Deliverable 7.3 Second Version

Current status of technologies and standards in the demonstration projects

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Date: **February 3rd, 2015**

Version: **2.0**

Document Information

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Distribution

Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Revision history

Version	Date	Author	Description
1.0	April, 7 2014		Initial version
1.1	June, 18 2014		Final Draft for Review
1.2	July, 10 2014	External Review by Bart Benders	Final Draft
1.3	August, 6 2014	Comments by Project Coordinator	Final Draft
2.0	February, 3 2015	Filippo Colzi, Silvia Celaschi	Second Version

Status	
For Information	
Draft Version	
Final Version (Internal document)	
Submission for Approval (deliverable)	x
Final Version (deliverable, approved on)	

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List of Abbreviations

A	Ampere
AC	Alternating Current
ACEA	European Automobile Manufacturers Association
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
BCU	Battery Control Unit
BDSG	Bundesdatenschutzgesetz
BE	Back End
BMS	Battery Management System
B2B	Business to Business

CA	Consortium Agreement
CAN	Controller Area Network
CCS	Combined Charging System
CD	Committee Draft
CDR	Charge Detail Record
CEE	Certification of Electrotechnical Equipment
CHAdeMO	CHArge de MOve
CIP	Critical Infrastructure Protection
CLEPA	European Association of Automotive Suppliers
COSEM	Companion Specification for Energy Metering
CP	Charging Point
D	Deliverable
DC	Direct Current
DCR	Database Change Request
DER	Distributed Energy Recourse
DKE	Deutsche Kommission Elektrotechnik
DLMS	Device Language Message Specification
DoW	Description of Work (Annex I of Grant Agreement)
DSO	Distribution System Operator
ELV	Extra-Low Voltage
EMC	Electro Magnetic Compatebility
eMI3	eMobility ICT Interoperability Innovation
E-Mobility	Electro Mobility
ENTSO-E	European Network of Transmission System Operators for Electricity
EPS	Electric Power System
ESF	External Stakeholder Forum
ESO	European Standards Organization
EURELECTRIC	Union of the Electricity Industry
EV	Electric Vehicle
EVCOID	Electric Vehicle COntract IDentification
EVSE	Electric Vehicle Supply Equipment
EVSEID	Electric Vehicle Supply Equipment IDentification
EVSP	Electric Vehicle Service Provider
FPF	Forward Power Flow
GeM	Green eMotion
HAN	Home-Area Network
HEMS	Home Energy Management System
HV	High Voltage
Hz	hertz
ICT	Information and Communication Technology
ID	IDentification
IEC	International Electrotechnical Commission
IECEE	International Commission on the Rules for the Approval of Electrical Equipment
IREC	Institut de Recerca en Energia de Catalunya
ISM	Industrial, Scientific and Medical
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
JMS	Java Message Service
kVA	kiloVolAampere
kW	kiloWatt

LBC	Load Balancing Controller
LEV	Light Electric Vehicles
Li	Lithium
LV	Low Voltage
MHz	megahertz
MV	Medium Voltage
NEC	National Electrical Code
NFPA	National Fire Protection Association
NPE	National Platform for Electric Mobility - Germany
NTA	Nederlands Technische Afspraak
NWIP	New Work Item Proposal
OEM	Original Equipment Manufacturer
OCHP	Open Clearing House Protocol
OCPP	Open Charge Point Protocol
OICP	Open Intercharge Protocol
PCD	Proximity Coupling Device
PFCV	Plug-in Fuel Cell Vehicles
PHEV	Plug-in Hybrid Electric Vehicle
PICC	Proximity Integrated Circuit Card
PLC	Power Line Communication
PoD	Point of Delivery
PODID	Point of Delivery IDentification
PWM	Pulse Width Modulation
RCCB	Residual Current Circuit Breaker
RESS	Rechargeable Energy Storage system
REST	Representational State Transfer
RFP	Reverse Power Flow
RFID	Radio Frequency IDentification
RIP	Revision In Progress
SAE	Society of Automotive Engineers
SCADA	Supervisory Control And Data Acquisition
SDM	Supply Demand Management
SDR	Service Detail Record
SEP	Smart Energy Profile
SG	Smart Grid
SOAP	Simple Object Access Protocol
SoC	State of Charge
SoH	State of Health
T	Task
TOA	Time Of Arrival
TOD	Time Of Departure
TOR	Technical and Organisational Regulations
V	volt
VDE	Verband Der Elektrotechnik Elektronik Informationstechnik
V2G	Vehicle to Grid
V2H	Vehicle to Home
WG	Working Group
WIP	Work In Progress
WP	Work Package
XML	Extensible Markup Language

1 Executive Summary

One of the key aspects that could boost a mass rollout of Electric Vehicles (EVs) 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).

In this report, the Gap Analysis process performed by Green eMotion (GeM) Working Package (WP) 7 is described. The aim of the work, which is strongly related with the global objective of the whole WP, is to identify which issues have still to be solved on e-mobility standards and how standardization activity should proceed in the next years.

The work started with the collection and the analysis of all the existing standards in the field of electric mobility, in order to identify the current situation. A specific focus on the 10 Green eMotion Demonstration Regions (DR) let to obtain a "real-life" overview of the applied technologies and standards. Then, a detailed analysis of the criticalities, issues and open points still present in this landscape have been carried on. Several means have been used to this scope, in order to cover a wide spectrum of stakeholders 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 organized;
- Relevant Green eMotion partners have been directly interviewed.

The combination of these instruments, with the involvement of many actors, brought to a quite large number of data, results and comments. The main issues have been so organized and included on a comprehensive table, which has been called "Gap Matrix". It has been possible to clearly identify 31 gaps, with different levels of criticality.

The main issues that need to be solved sorted by technology field are:

Vehicle

The vehicle itself is covered by many standards, but there are still some lacks regarding the "new" aspects that differ EVs from traditional vehicles, e.g.

- standardized procedures for battery handling during emergencies that will enable training of drivers and emergency services.
- new standards for driving range evaluation that will give the driver reliable range values for EV's.
- standards for regenerative braking that will harmonize the impact of accelerator pedal and brake pedal on speed.

Charger (Electric Vehicle Supply Equipment – EVSE)

The most important actor at the moment is the charging point (Electric Vehicle Supply Equipment – EVSE) and its interaction with the vehicle/user side, as well as with the grid/operator side:

- In roaming scenarios the user needs to identify himself at the EVSE of another operator than at home. He will often use an RFID card. As a high variety of standards for RFID exist, this will not always work. A common standard for identification/authorization is needed.
- In roaming scenarios a communication is needed between the operator of the EVSE and the service provider of the user which could be any service provider existing. In order to make communication of all involved computer systems possible, we need standardized identifiers and business objects.

- Regarding the interface between EV and EVSE we face the situation of several standardized plugs and also charging modes, e.g. slow charging with household plug, AC fast charging with type 2 plug, DC fast charging with combo 2 plug. To ensure that EV's really function with the foreseen charging interface of the EVSE we need standardized conformance tests.
- With the emerging of green energy coming from PV, water, wind, etc there is a need to manage the power demand by EV's based on the availability of those energy sources. Therefore a standardized protocol for communication between the grid control by DSO's/TSO's on one hand and the charge point (EVSE) operators on the other hand is needed.

Green eMotion has not only the task to identify gaps in standardization but also to actively work on the needed standards. To give a high impact it was decided to focus on development of new standards with ICT aspects. Part of that was the foundation of the eMI3 group (eMobility ICT Interoperability Innovation Group) together with other industry partners to broaden the agreement level on those consortium standards and to ensure the continuation of activities after Green eMotion project end. Partners of Green eMotion fulfill part of their obligations by contributing to eMI3.
In detail Green eMotion has started standardization activities in the following fields:

- Communication interface between the charging hardware (EVSE) and the control software (backend system) - This is mandatory if an operator of EVSE's, which will in general only have on control system, wants to connect chargers from different manufacturers that might require different communication protocols. Green eMotion drafted a plan how to get to a common communication protocol that has then been adopted by the eMI3 consortium where it is followed in the working group 5.
- Based on the proposal of former partner Better Place on interchangeable RFID cards for identification/authentication in roaming scenarios, standardization work has been started in IEC. Green eMotion partners are actively involved in the IEC work.
- One of the most urgent topics for standardization identified within Green eMotion is the standardized identifiers and business objects. Within eMI3 an agreement on standardized contract identifiers and EVSE identifiers could already be reached. The results are part of ISO/IEC standards 15118 and also documented in Green eMotion report D3.9 "Standards and protocols specifications" available at http://www.greenemotion-project.eu/dissemination-/deliverables-ict-solutions.php.
- Regarding power demand management (e.g. for load management purpose or smart charging) Green eMotion has developed a demonstration example 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 available at http://www.greenemotion-project.eu/dissemination/deliverables-evaluations-demonstrations.php in spring 2015.

Additionally Green eMotion will use the full list of identified gaps in standardisation (see gap matrix in this report) to derive a standardization roadmap for the mid-term future. This roadmap will be published in spring 2015 as report D7.8 "Guidelines for standardization and interoperability".

Updates in the second version

The document has been updated in February 2015, including the following contents:

- Update on technology and standards applied in the Demo Regions;
- Update on new relevant standardization activity (in particular 2014/94/EU Directive);
- Feedbacks on the Gap Matrix received during a dedicated workshop (Brussels, May 2014);
- Comments and suggestions on new gaps coming from involved experts;
- Updates on Green eMotion standardization activities.

2 Introduction

The transition of transport from fossil fuels to electricity will represent a significant part of the targets that Europe is aiming to achieve in the next few years. Electric mobility can indeed guarantee a higher well-to-wheel energy efficiency and, at the same time, the decrease of pollutant emissions as well as their delocalization from city centers to generation power plants. Despite of these advantages, Electric Vehicles are still struggling against some hurdles that limit their market share to a small percentage.

One of the key aspects that could boost a mass rollout of EVs is the development of harmonized standards at European and International level. This way, several benefits can be obtained, both for the end 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).

Inside the Green eMotion project, WP7 is the one devoted exactly to standards harmonization and its structure has been thought to identify which issues have still to be solved and how should standardization activity proceed in the next years. In the very first phase of the work, a detailed analysis of the existing standards has been carried out, which has been included in Deliverable 7.1 "Review of technologies and standards in the demonstration projects" (see http://www.greenemotion-project.eu/upload/pdf/-deliverables/D7_1-Review-of-Technologies-and-Standards-V1_11-submitted.pdf). In parallel, the demonstration projects on-going inside the Green eMotion framework have been examined, in order to detect which standards are the most used and which issues could arise from a real-world implementation of electro-mobility.

Once settled the current status of standards, the attention has been focused on identifying the open topics, i.e. issues and needs still not covered by standards and which will be necessary to address in short term. To do that, different stakeholders have been consulted through two properly arranged surveys, which results have been summarized in two subsequent versions of Deliverable 7.2 "Standardization issues and needs for standardization and interoperability" (see http://www.greenemotion-project.eu/upload/pdf/deliverables/D7_2-Standardization-issues-and-needs-for-standardization-and-interoperability_V2_5-submitted.pdf). At the same time, three Standardization Workshops have been organized in Valladolid, Brussels and Milan collecting opinions and experiences of GeM partners involved in standardization issues.

Given that, the aim of this Deliverable 7.3 is to recap the most important parts of this path and to summarize the results with an effective and synthetic instrument, which will have the shape of a "gap matrix". The document will include a synthesis of the existing standards, as collected in D7.1.Then, a picture of the standards used in GeM Demo Regions will be provided, leveraging on the updated data delivered by the partner IREC in the internal document "D1.3 Data logging annual report 3" (May 2013). The identification of the "open points" will then be presented, highlighting the results coming from both the surveys (D7.2), the workshops, and direct interviews of relevant GeM partners. At last, the Gap Matrix itself will be introduced, with a detailed description of its structure, its content and the related recommendations for future standardization activity.

New in second version

In the second version of the document (February 2015), the data related to Demo Regions were updated, thanks to IREC new D1.4 "Monitoring Demonstration Region, Lessons Learnt Report" (December 2014). Moreover, the intervened changes in European standardization and regulation situation were pointed out,

in particular regarding the 2014/94/EU Directive, definitely signed in October 2014. The comments and feedback on the Gaps gathered during the dedicated Standardization Workshop “E-Mobility Standards, what’s missing?” held in Brussels in May 2014 were also reported, giving a more complete and agreed view of actual standardization issues and needs.

3 E-Mobility Standards: what is existing?

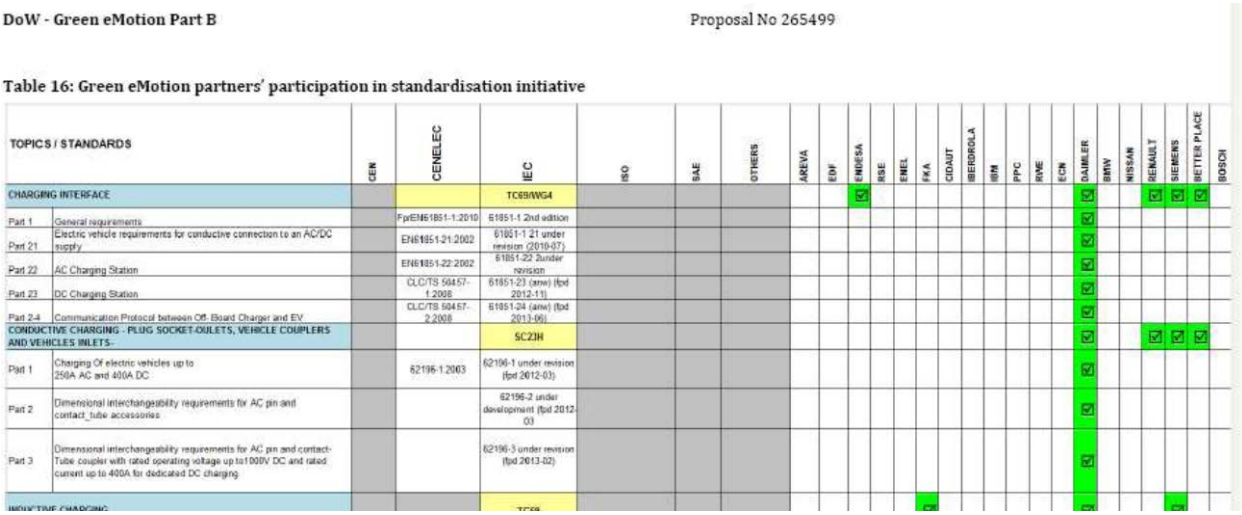
In order to obtain a complete view of the standardization activity and to identify the most critical and still not solved aspects, the first step inside WP7 was to collect and analyse all the existing standards related to electro-mobility.

This work, performed mainly by the partner Cidaut and reported in Deliverable 7.1, has brought to the construction of a wide table , which has represented a reference point for the following work.

In the next paragraphs, a short review of the table construction and of the information collected will be depicted.

3.1 Information collection

To elaborate Deliverable 7.1, different sources of information have been used. At the beginning, information included in the Description of Work (DoW) of the project (Figure 3-1) was taken as a first reference. In the DoW, a first list of standardization initiatives was indeed presented, including also the direct involvement of GeM partners.



DoW - Green eMotion Part B Proposal No 265499

Table 16: Green eMotion partners' participation in standardisation initiative

TOPICS / STANDARDS		CEN	CENELEC	IEC	ISO	SAE	OTHERS	AREVA	EDF	ENDESA	RSE	ENEL	FKA	CIDAUT	IBERDROLA	IBM	PPC	RWE	ECN	DAIMLER	BMW	NISSAN	RENAULT	SIEMENS	BETTER PLACE	BOSCH
CHARGING INTERFACE				TC69/WG4						☑										☑			☑	☑	☑	
Part 1	General requirements		FprEN61851-1:2010	61851-1 2nd edition																☑						
Part 21	Electric vehicle requirements for conductive connection to an AC/DC supply		EN61851-21:2002	61851-1 21 under revision (2010-07)																☑						
Part 22	AC Charging Station		EN61851-22:2002	61851-22 2under revision																☑						
Part 23	DC Charging Station		CLC/TS 50457-1:2008	61851-23 (anw) (fpd 2012-11)																☑						
Part 24	Communication Protocol between Off- Board Charger and EV		CLC/TS 50457-2:2008	61851-24 (anw) (fpd 2013-06)																☑						
CONDUCTIVE CHARGING - PLUG SOCKET-OULETS, VEHICLE COUPLERS AND VEHICLES INLETS-				SC23H																☑			☑	☑	☑	
Part 1	Charging Of electric vehicles up to 250A AC and 400A DC		62196-1:2003	62196-1 under revision (fpd 2012-03)																☑						
Part 2	Dimensional interchangeability requirements for AC pin and contact_tube accessories			62196-2 under development (fpd 2012-03)																☑						
Part 3	Dimensional interchangeability requirements for AC pin and contact-Tube coupler with rated operating voltage up to1000V DC and rated current up to 400A for dedicated DC charging			62196-3 under revision (fpd 2013-02)																☑						
INDUCTIVE CHARGING				TC69									CH											CH		

Figure 3-1 Information from Annex I, in "Description of Work" document

In the immediately following phase, WP7 partners (Siemens, Areva, Better Place, EDF, Endesa, RSE, Enel, fka, Cidaut, Iberdrola, IBM, IREC, PPC, RWE, ECN, Eurelectric, Daimler, BMW and Renault) were consulted, and this let the collection of additional information including, in some cases, working documents from standardization bodies with relevant information about standards.

