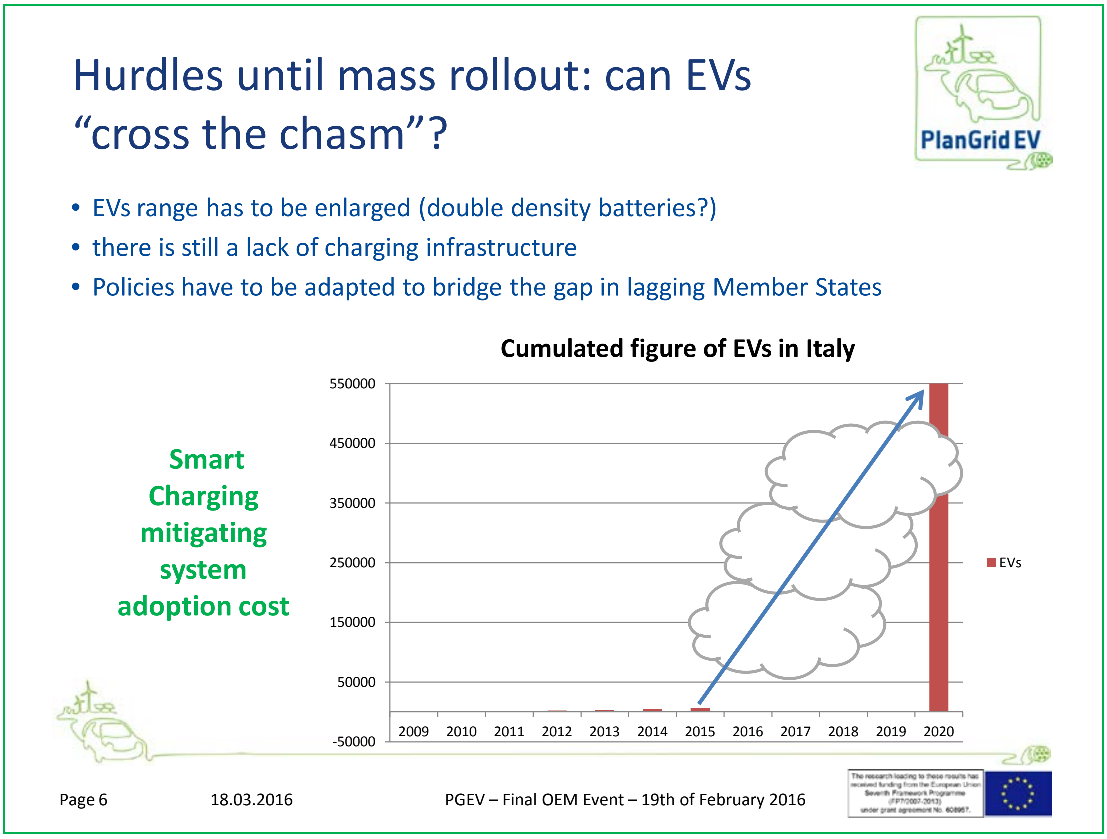

Figure 8 Impact of technology adoption's cost: the case of Italy

The results of simulations (both top-down and bottom-up) run within the Project have demonstrated that the deployment of smart charging services might significantly reduce the CapEX needed by DSO in order to cope with EVs uptake.

A subset of this CapEX investments being saved from grid reinforcements might be routed by the DSO as well as by other players in deploying the enabling IT innovation (as specified in Chapter 2 of this document), opening up an entire new market of active demand services based on e-mobility.

Therefore at the core of the value proposition of smart charging there is the fact that it improves the rate of EV adoption by minimizing the need of grid reinforcements and reducing the system cost for the EV technology integration in national markets by supporting LV grid management in a smarter way, rather than simply expanding grid hosting capacity by copper-based investments. Electric mobility is a promising instrument of de-carbonizing transport industry, and smart charging could be the "killer application" that typically emerges as a winner-take-all feature of new technologies.

Furthermore, being EVs controllable loads, they could be used through smart charging in order to maximize DERs integration at LV and MV level, as demonstrated through the Planned Demand Response: RES integration service throughout the Project. In this sense, enabling smart charging from a regulatory perspective as well as from policies perspective might be a key tool for simultaneously de-carbonizing transport and energy industries in the transition of Europe towards electric mobility.

Finally, the smart charging products constitutes active demand offerings where the flexibility harvested from the final EV user is typically monetized by the EV user himself, which is typically expected to lose degrees of freedom in exchange of services fee savings. This has a direct impact on lowering the TCO of the EV user, for example cutting the energy bills of charging the EV.

