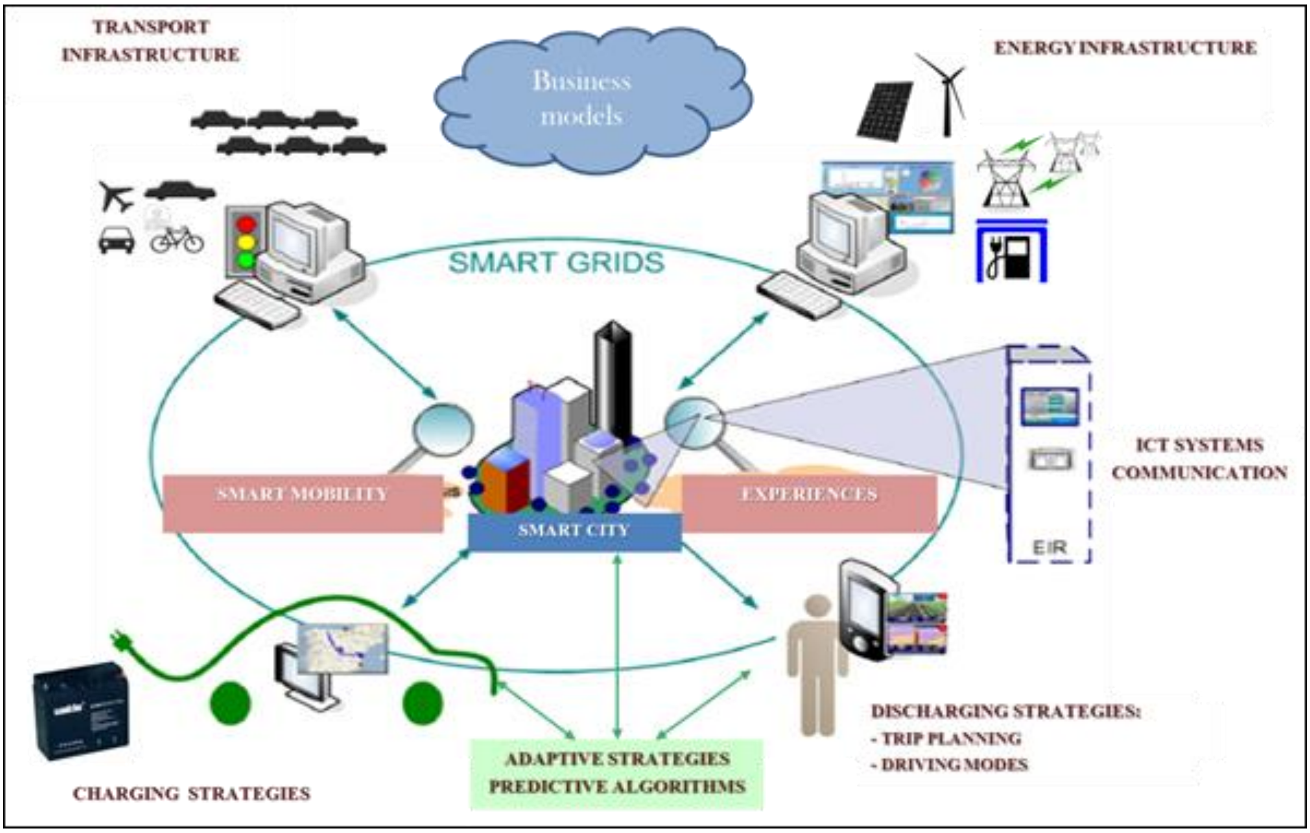
mobincity

SMART MOBILITY IN SMART CITY

Urban transport is responsible for about a quarter of CO_2 emissions from transport. The gradual phasing out of 'conventionally-fuelled' vehicles from the urban environment is a major contribution to significant reduction of oil dependence, greenhouse gas emissions and local air and noise pollution. Fully Electric Vehicles (FEV), for public and private transport, can contribute significantly to the lowering of the current pollution levels.



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Final summary report

EXECUTIVE SUMMARY

The general objective of MOBINCITY is to make urban mobility more environmentally sustainable by means of the wide deployment of Full-Electric Vehicles (FEV) as mass market product in cities. With this regard, MOBINCITY aims at the maximization of FEV autonomy range thanks to the development of a complete ICT-based integrated system able to interact between driver, vehicle and transport and energy infrastructures, taking advantage of the information provided from these sources in order to optimise both energy charging and discharging processes and the increase in energy efficiency.

The project Mobincity is divided into nine different work packages. The structure is based on the different interactions that will be developed within the project, as showed in the following figure.

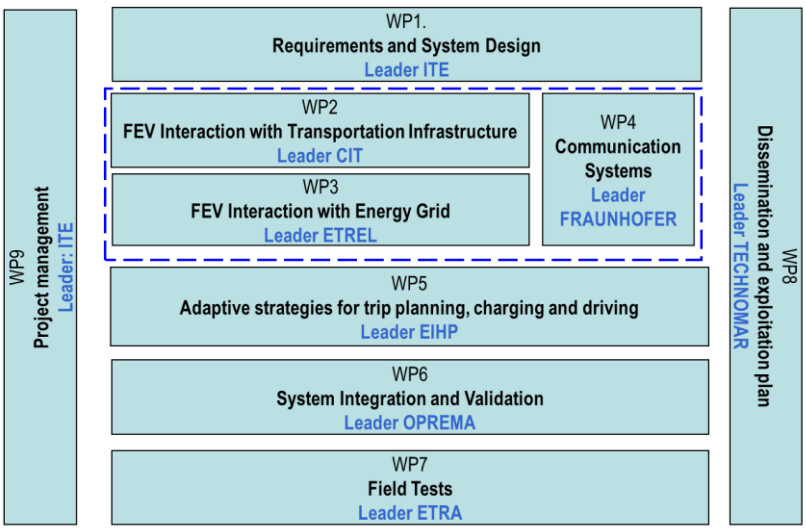


Figure 1: Structure of MOBINCITY project.

The first period of the Mobincity project was dedicated to the detail definition of Mobincity scope in terms of requirements and detailed design of the Mobincity system (WP1 and beginning of WP2, WP3 and WP4). The second period was mainly dedicated to the development of the main components defined in the Mobincity system and its communications and interfaces (WP2, WP3 and WP4). A significant effort has also been done in algorithms development (WP5). The third period has been focused on the integration (WP6) of the main Mobincity components and their deployment in the three pilot sites (Ljubljana, Italy and Valencia). The efforts of the Mobincity consortium have been addressed to the components lab testing during the integration period and to the real environment testing during the field tests period (WP7). During the whole lifetime of the project, Mobincity has been led by the project and financial management (WP9) and supported by dissemination and exploitation activities (WP8).

Mobincity has belonged to a cluster of FP7 e-mobility projects together with eCo-FEV and Mobility 2.0. These three projects have worked together to provide a common architecture vision of the future e-mobility platform. These cluster ideas have been spread out through two common workshop and presented in the EU Project Day (02/12/2014) held in Brussels in the scope of the European Electric Vehicle Congress (EEVC-2014).

1.1.1 PROJECT CONTENT AND OBJECTIVES

The **general objective** of MOBINCITY is to make urban mobility more environmentally sustainable by means of the wide deployment of Full-Electric Vehicles (FEV) as mass market product in cities. With this regard, **MOBINCITY aims at the maximization of FEV autonomy range thanks to the development of a complete ICT-based integrated system able to interact between driver, vehicle and transport and energy infrastructures, taking advantage of the information provided from these sources in order to optimise both energy charging and discharging processes and the increase in energy efficiency**.

To accomplish the overall targets, the following **specific objectives** are established within MOBINCITY:

- To **develop a system** to be installed within the vehicle able to **receive information from the surrounding environment**, which can have influence in the vehicle performance (traffic information, weather and road conditions and energy grid).
- To **optimise the trip planning and routing of FEV** using information from these external sources, with an estimated reduction of energy consumption up to 25%, including alternatives from other transport modes adapted to user's needs.
- To **define efficient and optimum charging strategies** (including routing) adapted to user and FEV needs and grid conditions, allowing user to take advantage from cheaper prices and more adequate charging conditions
- To **implement additional energy saving methods** (as driving modes and In-Car Energy Management Services) within the FEV interaction with the driver, contributing to an additional reduction of energy consumption in a percentage up to 15%.

In order to reach the previous specific objectives the following **operative objectives** have been defined:

- To develop an ICT-system based on current standards of communication and protocols, able to interact at real-time with:

- Transport infrastructure, receiving information related to traffic situation, road conditions and public transport alternatives (WP2).
- Energy infrastructure, receiving information related to the status of energy grid, the availability, features and location of charging stations, the hourly tariffs and the curve demand (WP3).

- To develop flexible and modular basic software framework which models the ETSI ITS architecture and helps to decrease the development time of new applications (WP4).
- To develop charging processes adapted to user needs and preferences regarding aspects as charge duration, electricity cost and quality, and increasing as well the flexibility of charging processes (WP3-WP5)
- To develop a software able to determine the most suitable location for charging station and charging infrastructure (WP3).
- To develop algorithms able to combine FEV and driver needs with the information provided by transport and energy infrastructures for planning the route in the most efficient way, avoiding traffic congestions and considering external factors as road and weather conditions (WP5).
- To develop an In-Car Energy Management Service able to control some parameters and accessory systems (as Air Conditioning system) of the vehicle to control energy consumption (WP5).
- To integrate the subsystems developed within the project in a common device (MOBINCITY System), easy to be installed in the vehicle (WP6).
- To validate at lab-scale the operation of the MOBINCITY System, testing the communications with the transport and energy infrastructure and simulating the trip planning and charging strategies developed within the project (WP6).
- To demonstrate at real-scale the performance of the MOBINCITY System in a real electric vehicle in two different European cities to be defined (probably Rome and Ljubljana) (WP7)
- To disseminate the results of MOBINCITY to relevant stakeholders, related to transport, energy and automotive sectors. (WP8)
- To develop a business plan within the project to prepare the exploitation of the results by the industrial members of the consortium (WP8)

1.1.2 PROJECT S&T RESULTS

MOBINCITY PROJECT LIFE CYCLE METHODOLOGY

Overview

Mobincity has used a Use case driven methodology for project specification. Figure 2 shows the conceptual methodology for the project life-cycle. The use cases' design was covered in ***D1.1*** *Use case scenarios* whereas both user and technical requirements together with the Architecture design were covered in **D1.2** *System design and technical requirements*. Detailed design, system development and unit testing have been performed on work packages 2 to 6. Integration testing at lab it is been covered on WP6 and the test cases developed for this purpose have been included in ***D6.2*** *Validation at lab-scale report* (this document). Finally, the Field testing in the three Mobincity pilot sites (Spain, Slovenia and Italy) will be covered by WP7 and the field tests will be included in ***D7.1*** *Experience plan*.

