Deliverable 7.5

Standardization Workshop for finalization of alignment in the demonstration projects

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List of Abbreviations

A	Ampere
AC	Alternating Current
CAN	Controller Area Network
CCS	Combined Charging System
CHAdeMO	CHArge de MOve
CP	Charging Point
D	Deliverable
DC	Direct Current
DER	Distributed Energy Resource
DKE	Deutsche Kommission Elektrotechnik
DoW	Description of Work (Annex I of Grant Agreement)
DSO	Distribution System Operator
EMC	Electro Magnetic Compatibility
eMI3	eMobility ICT Interoperability Innovation
E-Mobility	Electro Mobility
ESF	External Stakeholder Forum
EV	Electric Vehicle
EVCOID	Electric Vehicle COntract IDentification
EVSE	Electric Vehicle Supply Equipment
EVSEID	Electric Vehicle Supply Equipment IDentification
EVSP	Electric Vehicle Service Provider
GeM	Green eMotion
Hz	hertz
ICT	Information and Communication Technology
ID	IDentification
IEC	International Electrotechnical Commission
IREC	Institut de Recerca en Energia de Catalunya
kVA	kilo Volt-Ampere
kW	kiloWatt

LEV	Light Electric Vehicles
Li	Lithium
LV	Low Voltage
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
PHEV	Plug-in Hybrid Electric Vehicle
PLC	Power Line Communication
PoD	Point of Delivery
PODID	Point of Delivery IDentification
PWM	Pulse Width Modulation
RFID	Radio Frequency IDentification
RIP	Revision In Progress
SAE	Society of Automotive Engineers
SG	Smart Grid
SoC	State of Charge
SoH	State of Health
T	Task
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

In order to facilitate the sharing of experience and know-how among high level experts in the world of electromobility standards, Green eMotion (GeM) has been the promoter of a technical and high-focused workshop on May 6th 2014 in Brussels. Selected representatives from car manufacturers, distribution system operators, standardization bodies, industries, demo projects and research centres have met to actively debate on the status of standards in the field of electromobility and on what has still to be done to allow a real market penetration of electric vehicles.

The workshop has been powered up by the presentation of a "standards gap matrix" developed inside the Work Package 7 (WP7) of the Green eMotion Project. In the last years, WP7 – "Harmonization of technology and standards" collected indeed much information from relevant involved stakeholders and created a Gap Matrix, containing issues and gaps related to e-mobility technology and standards. Approximately 30 gaps were identified, in areas like batteries, range prediction, regenerative braking, charging modes, connectors, cables, communication, identification, payment, data security, grid connection and others.

The workshop main objective was to identify which is the E-Mobility standards situation, leveraging the Gap Matrix as starting point and looking for comments and improvements on the Matrix itself. The workshop was organized in order to stimulate knowledge sharing: it was characterized by the presence of only selected participants (experts, representatives of different involved actors, medium-low number), by limited direct-presentation phase, free discussion and feedback collection tools.

During the workshop, many feedbacks were received from the partners. The main outcomes can be 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;
- Smart charging, Vehicle to Grid (V2G) and Vehicle to Home (V2H) related standards will soon become a relevant aspects to address;
- Issues regarding the vehicle can be considered less relevant in Green eMotion view, as they only slightly affect interoperability;
- Interoperability is a complex task that should be addressed following precise methodologies that consider different layers and different steps (e.g. the definition of use cases and business cases).
- The process to obtain common standards has to be speeded up.
- In many cases the main problem is not to define new standards, but to choose one from multiple standardized versions (more regulation than standardization)

With regards to the last point, also thanks to the active participation of the European Commission (EC) at the workshop, it has been possible to identify which actors and which process could lead to effective choices and to regulation decisions. The best situation to enhance interoperability will be to have only one common solution, but this needs:

- Coordination among different research/industrial activities to point out the best technical solutions;
- Creation of working groups/alliances/partnerships among industries;

- Wide agreement on one solution by industries and stakeholders;
- Policy intervention through regulatory means (EC Directive or other).

During the workshop the presented gaps were thoroughly commented and then rated to the need for action. The results of this fruitful workshop will be a key part to lead the way forward to a standardization roadmap necessary for the uptake of the electro-mobility market in Europe.

2 Introduction

The sector of e-mobility is experiencing in the last years a really interesting evolution. Batteries and electronics technical improvements, as well as a significant political pressure on environmental regulation, have given a remarkable stimulus to pass from a small niche market to a considerably more relevant one. The progressive transition from extremely "local" realities to a Pan-European vision, with many international Original Equipment Manufacturers (OEMs = car manufacturer) involved, has by the way made more relevant the problem of finding common and harmonized standards. In absence of common solutions, the functionalities of the vehicles (i.e. the possibility to charge easily everywhere) will be substantially decreased and, at the same time, there will be barriers for new entrants in the market and difficulties in setting up an economically feasible and optimized charging infrastructure.

Considering that, inside the Green eMotion Project a complete Work Package has been devoted to standards harmonization and many efforts have been spent trying to identify the most critical issues and possible solutions, leveraging the technical expertise of GeM partners and the learning possibilities offered by the presence of the GeM demonstration projects in the so-called Demo Regions (DR).

More in particular, the final aim of the first part of Work Package 7 is to perform a Gap Analysis on e-mobility standards, comparing the existing standards with the needs expressed by the actors in the sector. By identifying the gaps, and their level of importance, it is indeed possible to sketch-up a roadmap and to try to manage at best the standardization process in the very next future.

The work has been carried out during the last years using different means. The starting point has been the collection of all the existing standards in the e-mobility field, which was conducted mainly by the partner Cidaut and has been reported in Deliverable 7.1 "Review of technologies and standards in the demonstration projects" (http://www.greenemotion-project.eu/upload/pdf/deliverables/D7_1-Review-of-Technologies-and-Standards-V1_11-submitted.pdf). The result of this big effort has been a very wide table including more than 230 standards, number that increases to 689 if the single parts composing a "series" (e.g. IEC 61851-1, 61851-21, 61851-22…) are considered separately. Then, the situation in the Demo Regions have been analysed, mainly thanks to the data collection process managed by the partner IREC and periodically updated. This let to identify which of the almost 700 standards are actually adopted and which can be considered to be more relevant in real implementations. Once clarified the present situation, the attention has been shifted to the still open issues, trying to detect which are the needs felt by the involved stakeholders. To do that, two surveys have been prepared and circulated among GeM partners and some external actors. The surveys have been properly designed to highlight the most relevant aspects related to e-mobility standards in all the technology areas (electric vehicle (EV), electric vehicle supply equipment (EVSE), connection to grid, communication). In parallel to that, three standardization workshops have been organized, involving both internal (to GeM) and external experts. In those occasions, interesting debate arose on many aspects, including technical aspects, policy/regulation aspects and strategy aspects. The discussions gave many interesting inputs in terms of open issues and needs. In order to leverage the experience gained in Green eMotion technical work packages, a direct contribution was at last asked to relevant representatives of Work Package 3 ("Electro mobility services / ICT solutions"), Work Package 4 ("Grid EV-olution"), Work Package 5 ("Recharging Infrastructures") and Work Package 6 ("Demonstration of Electric Vehicle Technology – validation and contribution to standardisation").

All this process, reported in detail in Deliverable 7.3 "Current status of technologies and standards in the demonstration projects" (http://www.greenemotion-project.eu/dissemination/deliverables-standards.php), let to collect many needs, and their comparison with the existing situation let to identify approximately 30 gaps. In order to give a synthetic view of these gaps, a matrix was properly structured, which has been called the "Gap Matrix".

Once this process ended, it has been 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, is indeed fundamental to obtain a more common and more precise view. In order to do that, one dedicated Workshop has been organized, which is thoroughly described in this Deliverable.

3 Workshop objectives

The work carried out inside Work Package 7 in order to perform the Gap Analysis on e-mobility standards has been extensive and involved many different stakeholders. Nevertheless, there was the risk that the picture that came from this process was not totally complete, considering that e-mobility includes many cross-sectorial aspects as well as many actors and roles. In order to obtain the most possible exhaustive and agreed description of gaps, it has been considered fundamental to present the identified gaps, and the used process, to selected experts in the field of e-mobility standards, triggering a debate and collecting feedbacks.

The "standardization workshop" that has been organized and held in Brussels on May 6th, 2014 born exactly with this general purpose: collecting comments, feedbacks, suggestions and ideas on the performed Gap Analysis.