The positive feedback loop established by smart charging is summarized in Figure 9.

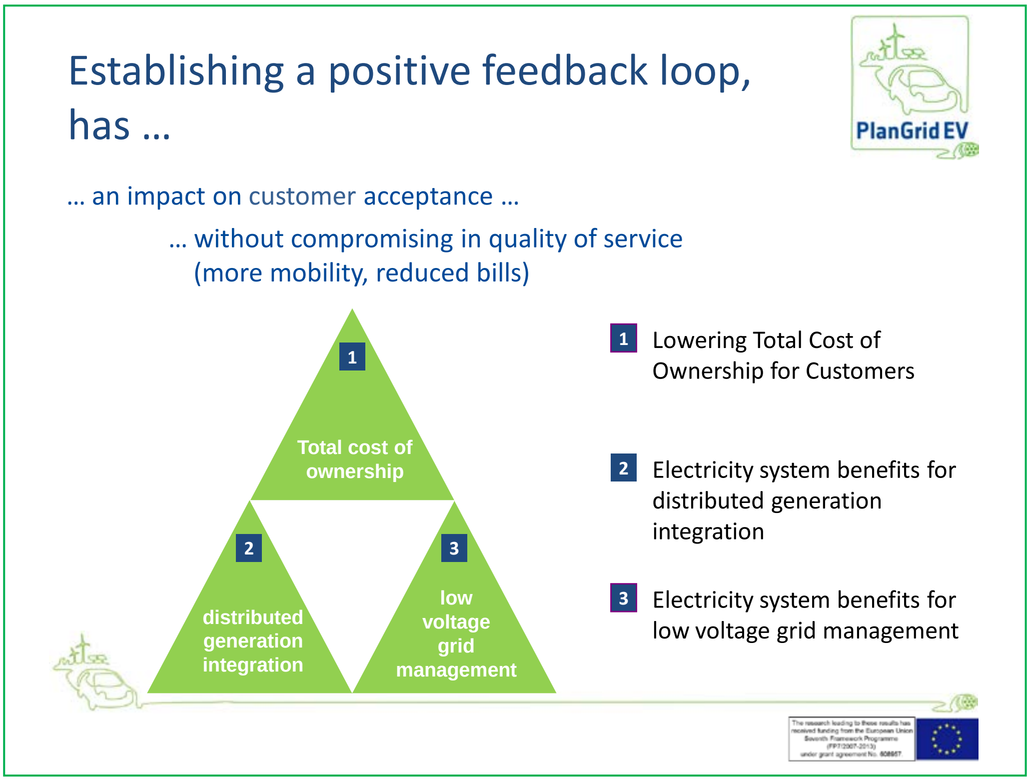

Figure 9 Positive feedback loop established through smart charging

Despite the benefits of EV technology integration in the electricity grid, such an integration has not become yet a market reality and severeal innovations must be executed for making smart charging market happen in Europe. One of the main reasons which is holding the TRL of smart charging still far from higher values is that the investments needs with regards to a proper re-charging infrastructure, the development of specific services offered to final customers and dedicated IT systems in operation for the execution of smart charging services. This perspective might be changed and the full potential of smart charging might be unlocked within a supporting combination of regulatory frameworks and policies.

In order to promote the deployment of smart charging a possible regulatory framework has been proposed in PlanGridEV, which is reported on Figure 10. At the core of this framework there is a concept that DSO might issue smart charging product requests to supporting parties (e.g. OEMs or EVSPs, with the aim of minimizing CapEX investments for sustaining EVs uptake. However, as this operational behavior would reduce the Regulated Asset Base of the DSO and prevent the DSO itself to promote similar services, such product requests might be co-incentivized by other players or supported by the national regulatory in a way that the overall financial performances of the DSO are stable, but the operations and the investments of the DSO are focused on higher-value and less cost-intensive instruments, in accordance with a general transition from copper-based investments to ICT-based investments. The regulatory support to the release of active demand products based on smart charging could unlock the reduction of customer's TCO as well as the DERs integration, which are the other key transactions of the regulatory structure reported with the green arrows of Figure 10.