Starting from this base, the work proceeded identifying the main standardization bodies today existing and working on this topic, in order to perform a deep and careful census of all the most relevant standards. The following standardization bodies have so been considered:

- **DS** (Danish Standards)
- **CEN** (European Committee for Standardization)

- **CENELEC** (European Committee for Electro-technical Standardization)
- **IEC** (International Electro-Technical Commission)
- **ISO** (International Organization of Standardization)
- **IEEE** (Institute of Electrical and Electronics Engineers)
- **SAE** (Society of Automotive Engineers)
- **UL** (Underwriters Laboratories)
- **NFPA** (National Fire Protection Association)
- **NERC** (North American Electric Reliability Corporation)

Figure 3-2 A sample of different Standardization Bodies studied in Deliverable 7.1.

In addition to that, international Committees and Groups active in the field have been analyzed, considering that several issues are included in these sources of information, from the definition of EV Plugs and Connectors to technical aspects about “Smart Grid” and Data Transmission.

At last, many information has been obtained by analysing real implementations in approximately 20 on-going demo projects, and by studying “on the market” products by the main Charging Point suppliers.

3.2 Table structure

The critical fields for EV Interoperability have been classified into four technologies:

- Vehicle;
- Charging Infrastructure;
- Connection to the Grid;
- Communication.

A possible architecture showing the linkage among these technologies was built by CEN/CENELEC *Focus Group on European Electro-Mobility* and is showed in the diagram of Figure 3-3. In Figure 3-4 the reference architecture officially developed by Green eMotion (building blocks) is instead shown.

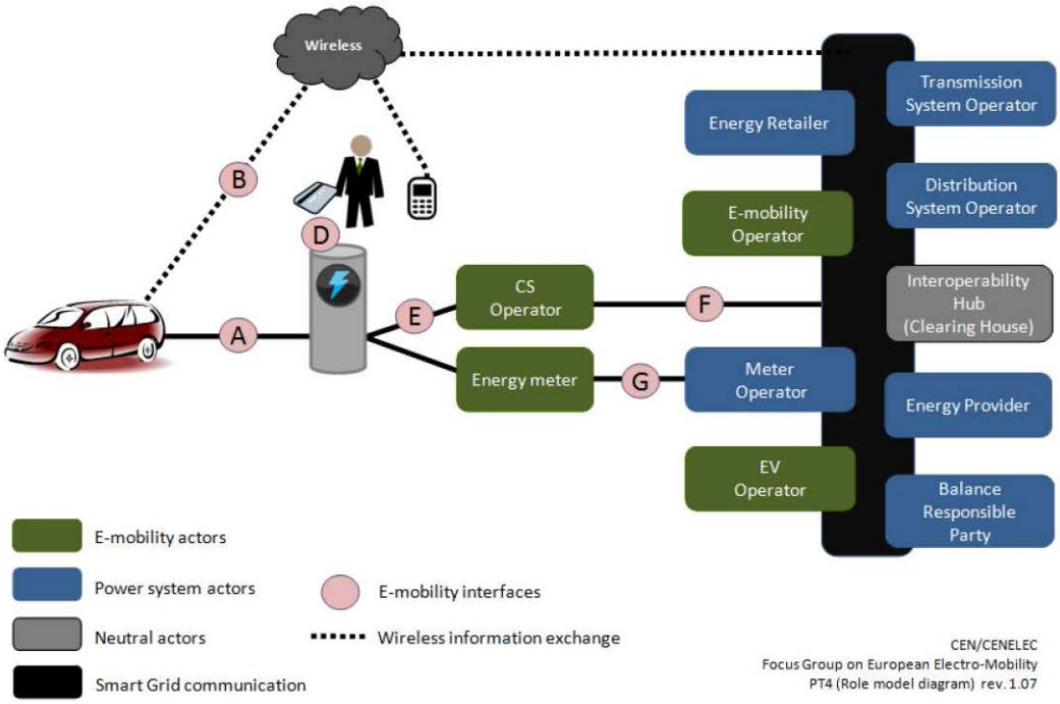


Figure 3-3 Overview of linkage among technologies in EV interoperability *(From CEN/CENELEC Focus Group on European Electro-Mobility).*

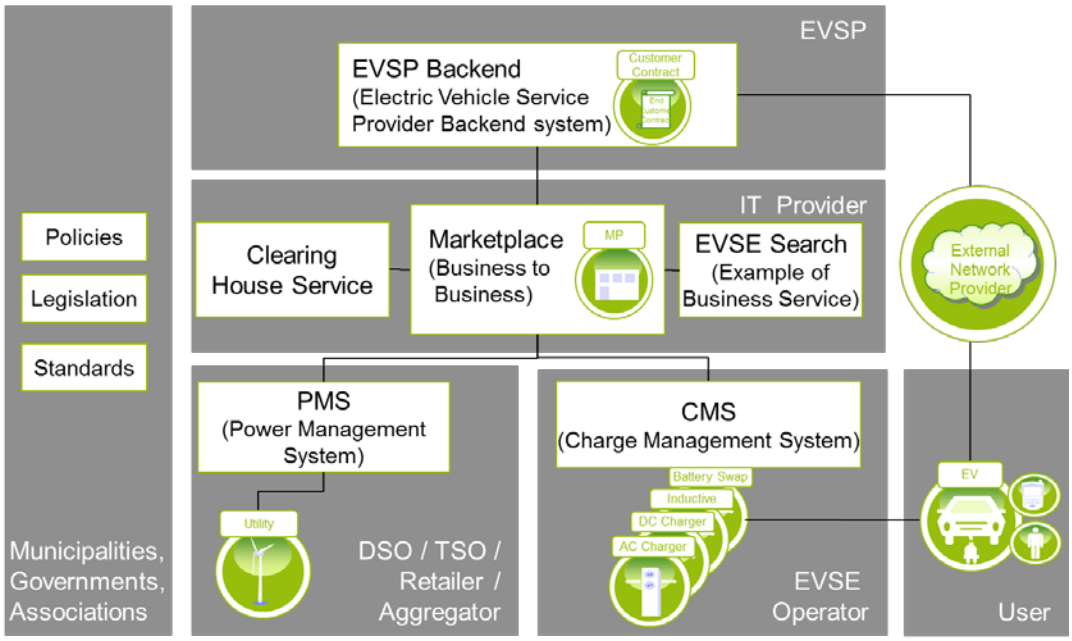


Figure 3-4 Green eMotion reference architecture: building blocks

For each technology there are different systems associated, which have been treated as a sub-type of the main classification (e.g. connectors, cables, charger, converter, energy storage, performance, user interface, safety, electromagnetic compatibility,…). For more detailed information, see the complete D7.1 (http://www.greenemotion-project.eu/upload/pdf/deliverables/D7_1-Review-of-Technologies-and-Standards-V1_11-submitted.pdf).

For each standard, the following information has been collected:

- Standardization Body;
- Code/number;
- Title;
- Date of Publication;
- Review Date;
- Draft/Maintenance Result Date;
- Related technologies/systems.

In Figure 3-5 a small part of the table has been reported, in order to show its general structure.

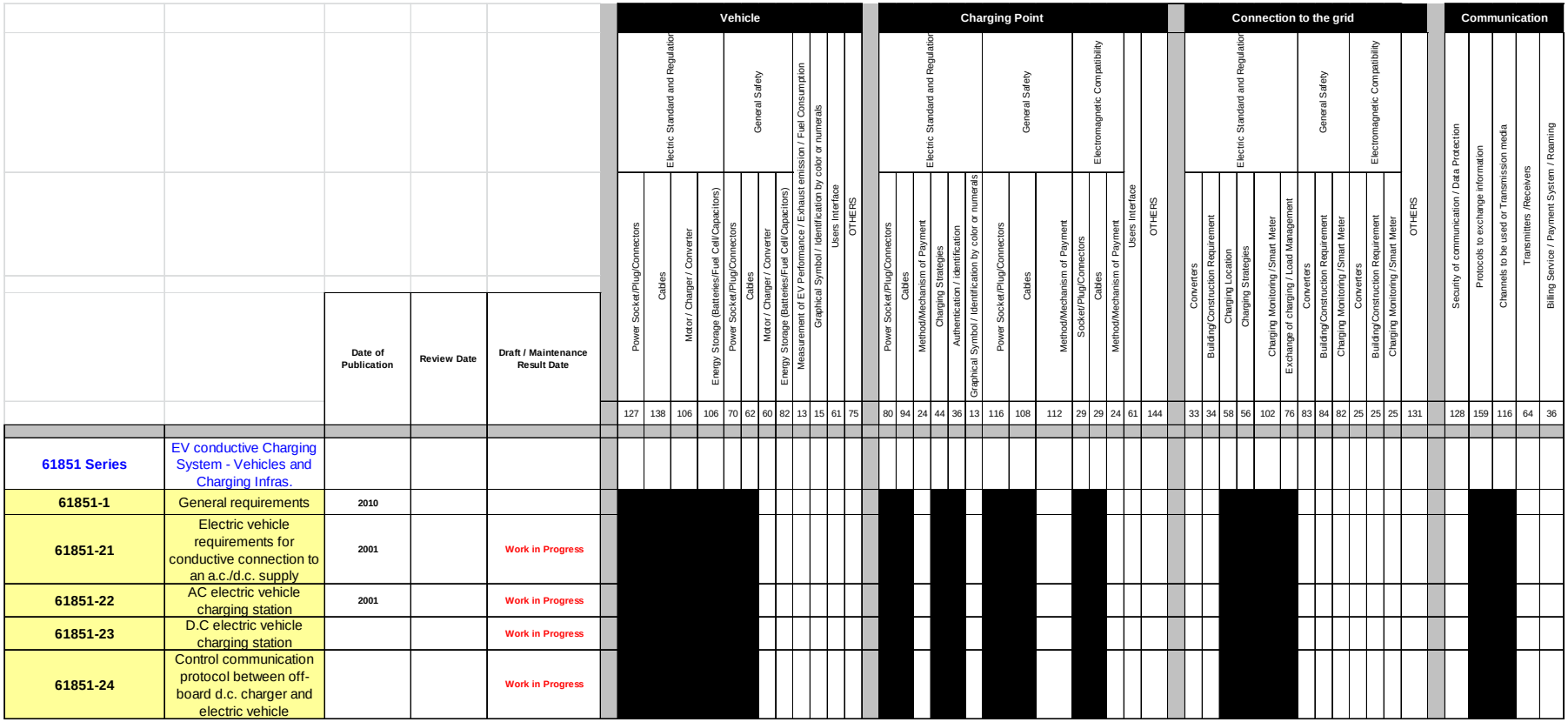


Figure 3-5 Comprehensive standards Table, sample part

3.3 Results

As already stated, the output of the work has been a very wide table which can be used as a picture of the existing situation. Wanting to extrapolate some first useful data, it can be seen that the total number of identified standards is **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**, followed by ISO, see Table 3-1.

Table 3-1 Number of standards collected for each standardization body

Standardization Body	Number of collected standards
IEC	**424**
ISO	**138**
SAE	**52**
CENELEC/CEN	**34**
UL	**16**
IEEE	**11**
European Parliament	**5**
DS	**2**
ITU	**2**
NFPA	**2**
NERC	**1**
Smart Energy 2.0	**1**
VDE (DKE)	**1**
ETSI	**0**
Others	**0**
TOTAL	**689**

Having divided the standards in the four technology areas, it is possible to identify which part was prioritized by the standardization bodies. Table 3-2 reports the number of standards that deal with each of the four areas. Notice that each standard could refer to more than one technology area, so the total number is significantly superior with respect to the previous table.

Table 3-2 Number of standards for each technology area

Technology area	Number of standards
Vehicle	**375**
Charging Point	**386**
Connection to grid	**307**
Communication	**189**

The charging point emerges as the most addressed component, but also the vehicle itself is considered in a high number of standards. Importantly inferior is the number of standards which refers to the communication, aspect that will be better examined in the next chapters.

More in general, it can be stated that the table considers a very high number of topics, many of which are not dedicated exclusively to electric vehicles but related to many kinds of vehicles or of electric equipment. These standards are obviously fundamental for a correct design and management of electric vehicles and charging infrastructure, but they are probably well known by manufacturers and don't include relevant modifications due to the innovations of electro-mobility. Just as example, ISO 9241 series, related to "Ergonomics of human-system interaction", or IEC 60068 series, which deals with "Environmental testing" can be mentioned. A deeper analysis of the "relevance" of the different standards with respect to e-mobility and interoperability will be presented in the next chapters.

3.4 The new 2014/94/EU Directive (new in version 2)

On October 22nd, 2014 the European Parliament and the Council of the European Union delivered a Directive on the deployment of alternative fuels infrastructure. It was an extremely relevant example of regulatory activity on e-mobility, giving for the first time clear indications on the development of a standardized charging 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, at least Combined Charging System (CCS Combo 2) for high power DC charging.

The process to develop the final version of the Directive included several drafts and several discussions. One of the most debated referred to choices on DC charging and, in particular, on CHAdeMO charging system. In 2013, the European Parliament published indeed a draft that suggested to terminate CHAdeMO in Europe at the end of 2018. This brought about a number of objections from several stakeholders' bodies (including CHAdeMO).

In April 2014, the European Union adopted then a draft proposal supporting the "Dual Standard Approach". While the Directive requires that all DC Fast Charging infrastructure support the Combo Charging System, through the EN62196-2 plug, at the same time it allows such charging stations to also support CHAdeMO. The Directive acknowledged also that some EU countries had already spent quite a bit on CHAdeMO fast charging infrastructure. The same approach was finally reported in the official and definitive Directive:

"Interface to charge electric vehicles could include several socket outlets or vehicle connectors as long as one of them complies with the technical specifications set out in this Directive, so as to allow multistandard recharging. However, the choice made in this Directive of Union-wide common connectors for electric vehicles (Type 2 and Combo 2) should not be detrimental to Member States having already invested in the deployment of other standardised technologies for recharging points and should not affect existing recharging points deployed before the entry into force of this Directive."

4 E-Mobility Standards: what is applied? - Technology and Standards in the demo Regions (updated in version 2)

The work carried out for deliverable D7.1 and just described in the previous chapter has let to draw a high-definition picture of the status of standards. In order to give a more practical approach to this topic, it has been considered useful to observe more in detail which is the real situation in the Green eMotion Demo Regions.

As well known, the Green eMotion project can indeed count on a high number of electric vehicles and charging points, distributed on the 10 Demonstration Regions (DR) reported in Table 4-1.

Table 4-1 List of Green eMotion Demonstration Regions

DR Code	Demo Region	City/Region	Responsible GeM partner
DE1	BERLIN	Berlin	RWE
DE2	STUTTGART−KARLSRUHE	Stuttgart, Karlsruhe	BOSCH
DK3	DENMARK 3	Better Place EV Demo	Better Place[1]
ES1	SPAIN 1	Barcelona, Málaga	ENDESA
ES2	SPAIN 2	Madrid, Guipúzcoa	IBERDROLA GENERACION
FR1	STRASBOURG	Strasbourg	EDF R&D
HU1	HUNGARY	Budapest	RWE
IE1	IRELAND	Dublin	ESB eCars
IT1	ITALY	Rome, Pisa, etc...	ENEL
SW1	SWEDEN	Malmö	City of Malmö

The analysis of the technologies and standards adopted in the Demo Regions resulted in the identification of which of the almost 700 standards are the most applied in real applications; being interoperability the focus of the project, the key part of the system looks to be the charging point and, in particular, its interaction with the vehicle on one side and with the grid and other involved actors on the other side. According to this, the chapter will start reporting some general information on the Demo Regions and will then proceed with a focus on the charging point.

All the presented data have been collected by partner IREC within the activity of WP1 “Synchronisation of demonstration regions” and are updated at December 2013 (Month 34 of the Project).

4.1 General overview

Table 4-2 reports the number of electric vehicles, charging points and users that the Demo Regions have registered during the different periods. At the end of this first 34 months of the project, there are **2264 charging points** installed, **685 vehicles** and **1362 users** registered in the data collection process, with a remarkable increase in comparison with the starting line situation.

[1] The data from Betterplace were collected until its bankruptcy in May 2013

Table 4-2 Number of items included in Demo Regions

Registered component	1st Data Logging Report (Aug. 2011)	2nd Data Logging Report (Dec. 2011)	3rd Data Logging Report (Nov. 2012)	4th Data Logging Report (Dec. 2013)
Electric vehicles	180	235	528	685
Charging points	422	598	1731	2264
Users	213	269	924	1362

Observing the general behaviour in the Demo Regions, Table 4-3 summarizes the dynamic data of the vehicle fleet, while Table 4-4 characterizes the charging processes that have been registered during the monitoring period. It must be remarked that **data coming from electric vehicles and charging poles are completely independent**. Charging points can indeed be used by vehicles that are not participating in the GeM and electric vehicles can charge in charging points not belonging to GeM. This information must then be analysed separately and no direct correlations can be made.

