smartCEM

Smart connected electro mobility

D4.3 smartCEM experimental design

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Authors (full list)

Txomin Rodriguez (TECNALIA)
Leandro Guidotti (UNIMORE)
Pietro Mascolo (ICOOR)

Project Coordinator

Fernando Zubillaga
MLC ITS Euskadi
Clúster de Movilidad y Logística
Centro de Negocios CTVi, Oficina 1, 3-A
Lermandabide, 8. Polígono Industrial Júndiz
01015 Vitoria-Gasteiz
Tel.: +34 945 10 80 88
Email: fzubillaga@mlcluster.com

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Abbreviations

Abbreviation	Definition
EV	Electric vehicle
eCar	Electric car
eVan	Electric van
eScooter	Electric scooter
CS	Charging station
Sub / Obj	Subjective / Objective
QN / QL	Quantitative / Qualitative
EU	European Union
HY	Hypothesis
PI	Performance Indicator
SC	Scenario
VM	Validation Matrix
RQ	Research Question

Executive Summary

The objective of this document is to present detailed information regarding the smartCEM testing environment.

First of all, the methodology aspects related to the experiment are described, i.e. the test methods, the participants, the vehicles, infrastructure equipment, and also baseline issues. Another important detail is the definition of sample sizes in order to have statistically powerful data. In some cases the nature of the tests will enable the acquisition of the needed amount of samples, whereas in others it will be difficult to have the optimal amount of data due to the limitations of the site.

After the methodology aspects, the calculation of the performance indicators using the measures is defined by Pilot Site.

The data acquisition, logging and analysis methodology are described in the following section. Here, recommendations for the data quality assurance and information on the acquisition architecture are included, as well as the common database system that all four pilot sites will use to upload all gathered data to the evaluation server. This is described with all the necessary details, like tables per file, file naming and communication specifics. The data acquisition plan is presented for the pilot sites at the end of this section. In the data analysis section, how to prepare the data to address the stated smartCEM hypotheses is described. This process is divided into steps and is presented in one table. The evaluation of the hypotheses deals with the statistical analysis needed to obtain the performance indicators and the comparability study of these indicators for with and without the system cases.

After this, the scenarios give all the basic information to develop the tests and evaluate the related hypotheses. Each pilot site has its own scenarios.

Finally, the legal and ethical aspects are related to the issues that can be produced when performing transport tests with people. The annex includes a check-list addressing those issues to be used in the pilot sites before the tests.

1. Introduction

1.1. *Purpose and scope of this deliverable*

The main objective of this report is to provide the needed details to perform the evaluation tests and the assessment of the hypotheses for the four smartCEM pilot sites.

The focus of this document has been put on the aspects related to the methodology to be followed in the testing and evaluation phase, the description for the test scenarios and the generation details of the performance indicators.

1.2. *Structure of the document*

In section 1, a brief description of the content and structure of this document is presented. In section 2, the specific methodology aspects for the experimental design activities are defined, customizing those elements for the case of the smartCEM project. For each pilot site a detailed analysis of each performance indicator is presented in section 3. This section includes a summary on what is going to be measured and the relationship among these measures for the calculation of the PI is described.

Then, the data acquisition process is presented in section 4, consisting of the following aspects: data quality recommendations, the architecture defined for acquisition, the database details, as well as the acquisition timing and steps to be followed in the data analysis. Section 5 covers the statistical considerations for the evaluation of the hypotheses.

Section 6, collects all the relevant information regarding the test scenarios and in section 7 valuable recommendations are given regarding the legal and ethical aspects when performing tests with people.

The last sections of the documents deal with the conclusions, references and the annexes complementing the information of the body of the document.

1.3. *Terminology*

smartCEM services	Experimental ITS systems adopted in the smartCEM project for having a high potential to foster electromobility. They are adapted and tested in the smartCEM PS in a real-life environment and which effects are going to be assessed in cooperation with other smartCEM services, in order to be validated according to the project objectives.
Assessment	The process of determining the performance and/or impacts of an application or group of applications, usually

	in comparison to a reference case. In ITS Pilots as smartCEM, assessment comprises an experimental process based on real-life traffic conditions and often involving users.
Evaluation	The process of determining the value of an application in comparison to alternative applications and/or to a reference case, and deriving recommendations for decision makers based on identifying requirements on and analysing results of related experiments.
Acquired measures	Measures as taken from the sensors. Also raw measures.
Required measures	Measures, acquired or derived from others, directly used in the calculation of the performance indicators
Hypothesis (HY)	The hypothesis is an answer to a RQ (research question) that contains a specific and testable prediction about the relationship between two variables.
Impact	Changes or effects brought about by an application as a result of its implementation in an experimental or 'real-life' situation.
Pilot site:	Real location in which the smartCEM services are adapted for a deployment during a specific time. These locations, that normally are delimited areas in a city or road, use to be relevant regions for their commitment in the current mobility and environmental issues
Performance indicator	Quantitative or qualitative measurement agreed on beforehand expressed as a percentage, index, rate or other value which is monitored at regular/irregular intervals and can be compared with one or more success criteria.
Baseline	The baseline is an early element in the monitoring and validation plan and provides the basis for subsequent assessment of how efficiently the system or application behaves according to the expected objectives.
Scenario	A scenario groups the use cases defined in WP2 in order to focus in the relevant test situations for smartCEM, depending basically on the user type, the trip stage and the vehicle in use.

Table 1-1.Terminology

2. Methodology considerations for the assessment

2.1. Assessment overview

The assessment is going to be performed according to the smartCEM scenarios for evaluation. These scenarios are defined in section 6 as a result of what is dealt through this section (in which the elements to be tested and the way they are going to be tested are described) and also in the following sections (hypotheses, performance indicators and data logging, among others). Section 6 describes as many different scenarios for each pilot site as are addressed by the users. The definition of the scenarios has been based on the use cases developed in the WP2 deliverable "D2.1 Reference Architecture" [5]. These scenarios contain all the information needed to perform the tests (vehicles, participants profile, infrastructure equipment, addressed use cases, etc.) and also to be able to evaluate the addressed hypotheses (hypotheses addressed, performance indicators, etc.).

2.2. Test methods

Test methods describe the technics used to perform the evaluation of the applications and services. The smartCEM test methods have been selected according to the evaluation objectives and also available resources in the Pilot Sites. Evaluation methods are quite different from one another, depending on the procedures and resources used. The most relevant for smartCEM project are described in the following sections.

2.2.1. Field trials

The field trial definition involves the tests of use in real conditions to identify and evaluate the technical and/or not technical advantages while using the system. The term "field trial" describes any test performed under the real specific conditions existing in the four smartCEM Pilot Sites. These tests will be performed with the smartCEM applications and systems integrated into these environments.

In these tests, the behaviour of the system and of the user will be monitored during the normal operation of the electric vehicles within their natural activity environment.

A large quantity of data will be recorded continuously during the planned months of testing in the four pilot sites, and the performance indicators will be obtained from the filtering of the existing data, taking into account the required conditions needed for the calculation of the indicator, according to the addressed hypotheses.

2.2.2. Driving Test

These tests are also performed under real conditions like the field trials, but in this case there is a limitation in the distance (specific lay-out) and time (start and end defined) of the test. Test drives will be used in smartCEM mainly for the assessment of the functionality of the applications (implementation stage). In some cases it can be used for specific assessment of the end-users behaviour and acceptance.

One disadvantage in this type of tests is that the repeatability of the measures is a requirement in order to guarantee the integrity of the performance indicators and impacts. Nevertheless, in a driving test every real driving situation is unique (the situational variables as traffic situation, other road users involved, weather, daylight, etc. may change); theoretically only a high number of samples allows typical situations to be classified or influencing values to be defined as insignificant. In this case, a planning of the efforts has to be made, to manage adequately the limited resources (budget) of the research projects.

2.2.3. Subjective assessment methods: interviews/questionnaires

The users of the smartCEM services (bus drivers, car drivers, passengers, etc.) are being carefully considered within smartCEM evaluation process. A common approach for the four Pilot Sites is being followed. In this approach, common assessment tools, like the questionnaires on user uptake (acceptance, willingness to pay and range anxiety), are being developed.

The use of interviews/questionnaires is suitable for collecting systematic information on personal opinions, knowledge and behaviour. The use of pre-defined questions, answers or scales simplifies the analysis of results as well as facilitating their comparability.

A specific deliverable on the development of the questionnaires exists in smartCEM (D4.4 Validation Tools), according to the planned activities in WP4. This deliverable will be produced during 2013.

2.2.4. Observation

It is based on pure observation, which can be done in an objective or a subjective way, or both. Normally, this kind of assessment is carried out together with another method (e.g. test drives). Different goals in the observation can exist, for example the observation of the driver behaviour (like speed adaption at junctions, lane changes, etc.) in real traffic along a route of between (in which the observation can be also limited in distance and time), and considering only certain situational variables (e.g. during the peak hours). Other type of observation can be made regarding to events, conflicts, etc.

2.3. *Participants*

Depending upon the research questions and hypotheses which inform the tests, there is often a need to select a particular group of participants as representative of a determined group of users. Consequently, a list of criteria to select the participants for the tests is needed. This list should be defined (and reported) with the collaboration of the Pilot Site leaders. The following sections contain the description of the main categories of smartCEM participants for validation purposes. The profile specification (that is, the common aspects to be considered in smartCEM for the description of the participants for all the Pilot Sites) has been also included in this section.

2.3.1. Participant categories

The participants in the tests will be the users of the system, mainly. The following categories have been defined regarding the participant types in smartCEM:

- EV driver: umbrella term for any person driving one of the below mentioned vehicles: eCar, e-Scooter, Hybrid Bus, eVan.
- Electric Car Driver (ECar Driver):Is the person who drives an electric car.
- Bus Driver: Is the person who drives the hybrid bus, a public transport vehicle.
- Traveller: is the person who use the public hybrid bus transport.
- Electric Scooter Driver (eScooter Driver): is the person who drives an electric scooter.
- Electric Van driver (eVan Driver): is the person who drives an eVan vehicle.
- EV- Sharing Operator: person of the service provider entrusted of managing the fleet of electric vehicles in a sharing scheme.
- Carsharing back office operator: person who is going to revise the state of the EV, when the user returns the vehicle.
- Public Transport Operator: the person entrusted to provide the service of public transport.
- Charging point operator: the person who controlled the level of charge for the electric vehicles, when the vehicles are returned. And who is going to charge the EV if needed for future use.
- Enforcement officer: The person that is legally able to enforce access to CSs that are installed in public places (e.g. a police officer that can verify if the EV is allowed to still occupy the CS, and if not, to give a fine to the driver or move away the EV in order to free the CS (Retrospective Human Intervention)

2.3.2. Demographics

Demographics data will be used to quantify and study different participant profiles. In the following table the main parameters to consider on this aspect fo smartCEM are included.

Parameter	Description
Permanent variables	Age and sex as basic aspects
Socio economic variable	Education, employment, income and marital status. User uptake and behaviour can be influenced by these factors
Driver impairment	Related to auditory perception, vision perception and mobility impairments. Also temporary impairments (e.g. fatigue, injuries)
Driving style	Eco-driver, sporty-driver according to the self-reported attitude of the participant when driving.
Driver experience	For how many years the participant is driving
Experience with vehicle systems	In the smartCEM case, ask if the participant has experience in the use of HMI with screens with/without touch system

Table 2-1.Demographics parameters description

2.4. Vehicles

The different type of vehicles involved in smartCEM project can be consulted in Table 2-2.

Vehicle type	Description
Electric Car	Four-wheeled electric vehicle for individual (not public) transport of passengers
Electric Scooter	Small two-wheeled electric vehicle
Hybrid bus	Bus used for public transport in urban environment
Electric Van	Small electric van used for institutional purposes. In protected areas of cities

Table 2-2.Vehicle types description

In Table 2-3, a summary of the vehicle types addressed in the smartCEM Pilot Sites can be seen.

	Pilot Site			
Vehicle type	Barcelona	Gipuzkoa	Newcastle	Reggio Emilia
Electric Car				
Electric Scooter				
Hybrid bus				
Electric Van (eVan)				
Electric Vehicle (EV)				

Table 2-3.Vehicle types by Pilot Site

2.5. *Infrastructure equipment*

The different infrastructure elements for the users of the smartCEM services are described in Table 2-4.

Infrastructure equipment	Description
eCar Sharing Post	This equipment allows carsharing users to rent EV at fixed points located in the street
Charging station	Infrastructure for electric recharging of EV

Table 2-4. Infrastructure equipment description

2.6. *Baseline*

The following general definition is going to be applied for baseline and functional operation in smartCEM:

- **Baseline**: the smartCEM services will be switched off, and the current systems and services will be running. Other measures that could be influencing the results, i.e. situational variables should be measured during the tests, such as weather conditions.
- **Functional operation**: the smartCEM services will be switched on. In this case the same situational variables should be logged.

This criterium will be applied as close as possible in all cases in the four smartCEM Pilot Sites.

2.7. *Sample size determination*

One of the most important statistical considerations in smartCEM is the calculation of the sample sizes in order to have a determined statistical power for a given Type 1 error (“false positive” or a result that indicates that a given condition is present when it actually is not present). This can be estimated using pre-determined tables, for a two-sample t-test of an experimental group (smartCEM test samples) and a control group (smartCEM baseline samples) of the same size.

