PROJECT

MERGE

Mobile Energy Resources in Grids of Electricity

Funding: European (7th RTD Framework Programme)
Duration: Jan 2010 - Dec 2011
Status: Complete with results
Total project cost: €4,432,644
EU contribution: €2,961,372

Call for proposal: FP7-ENERGY-2009-1
CORDIS RCN: 94380

Background & policy context:

Electric power systems are facing a major new challenge (and hence opportunity): the future massive integration into the electric grid of hybrid/pure electric plug-in vehicles (EV). The stimulus of this change is that electricity is likely to become the preferred energy vector for a new generation of road vehicles. Hydrogen is, of course, another option as an energy carrier for transport that will be considered in this project, often having a similar mode of operation, an electric motor fed in this case by fuel cells. The hydrogen powered vehicles will be considered only as power suppliers, as they don't have the need to recharge from the electricity grid.

Although conventional fossil fuels can be used to generate electricity to feed EV, this project will focus on the quantification of the allowable amount of renewable energies that can be integrated into the electric power system, as this is a more desirable option, which would greatly reduce CO2 emissions.

The plug-in EV technologies which are likely to be developed over the next 20 years for the global vehicle market are: plug-in hybrid electric vehicles (PHEV) and pure electric vehicles (EV). Pure EV are driven only by electric power stored in batteries while current plug-in hybrid electric vehicles also use mechanical power obtained from internal combustion engines. While these hybrids vehicles are expected to be massively sold in the markets in a near future, pure electric vehicles should take a little longer to attain considerable market shares. Nonetheless, the economic incentives provided by policy makers, the oil and gas prices evolution and the growing pressure to reduce CO2 emissions are important variables which might influence the deployment of both technologies along the next few years. For the sake of clear and compact explanation, from now on, one abbreviates in the proposal text "Electric plug-in and plug-in hybrid vehicle" by "EV" only.

Objectives:

Electric power systems are facing a major new challenge (and hence opportunity): future massive integration in the electric grid of electric plug-in vehicles (EV). Distribution and transmission grids and power system architectures still follow planning rules and procedures defined for the traditional operational paradigm.

Therefore, it is necessary to identify and prepare solutions for the operational problems that will be caused on the electric grid, to the generation sub-system and to its commercial operation as a result of progressively increasing deployment of EV.

The conceptual approach in this project involves the development of a methodology consisting of two synergetic pathways:

- Development of a management and control concept that will facilitate the actual transition the MERGE concept
- Development of an evaluation suite that consists of methods and programs of modelling, analysis, and optimization of electric networks into which electric vehicles and their charging infrastructure is integrated
The project mission is the evaluation of the impacts that Electric Vehicles (EV) will have on the EU electric power systems regarding planning, operation and market functioning.

The focus will be placed on EV and SmartGrid/MicroGrid simultaneous deployment, together with renewable energy increase, leading to CO2 emission reduction through the identification of enabling technologies and advanced control approaches.

The main scientific and technical (S and T) objectives of this project are:

1. To develop a management and control concept the MERGE concept and to identify potential smart control approaches (both centralized and decentralized) to be adopted by system operators, based on the SmartGrid and MicroGrid concepts, to allow the deployment of EV without major changes in the existing network and power system infrastructures;
2. To provide insights into the dynamic behaviour of power systems having a large penetration of EV together with intermittent RES, concerning balancing and black start procedures and all other aspects related to grid dynamic operation and control;
3. To address the impacts on generation and grid infrastructures planning, evaluating at the same time the required/deferred investments due to the simultaneous presence of intermittent RES and EV in the grid;
4. To identify the most appropriate ways to include EV into electricity markets, including an evaluation of how smart metering should take the present.

**Methodology:**

System operators will bring their expertise in terms of solid practices regarding operation and planning of electricity grids. Regulators will bring their experience regarding the implementation of solutions capable assuring that EV users will be treated in a fair and non-discriminatory way when using the electrical system infrastructure and will help discussing solutions for new tariffs and market solutions. Automotive industry connected partners will provide specific knowledge on the transportation sector and their specific requests.

Finally universities/research institutions will bring their advanced research capabilities in terms of designing new models and updating existing simulation tools to address the impacts of the integration of EV in the electrical network of the future. This results in a well-balanced mixture of industrial expertise and advanced research capabilities, which includes 5 leading research institutes/universities (INESC Porto, ICCS/NTUA, TU Berlin, Cardiff and Comillas), 5 automotive connected partners (AVERE, Ricardo, IMR World, C4D and InSpire) and 6 System Operators/Regulatory Entities (PPC, REE, REN, Iberdrola, ESB and RAE).