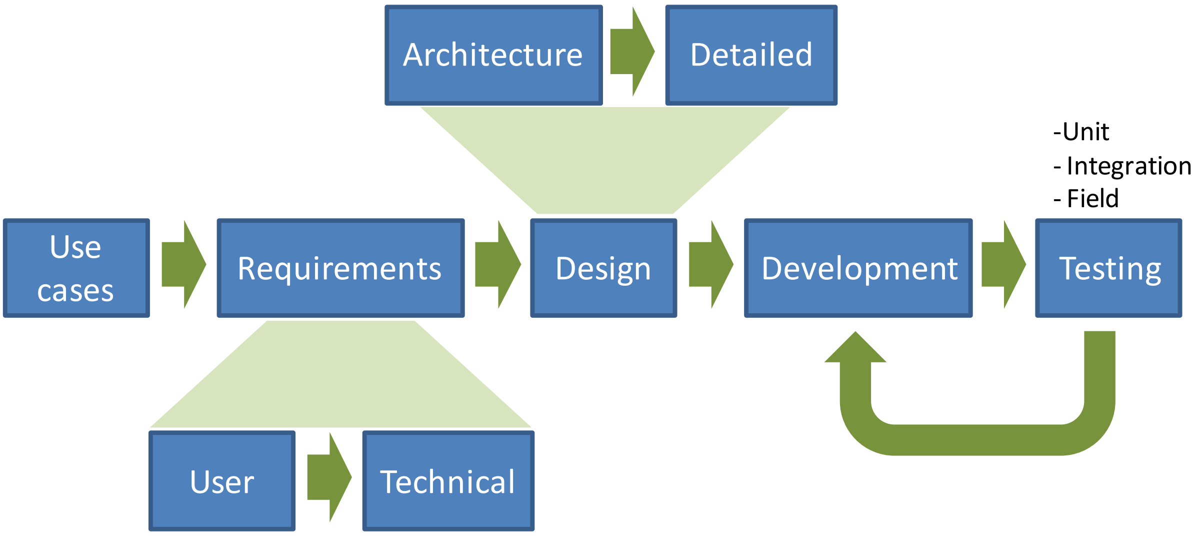


Figure 2: Mobincity's project life cycle methodology.

In the use cases' design phase the behaviour of the system was modelled. These behaviours shall be modelled by the domain experts in the project and processed into a harmonised set of diagrams by the project engineers. In this harmonisation process the original use cases were reviewed and eventually been split, expanded or joined. The requirements phase collected what have to be accomplished in the project and how. User requirements expressed what have to be accomplished. The technical requirements indicate how these objectives have to be met in the way of technical descriptions, applications and information flows. The use cases' design and requirement analysis phases trend to be coupled and they influence each other. Some overlapping between them was detected.

The design phase used the technical requirements to generate an overall architecture design where the main components and interfaces were identified and described. The detailed design went through each system component to describe in detail the structural and behavioural elements they can be decomposed in.

In the development phase the different subsystems have been developed based on the architecture and detailed designs.

Testing phase objective is to prove that the developments fulfil the requirements and use cases' specifications. This phase has been partially overlapped with the development phase. Unit testing has been done at development time whereas integration and field testing at the end of the development phase. Test cases have been created for both integration and field test phases that ensuring that all the use cases and requirements are met. During integration and field testing has been detected some loop back to development phase in order to resolve nonconformities and bugs.

Table 1 shows how life cycle's phases are distributed among Mobincity's work packages.

Phase	WP1	WP2	WP3	WP4	WP5	WP6	WP7
Use case	X						

Requirements	X						
Architecture design	X						
Detailed design		X	X	X	X		
Development		X	X	X	X	X	
Unit tests		X	X	X	X	X	
Integration tests						X	
Field tests							X

Table 1: Distribution of Mobincity's development life cycle phases within the project's work packages.

Coverage and traceability matrixes

In order to follow up the project activities and prove the coverage of use cases and requirements in the design, development and testing phases, a numbering and referencing scheme has been designed. These criteria have helped in cataloguing the functionalities for being developed in the project but also to guarantee they are fulfilled in the testing phases. Figure 3 shows how the different modelling criteria are referenced throughout all the phases.

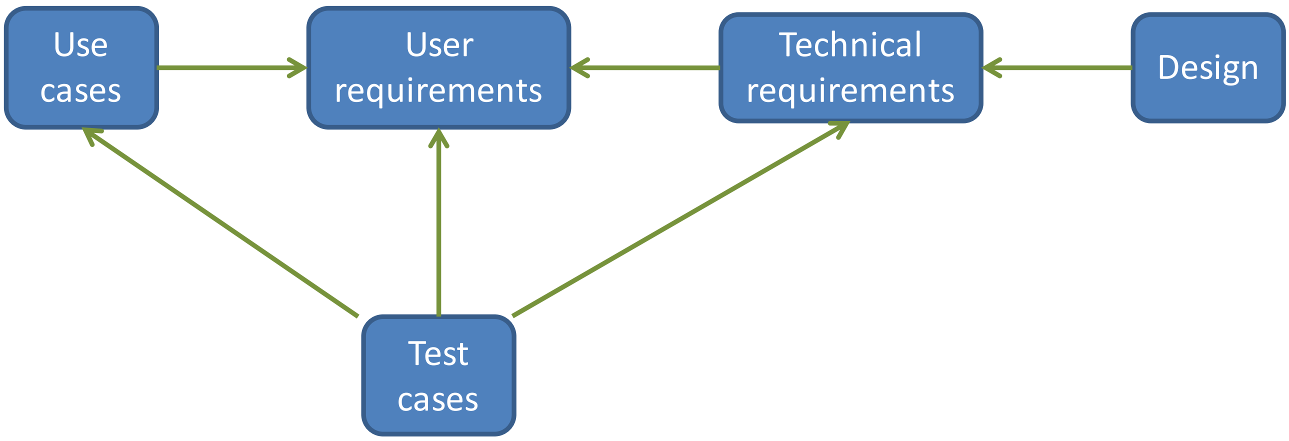


Figure 3: Relationship between specification, design and test features.

For managing these relationships and assure a total coverage of the specification throughout all the project's phases traceability matrixes will be created that will relate:

- Technical requirements and user requirements.
- User requirements and use cases.
- User requirements and test cases.
- Use cases and test cases.

Use case description

The process for capturing Mobincity's behaviour model first started by identifying system actors and stakeholders. Then a high level classification of the main required functionality was done for identifying the main categories the use cases may fit. Finally through several loops of use cases descriptions some gaps and over specifications were detected thus splitting, joining and expanding their descriptions.

The use cases were classified in high level and detailed use cases depending on how the described behaviours were described:

- High level for the use cases describing complex behaviours that can be decomposed in simpler (detailed) use cases through UML use case diagrams.
- Detailed use cases that describe atomic behaviours in the form of UML sequence diagrams.

The link between use cases and user requirements in the traceability matrix was done on a per step basis in the detailed use cases. High level use cases coverage was guaranteed with the sum of the links to user requirements of their detailed use cases.

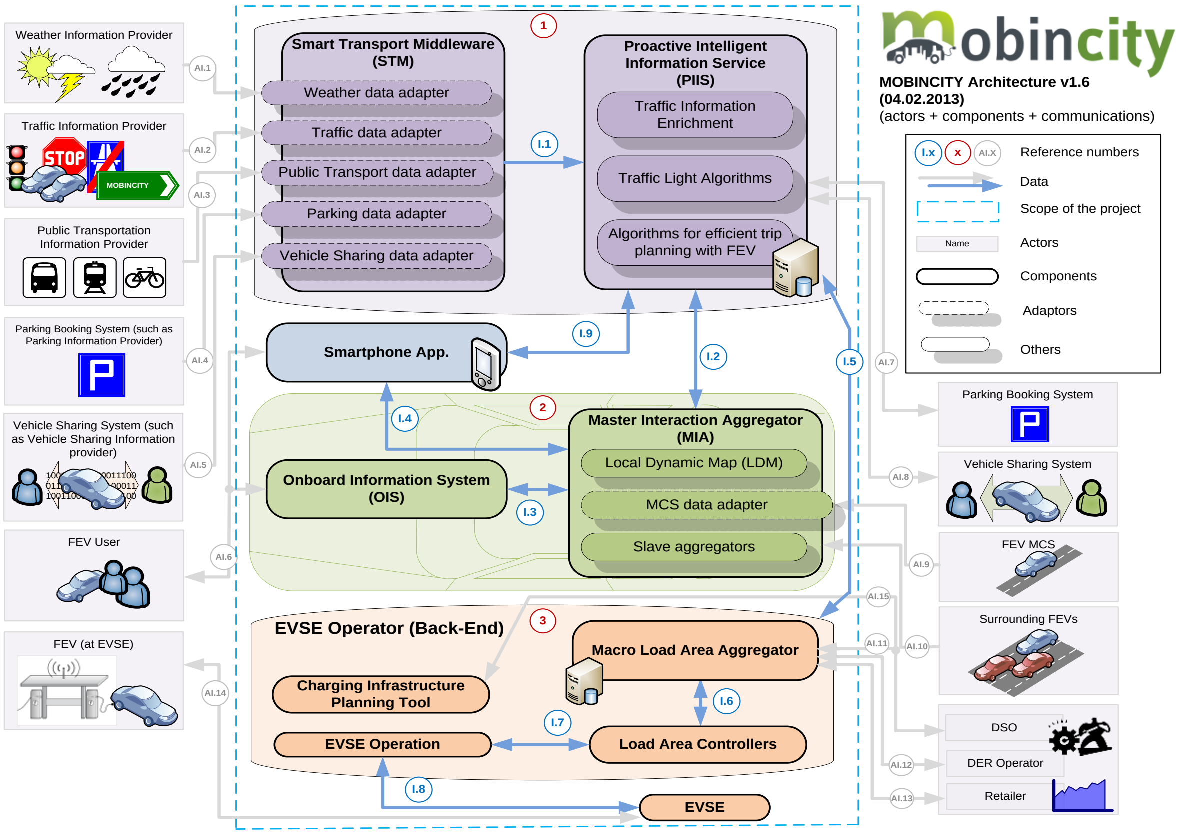


Figure 4: Mobincity architecture.