For significance level of 0.05 (which equals to the probability of having a Type 1 error) the size of a sample test can be calculated in function of the statistical "power" and "Cohen's d" parameters following the table below (Chapter 13, page 215, in: Kenny, David A. (1987). *Statistics for the social and behavioural sciences*. Boston: Little, Brown. ISBN 0-316-48915-8 [8]. See Table 2-5.

Power	Cohen's d		
	0.2	**0.5**	**0.8**
0.25	84	14	6
0.50	193	32	13
0.60	246	40	16
0.70	310	50	20
0.80	393	64	26
0.90	526	85	34
0.95	651	105	42
0.99	920	148	58

Table 2-5. Required sample size for hypotheses test using predefined tables [Kenny, David A., 1987]

Cohen's d measures the expected difference between the means of the experimental group and the control group divided by the expected standard deviation.

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s},$$

The power of a statistical test is the probability that the test will reject the null hypothesis when the null hypothesis is false (i.e. the probability of not committing a Type II error, or making a false negative decision).

Using a Cohen's d value of 0.8 as a reference (taking into account that the hypothesis expects to have changes between the baseline and the actual tests):

- For sizes with a number of samples greater than 20 the statistical power would be 0.7 (good).

- For sizes with a number of samples greater than 30 would be almost 0.8 (very good).
- For sizes with a number of samples greater than 50 would be more than 0.95 (excellent).

Taking this into account, a number of samples greater than 50 would be preferred as long as technical, logistic and economic conditions allow it for smartCEM Pilot Sites and applications.

The minimum size of 50 samples must be applied not only to test samples but also to baseline samples.

3. Performance Indicators generation through measures

In this section the procedure to obtain the different performance indicators from the addressed measures in the four smartCEM Pilot Sites is explained.

3.1. *Barcelona Pilot Site*

In the following sub-sections, the different performance indicators for Barcelona Pilot Site are described in detail for each of the evaluation categories addressed.

3.1.1. Environment

IND_ID	PI_BCN_01	Name	Average energy consumption (scooter).	Units	KWh/dt
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	• SOC final= State of charge of the battery final (Kw). • SOC initial= State of charge of the battery initial (Kw). • dt= travelled distance (km).				
Required measures	• kWh= Kilowatts consumed per hour(kW/h) = (SOC final- SOC initial/h)				
Transformation function or procedure to obtain the indicator	Average energy Consumption (scooter) = kWh/dt				

Table 3-1. Performance Indicators: Barcelona- Average energy consumption (scooter).

IND_ID	PI_BCN_02	Name	Average CO2 emissions (scootersharing).	Units	gr CO2 /100 km.day
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	• ipc = instantaneous petrol consumption (l) • dt = distance travelled (km)				
Required measures	• pcd = Petrol consumption per day (l/day) = Σipc (during a day) • kmd = Km travelled per day (km/day) = Σdt (during a day)				
Transformation function or procedure to obtain the indicator	Emissions for an equivalent ICE scooter can be calculated considering that 2325 g of CO2 are produced per liter of consumed fuel (x100 to obtain emissions for 100 km travelled) Average CO2 emissions (carsharing) = 232500 x pcd / kmd				

Table 3-2. Performance Indicators: Barcelona- Average CO2 emissions

(scootersharing).

IND_ID	PI_BCN_03	Name	Average number of run-out of battery events.	Units	event/day
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• NumD= Number of days (day) • NROB= Number of run-out of battery events(event)				
Transformation function or procedure to obtain the indicator	Average number of run-out of battery events =NROB/NumD(event/day)				

Table 3-3. Performance Indicators: Barcelona- Average number of run-out of battery events.

3.1.2. **Traffic and mobility**

IND_ID	PI_BCN_04	Name	Average number of trips per day per vehicle.	Units	Trip/day
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• NumT= Number of trips (trips). • NumD= Number of days (day).				
Transformation function or procedure to obtain the indicator	Average number of trips per day per vehicle = NumT/NumD (trip/day).				

Table 3-4. Performance Indicators: Barcelona- Average number of trips per day per vehicle.

3.1.3. User uptake

IND_ID	PI_BCN_05	Name	Average user acceptance scores	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • AccSIT= User acceptance scores (score).				
Transformation function or procedure to obtain the indicator	Average user acceptance score = $(\sum AccIT/ NumSc)/NumP$				

Table 3-5. Performance Indicators: Barcelona- Average user acceptance scores.

IND_ID	PI_BCN_06	Name	General user acceptance score (electric motorcycles)	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • GAccS= General acceptance score (score).				
Transformation function or procedure to obtain the indicator	General user acceptance score (electric motorcycles) = $(\sum AccS/ NumSc)/NumP$				

Table 3-6. Performance Indicators: Barcelona- General user acceptance score (electric motorcycles).

IND_ID	PI_BCN_07	Name	Average willingness-to-pay score (scooter sharing)	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				

Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • Swp= Willingness to pay score (score).
Transformation function or procedure to obtain the indicator	Average willingness-to-pay score = (∑ Swp/ NumSc) /NumP

Table 3-7. Performance Indicators: Barcelona- Average willingness-to-pay score (scooter sharing).

IND_ID	PI_BCN_08	Name	General willingness-to-pay scores for incentivised trips.	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures		<N/A>			
Required measures		• NumP= number of participants (participant). • NumSc= number of scores (score). • Gwp= Gerenal willingness to pay score (score).			
Transformation function or procedure to obtain the indicator		General willingness-to-pay score for incentivised trips = (∑ Swp/ NumSc) /NumP			

Table 3-8. Performance Indicators: Barcelona- General willingness-to-pay scores for incentivised trips.

IND_ID	PI_BCN_09	Name	Average range-anxiety score	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures		<N/A>			
Required measures		• NumP= number of participants (participant). • NumSc= number of scores (score). • AnS= Range Anxiety score (score).			
Transformation function or procedure to obtain the indicator		Average range-anxiety score =(∑ AnS/ NumSc)/NumP			

Table 3-9. Performance Indicators: Barcelona- Average range-anxiety score.

IND_ID	PI_BCN_10	Name	Percentage of complied trips (due to incentives)	Units	%
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures		<N/A>			
Required measures		• NumIT= Number of incentivized trips per day (trips). • NumTT= Number of complied trips per day (trips).			
Transformation function or procedure to obtain the indicator		Percentage of complied trips = (∑ AccS/ NumSc)/NumP			

Table 3-10. Performance Indicators: Barcelona- Percentage of complied trips (due to incentives).

IND_ID	PI_BCN_11	Name	Speed/acceleration profile per user.	Units	m/s2
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures		<N/A>			
Required measures		• Instant acceleration • Reference acceleration limits			
Transformation function or procedure to obtain the indicator		Plot the curve Instant acceleration - time			

Table 3-11. Performance Indicators: Barcelona- Speed/ acceleration profile per user.

3.1.4. **Driver behaviour**

(Not addressed in Barcelona Pilot Site)

3.2. Gipuzkoa Pilot Site

In the following sub-sections, the different performance indicators for Gipuzkoa Pilot Site are described in detail for each of the evaluation categories addressed.

3.2.1. Environment

IND_ID	PI_GIP_01	Name	Average energy consumption (carsharing).	Units	kWh consumed per 100 km.
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• Ec= Energy consumption per day (kWh). • dt= Travelled distance(km).				
Transformation function or procedure to obtain the indicator	Average energy consumed (carsharing) = Ec*100/dt.				

Table 3-12. Performance Indicators: Gipuzkoa- Average energy consumption (carsharing).

IND_ID	PI_GIP_02	Name	Average CO_2 emissions (carsharing) .	Units	Kg CO2/kWh
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• Ec= Energy consumption per day (kWh). • du= Duration of trip • da= Date • Emx= Energy mix • Td= Time of day				
Transformation function or procedure to obtain the indicator	For the calculation of CO2 emissions the tool developed in T4.4 is going to be used. More details in deliverable D4.4 “Evaluation tools”				

Table 3-13. Performance Indicators: Gipuzkoa-Average CO_2 emissions (carsharing).

IND_ID	PI_GIP_03	Name	Amount of fuel consumed for hybrid bus.	Units	l(litres) per 100 km.
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures		<N/A>			
Required measures		• ac= fuel consumption per route (l). • dt = travelled distance (km).			
Transformation function or procedure to obtain the indicator		Amount of fuel consumed for hybrid bus = Fc*dt			

Table 3-14. Performance Indicators: Gipuzkoa- Amount of fuel consumed for hybrid bus.

IND_ID	PI_GIP_04	Name	CO2 emissions for hybrid bus.	Units	gr CO2 per liter of fuel
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures		<N/A>			
Required measures		• Fuel consumption per route • Travelled distance			
Transformation function or procedure to obtain the indicator		The CO2 estimation will be made with the specific information contained in the hybrid bus specifications			

Table 3-15. Performance Indicators: Gipuzkoa- CO_2 emissions for hybrid bus.

IND_ID	PI_GIP_05	Name	Number of run-out of battery events.	Units	%
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures		<N/A>			
Required measures		• NROB=number of run-out of battery events (event). • NumTT= Number of complied trips per day (trip).			
Transformation function or procedure to obtain the indicator		Number of run-out of battery events per trip= (NROB/NumTT)*100.			

Table 3-16. Performance Indicators: Gipuzkoa- Number of run-out of battery events.

IND_ID	PI_GIP_06	Name	Number of off-peak charging events	Units	Integer
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	• Pt= Peak-time • da=Date. • Sce= Starting time charging event. • cpID= Charging post ID <N/A>				
Required measures	• number of start/end charging events per time of day per charging post per peak- and off-peak time				
Transformation function or procedure to obtain the indicator	Number of off-peak charging events = "=number of start/end charging events per time of day per charging post per peak- and off-peak time"				

Table 3-17. Performance Indicators: Gipuzkoa- **Number of off-peak charging events.**

IND_ID	PI_GIP_07	Name	Charging event distribution	Units	KWh
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	• da= Date<N/A>				
Required measures	• cpID= charging post ID • ctID= Charging transaction ID				
Transformation function or procedure to obtain the indicator	Charging point usage= number of charging transactions per day/ number of charging posts per day“				

Table 3-18. . Performance Indicators: Gipuzkoa-Charging event distribution.

3.2.2. Traffic and mobility

IND_ID	PI_GIP_08	Name	Number of trips	**Units**	trips
Subjective (Sub) / Objective (Obj)			Sub	**Quantitative (QN) / Qualitative (QL)**	QN
Acquired measures	<N/A>				

Required measures	• NumD= Number of days • NumT= Number of trips
Transformation function or procedure to obtain the indicator	Number of trips=∑ (NumT) / NumD. (trips)

Table 3-19. Performance Indicators: Gipuzkoa- Number of trips.

3.2.3. User Uptake

IND_ID	PI_GIP_09	Name	Average user acceptance scores.	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• AccSS= User acceptance scores (score). • NumP= number of participants. • NumSc= Number of Score.				
Transformation function or procedure to obtain the indicator	Average user acceptance score =(∑ AccSS/ NumSc)/NumP				

Table 3-20. Performance Indicators: Gipuzkoa-Average user acceptance scores.

IND_ID	PI_GIP_10	Name	General user acceptance score (for electric cars)	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• GAccS= General acceptance scores for electric vehicles(score) • NumP= number of participants (participant). • NumSc= Number of Score (score).				
Transformation function or procedure to obtain the indicator	General user acceptance score (for electric cars)= (∑GAccS/ NumSc)/ NumP				

Table 3-21. Performance Indicators: Gipuzkoa- General user acceptance score for electric cars.

IND_ID	PI_GIP_11	Name	Average willingness to pay score.	Units	Score per participant
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• AccSs= willingness to pay scores (score). • NumP= number of participants (participant). • NumSc= Number of Score (score).				
Transformation function or procedure to obtain the indicator	Average willingness to pay scores= (ΣAccSs/ NumSc)/NumP				

Table 3-22. Performance Indicators: Gipuzkoa-Average willingness to pay score.

IND_ID	PI_GIP_12	Name	Average willingness-to-pay score (for a transport card combining carsharing with public transport)	Units	Score per participant
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• Swp= willingness to pay scores (score). • NumP= number of participants (participant). • NumSc= Number of Score (score).				
Transformation function or procedure to obtain the indicator	Average willingness to pay scores= (ΣSwp/ NumSc)/NumP				

Table 3-23. Performance Indicators: Gipuzkoa- Average willingness-to-pay score (for a transport card combining carsharing with public transport).

IND_ID	PI_GIP_13	Name	General willingness to pay.	Units	Score per participant
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• Gwp= General willingness to pay scores (score). • NumP= number of participants (participant). • NumSc= Number of Score (score).				

Transformation function or procedure to obtain the indicator	General willingness to pay scores= (ΣGwp/ NumSc)/NumP

Table 3-24. Performance Indicators: Gipuzkoa-General willingness to pay.

IND_ID	PI_GIP_14	Name	Average range-anxiety score	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• AnS= Range of Anxiety scores (score). • NumP= number of participants (participant). • NumSc= Number of Score (score).				
Transformation function or procedure to obtain the indicator	Average range-anxiety score = (Σ AnS/ NumSc)/NumP				

Table 3-25. Performance Indicators: Gipuzkoa-Average range-anxiety score.