More in particular, the aim was to gather relevant representatives of standardization bodies and experts in the standardization field, in order to:

- Present the results of the Gap Analysis
- Collect "technical" feedbacks on the identified gaps:
    - Are the description and the technical content of the gap correct?
    - Does the gap still exist or has it been overcome in the last period?
- Identify the relevance of the identified gaps ("level of criticality")
    - How much the gap interferes with interoperability?
    - How many real-life problems happen due to the gap?
    - The evolvement of the e-mobility sector will make this gap more or less critic in the next years?
- Identify on-going activities:
    - Is there some on-going work to solve the gap?
    - Which actors are the most involved/active on addressing the gap?
    - Is it likely to have the gap solved in a few years?
- Identify other gaps (not covered by the Gap Analysis)
- Discuss on possible "new areas" that will have to be addressed by standardization bodies in the next years.
- Obtain inputs to define a possible strategy/roadmap for standardization activities in the next years, starting from the identified gaps.
    - Which aspects should be considered more urgently?
    - Who will be the key actors?
    - Which will be the role of the market?
    - Which will be the role of regulatory entities (e.g. the European Commission)?

Once these questions get reliable answers, the representation of e-mobility standards situation will be clearer, having more deeply depicted the following points:

- What is existing;

- What is missing;
- What has changed;
- What will happen.

The workshop structure have been properly thought to try to find answers to those questions, paying particular attention on encouraging interaction and active participation by the attendees. The connected organization choices will be better explained in the next Chapter.

4 Workshop structure and organization

As already stated in the previous chapter, the aim of the workshop was mainly to share knowledge with e-mobility standardization experts, in order to collect feedback on the work performed by WP7 and to obtain a quite exhaustive view of the present situation in e-mobility standards. The creation of a debate and the active involvement of the attendees were therefore crucial for the collection of useful results, and the workshop structure has been thought exactly to try to encourage those aspects.

4.1 Attendees selection and participation

The number and the kind of participants were thought to create an adequate environment for a highly-focused and effective discussion. More in particular, it was chosen to have a "close" event, with direct invitations and an upper limit of 30 participants. The invitation list was agreed by WP7 partners, according to the following criteria:

- High level of expertise on e-mobility standards;
- Representatives of automotive and electric sector;
    - Original Equipment Manufacturers (OEMs)
    - Electronic Manufacturers
    - Distributor System Operators (DSOs)
- Representatives of the Information and Communication Technology (ICT) sector;
- Representatives of many European countries;
- Members of Standardization Bodies/Groups;
- Representatives of Research Institutions;
- Representative of Political Institutions.

The response of the invited people was generally positive, and the final number of participants was 21, including representatives from:

- Two car manufacturers;
- Three Distributor System Operators;
- Two electronic/ICT companies;
- Five research centres;
- Four standardization groups/bodies;
- European Commission.

Seven different nations were represented in the audience.

4.2 Agenda

Coherently with the general aim of the meeting, i.e. enhancing interaction among the participants, the workshop agenda has been scheduled limiting the "direct presentation" formula only to the first part of the day. More in particular, only two general presentations have been planned, in order to introduce the

Green eMotion project to the audience and the specific activity on standards developed inside the dedicated Work Package 7 “Harmonization of technology and standards”.

After this introductory part, a quite relevant time-slot has been reserved for the presentation and a first discussion on the Gap Matrix, which includes all the most important results of the Gap Analysis process performed by GeM WP7. This is a core section, as it will give the inputs for all the following discussion. It can be said that the presentation of the identified gaps should “power-up” all the following debate on standards and standardization activity.

The rest of the day has been therefore thought to leave space for “free” discussion and to collect as many feedbacks and comments as possible. In detail, two 90 minutes interactive sessions have been scheduled, during which no direct presentations from GeM or WP7 will take place. During the first one, called “feedbacks on the Gap Matrix”, the attendees will be asked for their opinion and comments on the just presented gaps. During the second one, called “what after the Gap Matrix?”, the discussion will be shifted to the next future, in order to identify new possible areas for standardization activity and to try to sketch up a draft roadmap.

The whole agenda is summarized in Table 4-1.

Table 4-1 Workshop Agenda

E-Mobility Standards: what's missing? May 6th, 2014	
Time	**Topic**
9.00 - 9.30	*Registration and welcome coffee*
9.30 - 9.40	Introduction to the meeting
9.40 - 10.00	The Green eMotion project - overview
10.00 - 10.20	Green eMotion effort on standardization – WP7 activities
10.20 - 11.00	The GAP MATRIX - detailed description
11.00 - 11.20	*Coffee break*
11.20 - 13.00	Interactive session 1: *feedbacks on the Gap Matrix*
13.00 - 14.00	*Lunch*
14.00 - 15.30	Interactive session 2: *what after the Gap Matrix?*
15.30 - 16.00	Wrap up and conclusions

4.3 Approach and used tools

The objectives of the workshop, already presented in Chapter 3, were very clear. Considering that the time was quite small and that was really important to get relevant results from the high-level audience, the organizers of the workshop pointed out explicitly that the discussion should be extremely focused. More in particular, the work has been prepared in order not to discuss on general aspects regarding e-mobility, e.g. prices, range anxiety, comparison with hybrids, limitations as a second car, etc., while keeping the attention focused on standards and standardization activity.

The second key aspect for the achievement of good results was the interaction among the attendees. Also this point was directly stressed by the organizers, highlighting how discussion can often bring to unexpected and very interesting results.

In order to get feedbacks from the participants, not only discussion has been used. Two posters describing the gaps have been prepared and hanged in the room. The attendees have then been provided with green and red stickers, to indicate agreement or disagreement on the different gaps. The results will be shown in Chapter 6.

Also direct written contributions were asked to the audience, as better described in Chapters 5 and 6.

As last mean to collect inputs and feedbacks, detailed Minutes of Meeting were circulated after the workshop, and comments, corrections and new ideas were asked to all the participants.

5 Workshop contents and discussion

5.1 Inputs from Green eMotion WP7: the Gap Analysis and the Gap Matrix

The main objective of the workshop was to obtain feedbacks and comments from relevant experts on e-mobility standards on the work conducted inside Green eMotion Work Package 7. After the introductory presentation on the whole GeM project, the attention has therefore been immediately focused on Work Package 7 and the Gap Analysis process.

The Gap-Analysis process started from the study of the existing situation on e-mobility standards and then went on with the collection of issues and problems that have still to be tackled, according to the most relevant stakeholders in the field.

According to this general aim, the first step was then to collect and analyse all the existing standards related to electro-mobility. This work, performed mainly by the partner Cidaut, has brought to the construction of a wide table (see the file "Review of technologies and standards in the demonstration projects" in the Green eMotion website: http://www.greenemotion-project.eu/dissemination/deliverables-standards.php), which has represented a reference point for the following work. To elaborate it, different sources of information have been used:

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

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

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

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

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

- The 99.36% of the charging points has a socket as output. The remaining 0.64% is equipped with wire and connector.

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

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

The surveys were circulated in 2011 and 2012 among WP7 partners, Demonstration Regions and few External Stakeholders. The first one addressed directly the four technological areas used in the already mentioned table of standard (electric vehicle, charging point, connection to the grid, communication), but also gave the respondents the possibility to propose more generally a list of the most important topics in the standardization field.
The second survey was instead prepared with the objective to gain more insight and details on four other specific technological areas:

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

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

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

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

The just described efforts used for defining the most important standardization issues in the e-mobility field, have brought finally to a quite large number of data, results and comments. The combination of analyses, surveys, workshops and discussions, with the involvement of a large number of actors, gave an interesting overview of the European situation. The main issues have been so organized and included on a comprehensive table, which has been called “Gap Matrix” and which had to let the identification of the most important open points by indicating their level of criticality.

It has been possible to clearly identify 29 gaps, divided in four technology areas in accordance with the WP initial approach. For each gap, four columns are used in the Matrix, reporting the need, the existing standards, the gap and the level of criticality.
The contents of the Matrix are reported as bullets in the following, in order to let the reader better understand the inputs and the basis of the discussion that took place during the workshop.

Before listing the gaps, an overview of the Green eMotion reference architecture has to be provided, in order to clarify the roles and the related interactions. In Figure 5-1, the GeM building blocks are reported.

