MERGE: ‘Mobile Energy Resources in Grids of Electricity’

An assessment of traffic patterns and consumer behaviour and the impact of plug-in electric vehicle charging requirements on European electricity networks

Ed Bower
Ricardo UK

8th June 2011
CIRED
Frankfurt
Agenda

- **Introduction**
  - Questionnaire
  - Load profile change model
  - Summary of key findings
Introduction

- This brief presentation summarises some of the key findings of a report published by the EC FP7 MERGE project consortium
  - Report available on MERGE website:
    - [www.ev-merge.eu](http://www.ev-merge.eu)

- The report examines the traffic patterns and human behaviours of drivers from across Europe
  - To provide a benchmark of current vehicle usage patterns
  - To assess the impact of future plug-in electric vehicle charging requirements on European electricity networks

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16 partners from 8 countries form the consortium. The studies primarily focus on the partners’ home countries.

### Project Partners

<table>
<thead>
<tr>
<th>Participant organisation name</th>
<th>Short name</th>
<th>Country</th>
<th>Organisation</th>
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<tbody>
<tr>
<td>1 Power Public Corporation</td>
<td>PPC</td>
<td>Greece</td>
<td>Utility</td>
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<td>2 INESC Porto</td>
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<td>3 Cardiff University</td>
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<td>UK</td>
<td>University</td>
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<td>4 Technische Universität Berlin</td>
<td>TU Berlin</td>
<td>Germany</td>
<td>University</td>
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<tr>
<td>5 Institute Computers Communications Systems of National Technical University Athens</td>
<td>ICCS/NTUA</td>
<td>Greece</td>
<td>University</td>
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<td>6 Universidad Pontificia Comillas - Madrid</td>
<td>Comillas</td>
<td>Spain</td>
<td>University</td>
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<td>7 Rede Eléctrica Nacional</td>
<td>REN</td>
<td>Portugal</td>
<td>TSO</td>
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<td>8 Red Eléctrica de España (REE)</td>
<td>REE</td>
<td>Spain</td>
<td>TSO</td>
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<td>9 Iberdrola</td>
<td>Iberdrola</td>
<td>Spain</td>
<td>Utility</td>
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<tr>
<td>10 European Association for Battery Hybrid and Fuel Cell Electric Road Vehicles</td>
<td>AVERE</td>
<td>Belgium</td>
<td>Non-profit association</td>
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<td>11 Ricardo</td>
<td>Ricardo</td>
<td>UK</td>
<td>Vehicle consultant</td>
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<td>12 Interactive Media in Retail</td>
<td>IMR World</td>
<td>UK</td>
<td>SME Consultant</td>
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<tr>
<td>13 Regulatory Authority for Energy</td>
<td>RAE</td>
<td>Greece</td>
<td>Regulatory Entity</td>
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<td>14 Consulting4Drive</td>
<td>C4D</td>
<td>Germany</td>
<td>Vehicle consultant</td>
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<td>15 Electricity Supply Board</td>
<td>ESB</td>
<td>Ireland</td>
<td>Utility</td>
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<td>16 InSpire Invest</td>
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<td>Norway</td>
<td>SME Consultant</td>
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- EON, MIT and Renault are also involved as part of the project advisory committees.

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- Load profile change model
- Summary of key findings
A survey was developed in eight languages and provided 1,621 responses, primarily from six countries.

- 1,621 responses were received from a cross-section of the European population.
- Six countries were focussed on in particular: Germany, Great Britain, Spain, Greece, Portugal and Ireland.
- The questionnaire responses provided:
  - Direct statistics (e.g. proportion of responders that would participate in multiple-tariff electricity rates)
  - Datasets that were inputs to the load profile change model (e.g. profiles of times people return from last journey of the day)
  - Datasets that can be used in subsequent tasks (e.g. profiles of times people depart for first journey of the day)

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There was a spread of ages, sexes, occupations and locations such that no single group dominated the responses

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Although the regularity with which users will charge EVs is not certain, there is consensus that home recharging is preferred.

