Deliverable 7.8

Guidelines for standardization and interoperability

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List of Abbreviations

A	Ampere
AC	Alternating Current
ACEA	European Automobile Manufacturer's Association
ANSI	American National Standards Institute
ATEX	ATmosphères ed EXplosibles
CAN	Controller Area Network
CCS	Combined Charging System
CDR	Charge Data Records
CHAdeMO	CHArge de MOve
CMS	Charge Management System
D	Deliverable
DC	Direct Current
DER	Distributed Energy Resource
DKE	Deutsche Kommission Elektrotechnik
DoW	Description of Work (Annex I of Grant Agreement)
DR	Demo Region
DSO	Distribution System Operator
EC	European Commission
EMC	Electro Magnetic Compatibility
EMIOP	Electric Mobility Infrastructure Open Protocol
eMI3	eMobility ICT Interoperability Innovation
E-Mobility	Electro Mobility
ESF	External Stakeholder Forum
EU	European Union

EV	Electric Vehicle
EVCOID	Electric Vehicle COntract IDentification
EVSE	Electric Vehicle Supply Equipment
EVSEID	Electric Vehicle Supply Equipment IDentification
EVSP	Electric Vehicle Service Provider
FREVUE	Freight Electric Vehicles in Urban Europe
GeM	Green eMotion
Hz	hertz
ICT	Information and Communication Technology
ID	IDentification
IEC	International Electrotechnical Commission
IREC	Institut de Recerca en Energia de Catalunya
ISO	International Organization for Standardization
kVA	kilo Volt-Ampere
kW	kiloWatt
LEV	Light Electric Vehicle
LV	Low Voltage
NEDC	New European Driving Cycle
NEMA	National Electrical Manufacturers Association
NPE	National Platform for Electric Mobility - Germany
NWIP	New Work Item Proposal
OEM	Original Equipment Manufacturer
OCA	Open Charge Alliance
OCHP	Open Clearing House Protocol
OCPP	Open Charge Point Protocol
PA	Public Administration
PHEV	Plug-in Hybrid Electric Vehicle
PLC	Power Line Communication
PWM	Pulse Width Modulation
PV	PhotoVoltaic
RFID	Radio Frequency IDentification
SAE	Society of Automotive Engineers
SC	Subcommittee
SG	Smart Grid
SMS	Short Message Service
SORDS	Standardized On-Road Driving Schedule
T	Task
TC	Technical Committee
TSO	Transmission System Operator
UID	Unique permanent IDentification
US	United States
V	volt
VIN	Vehicle Identification Number
VHS	Video Home System
V2G	Vehicle to Grid
V2H	Vehicle to Home
V2O	Vehicle to Office
WG	Working Group
WP	Work Package
ZeEUS	Zero Emission Urban Bus System

1 Executive Summary

The Green eMotion (GeM) project, with 44 partners and 12 demo regions involved, represented in its four years of activity an incredibly rich environment to perform analyses, tests, development and proposals on practically all the e-mobility related aspects. Interoperability and standardization, in particular, covered a relevant part of the efforts, being considered as key aspects to boost a mass rollout of Electric Vehicles (EVs) in Europe.

The aim of this document is to present a short overview of the main activities carried out on this topic, both within the dedicated Work Package (WP) 7 “Harmonisation of technology and standards” and in other more technically-focused WPs. Then, to synthesize and present to a wide audience the main results, findings and suggestions that emerged from that working process.

More in detail, within GeM the following proposals related to standards have been developed:

- A new procedure to evaluate EVs range and consumption named SORDS (Standardized On-Road Driving Schedule);
- A new approach to use RFID cards, avoiding the use of serial numbers and using specific data in the card memory area;
- A standard focused on the management of charging stations, covering the communication between the Electric Vehicle Supply Equipment (EVSE) and the IT backend system(s).
- New standardized identifiers and business objects, in order to have a fixed and univocal identification of the key components for EV charging;
- A basic interface protocol for the communication between DSO backend and EVSE operator backend for Power Demand Management purposes.

In parallel with that, within WP7 an accurate Gap-Analysis process was carried out, starting from the study of the existing situation and then collecting issues and problems that have still to be tackled, according to the most relevant stakeholders in the field. Gaps and inconsistencies were pointed out in view of future interoperability and indication of the needs and route towards the necessary standardization activities was drawn.

The main results coming from these activities can be then divided in three big areas and summarized in three comprehensive recommendations, which are thoroughly described in the document.

1. **CONNECT THE ACTORS** – focus on communication interfaces.
2. **CREATE A COOPERATIVE ENVIRONMENT** – push regulation choices through wide agreement;
3. **START NOW WITH FUTURE-PROOF INFRASTRUCTURE** – guide “real-life” applications in order to fit future developments.

The first recommendation refers to the awareness that, according to GeM experience, an effective communication among the actors will represent a crucial aspect, but that the communication interfaces still remain quite an open issue. The lack of standards and relative choices came strongly out of the Gap Analysis process and should therefore be object of an intense work in the very next future. According to this, GeM is proposing a “Roadmap towards interoperability” focused on missing standards and, in particular, on communication interfaces. The Roadmap, presented in this document, considers 5 time steps (from 2015 to 2025) and 13 main targets distributed among them. The effort is to start ensuring an easy and “universal” charging to drivers, thanks to a definitive physical interoperability (plugs/sockets) and to concrete choices towards roaming features (identification, authorization, IT interfaces), and then work to progressively include e-mobility in the wider concepts of smart grids, through smart charging and reverse flow solutions.

The second recommendation expressed can be seen as the best “mean” to facilitate a quick and effective progress of the just mentioned standardization roadmap. The need for agreement in standardization and regulation phases is clear and it generates a strong demand to create a cooperative environment. This way, it would be easier to rapidly identify issues, solve them with the best technical solution and agree on their common application. In the document, five hints to help enabling this process are reported.

The last aspect, articulated in the document as some dedicated “guidelines”, expresses the concern that new e-mobility initiatives start immediately setting up an up-to-date and “interoperable” infrastructure. Precise and well-focused indications for Public Administrations and Municipalities willing to install a charging infrastructure are provided, with a particular attention to standards and ICT features.

After four years of Green eMotion activity, it can be stated that e-mobility today is a dynamic and fluid environment, where relevant changes happened and will happen quickly. According to the acquired experience, a correct combination of the three just described aspects would give a powerful stimulus to standardization and, as a consequence, to the e-mobility market.

Please notice that in order to comply at best with the aim of this document, which is to provide some effective “guidelines” towards interoperability, the report and its three macro-areas are thought and written with a specific attention for the “target group” they refer to. Despite of the fact that reading the whole document will obviously give the best overview on the topic, it can be said that different kind of readers could find more focused information in different sections of the Deliverable.

In particular, if you are associated to a:

- **Standardization body**: please refer particularly to section 5 and 6.
- **Policy Maker**: please refer particularly to section 6.
- **Municipality/Public Administration**: please refer particularly to section 7.
- **Manufacturer** (both car and charging station): please refer particularly to section 5 and 6.
- **IT Provider**: please refer particularly to section 5.
- **Utility**: please refer particularly to section 5 and 6.
- **Service Provider / Electric Vehicle Supply Equipment Operator**: please refer particularly to section 5 and 7.

2 Introduction

Four years ago, as the Green eMotion (GeM) Project started, e-mobility was just something more than a sprout. Very few car models were available on the market mainly due to retrofit solutions and to some "first-mover" car manufacturers. In parallel, a low number of charging stations was installed in European cities, with high predominance of low-power technology.

Today, after less than a lustrum, the situation has radically changed. Nowadays a large number of car manufacturers include a "zero emissions", pure electric model, or, at least, a Plug-In Hybrid model in their catalogue. The number of electric vehicles (EVs) sold in Europe is constantly increasing and, even if with remarkable differences among the countries, the market share is reaching some units, with an impressive 15% peak in Norway. The charging infrastructure development is going hand in hand with this evolution with an increasing trend towards high-power and fast charging technologies.

But this doesn't mean that all the problems are solved, far from it. Despite the considerable developments, e-mobility is still struggling against its typical hurdles, i.e. costs and functionality. Although first effects of large scale production, technology improvements and economic competition are contributing to some cost/price-reduction, electric vehicles are still very expensive if compared with homologous fuel-based vehicles. In addition to that, functionality intended as allowed range and charging ease-of-use and availability are still unsatisfactory for many potential users. The combination of these two aspects represents both a significant barrier for a real mass-market deployment and, at the same time, a stimulating challenge for research, industrial and political activity.

It is interesting to notice that solving some issues immediately creates new ones. The best example of this phenomenon is the fact that allowing longer ranges to EVs, their domain becomes less and less local, introducing new requirements for interoperability and roaming. Interoperability is indeed becoming a relevant issue, closely related to standardization. The Green eMotion project has worked deeply on these aspects, dealt in many Work Packages (WPs) and in particular in Work Package 7 "Harmonisation of technology and standards".

More in detail, the focus of WP7 activity, developed through several studies, surveys, workshops and deliverables, has been the identification of open issues in standards for the e-mobility field, considering interoperability as the main objective to achieve. Comparing existing standards and regulation with present and near-future requirements, some relevant gaps have been identified and discussed. Debate and discussions, both inside and outside the working group, have led to a compilation of an out-and-out "Gap Matrix", which includes also the level of criticality of each identified gap.

The Gap Matrix, built on the basis of a careful process, represents a powerful and useful tool to clarify the open points and, above all, to sketch-up an action plan for standardization activity in the next years. Besides, the experience gained during the building process and the continuous interaction with many different stakeholders let WP7 partners to obtain a quite complete overview on interoperability and standardization issues, from technical aspects, to policy, to "everyday-life" questions.

The aim of this document is to synthesize and present to a wide audience the main results, findings and suggestions that emerged from the last four years of work, firmly believing that these could represent useful sparks for the e-mobility roll-out.

3 Main contents and reading guide

The work carried out within Work Package 7 depicted quite clearly the situation on e-mobility standardization activities and pointed out many interesting aspects. The undeniable power of Green eMotion is the participation in the project of a high variety of actors, including practically all the stakeholders of the sector, and this allowed WP7 to obtain many different points of view, generating a quite complete picture.

The direct outputs from the Gap Analysis itself, but also the experience gained through the intense interaction with experts, led to identify some key aspects, which can be translated as recommendations and suggestions for different actors. A summary of the standardization-related activity carried out within WP7 and the whole GeM project has been reported in section 4.

The main results coming from these activities can then be divided in three big areas and summarized in three comprehensive recommendations, which will be thoroughly described in sections 5, 6 and 7:

1. **CONNECT THE ACTORS** – focus on communication interfaces. The Green eMotion standardization Roadmap.

2. **CREATE A COOPERATIVE ENVIRONMENT** – push regulation choices through wide agreement;

3. **START NOW WITH FUTURE-PROOF INFRASTRUCTURE** – guide “real-life” applications in order to fit future developments.

The first recommendation refers to the awareness that, according to GeM experience, communication among the actors involved will represent a crucial aspect.

An effective connection among actors will indeed lead to:

- Seamless charging experience for users;
- Complete control of the charging event in order to optimize the process → smart grid/smart cities/V2G/V2H vision.
- Possibility to provide additional services.

These three points, combined with technological improvements in EVs components, will be the key to ensure a massive roll-out of e-mobility.

To achieve this goal is not trivial, as for “effective connection” is intended both a “physical” connection between the car and the charging station, and the ICT-based connection among all the other actors involved. In both cases there is the need for standardized solutions and for common choices/regulations. Interoperability becomes a central topic and while the physical plug/socket aspects are becoming less problematic, the communication interfaces still remain quite an open issue. The lack of standards and relative choices came strongly out from the Gap Analysis process and should therefore be object of an intense job in the very next future. According to this, GeM is proposing a “Roadmap towards interoperability” focused on missing standards and, in particular, on communication interfaces.

The second recommendation tries to address the fact that in many cases the main problem is not to define new standards, but to choose one from multiple standardized versions (more regulation than

standardization). Thanks to active debate with many stakeholders, including the European Commission (EC), it has been possible to identify which actors should be involved and which process could lead to effective choices and to regulation decisions. The best situation to enhance interoperability will be to have only one common solution, but this needs:

- Coordination among different research/industrial activities to point out the best technical solutions;
- Creation of working groups/alliances/partnerships among industries;
- Wide agreement on one solution by industries and stakeholders;
- Policy intervention through regulatory means (EC Directive or other).

The need for cooperation is evident, since there is no single entity that is able or can be appointed to solve the set of existing gaps. This cooperation can be searched in user groups, industry parties, different sets of actors and stakeholders or groups making choices on standards since in some areas multiple solutions are available. Having more coordination and some kind of centralized control, both inside the EC and inside the industrial world, would represent a really important achievement.

The third recommendation, at last, has the aim to stress the importance of starting immediately to deploy a “smart and interoperable” infrastructure. Many Municipalities are now starting to install charging stations but there is the real risk that “old” systems are put in place. It is really important that also small initiatives are seen as a part of a much more complex and integrated “system”. In a few years probably EVs will often cross borders and the infrastructure developed since now on has to be able to charge them. The infrastructure has to permit identification and access through “up-to-date” methods (there are still systems accessible by physical keys). Charging stations have to be connected to some kind of marketplace and they have to allow roaming.