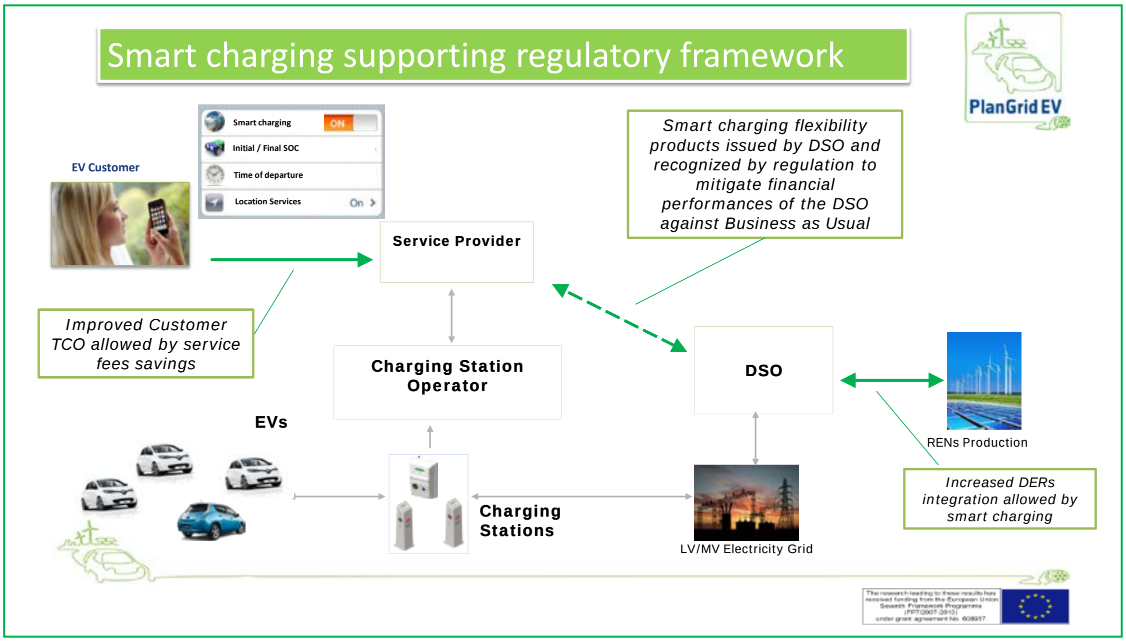

Figure 10 Smart charging supporting regulatory framework

3.2. EU-wide feedback over the proposed framework

A significant level of positive feedback was gathered through the execution of the project regarding the enabling role of the DSO proposed in the design of smart charging services as well as its proactive behaviour of using smart charging to minimize CapEX due to conventional grid reinforcements.

From one side, the project co-operated with Eurelectric association of EU utilities in the release of "Smart charging – Steering The Charge, Driving the Change" position paper[1], where the financial outlook of a smart charging market in EU was investigated and the project regulatory framework was considered as key instrument of enabling such a market. Furthermore, the analysis run in the preparation of the Eurelectric position paper led to results substantially in tune with the CBA performed in Deliverable 7.1, as shown in Figure 11 with regards to the calculated global reduction of peak load in Europe in case of a complete penetration of smart charging within residential areas by 2050.