Table 4-3 General information about GeM fleet

Total driven distance (km)	Average trip distance (km)
526 292	5.97

Table 4-4 General information about GeM charging points usage

Total charging processes	Total energy charged (kWh)	Average energy charged per event (kWh)
124 363	758 948	6.10

4.2 Charging points features

The charging point (CP or EVSE) represents the fundamental connection between the vehicle and all the related electric and service systems, and is therefore the main actor for many standardization aspects. Issues about plugs/sockets are referred mostly to the CP, as well as aspects of grid connection, communication, identification and payment.

In this section the principle results presented in D.1.4[2] dealing with the characteristics of the Charging Points installed in the Demo Regions are reported. The objective is to describe which are the most common situations, both in terms of management aspects (location), electric features (voltage, current,…) and standards-related characteristics (plugs, communication protocols,…).

[2] D1.4: Monitoring Demonstration Region Lessons Learnt Report (December 2014)

4.2.1 Location

Table 4-5 shows the absolute number and the percentage of where the charging points are placed according to the following locations:

- **street**: *charging point located in the street.*
- **public access parking**: *charging point located in a private parking with public access.*
- **office parking**: *charging point located in a parking of a private company.*
- **household**: *charging point located in a parking of a house or building.*
- **others**: *charging point located in any location not included in the previous cases.*
- **private**: *charging point located in a private parking.*

Table 4-5 Frequency table, CP Location in GeM Demo Regions

		Location					
		household	*office parking*	*others*	*private*	*public access parking*	*street*
GeM	N	133	323	37	3	63	1011
	%	8.47%	20.57%	2.36%	0.19%	4.01%	64.39%

The analysis of the data in the table shows that more than half of the Green eMotion charging points is located on the *street*.

4.2.2 Electric parameters

4.2.2.1 Input Power Supply

In Table 4-6, the characteristics of the connection between the charging point and the grid are considered (input power from the grid to the CP). Data about type of power supply and input nominal power are displayed and it can be stated that most of the charging points, 68.05%, are connected to a three-phase distribution circuit.

Table 4-6 Frequency table, input phase and power supply in GeM Demo Regions

		Input phase		Input Nominal Power [kW]							
		single-phase	three-phase(+neutral)	(2,4]	(4,6]	(6,10]	(10,13]	(13,15]	(15,22]	(22,44]	(44,51]
GeM	N	721	1536	579	44	2	716	81	484	234	1
	%	31.95%	68.05%	27.04%	2.06%	0.09%	33.44%	3.78%	22.61%	10.93%	0.05%

In Table 4-7, input nominal voltage and current at the CP are reported. The Table shows that most of the charging points, 62.92%, are connected with a nominal voltage of 230V and that 56% of charging points have an input current of 16A. The 43% left is mainly distributed between 32A and 63A.

Table 4-7 Frequency table, input nominal voltage and current in GeM Demo Regions

		Input Nominal Voltage [V]				Input Nominal Current [A]								
		220	230	380	400	10	13	16	17.64	25	32	48	63	125
GeM	N	5	1420	365	467	26	16	1263	6	1	538	1	406	1
	%	0.22%	62.92%	16.17%	20.69%	1.15%	0.71%	55.96%	0.27%	0.04%	23.84%	0.04%	17.94%	0.04%

4.2.2.2 Output power supply

In this section, the type of power supply going from the charging station to the electric vehicle is analyzed. In particular, several options are considered:

- **single-phase**: *the electric power transmission to the EV is done through a single-phase (phase+neutral) connection.*
- **three-phase**: *the electric power transmission to the EV is done throught a three-phase without neutral connection.*
- **three-phase+neutral**: *the electric power transmission to the EV is done through a three-phase with neutral connection.*
- **DC**: *the electric power transmission to the EV is done through a direct current connection.*

Table 4-8 shows the data on output phase and nominal power in the Demo Regions. The output phase connection most used by the charging points in GeM is three-phase (67.51%) and the common ranges of output nominal power are between 2 and 4 kW, 10 and 13 kW and 15 to 22 kW (approximately one third each).

Table 4-8 Frequency table, output phase and power supply in GeM Demo Regions

		Output phase			Output Nominal Power [kW]				
		DC	single-phase	three-phase(+neutral)	(2,4]	(6,10]	(10,13]	(15,22]	(44,51]
GeM	N	1	734	1529	712	17	700	718	1
	%	0.04%	32.42%	67.51%	33.15%	0.79%	32.59%	33.43%	0.05%

Table 4-9 shows the CP output nominal voltage and nominal current. Most of the charging points (62.99%), provides a nominal voltage of 230V and 58.5% of charging points in GeM have an output current of 16A. 35.7% provides a current of 32A.

Table 4-9 Frequency table, output nominal voltage and current in GeM Demo Regions

		Output Nominal Voltage [V]				Output Nominal Current [A]							
		220	230	380	400	10	13	16	17.64	25	32	63	125
	N	12	1426	365	461	26	16	1325	6	1	808	81	1
GeM	%	0.53%	62.99%	16.12%	20.36%	1.15%	0.71%	58.52%	0.27%	0.04%	35.69%	3.58%	0.04%

4.2.3 Charging characteristics: charging modes and connectors type

This section gives an overview of charging modes adopted in the Demo Regions charging stations. The classification is done accordingly with IEC 61851-1, where:

- **mode 1**: *slow charging from a household-type socket-outlet.*
- **mode 2**: *slow charging from a household-type socket-outlet with an in-cable protection device.*
- **mode 3**: *slow or fast charging using a specific EV socket-outlet with control and protection function installed.*
- **mode 4**: *DC fast charging using an external charger.*

From data in Table 4-10 it can be concluded that the most used charging mode is 3, registered in 89.49% of charging points.

Table 4-10 Frequency table, charging mode and socket/connector in GeM Demo Regions

		Mode				Type of socket or connector					
		1	*2*	*3*	*4*	*CHADEMO*	*IEC 62196-2 TYPE 1*	*IEC 62196-2 TYPE 2*	*multiple*	*others*	*Schuko*
	N	222	15	2026	1	1	150	1881	6	161	65
GeM	%	9.81%	0.66%	89.49%	0.04%	0.04%	6.63%	83.08%	0.27%	7.11%	2.87%

4.2.4 Authentication system

Table 4-11 presents the availability of authentication system of the vehicle/user per charging point, classified according to the following categories:

- **none**: *neither the vehicle or the user can be authenticated.*
- **vehicle**: *only the vehicle can be authenticated.*
- **user**: *only the user can be authenticated.*
- **both**: *both the vehicle and the user can be authenticated.*

It can be seen that 98% of the implemented systems authenticate the user and 44.7% both the user and the vehicle.

Table 4-11 Frequency table, authentication system of the vehicle/user in GeM Demo Regions

		Authentication system of the vehicle/user			
		both	*none*	*user*	*vehicle*
GeM	N	1012	38	1204	10
	%	44.70%	1.68%	53.18%	0.44%

4.2.5 Communication Protocols

The following Table 4-12, describes the communication protocol used between: EV – CP(EVSE) , CP(EVSE) – EVSE operator backend and EVSE operator backend – Clearing House, on the basis of the following categories:

- **CHADEMO**: *Global industry standard that states both a quick charging method for EV delivering up to 62.5kW on direct current and the connectors for this purpose.*
- **IEC 61851**: *Standard on "Electric vehicle conductive charging system" that applies to on-board and off-board equipment for charging electric road vehicles at standard AC supply voltages up to 1000V and at DC voltages up to 1500V.*
- ***others:*** *none of the previous cases.*
- ***none:*** *there is not any communication protocol between EV and charging point or between charging spot and the charging spot operator or energy meter..*
- ***gprs****: general packet radio service.*
- ***ethernet:*** *computer networking technologies for local area networks (LANs).*
- ***multiple****: the charging point has multiple outputs with different protocols.*

The first section of Table 4-12 shows the data from the Demo Regions; the communication protocol IEC 61851, between EV – CP, is the most used in GeM (72% of the registered charging points).
The second section of the Table 4-12 reports the communication protocol adopted between charging point and the operator. The most widely used communication protocols in GeM is gprs with 65.5%.
The third section describes the communication protocol from charging spot operator upstream. The communication protocol between the operator and the clearing house mainly used in GeM is gprs, with a 63%.

Table 4-12 Frequency table: communication protocols EV-CP(EVSE); CP(EVSE)- EVSE operator backend; EVSE operator backend - CH

		Comm. Prot. EV – CP(EVSE)					Comm. Prot. CP(EVSE) - EVSE operator backend					Comm. Prot. EVSE operator backend - Clearing house			
		CHADEMO	IEC 61851	multiple	none	others	ethernet	gprs	multiple	none	others	ethernet	gprs	none	others
GeM	N	1	1629	56	369	202	15	1362	6	47	649	167	1310	504	92
	%	0.04%	72.18%	2.48%	16.35%	8.95%	0.72%	65.51%	0.29%	2.26%	31.22%	8.06%	63.19%	24.31%	4.44%

4.2.6 Summary

From the analysis of more than 2.200 charging points used in Green eMotion Demo Regions it is possible to highlight the following points:

- The 64% of the charging points monitored in Green eMotion are located at the street.
- The most installed charging mode is Mode 3 with the 89% of the charging points.
- The most common communication protocol between the charging point and the electric vehicle is
    - IEC 61851 (72% of the monitored elements).

The just reported data can be considered as “static data”. The work conducted in WP1 has let to collect a lot of other data, related not only to the characteristics, but also to the use of the charging points. These data are referred as “dynamic information” and have not been reported here.

5 E-Mobility Standards: what is missing?

The work so far described, including both the collection of existing standards and the analysis of the situation in the Demo Regions, was preparatory to perform a detailed analysis of the criticalities still present in the standardisation 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 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 organized;
- relevant Green eMotion partners have been directly interviewed.

In this chapter, the results coming from the just mentioned efforts are reported, trying to highlight the topics that will then be included in the "Gap Matrix" described in Chapter 6.

5.1 Surveys on EV standardization objective and results (Task/Deliverable 7.2)

The object of WP7 task 7.2 was to monitor and manage the collection of standardization issues and needs as emerged in other WPs during the different development phases of the demonstration projects, as well as to observe the evolution of standards and standardization activities.

The work has been carried out through the preparation of two surveys, circulated in 2011 and 2012 among WP7 partners, Demonstration Regions and few external stakeholders.

The first survey addressed the same four different technological areas used in the previously described Task/Deliverable 7.1:

- Electric Vehicle;
- Charging Point;
- Connection to the Grid;
- Communication.

For each area, the following questions were made, in order to capture the most relevant standardization issues and needs:

- Which of the following standards on *vehicle/CP/Grid Connection/Communication* do you already use or intend to use? (Small list attached)
- Which other standards or non-standard solutions on *vehicle/CP/Grid Connection/Communication* do you (plan to) use?
- Which standards or extension to standards on *vehicle/CP/Grid Connection/Communication* do you miss?
- Do you have other issues or needs with respect to standards on *vehicle/CP/Grid Connection/Communication*, and which ones?

In addition to the four technological areas, a final section about “Other question and comments” has been proposed, with the intent to receive non guided feedbacks. The most significant part of this open section was the question:

- What are the top (three) standardization topics that really need to be addressed and that are the biggest challenges for the introduction of EVs?

This question gave the respondents the possibility to propose 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 the following technological areas, identified during the Green eMotion Month-18 Workshop on Standardization (October 2012, see Chapter 5.2.3 for more details):

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

For each of the listed aspects, several questions were proposed, in particular dealing with:

- Requirements or remarks for interoperability (including advices for EU decisions);
- Adopted technologies and solutions;
- Presence of country-specific standards;
- Needs for a work plan/roadmap;
- New aspects (and business models) that should be embedded in standards.

The principal results of the two surveys are reported in the following sections. To make the results more easy-to-read, there will not be a distinction of what came out from the first or the second survey. Besides, the results will be presented according to the same four technologies areas used in D7.1 and in the first survey.

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 - December 2nd, 2013” (http://www.greenemotion-project.eu/dissemination/deliverables-standards.php).

5.1.1 General results

As reported in chapter 3, in the first phases of WP7 activities it has been discovered that over 200 standards are potentially being used in electro mobility. From the two surveys, it instead appeared that only limited sets of standards have been mentioned by the respondents, confirming that many standards are used but are not considered a specific issue for e-mobility.
The significantly mentioned standards, used by multiple demonstrations sites and companies, are only 22 and they are listed in the table below, in decreasing order (most mentioned on the top).

Table 5-1 List of basic standards and protocols for and used in Electromobility

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 Charge 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

This list, which has not been treated as a complete list, but as a good starting point of basic standards, has been graphically transposed in Figure 5-1.

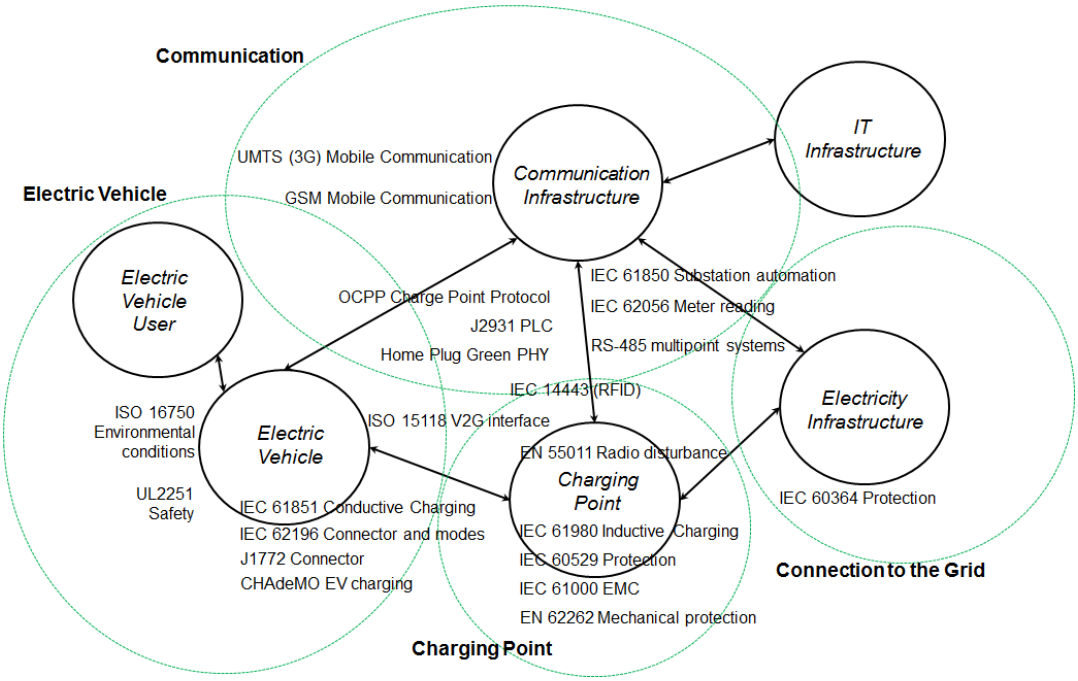


Figure 5-1 First list of basic standards mapped into their used area

A more detailed overview of the issues arisen for each technology area is reported in the following sections.

5.1.2 Electric Vehicle

The Electric Vehicle area seems relatively developed and mature, as several standards are now available and applied. Some missing points or overlaps have anyway been identified in the used standards.

In terms of **safety**, some respondents highlighted the need to harmonize the requirement about energy feedback at the vehicle inlet during the connection to the grid. Moreover, simple and reliable methods of identifying vehicles for rescue purposes (indicators for High Voltage, Lithium ions, hazardous substances etc.) need to be defined. In practice, it emerged the need for:

- battery safety labelling;
- battery systems safety condition after a severe crash;
- emergency rescue guideline.

Another critical aspect that emerged from surveys concerns **Electro Magnetic Compatibility (EMC)** regulation above harmonic range. The regulation and standards regarding EMC contains indeed a gap in the applied frequency ranges and the on-board chargers in vehicles might operate in these ranges.

Requests to clearly define the interfaces of **removable batteries to allow the battery switching** on the electric vehicles designed for this application also came out. It has been pointed out that:

- Standards about battery switch technology do not exist, at the moment;
- There is a lack of standards relating to battery switch station, especially for safety;
- There is a lack of standards for common interfaces for battery (e.g. standardization of battery module sizes);
- Stored battery data should follow a standard format/coding specification.

Standards for common interfaces should define the mechanical fixation points, the electric power connectors, the data connectors, the cooling fluids and their interfaces and the data formats that could be used during the charging of the batteries. These needs emerged from the surveys but at the moment, after the bankruptcy, in May 2013, of Better Place which proposed the solution of battery swapping, this solution is no more available and these issues are facing a “stand-by” situation. Another relevant area in which this standards are important is the second life usage of batteries; at the end of vehicle’s life, or simply when the performance of the battery pack is no longer valid for powering the EV the packs will be removed from the vehicle. Those batteries will still be available for other applications, in order to easy this process standards on the power connections and the data connections are required,

A specific attention from the respondents have been focused on charging modes and plugs/connectors in the vehicle side, aspect that will be deeply analysed also in the “Charging Point” area. From the answers to the surveys, it indeed came out that there are many different kind of electric vehicles, and that each of them still adopts a different charging solution.

