In March 2011, the European Commission kicked off a four-year Europe-wide initiative called Green eMotion. The aim of Green eMotion is to define and demonstrate an interoperable and user-friendly electromobility system based on existing installations and the experience thus gained. One of the goals of Green eMotion is to create an ICT system concept for the Europe-wide electromobility services marketplace (including definition of the requisite interfaces) and to demonstrate it. Almost all the 10 Green eMotion demo regions in Europe are using this business-to-business (B2B) marketplace, linking their IT systems to the marketplace via open standard interfaces. The test phase, which began in September 2012, comprises functions used for locating charging points and clarifying charging contracts with third-party providers (roaming). In addition to this key topic of ICT, Green eMotion is also working towards important developments in other areas:

1) improvements in standardization;

2) technical reports and policy recommendations;

3) extensive evaluation of static and dynamic electromobility data;

4) demonstration of a new approach to the sharing of electric vehicles in urban areas.

1.1. Background

Climate change and the reduction of greenhouse gas (GHG) emissions are one of the major challenges of our time. A growing world population is leading to higher demand for mobility and energy, aggravating the problem and pushing emission levels upwards. The transport sector faces serious environmental, economic and societal challenges, which in the short- and medium-term will necessitate the transformation of the system.

Chapter written by Gabriele Giustiniani, Luca Persia, Heike Barlag and Norbert Vierheilig.
There is a need to mitigate the negative impacts on the environment and transport that will seriously impede the goal of reducing GHG emissions by 20% before 2020, as well as the longer-term climate goals. Until now transport has been the only sector in which GHG emissions have increased since 1990.

Meanwhile, the proportion of European citizens living in urban areas is increasing steadily. It is expected that by 2050 some 84% of the population will live in cities. Urban transport accounts for 40% of CO₂ emissions and 70% of emissions of other pollutants from road transport. The congestion in urban agglomerations must be brought to tolerable levels, while a growing demand for mobility has to be satisfied in the near future.

For this reason, the decarbonization of road transport, starting from urban areas, is one of the top priorities of policymakers in Europe. Battery-powered electric vehicles are seen as one of the most promising long-term sustainable options. For a number of reasons, such as improved battery performance and changes in emission performance standards, sometime in the next ten years electric and plug-in hybrid vehicles (EV and PHEV)¹ are likely to begin to gradually replace vehicles using internal combustion engines. They offer advantages in energy efficiency and a number of environmental aspects, such as their potential contribution to reducing CO₂ and local emissions and other negative external effects of mobility (e.g. noise), but some conditions are still keeping EVs from a full rollout on the market.

In some niche markets, EVs are already performing well, and EVs are gradually being introduced to more markets thanks to a large number of national and local demonstration initiatives.

The extent to which EV and PHEV will contribute to reducing GHG emissions also depends on the energy mix used to recharge the battery. Theoretically, the driver can choose whether to run his EV using conventional electrical energy sources or strictly from renewable electrical energy sources. However, EVs also have the potential to contribute to the integration of renewable energy sources (RES) into the electricity grid as they provide storage and demand response options.

The implementation of alternative mobility concepts requires consumer acceptance, meaning that EV must provide car owners with the same kind of ease-of-use, safety and reliability at reasonable prices. A comprehensive and standardized recharging infrastructure is one of the aspects that will favor consumer acceptance of EVs.

¹ For simplicity, the abbreviation EV will be used for both electric vehicles and plug-in hybrid vehicles.
1.2. The Green eMotion project partnership and objectives

To enable the mass market for electromobility in Europe, important players from industry, the energy sector, municipalities and universities and research institutions have joined forces in the Green eMotion project (henceforth, GeM), which was kicked off in March 2011. GeM is a four-year EU funded project with 43 partners, coordinated by Siemens AG. An overview of the partnership is provided in Figure 1.1; for a more detailed description, see http://www.greenemotion-project.eu/.

The GeM partnership is convinced that transport, as a network industry, must be approached as a system integrating the ICT elements, services, interoperable equipment (vehicles and recharging infrastructure), and grid infrastructure as well as policies, incentives, and urban mobility concepts to ensure smooth and efficient interaction and, ultimately, a self-explanatory overall market system.

GeM aims to establish a unique and user-friendly framework for green electromobility in the EU. Based on existing regional demonstration projects, feasibility and scalability of an interoperable and standardized mobility system including a clearing house will be demonstrated to establish the best conditions to

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2 Clearing house: this enables roaming for electricity customers across Europe (comparable with mobile phone services).
allow businesses and consumers to drive EVs and, thus, enable their mass-market introduction.