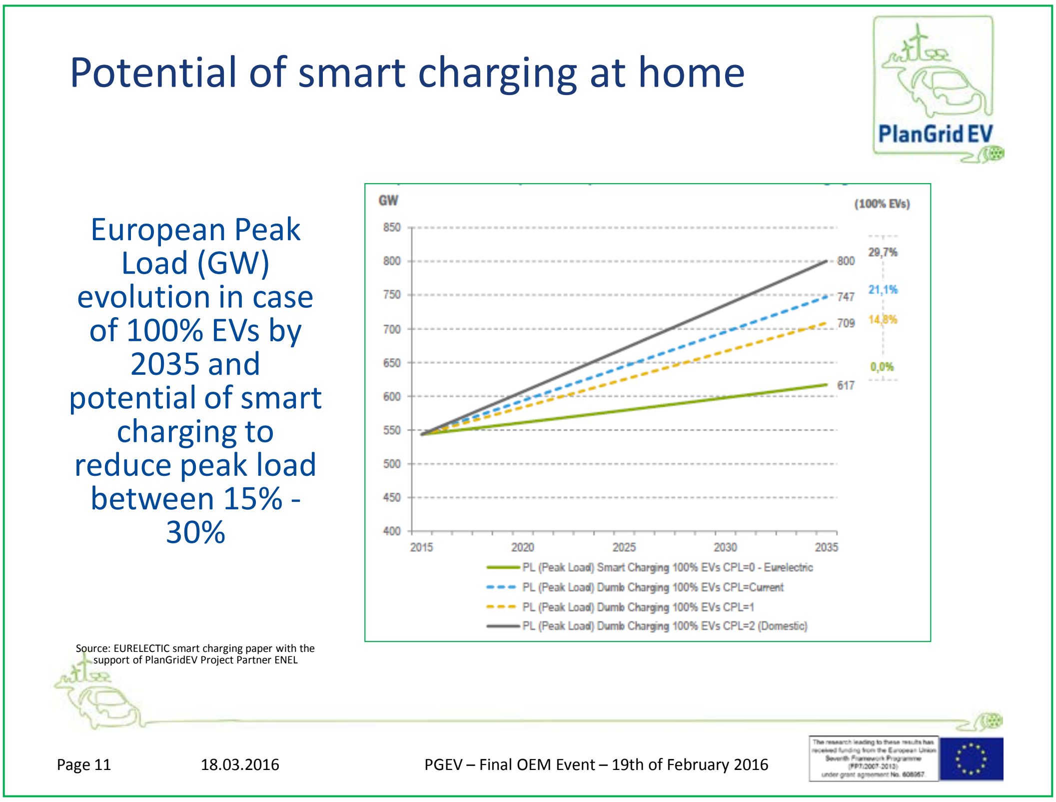

Figure 11 Potential of smart charging at home
(ref. Eurelectric, 2015, with support of PlanGridEV partners

[1] Available at www.eurelectric.org

Additionally, a consensus questionnaire was circulated amongst project partners, OEM forum and industry-relevant stakeholders, gathering independent replies regarding the proposed role of the DSO and the regulatory mechanisms by which smart charging might be enabled.

The questionnaire circulated is reported hereby, including an aggregation of the feedback received on the main sub-questions and allowed a significant cross-check, even within the limited scope of the R&D activity, the consensus and the momentum which is building around the smart charging concept.

1) Current simulations run from EU DSOs, with the support of the contribution from PlanGridEV project members, show that EVs uptake in Europe from today until the end of the TTM period will be more and more a matter of power peaks management rather than total energy capacity increase[1]. This means that even a full EV-based automotive market in Europe would raise by a manageable 25% to EU energy capacity demand, although the impact in terms of power allocation during the day might imply CAPEX figures from DSOs which in turn might have an impact as "EV technology adoption fee" for the DSO customers. Are you aware of these simulations and their impact on the electricity system policies for EVs uptake in the near future? What's your position with regards to this issue: do you also believe there is an inherent risk that the electricity system might need unsustainable upgrading cost in order to cope with increasing EVs demand?

2) A pragmatic definition of smart charging is: any control technique applied to electric vehicle charging process that might result in modulating and/or scheduling an EV charging process, as a result of tradeoff between optimization conditions such as availability of decentralized renewable power plants, customer preferences, grid congestion management issues, time of use tariffs.
   Do you recognize this set of techniques as useful for future integration of EVs into electricity grid? Have you been involved in trials / research and development projects with this regard? Do you plan any involvement in the Time To Market period.

3) Within the PlanGridEV project two paths have been followed with regards to the management of EVs uptake in electricity grids: an analysis over new possible operational methods from DSO perspective, as a way to react to EVs uptake, which include also smart charging, and a long-term conventional planning according to a BAU approach as well as a combination of BAU and the former innovative operational methods.
   Both paths lead to innovation required in terms of regulatory framework and policies making. Are you aware of any incentivized trials where operational methods and long-term planning approaches are being considered in order to properly manage EVs uptake? Would you see as welcomed the involvement of your institution into such a trial?

4) As part of the results out of PlanGridEV project, the most promising scenario that fits into a long-term sustainable management of EVs had been the so-called “Smart Grids integration of EVs” , based on which a set of smart charging – based possible products had been selected in the project and field – tested. Amongst these future products, with an expected TTM of 5 years, the most promising one are as follows:

   - Planned Demand Response for RENs integration, with regards to the possibility of controlling EVs charging processes taking into account customer preferences as well as the availability of local renewable power plants, in order to leverage EVs (both public and private charging) as a means of performing integration of RENs

   - Load Management for EVs fleets, with regards to the possibility of controlling and scheduling EVs charging processes belonging to a closed domain (e.g. corporate and public administration fleets) by maximizing the return on the investment of other assets, such as PVs and electricity storage, having a positive impact over the fleet’s running OPEX and TCO

   Although different in application and business model, both products aim at the same goal of enabling EVs mass market even through a smooth integration into electricity grids, turning their inherent power peak risks into an opportunity. Which one of the former do you see as the most urgent one within the context of your actions as institution involved in electricity system regulation and policy making?