Referring to IEC 61851, all the **charging modes** (from Mode 1 to Mode 4) are used for the charge of Electric Vehicles. In particular:

- Mode 1 is used for e-bikes and light EVs;
- Mode 2 for EVs charging in private places (typically at home);
- Mode 3 is the preferred solution for publicly accessible charging stations;
- Mode 4 (DC charging) is more rare, but is somewhere used for fast EVs recharge.

It has to be noticed that with regards to the charging solutions, Plug-in Hybrid Electric Vehicles (PHEVs) are considered by the respondents exactly as pure EVs, with the aim of developing a unique and common charging infrastructure.

Considering the **connectors** and referring to IEC 62196, it appeared that the most used is Type 2 connector, but that there are still a lot of different solutions. In particular, many respondents have reported the use of Schuko, Type E/F socket, both for Mode 1 public charging of light EVs and e-bikes, and for Mode 2 EVs private charging. This solution could present some problems, considering that extensive tests have revealed that Type E/F sockets could face overheating when used on a daily basis even at low power level (first overheating occurs at 10 A). Accordingly to that, the max available power will be limited to 8 A unless a specific socket is recognized thanks to a specific magnetic device implemented on both side of the plug and socket. In case of a dedicated socket, maximum current could be raised up to 14 A.

A quite peculiar situation can be found in Italy, where Light EVs (LEV) are connected to AC charging stations through both type 2 and type 3a connectors (most common solution) and with a simplified pilot circuit up to 16 A single phase. Mode 1 domestic charging is also allowed, but only in restricted private areas not opened to third party (access possible only to vehicle users by means of dedicated key or tools) and with charging current limited to 10 A.

Starting from these present-day issues, the most important aspects out of the survey can be summarized in the following points:

- Implement a simple and safe uniform charging systems both for home and for publicly accessible charging places.
- Define an unified connecting system (socket outlet + plug) on public charging point
- Overcome uncertainty on DC charging;
- Define connectors allowing for both AC and DC charge at a unique vehicle inlet.

A more detailed analysis of charging modes and connectors can be found in the next section referred to the Charging Point, as it appeared to be one of the most important aspects also for that technology area.

5.1.3 Charging Point

As already mentioned, the charging process represents a crucial aspect for the whole e-mobility system, involving issues on connectors, grid, communication and so on. In this part, we exclude grid connection and communication aspects, which will be treated later. The most critical issues appear then to be the several overlaps and non-homogeneities **in charging modes and socket outlets**.

To treat them, a division between AC and DC charging may be extremely useful.

5.1.3.1 Requirements for home AC charging

As just mentioned in the previous section, the respondents evidenced that for home charging, the most important issue is to guarantee a safe procedure with respect to overheating risks. In order to do that, there should be some limits on the current drawn from the domestic grid (proposal: 8 A for type 2 charging).

5.1.3.2 Requirements for public and semi-public AC Charging

As described in the previous chapter, the reference points for AC charging are IEC 61851 and IEC 62196. Having these always in mind, many respondents mentioned the IEC 60364-7-722:201X (64/1846/CDV) (EQV) “Low-voltage electrical installations - Part 7-722: Requirements for special installations or locations - Supply of electric vehicle”. This states that in some countries in public areas charging modes 1 and 2 are not allowed, as they are allowed only in restricted private areas not opened to third.

According to that, most of the respondents mentioned that IEC 61851-1 ed. 2 charging Mode 3 in public/semi-public charging should be mandatory with IEC 62196-2 type 2 connector on the charge point side. Nevertheless, in particular the Utilities remarked that each charging point should be also equipped with a classic type E/F socket to allow charging for two-wheelers and previous generation EVs in mode 1 or EVs charging with a mode 2 charging cable.

Interesting are also the comments on IEC 62196-2 type 3 connector. Some partners considered as essential the presence of shutters on the connector/socket (according to national regulation), guaranteed only by type 3. Others, instead, openly suggested to not use this connector, preferring the type 2.

An interesting evidenced point has been the need for minimum or maximum power levels, as EV users often implicitly expect that a (semi-) public AC charging points is able to charge faster than normal household outlets. Besides, a minimum power level is necessary in order to avoid long charging periods in public and semi-public places; on the other side, there should be probably a maximum power due to safety regulation, grid impact and also depending on the acceptance criteria of local grid operators.

It has been indicated that 6A is the minimum charging current as described in IEC 61851-1, and also that, by OEM point of view, 16A single phase AC charging (3,7 kW) is viewed as standard for AC public charging level. However, depending on the business model of the EVSE Operator, different regimes could be possible (e.g. for free charging at retailers, …).

According to the answers, there are three usual levels of power for public and semi-public AC charging points :

- normal charging (up to 3.7 kW) -16A single phase) ;
- accelerated charge (22 kW - 32A three phase), ;
- fast charging (43 kW - 63A three phase)

This last value has been proposed by some respondents as a possible maximum power level.

At last, another open point appeared to be the charging cable, which types and technical characteristics are mainly defined according to many different National Standards. It came out that there are differences in the section of charging cables even for the same rated current (e.g. 32A) but that at European level a first draft of a standard for charging cables is in preparation.

5.1.3.3 Requirements for public and semi-public DC Charging

The DC charging, described as Mode 4 by IEC 61851, is experiencing a slow but interesting diffusion, being recognized as an optimal solution to perform fast charging. The open points on this solution can be summarized in two bullets:

- presence of two different standards (CHAdeMO and CCS/Combo2);
- need for clear rules to install fast charging stations in public areas.

Starting from the first point, if for the AC charging recently a solution seems to have been reached on Type 2 with mechanical protective shutters when requested by national legislation, for DC charging the solution has not been yet found. CHAdeMO, the Japanese solution, is at the moment the most common connector in Europe but recently some of the most important organisations in the European automotive sector have agreed on a harmonised connector system for electric vehicles in order to avoid the current situation for AC charging (different technological solutions), with a standardization that plans to add DC wires to the existing AC connector types (Type 2 in Europe). This solution, named Combined Charging System (CCS) or Combo 2, is supported by the Union of the Electricity Industry (EURELECTRIC), the European Association of Automotive Suppliers (CLEPA) and the European Automobile Manufacturers Association (ACEA), and has been introduced in a proposal of European Directive on the deployment of alternative fuels infrastructure (mandatory by 31 December 2017 at the latest).

Being in this situation, it can be foreseen that the next future market will have both Combo2 and CHAdeMO cars available in Europe and as a consequence of this, some producers of charging points are already proposing **multi-standard DC fast charging station**.

Despite most of European respondents propose to use the Combo2, they in fact recognise that DC fast charging stations in the near and mid-term should not exclude existing EVs with CHAdeMO Couplers and should offer both connectors. The best solution is considered to allow the CHAdeMO connector provisionally and to suggest implementing retrofit capability for upcoming Combo2 charging post. So, CHAdeMO connectors should be an interim solution but will be necessary to reach an agreement on a unique European proposal.

Coming to the second point, it has been often stated that one of the best options for deploying a fast charging infrastructure is to install DC charging points in petrol stations, which generally have enough space and are already equipped with important connected services (grid connection, surveillance, rest area,…). For the installation of DC charging points in common places and in particular in petrol stations, some general National/European regulations can be applied (as Low Voltage, Explosive Atmospheres, work-related risk of injury by electric hazard, safety and health recommendations and Pollutions) but most of the respondents highlighted the need to define procedures and specific regulations (not only DC but also AC fast charging).

More in detail, fast DC charging is specified in IEC 61851-23, which defines the requirements for DC fast charging stations in terms of electrical safety, harmonics, grid connections and communication architecture. Furthermore fire protection regulation of each country/region applies.
It is considered important that regulations related to petrol stations evolves from a “country specific” status, with the need of a universal educational effort to convince regulator to properly address the safety of the state of art DC fast charging system.

It is worth mentioning, that an issue exists with standards for metering equipment and communication in direct current (charging) systems. It was indeed indicated by some respondents that standards in this area are lacking and that is difficult to obtain charging measurements reliable enough for billing purposes.

5.1.4 Connection to the Grid

Considering that the aspects related to charging modes, power and connectors are commonly referred to the charging point and the vehicle itself, the surveys gave quite little information about grid connection issues. None of the respondents of the survey mentioned that they miss standards or extension to standards on connection to the grid and therefore no issues or needs came out. This fact has to be taken into consideration, but probably further analyses are needed to properly identify the real situation of this topic.

The issue of Smart Charging, that in Green eMotion WP7 is defined as a proper combination of user friendly, grid friendly, battery friendly and energy friendly charging, can be considered related to the connection to the grid.
As general suggestion from the respondents, it came out the proposal not to focus on smart charging during this first phase of EVs market introduction, but to focus instead on interoperability (e.g. leveraging the GeM Market Place/Clearing House architecture and eMI3 activities.).

Despite that, the survey revealed that there is a strong need to make use of the advantages of smart charging but that it has to be clarified in which way they shall be treated, e.g. if user or grid requirements shall be treated with high priority or not.
With regards to standard, most of the respondents have indicated ISO/IEC 15118 as the standard available for smart charging between EV and EVSE, including a focus on bidirectional management.

Related to grid stability and security, some respondents mentioned the on-going development of a grid code for all loads that will be providing services to the electric system, similar to what exists for generators. This code is called "Demand Connection Code" and its development is being coordinated by the ENTSO-E (Association of European transmission system operators). This code should define all the technical requirements for the prevision of services to the electric grid and it's currently under discussion between the European Commission and the Member States.

As for smart charging, a general suggestion has been also to address Vehicle to Grid (V2G) late 2014 onwards and to concentrate resources begin 2014 on interoperability.
V2G is indeed seen as a long-term option that does not economically make sense until EVs come to the market in millions. Efforts to get an overview of such topics are anyway underway at IEC level. The suggestion is to refer also to their result which is coming out soon. In the meantime, V2H may be a good option to follow up.
V2H (Vehicle to Home) allows indeed to supply houses with the energy stored in the EV's battery. This can be extremely useful when it is done during daytime, after the battery has been charged at night (when there's more capacity for electrical supply). This way, power consumption in peak periods can be alleviated. Moreover, V2H can serve as a backup power supply system for emergencies, as the EV's battery can be used as a backup generator during a grid outage or a short duration distribution system fault.

There are some developments already in place:

- Nissan[3] has developed a V2H system addressed to companies that will use employees' EVs to regulate and reduce their electricity bills. This "Vehicle-To-Building" technology allows up to six Nissan LEAFs to be connected to a building's power supply. At peak hours, the building draws power from the cars, then, during off-peak hours when electricity is cheaper, it flows the other way. The system ensures the EVs are fully charged by the end of the working day. This system has been in use since July 2013.
- Toyota[4] has developed a V2H system by the end of 2012, using Prius plug-in hybrids at ten households.
- As of July, 2012, Hydro-Québec[5] has awarded GRIDbot Canada the contract for the development and supply of an advanced bidirectional charging station for an experimental project on vehicle-to-grid and vehicle-to-home power exchanges (V2G-V2H).
- Nissan and Mitsubishi[6] have already announced the availability of their V2H systems operating with the CHAdeMO protocol and connector. One application is to let this V2H system connected through Home

[3] http://chargedevs.com/newswire/nissan-carries-out-vehicle-to-building-field-test/
[4] http://chargedevs.com/newswire/toyota-develops-vehicle-to-home-power-system/
[5] http://electriccarsreport.com/2012/07/hydro-quebec-launches-v2g-v2h-project/
[6] file:///E:/Proyectos/Proyectos%20Europeos/Programa%20Marco/VII%20Programa%20Marco/Green%20eMotion/WP7/D7.3/Brochurelong20130327.pdf

Energy Management System (HOMS) with the roof top Photovoltaic panel and communicate with it for the optimal charge and discharge pattern.

5.1.5 Communication

Since the communication area plays a central role in electromobility and seems to be the most undeveloped one (see also the results of D 7.1), it has been investigated with a particular attention in the surveys.

The results show that this topic is still widely open and that interrelations among the different actors are still not completely determined. Probably due to that, the respondents mentioned many standards, but most of them did not express clear “gaps” or “missing standards”, as in real-world applications the roles are still confused and the main issue appears to identify a clear reference architecture.

Trying to sum up, surveys have highlighted these aspects:

- The communication **between EV-EVSE** is commonly carried out via PLC or PWM in AC charging system and the standards used are ISO/IEC 15118 and IEC 61851;
- GPRS is a commonly used technology in the communication between **EVSE and back-end** and many proprietary protocols are implemented. OCPP or another open protocol (for example the one proposed in a New Work Item Proposal by eMI3) are likely to play an important role.
- About communication aspects **with Clearing House and Market place** most of respondents highlighted the need for more study, before approaching a real standardization process for the interface protocols. Some proposals implemented in the market, as OCHP and OICP, are anyway available.
- There is a need for an overall ICT architecture. It is recommended to start with the one already provided in WP3 “Electro mobility services / ICT solutions” on this topic (see deliverable D3.2: “ICT reference architecture” http://www.greenemotion-project.eu/dissemination/deliverables-ict-solutions.php) and this will be taken up by eMI3 in their workgroup Architecture and Interfaces.
- **Identification** has emerged as an important topic that requires specific standardization activities. There is the need for a standard that simplifies identification, especially in a roaming perspective. Both the Identification of EVSE and EVSP contracts (EVSE-ID and EVCO-ID) should be considered. There should be sufficient available digits, appropriate security characteristics, and relevant data format (country, EVSP, customer). This is tackled by eMI3 in a first standard to be released July 2014.
- More attention is required on **security and privacy** aspects for example by means of encryption.

5.2 Standardization workshops

During the development of WP7 activities, a very important aspect was the interaction with the different stakeholders involved in standards, in order to obtain relevant inputs and feedbacks. A strong effort in this sense has been lavished during 2012, with the organization of three standardization workshops (both internal and external).

Involving many different actors, the workshops had a quite wide approach and they addressed a lot of different aspects in e-mobility. The results are so in some cases more general with respect to the highly-focused surveys or interviews but it is worth reporting some parts of the discussions that took place, in order to have a stronger inclusion in the work also of external point of views. In particular, in the following parts of the Chapter the aspects more related to gaps or issues identification are reported.

Please note that some results have also been used in Deliverable 7.4 "Year 1 Standardization Workshop - Gaps and recommended actions towards minimal features interoperable charging stations for EVs" – http://www.greenemotion-project.eu/dissemination/deliverables-standards.php.

5.2.1 Valladolid (internal workshop): March 28th – 29th, 2012

The general objective of the meeting was to learn and discuss about the situation on standards related to electro-mobility, focusing on interoperability. The approach in general of WP7 activity was also being discussed, in order to define the best strategy to obtain relevant results. In particular, the aim was to collect comments and position on the following aspects:

- Identify where are the key issues regarding interoperability;
- Potential solutions for those issues;
- Is it possible to find a common position for the industries in GeM?

The suggestion was to start a methodology combining the study on use cases already performed in other Green eMotion Work Packages (e.g. WP3 "Electro mobility services / ICT solutions") but considering that, due to the extreme complexity of the e-mobility context, there is the need to define scenarios of minima referring to the principle of "**first best**" (easy to find and to use).

According to that, a simple approach was chosen: simulate the requirements to travel from London to Paris and then to Rome. Obviously, for practical reasons the charging method has to be a quick charge method. The idea was then to proceed identifying potentially good ways to deal with a high market share of EVs, finding the simplest ways to implement these solutions. Or, more precisely, finding what it is missing for these solutions to be implemented.

The very first minimum requirements should include:

- **the possibility to charge the EV**
  - The Battery Management System (BMS) on the vehicle and the off-board charger must communicate because the battery must be charged with a precise I-V profile. This profile is function of the architecture chosen by the OEM and of the battery temperature, State of Charge (SoC) and State of Health (SoH).
  - There must be physical and technical compatibility among Vehicle Inlet Quick Charger port (Combo, Chademo) – connector (Combo, Chademo) – conducting cable – Plug – Quick charger socket outlet.

- **the payment system for the energy. On this point there is a plethora of possibilities regarding,** ID identification, identification of car, payment method or contract available, roaming, etc.
  Communication could be based on the following identifier:
  - *Contract-ID* ***(EVCOID)***
  - *Electric Vehicle Suppy Equipment ID* ***(EVSEID)***
  - *Vehicle Identifier Number* ***(VIN).***

Even when focusing on minimal requirements the context is not that simple and the following relations among different actors have to be considered:

1. Car ←→Charging point
    i. Type and mode to be decided
    ii. Data and energy
2. Grid → Charging Point
3. Charging Management System (CMS) ←→ Charging Point
4. DSO ←→ EVSE (CMS)
5. Authentication ←→ Charging Point (EVCOID Most likely a data format to be defined)
    i. RFID, ICC, NFC or Magnetic Stripe Card
6. CMS ←→ Marketplace
    i. Service Data Record (SDR)
7. EVSP ←→ Marketplace
8. Vehicle → Marketplace (EVSEID – VIN)

The following issues were so identified during the meeting:

- Unified ID cards;
- Plugs;
- CP identification (Need for CP definition, and attributes list);
- CP Status;
- CP Reservation;
- Contract ID;
- VIN or Equipment Number (ID)
- Cash vs. CC Payment
- Interface EVSE ←→ CMS
- Clearing (between different partners) → SDR
- DSO communications to the CMS (Energy available / Tariff) + (Forecast/Schedule) + (Grid Stability)
- Information from EV to the market place

According to the participants, a possible minimal approach could be to add a charging station to petrol stations already operating on gasoline, diesel, natural gas. Some safety criteria should be applied to avoid unsafe procedure. For safety reasons the pumps serving compressed natural gas are located at a minimal distance from the pumps serving gasoline, a similar criteria could to be applied to the charging station of electricity.