Design and development

Figure 4 shows the Mobincity system architecture including the components that have been developed in the scope of the project. The detailed design and the development of these components have been covered by WP2, WP3, WP4 and WP5.

WP2 has consisted on the development of the Mobincity cloud components (PIIS and STM) which gather the transport and energy infrastructure information from the external providers and stores it in an organised way to be used by the rest of the Mobincity components. WP3 has included the design and development of the appropriate components for the effective integration of FEVs with the energy infrastructure (CIPIT, EVSE Operation, EVSE Operator, MLAA and LAC). WP4 has provided the main on-board unit for the Mobincity system (MIA) and also the user interfaces (OIS and Smartphone App). Finally, WP5 has not produce an specific components for the system, but in the scope of this work package there have been developed the algorithms for efficient trip planning with FEV to be integrated in the Mobincity components.

Testing

As it has been mentioned before, the unit testing for the Mobincity components has been included in work packages from 2 to 5 and reported in those work package deliverables. WP6 has included the integration of the Mobincity components and also the integration tests.

The integration tests were included in WP6 and reported in D6.2. They have been defined based on each scenario of the use cases developed in WP1 with the objective to fulfil the user and technical requirements associated to each step of the step by step analysis included in the use cases definition. The traceability matrixes included in Annex A of this deliverable show the relation between user requirements and test cases and also between test cases and use cases to guarantee that the initial specifications defined for the Mobincity system have been accomplished by the final designed system.

WP7 covers the field tests that will be performed in the three pilot experiences included in the Mobincity project. The Slovenian pilot will show and validate the FEV interaction with the driver, the transport infrastructure and also de energy infrastructure. The Italian pilot will show and validate the FEV interaction with the driver and energy grid as it was initially planned. Finally, the Spanish pilot will show and validate the FEV interaction with an advance traffic infrastructure. The scope of each pilot will be explained in more detail in the following subsections.

WP2 INTERACTION OF FEV WITH ENERGY INFRASTRUCTURE

The main objective of WP2 *interaction of FEV with transportation infrastructure* is to define, design and develop systems, methodologies and tools for the effective integration of FEVs with the transport layer (traffic conditions, co-modality, e-sharing alternatives). In addition, the functionalities of ICT infrastructure enhanced with capability to support the FEV users' needs also during the process of trip planning.

The specific objectives are:

- To develop a Smart Transport Middleware (STM) able to collect information from external sources with influence in the operation of the FEV, including traffic information, weather and road conditions, unforeseen events, etc.
- To interoperate with other alternative transport modes compatible with driver needs
- To develop a Proactive Intelligent Information System based on algorithms for improving the traffic flow by learning and exploiting traffic data.

Two main different components has been developed within this WP2, on the one hand a Smart Transport Middleware (STM) able to collect information from external sources with influence in the operation of the FEV, on the other hand a Proactive Intelligent Information System (PIIS) based on algorithms for (1) improving the traffic flow by learning and exploiting traffic data, (2) **the pattern identification system which** aims at identifying typical patterns in urban mobility on the basis of real data and advanced data mining algorithms and (3) **the route planning algorithm** which takes as input data (both raw data and pattern related aggregated data) and calculates the optimal route planning. The two modules are linked by a common data model specifying both output data of the pattern identification system and the input data of the route planning algorithm.

The Smart Transport Middleware (STM) could be defined as a data adapters' cluster module which is able to collect different data from external information sources with influence in the operation of FEV including traffic information, weather and road conditions, unforeseen events, etc. When the user wants to plan a route, the routing algorithms algorithms running at PIIS thanks to the different STM data dapters are able to obtain information about the traffic status of the roads, weather conditions, unforeseen events on the road (accidents, closed roads, traffic works, etc.), ability to co-modality options, etc. The STM integrates different data adapters which gather the necessary information from different external data providers, the data adapters developed are:

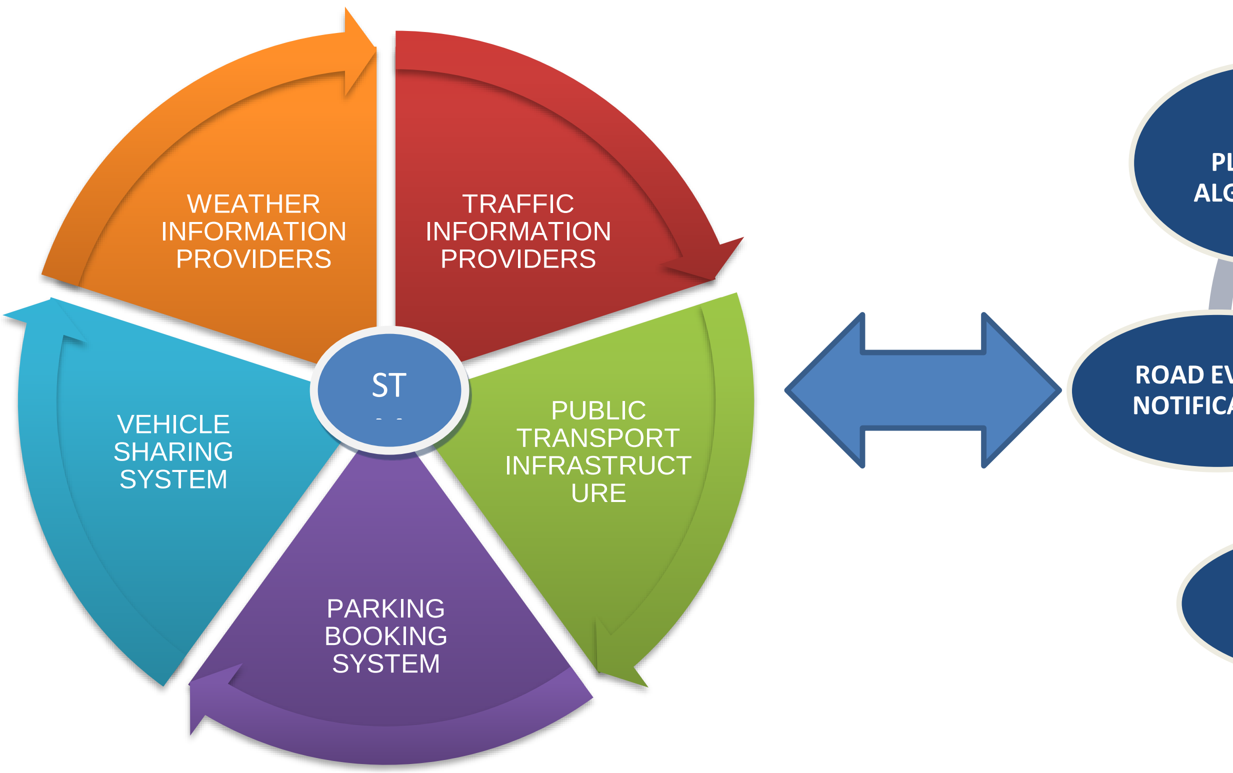


Figure 5: STM & PIIS components.

- **Weather data adapter**. Information about the current and forecast weather conditions is gathered from different external weather information providers. The information received by the weather information providers is refered to the humidity, temperature, wind speed, wind direction, pressure, solar radiation and rain and ice conditions, which can have effect in the road conditions and, consequently, in the electric vehicle performance. Weather data from different weather information providers is combined to obtain the most accurate real time and forecast weather conditions data and being sure that the weather information is always available even if any of the weather provider servers fails or does not respond. All the information requested are always referred to a geo-graphical position.
- **Traffic data adapter**. Information about traffic information, both real time and forecasted information is obtained by this data adapter. The traffic data adapter is conceived to retrieve process

and harmonize traffic data from several heterogeneous systems and information providers, in order to obtain a set of data that provides a "real representation" of the traffic status in each city. These data are used afterwards within the MOBINCITY system for different purposes, such as route optimization or visual representation of the traffic status through the user interface (WP4 and WP5). The trip optimization process could use several criterions for the private vehicle mode. In an optimization based on directed weighted graph, each link will have a weight associated that represents the cost from the tail node to the head node. Usual costs are: Travel Distance, Travel Time, Number of stops, energy usage, CO2 emissions...

- **Public transportation data adapter**. Information about co-modality route, combining different public transport media are obtained by this data adapter. Public transport modes often supply a lower accessibility level than car. This is one major reason why inducing mode shift from private cars to public services is difficult. One possible strategy to improve accessibility by public transport is to extend the possibility to use public modes in various combinations (or even in combination with car). The main goal of ths data adapter is that even if one public transport network (e.g. rail) alone cannot provide high accessibility, an integrated use of different networks (e.g. rail plus bus) can. When a combination of transport modes is involved, interconnection represents a key part of the trip and the quality of interconnectivity is then a major requirement
- **Parking data adapter**. An important part of the traffic in a city is generated by vehicles driving around looking for a parking space. One of the features of the MOBINCITY system is to provide personalized information to the users on where to park their vehicle depending on their destination or park and ride location. The Parking Data Adapter (PDA) gathers information from the different external information providers. Once the data is aggregated and processed, it is used afterwards within the MOBINCITY system for different purposes, such as to provide personalized information to the user or where is more suitable for them to park their vehicle or to include it in the route planner as park and ride facilities. In this sense, the parking booking system, such as an information provider, provides to the user the nearest car parks and the free slots available (with/without recharging capabilities) in each of them. This information is gathered from a set of heterogeneous systems such as different parking control systems or parking information providers that manage parking slots available in the area of influence of the MOBINCITY system.
- **E-sharing data adapter**. The designed e-sharing data adapter becomes a cluster of different e-sharing platforms in order to inform the MOBINCITY user about the available e-sharing platform for co-modality trips when he is planning a future route. This adapter develops to main ideas of trendy mobility: Car-Sharing and Bike-Sharing.

These STM data adapters contain a generic structure (communication and authentication protocols) that the external agents may implement in the adapters of the electro-mobility system. For demonstration purposes (field test scenarios), specific adaptors module have been developed in the adaptable periphery of the MOBINCITY kernel to interact with the external agents to meet their specific needs. Under the scope of Mobincity task 2.2 **"Development of Proactive Intelligent Information System" (PIIS**) several modules have been designed and developed to manage the information gathered by the different STM data adapters. The energy information is also collected from external sources and EVSE infrastructure enabling the Mobincity users to communicate with the charging and energy infrastructure and providing real time information about the operation status of each charging station, but also, allowing the users to interact with the EVSE infrastructure. The user will be able to book a charging station socket for a future charging session and to monitor in closed real-time, the status of his current charging sessions.

