Green eMotion Project Results

Executive Summary

After four years Green eMotion came to an end by February 2015. The project has defined and demonstrated a European framework that connects all stakeholders for a seamless and cost-efficient electromobility ecosystem. This report summarizes the main findings.

User Acceptance needs to be increased by demonstration of interoperability and convenient usage of EVs to the customer. Incentives for reduction of the EV price like direct purchase incentives or sales tax reduction are also effective measures. Prerequisite for consumer acceptance is the availability of sufficient charging infrastructure. Installation of home chargers should be supported, but also public charging infrastructure is needed whereas the locations have to be thoroughly evaluated according to target groups needs and economical requirements.

Environmental impact of EVs is mixed. The low noise level and the local zero emission are good arguments for buying an EV. EVs were found to be more environmentally friendly than ICE (Internal Combustion Engine) vehicles for a majority of impact categories, in particular those with global effects like global warming potential but not in all categories.

EVs in fleets show a positive business case already today. The assessed scenarios include office car pools, taxi services, urban bus routes and urban deliveries. The different types of electric transport are compared with alternative ICE technologies.

Both, private customers and fleet operators will require a coherent mobility plan of the cities that considers the mobility needs of all stakeholders. Main recommendations for policy makers were identified.

The open access to all existing public charging infrastructure is a mandatory prerequisite for the mass market roll-out of electromobility. Therefore we need an ICT system that allows roaming between all partners, meaning that EV drivers can use public charging infrastructure independent from the owner or operator. The goal is a situation comparable with that in the mobile phone market where also the customer can use his mobile phone everywhere. A basic step in that direction was the definition of actors and roles, the business processes and a suitable ICT architecture. As an example and to show the functionality of the ICT architecture Green eMotion implemented the Green eMotion Marketplace (as a non commercial pilot system).

Standardized interfaces e.g. for connecting chargers, are crucial**.** Green eMotion is proposing a “Roadmap towards interoperability” focused on missing standards and, in particular, on communication interfaces. The Roadmap considers 5 time steps (from 2015 to 2025) and 13 main targets distributed among them.

Grid reinforcement costs can be reduced by so called smart charging measures. Congestion in low voltage lines from a multitude of charging EVs might occur in the nearer future. Especially for home charging and employer charging most customers will start charging in the same time frame and therefore cause a high peak demand. Smart charging controls the charging process in a way that such a peak is avoided. E.g. with time dependent power tariffs, users can be motivated to accept smart charging.

EVs improve integration of renewable energy sources (RES) into the electricity grid. With a high number of EVs connected to the grid, Smart EV management approaches might become an important feature to prevent curtailment of RES or the need to activate reserve power production. Both will contribute to relevant CO_2 savings.

The Green eMotion analysis of the business models for public charging infrastructure revealed that public charging is a difficult business case today. The results lead to the conclusion that the business case of public charging as standalone business can only be profitable within such mid-term business scenarios in case of highly frequented charging stations. Hence, the charging stations need to be located at points of interest, so that people are willing to pay for the usage and usage time is short enough to allow for several charging events per day. An option to improve the business case of public charging is the combination of different businesses. Examples are advertising, parking in a parking lot, or to use charging to attract people for other services like shopping, cinema, eat & drink etc.

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1 Social acceptance

To enable the mass roll-out of electromobility in Europe, social acceptance is a prerequisite. Social profitability of electromobility in regards to the actual benefits and costs may be reached soon. A clear commitment of all levels of policymakers together with industries and services, committed to a consumer friendly electromobility system will allow it to happen. All measures should be aligned with the needs of target groups like commuters or owners of fleets to achieve a maximum impact with the lowest possible costs.

Demonstration experience on social acceptance

The results of the Green eMotion demonstrations are reported in **D8.5** [39] with references to the more detailed reports on demonstration **D8.2** [36] and **D8.3** [37].

A first step to consumer acceptance is the awareness of the advantages of electromobility by the public and also by the local policymakers. In Greece 15 chargers were installed in Kozani and Athens; EVs were acquired. Electromobility was a totally new experience in those cities and especially local authorities were invited to use the EVs. This direct experience will motivate the policy makers to support necessary actions for the further electromobility roll-out.

But also citizens should have the possibility to use EVs and learn more about their features. In the Basques Country and in Madrid electric bus services were established. Hence, people come to know firsthand how environmental friendly and quiet electric buses are. Unfortunately learning was that some of the first generation vehicles suffer from technical problems.

Beside public transport, also the implementation of EV sharing is a good measure for giving more people the possibility to use an EV without the need to directly buy one. In the rural area of Ataun, located in the Basques Country, an eCar sharing service was established. 5 EVs were made available with a dedicated location in the city centre. Most of the observed time, the usage of the EVs was around 150 times per month meaning one trip per EV per day. For a rural area, where the driven distances are usually higher, this is quite a good number and shows the good acceptance of the citizens even in smaller towns.

Another prerequisite for consumer acceptance is the availability of sufficient charging infrastructure. Most of the EV drivers prefer to charge their EV at home if and whenever possible. Therefore it is very important to support the installation of home chargers if feasible. EV ready buildings are a good way to ensure that new buildings are prepared for a later installation of chargers at low costs. The partner Verbund started a dialogue with the Austrian federal authority OIB on respective guidelines.

Even with the possibility for home charging commuters will use public chargers for their travel purposes. In the demo region Austria two new fast chargers were installed on typical commuting routes to Vienna. The increased use of the fast charger in the evening hours indicates that these commuters have an opportunity for home charging not needing to charge on their way from home to work. Yet they use the chargers in the evening on their way home implying they have no possibility to charge at work. A recharge at the fast charger on the route may then be necessary if either the commuting distance is high or the EV is planned to be used for another evening trip. At some locations in Europe the demand for fast charging has increased in the last months so that queuing occurs at single locations. In the city of Dublin a multi standard fast charger was installed next to an already existing multi standard fast charger to reduce queuing.

The bare existence of enough public chargers might not be sufficient. The user must also be able to find and use those chargers even across borders. A specific cross-border demonstration was done between the Republic of Ireland (ROI) and Northern Ireland (NI). EV drivers could use the same RFID card for charging on both sides of the border. Such experience will help to reduce the range anxiety we observe at the moment.

Consumers will be more willing to accept electromobility if convenience is comparable or even better then with using ICE vehicles. To motivate commuters to use eCar sharing for the last mile, an EV for sharing was deposited at a train station near Copenhagen/Malmö area. For easy access the EV was equipped with a reader that accepts the travel card, people use to authenticate for the public transport anyway. Therefore it is one card for all, permitting a seamless perception of mobility.

In public transport we see generally the trend to switch from payment by cards of any type to mobile phone applications. Such an app was developed and tested in several demo regions. One prototype was tested with users of partner Greenabout giving them the possibility to use the infrastructure of Malmö without RFID card. Another prototype, the so called user portal, was trailed in Ireland. Feedback from test users indicates a good usability with several advantages compared to physical means like a RFID card. An option with no authentication by the user but rather by the EV was tested with the so called "plug&charge" system. In the demo region Berlin, EVs and charging stations were equipped in a way that, simply by plugging them in, the authentication of the contract will automatically been done at the charging point. EV drivers gave very positive feedback and this might be the most convenient way of starting a charging process.

After authentication to get access to the charging infrastructure, the process of charging itself needs to be handled. The most common way is to either draw a cable from the trunk or in case of DC fast charging to plug in the cable coming with the charger. In both cases the user needs to handle a more or less heavy cable which also might be dirty from prior usage. An alternative is the wireless inductive charging. By positioning the EV above a dedicated spot on the ground the EV can be charged without physical connection to the charger. The advantages for the EV driver are obvious. A limitation of this technology is the maximum power that can be transmitted with the actual technology.

Data analysis from 77,620 charge events and 94,488 trip events

The data collection process has gathered data from eleven Demo Regions spread throughout eight countries in Europe on a monthly basis. The process has been carried out from May 2011 to December 2013. The Demo Regions are Berlin (Germany), Stuttgart/Karlsruhe (Germany), Copenhagen (Denmark), Better Place (Denmark), Barcelona and Málaga (Spain), Ataun and Madrid (Spain), Strasbourg (France), Budapest (Hungary), Dublin (Ireland), Italy and Malmö (Sweden).

At the end of the data collection process (December 2013), there are 2,682 charging points installed, 689 vehicles and 1,362 users registered in the GeM project. There are nearly 130,000 charging infrastructure and more than 170,000 electric vehicle dynamic registers (77,620 charge events and 94,488 trip events from the point of view of the vehicle).

The report **D1.10** [3] contains an extensive set of data that might help to simulate the user behaviour required to optimize grid integration, provide accurate information about the charge cycles in order to estimate the EV battery life span, identify client segmentation for car manufacturers, utilities and e-mobility service providers, help policy makers to regulate and promote the use of EV with objective data and to better understand the deployment of EVs.

The analysis of the collected data led to several conclusions that are reported in D1.10 and also D9.1 [40], e.g:

Charging point daily utilization depends on the location. Household and public access parking are used three times more than charging points located in the street. But also, the average percentage of utilization differs between locations.

In the case of office parking and household charging points, charging activity is most of the time lower during the weekend while in the street and public access parking utilization presents smaller differences between weekdays and weekends.

If we focus on the EV usage, captive fleet, business and private use EVs tend to charge their vehicles during shorter times on Friday, Saturday and Sunday but renting EVs present a different pattern: while daily charge times remain approximately constant during the week, the charge time per charge event increases from Thursday to Sunday. Moreover, it has been shown that statistically significant differences are observed between the charge time of different EV ownership and use.

Data Collection and Reporting Guidelines for European electromobility projects published by JRC

Another result from the Green eMotion data collection experience is the guidelines on data collection published by Joint Research Centre (JRC) Institute for Energy and Transport in cooperation with Green eMotion [58].

