smartCEM

Smart connected electro mobility

D6.3 Implementation Guidelines

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Table of Contents

Abbreviations

Abbreviation	Definition
3G	3rd generation of mobile telecommunications technology
APP	Application (software)
AVM	Automated Vehicle Monitoring
BCN PS	Barcelona Pilot Site
BEV	Battery Electric Vehicle
CAN	Controller Area Network.
CIP	Competitiveness and Innovation Framework Programme
CS	Charging Station
DB	Data base
DOD	Degree of Discharge
DoW	Description of work
EV	Electric Vehicle
EVSE	Electrical Vehicle Supply Equipment
GIP PS	Gipuzkoa Pilot Site
GPRS	General packet radio service
GPS	Global Positioning System
GTFS	General Transport Feed Specification
GUI	Graphical user interface
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport Systems
IVR	Interactive Voice Response
KPI	Key Performance Indicators
NEWC PS	Newcastle Pilot Site
OBU	On-Board Unit

Abbreviation	Definition
O-D	Origin-Destination
OCPP	Open charge point protocol
OPEX	Operating Expenses
OSM	Open street map
PPP	People, Planet and Profit
PAYG	Pay as you go
PHEV	Plug-In Hybrid Electric Vehicles
POI	Point Of Interest
PS	Pilot Site
PT	Public transport
PTW	Powered Two Wheeler
QoE	Quality of Experience
REG PS	Reggio Emilia Pilot Site
RFID	Radio Frequency Identification
SH	Stakeholder
SIRI	Service Interface for Real Time Information
SOC	State Of Charge
UC	Use Case
UID	Unique Identification Number
UMTS	Universal Mobile Telecommunications System
UN	User Need
WDM	Workflows and Demand Manager
WiFi	Commercial name of the wireless communication standard IEEE 802.11b
WP	Work Package

Executive Summary

These are the smartCEM Implementation Guidelines. In smartCEM, smart ICT services have been developed and implemented, to catalyse the uptake of electric mobility by end-users. The main question that this document revolves around is,

*"How did the implementation of these new services go,
what problems did we run into and how did we solve them?
And from that, what have we learnt
that future implementations can benefit from?"*

This document is aimed at municipalities, national governments and service providers. It covers technical, organisational, political and practical areas while constantly keeping the end-user in the foreground.

The document is structured, based on five business cases that have been identified within the project, to provide a uniform structure to the deployment activities of the project.

- The first business case is part of EV-Sharing, named Flexible One Way Sharing of electric scooters. These scooters are GPS-monitored, and controlled in terms of workflow and demand. End-users can end their trip and leave them at different places than where they started from. They use their smart-phone to reserve and unlock. A treasure of experiences has been gained, in the design phase as well as implementation and operations. Several additional services are and others can be added to this sharing service.
- Secondly there is Classic Round Trip EV Sharing, a service that is operated from two public transport hubs. The end-users use a website, a smart-phone, phone-calls, or the on-board-unit to make reservation (changes). They get navigation advice, charging stations can be included and Multimodality is also implemented.
- Then, EV-Sharing can also be in the form of an Electric Business Fleet. The vehicles can be managed by managing the respective car keys. The users, in this case employees, share electric vans, are offered navigation (geared to electric driving) and efficient driving advice.
- In the business case Cross Regional Charging Station Management, charging stations are managed by a company that offers smart-phone apps that include the possibility of paying for one's electric charging simply by using the smartphone. The app indexes the charging stations and gives pricing information. New models for pricing, in which the owner is free to set prices, are developed. Also it is possible to view efficient driving advice, after the trip is over, using data taken from the car-network.

- Unique Services Offerings is the fifth and final business case that can contain any unique services offering, and in the case of smartCEM that is the efficient driving service that is provided to the public transport bus drivers of Gipuzkoa. One of the main advices here, is that all involved staff, especially the drivers themselves should be included in the development process, to achieve a positive attitude from the moment the service starts running.

Beyond the above mentioned business cases, the document also addresses the implementation of a Mobile Portal, which is a cross-pilot site and cross-EV-service smart-phone app, that integrates the services for the end-user and makes them available from one single point of access.

Also the EV-Policy Tool, which is an additional service of smartCEM, is addressed. It is a tool that runs traffic data (like intensity, location, congestions, times of the day, battery charging moments etc.) through various analytics algorithms and simulations. This is done to gain insight into future demand on existing charging locations and to forecast where new charging station can best be planned to be built.

Throughout this document, the Environmental Benefits of electric mobility and specifically the smartCEM services are elaborated upon. These can be divided into

- Pollution reduction thanks to the efficiency of the electric motor itself;
- Reduction of pressure on parking space, due to sharing of vehicles (the use of the vehicles intensifies), and thus less searching for parking space;
- Reallocation of the position of cars (to the periphery of towns) or the transfer to two-wheelers, that reduce traffic pressure and thus ease the flow;
- Reduction of electricity cost, through efficient driving;
- Increased use of public transport due to multi-modality services.

Finally the document concludes with recommendations for municipalities, national governments and service providers.

A contact list of all involved implementers is provided at the end of the document, so any party that is interested in implementing any service in any new location can contact us, so we can respond to questions and share our experiences, beyond what we already share in this document.

Chapter 1

Introduction

1. Introduction

About the smartCEM project

The Smart Connected Electric Mobility project is a project that is funded by the European Commission, under the Information and Communications Technologies Policy Support Programme. It aims to boost the uptake and acceptance of electric vehicles (mobility) by developing clever ICT solutions that will offer more confidence to the end-user in EVs. For example, when a user's range is extended through efficient driving advice, he/she will be able to travel further. Or when charging stations are depicted on a navigation device, it will reduce 'range anxiety'. Ultimately it is the objective to increase the use of electric transport at the cost of transport propelled by fossil fuels, and through that reducing greenhouse gas emissions.

The project consortium consists of 28 partners. The project runs until mid-2015. Almost 600 person-months are performed in the project. Total cost are € 4.900.000. 50% of the work is covered by subsidy.

The smartCEM project is being operated in 4 pilot sites: Barcelona (BCN), Gipuzkoa (GIP) both in Spain, Newcastle (NEWC) in the UK, and Reggio Emilia (REG) in Italy. (Please refer to the map in figure 2.1).

The project participants develop five main services:

1) EV-Charging Station Management (indexing and disclosing cs information)
2) EV-Efficient Driving (advice to stretch the batteries use)
3) EV-Trip Management (Multi modal transport advice)
4) EV-Sharing Management (Sharing of electric vehicles like electric cars and scooters)
5) EV-Navigation Management (Navigate, including all the witty information an electric driver needs).

More detailed information about the services is found in the next chapter. More general information about the project can be found on the project website, www.smartcem-project.eu.

This deliverable

These are the smartCEM Implementation Guidelines. The reader will be given guidelines on how to implement one or more of the 5 smartCEM services, in new locations.

Implementing the services within the framework of the smartCEM project has yielded much valuable experiences and taught the project-team lessons. These lessons learnt and experiences, form the basis of these guidelines.

Target audiences like local authorities and service providers will find this document useful for the implementation of similar services in their cities.

Reading guide

This document is divided into five main chapters, being the Business Cases (Chapter 3 through 7). Each of these Business Cases focusses on a main service and one or more related services that have been additionally implemented in that pilot site location. (For more information, please refer to the next chapter, chapter 2).

Before the guidelines commence, chapter 2 introduces the structure of the Business Cases and the approach of how these guidelines have been composed. Also the context of the business cases is addressed.

Following the main Business Cases, there are two separate chapters (8 & 9) about respectively the smartCEM Mobile Portal and the EV-Policy tool.

Special attention is given to the perspective of the end-user. This is done in separate “End-user paragraphs”. The same goes for the aspect of environmental sustainability, since the ultimate objective of the smartCEM project is to increase the electric mobility uptake in order to lessen the burden of mobility on the environment.

Finally there is the conclusion containing recommendations for local authorities and service providers.

Please also note that at the end of the document there is an index, to make the information easily accessible.

Relation to other WP 6 Deliverables

This deliverable is mainly and closely related to D6.5 “Deployment Barriers and solutions” and D6.6 “Business Modelling”, that will also be published by the smartCEM project, respectively in December 2014 and February 2015.

- Where D6.5 “Deployment Barriers and solutions” looks at separate barriers and their solutions and the classification of each of these barriers, this deliverable looks at the process of implementation of business cases. In a business case, several barriers may have arisen and been solved, but the focus is on the actual implementation-process.
- And while D6.6 “Business Modelling” is looking into business cases and thus the market viability, this deliverable covers the practical implementation of them.

Chapter 2

Approach and structure

2. Approach and structure

This chapter explains how the smartCEM services, the Business Cases and Pilot Sites relate to one another.

Services

In the smartCEM project, 5 services have been implemented:

1) EV-Charging Station Management

   The station manager will maintain an advanced management central point of descriptive data of the charging stations available at each SmartCEM deployment site. This will present a uniform interface to the rest of the SmartCEM services that need location and attribute data for the charging stations. Also a set of recommendation for further implementation will be provided.

2) EV-Efficient Driving

   Miss V is driving an EV with a smartCEM system which evaluates her driving style taking into account the EV characteristics. This service will provide Miss V with the necessary information in order to maximise her driving efficiency and eco-driving-style.

3) EV-Trip Management

   Mr Z is planning to use public transport to go from location A to location B. He is using a WEB journey planning system which shows the best multimodal public transport combination for a given journey. This tool also provides car-sharing or scooter-sharing transport mode as part of public transport. The planner will also allow Mr Z to book and pay the EV from the system.

4) EV-Sharing Management

   While Mr Z is driving his EV, the on-board device is recording and sending vehicle information from data loggers to the infrastructure. This information is vital for the other services and existing modules and the classic sharing, the sharing 2.0 and the business fleet sharing service.

5) EV-Navigation Management

   Mr Z drives an Electric Vehicle (EV) with smartCEM equipment. The driver programmes the destination on the on-board unit, which displays the entire route, which was calculated to suit electric vehicles. The device will also show the location of charging points in order to make charging as flexible, secure and convenient for Mr. Z.

Pilot sites

The implementation has been done in 4 pilot sites. smartCEM services can be implemented stand alone, as a single service, but also combinations can be made. In the 4 smartCEM pilot sites, most of the 5 services have been combined, meaning that one single device features more than one service, like a navigator that also provides efficient driving advice.

Figure 2.1 smartCEM pilot sites

Business Cases

This document is structured around 5 "Business Cases":

A	EV-Sharing	
	A1)	Flexible (One Way) e-Vehicle Sharing
	A2)	Classic (Round Trip) e-Car Sharing
	A3)	Electric Business Fleet Management
B)	Cross regional Charging Station Management	
C)	Unique Service Offering	

These 5 business cases have been implemented at the 4 pilot sites of the project. Each of the business cases is primarily and mainly a representation one (or two) of the 5 smartCEM services. However the remaining services have often also been implemented at each location. One could see the 5 smartCEM services as a "Toolbox" that additional services can be picked from at ones desire. Table 2.1 on the next page provides a schematic overview of these business cases, the pilot sites and the "services toolbox".

Business case		Pilot Site	EV-Charging Station management	EV-Sharing management	EV-Navigation management	EV-Efficient driving	EV-Trip management
			smartCEM Services Toolbox				
EV-Sharing	A1) Flexible One Way Sharing	Barcelona (E) BCN	Not yet	Main	Main	Additional	Not yet
EV-Sharing	A2) Classic Round Trip Sharing	Gipuzkoa (E) GIP	Not yet	Main	Additional	Main	Main
EV-Sharing	A3) Electric Business Fleet Management	Reggio Emilia (I) REG	Additional	Main	Main	Main	Not yet
B) Cross Regional Charging Station Management		Newcastle (UK) NEWC	Main	Not yet	Additional	Additional	Not yet
C) Unique Services Offering		Any	Optional	Optional	Optional	Optional	Optional

Table 2.1 Schematic overview of business cases and services toolbox

2.1. Business cases context

The implementation guidelines in this deliverable are intended to present as many of the details on implementing the services using practical experience from the sites. This chapter intends to take a more generalized view of the services in order to broaden the scope on which aspects of the services may be relevant to business cases at other sites and after the project.

The business cases

From the business case perspective there are three basic groups that can be considered when asking the question who is responsible to support the usage of smartCEM services after the project is finished. These are

- the local mobility providers such as Going Green[1] (BCN) or other Car Sharing-Operators,
- the cross-regional service providers such as Charge-Your-Car[2] (UK) (charge station management)
- and finally the Technology Providers themselves that could offer variations of the services to customers even in alternative applications other than EV usage, e.g. Location-based Navigation tailoring.

End-user perception

It should also be mentioned that smartCEM services may also have two faces to the final user. One may not ever be seen by the user, e.g. in the case of the electric scooter-scheduler (WDM), but the other may have a direct interaction and hence perception by the user, e.g. EV-Navigation. Thus some of these services may operate in a stand-alone mode, while other would be combined as building blocks that form complete packages provided by a service company, such as the Electric scooters in Barcelona provided by Going-Green.

Instances to mobility providers

In the case of the local mobility providers there are also two views of these organisations:

- Those service providers that offer access to open “public” fleets such as car sharing or electric scooters. And even public transport providers;
- and those providers that manage municipal fleets that are restricted to use by the employees (a captured user group);

Looking at these alternatives, the focus of smartCEM services from a business point of view may be different for these two alternatives. The car sharing provider may see a priority with the trip management and the ease of booking, reserving a vehicle, whereas the service provider for managing the municipal fleet will

[1] For more information about Going Green, please refer to paragraph 3.2.1.
[2] For more information about Charge Your Car, please refer to paragraph 6.1.1.

probably put a priority on efficient driving and maximum utilisation of the fleet. Both of these priorities are not limited to one site of implementation but common drivers for these systems throughout Europe. However they will always rely on a local provider, who is familiar with the specific user needs as well as the local conditions and regulations that must be observed and followed when setting up the system.

Standardisation and economy of scale

In the case of cross-regional service providers such as charge-station management it makes sense to set up system services in as many areas as possible and rely on standardisation to ensure it has the same operating characteristics throughout the region(s). From the business case context this has two positive effects since it will take advantage of scale economies (re-using one-time programming efforts, incl. maintenance) as well as acting as an enabler for cross-regional interoperation. This directly benefits user acceptance even if the battery electric vehicles are seldom used for cross-regional travel. These providers would generally be providing services such as charge-station management that may require some fine tuning at the local level (e. g. acceptable walking distances between charge-station and final destination, but in general the service of guiding the driver should be based on principles that are valid in every region: The service itself operating by means of coordinating the station management (which station are available at which conditions) with navigation (how to actually find the suggested charge station).

Technology providers

Finally the technology providers themselves may see opportunities to provide their service blocks directly to an end-user such as a private driver or even the layer of management above the drivers in the municipality. This approach to the business case perspective assumes that there is an entrepreneur who is willing to take the business risk and make decisions on how the system is supposed to run to provide a user benefit. The technology provider supplies the necessary tool in the form of services that the entrepreneur bundles into a concept such as electric scooter sharing. In some cases such as EV-Navigation, the technology provider, who has provided such a building block to Going Green (local mobility provider), may find that the service can also be provided to private users independent of the sharing system and local specific requirements. Thus the technology provider may move in the direction of a cross-regional provider. The difference is that the cross-regional provider is providing a concept that relies on a business case utilizing several services. The technology provider would focus primarily on the single technology offering.

Chapter 3

EV-Sharing
Flexible one way sharing (Case A1)

3. EV-Sharing > Flexible One Way Sharing (Case A1)

3.1. Business case overview

What	Development of an electric scooter open sharing system by Going Green, where smartCEM services are more in the background
Pilot site	Barcelona, Spain (BCN)
Main smartCEM service	• EV-Sharing management • EV-Navigation management
Additionally implemented services	• EV-Efficient driving
Number of vehicles involved	45
Number of charging stations involved	0 (as a battery swapping strategy has been chosen); 141 charging stations for electric motorcycles are available in the city
Not implemented	• EV-Charging station management • EV-Trip management

3.2. Main service: EV-Sharing management

This paragraph 3.2 is about the flexible one-way sharing of electric scooters.

3.2.1. Organisation

The implemented service is a one-way sharing scheme with electric scooters. This is substantially innovative compared to traditional round-trip sharing schemes, where trips must start / end only at given charging stations. In the case of Barcelona, the user has many more levels of freedom to request availability for a given trip, starting at 'A', ending at 'B', where 'A' and 'B' are not (necessarily) charging stations. Or also, the user can rent an electric scooter for a given period of time, with no fixed destination / drop off location.

The service is operated by Going Green, with smartCEM partner Creafutur having implemented the core (software) part of the EV-Sharing management service.

Name	Role
Going Green	**Service Provider** Operates the so called “MOTIT” service, runs the back-end server (including the communication gateway with the electric scooters / the data-loggers, the user management, booking, invoicing, etc.); maintains the electric scooters fleet (recharging / battery swapping, technical maintenance and repairs); incidents management.
Creafutur	**Developer** Has implemented the “Workflows and Demand Manager” software component (WDM), which is the core component in the Going Green back-end server, that implements all the business logic to manage the fleet of shared electric scooters under the “open” scheme, meaning that users can freely use the electric scooters without the need to start and end trips at given charging stations. The WDM also takes care of re-distributing the fleet (by anticipating the expected demand of vehicles, or incentivizing users to drop off electric scooters at certain locations), assigns vehicles to users, monitors the SoC. The WDM is delivered to Going Green under a SaaS (Software as a Service) scheme, where the WDM interacts with the needed software components of the Going Green back-end server, database, etc.

3.2.2. The service

The “Motit” Electric scooter sharing service is described in 5 steps.

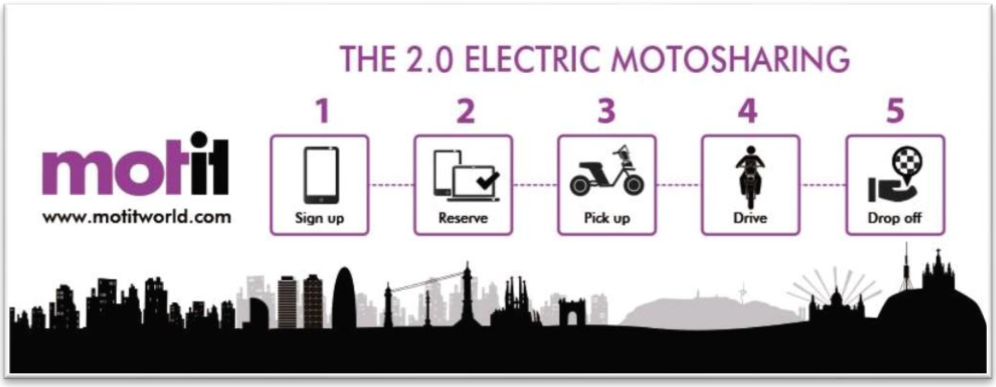


Figure 3.2.2.1 The five steps of using a “Motit” electric scooter

1. Sign up

Users must sign up for the "MOTIT" service, whether on their web page (app.motitworld.com/doRegisterUser) or through the smartphone app:

- Android: play.google.com/store/apps/details?id=es.goinggreen.motit.usuario;
- iPhone: itunes.apple.com/es/app/motit/id600486078.

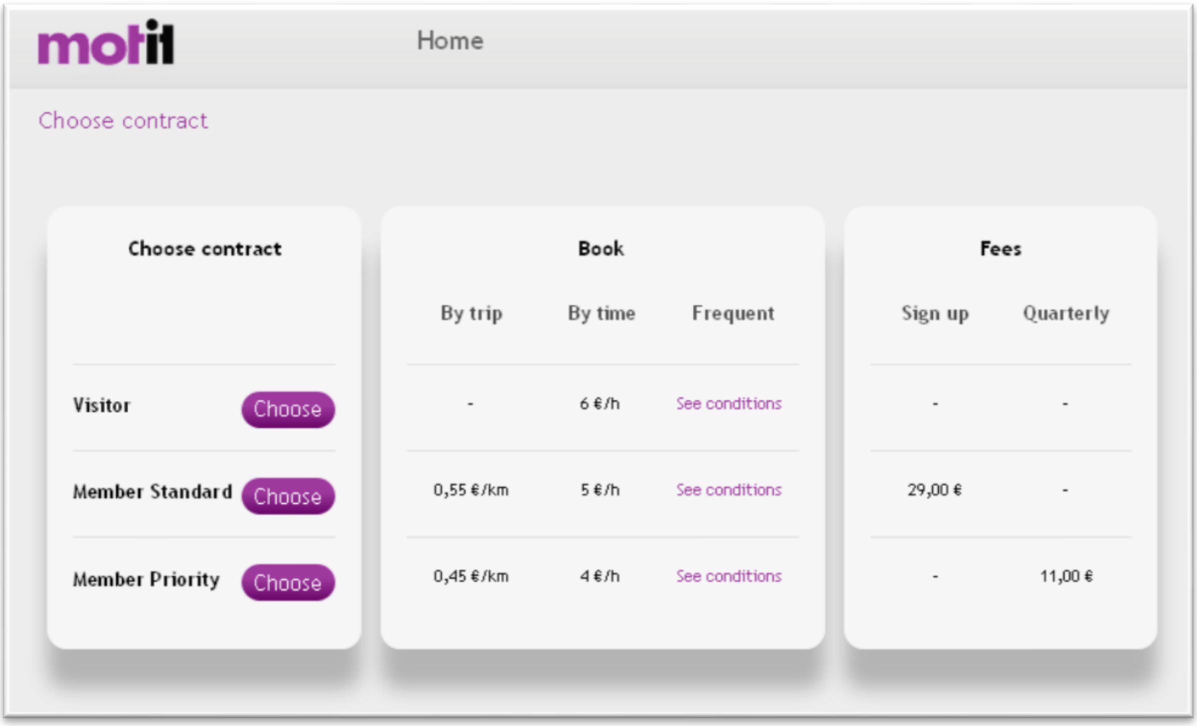


Figure 3.2.2.2 Pricing schemes of the "Motit" service contracts

Users are requested to sign up for one of the three available membership schemes.

"Visitor" is for occasional users, only allowing for a time-based usage (see figure above); the other two membership schemes, "Member Standard" or "Member Priority", are intended for more frequent users, with different pricing schemes and the possibility to book an electric scooter for a time-slot (e.g. *I need an electric scooter for 2 hours*) or by trip (e.g. *I need an electric scooter to go from 'A' to 'B'*). Frequent trips are also allowed (e.g. *I need an electric scooter daily, Monday to Friday, to go from home to work in the morning, and work to go home in the afternoon*): the WDM will determine whether the system can guarantee availability of an electric scooter under the requested conditions (intended time-frame and origin-destination) and, where possible, automatically allocate bookings in advance for the user. This guarantee poses quite a constraint on the fleet of electric scooters. As the volume of scooters increases this becomes easier to manage. It must be noted that at this stage, the start and ending points of all trips must be in the service area's (as shown in Figure 3.2.3.2), making it somewhat easier to manage. Fares for frequent reservations are cheaper, because it ensures more usage of the service (obviously), and because it helps the WDM to manage the fleet better, i.e. there are less levels of uncertainty about how the electric scooters will distribute in the city (location), and is gets far more easy to allocate resources and comply with service requests from the users.

FREQUENT RESERVATIONS

If you frequently perform the same trip, the same days of the week at the same time, we offer you a flat monthly fee. This type of reservation is only available for partners and members.

	One way	Round trip
5-7 days per week	36 €/month	54 €/month
3-4 days per week	22 €/month	38 €/month
2 days per week	14 €/month	27 €/month
1 day per week	7 €/month	13 €/month

Figure 3.2.2.3 Pricing of the “Motit” frequent reservations

In frequent reservations, Going Green will daily push the notification of the trip to the user smart phone (where exactly the allocated electric scooter is, at the agreed start time, and its license plate).

2. Reserve

Once logged in, users must reserve the electric scooter. “By trip” and “By time” reservations are done on a “here and now” basis. “Frequent trips” and “Touristic trips” can be reserved a reasonable amount of time in advance. Upon entering the reservation details, the WDM might determine that the user would better drop off the electric scooter at an alternative destination (where there is another user who has requested an electric scooter -could be a frequent user, for example), or that there is an available electric scooter not far from the requested initial location; in these situations, the WDM will send alternative options to the user, together with an incentive (discount in the standard rate). The user can decide whether to accept the alternative offered or not.

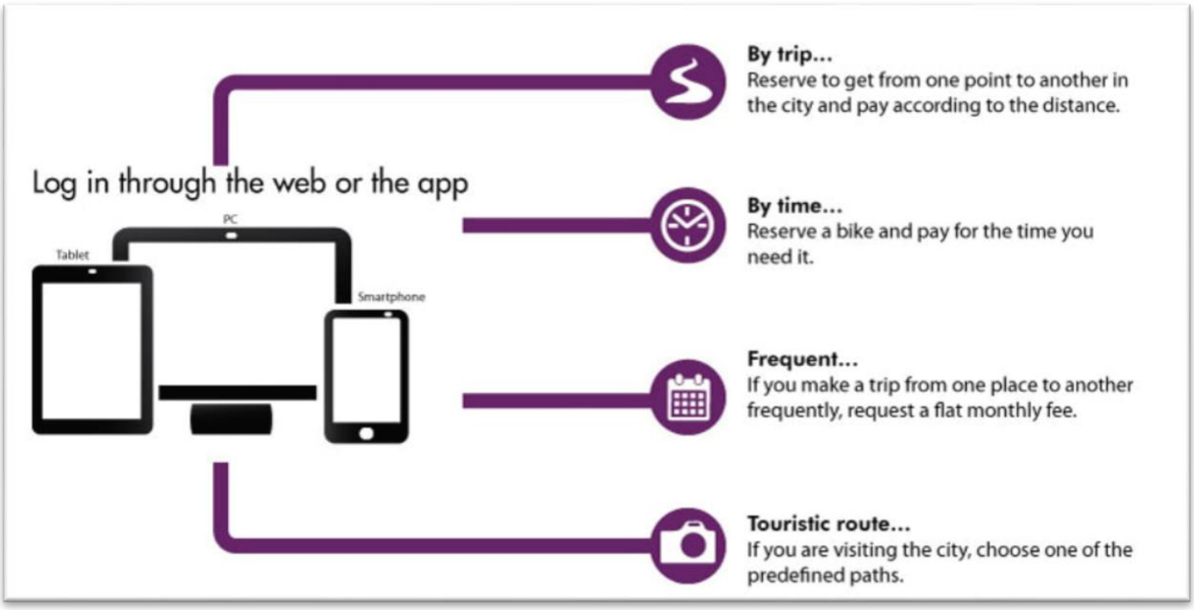


Figure 3.2.2.4 "Motit" reservation options

3. Pick up

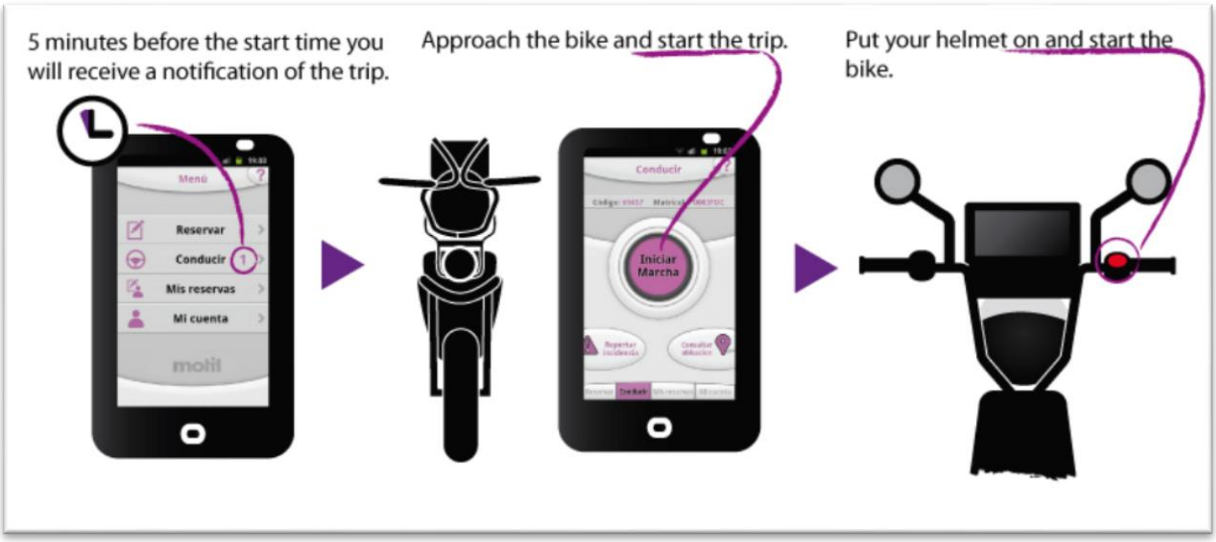


Figure 3.2.2.5 How to pick up a "Motit" electric scooter

Figure 3.2.2.6 Activate the "Motit" electric scooter

4. Drive

If the user needs to make an intermediate stop, he/she must press the red On-Off button on the electric scooter handlebar; to initiate the trip again, the user must press the "Drive" ("*Iniciar Marxa*") button again on his/her smart phone, and then turn on the electric scooter. Only the user with the current valid reservation can start-stop the electric scooter by means of the On-Off button, as the process must always be paired with the instruction given by the smart phone, which is the "key" to using the service.

Figure 3.2.2.7 The start button to activate the "Motit" electric scooter

5. Drop off

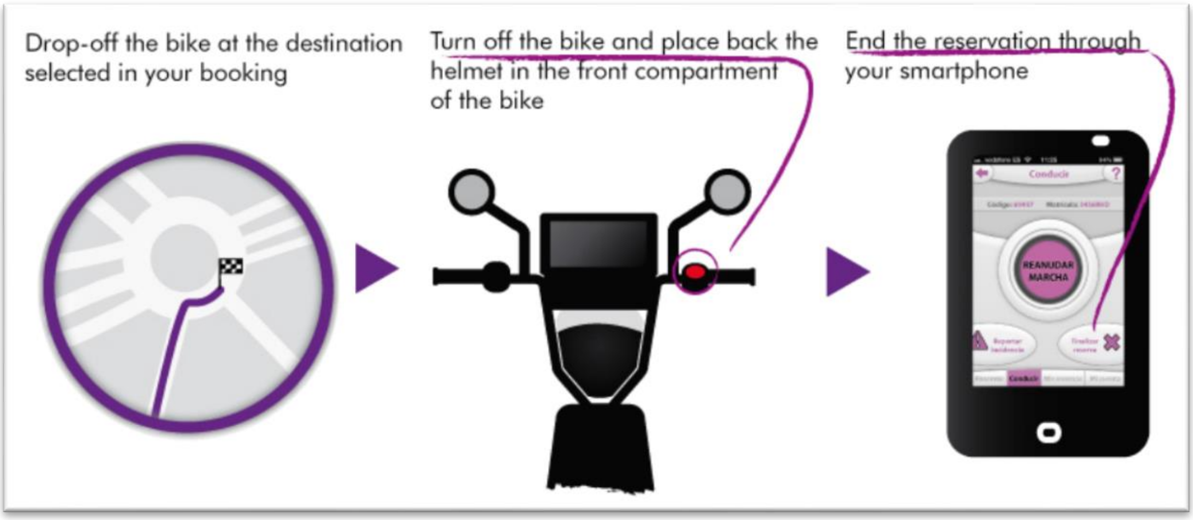


Figure 3.2.2.8 "Motit" electric scooter drop off instructions

3.2.3. Implementation process in BCN

The most innovative part of the "Motit" service implemented in the Barcelona pilot site, is the smartCEM EV-sharing engine (the WDM software component), which facilitates a flexible one-way sharing scheme. This has proven to be very challenging, and some technical and strategic decisions had to be taken. The main ones are summarised as follows:

Service areas

As the user-base grows it gets more complicated to efficiently manage the fleet

- location of the electric scooters at every time;
- assign users to available electric scooters – right now or in the future;
- monitor the SoC, etc.

while ensuring a good service level (meaning that electric scooters should be available, most of the time, to cover all the mobility needs of the registered users).