3.2.4. Driver Behaviour

IND_ID	PI_GIP_15	Name	Speed/Acceleration profile per EV driver	Units	Km/h
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• dt= travelled distance (km). • VIS= Vehicle Instant speed				
Transformation function or procedure to obtain the indicator	Plot profile of VIS against dt				

Table 3-26. Performance Indicators: Gipuzkoa-Speed/Acceleration profile per EV driver. Grafico

IND_ID	PI_GIP_16	Name	Rate of use for car and hybrid bus driver.	Units	%
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				

Required measures	• NumIF= Number of instructions followed by the driver, recommended by the on-board Ev-efficent driving service. • NumIG= Number of instructions given by the on-board Ev- efficient driving service. (Carsharing).
Transformation function or procedure to obtain the indicator	Rate of use for car and hybrid bus driver= (NumIF/NumIG)*100

Table 3-27. Performance Indicators: Gipuzkoa-Rate of Use .

IND_ID	PI_GIP_17	Name	Average amount of generated energy	Units	%
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Required measures	• Re= Regenerated energy (kWh). • dt= Travelled distance(km).				
Acquired measures	<N/A>				
Transformation function or procedure to obtain the indicator	Average amount of generated energy = (NumIF/NumIG)*100				

Table 3-28. Performance Indicators: Gipuzkoa-Average amount of generated energy.

3.3. *Newcastle Pilot Site*

In the following sub-sections, the different performance indicators for Newcastle Pilot Site are described in detail for each of the evaluation categories addressed.

3.3.1. **Environment**

IND_ID	PI_NEW_01	**Name**	Charging event distribution	**Units**	Events/posts per day.
Subjective (Sub) / Objective (Obj)			Obj	**Quantitative (QN) / Qualitative (QL)**	QN
Required measures	cpID= charging post ID. ctID= charging transaction ID. Da= date NumCE= number of charging events. NumCP= number of charging posts per day.				
Acquired measures					

Transformation function or procedure to obtain the indicator	To calculate the charging event distribution, first it is necessary to identify the date control, as well as known the charging post ID and the charging transaction ID in order to seek the necessary data. Charging event distribution=NumCE/NumCP

Table 3-27. Performance Indicators: Newcastle-Charging event distribution.

IND_ID	PI_NEW_02	**Name**	Average energy consumption per 100km per user	**Units**	KWh consumed per 100km.
Subjective (Sub) / Objective (Obj)		Obj	**Quantitative (QN) / Qualitative (QL)**		QN
Required measures	ec= energy consumption per day (kWh). dt= travelled distance (km).				
Acquired measures					
Transformation function or procedure to obtain the indicator	Average energy consumption= (ec*100)/dt.				

Table 3-28. Performance Indicators: Newcastle-Average energy consumption per 100 km per user.

IND_ID	PI_NEW_03	**Name**	CO_2 emissions per KWh charged.	**Units**	
Subjective (Sub) / Objective (Obj)		Obj	**Quantitative (QN) / Qualitative (QL)**		QN
Required measures	da= Date Td= Time of day Em= Energy mix. E= Energy consumption (kWh). It will use two graphs to get to a single graph. -The first graph will relate the distance with the time. -And on the other hand, the graph will relate the speed with the time.				
Acquired measures					
Transformation function or procedure to obtain the indicator	Finally it will get a function where the graphs expressed in the required measures will be related. The graph will be given depending on the time and distance.				

Table 3-29. Performance Indicators: Newcastle-CO_2 emissions per KWh charged.

IND_ID	PI_NEW_04	**Name**	Number of off-peak charging events.	**Units**	KWh consumed per 100km.
Subjective (Sub) / Objective (Obj)		Obj	**Quantitative (QN) / Qualitative (QL)**		QN

Required measures	cpID= charging post ID by the required date. Ece=end time charging event. Sce=Starting time charging event. da= date. Pt= Peak- time Td= time of day.
Acquired measures	
Transformation function or procedure to obtain the indicator	Number of off-peak charging= (Sce-Ece)* Td* cpID

Table 3-30. Performance Indicators: Newcastle-Number of off-peak charging events.

IND_ID	PI_NEW_05	**Name**	Number of run-out-of battery events.	**Units**	Number of run-out-of-battery per trip.
Subjective (Sub) / Objective (Obj)		Obj	**Quantitative (QN) / Qualitative (QL)**		QN
Required measures	Scb=State of charge of battery. NumTT= Number of complied trips per day.				
Acquired measures					
Transformation function or procedure to obtain the indicator	Number of run-out-of battery events= ∑ (Scb where zero)/NumTT				

Table 3-31. Performance Indicators: Newcastle-Number of run-out-of-battery events.

IND_ID	PI_NEW_01	Name	Charging event distribution	Units	Events/posts per day.
Subjective (Sub) / Objective (Obj)		Obj	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	• cpID= charging post ID. • ctID= charging transaction ID. • Da= date				
Required measures	• NumCE= number of charging events. • NumCP= number of charging posts per day.				
Transformation function or procedure to obtain the indicator	To calculate the charging event distribution, first it is necessary to identify the date control, as well as known the charging post ID and the charging transaction ID in order to seek the necessary data.				

	Charging event distribution = NumCE/NumCP

Table 3-29. Performance Indicators: Newcastle-Charging event distribution.

IND_ID	PI_NEW_02	Name	Average energy consumption.	Units	kWh consumed per 100km.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Required measures	• Ec= energy consumption per day (kWh). • dt= travelled distance (km).				
Acquired measures	<N/A>				
Transformation function or procedure to obtain the indicator	Average energy consumption= (Ec*100)/dt.				

Table 3-30. Performance Indicators: Newcastle-Average energy consumption.

IND_ID	PI_NEW_03	Name	Average CO_2 emissions	Units	
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Required measures	• da= Date • Td= Time of day • Em= Energy mix. • E= Energy consumption (kWh). • It will use two graphs to get to a single graph. -The first graph will relate the distance with the time. -And on the other hand, the graph will relate the speed with the time.				
Acquired measures	<N/A>				
Transformation function or procedure to obtain the indicator	Finally it will get a function where the graphs expressed in the required measures will be related. The graph will be given depending on the time and distance.				

Table 3-31. Performance Indicators: Newcastle-Average CO_2 emissions.

IND_ID	PI_NEW_04	**Name**	Number of off-peak charging events.	**Units**	KWh consumed per 100km.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	• da= date.				

	• Pt= Peak- time
Required measures	• cpID= charging post ID by the required date. • Ece=end time charging event. • Sce=Starting time charging event. • Td= time of day.
Transformation function or procedure to obtain the indicator	Number of off-peak charging= (Sce-Ece)* Td* cpID

Table 3-32. Performance Indicators: Newcastle-Number of off-peak charging events.

IND_ID	PI_NEW_05	Name	Number of run-out-of battery events.	Units	Number of run-out-of-battery per trip.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• Scb=State of charge of battery. • NumTT= Number of complied trips per day.				
Transformation function or procedure to obtain the indicator	Number of run-out-of battery events= Σ (Scb where zero)/NumTT				

Table 3-33. Performance Indicators: Newcastle-Number of run-out-of-battery events.

3.3.2. Traffic and mobility

IND_ID	PI_NEW_06	Name	Number of trips	Units	Trips
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumD= Number of days(days). • NumT= Number of trips(trips).				
Transformation function or procedure to obtain the indicator	Number of trips =Σ(NumT)/NumD				

Table 3-34. Performance Indicators: Newcastle-Number of trips.

3.3.3. User Uptake

IND_ID	PI_NEW_07	Name	Average confidence score	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures		<N/A>			
Required measures		• NumSc= Number of scores (score). • NumP= Number of participants (participant). • ConSc= confidence questionnaire items given by the drivers (score).			
Transformation function or procedure to obtain the indicator		Average confidence score= ((∑ ConSc)/NumSc)/NumP			

Table 3-35. Performance Indicators: Newcastle- Average confidence score.

IND_ID	PI_NEW_08	Name	Average range-anxiety score	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures		<N/A>			
Required measures		• NumP= number of participants (participant). • NumSc= number of scores (score). • AnS= Range anxiety scores (score).			
Transformation function or procedure to obtain the indicator		Average range anxiety score = (∑ AnS/ NumSc)/NumP			

Table 3-36. Performance Indicators: Newcastle- Average range-anxiety score.

IND_ID	PI_NEW_09	Name	Average user acceptance scores.	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures		<N/A>			
Required measures		• NumP= number of participants (participant). • NumSc= number of scores (score). • AccSIT= User acceptance scores for incentived trips. (score).			
Transformation function or procedure to obtain the indicator		Average user acceptance scores = (∑ AnS/ NumSc)/NumP			

Table 3-37. Performance Indicators: Newcastle- Average user acceptance scores.

IND_ID	PI_NEW_10	Name	General user acceptance score (for electric cars)	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • GAccS= General acceptance scores for electric vehicles				
Transformation function or procedure to obtain the indicator	General user acceptance score (for electric cars) = (∑ GAccS/ ∑NumSc)/NumP*100				

Table 3-38. Performance Indicators: Newcastle- General user acceptance score(for electric cars).

IND_ID	PI_NEW_11	Name	Average willingness-to-pay score	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • Swp= Willingness to pay scores (score).				
Transformation function or procedure to obtain the indicator	Average willingness-to-pay score = (∑ Swp/ NumSc)/NumP				

Table 3-39. Performance Indicators: Newcastle- Average willingness-to-pay score.

IND_ID	PI_NEW_12	Name	General willingness-to-pay	Units	Score per participant
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumP= number of participants (participant). • NumSc= number of scores (score). • Gwp= General willingness to pay items (score).				
Transformation function or procedure to obtain	General willingness-to-pay = (∑ Gwp/ NumSc)/NumP				

the indicator	

Table 3-40. Performance Indicators: Newcastle- General willingness-to-pay.

3.3.4. Driver Behaviour

IND_ID	PI_NEW_13	Name	Average amount of generated energy	Units	kWh / km
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• Re= Regenerated energy(kWh). • dt= Travelled distance(km).				
Transformation function or procedure to obtain the indicator	Average amount of generated energy = $\sum$ Re/dt				

Table 3-41. Performance Indicators: Newcastle- Average amount of generated energy.

3.4. Reggio Emilia Pilot Site

In the following sub-sections, the different performance indicators for Reggio Emilia Pilot Site are described in detail for each of the evaluation categories addressed.

3.4.1. Environment

IND_ID	PI_REG_01	Name	Average energy consumption	Units	kWh per km.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• dt= travelled distance (km). • Ec= energy consumption per day (kWh).				
Transformation function or procedure to obtain the indicator	Average energy consumptio =(Ec*100)/dt				

Table 3-42. Performance Indicators: Reggio Emilia- Average energy consumption.

IND_ID	PI_REG_02	Name	Average CO_2 emissions (carsharing)	Units	Kg / kWh
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Required measures	• Ec= Energy consumption per day (kWh). • da= date. • Td= Time of day. • Emx= energy mix.				
Acquired measures					
Transformation function or procedure to obtain the indicator	Average CO_2 emissions (carsharing)=				

Table 3-43.Performance Indicators: Reggio Emilia- Average CO2 emissions (carsharing).

IND_ID	PI_REG_03	Name	Number of run-out of battery events.	Units	Events.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• NumTT= Number of complied trips per day (trips). • NROB= Number of run-out of battery.				
Transformation function or procedure to obtain the indicator	Number of run-out of battery events =(NumTT/NROB)				

Table 3-44.Performance Indicators: Reggio Emilia- Number of run-out of battery events

IND_ID	PI_REG_04	Name	Number of off-peak charging events.	Units	Events
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• cpID= Charging post ID • Sce= Starting time charging event				

	• Ece= End time charging event • Td= Time of day • Pt= Peak-time.
Transformation function or procedure to obtain the indicator	Number of off-peak charging events= (Sce/Ece)*Td*Pt

Table 3-45.Performance Indicators: Reggio Emilia- Number of off-peak charging events.

IND_ID	PI_REG_05	Name	Charging distribution	Units	kWh per km.
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• cpID= charging post ID. • ctID= charging transaction ID. • Da= date.				
Transformation function or procedure to obtain the indicator	Chraging distribution=				

Table 3-46. Performance Indicators: Reggio Emilia- Charging distribution.

3.4.2. User Uptake

IND_ID	PI_REG_06	Name	Average range anxiety score	Units	%
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• AnS= Range anxiety • NumSc= Number of scores. • NumP=Number of participants				
Transformation function or procedure to obtain the indicator	Average range anxiety score = (∑AnS/NumSc)/NumP				

Table 3-47. Performance Indicators: Reggio Emilia- Average Range anxiety score.

IND_ID	PI_REG_07	Name	Average user acceptance scores.	Units	%
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• AccSIT= User acceptance score for incentive trips (score). • NumSc= Number of scores (score). • NumP=Number of participants (participant).				
Transformation function or procedure to obtain the indicator	Average user acceptance scores. = (∑ AccSIT/NumSc)/NumP				

Table 3-48. Performance Indicators: Reggio Emilia- Average user acceptance scores.