3.1 Document guide: what do I have to read?

The activity carried out inside Work Package 7 covers many topics and many points of view on the same topic. Standardization and regulation have to deal with extremely technical aspects, but at the same time with economics, management, marketing, politics, urban planning and others.

According to that, the involved stakeholders are numerous and heterogeneous. In order to comply at best with the aim of this document, which is to provide some effective “guidelines” towards interoperability, the report and its three macro-areas are thought and written with a specific attention for the “target group” they refer to.

Despite of the fact that reading the whole document will give the best overview on the topic, it can be said that different kind of readers could find more focused information in different sections of the Deliverable.

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Please notice that the **driver**, the final user of the whole complex system, is the most relevant and central actor but at the same time quite a “passive” actor with respect to interoperability and standardization aspects. The driver is the one expressing the needs and defining the minima requirements, but his direct intervention in the process to comply with them is limited.

Please notice, again, that the objective was to develop a concise and easy-to-read document, and it has therefore considered preferable not to include detailed descriptions of each standard or of standardization bodies and procedures. To access to more detailed information it is recommended to follow the Reference documents and webpages included in the final Section of this Deliverable.

4 Green eMotion efforts in standardization

According to the Green eMotion view, one of the key aspects that could boost a mass rollout of Electric Vehicles is the development of harmonized standards at European and International level. This way, several benefits can be obtained, both for the final user, which could drive and adopt the same behavior in different countries, for manufacturers, which could enter into the market with less risks and optimizing costs, and for all the stakeholders that could count on a sure and well-defined technology (e.g. public administrations that want to deploy a charging infrastructure).

Within the Green eMotion project, Work Package 7 is the one devoted exactly to standards harmonization, with the aim to identify which issues have still to be solved and how standardization activity should proceed in the next years. In parallel, also other Work Packages are involved in standardization-related activities, covering different technical aspects and in some cases also developing concrete proposals to standardization bodies.

In this chapter, a very short overview of GeM activity on standards will be provided, with the aim to allow for a better understanding of the following sections and of the related guidelines.

4.1 The Gap Analysis process in Work Package 7

According to GeM Description of Work (DoW), the objectives of this work package were to address the problem of standardization of key elements to allow the interoperability of EVs across Europe, with special reference to interfaces (power and signals). Gaps and inconsistencies had to be pointed out in view of future interoperability and indication of the needs and route towards the necessary standardization activities had to be drawn.

A Gap-Analysis process has therefore been carried out, starting from the study of the existing situation and then collecting issues and problems that have still to be tackled, according to the most relevant stakeholders in the field.

According to this general aim, the first step was to collect and analyse all the existing standards related to electro-mobility. This work, performed mainly by Cidaut, has led to the construction of a wide table which has represented a reference point for the following work and has been reported in Deliverable 7.1 “Review of technologies and standards in the demonstration projects” [1].

To elaborate it, different sources of information have been used:

- GeM partners;
- Main standardization bodies today existing and working on this topic;
- International Committees and Groups active in the field;
- Real implementations in approximately 20 on-going demo projects;
- “on the market” products by the main Charging Point suppliers.

The total number of identified standards, divided in four technology areas (vehicle, charging infrastructure, connection to the grid, communication), has been of 237. This number increases to 689 if the single parts composing a “series”, e.g. IEC 61851-1, 61851-21, 61851-22 are considered separately. The most active part in this landscape appeared to be the IEC (International Electro-Technical Commission) and the charging point emerged as the most addressed component. The vehicle itself is

considered in a high number of standards too, while a significantly lower number of standards refer to the communication.

After this first part of the work, it has been considered useful to observe more in detail which is the real situation in the Green eMotion Demo Regions, in order to give a more practical approach to this topic. Green eMotion can indeed count on a high number of electric vehicles and charging points, distributed on the 10 Demonstration Regions (DR). To be more precise, at the end of this first 21 months of the project, there were **1731 charging points** installed, **528 vehicles** and **924 users** registered in the data collection process.

From this analysis (performed mainly by IREC), focusing mainly on the charging points, it has been possible to highlight the following characteristics:

- The 56% of the charging points are located at the street.
- The most installed charging mode is Mode 3 (see IEC 61851) with the 86% of the charging points.
- The most common communication protocol between the charging point and the electric vehicle is IEC 61851 (79% of the monitored elements).

Both the collection of existing standards and the analysis of the situation in the Demo Regions, were preparatory to perform a detailed analysis of the criticalities still present in this landscape and of the issues that should be addressed to achieve the sufficient level of interoperability that will boost the EV market. To do that, several means have then been used, in order to cover a wide spectrum of actors and to try to gather all the most relevant aspects. More in particular:

- Two surveys have been prepared and sent to selected actors;
- Three standardization workshops have been held;
- Relevant Green eMotion partners have been directly interviewed.

The surveys were circulated in 2011 and 2012 among the WP7 partners, Demonstration Regions (through the Site Operation Manager IREC) and few External Stakeholders. The first one addressed directly the four technological areas used in the already mentioned table of standard (electric vehicle, charging point, connection to the grid, communication), but also gave the respondents the possibility to propose more generally a list of the most important topics in the standardization field.

The second survey was instead prepared with the objective to gain more insight and details on four other specific technological areas:

- AC and DC Charging;
- Identification;
- Communication;
- Smart charging.

For more detailed information on the result of the surveys please refer to “Deliverable 7.2 – 2nd version Standardization issues and needs for standardization and interoperability” [2].

The three standardization workshops (both internal and external) were organized in 2012. Involving many different actors, the workshops had a quite wide approach and they addressed a lot of different aspects in e-mobility.

Considering that Green eMotion can take advantage of a large number and variety of involved partners, as well as of the coexistence of many WPs dealing with different technical aspects, it has then been straightforward to ask for direct contributions from relevant representatives of the other GeM technical WPs. In this case, the direct and less formal interaction has let the respondents point out the main standardization issues that came out from the practical activity in their WP. More in particular, contributions from the following WPs have been collected:

- WP3 “Electro mobility services / ICT solutions”
- WP4 “Grid EV-olution”
- WP5 “Recharging Infrastructures”
- WP6 “Demonstration of Electric Vehicle Technology – validation and contribution to standardisation”

This process, reported in detail in Deliverable 7.3 “Current status of technologies and standards in the demonstration projects” [3], let to the collection of many needs, and their comparison with the existing situation let the identification of approximately 30 gaps. In order to give a synthetic view of these gaps the main issues are included on a comprehensive table, which has been called “Gap Matrix” and which had to let the identification of the most important open points by indicating their level of criticality.

The matrix is simple, easy-to-read and coherent with the structure of the whole WP, so its main structure is based on just five rows, one for each technology area (electric vehicle, charging point, connection to grid, communication) plus one extra for other eventual issues, and on four columns, reporting the needs, the existing standards, the gaps and the level of criticality. The complete matrix can be found in the file “Standardization Gap Matrix_WP7” (http://www.greenemotion-project.eu/dissemination/deliverables-standards.php).

After finalization of this task, it was considered necessary to involve the standardization experts again. Considering that the results of a Gap Analysis could represent a really powerful mean to schedule a roadmap and to manage the standardization process in the next future, their presentation to external experts, and the subsequent debate, was indeed fundamental to obtain a more common and more precise view. In order to do that, one dedicated Workshop was organized, which was thoroughly described in Deliverable 7.5 “Standardization Workshop for finalization of alignment in the demonstration projects” [4]. During the workshop, many feedbacks were received from the partners: the presented gaps were thoroughly commented and then rated to the need for action and also thanks to the active participation of the European Commission it has been discussed which actors and which processes could lead to effective choices and to regulation decisions.

The results of this Gap Analysis process are the fundamental base on which the Roadmap presented in Section 5 is build up and presents the opinion of the most relevant stakeholders in the field. To provide a short overview of the gaps and of one of the methods used to collect feedback, in Annex A, the list of gaps is reported (rated through a simple colour-based technique).

4.2 Direct contributions and proposals for standardization activities

As mentioned previously, Green eMotion has not only the task to identify gaps in standardization but also to actively work on possible needed standards. This duty is mainly carried out by technical Work Packages, which cover most of the key aspects of e-mobility, from the vehicle itself to communication interfaces. During the last 4 years, in this way, several proposals were developed, which are now under

discussion among relevant stakeholders and standardization groups. A summary of these proposals is reported in the next sections.

Before entering into details, it is worth remembering here that the development of new standards on ICT aspects represents a core part in GeM activity and is covered in WP3. Part of this work was devoted to the foundation of the eMI3 group (eMobility ICT Interoperability Innovation Group) together with other industry partners. The aim was to broaden the agreement level on those consortium standards and to ensure the continuation of activities after Green eMotion project end; the success of eMI3 group in involving new partners and in working tightly on standards development represents a first relevant achievement of GeM project [5].

4.2.1 SORDS: Standardized on road driving schedule

Green eMotion Work Package 6, "Demonstration of EV Technology – validation and contribution to Standardization", represents the part of the Project which is mainly focused into the vehicle. Among other activities, the WP6 team worked on the design of a new test cycle to characterize EVs energy behavior [6][7].

The internationally accepted standard for testing EV range and consumption is ISO 8714:2002 "Electric road vehicles -- Reference energy consumption and range -- Test procedures for passenger cars and light commercial vehicles". The current version of the standard was released on 2002 and reviewed in 2014. ISO 8714 basically uses the same driving cycles as the legislative type approval schemes in each region (Japan, Europe and USA). This means for Europe, that NEDC (New European Driving Cycle) is to be used. According to WP6 expertise, NEDC does not yield results representative the expectations of European drivers. Moreover, WP6 pointed out that there is no official test cycle to be used on the road for passenger vehicles, (the commonly used ones can only be performed on a test bench due to their velocity complexity).

Due to these reasons, a new procedure named SORDS (Standardized On-Road Driving Schedule) was designed, inspired by on road tests for city buses. The SORDS represents a fairly dynamic drive pattern, which results in an accelerated depletion of the traction battery. The rather simple speed profile is shown in Figure 4-1.

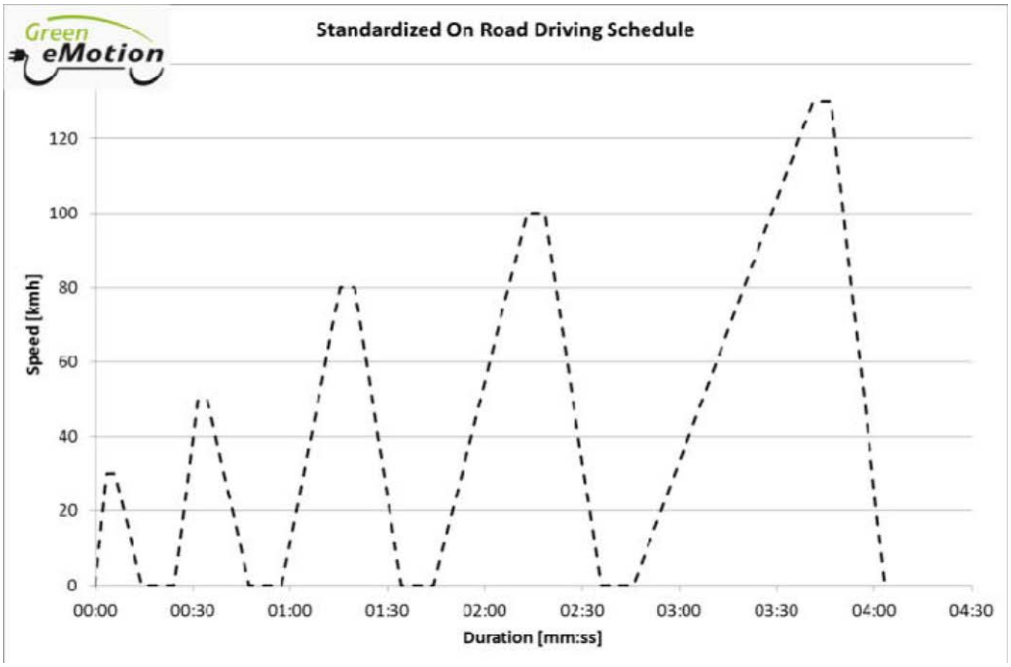

Figure 4-1 Speed profile of the standardized on road driving schedule

The first part of the schedule consists of start-stop sequences, representing swift urban driving, whereas the last part is a highly demanding highway stint at speeds up to 130 km/h ending up with a firm deceleration, putting especially high stress on the regenerative braking system.

In connection with the 2014 review of ISO 8714, the WP6 team did make contact with the international committee in charge (ISO/TC22/SC21/WG2 Definitions and methods of measurement of vehicle performance and of energy consumption), sending a proposal via the Danish Standards Institute. The proposal is now passing through different discussion stages, which next step will be in March 2015.

4.2.2 Interchangeable RFID cards for identification/authentication in roaming scenarios

RFID cards have been in use for several years as a simple, cheap, and convenient method for identifying users or user's contracts e.g. in public transport. Cards and readers are widely available and cheap and users are used to work with contactless cards from their daily life. Consequently a lot of different energy suppliers, municipalities and other companies, acting as EV service providers, started to hand out RFID-based customer cards for the use at the charging stations operated by themselves. The serial number of the RFID card was (and often still is) used as an identifier.

This works well as long as the drivers stay within their energy provider boundaries and the whole system, handling the customer contracts and in the same time the EVSE operation, is in one hand. In the case the two roles are independent, meaning the EVSE operating system is different from that one handling the customer contracts, the EVSE operating system would have to check with all potential partners for a valid customer contract.