All the information gathered by the different interfaces, is processed by means of adaptive algorithms (see WP5), which will determine the speed, the energy consumption and the estimated arrival time to destination, proposing alternative routes and trip planning

Traffic prognosis

Traffic forecasting is the process of estimating the number of people or vehicles that will use a specific transportation facility in the future. Transportation forecasts can be utilized in a variety of different situations and with different modes of transport, from estimating traffic volumes on a specific segment of road or highway to estimating ships in a port or passenger volumes on a city buses. Forecasts determine how the needs of the future might be and provide benchmarks for proper design and operation of an efficient transportation system. Transportation forecasts are important inputs for the development of the city infrastructure – from developing overall transportation policy, to planning studies, to the engineering design of specific projects. The MOBINCITY system is able to predict and anticipate traffic congestions before they occur (using real-time and historical data) by means of the traffic prediction module. The traffic forecast enriches the traffic information gathered.

The prognosis of traffic within a Mobincity project is developed thought a mathematic model based on temporary series. These models have a lineal dependency respecting to the historic samples. For example, an autoregressive model p has the next form:

$$Y_t = c + \sum_{i=1}^{p} a_i \, Y_{t-i} + e_t$$

Where:

Yt	Is the prognosis variable for the instant *t.*
c	This is a constant
ai	This is a parameter establishing the dependency.
Yt-i	Show the simple corresponding to *t* instant

The forecast process is based on time series. The process consists on the separation of seasonal behavior from the stochastic behavior, using the stochastic component to do the forecast and merge the forecasted data with the mean data to get the result data. The seasonal component of the time series is modeled by the mean value of each time sample for a day type. The definition of day types is based in the characterization of day with similar behavior. This characterization includes weeks, days, holidays and other special day and include too other factors like weather and special events.

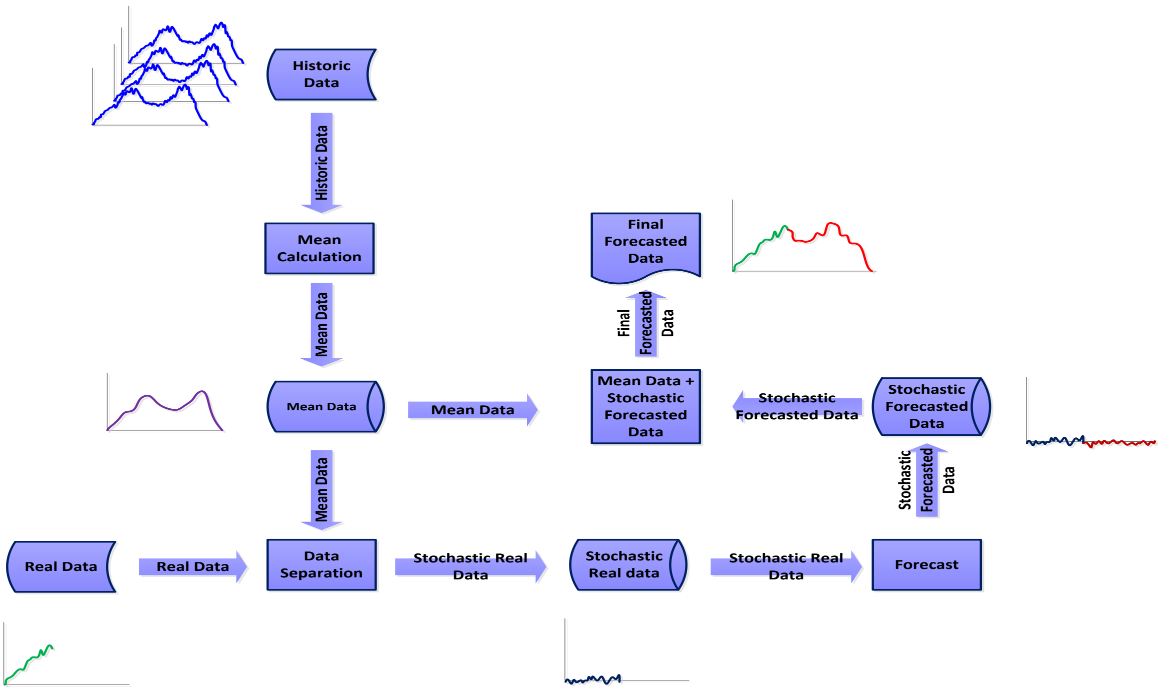


Figure 6: Forecasting process. Communication with EVSE infrastructure.

The goal of this communication process is to allow the Mobincity system to gather information about the changes in the charging infrastructure that may affect the trip planning and re-routing process. If the trip planning or re-routing results in the selection of a certain charging spot to be reserved for charging, the PIIS provides to the EVSE Operator (Back-End) with the socket reservation data and optionally with the cancellation of the socket reservation.

The actors involved within the communication process are:

- **PIIS** which communicates to the EVSE Operator the request for the reservation of the charging spot.
- **EVSE Operator** which checks (for security reasons) the availability of the charging spot and approves or rejects reservation or proposes to PIIS the modified reservation schedule.
- **EVSE** which receives from the EVSE Operator the reservation schedule with related FEV user's IDs in order not to allow other FEV users to occupy the charging spot.

The information coming from the charging infrastructure is exchanged via the interface I.5 between the EVSE Operator's Back-End (precisely its module EVSE Operation) and the PIIS. Two different sets of data are exchanged between the EVSE Operation and PIIS:

Static information

The static information contains the data which is not dependent on any EV user or charging session. This information is used by the PIIS to present the location and general properties of the EVSE composint the charging infrastructure on the graphical interface for FEV users. The static information contains at least the following data:

- General information such as EVSE Operator ID and contact data,

- EVSE characteristics: geographical location, charging spot ID, type of sockets, maximum socket current of power, identification and payment options, opening hours, etc.

This set of information is communicated by EVSE Operator to the PIIS at every change of EVSE parameters (new EVSE, change of socket type or of its maximum power, change of payment and identification options).

Dynamic information

The dynamic information describes the future availability and current status of charging spots. It is used also for handling the charging spot reservations. The static information contains several groups of data related to:

- **Charging spot availability**: the EVSE Operator informs the PIIS about the malfunctions and duration of planned maintenance works on the particular EVSE and about start and end time of charging spot reservations which are made outside of the PIIS. These data represent the EVSE's or charging spot's unavailability in the future and are accordingly presented by the PIIS's to the FEV users;
- **Current status of charging spots**: the EVSE Operator informs the PIIS whether each particular charging spot is free or occupied and, in the latter case, provides information to PIIS about the charging session parameters (FEV user's ID, current power, energy delivered from the beginning of charging session). The charging socket status data (free, occupied) are presented on the geographical map of EVSE while the charging session parameters are further, if required, forwarded to the FEV user;
- **Charging spot reservations**: the information about the FEV user's ID and the start and end time of reservation is transferred by the PIIS to the EVSE Operator in the case the FEV user reserves a particular charging spot via the PIIS or cancels the previously requested reservation.

Trip planning algorithms hosted by the PIIS

The trip planning problem in MOBINCITY has been treated as an optimization problem. First of all, a network model has been introduced in order to represent as closely as possible the different transportation networks arising in the multimodal problem which we are facing in the MOBINCITY project. These algorithms (described in details within WP5) are designed towards implementation in two main components (modules) of the system: **the pattern identification system and the route planning algorithm**. The former aims at identifying typical patterns in urban mobility on the basis of real data and advanced data mining algorithms. The latter processes input data (both raw data and pattern related aggregated data) and calculates the optimal route planning. The two modules are linked by a common data model specifying both output data of the pattern identification system and the input data of the route planning algorithm.

The pattern extrapolation system (the data mining module) considers the data available to PIIS coming from several data sources available (STM data adapters information). The data sources are primarily FEVs themselves and FEV users, but there are data arriving from the electric grid, the traffic information (e.g. from the city traffic monitoring system) and data coming from other sources. To extract the useful information content and convert the information into a form usable in the trip planning process, a data processing procedure is required and this is the task of the data mining module: to extract general rules, detect patterns and identify trends of practical interest in the bulk data. The results are being used within the route planning algorithm and elsewhere within the PIIS.

The route planning algorithm is an optimization algorithm providing service to MOBINCITY users as a navigation support tool taking into account all the FEV mobility specifics and constraints, as well as the FEV user - the mobile citizen preferences regarding other modes of transport and driving preferences. The trip planning work has been conceived according to a layered structure and is now completed by defining the graph based solution approach to the problem. The description of the trip planning problem is presented as well as the complete mathematical formulation of the problem. Then the solution approach following seminal papers from the state of the art concerning vehicle routing problem (with particular attention to the so called Resource Constrained Shortest Path Problem) is presented and integrated by considering further issues arising in scenarios with constraints on the FEV battery autonomy and multi-modality transportation systems. Experimental results based on real data on three different urban scenarios (Ljubljana, Valencia and Rome) showing both the solution approach and the resulting optimal solutions with respect to different user preferences in terms of trip planning.

WP3 INTERACTION OF FEV WITH ENERGY INFRASTRUCTURE

The main objective of WP3 was to define, design and develop systems, methodologies and tools for the effective integration of FEVs with the charging infrastructure (power grid, EVSE, Charging Station Control Centres, end-user information services related to FEV charging and other actors involved in the power network operation and energy supply).

The objectives were achieved by development and implementation of SW solutions which were tested in two pilots: pilot Ljubljana and Pilot Italy.

The activities were focused on the following tasks:

- development of an ICT tool which enables the EVSE Operator to optimally plan the development of charging infrastructure (Pilot Ljubljana),
- integration of FEV charging infrastructure into MOBINCITY system architecture to enable effective trip planning and re-routing (Pilot Ljubljana),
- integration of FEV users' needs into FEV charging control strategies (Pilot Ljubljana & Pilot italy),
- integration of external conditions (power grid, energy market) into FEV charging control strategies (Pilot Ljubljana & Pilot Italy).