As a result, the user-friendly, interoperable, and scalable framework demonstrated will serve as a benchmark for further regions and their interconnection in Europe. In short, GeM will provide policymakers, urban planners, and electric utilities with the necessary tools to facilitate the Europe-wide rollout of EV.

1.3. GeM achievements so far

In the first two years of the project GeM partnership work covered four different areas:

– development of a marketplace as common innovative service platform: Europe-wide roaming and other services connecting the electromobility market players;

– improvement in standardization: highlighting and addressing the most urgent “new” needs;

– technical reports and policy recommendations: lessons learned in the practical implementation of electromobility;

– extensive amount of valuable electromobility data: use patterns, environmental impact (e.g. CO₂).

1.3.1. Development of a marketplace as common innovative service platform

GeM’s first step was to create an ICT system concept for a European marketplace3 for electromobility services and to demonstrate its operability in practice. For the first time, such a Business To Business (B2B) marketplace is bringing together all the actors involved in this segment: providers of charging services, charging station operators, power utilities, and suppliers of other electromobility-related services.

Such a marketplace permits associated service offerings – for instance, roaming between different charging point operators – to be provided on a pan-European

3 An electronic marketplace (for eMobility) is the virtual place where all participants in the ecosystem can connect and operate (process) their business (transactions). The marketplace in this proposal is not to be understood as the electricity or vehicle market. The “electromobility (mass-) market” refers to the whole set of products (vehicles, electricity and infrastructure) and services associated with electric vehicles and their operation.
scale, similar to current practices with cellphones. Furthermore, since the marketplace is open to other service providers, this would allow for innovative electromobility concepts to be made available more easily (see Figure 1.2). As the central technological component, the marketplace serves the following two functions:

– to reduce the number of interfaces between participants;
– to prove easy access to all offerings through standardized software services.

**Figure 1.2. The “Big Picture” of electromobility shows the complexity of a real interoperable system**

Right now, the first demo regions are connecting up. Subsequent phases will include energy-related services for optimizing grid utilization and new, added-value services for end customers, e.g. reservation of charging points.

Drivers of electric cars can make use of such services, which provide access to a variety of electromobility offerings. The result is a global system that allows for competition and individual solutions. Furthermore, the GeM marketplace for electromobility communicates with other marketplaces, such as pre-existing regional solutions, allowing broader integration beyond the GeM partners.

Currently two added value services are available through the marketplace:

– the roaming service allows the EV drivers who are customers of one GeM partner to access the charge points of the other partners easily. This is supported by a clearing house made available as a service on the marketplace. The clearing house service is in the background, transparently validating contracts of business partners involved in roaming;
- the search for EVSE service offers the charge spot data from most of the GeM demo regions. B2B partners connected to the marketplace can utilize this data and offer EV drivers to search for the charge spots through either a website, a mobile phone application or an in-car display.

The marketplace information hub is operational since August 2012 (see also Figure 1.3) and the integration of project partners using the enabled services is in progress. Successful tests between the first GeM demo regions have taken place.

The open ICT system architecture and the standardized interfaces and business objects enable all market participants to develop and offer the services in accordance with their own business models. If other marketplace operators follow the published IT architecture, the offering of services on different systems is enabled leading to enhanced competition.

1.3.2. Improvement in standardization

GeM partnership considers standardization as the key for an interoperable electromobility system, because this will allow convenient EV driving all across Europe, create new businesses and bring future-proof investments.

For this reason GeM focused the standardization work on identifiers and interfaces for the electromobility ICT systems, to enable roaming and allow a smooth system communication, independently from manufacturers, to allow an open competition.

Figure 1.3. Commissioner Günther Hermann Oettinger (Energy) started operation of the first charging point at the European Commission on 19 June 2012
To extend its results beyond Europe, GeM, with many other market players, initiated the electromobility ICT Interoperability Innovation Group (40 participants covering Asia, Europe and the Americas) to define industry standards for interfaces and user IDs for smooth communication between all the different electromobility ICT systems (for more information see www.eMI3group.com).

As the final standardization activity GeM proposed a New Work Item for the communication protocol between EVSE (EV Supply Equipment) and backend systems, leading to more competition for charging infrastructure and IT systems by avoiding proprietary protocols.

1.3.3. Technical reports and policy recommendations

Reports and recommendations were developed with the mass market for electromobility in mind. Obstacles encountered by the project partners in the electromobility policymaking process were described, as were the factors that made electromobility projects successful. This covers financial and non-financial incentives, infrastructure, EV issues and also the political environment.

