

## Assessing the impact of ICT services for electromobility

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### Abstract

In a scenario in which there is an increasing range of sustainable mobility options based on ICT services, it is essential to have adequate methods for the proper evaluation of the potential impact of the implementation and deployment of such services, especially from the environmental point of view. Under the project Mobi.Europe, and in collaboration with the other electromobility demonstration projects supported by the European Commission under the CIP ICT PSP call, a set of indicators have been defined to assess this impact, quantitatively and qualitatively. Eventually, these indicators are applicable to any service of electromobility based on ICT technologies, which could be used to compare the expected impact of each service. This paper describes these indicators in detail, and its application to the pilot test in Vigo within Mobi.Europe.

### Keywords:

electromobility, car sharing, ICT services.

### Introduction

Within the Competitiveness and Innovation Framework Programme (CIP), four “Smart Connected Electromobility” pilot projects - ICT4EVEU, Mobi.Europe, MOLECULES and smartCEM - were funded to enhance the uptake of information and communication technologies (ICT) in the electromobility context. These projects, focused on specific aspects of the integration of electromobility into given transportation systems and environments, are part of the FOT-Net as demonstration projects. The city of Vigo, in Spain, is one of the test sites within the Mobi.Europe project.

The common approach to assess the impact of the ICT services tested in the pilot sites and, specifically, in the test site of Vigo, takes into account both qualitative and quantitative indicators. To reach that goal, an Evaluation Working Group (EWG) was established for harmonising and coordinating activities between these CIP projects, given that the results of the projects should be comparable applying FOT-Net methodologies and expertise, such as the FESTA methodology. Thus, for the assessment of the technical systems and services performances FESTA methodology was used where appropriate.

It is worthy to note, within the EWG, that special attention has been paid to the development of a qualitative common user questionnaire to evaluate the uptake of electromobility in general and implemented services and applications in the pilot-sites in particular. In an iterative manner, the categories for assessment were agreed upon. These categories are:

- Demographics
- Attitudes and technology use
- Travel and mobility
- Willingness-to-pay
- Range-anxiety
- User-acceptance

Best practices and models from other projects have been adapted and used where applicable. The Technology Acceptance Model (TAM, [1], [2], [3]), for example, has been used for the category user-acceptance and it covers perceived ease-of-use, perceived usefulness and attitudes towards using.

Within the Mobi.Europe project, the city of Vigo (Spain) is one of the pilot sites to test ICT based mobility services, as introduced in [4]. An EV car-sharing service has been launched in Vigo in the framework of the pilot, allowing citizens to use an EV reserved by short periods of time. [5] and [6] present car sharing organizational models and their main advantages in urban environments. Car sharing is typically oriented to 1) casual drivers and 2) transit transport systems, generally linking public transport infrastructures and urban cores. So, car sharing may be considered as complementary to public transport network, impacting in the urban mobility as follows:

- Increasing the shared use of vehicles
- Reducing the number of private vehicles
- Reducing the necessity of parking lots
- Increasing the urban mobility offer

In the particular case of Vigo, a medium-sized city in the northwest of Spain, with approximately 500.000 inhabitants in the metropolitan area and industrial driver of the region, the city lacks many of the services available in bigger cities, as tram, tube, bike sharing or commuter trains. Private car is the main transport mean, which results in heavy traffic and congestion. Hence alternative transport modes, based on electromobility, offer the possibility to reduce traffic jams and congestion, pollutant emissions and noise level.

## Background

Within the four “Smart Connected Electromobility” CIP Projects launched in January 2012, one important cooperation topic among them is “evaluation”, whose purpose is to have intercomparable results of the impact of the projects. Following FESTA methodology, some research questions and hypothesis have been discussed to define a common set of quantitative and qualitative indicators with the purpose of monitoring pilot tests execution and, afterwards, evaluating their results [7]. The list of indicators is shown below:

**Table 1 – List of common indicators**

Evaluation category	Common indicator title	Type of indicator	Type of data	Required measures
Environment	CO2 reduction, in %	Objective	Quantitative	Energy mix
				Charging time
				Charging duration
				Charging process
				Charging volume
				Aggregated road mileage performance
Transport and mobility	Modal share, in %	Objective	Quantitative	Number of CIE car trips replaced by EV
	Penetration rate, in %	Objective	Quantitative	Number of incorporated CIP services by EV
User uptake	User acceptance	Subjective	Qualitative	Easy of use
		Subjective	Qualitative	Satisfaction
		Subjective	Qualitative	Usefulness
		Subjective	Qualitative	Trust
		Subjective	Qualitative	Compliance
	Willingness to pay	Subjective	Qualitative	Willing to pay
	User awareness	Subjective	Qualitative	Knowledge
Subjective		Qualitative	Usage	
Economic	Roaming charging processes of users	Objective	Quantitative	Number of charging processes
	Roaming charging processes of operators	Objective	Quantitative	Number of clearing processes