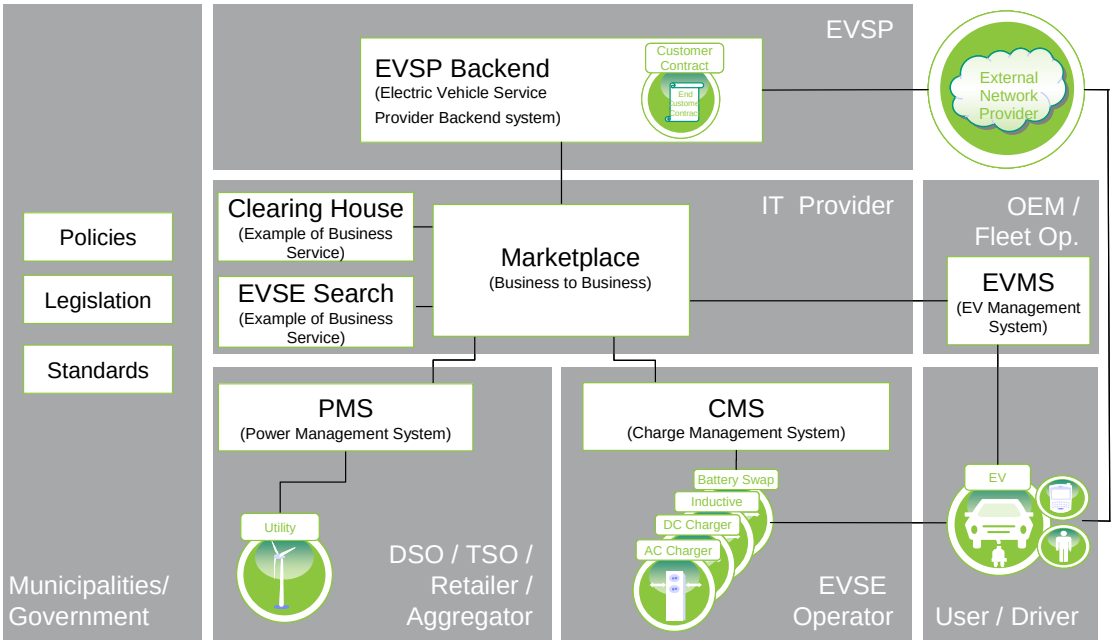

Figure 5-1 Green eMotion Building Blocks, evidencing roles and interactions

5.1.1 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 "Labelling 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)

- **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")

- **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

5.1.2 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

5.1.3 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

5.1.4 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

5.2 Presentation of the Gaps and first comments

The above described gaps have been thoroughly presented to the audience by RSE as responsible partner for the Gap Analysis process. During the presentation, comments from the audience have been allowed, and they are reported in detail in the following.

It has to be noticed that before providing the comprehensive list and description of all the identified gaps, RSE asked to the participants to wrote down from 1 to 3 topics that still represent an open issues (a gap), according to the attendees' experience. This was considered to be another effective way to collect issues, addressing directly experts coming from different countries and institutions. The answers have then been collected and have been analysed in a second phase (see Chapter 6.2).

In the following part, the comments that were made during the gaps presentation are reported. In order not to filter the contents of attendees' contributions, it has been chosen to report them in a direct way, leaving rework on them to the last part of this document.

- Gap #1: missing a common label to guide operators during **maintenance and emergency situation with batteries**

  OEM: "The operators are normally properly trained by the OEMs to manage maintenance and emergency situations, so the gap is probably not to have a label. But there are still some issues on how to manage batteries in emergency or after a crash. They could emit gases, and this should be taken into account, as it happen for Liquid Natural Gas vehicles. Besides, the transportation and disposal of damaged batteries is not trivial (post-crash regulations for transport)."

- Gap #2: missing a standard way to **communicate between battery and vehicle** (CAN bus)

  OEM: "According to the standardized cabling procedure for CAN, the CAN system works well only if the wires length doesn't exceed 1,5 m. This should be taken into account while considering the possibility to include batteries in the system. In some cases, the use of a CAN-to-CAN bus can be considered, to allow longer connections".

- Gap #3: missing a sufficient and dedicated standard to allow **battery swapping**

  Research Center: "After Betterplace bankruptcy, this doesn't seem to be an urgent matter anymore".

- Gap #4: missing a new and effective standardized **Driving Cycle**

  OEM: "The need to have better and more "easy-to-perform" driving cycles is not related to e-mobility, but to all vehicles, including the traditional ones. Anyway, it is true that the driving cycles should be modified."

- Gap #5: missing a standard and common way to **predict driving range**

  No comments.

- Gap #6: missing the definition of a minimum level of energy recover (through **regenerative braking**)

  OEM: "There is no need for that. The minimum level is already known and is 0, when the battery is already full. For the other situations, the level of regenerative braking is defined by OEMs as a compromise between comfort and battery stress, always considering the restrictions imposed by the regulation on braking forces. There is no point in having a standard for that."

- Gap #7: missing safety restriction for **Mode 1 charging** (overheating risks when charging cars)

  OEM: “The need for a current limit is more related to Mode 2 than to Mode 1. There has been a lot of discussion on the limit, which has been progressively decreased, from 16 A, to 13 A, to 10 A. Also 10 A, which is a quite accepted value, is too high according to our experience, as it can create problems for long charges and after many plugging/unplugging procedures. A correct limit is around 8 A.

  DSO: “As Mode 1 is simply connecting and charging, it is practically impossible to impose a limit on the current. The absence of a control system doesn’t allow a limitation. The only possible solution to avoid overheating risks with Mode 1 is to forbid completely this charging mode.”

- Gap #8: missing common choice on **public charging**. Too many solutions used (Mode 1, 2, 3).

  No comments (but please see the “interactive session 1”).

- Gap #9: missing a common choice on **AC connector**. Still too many solutions used.

  No comments (but please see the “interactive session 1”).

- Gap #10: missing a common decision on **DC connector**. Two solutions coexisting.

  No comments (but please see the “interactive session 1”).

- Gap #11: missing a common decision on a **“universal” connector**. Competition CCS/CHAdeMO.

  No comments (but please see the “interactive session 1”).

- Gap #12: missing a common standard on **cables**.

  OEM: “Standardization on cables is a real issue. In particular, there are standards for flexure and torsion but one doesn’t consider the other. We experienced many problems due to that, in particular with the pilot wire.”

- Gap #13: too many solutions still present for the **communication EV-EVSE**

  No comments (but please see the “interactive session 1”).

- Gap #14: open points on energy transfer aspects for **inductive charging**.

  No comments (but please see the “interactive session 1”).

- Gap #15: missing a common standard for **identification in roaming perspective** and with sufficient features (available digits, security, data format,…)

  No comments (but please see the “interactive session 1”).

- Gap #16: insufficient existing standards for **communication EVSE – EVSE backend**

  No comments (but please see the “interactive session 1”).

- Gap #17: absence of specific regulation for **Fast Charging Points in Petrol Stations**

  No comments (but please see the “interactive session 1”).

- Gap #18: missing effective limits for **EMC** in the range 3-150 kHz

  OEM: “There is a real issue on disturbances and pollution”.

  Standardization Body: “Technical Committee (TC) 77 is working on that”.

  European Commission: “Is it still an open point the evaluation of the radiation and their effects on the health of driver and passengers for the EV?”

- Gap #19: missing evaluations/limits on **Power Quality** including multiple EVs charging effects

  OEM: “A limit on harmonics exists, defined by 65100, but it has to be respected only at maximum power charging. If a car creates problems at half power, this is not considered.”

- Gap #20: missing a standard for **DC metering**

  DSO: “It is a problem. It is not directly related to utilities in the sense that is not related to energy aspects. But as well as you want to provide a charging service and to bill energy, this becomes an important issue.”

- Gap #21: missing standard for **communication EVSE Backend – DSO** (e.g. for Smart Charging)

  No comments (but please see the “interactive session 1”).

- Gap #22: missing a **maximum power limit** on charging

  No comments (but please see the “interactive session 1”).

- Gap #23: missing standard for **communication EVSE Backend – EVSP**

- Gap #24: missing standard for **communication EVSP – Energy Provider**

Gap #25: missing standard for **communication EVSE (or EVSP) Backend – Clearing House**

- Gap #26: missing standard for **communication Marketplace – all actors**

  General comments on the previous gaps:

  Standardization Group: “It would be important to identify which is our definition of “common standards”. There are a lot of solutions, as the Wi-fi or others in the ICT field, which are widely accepted and used while not being defined as a real standard (ISO/IEC/….). To enable communication in e-mobility, do we need an IEC/other standard?”

Research Center: “According to the general view of the GeM project, which is to enable interoperability to guarantee the roll-out of the market, it is not important the “origin” of the adopted solution, as long as it is commonly used and user friendly.”

DSO: “The solution should be “widely adopted”, also if it is true that there is not a clear “minimum number” of charging stations which identifies what we intend for “widely”.

- Gap #27: missing sufficient features to guarantee **protection from cyber attacks**

  No comments (but please see the “interactive session 1”).

- Gap #28: missing common rules and guidelines to handle **privacy sensitive data**

  No comments (but please see the “interactive session 1”).

- Gap #29: missing a common choice/standard on business models for **payment** (pay by contract, pay by cash-equivalent system, charge for free,…)

  OEM: “In the new EC Directive, regarding payment it is stated that an “ad-hoc” solution should be adopted. This is not really clear, also because “ad-hoc” could mean that is a specific solution for e-mobility, different from other systems that we normally use”.

5.3 Interactive session 1: feedbacks on the Gap Matrix

Once the detailed description of the gaps was completed, RSE moderated a session with the objective of receiving other feedbacks on the presented results, in addition to what already commented during the previous presentation. During the session, the gaps have been quickly recalled, but it has been given space to “free” discussion. The main addressed issues and comments are reported in the following. In the last part of the session, the ICT and interoperability aspects have been more deeply analysed, also thanks to the presentations given by three of the most active groups in the field:

- the Open Charge Alliance – O.C.A.
- the eMobility ICT Interoperability Innovation Group – eMI3
- the Working Group Interoperability (WGI) of the Smart Grid Coordination Group (M490 – SGCG).

