



Frankfurt (Germany), 6-9 June 2011

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

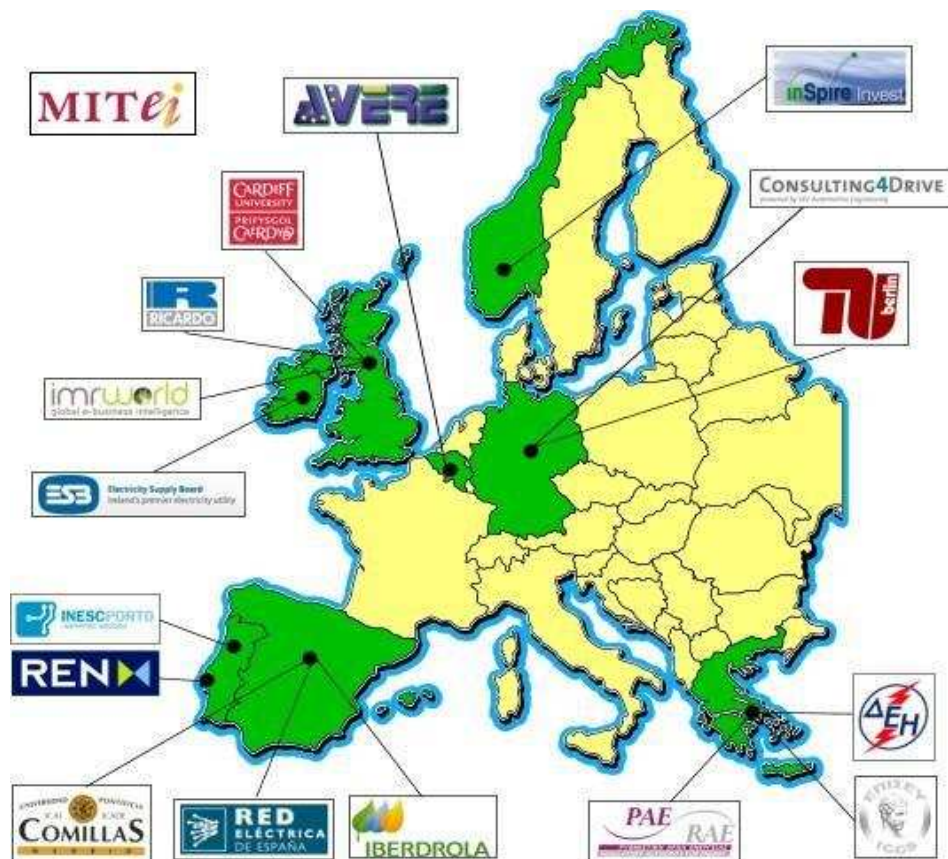
- This brief presentation summarises some of the key findings of a report published by the EC FP7 MERGE project consortium
 - Report available on MERGE website:
 - www.ev-merge.eu
- The report examines the traffic patterns and human behaviours of drivers from across Europe
 - To provide a benchmark of current vehicle usage patterns
 - To assess the impact of future plug-in electric vehicle charging requirements on European electricity networks



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



Project Partners



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

- EON, MIT and Renault are also involved as part of the project advisory committees

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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)