Therefore, the goal was to develop a common user questionnaire in order to evaluate 1) the usage of electric vehicles and 2) the implemented services in the pilot-sites. This questionnaire has been divided in six different categories for user-assessment: demographics, attitudes and technology use, travel and mobility, willingness-to-pay, range-anxiety and

user-acceptance. Each category is composed by different questions, which will be evaluated by each pilot in a common way by all CIP projects. By way of example, some questions included in the questionnaire, with their corresponding category, are shown below:

**Table 2 –Example questions**

Categories	Questions
Demographics	What is your current employment status?
	Where is your company/institution located?
	Do you hold a public transport card?
Attitudes and Technology Usage	To what extent do you participate in car sharing/pooling networks?
	Do you have Internet access in your mobile phone?
	How often do you drive?
	What type of transport do you use more frequently (private car, rented car, car sharing, public transport, company transport, other)?
	Which options would encourage you to use an EV: low running costs, no carbon emissions, no noise, love of new technologies
Travel & Mobility	How many vehicles are owned, leased or available for regular use by the people who currently live in your household?
	How many km do you usually drive per year by car?
	What is your main trip purpose?
	At what time do you do your car sharing vehicle reservation in advance?
Willingness-to-Pay	Would you pay more for a multimodal transport card including EV-sharing?
	What do you think about government incentives to buy EV?
	What is the minimum daily EV range you would accept?
	What is the maximum time you would accept for charging the EV?
	What kind of payment option for EV-car sharing do you prefer: depending on Km, depending on time, or flat rate fee
Trust/Range anxiety	What range would you consider optimal for an EV?
User acceptance (of services and applications)	Based on your present impression, would you consider driving electric vehicles/scooters more often in the future?
	Was it easy for you to use the service?
	Was it easy to you to interact with the service?

### **Pilot services tested in Vigo**

The EV car-sharing service points are located in some of the car parks of the city centre, where the major charging network for EVs is available. The service started in October 2012 with a fleet comprising 6 Renault Twizy; by the end of 2013 it was completed with 12 new cars (Peugeot Ion and Citroën cZero models). The car-sharing system is embedded into the parking management system, and implies a higher level of integration over ICT applications and ITS (Intelligent Transport Systems) technologies. Altogether, the services provided in the pilot are:

- EV car sharing management
- Parking integration management
- Charging network and energy management
- Car sharing web platform
- Interoperable mobile app
- ITS deployed in parking areas

The following table shows some indicative data to characterize the pilot in Vigo. It is remarkable that, as it is the first EV car sharing experience in the city, there are no other similar initiatives in Vigo to compare this pilot's characteristics.

**Table 3 – Indicative data for the pilot in Vigo, October 2012 – December 2013**

Concept	Value
Electric vehicles	18
Car parks with car-sharing stations	3
N° charging points within pilot network	125
N° ICT-based services	6
Users	119
Car-sharing reservations	400
Effective vehicle pick-ups	360
Effective vehicle occupation	24%