5) The above mentioned products, which could be offered by competing Service Providers bidding in a secondary balancing market (in case of service “Planned Demand Response..”) or acting as virtual utilities (in case of service “Load management for EV fleets”) do require investments executed by actors involved in electric mobility value chain, especially Charging Point Operators, DSOs and Service Providers. Such investment are typically a fraction of the cost of the charging stations, but might burden the financials of the e-mobility players at the beginning, thus resulting in further delays in the deployment of smart charging techniques, causing an even higher investment on electricity grids if the BAU approach keep being pursued. This is mainly due to the fact that a minimum amount of EVs must be aggregated in order to extract value from modulating and/or scheduling their charging processes, thus kick starting the return on the additional investment performed on smart charging enabling technology. Do you see incentives specifically for smart charging techniques to be included in innovative charging assets might be adopted or promoted, with regards to the future deployment of charging stations and their rollout, e.g. delivering recommendations at national level to comply with Alternative Fuels Infrastructure directive as well as enabling smart charging? What might be an expected role of your institution to promote supporting funding action on smart charging until TTM ends?

6) The general business model of smart charging based products is as such that typically the DSO is the service buyer, whereas an aggregator (CPO or EVSP) is controlling the customer relationship and unlocking value for the end customer by aggregating its time flexibility and turning into power flexibility at the service of DSOs needs of grid balancing, renewable integration, or both.

   With this regard, and thinking of smart charging as one of the services of a low voltage and medium voltage active demand market in Europe, similarly to what is being experimented in other countries, the DSOs might be involved as responsible party for deploying the enabling technology, including, not limited to, the charging stations, until the tipping point of EVs sales that justify private equity investments at a sustainable rate of return into charging stations. This could be understood as a way to minimize the risk of uncontrolled CAPEX due to EVs uptake, whilst guaranteeing QOS and SAIDI also with regard s to electric mobility as additional grid service. Smart charging might be part of this approach as well, with the DSO performing the enabling investments to kick-start the market of aggregated power demand at LV and MV level. Do you see this a possible strategy to be studied within the domain of action of your institution?

The aggregated feedback received throughout the questionnaire is reported in the Figure 12 to Figure 17 and shows a general support of the proposed regulatory framework as well as a significant readiness level of the representatives of EU industry considered in the survey.