5.3.1 Part 1: Free discussion

While going through the gaps again, the moderator asked for other comments or put some questions to the audience. The discussion started highlighting some aspects that haven’t been properly included in the Gap Matrix according to the attendees (“the gaps of the gaps”), and then proceeded addressing many relevant aspects for e-mobility standards. As in the previous chapter, it has been chosen to report the comments in the most “direct” way, leaving their analysis to the last part of the document.

5.3.1.1 Gaps of the gaps

OEM: "There are three important issues that have not been included in the gaps, but that are very relevant according to our experience:

1. SCHUKO housing: there is no definition of the housing of the Schuko plug on the charging pole (mode 1/mode 2). There are different solutions in different countries and in some cases the flap can not be closed, due to the arrangement of the cable (straight or 90 degrees). This turns out to be a serious problem, since the charging can not start unless the flap is fully closed.
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.
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 is the 10.000 connections/disconnections that are performed on the socket/plug for the charging points (this is not official)."

Regarding the first aspect, another **OEM** provided this comment:
"Our vehicle connector for mode 2 charging has a 90° angle. The majority of charging stations work well with this configuration but in isolated cases of station design there can be problems. Even 180° or 45° connectors can have isolated problems with some charging stations so there could be a need for standardization.
Until a standard is established and accepted, and the DAFI legislation goes a long way to do this, we believe our current setup for mode 2 charging is the best solution for today's charging stations' design."

Standardization Body: "TC64 and TC17 are working on these aspects. There is the document regarding Low voltage switching control gears which includes marinas, camping and also EVs. It is not a standard, but a technical report. It can be said that the situation is still a bit fuzzy."

5.3.1.2 Pilot signal and blocking system at the charging poles

Standardization Group: "There is an issue regarding the pilot wire; considering that it transmits radio frequencies, why is it not shielded? Also regarding pilot signal, is there a difference between the two related standards (IEC 61851-1 and SAE J1772)?"

DSO: "The two standardization groups have worked together till 2010, so the standards are practically the same abut pilot signal. There could be just a 2-3 % of difference regarding some "status" definition."

Standardization Group: "Another important issue that came out from direct experience in the US is the presence/absence of blocking systems on the charging pole. It happens, indeed, that people find the car unplugged by strangers. In this moment, without blocks and without communication (alert, state of charge, others) between the car owner and the charging provider, there is no insurance of finding the car still plugged and therefore charged."

OEM and DSO: "In the Type 1 definition, the blocking system is present, but Japanese car-makers decided not to implement it. The problem is therefore not related to standards, but to their implementation".

5.3.1.3 Connectors

Moderator question: "Will the new European Commission Directive proposal (January 24th, 2013, voted by the Parliament on April, 15th 2014) completely solve the issue about connectors?"

DSO: "Also with the Directive, there are still thousands of vehicles and charging points that are already on the road and that are not compliant. For example, in Switzerland there are Charging Points that are accessible only through a physical key."

OEM: "The whole on the connector is standardized. But the interface testing is probably not sufficiently defined yet. There are details that have to be considered regarding interfaces, and testing procedures are needed. For example, connecting an AC fast charger to some cars, there will be problems because the weight of the connector and the cable is too high and the connector itself is therefore pulled down so that the lock for the cable does not work and the vehicle cannot charge. The user must so deliberately put the plug in taking the weight of the cable in the hand and then lock it."

Regarding this aspect, another **OEM**:
"We believe that this situation resulted from the use of a specific AC connector, with the locking pinhole not conform with the IEC specification. This would explain the non-locking issue. This problem was also experienced by others, when using a specific charging station. The vehicle inlet meets the IEC specification, but this locking problem needs to be investigated in an interoperability test."

5.3.1.4 New market entrants and proprietary solutions: the Tesla case

The moderator raised the question if the sudden increase in Tesla sells in Europe and the related deployment of a Tesla proprietary infrastructure of "Supercharger" will represent a problem or an opportunity to obtain interoperability in Europe.

OEM: "It is a different system and it's not compliant with EU standards, but as long as it is their solution for their cars, that will be ok. Moreover, there are adaptors to pass from supercharger to CHAdeMO (if the adaptors should be allowed or not, is another important aspect!)."

DSO: "As long as they pay for their own infrastructure, it's ok. It would be a non-sense to limit a new entrant that is strongly contributing to the roll-out of the EV market." (agreed also by another **DSO**)

OEM: "The "unfair" aspect related to Tesla is, instead, that their AC charging station is compliant with Type 2, but is anyway impeding the charging of other OEMs cars. They use their own PLC system and this doesn't allow the non-Tesla car to charge. The point is so not so related to supercharger, but to normal AC Type 2 chargers."

Moderator: "Shouldn't we avoid that new entrants come with other new solutions, ignoring existing standards?"

DSO: "How? If you operate on private ground, also if publicly accessible, you can do whatever you want."

Other DSO: "It could be done as for mobile-phones chargers, by forcing the adoption of a common solution from the EC. The point is that following a standard is always a choice; it is not compulsory as long as it is not stated in national or European regulations. There is no need for other standards (approximately 700 of them are already present) but there is an urgent need for regulation, that means imposing a standard.

EC: “Tesla, as new entrant in Europe, discussed with the EC and will have to comply with the Directive and standards agreed. To ensure interoperability of the charging infrastructure, we have to look further than the plug and make protocols and software compatibles. Industries have to come with agreed proposal to make this possible and able a full interoperability in Europe.”

5.3.1.5 Interoperability today – Mode 3 and New Mode 3

DSO: “It is not clear if, today, following Mode 3 is enough to guarantee that all vehicles can charge at all the charging points. If both the vehicle and the CP follow Mode 3, are we sure that charging will be possible? According to our experience, this is not the current situation, probably because there some discrepancies on standards that at the end impede the charging.”

Second DSO: “Standards are able to standardize some “behaviours”. If some behaviours are combined, it can happen that some “uncertainties” come up. Working to release a new Mode 3, there is a lot of efforts on covering more “behaviours” and on studying conformance tests, which represent the last step in the standardization process. As long as a conformance test (which could be performed by third parties) is not defined, we will not be sure that all cars could charge in all charging stations, and that the charging stations themselves could face a series of technical issues. When conformance tests will be defined, the problem will be solved, at least for upcoming vehicles and CPs. Obviously, the problem will remain for old components, in which a software update is not sufficient.”

Third DSO: “If we continue to let the diversification of chargers and components in Europe in this moment, we will never reach an interoperable system. Each day that we hesitate in making choices about all the relevant aspects (backend, communication, CPs…), we increase the difficulties in having an interoperable system in the future. The best existing standards should be chosen and this common choice should be done as soon as possible.”

DSO: “It would anyway be a step-by-step process, especially because the system is not yet completely in-place. But it is important that at least the “hardware” will ensure interoperability. Then, the communication and other aspects will come as following steps.”

Second DSO: “The process to reach a common choice on Type 2 took approximately 5 years. If we don’t accelerate this process, there is the serious risk that in 2020 there will be too many different systems and that there will be no market at all.”

5.3.1.6 Fast charging

The moderator raised up the question if the “multi-standard” option, that seems to be accepted by many Charging Point manufacturers in this moment, could represent a viable solution for interoperability.

DSO: “The optimal solution would be a single standard. Nevertheless, if we think that performing a fast charging will not be so different than refuelling a normal car in a petrol station, people is already used to have multiple choices (gasoline, diesel, methane…). The most important difference about DC and AC fast charging is anyway not the connector but the placement of power electronics.”

OEM: “Regarding power electronics, the choices of OEMs come from an “historical” process. Japanese started with the DC, then it came the AC at high power and now the Germans decided to adopt a new

version of DC charging. It is a fact that standards are not yet stabilized and so each car-maker can choose to adopt a new solution or to align with what is in the market in that moment. Today, the presence of three standards is negative because it provokes an increase in the cost of the CPs, but as long as CHAdeMO is so diffused in this moment, it is too late to come back to a unique standard. It has been a real example of imposing a "de-facto" standard."

Other DSO: "It has to be considered that, also if not on a market phase yet, there are many other possibilities to perform high-power charging, as inductive charging, conductive charging through air-lines, etc. So the three standards now available are not covering the whole spectrum."

5.3.1.7 Single/multi-phase charging (maximum power definition)

OEM: "A problem that has been experienced in Italy, in Milan, is related to the control of the number of phases used during the charging process. In the CPs located in Milan, the control of the maximum power is made by limiting the current, which has a maximum value of 32 A. This way, the maximum power is approximately 7 kW. The problem is that is not specified the number of phases, so that if you plug a Nissan Leaf, it will draw 32 A from a single-phase, but if you plug a Renault Zoe, it will charge 32 A on three phases, so absorbing 22 kW. This is too much for the CP design and after some time, the pole will have problems."