Analysis of the data collected from electro-mobility projects has shown that only in very limited cases, the data reported were of enough quality and/or comprehensive enough to allow a meaningful and complete analysis. Various types of data are sometimes missing, making it almost impossible to analyse them correctly. The objective of this report is to provide guidance to publicly funded European Electro-mobility Projects on what and how to monitor and report. Detailed description of the necessary monitored elements and those which are considered as optional due to the complexity or expense involved in collecting them, is included, as well some ideas on quality control and on data collection. An extensive stakeholder consultation has taken place before the release of this report.

Analysis of user behaviour based on data collection and stated choice survey

The stated choice survey documented in **D9.1** [40] has shown that customers are particularly sensitive to the purchase price of the EV. Even with the total cost of ownership being competitive to an ICE vehicle they will often prefer the ICE car, which they are used to. Incentives for reduction of the price like direct purchase incentives or sales tax reduction are effective measures. Smaller cars at acceptable costs are needed to get to the uptake of electromobility in Europe.

The driving range is seen as the second most important attribute despite the fact that most of the trip lengths are quite well in the range of an EV. The so called range anxiety can be encountered by simply more driving experience to increase the knowledge about the fit of daily needs and by combined offers for EVs with the option to rent an ICE vehicle for special purposes.

A deep dive into the collected data in D9.1 revealed that individuals tend to charge their vehicles more frequently than required and do not let vehicle batteries deplete a significant amount. A large percentage of battery capacity remains in a vehicle's battery prior to a charge event across all demo regions, with no mean value falling below 50%.

Regardless of the demo region or vehicle in question, all demo region data returned mean distances travelled since last charge event well below the available range of the vehicles, again showing that individuals are charging more frequently than is necessary.

The data from most demo regions suggest that EV users charge their vehicles on average once every 24 hours although higher frequencies are evident in captive fleets. This is again caused by a tendency for users to adopt conservative regular charging habits e.g. similar to mobile phone charging patterns which may or may not be related to range anxiety.

Performance validation of EVs under different climatic conditions

The report **D6.2** [24] describes the performance validation of EVs under different climatic conditions and use patterns. The methodology for this is described in detail in the report **D6.1** [23].

The validation is done over time so that degradation mechanisms on the vehicles can be discussed. It must be pointed out that the goal is not the comparison of different brands of EVs, but the evaluation of EV technology viability in general. Therefore vehicles of different size and brand are included in the work to assess the impact of several parameters, such as weight in combination with driving style, climatic impact onto different battery types and others.

The tests revealed that state to the art electric vehicles offers good consumer convenience, but that the driving range is strongly dependent on user behaviour and climatic conditions. An aggressive driving style, meaning high speeds and fast acceleration/decelerations, will increase the consumption significantly. The electric vehicles as of today are safe. And in contrast to some public statements in the past, fast charging does not seem to negatively affect the battery. Proper information and education of drivers is requested here.

Educational Green eMotion web site for public use

One of the outcomes of Green eMotion is a public education website accompanied by a printed guideline handbook available in different languages:

- Link to Educational Green eMotion web site: http://education.greenemotion-project.eu
- Link to handbook in English, German and French: http://education.greenemotion-project.eu/library.aspx

The handbook and website have been targeted at users and stakeholders who are not directly involved in the electric car industry. This includes such groups as potential EV-owners, fleet operators, motorists, cyclists, teachers, planners and policy makers. The web site is open to everyone and can be automatically translated into 81 languages. The report **D10.6** [51] describes the features of the educational website for use by other developers of such tools.

Green eMotion communication - External Stakeholder Forum

The purpose of the Green eMotion External Stakeholder Forum (GeMs Forum) is to increase knowledge sharing between the Green eMotion project and its stakeholders. These include municipalities, governments, industry, utilities, OEMs, private businesses and universities. The objective is to inform stakeholders as well as raise awareness of the findings and knowledge gained through the project. It also seeks to gather information and feedback to further enhance the work being done, in order to make mass market adoption of electric vehicles a reality in Europe through the Green eMotion Project.

During the 4 years of the Green eMotion project 10 Stakeholder Forums meetings were held. The two last ones are described in the report **D10.5** - year 4 [50].

For the 9th Green eMotion Stakeholder Forum meeting Green eMotion organized a Rally to Brussels. That was the first electric vehicle rally from the Green eMotion demonstration regions to Brussels. Five teams – EDF (Strasbourg), ESB (Belfast), RSE (Milano), TÜV Nord (Hanover), and Verbund (Vienna) – drove with electric vehicles to Brussels using different charging stations along the way.

The tour culminated in a high-level conference with Vice President of the European Commission and Commissioner for Transport Siim Kallas. A parallel interoperability demonstration showed that the Marketplace developed within the project now allows Europe-wide access to charging infrastructure.

The tenth and last External Stakeholder Forum was held together with the projects ZeEUS [62] and FREVUE [61] as already other forums before. This has allowed more interaction between the projects. The workshops which generally have one speaker from each project, helps networking and gives each speaker a better opportunity to understand the research and trials being carried out in each project. With about 190 participants a broad audience was reached. A dedicated Green eMotion session gave the opportunity to present the most important final results of the project.

Environmental impact of EVs from cradle to grave

Electric Vehicles (EV) are a promising technology to facilitate a drastic reduction on the environmental burden of road transport. During the last decade, and especially more recently, they have been promoted as an important element in reducing the emissions of CO2, air pollutants and noise of passenger cars and light commercial vehicles. The interest in EV is therefore primarily motivated by their low level of tailpipe emissions. Obviously EVs offer advantages, which have led to a general perception of EV as an environmentally benign technology.

However, the reality is more complex, requiring a more complete assessment of the environmental impact of EV throughout their life cycle. To ensure that the promotion of EVs to reduce greenhouse gas (GHG) emissions from transport does not lead to other undesired consequences, it is critical to conduct rigorous, scenario-based environmental assessment of the new vehicle technologies before their widespread adoption.

In that context, the life cycle assessment (LCA) is a suitable tool for comparing the environmental impacts of different transportation options because it explicitly quantifies the resource use and environmental releases along the entire life cycle of a product, from the production of raw material to the end of life of the product. This analysis will therefore cover the stages from the raw materials production phase (cradle) to vehicle end-of-life (grave), thus going beyond the classical approaches.

As described in **D9.5** [45] EVs were found to be more environmentally friendly than ICE vehicles for a majority of impact categories, in particular those with global effects like global warming potential. As more renewable generation as better the environmental balance of an EV! With the current European energy mix the CO2 balance of an EV is better than an ICE-car.

On the other hand, in certain impact categories occurring at a more local scale, e.g. acidification, EVs show a higher impact than ICE vehicles, predominantly because of the battery manufacturing process. The expansion of renewable and other low-carbon electricity generation, as well as the development of more environmentally friendly batteries, is necessary for the future acceptance of electromobility.

Visions, strategies and experiences of cities and regions

The report **D2.1** [4] describes the visions and strategies of different cities or areas in Europe. For example the Irish government aims to have one in every ten vehicles powered by electricity by the year 2020. Ireland's largest energy provider, the Electricity Supply Board (ESB), is to develop a nation-wide infrastructure for Ireland. Every town in Ireland with a population greater than 1,500 will have a minimum of one charge point. Fast chargers will be installed across the nation's motorways to create "electric highways" between major urban centres. This large-scale public network will supplement thousands of home charging points. This initiative is enabled by a combination of research and infrastructural funding from the European Commission and direct investment from the ESB.

The reports **D2.2** [5] and **D2.3** [6] give an overview about the experience of the cities/regions with the chosen strategies. D2.2 focuses on successful measures whereas D2.3 deals with experienced hurdles and recommendations how to overcome them.

Some successes encountered in the Electromobility policy making process are e.g. the procurement of low or zero emissions vehicles by municipalities, such as EVs, for their own vehicle fleets, showing leadership and helping develop a market for Electromobility or measures to promote the deployment of EV Taxis. Those are particularly successful in demonstrating significant overall reductions in fuel costs for the operator and in presenting the experience of a trip by EV to a large potential audience.

A hurdle experienced in infrastructure deployment is charge points underused, because there are too many charger and/or locations were not adequately selected: the number of the parking places for chargers should be adjusted to the sales volume of EVs. If possible the selection of the parking places should be made in collaboration with enterprises that own parking places, like large commercial surfaces that also could see this as a way of promotion. Another example for a hurdle is the lack of coordination of efforts in the development of the electromobility strategies: It is important to set realistic targets, select the stakeholders that could be involved in the process, creating the proper communication channels and discussion groups, and configure a control entity to monitor activities and propose corrective measures.

Report **D2.4** [7] summarized the recommendations as derived from the demonstration experience of the cities and regions in Green eMotion. Those recommendations cover the fields charging infrastructure, vehicles, policies, financial incentives, marketing and communications. A summary of the conclusions coming from D1.10, D2.1, D2.2, D2.3, D2.4, D9.1 [40], and D9.6 [46] can be found in D9.7 [47].

Additional information about one of the biggest electromobility demonstrations in Europe can be found in the special report "**Better Place_Lessons Learned**" [57].

Commercial and regulatory framework to enable a mass rollout of EV

Report **D9.6** [46] identifies current gaps and barriers to incorporating the actual internal and external benefits and costs for all players in the EV ecosystem, and to investigate the requirements of a suitable commercial and regulatory framework to enable a mass rollout of EV.