The same credit card reader can be used to manage the payment of gasoline, diesel, natural gas and electricity. A single charging station can additionally be provided with several charging points outlet ports-conducting cables-connectors, consequently several cars can be charged in parallel.

Supposing that all petrol stations in highways and in cities would install a quick charging point (area) most of the complexity would decrease. The problems would be “limited” to standards related to the physical connection between the vehicle and the charger.

5.2.2 Brussels (external workshop): May 10th, 2012

During the workshop, the approach firstly proposed in Valladolid has been progressively developed, presenting two scenarios to be studied using a “minimal requirements” analysis.

A simple and basic approach is to sketch the interfaces around EV and charging infrastructure. Basic physical elements are an

- EV driver, that uses an
- EV, that needs to be electrically connected to a
- Charging Point, that is electrically connected to the
- Distribution Grid, that gets it electricity (for this EV) indirectly from
- Energy Provider/Retailer (in this at border of the scope of charging infrastructure).

Other elements are related to ICT infrastructure. Connected to Charging Point, via a communication link is the

- Charge Management System (manages Charging Points in a certain area/district);
- EV Service Provider, that has a contract with the EV driver/owner.

5.2.2.1 Short Distance scenario

The first proposed scenario has been the so-called **"Short Distance Travel"** which is so structured:

- Beginning: Car fully charged (and still connected to home charger);
- Disconnect EV;
- Drive to work;
- Connect EV to charger at work;
- Disconnect EV;
- Drive to city center;
- Park at parking place;
- Connect EV to charger at parking place;
- Disconnect EV;
- Drive home;
- Connect EV to charger at home.

Also considering the minimal requirements, this scenario imposes several features and functionalities to the whole system:

- Right connection and **plug** between EV and CP
- CP connected to the electrical **grid**
- **Communication** between EV and CP for charging power and type
- **ID** needed (to the CP)
- Interface with **contract system** of EV service provider
- Interface or **handshake** EV owner for contract with EV service provider
- Smart charging to prevent for example grid overloads, so data interface between Charge Point/System to **Grid/DSO**
- **Search** and reserve charging spot: user/car needs direct connection to this information
- **CP to Charge Management System**, to enable different CMS operators
- **Grid to Energy Provider** connection
- Interface of **Energy Provider to the (market)** of EV service provider(s)

In the short distance scenario many standards are therefore involved. Some considerations came out from the debate, trying to address the most important open points for this scenario.

- **Power Quality**: the increasing number of electric vehicles charging at slow charge has caused concern over their combined effects on the power quality and reliability of electric utility grids. Power Quality Requirements (e.g. harmonics emission) for chargers are needed in terms of requirements together with more stringent test procedures, to avoid possible problems arising from resonance phenomena appearing when several EVs are connected at the same point (for more information please refer to Green eMotion deliverable D4.2. "Recommendation on grid-supporting opportunities of EVs"

http://www.greenemotion-project.eu/upload/pdf/deliverables/D4.2_Recommendations_on_grid-supporting_opportunities_of_EVs_V1.2_March2013.pdf)
It is so recommended to promote studies to evaluate the e-cars impact on the network and the development of procedures to certify the efficiency of the adopted charging procedure.

- **Communication protocols**: required, at least, for exchange identification data and for smart charging. The topic is currently under discussion inside the eMI3 working group, and, besides, a New Work Item Proposal on identification via RFID card in IEC has been developed by Better Place. A standard mechanism and (physical) interface for user identification/authentication is required, but also privacy needs to be taken into account for user acceptability.

- **Pan-European charging standard**: especially in near border and for long travels in multiple countries a Pan-European standard is required to prevent that a system only works in a certain area/country or city.

- **Payment interoperability** on a business level: let the payments in one area easily be exchanged with the contract of EV users in another (their) home areas.

- **Interoperability and roaming**: partly overlapping with the topics before but more specifically referred to the roaming requirements from users and service providers. This has also been identified as a gap by the ANSI: “Gap: Charging of Roaming EVs between EVSPs. There is a need to permit roaming EVs to charge at spots affiliated with a different EVSP” (see also: ANSI Standardization Roadmap for EVs Version 1.0 April 2012).

Some first recommendations related to the just mentioned issues followed:

- Define a few use cases/scenarios and associated data and interactions that enable all involved stakeholders and parties to test their part of the system stand-alone and later in combination with the total system. This action was originally covered within WP3 of green eMotion and has been transferred into eMI3 for further progress.

- Define a minimal set of standards to be used in communication. Create a list of (detailed) issues to be solved and solutions or standards that can help in the solution. Due to the large number of communication possibilities an optimal solution could be to use the recently approved ISO/IEC 15118 as communication interfaces with a defined but upgradable data model for the datum that is communicated.

5.2.2.2 Long Distance scenario

The **second scenario** refers to a “Long Distance Travel” (distance longer than 150 km, with fast charging):

- Beginning: Car fully charged (and still connected to home charger);
- Disconnect EV;
- Drive highway to 90% range;
- Connect EV to fast charger;
- Charge;
- Disconnect EV;
- Drive to 90% range in highway;
- Connect EV to fast charger;
- Charge;
- Disconnect EV;
- Drive destination;

- Connect EV to charger at destination.

Basic requirements in the long distance scenario are simpler than in the short distance one:

- **Safe and secure connection** (energy and data) between EV (Battery) and Charging Point, according to Modes and Types definition in IEC 61851-1 and IEC 62196-1/2.
- **Fast charging** available.

With regards to the connectors, still different solutions are coexisting, but once sufficient infrastructure is in place, it may prove difficult to switch connector types, so **the harmonization effort for DC connectors is considered a gap to address in the near-term**.

Extremely relevant to enhance interoperability in this case could be a combined charging system that gives EV owners the ability to charge at most existing charging stations regardless of the individual power source. This should integrate one-phase AC-charging, fast three-phase AC-charging, DC-charging at home and ultra-fast DC-charging at public stations into one vehicle inlet. The Combo connector, which features a single inlet for AC and DC charging on the side of the vehicle and can potentially deliver high-power charging of up to 100 kW in future, is a first example of this kind of solution. As already mentioned in section 5.1.3.3, the Combo connector is already standardized European car manufacturers (ACEA) recommend installing Type2/Combo inlet/connector for charging electric vehicles. Audi, BMW, Daimler, Ford, General Motors, Porsche and Volkswagen agreed to support a harmonized single-port fast charging approach for use on electric vehicles in Europe and the United States (compatible with the J1772 connector standard in the U.S.). It has also been agreed to use HomePlug Green PHY as the communication protocol to facilitate integration of the electric vehicle into future smart grid applications.

A specific standard that sets the rules to install fast charging points is also urgently needed. Many existing and under development standards should be taken into account:

- **IEC 60364-4**: Low Voltage Electrical Installation;
- **EN60079-10**: Explosive Atmospheres, Classification of areas;
- **EN50014**: Electrical Apparatus for potentially explosive atmospheres. General Requirement;
- **EN50018**: Electrical Apparatus for potentially explosive atmospheres. Flameproof enclosure;
- **ISO/IEC 29123**: Identification Cards - Proximity Cards - Requirements for the enhancement of interoperability
- **ISO/IEC 14443**: Identification cards - Contactless integrated circuit cards
- **IEC 60364-7-722**: Low voltage electrical installations - Part 7-722: Requirements for special installations or locations - Supply of Electric vehicle;
- **IEC 61439-7**: Low-voltage switchgear and control gear assemblies - Part 7: Assemblies for specific installations at public sites for charging station for Electrical Vehicles.

It has to be noticed, that the need for properly trained personnel for the installation and maintenance of fast charging stations along highways or city rings will emerge. A possible solution to assure a long travel interoperable infrastructure could be the direct involvement of highways and city rings owners and managers, being them active part of the system.

Also in this second scenario, some first recommendations came out:

- Address the Connector aspect, promoting Combined Charging Systems as possible alternatives to the ChaDeMo protocol but considering that in the first phase multi-standard (CCS/AC/CHAdeMO) quick charging stations are the most viable and practical solutions.

- Keeping in mind that the dispute AC versus DC slow and fast charge will continue for at least another decade, promote the development of:

  - Universal quick charger modules that should be able to communicate with the on-board BMS via Analog or PLC, CAN or PWM interfaces.
  - AC quick chargers (22kW and 43kW) able to manage the PWM according the availability of the grid and the communication with the EV through ISO/IEC 15118 protocol.

- DC quick chargers should consider a variable DC output [50V, 500V] to satisfy the request of all type of vehicles adopting different DC battery links. The DC quick charger should be capable to deliver an I-V output curve as demanded by the on board BMS. Then it should be equipped with a library of charging procedures and I-V functions.

- Use energy meters, charge plans and flexible tariff models, which permits to create economic incentives for vehicles charging during off-peak times. It will also allow the DSO to provide charge schedules to the EV according to the available energy.

It has to be said that the recently approved ISO/IEC 15118 Series have covered some of the arisen technical recommendations, in particular giving indications on:

- DC quick chargers having variable DC outputs [50V, 500V] to satisfy the request of all type of vehicles adopting different DC battery links,
- DC quick chargers capable to deliver an I-V output curve as demanded by the on-board BMS.
- A charging interface on the quick charger allowing to charge with slow DC-charging and ultra-fast DC-charging.

5.2.3 Milan (internal workshop): October 4th-5th, 2012

The workshop held in Milan came after a period of debate on the approach followed by the WP7 during 2012. While trying to clarify some crucial points of the discussion, WP7 partners have organized the Milan meeting to start a process of WP "reshaping", in order to better fit the global GeM message and aim.

In particular, the idea was to focus on some "open topics" in which WP7 may work to give a strong contribution to the standardization processes. It was decided to reflect on a selection of the **most important technological area/s** where try to influence/promote de facto standards. The debate brought to identify the following technological areas/subareas and the related issues as the most relevant for standardization activity:

- **AC Charging Mode**: Need for Mode 3 for AC charging
  - Requirements for public and semi-public charging points: Mode 3 should be mandatory for publicly accessible CPs. At least Type 2 connector.
  - Inventory for low power charging solutions for light EVs, PHEVs, e-bikes, …
  - Analyze the availability of 3-phase > 16 Amps and 1-phase max Amps connections (on roads) at EU level
  - Inventory of State of the Art of charging cables (Type? Dimensions? Material?), public and private use
- **DC Charging**: Combo2 connectors for HV DC charging
  - Status of standards (61851-23 Annex CC – WP5);
  - Need for quick EU decision/deployment in order to achieve unified EU standard;
  - Same grid connection aspects as for AC high power charging (see above).
- **Identification and data format**
  - e-mobility ICT Interest Group working on EVCOID and EVSEID;
  - need for roadmaps and work plan for common data formats;
  - inclusion of privacy/data protection and security issues;

- involvement and organization of GeM in eMI3

- **Communication between EV or EVSE and all secondary actors (e.g. EVSE- backend)**
  - Different solutions, “OCHP” (WP3),“OCPP” (WP5);
  - market place must support multiple communication channels (via CP or direct to EV, to backend, etc,..);

- **Smart charging**
  - Clarify the definition of Smart Charging (refer to Smart Charging ad Hoc Group);
  - Scenarios/use cases needed to study the combination of user friendly/grid friendly/battery friendly/energy friendly charging;
  - Consider V2G as long-term option?

- “**New” areas**
  - Regulation of quick-fast charging installations;
  - Inductive charging.

5.3 Direct interviews

One of the main strong points of the GeM project is the large number and variety of the involved partners, as well as the coexistence of many WPs dealing with different technical aspects. Considering that, and the fact that WP7 has the role of collecting real issues, it has been straightforward to perform also some direct interviews with 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.

In the following sections, a summary of the outcomes from the discussion with other WPs is reported. In particular, the issues have been collected by interviewing the following reference people[7]:

- Silvio Weeren – IBM – WP3
- Sven Jundel – RWE – WP4
- Jan Rasmussen – Dansk Energi – WP4
- Thomas Gereke – Siemens – WP5
- Andreas Zwirlein – Siemens – WP5
- Bart Benders – Fka – WP6.

It has to be noticed that inside the technical WPs most of the partners involved are dealing with the Demo Regions. By interviewing them, we can so take into account most of the issues coming from the Demo Projects.

5.3.1 Contribution from WP3 “Electro mobility services / ICT solutions”

Work Package 3 focuses on the value added services to the driver that could be enabled by the use of ICT. More in particular, the objective of the activity is to implement a demonstrator of a European-wide Marketplace for electro mobility services, studying and developing an open architecture, common standards and protocols and well-defined interfaces.

[7] Thanks to all the respondents for their competence and their kind availability.

The activity is led by IBM and, in particular in the last period the standardisation efforts in WP3.8 are conducted in strong cooperation with the already mentioned eMobility ICT Interoperability Innovation Group (eMI3), funded by Green eMotion partners themselves and today joint by many relevant stakeholder (see eMI3group.com)

The interview with Silvio Weeren, representing both WP3.8 leader and eMI3 chair, let to collect the following aspects:

- No standards exist defining the communication between the EVSE and the EVSE Operator Backend. There is a NWIP handed over from GeM to eMI3, but at present this has to be considered as a gap.
- No standards exist defining the communication between the EVSP Operator and the energy provider or grid operator. A first proposal is on-going, named OSCP (Open Smart Charge Protocol).
- No real standards exist defining the communication between the EVSE Backend and the EVSP (or the Clearing House/Marketplace). Some proposals are existing, as the OCHP (Open Clearing House Protocol), which is implemented in the market. eMI3 is also working on this aspect.
- Considering the Marketplace platform, the interface of all actors with the MP itself is not standardized. WP3 is feeding the open GeM specifications to eMI3 (in relation with the Clearing House issues).
- About identification with contactless cards, the Better Place NWIP is temporarily inactive, while the Nation Electrical Manufacturers Associations (NEMA) is working on it in coordination with eMI3. The presence of rapidly upcoming alternatives for identification, e.g. smartphone apps, could lower the priority of this aspect.
- Privacy and Information Security issues are present and are addressed, among others, by Working Group DKE AK1911-11-5 Information Security in electro-mobility.

5.3.2 Contributions from WP4 “Grid EV-olution”

Work Package 4, focuses on the study of an infrastructural EV charging grid which could provide adequate capacity, be oriented to EV customers’ needs and use agreed standards of safety, economic and technical capability. The activity is led by RWE, with a strong commitment also from Dansk Energi.

According to that, the comments on grid connection aspects provided by Sven Jundel and Jan Rasmussen, respectively reference for RWE (WP leader) and Dansk Energi, are synthesized in the following.

Sven Jundel has indicated the following issues:

- There is a lack on how to integrate EVs into Smart Grid environments. Although ISO 15118 is available, the question on how to address charging stations to perform grid actions is lacking.
- The key findings of the Ad Hoc Smart Charging Group in Brussels should be taken into account. In particular two recommendations have to be reminded:
    - **Develop a new standard for data communication between EV supply equipment and EVSE operators**. A standard for data communication between the EVSE and the EVSE Operator is missing under the European Standardization organizations. It is recommended to work on a New Work Item Proposal. Also a standard for data communication between the

EVSE Operator and E-Mobility Service Providers for standardized business transactions and roaming issues is missing under the European Standardization organizations.

- **The quality of service and reliability of the Smart Charging is of prime importance** from the customer point of view. New standards addressing the information to be sent to the customer in case of troubleshooting have to be started.

Jan Rasmussen has pointed out the following needs:

- **Power Quality**
  Measurements of power quality, including harmonics, are the key to gain knowledge in this field as local conditions must be considered in assessing power quality. Standardization related to EVs is covered by the emission standard EN 61000-3-2 Electromagnetic compatibility (EMC) -- Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase) The emission limits, which cover EVs, are set as absolute values. This has the disadvantage that the relative emission limits increase when charging power is reduced. Thus it is recommended to develop limits, taking into account reduction of charging power.

  There is a need to develop emission limits between 2 and 150 kHz, so that disturbances emitted by EVs in this frequency range, do not disturb PLC communications used for smart metering and intended to be used in the Smart Grid.

- **Measurements**
  As this stage it is not feasible to include harmonics from EVs in the grid planning of low-voltage grid due to the imprecise methods to assess harmonics. Roll out of Smart meters or any other sensor devices with harmonic measurement capabilities, could be the first step of including harmonics in grid planning. Most of Today's Smart Meters do have capabilities in this regard, however they are not standardized.

- **Charge Management Strategy**
  Studies on charge management strategies, with controllable charging power depending on the load, showed a very limited impact from EV penetration and charging power. In the majority of the networks, no reinforcements were seen regardless of EV penetration and charging power. This demonstrates that with more complex, i.e. grid friendly charge management strategies, many parameters can become largely insignificant.

  An advanced charge management strategy prerequisite on-line measurements and exchange of measurements to some extent. Smart meters could provide that, however no standards exists in that area. Additional standards and communication standards enabling control/regulation of EVs must be developed.