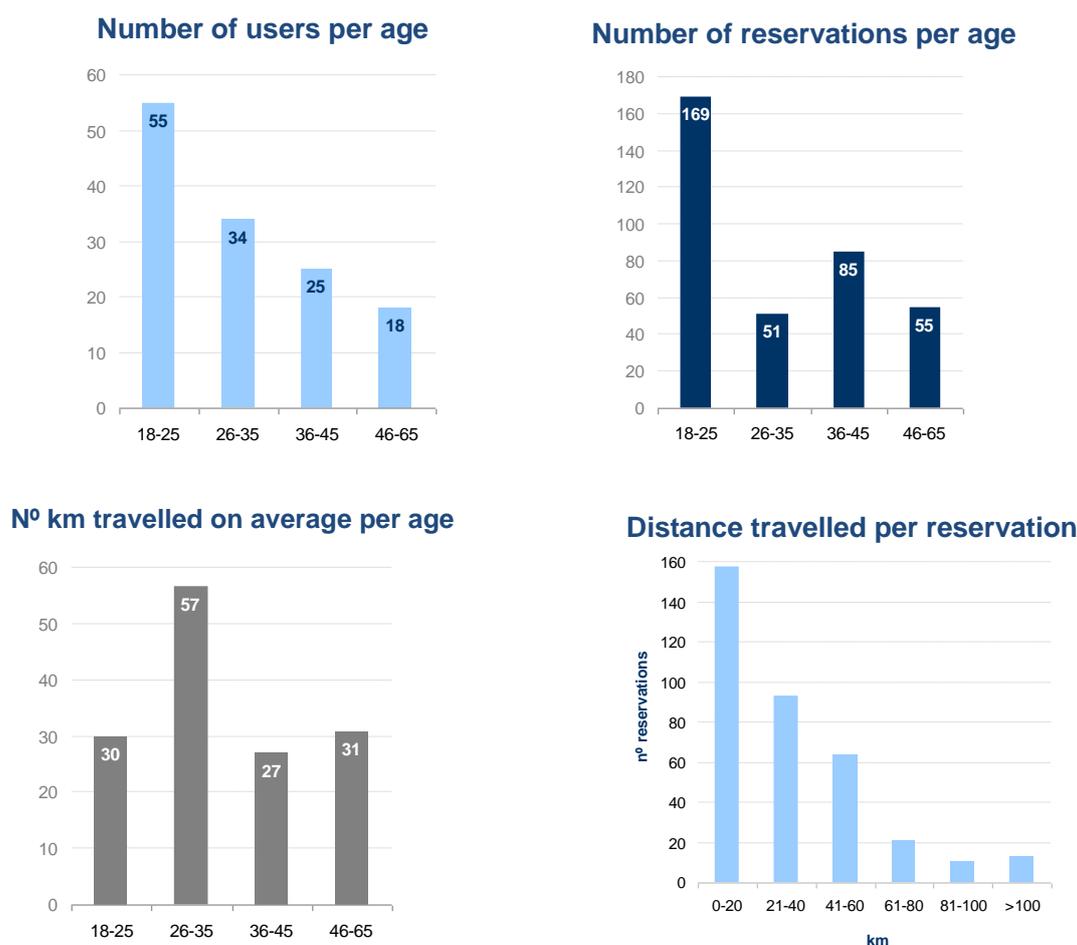
### **Results**

The car sharing service test started in October 2012 and it will finish by the end of 2014. For the moment being, the pilot test is under execution, so no definitive conclusions can be drawn yet. Nonetheless, a first set of indicators were calculated, based on the data recorded in the car sharing management system. The characteristics of the car sharing users registered in the

system is as follows:

- 46% of users are under 25 years old
- 47% of reservations are carried out by users between 18-25 years old
- Users between 26-35 years old do longer travels
- 44% of reservations travelled less than 20 km
- 47% of users reserved 2 or more times

**Figure 1 – Car sharing user characterization**



Also, average distance per reservation has been studied. The average distance travelled per reservation is approximately 37 km per month, for an average of 24 reservations per month. However, some deviations can be seen in car sharing use corresponding to two typical holiday's periods: Easter and summertime.

The data recorded in the car sharing management system is the basis for the calculation of the quantitative indicators of the pilot test. These preliminary results are summarized in the following table:

**Table 4 – Indicators for the pilot in Vigo, October 2012 – December 2013**

Evaluation category	Required measure	Value
Environment	Energy mix	42.4% from renewable energy sources
	Charging time	453 h
	Charging duration	3.5h to fully charge Renault Twizy's batteries
	Charging process	Associated to car sharing
	Charging volume	693.51 kWh
	Aggregated road mileage performance	11.957 km
Transport and mobility	N° ICE car trips replaced by EV	360
	N° incorporated CIP services by EV	5
Economic	N° charging processes	360
	N° clearing processes (roaming)	pending

Some of the indicators are directly retrieved from the car sharing management system (e.g. distance travelled), whereas others need further external information. This is the case for energy production mix while charging, for example, that needs information provided (in real time) by the Spanish electric grid operator.

Regarding the last item of Table 4 (n° of clearing processes), it is worth mentioning that roaming operations started in the beginning of 2014, when the interoperable modules developed in Mobi.Europe were successfully implemented in the car parks and charging network management systems in Vigo. This is one of the main goals of the project: to allow EV users to have access to a variety of ICT-based mobility services (access to charging points, mainly, but not restricted only to that) regardless of their service provider.

On the other hand, regarding the qualitative indicators, a questionnaire, based in the work of the EWG, was launched in April 2014 to the **EV car sharing users**, who have access to the following pilot services:

- EV car sharing web platform
- EV car sharing reservation management
- EV car sharing vehicles, parking and charging network usage

## **Discussion**

The EV car sharing pilot experience is an electromobility pioneering initiative which intends to introduce an alternative transport mode in Vigo. Even more, this service consists on sharing a set of electric vehicles between a large number of different users in a medium-sized city where private car is the main mobility mean.

Anyway, near 1 of each 2 users reserve more than 1 time can be stated as a successful percentage considering that car sharing located in the city centre is devoted to casual drivers for whom Renault Twizy covers their mobility needs. It is expected that a fleet with different vehicle models may cover mobility needs for more different users.

Also, one of the main project purposes is **interoperability**, i.e., addressing the objective of allowing users of any electromobility service to use other services provided by different providers **in a transparent way to users**, avoiding the necessity of new registers. Given the Portuguese border proximity to Vigo, it is especially interesting to ensure that EV users will be able to charge their vehicles regardless of which side of the border they are (**roaming**).

## **Conclusions and next steps**

This paper shows an adequate method for evaluating EV users experience with the aim of ensuring user acceptance. Indeed, there will not be a total integration of EV into current transport systems unless a range of mobility options are available to the users. In this sense, ICT applications will cover user's demands in terms of service information, seamless mobility and interoperability, facilitating the market uptake of EV and a new cloud of ICT services regarding to a more sustainable mobility.

## **Aknowledgments**

The Mobi.Europe project, "Integrated and Interoperable ICT Systems and Services for Electro-Mobility in Europe", is cofunded by the European Commission under the Competitiveness and Innovation Programme (CIP).

The common high level indicators and the questionnaire are the results of the work done by Evaluation Working Group (EWG), comprising representatives from all the CIP-ICT-PSP

projects: ICT4EVEU, Mobi.Europe, Molecules and Sm@rtCEM.

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