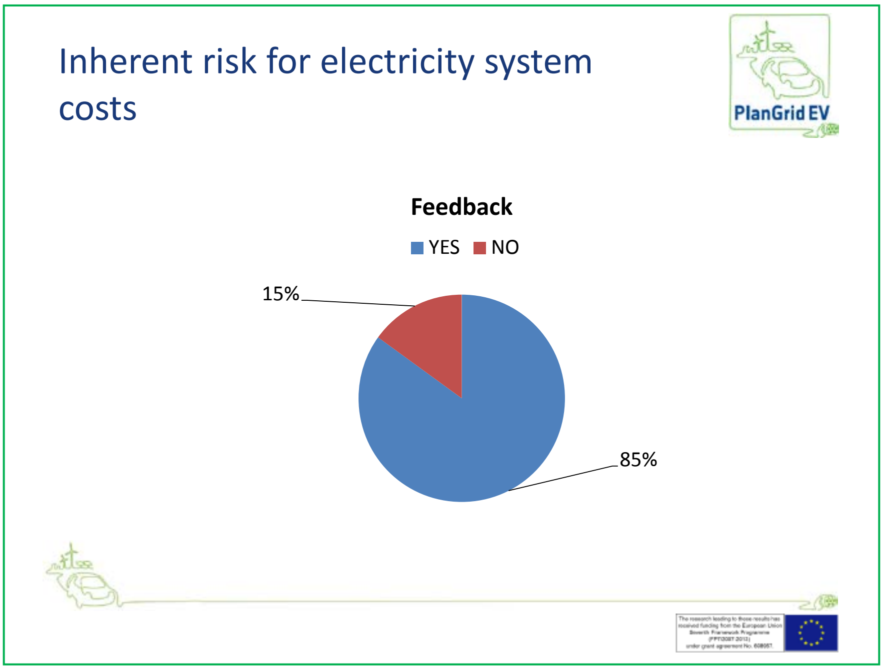

Figure 12 Feedback over inherent risk for electricity system costs

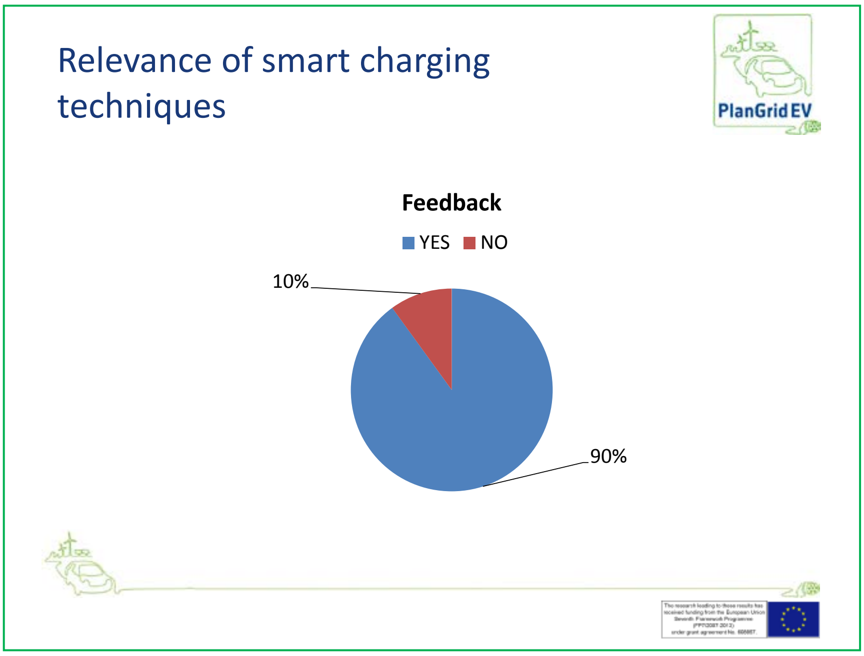

Figure 13 Feedback over relevance of smart charging techniques

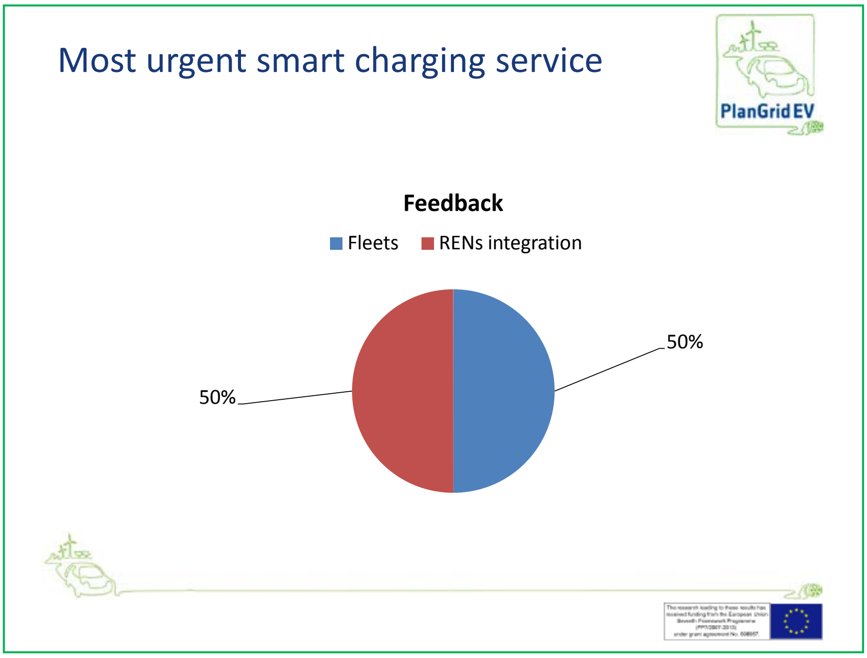

Figure 14 Feedback over most urgent smart charging service

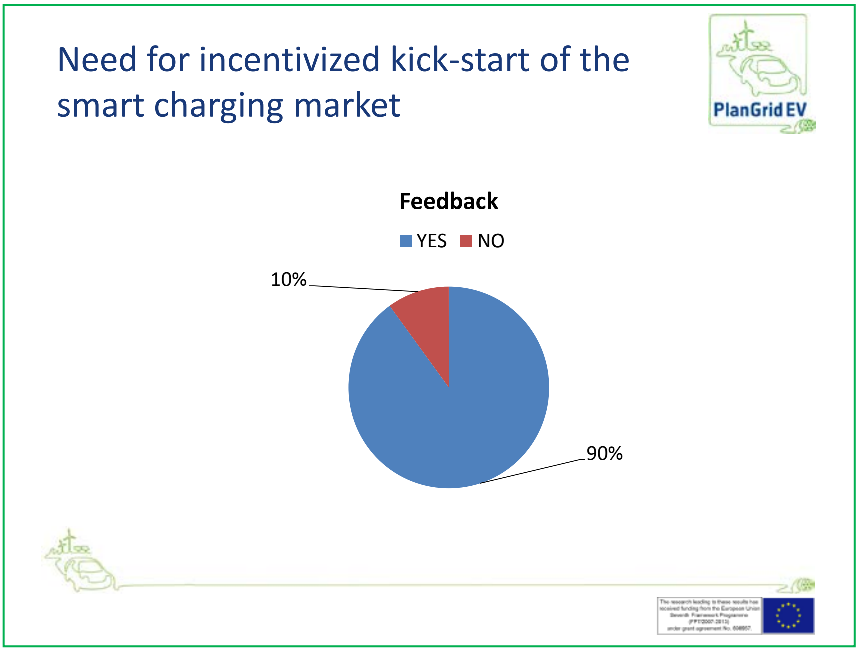

Figure 15 Feedback over incentivized kick-start of the smart charging market

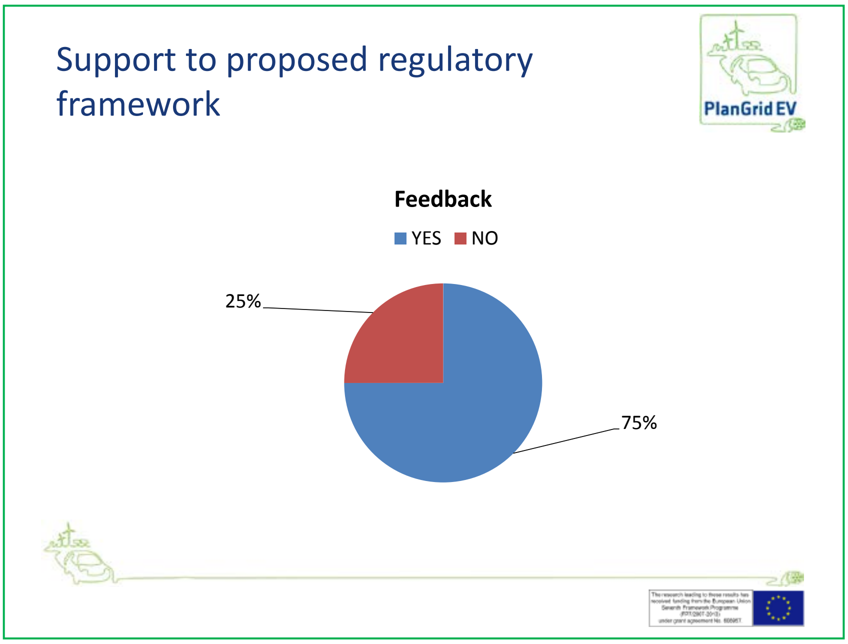

Figure 16 Feedback over support to proposed regulatory framework

3.3. Outlook over supporting policies and conclusions

This project demonstrated at various levels the technical viability of smart charging techniques as a possible tool offered through the capabilities of EVs and converged IT systems to the DSOs in order to support them in grid operational needs as well as for integrating DERs.

With regards to the activities that have been conducted in the project, this document provided an overview of the needed innovation to be executed to bring the TRL of smart charging techniques at higher levels than what obtained through this project.

The main conclusions can be summarized as follows:

- Smart charging could be a key instrument in decarbonizing transport and electricity industry at the same time, by enabling an entire new market of customer services
- IT-based systems deployed for enabling smart charging services are a more sustainable alternative to conventional copper-based investments
- A precise innovation roadmap must be understood and executed in Europe across different industries (DSOs, OEMs, Technology Providers and EVSP/DER Operators) in order to increase the TRL of smart charging and bring it to a market reality