The underlying problem facing BEVs is that as a more capital-intensive transport solution than ICVs they ought to be used in higher intensity use (as capital-intensive generation should be used for base-load power), which means high annual driving distances, but this runs up against the obstacle of slow charging times and limited range. There are natural but niche markets such as longer-distance commutes with charging at home and work, and possibly for taxi use in urban environments, but until battery range and costs improve and charging speeds increase (as might happen if and when a viable battery-swap business emerges) these niches are likely to remain modest, and domestic BEV ownership likely restricted to two-car families. With growing confidence in the range and normal driving distances, the two-car families may decide to retain just the BEV, and use that to travel to car rental locations to hire ICVs for longer journeys. Studies from the US suggest that Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) could be cost competitive by 2015 against gasoline ICVs for typical car usage patterns, particularly with a reasonable carbon price and low cost at home or work charging, provided the battery size is kept small (4 kWh). As such these PHEVs offer a useful transition to extensive BEV penetration, encouraging the development of charging infrastructure and further battery development.

The case for heavy subsidies is that they will stimulate battery development to drive down costs and create the demand to support the necessary mass roll-out of the charging infrastructure and associated roaming capabilities. At some future date it seems likely that BEVs will be required to largely replace ICVs, leaving the key question of when is the best time to provide the financial stimulus. On the evidence presented here, a 2020 (or even earlier) target for cost competitiveness is not implausible, given high oil and carbon prices, and thereafter the attractions of BEVs should improve, although one should not under-estimate the rate at which ICVs might improve under the same pressures to reduce carbon emissions.

Recommendations to overcome barriers and gaps for the uptake of electromobility

Collecting the results and already expressed recommendations from the reports D1.10 [3], D2.1 [4], D2.2 [5], D2.3 [6], D2.4 [7], D9.1 [40], and D9.6 [46] the report **D9.7** [47] identifies needs for and possible issues with the large-scale deployment of electric vehicles in the EU. Wherever issues were detected, solutions were developed to overcome them. And, finally, a list of actions was developed for various stakeholders.

The main needs identified for a large-scale EV roll-out are customer acceptance, attractive business cases, a stable and efficient grid, interoperable charging networks, and the right governmental actions. Related to these needs, 18 issues were identified, eight of which had high priority.

To overcome the issue of low utilization of public charging posts, vehicle adoption and the realization of unprofitable charging infrastructure need to be subsidized. High grid reinforcement costs due to peak demand can be avoided by enabling smart charging; providing drivers with the right incentives to use smart charging. Demand forecasts need to be developed to identify grids that might be congested.

Higher purchase costs for EV compared to ICE vehicles should be compensated by incentives that lower the total costs of ownership (TCO). That might be purchase incentives but can also be achieved by other measures like free parking or reduction of congestion fees. Customers need to be informed about the TCO as they see mostly the upfront investment costs.

The services for electromobility like charging or finding of charging stations must be adapted to the real needs for an optimal convenience. Range anxiety can be reduced by providing drivers with information on charging possibilities, e.g. via a route planning tool. Also educational information about the influence of driving behaviour on available range of the EV should be provided.

Reduction of installation costs for charging infrastructure can be achieved by regulations for some degree of preparedness for charging infrastructure in building codes and tenders. An overarching topic is standardization. To fill gaps in standards further joint efforts to develop and implement standards are required.

Guidance for policymakers from municipal to European level

Policymakers are looking for guidance when rolling out large-scale infrastructure for EVs in cities and regions or developing electromobility strategies and policies. The Green eMotion project offered possibly the broadest ever approach within its consortium of 42 different participants – municipalities, research and development labs, industrial partners, universities, etc. – to offer such guidance. Based on the summarized recommendations for policymakers D9.7 [47], the input from a policy workshop **D10.4** [49] and the broad experience of the Green eMotion demo regions, the report **D10.7** [52] culminates in a guidance document for policy makers.

Local policymakers directly steer the deployment of electromobility, either by directly managing projects, or by supervising/authorising them. They integrate electromobility within their general urban mobility planning, for example within a Sustainable Urban Mobility Planning (SUMP) effort. They can help to make electromobility grow by:

- **Stimulating the uptake of electric vehicles** by providing individual purchase incentives, by setting up procurement rules (for themselves or their suppliers), and they can support the use of electric vehicles with other financial and non-financial incentives, like free parking at prime locations, or use of local bus lanes.
- **Supporting the deployment of the various forms of charging infrastructure**, namely home charging, public charging (which includes hotspot charging), employer/company charging, and car-sharing charging. The support will depend on the nature of the charging infrastructure, and includes elements such as information provision, setting of subsidies, clear requirements for granting of individual permits and concessions, or installing of an own network.
- **Reaching out towards citizens,** e.g. by acting as a hub/central point of information about electromobility, setting up knowledge platforms and organizing test drive campaigns.

National policymakers can support deployment of electric mobility by:

- Developing a national vision on sustainable mobility and the associated transition trajectory, and adopting a clear role for electromobility within the wider mobility transition.
- Setting clear targets over time for deployment of vehicles and charging points.
- Developing and implementing an action plan that addresses regulation and coordination issues, engagement with stakeholders, promotion of electromobility, support of the uptake of electric vehicles, and the roll-out of charging infrastructure, and monitoring and evaluating progress of electromobility deployment.
- Setting up regulations and legislation that provide clarity about safety requirements, and foster the development of standards for hardware and software.

European policymakers play a crucial role in fostering and enabling the electromobility roll-out, by providing guidelines, norms and directives.

- **For cars and vans***:* Provide ambitious and long term CO_2 emission standards for cars and vans in line with the trajectory towards 60% CO_2 reduction in transport by 2050, as this will incentivise the market uptake of ZEVs in general, and electric vehicles in particular.
- **For charging infrastructure:** Support the Member States in achieving their national ambitions for rolling out charging infrastructure with the directive on alternative fuels infrastructure and other incentives.
- **Low carbon fuels:** Extend the Fuels Quality Directive as an incentive to adopt low-carbon fuels in transport, or use a similar kind of instrument to foster the use of renewable electricity in transport.

2 Freedom of movement

To allow convenient traffic with electric vehicles (EV) throughout Europe, a standardised, interoperable electromobility system is required, creating new business cases and making investments future-proof. Green eMotion has defined the European ICT architecture that is needed to ensure a proper connection of all market participants. It will allow open and convenient access by EV drivers to the charging infrastructure. The ICT systems of all participating companies are networked by means of a so-called marketplace. While users get easy access to a charging infrastructure independent of the equipment operator, service providers can offer their services to all market participants. In addition, value-added services like reserving a charging point or easy payment systems can make e-driving a more convenient experience.

Demonstration experience on interoperability

The results of the Green eMotion demonstrations are reported in **D8.5** [39] with references to the more detailed reports on demonstration **D8.2** [36] and **D8.3** [37].

Improvement of interoperability, especially for public charging, was one of the main objectives of Green eMotion. Therefore the project partners analyzed carefully the existing systems we already had in place in Europe and came up with a system architecture that would allow European wide, convenient usage of public charging infrastructure.

The core of this solution is an IT backbone, the marketplace, which connects all necessary business partners. Together with the so called clearing house this system allows roaming between all partners, meaning that EV drivers can use public charging infrastructure independent from owner or operator. The goal is a situation comparable with that in the mobile phone market where also the customer can use his mobile phone everywhere.

A limitation to this solution is the fact that both, the charging infrastructure operator and the service provider, having the contract with the EV driver, need to be connected to the same roaming system. However, if those business partners are connected to any roaming platform, this can also be achieved by connecting the existing roaming platforms.

In the Green eMotion demonstrations all demo regions were connected to the marketplace and the feasibility of this solution, especially for roaming between all the demo regions, was successfully demonstrated. Learning from this real life tests was that the usage of RFID cards for authentication of the EV driver has many obstacles. Due to different sub standards used in Europe the interoperability is limited and in general the usage of the UID of the RFID card is not a good solution as it is no unique identifier.

Therefore Green eMotion has defined the contract identifier (EVCO-ID) which fits the needs for roaming much better. It is easy to derive the correct EVSP from the EVCO-ID in order to identify the correct business partner. Together with eMI3 [60] a standard for usage of the EVCO-ID for contactless authentication is on the way.

Roaming is a basic step for interoperability, but we also need to develop a system which improves the convenience for the EV driver. Therefore Green eMotion partners developed the service “Search”. This service collects geographical and technical data about the public charging infrastructure that is connected to the marketplace. These data was then used by a web site and by a mobile phone application to enable the EV driver to search for chargers that suit his needs regarding travel distance and compatibility with his EV. In the specific case of Malmö and Ireland this data link was dynamic so that also the actual status/availability of the charger could be shown. From Irish users we received the feedback that the inclusion of real time data is highly appreciated.

However, the app developed within Green eMotion could not only be used for the search of public chargers, but also for the authentication itself. That means with his EVCO-ID the EV driver is able to start a charging process at the chargers connected to the marketplace. In this way the issue of different sub standards for reading an RFID card could be overcome. Especially for the customers of the electromobility service provider Greenabout this was an important feature as Greenabout infrastructure does not require RFID cards and the EV drivers therefore don't have those. With the Green eMotion app they were able to use the public chargers of the City of Malmö in a very convenient way.

Establishing standards is the most important measure for interoperability. Beside the definition of several identifiers needed for unambiguous identification of the electromobility players, Green eMotion has also worked on standardized interfaces. In Austria we face the situation that chargers of different manufacturers need to be connected to the same charge management software (CMS) of the operator Verbund. Due to several proprietary interface protocols of the chargers it was complex and costly to connect all chargers to one CMS. In cooperation with eMI3 a standard for the interface between charger and CMS is under development, see also D7.8 [34].

Business analysis for ICT related services

Before designing and implementing Green eMotion's ICT systems, a thorough analysis of previous electromobility demonstrations and their IT approaches was performed to leverage the lessons learned by them. On this way, a Best Practices Analysis has been undertaken to gather and analyze data and lessons learned from previous electro mobility demonstration projects and studies related to previous chosen ICT solutions. A survey on the expectations of internal and external stakeholders ensured that no requirements were missed, producing a holistic goal definition on the system. The business scenarios are described in which the identified stakeholders interact and use the ICT services, providing detailed per-stakeholder requirements on the Green eMotion's ICT systems.