Questionnaire in 8 languages



Deutsch



ελληνικά



English



Español



Português



Norsk



Français



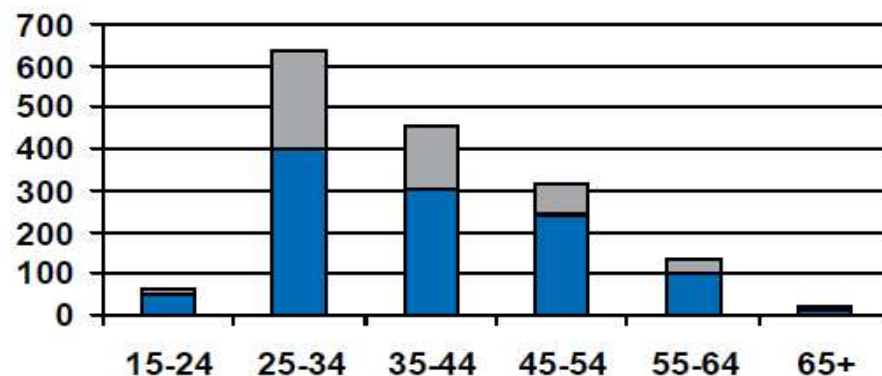
Nederlands



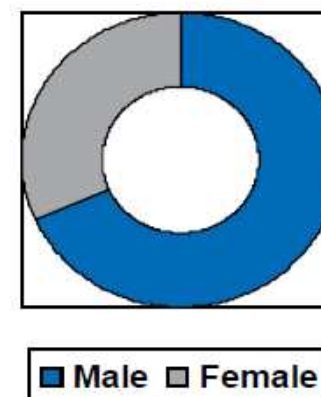
There was a spread of ages, sexes, occupations and locations such that no single group dominated the responses



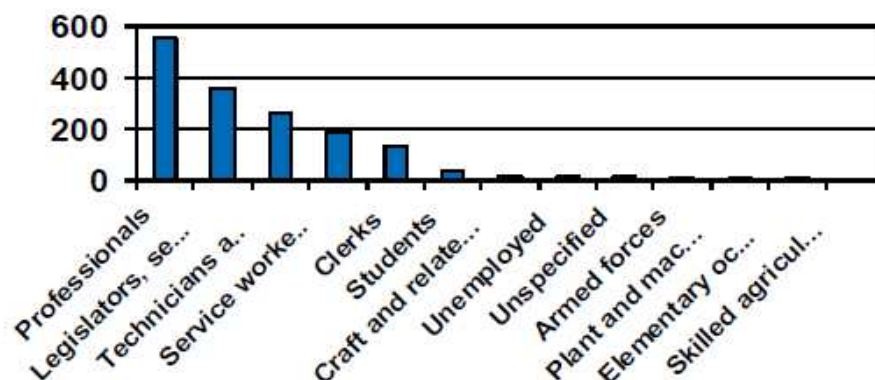
Age group



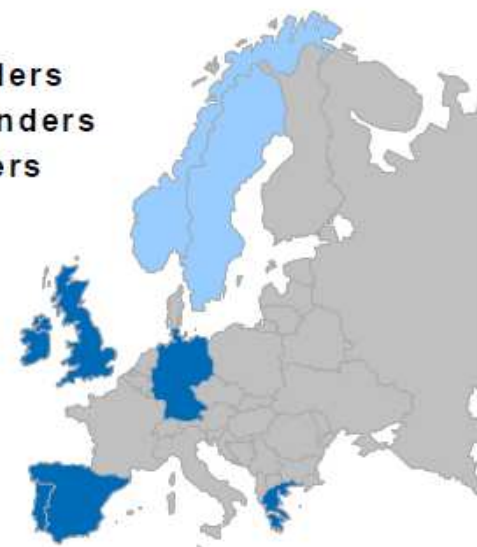
Male-Female Ratio



Occupation



- >100 responders
- 20-100 responders
- <20 responders



Sample size: 1621

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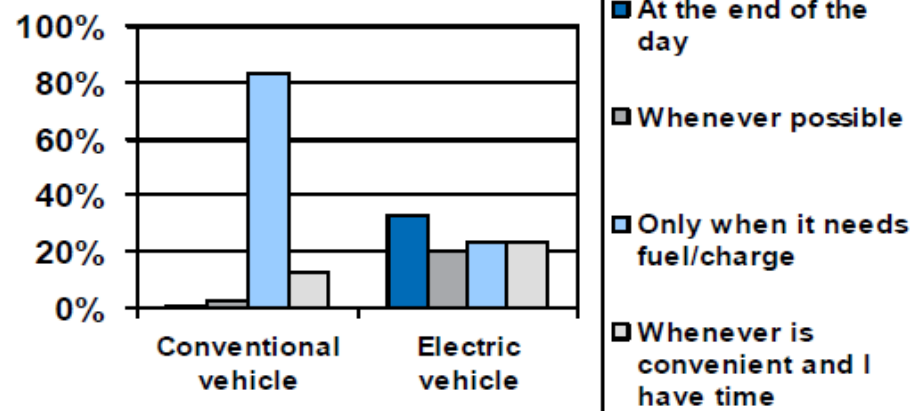
Although the regularity with which users will charge EVs is not certain, there is consensus that home recharging is preferred