There is a strong consensus around the deployment of smart charging services in the future and industry-wide momentum is building, although the need of incentivized kick-start of active demand smart charging products market is generally foreseen

It is key to put those conclusions in the context of the current EU policies as follows.

The Strategic Energy Technologies Plan (SET-PLAN) provides a general framework to accelerate the development and deployment of cost-effective low carbon technologies, by which EU is on a good track to reach its 20-20-20 goals consisting in a a 20% reduction of CO2 emissions, a 20% share of energy from low-carbon energy sources and 20% reduction in the use of primary energy by improving energy efficiency by 2020[2]. Additionally, the recently launched 2030[3] Framework for climate and energy, the EU set new targets and policy objectives for the period between 2020 and 2030:

- a 40% cut in greenhouse gas emissions compared to 1990 levels
- at least a 27% share of renewable energy consumption
- at least 27% energy savings compared with the business-as-usual scenario

[2] https://setis.ec.europa.eu/about-setis/set-plan-governance
[3] http://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy

General low carbon technology is a fundamental enabler for all of these targets. The electrification of transport is an important driver to meet EU energy policy objectives and a key low carbon technology; however, integrating EVs in European market EV requires the availability of a widespread recharging infrastructure and the adaption of EU LV and MV networks to mobile, power-dens loads such as EVs. while taking into account all the impacts that it will have onto distribution grids.