DSO: "We are also aware of this problem and, in fact, in the current definition of Mode 3 the number of phases is not specified. In the 15118, on the opposite, the number of phases has been included as relevant parameter to define the maximum power. In this case, it has to be said that is an issue regarding the CP; the car cannot be considered responsible for this problem."

5.3.1.8 Identification and universal transport cards

OEM: "There are hardware standards on identification, for example many standards on the RFID (e.g. the Mifare classic). But a common choice is missing and the point is which standard we should apply. Another important aspect is the locking of the door in the CP. According to 15118, in Italy the door has to be locked, but this way it is impossible to perform a "plug-n-charge". The procedure becomes: identification – door unlocked – plugging – charging. Also in Germany there is a similar situation."

Moderator: "Who will be asked to decide on the RFID standard?"

DSO: "The User Groups should decide, according to the Use Cases. This is the "Choice Making Path" that is under discussion in the M490 Interoperability Group; it is referred to smart grids, but it can be similarly used for e-mobility."

OEM: "By our point of view it would be better if the European Commission would identify one RFID standard, imposing also that it should be used as universal ID for all the means of transport. A universal reader (for all standards) should be deployed too."

DSO: "This is true, but it is anyway essential to generate Business Cases. There must be a Business Layer which is made by Users."

Second DSO: "In Germany there is the willing to have a universal card for transport. But in practice, despite the existence of some guidelines on how to adopt this system in the cities, we have discovered

that only 4 cities in Germany follow them, while all the others use different solutions. Somebody proposed to use e-mobility to harmonize and realign all the different realities, but this will be really difficult. In this moment, indeed, the EV market is too small to effectively affect transport regulations in German cities."

Research Centre: "In Belgium there is a universal card and it works on voluntary basis. Who installs charging points and wants to participate, has to change its RFID reader, as normally the CPs are equipped with cheap ones that are not able to read the universal card. In this moment, a common choice of operators is to change the readers but only in strategic points, as in the ones that are more linked to public transport (e.g. in train stations). There are some retrofit costs, and the point is how to convince operators to adopt more expensive readers, able to provide more services."

Second DSO: "It has also to be considered what could happen in the next years, according to the wide spreading of "apps" for smartphones and of their use. It's not Near Field Communication (NFC) solutions, but directly internet applications. If this digitalization will continue fast, there will not be the need for hardware installations (no cards, just bit&bytes)."

OEM: "Relying only on internet applications, it will then be impossible to control the charging post in offline mode, for example managing white-lists or black-list of the users."

Second DSO: "That is true, but considering the high level of availability of the charger (normally above the 95%) it will be a risk that could be considered to be acceptable for service providers."

Research center: "There are some chargers that already have multi-standard also for identification. Their readers can work with RFID, NFC, Apps, …. but they are obviously more expensive. There is a lot of discussion about this among operators, as they have different business models. It is still an open market, but we should avoid the risk of having many different hardware, which could provoke the impossibility to read some cards and, so, the impossibility to charge."

5.3.2 Part 2: What's going on about communication aspects – OCA, eMI3, WGI-M490 SCGC

Considering the fact that the communication aspects seem to be still quite open issues, it has been considered useful to have an overview of the activities that are being performed in this moment by the most active groups dealing with these topics. According to that, the representatives of Open Charge Alliance, eMI3 group and M490 Working Group Interoperability have been asked to provide a description of their activities and proposals.

5.3.2.1 Update on Open Charging Point Protocol (OCPP) and Open Charge Alliance (OCA) for the GeM E-Mobility Standards Workshop

Craig Rodine, Director of Standards Development of the Open Charge Alliance, gave an overview of the organization, including its structure, its governance and its main objectives.

Currently, the OCA is formed by 31 members, is characterized by a vital core and is experiencing a rapid growth. The Alliance vision, mission and principles, can be so summarized:

- Commitment to *open* processes and products;
- *Free*: no constraints on implementation or use;
- Development is *market (requirements) driven;*

- *Pragmatic* approach leverages expertise;
- *Vital* standards: wide adoption and deployed.

Its structure is characterized by the following aspects:

- 3 Board Members (E-Laad, ESB, Greenlots);
  - Board will grow to 5-7 members in 2014;
- No cost to implement or use (Intellectual Property Rights = Reasonable and Non-Discriminatory terms)
- Governed by (concise) Policies and Procedures;
- Culture is informal, welcoming and productive.

The presentation focused then on the Open Charging Point Protocol, presenting both the version 1.5 and the version 2.0 and describing their features and the status of the work.
More in particular, the version 1.5 can be considered to be in a mature phase as it is characterized by:

- Wide deployment
  - 13,000+ charge points under management;
  - Tens of vendors serving all geos;
  - Enabled choice of CPs and back office.
- Compliancy now well established
  - Proven plug and play.
- Respect of open standards mandates
  - De facto European standard;
  - New United States Request For Proposals (RFPs).

The new version, OCPP 2.0, comes directly from version 1.5, as its core part is composed by the same functionality and messages. But in addition to the core, version 2.0 includes optional extensions, which contain multiple feature sets (see Figure 5-2):

- Monitor & Control: improved customer experience, lower Operation Administration and Maintenance (OA&M) costs
- Smart Charging: supports both Pulse Width Modulation (see IEC 61851) and ISO/IEC 15118
- Pricing: basic usage-based cost calculation on the charge point; more complex pricing models in coordination with central system.

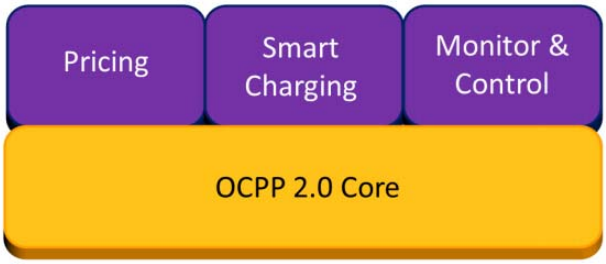

Figure 5-2 OCPP 2.0 structure

Both for OCPP 1.5 and 2.0, compliancy is a key aspect, which is actively addressed by the OCA. Today, a self-compliancy procedure exists, but a formal third-party certification will be soon available. The importance of this aspect is witnessed by the creation of a dedicated OCPP Compliancy working group, with the aim to:

- Provide compliancy tools, e.g. reference versions, test harnesses, scripts processes and procedures;
- Develop a path to formal third-party certification;
- Administer an OCA mark for OCPP conformance.

5.3.2.2 eMobility ICT Interoperability Innovation Group: accelerating E-Mobility to the next level through Open ICT Standards. Status and next steps.

Silvio Weeren, chairman of the eMobility ICT Interoperability Innovation Group (eMI3), presented the vision, the goals and the structure of the group. In particular, the eMI3 is composed by 36 members, including 22 Full members, 8 Associates and 6 Supporters. The vision and key beliefs of the group can be so summarized:

- An open and cross industry organization is best suited to drive ICT standardization;
- Remove key obstacles to, and drive faster the development of a larger global eMobility market;
- Drive global growth and utilization of EV related products and services;
- Increase the convenience and adoption rate of electric vehicles.

The goals are indeed so defined:

- Enable global EV services interoperability by harmonizing existing ICT data and protocols, and proposing new ones where none are yet defined;
- Harmonise, promote and improve cross-sector implementation;
- Co-ordinate and build upon the work of existing EV initiatives and projects;
- Strive to rapidly grow a large market by supporting all required business processes to ease and speed-up the introduction of new services and provide a richness of compelling services to EV users;
- Liaise and co-ordinate with other EV organisations and initiatives to maximise interoperability and minimise effort.

With regards to eMI3 activity, it has been evidenced how within only one year of life, the group has obtained a high visibility and has created a formal organization structure. Moreover, while the reference Architecture development and Charging Protocol is still an on-going work, an eMI3 standard version 0.8 has been already sent for Intellectual Property Right review at the end of April 2014. Version 0.8 includes two parts of the standard:

- Part 1: General overview & Applicable Use Cases
- Part 2: Business Objects & Unique Identifiers

It is important to notice that ISO 15118-2 and NEMA already adopted eMI3's definitions of unique identifiers.

The eMI3 working plan foresees the development of a complete standard, which will include, together with the two already presented parts:

- Part 3: Interface for Electric Vehicle Supply Equipment (EVSE) Directory
- Part 4: Contactless Authentication
- Part 5: Interface for EVSE to EVSE Operator
- Part 6: Interface for Smart Charging Provider to EV (via OEM and EVSE) and EVSP
- Part 7: Interface for Smart Charging Provider to Grid Operator and Energy Market
- Part x….

The complete standard will be focused on aligning key interfaces to drive mass uptake of EVs, and it is expected to be ready within 2015.