5.3.3 Contributions from WP5 "Recharging Infrastructures"

Work Package 5 has the aim to provide advanced and interoperable, managed recharging infrastructures and services to EV users. The reference partner in this case is Siemens and in the following the inputs coming from Thomas Gereke (focus on T5.5.1 – Load mangement) and Andreas Zwirlein, both by Siemens, are summarized.

Thomas Gereke has indicated some open topics on load management are under observation in the Demo-Region Malaga. From the experience in this demo, the following aspects can be pointed out:

- For the interface EV-EVSE:
  - IEC 61851 is today in place;
  - ISO 15118-2 has been finalized and is planned to be used;
  - Requirements for load-management have to be defined (e.g. 1 or 3 phase charging).

- For the interface between Charging Management System (CMS) and EVSE:
  - several solutions are in place (e.g. the OCPP).
  - eMI3/WG5 is actively addressing this aspect;
  - Requirements for load management are not finally defined yet.

- For the interface CMS-DSO
  - The definition of the DSO requests for load management is missing;
  - Business-object and identifier for the Point Of Delivery (POD) are not defined.

- For the interface CMS-EVSP Backend
  - The definition of the EV-driver behavior in interface EVSP and EVSE Operator (e.g. VIP, renewable energy,…) is missing.

A graphical representation of what just listed can be seen in Figure 5-2.

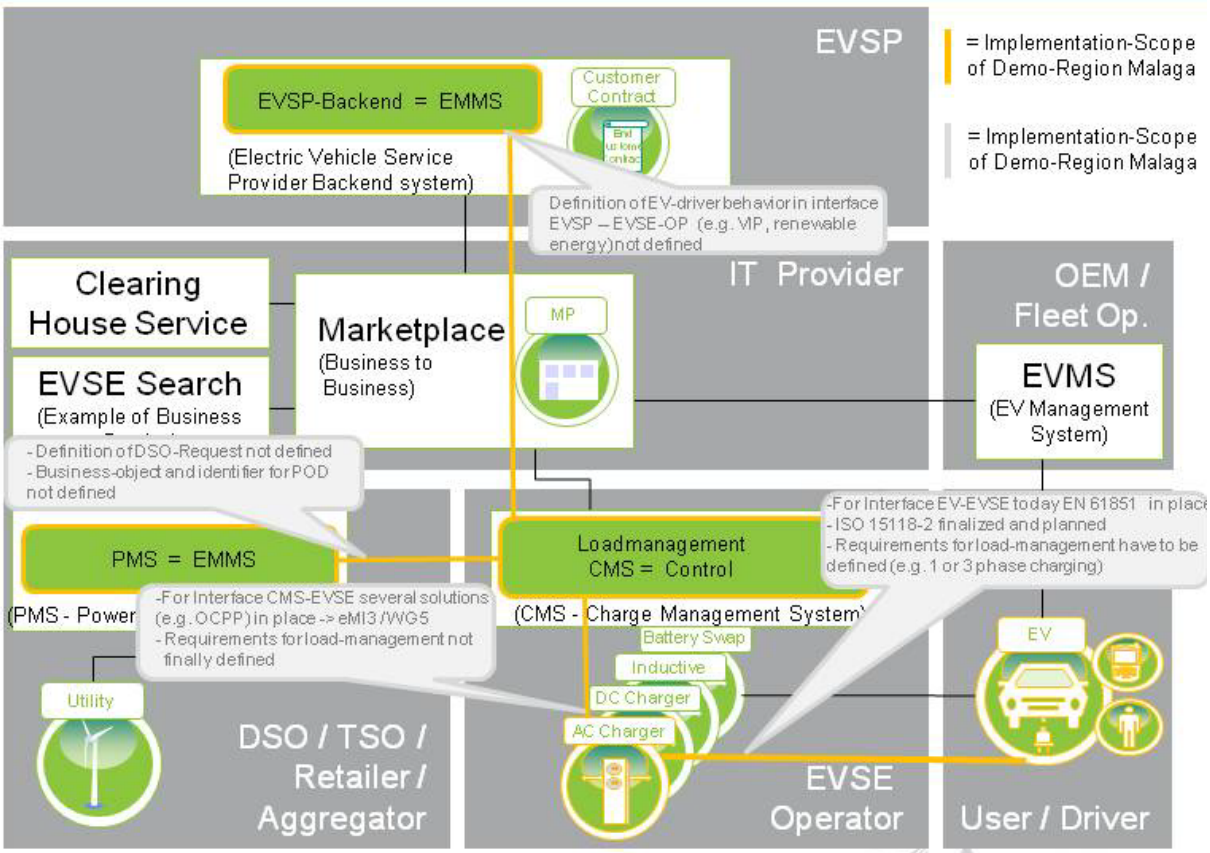


Figure 5-2 Load Management in DR Malaga: necessary standardization areas

Andreas Zwirlein has pointed out the following issues:

- Communication standard between EVSE and backend systems is needed. This will be covered by WP7 NWIP and by activity in the eMI3 group.
- There is a lack of standardization on identification/authentication via RFID. This was supposed to be covered by Better Place NWIP, but the standardization work is at the moment on hold due to bankruptcy of the main proponent.
- There is a lack of support of ISO/IEC 15118 features in communication protocols and market places. Analysing the full 15118 scenario, there are a lot of use cases that are not yet described.
- There is a lack of standardization regarding smart grid aspects, as load management, forecasts, etc.
- Inductive charging is still an open topic. It is now covered in the ISO/IEC 15118 from the communication perspective, but not from energy transfer aspects. Are there other standards involved?
- The results of the previously held standardization workshops (and partially reported in Deliverable 7.4) give a wide and useful description of currently going on activities and gaps

5.3.4 Contribution from WP6 "Demonstration of Electric Vehicle Technology – validation and contribution to standardisation"

Work Package 6, is focused on the vehicles, with the objective to validate their performance in terms of durability, costs and safety aspects under real world driving conditions in different climatic zones.

The activities are led by Fka and comments and suggestions coming from Bart Benders as representative of the WP leader are reported below:

- **Range/Driving cycle**
  As a result of the testing in WP6, it can be stated that all nowadays used driving cycles for determining the range of an EV are insufficient, as all procedures are proceeded in "test bench environment". There is no official test cycle to be used on the road for passenger vehicles; NEDC and WLTC can only be performed on a test bench (dynamometer) due to their velocity complexity. Some standardization work (new driving cycle or revision of the existing) should be done in this sense.

  According to this idea, the WP6 team designed a new procedure named SORDS (Standardized On-Road Driving Schedule) 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 driving cycle can be performed on the road as well as on a test bench. Results show that the current driving cycles are not displaying range well, while the SORDS developed in Green eMotion shows a very realistic consumption.

- **Technical issues such as recuperation, how to tackle them?**
  An EV is able to regenerate energy when braking. According to WP6 team, this technical feature of EVs which should be developed more, as it can significantly add range during driving.

Some debate arose on this aspect, as some would claim that regenerative braking is no better than a careful driver who is able to see forward in traffic. A sufficiently careful driver would also be able to re-use kinetic energy by rolling the car in neutral. Is it so really better to automate this process? Besides, others might argue that brakes are mainly used at low speeds where engine braking has little effect, compared to a set of disc brakes. Even at high speeds the electric engine braking would be limited by power or current, and would never match the stopping power of disc brakes.
The WP6 team believes that regenerative braking holds a significant potential, if correctly used. In practical tests this is validated by repeating the same driving cycle with and without regeneration to compare with the normal run-through including regeneration. The EV motor is simply shifted into neutral prior to braking.

Different vehicles handle the regenerative braking effect different, and also the level is different for regenerative braking. Some standardization work should be done here, to insure a minimum level of getting energy back from the “street into the battery” and so increase range as well as save energy.

- **Compliance on (charging) communication**
  Due to the fact that the battery of an EV (and possibly also other components) is a “non vehicle OEM” part, the possibility to standardize all battery communication inside the vehicle and the V2G communication could be a sensible way to make the next step towards interoperability of the EV interfaces and Battery - Vehicle interface.

  The work done in WP6 shows that often the battery communication goes through a separate CAN and thus also from OEM perspective is a “non vehicle OEM” component. A standardized battery communication would also give a better insight in the battery status and therefore this would be an additional value for the vehicle used car market as well as battery aftermarket value chain. Some standardization work (battery communication) should be done in this sense.

6 A comprehensive summary: The Gap Matrix

The efforts spent during the last years in defining the most important standardization issues in the e-mobility field, have brought a quite large number of data, results and comments. Thanks to the combination of analyses, surveys, workshops and discussions, with the involvement of a large number of actors, it has been possible to obtain many indications on needs and existing issues. As obvious, and as it is easy to see from the previous sections of this document, many actors gave similar answers, pointing out the same issues, as well as using different "means" (workshops, survey,…) the same aspects came out. All the needs have so been extrapolated from their origin and then carefully analysed. Repetitions have been erased and similar issues have been unified. The comparison of the needs with the existing standards previously collected in the table of Deliverable 7.1 (see Chapter 3) let the identification of 31 gaps.

In order to give a more direct view of the situation, it was agreed to include the main issues on a comprehensive table, which has been called "Gap Matrix" and which had also to identify the most important open points by indicating their level of criticality.

In the following parts of this chapter, a description of the Gap Matrix will be carried out, showing its aim, its structure and its contents.

The complete Gap Matrix can be found attached to this Deliverable (see "Standardization Gap Matrix_WP7").

6.1 Aim and structure

As stated in the GeM DoW, the general objective of the Gap Analysis and of the related Gap Matrix is to identify the existing gaps between technologies and standards and to evaluate their criticality. The comparison of the collected issues with the on-going standardization activities allows pointing out the most critical differences and needs for improvement.

On a less general level, the Gap Matrix can be a useful tool both inside and outside Green eMotion. Within the project, it gives a picture of the open topics so that, where a critical gap is found, the possibility of developing and pushing the establishment of a "de facto" standard proven in one GeM demo site will be evidenced. Outside the project, it can represent the starting point to draw out a standardization roadmap for the next future. This will be part of the focus of the next Task 7.6.

In order to achieve this aim, the work has been focused on the design of a matrix which:

- is coherent with the approach of D7.1 and D7.2;
- is sufficiently clear and easy to read;
- collects the issues coming from the surveys and the standardization workshops;
- collects the main issues coming from other WPs;
- highlights the most critical aspects.

According to this, the structure of the matrix will:

- use the same technology areas as in D7.1 and D7.2 (coherence);
- Enlighten the needs, the existing and what is missing (easy to understand);
- Point out the level of criticality (highlights critical aspects).

The matrix main structure is therefore 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 (see Figure 6-1).

Please note that the level of criticality is assigned considered as main criterion the effect on the interoperability, being this the main global objective of the whole GeM project. Besides, the level of criticality will be evaluated during the discussion with the participants to the standardization workshop that will be held in Brussels on May 6th, 2014.

	Needs	Existing Standards/On-going activities	Gaps	Criticality
Electric Vehicle				
Charging Point				
Connection to Grid				
Communication				
Others				

Figure 6-1 Gap Matrix main structure

6.2 Contents

The main aspects emerged by the activity described in the previous chapters are summarized in the Gap Matrix. For a correct use of the Gap Matrix, and to better exploit its synthetic features, we recommend to refer at the whole matrix, as reported in the attached file “Standardization Gap Matrix_WP7”.

To provide a complete description of the contents also in this document, we anyway report here the contents as bullets, detailing the needs and the relative gaps.

Please consider that many aspects could be referred to more than one technology area. To avoid useless repetitions, the issues have been reported only in one area, choosing the most related one according to the authors’ opinion.

6.2.1 Electric Vehicle

- **Gap #1**
  - Sub-area: battery
  - Need: guarantee the safety of users and operators during anomalous situations;
  - Standards existing:
    - ISO 11428 "Visual danger signals "
    - ISO 12405-3 "Safety performance requirements"
    - IEC 60784 "Instrumentation for electric road vehicles"
    - IEC 60073 "Coding principles for indicators and actuators"
    - SAE J2936 "Labeling Recommended Practice"

- Gap: missing a common label to guide operators during maintenance and emergency situations;
- Criticality: M

- **Gap#2**
  - Sub-area: battery
  - Need: guarantee an effective communication among “OEMs” and “not-OEMs” vehicle components;
  - Standards existing: none
  - Gap: missing a standard way to communicate between battery and vehicle (CAN bus)
  - Criticality: L

- **Gap #3**
  - Sub-area: battery;
  - Need: allow safe and effective battery swapping on different vehicles;
  - Standards existing:
    SAE J1766 "Vehicle Crash Integrity Testing"
    SAE J3004 "Battery Packs"
  - Gap: missing sufficient and dedicated standards to allow battery swapping;
  - Criticality: L (no Battery Swapping operator after Better Place bankrupt)

- **Gap #4**
  - Sub-area: range prediction and State of Charge
  - Need: guarantee a good precision in the definition of the car range;
  - Standards existing:
    - ISO 8714 "Energy consumption and range -- Test procedures"
    - ISO 8715 "Road operating characteristics"
    - SAE J1711 "Measuring the Fuel Economy"
  - Gap: missing a new and effective standardized Driving Cycle
  - Criticality: M

- **Gap #5**
  - Sub-area: range prediction and State of Charge;
  - Need: ensure a good precision in range prediction;
  - Standards existing:
    - ISO 23828 "Fuel cell road vehicles -- Energy consumption measurement"
    - SAE J1711 "Measuring the Fuel Economy"
    - SAE J2711 "Measuring Fuel Economy”
    - SAE J1634 "Energy Consumption and Range Test Procedure"
    - SAE J2991 "Range Test Protocol for PEV"
  - Gap: missing a standard and common way to predict driving range;
  - Criticality: M

- **Gap #6**
  - Sub-area: regenerative braking;
  - Need: ensure a sufficient exploitation of regenerative breaking;
  - Standards existing:
    - CEN/CENELEC CR 1955 "Proposals for the braking of electrical vehicles"
  - Gap: missing the definition of a minimum level of energy recover;
  - Criticality: M

- **Gap #7**
  - Sub-area: charging modes;
  - Need: guarantee a safe and reliable charging at home;
  - Standards existing:
    - IEC 61851-1, -21, -22 “Electric vehicle conductive charging system - Part 1: General requirements , Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply , Part 22: AC electric vehicle charging station”
  - Gap: missing safety restriction for Mode 1 charging (overheating risks when charging cars).
  - Criticality: M

- **Gap #8**
  - Sub-area: charging modes;
  - Need: guarantee a safe and reliable charging in public charging points, both for cars and for Light Electric Vehicles (LEVs);
  - Standards existing:
    - IEC 61851-1, -21, -22 “Electric vehicle conductive charging system - Part 1: General requirements , Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply , Part 22: AC electric vehicle charging station”
  - Gap: missing a common choice. Too many solutions used (Mode 1, 2, 3).
  - Criticality: H

- **Gap #9**
  - Sub-area: connectors
  - Need: guarantee the connection of the vehicle to all the AC charging stations;
  - Standards existing:
    - IEC 62196 -2 “Plugs, socket-outlets, vehicle couplers and vehicle inlets - Dimensional interchangeability requirements” (Type 2, Type 3)
    - CEE 7/4,7/7 (Schuko)
  - Gap: missing a common choice. Still too many solutions used.
  - Criticality: L/M (EU proposal 2013/0012: Type 2 for cars, type 3a for scooter and LEVs)
    Second version: Criticality: L (2014/94/EU Directive)

- **Gap #10**
  - Sub-area: connectors
  - Need: guarantee the connection of the vehicle to all the DC charging stations;
  - Standards existing:
    - IEC 62196-3 “Dimensional compatibility and interchangeability
    - requirements for pin and contact-tube couplers with rated operating voltage up to 1000 V d.c.“ (Combo 2, CHAdeMO)
  - Gap: two solutions coexisting. Missing a common decision.
  - Criticality: M (multistandard chargers commercially available)

- **Gap #11**
  - Sub-area: connectors
  - Need: allow the connection of the vehicle to ALL the charging stations
  - Standards existing:
    - IEC 62196-3 “Dimensional compatibility and interchangeability
    - requirements for pin and contact-tube couplers with rated operating voltage up to 1000 V d.c.“ (Combo 2)
  - Gap: defined a unique connector (Combo2), but still competition with CHAdeMO. Missing a common decision.

- Criticality: M (multistandard chargers commercially available; draft proposal of the European Union supporting the "Dual Standard Approach")
  Second version: EU definitely accepting a “Dual Standard Approach”.