The actors and components involved in both pilots and the main scope of information exchanged between them are presented in the following figure:

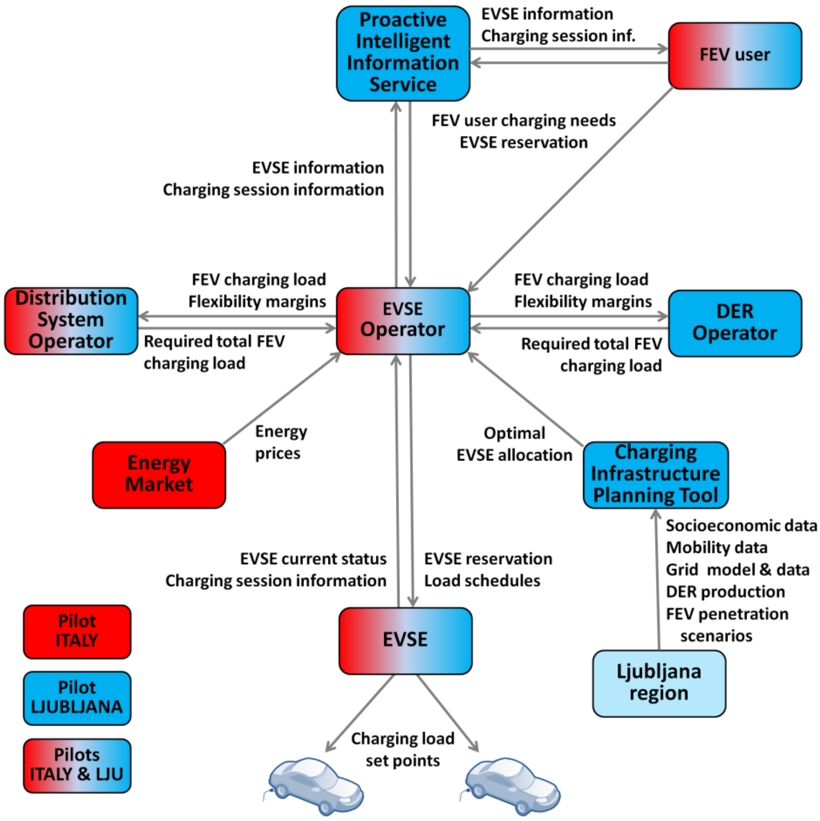


Figure 7: Actors and components involved in the interaction of FEV with energy infrastructure

The Charging Infrastructure Planning Tool (CIPT) was developed as a tool to support the EVSE Operator in **planning the development of charging infrastructure**. The CIPT proposes the optimal quantity and allocation of public EVSE to be erected in a given area to satisfy the FEV users' requirements for public charging spots. The optimisation algorithm implemented in CIPT takes into account the following inputs:

- geographical data: extent of studied area, municipalities involved, points of interest;
- socioeconomic data: population, population density;
- e-mobility data: number of EVs registered, FEV market trends, FEV technical characteristics, average day trip distance and energy consumption, FEV users' behaviour (time frame and location of FEV charging), locations of existing EVSE and their occupancy;
- grid data: grid model, rated loads of grid elements, consumption and voltage patterns in nodes, DER allocation and production patterns;
- e-mobility scenario: low/medium/high FEV penetration.

The optimization method used in the algorithm for achieving the optimal solution is based on evolutionary algorithms techniques related to the genetic algorithm theory. The target function of the algorithm is to satisfy the requirements related to operation of new EVSE: the geographical distribution of EVSE shall correspond to input requirements related to distances between EVSE and to number of EVSE per municipalities, per inhabitant and per registered FEV, while the FEV charging loads shall not cause the violation of grid operation limits.

The outputs of the CIPT are: proposed EVSE locations, population covered by existing and newly proposed EVSE and simulated grid conditions during use of new EVSE (charging load predictions, loading of grid components, voltage conditions). The results are presented by e-mobility scenarios (low/medium/high FEV penetration) with presented comparison between them. In addition, in the case the power grid is not capable to support the FEV charging loads, the CIPT indicates the power grid components (nodes/transformers, lines) which shall be upgraded to cope with the increased consumption due to FEV charging at newly erected EVSE.

The **integration of FEV charging infrastructure into trip planning and re-routing algorithms** is carried out by establishing the communication path between the EVSE Operation (EVSE Operator's IT toll for operation of charging infrastructure) and the Proactive Intelligent Information Service (PIIS). The data exchange provides the PIIS with all information from charging infrastructure which can influence the trip planning, such as EVSE locations, opening hours, available charging modes, types of connectors, identification and payment modes, charging service fees and current status/availability of charging spots. In the opposite direction the PIIS requires from EVSE Operation to reserve for a defined time frame the charging spot selected by the FEV user and to prevent other FEV users to use this charging spot during the selected time frame.

To enable **integration of FEV users' needs into FEV charging control strategies** the EVSE Operator must know the FEV user's charging preferences (energy required and time available for charging) and FEV's technical characteristics (available charging modes, maximum and minimum FEV charging current). This information is contained in the data exchange provided by the ISO 15118 standard which regulates the information exchange between the FEV and EVSE. Since this standard is not yet widely implemented in the FEVs, a temporary solution was developed which enables the FEV user to communicate the listed data to EVSE Operator. In Pilot Italy the communication between the EVSE Operator and the FEV user is direct, via smart phone app, while in Pilot Ljubljana the FEV user communicates the information via PIIS, either by using a smartphone or from FEV's Onboard Information System within the request for reservation of a charging spot. During the charging session the EVSE Operator informs the FEV user about the charging parameters (current power, energy delivered from the beginning of charging session, end of charging) to enable the FEV user an overview over the realization of his/her charging needs.

In the most basic use case the FEV charging control strategies consider the FEV user charging needs and FEV technical characteristics as described in previous paragraph, EVSE technical characteristics and characteristics of EVSE connection to the grid (list of EVSE connected via the same grid connection point, rated power of grid connection point). In Pilot Ljubljana the target function of charging scheduling is to avoid violation of technical limits of EVSE and of grid connection with maximum possible consideration of FEV users' needs. For this reason the individual charging sessions are ranked according to the current charging state (remaining energy to be delivered, remaining time available for charging); the available charging power at individual location (e.g. rated power of EVSE with several charging spots, rated grid connection power of a cluster of EVSE) is then distributed to individual FEVs in accordance with their ranking within the group of FEVs. In Pilot Italy the target function represents the deviation of the aggregated charging load with respect to target load curves established by the DSO for normal grid operation. The charging power is distributed among the FEVs guaranteeing that the user preferences in terms of time available for charging and of final desired state of charge are satisfied.

The scheduling algorithm operates in real-time. The scheduling algorithm is repeated at appearance of any new input (end of charging session, new FEV connected to EVSE) and cyclically at predefined time frames (e.g. each 5 or 15 minutes). In each recalculation the real data from EVSE energy meters (energy delivered to each FEV in 1 minute intervals) are collected and used for determination of remaining energy to be delivered to FEVs currently connected to EVSE.

Integration of external conditions into FEV charging control strategies means, that the FEV charging scheduling is influenced (beside the FEV user needs and technical characteristics of FEV and EVSE) also by other, not strictly e-mobility actors.

The charging scheduling algorithm considers day-ahead and short term requirements of Distribution System Operator (DSO) to limit the FEV charging load in a certain load area. For this reason the power grid where the EVSEs are connected is distributed into hierarchically arranged load areas. For each local load area (e.g. a part of power grid connected to the same line or MV/LV transformer station) the EVSE Operator calculates the current and predicted FEV charging load and the flexibility of this load (ability to reduce the load without excessive violation of FEV users' needs). The charging loads with associated flexibility margins which are valid for wider, higher level load areas (macro load areas) are determined by summing up the stated parameters of adjacent lower level load areas. The EVSE Operator regularly informs the DSO about the charging loads with flexibility margins in individual load areas. In the case of violated grid operation limits (e.g. overloading of grid components) the DSO requires from EVSE Operator to modify the FEV charging load in a certain load or macro load area during a certain time period (provisioning of Active Demand Products). As a consequence, the EVSE Operator re-schedules the FEV charging loads in accordance with new available power for FEV charging in the affected areas. The DSM strategies are not yet implemented in the DSO'S Control Centre; therefore the interaction between the DSO and EVSE Operator was simulated on the EVSE Operator side. However, the charging control strategies are fully developed and integrated in the EVSE Operator's back-end and might be exploited immediately after the DSO establishes DSM strategies in its Control Centre.

DER Operator is another external actor whose requirements are considered within Pilot Ljubljana. The role of DER Operator is taken over by VPP developed within the FP7 e-BADGE project and operated by Elektro Ljubljana. The VPP members are (beside the EVSE) households and industrial and commercial end customers. The goal of VPP is to schedule the FEV charging in the way to minimize the deviation between the nominated (announced in advance) and actual total production/consumption of actors included in the Virtual Power Plant. As in the case of interaction with DSO, the EVSE Operator exchanges with DER operator the information about total FEV charging load and associated flexibility margins of EVSE included in the VPP. In the case of deviations between the VPP's nominated and actual production/consumption the DER Operator requires from EVSE Operator to modify the FEV charging load in real-time in order to reduce the deviation. The EVSE Operator re-schedules the FEV charging loads in accordance with new target load of all EVSE (FEVs) included in the VPP.

After development of SW the functionalities of individual components and interfaces were preliminary lab tested (component tests). The component tests have proven the correct operation of components which enabled a smooth execution of integration lab tests (WP6) and of field tests (WP7).

WP4 Communication Systems

The main objectives of WP4 were to analyse the communication requirements in detail, elaborate a concept for the whole communication system and define its interfaces. The communication system allows the exchange of data within the Mobincity components besides the integration of the information coming from different providers. In order to ensure the interaction of the FEV with all information sources and components, the Master Interaction Aggregator (MIA) is also developed in this WP. The main activities carried out in WP4 were the following:

- Gathering the functional and non-functional communication requirements for all interfaces involved. This activity took place at an early phase of WP4 and was iterated during the development.
- Definition and design of the communication system, including the specification of the interfaces with feasible technologies for their implementation. The communication standards considered in the project are either issued by international committees or developed as proprietary by the partners of the consortium.
- Definition of the information flow between FEV and transport infrastructure as well as public transport through the Mobincity backbone. The information about the availability of charging stations is also guaranteed and transparent to the user. The charging station positions are stored in the LDM data base.
- Design and development of the MIA software to support the interaction between the user, the Mobincity infrastructure and the FEV sensor.

The objectives were reached and demonstrated in both Pilot Ljubljana and Valencia.

The interfaces in Mobincity are either classified in interfaces between components or interfaces between actors and components. For each interface, first the communication technology was described and also the type of messages that are exchanged between the considered components (or actors) was documented. A set of test cases for the verification and evaluation of the communication interfaces in the Mobincity system was also defined. Each interface was verified by at least one functional test executed in the lab. The objective of the test cases was not to evaluate the functionality of the use cases from an overall point of view but of separate interfaces connecting two components in the Mobincity system. Each test case was assigned to a particular mobility scenario: trip planning, on trip services and charging. The results were reused in the following integration tests as well as in the field tests.