In 2012, GeM partner Better Place proposed a solution of this problem. The proposal described an approach away from using the serial number of an RFID – the so called UID – but to have specific data in the memory area of the RFID card. Any RFID reader following this approach would be able to find out whether a RFID card used at an EVSE is suitable for the charging process in general. Security issues have been considered in the proposal.

The document was handed to the IEC in the form of a new work item proposal (NWIP) and members of the IEC agreed in fall 2012 to pursue the standardization of this topic, choosing the name "User identification in Electric vehicle Service Equipment using a smartcard" – IEC 62831 [8].

Since that date, the proposal have been progressively enhanced, first with the lead of Better Place and then (after bankruptcy) of the German DKE. Several Green eMotion partners have joined the work there to continue the Green eMotion effort. At present, there is ongoing work inside DKE, including also the analysis of an enhanced version presented by NEMA (US based standardization body).

More details are presented in Green eMotion Deliverable 3.10 "Standards and protocols specification 2", chapter 3 [11].

4.2.3 Communication interface between the charging hardware (EVSE) and the control software (backend system)

During the Gap Analysis process in the Green eMotion project it has become clear that a lot of partners were complaining about general incompatibilities in the communication procedures among EVSE and its backend systems. An effective communication is mandatory if an operator of EVSE's, which will in general only have one control system, wants to connect chargers from different manufacturers that might require different communication protocols.

WP7 partners decided to elaborate a new work item proposal (NWIP) for standardization bodies on communication messages, focused on the content of this interface and not on the specific protocol to be used. In particular, it was decided to identify the information and the specific requirements needed to ensure interoperability, and later write them down in a proposal form to be addressed to the IEC.

The NWIP passed through different stages, also thanks to the direct involvement of the eMI3 group, which worked to provide a "use cases and requirements" document and to add perform studies on protocols. At the end of 2014, the NWIP proposal took a more defined shape, with the so-called **Electric Mobility Infrastructure Open Protocol** [9].

This standard should focus on the management of chargers, covering the communication between the EVSE and the IT backend system(s). This should allow:

- Management of EVSE, including controlling, monitoring, the maintenance, provisioning, firmware update, and configuration (profiles) of EVSE and associated backend system;
- Authentication/authorisation/payment of charging sessions, incl. roaming, pricing and metering information;
- Management of charge session, incl. interface for Human Machine Interface, reporting;
- Information exchange, e.g. required energy, grid usage, contractual data, metering data;
- Associated added-value services.

The different requirements for security, privacy and other safety associated issues shall be an inherent part of the specifications.

Additional information is presented in chapter 3 and 5 of Green eMotion Deliverable 3.10 “Standards and protocols specification 2” [11].

4.2.4 Standardized identifiers and business objects

From GeM experience it was obvious that for an efficient inter-organizational interoperability (Roaming between EVSP/EVSE and countries, third party access,…) a fixed and univocal identification of the key components is fundamental. To have standardized identifiers and business objects can so be considered one of the most urgent topics for standardization identified in the project and there is on-going work both within WP3 “Electro mobility services / ICT solutions” and inside the eMI3 group.

The charging and discharging of Electric Vehicles (EVs) at an Electric Vehicle Supply Equipment (EVSE) within an existing contract requires a set of identifiers that are guaranteed to be unique beyond organizational and country borders. In particular, the unique identification of the following entities is required:

- Electric Vehicle Service Provider (EVSP)
- Electric Vehicle Operator (EVSE)
- Electric Vehicle Contract (EVCOID) (eMI3 calls it EMA ID)
- Electric Vehicle Supply Equipment ID (EVSEID)
- Vehicle Identification Number (VIN)

The identifiers should be persistent during the life of the identified entity. The identifiers should be used to support the processes for the clearing house services and defined basic and value end-user services. Clearinghouse service will use the identifiers for the following process-steps:

1. Validation of customer (Identification (Authentication), Authorization)
2. Routing of charge data (CDR) between roaming partners (EVSP / EVSE)

Within eMI3 an agreement on standardized contract identifiers (EVCOID) and EVSE identifiers (EVSEID) is already being reached. The results are part of ISO/IEC standard 15118 and also documented in Green eMotion report D3.9 “Standards and protocols specifications” and D3.10 “Standards and protocols specification 2” [10][11].

4.2.5 Power Demand Management

With the emerging of green energy coming from photovoltaic (PV), water, wind, etc there is a need to manage the power demand by EVs based on the availability of those energy sources. The grid must always be balanced meaning energy production and energy consumption must be leveled. For environmental reasons it is most preferable to use as much green energy as possible. Due to the fact that the production of the green energy changes based on e.g. weather conditions, the energy provider tries to balance this factor by influencing the power demand in the grid.

Leveling the grid can be done in different ways. On one hand the energy provider tries to balance the mix of fossil and green energy according to energy demand forecasts. On the other hand he tries to inform the energy consumers (e.g. EVSE-operators) to increase or decrease the energy consumption (e.g. charging EVs) to cover for short term variation.

To facilitate this process a standardized protocol for communication between the grid control by DSOs/TSOs on one hand and the EVSE-operators on the other hand is needed. Green eMotion developed a demonstration example for power demand management (e.g. for load management purpose or smart charging) realized and shown in Malaga.
A basic interface protocol for the communication between DSO backend and EVSE operator backend (CMS Charging Management System) has been described, and will be available for future references in report D.8.2 “Tests reports regarding the usability of each prototype” [12].

5 CONNECT THE ACTORS – focus on communication interfaces. The Green eMotion standardization Roadmap

The importance of standards both in every day-life and in economic activities is well known. With regards to e-mobility, according to the Green eMotion view the development and harmonization of standards is an essential issue for the mass rollout of Electric Vehicles and Plug-in Hybrid Electric Vehicles (PHEVs) across the EU. Standards increase the economic efficiency of the sector and increase the usability of the vehicles and of the charging infrastructure. They would allow EV users to adopt the same interfaces internationally for the connection of the vehicle to the charging infrastructure and, for example, to address the payment of the charging in an immediate and easy way, similar as the roaming for their mobile phone.

Following this view, it is quite understandable why a Work Package has been completely devoted to standardization and why its final remarks and suggestion are considered a fundamental output of the work.

More in particular, due to the strong connection between standardization and market development, it is considered fundamental to plan standardization activities in the next years, in order to fulfill at best the increasing requirements coming from real-use.

In this section, a standardization roadmap coming from WP7 results and experience will be proposed and described.

5.1 Standardization Roadmaps: what is out

As mentioned, there is quite common awareness of the importance of planning standardization activity, also if in some cases this doesn't represent an easy task. As e-mobility represents a new and growing sector, it is gathering attention also by this point of view, and some standardization roadmaps have already been developed in the last years.

In particular, two documents have been produced in May 2013, which have represented an interesting starting point for the present part of work:

- "Standardization Roadmap for Electric vehicles", Version 2.0 – May 2013, by American National Standards Institute (ANSI) [13]
- "The German Standardization Roadmap for electromobility", Version 2.0 – May 2013, by the Nationale Plattform Elecktromobilitä (NPE) (an updated version 3.0 has been released only in German in December 2014) [14].

The first roadmap is a quite dense document developed by the American National Standards Institute. It reports the results of a Gap Analysis process which includes 58 "Issues" and 44 "Recommendations". The content is divided under three broad domains:

- Vehicles;
- Infrastructure;
- Support services.

Within these three domains, seven broad topical areas of relevance to standards for electric vehicles were identified:

- Energy storage systems;
- Vehicle components;
- Vehicle-user interface;
- Charging systems;
- Communications;
- Installation;
- Education and training.

Thirty of the 44 recommendations were identified as near-term priorities, 13 as mid-term and 1 as long term.

The second roadmap, however, is a lighter document developed by Working Group 4 of the German "National Platform for Electromobility", in which several high-ranking politicians, and representatives of commerce and industry are involved. Many stakeholders are represented, as well as German technical associations.
The work conducted by the NPE showed that the fields of greatest relevance are system integration into the overall vehicle, the energy supply grid, safety and security, reliability, availability and interoperability. Due to the need to integrate electric vehicles into the energy supply grid, issues concerning distributed energy generation, energy storage and data management also play an important role.
Some cross-sectoral topics have moreover been identified and used to structure the 33 recommendations:

- Electrical safety;
- Electromagnetic Compatibility (EMC);
- External Interfaces and communications;
- Functional safety;
- IT security and data privacy;
- Performance and consumption characteristics;
- Accidents;
- Recommendations for the research landscape.

5.2 Green eMotion Standardization Roadmap: why?

Both roadmaps described above give an interesting and embraceable view of open points for standardization activity. Nevertheless, some peculiarities of the Green eMotion project and of WP7 work makes it worthwhile to develop a new specific Standardization Roadmap, which could have much added value.

The strengths of the Project and of this document can thus be summarized:

- **European point of view**: the above described roadmaps present only a partial vision of the standardization environment, being focused specifically on US and German realities. A roadmap specifically devoted to the European situation was still missing. Green eMotion, as the biggest European project on e-mobility, is the ideal actor to pursue this issue.

- **Inputs from all the stakeholders**: Green eMotion can count on the involvement of 44 partners, covering the whole spectrum of possible stakeholders in the e-mobility field (from car manufacturers to Municipalities).

- **Direct experience in the demo regions**: Green e Motion can count on 10 Demonstration Regions, actual test beds to study and analyse the effectiveness of standards and technical solutions. Highlight of the demonstration activity has been the "Green eMotion electric Rally", during which 5 teams coming from different countries in Europe reached Brussels on September 18th 2014, charging under Roaming conditions in many different European charging infrastructures.

- **High level of expertise and direct participation in standardization bodies**: many partners participating in Green eMotion have a deep knowledge on standards and are also directly involved in standardization bodies or working groups.

- **Direct contact and feedback from the European Commission**: being a European Project, Green eMotion is constantly in direct contact with members of the European Commission, a key actor for standardization/regulation activity in Europe.

- **Four-year experience dealing with standards on e-mobility**: WP7 started analysing standards and standardization activities in early 2011 and carefully followed the developments (including market developments) till 2015. This gave a good understanding of processes dynamic and trends.

- **Founders and partners of the eMI3 group**: the "eMobility ICT Interoperability Innovation Group" is one of the most active actors in the field of e-mobility standards. Green eMotion has been a founding member of eMI3 and GeM partners are deeply involved in it. This lets GeM to enlarge the group of relevant contacts and, besides, to have a permanent observatory on the latest standardization issues.

5.3 Global aim: roadmap to what?

The first action in order to develop a Roadmap has been the identification of the goal to reach. GeM is working to enhance e-mobility through implementing interoperability and roaming, so to offer easy charging to the user and an effective control of charging to grid/service operators.

According to that, the optimal scenario which will be the objective of the standardization process foresees:

- **Physical interoperability**: the possibility to physically connect every vehicle to every charging stations, thanks to a proper choice of standardized sockets and plugs.
- **Universal access and payment through roaming**: the possibility to start the charging process and pay for it in all the charging stations in a simple and immediate way. The Roaming approach contemplates charging to any provider under one single contract.
- **Smart Grid integration**
    - **Demand Response**: the control of the charging procedure is performed by applying price signal to energy and/or power (e.g. tariff on hourly basis). This control is "open loop" type and provides the possibility for demand response in the same way as for other loads

connected to the grid: the user may take the information into account or decide to ignore them.

- **Smart Charging**: the charging is controlled by price and technical signals in relation to various constraints such as overload risk, lack of balance between production and consumption, or coordination between loads to avoid peak demand exceeding the capacity of a network. The EV customer is "contractually" agreed (in specific clauses of the contract) in participating to the congestion of the network.
- **Vehicle to Home**: the car connected to a bi-directional home charger is managed to alleviate consumption of power in peak periods, help in maximizing the use of privately produced renewable energy and provide backup power supply during major power black-outs.
- **Vehicle to Grid:** the vehicle is considered as a power storage system that can be used by the network operator to increase power reliability and the amount of renewable energy available to the grid during peak power usage. V2G could provide regulation services, replace spinning reserves, or replace peak generation units.

- **Integration with secondary actors** for future additional services (e.g. parking providers).

It is important to notice that the focus of this future scenario and of this roadmap is mainly concentrated on passenger cars, as they represent a crucial part of personal mobility in Europe. Other transport means which will probably experience a progressive "electrification", like public transport vehicles or freight transport vehicles, are analysed in complementary European Projects such as the Freight Electric Vehicles in Urban Europe (FREVUE) [15] and the Zero Emission Urban Bus System (ZeEUS) [16] Projects.

5.4 What's missing? Gap Analysis

After defining the optimal scenario, a comparison between the "existing" and "desired" situation became necessary, in order to quantify the needed actions and to define the priority order to reach the desired target. Open issues to address and solve were so investigated and identified through a dedicated gap analysis.

Many efforts have been spent in this process, trying to identify the most critical issues and possible solutions, leveraging the technical expertise of GeM partners and the learning possibilities offered by the presence of the GeM demonstration projects in the Demo Regions (DR).

The work has been carried out during the last years using different means, as already described in Section 4.1. The results of the Gap Analysis process are the fundamental base on which the present Roadmap is built on. It tries to express at best the opinion of the most relevant stakeholders in the field.