IND_ID	PI_REG_08	Name	General user acceptance score (for electric cars)	Units	%
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• GAccS= General acceptance scores for electric vehicles (score). • NumSc= Number of scores (score). • NumP=Number of participants (participants).				
Transformation function or procedure to obtain the indicator	General user acceptance score (for electric cars) = (∑GAccS /NumSc) / NumP				

Table 3-49. Performance Indicators: Reggio Emilia- General user acceptance score (for electric cars).

IND_ID	PI_REG_09	Name	Average willingness to pay score.	Units	%
Subjective (Sub) / Objective (Obj)		Sub	Quantitative (QN) / Qualitative (QL)		QN
Acquired measures	<N/A>				
Required measures	• Swp= Willingness to pay scores (score). • NumSc= Number of scores (score). • NumP=Number of participants (participants).				
Transformation function or procedure to obtain the indicator	Average willingness to pay score = (∑AnS/NumSc)/NumP				

Table 3-50. Performance Indicators: Reggio Emilia- Average willingness to pay score.

IND_ID	PI_REG_10	Name	General willingness to pay	Units	%
Subjective (Sub) / Objective (Obj)			Sub	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• Gwp = General willingness to pay item (scores). • NumSc= Number of scores (scores) • NumP=Number of participants (participants).				
Transformation function or procedure to obtain the indicator	General willingness to pay = (ΣAnS/NumSc)/NumP				

Table 3-51. Performance Indicators: Reggio Emilia- General willingness to pay

IND_ID	PI_REG_11	Name	Average amount of generated energy	Units	Kwh
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• Re= Regenerated energy per trip (kWh). • Stt= Starting time of trip.				
Transformation function or procedure to obtain the indicator	Average amount of generated energy = Re/ Stt				

Table 3-52. Performance Indicators: Reggio Emilia- Average amount of generated energy.

IND_ID	PI_REG_12	Name	Speed/ Acceleration profile per EV user.	Units	%
Subjective (Sub) / Objective (Obj)			Obj	Quantitative (QN) / Qualitative (QL)	QN
Acquired measures	<N/A>				
Required measures	• VIS= Vehicle Instant speed. • dt= travelled distance (kilometers).				
Transformation function or procedure to obtain the indicator	Graph: speed vs travelled distance.				

Table 3-53. Performance Indicators: Reggio Emilia- Speed/ Acceleration profile per EV user.

3.4.3. Driver Behaviour

(Not addressed in Reggio Emilia Pilot Site)

4. Data acquisition, logging and analysis

The following sections describe the data chain acquisition and logging for all of smartCEM test sites. The process of data logging was discussed within WP2 and more detailed information may be found in D2.1 and D2.2.

4.1. General considerations for taking measures

In order to be able to estimate whether a specific HY has been achieved, different performance indicators are monitored in each pilot site using a range of measures using both sensors and questionnaires depending on the nature of the performance indicator. The required measures to evaluate the performance indicators are defined in the validation matrix.

During the evaluation phase, each pilot site will acquire raw data through sensors, intended a sensor as any method to obtain relevant data in the tests. This information is post-processed obtaining the derived measures from raw data, and also synchronizing the data coming from different data loggers in order to have coherent global registers from the pilot site. Then data is logged to a local data base following the format and table structure proposed in section 4.4. Each pilot site stores the logging files in their own central server.

After storing all logged data in the central server on each pilot site, these files are sent to the smartCEM validation work package server using ftp communications. There is a directory in the ftp server for each pilot site with enough space to store all logged data for the project. This allows the validation team to compile early reports and also it provides a backup service for the pilot sites.

The smartCEM historical data is stored in the validation server which contains all the information necessary to generate the reports for evaluating targeted criteria and for making the impact appraisal. To generate these reports, data mining and statistical analysis software will be used. The whole process is shown in Figure 4-2.

4.2. Data quality assurance

The following table includes the main aspects concerning to data quality when preparing experimental design. This information is based on

Aspect	Description
Participant selection	Age, gender and other demographics information to be obtained through questionnaire and should be representative of the target population of the smartCEM services
Sample size	This is dealt in detail in section 2.7 of this document

Aspect	Description
Situational variables	Other measures apart from the ones for the calculation of the performance indicators are needed to allow result analysts to put in context the calculated indicators and, then, to be able to evaluate the hypotheses more adequately
Robust acquisition	Avoid loss of data by verifying periodically data loggers HW and SW, ensuring in that way their functionality during the test periods. Major part of current damages are due to connector issues and also to external temperatures and mechanical moving parts
Connection to vehicle systems	To connect any equipment to CAN bus or other in-vehicle system should be made carefully to avoid unexpected vehicle behaviors that can derive in personal injuries
Nomadic devices	When using nomadic devices as user interfaces, ensure that they are operating properly by continuous monitoring
System verification	It is important that all the systems of the same category are calibrated and verified using the same procedures. For installation verification, check it against analysis requirements by recording a full dataset
Data transmission	Data is transferred and uploaded at several stages of the logging and acquisition period. Establish a routinary procedure to ensure correct storage and reduce data losses
Clean data acquisition systems	Ensure storage capacity by deleting not relevant data for smartCEM analysis. Check data consistency after uploading sequence before deleting it from the data logger.
Synchronization	Ensure that time measurement is synchronized for all the different data loggers of one pilot site, in order to be able to establish a correct temporal relationship among different measures
Data storage	A certain tolerance in the storage size (20% to 50%) is recommended to avoid data loss. Ensure the vehicle data recording by guaranteeing free space in the data logger. For that, the sample rate should be the minimum needed to be able to evaluate the hypotheses.

Table 4-1. Data quality assurance recommendations

4.3. *Data acquisition architecture*

A high-level view of the reference architecture is shown in Figure 4-1 with the smartCEM services domain and the external entities such as data-loggers, public transport data, traffic data and charging stations data.

The specific acquisition and logging architecture for each pilot site is defined in the WP2 deliverable D2.3 “Guidelines and requirements for the integration of local systems into the smartCEM architecture” [6]. Within the activities of Task 2.4, deliverable D2.3 describes how the smartCEM technical architecture is adopted by the pilot sites and how the local implementation is done, identifying the local data loggers and servers for data recording and storage.

This chapter describes how smartCEM ICT components are connected, the data

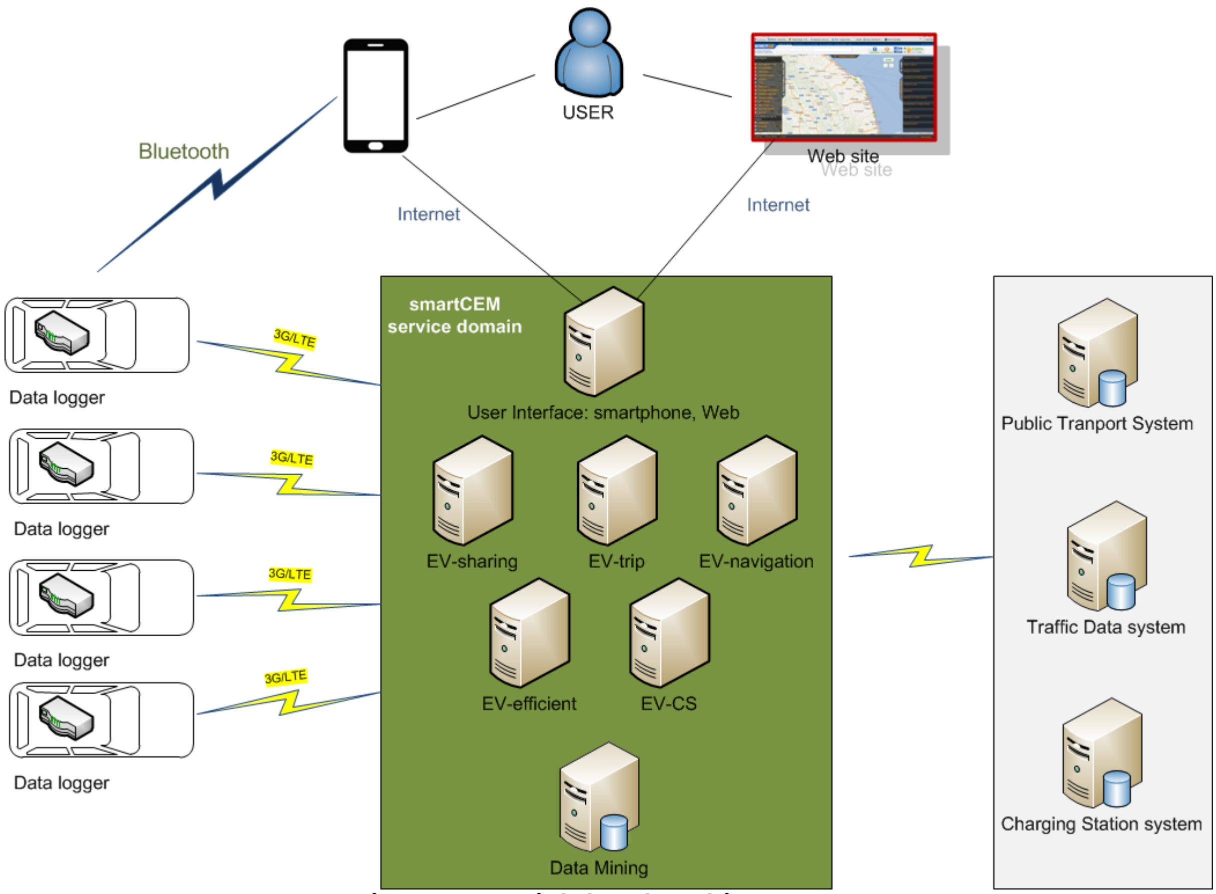


Figure 4-1- High level architecture

For the subjective assessment, questionnaires designed in WP4 deliverable D4.4 “smartCEM assessment tools” will be sent/given to participants at the end of their trip. It will contain questions relating to user uptake according their experiences during the trip. The questionnaire will be circulated for use by the partners during the trial and the results will be stored for their analysis.

4.4. *Database description*

UNEW provides access to a central server through the e-Science Central platform. e-Science Central is a Science-as-a-Service platform that combines three emerging technologies — Software as a Service, and Cloud Computing. Using only a browser, pilot sites can upload data to allow a centralised analysis.

The key components of the e-Science Central Science "Platform as a Service" sitting on an "Infrastructure as a Service" cloud. Services in workflows can be scheduled on a cloud, so exploiting their potential for scalability, and the ability to acquire resources when needed. e-Science Central is a Cloud based Platform for Data Analysis. It supports secure storage and versioning of data, audit and provenance logs and processing of data using workflows. Workflows are composed of blocks which can be written in Java, R, Octave or Javascript. e-Science Central is portable and can be run on Amazon AWS, Windows Azure or other hardware.

Each pilot site is responsible for collecting data from the vehicles. For the common data analysis, data are collected on a trip level and uploaded to e-Science Central, as shown in Figure 4.2.

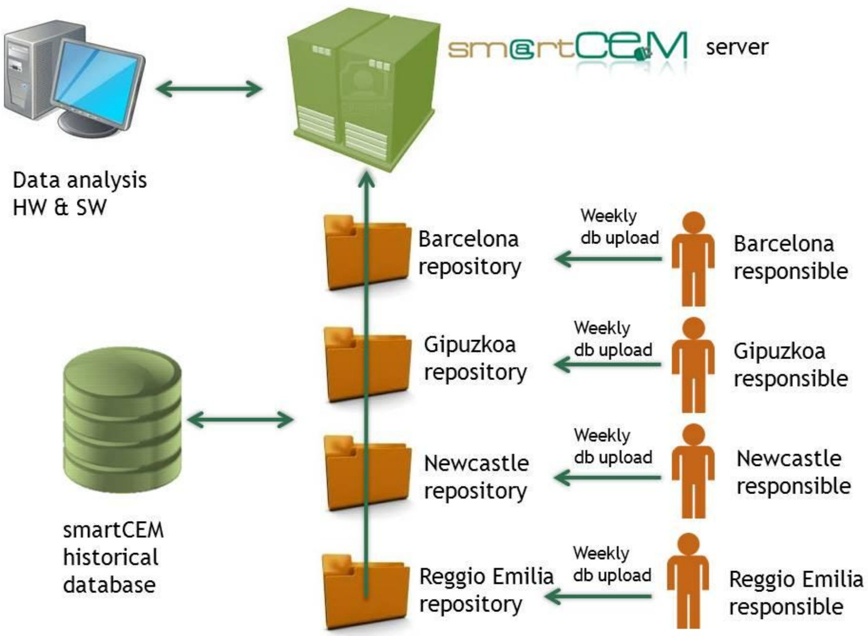


Figure 4-2- smartCEM database uploading scheme

Trip data (measures) to be collected, are listed in Annex 1. The data collected from each pilot site may vary depending on the performance indicators addressed and the data logging capabilities for each of the data loggers.

Each pilot site should create a file in the agreed database formats for each week and upload it to the smartCEM Validation Server. The general naming of the files should be as follows "FileName.EXT" where "EXT" is the extension of the database file and "FileName" is composed of two fields separated by underscore characters, as a reference:

"Scenario_acronym_Date.EXT"

The "Scenario acronym" field can be taken from Table 7, where "##" is an integer to distinguish the scenarios of the same pilot site.