The MIA was developed to be the central component in the Mobincity architecture. It supports the interaction of the whole system with the user, as it processes user's requests by gathering all needed information from the backbone and the vehicle sensor (MCS). For this specific access to the vehicle's data through the sensor, the MIA provides all interfaces and functionalities required for the situation of the vehicle on route (on trip services). The MIA reads the battery state from the MCS and makes it available for the backbone to calculate the optimal route. On the other hand, the desired driving modes are set on the sensor by the MIA to ensure that energy saving strategies are applied. The communication concept for the scenario trip planning set different requirements on the communication interfaces since the user is supposed to access the Mobincity services directly from his smartphone. Therefore the communication to the backbone is established directly.

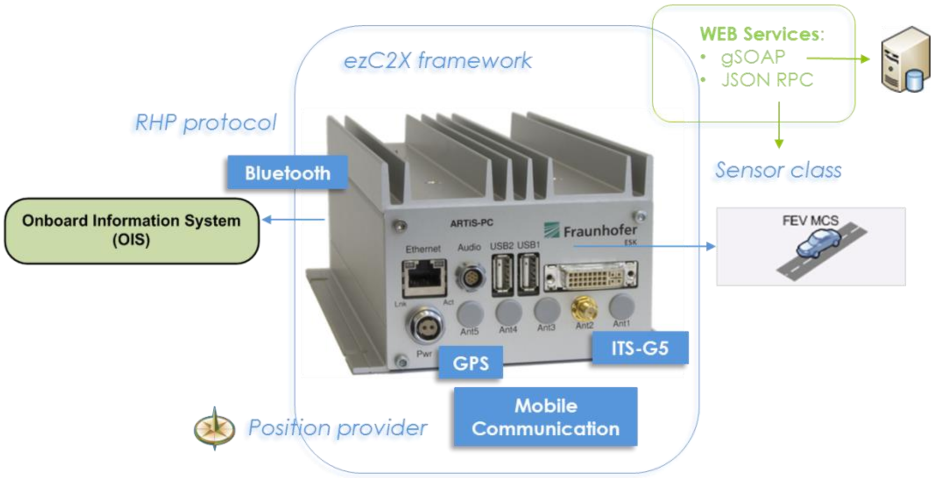


Figure 8: Main MIA interfaces.

The Master Interaction Aggregator works as an on board unit; the hardware is the Automotive Real Time Prototyping System ARTiS-PC, an embedded computer specifically developed for automotive applications. The MIA software is modular and integrated with the ezC2X framework to support the communication with the MCS sensor, manage GPS positions and provide Bluetooth connectivity with the OIS via a proprietary protocol. Figure 8 represents in detail how the software components in ezC2X (RHP, position provider and sensor class) are articulated within the MIA. Furthermore, the communication between the MIA and the external providers via the backbone takes place by means of web services: the SOAP messages at the interface with the PIIS are mapped using the gSOAP toolkit.

The whole logic behind the exchange of messages in each one of the Mobincity use case is implemented inside the MIA. The MIA works as a state machine with a well-defined sequence of message exchange between OIS, PIIS and MCS. When communicating with the other components and retrieving relevant information, the MIA saves such information in the forms of user Id, route Id and point coordinates of a given route. In the LDM data base, the charging station positions are additionally stored as relevant POIs (Figure 9).

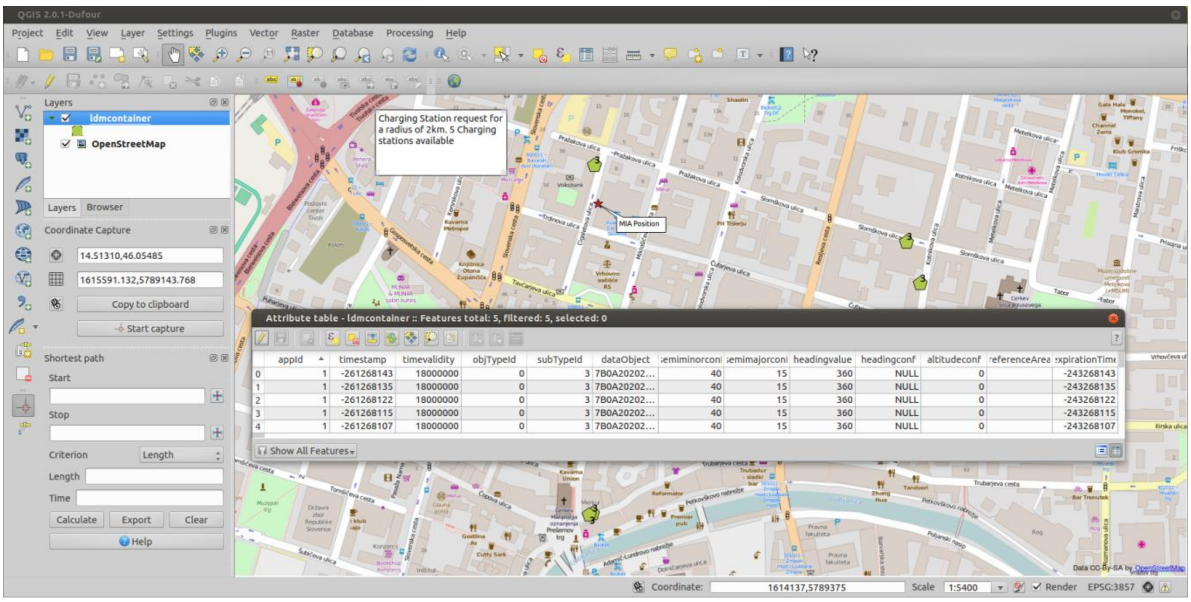


Figure 9: Charging station positions stored in the LDM.

Inside the MIA a mechanism is also implemented which triggers the rerouting in case the user position deviates from the suggested route. By keeping track of the current distance of the vehicle (thus, the user) to the closest route point, the MIA sends a rerouting suggestion to the OIS when needed. If the user confirms that he wants to reroute, a new route will be calculated in the PIIS. Every time the end of the route is reached, the user is also notified of the conclusion of the trip.

The functionalities of the MIA in Mobincity were demonstrated in both Pilot Ljubljana and Pilot Valencia, whereas in this last Pilot the MIA software runs on a laptop and not on the ARTiS. Since the ARTiS does not have a direct connection to the MCS, this is simulated by a web service which is remotely connected via mobile network.

An additional task in WP4 was the definition of different test scenarios for smart grid communication. An important part of the smart grids is the integration of different components, each one with different requirements. With reference to that, the requirements for two selected scenarios based on the IEC 61850 protocol stack are summarize in a report. The report also contains a definition of terms and relevant parameters, an economic motivation as well as an extensive description of use cases. In particular, the following use cases were considered (for each use case a special scenario was selected):

- UC1: Integration of electric vehicles; the related scenario simulates the interface between a charging station and the control center via LTE.
- UC2: Integration of DER; the related scenario simulates the interface between DER and control center via LTE.

Another document contains an overview of relevant communication standards for electric systems and the typical information exchanged among the devices in such scenarios. The two UC scenarios were simulated in the facilities of Telecom Croatia with the purpose of testing whether LTE meets the initial requirements. The results are included in a test report which contains a description of the test environment and also a comparison of the tests executed using both 3G and 4G technology.

WP5 ADAPTIVE STRATEGIES FOR TRIP PLANNING, CHARGING AND DRIVING

The main objectives of WP5 are to develop the algorithms that will define the most efficient and flexible strategies for the trip, taking into account all smart city environmental variables, the interaction with the user and his preferences and also the internal efficiency processes of the FEV.

The activities within this working package were divided in three tasks, with five deliverable reports. In this WP the results and guidelines coming from the results of several previously completed WPs are coming to life in specifications and implementation (namely WP2, WP3 and WP4).

Within Task 5.1: **Development of algorithms for efficient trip planning with FEV**, the algorithms and practically a complete functional specification of the PIIS: Proactive Intelligent Information Service, the central MOBINCITY cloud backend, designed as the support for the MOBINCITY infrastructure, was provided and implemented. Detailed descriptions of the adaptive pattern recognition module and the optimal routing algorithm were given, as well as the data model and interfaces that were implemented in the PIIS.

Finally, in the task 5.3 a specification for an **Adaptive energy management** system aimed towards increasing the energy efficiency of the FEV driving, taking advantage of information from the vehicle information itself and the environment conditions and route plan. Besides the specification, an implementation of an In-Car energy management service coherent with this specification and the realistic constraints of MOBINCITY lab tests and field tests has been provided in this task as well.

Within Task 5.1: Development of algorithms for efficient trip planning with FEV, the complete functional specification of the PIIS: the MOBINCITY cloud was provided and implemented. Detailed descriptions of the adaptive pattern recognition module and the optimal routing algorithm were given, as well as the data model and interfaces that were implemented in the PIIS. Task 1 included two deliverables, D5.1: Definition of potential driving modes for trip planning and FEV routing and D5.2: Algorithms for facilitation of decision making for trip planning.

The deliverable D5.1: Definition of potential driving modes for trip planning and FEV routing deals with variables describing driving modes and how these driving modes can impact on the navigation objectives and constraints. To understand profoundly the motivation behind description of these driving modes, different parameters that influence the choice of driving mode are described and grouped in three major groups depending on the source of influence: the FEV itself, FEV user (the mobile citizen) and the FEV environment. Following the analysis five different driving modes were defined:

- ECO driving mode.
- SPORT driving mode.
- Default/Normal driving mode.
- Management driving mode.
- Comfort/Individual driving mode.

The choice of the driving mode reflects the user’s needs in different conditions. The driving mode directly affects the trip planning and routing process: in other words, the chosen driving mode preference affects the preferred weights that condition the various optimization criteria in the trip planning optimization process. By respecting the driving modes and the relevant factors, the optimization process then ensures the driver’s preferences are adequately respected. The deliverable D5.1 also designs the layered structure of the graph data structure on which the algorithms will work. By using this flexible structure, it is ensured that MOBINCITY algorithms fully support intermodal means of transport and that they are focusing towards a mobile citizen and not solely on FEV drivers. Also, by designing the graph in a layered form, modularity is ensured so that MOBINCITY system can be implemented in a city that doesn’t offer certain means of transport. Furthermore, the layered characteristics ensures that MOBINCITY system, once implemented, can allow new layers (e.g. newly installed underground transit) into the MOBINCITY structures. Finally, the user preferences can exclude certain layers from the planning process.