- **Gap #12**
  - Sub-area: cables
  - Need: guarantee European common quality and design rules;
  - Standards existing: only National Standards. None at EU level.
  - Gap: missing a common standard;
  - Criticality: M

- **Gap #13**
  - Sub-area: communication
  - Need: guarantee a sufficient and secure communication between the EV and the EVSE
  - Standards existing:
    - IEC 61851-1 “Electric vehicle conductive charging system - Part 1: General requirements”
    - ISO/IEC 15118 “Vehicle to grid communication interface”
    - SAE J2836/2 “Use Cases for Communication between Plug-in Vehicles and the Supply Equipment (EVSE)”
    - SAE J1772 (RIP) “Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler”
    - SAE J2953 (WIP) “Plug-In Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)”
    - DIN 70121 “Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging System”
    - IEC 61851-23 “D.C. Electric vehicle charging station”
    - IEC 61851-24 “Control communication protocol between off-board d.c. charger and electric vehicle”
  - Gap: too many solutions still present and sometimes even via OEM Backend
  - Criticality: L/M

- **Gap #14**
  - Sub-area: inductive charging;
  - Need: guarantee a safe and effective procedure;
  - Standards existing:
    - IEC 61980 “Electric vehicle wireless power transfer systems (WPT)”
    - SAE J1773 “Inductively Coupling Charging”
    - UL 2750 “Outline of Investigation, for Electric Vehicle Wireless Charging”
    - SAE J2954 “Wireless Charging of Electric and Plug-in Hybrid Vehicles”
    - SAE J2847/6 (RIP) “Wireless Charging Communication between Plug-in Electric Vehicles and the Utility Grid”
    - SAE J2931/6 (WIP) “Digital Communication for Wireless Charging Plug-in Electric Vehicles”
  - Gap: open points on energy transfer aspects;
  - Criticality: L

6.2.2 Charging Point

- **Gap #15**
  - Sub-area: identification
  - Need: allow user identification in a simple and universal way;
  - Standards existing:
    - IEC 14443 “Identification cards - Contactless integrated circuit(s) cards - Proximity cards”
    - NEMA/eMI3 proposal
  - Gap: missing a common standard that simplifies identification in a roaming perspective and with sufficient features (available digits, security, and relevant data format);
  - Criticality: H

- **Gap #16**
  - Sub-area: communication
  - Need: guarantee a sufficient and secure communication between the EVSE and the EVSE Backend;
  - Standards existing:
    - EN 61850 “Communication networks and systems in substations”
    - GSM, UMTS, GPRS
    - NWIP coming from GeM WP7 (ongoing)
    - OCPP (commercial proposal by Open Charge Alliance)
  - Gap: insufficient existing standards;
  - Criticality: H

- **Gap #17**
  - Sub-area: safety
  - Need: guarantee a safe installation and use of Fast Charging Points in petrol stations;
  - Standards existing:
    - 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'”
  - Gap: absence of a specific regulation.
  - Criticality: M

- **Gap #18**
  - Sub-area: Electro Magnetic Compatibility
  - Need: avoid possible interferences between EVs and other equipment (e.g. Smart Meters)
  - Standards existing:
    - EN 50065-1 “Signaling on low-voltage electrical installation in the frequency range 3 kHz to 148,5 kHz”
    - EN 50065-2-1, 2, 3 “Immunity requirements”
  - Gap: missing effective limits in the range 3 – 150 kHz;
  - Criticality: M

6.2.3 Connection to Grid

- **Gap #19**
  - Sub-area: Power Quality
  - Need: guarantee safety and quality of the grid with respects to harmonics, flicker, overvoltage, overcurrent and avoiding possible resonant phenomena;
  - Standards existing:
    - IEC 61000-X “Electromagnetic compatibility (EMC)”
  - Gap: missing evaluations/limits on multiple EVs charging effects
  - Criticality: M

- **Gap #20**
  - Sub-area: DC metering
  - Need: obtain reliable measures from DC metering
  - Standards existing: none
  - Gap: missing standard
  - Criticality: M

- **Gap #21**
  - Sub-area: Smart Charging – Load Management;
  - Need: guarantee the exchange of fundamental information between EVSE Backend and DSO;
  - Standards existing:
    - IEC/TR 61850-90-7 “Communication networks and systems for power utility automation - Part 90-7: Object models for power converters in distributed energy resources (DER) systems”
    - IEC 61850 “Communication networks and systems in substations”
    - ISO 9506 “Industrial automation systems -- Manufacturing Message Specification (MMS)”
    - SAE J2836-1 “Use Cases for Communication Between Plug-in Vehicles and the Utility Grid”.
    - SAE J2836/3 (WIP) “Use Cases for Communication between Plug-in Vehicles and the Utility Grid for Reverse Power Flow”
    - Open Smart Charge Protocol (proposal)
  - Gap: missing effective and common standard
  - Criticality: H

- **Gap #22**
  - Sub-area: Power Level
  - Need: ensure a “grid-safe” but sufficiently fast charging procedure;
  - Standards existing:
    - IEC 61851 -1 “Electric vehicle conductive charging system - Part 1” (minimum current level: 6 A)
  - Gap: missing maximum power limits (higher minimum limit for public charging under discussion);
  - Criticality: M

6.2.4 Communication

- **Gap #23**
  - Sub-area: data exchange;
  - Need: guarantee a sufficient and secure communication between the EVSE Backend and the EVSP;
  - Standards existing:
    - OCHP and OICP (proposals implemented in the market)
  - Gap: missing standard;
  - Criticality: H

- **Gap #24**
  - Sub-area: data exchange;
  - Need: guarantee a sufficient and secure communication between the EVSP Operator and the Energy Provider or Grid Operator;
  - Standards existing:
    - Open Smart Charge Protocol (proposal)
  - Gap: missing standard;
  - Criticality: H

- **Gap #25**
  - Sub-area: data exchange;
  - Need: guarantee a sufficient and secure communication between the EVSE (or EVSP) Backend and the Clearing House;
  - Standards existing:
    - Open Clearing House Protocol (proposal implemented in the market)
  - Gap: missing standard;
  - Criticality: H

- **Gap #26**
  - Sub-area: Marketplace Platform;
  - Need: guarantee a sufficient and secure communication between the Marketplace and all the connected actors.
  - Standards existing:
    - On-going activities: Proposals from GeM WP3
  - Gap: missing standard;
  - Criticality: H

- **Gap #27**
  - Sub-area: security – data protection;
  - Need: guarantee protection from cyber attacks
  - Standards existing:
    - NERC-CIP
    - DKE AK 1911.11.5 “Information security in electromobility”
    - On-going activities in SG Information Security WG, eMI3
  - Gap: System wide way to handling security
  - Criticality: M

- **Gap #28**
  - Sub-area: privacy
  - Need: guarantee users privacy
  - Standards existing:

        - On-going activities from SG Information Security WG, eMI3
    - Gap: missing common rules
    - Criticality: M

- **Gap #29**
    - Sub-area: Payment
    - Need: guarantee the possibility to pay for charging in all the public charging stations;
    - Standards existing:
    - Gap: missing a common choice/common standard on business models (pay by contract/pay by cash-equivalent system/charge for free/…)
    - Criticality: M

6.2.5 Others

- **Gap #30**
    - Sub-area: terminology
    - Need: identify a clear and universal terminology;
    - Standards existing:
        - SAE J1715-1/2 "Battery Specific Terminology"
        - ISO 8713 "Electric road vehicles -- Vocabulary"
        - ISO 13062 "Electric mopeds and motorcycles - Terminology"
        - CEN/CENELEC 13447 "Electrically propelled road vehicles. Terminology "
        - IEC 60050-482 "Primary and secondary cells and batteries - Vocabulary"
    - Gap: common choice missing;
    - Criticality: L

- **Gap #31**
    - Sub-area: emergency rescue;
    - Need: guarantee safety in emergencies
    - Standards existing:
        - "Hybrid and Electric Vehicle Emergency Field Guide", published by NFPA
        - ISO 6469-3 "Protection of persons against electric shock"
        - FMVSS 305 "Electrolyte Spillage and Electrical Shock Protection"
        - SAE J1495 (RIP) "Test Procedure for Battery Flame Retardant Venting Systems"
        - SAE J1766 (RIP) "Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing"
    - Gap: missing a commonly chosen procedure.
    - Criticality: L

7 Feedbacks on the Gaps and proposed changes in the Matrix (new in version 2)

Once the just described Gap Analysis process ended and the Gap Matrix was built, 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 in Brussels, which was exhaustively described in Deliverable 7.5 “Standardization Workshop for finalization of alignment in the demonstration projects” (available at http://www.greenemotion-project.eu/dissemination/deliverables-standards.php).

During the workshop, many feedbacks were received from the partners and the presented gaps were thoroughly commented and then rated to the need for action. Moreover, some suggestions for new gaps were provided.

Aim of this section, new in version 2 of this Deliverable, is to present a summary of the most relevant comments, in order to complete the overview on the gaps and on the required actions in the next future.

7.1 Feedbacks on the Gap Analysis results

The Gap Analysis process produced a list of 29 main gaps, which have been presented in detail to the audience during the just mentioned workshop. The attendees provided comments and feedbacks on every gap. 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 first, interesting feedback can be obtained by the global view of the agreement/disagreement expressed by the participants with regards to the identified gaps. To obtain this feedback, 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 7-1 and Figure 7-2. A quite varied situation can be observed, with gaps completely agreed, others completely disagreed and many with “medium” agreement.

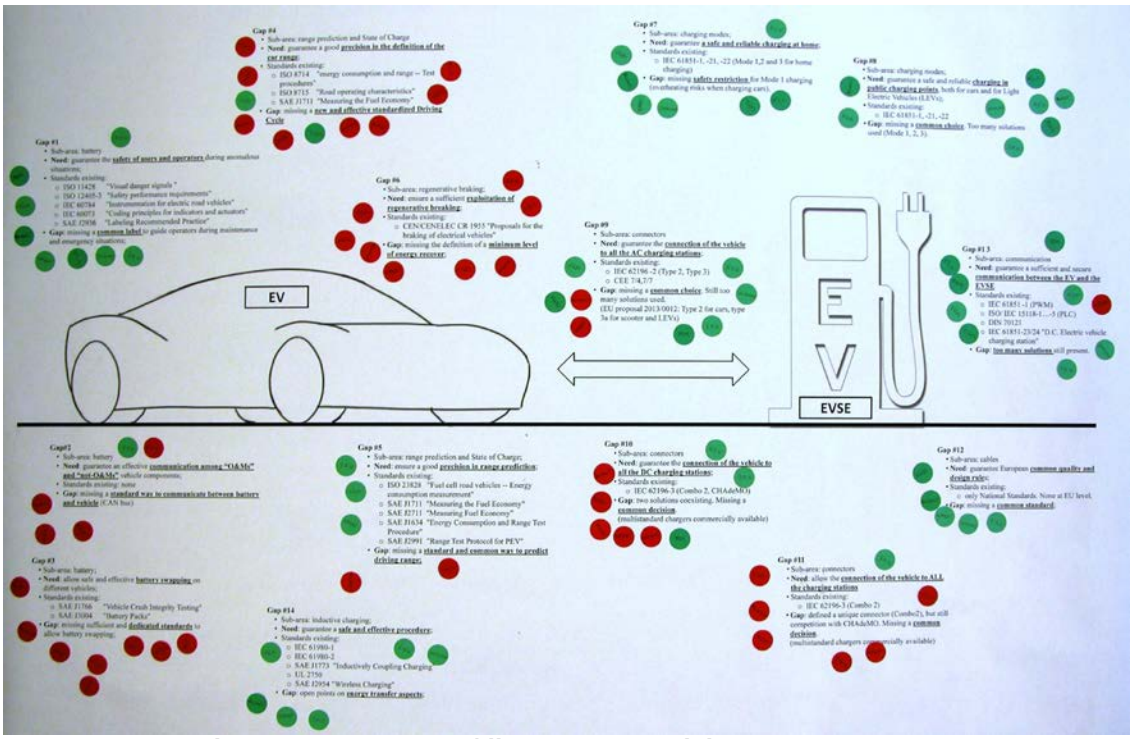


Figure 7-1 Agreement/disagreement stickers on Gaps 1-13

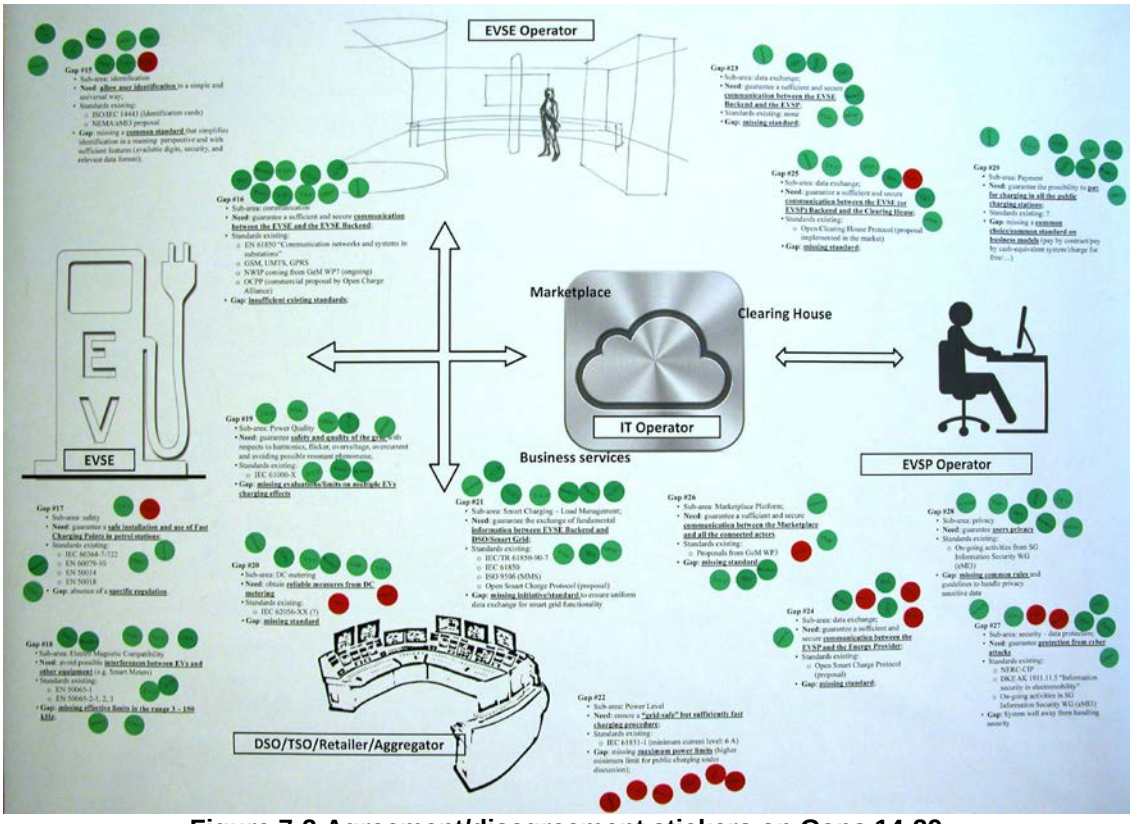


Figure 7-2 Agreement/disagreement stickers on Gaps 14-29

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 was possible also to evidence the opinions of the different stakeholders.

In Table 7-1, the feedbacks on each gap are reported, divided for stakeholders groups.

Table 7-1 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

A color 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

Some criticalities can be immediately seen:

- 3 gaps got full disagreement:
  - #3: Battery swapping
  - #6: Regenerative Braking
  - #22: Maximum Charging Power
- 3 gaps got large disagreement:
  - #2: Inside vehicle communication with the Battery (CAN bus)
  - #4: New Standardized Driving Cycles;
  - #11: Universal connectors.
- 3 gaps got medium agreement:
  - #5: Driving Range prediction;
  - #10: DC connectors;
  - #24: Communication EVSP – Energy Provider

The other 20 gaps were substantially approved by the attending experts.

The table evidences that, with this participants, there are no substantial discords among the different stakeholders, as only in 3 cases out of 29 we have a “medium agreement” situation. In the other 26 cases, all the stakeholders expressed quite similar opinions.

These results expressed a good general feedback but also some disagreement with the proposed gaps and will be fundamental to design the Standardization Roadmap described in D7.8 “Guidelines for standardization and interoperability” (soon available at http://www.greenemotion-project.eu/dissemination/deliverables-standards.php).

7.2 Suggestions for new gaps: “The gaps of the gaps”

One of the most important results obtained during the workshop was to gather comments and suggestions on the completeness of the Matrix, identifying also new topics that were missing in the analysis (“The gaps of the gaps”) and that could be added (both in a short-term and in a medium-term vision). The discussion, both directly within the workshop and in the following weeks, led to point out some interesting issues, covering different aspects. These are briefly summarized in the next sections.

7.2.1 SCHUKO housing:

There is no definition of the housing of the Schuko plug on the charging pole (both for mode 1 and mode 2). There are different solutions in different countries and in some cases the flap cannot be closed, due to the arrangement of the cable (straight or 90 degrees). This turns out to be a serious problem, since the charging cannot start unless the flap is fully closed.

7.2.2 Battery terminology

There isn't a common understanding of what are the battery State of Charge (SoC) and State of Health (SoH). Which is their definition? Which is the measurement unit (%, kWh, others)? There is a need for definition on how to estimate this SoC and SoH, and of the methodology to do it.

7.2.3 Testing methods

In many standards it's missing the definition of the testing procedure, and thus is very difficult to know if the component is good enough. An example of testing method could be the unofficial 10.000 connections/disconnections that are performed on the socket/plug for the charging points.

7.2.4 Test and assessment of battery performance

There are some specifications regarding EV battery performance in the EU (UN-R 101, Annex 2). The EU does have stipulations concerning specifications that must be furnished for electric vehicle battery performance through UN-R 101, Annex 2. Despite of that, no official test procedure has been specified and released to date.