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

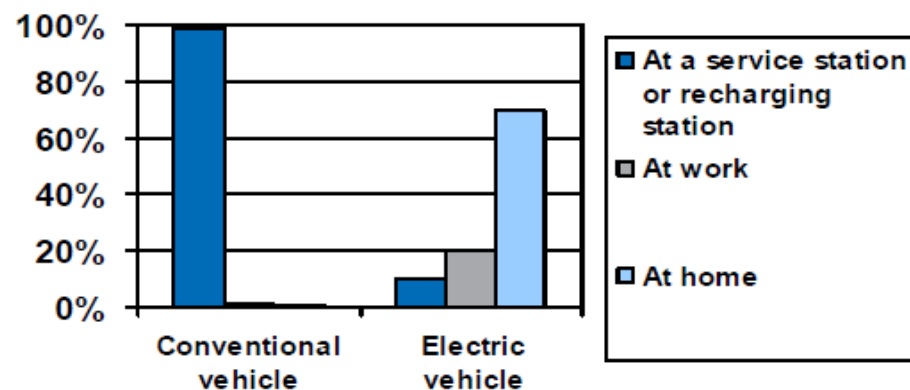
When do you (would you) refuel/recharge?



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

Where do you (would you) refuel/recharge?



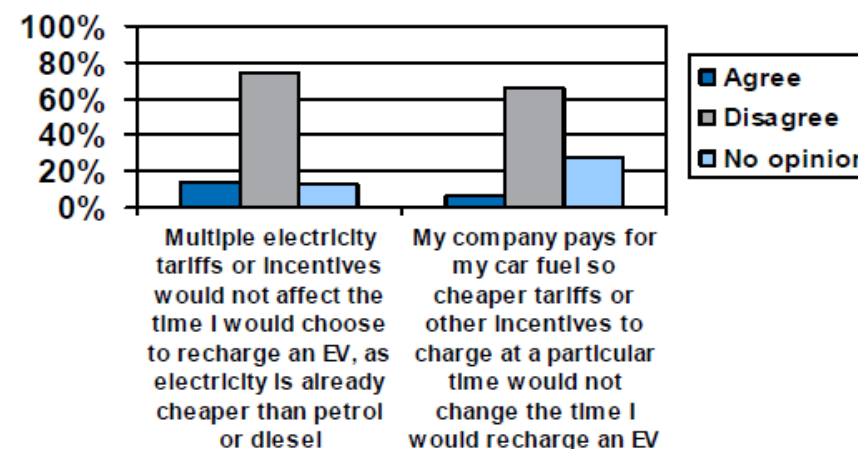
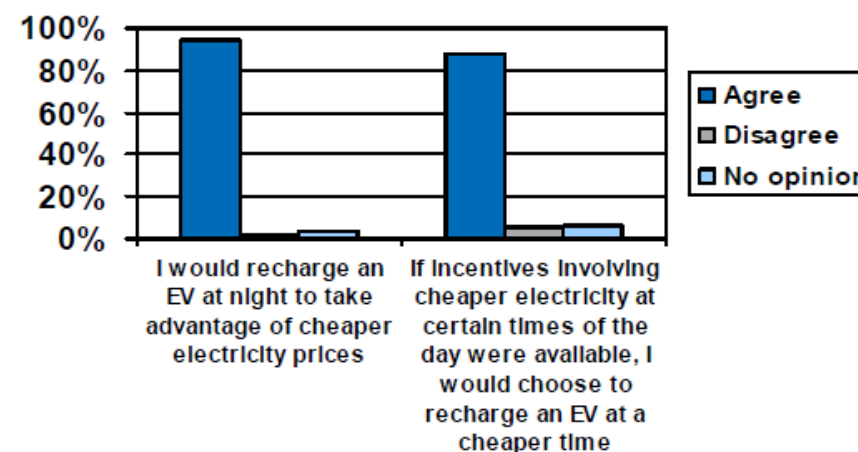
Sample size: 1272 conventional vehicle, 1270 electric vehicle