Growing the fleet (adding more electric scooters) and the user base is in the operator's business plan, but the way to grow towards a fully implemented one-way sharing service has required the implementation of an intermediate stage, in which users can pick-up and drop-off electric scooters only at a number of predefined "service areas", where most of the current users (and their mobility needs) are concentrated:

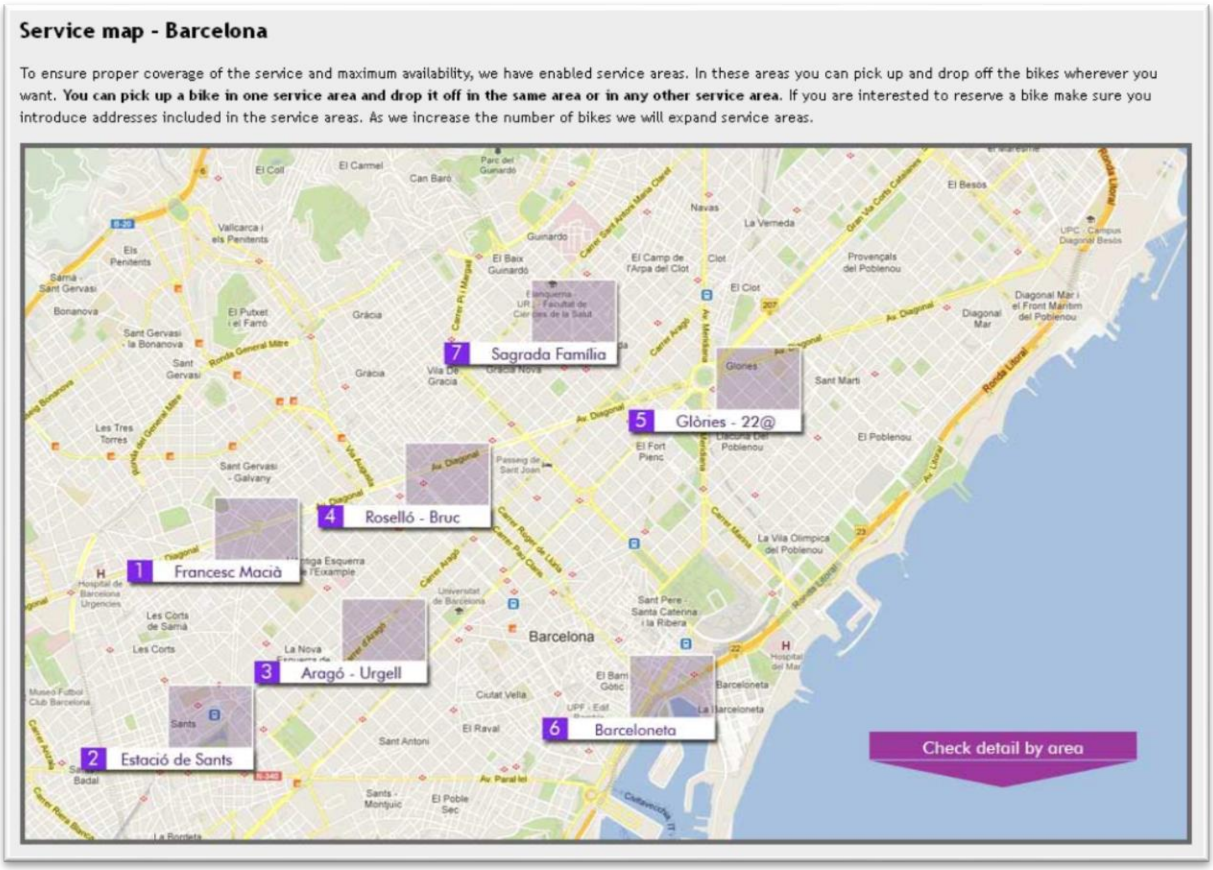


Figure 3.2.3.1 Seven "Motit" electric scooter service areas

Figure 3.2.3.2 Detail of a "Motit" electric scooter service area

It is planned that additional service areas will be added, as the number of users grows, and also the number of electric scooters, until the city is fully covered by the service.

Defining service areas is helpful in order to concentrate the electric scooters where (most of) the users are (or are expected to be). Therefore, the service areas have been defined based on studies about mobility patterns by motorcycle users in the city. When needed, there is a Going Green staff member available to transport the electric scooters (with a van) to where the service requests are placed, especially for scheduled reservations – frequent use, where Going Green guarantees, by contract, that there will be an available electric scooter at the agreed location and time. The scooter will be in place 15 minutes before the actual reservation. And a message is pushed by the WDM to the user to notify him/her about the upcoming reservation, the location of the scooter and the licence plate of the scooter.

From an operational point of view, this might seem costly to transport scooters with a van, and it is. In order to mitigate the operational costs to redistribute the fleet, the WDM is capable of generating “incentives”, in that users get a discount on the standard rate, when they are willing to drop the electric scooter off at a certain location (which is reasonably close to destination that the user intended to drive to initially) that is more convenient for the operator. It has to still be investigated what kind of incentives will be effective. 10% on € 2,- will probably not motivate many users to divert from their plan. 50% on a longer trip of € 4,- may have a result.

In the midterm, it could also happen that users are offered incentives to drop off electric scooters at charging stations, if their destination is not too far from a charging station and the WDM determines that the SoC is insufficient to allow for the next reservation. (At this stage, the operator provides full batteries by swapping them).

Figure 3.2.3.3 Example of an incentive (discount) sent to the user

GPS accuracy

Accuracy of the GPS location of the electric scooters is posing problems where the GPS coverage is poor. Users receive a notification on their smart phone "Motit" app, with the location of the assigned electric scooter (on Google Maps), but sometimes the actual location is a few metres away from the location sent to the user. Normally, the user will find the electric scooter easily, but sometimes there are issues.

Going Green has mitigated this problem by installing more precise GPS receivers in the electric scooters and has developed an algorithm to better determine their location.

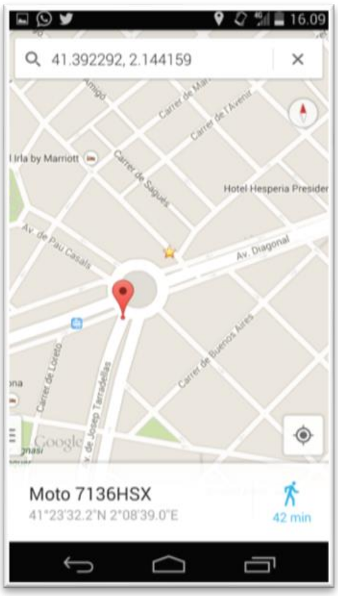


Figure 3.2.3.4 Location of electric scooter (with license plate number)

Suitable city

It is worth mentioning that smartCEM partner Creafutur conducted a market research study, previous to smartCEM, in which it was evaluated whether a service like "Motit" could be viable in a city like Barcelona. Needless to say, the conclusion was that Barcelona is an ideal city to launch such a service for several reasons, including (but not only):

- The motorcycle is one of the preferred personal modes of transport in Barcelona, with more than 300.000 PTWs currently in the city.
- The city is hilly, such that the motorcycle is a very flexible and convenient mode of transport when compared to pedal cycles. It is easier to park a scooter than a car and it (usually) gets you faster to your destination. In Barcelona, even electric energy in public charging stations for EV's is free of charge (for the moment), although "Motit" users are not yet requested to recharge their electric scooters.

- Focus Groups among (conventional) motorcycle users were conducted, resulting in a very positive predisposition to adopt a flexible one-way sharing scheme. The vast majority of the interviewed individuals would become “Motit” user, as they foresee that the service would cover their mobility needs.
- There is a strong local support from the Barcelona municipality, with policies and incentives to foster electric mobility initiatives (see www.livebarcelona.cat).
- Barcelona citizens have very well adopted another sharing service with bicycles, the so called “Bicing” (www.bicing.cat). In other words, there is already a well-accepted culture of sharing a two-wheel vehicle to get around the city.
- Barcelona is a dense, compact city of 10kms by 10kms. The typical range of an electric scooter is sufficient to allow for multiple rides per day, being the most common urban trip of about 4-5 Km. As a reference, the average range of the “Motit” electric scooter is between 40 and 60 Km (depending on driving style, traffic congestion, etc.), which allows for a usage rate of about 8-10 trips per vehicle per day.
- It has a sunny climate and low rainfall.

Clogging

The provider of the “Motit” electric scooters was asked whether a pattern of clogging is beginning to show up. In other words that electric scooters are often left in a certain place, and people make their way back through other means of transport. This is not the case (yet). The reason that there is no pattern visible at this stage, is probably related to the current amount of electric scooters in the pool. The provider is monitoring this phenomenon and, in the future when needed, has the option to apply incentives to users who drop electric scooters at less favourable locations.

Weather

Since it hasn’t rained much in Barcelona since the introduction of MOTIT it is not possible to examine possible changes in pattern due to adverse weather.

In those cities where there is higher rainfall, providers could consider alternative models along the lines of the electric BMW C1 (an electric scooter version of the discontinued C1 was prototyped in the eSUM project www.esum.eu).

Figure 3.2.3.5 BMW C1 electric

This BMW has the added advantage that there is no need to share a helmet (with strangers), because a helmet is not obligatory.

Promotion of the "Motit" electric scooter service

The "Motit" service is promoted by Going Green through the following channels: The Motit website, Newspaper advertorials, Magazine advertorials, Professional (B2B) literature, Press releases, Twitter, Facebook, Outdoor (poster) campaigning, and word of mouth promotion.

Also test-drive-opportunities were given to participants of public dissemination events. On 2nd April 2014, in collaboration with RACC and Going Green and other SmartCEM partners, Barcelona Municipality held the SmartCEM Barcelona pilot Launch event, a one-day workshop attended by some 80 people, with presentations and opportunities to test-ride the e-scooter sharing service. The event was promoted by a mailing of Municipality contacts, as well as the LIVE and RACC websites.

Finally there were presentations at congresses and seminars (e.g. presentation of the e-scooter sharing at the ITS Europe Dublin last year and the SmartCEM consortium meeting in December 2013).

3.2.4. Implementation in a new city

Going Green has set MOTIT up with a view to franchising its roll-out to other cities and the following figure shows the responsibilities that the local partner would be expected to assume, as well as the central support that Going Green offers.

Figure 3.2.4.1 Going Green offer

Operators intending to implement a one-way sharing service with electric vehicles like the “Motit” service, in a different city or region should take the following aspects into account:

Mobility study

A Mobility study is much needed and strongly recommended. No city is equal to another, neither “comparable”. Mobility patterns need to be thoroughly assessed, and the potential users of the service must be clearly identified:

- Who are they?
- Where do they live?
- What is their age?
- Are they tech-savvy?
- Which are their typical trips in the city?
- What are their mobility needs?
- Would they use such a service?
- With motorcycles? Cars?
- How much would they be willing to pay for the service?
- Etc.

Current modes of public / private transport available in the city must be included in the analysis.

Potential competitors

- Are there other sharing services available in the city?
- even if not exactly with the same approach or type of vehicle

Local incentives

- Are there local incentives favouring the implementation of electric mobility services (e.g. free parking for EV's, free electric energy …)?
- Are there specific local policies?
- Is there government funding available?

Other

Other aspects that the study should tackle:

- Are EV's fit for the service (especially regarding battery range for the expected use – mobility needs)?
- Is there enough charging infrastructure in the city (to minimise the transport of recharged swappable batteries, or for direct on-street re-charging)?

The study should provide valuable inputs to the business plan, i.e. expected number of users (and how the user base will grow), required investment (hardware: number of – which - vehicles mainly; other activities needed: marketing campaign, etc.). The study might conclude that the service must be implemented progressively, as in Barcelona, starting from a limited number of "service areas" (and determine which these "service areas" should be). Or, if the use case has proved to be profitable in Barcelona, the implementation strategy could be to launch with a rather big number of available vehicles and a single service area covering a large part of the city. In any case, the business plan will determine the required investment for each of the approaches.

It is recommended that municipal policymakers (together with service providers) try to oversee the various implications of introducing a sharing service that does use public charging stations, as opposed to a battery swapping program. Potentially a sharing 2.0 service can be very advanced, with a WDM (Workflows and Demand Manager) that directs end-users towards returning a scooter back at any charging station, while leaving the choice to do so, up to the user. But the main complication in this is, that the charging station can't be solely be available to the sharing service, because then they wouldn't be public anymore. Since it is possible to monitor the network of charging stations, a solution could be, that scooters are directed sooner than necessary to available charging stations, and that if (unexpected) the station is occupied in those last 5 minutes of the trip, the user is asked to leave the scooter unplugged. The scooter would then still be able to make one or two more trips.

GPS coverage

On the issue about users experiencing issues to locate the booked vehicles, GPS coverage should be assessed in the city where the service will be implemented, in order to clearly identify which areas of the city have poor GPS coverage. An error of some metres in the actual location of the vehicle (due to the GPS accuracy) should not be a problem if there are not significant obstacles (e.g. a building) between the user (at the supposed location of the vehicle) and the vehicle. Goal is that the user can easily find the vehicle, and each situation should be studied with real field tests (in any case, a telephone hot line is absolutely needed, so that users can call and get precise instructions on where the vehicle is located). A possible solution would be that the users would be requested to pinpoint, on the map on their app, where exactly the vehicle has been drop off after a trip, and make this step mandatory in order to complete the check-out.

Management of incidents

smartCEM recommends to not overlook the subject of “Managing incidents”. What if a vehicle is damaged while in use? Or what if the vehicle is scratched at the point the user wants to start the use? This could be an option in the app on the smart-phone, or it could be implemented through the use of the call-centre. Also assistance and tow away service needs to be thought about, which is in the case of the “Motit” electric scooter the same as the service-van that transfers the scooters to the various locations.

Availability Creafutur

Creafutur is available to provide further advice. They can be contacted if any potential implementing party wants to find out more. Going Green can be contacted through Creafutur. Please refer to the contact list in this document.

3.3. Main service: EV-Navigation management

This paragraph 3.3 is about navigation on the “Motit” electric scooters.

3.3.1. Organisation

The service is operated by Going Green, with smartCEM partner PTV having implemented the EV-Navigation component.

Name	Role
Going Green	**Service Provider** Operates the back-end of the “MOTIT” service on which the EV-Navigation service runs. It handles reservations, queries the EV-Navigation each time a trip-based reservation has been placed by a user and forwards the route details back to the OBU.
PTV	**Developer** Has implemented the EV-Navigation service. Has provided an SDK for the integration of the service into Going Green OBU User Interface.

3.3.2. The service

The implemented service is offline[3] turn-by-turn navigation on the electric scooter OBU:

Figure 3.3.2.1 Navigation on the "Motit" electric scooter

There are three use cases for booking an electric scooter in the "Motit" service:

- Route-based reservation. The users must indicate their origin-destination; this information is sent to the Going Green back-end, where the EV-Navigation service runs and the route is sent back to the OBU. When the user arrives at the vehicle and starts the engine, the route is displayed and visual (not audible) turn-by-turn instructions are provided.
- Time-based reservation. The user receives no navigation advice; neither can interact with the tablet as with a conventional GPS navigator device. Still, the map is shown together with the position of the vehicle.
- "Touristic routes". There is a set of predefined routes the user can choose from; in each of these the navigation service will guide the user through the well-known tourist attractions in the city.

3.3.3. Implementation process in BCN

A main challenge while implementing the EV-Navigation service has been to adapt it to a User Interface where other data (obtained from the data-logger) is also displayed. An available SDK provided by PTV had to be used, which posed some technical difficulties. This means that a potential operator of this service must have software development expertise.

[3] Off-line in the sense that the maps are in the navigator's memory and aren't kept updated on-line.

Users are never guided (for now) to charging stations because a battery-swapping strategy has been implemented instead. If this would change in the future, alternative routes (if SoC drops below a certain level, for example) could be pushed from Going Green server to the OBU navigator. Charging Stations (Points-of-Interest) are very easy to upload to the EV-Navigation service through the EV-Charging Station Manager service implemented by TeamNet.

Promotion of the EV-Navigation service on the "Motit" service

The Navigation service on its own is not promoted because it comes along in one package with the rest of the "Motit" service.

3.3.4. Implementation in a new city

The easiest way to implement the EV-Navigation service is by using PTV's API. Different features of the service can be added or configured through the API, but there is no control over the User Interface provided by PTV (apart from some customizable look & feel options).

If the service should be presented in a customized User Interface (typically together with other services / features), then an available SDK should be used.

Decision on whether to provide offline or online navigation is key, and is much related with the expected use-cases and type of vehicle for the (EV-sharing) service (e.g. in an EV car, interaction with the EV-navigator by the user could be enabled; this is a feature that has been disabled in the electric scooters to avoid vandalism). It has also impact in the data transmission costs (for online navigation), thus in the operational costs to run the service.

The information about charging stations (like GPS position, name, owner, type of plugs) are very easy to upload as reachable POI for the Navigator, to the charging station manager service developed by TeamNet.

3.4. Additional service: EV-Efficient driving

This paragraph 3.4 is about a separate website with efficient driving advice. The users are notified by e-mail that they can view it as an option.

3.4.1. Organisation

Name	Role
UNEW	**Service Provider** Receives data (bus current, speed, throttle position) at a 1-second sampling rate from the electric scooters. Data is stored in the smartCEM Central Database and EV-Efficient Driving algorithm has been developed that takes this data, processes it and provides feedback to the driver through a website.
Going Green	**Service Provider** Has upgraded the data acquisition policy of the data-logger in order to take data needed for efficient driving analysis at a 1-second sampling rate (default is 1-minute sampling rate). Data is taken and recorded at local memory; right after a trip has finished, when the electric scooter is idle and waiting for the next service request, data of the recent trip is compressed and sent to a FTP resource which has been set up by Idiada.
Idiada	**Service Provider** Receives data from the electric scooters, stores in local database, conforms data and sends to UNEW smartCEM Central Database.

3.4.2. The service

Users of the “Motit” service will be granted access to a website where statistics and eco-driving advice is provided based on data from their previous trips.

Going Green invites their users by e-mail to join the service and eco-drive based on the recommendations provided in the web-based EV-Efficient Driving service.

3.4.3. Implementation process in BCN

Data acquisition policy of the data-loggers was modified from a standard 1-minute sampling rate to a 1-second sampling rate. Standard data sampling works at a 1 minute sampling rate for everything except the EV-Efficient Driving service, where data sampling must be much more intensive (it is not possible to derive a behaviour pattern from speed samples taken once every 1 minute). While other data is taken every 1 minute, only the following data is taken at every second: “bus current”, “speed” and “throttle position”.

3.4.4. Implementation in a new city

Data

Very intensive acquisition of data is needed in order to derive efficient driving advice (normally, there will be some technical adaptation needed in the data-logger, if not using the “Motit” electric scooter for the service). This has some implications that need to be considered on the technical side, but also in terms of (communication) costs to run the service. These need to be considered in the business plan.

Solutions are:

- To compress the data;
- To burst send the data in packets every 15 minutes;
- To only send data when the vehicle is not in use.

Different implementations

The EV-efficient driving service can be provided in different implementations, depending on the type of vehicle (motorcycle, car) and the driving environment (urban, interurban):

In the case of a motorcycle or electric scooter, the recommendation is that the eco-driving advice is provided post-trip for two reasons: it can be highly distracting (thus, dangerous) to provide Real-Time (on-trip) eco-driving advice (plus, communication costs would increase) and it is not likely that the users will (positively) react to these recommendations while driving, as the dynamics of driving a motorcycle make it difficult to combine with paying attention to eco-driving feedback on a screen.

In the case of a car, Real-Time (on-trip) eco-driving advice does make sense, but then a User Interface should be designed and implemented in the OBU in order to get the feedback from the UNEW EV-Efficient Driving back-end engine.

Incentives

Last but not least, it is worth to mention that it is very difficult to get the users drive more efficient (even if the provided feedback is very friendly and comprehensive) under a sharing scheme. If the vehicle does not belong to the user, and the user pays the same for the service regardless of his/her driving style then most of the time users will want to get around as fast as possible, thus driving inefficient.

There must be ways to motivate users to change their driving behaviour besides the sole “green” attitude. A possible way to achieve this goal would be to use the “incentives” strategy explained before in order to engage users to drive more efficient. Of course, providing discounts in the service fare to the users that drive more efficient should be well balanced with savings on the operator side in terms of cost of recharging or, maybe, costs related to eventual battery swapping events, partially caused by users that discharge the battery very rapidly due to aggressive driving.

Another solution could be the “Gamification” of the challenge to drive efficient. A ranking of most efficient drivers (identified per user account) could motivate the efficient use of the vehicles. And of course a combination of incentives and the game could be implemented, or a monthly price (in the form of a service voucher) could be awarded for the winners or top-three drivers.

Again, this should be included and analysed in the business plan.

3.5. EV-Charging Station management

This is paragraph 3.5 about a tool to upload CS to the EV-Navigator.

3.5.1. Organisation

Name	Role
TeamNet	**Developer** Has implemented the tool to upload CS into the EV-Navigator.
PTV	**Service Provider / Developer** Provides the EV-Navigator service and has cooperated with TeamNet in order to develop the interface for easy plug-and-play upload of CS data.

3.5.2. The service

EV-Charging Station management has not been implemented in Barcelona up to today. At any time in the future, EV-charging station management could be implemented in Barcelona, into the “Motit” service of Going Green. It would be a logical step to take, as soon as the “Motit” service upgrades from battery swapping to on-street charging. The “Motit” app and the navigation will then be incentivising the user to drive a few (hundred) metres extra and connect the electric scooter to a Charging Station.

Technical implementation

smartCEM partner TeamNet has built the service. It is ready to be implemented. (Please refer to business case B Cross regional charging station Management, chapter 6). Any Pilot site or new city can use it. It requires the following:

- An Excel sheet with table with CS data;
- Uploading that to TeamNet;

Immediately the information will be available in the smartCEM navigator. The information is kept up to date as the CS-provider is uploading it to TeamNet.

Practical implementation

If the electric scooters were to be charged at public Barcelona CSs, then compatibility between electric scooters and the public CSs has to be organised as well. Currently, users of electric motorcycles who recharge at a public CS have to have an RFID card issued by the Municipality in order to open the CS and receive free electricity. The integration with a private service such as Motit, plus future invoicing of the electric energy is something that should be carefully studied, both from a functional side as well as, if required, policy aspects, and also from a technical side (e.g. Going Green will probably not agree to a solution that their users must have an RFID card to access CSs). If RFID solutions are implemented, the use of standardised RFID technology is recommended, allowing for future integration with other RFID card based services. But even better (more convenient for the end-user) is a smart-phone based solution as seen in Barcelona.

3.5.3. Implementation process in BCN

Not yet implemented.

3.5.4. Implementation in a new city

It would be very straightforward and not site-specific to implement the EV-charging station management service in a new city. Because actually it is not implemented in that city, but uploaded from that city to the Teamnet server, that contains the information about the charging stations. To keep the information up to date, it can be uploaded as often as needed. This is done in the form of an Excel sheet with a fixed format.

Exceptions are Real-Time data (such as the availability of CS, etc.) and other features, like the booking of CS, which would need more development than currently available, in cooperation with TeamNet and PTV.

3.6. EV-Trip management

This paragraph 3.6 is about a trip planner that combines public transport with the electric scooter sharing service as an additional mode of available transport, in order to provide more flexibility for the end-user.

3.6.1. Organisation

Name	Role
Going Green	**Service Provider** Runs the EV-Sharing service and the back-end scheduler, which is a needed input to the EV-Trip Planner
Barcelona PT Operator	**Service Provider** There are several PT operators in Barcelona and some PT planners already available.

3.6.2. Implementation process in BCN

EV-Trip management has not been implemented in Barcelona. But it almost was. And it is interesting to understand how this unfolded.

First of all, a multi modal travel service was proposed by RACC to Going Green, the provider of the “Motit” electric scooters. This was soon discarded due to the fact that Going Green didn’t want to propose competing transportation options to their customers, and because they had many other technical priorities that were essential for the service and required their full attention. This could be debated and revised in the mid-term as the “Motit” service gets more (technically) consolidated and (massively) adopted by users. The EV-Trip Planner could be seen by Going Green as a “tool” to get potential new users in their “Motit” service if this mode of transportation would be integrated in the route planner engine. Of course, this would require new developments on the Going Green side, as electric scooters would only be available for a given part of the trip with a previous reservation. But it opens opportunities to have metro-entrances of bus-hubs as frequently used pickup and drop point for the electric scooters, which would contribute to the smooth running of the “Motit” service.

All the above said, in other cities therefore it is a realistic option to implement the Multi Modal travel advice of smartCEM.

Then, as a second option, RACC proposed to Going Green and the Public Transport provider, to present Public Transport alternatives, only if there would be no “Motit” electric scooter available to fulfil the users’ travel request. This made sense to the service provider Going Green and also it was technically feasible.

This option was agreed and the development of it was started. The next question was whether to prompt the PT-alternative to the user immediately when the electric scooter-request could not be fulfilled, or whether to just send the user to the PT-app to get the advice there.

From a PT provider point of view it would be nice to get the potential user to be lead to their website or app. But from an end-user point of view it is much more practical to be presented immediately with the PT option, including timing, bus and or metro stops, without having to go to another app and having to input the travel variables again.

Ultimately, the implementation of the “other mode alternative” was cancelled all together due to unclear reasons. It was probably decided by the management of the PT that it was to be cancelled. Maybe due to the fact that they didn’t want to disclose PT timetable data to outside apps.

Ultimately it is the decision of all involved parties how far they go with the disclosure of their information. smartCEM advices to take this rather further than not. Because it will result in much appreciation by the end-user (when all alternatives are shown) and thus a better uptake. And in the end all parties will benefit from the increase of usage of the sum of different modalities.

3.6.3. Implementation in a new city

It is a business decision of the service provider, whether to present multi modal travel advice to their users. Other modes are competition. But if the operator’s capacity is (almost) reached, it could present an appreciated service.

During implementation in new cities of such a service, the disclosure of PT time table and Real-Time data (which is generally accepted as open data, in any case more and more) has to be clarified in an early stage.

Also the question how to present the data to the user (in the app, the user was already active or in a separate app) needs to be addressed.

3.7. The end-user

As previously mentioned, smartCEM partner Creafutur conducted a market research study, previous to smartCEM, in which it was evaluated whether a service like “Motit” could be viable and be adopted by users of motorcycles in a city like Barcelona. Conclusions of this study led to the actual implementation of the service.

One can rightfully state that Going Green and Creafutur have centralized the end-user in the design phase of their service.

The smartCEM project is (ultimately) about raising awareness and fostering user uptake of EVs. This is why end-user questionnaires have been developed in order to assess user acceptance of the smartCEM services implemented. Feedback gathered from users (user uptake performance indicators) can lead to modifications or adaptations of the implemented services. Like future improvements to the EV-Navigator including features for a more intelligent battery management.

3.8. Sustainability aspects of service implementation

The use of electric scooters being shared represents a light mobility eco-friendly service in a town like Barcelona. The term ‘light’ indicates the use of vehicles in which the ratio between the weight of what is transport compared to the total weight (I.e. vehicle plus driver), is close to equal. The reduction of the weight (and volume) of the vehicle is therefore the first way to improve urban mobility, on both the field of energy (the energy that is required to move a vehicle, is proportional to its weight, especially in low and middle speeds in urban settings) as well as in the field of environment.

The main impacts of the smartCEM services and the consequent use of eco-friendly mobility are twofold:

3.8.1. Reduction of congestion and traffic

The congestions in fact become more frequent and of longer duration depending on the means of transport used. In the case of the Barcelona “Motit” service, the urban transport can be divided into two large categories: collective transport and individual transport. While increasing the amount of available public transport options can improve the use of space and (ultimately) reduce the travel time, at the same time we should act at the individual mobility level. If we adapt our choice of means of individual transport and use compact mobility like scooters and bicycles, it will affect the amount of space a traveling user occupies.

The availability and flexibility of smartCEM “Motit” electric scooters allows the user to choose a simple, fast and accessible way without limitations or constraints of use, which is advantageous.

Another aspect to consider on such light mobility is the occupation of space. In this sense, it is necessary to make better use of existing infrastructure space. The use of electric scooters allows less stress and congestion in cities with historical centres. Therefore it is very important to combine well-organized integrated mobility with means to transport light and compact.

Of course one should also consider multi modal systems that link individual mobility to collective mobility. For example commuting colleagues of a company can travel along transport nodes such as Park & Ride or relevant points such as subway stations or bus stations or parking places from which one can easily access public transport or a shared vehicle.

Everything depends, however, on a strong logistics management capacity, the political will to design and the overview of practical policies for sustainable mobility.

Obviously the use of electric scooters is encouraged by the possibility of being able to move freely on the dedicated lanes for buses and taxis and accessibility in urban areas with limited traffic. The freedom of movement has significant effects on positive decision by the end-user to use electric scooters rather than large vehicles.

Another important variable in the user's choice to select an electric scooter is the possibility, to eliminate the cost of parking in the city. Upon arrival, the user will drop the electric scooter, sign off and is not responsible for it anymore.

Finally, the use of electric scooters reduces dependence on fossil fuels and meets the need and demand of the community to drastically reduce the rate of release of CO_2 into the atmosphere and, in reverse, may serve as an indirect incentive for the production of renewable energy.

3.8.2. Impacts on air pollution

The environmental aspects related to mobility can be divided into two broad categories: local and global ones.

The local category, concerns the pollution resulting from the use and exposure to emissions which we are subjected in our daily lives. These emissions are reduced drastically with electric scooters, when compared to transport with normal engines. Regarding the global aspects, the main concern is the emission of greenhouse gases such as carbon dioxide, which is (amongst other sources) produced by burning fossil fuels.

The combustion of a litre of petrol produces the emission of 2,3 kg of CO_2. So, if in a year one drives 10.000 km with a scooter that consumes 3,5 litres for every 100 km, one produces 3,5 / 100 x 10000 x 2,3 = 805 kg of CO_2 per year.

Studies by CONCAVE / EUCAR / JRC confirm that the production of electricity for electric vehicles takes around 60 grams of CO_2 per km. When driving the same 10.000 km, this would emit 600 kg of CO_2 per year. Other studies show even more favourable differences.

This defines the immediate average savings of emissions using an electric scooter in a city.

It is important to realise that the more the energy mix tends towards renewable energy sources, the less CO_2 is emitted. Ultimately if the electric scooters are charged straight from solar panels, windmills or water-powered plants, the CO_2 emissions of the scooter usage becomes close to zero. The production footprint will however still come with a certain amount of emissions.

The emissions savings allows the improvement of the living conditions of the environment and a reduction of the impact on the urban ecosystem and especially a reduction in social costs due to health care problems. Also, it will reduce the noise and tensions in the immediate surrounding environment.

The electric motor technology allows for a much lower operating cost than vehicles with internal combustion engine. In particular, the benefits arising from the regeneration of braking into electricity gains flexibility in situations of frequent stop and go. In the classical internal combustion engine, during braking, there is a conversion of the kinetic energy into heat energy. The heat will dissipate and can't be reused. While, with the introduction of an electrical system with bidirectional accumulation, this energy can be recovered partially. This definitely improves the operating efficiency of the vehicle and in addition allows the engine to run at with the highest efficiency.

There is also a benefit in terms of the size of the motor. The internal combustion engine takes much more space. Nowadays, drivers express a need for rapid accelerations. To meet this demand, the internal combustion engines must increase power and consequently be designed larger in size. The electric motor, however, has a high mechanical torque (even at zero speed) thus enabling to reduce the maximum needed volume inside the vehicle. With a power smaller than the internal combustion engine it still operated in average working points with higher efficiency.

In the meantime, the market is showing a remarkable development of the technologies that go on board of an electric vehicle - motors, controllers and batteries. These are pushed forward by other business areas in parallel. First of all, the field of communication devices and portable computing. This has required the development of accumulations with specific energies and energy much higher densities. The resulting enhancement is helping to increase the production volumes by attracting new investment on the one hand and reducing costs on the other hand. This will facilitate the penetration and diffusion pushing the development of electric vehicles.

The development of new technology involves the research in the field of batteries. Nowadays about 130 - 150 watt-hours per kilogram is possible to attain. But laboratories are developing new technologies that within a few years can put accumulators on the market of 250 watt-hours per kilogram. In the medium term it will continue to increase to 400 watt-hours per kilogram, which are sufficiently high levels to achieve much more economically competitive vehicles. The new storage technologies allow the end-user to recharge much faster and take about 30 minutes to get to restoration of 50 – 70 % of autonomy. This allows them to expand the operation range of the vehicle, from within the city to the provincial or even regional level.

Small, electric, shared and technologically accessible in a fast and flexible way: this is the new scenario in which the models of urban and metropolitan mobility, in the next decade, seem to unfold.

A key element of smartCEM is the design and development of innovative systems of integrated vehicle sharing, based on lightweight electric scooter suitable for use in urban and metropolitan areas.

The smartCEM service EV efficient driving is important for the construction of methods and tools to monitor and profile the end-users use of available battery charge. With data on of each user's actual energy consumption, behaviour can be analysed and used for improved model design.

Also smartCEM services allow to control and verify business models and economic and financial sustainability, urban impact, social networking and behavioural patterns of users with the development of a sustainable mobility policy integrated and complete that will have repercussions in multiple directions, even outside of the solution studied in the context of the proposed project.

Chapter 4

EV-Sharing
Classic Round Trip Sharing (Case A2)

4. EV-Sharing > Classic Round Trip Sharing (Case A2)

4.1. Business case overview

What	EV-sharing running in Elgoibar municipality, where smartCEM implementations work / operate as service improving applications.
Pilot site	Gipuzkoa, Spain (GIP)
Main smartCEM service	EV-Sharing management EV-Trip Management
Additionally implemented services	EV-Navigation CS-Management
Number of vehicles involved	5
Number of charging stations involved	5
Not implemented	On-Trip Efficient Driving

4.2. Main service: EV-Sharing Management

This paragraph 4.2 is about a round-trip classic sharing service with electric cars.

The service operator is the municipality of Elgoibar, located in Gipuzkoa province. The idea of this public entity is to provide sharing services as alternative public transport option.

Elgoibar municipality rented five electric vehicles for the car-sharing service named EMUGI, and distributed them across two CS locations on the two sides of the town, next to the train stations, in order to promote the interoperability between public transport options and the electric cars.