The Green eMotion report **D3.1** [8] provides a business analysis for the description of ICT Marketplace relevant business scenarios, thus including best practice analysis and stakeholder analysis. Also, this document presents an identification of critical success factors for the effective deployment of services that can sustain EV mass rollout, without jeopardizing electromobility business during the very first part technology curve.

ICT reference architecture

One of the main goals of Green eMotion is the definition and demonstration of the European virtual Marketplace. That means, the ICT needed for electromobility processes and services, e.g. Clearing House services (roaming), forwarding service detail record or basic end user services like search for charging points or value added services like reservation of charging points.

The European Marketplace will support the efficient integration of the various demo regions with their charge management systems and customer backend systems. With that all connected demo regions can use the provided Electric Vehicle services including roaming of the European Marketplace.

By the open architecture, standardized interfaces and business objects (e.g. identification of charging points and contracts) it is ensured that all market participants can develop and commercialize their own services on the Marketplace. By that a competitive approach between the different EV service providers will be boosted.

The GeM European Marketplace will also facilitate the interconnection of several Marketplaces. That enables e.g. roaming between EV service providers even if one is connected to the GeM European Marketplace and the other one is connected to a local Marketplace.

The report **D3.2** [9] describes the ICT reference architecture for the GeM European Marketplace components and their relation and interaction. The ICT reference architecture includes all non functional requirements, including security, safety and privacy concepts, components and interfaces.

ICT services use cases & requirements description

The report **D3.4** [10] comprises a very comprehensive set of requirements for e-mobility organized through shared IT platforms, such as the Green eMotion Marketplace. Partners who are leading the key electromobility related industries have defined services carefully chosen based on their high added value to the end users, their likely early market adoption, business applicability, and usability. It is expected that these requirements will contribute to the electromobility industry by enabling market players to efficiently develop functions and services on their IT infrastructures. The immense effort of e-mobility experts spent on defining of which information can be handled by IT systems and how the stakeholders can interact, all summarized in this deliverable, shall serve as a "what to build" recipe to the EV service providers, energy utilities, public sector, OEMs and others.

The results of the stakeholder analysis and surveys from D3.1 were described as high level business scenarios and were with the use of applied meta-model transformed with increasing granularity to features and use cases described in report D3.4.

D3.4 comprises a complete set of business requirements of Green eMotion, including those described in the interim version D3.3, improved and enhanced features and use cases, improved structure and inclusion of additional use cases based on the feedback.

This deliverable provides, in form of structured ICT requirements, an overview of all services described by the Green eMotion project partners. More than one hundred use cases described in this deliverable outline the business interactions around the central IT information platform. This platform, the Marketplace itself is described, listing all core Marketplace services and also potential interconnections between Marketplaces. Further chapters features general basic and value added services of electromobility such as search and reservation of charge points, roaming provided by a contractual Clearing House and the Energy and smart grid perspective, including congestion management for DSO and potential aggregator market interactions in the future.

ICT core services and transactions design specification

Carefully selected requirements from D3.4 were further detailed by the IT developers in the specification phase in report **D3.6** [11], leading to the two releases of the Green eMotion Marketplace and related EV services. D3.6 thus comprises the complete specification of the key business components, service interfaces and user interfaces for the Green eMotion Marketplace eco-system, including those from the interim version D3.5, and reflects the final implementation of this ecosystem.

Work on the D3.6 commenced with business components identification. Business components are describing the selections of systems that need to communicate in order to implement a particular use case. In a second step the service interfaces between these systems have been specified. By the business to business nature of the Green eMotion project this specification considers solely the service interfaces (APIs) between the back-end systems of the involved partners. Business objects are further describing the implementation details of the interfaces.

Components, interfaces and business objects of the platform, the Green eMotion Marketplace, are described in the last chapter, featuring all core Marketplace components and also interconnection between Marketplaces. Other chapters cover technical components of the general electromobility services such as search and reservation of charge point, roaming provided by a contractual Clearing House, and the energy and smart grid perspective, including congestion management for DSO.

Implementation of the Green eMotion Marketplace

In the software engineering process a prototype in general is an early release of an IT system that is used to verify the concepts and processes that are laid out in the software design. This is a crucial step, since it helps to identify problems early in the development process. If these problems would occur in a later phase, it would involve significantly more effort to resolve the issues and might also impact the release schedule.

Within Green eMotion a prototype for an electromobility Marketplace was defined, implemented and tested. The technical description of the prototype can be found in **D3.8** [12]. Test results are documented in D8.5.

Minimum requirements of charging infrastructure

The market of electromobility and the associated deployment of recharging infrastructure today are still at a very early stage. Numerous pilot projects are currently under operation. The report **D4.1** [14] shows relevant aspects that need to be considered when new charging posts are to be erected. Technical requirements differ from country to country and partly from company to company so technical solutions do also.

In general it can be said that there are usually good reasons for particular technical solutions. Thus the report does not assess whether solution A compared to solution B is "better" or "worse" but identifies the topics which are important to be resolved when dealing with different categories of recharging infrastructure. An index about these topics can be found in section 10 of this report. The technical questions which have been created to collect the data set for this report are very relevant to the definition of minimum requirements, therefore the survey itself can be considered to be a "list of minimum requirements for recharging infrastructure".

Recommendations for planners of public infrastructure

The approach taken by the planner will differ depending on what type of body is responsible. Municipalities will be less interested in inter-urban travel compared to regional authorities. DSOs will choose sites based on minimal amount of network reinforcement and may have regulated asset funding. Private companies will be looking for short-term revenue streams. In general it can be recommended, see **D1.6** [1]:

- Identify the target group, e.g. private drivers like commuter, city/rural residents or company fleet drivers, eCar sharing user, etc.
- Analyze their travel and parking behaviour, including the opportunity for home charging.
- Identify the charging service they need, e.g. fast charging at highways, public charging spot for street parking, traffic hot spot charging at place of interest (see also D9.7 [47]).
- Analyze the business case for the different charging services
- Choose location and technology (fast or normal AC, DC, inductive) based on business case and charging service. Consider also the local grid capability that will influence the grid connection costs. See also D4.3 B-2 [18] and D8.4 [38].
- Remembered that a charging station is both a mechanical and electrical component and a civil construction. Refer to all devoted electric, mechanical and building standards. In particular, a special attention should be paid to safety aspects, given the direct contact of the equipment with a public of non-expert users and possible accidental interactions with critical subjects (e.g. children). For more details see **D7.8** [34] chapter 7.
- E-mobility processes, e.g. charging of EV, will need the implementation of an ICT infrastructure, GSM network and integration in existing ICT applications (e.g. accounting systems or web-portals)
- Develop a marketing and dissemination strategy
- Collect data about usage pattern of your infrastructure for further optimization of the services

Special report "Electromobility implementation plan Malaga"

The purpose of this study [56] is to analyse in depth the ideal locations to install charging stations in the city of Málaga, the province and the region where it is located (the province of Málaga and the region of Andalusia), aiming at connecting:

- The different areas of the city of Málaga.

- The city of Málaga with the rest of towns in its province (although the tender specifications established to consider only those towns with a population over 25,000 inhabitants, finally it has been taken into account all towns over 10,000 inhabitants, in order to improve the connectivity of the province).
- The city of Málaga with the rest of provincial capitals of the Andalusian region (as an improvement to the requirements included in the tender specifications, it has also been analysed and guaranteed the connectivity among the rest of the Andalusian provincial capitals).

The study contains an analysis of the supply in place like electric vehicle fleet, charging stations, parking spaces and grid constraints. Based on demographic data the demand for electromobility was derived. Finally an action plan for a roll-out of charging infrastructure is elaborated.

How to set up an electromobility system from scratch – a guideline

D8.4 [38] is a reference guide for pilot projects that are going to be established in the next years throughout Europe, in order to give them an overview of what the hurdles could be in getting started locally, how to overcome them and how to strengthen the local initiative by connecting it to a wider framework, increasing the number of possible customers and granting the continuous update of technical infrastructure in a way that it can be operated for value throughout its life cycle.

This reference guide is built by reporting the experience of Greece as main Green eMotion replication region. The replication was focused on a selection of Green eMotion use cases: AC charging in big cities (Athens) and smaller ones (Kozani), alongside the integration of local demonstration into the general idea of wider EU framework (e.g. through the “search” and “roaming” services). In Greece within the timeframe of 1 year an electromobility initiative was initiated, 15 charging stations deployed and the local pilot was connected to Green eMotion wider framework, finally demonstrating some of the main Green eMotion products, such as Search, allowing customers to display charging stations from all EU on Green eMotion website and Roaming. The Greek experience shows the need for stakeholder involvement at the earliest possible opportunity, avoiding possible setbacks and allowing the uniformity among activities, projects and tools.

Besides reporting the local set up of the electromobility pilot from PPC, D8.4 includes also a useful review of Green eMotion Roaming product specification/use case, precisely how to leverage it for going beyond a local pilot in this case the Greece demo region of Green eMotion. The document also provides an expected market outlook of Green eMotion R&D in terms of European Marketplaces for electromobility products and services, which are currently being developed as the main industrial exploitation of this project, and useful guidelines for subsequent R&D on this matter.

Standardisation – evaluation of gaps and definition of a roadmap

The harmonization of technology and standards is an essential issue for the mass rollout of EV and PHEV across the EU. In a first step GeM collected information about already existing technologies and standards within electromobility in Europe. The result is documented in **D7.1** [26] respective in the attached excel lists.

As a complement to that, the standardization issues and needs were collected by GeM performing several surveys. The results including recommendations are documented in **D7.2** [27] grouped in the topics: electric vehicle, charging point, AC/DC charging, identification / communication, connection to the grid / smart charging and future trends in eMobility and advices for standardisation guidelines.