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



Sample size: Q1 1258, Q2 1239, Q3 1216, Q4 1201

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- ❑ **Load profile change model**
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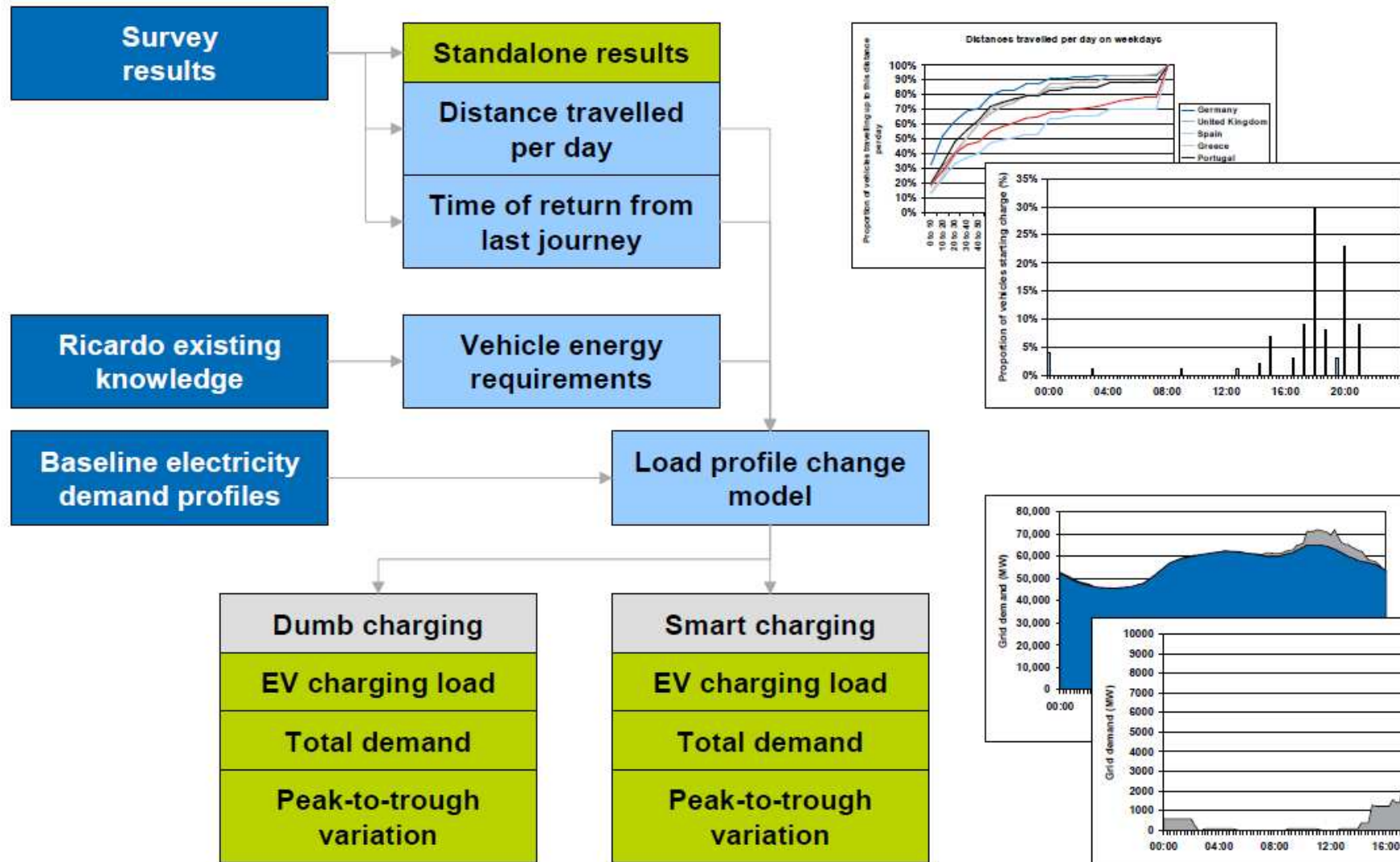


A high level overview used sensible assumptions to assess the impact of 10% integration of EV on the grids of six countries



DESCRIPTION	VALUE	SOURCE
Proportion of EV in vehicle fleet	10%	Assumption based on possible medium-term EV penetration
Regularity of recharging	1 charge per day	Assumption based on a possible scenario driven by range anxiety and ease of access to charging at home
Charger power	3 kW	Standard domestic electricity supply, 230 V, 13 A, single phase
Vehicle energy requirement	0.16 kWh/km	Ricardo analysis based on V-SIM (vehicle simulation software) analysis
Average distance travelled between charges	40km	Ricardo analysis based on UK Department for Transport statistics and backed up by questionnaire results
Charger efficiency	90%	Ricardo analysis based on existing charger technology