When do you (would you) refuel/recharge?

- The majority of conventional vehicle owners refuel only when the fuel tank is nearly empty.
- There was no consensus on when people would recharge an electric vehicle if they owned one.

Where do you (would you) refuel/recharge?

- A strong consensus emerged that an EV owner’s home is the preferred location for recharging:
  - 70% at home
  - 20% at work
  - 10% elsewhere

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Most responders would take advantage of multi-tariff electricity rates both at night and during the day.

Key findings relating to tariffs:

- Over 90% of future EV owners would recharge vehicles **at night** to take advantage of multiple-tariff electricity rates.

- Over 80% of future EV owners would recharge vehicles at certain times of day if it was cheaper (other than overnight) if more complex multiple-tariff electricity rates were to incentivise it.

- Over 75% of future EV owners would still try to reduce their charging costs **even though electricity is cheap (currently)** compared to conventional fuels.

- Over 60% of future EV owners would still try to reduce their charging costs **even if charging costs are paid by their employers**.

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A high level overview used sensible assumptions to assess the impact of 10% integration of EV on the grids of six countries.

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<thead>
<tr>
<th>DESCRIPTION</th>
<th>VALUE</th>
<th>SOURCE</th>
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<tbody>
<tr>
<td>Proportion of EV in vehicle fleet</td>
<td>10%</td>
<td>Assumption based on possible medium-term EV penetration</td>
</tr>
<tr>
<td>Regularity of recharging</td>
<td>1 charge per day</td>
<td>Assumption based on a possible scenario driven by range anxiety and ease of access to charging at home</td>
</tr>
<tr>
<td>Charger power</td>
<td>3 kW</td>
<td>Standard domestic electricity supply, 230 V, 13 A, single phase</td>
</tr>
<tr>
<td>Vehicle energy requirement</td>
<td>0.16 kWh/km</td>
<td>Ricardo analysis based on V-SIM (vehicle simulation software) analysis</td>
</tr>
<tr>
<td>Average distance travelled between charges</td>
<td>40km</td>
<td>Ricardo analysis based on UK Department for Transport statistics and backed up by questionnaire results</td>
</tr>
<tr>
<td>Charger efficiency</td>
<td>90%</td>
<td>Ricardo analysis based on existing charger technology</td>
</tr>
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Ed Bower – UK – RT 5c/4a – MERGE: ‘Mobile Energy Resources in Grids of Electricity’
Ricardo developed a load profile change model to determine the power required at each time step to charge electric vehicles.
Dumb charging shows similar trends in each of the six European countries studied – a 10% penetration of EV corresponds to a ~10% increase in peak electricity demand...
... whereas Smart charging can prevent an increase in peak total load, whilst also reducing the peak-to-trough variation.
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The MERGE project aims to evaluate the impacts that electric vehicles will have on EU electric power systems

- Current vehicle usage and consumer perceptions of EV recharging options in Europe have been examined
  - A strong consensus emerged from the questionnaire that an EV owner’s home is the preferred location for recharging
  - It also revealed that despite the relatively low cost of re-charging, users were still highly motivated to make use of any low cost tariffs that may be available during off-peak demand
- Basic models of the energy requirements of EVs have shown the effect of dumb and smart charging scenarios in six European countries
  - Whilst there are some national variations, a 10% penetration of plug-in vehicles corresponds to a 10% increase in peak electricity demand using a “dumb” re-charging scenario (where users plug-in their vehicles returning home in the early evening)
  - Smart charging can prevent an increase in peak total load, whilst also reducing the peak-to-trough variation
- The full results of these studies is being used to provide robust data and models for later and more in-depth analysis by the MERGE project partners
Where should I go for more information?

- The MERGE project is past its half-way point with many reports online already and many more to come later in the year…
  - www.ev-merge.eu