An important characteristic of the service is that the scale is currently such, that the operator knows many of the user personally and issues can be dealt with in a flexible way. In return, the users will also be flexible towards the service provider, simply due to the human contact and thus report issues timely to the provider.

Being a classic sharing service, the user needs to return the vehicle in the same CS location where it was picked up. At this stage, the EMUGI EV-Sharing service only supports round trip schemes.

4.2.1. Organisation

Name	Role
Elgoibar Municipality "EMUGI"	**Service provider** Operates the service called "EMUGI", managing it through a back office administrative web application. Vehicle monitoring, booking management, user registration, tariffs, etc. are controlled through this platform.
ENNERA	**Developer** Has implemented the EV-Sharing management system called "MOBERA" for EMUGI service. This sharing management system consists of three main parts: • The OBU: On board unit, working as an embedded system equipped with GPS and GPRS/3G antennas and an RFID reader installed for the on-board sharing management. • Back office: The administrative web application provided to the service provider to manage the EV sharing. • Front office: The web application provided to registered users for the vehicle booking.

4.2.2. The service

The "EMUGI" car-sharing service can be described in 5 steps:

1. Registration

The first step needed to be completed by a user is the registration to the sharing service. EMUGI provides a web based registration form on the web site. The user also defines the password that he/she will use to login to the service client web page afterwards.

Web link: www.emugicochecompartido.net/es

Figure 4.2.2.1 EMUGI service web site

Registration and log in web link:
www.emugicochecompartido.net/emugi/cliente/index.php?lang=en

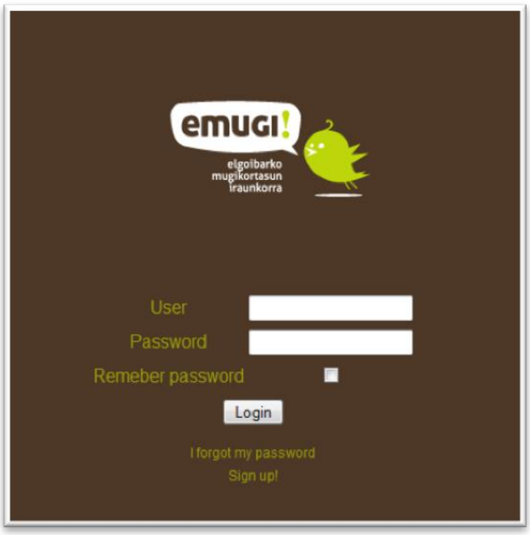


Figure 4.2.2.2 Emugi login screen

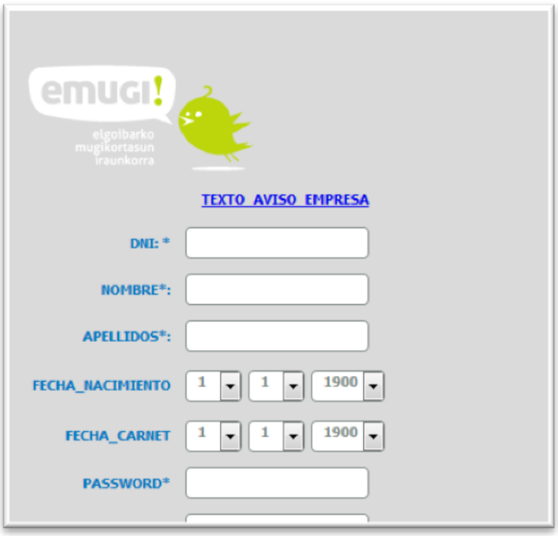


Figure 4.2.2.3 Emugi registration screen

Although having this on-line registration form, in order to ensure that the provided information is correct, the users are also required to visit the municipality to complete the registration process, with certified documentation copies (i.e. bank account number, driving license and national identification card, etc.). They also have to make a deposit. This deposit is required to guarantee the proper usage of the service by the user.

Once the registration is completed, the service provider sends an RFID card to the user. This is the user card that will be used as a key to unlock and lock the vehicles. It might happen that the registered user already owns a personal public transport card known as “MUGI” (RFID card used for public transport payments in Gipuzkoa province). In those cases, the end-user will be asked if he/she wants to use this “MUGI” card for the EV-sharing service as well, or whether they prefer to receive a separate service user card. According to what the user decides, the Unique Identification Number (UID) corresponding to one of those cards will be attached to the end-users register in the database through the back office administrative panel.

2. Booking

Once the user is registered in the EMUGI sharing service he/she has the possibility to start the booking process. The booking or reservation of a vehicle can be completed using two different platforms: the web application or the android application.

In both cases the user needs to login to the booking client page using the credentials defined during the registration process. Once logged in, the vehicle availability search needs to be completed. The user needs to specify in which CS he/she wishes to pick up the vehicle, the required usage time (range), as well as the corresponding amount of kilometres that he/she is going to complete during the trip. Other filtering options are also available, such as the vehicle model and the number of seats.

Figure 4.2.2.4 Reservation overview (Android application)

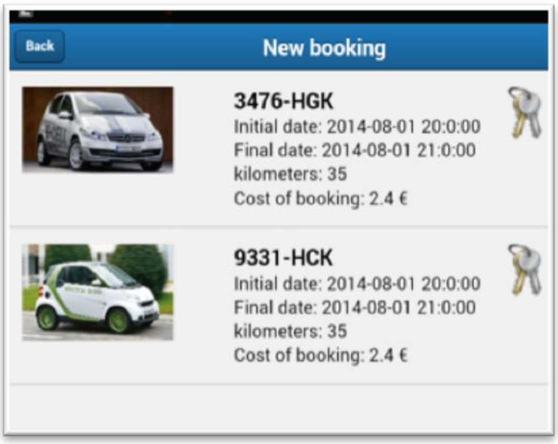


Figure 4.2.2.5 Vehicle selection (Android application)

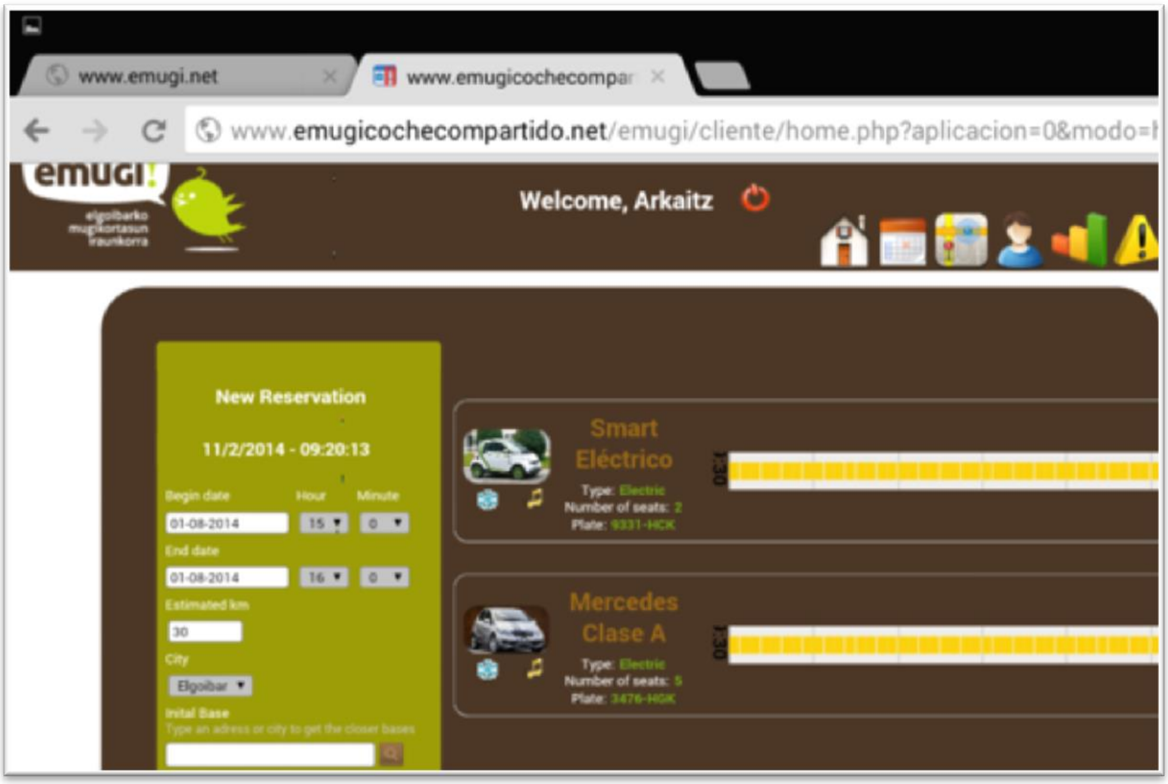


Figure 4.2.2.6 Emugi vehicle booking screens (web application)

The available vehicles for the specific search will be displayed, along with the cost of the booking.

When the best choice is selected and confirmed by the user, the booking is registered in the database and shown in the administrative back office to the service provider. The user will be able to check his next or pending bookings in the corresponding screen both in the client web application and in the android application.

3. Pick up

On the day of the booking, the user needs to go to the corresponding CS to pick the vehicle up. If the reservation time has already started, he/she needs to put his user card near the RFID reader, located in the driver's side of the windshield of the vehicle, until the vehicle is unlocked. The OBU will grant the operation and unlock the vehicle if the read RFID card ID corresponds to the user that has booked it for that period.

If the user forgets about the reservation and doesn't show up, the booking starts, the user is charged with the cost of the trip and the car will be unavailable for other users. Once the booking time has started, the booking can't be cancelled anymore. There is a good chance that the operator will call the user to remind the user. If the user knows he/she is unable to make it on time, he/she can better cancel the booking and make a new one a bit later.

Figure 4.2.2.7 Picking up the vehicle. RFID user card read through windscreen

With the car opened, the user will find the car-keys in the glove box. The car-keys will be used just to start and stop the engine. The RFID user card must be used to lock and unlock the vehicle in any of the initial, intermediate or final stops. At these stops, there are currently no added facilities for the EMUGI users. Since they don't need to charge as the provider takes care of that, they cannot use parking space at charging stations. Also they would have to pay for parking if this is applicable.

Inside the vehicle the touch screen OBU will turn on and after showing a welcome message the user will be asked about the vehicle status. Here, the user has the opportunity to notify any issues encountered in the vehicle (like scratches or other damage) before starting the trip. The notifications will be sent to the service provider.

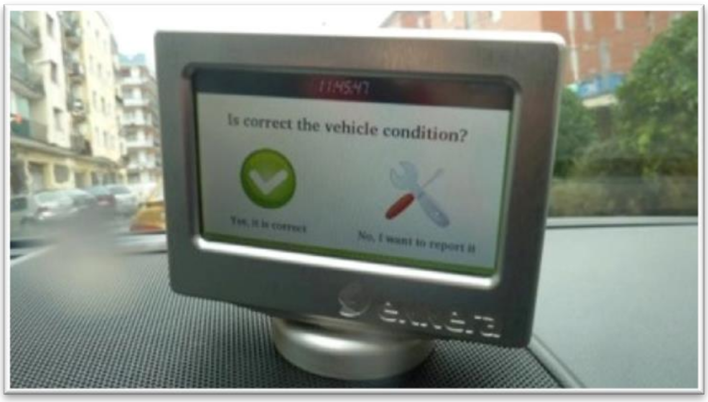


Figure 4.2.2.8 Vehicle condition verification by OBU

After this step, the OBU will show the summary data of the reservation on-screen.

Figure 4.2.2.9 OBU booking summary

4. Drive

During the trip the user can check and change booking parameters using the OBU. The booking extension, issue notification, nearest CS, etc. are some of the provided options.

Figure 4.2.2.10 OBU main screen

- **Booking extension:** The users will be able to extend the booking using the booking extension screen, in case there are no bookings that overlap after the current one. (There should be at least a gap of 5 minutes). The extension can be done in increments of 5 minutes. They just need to define the new estimated finishing time for the reservation, and make the request to the service management server (via 3G). In case the extension is approved the confirmation notification will appear on-screen. If not, the user will be also notified about the denial of the extension process.

If the user is unable to make it back on time to the end-station of the trip, it is better he/she books an extension, because the fee paid for returning the vehicle too late is higher than an extension of 5 minutes.

Figure 4.2.2.11 OBU: Select timing of booking extension

Figure 4.2.2.12 Extension confirmed

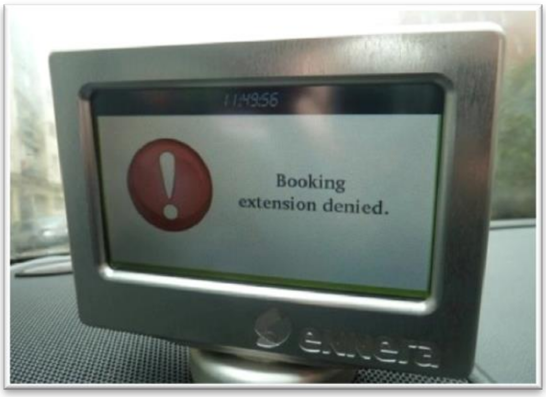


Figure 4.2.2.13 Extension denied

- **Incidence notification:** The user has the chance to inform about any issues suffered during the trip or noticed in the car, using the incidence notification screen. Here the typical issues are suggested as possible selections to speed up the notification process.
- **Nearest CS:** The nearest CSs are plotted on the map. The map will be centred according to the current GPS location of the vehicle.
- **Return vehicle:** This is the option that needs to be selected, in order to finish the reservation. Once this option is selected and confirmed, the next locking of the vehicle using the RFID card will indicate the finalization of the booking process.

- **Configuration:** In this option different configurations of the OBU can be modified, like screen brightness or text language.
- **Back button:** Takes the user back to the reservation summary screen.

Apart from the OBU, the user will find an android device in the car. This device has two main applications installed and accessible. One of those is the EV-Navigation application, that can be used to reach the destination guided by visual and voice indications. The navigator is a smartCEM project contribution. Apart from the typical navigation tips, it gives the option of showing the reachable range of the vehicle according to the battery level, as well as integrated information about public CS locations (also the private CS working for the sharing service are shown). The other application is the CS-Management, which shows the list of CS in the covered region, with additional information like, address, number of connectors, etc. When the user selects a specific CS in this application, the Navigator is automatically executed, giving indications about how to reach there.

Figure 4.2.2.14 Selection of destination

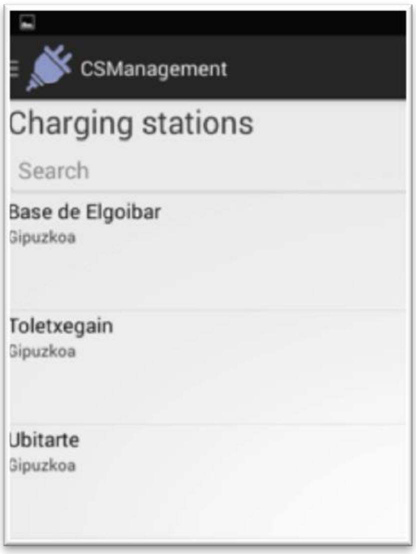


Figure 4.2.2.15 Charging station listing

Figure 4.2.2.16 Navigation overview on PTV navigator

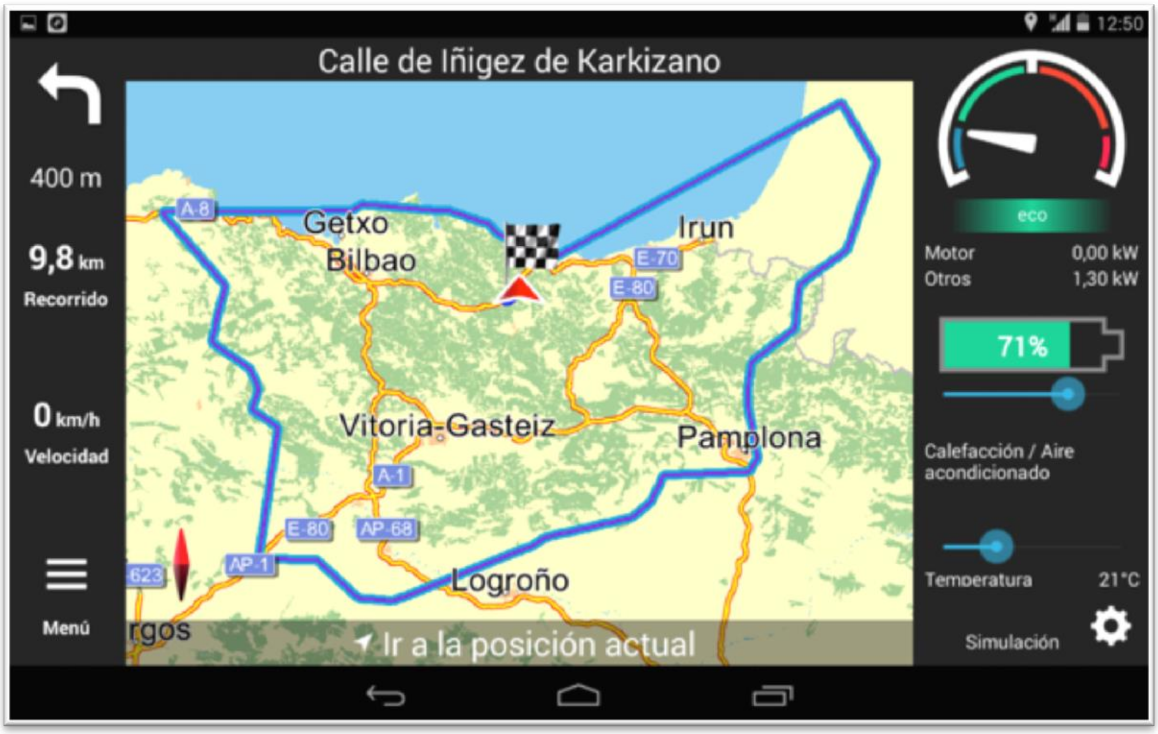


Figure 4.2.2.17 Autonomy polygon and DoD estimation on PTV Navigator

Figure 4.2.2.18 Navigation instructions and DoD estimation on PTV Navigator

5. Return

Once at the end of the trip the user needs to select the return vehicle option on the OBU screen. This is how the OBU knows that the next time the user closes the vehicle using the RFID card, the real finishing time of the booking needs to be registered. The RFID user card must be used to lock and unlock the vehicle in any of the initial, intermediate or final stops.

When completing the trip, the user needs to respect the time (and km) estimations given when he/she booked the vehicle. If the user exceeds the initial time estimation when returning the vehicle a penalty will be added to the final trip cost. As mentioned, it is cheaper for the user, when he/she requests a booking extension, rather than exceed the time and pay the penalty.

Figure 4.2.2.19 Selection of return vehicle

Figure 4.2.2.20 Confirmation by user

Figure 4.2.2.21 Confirmation by OBU

Figure 4.2.2.22 Hold RFID close to windscreen

4.2.3. Implementation process in Gipuzkoa

EMUGI EV-Sharing started in 2011 as an innovative project of the municipality of Elgoibar.

The most challenging tasks when implementing this service have been the following:

Infrastructure

Once the project was planned, two main elements needed to be defined: the charging stations and the vehicles.

EMUGI service acquired the vehicles in a rental agreement. The purchase of the vehicles was considered to be a too risky option at first not knowing the uptake by the end-users, for such an innovative service. Two different models of FEV have been selected and are used for the service.

- Mercedes Class A e-cell: A model with a medium / high autonomy (compared to other electric vehicles of that date) for longer interurban distances. Elgoibar is a town located almost equidistant from the three Basque capitals (Bilbao, Donostia/San Sebastián and Vitoria/Gasteiz). The Mercedes has enough autonomy to make a trip to any of the capitals and back to Elgoibar on a single battery cycle. This was a key factor to attract potential users.
- Smart ED: This vehicle with a smaller autonomy was selected for urban trips or shorter trips to nearby towns. (This vehicle model was included after some months operating with the service).

The charging stations selection was negotiated with one of the main CS providers in the region. Elgoibar municipality wanted to link the sharing service with the main public transport options in the town, so they decided to locate the CS near train stations to enable interoperability. The service was launched with a unique charging station with three connectors, and three cars.

Nowadays, they have two CS (one with three connectors and the other with two) located on both sides of the town, each of them next to a train station. Five vehicles are in operation, Two Mercedes Class A e-cell, two Smart ED and the last acquisition a Renault ZOE, used only by the municipal staff.

Figure 4.2.3.1 Mercedes Class A e-cell

Figure 4.2.3.2 Emugi Charging station

Operation

Introducing a sharing scheme was a challenge, as people were not used to car sharing to complete their daily tasks. Moreover, apart from the sharing scheme, the usage of FEV in such a service seemed to be complex.

Taking this into account, EMUGI agreed that it was important to make the service usage as simple as possible. They decided not to involve the user in the vehicle charging plug/unplugging processes. As the service operates from 7:00 to 22:00 and the two charging stations are located in the same town, the operator connects the cars every night and disconnects them every morning. The charging is always completed overnight, and each charging cycle covers just a service day for each car.

This minimizes the impact for the end-user when using the FEV, as they find an unplugged vehicle, ready to pick up that they don't need to be charge during their trip, and that they just need to park back in the starting station when the trip is completed. Moreover, the less battery charging cycles they have the longer these batteries lifetime will be. On the downside, not charging the battery in between the reservations results in having a more limited daily availability of the cars, and the given service is less than the vehicles are capable of providing in full operation.

The user needs to define the amount of kilometres that he/she is going to complete in the trip, apart from the reservation time (range) in order to check vehicle availability. Each vehicle will be allowed to complete in a day the km amount corresponding to the autonomy of the battery for a cycle. The operator sets a margin between the tested (in real life) maximum autonomy obtained from the vehicle, and the maximum autonomy or km amount provided to book per car. That way, in case a user exceeds the estimated quantity of km, the operator is always covered with a margin to solve the situation.

Round Trip Sharing

Although one-way trips give more flexibility to end-users, such a service configuration needs to have a considerable quantity of vehicles and CS to relay on, as well as complex algorithms to assure the vehicle availability for end-users in each of the CS. This would require a really high investment, which wasn't decided upon by the local municipality to begin with.

The service was launched based on round trip operation, which seemed to be an easier option both to start and maintain. Being a local service, most of the users are Elgoibar inhabitants so EMUGI needs to have vehicle availability in town. It really didn't make sense permit the vehicle return outside the Elgoibar municipality, because the logistics to bring all the vehicles back is too expensive, and the demand is focused on the town.

Other approaches could be possible in the future, but always linked to the extension of the current service infrastructure.

Usage

It is worth mentioning that the service is used both by public users as well as the staff of the municipality town hall. EMUGI has always intended to give priority to the public user over the town hall staff, that is why after a couple of years of successful operation, it was decided to add a new vehicle to the sharing fleet, the Renault Zoe, which was exclusively aimed at the internal (municipal) usage leaving the other models Mercedes Class A e-cell and smart ED (4 cars) for public use.

These are some of the most common usage cases that have been registered during the operation of the sharing service:

- To reach a work meeting;
- For delivery purposes, when the user doesn’t own a company car;
- Regular shared trips among partners of a group: colleagues, sports teammates;
- Sporadic trips, to pick up or bring someone to the airport;

Users tend to have trips planned beforehand. Although having vehicles available for immediate use is always a good feature to offer, working in a flexible one-way sharing scheme for EMUGI still seems unviable. Elgoibar is not a large city and the resource that is provided to users is more costly than a bike or an (electric) scooter.

Promotion of the EV-Sharing service in Elgoibar

At this stage, the only thing that is visible to EV-Sharing service end users about smartCEM are some banners with the smartCEM logo on the Mercedes Class A e-cell vehicles of the service. But while smartCEM services haven't been promoted as such, the EMUGI EV sharing service itself has had its own promotion at the beginning. This was done through the following channels: A press conference, media like newspapers, TV, Radio, internet, etc. And there were public events to explain the service.

4.2.4. Implementation in a new city

Operators intending to implement a classic sharing service in a new city should take into account the following aspects:

- The first thing that needs to be established is having a service infrastructure. This includes the vehicles (can be acquired in either a purchased or rental agreement), the CS (which should be dedicated to the sharing service) and the parking places in the base stations (also need to be dedicated to the EV-Sharing service).
- After the establishment of the infrastructure, a sharing management system needs to be installed, based on the infrastructure. There are different options in the market, but normally all of them tend to be divided into server side software and on-board hardware. The server side software is used to manage the service through an administration web application and also provides users with a client web page or application for the vehicle booking requests. The on board unit installed in the car manages each individual booking made for the car and reports the status to the server along with the vehicle status data

obtained from the Controller Area Network (CAN) signals.

The more information is acquired from the vehicle (current battery level, charging or not, etc.) the more it will be possible to optimise the vehicle performance for the service. For example, not having the information of CAN signals available, results into not being able to monitor the real battery level of the vehicle so that the booking availability is reduced to just a single battery cycle per day.

- Apart from the infrastructure of vehicles, charging stations and the sharing management software and equipment it is relevant to have a service maintenance operator. This would be the team in charge of the service operation and control. They will monitor the daily issues and they would report them to the corresponding technology provider to have them fixed and maintained. Not having a service maintenance operator, can result in problems and ultimately a failing service. Preventive actions and continuous maintenance is the best way to have a successful service.
- The vehicles are normally monitored in sharing services. This supposes having a 3G communication between the vehicle and the service server. So for the proper functioning of the service, a good 3G network coverage is needed at the key moments of a booking process. It is impossible to know what will be the network coverage quality throughout the whole route completed by the cars, but at least the CS or base stations of the service should be located in places with good 3G coverage, to ensure that there are no problems when loading the bookings in the vehicles, the picking ups and returns of the vehicles, etc.
- Having an OBU running and fed by the vehicle auxiliary battery can be tricky. The auxiliary battery is normally fed via the traction battery when the vehicle engine is started and moving. If a car is not booked for a long period, having an OBU consuming constantly energy for the equipment and 3G/GPS communications could suppose running out of auxiliary battery and not to be able to turn on the engine. This is why vehicles that have not been booked and moved during a specific period should be moved by the service operator as part of the maintenance to ensure the energy transmission from the traction battery to the auxiliary battery. Also, energy consumption of the OBU should be checked, in order to make it as efficient as possible: aim for more standby time and less frequent communications, etc.
- When RFID solutions are implemented, the use of standardised RFID technology is recommended, allowing for future integration with other RFID card based services. But even better (more convenient for the end-user) is a smart-phone based lock-unlock solution.
- Management of incidents. In this pilot site it is clear that the subject of “Managing incidents” has been addressed. The user can use the OBU to report damage to the vehicle or can call the call-centre. But what also needs attention is the stand-by of a tow away service in case of a stalled vehicle or an accident. Also insurances have to be considered and organised.

4.3. Main service: EV-Trip Management

This paragraph 4.3 is about the multi modal EV Trip management in the region of Gipuzkoa.

4.3.1. Organisation

Name	Role
Pluservice	**Developer** Pluservice developed a web and android based multimodal trip planner application. This application takes into account different public transport options as well as the EV-Sharing services, in order to give possible and suitable trip plan results to the end-user, combining them.
ENNERA	**Developer** Ennera provided interfaces from the sharing management server in order to respond to the Trip Planner app about EV-vehicle availability, for the specific trips.
PT-dBus	**Local Public Transport Company** dBus provided static updated public transport data (timetable) for the city of San Sebastian, necessary to feed the multimodal trip planner application.
TGG	**Territorial Transport Authority of Gipuzkoa** TGG provided static updated public transport data (timetable) for the province of Gipuzkoa and part of the Basque Country, necessary to feed the multimodal trip planner application.

4.3.2. The service

The implemented service works with an internet connection and can be executed either through a web application or an android app.

In the applications main feature, the travel solution search, the user defines the origin and the destination for his/her journey as well as the maximum distance he/she wants to walk in between modal changes. The user needs to decide if he/she is going to use just public transport or if combining EV-Sharing is mandatory for the results.

- When ‘just PT’ is selected, the user needs to specify the starting time for the trip, so that the system will search for different solutions to start the trip in a station, near by the departure point.

- When 'EV-Sharing' is chosen, the user needs to specify the time (range) that he/she expects to spend at the destination. The system will check the best option to bring the user to the nearest EV-Sharing station, and will check the availability of vehicles in that station, taking into account the requested booking time (time to spend in destination + travel time) and range.

Results are shown in a list, with the additional information of how much time the trip will take. These results can also be visualized on a map. In case an EV-Sharing option is involved, the application provides the link to the booking web page.

The following figures are screen-shots of the web-based EV-trip management service.

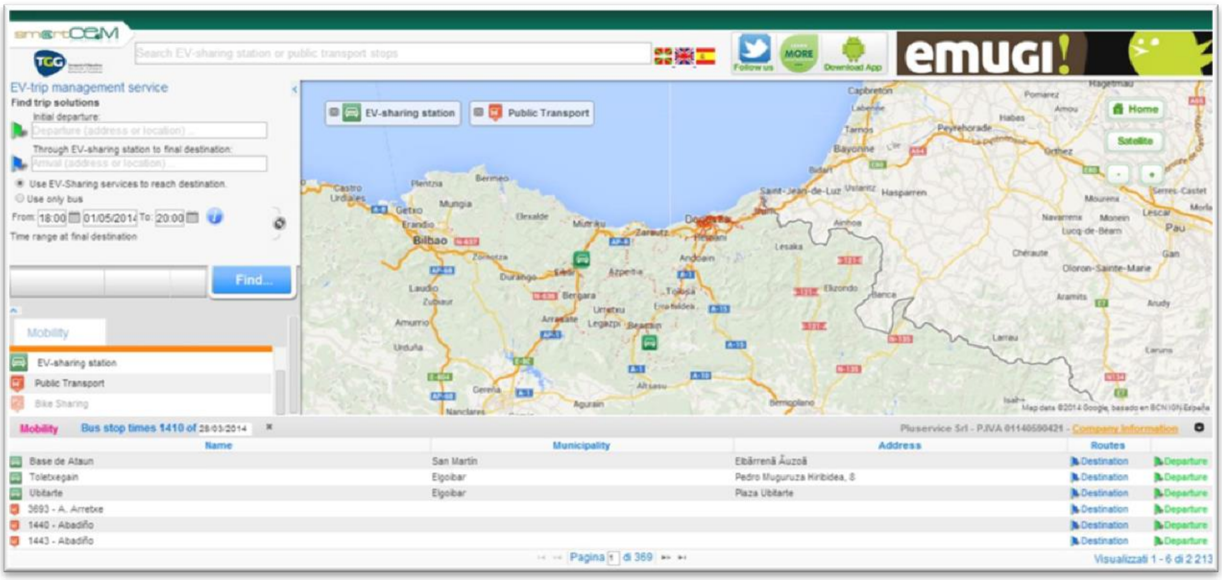


Figure 4.3.2.1 Multimodal Travel planner: Main page

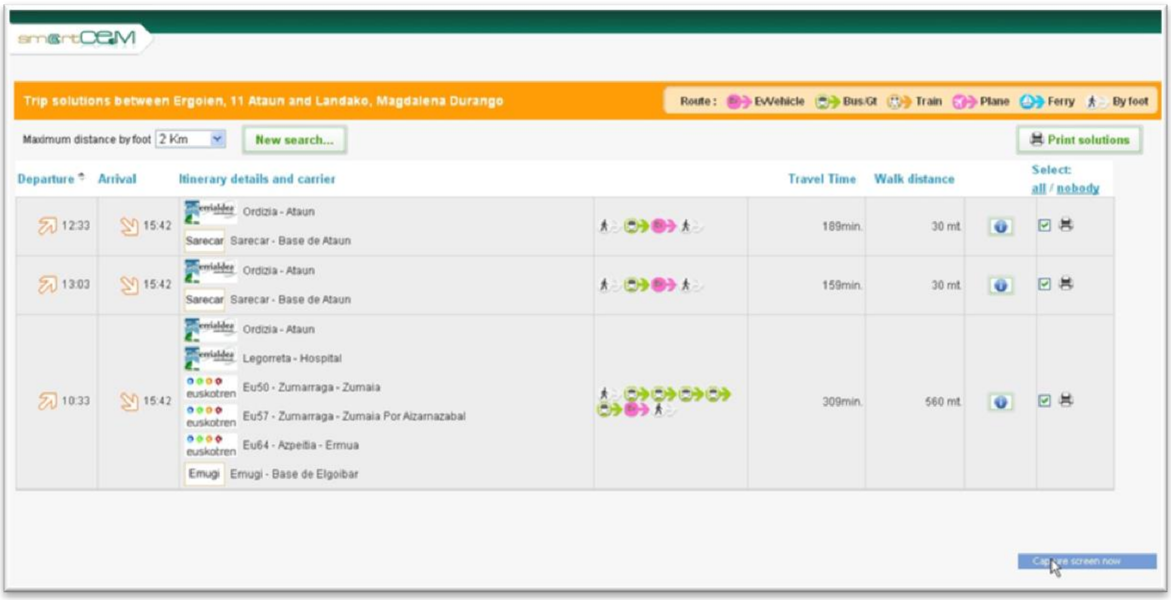


Figure 4.3.2.2 Multimodal Trip planner: Show solutions

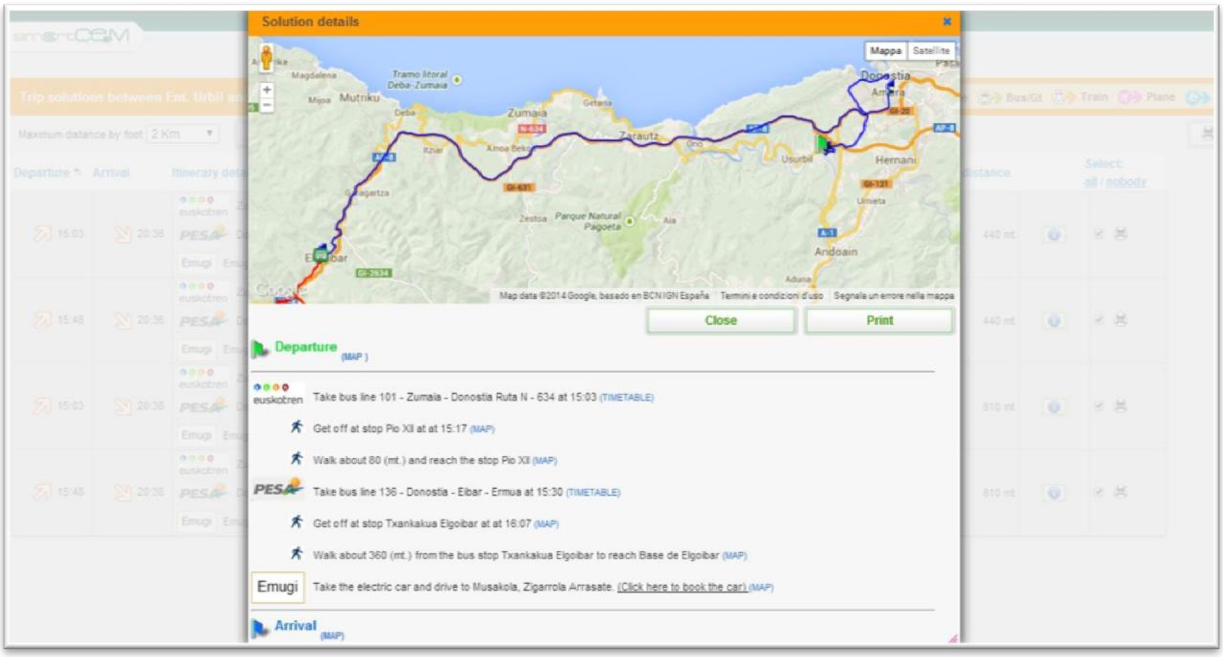


Figure 4.3.2.3 Multimodal Trip planner web portal: Show solution details

The following figures are snapshots of the Android application for the EV-trip management service.