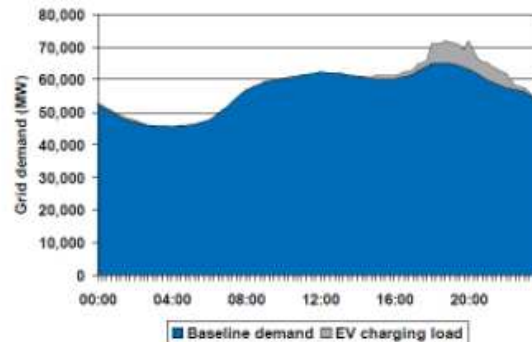
Ricardo developed a load profile change model to determine the power required at each time step to charge electric vehicles



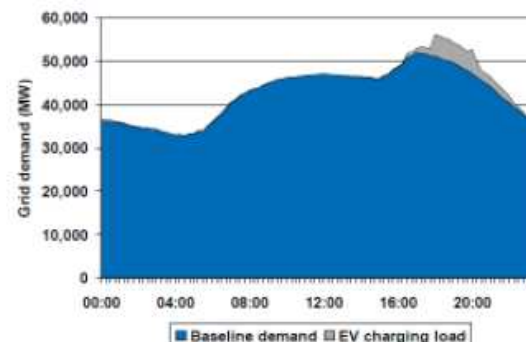
Dumb charging shows similar trends in each of the six European countries studied – a 10% penetration of EV corresponds to a ~10% increase in peak electricity demand...