A specific focus on the 10 Green eMotion Demonstration Regions (DR) let to **D7.3** [28] obtaining a “real-life” overview of the applied technologies and standards. A detailed analysis of the criticalities, issues and open points still present in this landscape have been carried on. Several means have been used to this scope, in order to cover a wide spectrum of stakeholders and to try to gather all the most relevant aspects. More in particular:

- Two surveys have been prepared and sent to selected actors;
- Three standardization workshops have been organized, documented in **D7.4** [30] and **D7.5** [31]

- Relevant Green eMotion partners have been directly interviewed.

The combination of these instruments, with the involvement of many actors, brought to a quite large number of data, results and comments. The main issues have been organized and included in a comprehensive table, which has been called **Gap Matrix** [29].

The gap matrix (Annex of D7.3) identifies 31 gaps, with different levels of criticality. The vehicle itself is covered by many standards, but there are still some lacks regarding the "new" aspects that differentiate EVs from traditional vehicles, e.g.

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

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

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

To proceed from that GeM elaborated the following proposals that are summarized in the report **D7.8** [34]:

- In order to achieve results that are comparable with real driving experience, the team designed a new procedure named SORDS (Standardised On-Road Driving Schedule) inspired by the UITP-SORT test for city buses. The SORDS represents a fairly dynamic drive pattern, which results in an accelerated depletion of the traction battery; see **D6.1** [23] and **D6.3** [25].
- A new approach to use RFID cards, avoiding the use of serial numbers and using specific data in the card memory area, see **D3.10** [13];
- A standard focused on the management of charging stations, covering the communication between the Electric Vehicle Supply Equipment (EVSE) and the IT backend system(s), see also **D7.7** [33] and **D3.10** [13].
- New standardized identifiers and business objects, in order to have a fixed and univocal identification of the key components for EV charging, see **D3.10** [13];
- A basic interface protocol for the communication between DSO backend and EVSE operator backend for Power Demand Management purposes, see **D3.10** [13].

To give the standardization activities of GeM a high impact it was decided to focus on development of new standards with ICT aspects. Part of that was the foundation of the eMI3 group [60] (eMobility ICT Interoperability Innovation Group) together with other industry partners to broaden the agreement level on those consortium standards and to ensure the continuation of activities after Green eMotion project end. Partners of Green eMotion fulfil part of their obligations by contributing to eMI3.

As a first result, eMI3 has acted on the most pressing issue identified and produced a first draft specification with updated unique identifiers EVCO ID and EVSE IDs and sent it to DIN and ISO15118 for review and inclusion. Also the GeM New Work Item Proposal draft for the backend communication protocol for EVSE was handed over to eMI3 that will place this new work item proposal in the IEC TC57. For a detailed description of eMI3 activities see **D3.10** [13] or the eMI3 homepage [60].

As an outlook GeM is proposing a "Roadmap towards interoperability" focused on missing standards and, in particular, on communication interfaces. This roadmap, presented in **D7.8** [34], considers 5 time steps (from 2015 to 2025) and 13 main targets distributed among them. The effort is to start ensuring an easy and "universal" charging to drivers, thanks to a definitive physical interoperability (plugs/sockets) and to concrete choices towards roaming features (identification, authorization, IT interfaces), and then work to progressively include e-mobility in the wider concepts of smart grids, through smart charging and reverse flow solutions.

Another aspect, articulated in D7.8 are some dedicated "guidelines", expresses the concern that new electromobility initiatives start immediately setting up an up-to-date and "interoperable" infrastructure. Precise and well-focused indications for Public Administrations and Municipalities willing to install a charging infrastructure are provided, with a particular attention to standards and ICT features.

Common methodology to ensure interoperability of developments with standards

The first step to come to a common methodology for product development as described in **D7.6** [32] is to define a common basic architecture. In this context of standardization interfaces and communication this is a picture showing the interfaces between the different stakeholder groups / physical systems and components. In practice, architectures can differ, but therefore a Common Basis Architecture has been defined that serves as starting point for different architecture implementations.

Use cases are crucial in all stages of the development of products and standards: for customer communication, for creating requirements, for verifying architectures, as starting point for interoperability etc. To enable fast convergence of ideas and easy sharing of information and terminology it is advised to share the use cases as much and open as possible; preferably (parts of these) public, else open for user groups or industry alliances. If these will not be shared, they will not be used, and as such not lead to or influence standards.

The creation of a set of coherent and consistent business objects and data models is crucial since they help in detailing and verifying use cases, and at the same time they help to abstract the technical interfaces. This creation process also forces choices to be made. These choices, detailing and verification will make the models more robust and future proof.

This all leads to the following recommendation:

"For eMobility agree on a Common Basic Architecture and define Data Models compliant with the semantic models and the business context/procedures and objectives. This Basic Architecture and Data Models will ensure use cases to be implemented and technical interfaces to be aligned."

A set of terms and definitions for a future European standard for the smart grid integration of electromobility can be found in the "EV integration in smart grids glossary" **D7.10** [35].

3 Economic Challenges

A major result of the Green eMotion project: While economies of scale must substantially lower the price of batteries in the coming years, charging points accessible to the public can only be profitable, if highly frequented and combined with other services. Costs for grid integration of charging infrastructure can be significantly reduced using smart charging strategies to control the charging time and power. Smart EV charging management can also optimise the integration of variable power from renewable such as solar and wind by aggregating and controlling the power demand for so-called load areas.

Demonstration experience on grid integration

The results of the Green eMotion demonstrations are reported in **D8.5** [39] with references to the more detailed reports on demonstration **D8.2** [36] and **D8.3** [37].

The power quality impact of charging infrastructure was studied under real life and lab conditions. These measurements revealed no issues in the concerned low voltage grids. However, with lab tests it could be shown that a buffer battery would compensate for reactive power and though stabilise power quality if necessary.

A reduction of energy costs can be achieved by optimization of energy demand over time if different tariffs are implemented. For the headquarters of Iberdrola in Valencia it could be shown that by considering the Spanish DH3-supervalle tariff savings of almost 40% were possible. That means that such a tariff structure might be an important measure to motivate customers to adapt their charging behaviour to the grid conditions.

Smart grid management schemes are useful for the optimization of integration of renewable energy sources (RES). By controlling the charging process and shifting it to certain time slots, the usage of renewable energy, e.g. from photovoltaic, can be optimized. However, this is limited by the mobility needs of the EV driver. To ensure customer satisfaction, the system might use an energy buffer to compensate time offsets between production of energy and the demand. In the easiest case that will be accomplished by the grid itself meaning that the grid tie must be able to deliver the maximum requested power. Another option is the usage of a buffer battery. In that way the grid tie can be much weaker and depending on the local grid that might save a lot of costs for grid reinforcement. A lab simulation showed the potential of this solution. Yet, a real life demonstration in Malaga also revealed the issues evolving from the installation of a medium sized second-life Li-Ion battery. The regulatory situation is complicated and requires a long legalization process.

Another and cheaper option for controlling the power demand from the grid resulting from EV charging is load management. On a local level it can be used to reduce the necessary grid tie capacity and therefore save grid reinforcement cost. The load management demonstrated in Malaga showed that under consideration of customer needs and by applying different customer profiles like “Gold” or “Basic” the maximum requested energy could be limited to a preset value.

But load management can also be used for the optimized integration of RES on a broader level. By aggregating and controlling the power demand for so called “load areas” the DSO is able to control the power demand from his distribution network. With a high number of EVs connected to the grid this might become in important feature to prevent curtailment of RES or the need to activate reserve power production. However, the results of simulation performed for the demo regions Italy and Greece brought out that with the communication and control possibilities that is most common at the moment a real power balancing is not possible. Due to the limitations of the EV interface – using PWM signalling based on 61851 - it cannot be guaranteed that the EVs really draw a certain amount of energy per time interval. Only with communication capabilities as with the EV interface protocol ISO/IEC 15118 it will be possible to negotiate so called charge plans between the EV and the infrastructure. Once the implementation of ISO/IEC 15118 communication is available at the majority of EVs and EVSEs load management can bring even more benefit to the grid integration.

An option to avoid grid reinforcement costs for the low voltage grid is a power management for distribution networks (Soft Open Point). The SOP has the potential to balance load across adjacent feeders and control local system voltages. The SOP has cost saving implications for utilities and represents a much more efficient use of the existing network.

Influence of harmonic emissions from EVs on the grid

The scope of **D4.3 A-1** [16] is to describe the impact of EVs related to harmonics, i.e. electric voltage and current that appear on the electric power system as a result of non-linear electric loads, with focus on low-voltage grids in households as primary consumption. The method has been chosen and developed in accordance with EV charging done in household installations and with focus on a charging level of 16 A at 230V.

Harmonic load flow simulations in Power Factory have been performed for three different charging strategies, User dependent, Timer Based and Load dependent. Based on a "base-case" simulation on 30 specific low-voltage grids from Italy, Spain and Denmark, 6 specific grids have been selected for a more comprehensive assessment.

From the analysis, harmonic emissions from EVs are not expected to create a need for reinforcement of the grid in nearest future, but could be considered as a severe issue for communication like e.g. Power Line Communication. The results show that sufficient short-circuit level is the most important parameter to avoid harmonic distortion. This should be considered when extending or reinforcing the existing grid, as great improvements can be achieved with relatively low costs. Furthermore, the results show that the total level of harmonics is highly dependent on other types of equipment connected to the grid also.

Role of DSOs in smart grid integration of EVs

As the EV market and particularly PHEV are about to enter into the rollout phase, ensuring the correct operation of the electrical system within technical standards is one of the main criteria which will have to be constantly fulfilled at all times in order to sustain a mass market. Furthermore, technological solutions must guarantee compliance with the innovative business scenarios that are being proposed by all stakeholders in the electromobility field.

The mobility and load unpredictability of moving customers will simultaneously set challenges and create new value within the electrical system and the headstone of this smart-grid integration of EVs is the possibility to manage the EV load according to the LV/MV electricity network needs.