In conclusion of his presentation, Silvio Weeren gave an overview of a specific activity carried out inside the eMI3 “Working Group Use Cases”. A new Smart Charging concept has indeed been developed by the group, called Lean Smart Charging and managed through a new actor called Smart Charging Provider (SCP). This actor has been already presented (and well received) to standardization bodies and will be included in Part 6 and Part 7 of the proposed standard.

5.3.2.3 Mandate 490 Working Group Interoperability – Smart Grid Coordination Group

André Postma convener of the Working Group Interoperability (WGI) of the Smart Grid Coordination Group (SGCG), provided a description of the activities carried out in that group, which is mainly focused on “Methodologies to achieve Smart Grid system interoperability through standardization, system design and testing”.

More in particular, the scopes of the group can be summarized in two points:

- Methodology for interoperability
  A system interoperability design method including testing, "profiles" and "test use cases".
- Recommendations for deployment
  An assessment of needed profiles (limiting implementation options given by the standards to improve interoperability).

According to WGI, due to the scale of the electric system and its economic importance, failures in operation and especially architectural and functional planning of the system, potentially induce high costs. In order to enable a well-structured migration process, the requirements for the Smart Grid and the current system have to be decomposed using an appropriate model. This can be applied to Smart Grids as well as to e-mobility.
A System Development Life Cycle can be considered, as represented in Figure 5-3.

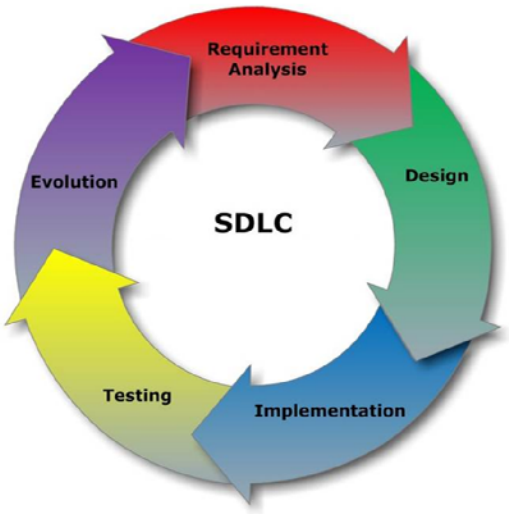

Figure 5-3 Example of System Development Life Cycle

A precise development process is considered inside the WGI: the V-Model, which was first proposed in the late 1980s and is still in use today. It is applicable to hardware and software development and it demonstrates the relationships between each phase of the development life cycle and its associated phase of testing (see Figure 5-4).

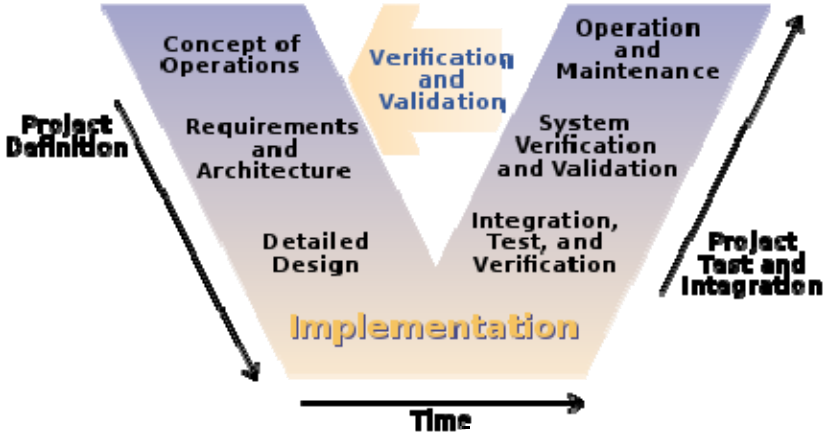

Figure 5-4 V-model phases

A particular attention has been given by the Group to the part of Project Definition, which should proceed through a careful “Profiling Definition”. An InterOperability Profile (IOP) can be seen as a document that describes how standards and additional specifications are deployed to support the requirements of a particular application, function, community, or context. The aim of a correct profiling is to reduce complexity and clarify vague or ambiguous specifications, in order to improve interoperability. Important in this sense are the so-called Basic Applications Profiles (BAP), which are:

- Based on domain specific basic application functions descriptions;
- Agreed-upon selection and interpretation of relevant parts of the applicable standard;
- Intended to be used as building blocks for interoperable user/project specifications.

BAPs may include:

- Description of the related Application function;
- Interaction diagrams;
- Relevant data models;
- Communication services.

According to WGI, BAPs are intended to represent a user agreed common denominator of a recommended implementation, or a user selected best practice implementation of an application function in a specific smart Grid domain. BAPs are valid for specific application domains e.g. Substation automation, Distributed Energy Resources (DER) management, hydro power, E-mobility, etc.

Once the profiles have been identified, the testing phase can properly take place. In particular, interoperability testing may be viewed as a supplement to conformance testing, by verifying that diverse implementations do indeed work together effectively, to deliver the expected results. Devices/systems in the interoperability test should be tested according the same profile.

In the last part of the presentation, Andre Postma showed and described an InterOperability Profile Tool (IOP Tool), which is an evolved spreadsheet including a lot of standards related to at least one of the

Smart Grid domain. The IOP tool is a helpful instrument for selecting standards for the profiling process and to identify gaps on tests.

5.4 Interactive session 2: what after the Gap Matrix?

Once collected many comments during the very debated first session, the objective of the second interactive part was to try to outline some key points for e-mobility standardization activity in the next years. The session started with a short presentation by WP7 leader Cidaut, and then proceeded in the very last part of the workshop with some debate on who will be the main actors leading the standardization process in the short/mid-term period.

5.4.1 Roadmap and guidelines definition

Cidaut, as Work Package 7 leader, presented then the new aims of the WP, after having completed the Gap Analysis process. In particular, the Gap Analysis and the Gap Matrix will represent a valuable starting point to design a roadmap towards interoperability.

The “level of criticality” of each gap expressed in the Gap Matrix gives interesting indications on which aspects are considered to be more relevant and more urgent. According to that, and considering as a reference timeframe the years 2020 and 2030, a first roadmap will be drafted.

In this process, three aspects should be addressed:

- What are the steps to ensure covering the identified gaps?
- Would those actions be enough?
- Which are the constraints limiting the development of standards?

In parallel with that, a document containing “Guidelines to interoperability” will be developed by WP7. This is intended to address both standardization bodies/experts and other less technical stakeholders (e.g. municipalities). The main idea is to provide to a possible “new entrant” in the sector: a guide to understand which the situation in terms of existing standards is, issues not completely solved and future challenges. Considering that the field is quite wide, one proposal could be to identify the main stakeholders (user, DSO, OEM, EVSP…) and to assign to each kind of stakeholder a dedicated section of the document. This way, each actor could concentrate only on its dedicated part, where focused information will be found.

With this kind of structure, each reader should go to its dedicated part and obtain information on:

- Which benefits can come from common/harmonized standards;
- Which standards exist;
- What has been agreed;
- Which gaps are still present;
- Which groups/bodies/organizations/companies are addressing existing gaps;
- Which issues will probably arise in the next future.

With regards to this last point, some possible future challenges for e-mobility have been indicated in the presentation. The attention has indeed been till now focused mainly on cars and on private/fleet use. Other kind of vehicles and uses are anyway gathering attention, for example public transport and city services (police, urban cleaning services…). These new areas could require particular standards, only

partially similar to the already existing ones. An analogous consideration can be made for freight vehicles, both for commercial vehicles and for big dimensions trucks.

One last aspect that could deserve attention in the next future is the smart integration of electric vehicles into the electric grid, both for public and domestic charging. Aspects like “Vehicle to Grid” (V2G) or “Vehicle to Home” (V2H) services will probably represent future challenges for e-mobility standards. As long as EVs will reach an interesting market penetration, these services will represent a key point for an efficient use of the grid and for a subsequent reduction in “grid reinforcement” costs.

5.4.2 Final comments: who will be the main actors?

Having identified some real (and agreed) gaps in the e-mobility standards, one last point that was considered interesting to investigate is which could be the next steps in order to put into practice an effective and real process to solve those gaps and to achieve interoperability.

The moderator asked therefore the attendees’ opinion on the following question:

- Which will be the main actors?
- Will it be, at last, the market?
- Or the EC, or user groups, or standardization bodies?
- Who will lead this process, which is so important to enable the EV market roll-out?

The most relevant answers came from the European Commission:

EC: “From the policy perspective we don’t think that it will be one leader or one single subject, as the field is quite complex and involves many actors and many interests. We would like to work at the same moment on many different important aspects with as many stakeholders as possible to find consensus on different solutions. Choosing one solution will be the best way to reach interoperability.”