Technical reports cover areas from infrastructure planning on different voltage levels to the performance of EVs in fleets.

1.3.4. Extensive amount of valuable electromobility data

GeM is also running an extensive data collection program in 10 demo regions, monitoring 600 electric vehicles and 1,800 charging points; 85% of the electric vehicles and 70% of charging points provide dynamic data sets today. These dynamic data are used by GeM teams to generate further results in the near future. Other external European mobility projects are being included in the data collection, and their data will be compared with GeM results.

Some results from the tests on site include:

– the mean distance run between EV charges is 37 km, but 75% of the users run a distance of up to 51 km;

– the maximum distance run between two charges has been 145 km;

– the mean battery level when starting a charging process is 65%, which means that most of the EV drivers charge their vehicle before the battery is drained;

– up to now, GeM EV drivers have run more than 65,000 km, saving more than 60 tons of CO$_2$. 
1.3.5. Developments in other areas

In addition to building selected charging systems, infrastructure partners in GeM have issued preliminary findings on the effects of different charging strategies on the grid both in power quality and required reinforcement costs.

A deterministic network investment tool has been developed and successfully tested. It analyses the effects of different load charging profiles on real grids and calculates the total investment cost required in the network for hosting a specific percentage of EVs. The tool does not optimize the EV charging directly but is able to consider the value of control strategies by comparing the investment for different load profile shapes. For the first time, such a tool can be applied by the network operator itself. Furthermore, this tool will be publicly available.

GeM has also emphasized the design and development of EV-related hardware infrastructure.

This culminates in the completion of three important ongoing tasks:

– fast charging station, a novel charging station with second life buffer battery for integration of fast charging capability in weak grids;

– design and development of an inductive charger to provide wireless charging to a converted Nissan Leaf. This new design will allow easy conversion of EVs with CHAdeMO\(^4\) interface;

– a 50 kW AC/DC/AC converter unit for grid re-enforcement application to support the grid in case of overloads due to a high number of charging EVs\(^5\).

GeM is working on business models for electromobility. Key business model environments have been established, with all relevant interactions among actors defined. The goal is to evaluate the profitability of the different business models under various market considerations.

Concluding, GeM has done a broad set of measurements on various types of EVs. The goal is to evaluate the usability of EVs in everyday life. A new test setup for standard usage pattern (driving cycle) suitable for EVs was developed to show which range can be achieved realistically. Also, the influence of driving behavior on the driving range of EVs is under evaluation.

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\(^4\) CHAdeMO is a standard for DC fast charging defined in Japan.

\(^5\) This project is running under the responsibility of one GeM partner. It is a grid buffering system realized with second life EV batteries to stabilize the grid and able to charge EVs.
1.4. Next steps

In the first two years of activities, GeM has already achieved important results and expects more of the same over the next two years, especially in:

– assessment of impact on EVs’ diffusion of support/regulatory measures at local level;
– assessment of potential market penetration of EVs;
– demonstration of new forms of EV sharing and assessment of their transport and environmental impacts.

1.4.1. Assessment of impact on EVs’ diffusion of support/regulatory measures at local level

The first activity is related to the understanding and assessment of the impacts on EVs’ diffusion of support/regulatory measures that may be implemented at local level. In this regard, it is also important to understand and assess whether and how the impact of such measures varies according to local conditions such as population or gasoline prices. The assessment will be carried out by analyzing the support/regulatory measures already implemented on a sample of cities involved in GeM and the impacts they have had or are having on the diffusion of EVs. The methodology for the assessment has already been defined. Three main steps are foreseen for the assessment:

– survey of cities involved in GeM;
– analysis of data collected;
– review of the results and draft of a report.

The survey will be carried out by means of a questionnaire to the city representatives. The data collected will be of three types.

The first set of data is related to the city being investigated (population trends, area of the city and gasoline cost evolution).

The second set is related to the possible measures implemented to support the diffusion of EVs. The data will be related to how and when the measures have been implemented. Some of the measures considered in the survey are limited traffic zones in inner cities open/free for EVs, exceptions to road pricing for EVs in urban areas, the possibility for EVs to use bus lanes and reduction of local/national vehicle tax for EVs. In total, 11 possible measures will be investigated in the survey.
The third set of data is related to the evolution of EVs and internal combustion engine vehicles in recent years.

Once all the data are available, analysis will begin. Different analysis methods (e.g. time series analysis) will be used, and cities will be clustered according to selected data (e.g. population or area of the city). The results of the analysis were expected in summer 2014.