The main results from **D4.2** [15] analysis of macroeconomic factors and field tests led to the comparison between Business as Usual and Time of Use (ToU) tariffs with real time adjustments strategies. The latter is the one where the DSO has a more active role and is able to ensure power quality and fully exploit existing grid capacity. According to current state-of-the-art techniques, these strategies lead to binary EV load management process (ON-OFF or charge scheduling) and granular (fine-tuned) EV load management process that have been field-tested

These results from business analysis and field-tests lead to the recommendations:

- to OEMs to improve the design of embedded hardware of EVs in order to sustain ToU tariffs with real time adjustments strategy;
- to Regulatory Bodies to set the incentives framework and suggestions for smart charging business actors depending on the national policies that might be adopted.

Parameters influencing grid reinforcement costs

Report **D4.3 B-2** [18] describes the impact of EVs on the reinforcement costs of low-voltage networks. The focus is on how different parameters relating the EVs to the grid affect the reinforcement costs. The evaluation has been done by developing and analyzing a set of scenarios that vary the parameters under study. These parameters are:

- Charging Power
- Charging Profile
- EV Location
- EV Penetration

Grid reinforcement schedule and reinforcement cost results have been analyzed and comparisons have been made for each of the parameters in the study. The comparison of costs is based on net present value (a way of representing time value of money concept). This assures that it is not only the amount of reinforcement that is considered, but also the time at which it occurs.

The results have shown that the charging profile is the most important parameter of all the investigated parameters. As the charging profile depends on the charge management strategy, it means that the charge management strategy is the most important parameter. With a grid friendly charge management strategy it is possible to avoid most reinforcements and their associated costs, reducing the significance of all the other parameters.

The results also showed that a simple timer based charge management strategy with the goal of improved grid friendliness could end up making the charging process less grid friendly due to a kickback effect. This resulted in significantly increased reinforcement costs in many of the networks when using the simple timer based charge management strategy. More elaborate timer based charge management strategies can likely avoid kickback and its negative effects on reinforcement costs, while still providing the benefits of moving EV charging away from the existing load peaks.

Variations in EV penetration and charging power had a significant impact on reinforcement costs, showing the importance of accurate forecasting.

EV location and voltage control only had an economic impact in networks where reinforcement was necessary due to voltage issues. Location had a significant impact on reinforcement costs and showed that in order to evaluate the reinforcement of a network, it is necessary to know the exact location of EVs during grid planning. The use of voltage control could defer the vast majority of reinforcements associated with voltage issues and allow long feeders to accommodate a significantly larger amount of EVs before reinforcement is necessary.

The load flow simulations have been performed on each scenario using ITRES. ITRES is a tool developed within Green eMotion that evaluates reinforcement costs over a number of years with a user-specified load increase. It has been designed to quantify the impact of a significant uptake of electric vehicles on the need for reinforcements in a specific low voltage (LV) distribution network, and hence to facilitate the network planning process in the context of accommodating a high number of EVs. The reinforcement needs are quantified over the time-horizon of up to 25 years, with the possibility to consider alternative EV charging strategies. The **ITRES tool** [55] is publicly available and can be downloaded together with the user manual **D4.3 C-1** [20]. It is recommended to be used by DSOs for calculation of their grid reinforcement costs.

Report **D4.3 B-1** [17] describes the relevant parameters for performing a comprehensive assessment of EV's impact on the low voltage electricity grid. The report served as basis for the simulations performed with the ITRES tool. However the report can be used as introduction for external stakeholders, who wish to improve knowledge on EV's impact on the low voltage electricity grid.

Necessary features of future distribution network planning tools

Report **D4.3 B-3** [19] argues that a fundamental review of the current distribution network planning and security standards is needed. This results from the need to facilitate a cost-effective evolution to a low carbon energy system through exploiting various Smart Grid technologies. Those are critical for the efficient integration of large amounts of distributed renewable generation and flexible demand technologies such as EVs. Future distribution network planning standards and tools should assist network planners in selecting optimal portfolios of network development strategies, including network reinforcement, use of distributed generation, flexible demand (e.g. EVs), application of energy storage technologies and advanced network technologies so that the costs of these options are balanced against the value they bring to network consumers. It is also critical for the new tools to take into consideration the risk profile of smart grid solutions, to ensure that adequate levels of reliability are delivered to consumers.

The majority of existing reliability tools and techniques in the context of distribution network planning focus on the average or expected performance of the system, and future tools should explicitly characterise the network reliability performance as well as the service quality profile delivered to individual customers, which could vary massively from the system-wide reliability indices. This approach would support a detailed and explicit representation of the effects of alternative network design and operation strategies, involving both network and non-network solutions, on customer reliability of supply. Quantifying the security contribution of non-network solutions, such as flexible EV charging demand, needs to include a careful consideration of their specific operating constraints, such as the energy requirements and flexibility to shift demand in time. Future network planning tools will also need to accommodate the reliability performance of the ICT infrastructure that will be essential for future network operation.

Recommendations for mass integration of EVs in the European networks from a DSO perspective

The work carried out and summarized in **D4.4** [21] analysed how the charging of EV may impact the grids (in terms of both power quality and grid capacity) and showed that in the short term most electricity grids are not going to be affected by the current share of EVs. However, some aspects should be examined in more detail and led to the following recommendations for the future:

The effects of harmonic distortions on the grid, although not particularly critical today, could represent a significant aspect of the impact of EVs in the future if no specific regulation is put in place. Following the recommendations regarding harmonics given in **D4.2** [15], OEMs (in case of AC charging) and charging station manufacturers (in case of DC charging) should work on common design requirements for inverters in order to reduce harmonics when the inverters are not operated at nominal power (i.e. when load management is applied for reducing the demanded power of the EV).

In addition to modifying hardware, grid planning rules will also need to adapt to EV rollout. As there is no 'standard' distribution grid in Europe and the impacts of EVs in the specific regions are likely to vary, a European-wide effort should be made to develop distribution grid planning practices that appropriately consider the additional demand by EVs.

It was also found that new methods may be necessary for estimating load, especially in cases with fewer customers and flexible loads, where averages are a poor estimation. Technologies such as Smart Meters can provide a large statistical base which can facilitate more accurate load estimation and forecasting.

When looking at the current market design and the regulatory regime of the electricity distribution business, it is evident that there is no general 'hub' for matching the energy demand of EVs with local restrictions of DSOs. On a local level, e.g. parking lots, this concept has been tested in the Spanish Demo Region ES01 of Green eMotion, see **D8.5** [39]. However, in the case of mass market applications, a local management (dispatch) does not incorporate effects of the overlaying network levels. For the upcoming years one major task for DSOs will be to work on a centralized integration model for coordinating EV charging behaviour.

To summarise, Europe has a good starting position to de-carbonize road transport, but significant work yet remains to be done, especially in linking the currently more or less detached industries of OEMs and utilities. The findings highlight the current capabilities and future challenges and therefore open questions and identify areas for future projects.

Calculation of hosting capacity for EVs of exemplary grids

D9.3 [42] evaluates the network capacity of hosting electric vehicles, using data collected by smart metering systems. Such information along with the knowledge of topology of low voltage networks, technical and constraints data for all components allows evaluating the number of EVs that can be charged on each node of network. This is done both considering an “uncontrolled” and a “smart” charging system. By using three kinds of representative charging profiles, this tool has been applied to assess three different case studies, one in Italy, one in Denmark and one in Spain.

Although the three cases are quite different regarding the location, it has been shown that the networks appear to be ready for a rollout of EVs in a reasonable 2030 scenario. The Danish and Spanish networks are even less loaded than the Italian case. The analyses and evaluations carried out have shown the importance of Smart Charging. This mode allows to charge a number of EVs at least one order of magnitude higher than in Normal Charging, by making the most of the components. It must be pointed out that only the Italian case study can be considered statistically representative of urban areas. Results cannot be extrapolated to other areas of Europe, whose network performance should be tested more extensively. However, since the three sample cases are random and refer to different kinds of locations, they represent a partial, but significant view of the situation in Europe.

Measurements on battery performance and degradation

The report **D9.8** [48] investigates the performance of electric vehicle batteries and how their performance degrades over time. Battery degradation is a cause for great concern because batteries are the single most expensive part of the electric vehicle. The potential cost of replacing batteries therefore has a dramatic impact on the business case, both for the consumer and for the operators of charging infrastructure.

Monitoring the performance of EV batteries requires a technical platform that allows electrical tests to be performed on the vehicles. The realized mobile test platform is a multipurpose van prepared with custom interior for accommodating a complete set of test equipment for batteries and electric vehicles. This includes a set of electrical load banks and chargers for capacity measurements and equipment for more sophisticated measurements. The mobile test platform was successfully used for both the test in the field and some of the testing in the lab.

In that context, the main outcomes of the analysis presented in this report are:

- **Technical test platform:** By equipping a dedicated Battery Service Vehicle with electrical load banks, AC/DC chargers, power analysers etc. the team developed a flexible, mobile test platform that was used both in laboratories and in the field to analyse the state of EV batteries.
- **Well-defined performance metrics**: We found that neither the Battery Capacity, nor the State of Health nor the State of Charge were universally defined. Thus these important performance metrics can be used in a somewhat arbitrary way.
- **Access to batteries**: We found that direct access to the battery poles on modern EVs is hindered by a complex set of control functions. Thus a simple plug-and-play approach to battery testing was not possible. Instead we used the vehicle itself as a test mule and recorded the necessary data from the CAN bus.
- **Advanced modelling**: To simulate the impact of load profile on the performance of the batteries a Randle’s circuit modelling was used. This allowed standardised test sequences like ISO12405-2 to be simulated without taking the battery out of the car.
- **Impacts of temperature**: We found a significant impact of temperature on the available energy capacity of the batteries. This underlines our observation that battery measurements are highly subject to influence by the weather.
- **Performance over in-use life time**: Despite doing many tests in laboratories and in the field we found no proof of irreversible degradation over the time span of the project. One battery did break down at the age of 4 years, but even this was relatively easily repaired. Our tests confirmed that the battery performed as new after the repair.