Figure 4.3.2.4 MyCicero splash screen

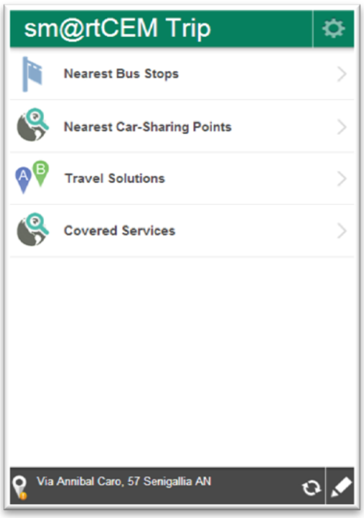


Figure 4.3.2.5 Service selection

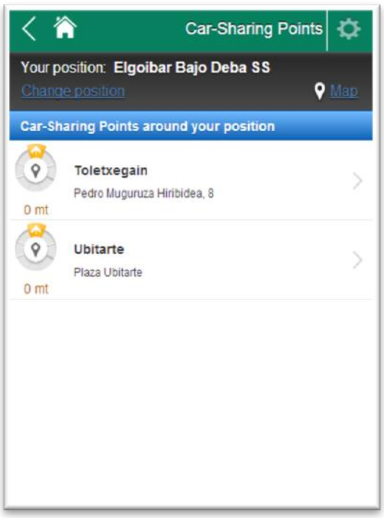


Figure 4.3.2.6 Nearest car-sharing points

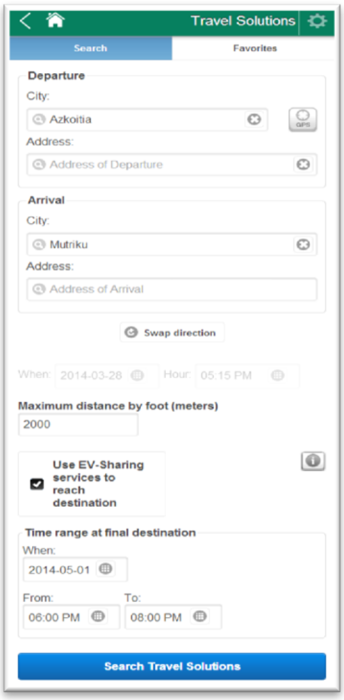


Figure 4.3.2.7 Screen to set travel request

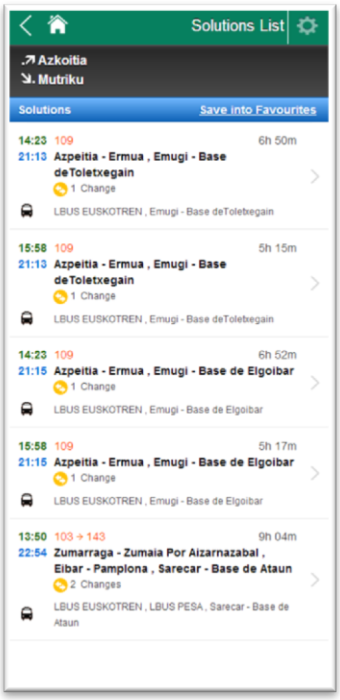


Figure 4.3.2.8 List of options

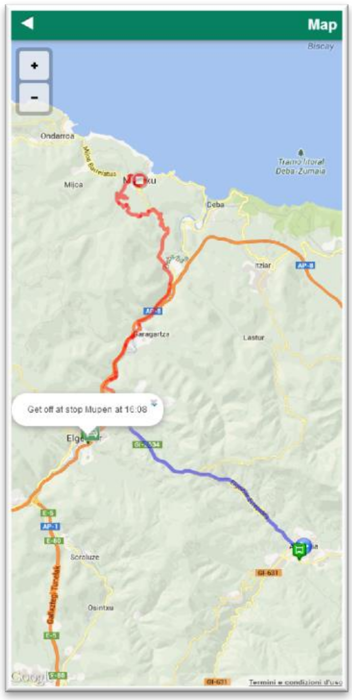


Figure 4.3.2.9 Map with multi modal route in red and blue

4.3.3. Implementation process in Gipuzkoa

Important aspects of implementation process of the EV-trip management system in Gipuzkoa are the following:

- Pluservice adapted the existing travel planner, part of the MyCicero platform. The original solution didn't take into account the integration of other modes besides public transport, therefore new specific functionalities had to be developed and implemented for the project.
- In order to import the Gipuzkoa regional public transport data, a "de facto" standard protocol was adopted. This protocol is the GTFS (General Transport Feed Specification), as created and used by Google Transit. This format was selected because it is the most used one among authorities and PT companies and because TGG (Territorial authority of Transport in Gipuzkoa province) currently owns and maintains data in the GTFS format. Because of this, the most convenient solution was that Pluservice would develop an interface to import PT data in the GTFS format to include it in the smartCEM general architecture and in the MyCicero product.
- Another important decision was the selection of the Map data provider. After a discussion with the involved parties (TGG, the pilot leader Tecnalia and the local service provider Ennera), Pluservice decided to integrate an open-source based Map: Open Street Map (www.openstreetmap.org). The decision was

taken considering the price of commercial Map data (e.g. Navteq and TeleAtlas) against the (almost) free usage of the open-source data. This decision was taken being while realising that commercial Map data is more accurate and has more attributes of road elements as compared to the open-source database. Pluservice usually works with commercial Map data, therefore an adaptation effort was made to integrate the OSM services into the MyCicero trip planner engine (the algorithm that returns travel solutions).

- In order to make the existing MyCicero trip planner multimodal and electric mobility oriented, Pluservice implemented the software interfaces towards the EV-sharing system provided by Ennera. Web Services have been implemented to query the EV-sharing system in terms of car availability in a slot of time, estimated Km available based on the battery autonomy and ID of the Car-sharing station.
- The Solutions builder of the MyCicero trip planner was modified by Pluservice to consider the information provided in real time by the EV-sharing systems and return solutions that combine public transport with the car sharing services.

Promotion of the EV-Trip management service in Elgoibar

The service is promoted through the following channels: The website that contains the service itself, press releases, Twitter, Facebook and word of mouth promotion.

4.3.4. Implementation in a new city

Local Authorities, Public Transport Operators or Car-Sharing Operators intending to implement a multimodal trip planning service in a new city should take into account the following aspects:

- The first thing that needs to be sorted out is to have the Public Transport Data. A reliable travel-information system should cover all the interested area with updated PT information. Data should be provided in the GTFS format. Where possible, having real time data, coming from AVM systems (Automated Vehicle Monitoring) of PT Operators, to be integrated in the trip planner would provide the user with the real situation and not only the situation according to the timetable. The Trip planner is prepared to interface real time PT data according to the SIRI standard (Service Interface for Real Time Information).
- After having the PT data a sharing management system needs to be installed as fundamental infrastructure. There is no multimodal trip planner if no EV-sharing service is operated. The EV-sharing system should disclose the information of the availability of cars and their battery autonomy according to the web services description given.
- The Commercial Map data can be expensive (5.000 € per year and pilot site) as compared to free open source maps, but it may result in less accurate information to the end-user. A cost-benefit analysis is needed to address this.

- In the design phase of the multi modal service in a new city, there is an opportunity to create a service that functions with a single RFID card. Public transport is often accessed and paid for with RFID, but also shared vehicles are unlocked with the same type of card. When taking into account the wish of end-users, it will be apparent that a single card is preferred. If possible, no card at all would be best. As smartCEM shows in Barcelona, it is possible to access and activate a vehicle with a smart-phone.

4.4. *Additional: EV-Navigation Management*

This paragraph 4.4 is about the option of implementing EV-Navigation in the region of Gipuzkoa.

4.4.1. Organisation

Name	Role
PTV	**Developer** The main developer of the application that has implemented the EV-Navigation service.
TeamNet	**Developer** Provides CS location information for the Navigation system
ENNERA	**Infrastructure Provider** Provides android devices in the vehicles to give the possibility to use the navigator during the trips.

4.4.2. The service

The EV-Navigation system is an application that runs on android devices, in which apart from the common navigation indications and functions some EV related features are available for the end-user:

- **Range estimation:** The navigator has several vehicle profiles included. These vehicle profiles are generated based on parameters like vehicle dimensions, average consumption, peak-consumption rate, etc.

  Taking into account this profile and the current battery level of the vehicle as well as the surrounding geography (route types, slopes, etc.) the application elaborates range estimation and visualizes it on a map drawn as a polygon (e-horizon).

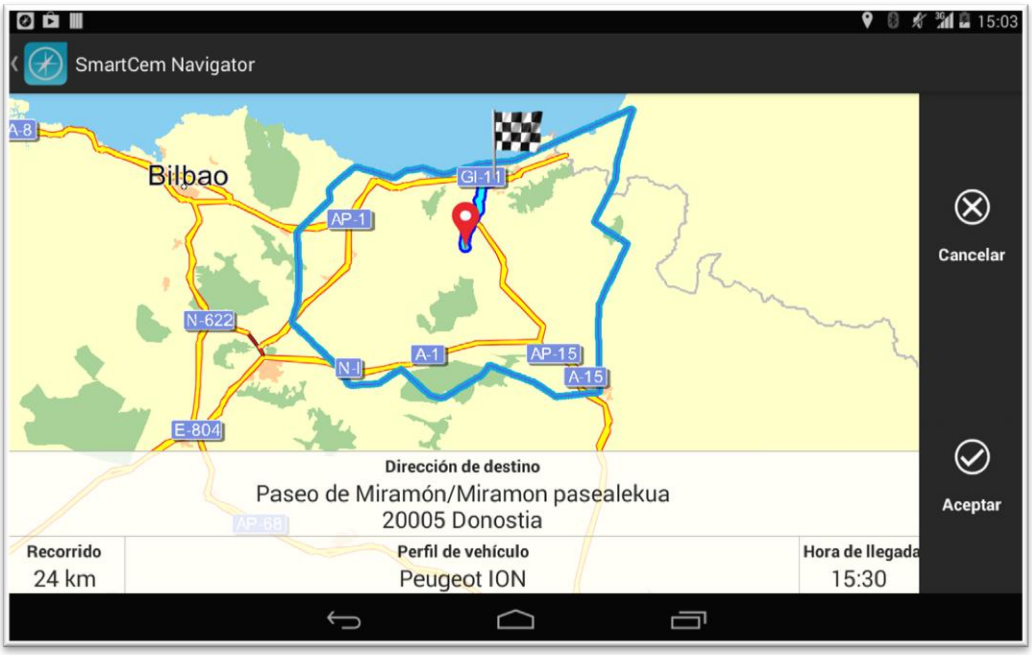


Figure 4.2.2.1 EV-Navigation service range estimation

- **CS location information:** The Navigator has the option to include CS location information. This information is downloaded from the smartCEM portal in a file and stored in the Navigator app folders of the device. If the user enables CS locations as POI, they will be shown on the map. Also the divided screen assistant can be used to visualise the CS near by the planned route. These can be selected as intermediate stops during the trip.

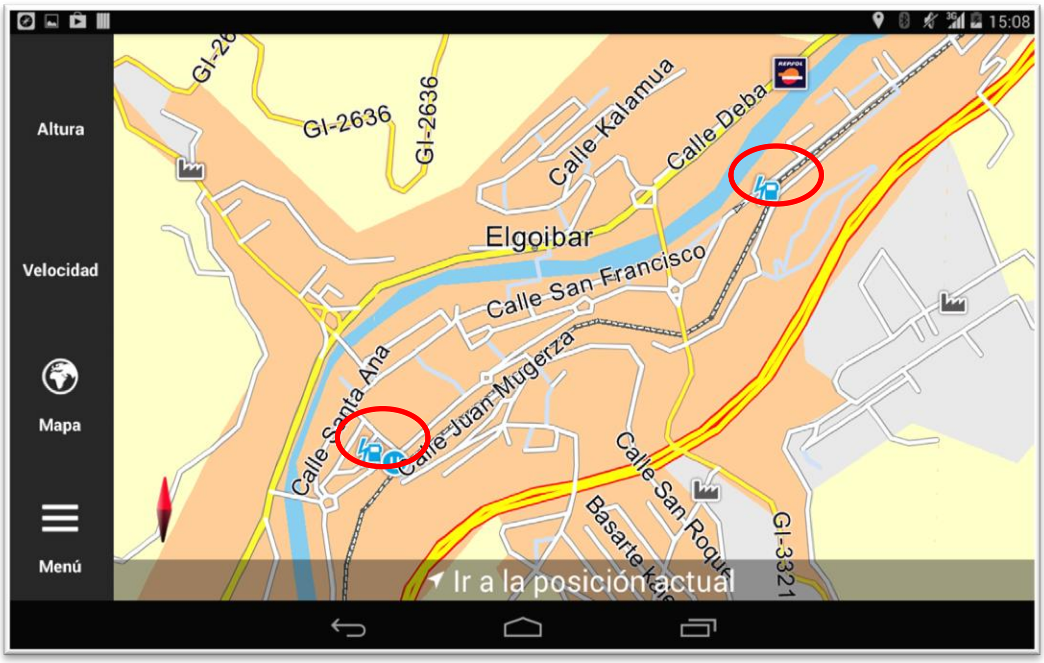


Figure 4.2.2.2 EV-Navigation service CS locations

- **Current consumption estimation and simulation:** The current consumption is estimated, on base of the vehicle profile, map data, environment parameters and GPS with speed, acceleration and slope. Using this data the current consumption in the driving situation can be visualized in a cockpit view and numbers, as well as the battery decrease by driving is estimated. These features can be used where the Navigator is not connected to the vehicle (for example EMUGI case in Gipuzkoa).

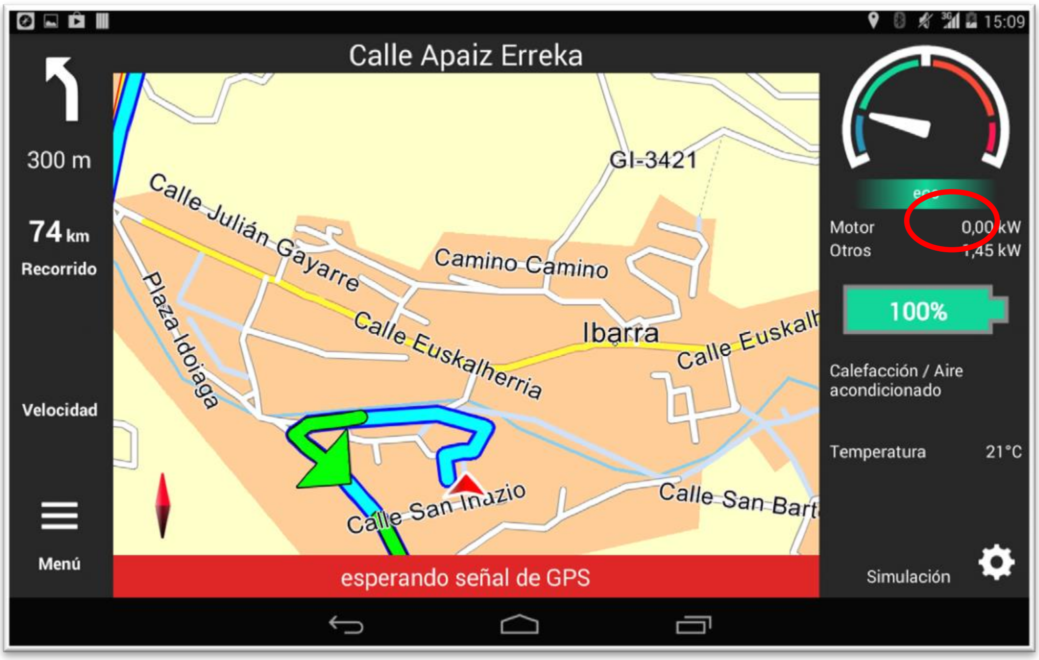


Figure 4.2.2.3 EV-Navigation service current consumption

- **Integration of real time data**

  If the navigator is connected to the vehicle through a hardware connected to the OBD2 port (for example the Blue Dash module) it is able to interact with the CANbus signal values, to refresh and show vehicle battery level and consumption rates (engine and other consumers) in real time.

  Beyond the EV-integration, the Navigator can be integrated into business workflows, to show stations, geocode, inform about situations, display driving hints, set vehicle profiles etc.

4.4.3. Implementation process in Gipuzkoa

Some of the most important tasks to implement the EV-Navigation system in Gipuzkoa have been the following:

- In EMUGI service the operator rented the vehicles. Connection to the vehicle (CANbus signal) was not permitted by the renting entity so there is no option to get real data. That is why just simulation mode can be used and simulated data is shown on screen for range estimation, battery drain, and current consumption calculations. The more training is reported the more accurate the system can be, as the simulated patterns can be adjusted according to the training data.

- Not having communications with the vehicle supposes also more interaction of the user with the device. For example, the user needs to determine the vehicle type and the battery level of the vehicle (according to the value shown on the dashboard) before starting the trip. The range estimation will be calculated considering these specific values.
- The Navigation system is not published for an open download. It has been installed in specific android devices that are used just for project purposes and provided to the service providers. As EMUGI service operates from 7:00 to 22:00, the service provider has decided to put the devices in the car every morning and to take them out, to the office for an overnight charge. This strategy is to avoid battery run outs of devices as well as reducing night time vandalism risk on the cars.

Promotion of the EV-Navigation service in Gipuzkoa

The Navigation service on its own is not promoted. It is explained to the users on an individual basis.

4.4.4. Implementation in a new city

First the needed vehicles should be defined, if a vehicle profile doesn't exist, a vehicle model is created on base of the specification parameters. PTV then provides specific profiles to be fed into the Navigator.

It should be decided whether the Navigator will be an integrated solution or not. For integrated solutions to integrate into workflows or access real time data, the Navigator API is used by a secondary app on the device to feed real time data or to control the Navigator via the API. A programmers reference, tutorial and example program with source code are provided.

It should be decided which devices are used, and what happens with the devices overnight. Do they stay in the car, or who takes them out of the car? And how is charging organised. Also there should be an introduction available on how to use the Navigator EV-functions.

In new cities it is recommendable that CANbus data is accessible, in agreement with the owner and the manufacturer of the vehicle. This allows the data shown on the navigator to be more accurate. Take a good amount of time into account, to arrange this. The field of CANbus access has many implications in the field of accountability, responsibility and safety.

While the navigator is in use, the vehicle model improvement should be active. While using the Navigator, logs, battery levels (start/end), temperature should be recorded (own program for recording provided), so it can be used to calibrate the vehicle model, which means that the model-parameters, that exists in the navigator are adjusted to reflect the new 'real world' data. Originally the manufacturer may have stated that the vehicle's electricity consumption is 0,11 kWh per kilometre, but when the driver doesn't maintain proper tyre pressure, this may in reality be 0,13 kWh per kilometre.

4.5. Additional: EV-Charging Station management

This paragraph 4.5 is about the optional installation of EV-Charging Station management in the region of Gipuzkoa.

4.5.1. Organisation

Name	Role
TeamNet	**Developer** Has implemented the tool to have CS locations available in the EV-Navigator as destinations.
PTV	**Developer** Provides the EV-Navigator service and has cooperated with TeamNet in order to develop the interface for easy plug-and-play share of CS location data.
Elgoibar municipality "EMUGI"	**Data provider** In GIP PS EMUGI sharing service has provided the location information of their CS in order to have them included in the CS Management application.

4.5.2. The service

The EV-Charging Station management application shows the list of CS of the PS and links them to the Navigator in order to be able to show them as destination points, and get the directions to reach the charging station.

To feed the CS list, the administrator needs to upload CS data in the smartCEM web portal. The data includes parameters like CS name, address, location, etc. Once the CS data is stored in the server, the android client application (CS Management app) is able to load all the updated CS data in a list. The list will correspond to the CS located in a specific PS, or all of them, depending on how the filtering is set. There is also the auto option which provides the specific PS CS list based on geo-location.

If a specific CS is selected, this is loaded into the EV-Navigation system as a destination point.

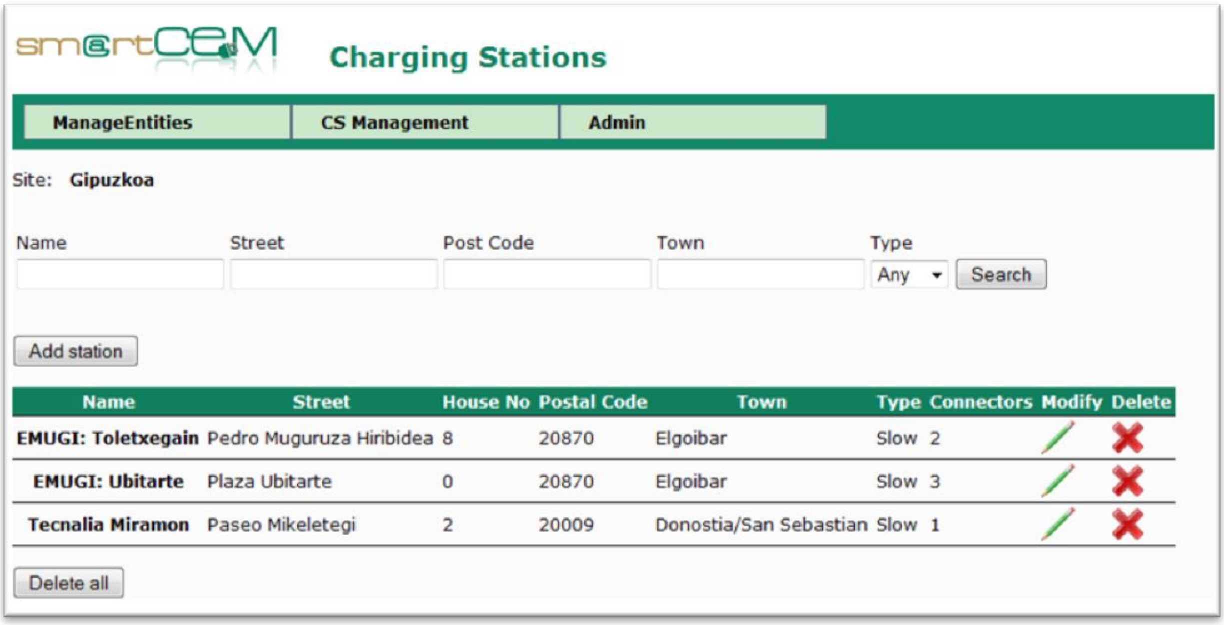


Figure 4.5.2.1 smartCEM portal, CS Management administration

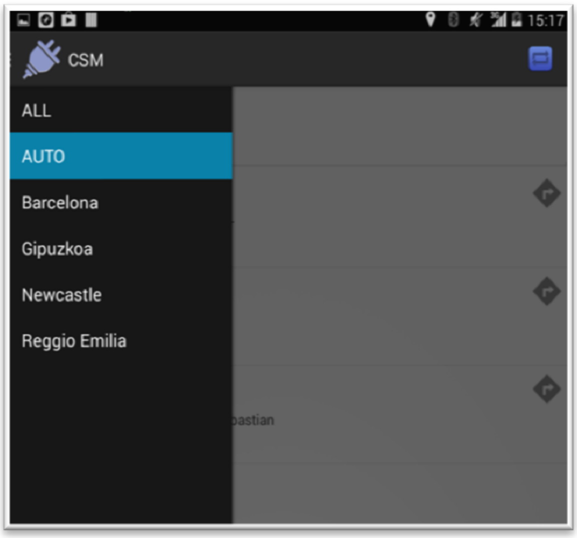


Figure 4.5.2.2 Site selection android application

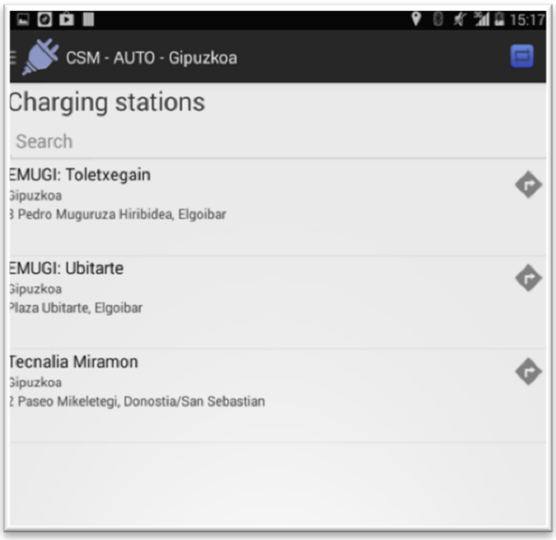


Figure 4.5.2.3 Charging stations android application

4.5.3. Implementation process in Gipuzkoa

The most important aspects when implementing the EV-Charging Station management system in Gipuzkoa are:

- EMUGI sharing doesn't ask their end-users to plug and charge the vehicles in intermediate stops, as the autonomy in the vehicle is enough to complete the trip specified in the booking process. That is why showing public CS location information is not essential. However, providing this data makes sense in order to reduce range anxiety, because it determines that in case anything goes wrong (user driving more km than planned, issues, etc.) there is an additional infrastructure as a support.

- At first the application was aimed also to show the CS availability live information. The main problem was that the CS service provider is not part of smartCEM, and their business model includes also proprietary applications, that already make the same work. They just allowed smartCEM partners to show the location data of the public charging stations but not live information. (But again, in the case of the Emugi service, the driver doesn't have to worry about this).

4.5.4. Implementation in a new city

A CS provider that wants to show their stations as part of this service needs to provide the requested information: name, address, location, manufacturer, telephone number, connector amount and type, etc. This information is added/updated in the smartCEM Portal.

At this stage four PS are managed from the portal (GIP, BCN, REG & NEW), so in case this new CS information corresponds to an operator working in another country/site, the CS Manager portal and client application should be modified to add the new Site.

Once the new information is readily stored in the smartCEM portal the client application would refresh the information automatically.

In case the new service provider would also share CS real-time availability data, the application could be extended, interfacing with the CS service provider's management servers, from which this availability information will be passed on.

4.6. Sustainability aspects of service implementation

EV Sharing is an alternative system of ownership and use of vehicles, that promotes sustainable mobility and integrates the supply of public transport on routes that are not standardised. It also enables a new mode of mobility for those who want to have a car at their disposal without the cost and expenses of owning one.

This transport service allows individual subscribers, through means of reservation, to use a car, choosing between a fleet spread over several city parking locations, for the period necessary to meet their needs. The car can be used as long as it really should be, if only for an hour, as well as for several days (not in the case of Emugi in Gipuzkoa, where vehicles are returned at the end of the day), all over the city, paying only the actual use (travel time and distance covered).

Usage of an EV Sharing service provides many benefits to the users:

- The user will save substantially. Subscribers to the service only pay the hours of actual usage of the vehicle and mileage. While the operator bears expenses like maintenance and repair of the vehicle, insurance, road tax, fuel (electricity) costs and parking.
- In addition, the rates are lower than those charged by a taxi on the same distance covered.
- The user has the availability of a diversified fleet of (electric) cars, that allows him to choose the vehicle as desired according to the purpose of the trip. (I.e. a city car for city centre errands, a minivan for leisure, a van for moving or for freight, etc.).
- Electric cars emit no pollution (locally). The electric car contributes to the improvement of the air in the immediate surroundings of it. A reduction of CO_2 emissions in historic centres of cities as already mentioned in the previous paragraph 3.8 can be achieved.
- With the service of EV Sharing, the user, with appropriate incentive policies from the public authorities, has ample freedom of movement.

Depending on the local authorities' legislation across Europe, it's possible to pass free of charge through the electronic gates for Limited Traffic Zones. Users can park for free in designated electric charging parking places (often provided they are charging) and in some cities or provinces users can drive on the bus lanes at moments that the other lanes are clogged by other traffic.

And another advantage of EV sharing schemes, is the positive impact on urban mobility: there are fewer cars on the road, because the shared car circulates throughout the day and ultimately is used more intensively parked less long, because it serves more users. While a car that is owned by a single party is parked most of the time. Therefore, an impact of decongestion of urban areas from traffic and the occupation of parking space can be noticed once implemented at a large scale.

The smartCEM services allow you to take advantage and make maximum use of electric vehicles available because the user can easily, quickly and without any use of cash money avail over an electric car.

The user is able to find out at any time, exactly where the nearest free car is located, simply by consulting the application on the smartphone. This, thanks to the advanced GPS geolocation systems, accessible in real time on smartphones. Not only that, the operation of charging and issuing a car is done without ever having to reach for one's wallet. No cash, but rather the registration in the system, with user identification and micro transaction payment (most of the price of one vehicle booking remains below 10 euros) are made entirely using electronic swipe cards directly through a RFID chip that unlocks the car. The car transmits data, to enable the driver to drive. Later, after all time-cost, kilometre-cost, fees and penalties have been added up, the amount to be charged is debited from the account, the balance or the credit card registered. (In the case of Gipuzkoa, a separate billing system is used).

The smartCEM Services have the advantage of providing information to users to be able to choose the car with a sufficiently charged battery for the user's needs and to be able to use the car to be shared with other users.

Finally, appropriate incentive policies (like price discounts, or extra loyalty points) can be implemented into the service with cost savings during periods of lower frequency of usage, to increase the use of vehicles as much as possible and in a well distributed way.

The development and expansion of the EV Sharing on a larger scale can no longer ignore the existence, and therefore the integration with a good network of public transport options in the area, which should be seen as a complementary service and not a substitute or competition.

Another indirect effect is to encourage the use of public transport by planning the location of reserved parking close to intermodal interchanges (train stations, tram-hubs, bus-stations).

It is also important to emphasise that the trend towards the use of electric vehicles is directly linked to energy production. Slowly a transformation process has started to emerge, of the electricity network into a giant "collector" and "homogenizing" of countless mini / micro-generators of renewable energy throughout the country (wind, solar, geothermal, biomass, etc.). The development of renewable energy production with low environmental impact should be closely coordinated and aligned with the development of new patterns of mobility. Electric vehicles are to be regarded in the light of this synergy between the world of energy and the world of mobility.

Figure 4.6.1 Sources of sustainable energy

Chapter 5

EV-Sharing
Electric Business Fleet Management
(Case A3)

5. EV-Sharing > Electric Business Fleet Management (Case A3)

5.1. Business case overview

What	A fleet of e-vehicles owned and operated by the municipality for municipal workers.
Pilot site	Reggio Emilia, Italy (REG)
Main smartCEM service	• EV-Sharing management • EV-Navigation management • EV-Efficient driving
Additionally implemented services	• EV-Charging station management
Number of vehicles involved	50 to 60 electric vehicles out of which 10 are equipped with services
Number of charging stations involved	50-60
Not implemented	• EV-Trip management

5.1.1. Introduction

In Reggio Emilia, the municipality owns and operates around 60 fully electric vehicles (Piaggio Porter minivan). Out of these vehicles 10 are equipped with smartCEM services. There are 20 users appointed to use these 10 vehicles.