To summarize the main outcomes of the whole process, it can be stated that a substantial distinction between "physical" standards and "communication" related standards came out. With regards to the first group, some technical aspects nowadays really need a better technical definition through standards. It's the case of:

- Battery Safety after crash;
- Cables;
- Electro Magnetic Compatibility;

- DC metering.

The aspect of connectors and charging modes, which was very much debated in the last years, seems to have become less relevant thanks to the intervention of the 2014/94/EU Directive and the identification of Type 2, Mode 3 as common standard for public charging. At the same time, the work on an improved definition in Mode 3 standard (the “New Mode 3”), will probably cover many open points and will introduce precise conformance tests.

For DC charging, the coexistence of two standards, CHAdeMO and Combo 2, seems to be unavoidable at least in a first medium-term period, and it will be tackled through the deployment of multistandard fast chargers.

That said, the analysis showed that physical issues and issues regarding the vehicle can be considered less relevant (in Green eMotion view), as they only slightly affect interoperability. The generic trend highlighted indeed that the physical standards need much less attention than the communication interfaces between the different actors and elements in the system.

To guarantee an effective and standardized information flow among the different actors involved, will actually represent a key aspect to provide high-quality services to the users and a rational and cost-effective use of the electric grid. Despite that, the field is still extremely open and there is the need for many efforts to obtain common solutions in reasonable time.

“Connect the actors: focus on communication interfaces”. This, the main outcome of the process.

5.5 Roadmap towards interoperability

Taking into account the need for urgent decisions but also the complex procedure to obtain common and globally adopted standards, the optimal scenario described in section 5.3 could reasonably be reached in 10 years from now, proceeding through different steps.

5.5.1 Reference architecture and involved actors

Before entering into detail, it is useful to recall the reference architecture adopted by the Green eMotion project and represented through the Building Blocks in Figure 5-1.

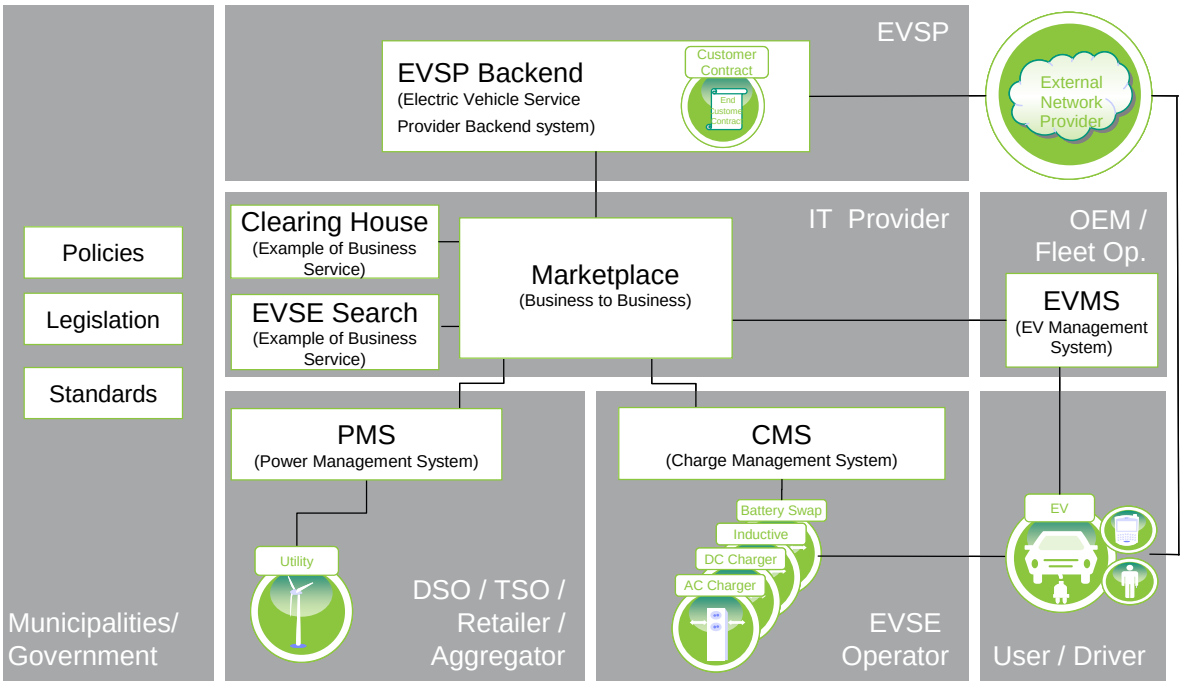

Figure 5-1 Green eMotion Building Blocks, evidencing roles and interactions

The main actors involved and their interactions are depicted:

- User/Driver;
- Original Equipment Manufacturer (OEM)/ Fleet Operator;
- Electric Vehicle Supply Equipment (EVSE) Operator;
- Information Technology (IT) Provider;
- Distribution System Operator/Transmission System Operator/Retailer/Aggregator;
- Electric Vehicle Service Provider (EVSP);
- Municipalities/Government.

Key part in the GeM vision is the IT infrastructure, which includes many IT services (e.g. Clearing House and Search EVSE) managed by a central Marketplace providing core services (e.g. service creation, delivery and monitoring). This architecture is indeed considered the most rational solution to allow an effective communication limiting direct bilateral contracts among operators.

5.5.2 Relevant standards and protocols

In order to let the reader get a better understanding of the next Roadmap sections, a summary Table of the most relevant standards and protocols for e-mobility is reported here. Information about the technological area covered by the standard/protocol is also included. For a more complete description of e-mobility standards and protocols please refer to Deliverable 7.1 and Deliverable 7.2 [1] [2].

Table 5-1 List of basic standards and protocols for (and used in) e-mobility

Standards and Protocols	Related to	Electric Vehicle	Charging Point	Connection to Grid	Communication
IEC 61851	Conductive Charging	X	X		
IEC 62196	Connector and charging	X	X		
ISO 15118	V2G interface	X	X	X	X
J1772	Connector	X	X	X	
IEC 60364	Protection		X	X	
CHAdeMO	EV charging	X	X		X
IEC 14443	RFID		X		X
IEC 61850	Substation automation			X	X
IEC 61000	EMC		X	X	
OCPP	Open Charging Point Protocol				X
HomePlug Green PHY	Home Area Network		X		X
UL2251	Safety	X			
ISO 16750	Environmental	X			
J2931	PLC				X
IEC 62056	Meter reading				X
UMTS (3G)	Mobile Communication				X
GSM	Mobile Communication				X
EN 55011	Radio disturbance		X		
IEC 60529	Protection		X		
EN 62262	Mechanical protection		X		
IEC 61980	Inductive Charging		X		
RS-485	Multipoint systems				X

5.5.3 Roadmap first step: 2015

The starting point of the roadmap is fixed at 2015, naturally coincident with the end of this phase of study and analysis. But it is interesting to notice that this same date can somehow represent also a first step and a first arrival point, if the situation is compared with 2011, year of Green eMotion kick-off. As already mentioned in the introduction of the document, the market experienced an interesting evolution and, in parallel, relevant results have been obtained also in standardization and regulation.

In particular, three key achievements of the last year have to be mentioned:

- **2014/94/EU Directive**: on October 22nd, 2014 the European Parliament and the Council of the European Union delivered a Directive on the deployment of alternative fuels infrastructure. The Directive covers different fuels, from synthetic fuels to hydrogen to electricity. About this last, the Directive specifies that Member States shall ensure within December 2020 an appropriate number of charging points. Besides, it clearly specifies some minimal technical requirements that charging point deployed after November 17th, 2017 have to comply with. Among these, for the first time clear indications on common Plugs are included: Type 2 “Mennekes” plug for normal power charging, Combined Charging System (CCS Combo 2) for high power DC charging [17].

- **IEC 61851-1 Ed. 3.0** under discussion (last phases): the third version of IEC 61851-1 “Electric vehicle conductive charging system - Part 1: General requirements” is passing through the last stages before its finalization. The contents of this third edition will address many issues and problems arisen during the first years of e-mobility experience in Europe. In particular, standardized conformance tests to assess the effective compliance of components will be defined, covering a gap many times expressed by both car and charging stations manufacturers [18].

- **On-going GeM IT Infrastructure:** starting from November 2013, when a first roaming session was demonstrated in Barcelona [19], the GeM IT infrsatructure has been activated and continuously improved. In September 2014, the Green eMotion Electric Rally proved the real and actual capabilities of the clearing house and marketplace system [20]. The presence and operation of this and other marketplaces for e-mobility demonstrate the willingness and the first step in developing appropriate standards on ICT aspects.

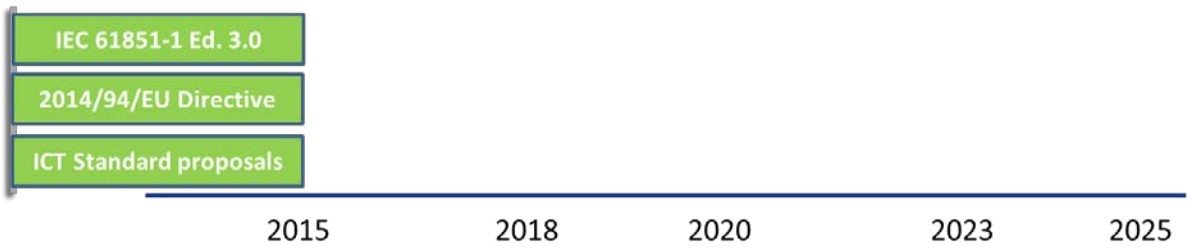

Figure 5-2 Roadmap first step time schedule

5.5.4 Roadmap second step: 2017-2018

The second step of the roadmap is fixed in 2-3 years from now. The target, and the expectation, is to solve the issues most affecting (and limiting) users behaviour today, in order to give an immediate stimulus for EV diffusion and market development.

AIM:

Physical interoperability and roaming scenario. It will be possible to:

- **Connec**t the car to every charging station in Europe;
- **Access** to the charging service in a unique and effective way;
- **Pay** the charging service through a contract which one single EVSP.

HOW TO?

The time available to achieve the target is quite limited, but the know-how and the already developed work are relevant. The problems are well known and some solutions are already available. It is recommended to work on the following aspects:

- **Plug/socket**: effective implementation of 2014/94/EU Directive [17] (deadline November 17th, 2017)
  - EN 62196-2 Type 2 “Mennekes” for AC normal power charging;
  - EN 62196-3 Combo 2 for DC high power charging;
  - CHAdeMO accepted in addition to Combo 2 for DC high power charging.

- Find industrial agreement on **EV-EVSE communication** and push for a decision by EC. Favour standards already in-place:
  - IEC 61851-1, Mode 3 (PWM communication) for AC charging;
  - IEC 61851-23, -24, PLC communication for DC Combo 2, CAN communication for DC CHAdeMO.

- Define some minima requirements for **identification**, to be adopted in all the EVSEs.
  - Agree on universal identifiers and business objects, following the work started in ISO/IEC 15118 and inside eMI3 [10][11].
  - Agree on a minimum solution for identification among the various existing standards. Favour standards already widespread (e.g. RFID cards);
  - Define an effective use of RFID internal memory (IEC 14443) by a new standard – start from the New Work Item Proposal (NWIP) developed by BetterPlace and now managed by DKE and within IEC Project Team 62831 [8];
  - Agree on the kind and minima requirements for RFID hardware (MIFARE Classic, Plus, DESfire….). Push for multi-standard RFID readers.
  - Follow the development of smartphone applications and of internet-based solutions which do not require physical readers.

- Define a real and agreed standard to guarantee **communication between EVSE and EVSE Operator backend** (guarantee that EVSE operators can communicate in the same way with EVSEs produced by different manufacturers)
    - Leverage experience gathered in existing working groups:
        - Open Charge Alliance → Open Charging Point Protocol, version 1.5 and version 2.0 [21]
        - eMI3/GeM → NWIP for "Electric Mobility Infrastructure Open Protocol" (EMIOP) [9]

- Define a common standard to guarantee **communication between EVSE Operator Backend and EVSP**

- Address the issue of **data security/privacy sensitive data/cyber-attacks.**

- Solve still pending **technical aspects** related to standards:
    - Identify a common standard for cables or harmonize national standards;
    - Define effective testing methods/conformance tests which address also physical housing of plugs;
    - Electro Magnetic Compatibility;
    - DC metering.

WHEN TO START?

Many aspects that should be solved within 2017-2018 are already subject of work within both standardization bodies and regulatory entities since the last two-three years. The urgency is to work immediately to speed up the process, finding agreement and common solutions in the smallest possible time frame.

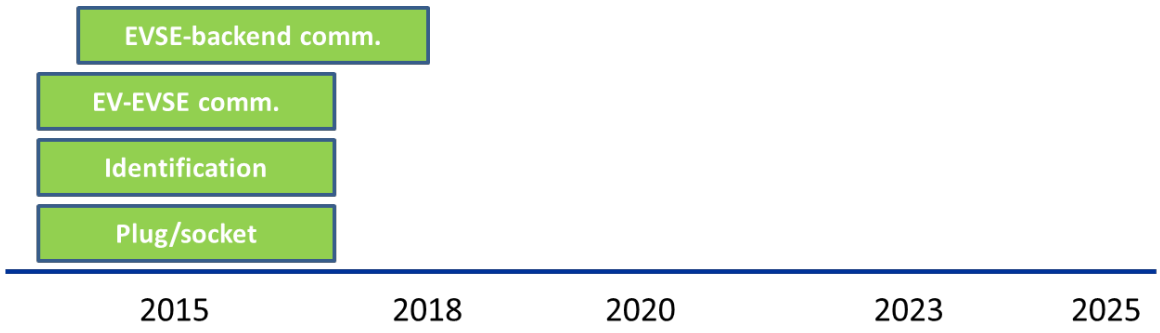

Figure 5-3 Roadmap second step time schedule

5.5.5 Roadmap third step: 2020

The third step of the roadmap is in a 5-year period from now. The challenge will pass from allowing the "simple" charging procedure, to a more sophisticated way of controlling the charging station and the connected vehicles, starting to move towards a smart grid integration of e-mobility.