Demonstration experience on new Business models for electromobility

The results of the Green eMotion demonstrations are reported in **D8.5** [39] with references to the more detailed reports on demonstration **D8.2** [36] and **D8.3** [37].

A possibility to improve the business case for public charging infrastructure is the combination with other services, e.g. shopping. The idea is that the option for charging increases the attractiveness of the basic service. In case of shopping that means that more people would visit the shop or buy more while charging.

As part of the Green eMotion demonstration, chargers were installed at the parking facilities of 12 REWE sites. The chargers were operated by SMATRICS and also the charging service was provided by SMATRICS. A detailed agreement between REWE and SMATRICS about the liabilities was concluded.

The result of this demonstration was that customers indeed appreciate to have the opportunity for charging during shopping. The requirement is fast charging as the shopping duration is not suitable for slow charging. Based on the available data it cannot be evaluated if the basic business of shopping was really supported by the charging service. However, REWE will continue its engagement in electromobility. A combination of REWE customer loyalty programs and the charging service offer might enhance the positive effect of combined business.

Another opportunity for combined business is the charging service in parking lots. People are used to pay for parking in city centre located facilities, so that might be a good starting point for making real business also with charging services. Within Green eMotion a concept for bundling parking and charging offer was elaborated.

A main still open point in this concept is the question who will act in which role. The parking lot is in general operated by a company that also sells the parking service. Additionally we have the roles of the charge point operator and of the service provider. The latter sells per definition the charging service to the end customer, the EV driver. Different approaches were discussed whereas both services might be offered by one company including the operation or not. It can be concluded that the combination of such services is complex and needs a careful coordination to ensure customer convenience especially in access control and billing.

An option for improvement of the business case for eCar sharing is the reduction of costs. Therefore the partner Greenabout thought about enlarging their public private partnership they already have on the island of Bornholm. In this set-up, municipalities, private companies and citizens (tourists) can share the same EV. During daytime it is used by the municipality, but after office hours the EV is available for private use by citizens. The system has been up and running and tested at the island from 2013 on. Unfortunately this could not be replicated with the city of Malmø due to organizational reasons. However, the idea to save costs by reusing EVs, that are otherwise unused half of the time, is promising.

Beside the costs for EVs, also costs for the operation of public charging infrastructure should be minimized whenever possible. The costs for the hardware itself have already dropped and it can be expected that while chargers become a mass product the prices will decrease further. But also the operation, meaning control and maintenance, should be reduced. On the software side this can be achieved by sharing of a charge management systems in the form of software as a service. Within Green eMotion a “Network Infrastructure Portal” (NOP) was developed which can be offered via the Marketplace. Therefore the operator has not to develop or buy his own charge management software but can take this offer from the Marketplace and pay only for the service he really uses. The functionality of the NOP was tested with the charging infrastructure in Ireland. It provides a convenient mechanism for efficiently monitoring, managing and maintaining a charging network of any size.

EVs in fleets show a positive business case already today

Report **D1.9** [2] describes the types of EVs and their uses in fleet scenarios. Documenting real life scenarios, the report shows successful use of EV technologies including any specific challenges encountered. These scenarios include office car pools, taxi services, urban bus routes and urban deliveries. The different types of electric transport are compared with alternative Internal Combustion Engine (ICE) technologies.

If we compare electric mini-buses with diesel equivalent buses in the same conditions, the use of electric fleets is more favourable in aspects such as emission reduction, low maintenance, little noise beside consumption what makes this type of buses ideal for this type of routes in historical urban areas that usually cover routes of 5km. For more information on electric buses for urban transport see also activities of the European project ZeEUS [62].

EVs as taxis have been assessed in Dublin and Valladolid and are seen to provide a good alternative to ICE vehicles. The range limitations and speed of battery charging are limiting but not excluding factors, allowing substantial opportunity in this area. A modest range increase combined with wider access to fast battery charging services would greatly increase the penetration levels.

The postal sector plays an important role within the urban freight logistics. For more information on freight electric vehicles in urban Europe see also activities of the European project FREVUE [61]. In this report D1.9 we see the composition evolution of the main European postal fleets and some examples of cities that have implemented the electric car in urban freight. Perhaps the most prominent case is the Group Laposte where the French government along with Renault has promoted the introduction of the electric vehicle in some major companies, such as the French postal fleet. It is clear that there is great potential for the implementation of the electric car not only in Public Postal Operators of the 28 EU Countries but also in the whole European postal fleet with about 49 organizations and more than one million postal vehicles travelling across Europe.

The success of a car pool scheme at companies in Ireland and Spain has been recorded, while the proven use has triggered steps to expand the scheme. The use case has been assessed for capital costs, running costs and emissions as against the alternative means of transport such as taxis. The opportunities in this area are great, particularly for medium to large companies where the employee base is sufficient to support the investment in EVs.

Fuel costs have been assessed, showing the trends over previous years, giving a clear indication of the future opportunity to control the cost of transport energy for fleet managers through the use of EVs. The developing market and growing selection of vehicles is evident, providing confidence to the fleet operator in the commitment of policy makers, the auto industry and the other actors in the EV field.

Business opportunities related to grid integration of EVs

Report **D4.5** [22] includes an in-depth description of the business opportunities related to the so called "new functionalities" which are related to the EV appliances. As an outcome of this task a cost-benefit analysis has been carried out following a standardized calculation methodology in order to further identify the potential viability in a market environment as well as its externalities. An in-depth review of the results from previous EV research projects founded by the EC has been performed.

In general, the design of e-parking facilities for EV charging should ensure that all components are perfectly sized and adapted to the real recharging needs to be covered. In the analyzed context, the more profitable functionality is the application of DUoS tariffs depending on the time of use. This functionality involves low investments and allows the charge point operator to carry out an optimization of slow charges to adapt them to variable hourly electricity prices.

The investment in second life batteries is only profitable under consideration of regulation services to the grid. Also V2G is not a profitable service if only peak reduction and energy arbitrage are taken into account. The importance of a change in the regulation for facilitating the adoption and penetration of the V2G technology is highlighted.

From the DSO point of view, DSO load management tried to reflect the savings/benefits that could be obtained by the DSO when demand management strategies are implemented instead of extending the existing grid. In order not to penalize the DSO by the implementation of demand response strategies, a minimum benefit has been calculated that should include the payment or incentive to the charge point operator for responding to the request. The best results would be obtained when the amount of controlled kW in a year are the highest possible and the investment cost are the lowest.

Impact of mass EV roll-out on the EU electricity system

The report **D9.2** [41] applies a novel whole-system analytical framework to understand the simultaneous impact of electricity demand for electric vehicle (EV) charging on the operation of electricity system as well as the required investment into generation, transmission and distribution infrastructure. This analysis estimates the economic and environmental impact of a Europe-wide EV rollout on the operation and design of European electricity system considering the 2030 horizon.

The results presented in the report suggest there are significant economic opportunities for flexible EV charging that can substantially reduce the system integration cost of EV deployment, as well as mitigate the environmental impact in terms of additional carbon emissions from the electricity sector. In other words, smart integration of EVs into electricity system operation and design will not undermine their rollout, as the additional cost involved is estimated to be relatively modest.

We show that the split benefits of flexible EV demand can span multiple sectors of the electricity system – balancing and energy arbitrage, ancillary service provision, generation capacity adequacy, and transmission and distribution networks. Given that these sectors are characterised by different market structures, competition levels and regulation, it will become necessary to develop an appropriate market and regulatory framework to support a cost-efficient integration of electromobility. One of the key challenges in that respect will be to devise commercial structures that deliver adequate revenues to flexible EV owners from diverse sources of value. Creating adequate commercial arrangements for flexible EV providers is addressed in the subsequent GeM reports D9.6 [46] and D9.7 [47].

Business case analysis for charging services

The business models (BM) analysis performed in Green eMotion seeks to identify the BMs most suited to facilitate large-scale electric vehicles (EV) roll-out in terms of social acceptance, commercial viability and system/environmental impact. The **first part of D9.4** [43] made a detailed economic impact of the deployment of publicly accessible slow charging infrastructure in the whole ecosystem of actors. The **second part of D9.4** [44] assesses the impact on the main actors (charge point operators and EV customers) in four different charging services, to account for the different charging alternatives that EV customers may have for charging their EVs:

In order to assess whether there is room for developing a positive business model for all the actors involved in the ecosystem, the analysis assumes that each charge point operator, as well as the EVSP, use a pricing strategy which allows them to recover their costs. Then, the effect on EV customers is compared with a similar situation for an Internal Combustion Engine (ICE) vehicle driver.

Private home charging is expected to be the preferred charging alternative by those EV customers who can charge their EVs at home, while public charging spot for street side parking is likely to be the most used option for those EV customers without access to private home charging. As a result, the total cost of ownership (TCO) for EV customers is compared with the cost of owning an ICE vehicle with an equivalent usage rate. On the contrary, traffic hotspot charging and highway charging are expected to be used quite seldom by EV customers (almost only when they require extending their range and cannot use the other two services) and, hence, they are not likely to have a big impact on their TCO. The relative cost of a single, equivalent trip for EV customers and for drivers of ICE vehicles is compared.

The analysis presented in this report shows that EV customers with private home charging availability are likely to be the early adopters of electromobility, as long as they need to use their EVs regularly and subsidies for EV purchase exist. Then, as EV market grows, publicly accessible charge point with semi-fast charging capabilities are likely to appear in cities and traffic hotspots. In the meantime, technology development is expected to increase driving ranges while reducing costs, so that highway charging can also be profitable in the medium term. Until these technological developments materialize, electromobility should be supported by a favourable regulatory framework, both for EV customers and for the deployment of the charging infrastructure.