Figure 5.1.1.1 Two Piaggio Porter minivans

The vehicles are not available to the public and therefore can be referred to as a Business Fleet.

On the vehicles, there are Android 7 inch tablets (Asus Fonepad) that operate the navigator developed by PTV, and the efficient driving app developed by CRF. The sharing is managed by software that manages the availability of the car keys. The Charging Stations are also displayed in the navigator, but since the vehicle is always returned to the same location at the end of the day, the information is only valuable to provide confidence to the driver that other locations are available in case the charge of the battery is about to run out. Moreover, it is important to ensure that this information is available in case other business fleets (which may need a larger EV range) are interested in the smartCEM services.

Multi Modal Trip management is not and will not be implemented for reasons explained in paragraph 5.5 EV-Trip management.

5.2. Main service: EV-Sharing management

This paragraph 5.2 is about the sharing of the electric (business) fleet in Reggio Emilia.

5.2.1. Organisation

Name	Role
Municipality of Reggio Emilia	**Service provider** (EV-Sharing service). Owner of fleet, manager of vehicle allocation. Owner and manager of key cabinet. Employer of users.
ICOOR	**Supporting coordinator** Support in REG Pilot site coordination.
University of Modena and Reggio Emilia	**Coordinator of REG Pilot Site** Vehicle equipper

5.2.2. The service

EV-sharing is managed in the Reggio Emilia (REG) Pilot Site, through a key management cabinet functionality at the municipal back office. The EV keys are located in a specific cabinet. The keys are identified by their position, ID and label with an EV license plate number. The keys can be available (i.e. locked) or unavailable (i.e. unlocked) to be used. If available, a user can take one of them and use the related vehicle. Usually the user knows exactly which vehicle he needs and he gets the related key. Users access the cabinet using a personal badge. The key management cabinet collects data about vehicles taken in charge by employees. The cabinet records data such as who took which (vehicle) key and when, also the return of the key is traced.

Figure 5.2.2.1 Electric mini-van key locker

5.2.3. Implementation process in Reggio Emilia

The University of Reggio Emilia and Municipality manage the adaptation of the key management cabinet software for the smartCEM project. A list of users involved in the project will be traced and software is adapted to allow particular users to get only smartCEM equipped vehicles.

All trips will be traced and data logged. An export of data will be managed through a specific functionality of the cabinet. The data moves to a local Database located at UNIMORE and is there merged with other data.

5.2.4. Implementation in a new city

The availability of this service in other cities/public administration depends on the organisation structure and internal organisation.

It also depends on how accessibility of vehicle to users is arranged and managed. It requires facilities and resources to guarantee functionalities. Data collection functionality also requires an ICT infrastructure.

This service could be very useful in locations where a closed sharing scheme is present and an organisation is managing the fleet. However, other solutions can also be adopted. For example something similar to the services offered in Gipuzkoa (please refer to chapter 4) or another smart solution with the use of the smartphone as a key to access the vehicle.

The key-cabinet solution of the Reggio Emilia pilot site is working in their case, but alternatives for the organisation of EV-sharing are possible.

5.3. Main service: EV-Navigation management

This paragraph 5.3 is about Navigation services in the Reggio Emilia pilot site.

5.3.1. Organisation

PTV is the main technology provider. They have developed the service being the EV-Navigation App. TeamNet linked it to smartCEM Portal so that it can also be launched from the Common App. CRF developed the Efficient Driving App and together with PTV made it possible for the driving-style advices to be shown in real time with the EV-Navigation on the tablet. UNIMORE provided a list of all available CS in Reggio Emilia, mapping their GPS position so that TeamNet and PTV could also test the EV-CS Management service at REG PS.

Name	Role
UNIMORE	**Service Provider** Responsible for the implementation of the hardware/software components into the smartCEM platform at REG PS
PTV	**Technology provider**
CRF	**Integrator** Responsible for the integration of the Efficient Driving App with the EV-NAV
TeamNet	**Software developer** Responsible for the integration with the Portal App and with the CS Manager
Municipality of Reggio Emilia	**E-Vehicle provider** Though not a project member

5.3.2. The service

The navigator, developed by PTV, runs on the tablet and directs the user to the intended destination via a path which is specific for the electric vehicles. In fact, the limited traffic zones in the city centre of Reggio Emilia don't apply to electric vehicles.

The navigator has an integrated efficient driving component that is developed by CRF, which is shown to the driver and provides advices to improve the driving efficiency and therefore the battery's autonomy and ultimately lifetime. (Please refer to the next paragraph on efficient driving).

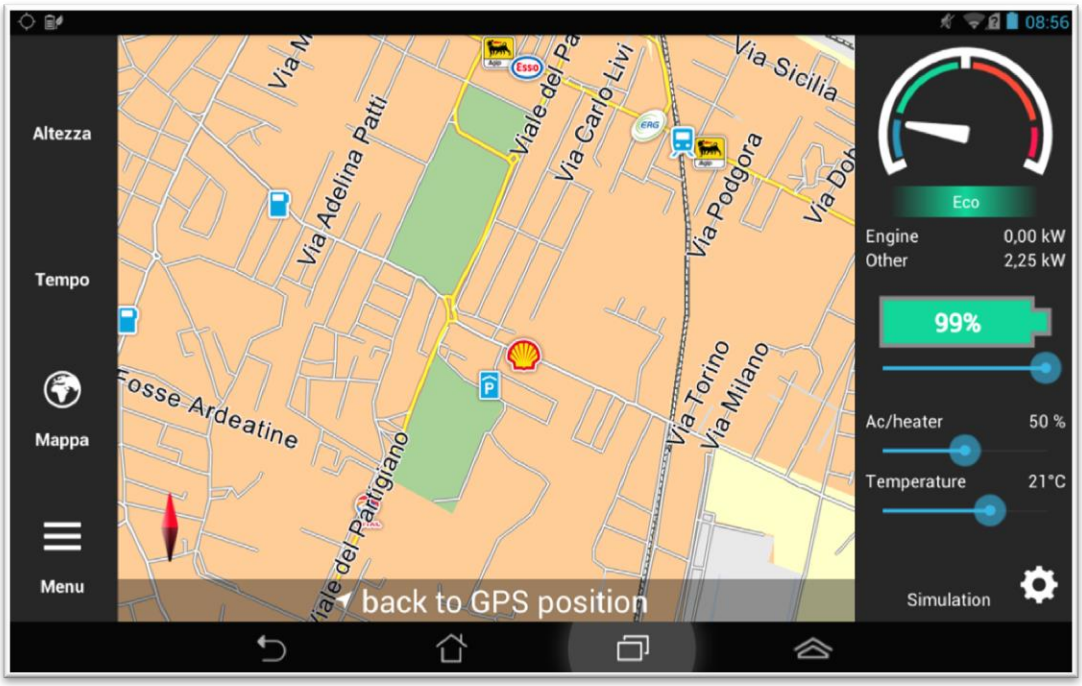


Figure 5.3.2.1 EV-Navigation management

5.3.3. Implementation process in Reggio Emilia

The application was released by PTV in the form of an .apk file, meaning that it only had to be transferred to the tablet and it could be installed by clicking on it. No software issues emerged to implement this service.

While planning the physical installation of the tablets into the EVs, we had to be sure that the vehicles were not damaged nor any of their functionalities would be altered by the components of the smartCEM platform, especially considering that the Municipality of Reggio Emilia is not a member of the project. For the same reason, the installation of all the smartCEM software/components could not be permanent, so that it will be possible to remove them after the project without affecting the vehicles.

Moreover we had to take into consideration possible security issues concerning the on board tablets in order to prevent them from being stolen, which could also possibly cause damage to the vehicle's (dashboard). The installation will then be done in a way that the on board unit looks fully integrated in the vehicle and impossible to easily be removed. It is also worth considering taking out an insurance policy at least for the vehicles, in order to ensure that the Municipality is not affected negatively in any way.

Promotion of the EV-Navigation service in Reggio Emilia

The Navigation service on its own is not promoted. It is explained to the municipal staff on an individual basis.

5.3.4. Implementation in a new city

A specific installation design for the on-board unit (tablet and related cables) should be planned for the type of vehicle involved for this service. This design should offer the possibility to take advantage of the service without altering the vehicle's own functionalities.

Safety issues may also be considered in a new city, depending on the openness of the access to the vehicles.

5.4. *Main service: EV-Efficient driving*

This paragraph 5.4 is about the EV efficient driving app that was developed by CRF for the use in Reggio Emilia.

Figure 5.4.1 The Reggio Emilia municipality electric vehicles

5.4.1. Organisation

The Efficient Driving service is an Android App installed on the tablet mounted inside an electrical vehicle. It acquires vehicle data by means of an HW device called BlueDash that transfers the vehicle's signals using Bluetooth.

The acquired data is used for the real-time suggestion messages to the driver and for storing data of the trip. The data can be sent to the local database managed by UNIMORE. The local server produces statistical analysis on the data and sends the result to the central database of UNEW.

Name	Role
UNIMORE	**Coordinator and main actor** in the implementation process, provider of the local database

PTV	**Software developer** of the PTV Navigator Android App
CRF	**Software developer** of the Efficient driving Android App
DQuid	**Hardware provider** Producer of BlueDash, the Bluetooth interface between vehicle and the Android App (not a project member)
UNEW	**University** Provider of the central database
Municipality of Reggio Emilia	**E-Vehicle provider** not a project member

5.4.2. The service

Figure 5.4.2.1 Screen overview

The efficient driving component is developed by CRF, it is a standard Android App running on a tablet. This app operates in conjunction with PTV Navigator, implementing POIs, e-horizon (electric autonomy) and specific advice to the driver to achieve a better efficiency of battery usage. The efficient driving component acquires the most relevant vehicle data (like SOC, speed, vehicle state, battery voltage and current, etc.) via a Bluetooth channel by means of a dedicated HW developed by DQuid (www.dquid.com) and is called "BlueDash". This piece of HW is directly interfaced to the vehicle itself. Data collected is stored locally into the device hosting the application. Afterwards, the same data can be uploaded automatically (only when a 3G connection is available) or manually via USB from the device to the UNIMORE server.

The Efficient Driving component is divided in three sub-components:

EV-Assistant

Displays current status of electric consumption and other current values.

Figure 5.4.2.2 Current status of electric consumption and other current values

EV-Efficient driving

Provides real-time on trip advice on how to improve driving style to attain a better efficiency on battery usage. The warning messages are obtained by combining the EV-Eco driving current data with the current vehicle signals (speed, SOC, etc.) and the e-horizon provided by the PTV Navigator.

Figure 5.4.2.3 Hard breaking warning

EV-Eco driving scores

Displays the corresponding values for the three eco scores, acceleration/deceleration style, and respect for the speed limit.

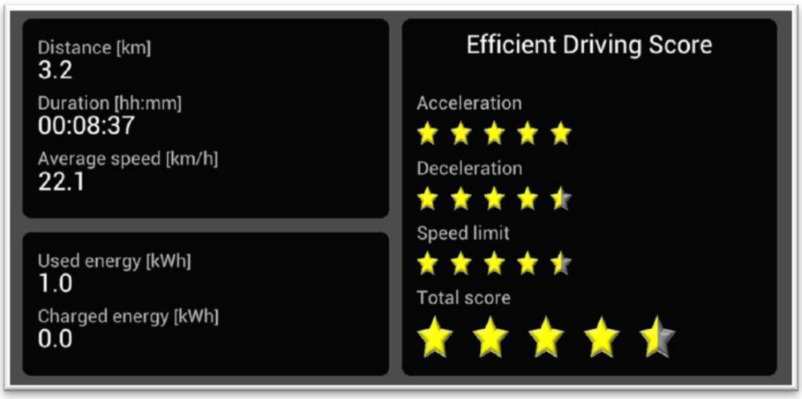


Figure 5.4.2.4 Efficient driving scores

These scores are a stimulus for the driver to improve him/herself towards a more efficient driving style. Also other incentives could be thought of.

The Efficient Driving component is started like any other Android app. A few seconds after starting up the application, the splash screen is visible, and then the login page appears. The user is requested to select his/her id and then to confirm. The selection of user is useful to relate the collected travel data to the current driver for statistical usage.

Typical usage of the efficient driving component is the following. The driver brings a tablet in the beginning of the day, starts the CRF-App which in turn starts the PTV Navigator, selects the destination(s) and then starts driving. During the trip the driver can switch between the CRF-App and the PTV navigator depending on which info he/she needs. In the meantime the App provides suggestions to the driver by vocal and visual messages.

5.4.3. Implementation process in Reggio Emilia

Installing the software on the tablet was very easy, as CRF released the App in the form of an .apk file. Also launching the Efficient Driving App can be easily done from the Portal App screen or, alternatively, from the EV-Navigator application.

The main issue which had to be dealt with was a strictly technical one: the vehicles of the municipal fleet don't have a CANbus, so the BlueDash unit could not be connected directly to the EVs. In order to solve this issue, we used an additional interface between the EV and the BlueDash, specifically an analogic/digital converter HW unit (signalling machine), able to read the data from the vehicle's electrical network. A custom wiring had to be designed and implemented in order to connect the two units and make them able to communicate with each other. While doing this we also had to ensure that the wiring was not in the way of the driver, so we plugged and hid the signal machine under the driver's seat and placed the connecting wire in a lateral position.

The CRF efficient driving and the PTV Navigator are standalone Apps but they need each other to perform all functionalities (CRF App needs to know the autonomy of the vehicle provided by PTV App). For this reason both Apps must run on the same Android Tablet. At start-up, CRF efficient driving app checks whether the PTV Navigator is active: If not, the CRF App suggests to the user to activate PTV Navigator. If the user didn't activate the PTV App, the CRF App would still run, but with limited functionalities. It is also possible to start the PTV Navigator first, and then the CRF efficient driving app using the PTV icon on the tablet.

Due to the fact that both apps are always active in background they consume tablet resources (CPU time, GPS signal and Bluetooth connection) continuously. This means that the tablet must be always plugged in during the trip (with such resources usage the battery of the tablet will not be able to last long).

Real-time advices had to be designed and implemented taking care of the safety regulations and guidelines concerning on-board User Interaction, meaning that the driver shouldn't be distracted or unnecessarily receive too many external inputs while driving. Additionally, since the REG PS end-users aren't part of the smartCEM consortium, they must be able to easily switch the tablet and the related project's services on and off.

Promotion of the EV-Efficient driving service

At this stage CRF is not yet commercialising the service. Still, it is available for other cities to pilot and collaborate on developing a commercial model (that would include promotion).

5.4.4. Implementation in a new city

When planning the implementation of this service, any electric business fleet manager should ensure that all necessary input signals are available from the vehicle. In our case, as described above, this was achieved by introducing a signalling machine between the EV and the BlueDash unit, the latter communicating with the smartCEM tablet. If the fleet manager selects vehicles, or already has vehicles that have a CANbus, then there is no need for such a signalling device.

Depending on the hardware which will be installed on-board, it would be nice if it could automatically shut down when the vehicle is shut down, (unless specified to stay on), in order to prevent it from draining the vehicle's battery. This feature was not included at REG PS since the EVs are returned to the Municipality and plugged in every night, but might be useful for other Business Fleets.

The hardware requirements for the tablet that is used for the service are: 7 inch screen, Android operating system, Blue Tooth connectivity, Mobile data connectivity (2G GPRS or 3G UMTS) and a touch screen. (For example the ASUS K004).

5.5. EV-Trip management

This paragraph 5.5 is about the (absence of) Multi Modal EV-Trip management in the city of Reggio Emilia.

EV-Trip management is not really a service that is logically linked with a business fleet. In the pilot Site of Reggio Emilia it was decided to not include EV trip management, since municipal workers are very unlikely to make multi modal trips. They often have material with them and that is why they use the municipal (electric) vehicles.

Moreover, at this pilot site the end-users are also employees of the owner of the fleet, already sharing all the relevant information concerning the trip (such as destination, duration, etc.) by means of the Municipality's Key Management system described in D2.4.4. "Platform integration for Reggio Emilia pilot site" and paragraph 5.2.2 of this document.

5.6. Additional service: EV-Charging station management

This paragraph 4.5 is about the installation of EV-Charging Station management in the city of Reggio Emilia.

5.6.1. Organisation

To implement this service, UNIMORE mapped the position of the Charging Stations available in Reggio Emilia and provided the complete list to TeamNet, who added it to the CS database and integrated the list in the Navigator together with PTV. UNIMORE will manage the CS of the city and in the case that there is any update they will immediately communicate a new list to TeamNet. TeamNet also included the integration of the service with the Portal App.

Name	Role
TeamNet	Main technology developer and provider
PTV	**Developer** EV-Navigation developer
UNIMORE	**Service provider** Responsible for the list of CS of the city

5.6.2. The service

The Charging Stations are listed in the navigator developed by PTV and displayed on the map. Each CS entity has a set of attributes relevant to the Navigator, which are made available to the Navigator via a REST web-service, in two formats:

- CSV text;
- Proprietary binary format.

The data of the locations is managed by TeamNet. The CS Manager Service maintains a CS database that allows for modifications to the CS data that need to be applied.

If driver needs to go to a charging station, he can select the closest one on the screen of the tablet and he will receive directions to this point. This service will likely not be used much at REG PS, because all vehicles always return to the base parking where they charge overnight. But still, it can provide more confidence to the driver, in case the charge is about to run out.

The following screenshot present the user interface of the Android application developed by TeamNet for the CS management service.

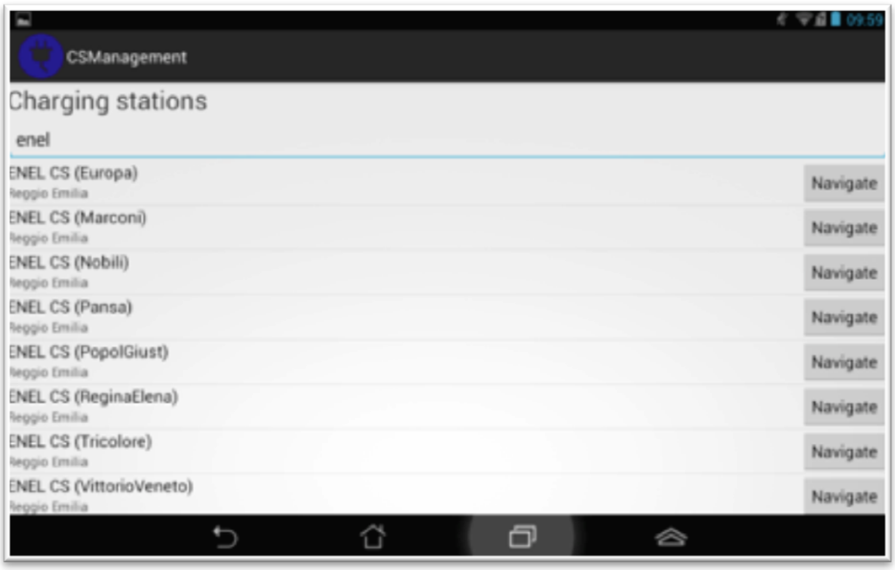


Figure 5.6.2.1 CS management overview

5.6.3. Implementation process in Reggio Emilia

Initially, UNIMORE had to put together a list of charging stations available in Reggio Emilia with their corresponding data. This list was fed into the CS DB. From that point onwards, the data was immediately available in the EV Navigation app on the tablet.

Beyond that, UNIMORE is responsible for the maintenance of the list and the upload into the system (i.e. to TeamNet and automatically to the PTV app).

5.6.4. Implementation in a new city

The procedure of CS Management implementation is the same for all pilot sites involved in smartCEM project. Therefore please refer to paragraph 4.5.4 Implementation in a new city.

5.7. The end-user

At the Reggio Emilia PS, the end-users are the employees of the Municipality who drive the EVs of their fleet. They are a specific kind of end-user because they only need the vehicles for daily trips, so it is unlikely that they benefit much from the range-related advices.

Since they are not directly involved in the project, UNIMORE organized specific meetings with the 20 drivers involved, in order to provide them with a brief overview of the project, its objectives and particularly regarding their involvement, which had to be organised in such a way that it would interfere with the daily activities as little as possible. UNIMORE also translated the smartCEM questionnaires into Italian to simplify their task.

The implementation of the services, including the physical installation of the on-board units onto the vehicles, was entirely performed by UNIMORE personnel, so that the end-users were not affected by it. They picked the EV up according to their usual procedure and they just need to switch on the tablet and touch the smartCEM Portal App icon in order to access the project's services. UNIMORE, as service provider, is trying to receive as much as possible feedback, to improve the service and to stop users from skipping the services because they are too difficult or inconvenient to reach.

5.8. Sustainability aspects of service implementation

The large-scale use of electric vehicles in Reggio Emilia can be regarded as an experimental project, based on a rational and integrated program. It promotes and disseminates the use of the electric car as a daily tool. The experiences are based on the concept of normal and continuous use of the electric vehicle, through concrete use both at the public level as well as the private one.

More than 400 electric vehicles have been purchased and they are not used only for the activities of the City of Reggio Emilia and municipal bodies, but are also used for the development of other community services such as public transportation, garbage collection, the distribution of goods in the historic centre, home care and transport of disabled people.

Both the rental as well as the direct purchase of vehicles is encouraged for people other than municipality users. Like sister companies, private companies, commercial enterprises.

In addition to the overall benefits already listed in paragraph 3.8 (the reduction of pollution and CO_2 emissions, the reduction of hazards to human health and quality of life resulting from the emissions of harmful chemicals or dangerous by vehicles, the obvious noise reduction, the savings on propellant) further success factors are:

- The initiative of local public utilities to use electric vehicles with a limited daily mileage. We must consider that the majority of service vehicles in the institutions run for only a limited distance and therefore could potentially all be electrically driven and to be equipped with smartCEM services.
- A separate company for the purchase and management that will not only take care of the renting at competitive prices and with formulas with sufficient flexibility, but which will also provide assistance and service in the area with the option of receiving a replacement vehicle. The efficiency of the vehicle is an important condition for the success of the project, which allows overcoming the prejudices attached to electric vehicles.
- Encouraging raising awareness in the community regarding the subjects of sustainable means of transport for private journeys.
- Involve commercial and company operators by pushing a self-enhancing cycle which leads to daily circulation in the city of electric vehicles, in that way showing good practices, pursued for over 15 years, can contribute to citizen's environmental sensitivity and their decisions to make changes in their lifestyles.
- Provision of benefit to the users through the free movement and access in the historic centre without hours slots.
- The daily and continuous movement of electric vehicles has convinced local institutions and numerous companies who are operating or working in the city to start using electric vehicles for business trips as well.

In addition, the municipality has publicized this project at press conferences, making videos and photographs, published articles in newspapers and magazines, had posters and brochures printed, also using a specialized website of the Municipality.

The municipality has been characterized strongly with an image of green city and it was not only visited by several foreign delegations but also invited in numerous national and international conferences to disseminate the know-how they have acquired and are still acquiring.

The smartCEM services allow to use even all the electric vehicles more efficiently and economical according to the amount of charge present in the battery, improve their efficiency and performance and to best use the battery energy present.

To have more agility and enable further affirmation of electric mobility, Reggio Emilia also has a network of distribution of energy for charging electric vehicles, installed by Enel, who has chosen Reggio because of its preference for electric mobility. The integration of a system of charging stations in the municipal area allows for even more promotion to use electric cars.

Only when municipal policies are integrated and synergetic, i.e. the use of electric vehicles by the public authorities is promoted and the use sharing EVs amongst the citizens is promoted, and the companies working in the sector are involved, this will allow for a significant improvement in liveability and a concrete example of true sustainable mobility in the community.

Chapter 6

Cross Regional Charging Station Management (Case B)

6. Cross Regional Charging Station Management (Case B)

6.1. Business case overview

What	The development of a successful nationwide business with charging infrastructure, by CYC, independent of local issues
Pilot site	Newcastle, United Kingdom (NEWC)
Main smartCEM service	• EV-Charging station management
Additionally implemented services	• EV-Efficient Driving • EV-Navigation
Number of vehicles involved	10
Number of charging stations involved	160
Not implemented	• EV-Trip Management • EV-Sharing management

6.1. Main: EV-Charging Station management

This paragraph 6.1 is about EV-Charging Station management, the main service provided in Newcastle.

6.1.1. Organisation

The Charge Your Car (CYC) service revolved from the NE PIP project EV User scheme with RFID membership access, a live status charge-point navigation map and usage data for both EV drivers and charge-point owners. It has since developed into a commercial scheme with full billing and settlement facilities and now operates Pay As You Go capability on a 2nd generation website with added functionality for drivers and charging station owners including billing and settlement. A cross-platform App has been added to further improve the customer experience.

CYC doesn't own Charging Stations, CYC concierges them for Hosts for whom CS management is not their core business i.e. Hotels, Factories, Coffee shops, Sports Centres etc.

Name	Role
Charge Your Car	**Service Provider**
APT	**Charging Station Manufacturer** manufactures CS to OCPP – ensuring compatibility to CYC service
Elektromotive	**Charging Station Manufacturer** manufactures CS to OCPP – ensuring compatibility to CYC service
ABT	**Charging Station Manufacturer** manufactures CS to OCPP – ensuring compatibility to CYC service
Chargemaster	**Charging Station Manufacturer** manufactures CS to OCPP – ensuring compatibility to CYC service
Siemens	**Charging Station Manufacturer** manufactures CS to OCPP – ensuring compatibility to CYC service
Esseye	**Service provider** M2M service provider to CYC
Ecototricity	**Charging Station Management Service Provider** The CYC white list is uploaded on to Ecotricity CS's. (The arrangement is not reciprocal as the CYC network has a tariff associated with it and Ecotricity does not (no facility for billing and settlement with the Ecotricty network)
Charging Station Owner	Responsible for equipment installation / maintenance
Driver	CS equipment user

6.1.2. The CYC Service

The Charge Your Car Website and web portal is the customer window to the Charge Your Car Charging Station Management System.

The technical architecture of the CYC service consists of a web portal, back office communications to Charging Stations and a shared Database. The Web Portal can be accessed at www.chargeyourcar.org.uk. The portal consists of 3 public areas for the EV driver, the charging station host and the charging station manufacturer.

The current CYC Service is able to offer three forms of system access:

- RFID (Radio Frequency Identification) cards: CYC Access Card –a single RFID card that allows Users to access and pay for charging across the CYC national network using the same card.
- Pay By Phone – Users are able to charge and pay by phone using any mobile phone, debit or credit card and the proven CYC Interactive voice response (IVR) system.
- CYC Smartphone App – the world's first app that lets EV drivers use Charging Stations. Source network Users are be able to download the free Charge Your Car app from Google Play or the App Store (together covering 94% of Smartphone Users). The App lets Users view the national CYC network, locate Charging Stations, plan a route, start, end and pay for a charge, via pre-pay account.

CSs can be located via the CYC Web Site or via the Smartphone App. Search parameters include Station Status, Postcodes, Favourites, nearby locations and Socket Types.

The Smartphone App and RFID cards access the CYC PAYG service enabling drivers to pay for charge using either a credit / debit card or a corporate account. The IVR service operates with credit / debit cards.

The CYC service includes a reimbursement facility. Hosts are able to set pricing for their CS(s) via their Portal. Hosts may charge different rates for each charge point and, in addition, may charge different user groups different prices for the same CS.

The user will determine in advance how long they will use the Charging Station for and the fee will be calculated and deducted at the end of the transaction once the CYC back office has validated that it was successful and power was drawn.

From the revenue collected from the Users there will be transaction deductions for bank fees and CYC service charges and, on a quarterly basis, CS Hosts will receive the revenue collected by CYC.

CYC is supported with the following web browsers: Internet Explorer 7+ / Mozilla Firefox 3+ / Safari 4+ / Google Chrome 20+ / Opera 9.

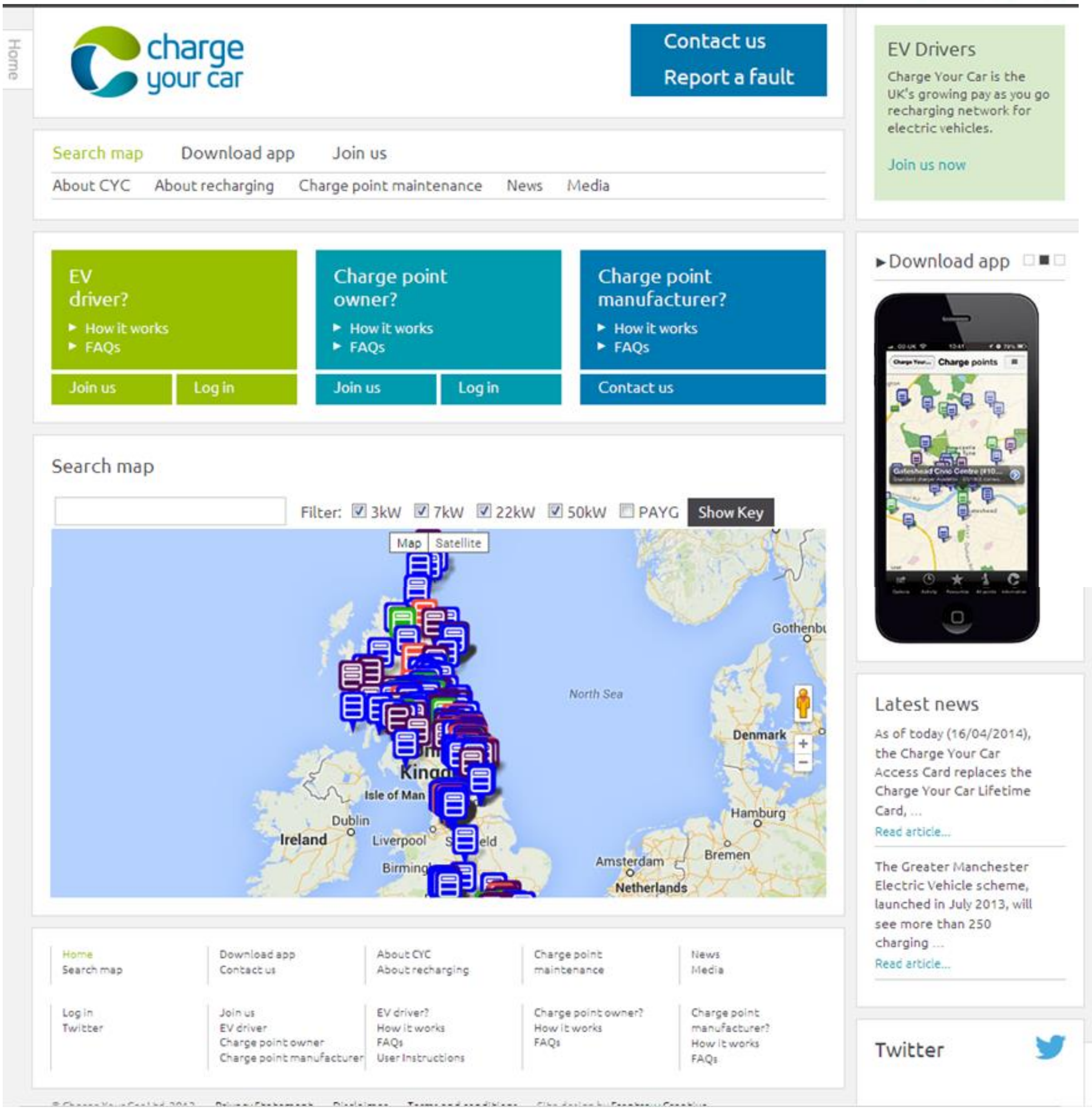


Figure 6.1.2.1 Charge your Car Website, main page

Customer (Driver / CS Owner / CS Manufacturer) Web Portals

The Customer Portals have been included in the screenshot above and below. The first page allows a user the choice of identifying a CS using the CYC map, reading the latest news items or navigating to an appropriate page e.g. driver, Charging Station host or Charging Station manufacturer. The map allows a driver to search for a Station using different search parameters including power and payment methodology. The map also shows the status of the CS via its colour:

- Green for free,
- Blue for in-use
- And red for out of service.

Each CS shown on the map also has a click to access an information screen showing the CS details and allowing a click transition to a nearby Station menu with driving distances. There is also a 'directions to a nearby CS' option. The smartphone app also mirrors this essential user information.

The driver and CS host pages offer the option of registration or login. The login page allows access to the individual account for drivers and to CS report facilities for Hosts. Password reset is also available. The CYC driver portal allows drivers to view their EV charge account, change user details and their charge payment tools. The CS manufacturer's page offers the option of communication with CYC to request details of the CYC certification scheme and other enquiries. Manufactures of CSs who are CYC certified will be listed here.

The CYC Owner / Host portal can be configured to allow administration rights to owners and hosts of the CS infrastructure to have real time access to their CSs. This gives owners and hosts the ability to be able to monitor performance, produce reports and to use it as a tool to enhance service to their customers. The CYC service allows Station owners / hosts to manage variable charging fees for each Charging Station, presenting the opportunity to react to demand or other influencers by price manipulation.