Other applicable standards, currently available as optional test procedures for Li-ion batteries are:

- ISO 12405-1:2011: for high-power applications
- ISO 12405-2:2012 : for high-energy applications
- IEC 62660-1:2010 : for battery performance testing
- IEC 61982:2012 : for secondary batteries (Li-ion not included) performance and endurance (application: EV propulsion)

7.2.5 Methods and requirements to determine battery durability

Just mentioned ISO 12405-1:2011, ISO 12405-2:2012 and IEC 62660-2 (for Li-ion) are just voluntary regulations, but there are no official standards regarding battery durability requirements in the EU.

7.2.6 Second-life applications for EV batteries

Directive 2005/64/EC addresses the reusability of EVs components and systems, but battery packs are excluded as they are not considered as such. Several OEMs are assessing second-life applications for these battery packs, e.g. proposing home/neighborhood back-up power systems or smart grid buffering strategies.

Two SAE standards can be mentioned in relation with second-life applications and recycling for automotive batteries:

- J3097 (Work In Progress - WIP)**:** (Standards for Battery Secondary Use): on-going work to develop standards for a testing and identity regimen to define batteries for variable safe reuse. Utilize existing or in process standards such as Transportation, Labeling and State of Health. Add to these reference standards the required information to provide a safe and reliable usage.

- J2974 (WIP) (Technical Information Report on Automotive Battery Recycling): SAE Technical Information Report that provides information on Automotive Battery Recycling. This document provides a compilation of current recycling definitions, technologies and flow sheets and their application to different battery chemistries.

7.2.7 Vehicle as Electricity Supply

So far, there's not any standard or recommended regulation addressing the EV as an instrument to transfer electric energy to the grid (V2G), though some first steps are being taken:

- ISO/IEC 15118: under development in the UE;
- J2836, J2847, J2931: voluntary standards offered by SAE.

There's still a lot of work to be done both in the EU and in US. Japan, on the other hand, is developing requirements that allow EVs to act as electricity supply in emergency cases.

7.2.8 EV Labelling

OEMs should provide the EVs buyers with information in the most comprehensive and adequate format, through proper labeling. They should include at least the CO_2 emissions, fuel and energy consumption and range.

8 Results and first uses: Green eMotion standardization activities

As just evidenced, the work carried out has let to identify more than 30 gaps, divided into five technology areas. The indication of the level of criticality is a useful mean to immediately highlight the most sensible topics and to choose where it is worthwhile to spend more efforts in the short-medium term.

Exactly according to that, the performed gap analysis and the relative gap matrix have been used by WP7 partners to identify the most important areas to address in the following part of WP activities.

The most important actor at the moment is the charging point (EVSE) and its interaction with the vehicle/user side, as well as with the grid/operator side:

- In roaming scenarios the user needs to identify himself at the EVSE of another operator than at home. He will often use an RFID card. As a high variety of standards for RFID exist, this will not always work. A common standard for identification/authorization is needed.
- In roaming scenarios a communication is needed between the operator of the EVSE and the service provider of the user which could be any service provider existing. In order to make communication of all involved computer systems possible, we need standardized identifiers and business objects.
- Regarding the interface between EV and EVSE we face the situation of several standardized plugs and also charging modes, e.g. slow charging with household plug, AC fast charging with type 2 plug, DC fast charging with combo 2 plug. To ensure that EV's really function with the foreseen charging interface of the EVSE we need standardized conformance tests.
- With the emerging of green energy coming from PV, water, wind, etc there is a need to manage the power demand by EV's based on the availability of those energy sources. Therefore a standardized protocol for communication between the grid control by DSO's/TSO's on one hand and the charge point (EVSE) operators on the other hand is needed.

While completing the analysis of the gaps in standardization, Green eMotion started also to actively work on the needed standards. To give a high impact it was decided to focus on development of new standards with ICT aspects. Part of that was the foundation of the eMI3 group (eMobility ICT Interoperability Innovation Group) together with other industry partners to broaden the agreement level on those consortium standards and to ensure the continuation of activities after Green eMotion project end. Partners of Green eMotion fulfill part of their obligations by contributing to eMI3.

In the following, some details of Green eMotion standardization activities are reported.

Please notice that the presented Gap Matrix has also represented the starting point for the debate during the standardization workshop that was held in Brussels on May, 6th 2014 and which results are included in Deliverable 7.5 and partly in this second version of D7.3.

8.1.1 Interchangeable RFID cards for identification/authentication in roaming scenarios

RFID cards have been in use for several year as a simple, cheap, and convenient method for identifying users or user's contracts e.g. in public transport. So, most producers of EVSEs thought of RFID cards as a suitable method for authentication of users for charging at an EVSE. Most RFID cards are based on the ISO 14443

standard, cards and readers are widely available and cheap. Furthermore 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 service providers, started to hand out RFID-based customer cards for the use at the charging stations operated by themselves. This worked well until EV drivers wanted to drive outside the boundaries of the EVSE locations of their energy provider. This became reality very quickly, since the autonomy of the EVs available was increasing.

An example is the situation in Denmark by 2012. Two major players were on the market of operating EVSEs: Better Place and ChooseEV (now “Clever”) and they faced the same issue: customers finding enough EVSEs but they were not able to use the chargers of the other company.

Companies were then and are now mostly using the serial number of an RFID card as an identifier. This works well as long as 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 Better Place therefore proposed a solution of this problem to the Green eMotion WP7 partners. Their 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. Furthermore there is also information available about who has issued the card and about the underlying contract. In addition the proposal also addressed security issues with the existing RFID cards and proposed ways around those issues.

As a next step Better Place handed their concept document - in the form of a new work item proposal (NWIP) - to the IEC. In a ballot following the review period of the document, the members of the IEC agreed in fall 2012 to pursue the standardization of this topic. The name of the upcoming standard was chosen to be “User identification in Electric vehicle Service Equipment using a smartcard” – IEC 62831.

Better Place was named to lead the project team. But due to the financial turmoil and the following bankruptcy of Better Place the work did not start.

Beginning 2013 the German DKE offered to take over as an interim lead and the work progressed there in the group DKE/AK 353.0.8 "Nutzerautorisierung für Ladeinfrastruktur" (German for “user authorization in EVSEs”). The group continued working on the better place proposal, enhancing it with now standardized information like the electrical vehicle contract ID (EV-COID) and new means of identification like NFC enabled smart phones. Also, a security team joined the group to ensure security needs. Several Green eMotion partners (e.g. Bosch, IBM, RWE, Siemens) have joined the work there to continue the Green eMotion effort.

Meanwhile in the US, the standardization body NEMA also continued to improve the original proposal. They presented an enhanced version of the original Better Place proposal to the eMI3 group which was consequently handed over to the DKE group. It is currently been analyzed by the experts of the DKE group and if suitable will be merged into the ongoing work.

8.1.2 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 between EVSEs of different suppliers and the corresponding charge management systems. There was always the need to have separate implementations in a charge management system for different charging points. This finding was even valid for chargers or management

systems claiming to be compatible with an existing “open standard” called OCPP (Open Charge Point Protocol), in which some basic functions were defined, but there was common way of implementing this “standard”.

During January 2013 a technical meeting was held in Malaga (Spain) among WP7 task leaders (RSE, TNO and CIDAUT), together with ENEL, RWE, Siemens and Bosch. The objective of the meeting was to develop a working plan for analyzing the requirements of communication among EVSE and its backend systems.

It was agreed that this was a very relevant topic towards interoperability of EV. The aim of this activity was defined as follows: to elaborate a new work item proposal (NWIP) for standardization bodies on communication messages. This proposal focused on the content of this interface, not on the specific protocol to be used. Partners decided to identify the information needed to ensure interoperability, and later write it down in a proposal form to be addressed to the IEC.

A second working meeting was organized, and later held by Siemens in Munich in March 2013. During this meeting the specific requirements to be included in the communication protocol were identified. The demand for such a standardized communication protocol was broadly accepted: the meeting was very well attended with participants from many GeM partners, but also relevant external stakeholders.

During the following three months, CIDAUT, Siemens and RWE prepared a draft for a possible NWIP which included all the requirements discussed in the Munich meeting. This NWIP was later agreed among all WP7 partners. This document, together with the recommendation of addressing the National bodies to start the formal process to create a working group was sent to eMobility ICT Interoperability Innovation Group (eMI3).

The decision to involve eMI3 was taken to enlarge the number of industries involved, as well as to make sure that the process continued after the end of Green eMotion project.

eMI3 acknowledged the Green eMotion proposal and established a new working group “WG5” on the topic communication protocol. The group decided to improve the NWIP by preparing an annex document which can then be later used for a more sophisticated NWIP to the IEC. This annex document shall provide requirements and use cases for the upcoming protocol.

In order to create such document the group started a call for protocols to find possible candidate protocols already available on the market. These protocols are currently analyzed for functionality and help create the use cases and requirements documents.

Due to legal reasons it took some time to gather the proprietary protocols of the partners. Currently available to the group are OCPP 2.0, Siemens and Enel protocol. Furthermore partners supply information about different other protocols. According to plan the requirements and use-case document should be ready by end of 2014.

In the meantime the group still met on a regular basis to define e.g. non functional requirements, which shall also be covered by the document to be created.

Update in second version

At the end of 2014, the NWIP proposal took a more defined shape, with the so-called **Electric Mobility Infrastructure Open Protocol**.

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.

8.1.3 Standardized identifiers and business objects

One of the most urgent topics for standardization identified within Green eMotion is the standardized identifiers and business objects. 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.

The unique identification of the following entities is required for efficient inter-organizational interoperability (Roaming between EVSP/EVSE and countries, third party access):

- 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[8] 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) could already be reached. The results are part of ISO/IEC standard 15118 and also documented in Green eMotion report D3.9 “Standards and protocols specifications” available at http://www.greenemotion-project.eu/dissemination/deliverables-ict-solutions.php. The full specification will be available in the upcoming deliverable D3.10.

8.1.4 Power Demand Management

With the emerging of green energy coming from 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 levelled. 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.

[8] http://emi3group.com/

Levelling 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 has 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 available at http://www.greenemotion-project.eu/dissemination/deliverables-evaluations-demonstrations.php in spring 2015.

8.1.5 SORDS: Standardized on road driving schedule (new in second version)

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, WP6 team worked on the design of a new test cycle to characterize EVs energy behavior.

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.

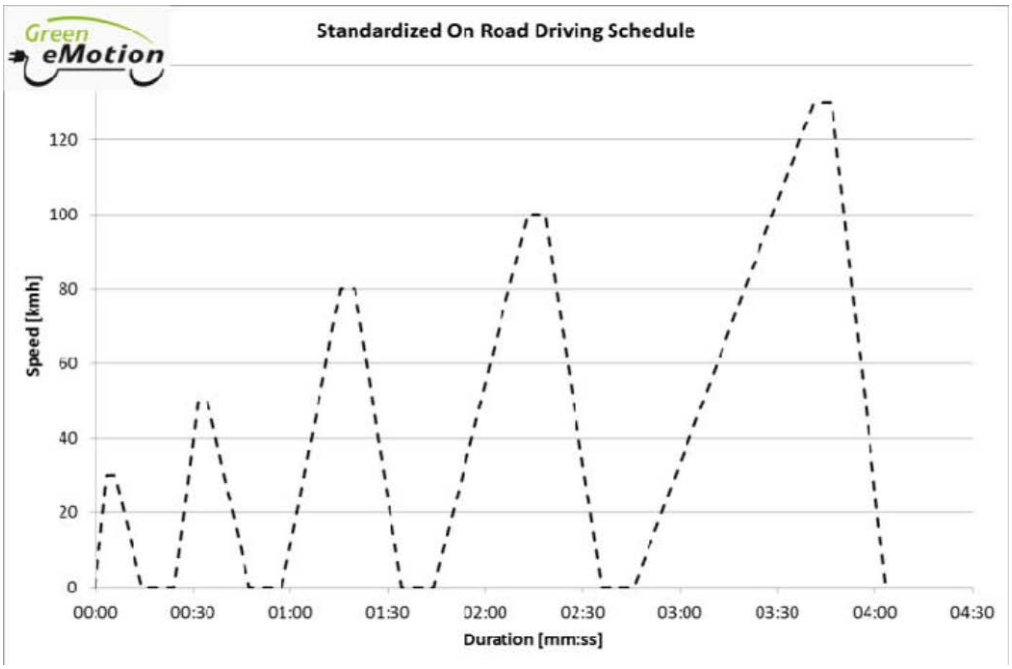


Figure 4-1 Speed profile of the standardized on road driving schedule

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.

9 Conclusions

Nowadays standardization and harmonization of standards represent a fundamental aspect to guarantee the interoperability of electric vehicles across Europe and, subsequently, to stimulate a significant market penetration of this kind of vehicles. A lot of work is going on in this sense, but the e-mobility sector is still suffering the presence of hurdles, difficulties and uncertainties. In this context, a Gap Analysis, which is by itself nothing more than a comparison between what is existing and what is desired, can be a really effective way to avoid the waste of resources and the risk to perform below the potential. By identifying the gaps, it is possible to quantify the needed actions and to define the priority order to reach the desired targets, properly managing the evolution process.

The work performed in the last years by the Green eMotion Work Package 7 participants has aimed exactly to this scope and has brought, at this time, to identify approximately 30 standardization aspects that are still representing an open issue according to the most relevant stakeholders in the sector.

More in particular, these aspects, which may be equally referred as “gaps” or “needs”, have been collected during the last two years through two standardization surveys, three workshops and several debates with representatives of GeM technical work packages. The results of this “collection” phase have then been transferred in a Gap Matrix, which structure has been properly designed to be easy-to-read and coherent with the global approach of the WP activity.

The identified gaps show that there are still several issues to solve in all the considered technology areas. The vehicle itself is presenting some lacks in particular regarding the “new” aspects that differ EVs from traditional vehicles, i.e. the batteries handling during emergencies, the range definition/prediction (really much more relevant than for fossil fueled vehicles) or the regenerative breaking. However, it is quite clear that the most important actor at the moment is the charging point (EVSE) and its interactions with the vehicle/user side as well as with the grid/operator side. The complex exchange of information which is needed to achieve an effective interoperability appears in fact to be still quite unregulated and, despite of some on-going proposals, there is still much work to do. Green eMotion, with the development of the Marketplace platform and the test of many roaming features, represents in this moment a really important actor of this process.

More in particular, Green eMotion has started standardization activities in the following fields:

- Communication interface between the charging hardware (EVSE) and the control software (backend system) - This is mandatory if an operator of EVSE’s, which will in general only have on control system, wants to connect chargers from different manufacturers that might require different communication protocols. Green eMotion drafted a plan how to get to a common communication protocol that has then been adopted by the eMI3 consortium where it is followed in the working group 5.
- Based on the proposal of former partner Better Place on interchangeable RFID cards for identification/authentication in roaming scenarios, standardization work has been started in IEC. Green eMotion partners are actively involved in the IEC work.
- One of the most urgent topics for standardization identified within Green eMotion is the standardized identifiers and business objects. Within eMI3 an agreement on standardized contract identifiers and EVSE identifiers could already be reached. The results are part of ISO/IEC standards 15118 and also documented in Green eMotion report D3.9 “Standards and protocols specifications” available at http://www.greenemotion-project.eu/dissemination/deliverables-ict-solutions.php.
- Regarding power demand management (e.g. for load management purpose or smart charging) Green eMotion has developed a demonstration example 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 available at http://www.greenemotion-project.eu/dissemination/deliverables-evaluations-demonstrations.php in spring 2015.

It has to be noticed that the results obtained in this phase of work and reported in this document don't represent the final step of the activity. They, at the opposite, represent the basis and the starting point to develop some guidelines for standardization, which will have to specify the most urgent steps in order to effectively arrive to common and well-defined technological solutions. This will be exactly the target of next Task 7.6 activity.

Moreover, it has to be noticed that the performed Gap Analysis has not to be considered "closed" or "static". It will be, on the contrary, an open process, where comments, inputs and feedbacks coming from relevant actors in the field will be included and discussed. Exactly in this sense, the results of the Gap Analysis will be presented to experts in a specific workshop in Brussels and in many other occasions, which will represent a significant opportunity to improve the outcomes of the work and to have a clearer view of the steps needed in the next future.

New in second version

The document has been updated in February 2015, in order to provide the readers with a more precise overview of standard situation and Green eMotion standardization activities and with more complete results on the Gap Analysis process. Data related to Demo Regions, new regulation and GeM activities were so changed and updated. At the same time, the results and feedbacks on the Gap Matrix coming from the above mentioned workshop in Brussels were reported. The most important results of this last phase of the analysis can be so summarized:

- WP7 Gap Matrix can be considered a reliable an useful representation of the open issues:
  - 20 on 29 gaps got full or large agreement by the attendees;
  - Only 3 gaps got full disagreement (related to battery swapping, regenerative braking, maximum power limit on charging);
- Some technical aspects (e.g. cables, Electro Magnetic Compatibility aspects, battery safety after a crash, data security,…) really need an improved definition through standards;
- There is the urgent need for testing methods and procedures, both for vehicles and for batteries;
- Issues regarding the vehicle can be considered less relevant in Green eMotion view, as they only slightly affect interoperability. ICT aspects will represent a core issue.