Pilot Site	Scenario	Scenario Acronym
Barcelona Pilot Site	Scenario ##	BAR_s##
Gipuzkoa Pilot Site	Scenario ##	GIP_s##
Newcastle Pilot Site	Scenario ##	NEW_s##
Reggio Emilia Pilot Site	Scenario ##	REG_s##

Table 4-2. Scenario acronym table

The "Date" field format is **ww-yyyy,** indicating the week and the year to which the logged data belong. For instance, the 7th of June of 2013 (Week 23 of 2013) should be written as 23-2013.

<u>Example</u>: the log file (sqlite format) for the first Reggio Emilia scenario during week 23 of 2013 should be named:

REG_S1_23-2013.sqlite

Each file should be composed of two tables, **data_items** and **data_types**.

- **Data_items** contains all the information that is being measured by a specific pilot site. Each row of this table corresponds to a new sample of specific measurement.
- The table **data_types** defines what that is being measured in the scenario the file is related to.

The structure of these tables is described in the two following subsections.

4.4.1. Structure of table for data types

Each measure will result in a data type that can be organised in tables like the one presented in Table 4-3. The fields are explained as follows:

- **DataType** (Single precision integer)**:** Is the identifier for a measure type (i.e:

speed, position, etc.) It is an integer value and its meaning is defined in typeDesc column of this table. This column is used to relate data_items with data_types tables. The data type is a numeric code like the one of the example in Table 4-3. In smartCEM the numeric part of the measure code (see Annex 1) can be used for this purpose.

- **Abbreviation (string)**: alphanumeric abbreviation for the datatype
- **TypeDesc** (Text): This field describes what each number in DataType column means. (For instance speed, position…).

Data type	Aspect	TypeDesc
01	tripId	Generic numbering of the trip (numberical)
02	vehicleId	ID tag for the vehicle based on the logger
03	driverId	ID tag for the driver based on transactions
04	Services on/off	ID tag for the use of the services (on/off)
05	journeyStartDate	Start date of a journey. A journey is defined as a drive event that is further than 500 m, after the ignition was switched on (dd:mm:yyyy)
06	journeyStartTime	Time of ignition on (h:min:sec)
07	journeyEndDate	Date of ignition off (dd:mm:yyyy)
08	journeyEndTime	Time of ignition off (h:min:sec)
09	journeyDuration	Derived value for the duration of a journey based on journeyStartTime and journeyEndTime (h:min:sec)
10	chargeStartDate	Start date for charging event (dd:mm:yyy)
11	chargeStartTime	Start time for charging event (h:min:sec)
12	chargeEndDate	End date for charging event (dd:mm:yyy)
13	chargeEndTime	End time for charging event (h:min:sec)
14	chargeEventDuration	Derived value for the duration of a charge event based on chargeStartTime and chargeEndTime (h:min:sec)
15	totalEnergyTransferedPerJourney	Energy used during journey (kWh)
16	totalEnergyTransferPerCharge	Energy charged during charge event (kWh)
17	distance	Distance driven during drive event
18	temperature	Ambient temperature (degree C)
19	chargingLocation	GPS location of the charge event, which can later be compared to a database of known charge locations (long/lat)
20	lat_st	
21	long_st	

Table 4-3. Example of data type for the data types table

4.4.2. Structure of table for data items

Data_items is composed of 4 columns, node_Id, Timestamp, dataType and dataValues. The number of rows is undefined and it depends on the number of measures that are being done in a specific scenario.

- **Log_Id** (Single precision integer): This field is used to define the Pilot Site the measure is coming from (NEW, BAR, REG, GIP).
- **Timestamp** (string): The timestamp on which the measure has been acquired. This field should be formatted following UNIX time in milliseconds.

- **DataType** (Single precision integer): Specifies what is being measured. It is an integer value and its meaning is defined in data_types table. Both tables are related using the column dataType.
- **dataValues** (Double precision floating point): It contains the actual value of what is being measured.

data items

Record ID	Timestamp	Data type	Data value
NEW	130722091528	01	5
NEW	130722091632	17	523,2
NEW	130722091822	11	1
...	...	...	...

data types

Data type	Abrev.	Description
01	tripId	Generic numbering of the trip (numberical)
02	vehicleId	ID tag for the vehicle based on the logger
03	driverId	ID tag for the driver based on transactions
...	...	...

Figure 4-3- smartCEM database tables

Additional data from the vehicle sensing system will be gathered by an event monitoring software at a sampling rate of 1Hz.

The primary data acquisition system currently functions as a data logger where the data transfer to the central server occurs at the end of each journey when the ignition is switched off. The event monitoring infrastructure acts as a gateway to receive heterogeneous event from the vehicle sensors and positioning systems. The event monitoring infrastructure is built to scale for events from more than thousand vehicles every second.

The system software is created with the vehicle and battery monitoring rule base to assess the vehicle performance. The system dynamically identifies the patterns in near real time to monitor the vehicle and also collates the historic knowledge from the previous experiments.

The information about every individual journey performed by the vehicle will be summarized on the basis of the data analysis, which will be further disseminated using various platforms such as web site.

4.5. Data acquisition plan

The data acquisition during the testing periods are planned to be the same for the four Pilot Sites. Different periods are stated considering baseline and operational situations and also the initial trial for data process setup (see *Figure 4-4*). In this first initial trial period of two weeks the main data quality issues should be solved in order to ensure a successful period of measures production and recording. During this period, the data will be uploaded daily in the project database for early detection of possible failures and misfunctions.

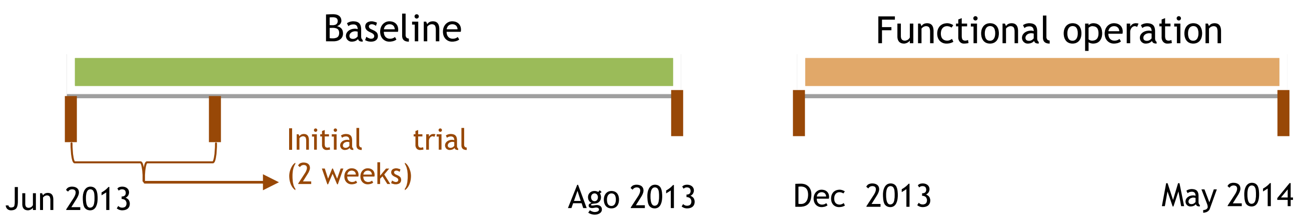


Figure 4-4- smartCEM test planning

4.6. Data analysis

During the analysis, data is prepared to address specific hypotheses in five main steps. Data filtering, derived measures generation, use of events, time scale definition and calculation of the performance indicators. In these steps are described.

Step	Description
Data filtering	This part relates to the selection of part of data which are relevant for addressing a specific hypothesis to be tested. This filter can be made using the situational variables (time, space, weather, traffic status and others) in order to obtain the required dataset to calculate the addressed performance indicator(s).
Derived measures generation	Some measures required for the calculation of the performance indicators are obtained from the raw measures taken with the sensors. Data analysis can also be interested, for instance, in the distribution of two measures, one from each other.
Use of events	Some hypotheses refer to situations in which one specific event (traffic jams, accidents or battery depletion) is produced and for that in these cases the event is one of the required criteria to filter the data. These events should be identified through all registered data.
Time scale definition	In smartCEM pilot sites, data will be collected for several months. As a consequence, the data analyst will probably look at the data using very different time scales: seconds, minutes, trips, days, weeks, months, according to the addressed hypothesis.

Step	Description
Calculation of the indicator	When developing the evaluation matrix, many PI are simply described and understood in a high level description, but they can be quite complicated to calculate with the data obtained from tests. Field trials involve situations in which the test is not under strict control. First, contextual influences should be identified (not always easy) and controlled subset of data used for comparison (with or without the smartCEM services).

Table 4-4. Steps for data preparation

5. Hypotheses evaluation

The performance indicators (PI) calculation refers not only to the procedure followed to generate the PI, but also to other tasks needed to determine dataset statistical robustness Table 5-1 shows the steps to be followed in this process.

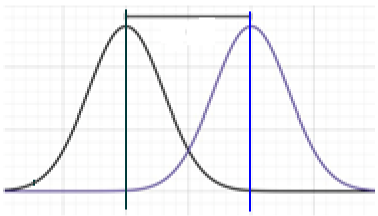
Step	Description
Outliers analysis	In statistics, an outlier is an observation that lies an abnormal distance from other values in a random sample from a population. A multidimensional analysis will be performed to detect and remove these abnormal data for each dataset.
Sample power	To check the power of the sample according to the required precision and sample number (see section 2.7 of this document).
Shape of the distribution	To check if the sample follows a normal distribution, the shape of the distribution can be evaluated, for example, by calculating the skewness (side assimetry in the distribution) and Kurtosis (peakedness of the distribution) is made. With these criteria it can be said if normal distributions have been achieved.
Comparability analysis	Using all samples, the mean value and the standard deviation of the parameter under evaluation is going to be calculated, both for baseline and functional operation. Both mean values and resulting curves (see example below) for baseline and functional operation are going to be compared in order to know if the success criteria have been achieved. 

Table 5-1. Steps for hypotheses evaluation

6. Scenarios definition

6.1. *Validation environment*

The four pilot sites involved in smartCEM have their own features and characterization as can be seen in Table 6-1.

	Barcelona Pilot Site	Gipuzkoa Pilot site	Newcastle Pilot Site	Reggio Emilia Pilot Site
Environment	Urban (3,5 mill. inh)	Urban (150.000 inh), interurban	Urban, interurban, semi-rural	Urban (170.000 inh.)
Services	EV navigation , EV trip management, EV efficient driving, EV sharing management, EV charging station management.	EV navigation , EV trip management, EV efficient driving, EV sharing management	EV navigation , EV trip management, EV efficient driving, EV charging station management.	EV navigation and range estimation, EV efficient driving, EV sharing management
Transport type	Passengers (individual)	Passengers (individual and public)	Passengers (individual)	Commercial and passengers (individual)
Vehicles	45 EV scooter-sharing fleet	Hybrid bus, EV car-sharing	Electric cars	10 vehicles (minivans and cars)
Infrastructure	Connected charging B.O., EV operator B.O., 234 charging points, in-veh. Dataloggers, mobile devices for EV users,	2 bus lines, bus operator B.O., EV car sharing back office, charging stations, on-board devices, mobile devices	600 to 1300 charging posts	14 charging stations and Power supply system

Table 6-1.Pilot sites environment overview

The smartCEM Pilot Sites (Barcelona, Gipuzkoa, Newcastle and Reggio Emilia) have their own set of scenarios defined for the implementation of the smartCEM services that requires determined lay-outs of vehicles, in-vehicle equipment and infrastructure and back-office equipment. In some cases several or even all the services work together in a single scenario set up, whereas in others each scenario is composed of a single service.

Each scenario is designed in order to address different hypotheses (HY) and corresponding success criteria, though some could only address a single HY.

Scenarios for the four Pilot Sites are defined in this section according to the analysis and information of this document, considering the user type and the trip phase as main criteria for their delimitation (see summary table at the beginning of each pilot site section). The scenarios summarizes the testing, timing and evaluation parameters.

From the validation point of view, two levels will be considered:

- Pilot Site level: Assessment will be performed and conclusions extracted in the ambit of the characteristics of each pilot site. At this level, scenarios are defined for each Pilot Site
- smartCEM level: an overall approach for common assessment objectives that can be found in the four pilot sites is performed at project level.

6.2. *Scenarios for Barcelona Pilot Site*

Two scenarios are considered here according to the user types that are going to be assessed in this site and trip stages (see *Table 6-2*).

Trip phase / User	Pre-trip	On-trip
Electric scooter driver	SC-BCN-01	SC-BCN-02

Table 6-2. Summary of the scenarios for the Barcelona Pilot Site

Each of these scenarios are detailed in the following tables.