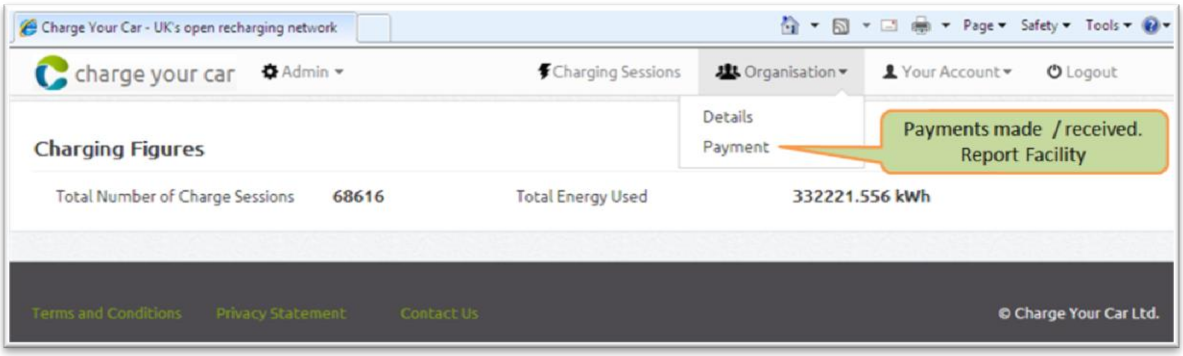


Figure 6.1.2.1 CYC customer web interface

6.1.3. Implementation process

The Charge Your Car (CYC) service revolved from the NE PIP project EV User scheme with RFID membership access, a live status Charging Station navigation map and usage data for both EV drivers and Charging Station owners. It has since developed into a commercial scheme with full billing and settlement facilities and now operates Pay As You Go capability on a 2nd generation website with added functionality for drivers including a cross-platform App and for CS a full including billing and settlement feature.

There have been a number of barriers to implementation.

Desire from grant funded Charging Station owners to guide the design of the back office whilst not understanding the end objective of commercialisation and self-sustainability for the network.

The transition from a grant funded project to a full commercial organisation.

Driver education has been sparse:

- Incorrect assumptions about the interoperability between the myriad networks across the UK have led to adverse publicity
- Driver reluctance to pay or opinion on how they should pay has been hard to manage

There are 3 key players in the business:

- Power Suppliers
- Car Manufactures
- and Infrastructure Manufacturers / Suppliers

However each believes that greater investment to generate long term business growth is the responsibility of the other two, whereas the reality is that the investment should be made by all.

6.1.4. Implementation in a new location

Implementation should not be done on a city or a regional basis – it should be done on a national basis or at least to a national plan with a central objective and procurement / stand / implementation parameters.

Myriad Networks present huge problems with integration which could be avoided with some forward planning as above.

Grant funding should include a revenue element to support the hardware whilst there is no Return on Investment so that if this happens it can be repaired.

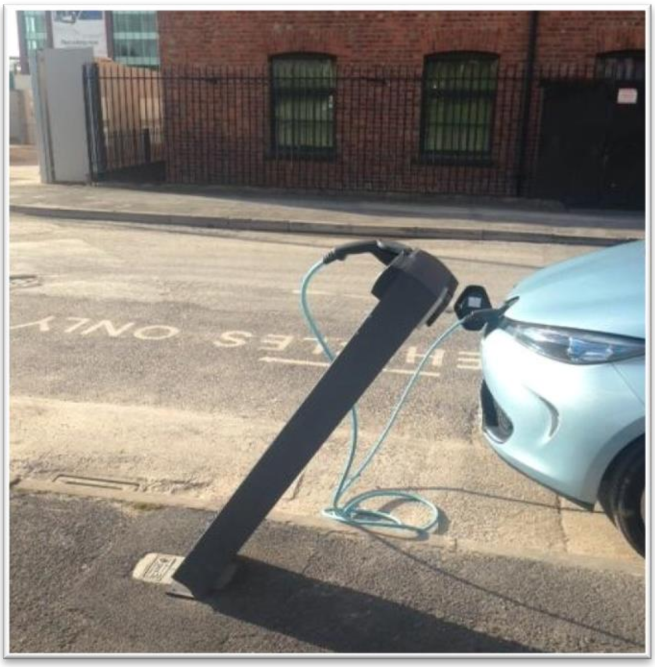


Figure 6.1.4.1 Damaged charging station

Legislation should be reviewed so that it is appropriate and ready before hardware is placed in the ground – the UK legislation on signage for parking makes it costly to implement / change parking tariffs which encompasses any tariffs implemented on EV CS for parking and use.

Legislation – unless implemented correctly- is powerless to deal with the local phenomena of "being iced" – finding a non-EV in an EV parking bay. This also has an impact on the nirvana of being able to reserve a charging bay.

If new RFID based solutions are implemented, the use of standardised RFID technology is recommended, allowing for future integration with other RFID card based services. But even better (more convenient for the end-user) is a smart-phone based solution as seen at CYC.

6.2. *Additional: EV-Efficient driving*

This paragraph 6.2 is about the implementation of EV-Efficient driving in Newcastle.

6.2.1. Organisation

Name	Role
UNEW (Civil Engineering & Geosciences and Learning Technologies for Medical Sciences)	**Development** The web tool was developed jointly by CEGS and LTMS based on an existing web tool deployed for the Footlite project (www.foot-lite.net)
UNEW	**Implementation** Implementation and functional verification of the web tool was carried out by staff in UNEW's school of Civil Engineering & Geosciences who are the participating entity in the smartCEM project
UNEW	**Data Management** In its joint roles as manager of the project's Central Database and of smartCEM's Newcastle pilot site, which provides EV-Efficient Driving as a key service, UNEW manages the data that is obtained from the CDB and presented in the web tool, including data acquisition, data quality, and security and privacy arrangements (primarily ensuring that individual drivers only access their own data)

6.2.2. The service

Technical Development

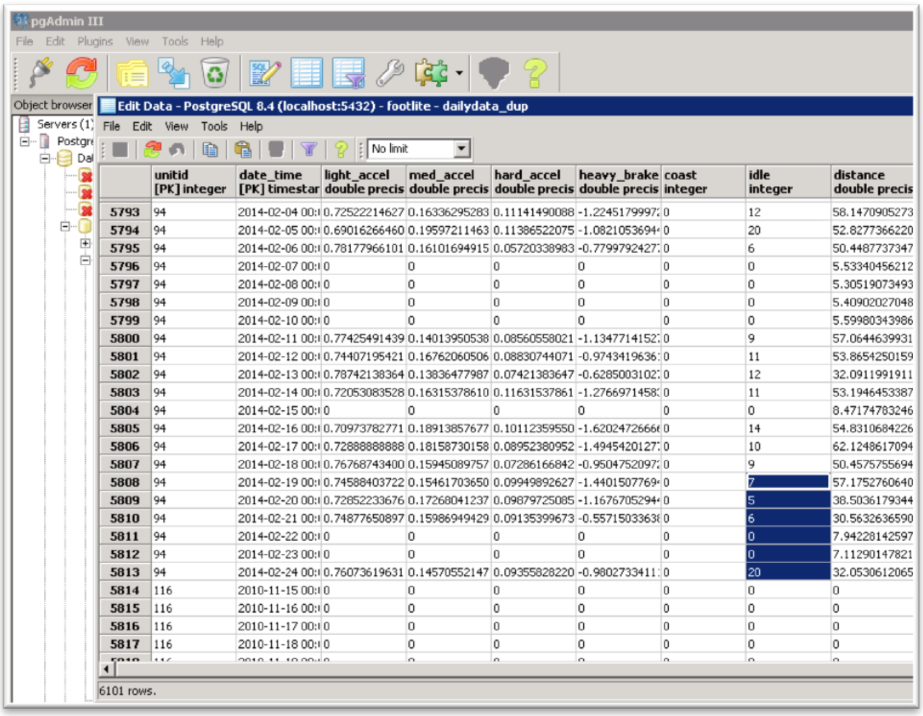
An EV-Eco-Driving service delivered via a web tool was originally deployed for the Footlite project (ICE vehicles). The tool was set up and managed by UNEW, and it was this that formed the basis for the version implemented in smartCEM. The web tool was delivered jointly by personnel in UNEW (school of Civil Engineering & Geosciences and department of Learning Technologies for Medical Sciences).

How does the service work?

The service comprises server side and vehicle side functionality.

Server side: This includes all the software and web portals hosted in UNEW's server.

- DATABASE: The main source of historic EV driving data. It stores the raw second-by-second driving data and processed trip summaries for each trip (including energy use, GPS signal and time stamp).



	unitid [PK] integer	date_time [PK] timestar	light_accel double precis	med_accel double precis	hard_accel double precis	heavy_brake double precis	coast integer	idle integer	distance double precis
5793	94	2014-02-04 00:	0.72522214627	0.16336295283	0.11141490088	-1.2245179997	0	12	58.1470905273
5794	94	2014-02-05 00:	0.69016266460	0.19597211463	0.11386522075	-1.0821053694	0	20	52.8277366220
5795	94	2014-02-06 00:	0.78177966101	0.16101694915	0.05720338983	-0.7799792427	0	6	50.4487737347
5796	94	2014-02-07 00:	0	0	0	0	0	0	5.53340456212
5797	94	2014-02-08 00:	0	0	0	0	0	0	5.30519073493
5798	94	2014-02-09 00:	0	0	0	0	0	0	5.40902027048
5799	94	2014-02-10 00:	0	0	0	0	0	0	5.59980343986
5800	94	2014-02-11 00:	0.77425491439	0.14013950538	0.08560558021	-1.1347714152	0	9	57.0644639931
5801	94	2014-02-12 00:	0.74407195421	0.16762060506	0.08830744071	-0.9743419636	0	11	53.8654250159
5802	94	2014-02-13 00:	0.78742138364	0.13836477987	0.07421383647	-0.6285003102	0	12	32.0911991911
5803	94	2014-02-14 00:	0.72053083528	0.16315378610	0.11631537861	-1.2766971458	0	11	53.1946453387
5804	94	2014-02-15 00:	0	0	0	0	0	0	8.47174783246
5805	94	2014-02-16 00:	0.70973782771	0.18913857677	0.10112359550	-1.6202472666	0	14	54.8310684226
5806	94	2014-02-17 00:	0.72888888888	0.18158730158	0.08952380952	-1.4945420127	0	10	62.1248617094
5807	94	2014-02-18 00:	0.76768743400	0.15945089757	0.07286166842	-0.9504752097	0	9	50.4575755694
5808	94	2014-02-19 00:	0.74588403722	0.15461703650	0.09949892627	-1.4401507769	0	7	57.1752760640
5809	94	2014-02-20 00:	0.72852233676	0.17268041237	0.09879725085	-1.1676705294	0	5	38.5036179344
5810	94	2014-02-21 00:	0.74877650897	0.15986949429	0.09135399673	-0.5571503363	0	6	30.5632636590
5811	94	2014-02-22 00:	0	0	0	0	0	0	7.94228142597
5812	94	2014-02-23 00:	0	0	0	0	0	0	7.11290147821
5813	94	2014-02-24 00:	0.76073619631	0.14570552147	0.09355828220	-0.9802733411	0	20	32.0530612065
5814	116	2010-11-15 00:	0	0	0	0	0	0	0
5815	116	2010-11-16 00:	0	0	0	0	0	0	0
5816	116	2010-11-17 00:	0	0	0	0	0	0	0
5817	116	2010-11-18 00:	0	0	0	0	0	0	0

Figure 6.2.2.1 Database interface with EV driving data

- **WEB PORTALS:**
  - **Admin web:** A private web page where the system administrator checks and configures all the data related to the eco-driving application.

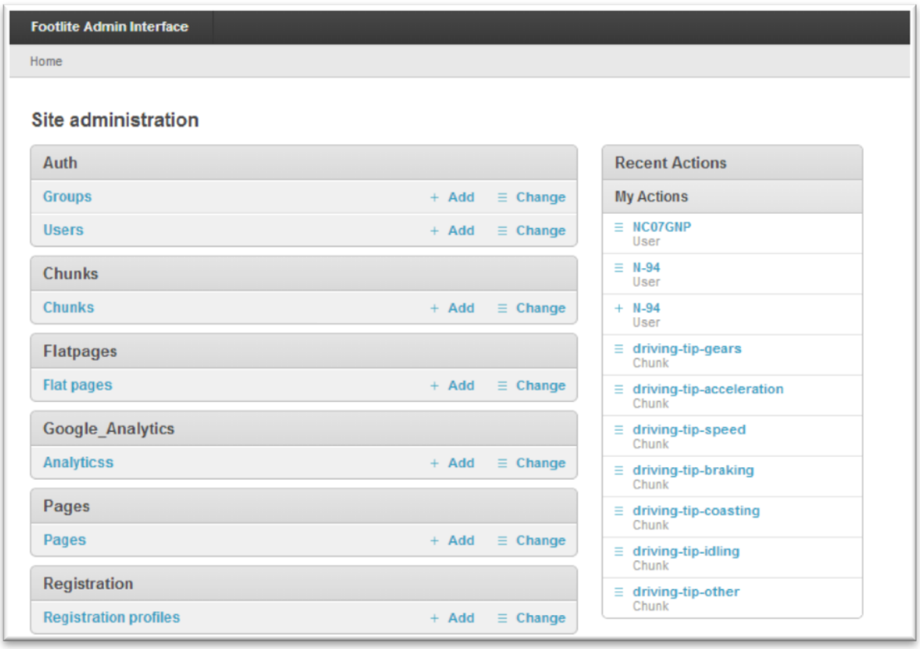


Figure 6.2.2.2 Administrator interface for efficient driving data management

- **Client web:** A public web page where end-users can review their trip summary in terms of energy usage, acceleration and deceleration profile, idling time and energy regeneration, and driving tips.

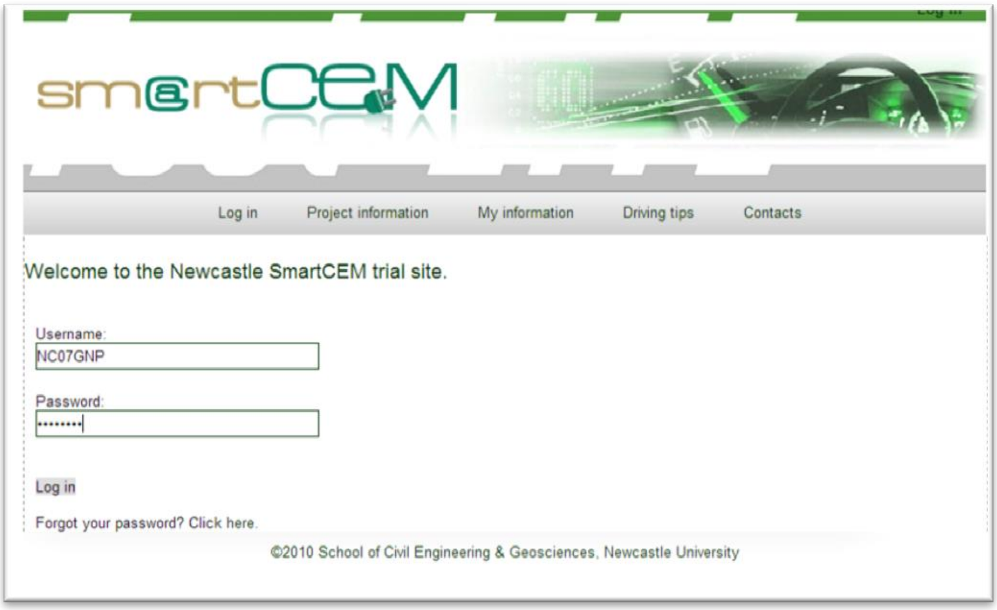


Figure 6.2.2.3 User login to efficient driving website

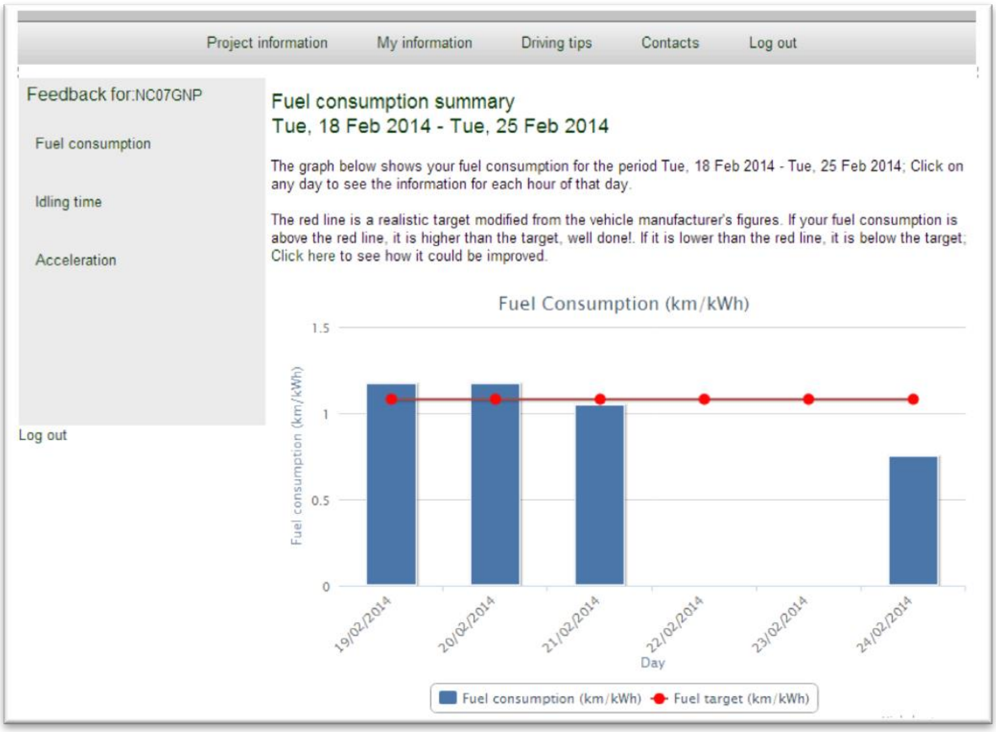


Figure 6.2.2.4 Consumption summary

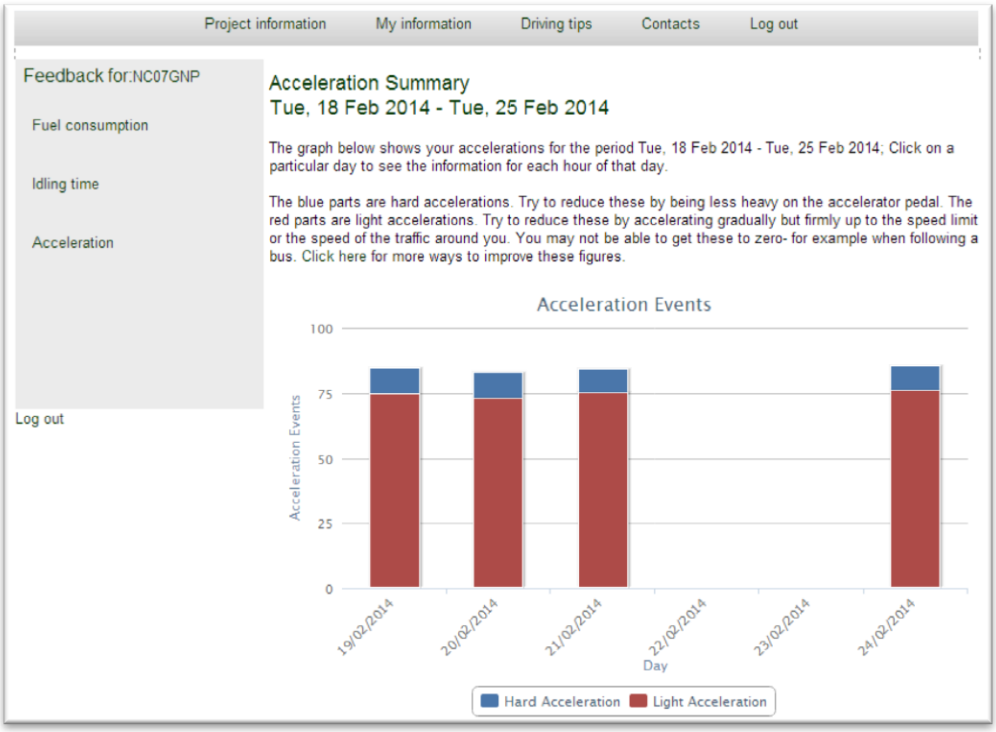


Figure 6.2.2.5 Acceleration summary

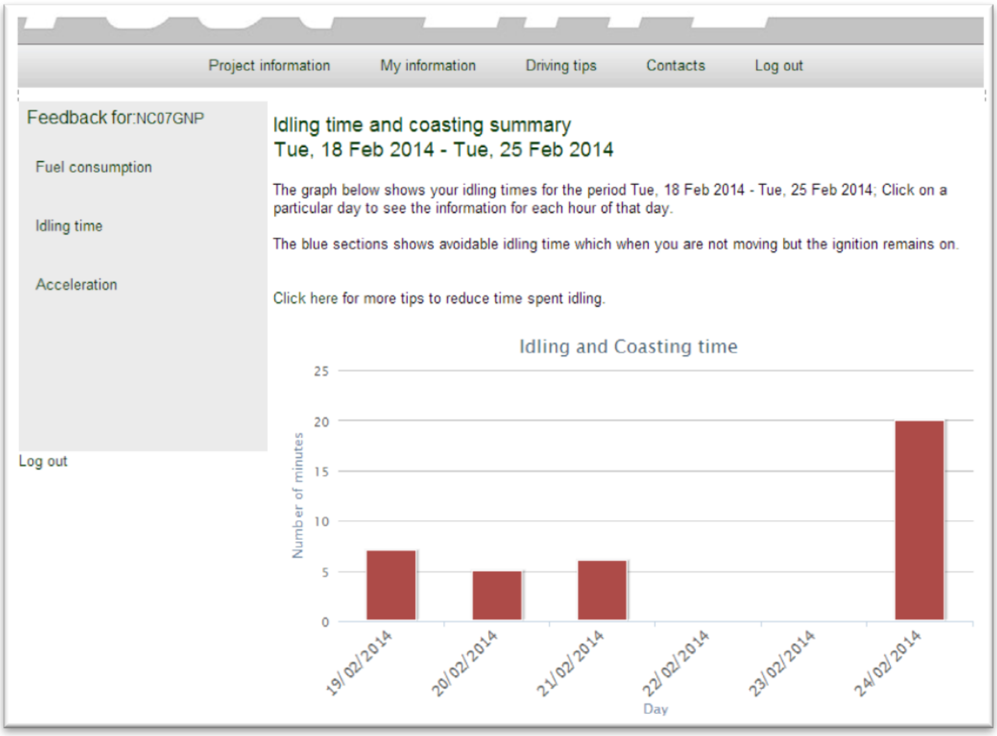


Figure 6.2.2.6 Idling time and coasting summary

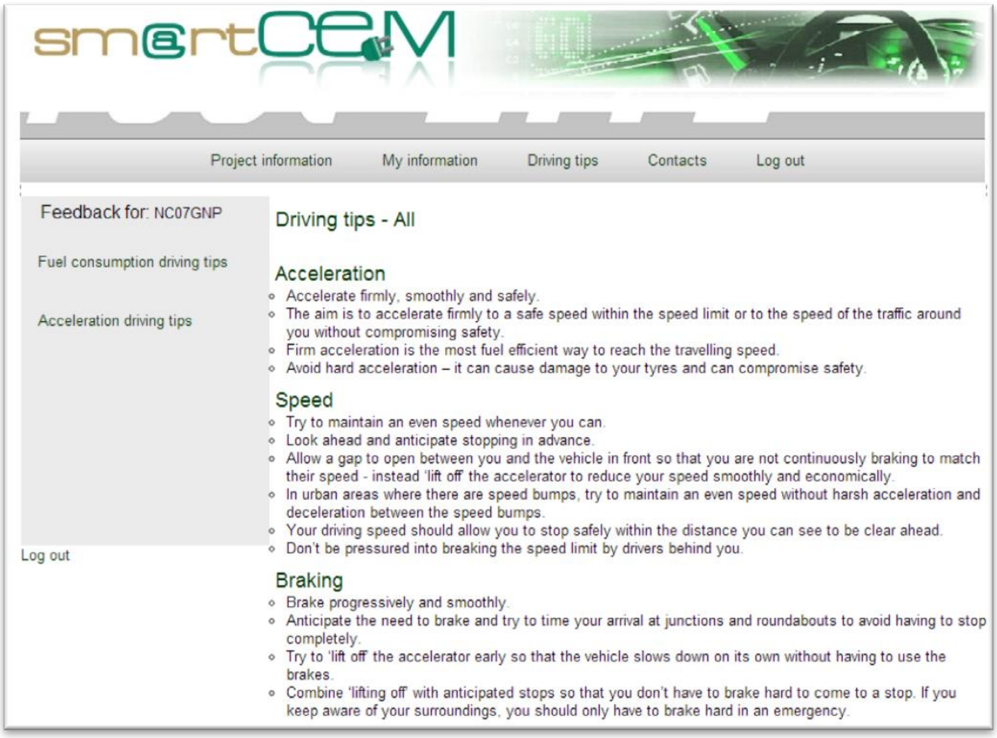


Figure 6.2.2.7 Efficient driving tips

- **BACKGROUND SOFTWARE:** Algorithms that are based on the Footlite project and have been adapted for EVs for smartCEM. The server side has been developed using Python and R scripts. The web portal has been designed using Django, PostgreSQL and Python scripts.

Vehicle side: this part includes all the hardware and software installed in on board data-loggers. The system in the Peugeot Ions is based on RDM data-loggers. The loggers enable the collection of real-time second-by-second driving data by connecting to the CANbus through the vehicle's on-board diagnostics port. In addition to the CANbus the loggers can also record external analogue and digital inputs. These inputs include GPS and timestamp as well as a number of analogue inputs from current clamps which are attached to various electrical systems to measure current flow and battery drain (and regeneration). The raw data collected monitors all aspects of vehicle usage and can be used to calculate vehicle performance under different topographical and traffic levels. The performance is expressed in terms of energy consumption (kWh) per kilometre driven.

6.2.3. Implementation process

Technical Implementation and Verification

The completed web portal was delivered for testing to UNEW's smartCEM personnel. Two key aspects of technical verification were then performed:

- To ensure that the website is displaying the appropriate data for a given user
- To ensure that the connection between the website and the Central Database is reliable

To verify these aspects the following steps were applied:

Administration Step 1: Register user within the system

Due to security issues, it is necessary for the administrator of the website to specifically add users into the system. However this is a straightforward procedure, taking less than five minutes per user.

Administration Step 2: Confirming user addition

To confirm that a user has been added it is possible to check the back-end database for the system and check that the registered user has been added to the participant details list. Additional information can also be added at this stage.

Administration Step 3: Data check between Central Database and website

To check that the data being provided by the Central Database is the same as that being displayed on the website it is necessary to directly examine the data both in the database and on the website.

Administration Step 4: Dealing with unexpected values

Due to the nature of the PostgreSQL database, it is impossible to insert incorrect types of values (e.g. it is not possible to insert a string variable into an integer column) therefore data sanitisation is handled by an R script (an open source statistical language) which generates the data from the raw data files. Within the R script there are multiple checks to ensure that the data being produced is of the correct quality and type, with no unphysical data sets being sent forward to the Central Database. This data processing tool has been used in previous projects with great success in automating the process of data analysis and trip generation, which allows great quantities of data to be handled with relative ease.

User Step 1: Log in

After registration is completed by the administrator of the website, it is then possible for the user to log in under a chosen username and password.

User Step 2: User can access expected statistical information

Users can review their trip summary in terms of energy usage, acceleration and deceleration profile, idling time and energy regeneration.

User Step 3: User can access driving tips

This can be accessed through the appropriate link on the user homepage.

Technical Issues

No technical issues are evident.

Data Issues

Some of the drivers participating in the original Footlite scheme were uncomfortable being monitored and having their driving (as they perceived it) ‘judged’ by their managers. The Footlite participants were fleet drivers working for a local authority. In smartCEM this is not seen as an issue as the participating drivers are all private motorists who are likely to ‘buy in’ to the project ethos. Use of the EV-Efficient Driving web tool is also voluntary. However, there is a possible implication in terms of wider implementation of the service, especially amongst fleet operators.

6.2.4. Implementation in a new city

Transferability

This system can be implemented into other cities quite easily. In the short term it is foreseen that UNEW will host a Central Database to which data is sent, and from which the specific data for an individual user is transferred to the web tool. With this set up, as long as UNEW is provided with the second-by-second data for each trip, the system functions appropriately. On the vehicle side, data can be collected through smart phones, data-loggers or OBUs. On the server side access to the web tool has to be provided by UNEW with specific access rights for additional users. In terms of the functionality on offer, and the data to be presented by the web tool, transferability would have to be discussed bilaterally between an adopter and UNEW.

6.3. EV-Sharing management

The Newcastle pilot site has not implemented EV-sharing.

6.4. EV-Trip management

The Newcastle pilot site seeks to provide an eco-friendly driving culture in the north east of England. By providing a connection to an already existing web-based national journey planner called Transport Direct, EV drivers can take advantage of real-time pre-trip and on-trip information on door-to-door multi-modal travel to make fully informed travel decisions.

6.5. EV-Navigation management

There is limited implementation of EV-Navigation in Newcastle. Navigation is largely provided by CYC through the CYC APP. However in “Cue V vehicles”, which are vehicles supplied by project partner HyperDrive the PTV navigation service is implemented in collaboration with BlueDash™ (produced by dQuid, www.dquid.com), which transmits on-board vehicle data via Bluetooth to a smart phone or tablet.

6.6. The end-user

Most EV drivers would like to see this:

Figure 6.6.1 Coffee and charge

And the reality is that it's not far off but in a different format. Businesses will install equipment as a Value Add footfall increaser.

There is already research / driver feedback that suggests drivers will use a facility with EV equipment in preference to that with none. This means that certain elements of the EV CS service can be implemented or supported by commercial strands from investment to push / pull marketing.

6.7. Sustainability aspects of service implementation

A project aimed at creating a system of charging infrastructure for electric vehicles of public administrations and the private sector has the objective of improving local electric mobility, reducing the air pollution and the efficiency of vehicle movements, with a full environmental impact of urban traffic plans with the additional cost savings and fuel management.

The city of Newcastle committed to this project because of the economic area with the greatest flows of mobility, since there is a heavy flow of traffic, for the movement of private people, tourists and for all the people who have work activities in the urban centres.

In order to be accessible to the majority of the traffic flow, main highways as well as petrol stations, car parks near commercial hubs etc., may be considered as a location to install charging stations for electric mobility. Stations that are to be used by tourists, commercial and labour staff.

In this way, a well distributed network of charging stations, ensures access to charging at all times to every potential customer. Thanks to smartCEM services the end-user has accessibility with great ease of use.

In the field of emissions, taking a basis of calculation, the following parameters can be considered to yield the following benefits for reduced emissions of electric vehicles beyond the maximum permissible emissions of EURO 5 vehicles:

- Carbon monoxide (CO): 1000 mg / km for petrol and 500 mg /km diesel engines;
- Total hydrocarbons (THC): 100 mg / km for petrol engines;
- Non-methane hydrocarbons (NMHC): 68 mg / km for petrol engines;
- Nitrogen oxides (NOx): 60mg/km for gasoline and 180mg/km for diesel;
- Hydrocarbons plus oxides of nitrogen: 230 mg / km diesel engines;
- Particulate (PM): 5 mg / km for both types of engine (-80% compared to Euro IV).

To find the best location of charging infrastructure in line with the mobility needs and constraints of the power grid, it is essential that consultation between all stakeholders takes place, including and in particular, regardless of the business model identified, the local authorities for the selection of the best sites on the basis of knowledge of the area and to simplify and shorten the permitting procedures.

It is also very important to encourage the development of charging infrastructure in car parks of commercial hubs like shopping malls, or close to train stations or bus stops and near historical centres, because very often the residents of these areas do not have a garage or personal parking place.

Electric vehicles also contribute to a better distributed use of car parking spaces, because the spaces are used more evenly across time of the day.

In order to minimise the impact on the use of public land surface, each charging station, should best be able to simultaneous charge two vehicles at the same time. Though this is subject to the capacity of the available network. Obviously also two adjacent stalls should be available.

The development of charging should not be based on a single model, which could discourage research and development of new technologies, but must give priority to flexible models (at the same time with the same charging station you can charge with normal standard and quick or fast charge), designed to support the development of competitive markets, that will best allow the adaptation of the charging systems to the different needs of consumers and the different availability for investment in charging infrastructure depending on the type of urban area concerned.

At this early stage it is necessary to focus on open solutions that, in particular, make it possible to consider the 'charging' not only as a 'sale of energy' but also as part of the provision of a service. In this context, even in the wake of nearly all European experiences in the course, the sale of kWh is not the only component of the entire service sales. Looking at recharging of electric vehicles in this way, opens the opportunity that many operators can provide a "mobility service" that includes, for example, the installation, maintenance and operation of charging infrastructure, as well as any additional smartCEM services to use charging station infrastructure (e.g. geolocation services, information and reporting on costs, etc.). Furthermore, making charging electric cars attractive can be done through offering a variety of additional services such as WiFi internet access, discount on products and services, customer loyalty programs etc.