The task of the D5.2: Algorithms for facilitation of decision making for trip planning was to provide the integral description and definition of the trip planning algorithms, respecting the D5.1 inputs and all the FEV specifics, as well as taking into account the MOBINCITY system architecture and all the relevant sources of information. The algorithms designed in this task are slated for implementation in the Proactive Intelligent Information Service (PIIS).

Two main components of the system are described and formulated:

- the pattern identification system and
- the route planning algorithm.

The pattern identification system is designed to identify typical patterns in urban mobility on the basis of real data and advanced data mining algorithms. Within this system component, there are three modules: pattern extraction, classification and pattern selector modules. The pattern extraction module deals with: obtaining trajectory patterns from a dataset of recorded input trajectories. The classification module classifies new trajectories based on an existing classification, with the option to update the patterns with the new information. The pattern selector chooses a trajectory associated to specific indicators based on similarity to the input values of the same indicators. A modified K-means clustering algorithm has been used in the pattern extraction module. The modification to the K-means method has been made in the similarity distance, which has been modified to be able to compare matrices of time series with two dimensions (longitude and latitude). With regards to classification, Self Organizing Maps have been used, thus allowing clustering of the existing trajectories and classifying new ones onto the existing map. Within the deliverable, a complete description of all the designed algorithms, as well as the testing results of the test implementation of the clustering algorithm using the actual data retrieved from online repository were provided.

The optimal planning algorithm considers the relevant input data and then after performing the optimization, retrieves the optimal route per user request. The trip planning algorithm relies on the layered graph structure as reported in D5.1, and this document gives a detailed mathematical formulation of the problem. The problem is being formulated as a mixed integer optimization problem and solved using a specifically crafted decomposition technique. A newly developed optimization technique was needed to respect the FEV specifics, e.g. the ones related to regenerative braking that cause a segment of the graph to have a negative cost which is problematic for the classic optimization techniques. The deliverable D5.2 also delivered a set of experimental results of the optimal route planning problem. The results were based on realistic data on three different urban scenarios (Ljubljana, Munich and Rome). Further examples are provided for the solution approach and for the behaviour of the resulting optimal solutions, with respect to different user preferences in terms of trip planning.

The two modules are connected through the use of the common data model that specifies the pattern identification system output and input data for the route planning algorithm. A procedure of using the data from pattern identification system in the route planning algorithm is described as well, and the data models rely on information provided in previous deliverables, mainly D2.1, D4.2 and D5.1. Upon completion of the D5.2, basically a functional specification of the MOBINCITY cloud was provided: there are three main building blocks of the software system, pattern identification system (data mining module), the customized route planning algorithm and a common underlying data model linking all the modules together. Further efforts in the task 5.1 led towards the complete integration and implementation of the PIIS system: a proactive and adaptive central service serving the users on request. The names PIIS and “MOBINCITY cloud” can practically be used interchangeably since PIIS is the MOBINCITY central information backbone.

The Task 5.2: **Interaction of the FEV with the driver** defined and provided an implementation of the functional architecture as a carrier of information between EV user (the mobile citizen) and all the elements of the surrounding environment. The Deliverable D5.3: Functional architecture for the interaction of the FEV with the driver provided a complete functional description of the user interface modules, as well as the preliminary implementation of the application implementing these modules. This task is also closely related to the developments in work package WP6 where the functional specification documented here was completely implemented and installed in a real FEV. Within this task several data pathways for data acquisition were defined, as well as triggers for rerouting activities. In D5.3, a detailed definition of user interface modules was provided as well as how the relevant information would be sourced. Subsequently, an implementation of the defined modules was completed.

The task 5.3 provided a specification for an **adaptive energy management system** aimed towards increasing the energy efficiency of the FEV driving, taking advantage of information from the vehicle information itself and the environment conditions and route plan. In other words, a MOBINCITY-enabled energy management system would be aware of the local vehicle information sourced from the vehicle's on-board devices (through the local dynamic map), and it would be taking advantage of the known environment conditions and route planning. Thus the MOBINCITY enabled strategy is also aware of information that arrives through the central route, via the PIIS system.

By using information sourced from Local Dynamic Map (LDM) and trip plan information, several actions can be adopted by the FEV as "passive actions", requiring no particular user intervention and keeping the safety and comfort of the user. The D5.4 was designed as a functional specification to define the possible energy saving strategies and was aimed to be extensible and aimed towards a wider goal, having in mind future FEV developments as well. Besides this functional specification, an implementation of an In-Car energy management service coherent with this specification and the realistic constraints of MOBINCITY lab tests and field tests has been provided in this task. This was the goal of the D5.5 which was more focused towards the actual implementation (lab-scale in WP6 and field tests in WP7) within the MOBINCITY project.

Overall, WP5 laid out the mathematical fundamentals on taking the user preferences into account and then and implemented the most relevant blocks in the MOBINCITY central "cloud" system in the Task 5.1. In the task 5.2 the focus was on efficient communication with the FEV user (the mobile citizen) and the Task 5.3 focused on taking energy management actions within the FEV itself, respecting all the previous developments. All the proposed and functionally specified algorithms in this WP have also been implemented and tested.

WP6 SYSTEM INTEGRATION AND VALIDATION

The main objective of this work package was to materialize and integrate all the systems and tools developed in previous WPs into a compact system. The work package was divided into three tasks, Task 6.1 – *Integration of all communication systems into a compact unit*, Task 6.2 – *Integration of the system into a real FEV* and Task 6.3 – *Validation of the system at lab-scale*. The objectives were achieved by development and implementation of software and hardware solutions, by integration of developed components into a FEV and were tested in two pilots: Pilot Ljubljana and Pilot Valencia.

The activities were focused on the following tasks:

- Development of Main Control System (MCS), Master Interaction Aggregator (MIA), On-Board Information System (OIS) and Smartphone Application.
- Integration of MCS, MIA and OIS into a prototype vehicle
- Validation of all developed components at lab-scale

The MCS component was developed as an entry point for the Mobincity system to the vehicle. It provides a communication link for MIA to FEV data over a webservice interface defined in previous WP. The MCS retrieves information from different Electronic Control Modules (ECU) and forwards this data to MIA.

The MIA is the central component in the Mobincity architecture. It supports the interaction of the whole system with the user as it processes user's requests by gathering all needed information from the backbone and the vehicle sensor. The MIA provides all interfaces and functionalities required for the situation of the vehicle on route. It works as an on board unit; the hardware is the Automotive Real Time Prototyping System ARTiS-PC, an embedded computer specifically developed for automotive applications. The MIA software is modular and integrated with the ezC2X framework to support the communication with the MCS sensor, manage GPS positions and provide Bluetooth connectivity with the OIS via a proprietary protocol. The whole logic behind the exchange of messages in each of the Mobincity use case is implemented inside the MIA. The MIA works as a state machine with a well-defined sequence of message exchange between OIS, PIIS and MCS. When communicating with the other components and retrieving relevant information, the MIA saves such information in the form of user Id, route Id and point coordinates of a given route. In the LDM data base, the POIs (charging station positions) are additionally stored.

Inside the MIA a mechanism is also implemented which triggers the rerouting in case the user position deviates from the suggested route.

The OIS is the interface, which is available within the FEV to the user. It uses the MIA's Front-End interface to enable the FEV user to use MIA's functionalities. The OIS provides input and output functionalities to the user. Input-functionalities include everything that involves user input related to the trip planning, on-trip services and charging use cases. Output-functionalities include all informative services like the display of point of interest (POIs) in the vicinity or current vehicle status.

The MIA, OIS and MCS components were integrated into prototype vehicles for execution of tests at lab-scale and later for Pilot Ljubljana. For Pilot Valencia MIA software was running on a virtual hardware and MCS was simulated on a PC. The preliminary tests have proven the correct operation of components with simulated inputs and outputs.

The preliminary unit tests have been done in work packages 2 to 5. WP6 has included the integration of Mobincity components making it possible to test the defined use cases. The test cases tested and reported in WP6 cover the integration tests. They have been defined based on each scenario of the use cases developed in WP1 with the objective to fulfil the user and technical requirements associated to each step of the step by step analysis included in the use cases definition. The traceability matrixes included in Annex A of the deliverable D6.2 show the relation between user requirements and test cases and also between test cases and use cases to guarantee that the initial specifications defined for the Mobincity system have been accomplished by the final designed system.

Three scenarios have been created based on several groupings of Mobincity systems and equipment. For each scenario Device under Test (DUT) was defined together with the test cases. The test cases have been defined based on each step of each use case where DIT has some implication. The rest of Mobincity components and actors that are linked to the DUT have been simulated.

At a glance the test scenarios are:

- **TSCEV FEV validation:** Includes all the interactions of the FEV components with the rest of Mobincity components and actors. The smartphone interactions were tested here too.
- **TSCCS Cloud system validation:** Interactions of the PIIS and STM with FEV, energy system and external agents were considered.
- **TSCES Energy system validation:** Centred on EVSE operator and subsystems (MLAA, LAC EVSE operation and CIPT).