This has been the driver also of the recently issued EU Directive 94/2014, which is delivering guidelines for the implementation of charging infrastructure in Europe as well as its smart – grids integration. By fostering the delivery of smart charging products such as the ones envisioned in the Catalogue of Products released in Deliverable 2.2, this Project is reasonably fitting the currently available policies for Europe as well as the impact of those policies for the future of decarbonized transport and electricity systems. Smart charging, however, requires a change in perspective in how conventional industry roles are understood for transport and electricity markets, as it represents a technology which is sitting at the intersection of both.

There is a building evidence on how electric mobility is changing the relationship between OEMs, Utilities and their customers. This implies, in several scenarios, combining of roles as well as OEMs getting more and more close to general technology companies and/or service providers, able to provide not only vehicles but also other enabling assets of their customer experience. This is particularly true in the case of EVs, and could lead to a significant widening of B2C portfolio of OEMs in the management of their customers relationship.

On the other hand, electricity utilities are increasingly under pressure to de-commoditize the customer relationship by pursuing a diversification of the services provisioned, including possibility to support them in the role of “energy prosumer”, at the intersection of conventional consumer and energy producer. Furthermore, energy efficiency and CO_2 policies are dramatically switching the utilities business from a volume-based mode lto a value-based model, where new mechanisms of value creation must be established within the electricity value chain, such as the ones that have been investigated in this project around the concept of smart charging.

Such a revolution in roles, together with the need of kick-start the smart charging market by a supporting regulatory framework, might imply the prospect of supporting policies to promote the change in perspective and the capability of leaving “comfort zones”, out of already established must increasingly inadequate business models. It is within such framework that also smart charging might be supported through the following list of focused policies adopted at the level of pan-EU policy making processes as well as national ones.

- Regulatory discussions should take into account the possibility of evaluating the role of DSOs in financing the establishment of an active demand services market as alternative means to electricity grid reinforcements. This might lead to the establishment of the proposed regulatory framework, where smart charging products issued by the DSO are recognized as more efficient, alternative means to the grid infrastructure without producing a negative impact on DSO financial performances.

- In accordance with the European Alternative Fuels Infrastructure Directive 94/2014, EV-Smart Grids integration might be promoted in the reference framework that will be issued by the Sustainable Transport Forum at EU level in support to the implementation of the Directive.

- AS for the implementation of EU Directive 94/2014 t the level of Member States, in cases of both public and private procurement for the deployment of charging stations, tendering processes which recognise the added value of smart charging in terms of tendering evaluation might be fostered.

- Similarly to the or public subsidised programmes which will be considered by Member States in order to support the kick-start of electric mobility markets that are currently lagging behind expectations, the EV-Smart Grids integration topic might be fostered as a mandatory parameter in deployment evaluations, particularly in the uptake of the mass market where the system adoption cost for the electricity system will reasonably be higher.

- SME instrument, Fast Track To Innovation and future H2020 calls with regards to the Energy and Transport work programmes might include smart charging as leading item to be considered at the level of calls definition as well as at the level of impact evaluation, for those calls who are not focused on de-carbonization of transport.

4. References

4.1. Project documents

Deliverable 2.1	EV-Grid integration business scenarios DOI: 10.13140/RG.2.1.2309.2966 (31. December 2013)
Deliverable 2.2	Technical requirements for tools/methods for smart grid integration of EVs, DOI: 10.13140/RG.2.1.4868.2720 (31. July 2014)
Deliverable 2.3	Economical requirements for tools/methods for smart grid integration of EVs, DOI: 10.13140/RG.2.1.3882.1609 (31 October 2014)
Deliverable 3.2	Specification of energy grid/ Functional and service architecture, DOI: 10.13140/RG.2.1.2574.5121 (24 July 2015)
Deliverable 5.3	Report on the impact of the validation and real testing, DOI: 10.13140/RG.2.1.5147.8165 (29 February 2016)
Deliverable 7.1	EV-Grid integration best scenario and its investment strategies DOI: 10.13140/RG.2.1.1000.3607 (29 February 2016)

4.2. External documents

Smart Charging: Steering the Charge, Driving the Change – Eurelectric Position Paper, 2015

5. Revisions

5.1. Track changes

Name	Date (dd.mm.jjjj)	Version	Changes	
			Subject of change	page
G. Coppola	18.03.2016	1	Final Version	
Armin Gaul	19.03.2016	1.1	Minor Changes	All
Daniel Feismann	21.03.2016	1.2	Complete References	45
Daniel Feismann	24.03.2016	1.3	Minor Changes	19
Armin Gaul	30.03.2016	1.3	Complete Document	All