The charging stations can also be an integral part of a smart grid as the point of interchange for the energy that is "sold" to the network from the battery pack of the electric vehicle. Although currently most cars are not provisioned to be able to deliver electric power to the network yet.

Figure 6.7.1 Added services, such as WiFi-internet access during EV Charging

Chapter 7

Unique Service Offering (Case C)

7. Unique Service Offering (Case C)

7.1. *EV Efficient driving*

This paragraph 7.1 is about EV Efficient driving on the hybrid bus in Gipuzkoa.

7.1.1. Organisation

The Efficient Driving is a service that dBus provides on the Electric Hybrid bus and it is an android application (EcoAssist) realized by Datik Información Inteligente.

Name	Role
PT-dBus	**Service provider** Provides the vehicle to implement an application for company buses
Datik Información Inteligente	**Technical implementation of a service** Implementation of Android application of Efficient Driving

7.1.2. The service

The aim of the service that dBus provides on the Hybrid bus, is to improve the driving of its drivers. For this purpose, an Android application is running on the tablet (HMI), located in the bus so the driver is informed how to improve the efficiency of her/his driving.

Figure 7.2.2.1 Driver ready to start

Figure 7.2.2.2 Driving with HMI activated

The tablet is connected to the bus batteries by a USB cable, so when the bus is running the tablet is charging. The data, such as the ID of the driver, the line number of the concerned bus, the speed of the vehicle, the location of a vehicle at each moment, are obtained via Bluetooth from the CANbus. . The data obtained (recommendations, alarms, speed etc.) during services is periodically sent to the server at Datik, using a Wi-Fi system. The data is saved to the data base for the future usage.

The application EcoAssist provides recommendations for efficient driving, with the goal of improving the driving skills of the drivers in order to reduce the fuel consumption (and through which also the emissions will reduce), improve the comfort of the passengers and reduce the stress that the driver experiences in his/her daily work.

The first step of the implementation needs an initial storing of the driving parameters containing optimal speed, curves and breaking so that the consumption is minimal.

Next, the system will give recommendations based on this ‘ideal’ speed model. When the driver is above the target speed, the system will give a recommendation to slow down. Moreover, different situations to be avoided to reduce consumption are identified. These are situations like:

- High rpm;
- Excessive idle time;
- Abrupt acceleration;
- Abrupt braking.

Figure 7.1.2.3 HMI giving instructions to the driver

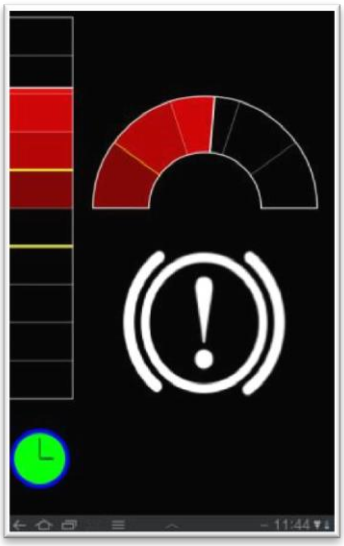


Figure 7.1.2.4 Snapshot of an excessive braking alert

All the information collected is stored in DATIK's server. After it is processed, the information can be used to study the driving and vehicle behaviour using the web tool called "iPanel".

The information is strategically vital for the bus service provider (dBus).

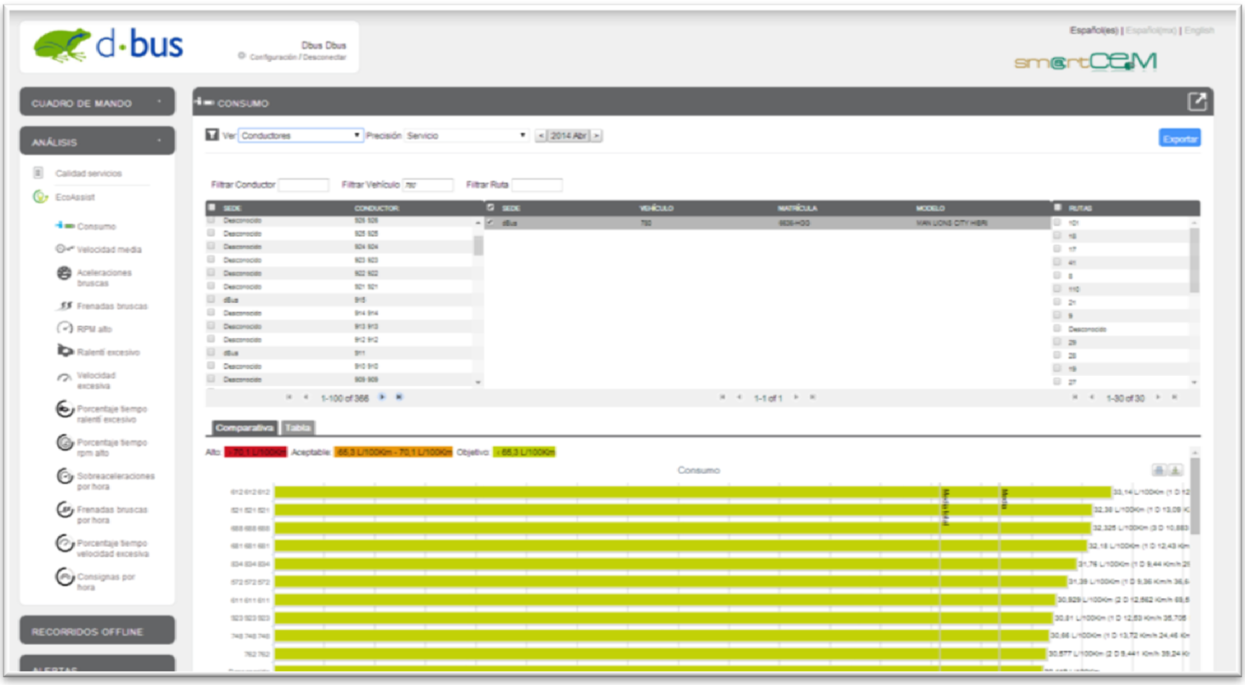


Figure 7.1.2.5 Screenshot of iPanel, consumption per driver

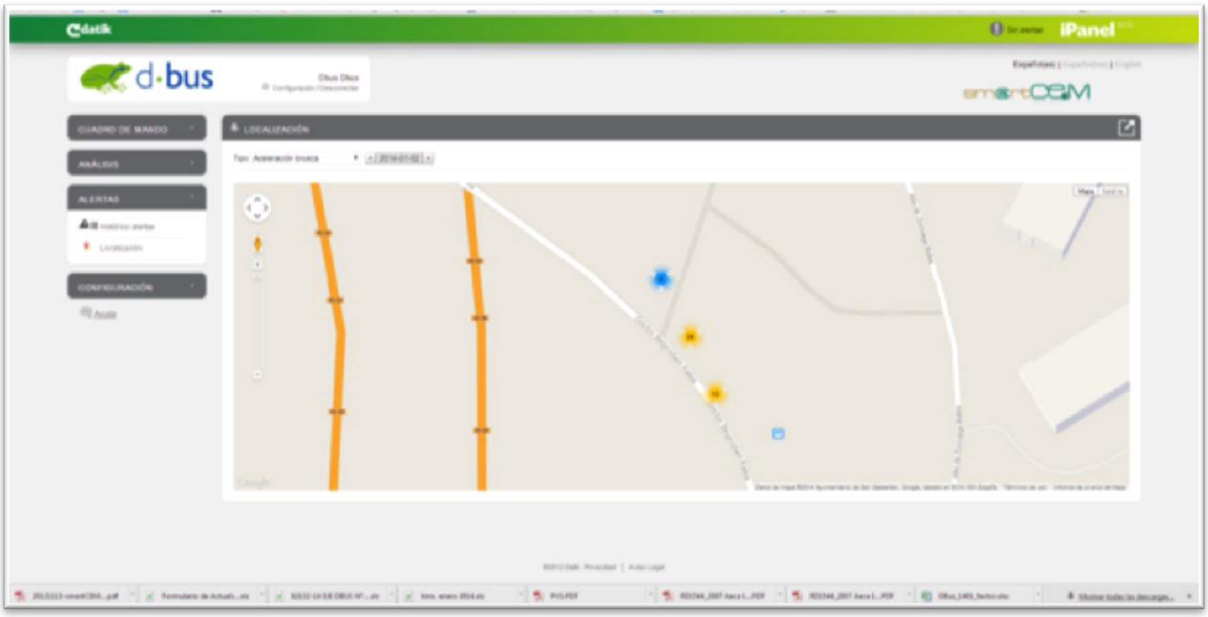


Figure 7.1.2.6 Screenshot of iPanel, alerts locations on the map

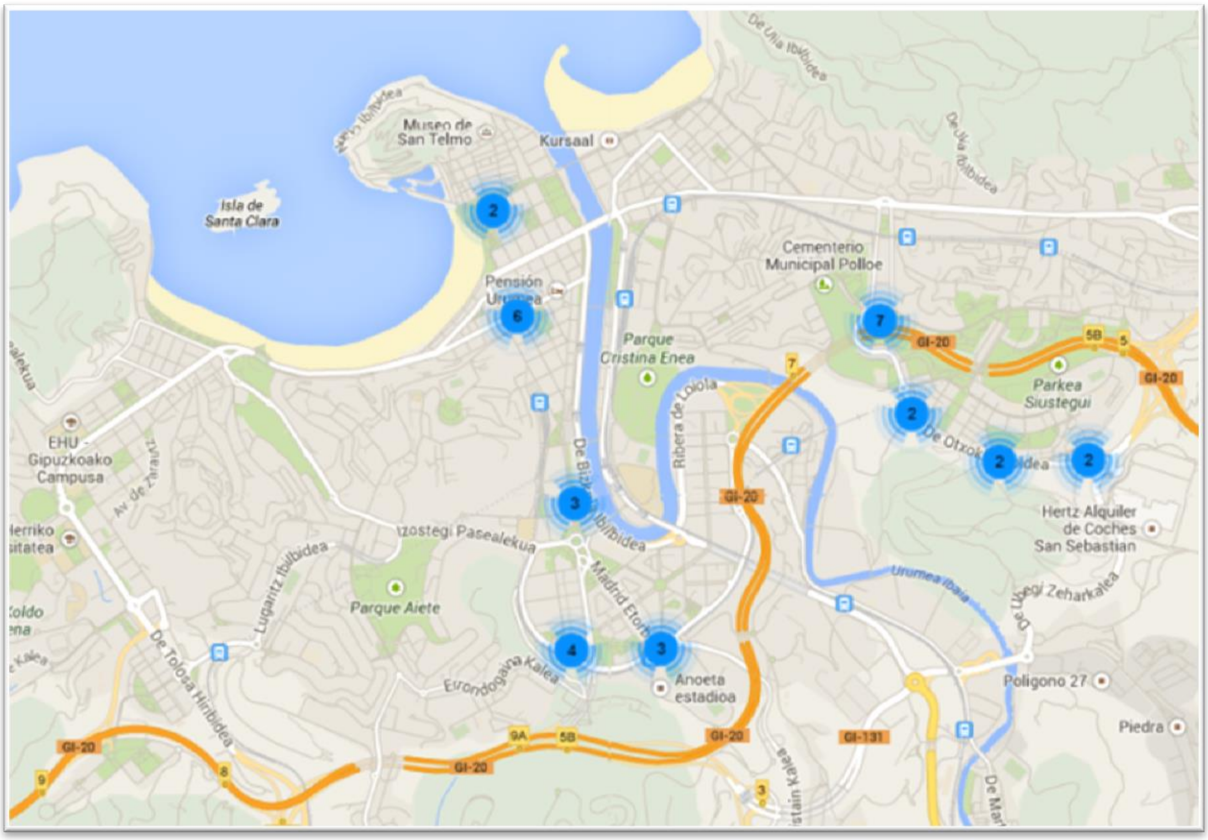


Figure 7.1.2.7 Screenshot of iPanel map, alerts locations, city of Donostia

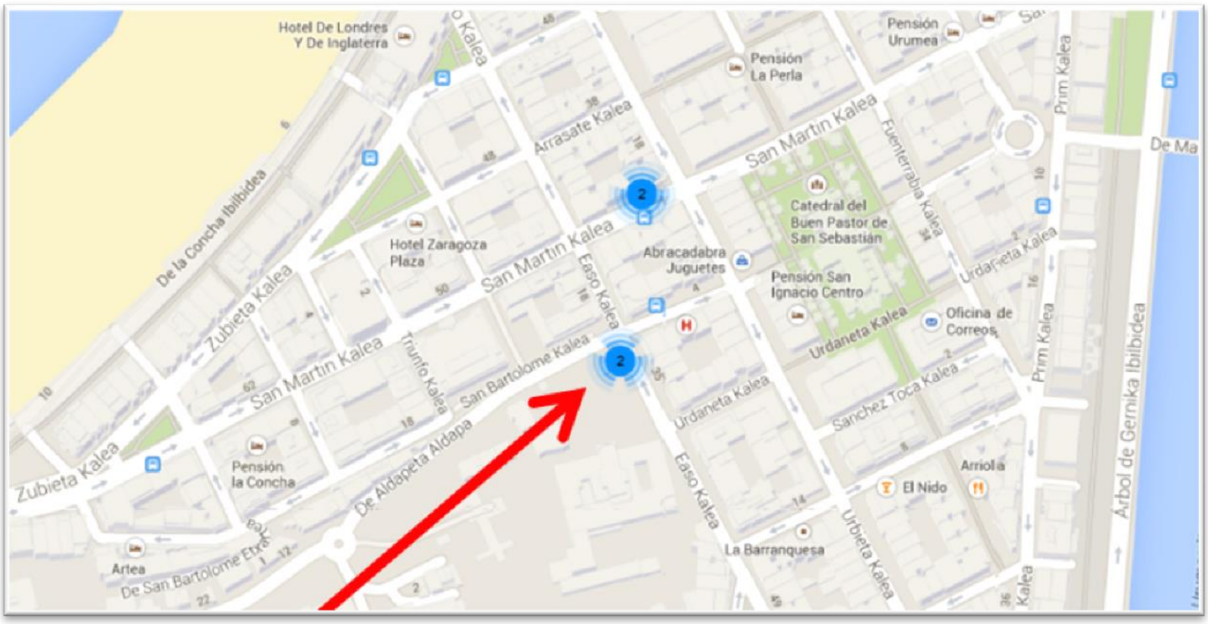


Figure 7.1.2.8 Zooming in to 4 events

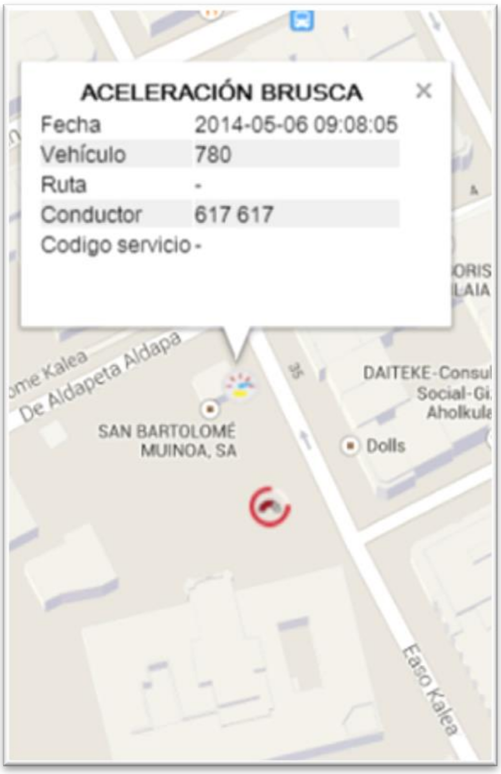


Figure 7.1.2.9 One single event: Abrupt acceleration

Figure 7.1.2.10 One single event Excessive rpm usage

7.1.3. Implementation process

First of all, before dBus began providing the service with the application, the whole physical installation of the on board components was done.

The components needed are:

- Tablets. One for each bus;
- USB cables to charge the tablets;
- Bluetooth Adaptors and their installation;
- Mounts to fix the tablets.

The hardware requirements for the tablet that is used for the service are: Approximately 7 inch screen, Android operating system, Blue Tooth connectivity, wifi and mobile data connectivity (2G GPRS or 3G UMTS) and a touch screen.

The installation was done and mounting was designed and built correctly too. So the Android application was installed and executed in the tablet.

After the implementation was done and some time passed, there were several technical problems like:

- Wi-Fi connection: The bus has its Wi-Fi connection on board and in some cases it was not possible to connect to it from the tablet. The mount hides the Wi-Fi antenna inside the tablet.

  Solution: Verify the connection with the device and talk with the responsible provider for on board Wi-Fi.

- Incorrect adaptor of Bluetooth: There were problems with the Bluetooth adaptor that was installed, sometimes it was reading nothing.

  Solution: Replace bad adaptor with correct one and verify the correct reading and emitting of data from it.

- The USB cable of the tablet didn't charge correctly: The Tablet is intended for domestic use and when the bus is driving and providing the service there are a lot of vibrations that these kind of devices can't bear and the charging cable and connector don't work correctly.

  Solution: Replace the cable by a new one.

- Power button is pressed by bus vibrations: The tablets have a power button on the right side and with a simple pressing the screen is not available. When the bus is providing a service there are a lot of vibrations so the action of pressing the button is done 'accidentally'.

  Solution: Attaching a little sponge to the tablet above and below the power button, so that the bus vibrations can't accidentally press the off-button.

- Driver's reaction: Drivers were confused during the early stages of this implementation and with installing these tablets on board.

  Solution: An additional training was executed for all the drivers in dBus to teach how this application works and what the benefits for all are, of using this implementation on the buses.

These problems were solved and the application works fine ultimately.

Promotion of EV-Efficient driving service in dBus

The EV-Efficient driving service was promoted internally through the various meetings and moments of involvement of staff, like drivers, unions and other staff. Training leaflets that were shared among all the drivers.

The service is promoted externally through the following channels: A website, press releases and Twitter. Also there was a presentation at the Municipality. And there were presentations in workshops and forums in the bus sector.

7.1.4. Implementation in a new city

The **technical Implementation** in a new city or new transport company could be easily carried out. The smartCEM project will serve to identify all the initial barriers and suggest solutions. So once the combination of hardware, software and data analysis systems are defined, it can be implemented in another city or company.

The preferred situation is to install the system in new buses, but as smartCEM is demonstrating, the system can be adapted to existing vehicles. Installation in new buses is preferred because the bus bodybuilder can provide a better solution in the installation of all the components of the system and integrate them in the driver cabin.

For the **strategic or political decision of implementing** the service, there can be many cases, but the most common in local public transport would be that the local authorities would demand the implementation of the EV Efficient driving service as a mandatory requirement, in public transport tenders. In this way, any bus service provider, that would want to participate in such a tender, would need to install the service on its vehicles.

This could be done easily by a provider that would “sell” the whole package. Including the initial training needed for the drivers.

If you have the support of the Unions, the drivers, things will be easier to implement. You can install the system but if the workers are against or even when they are neutral, it will be difficult to achieve results.

That's why we made some drivers participated in the design of the interface and the placement of the tablet.

7.2. The end-user

The project must be introduced and well explained to the users before implementing the system on the busses. It is important to make a good start. If the attitude of the users is negative towards the system, it will be much more difficult to gain trust and confidence from them in a later stage.

In the case of the EV-Efficient driving in the Electric Hybrid bus, the end-users are the bus drivers of the dBus company. They are of key importance for the success of the service. Since this is a public company, it is vital that all aspects of the system meet the requirements from the drivers or any special request in terms of ergonomics, graphic design etc. The implementation of the service must be followed by the technological provider to correct any problems immediately. The opinion about a system that doesn't function can influence in the rest of the drivers in a negative way. Even the involvement of the union is recommended.

Involving these parties works both ways: The users feel valued, and at the same time they provide useful input to the developers.

Ultimately, the 'end'-users in this case are the passengers that travel on the bus. On the whole, they will not be too involved or concerned. But there are two moments that they might become aware of the service and probably in a positive way: firstly, it should be noticeable, that the ride on a bus, with a driver that respects the efficient driving indications, is more smooth. And secondly when they enter the bus or when they travel in the front of the vehicle, they might notice the screen of the tablet, with live indications. If the bus-driver is willing, he/she might explain what it is about, which is a good example of why a positive attitude is so important, since that decides in what way he/she will speak about it.

7.3. Sustainability aspects of service implementation

The electric bus is the ideal solution for public urban transportation of people. Using an innovative traction method with lithium batteries with a high autonomy combines better environmental sustainability with a higher profitability and usability. In this way maximum efficiency is achieved, with zero emissions. The modern electric technology not only helps to safeguard the environment and implies savings, but also improves the quality of life in urban centres, thanks to reduced emissions of exhaust gases and low noise levels.

The transport of people within the city involves constant stop and go. This style of driving is very expensive not only from the point of view of time, but also energy. In electric busses this energy can be reused, thanks to the recovery of braking energy. In conventional drive systems, this energy usually left unused and lost. This innovative system allows instead of storage of the braking energy in capacitors, high-performance aerodynamically placed under the lining of the roof of the bus and can be reused in the electric motor.

Allowing the transition towards all-electric buses in the centre of towns will help improve the population's perception regarding public transport. In this way the transformation of logistics towards sustainability is encouraged for transport of residents and businesses.

Nowadays, many people realise what the problem really is the traffic, and how illogical the transport system actually is. However, it is what it has become at this stage and changing isn't an easy process. It is necessary to start a trend reversal that starts a positive approach and in that, the role of citizens is crucial. Their daily choices, preferring public transportation whenever the car can be replaced, along with a collective claim for action to the political decision makers, will serve to increase the demand for an efficient public service and will encourage investment in this field.

It should not be underestimated the impact that giving the "good example" can have on the cultural preconception. A satisfied user who says that the quality of his life has improved since he goes to work by public transport or an electric vehicle can incentivise dozens of other users and encourage them to try. A supportive role of the citizen's right to take the lead and trigger the movement, now that the system still has many gaps which may be not particularly inviting, since the cost of the service, which sometimes are not very competitive with the private car, or by a shortage of passages and transit and attainable goals or places.

In the initial phase the adoption of intermodal systems can be of great importance. For example by providing park and ride services, where those arriving by car from town not served by public transport can leave their vehicles and continue the trip by bus to get to places where parking is very difficult or expensive. The public transport could earn a few more points if it is less affected by traffic jams of cars, traffic lights and so on.

When intermodal transport is combined with the use of electric vehicles will reduce the negative impact on the environment even further, in addition to the intermodal transport in itself that already reduces the pressure on traffic and parking space.

Several experiments have been executed to bus lanes, traffic lights that give priority to buses and so on. To speed up the path of a bus means you can increase the swiftness, reduce the travel time and improve efficiency in the management of public company and the time spent in public transport by the citizens.

Chapter 8

The smartCEM Mobile Portal

8. The smartCEM Mobile Portal

In the smartCEM project, the smartCEM Mobile Portal has been developed. It is an app that currently provides access to all smartCEM services in all Pilot Sites. This chapter describes how (new) locations can be included in the smartCEM Smartphone app.

8.1. Description

The smartCEM Mobile Portal is an Android application that is available in the Google Play Store, (provided the user lives in one of the pilot site countries of Italy, Spain or the UK). It is targeted at the general public and it provides the users with the following:

- Information regarding the smartCEM electro-mobility services that the user can access with their Android device;
- The ability to install additional applications that provide the above mentioned services;
- Information regarding the smartCEM implementation sites and the services available in each of them;
- Links to background information regarding the project and its partners.

8.1.1. User interface

All the background information that is being presented to the user, as well as meta-data that is needed by the mobile application to function properly and launch third-party applications that provide smartCEM services, are stored within a central database and made available over Internet (through a web-service interface).

Automatic synchronisation of the mobile application installations with the central database is being performed each time the app is launched on the user device and upon demand, by tapping a dedicated button.

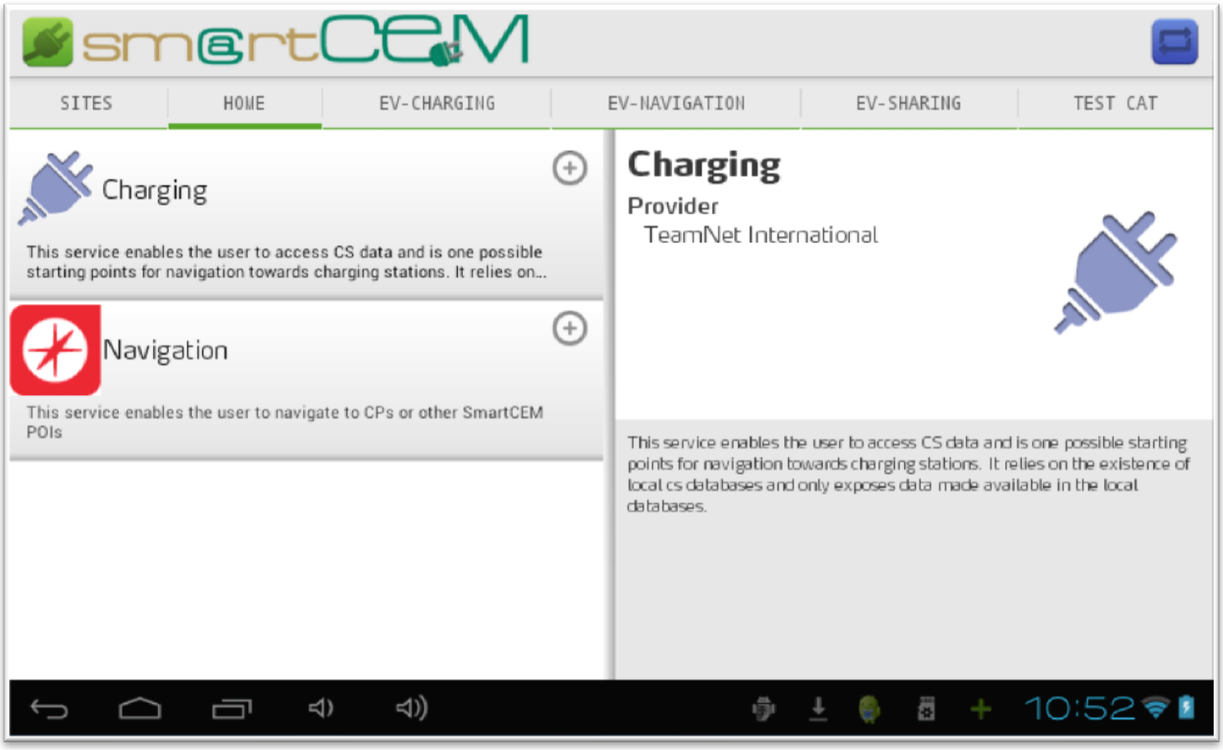


Figure 8.1.1.1 The Mobile Portal screen in "landscape" mode

In order to improve the usability and to un-clutter the interface, the application allows the selection of "the current" site. Only services available in "the current" site are being displayed in the GUI:

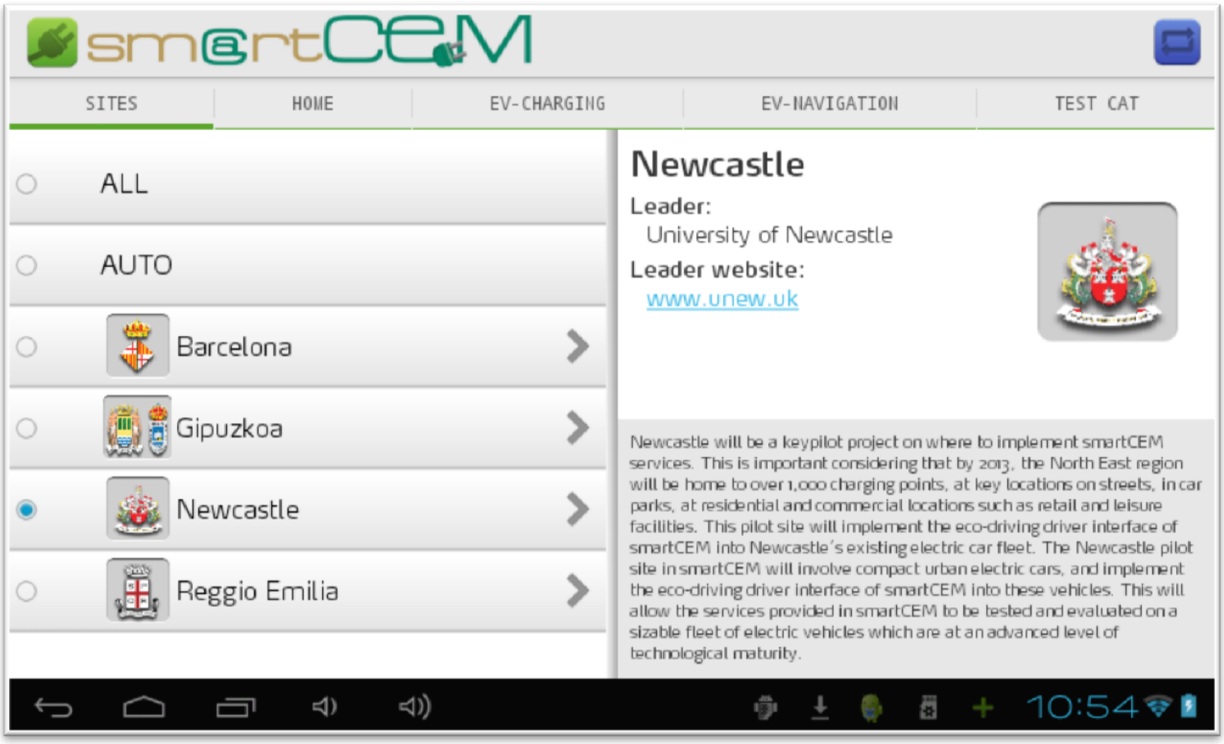


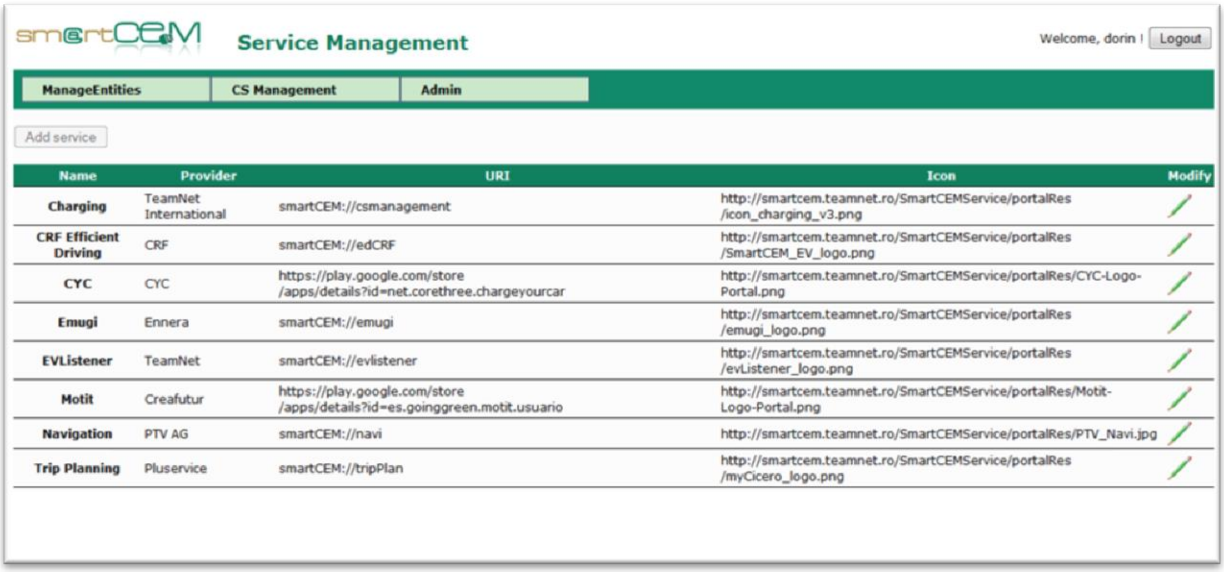
Figure 8.1.1.2 Current site selection screen, displayed in "landscape" mode

It is possible to automatically select the current site based on the current GPS coordinates of the device, as well as display all the services regardless of their availability.

8.1.2. Management Console

In order to be fully extensible and flexible, the system offers also the means to maintain and update the metadata. This is being achieved through a secured web interface – the smartCEM Management Console.

Then Management Console is a tool targeted at site administrators. Through it, properly authenticated users can update and improve the background info, configure the geographical definitions of the sites, select which applications may be launched and map those applications to sites, service categories and user interface pages.