AIM:

First solutions for a smart integration of the charging process in the management of the grid. In addition to what already achieved in 2018:

- **Demand Response:** the control of the charging procedure is performed by applying price signal to energy and/or power (e.g. tariff on hourly basis). This control is "open loop" type and provides the possibility for demand response in the same way as for other loads connected to the grid: the user may take the information into account or decide to ignore them.
- **Smart charging** capabilities:
  - At home;
  - In public stations.

  The charging is controlled by price and technical signals in relation to various constraints such as overload risk, lack of balance between production and consumption, or coordination between loads to avoid peak demand exceeding the capacity of a network. The EV customer has "contractually" agreed (in specific clauses of the contract) to allow smart charging.

HOW TO?

Both demand response and smart charging are topics which are already under test, to understand the technical issues and the business opportunities. The up-scaling from demo projects to an actual implementation will need agreement and standardization, in particular to define roles and communication procedures.

- Leverage acquired experience and pilot projects (also in Green eMotion demo regions) to agree on the best architecture, roles and business model.
- Create a standard to guarantee a sufficient and secure communication between the EVSP, the DSO and the Energy Provider.
  - Develop already existing proposals:
    - Open Smart Charging Protocol/Open Charging Point Protocol [21],[22];
    - eMI3 standard proposal, version 0.8 [23] and smart charging via OEM backend as described in D3.10 [11];
    - ISO/IEC 15118.

WHEN TO START?

The long time needed to define the best technical requirements (test and demo projects are on-going with this aim) and to proceed with proper standards development and wide acceptance suggests to start immediately addressing this topic. A strength point can be seen in the fact that ICT standards related to this aspect are cross-sectional with others, therefore increasing the possibility to leverage on parallel work.

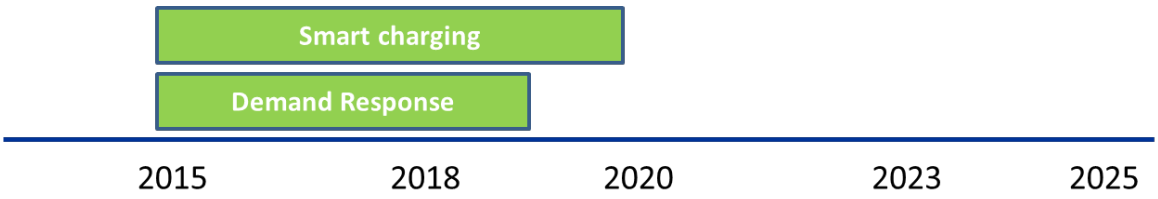

Figure 5-4 Roadmap third step time schedule

5.5.6 Roadmap fourth step: 2023

The fourth step, 8 years from the present time, foresees improvements in the integration of e-mobility in the "smart grid" and "smart city" vision. Electric vehicles, thanks to their storage system, are supposed to become not only a load, but also a source of energy for the grid. As first passage to this "bidirectional" and smart exploitation of e-mobility, Vehicle-To-Home features will have to be ready for 2023.

AIM:

First real applications of bi-directional solutions for a smarter use of vehicles storage capacity. In addition to what already achieved in 2020:

- Vehicle-To-Home (V2H) or Vehicle-To-Office features:
  The car, connected to a bi-directional home/office charger, is managed to alleviate consumption of power in peak periods, help in maximizing the use of privately produced renewable energy and provide backup power supply during major power black-outs.

HOW TO?

The development of Vehicle-To-Home/Vehicle-To-Office is strictly connected to the evolution in building management technology, still quite underdeveloped in many European countries. Besides, the passage from unidirectional to bidirectional flow implies technical issues to be better defined through standards.

- Encourage the adoption of Home/Office Management Systems;
- Define common standards for reverse-flow components;
- Define a common architecture and involved actors;
- Define and agree on common standards for communication among the involved actors;
- Harmonize and align with works carried out in the sectors of home automation, smart cities and smart grids.

WHEN TO START?

Study and demonstration projects on reverse flow are still quite far from an effective real-life implementation and V2H/V2O features can be seen as a mid-term need. It can be foreseen that both electric and communication new aspects will have to be tackled, and that a 5-year period could be necessary to properly solve the open issues. The suggested starting point is therefore 2018.

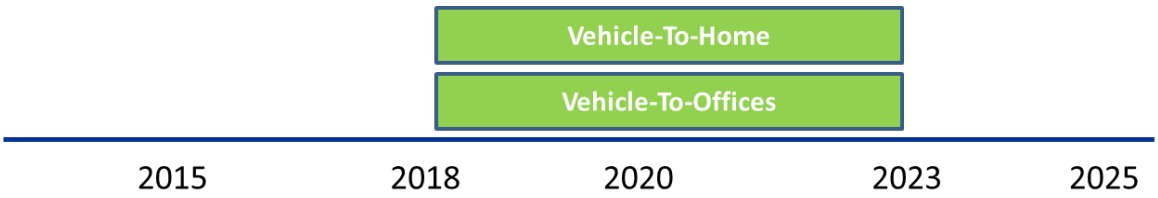

Figure 5-5 Roadmap fourth step time schedule

5.5.7 Roadmap fifth step: 2025

The fifth and last step of the Roadmap is in ten years. Hypothesizing technical developments which will improve cars functionality, standardization evolution (according to the previous steps) which will give positive inputs to the market and scale economies which will decrease the prices, it can be foreseen that the number of electric cars circulating will experience an interesting escalation. This case, a further increase in the smart integration of the charging vehicles into the grid and its management system would be welcomed (if not totally required).

AIM:

Complete integration of EVs into a smart grid vision allowing bidirectional flows from/to the vehicles storage system. In addition to what already achieved in 2023:

- Vehicle-To-Grid (V2G) features:
  The vehicle is considered as a power storage system that can be used by the network operator to increase power reliability and the amount of renewable energy available to the grid during peak power usage. V2G could provide regulation services, replace spinning reserves, or replace peak generation units.

HOW TO?

Having gained some experience with V2H technology, technical issues on bidirectional flow should be easily solved. The biggest issue will then be the definition of the exact roles and of dedicated standards to effectively communicate among the actors, guaranteeing an effective management of the flows.

- Leverage the knowledge on reverse-flow gathered with V2H;
- Define a common architecture and involved actors;
  - Work in close relationship with working groups on smart grids.
    - Aggregator role;
    - Information flows;
    - Business models.
- Define and agree on common standards for communication among the involved actors;
  - Work in close relationship with working groups on smart grids.

WHEN TO START?

Vehicle to Grid features can be considered as a relevant extension of V2H/V2O ones, with a substantial increase in the complexion of interactions. Due to that, it is recommended to start working on the topic with a significant advance in time and just immediately following V2H/V2O related activity. 2019 could represent a rational starting point, while the full smart grid integration will be the immediately following step (starting 2020).

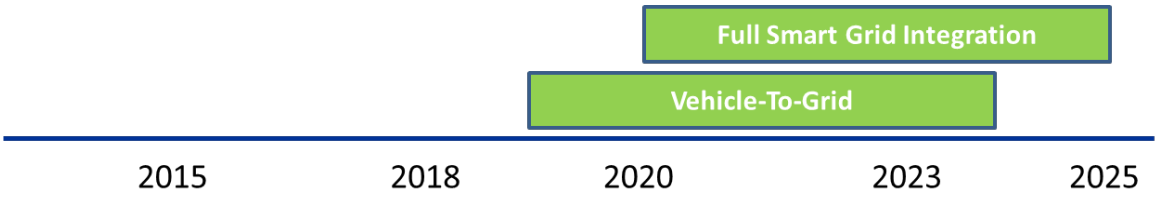

Figure 5-6 Roadmap fifth step time schedule

5.6 Conclusions

The just described Standardization Roadmap is deliberately structured in a simple and extremely focused way, in order to stress the main message to transmit:

- Connect the actors – focus on communication interfaces.

After four years working on standards within the Green eMotion project, this is indeed the main outcome and the main added value that should be conveyed to standardization bodies and working groups.

It is well known, as also reported in other Standardization Roadmaps, that many technical aspects only slightly mentioned here still have to find a better definition through standards and that some relevant work will have to be carried out to address them. Identically, it is undeniable that other issues are already coming out or are about to become relevant. It is the case, for example, of battery safety, battery recycling or inductive charging. Being well aware of that, and considering fundamental to carefully study and develop these aspects (please refer also to section 6.1), it is anyway a firm belief that building an effective framework and guaranteeing an effective, common and standardized communication among the involved actors will be the best first move to properly tackle also more specific technical issues.

In Figure 5-7, the complete roadmap is reported, evidencing the suggested time schedule and the need to overlap some parts of the work.

In Figure 5-8, a simplified view is shown, more focused on the five steps and on the related targets.

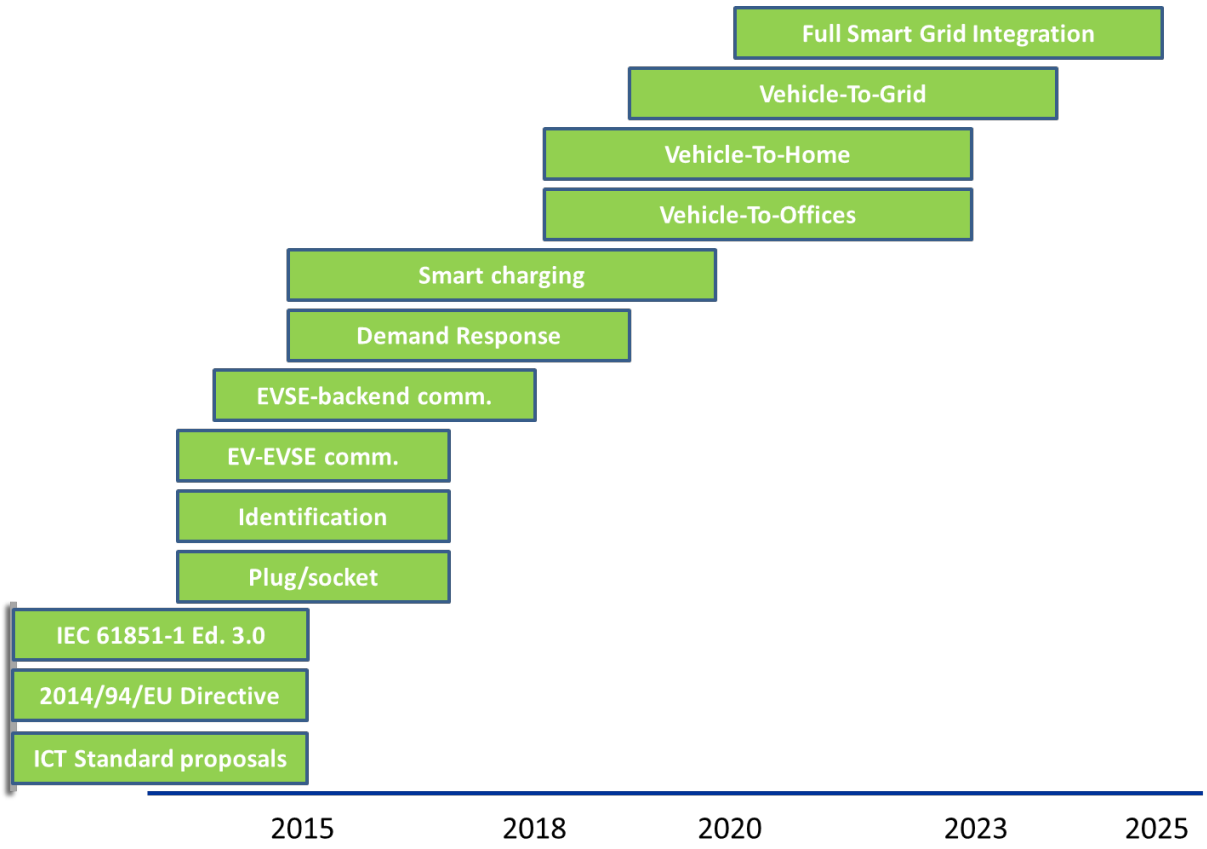

Figure 5-7 Green eMotion Standardization Roadmap, time schedule

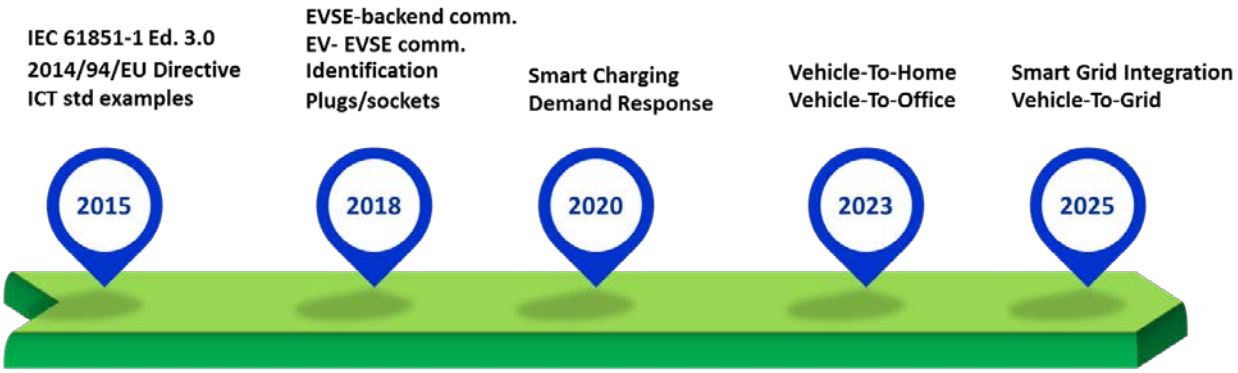

Figure 5-8 Green eMotion Standardization Roadmap, targets

6 CREATE A COOPERATIVE ENVIRONMENT – push regulation choices through wide agreement

Standardization is historically a complex task. Many aspects merge into this topic, strictly linked to technics, economics, marketing and politics. Many examples are well known as “case-studies” for successful or unsuccessful standards, as well as for “battles” between similar competing products (from Direct Current versus Alternate Current, to Betamax versus VHS) [24].