Scenario ID	SC-BCN-01		
Title:	Electric scooter sharing service registration and booking		
Environment	Urban	Transport type	Individual
Trip phase	Pre-trip		
Objective:	To evaluate registration, booking, cancellation options of electric scooters sharing service from the point of view of the user acceptance, willingness to pay and range anxiety.		
Impact Area:	User uptake		
Service(s) evaluated:	EV-sharing management		
Use Cases	BCN_UC_01, to, BCN_UC_10		

<table>
<tr><td>Scenario ID</td><td colspan="4">SC-BCN-01</td></tr>
<tr><td>Title:</td><td colspan="4">Electric scooter sharing service registration and booking</td></tr>
<tr><td rowspan="6">Test setup</td><td>Test method(s)</td><td colspan="3">Subjective assessment (questionnaires) →User uptake</td></tr>
<tr><td>Test participant(s)</td><td>Scooter driver</td><td>Vehicle(s)</td><td>Electric scooter</td></tr>
<tr><td>In-vehicle equipment</td><td>On-board unit</td><td>Infrastructure equipment</td><td>e-scooter service back office</td></tr>
<tr><td>Test route(s)</td><td colspan="3">Any (according to user demand)</td></tr>
<tr><td>Control factors</td><td>Driver profile</td><td>Situational variables</td><td>Traffic conditions, route, weather</td></tr>
<tr><td>Baseline</td><td colspan="3">User managing electric scooter sharing service without smartCEM services</td></tr>
<tr><td rowspan="3">Evaluation criteria</td><td>Hypotheses</td><td colspan="3">HY-BCN-05, HY-BCN-06, HY-BCN-07, HY-BCN-08, HY-BCN-09</td></tr>
<tr><td>Performance indicators</td><td colspan="3">PI-BCN-05, PI-BCN-06, PI-BCN-07, PI-BCN-08, PI-BCN-09</td></tr>
<tr><td>Baseline dates</td><td colspan="3">1-jun-2013 to 30-sep-2013</td></tr>
<tr><td rowspan="2">Data logging and storage</td><td>Functional operation dates</td><td colspan="3">1-oct-2013 to 31-dec-2013</td></tr>
<tr><td>Periodicity in data uploading in data base</td><td colspan="3">Training period: per day
Testing period: per week</td></tr>
</table>

Table 6-3. Barcelona Pilot Site scenario: SC-BCN-01

<table>
<tr><td colspan="2">Scenario ID</td><td colspan="3">SC-BCN-02</td></tr>
<tr><td colspan="2">Title:</td><td colspan="3">Riding electric scooter</td></tr>
<tr><td colspan="2">Environment</td><td>Urban</td><td>Transport type</td><td>Car sharing</td></tr>
<tr><td colspan="2">Trip phase</td><td colspan="3">On-trip, Post-trip</td></tr>
<tr><td colspan="2">Objective:</td><td colspan="3">To evaluate electric scooters driving from the point of view of user uptake (acceptance, willingness to pay, range anxiety) as main aspect and also environmental and transport & mobility achievements</td></tr>
<tr><td colspan="2">Impact Area:</td><td colspan="3">Environmental, Transport and Mobility, User acceptance, Driver Behaviour</td></tr>
<tr><td colspan="2">Service(s) evaluated:</td><td colspan="3">EV-sharing management, EV-energy efficiency</td></tr>
<tr><td colspan="2">Use Cases</td><td colspan="3">BCN_UC_11, BCN_UC_12</td></tr>
<tr><td rowspan="6">Test setup</td><td>Test method(s)</td><td colspan="3">• Field trial → Environment, Transport & Mobility and driver behaviour
• Subjective assessment (questionnaires) →User uptake</td></tr>
<tr><td>Test participant(s)</td><td>Scooter driver</td><td>Vehicle(s)</td><td>Electric scooter</td></tr>
<tr><td>In-vehicle equipment</td><td>On-board unit</td><td>Infrastructure equipment</td><td>e-scooter service back office</td></tr>
<tr><td>Test route(s)</td><td colspan="3">Any (according to user demand)</td></tr>
<tr><td>Control factors</td><td>Driver profile</td><td>Situational variables</td><td>Traffic conditions, weather</td></tr>
<tr><td>Baseline</td><td colspan="3">Riding electric scooter without smartCEM services</td></tr>
<tr><td rowspan="3">Evaluation criteria</td><td>Hypotheses</td><td colspan="3">HY-BCN-01, HY-BCN-02, HY-BCN-03, HY-BCN-04, HY-BCN-05, HY-BCN-06, HY-BCN-07, HY-BCN-08, HY-BCN-09, HY-BCN-10, HY-BCN-11</td></tr>
<tr><td>Performance indicators</td><td colspan="3">PI-BCN-01, PI-BCN-02, PI-BCN-03, PI-BCN-04, PI-BCN-05, PI-BCN-06, PI-BCN-07, PI-BCN-08, PI-BCN-09, PI-BCN-10, PI-BCN-11</td></tr>
<tr><td>Baseline dates</td><td colspan="3">1-jun-2013 to 30-sep-2013</td></tr>
<tr><td rowspan="2">Data logging and storage</td><td>Functional operation dates</td><td colspan="3">1-oct-2013 to 31-dec-2013</td></tr>
<tr><td>Periodicity in data uploading in data base</td><td colspan="3">Training period: per day
Testing period: per week</td></tr>
</table>

Table 6-4. Barcelona Pilot Site scenario: SC-BCN-02

6.3. *Scenarios for Gipuzkoa Pilot Site*

Five scenarios are considered here according to the three different users that are going to be assessed in this site (see Table 6-5).

User \ Trip phase	Pre-trip	On-trip	Post-trip
Carsharing driver	SC-GIP-01	SC-GIP-02	
Hybrid bus driver	SC-GIP-03	SC-GIP-04	
Traveller	SC-GIP-05		

Table 6-5. Summary of the scenarios for the Gipuzkoa Pilot Site

Each of these scenarios are detailed in the following tables.

<table>
<tr><td>Scenario ID</td><td colspan="4">SC-GIP-01</td></tr>
<tr><td>Title:</td><td colspan="4">Preparing the e-carsharing trip</td></tr>
<tr><td>Environment</td><td colspan="2">Urban</td><td>Transport type</td><td>Public transport</td></tr>
<tr><td>Trip phase</td><td colspan="4">Pre-trip</td></tr>
<tr><td>Objective:</td><td colspan="4">To evaluate user uptake for the service registration and booking</td></tr>
<tr><td>Impact Area:</td><td colspan="4">User uptake (acceptance, willingness-to-pay, range anxiety)</td></tr>
<tr><td>Service(s) evaluated:</td><td colspan="4">EV-sharing management</td></tr>
<tr><td>Use Cases</td><td colspan="4">GIP_UC_01, GIP_UC_02, GIP_UC_03</td></tr>
<tr><td rowspan="3">Test setup</td><td>Test method(s)</td><td colspan="3">• Subjective assessment (questionnaires)
• Information from carsharing service back office</td></tr>
<tr><td>Test participant(s)</td><td>Car driver</td><td>Vehicle(s)</td><td>Electric car</td></tr>
<tr><td>In-vehicle equipment</td><td>On-board unit</td><td>Infrastructure equipment</td><td>Car sharing service back office and sharing posts</td></tr>
</table>

	Test route(s)	<None>		
	Control factors	Driver profile	Situational variables	<None>
	Baseline	The user makes service registration and booking without the smartCEM services		
Evaluation criteria	Hypotheses	HY-GIP-08, HY-GIP-09, HY-GIP-10, HY-GIP-11, HY-GIP-13, HY-GIP-14		
	Performance indicators	PI-GIP-08, PI-GIP-09, PI-GIP-10, PI-GIP-11, PI-GIP-13, PI-GIP-14		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-6. Gipuzkoa Pilot Site scenario: SC-GIP-01

Scenario ID	SC-GIP-02			
Title:	Driving in electric car sharing environment			
Environment	Urban		Transport type	Car sharing
Trip phase	On-trip			
Objective:	User uptake for carsharing use and driving (acceptance, willingness to pay, range anxiety) are majors goals. Also environmental aspects and transport & mobility features are evaluated, considering the recommendations given to the driver.			
Impact Area:	Environmental, Transport and Mobility, User acceptance, Driver Behaviour.			
Service(s) evaluated:	EV-sharing management EV-navigation, EV-efficient driving,			
Use Cases	GIP_UC_06, GIP_UC_07, GIP_UC_08, GIP_UC_09, GIP_UC_10, GIP_UC_11			
Test setup	Test method(s)	• Field trial → Environment, Transport & Mobility and driver behaviour • Subjective assessment (questionnaires) →User acceptance		
	Test participant(s)	Car driver	Vehicle(s)	Electric car
	In-vehicle equipment	On-board unit	Infrastructure equipment	Car sharing service back office

	Test route(s)	<None>		
	Control factors	Driver profile	Situational variables	Traffic conditions, weather
	Baseline	The user makes service registration and booking without the smartCEM services		
Evaluation criteria	Hypotheses	HY-GIP-01, HY-GIP-02, HY-GIP-05, HY-GIP-06, HY-GIP-07, HY-GIP-08, HY-GIP-09, HY-GIP-10, HY-GIP-11, HY-GIP-13, HY-GIP-14, HY-GIP-15		
	Performance indicators	PI-GIP-01, PI-GIP-02, PI-GIP-05, PI-GIP-06, PI-GIP-07, PI-GIP-08, PI-GIP-09, PI-GIP-10, PI-GIP-11, PI-GIP-13, PI-GIP-14, PI-GIP-15		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-7. Gipuzkoa Pilot Site scenario: SC-GIP-02

Scenario ID	SC-GIP-03			
Title:	Preparing the trip for hybrid bus			
Environment	Urban		Transport type	Public transport
Trip phase	Pre-trip			
Objective:	To evaluate the value perceived by bus driver regarding smartCEM services as a support to the initial tasks before starting the bus trip			
Impact Area:	User uptake			
Service(s) evaluated:	EV-efficient driving,			
Use Cases	GIP_UC_04, GIP_UC_05			
Test setup	Test method(s)	• Subjective assessment (questionnaires) →User uptake		
	Test participant(s)	Bus driver	Vehicle(s)	Hybrid bus
	In-vehicle equipment	OBU, Tablet (HMI), in-vehicle ticket machine	Infrastructure equipment	ublic transport back office
	Test route(s)	Urban bus routes 17 and 21 in Donostia city		

	Control factors	Hybrid unit (vehicle), route profile, driver training (professional)	Situational variables	<None>
	Baseline	The bus driver performs the initial tasks previous to the bus trip without the smartCEM services		
Evaluation criteria	Hypotheses	HY-GIP-09		
	Performance indicators	PI-GIP-09		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-8. Gipuzkoa Pilot Site scenario: SC-GIP-03

Scenario ID	SC-GIP-04			
Title:	Driving hybrid bus			
Environment	Urban	Transport type	Public transport	
Trip phase	On-trip			
Objective:	Environmental (fuel consumption and CO2 emissions) and transport & mobility features are evaluated for hybrid bus while bus driver follows the recommendations given by the system within and urban bus route. Acceptance and driver behaviour are also evaluated in this scenario.			
Impact Area:	Environmental, Transport and Mobility, User acceptance, Driver Behaviour			
Service(s) evaluated:	EV-efficient driving, EV-navigation			
Use Cases	GIP_UC_12			
Test setup	Test method(s)	Subjective assessment (questionnaires) →User uptake		
	Test participant(s)	Bus driver	Vehicle(s)	Hybrid bus
	In-vehicle equipment	OBU, Tablet (HMI)	Infrastructure equipment	Public transport back office
	Test route(s)	Urban bus routes 17 and 21 in Donostia city		
	Control factors	Hybrid unit (vehicle), route	Situational variables	Traffic conditions,

		profile, driver training (professional)		weather, engine temperature
	Baseline	The bus driver drives hybrid bus without the smartCEM services.		
Evaluation criteria	Hypotheses	HY-GIP-03, HY-GIP-04, HY-GIP-09, HY-GIP-15, HY-GIP-16, HY-GIP-17		
	Performance indicators	PI-GIP-03, PI-GIP-04, PI-GIP-09, PI-GIP-15, PI-GIP-16, PI-GIP-17		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-9. Gipuzkoa Pilot Site scenario: SC-GIP-04

Scenario ID	SC-GIP-05			
Title:	Multimodal traveller			
Environment	Urban / interurban		Transport type	Carsharing / Public transport
Trip phase	Pre trip, on-trip			
Objective:	To evaluate the value perceived by traveller regarding electromobility as a result of smartCEM services support that allows the use of existing public transport card also for carsharing			
Impact Area:	User acceptance			
Service(s) evaluated:	EV-Multimodal trip management			
Use Cases	GIP_UC_03, GIP_UC_08			
Test setup	Test method(s)	Subjective assessment (questionnaires) →User uptake		
	Test participant(s)	Traveller	Vehicle(s)	Electric car, public transport bus
	In-vehicle equipment	OBU, Tablet (HMI)	Infrastructure equipment	Public transport back office
	Test route(s)	Any bus line and carsharing trips		
	Control factors	Traveller profile	Situational variables	Traffic conditions,

				weather, bus line
	Baseline	Car sharing and public transport are used without an unique transport card (current situation)		
Evaluation criteria	Hypotheses	HY-GIP-03, HY-GIP-08		
	Performance indicators	PI-GIP-03, PI-GIP-08		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-10. Gipuzkoa Pilot Site scenario: SC-GIP-05

6.4. *Scenarios for Newcastle Pilot Site*

Two scenarios are considered here according to the user types that are going to be assessed in this site and trip stages (see *Table 6-2*).

User \ Trip phase	Pre-trip	On-trip	Post-trip
Electric car driver	SC-NEW-01		
Electric car driver		SC-NEW-02	

Table 6-11. Summary of the scenarios for the Newcastle Pilot Site

Each of these scenarios are detailed in the following tables.