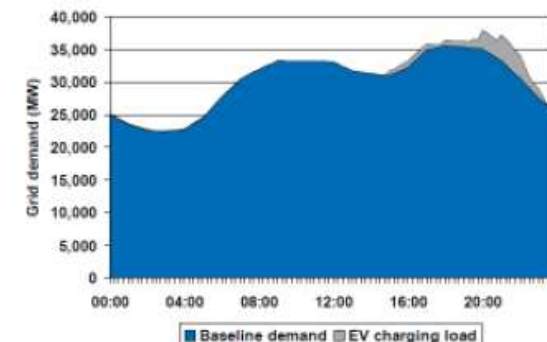
Germany



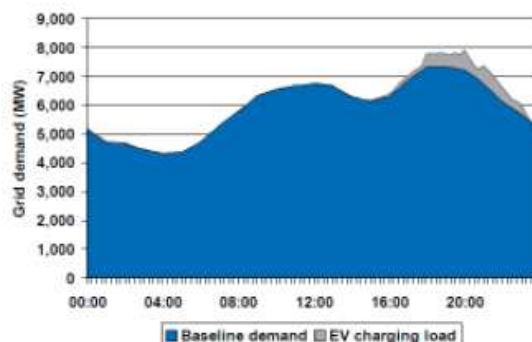
Great Britain



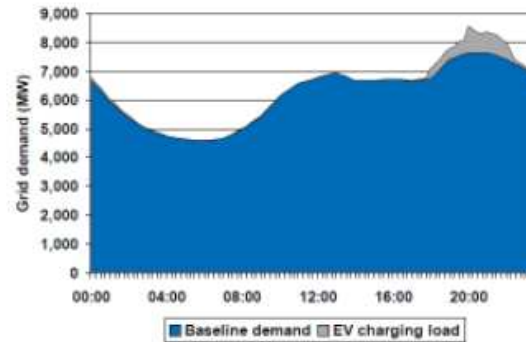
Spain



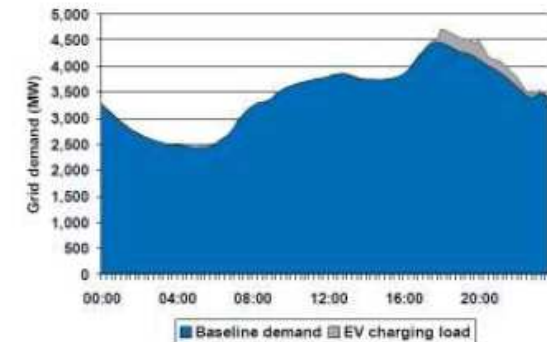
Greece



Portugal



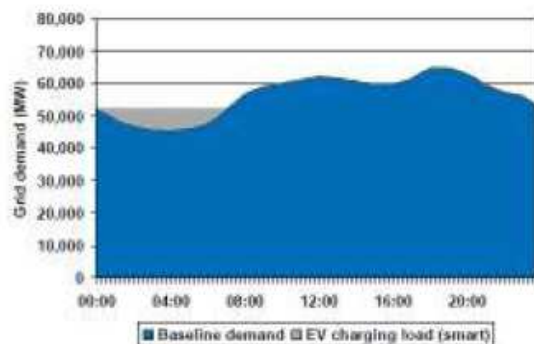
Ireland



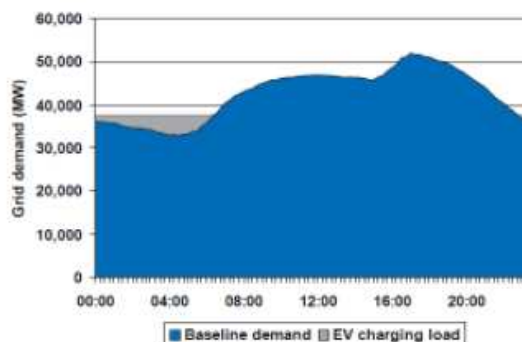
... whereas Smart charging can prevent an increase in peak total load, whilst also reducing the peak-to-trough variation



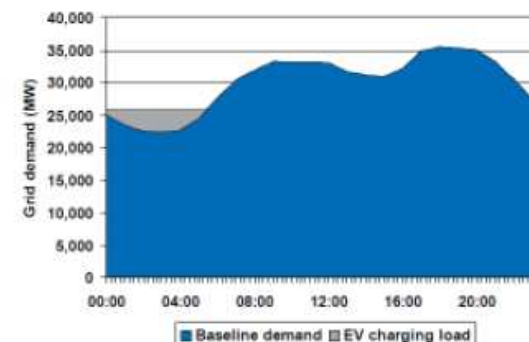
Germany



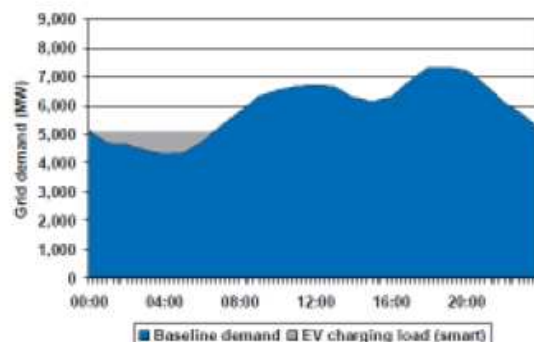
Great Britain



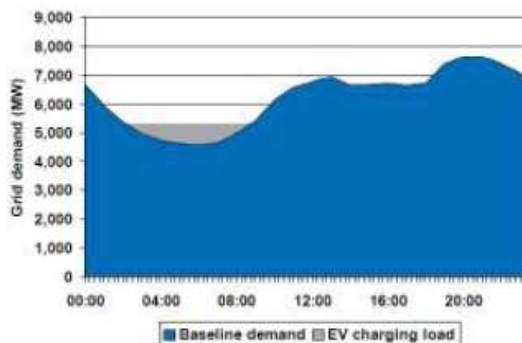
Spain



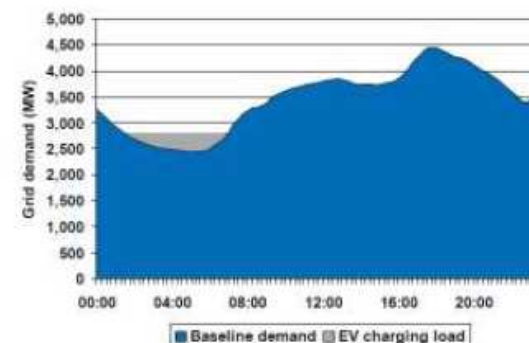
Greece



Portugal



Ireland



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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