On the other hand, as many times repeated also in this document, benefits of standardization are relevant, both for final users and for manufacturers. Considering the importance of e-mobility in European plans for reducing the transport environmental impact, it is therefore well recommended to adopt a collaborative approach.

During WP7 activities, discussions have been carried on with the aim to identify the possible approaches to perform an effective standardization process and the key actors that should be involved in that. From a “high-level” point of view the main outcomes can be so summarized [4]:

- Interoperability is a complex task that should be addressed following precise methodologies that consider different layers and different steps (e.g. the definition of use cases and business cases);
- The process to obtain common standards has to be speeded up;
- In many cases the main problem is not to define new standards, but to choose one from multiple standardized versions to achieve interoperability (**more regulation than standardization**).

With regards mainly to the last point, it came strongly out the need for definitive choices, coming from regulatory entities. The recent 2014/94/EU Directive has represented a clear example of regulation activity that has gathered quite common satisfaction, contributing to create a stable situation and to partially solve long-standing disputes.

Obviously, it is not a duty of regulatory entities to choose among different standards and to impose one. Regulatory activity has to follow indications of industry and of all the involved actors. Only after a wide agreement through the stakeholders, the common choice could be formally ratified through regulatory means.

The immediate consequence of the need for agreement and of the lack of time (due to environmental targets) is therefore the demand to create a cooperative environment, where most rapidly identify issues, solve them with the best technical solution and agree on their common application.

The experience on these aspects gathered during WP7 activities let so to provide the recommendations reported in the following sections. They are not related to single standards or precise technologies, but they are, instead, more general suggestions that could help to create a fruitful environment for a quicker and more effective standards development and agreement.

Please notice that the following recommendations have standardization as specific focus. Other recommendations, less “standard-related” but equally important to prepare a successful rollout of EVs throughout Europe, can be found in Green eMotion Deliverable 9.7 “Policy evolution recommendations and stakeholder actions towards effective integration of EV in EU” [28].

6.1 Encourage common studies on e-mobility trends to better focus standardization efforts

The creation of standards is a quite complex and time-consuming process and it is known that at least three years have to be considered for this purpose. In order to avoid a too large time between the generation of an issue and its solution, it is therefore important that experts try to foresee which will be the future standardization needs. Moreover, it is important that resources are optimized, and therefore standardization activity should be focused on the most relevant actual and future aspects.

In order to do that, it is well recommended that research centers, industries and all the involved actors cooperate to study, monitor and try to predict the trends in e-mobility technology and standards.

As an example, some of the most important topics to be monitored are:

- Improvements in battery technology and allowed range;
- Charging behaviors and power needed for charging;
- DC versus AC charging:
- How will be the public network? (AC or DC? How fast? Possible to do smart charging?)
- Business models and technical limits for wireless charging;
- Business models and technical limits for battery swap.

6.2 Encourage the development of wide working groups of industries

As already mentioned, the process to obtain a common and definitive standard solution has to pass through wide industrial agreement. Within Green eMotion work, the European Commission has several times pointed out that it is not the task of the regulatory entity to choose among different technical solutions and to impose one, especially if there are different competing systems on the market. The only possible way to ratify one single choice is the presence of a wide agreement on that, as happened with the 2014/94/EU Directive, which was highly supported by the whole ACEA - European Automobile Manufacturer's Association.

In order to allow for the identification of the best technical solutions and to obtain a wide agreement on them, it is therefore well recommended to encourage the development of wide working groups of industries.

Considering that e-mobility presents multidisciplinary aspects, it is also recommended to include in the working groups the most possibly complete stakeholders, in order to best cover cross-sectorial aspects (e.g. ICT aspects).

Two working groups have to be mentioned as example of this kind, as they could represent a reference and a starting point to boost industrial cooperation:

- **eMobility ICT Interoperability Innovation group**, eMI³: an open group of significant actors from the global Electric Vehicles market who joined forces to harmonize the ICT data definitions, formats, interfaces, and exchange mechanisms in order to enable a common language among all ICT platforms for Electric Vehicles. eMI³ core objectives lie in the development, publication, sharing and promotion of ICT standards. It can count now on 38 Members, but it is in liaison with more than 50 partners [5].

- **Open Charge Alliance, OCA**: an industry alliance of EV charging hardware and software vendors, and charging network operators and service providers. OCA's mission is to foster global development, adoption, and compliance of the Open Charge Point Protocol (OCPP) and related standards through collaboration, education, testing, and certification.
  OCA recently reached the number of 50 participants, covering both US and European areas [25].

6.3 Increase the effort to coordinate the high number of activities on e-mobility and interoperability

In the last years E-mobility is gathering more and more attention, thanks both to its environmental opportunities and its possibility to become a new profitable business. According to that, many projects, studies and working groups started to arise all over the world. In this situation, the risk of duplicating activities, partially losing resources, has become an issue. To optimize resources, performing complementary studies and choosing common references and common standards would represent a relevant advantage. This could happen only creating an environment of strong connection and information sharing among the different activities.

Considering that a cooperation among thousands of projects around the world would clearly be an impossible and unreasonable task, a sort of connection and cooperation at least among the most important initiatives on going in Europe could otherwise represent a relevant advantage.

More in particular, it would be recommendable to start creating a contact and to share information, knowledge, objectives and methodologies among the many EU funded projects related to e-mobility and interoperability. This could be performed in many ways, for example creating a permanent observatory and using a proper web-based tool, which could be easily used by involved (and also external) partners.

A first virtuous example of cooperation and information sharing among European Projects is the European Electromobility Stakeholder Forum, which sees the joined participation of three relevant EU funded projects on e-mobility [26]:

- Green eMotion;
- Freight Electric Vehicles in Urban Europe (FREVUE)
- Zero Emission Urban Bus System (ZeEUS)

6.4 Work in close relationship with smart-grid and smart cities working groups.

Electric Vehicles present the peculiar characteristic of not being only a transport mean, but also a component to be connected to the electric grid. This generates at the same time both challenges and opportunities, as they will have to be properly fed with energy while charging, but as they could also provide flexibility and other services to the grid. These aspects, mostly covered in the already mentioned Vehicle-To-Home and Vehicle-To-Grid approaches, are strictly linked to the most generic Smart Grid and Smart Cities visions.

Considering that, and the fact that there is a huge on-going work on these smart visions, it is highly recommended that the two sectors move together. E-mobility sector has to closely monitor and cooperate

with working groups and projects on Smart Grids and Smart Cities, with a particular attention to the following aspects:

- Reference architecture and roles;
- Technical solutions and protocols;
- Communication interfaces;
- Data security and privacy.

6.5 Push e-mobility through pushing/guiding parallel sectors

As partially mentioned in the previous section, e-mobility development is strictly connected to “close” sectors evolution. For example, the technologic improvements in smartphone functionalities and the Internet Of Things could substantially influence the way of managing the vehicles and their charging process. Moreover, the development of Smart Building solutions, as well as Domestic or Home Management Systems could give a substantial stimulus to Vehicle-To-Home services. These are just two examples, but many other can be found.

Considering that, it is highly recommended to monitor and control the evolution and the possible trends in sectors moving in “parallel” with e-mobility. When possible, the adoption of solution that will foster e-mobility should be pushed, in order to obtain a double benefit.

7 START NOW WITH FUTURE-PROOF INFRASTRUCTURE – guide “real-life” applications in order to fit future developments

In the last years E-mobility has started to exit from a niche situation, becoming known also by not technicians and occupying a more and more relevant position in public opinion. Due to that, and to the increasing quality of vehicles and charging stations, several public and private actors are paying attention to this sector and are starting developing first samples of EVs fleet and charging infrastructure.

The number of initiatives on e-mobility is therefore continuously increasing, including examples of “Green Public Procurement”, such as the adoption of EVs in public fleets (police, PAs employees vehicles, post services,…) or examples of private companies converting a small part of their company vehicles to electric (mainly for deliveries or maintenance services).

This trend is absolutely positive for e-mobility development but it is fundamental that the new initiatives start immediately setting up an “interoperable” infrastructure.

In particular, many Municipalities are now starting to install a charging infrastructure but there is the real risk that “old” systems are put in place. It is really important that also small initiatives are seen as a part of a much more complex and integrated “system”. The infrastructure has to permit identification and access through “up-to-date” methods (there are still systems accessible by physical keys), they have to be connected to some kind of IT infrastructure (e.g. a marketplace) and they have to let roaming. In a few years probably Electric Vehicles will often cross borders and the infrastructure developed since now on has to be able to charge them.

In order to immediately achieve this and thanks to the experience gathered in the last years, Green eMotion can provide some guidelines to public bodies that have to develop a charging infrastructure. Next sections are thought to provide information and technical suggestions on e-mobility standards, in order to help Municipalities and Public Administrations in setting up tenders for charging infrastructure or in evaluating proposals coming from external parties. Following the next suggestions would let PAs to install an effective and up-to-date infrastructure, ready by now to tackle future challenges.

Please notice that the sections are structured in a Question/Answer form in order to let an immediate reading and that the glossary is thought to be easily understood by not-expert technicians.

7.1 Power

Question: *"which is the power level that I have to consider to develop an effective public infrastructure?"*

GeM answer:

"The power level depends on the aim for which the infrastructure is set up. It can be said that two levels are nowadays widely adopted:

- "Normal power": 22 kW AC (32 A – 3 phases);
- "High power": 50 kW DC.

Figura 7-1 Examples of "normal power" charging stations

The first power corresponds to "normal power" charging. In the mid-term future, it can be considered mainly as an alternative to home/work charging for users that don't have availability of a private box. It implies quite long stops. An infrastructure with this power level should be planned according to several parameters typical of the urban environment. Among others:

- number of inhabitants;
- private parking spots/total parking spots ratio;
- number of cars for inhabitants;
- foreseen e-mobility penetration;
- mean daily mileage.

The second solution, commonly referred as "high power charging" (or "fast charging"), will instead have as main objective to allow longer daily mileage to the vehicles. The chargers will be used mostly as "fuel stations" during mid-range missions and their localization should therefore be planned according to that (highways, city rings,…).
Most of the present cars already accept 50 kW fast charging and this could be seen as a reasonable power almost in the mid-term. Despite that, some high-level brands are already installing more powerful chargers (up to 125 kW).

To conclude, a reasonable public infrastructure should include both the power levels (22 kW and 50 kW) localized after a careful planning and taking into consideration the different aims.

Figura 7-2 Examples of "high power" charging stations

7.2 Connectors

Question *"Which sockets/connectors should I adopt?"*

Figura 7-3 Examples of connectors for e-mobility

GeM answer:

The topic of connectors has been highly debated in the last years, but the recent 2014/94/EU Directive has finally identified a common choice and given clear recommendations [17].

In particular, the Directive has stated that starting from November 2017 charging points should adopt at least:

- Type 2 "Mennekes" connector (EN 62196-2) for AC normal and high power charging
- Combined Charging System (CCS) Combo 2 connector (EN 62196-3) for DC high power charging

These two indications are quite clear, but have to be read in relation with the actual market situation, for vehicles and charging points.

Considering passenger cars, it can be said that Type 2 “Mennekes” connector is the most widely adopted solution for AC charging. Normal power charging points should therefore be equipped with this socket and no others will be needed.

In order to charge also Light Electric Vehicles (LEVs), a different socket could be added, but the 2014/94/EU Directive still does not specify a common solution. Due to that, different standards are adopted across Europe (e.g. Schuko socket in Germany and Scame 3A socket in Italy). For this purpose, it is so recommended to refer to national regulation while carefully monitoring the evolution in European choices.

In the field of high-power charging, Combo 2 solution will represent the common European choice but it has to be considered that nowadays the most common DC charging solution is the CHAdeMO one. More than 1.300 CHAdeMO DC chargers are already in place in Europe and thousands of vehicles are equipped with this technology [27]. In order not to exclude all these vehicles, the EU itself suggests as a feasible solution the adoption of “multistandard” chargers, including both Combo 2 and CHAdeMO connectors.