Scenario ID	SC-NEW-01		
Title:	User manages services for charging		
Environment	Urban	Transport type	Public transport
Trip phase	Pre-trip, on-trip, post-trip		
Objective:	To know the value given by users to smartCEM services support when accessing a charging station and while charging an electric car as a way to improve electromobility. Environmental, transport & mobility and driver behaviour aspects are evaluated, considering the recommendations given to the driver.		
Impact Area:	User uptake (acceptance, range anxiety, charging behaviour), Transport and Mobility, Environment, Driver behaviour		
Service(s)	EV-charging station management, EV Navigation		

evaluated:				
Use Cases	NEW_UC_01, NEW_UC_02, NEW_UC_03, NEW_UC_04, NEW_UC_05, NEW_UC_06, NEW_UC_07, NEW_UC_08, NEW_UC_09, NEW_UC_10, NEW_UC_12, NEW_UC_13			
Test setup	Test method(s)	• Field trial • Subjective assessment (questionnaires)		
	Test participant(s)	Car driver	Vehicle(s)	Electric car
	In-vehicle equipment	On-board unit	Infrastructure equipment	Charging back office, charging station
	Test route(s)	Any		
	Control factors	Driver profile, vehicle type	Situational variables	Traffic conditions, weather, charging station status
	Baseline	The user accesses and uses charging points without the smartCEM services		
Evaluation criteria	Hypotheses	HY-NEW-01, HY-NEW-04, HY-NEW-05, HY-NEW-07, HY-NEW-08, HY-NEW-09, HY-NEW-10, HY-NEW-11, HY-NEW-12, HY-NEW-13		
	Performance indicators	PI-NEW-01, PI-NEW-04, PI-NEW-05, PI-NEW-07, PI-NEW-08, PI-NEW-09, PI-NEW-10, PI-NEW-11, PI-NEW-12, PI-NEW-13		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and storage	Functional operation dates	1-oct-2013 to 31-dec-2013		
	Periodicity in data uploading in data base	Training period: per day Testing period: per week		

Table 6-12. Newcastle Pilot Site scenario: SC-NEW-01

Scenario ID	SC-NEW-02		
Title:	Driving electric car efficiently		
Environment	Urban, interurban	Transport type	Individual
Trip phase	On-trip		
Objective:	To know the value given by users to smartCEM services support when driving an electric car as a way to improve electromobility. To evaluate environmental aspects, transport & mobility and driver behaviour aspeces are evaluated, considering the recommendations given to the driver.		

<table>
<tr><td colspan="2">Impact Area:</td><td colspan="3">Environmental, Transport and Mobility, User acceptance, Driver Behaviour.</td></tr>
<tr><td colspan="2">Service(s) evaluated:</td><td colspan="3">EV-navigation, EV-efficient driving, EV-charging management</td></tr>
<tr><td colspan="2">Use Cases</td><td colspan="3">NEW_UC_11</td></tr>
<tr><td rowspan="6">Test setup</td><td>Test method(s)</td><td colspan="3">• Field trial → Environment, Transport & Mobility and driver behaviour
• Subjective assessment (questionnaires) →User acceptance</td></tr>
<tr><td>Test participant(s)</td><td>Car driver</td><td>Vehicle(s)</td><td>Electric car</td></tr>
<tr><td>In-vehicle equipment</td><td>On-board unit</td><td>Infrastructure equipment</td><td>Charging back office, charging station</td></tr>
<tr><td>Test route(s)</td><td colspan="3">Any</td></tr>
<tr><td>Control factors</td><td>Driver profile, vehicle type and age</td><td>Situational variables</td><td>Traffic conditions, weather, charging station status ambient temperature,</td></tr>
<tr><td>Baseline</td><td colspan="3">The user drives an electric car without the smartCEM services</td></tr>
<tr><td rowspan="3">Evaluation criteria</td><td>Hypotheses</td><td colspan="3">HY-NEW-01 to HY-NEW-13</td></tr>
<tr><td>Performance indicators</td><td colspan="3">PI-NEW-01 to PI-NEW-13</td></tr>
<tr><td>Baseline dates</td><td colspan="3">1-jun-2013 to 30-sep-2013</td></tr>
<tr><td rowspan="2">Data logging and storage</td><td>Functional operation dates</td><td colspan="3">1-oct-2013 to 31-dec-2013</td></tr>
<tr><td>Periodicity in data uploading in data base</td><td colspan="3">Training period: per day
Testing period: per week</td></tr>
</table>

Table 6-13. Newcastle Pilot Site scenario: SC-NEW-02

6.5. *Scenarios for Reggio Emilia Pilot Site*

Two scenarios are considered here according to the user types that are going to be assessed in this site and trip stages (see *Table 6-2*).

User \ Trip phase	Pre-trip	On-trip	Post-trip

Electric car driver		SC_REG_01 SC_REG_02 SC_REG_03	

Table 6-14. Summary of the scenarios for the Reggio Emilia Pilot Site

<table>
<tr><td colspan="2">Scenario ID</td><td colspan="3">SC_REG_01</td></tr>
<tr><td colspan="2">Title:</td><td colspan="3">Route to the nearest available charging point</td></tr>
<tr><td colspan="2">Environment</td><td>Urban</td><td>Transport type</td><td>Municipality employees</td></tr>
<tr><td colspan="2">Trip phase</td><td colspan="3">On-trip</td></tr>
<tr><td colspan="2">Objective:</td><td colspan="3">Ability to identify the closest charging spot</td></tr>
<tr><td colspan="2">Impact Area:</td><td colspan="3">User acceptance, Driver Behaviour</td></tr>
<tr><td colspan="2">Service(s) evaluated:</td><td colspan="3">EV-navigation, EV-efficient driving</td></tr>
<tr><td colspan="2">Use Cases</td><td colspan="3">REG_UC_08</td></tr>
<tr><td rowspan="6">Test setup</td><td>Test method(s)</td><td colspan="3">Subjective assessment (questionnaires) →User acceptance</td></tr>
<tr><td>Test participant(s)</td><td>Electric Car driver</td><td>Vehicle(s)</td><td>Electric car, electric van</td></tr>
<tr><td>In-vehicle equipment</td><td>On-board unit</td><td>Infrastructure equipment</td><td>Charging back office, charging station,</td></tr>
<tr><td>Test route(s)</td><td colspan="3">Any</td></tr>
<tr><td>Control factors</td><td>Driver profile, vehicle type</td><td>Situational variables</td><td>Traffic conditions, weather, charging station status</td></tr>
<tr><td>Baseline</td><td colspan="3">Find route to the nearest available charging point without the smartCEM services</td></tr>
<tr><td rowspan="3">Evaluation criteria</td><td>Hypotheses</td><td colspan="3">HY-REG-06, HY-REG-07, HY-REG-08, HY-REG-09, HY-REG-10</td></tr>
<tr><td>Performance indicators</td><td colspan="3">PI-REG-06, PI-REG-07, PI-REG-08, PI-REG-09, PI-REG-10</td></tr>
<tr><td>Baseline dates</td><td colspan="3">1-jun-2013 to 30-sep-2013</td></tr>
<tr><td rowspan="2">Data logging and storage</td><td>Functional operation dates</td><td colspan="3">1-oct-2013 to 31-dec-2013</td></tr>
<tr><td>Periodicity in data uploading</td><td colspan="3">Training period: per day
Testing period: per week</td></tr>
</table>

	in data base	

Table 6-15. Reggio Emilia Pilot Site scenario: SC-REG-01

Scenario ID	SC_REG_02			
Title:	Most efficient route to go from A to B			
Environment	Urban		Transport type	Municipality employees
Trip phase	On-trip			
Objective:	Ability to identify most efficient route between two points			
Impact Area:	Environmental, Transport and mobility, User acceptance, Driver Behaviour			
Service(s) evaluated:	EV-navigation, EV-efficient driving			
Use Cases	REG_UC_08			
Test setup	Test method(s)	• Field trial → Environmental, Mobility pattern, Driver Behaviour • Subjective assessment (questionnaires)→User acceptance		
	Test participant(s)	Electric Car driver	Vehicle(s)	Electric car, electric van
	In-vehicle equipment	On-board unit	Infrastructure equipment	Navigation server
	Test route(s)	Any		
	Control factors	Driver profile, vehicle type, route	Situational variables	Traffic conditions, weather,
	Baseline	Route to the nearest available charging point without the smartCEM services		
Evaluation criteria	Hypotheses	HY-REG-01, HY-REG-02, HY-REG-06, HY-REG-07, HY-REG-08, HY-REG-09, HY-REG-10, HY-REG-11, HY-REG-12		
	Performance indicators	PI-REG-01, PI-REG-02,PI-REG-06, PI-REG-07, PI-REG-08, PI-REG-09, PI-REG-10, PI-REG-11, PI-REG-12		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and	Functional operation dates	1-oct-2013 to 31-dec-2013		

storage	Periodicity in data uploading in data base	Training period: per day Testing period: per week

Table 6-16. Reggio Emilia Pilot Site scenario: SC-REG-02

Scenario ID	SC_REG_03			
Title:	Find charging point			
Environment	Urban		Transport type	Municipality employees
Trip phase	On-trip			
Objective:	Ability to browse existing charging points and choose one in particular			
Impact Area:	Transport and mobility			
Service(s) evaluated:	EV-navigation, EV-efficient driving			
Use Cases	REG_UC_08			
Test setup	Test method(s)	• Field trial → Environmental, Mobility pattern, Driver Behaviour • Subjective assessment (questionnaires)→User acceptance		
	Test participant(s)	Electric Car driver	Vehicle(s)	Electric car, electric van
	In-vehicle equipment	On-board unit	Infrastructure equipment	Charging back office, charging station
	Test route(s)	Any		
	Control factors	Driver profile, vehicle type, route	Situational variables	Traffic conditions, weather, charging station status
	Baseline	Browse existing charging points and choose one in particular without the smartCEM services		
Evaluation criteria	Hypotheses	HY-REG-03, HY-REG-04, HY-REG-05, HY-REG-06, HY-REG-07, HY-REG-08, HY-REG-09, HY-REG-10		
	Performance indicators	PI-REG-03, PI-REG-04, PI-REG-05, PI-REG-06, PI-REG-07, PI-REG-08, PI-REG-09, PI-REG-10		
	Baseline dates	1-jun-2013 to 30-sep-2013		
Data logging and	Functional operation dates	1-oct-2013 to 31-dec-2013		

storage	Periodicity in data uploading in data base	Training period: per day Testing period: per week

Table 6-17. Reggio Emilia Pilot Site scenario: SC-REG-03

7. Legal and ethical aspects in tests

From the legal and ethical point of view several aspects should be considered in order to the following indicative categories listed below and related main issues based on FESTA Support Action information [2]. A check-list for the control of these aspects can be found in annex #10

Briefing of test participants and contractual agreements

- Information provided to test participants
- Information on system limitations and possible malfunctions in intervening and cooperative systems
- Information on data recording
- Information and agreement on cost allocation and liabilities
- Administrative issues
- Regarded to the issues (fines) from use of on-board test systems and applications

Data privacy

- Basic principles and regulations. EU minimum required
- Data privacy in research activities
- Legally relevant data and general measures to ensure data privacy
- Consent of test participants
- Data acquisition
- Technical and organisational measures
- Video recording of driver and passengers

Insurance

- Road traffic liabilities
- Insurance for road traffic in EU countries
- Specific insurance for research and testing activities

Licensing requirements

- Licensing requirements for motor vehicles in EU countries
- Special regulation for vehicle manufacturers
- Licensing of not approved systems being object of the research
- Special licences for special vehicles and systems

Ethical rules

- Respect for the person
- Informed Consent
- Privacy
- Research on/with animals

8. Conclusions

The evaluation framework was presented for smartCEM in deliverable D5.1, in which the V-model for validation based on FESTA methodology was proposed as a valid methodology for the smartCEM project validation. The three validation stages (Definition, Testing and Evaluation and Deployment) were described, the templates for the scenarios definition, and also an overview of the Pilot Sites for evaluation.

In the deliverable D4.2 “Performance Indicators and Evaluation Criteria” a series of Research Questions, Hypothesis, associated Success Criteria and related Performance Indicators were detected and defined for each pilot site.

The present deliverable D4.3 “Experimental design” complements the previous two deliverables furnishing the details of the evaluation and testing stage. The fundamentals for the testing, data analysis, evaluation database, hypotheses evaluation and other legal and ethical aspects in smartCEM have been settled in this document. With this deliverable, the partners involved in the evaluation tasks should have a more concrete idea on how the testing and evaluation is going to be perfomed, being able to assess the hypotheses extracting conclusions on their functionality and deployment issues.

9. References

[1] Driessen, B., Hogema, J., Wilmink, I., Ploeg, J., Papp, Z., & Feenstra, P. (2007). *The SUMMITS Tool Suite: supporting the development and evaluation of cooperative vehicle- infrastructure systems in a Multi-Aspect Assessment approach* (TNO memo 073401-N17). Delft: TNO Verkeer en Vervoer.