4 Follow up activities Green eMotion

Furthermore results from GeM are used for other funded projects running in parallel or as follow up, see table below.

Table 1: Projects using Green eMotion foreground

Project Name	Funding Scheme	GeM partner(s) involved in the project	Contact Person	Main Topic(s) of the Project	Follow up on the following Green eMotion Topic(s)
PlanGrid EV	FP7	ENEL RWE, ESB, Renault, Tecnalia, Università degli Studi di Roma "La Sapienza"	Giovanni Coppola	The overall objective of PlanGridEV is to develop new network planning tools and methods for European DSOs for an optimized large-scale roll-out of electromobility in Europe whilst at the same time maximizing the potential of DER integration. The project will also identify gaps in current network operation procedures and update tools and methods to address local load and congestion issues, leveraging on the possibilities of managing EV as controllable loads. For the validation activities the project will rely on existing infrastructures of the four involved DSOs.	Load Management (WP3 and WP5) and EV-Grid Opportunities (D4.2), Future Grid planning tools (D4.3-B3), Business models (D9.4)
Eware	Horizon 2020	ESB	Senan McGrath	To analyse and identify good practices with respect to teh development of electromobility based on actual data and the involvement of actual players and to set a comprehensive view for the sustainable and cost-effective growth of the infrastructure and related services for both public and private charging of EVs	WP1 - usage of EVS and Charging infrastructure and WP2 - Best Practice and learnings -(good and bad) from the demonstration regions.
EasyBat	FP7	DTI	Lars Overgaard	Swapping battery technology	EV infrastructure
Capire	FP7	Iberdrola	Enrique Merono	CAPIRE is a Coordination Action within the framework of the European Green Cars Initiative and is intended to support the implementation of this PPP. The project focuses on the definition of the potential Flagships projects which could foster the competitiveness of the European Automotive Industry in the domain of Transport Electrification as well as in the development of technologies and services to reduce the European CO2 footprint. Major outcomes of CAPIRE were a dedicated roadmap based on an elaborated and deep analysis of R&D needs, respective milestones and supporting measures. The goal is to increase by a joint approach of the involved economic sectors and the public authorities the competitiveness of European Automotive Industry in the domain of energy efficient, safe, non-polluting and CO2-free vehicles at the global scale.	WP2 regarding experience of the current Charging infrastructure, WP 7 regarding present and future of the charging infrastructure.
ELSA	AVEM	RENAULT	Sébastien Albertus	Use of 2nd life batteries as a storage in buildings	WP5 regarding experience of 2nd life batteries used in Endesa Grid
FABRIC	FP7	fka	Bart Benders	FABRIC addresses directly the technological feasibility, economic viability and socio environmental of dynamic on-road charging of electric vehicles. FABRIC responds to the need to assess the potential and feasibility of a more extensive integration of electric vehicles in the mobility and transportation system, focusing primarily on dynamic wireless charging which would allow practically all of the drawbacks of on-board battery packs to be avoided. On-road charging would also enable the direct link to renewable energy sources: Ultimately this is the only way to fully decarbonise road transport and hence provide true sustainability from the socio-environmental perspective.	WP5 inductive charging
DIMLAV	Danish DSOs	DEA	Jan Rasmussen	DIMLAV is a tool used by Danish DSOs for dimensioning LV networks, mainly for residentials. The goal of the project is to update the DIMLAV tool, to include impact from EVs, HPs and PVs in addition to traditional loads. The present version of the tool applies velander curves to determine the aggregate the loads, which is appropriate for the design of new networks. To determine the aggregated loads, a statistical approach is applied based on data recorded from smarts meters.	WP4 regarding the method developed to aggregate traditional loads and loads from EVs.
Cotevos	FP7	Tecnalia, RSE, DTU, TNO	Eduardo Zabala	The aim of COTEVOS is to establish the optimal structure and capacities to test the conformance, interoperability and performance of all systems making up the infrastructure for the charge of Electrical Vehicles (EV). By being in close collaboration with European EV initiatives, equipment manufacturers, service providers, utilities and industrial networks, COTEVOS seeks a collective EU approach to EV interoperability and smart charging.	Integration of EVs in electricity grids (WP4), EV charging infrastructure (WP5), Standards (WP7), interoperability demonstration (T8.2), power system impact (T9.2) and business models (T9.3)
UPGRID	Horizon 2020	Tecnalia, Iberdrola, Imperial College London	Eduardo García	The main objective of UPGRID project is the developing and testing in four real smart grid distribution networks (1. Iberdrola in Spain; 2. EDP in Portugal; 3. Vattenfall in Sweden; 4. ENERGA in Poland) innovative solutions for advanced operation and exploitation of LV/MV networks strengthening the capacity of distribution networks as an enabler for Distributed Generation (DG), Active Demand (AD), the Electric Vehicle(EV) and storage, and covering the needs and expectations of the rest of the actors in the electricity market.	EV management and grid integration (T4.2, WP5), Business Models (T9.3), Societal research (T9.1)

The question of how to continue with the Green eMotion key values after February 2015 has been in the focus right from the outset. Deliverable D10.8 [53] describes the specific key values defined from the project and outlines the activities implemented to make them available after the project end.

5 References

[1] D1.6 Final Report on Macro and Micro Level Infrastructure Planning

[2] D1.9 Final Report on EVs in Fleets

[3] D1.10 European global analysis on the electromobility performance

[4] D2.1 Visions and Strategies of the Demonstration Cities

[5] D2.2 Successes encountered in the Electromobility policy making process

[6] D2.3 Hurdles encountered in the Electromobility policy making process

[7] D2.4 Key features of successful implementation of Electromobility

[8] D3.1 ICT Business analysis

[9] D3.2 ICT reference architecture

[10] D3.4 Electric Mobility Business Requirements Enabling Services Through Central IT Platform

[11] D3.6 Core services and transactions design specification Release 2

[12] D3.8 Implementation of demo prototype for Release 2

[13] D3.10 ICT Standards & Protocols 2

[14] D4.1 Specification for Minimum Requirements for Charging Spots

[15] D4.2 Recommendations on grid-supporting opportunities of EVs

[16] D4.3 A-1 Grid Impact studies of electric vehicles - EVs´ impact on Power Quality related to harmonics

[17] D4.3 B-1 Grid Impact studies of electric vehicles - Parameters for Assessment of EVs Impact on Low Voltage Grid

[18] D4.3 B-2 Grid Impact studies of electric vehicles - Reinforcement Costs in Low Voltage Grids

[19] D4.3 B-3 Grid Impact studies of electric vehicles - Future Distribution Network Planning Tools: Functional Specifications

[20] D4.3 C-1 ITRES Tool for assessing the technical and economic impact of electric vehicles on distribution networks - User Manual

[21] D4.4 Common findings for the interaction between Electric vehicles and electrical networks

[22] D4.5 Survey of business opportunities related with EVs in grids

[23] D6.1 Methodology of EV measurements

[24] D6.2 Performance validation - Results from EV measurements

[25] D6.3 Contribution to national and international technical standardisation committees regarding electric vehicle relevant standards

[26] D7.1 Review of Technologies and Standards in the Demonstration Projects

[27] D7.2 Standardization issues and needs for standardization and interoperability

[28] D7.3 Current status of technologies and standards in the demonstration projects

[29] D 7.3 Annex: Standardization Gap Matrix_WP7

[30] D7.4 Year 1 Standardization Workshop - Gaps and recommended actions towards minimal features interoperable charging stations for EVs

[31] D7.5 Standardization Workshop for finalization of alignment in the demonstration projects

[32] D7.6 Common methodology for development conformity with standards – 2nd updated version

[33] D7.7 New Work Item Proposal on requirements for a Communication protocol between EVSE and Backend systems

[34] D7.8 Guidelines for standardization and interoperability

[35] D7.10 EV integration in Smart Grids Glossary

[36] D8.2 Tests reports regarding the usability of each prototype

[37] D8.3 Framework integration and report on system interplay

[38] D8.4 Recommendation and manual for replication

[39] D8.5 Summary report demonstration experience of European framework for electromobility

[40] D9.1 Consumers' preferences and attitudes to, demand for, and use of electric vehicles (EV)

[41] D9.2 Smart (and less smart) large-scale integration of EV into European power systems

[42] D9.3 Impact on operation and design of distribution systems from smart (and less smart) integration of EV

[43] D9.4 Part 1: Envisaged EU mobility models, role of involved entities, and Cost Benefit Analysis in the context of the European Clearing House mechanism

[44] D9.4 Part 2: Envisaged EU mobility models, role of involved entities, and Cost Benefit Analysis in the context of the European Clearing House mechanism

[45] D9.5 Environmental impacts of widespread shifting towards electricity based mobility

[46] D9.6 Barriers, gaps, and commercial and regulatory framework for broad rollout of e-mobility

[47] D9.7 Policy evolution recommendations and stakeholder actions towards effective integration of EVs in the EU

[48] D9.8 Report on mobile battery test platform and results of the measurements

[49] D10.4 Preliminary Findings of the 'Best Policy Practices'

[50] D10.5 Annual Report on activities with External Stakeholder Forum – Year 4

[51] D10.6 Guideline handbook for web based education of different professionals handling EVs

[52] D10.7 Policies and good practices to foster electromobility roll-out at the local, national and European level

[53] D10.8 How to ensure the sustainability of Green eMotion activities

[54] D11.8 Final Green eMotion project report – public part

[55] ITRES tool program file

[56] Special GeM report "Electromobility implementation plan Malaga"

[57] Special GeM report "Lessons Learned by Better Place"

[58] Special report "Data Collection and Reporting Guidelines for European electromobility projects" published by JRC

[59] Green eMotion official website - http://www.greenemotion-project.eu/

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