EC_R&D department: “It has been quite a surprise to hear that there are already so many standards and that the real issue is not technical but is to make choices. It is interesting also to hear that if you actually test interoperability, the technology at large scale doesn’t always work, and this could be addressed by developing new projects. Moreover, one important point is that there are quite a few projects related to technologies that we want to standardize, but that there is a lack of coordination among those. Having more coordination and some kind of centralized control, both inside the EC and inside the industrial world, would be a really important achievement.”

eMI3: “The eMI3 has been funded by industries just to provide this kind of coordination. At least on the ICT aspects, the coordination role could be covered by the eMI3.”

EC: “The important point is that the solutions and proposals that are brought to the EC are widely agreed by industries and stakeholders. At the moment there are still many different and parallel approaches and groups; a consolidation is not yet complete.”

6 Workshop results

The workshop was carried out in accordance with the desired approach and it can be said that it met most of the organizer expectations. The discussion has been wide and all the attendees contributed to the debate, sharing their know-how and producing interesting results. Despite of the high numbers of topics involved, from mechanics to ICT or data privacy, the discussion always remained focused on standards and regulation. Thanks to the contribution of the European Commission, also an interesting insight on policy regulators expectations has been given.

Trying to summarize the most relevant results, they can be divided in three areas:

- Feedbacks on the Gap Analysis results;
- Missing gaps and future challenges;
- General actions and involved actors.

6.1 Feedbacks on the Gap Analysis results

The Gap Analysis process produced a list of 29 gaps, which have been presented in detail to the audience. Both during the presentation and during the “first interactive session” the attendees provided comments and feedbacks on the single gaps. 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.

The single comments, already reported in sections 5.2 and 5.3, will be used to improve the gaps description and to clarify some aspects. The new and more precise gaps will then be included in the updated version of Deliverable 7.3, devoted to the Gap Analysis itself.

More interesting, in this part, is a global view of the agreement/disagreement expressed by the participants with regards to the identified gaps. As already mentioned in Chapter 4.3, 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 6-1 and Figure 6-2. A quite varied situation can be observed, with gaps completely agreed, others completely disagreed and many with “medium” agreement.

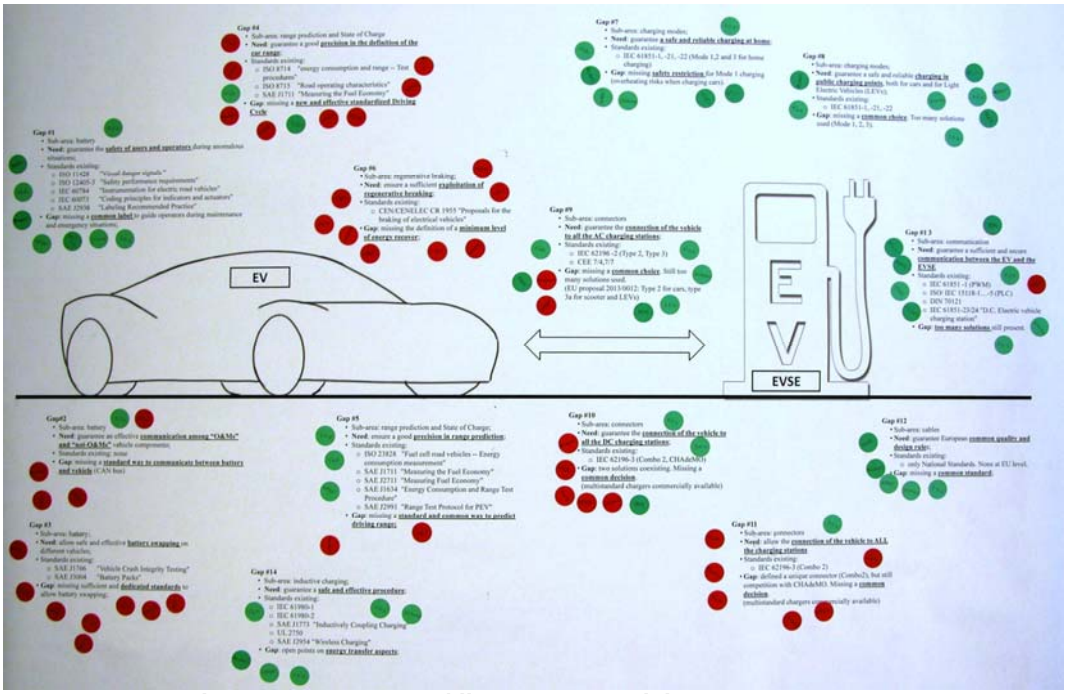

Figure 6-1 Agreement/disagreement stickers on Gaps 1-13

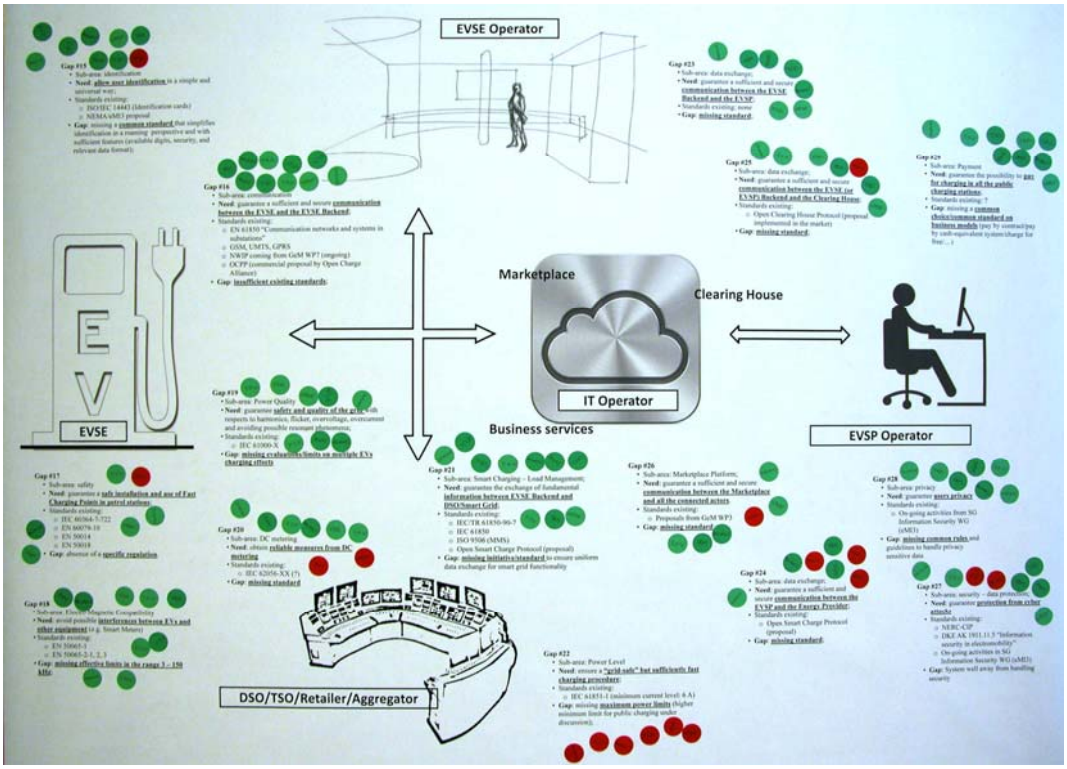

Figure 6-2 Agreement/disagreement stickers on Gaps 14-29

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

In Table 6-1, the feedbacks on each gaps are reported, divided for stakeholders groups.

Table 6-1 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.

6.2 Missing gaps and future challenges

The Gap Analysis process was conducted addressing a very wide number and kind of stakeholders, but it was obviously very difficult to gather all the existing gaps in e-mobility standards. In order to try to be more precise and complete, the attendees were asked to give their contributions on the not identified gaps.

An interesting, direct contribution came from an OEM during the “free discussion” part of the “First Interactive Session”, which evidenced the following “gaps of the gaps” (see also Chapter 5.3.1.1):

- **Schuko housing**: there is no definition of the housing of the Schuko plug on the charging pole (mode 1/mode 2). There are different solutions in different countries and in some cases the flap can not be closed, due to the arrangement of the cable (straight or 90 degrees). This turns out to be a serious problem, since the charging can not start unless the flap is fully closed.
- **Battery terminology**: there isn’t a common understanding of what the battery’s State of Charge (SoC) and State of Health (SoH) are. 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.

- **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 is the 10.000 connections/disconnections that are performed on the socket/plug for the charging points (this is not official).

The other adopted method to collect the new gaps have been already described in chapter 5.2: the organizers asked to the participants to note down from 1 to 3 topics that still represent an open issues (a gap), according to the attendees experience.