[2] FESTA Support Action, FESTA deliverables D2.2, D2.3, D2.4, D6.3 and Handbook http://www.its.leeds.ac.uk/festa/downloads.php

[3] CONVERGE Project TR 1101, Deliverable D2.3.1

[4] TELEFOT Project, Deliverable D2.3.1

[5] smartCEM Project, Deliverable 2.1, Reference architecture

[6] smartCEM Project, Deliverable 2.3, Guidelines and requirements for the integration of local systems into the smartCEM architecture

[7] smartCEM Project, Deliverable 4.4 “smartCEM assessment tools”

[8] Kenny, David A. (1987). Statistics for the social and behavioural sciences. Boston: Little, Brown. ISBN 0-316-48915-8. (1987)

[9] Zhang, X., et al., (1998): Guidebook for Assessment of Transport Telematics Applications: Updated Version, CONVERGE Project TR 1101, Deliverable D2.3.1

[10]

10. ANNEX 1: MEASURES TABLE

Field name	Type	Description	Description	Comments	Measure Source		Pilot Site *(In which PS the measure is logged)*				Unit	Direct or derived measure
The general class of measure, such as engine, speed, acceleration, etc.	*BCN: Barcelona GIP: Gipuzkoa NEW: Newcastle REG: Reggio Emilia*	*The name of the measure. It also works as key for this table, therefore no duplicates can occur.*	*Description of this measure.*	*Additional comments to the measure.*	*Real (sensors)*	*Questionnaire*	*Barcelona*	*Gipuzkoa*	*Newcastle*	*Reggio Emilia*	*Standard unit that applies to the measure. Use preferably SI units.*	*Direct measure or derived from other measure*
DEMOGRAPHICS	ME_001	NumP	Number of participants.								pariticpant	Direct
MOBILITY	ME_101	Td	time of day								hh:mm:ss	Direct
MOBILITY	ME_102	da	Date								yy:mm:dd	Direct
MOBILITY	ME_103	Stt	Starting time of trip								hh:mm:ss	Direct
MOBILITY	ME_104	Ett	End time of trip								hh:mm:ss	Direct
MOBILITY	ME_105	du	Duration of trip								min	Derived from ME-103 and ME-104
MOBILITY	ME_106	NumD	Number of days.								Number	Direct
MOBILITY	ME_107	dt	travelled distance	Travelled distance by EV.							km (kilometers)	Direct

MOBILITY	ME_108	kmd	Kilometers travelled per day	It will be the sum of kilometers travelled by a scooter per day.							km/ day (kilometers per day)	Direct
MOBILITY	ME_109	Skt	Starting km of trip	Initial measuring of accumulated km before starting the trip.							km(kilometers)	Direct
MOBILITY	ME_110	Ekt	End km of trip	Final measuring of accumulated km after finishing the trip.							km(kilometers)	Direct
MOBILITY	ME_111	NumIT	Number of incentivized trips per day.	Number of incentivized trips per day in which the user has changed his initial preference.							Number	Direct
MOBILITY	ME_112	NumTT	Number of complied trips per day	It includes all the trips carried out per day. For all the PS.							Number	Direct
MOBILITY	ME_118	NumT	Number of trips								Number	Direct
ENGINE	ME_201	ipc	Instantaneous fuel consumption	It will be the instantaneous fuel consumed during a day of an equivalent fuel scooter							l (liters)	Direct
ENGINE	ME_202	pcd	Fuel consumption per day.	It will be the sum of the fuel consumed during a day of an equivalent fuel scooter							l/day (liter per day)	Direct
ENGINE	ME_203		Fuel consumption per 100 km.								l(liters)	Direct
ENGINE	ME_204	Fc	Fuel consumption per route								l(liters)	Direct

VEHICLE	ME_251	VIS	Vehicle instant speed								Km//h per time unit	Direct
VEHICLE	ME_252		Vehicle ID								Code	Direct
BATTERY	ME_301	SOC initial	State of charge of the battery initial.								kWh (kilowatts x hour)	Direct
BATTERY	ME_302	SOC final	State of charge of the battery final.								kWh (kilowatts x hour)	Direct
BATTERY	ME_303	NROB	Number of run-out of battery events								Number	Direct
BATTERY	ME_304	Scb	State of charge of battery								kWh (kilowatts x hour)	Direct
ENERGY	ME_401	E	Energy consumption	Is the energy comsumed per 100 km.							kWh (kilowatts x hour)	Direct
ENERGY	ME_402	Re	Regenerated energy								kWh (kilowatts x hour)	Direct
ENERGY	ME_403	Ec	Energy consumption per day	Instantaneous consumption of energy							kWh	Direct
ENERGY	ME_404		Estimated energy consumption								kWh	Direct
ENERGY	ME_405	Emx	Energy mix								kWh	Direct
ENERGY	ME_406	Se	Supplied energy								kWh	Direct
CHARGING	ME_501	Ece	End time charging event								hh:mm:ss	Direct
CHARGING	ME_502	Sce	Starting time charging								hh:mm:ss	Direct

			event									
CHARGING	ME_503	Sce/d	Starting charging events per day.								hh:mm:ss	Direct
CHARGING	ME_504	Ece/d	Ending charging events per day.								hh:mm:ss	Direct
CHARGING	ME_505	cpID	Charging post ID	To know the number of charging events it is necessary first to have the charging post ID.							post per day	Direct
CHARGING	ME_506	ctID	Charging transaction ID								Number	Direct
CHARGING	ME_507	Pt	Peak- Time								hh:mm:ss	Direct
USER UPTAKE	ME_601	NumSc	Number of score	Is the maximum score that can be obtained in questionannaire if all users give the highest possible values.							score	Direct
USER UPTAKE	ME_602	AnS	Range anxiety score	The user gives the anxiety range score after using smartCEM services.							score	Direct
USER UPTAKE	ME_603	GAccS	General acceptance scores for electric vehicles	Is the acceptance score given by the users of dynamic pricing-incentivised trips.							score	Direct
USER UPTAKE	ME_604	Gwp	General willingness to pay items	Is the impact of dynamic pricing- incentivised trips on users willingness-to-pay.							score	Direct

USER UPTAKE	ME_605	AccSbC	User acceptance scores for on-board unit (car driver).	The cardrives indicate the acceptance of the impact of the on-board application for both *Hybrid bus drivers and for EV drivers*.							score	Direct
USER UPTAKE	ME_606	AccSs	User acceptance score of smartCEM services	The cardrives indicate the acceptance of the impact of the smartCEM application for both *Hybrid bus drivers* and for *EV drivers*.							score	Direct
USER UPTAKE	ME_607	ConSc	Confidence questionnaire items	This score indicate the confidence the drivers have to take longer trips.							score	Direct
USER UPTAKE	ME_609	Uss	Usefulness scale scores								score	Direct
USER UPTAKE	ME_610	Sss	Satisfaction scale scores								score	Direct
USER UPTAKE	ME_611	AccSIT	User acceptance scores for incentived trips.								score	Direct
USER UPTAKE	ME_612	AccSbB	User acceptance scores for on-board unit (bus driver).								score	Direct
USER UPTAKE	ME_613	Swp	Willingness-to-pay scores								score	Direct
DRIVER BEHAVIOUR	ME_701	NumIF	Number of instructions followed by EV driver	Number of instructions followed by the driver, recommended by the on-board Ev-efficent driving service.							instruction	Direct

DRIVER BEHAVIOUR	ME_702	NumIG	Number of instructions given by EV driver	Number of instructions given by the on-board EV-efficient driving service(Carsharing and Hybrid bus HM).							instruction	Direct
DRIVER BEHAVIOUR	ME_704	NumIGB	Number of instructions given to hybrid bus driver								instruction	Direct
DRIVER BEHAVIOUR	ME_707	NumCP	Number of charging post per day								posts used per day	Direct
DRIVER BEHAVIOUR	ME_712	InsAccel	Instant acceleration (EVs)								m/s2	Direct
DRIVER BEHAVIOUR	ME_714	LimAccel	Reference acceleration limits								m/s2	Direct

11. ANNEX 2. LIST FOR CONTROL OF LEGAL AND ETHICAL ASPECTS

1.	Briefing of test participants/ Contractual agreements	Status
1.1	Have all participants been provided with detailed information of the exact test design and testing procedures? (This is essential to ensure that they have full knowledge about the tests and as a basis for the Letter of Agreement),	
1.2	Have participants been informed that they must always comply with traffic rules when taking part in a driving test?	
1.3	Does basic technical information exist for participants explaining system limitations, that can lead to wrong use, and possible malfunctions with instructions on how to deal with them? (This is important from an operative point of view to ensure the best results in the tests).	
1.4	Is there comprehensive information for participants clearly explaining the implications for them relating to safe use of the on-board technology and legal responsibilities? Have the consequences of certain behaviours been explained as clarifying examples of these responsibilities? (This is important from legal and safety point of view).	
1.5	Is manual override foreseen in cases in which system failure or malfunction can result in a safety risk? (e.g. intervening cooperative systems).	
1.6	Have further legal implications for the researcher under tort law been investigated related to the risks for participants derived from the use of systems capable of interfering driving functions (as braking or steering)?	
1.7	Have they been informed on the type and method of data to be logged?	
1.8	Does a contract or "Letter of Agreement" establishing the	

	relationship between smartCEM project and test participants been signed by all participants? Does LoA contain all the related relevant aspects, namely costs allocation, on-board equipment or vehicles borrowing and return, insurances, responsibilities, previous requirements for being a test participant?	
2.	**Administrative issues**	**Status**
2.1	Is it clear for participants that they are legally responsible of every movement of the vehicle when on-board experimental systems are fully overrideable (even in the case of driving task being carried out by the system)?	
2.2	In particular for experimental informing systems, is it clear that in case of contradictory information between on-board systems and sign posted information, the latter provide the only legally relevant information in the case of legal issue is produced?	
3.	**Data privacy**	**Status**
3.1	Are the EU Directive 95/46/EG, related to the minimum standard for data protection, and specifically 2002/58/EG, related to privacy and electronic telecommunication, known and understood in the context of smartCEM project?	
3.2	Are anonymisation (no possible traceability of data) and use of pseudonyms (modification of person name) considered in smartCEM as measures to assure data privacy?	
3.3	In order to ensure data privacy for third persons, have the participants given written authorization to the project to record and track them during the tests?	
3.4	Is it clear for researchers and participants that acquired data may only be used only for the purpose(s) it has been collected/saved and that further authorization is needed for other purposes?	
3.5	Will it be necessary to collect sensitive data from people (ethnic, political opinion, religious, health, personality or sex life)? If so, has the required special treatment been taken into account?	
3.6	Is the data acquisition limited by the principle of economy, that is, no more personal data shall be collected and saved than really	

	necessary?	
3.7	What kind of technical or organisational measures are going to be taken in order to preserve data privacy in smartCEM (access to data, authorized persons for data operation, protection of data against read, copy, alter or delete, data input control, data storage management, data availability control)?	
3.8	In order to preserve privacy, has the separation of participants' personal data from the data obtained from the research been considered?	
3.9	If re-identification of personal with research data is thought to be needed, has the deposit of necessary data with a bearer of secrets (e.g. a lawyer) been considered?	
3.10	Since video recording is specially delicate in terms of data privacy (high quality technology, easy access to internet, possibility of recording certain behaviours during the test, etc.), have specific measures been taken for acquisition, storage and end of life of this type of data to preserve privacy of participants?	
3.11	Have participants been informed and explicitly authorized video recording during the tests?	
3.12	Do the systems and data logging have an off switch in order to avoid recording drivers other than the test driver using the same test vehicle?	
3.13	In case of third parties (passengers) in the test vehicle, is the on board camera well on view, making it obvious that data is being recorded?	
3.14	Have test participants been sensitised to inform passengers of the recording?	
3.15	Do test participants know that, in the case of an accident, personal information which has been recorded might be used to clarify responsibilities regarding criminal prosecution, as it is not possible to bar the confiscation of data for this purpose?	
4.	**Insurance**	**Status**

4.1	Are national road traffic liability laws in countries of the smartCEM test sites well known and understood by those responsible for the tests, keepers of the vehicles and test participants?	
4.2	Have all test vehicles the compulsory road traffic insurance?	
4.3	Is it seen as necessary to require minimum insurance coverage for test vehicles (vehicle, driver, passengers)?	
4.4	Is it considered to be covered as a project cost within smartCEM funding?	
4.5	Are test participants aware of general limitations of the insurance coverage?	
4.6	Has a personal accident insurance been considered for passengers to cover specific cases of accidents (hit and run, no insurance coverage of third party, etc.)?	
4.7	In case of third party insurance, is driver supplementary insurance being considered as far as, is the only car occupant who may not be covered in all accidents?	
4.8	Have sums from insurance specially been considered in detail to know if sufficient coverage in case of severe injuries, disabilities, etc., exists?	
4.9	Do trials need a specific insurance according to the expected risks involved in the testing?	
4.10	Has an insurance been foreseen for test equipment (data acquisition devices, experimental on-board applications , etc.).	
4.11	Is it clear that any type of insurance known today assumes full driver's control and that special arrangements are needed for coverage in the case of non-overrideable systems?	
4.12	Specific insurance issues can be found when using cooperative systems in which the control of a vehicle is dependent on other vehicles. Do the insurance contracts of cooperative vehicles cover all possible damages between them and towards surrounding traffic?	

5.	Licensing requirements	Status
5.1	Have any modifications to vehicles foreseen in smartCEM been classified according to their affect on vehicle licensing requirements and taken into account for testing development?	
5.2	Does smartCEM intend to use manufacturers´ test vehicles? Can they develop the tests without modifying their operating license?	
5.3	In the case of non approved systems, is some kind of expert report needed in order for public authorities to accept the use of these systems during testing?	
5.4	Has special licensing been considered in case of vehicles with non-overrideable systems that do not ensure full control of the driver?	
6.	**Ethical rules**	**Status**
6.1	Does smartCEM test and procedures reach a commitment to maximise potential benefit (actions and personal attitudes aiming to obtain the best project results) minimising possible risks (ensuring safety of persons and reducing possible damage in equipment and other goods)?	
6.3	Does the smartCEM test and procedures ensure the respect for persons and their personality?	