As one European car manufacturer has developed one vehicle equipped with AC high power charging (43 kW AC), the suggestion is to strictly monitor the evolution of this technology, in order to evaluate if including also this third standard in the “multistandard” chargers. The three-standard fast charger should anyway be the preferred solution at least in the short-term.

7.3 Access/Identification

Question: *“Which solution should be adopted to allow users access and identification?”*

GeM answer:

Although in many pilot projects the charging is provided for free and with unrestricted access, it is essential that the charging stations are equipped with up-to-date systems able to identify the user and allow/not allow the charging process.

The first recommendation is to set-up an infrastructure which is at least connected with a backend system (see dedicated section). Avoid severely “stand-alone” solutions. Moreover, avoid physical locks that cannot be remotely controlled (e.g. barriers that can be opened only through physical keys given to the users).

The most adopted solution for identification/access are today RFID cards, well known by users as common to many other circuits (transport cards, fidelity cards, ski-passes,…). The charging station should therefore be equipped with an RFID reader. Considering that different RFID standards exists according to ISO 14443 (Classic, Mifare, Calypso,…), it is required that up-to-date charging points include “multistandard” RFID readers. This way, cards issued by different providers and also for different purposes (e.g. transport cards) can be easily read by the charging station, allowing for a wider range of services. In addition to that, the “updateable” features of the reader should be taken into careful consideration, as it could be a relevant benefit to allow for new services without the need for a hardware substitution.

Following the continuous increasing amount of smartphones and web-based technologies, it is recommended that the charging point is already arranged to allow the activation through smartphone

applications (apps). This won't need any hardware component into the charging post, but a concrete and effective communication between the charging station and the backend system.

At last, according to the 2014/94/EU Directive [17]:

"All recharging points accessible to the public shall also provide for the possibility for electric vehicle users to recharge on an ad hoc basis without entering into a contract with the electricity supplier or operator concerned."

This could imply a request for:

- Roaming (see next section)
- Identification and authorization for occasional users not registered to any provider.

In this case, a possible solution can be the activation of the procedure through SMS, with immediate billing on the phone bill.

7.4 Communication vehicle (EV) – charging station (EVSE)

Question: *"Are there specific requirements to allow the communication between the car (EV) and the charging point (EVSE), so to guarantee an effective charging?"*

GeM Answer:

"An effective communication between the vehicle and the charging point is fundamental to allow a safe and controlled charging process. Three standards are now widely adopted, covering the three most common charging technologies:

- AC charging: PWM communication according to IEC 61851-1 (mode 3);
- DC CCS Combo 2 charging: PLC communication according to ISO/IEC 15118;
- DC CHAdeMO charging: CAN communication according to IEC 61851-24.

Improvements on these standards are ongoing (e.g. IEC 61851-1 Ed. 3.0 [18]). In parallel, work on ISO/IEC 15118 standard (designed to be compatible with IEC 61851) will probably specify additional features for EV-charging station communication.

It is therefore well recommended to follow the developments and be sure to install the latest version.

7.5 Communication charging station – backend

Question: *"Who will control the charging station and how?"*

GeM Answer:

At present, different business models are under development in the field of EV charging. By many points of view, this is anyway not really relevant, as long as the charging procedure is easy to access and the charging station can be at least properly managed, monitored and controlled by a remote management system (charging station backend).

The communication between the charging station and its backend is still an open issue, as no definitive choices have been made on the protocol to be used. At present, many manufacturers adopt proprietary solutions as they often represent both the charging station and the backend sides. In a future, more complex, environment, it will be advantageous to have a common standardized solution, in order to let charging stations operators (and subsequently EV Service Providers) to manage in an immediate way several charging stations manufactured by several different producers.

Many efforts are on-going to develop and identify a common protocol. In particular, some standardization groups are gathering industries, operators and research centers and proposing some solutions, which are obtaining an interesting success in the market and inside standardization bodies:

- Open Charge Alliance OCPP (Open Charging Point Protocol), now in v2.0 [21];
- eMI3 specifications (final draft status) [5][23].
- Green eMotion / eMI3 Electric Mobility Infrastructure Open Protocol (EMIOP), now as an IEC New Work Item Proposal [9].

It can be imagined that a solution will become a "de facto" standard or will be object of regulation by the European Commission (in case of wide agreement) in the next years. It is so recommended to follow the development of the on-going work and to avoid proprietary solutions.

7.6 Allowed users and payment (roaming features)

Question: *"How can I allow charging for the widest number of citizens, avoiding expensive duplications of the infrastructure and optimizing its use?"*

GeM Answer:

"As for many other services, it is predictable that in the next future many different operators will provide the service of EV charging, both in the same territory and in adjacent territories. A "rigid" scheme would imply that each operator installs its own infrastructure for its own customers, bounded by a contract. This way, severe limitations would occur for EV users, in particular when travelling outside the usual, everyday environment. There would be the risk of not being allowed to charge, unless a new contract is signed.

To avoid limitations for users and at the same time optimize the "capacity factor" of the infrastructure, it is therefore strictly recommended to structure the system in order to allow "roaming" features. With a roaming scheme, users need only one contract (with a single operator) to access to any operator infrastructure. The payment for the charging service will be always charged on the "personal" bill, not

affecting the functionality for users and leaving to the operators the task to perform economic compensations.

Practically putting this scheme in place is not an immediate option as it requires a thorough communication among operators and the sharing of sensitive amounts of data, expressed with a common protocol. Some examples exist, however.

Green eMotion in particular is proposing an “IT infrastructure-based” architecture which includes Clearing House and Marketplace services. This architecture is indeed considered the most rational solution to allow an effective communication limiting direct bilateral contracts among operators.

From a technical point of view, a charging station equipped with access/identification hardware as defined in the previous section 7.3 and with an effective communication with the backend (see section 7.5) is ready to implement roaming features as it is. The focus moves on a “higher level”, i.e. the interaction among operators.

In this case, it is recommended to privilege operators that are already included in some marketplace platform. As starting point, at least a “roaming” among operators present in the same territory should be pushed.

7.7 Localization and safety

Question: *“Are there areas considered risky for charging station installation? Is there a common standard procedure to define them? What about petrol stations?”*

GeM Answer:

As already mentioned, a correct infrastructure plan takes into consideration several urban parameters, differentiating also on the power level and on the purpose of each charging station. Said that, there are some areas that cannot be suited to host a charging station due to safety risks.

This aspect is particularly felt when dealing with high power charging stations inside existing petrol stations, which are subject to ATEX (ATmosphères ed EXplosibles) regulation.

With regard to this particular aspect, some standards can help, but it has to be noticed that specific and clear European common rules are still absent.

- IEC 60364-7-722 Low voltage electrical installations: Part 7-722: Requirements for special installations or locations - Supply of Electric vehicle
- EN 60079-10 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres
- EN 50014 Electrical apparatus for potentially explosive atmospheres. General requirements
- EN 50018 Flameproof enclosure 'd' "

Different States adopt different rules, while some others don’t have a clear legislation yet. The general recommendation is therefore to check and adopt national rules, while carefully monitoring the development of a European common decision.

7.8 General aspects

It has to be remembered that a charging station is both a mechanical and electrical component and a civil construction. In parallel with the specific aspects just detailed in this document, to correctly set up the infrastructure is therefore highly recommended to refer to all the devoted electric, mechanical and building standards. In particular, a special attention should be paid to safety aspects, given the direct contact of the equipment with a public of non-expert users and possible accidental interactions with critical subjects (e.g. children).

8 Conclusions

In the last four years Green eMotion has represented a reference point for research and demonstration activities on e-mobility. The high number and variety of involved partners gave the project the strength to address the core topic, interoperability, under many technical and policy points of view.

Work Package 7 in particular had the general aim to analyze the complex situation on standards and standardization activities mainly in order to identify the most important open issues and to propose actions to tackle them properly.

This Deliverable represents both a summary of the activities carried out in the last four years with regards to WP7 Gap Analysis as well as a presentation of the main outcomes, which can be expressed as guidelines and recommendations. More in particular, the Gap Analysis process was recalled in the document. This started with the fundamental analysis of the existing e-mobility related standards and proceeded with the collection of open issues and gaps according to the most relevant stakeholders in the field. Surveys, workshops and direct interviews led to gather many unresolved aspects, which were properly rationalized and organized in a Gap Matrix. The same Matrix was then thoroughly discussed with experts and the gaps were classified according to their "level of criticality". The immediately following step was then to set-up an action plan according to the relevance of the open issues, always keeping in mind the general aim of interoperability.

The results of this process and of all the parallel debates and activities carried out within Green eMotion, led WP7 partners to identify some key messages to be conveyed to interested stakeholders. More in particular, three comprehensive recommendations have been formulated and presented in this document:

1. **CONNECT THE ACTORS** – focus on communication interfaces.

2. **CREATE A COOPERATIVE ENVIRONMENT** – push regulation choices through wide agreement;

3. **START NOW WITH FUTURE-PROOF INFRASTRUCTURE** – guide "real-life" applications in order to fit future developments.

The first point reflects Green eMotion firm belief that communication interfaces will represent a key component to guarantee a seamless, effective and properly controlled charging process. Despite of that, many ICT aspects are still unresolved and a deep and fast standardization/regulation work should be done in this sense. To provide an actual work-plan to standardization groups, this concept has been included in a wider "Standardization Roadmap", which has the aim to address the next 10 years of standardization work.

The Roadmap presented in this document considers 5 time steps and 13 main targets distributed among them. The effort is to start guaranteeing an easy and "universal" charging to drivers, thanks to a definitive physical interoperability (plugs/sockets) and to concrete choices towards roaming features (identification, authorization, IT interfaces). This process already started, so that the first step of the roadmap (2015) is actually at the same time both a starting point and a first arrival step. The following targets have been set with the aim to progressively include e-mobility in the wider concepts of smart grids, universally recognized as the necessary future of electric networks. A progressive approach would therefore start addressing lighter integration with smart charging and load management features, and then proceed with reverse flow solutions in a Vehicle-To-Home and Vehicle-To-Grid approach. In Figure 8-1, the complete Roadmap is reported, including both the main targets and the related timeframes.

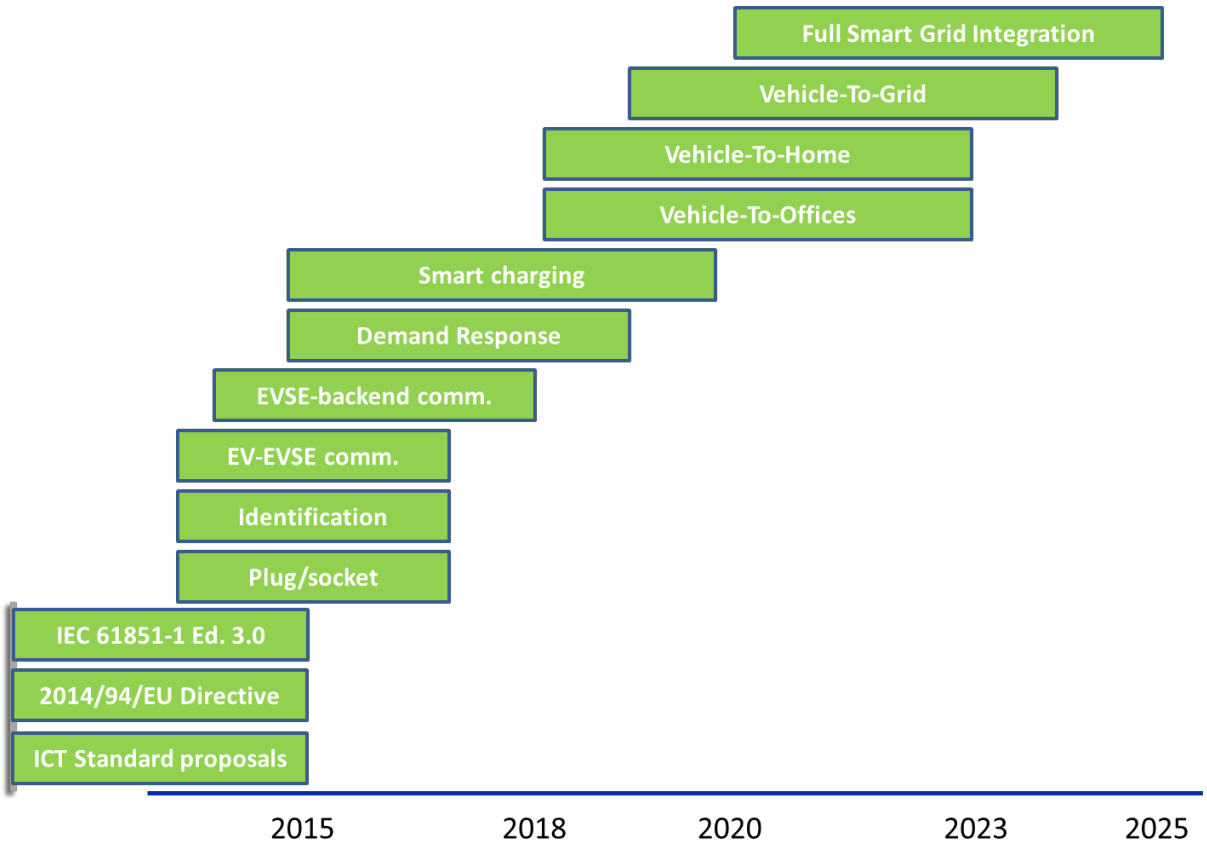

Figure 8-1 Green eMotion Standardization Roadmap

The second recommendation expressed in the Deliverable can be seen as the best "mean" to facilitate a quick and effective progress of the just described standardization roadmap. Several examples, both in the past and in more recent years, have clearly shown that cooperation is a fundamental principle to speed-up standardization and regulation processes and the topic often came out during GeM activities. Cooperation and communication should be key words in many phases, starting from research activity, to demonstration projects, to actual standards development in the committed organs, to regulation choices. Moreover, interdisciplinary has become so strong among technological areas, that e-mobility should look for a solid connection and harmonization also with different (but close) developing areas (e.g. Home automation, smartphones, Internet Of Things,…).