These results will be very important because the measures proposed can support the diffusion of electromobility at little or no cost to the local administrations. For this reason, these results will be used to support cities in selecting suitable support/regulatory measures to foster the diffusion of EVs according to local conditions and will be synthesized in a report available to the public.

### 1.4.2. Assessment of potential market penetration of EVs

To support full deployment of EVs in Europe, it is important to understand their potential market penetration, especially as regards recharging locations. To assess the driving factors, a study is underway in GeM Demo regions using a Stated Choice survey. The survey asks householders to indicate their most likely car purchase given multiple options, including lease of car or just batteries.

An efficient design is built and customized on the most likely next car purchase of each household. In particular, respondents are presented with different car classes and are asked to assume that they are in the purchase situation (previously defined in the survey) assuming that at the car dealership there are both the conventional vehicle and a comparable EV available with the characteristics shown for a given car class. Other than that, the respondent must assume that the two cars are identical.

The data collection is already complete in Denmark, and those results will soon be available. The survey is still in progress in the other GeM Demo regions.

### 1.4.3. Demonstration of new forms of EV sharing

Another interesting activity to be carried out within GeM is a small demo of micromobility in Rome. Micromobility is a new concept of EV sharing in cooperation with public transport. It aims to solve the last-mile problem for individual transport by integrating conventional collective PT with EV sharing. This represents a real opportunity for PT to compete with private transport. Micromobility stations spread over the area allow users to rent an EV (e-bike, e-moped or e-car) in A to reach B and leave the EV in the B station. This concept,
which integrates sharing of EVs with public transport, can completely alter the approach to urban mobility, and users can use conventional collective PT for covering the long part of the trip and cover only the last “mile” by e-vehicle. Moreover, although the business model of the micromobility has not yet been defined, micromobility e-vehicles will not pay parking fees and will be able to enter limited traffic zones.

An example of the potential coverage of such a service, integrated with the underground lines of Rome, is shown in Figure 1.4. Of course, it needs to be tested. Accordingly, Rome will implement a small demo with three stations and a total of 24 EVs (eight vehicles per station) of different types (e-bicycles, e-mopeds, quads and city cars). The demo aims to shed light on such aspects as:

– costs and financial sustainability of the service;
– user acceptance;
– technical and administrative problems that can hinder the diffusion of such a system.

Figure 1.4. Distance covered from underground station in Rome (above: distance covered by foot in 15 min; below: distance covered in 15 min with EVs, Vcom= kph)
In parallel with the demo, which will provide important technical and financial information, a study will be carried out in Rome to:

– select the best area of Rome to deploy such a system and scale the system itself;

– estimate the number of private vehicle users that would shift to a combined use of PT and micromobility (considering also different scenarios of implementation);

– assess the potential reduction of pollutant emissions.

The results of this study are expected for autumn 2014 and will be used to evaluate a full deployment of micromobility in Rome.

1.5. Conclusions

In the first two years of work, GeM has already achieved important results. Its first step was to set up an ICT system concept for a European marketplace for electromobility services and to demonstrate its operability in practice. The marketplace is now open, and two added value services are available through the marketplace:

– the roaming service allows the EV drivers who are customers of one GeM partner to access the charge points of the other partners easily;

– the search for EVSE service offers the charge spot data from most of the GeM demo regions. B2B partners connected to the marketplace can utilize these data and allow EV drivers to search for charge spots through a website, a mobile phone application or an in-car display.

It is important to stress that the marketplace being developed is open. If more operators follow the published IT architecture, services can be offered on different systems, leading to greater competition.

To set up the marketplace and support the rollout of electromobility, GeM has carried out activities in:

– standardization of different protocols, procedures and tools;

– definition of recommendations to support policy makers and technicians in a successful rollout of electromobility;

– extensive data collection program in 10 demo regions;

– preliminary analysis on the effects of different charging strategies on the grid in power quality;
– design and development of EV-related hardware infrastructure;
– set-up of key business model environments with all relevant interactions between actors defined in order to evaluate the profitability of the different business models under various market considerations.

In the next two years, other important activities will be carried out:
– assessment of impact on EVs’ diffusion of support/regulatory measures at local level;
– assessment of potential market penetration of EVs;
– demonstration of new forms of EV sharing and assessment of their transport and environmental impacts.

All these activities and the related results will allow the project to provide the EU, and elsewhere, with a wide and comprehensive set of tools, studies and measures to support the diffusion of electromobility, making Europe a leading area on the subject.

1.6. Bibliography


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