**Parent Programmes:**

FP7-ENERGY - Specific Programme "Cooperation": Energy

**Institute name:** Directorate-General for Research and Innovation Research Programmes: Directorate K - Energy

**Funding type:** Public (EU)

**Other programmes:** FP7-ENERGY - ENERGY.2009.7.3.3

**Lead Organisation:**

**Public Power Corporation**

**Address:**
30, Chalkokondili Street 32
10432 ATHENS
Greece

**Organisation Website:**
[http://www.dei.gr](http://www.dei.gr)

**EU Contribution:** €307,457

**Partner Organisations:**

Imrworld Ltd

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United Kingdom | Organisation Website:  
http://www.imrworld.org | EU Contribution: €40,500 |
| Esb Networks Ltd | LOWER MOUNT STREET CLANWILLIAM  
2  
DUBLIN  
Ireland | Organisation Website:  
http://www.esb.ie/esbnetworks | EU Contribution: €55,912 |
| Rheinsche Bahngessellschaft Aktiengesellschaft | LIERENFELDER STRASSE 42  
40231 DUSSELDORF  
Germany | Organisation Website:  
http://www.ricardo.com | EU Contribution: €160,211 |
| Iberdrola Distribucion Electrica, S.a. | Avenida San Adrian 48  
48003 Bilbao  
Spain | Organisation Website:  
http://www.inescporto.pt | EU Contribution: €145,855 |
| Inegi - Instituto De Ciencia E Inovacao Em Engenharia Mecanica E Engenharia Industrial | Rua Dr Roberto Frias 400  
4200 465 Porto  
Portugal | Organisation Website:  
http://www.inescporto.pt | EU Contribution: €475,432 |
| Universidad Pontificia Comillas | CALLE ALBERTO AGUILERA 23  
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Belgium

**Organisation Website:**
http://www.averse.org

**EU Contribution:** €51,600

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**Institute Of Communication And Computer Systems**

**Address:**
Patiission
10682 Athens
Greece

**Organisation Website:**
http://www.iccs.gr

**EU Contribution:** €295,400

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**Regulatory Authority For Energy (Rythmistiki Arhi Energias)**

**Address:**
PIRAEUS STREET 132
11854 ATHENS
Greece

**Organisation Website:**
http://www.rae.gr

**EU Contribution:** €62,500

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**Cardiff University**

**Address:**
Newport Road 30-36
Cardiff
CF24 0DE
United Kingdom

**Organisation Website:**
http://www.cardiff.ac.uk

**EU Contribution:** €285,886

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**Technologies:**

- EV support technologies
- Electric vehicle control software architecture

**Development phase:** Research/Invention

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**Key Results:**

The project mission was the evaluation of the impacts that EV would have on the European Union electric power systems regarding planning, operation and market functioning. The main scientific and technical (S and T) objectives of the MERGE project were:

- to develop the MERGE management and control concept and identify potential smart control approaches to be adopted by system operators based on the SmartGrid and MicroGrid concepts, so as to allow for the deployment of EV without major changes in the existing network and power system infrastructures
- to provide insights into the dynamic behaviour of power systems having a large penetration of EV together with intermittent RES
- to address the impacts on generation and grid infrastructures planning, evaluating at the same time the required or deferred investments
• to identify the most appropriate ways to include EV into electricity markets
• to propose a regulatory framework capable of treating EV users in a fair and non-discriminatory way and of defining a way to deal with the additional investments in control and management structures that network utilities would have to make in order to reliably accommodate a large number of EV
• to provide quantitative results on the impact of integrating EV into the grid of EU national power system.
• to provide an evaluation computational suite able to identify and quantify the benefits that a progressive deployment of the MERGE concept would bring to the European Union national power systems.

Among the project results was the development of specifications for an enabling smart technology which included:

• an interface that enabled a user-friendly coupling of EV and grid to enable large scale deployment of EV and allow simultaneously an increased integration of renewable power sources into the electric power system
• the specification of a smart metering technology with efficient technical support and business relationships between EV, utility and power provider
• the adaptation of the concepts of Microgrids and virtual power plants for effective integration of EV
• the specification of traffic patterns of European Union countries and their influence on EV integration.

In terms of developing evaluation capability, the project resulted in:

• battery capacities, charging rates, commercial data on available and prototype EV for data modelling. Information on battery chemistry, battery capacity, drivetrain power

**Strategy targets**

Innovating for the future: technology and behaviour

• Promoting more sustainable development

Documents:
- [ Deliverable 1.1 Specifications for EV-Grid interfacing communication and smart metering technologies (Other project deliverable) ]
- [ Final Report Summary - MERGE (Mobile Energy Resources in Grids of Electricity) ]

**Transport STRIA Roadmaps:** electrification

**Transport mode:** Road transport

**Transport sectors:** Passenger transport, Freight transport

**Transport policies:** Environmental/Emissions aspects, Decarbonisation

**Geo-spatial type:** Other