Name	Provider	URI	Icon	Modify
Charging	TeamNet International	smartCEM://csmanagement	http://smartcem.teamnet.ro/SmartCEMService/portalRes/icon_charging_v3.png	
CRF Efficient Driving	CRF	smartCEM://edCRF	http://smartcem.teamnet.ro/SmartCEMService/portalRes/SmartCEM_EV_logo.png	
CYC	CYC	https://play.google.com/store/apps/details?id=net.corethree.chargeyourcar	http://smartcem.teamnet.ro/SmartCEMService/portalRes/CYC-Logo-Portal.png	
Emugi	Ennera	smartCEM://emugi	http://smartcem.teamnet.ro/SmartCEMService/portalRes/emugi_logo.png	
EVListener	TeamNet	smartCEM://evlistener	http://smartcem.teamnet.ro/SmartCEMService/portalRes/evListener_logo.png	
Motit	Creafutur	https://play.google.com/store/apps/details?id=es.goinggreen.motit.usuario	http://smartcem.teamnet.ro/SmartCEMService/portalRes/Motit-Logo-Portal.png	
Navigation	PTV AG	smartCEM://navi	http://smartcem.teamnet.ro/SmartCEMService/portalRes/PTV_Navi.jpg	
Trip Planning	Pluservice	smartCEM://tripPlan	http://smartcem.teamnet.ro/SmartCEMService/portalRes/myCicero_logo.png	

Figure 8.1.1.3 The list of smartCEM services, as displayed in the Management Console

8.2. Benefits of the Mobile Portal

- Improves access to electro mobility-related IT services;
- Increases usability and keeps the user up-to-date with the available services;
- Helps newly implemented services gain popularity and increase their user base.

8.3. Integration of a new location into the portal

Since it is an application running on mobile devices and accessing Internet, there are very few things to be done in order to add new sites. One must perform some configuration in the back-office of the smartCEM Portal (by using the Management Console).

Since access to the web Management Console is secured, a user account with the “Site Admin” authorisation role needs to be obtained from the current web-service administrator – TeamNet (contact details available below).

Once the access is granted, the following needs to be specified:

Information required	Details
Identification of the implementation site;	The name of the city/region/area in which the services are available. The name of the entity that leads the implementation site, and other useful info, i.e. the URL of their website; An icon that best represents the site; A short description of the site.
Geographical location and georeferenced shape of the area in which the services are available;	A list of pairs of GPS coordinates, each of them being a vertex of the polygon that surrounds the area of the site. Such coordinates can easily be obtained from map applications like Google Maps or Bing Maps. The list of vertices must be given in the order of adjacency. The service assumes that the first and the last vertices are also adjacent.
Identification and description of the available services;	The name of the service, the name of the provider entity (e.g. the company name, the project name, so on), an icon/symbol that depicts the service, a short description
Mapping between the site, the services, the service categories and the applications.	For each service available, the site administrator must select a list of sites in which the service available and also a list of service categories in which the service falls. The same service may be available in one or more sites, and it can also be available globally (e.g. Navigation is available everywhere on Earth). Also the same service may cover more than one category. The smartCEM Categories are: • EV Sharing • EV Charging • EV Trip Planning • EV Efficient Driving • EV Navigation

There is no need to change anything in the portal application. The above data propagates automatically to all the users (either when they restart their app or when they explicitly trigger a synchronisation).

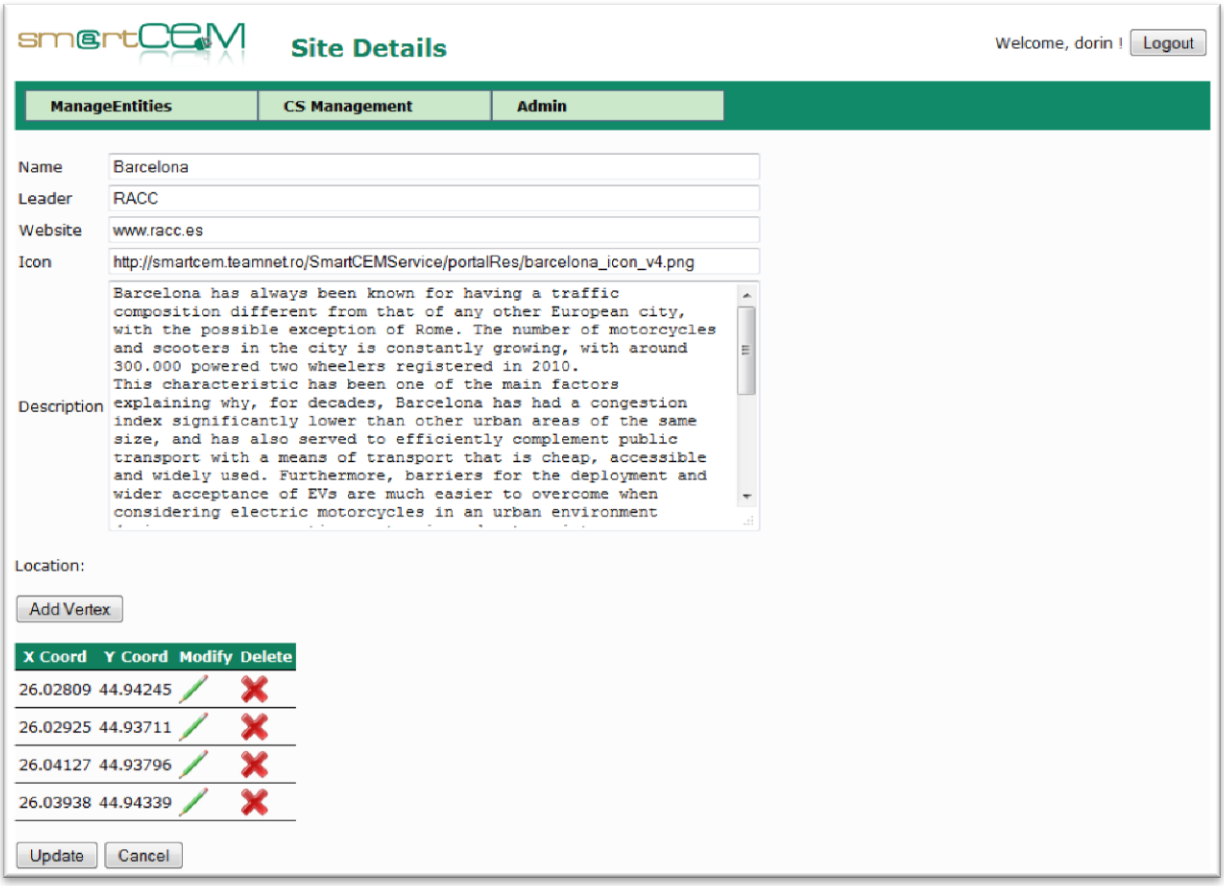


Figure 8.1.1.4 The input of details for a smartCEM site

If the applications that provide the services are not available on GooglePlay or in another repository provided by their implementing party, the installation resources can be hosted on the back-office server of the smartCEM Portal.

The hosting of application on the back-office server, as well as the publication of services in the Mobile Portal are freely available on the entire duration of the smartCEM Project. Once obtained, the administrator account enables the site operator to maintain its site metadata and resources directly and without limitations.

Chapter 9

EV-Policy Tool

9. EV-Policy Tool

Local and state governments need to have tools at their disposal that can be used to more successfully and seamlessly integrate EV's and EVSE (electric vehicle supply equipment) into the planning and administration of states, cities and towns. A key strategy to capture the many benefits of EVs will be the development of policies and programs that aim to deploy an EVSE infrastructure to meet today's charging needs and prepare cities, towns and regional corridors for a growing EV use.

The EV policy tool through analytics algorithms and simulations will evaluate and establish a wider perspective of the challenges faced by the fleet of EVs. More precisely, the EV Policy tool will implement pilot scenarios for EV fleets to analyse the data from them, study the impact and identify the requirements and limitations. The tool will also identify the resource constraints (in terms of limited charging options) and compute optimal plans on the fly based on user needs without taxing the energy providers. Once the gain has been outlined, the system/ algorithms developed can provide feedback to the smartCEM services to improve the impact and user experience.

9.1. The service

The acceptance of EVs is still hindered by limited battery capacity, which currently allows cruising ranges of only 150 to 200 kilometres. Thus, accurate prediction of remaining cruising range, energy-aware routing and the optimized placement of charging stops are still important for EVs in the foreseeable future.

Electric vehicles could use route planners to find routes which consider battery constraints. But, even with quick charging technology, a battery recharge could take several minutes. In congested areas the concurrent and frequent recharging demand would lead to waiting time at the charging area, thus affecting both the charging network as well as the vehicle travel time.

Traditional vehicles can work with solutions which are two-step processes (plan-execute), without mechanisms to cope with dynamicity. The term dynamicity can be related to:

- EV behaviour: new charging demand, charging time and location changes;
- Unpredictable external conditions: traffic congestion, weather.

These factors cause:

- Increased waiting time at charging stations;
- Inaccurate range predictions.

And they ultimately have an impact on the user acceptance of EVs.

In this regard, EV Policy tool is divided into two parts: the analytics phase and the optimisation phase (Figure 9.1.1).

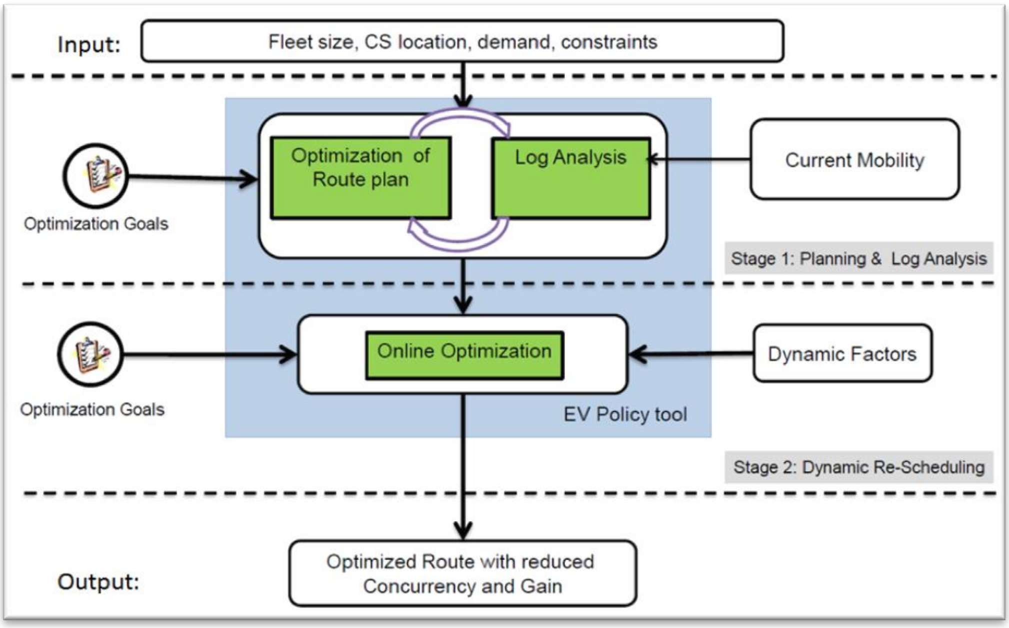


Figure 9.1.1 EV Policy Tool Architecture / Workflow

9.1.1. Analytics Phase

For the functionality of the data analytics tool, traffic flow data, charging schedules, service stops' topology and GPS data from vehicle including location information and the time stamp of transmissions are required. Also information on the waiting time at each charging and service station is required to process and determine the shortcomings in the existing plans.

The aforementioned data can be extracted from an urban region over a significant time period. In a first stage, the data analytics tool will pre-process the collected, historic data for guarantying data harmonisation via erasing erroneous data and imputing missing data when needed.

After the pre-processing, the data analytics tool will analyse the data characteristics via computing a number of descriptive statistics, i.e. mean waiting time at each charging station and variations during the day, etc. Descriptive statics together with a time-series analysis of seasonal data variations will facilitate the identification of:

- Certain patterns and quirks of EV fleets operating within the study area;
- Daily and periodic variations on:
    - The dwelling time spent at each station;
    - The time spent to travel among stations.

For performing the analytics part, the development of a platform is required with the aim of processing vast amounts of historic data and identifying automatically gaps in the operational plan without external supervision.

For such an approach, a series of empirical rules and statistical techniques are being developed and integrated to facilitate the identification of operational gaps without manual inspection.

After the gap identification, countermeasures and alternative scenarios can be evaluated via extensive simulations after calibrating a working, base simulation scenario.

In a final step, instead of proposing a discrete number of countermeasures and test their performance against reality, a set of optimisation techniques can be developed for responding to the demand of EV users.

9.1.2. Optimisation Phase

The Optimisation phase, counters any dynamism which affects the route plan of the EV's. In this phase, the EV policy tool can continuously monitor for any dynamicity which affect the whole fleet of EV's.

During the execution, the algorithm within EV Policy tool finds appropriate slots for an attempted re-charging for EV's based on the operational cost minimisation. After defining the timing of the charging (taking into account the user preferences), a notification for the delivery waiting time is given to the EV user. During the re-assignment phase, the algorithm tries to stay strongly committed with the existing users so that their charging time slot is not affected.

The re-assignment algorithm can either retain the –EV users in the same charging time slot or move them to another slot if better OPEX (Operational Expenses) is achieved. This approach helps to optimise further the OPEX of fleet operators, without penalizing the EV users.

9.1.3. Promotion of the EV-Policy Tool

At this stage, the EV-Policy Tool isn't yet promoted. Once a more tangible demo has been developed NEC will commence promotion.

9.2. *Experiences*

The algorithm developed for the optimisation phase has been preliminarily tested for the data from Newcastle pilot site. For the functioning of the EV policy tool, the traffic flow data has to be acquired from the site.

The traffic data is entered into the traffic simulator and the EV penetration will be varied. This will enable the DoD (Degree of Discharge) in the network to be studied. DoD will be an indicator for the amount of charging requests that will be generated within the network.

Once this baseline is established, the next phase will comprise implementation of the demand-based dynamic routing of EVs to the charging stations. In this phase the optimal charging plan for EVs can be dynamically changed such that the optimality is not overly compromised at the same time the EV users are sufficiently satisfied. This will help to increase the user acceptance. This phase will also avoid the conflicting charging request.

An initial in-corporation of New Castle map in traffic simulator and the key areas where traffic originate are shown in Figure 9.2.1. This data is based on the traffic data received from Newcastle City Council. For this study, in simulation environment, conventional vehicles are changed to EV with standard battery model.

Figure 9.2.1 Real-time data collection infrastructure

The DoD for single journeys is shown in figure 9.2.2. The data is taken from the pilot site of Newcastle, specifically, the urban region. For every amount of battery discharging (X-axis), the number of instances (y-axis) is given. For example, in the red circle it is shown that 17 trips have been made, that have caused the car-battery to reduce its charge by 2,7%. (For example from 100% (full) to 97,3%, or from 56,8 to 54,1 etc.).

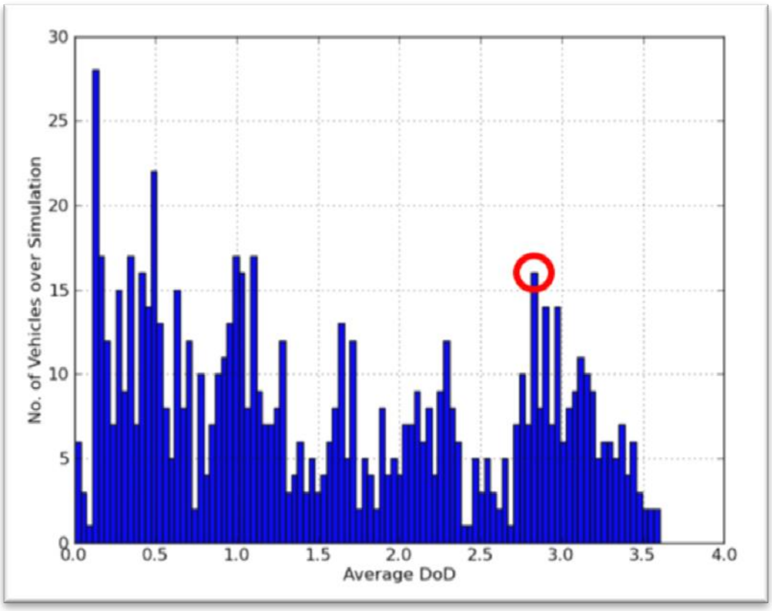


Figure 9.2.2 Average DoD (%) per single trip

With a more detailed analysis of the trend, the EV policy tool, city planners can install charging stations in a well-planned manner. CS operators can provide a more accurate availability of the CS and also ensure that conflicts are resolved so that the EV users can plan their charging stops and also experience a minimum waiting time.

In the future, with a higher EV penetration the city council may introduce EV delivery vehicles. In such a scenario, the policy tool will be able to map an energy optimal route with a possibility of automating the re-delivery attempts (in case of dynamicity in the consumer behaviour). To realise this, the EV Policy tool can continuously monitor for spatio-temporal demand changes that the vehicles encounter during their journey. For example, If a vehicle V_k encounters a customer C_i who has dynamic demands the re-assignment algorithm allots running in the EV policy tool, will assign this customer into a different feasible timeslot. During the execution, the algorithm finds an appropriate slot for an attempted re-delivery for customer〖C〗_i based on the operational cost minimization. The re-assignment algorithm can either retain the quasi - customer in the same slot or move the customer to another slot if better OPEX is achieved. This approach helps to optimize further the OPEX of fleet operators, without penalizing the other EV users. The re-delivery will account for the amount of energy remaining and as well as user preference. The planning tool can also be used by individual EV users to plan their route to optimise the drive time. As shown in Figure 1, the EV Policy tool monitors any discrepancies in the route and re-routes the vehicles to so that the operational cost is reduced.

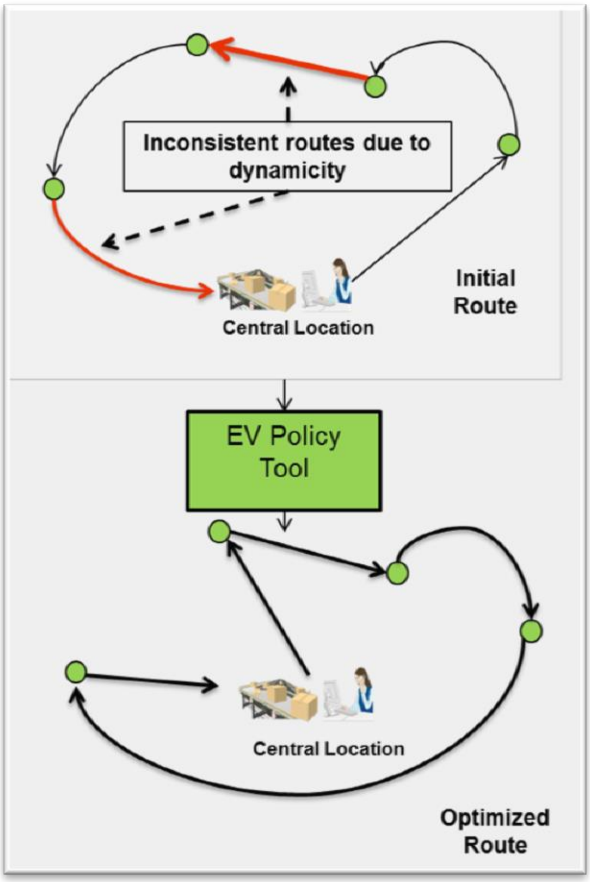


Figure 9.2.3 Route Optimization

An initial prototype for the tool is implemented with Java. In addition to the implementation of the main algorithm the prototype also has a simple GUI (graphical user interface) which is used to simulate the routes. Also the GUI is used for providing the inputs during the testing (figure 9.2.3 and figure 9.2.4).

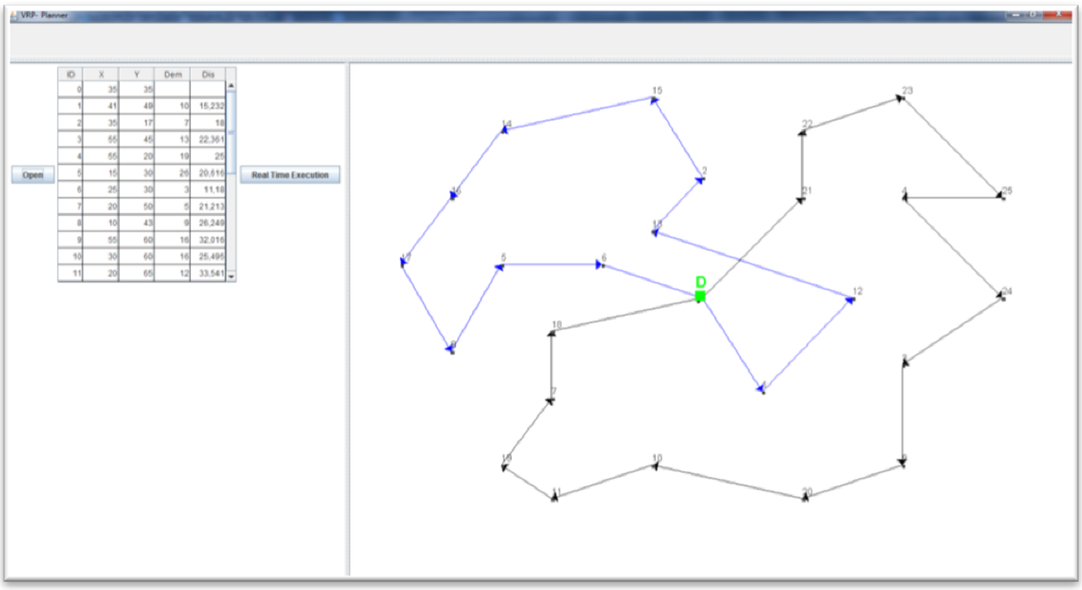


Figure 9.2.4 GUI of the developed prototype to visualise the entire EV fleet

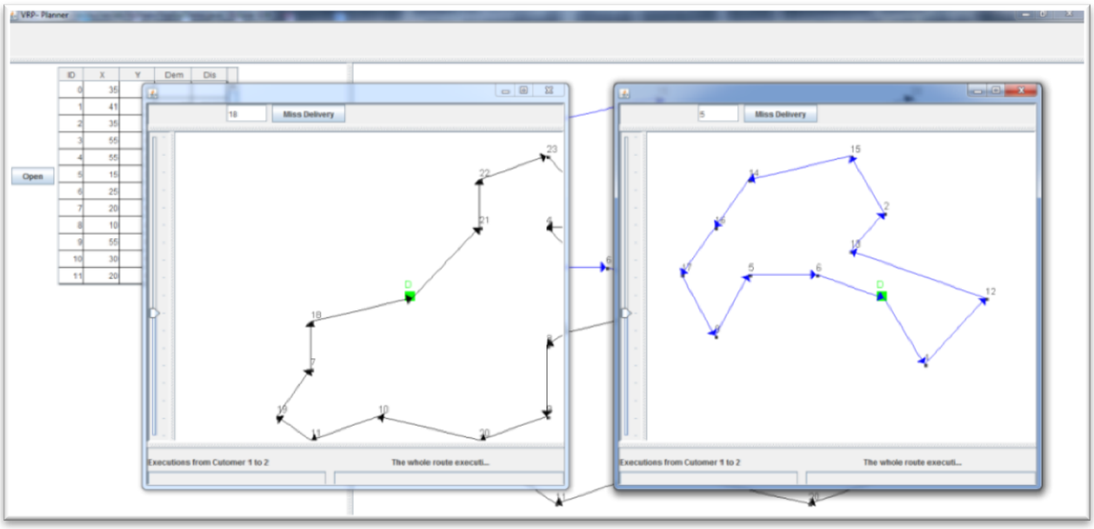


Figure 9.2.5 GUI of the developed prototype to visualise individual EV's

9.3. Benefits

The data analytics tool will learn a number of patterns from historical data analysis and will provide on-time information regarding expected failures in the operational plan.

The benefits of the data analytics tool are in the form of information provision to decision-makers and service providers. Offering real-time information about the condition of the EV fleets and services that are not performing as expected will enable decision-makers to take more targeted countermeasures and improve customers' convenience/level of satisfaction without unreasonably increasing the total operational costs.

During the optimisation phase, the tool will allow finding an optimal solution for EV fleets and EVs can be assigned to the charging stations with a less conflicting situation. This will hence allow:

- Effective planning and re-scheduling of charging stops;
- A system that can respond to varying dimensions of dynamicity;
- Addressing customer QoE and Service operators OPEX.

9.4. Implementation in a new city

The provisioning of the EV fleet and general traffic data will enable the cities to model the tool according their requirements.

The architecture and the implementation of the EV policy tool are kept very generic, however within each block, a site specific implementation needs to be modelled. To achieve this, a detail of the requirements pertaining to what the city wants to analyse and improve should be provided by the city. Along with this, the EV fleet and general traffic data should be provided which will enable to refine the tool according to the requirements of the cities.

Precisely to implement the EV policy tool in a new city, the following steps are necessary:

- Specifying requirement and expectation from the tool;
- Traffic and relevant data should be made available;
- Optimisation parameters should be mentioned.

To use this tool to understand and improve the condition of EV fleets, the city authorities need to contact NEC Europe Ltd. (NEC Labs Europe) and initiate the formalities which will enable the city to implement this tool in a pilot phase before it will be commercially deployed.

Chapter 10

Recommendations for implementation in new cities

10. Recommendations for implementation in new cities and regions

To conclude this deliverable, this chapter gives recommendations to the reader that can be used when an implementation in any other city is carried out. The recommendations are divided into those for municipalities, those for national governments and those for providers.

10.1. Recommendations for local authorities

On the municipal level, it will not take much effort to explain why Vehicle Sharing is a wise service to implement. As the use of a single vehicle intensifies by being shared, the pressure on any parking place that the vehicle may need is reduced. It can also lead to significant cost-reduction. On top of that, municipalities are in the position to incentivise and therefore stimulate the use of environmentally clean (or cleaner) vehicles, like electric ones. smartCEM recommends to do so.

The smartCEM project sees several instances of vehicle sharing:

- Electric scooters in Barcelona;
- Electric cars in Gipuzkoa;
- Electric vans in Reggio Emilia.

And upon these examples of vehicle sharing, additional services can be introduced. This is recommended, because it a) makes the use of the vehicles more attractive, b) will save energy and c) provide more flexibility to the end-user.

In Barcelona, the service provider has opted to launch the electric scooter sharing service based on battery swapping, avoiding the location restrictions of charging stations. As the volume of the scooters increases and the amount of charging stations also does, a migration to on-street charging can be planned.

When navigation is added to the sharing service, it provides above all, convenience to the end-user.

smartCEM recommends strongly to execute an extensive survey amongst potential users of a sharing service, well before it is introduced. The success of a service is decided by the adaptation of the service by the end-user, not by what the implementer thinks will be adapted by the end-user.

Locating charging stations and centralizing sharing-projects near a public transport hub has shown a great motivator to increase the use of the service and to make public transport more competitive. This is the case in the pilot site of Gipuzkoa. End-users can easily change modality at such points. This is where EV-Sharing and EV-Trip management meet.

Multi modal trip management is a fascinating field of expertise, where conflicting interests play a role that can be difficult to manage. Being a local government, one would want the user of a trip management service, to choose travel options that (for example) lead the user to leave a car outside the city or town and switch to a public transportation option, so that the parking pressure is reduced in the city centre. Another factor in deciding what options to present to the end-user, could be the amount of pollution of the various transport choices. However, that same end-user him/herself may be rather be interested in the options with the quickest travel time, the cheapest way to get somewhere, or the most convenient one. smartCEM recommends to make decisions on how the mentioned weighing factors are applied. And to build in flexibility to accommodate changes, or most preferably, to give the end-user the option of making the choice according to which factor he/she wants the travel options to be ranked.

As said, municipalities are in the position to steer developments. For example they can 'demand' energy efficiency from their suppliers through making it a compulsory aspect in a public transport tender. The challenge is to formulate the tender in such a way that a public transport provider is motivated to introduce a system that minimises energy consumption, while really wanting to actually do that, so not just because it wants to win the assignment, but to get all the involved employees up to the level of the drivers, to be motivated to reduce their energy consumption.

Universities are also developing efficient driving applications. smartCEM has yielded experience regarding the adaptation of such services by end users.

It is shown (in Reggio Emilia) that a fleet of (electric) vehicles can easily be shared and managed by simply managing the keys to access the vehicles well. Next, it is possible to offer the end-users of such a fleet extra services that benefit the energy efficiency and aid them with navigation.

The smartCEM project proves that it is very important to pay thorough attention to the design and the interaction between the palette of services that will be introduced in a city. Municipalities can play a central role in the alignment of the services. Municipal policymakers should realise that, once starting the design phase, the commercial interests of the service providers may occasionally lead to conflicting interests, that may need to be realigned somehow, while remaining worthwhile for all commercial players to stay involved. While doing so, the end-user should always be the central "point of calibration" that the services are aligned to, (rather than the possibilities that technology offers at that point in time).

10.2. Recommendations for national governments

As battery technology advances, electric cars will travel further and further on a single charge. With the expansion of fast charging station networks (Like CHAdeMO and Tesla SuperCharger), the autonomy of such cars is again further increased. It has also been proven that as 'electric drivers' become more experienced, they 'dare' to drive further on a single charge and discover more and more new charging stations and add them to their portfolio.

A service like Charge Your Car in the United Kingdom can play a central role in the rollout and subsequent usage of the charging stations, the convenience of using them and ultimately the adaptation of electric vehicles.

smartCEM has two recommendations for governments. Firstly to establish consistent policies, that service providers can count on to remain in place for a period of time that stretches beyond a few government-election-cycles. Because rolling out and maintaining an electric charging network is a long-term investment. It is not so much the height of subsidies or incentives provided by the government that will help the business forward, but rather the consistency. (Although more backing always helps, of course).

Secondly governments, service providers and in the end, end-users can benefit if policy makers would pay closer attention to lessons learnt material. Which is closely linked to the organisation of proper handovers between predecessors and successors.

10.3. Recommendations for service providers

In smartCEM the 3 Ps of "People, Planet and Profit" meet and work together. Contrary to municipal and national bodies (representing "people" and addressed in the previous two paragraphs), service providers and developers are mostly commercial entities ("profit"). For "planet" please refer to the next paragraph. The three Ps complement one another.

End-user benefit is the main driver to make a service successful. And there is no such thing as profit without user uptake, without large numbers of users beyond the pilots. In deliverable 6.6 Business Modelling we will look further into the marketability of the developed smartCEM services. Here, the main lesson learnt, if not already known to the providers, is that end-user uptake is essential for success.

Each of the service and technology providers have their own business model, in which an uptake by the end-user is projected and with which go-no-go decisions are taken.

- smartCEM will not make recommendations to commercial companies about how to run their business, as they are obviously capable of doing so themselves. Examples of such companies are Going Green, PTV, NEC and CYC.

But smartCEM does address the area, where these companies interact with (local) governments. For a long term success it can namely be profitable to invest in the development of more, better, more seamless integration with other services offered in the same location.

Example of this are:

- Going Green’s “Motit” sharing service can be combined with Public transport in Multi-modality, and is combined with PTV's navigation.
- CYC is combined with the University of Newcastle’s efficient driving.
- PTV’s navigation is combined with efficient driving in Reggio Emilia.

The more seamless the integration between services is, the better the user experience will be, and ultimately the higher the uptake.

Organisations like universities and municipalities that develop services are encouraged by smartCEM to continue to do so. Examples are UNIMORE, UNEW and the municipality of Elgoibar. Although a large user uptake may not be the main focus of such organisations, they are advancing the knowledge on relatively new services such as EV-efficient driving and EV-Trip management.

10.4. Environmental sustainability

End-users, providers, civil servants, smartCEM partners, project officers, we all live on the same tiny space-ship called ‘Earth’. And we only have one single atmosphere. We need that atmosphere long-term. Set aside a few climate-sceptics, there is a broad consensus that humanity is affecting the climate in an endangering manner. Pollution levels need to reduce. That is why the European Commission favours transport that is less stressful on the atmosphere.

Electric mobility is one of the proven solutions, due to the enormous energy efficiency of the electric motor. (So much so, that the question how the consumed electricity has been generated isn’t even decisive).

In order to minimise the current EV limitations and increase the uptake of electric mobility, smartCEM has developed and applied clever services and apps and linked them together.

The project team as a whole recommends to any reader of this document, to try electric driving, because we know it will offer you a more comfortable and basically a more logical way of moving yourself and goods around, without the use of fossil fuels. So please try the smartCEM services. Become inspired, become enthusiastic, implement them in your city and motivate anyone around you, to do the same.

Index

Since not all implemented smartCEM services seem to fall under the header of one of the business cases in this document, this is an index for easy access to all services and subjects.

Appendices

Appendix 1. References

- Description of Work, (update 22nd March, 2013)
- D6.5 “Deployment Barriers and solutions”
- D6.6 “Business Modelling”
- D2.4.4 “Platform integration for Reggio Emilia pilot site”
- NE PIP project www.zerocarbonfutures.co.uk

Appendix 2. Contact points

This chapter is meant to provide contact information of the relevant participants in the smartCEM project. Please feel free to contact any of the participants for further enquiries regarding the services they provide.

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smartCEM service(s)	all

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smartCEM service(s)	EV sharing management, EV Navigation, EV Efficient driving

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smartCEM service(s)	GIP

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smartCEM service(s)	EV Efficient driving

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Active in pilot site	NEWC REG GIP BCN
smartCEM service(s)	All

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smartCEM service(s)	EV sharing management, EV trip management, EV navigation management

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smartCEM service(s)	all

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smartCEM service(s)	EV navigation management

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smartCEM service(s)	all

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smartCEM service(s)	EV charging management

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smartCEM service(s)	EV policy tool

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smartCEM service(s)	all

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Appendix 3. List of tables and figures