The answers given are here textually reported:

- Authentication;
- Smart Charging;
- Grid connection;
- Smart Grid integration;
- Actor/Communication/ICT Architecture;
- How and when to do V2G, V2H,…;
- Missing common choice!
- Automatic common payment method;
- Overcharging Protection standard;
- Smart Grid standards;
- Range determination for EVs;
- Inductive Charging (frequency, communication, safety);
- Incoherent standards for grid and charging (smart meters Vs EMC pollution, mode 2 cable);
- Undefined and incoherent testing methods (car side Vs grid side);
- Standard definition for SOC/SOH and their measure units;
- Submetering;
- What is missing in IEC 61851 (mode 3) to ensure that any EV can be charged at any EVSE?
- How Smart Charging is compatible with present and future electricity market and organization?
- Which ID and protocols need to be standardized to ensure an open market for EV services?
- Communication EVSE – EVSE operator;
- Communication EVSE operator – EVSP;
- Communication Smart Charging Provider – OEM – EV driver;
- V2H/V2G;
- Needs of public transport/taxis/delivery;
- Driving Cycles;
- Extending battery standards.

Comparing this list with the gaps reported in the Gap Matrix, it can be seen that many of the written gaps were substantially already included (authentication, communication aspects, grid connection,…). Some interesting new aspects came anyway out, in particular regarding future possibilities of managing EV charge in a "smarter" way. The participants, indeed, suggested that is important to develop standards and regulations on smart charging and on Vehicle to Grid (V2G) and Vehicle to Home (V2H) solutions.
These aspects were also mentioned in the "Second interactive session" and were regarded as potential issues that will arise in the next future. Till now, the low market penetration of EVs made this aspect less relevant, but the urgency to consider them is becoming a common feeling.

6.3 General actions and involved actors

Moving out a bit from the direct focus on the Gap Matrix, it can be said that during the workshop many comments were received addressing more general aspects. More precisely, it can be stated that the free discussion brought to address some high-level topics related to the approach to standardization activity that should be taken in order to stimulate a real market deployment of EVs.

Some more general conclusions coming from the debate can be summarized in the following points:

- Some technical aspects (e.g. cables, EMC 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;
- Issues regarding the vehicle can be considered less relevant in Green eMotion view, as they only slightly affect interoperability;
- Interoperability is a complex task that should be addressed following precise methodologies that consider different layers and different steps (e.g. the definition of use cases and business cases).
- The process to obtain common standards has to be speeded up.
- In many cases the main problem is not to define new standards, but to choose one from multiple standardized versions (more regulation than standardization)

Also thanks to the active participation of the European Commission at the workshop, it has besides been possible to have a better idea of which actors and which process could lead to effective choices and to regulation decisions. The best situation to enhance interoperability will be to have only one common solution, but this needs:

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

7 Conclusions

Green eMotion Work Package 7 (Harmonization of technology and standards) organized a workshop with key people involved in EV standardization, coming from more than ten organizations. The focus of the workshop was to discuss on the standardization gaps currently still present in the e-Mobility field.

One of the main activities performed by Green eMotion WP7 is indeed a Gap Analysis on e-mobility standards. This analysis, carried out collecting standardization issues through surveys, workshops and direct contributions from relevant stakeholders, led to identify approximately 30 gaps, which have been included in a Gap Matrix and which cover areas like batteries, range prediction, regenerative braking, charging modes, connectors, cables, communication, identification, payment, data security, grid connection and others.

The objective of the workshop was to discuss these results with recognized experts in the field, in order to refine the Gap Matrix and to obtain a quite clear and agreed overview of the standardization present and future situation. 21 selected people attended the workshop, representing seven different countries and most of the stakeholders involved in e-mobility.

The workshop was managed by the organizers in order to enhance discussion, interaction and active participation by the attendees, limiting the “direct presentation” style and leaving space to free discussion. This way, a really fruitful debate took place during the meeting and many feedbacks were received from the partners.

7.1 Feedbacks on the gaps

In relation to the Gap Analysis and the Gap Matrix, it can be said that the workshop results indicated that WP7 Gap Matrix can be considered a reliable and 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 and maximum power limit on charging).

Given that, the comments by the attendees showed that some gaps could be better technically detailed. This will be part of the activities following the workshop and the results of this review will be properly included in the updated version of Deliverable 7.3, devoted to the Gap Analysis/Gap Matrix.

In the updated version of the Gap Matrix, also the new gaps emerged during the meeting will be analysed and included. In particular, the discussion pointed out three standardization issues that are nowadays present and that should be addressed in the very next future:

1. **Schuko housing**: there is no definition of the housing of the Schuko plug on the charging pole (mode 1/mode 2). Different countries adopt different solutions, in particular regarding the arrangement of the cable (straight or 90 degrees) and the flap. This turns out to be a serious problem, since there could be problems in closing the flap, impeding the charging process.
2. **Battery terminology**: there isn’t a common understanding of the terms “State of Charge” (SoC) and “State of Health” (SoH). There is the need for an agreed and clear definition, including measurement units and estimation methodologies.

3. **Testing methods**: in many standards it's missing the definition of the testing procedure, and thus is very difficult to identify if the component is effectively compliant.

Besides that, the participants highlighted the increasing need for standardization activity in the field of "innovative" charging procedures and grid-vehicle interaction. Smart charging, Vehicle to Grid (V2G) and Vehicle to Home (V2H) related standards, not yet included in the Matrix, will soon become a relevant aspects to address.

7.2 What and who? Trying to find answers

As reported in Chapter 3, one of the main objectives of the workshop was to obtain some clues on the following questions:

- Which aspects should be considered more urgently?
- Who will be the key actors?
- Which will be the role of the market?
- Which will be the role of regulatory entities (e.g. the European Commission)?

Although during the meeting these questions were not directly proposed to the attendees, the contents of the discussion makes it is possible to sketch up some answers.

Which aspects should be considered more urgently?

The debate pointed out a substantial distinction between "physical" standards and "communication" related standards. With regards to the first group, it can be said that some technical aspects nowadays really need a better technical definition through standards. It's the case of:

- Battery Safety after crash;
- Cables;
- Electro Magnetic Compatibility pollution;
- DC metering.

The aspect of connectors and charging modes, very debated in the last years, seems to have become less relevant thanks to the intervention of the European Commission Directive proposal and the identification of Type 2, Mode 3 as common standard for public charging. At the same time, the work on an improved definition in Mode 3 standard (the "New Mode 3"), will probably cover many open points and will introduce precise conformance tests. For DC charging, the coexistence of two standards, CHAdeMo and Combo 2, seems to be unavoidable, and it will be tackled through the deployment of multistandard fast chargers.

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

To guarantee an effective and standardized information flow among the different actors involved, will actually represent a key aspect to provide high-quality services to the users and a rational and cost-

effective use of the electric grid. Despite that, the field is still extremely open and there is the need for many efforts to obtain common solutions in reasonable time.

Who will be the key actors? Which will be the role of the market and of regulatory entities?

Once defined the most relevant aspects to address, the workshop discussion moved to the identification of the possible approaches to carry on an effective standardization process and on the key actors that should be involved in that.

From a "high-level" point of view the main outcomes can be so summarized:

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

With regards to the last point, also thanks to the active participation of the European Commission at the workshop, it has been possible to identify which actors and which process could lead to effective choices and to regulation decisions. The best situation to enhance interoperability will be to have only one common solution, but this needs:

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

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

In this situation, the role of working groups composed by industries and devoted to standards and interoperability could play a fundamental role. OCA, eMI3, M490 WGI are really active subjects in the field of communication and interoperability:

- OCA, fostering OCPP 1.5 and OCPP 2.0, focuses currently on compliancy with a dedicated OCPP Compliancy working group;
- eMI3, will soon come out with a standard (now in V0.8) which will deal with Use Cases and Business Objects and that will cover aspects on interfaces among e-mobility actors;
- M/490 WGI, is working on methodologies to achieve Smart Grid system interoperability. Based on the testing V-model, a process to achieve interoperability has been worked out, in which key role is seen for user groups.

On the other side, the role of the market is still somehow contradictory. The CHAdeMO solution is a perfect example of "de facto" standard, imposed by the market. The high number of Japanese vehicles already sold in Europe makes it impossible to impose a European regulation on DC charging without considering the CHAdeMO protocol. Despite of that, the power of this solution has not been so strong to avoid the born of the CCS, resulting in the coexistence of two different standards. Also the Tesla experience reveals conflicting aspects. On one side, the big success of Tesla both in the US and in Europe can represent a very powerful driver to stimulate the global EV market. On the other hand, the attempt of Tesla to adopt proprietary solutions for both AC chargers and DC "superchargers", could imply

the risk of duplicating the charging infrastructure, completely dismissing the concepts of roaming and interoperability. A proper trade-off should be found, with the involvement of both the European Commission and the Manufacturer itself.

The European Commission, as main regulatory entity, will play a crucial role on the choice of common solutions, but its activity will be firmly restricted to the very last part of the process. Only when facing solutions and proposals that are widely agreed by industries and stakeholders, the Commission will have the possibility to impose them through regulatory means. This doesn't look so easy in the short period as at the moment there are still many different and parallel approaches and groups; a consolidation is not yet complete.