The last aspect, articulated in the document as some dedicated "guidelines", expresses the concern that the on-going processes inside standardization bodies and regulatory entities are properly and immediately conveyed to "real-life" applications. On a market level, still many different solutions are available, compliant with different standards and including different levels of ICT features. Green eMotion recommendation in this sense, mainly directed to Municipalities and Public Administrations willing to set up a new charging infrastructure, is to take a good care in choosing up-to-date technologies, in particular with regards to ICT solutions, and to flow into widely accepted standards. This way, the biggest number of

drivers could be served, both immediately and in the next years, and the installed infrastructure will be ready to tackle at best the next future technological challenges.

After four years of Green eMotion activity, it can be easily observed that e-mobility is today a dynamic and fickle environment, where important changes happened and will happen quickly. The Green eMotion and Work Package 7 effort led to obtain a quite detailed overview on the standardization aspects of this complex environment and to point out the three comprehensive recommendations expressed in this document. According to the acquired experience, a correct combination of the three aspects will give a powerful stimulus to standardization and, as a consequence, to e-mobility market.

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ANNEX A – Gap Matrix and Feedbacks

The Gap Analysis process produced a list of 29 gaps, which have been presented and discussed in different ways with experts coming from various stakeholders. Many comments included technical features and came in particular by OEMs and DSOs, which compared their own experience with the issues highlighted by the Gap Analysis.

A global view of the agreement/disagreement expressed with regards to the identified gaps was obtained during the “E-Mobility Standards: what’s missing?” Standardization Workshop in Brussels. Two posters summarizing the gaps have been prepared and the participants have been provided with red and green stickers. During the workshop, the attendees have been asked to put a green sticker on the posters if they thought the respective gap was correct and important, while to put a red dot if the gap was not considered relevant for e-mobility standardization, keeping in mind the GeM general aim of interoperability.

A global view of the results can be seen in Figure A-1 and Figure A-2. A quite varied situation can be observed, with gaps completely agreed, others completely disagreed and many with “medium” agreement.

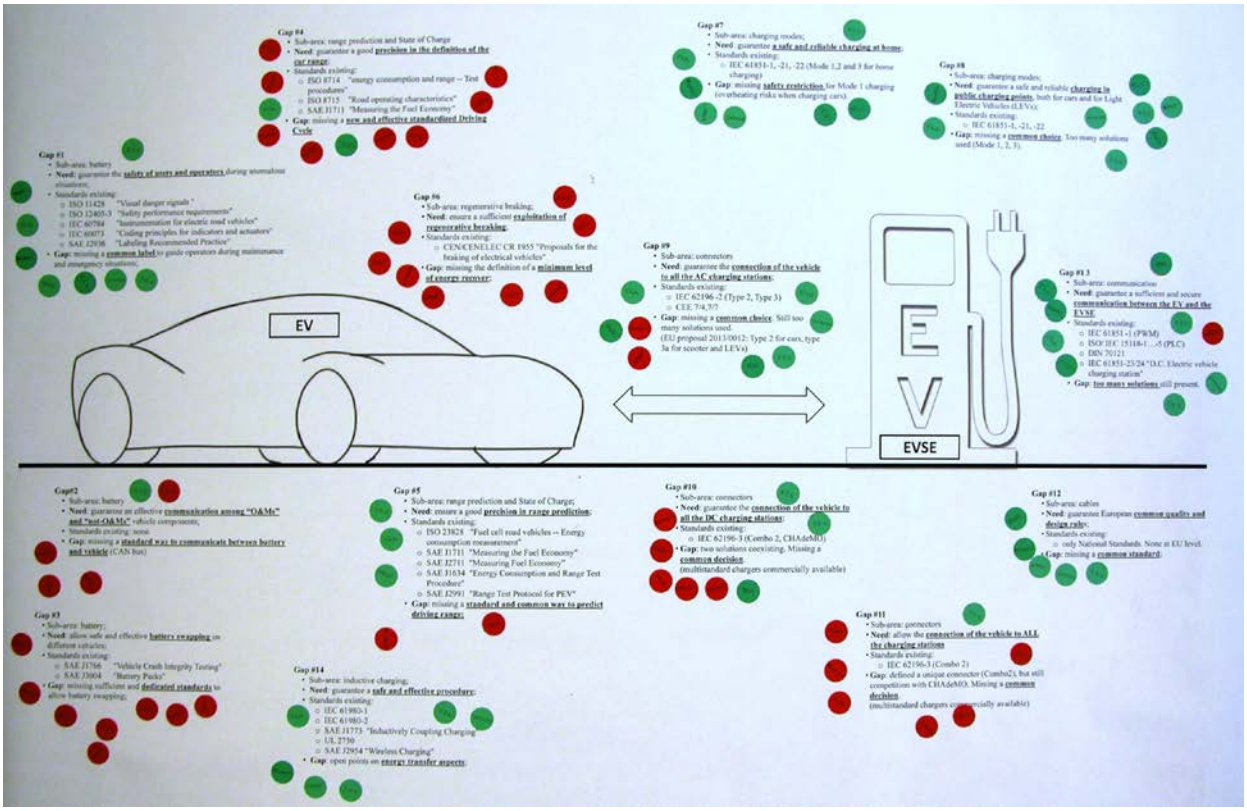

Figure A-1 Agreement/disagreement stickers on Gaps 1-13

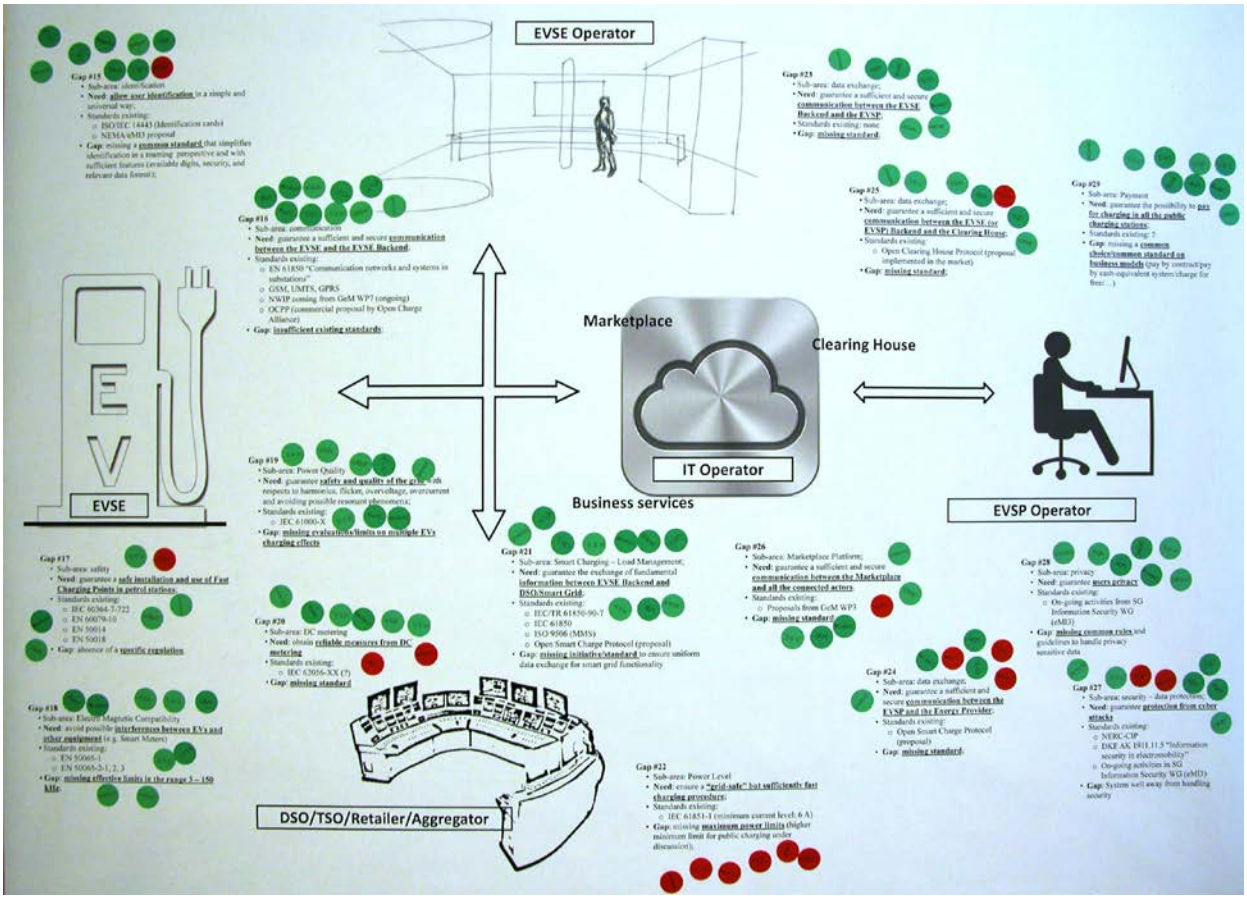

Figure A-2 Agreement/disagreement stickers on Gaps 14-29

A detailed analysis on the agreement/disagreement results has been conducted. As the stickers were "personal", with the name of the company written on them, it has been possible also to evidence the opinions of the different stakeholders.

In Table A-1, the gaps identified in the Gap Analysis are reported and the feedbacks received on each gap are evidenced, divided for stakeholders groups.

A colour scheme has been adopted in the first and last column of the table, according to the following criterion:

	full agreement
	large agreement
	medium agreement
	large disagreement
	full disagreement

Table A-1 Agreement/disagreement on the gaps divided by stakeholders

		OEMs		DSOs		Research Centers		ICT/electronics manufacturers		Standardization groups/bodies		Total	
Gap#													
1	Missing a common label to guide operators during maintenance and emergency situation with batteries		2		2		2		1		1	0	8
2	Missing a standard way to communicate between battery and vehicle (CAN bus)	2		2							1	4	1
3	Missing a sufficient and dedicated standard to allow battery swapping	2		1		2		2		1		8	0
4	Missing a new and effective standardized Driving Cycle	2		2		1	3	1		1		7	3
5	Missing a standard and common way to predict driving range	1	1		1		1			1		2	3
6	Missing the definition of a minimum level of energy recover (through regenerative braking)	2		2		2		1		1		8	0
7	Missing safety restriction for Mode 1 charging (overheating risks when charging cars)		1		1		3		1		1	0	7
8	Missing common choice on public charging. Too many solutions used (Mode 1, 2, 3).		2		2		2		1		1	0	8
9	Missing a common choice on AC connector. Still too many solutions used.	1	1	1	1		1		2		1	2	6
10	Missing a common decision on DC connector. Two solutions coexisting.	1	1	2		1		1	1		1	5	3
11	Missing a common decision on a “universal” connector. Competition CCS/CHAdeMO	1	1	2		1		1		1		6	1
12	Missing a common standard on cables.		2		2				1			0	5
13	Too many solutions still present for the communication EV-EVSE		1	1	1		3		2		1	1	8
14	Open points on energy transfer aspects for inductive charging.		2		1		1		1		1	0	6
15	Missing a common standard for identification in roaming perspective and with sufficient features (available digits, security, data format,…)	1	1		2		3		2			1	8
16	Insufficient existing standards for communication EVSE – EVSE backend		2		2		4		2			0	10
17	Absence of specific regulation for Fast Charging Points in Petrol Stations		2		1		1	1	1			1	5
18	Missing effective limits for EMC in the range 3-150 kHz		2		2		2		2		1	0	9
19	Missing evaluations/limits on Power Quality including multiple EVs charging effects		2		2		2		1		1	0	8
20	Missing a standard for DC metering		2	1	1		1	1	1		1	2	6
21	Missing standard for communication EVSE Backend – DSO (e.g. for Smart Charging)		2		2		3		2		1	0	10
22	Missing a maximum power limit on charging	1		1		2		2				6	0
23	Missing standard for communication EVSE Backend – EVSP		1		2		2		2			0	7
24	Missing standard for communication EVSP – Energy Provider		1	2		1	1		2			3	4
25	Missing standard for communication EVSE (or EVSP) Backend – Clearing House		1	1	1		2		2			1	6
26	Missing standard for communication Marketplace – all actors		2	1	1				2			1	5
27	Missing sufficient features to guarantee protection from cyber attacks	1	1		2	1	1		2			2	6
28	Missing common rules and guidelines to handle privacy sensitive data		2		2		1		2			0	7
29	Missing a common choice/standard on business models for payment (pay by contract, pay by cash-equivalent system, charge for free,…)		2		2		3		2			0	9
											TOT	60	159