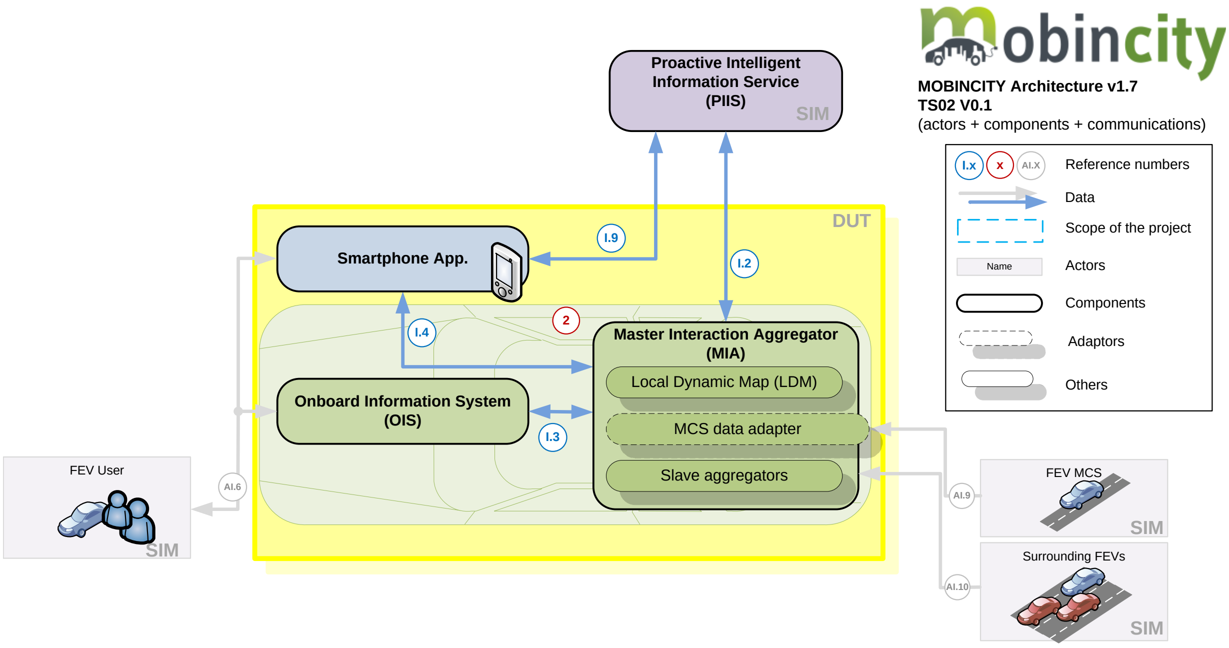


Figure 10: Validation scenario for user centric systems (FEV and Smartphone app)

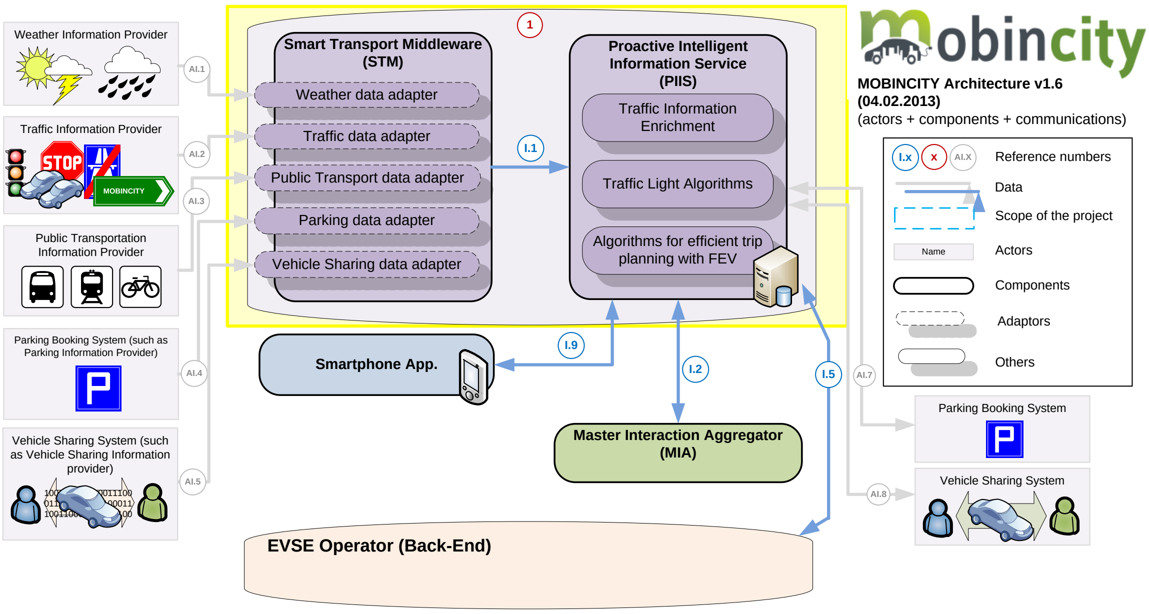


Figure 11: Validation scenario for Cloud system

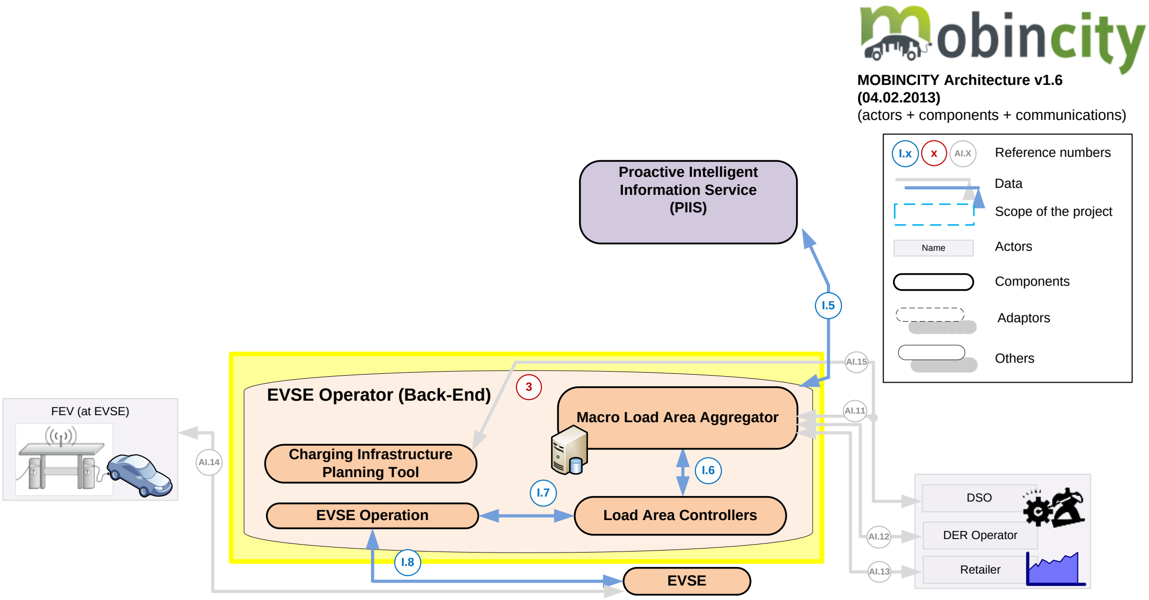


Figure 12: Validation scenario for Energy system

WP7 Field tests

MOBINCITY is the kernel of the electromobility system. This electromobility system will be able to interact with the transportation and energy infrastructure using the interfaces and adapters that are going to be developed in the scope of the project. This definition of the system implies that **MOBINCITY may be applied to any geographical area** such as a city or a region.

The design of this adapters and interfaces will allow MOBINCITY to include as information provider any agent available in the selected geographical area to give information about weather, traffic, public transportation options, vehicle sharing alternatives and parking possibilities. MOBINCINTY will be also able to communicate with the charging and energy infrastructure as well as the grid agents, such as retailers, distributed energy operators and distribution system operators.

For the adaptation of MOBINCITY system to each geographical area, the external agents may implement the APIs and communication protocols implemented in the adapters of the electromobility system. If this is not feasible, specific adaptors may be developed in the adaptable periphery of the kernel to interact with the external agents to meet their specific needs.

In any case only some modifications of interfaces and system adaptors (system peripheral components in charge of the communications) will be needed. Meanwhile components making the system core won't experience changes and would work as required no matter the scenery where MOBINCITY shall become the electro-mobility solution.

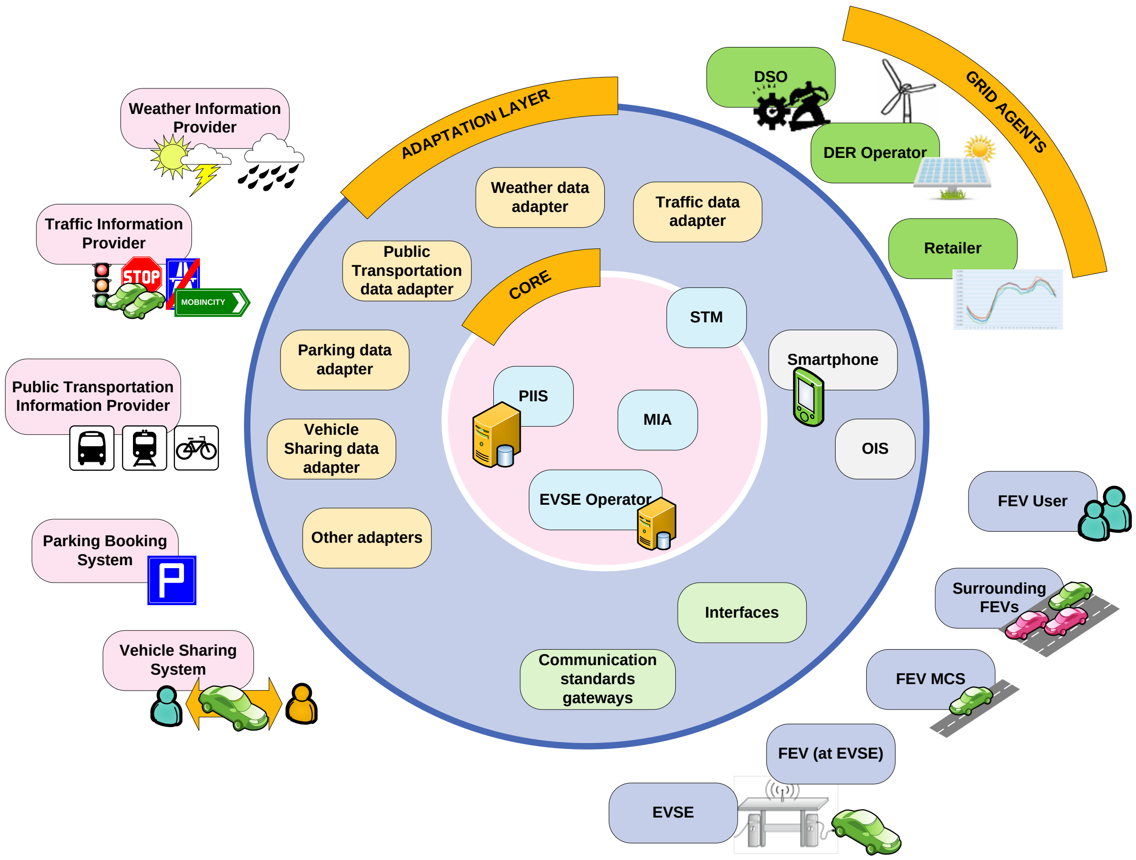


Figure 13: Mobincity approach as the kernel of an electromobility system.

The initial Mobincity validation phase proposed in the DoW was divided into two pilots. The pilot experience 1 was focused in the FEV interaction with the driver and the transport infrastructure and the deployment was planned in Slovenia. Meanwhile, pilot experience 2 included the FEV interaction with the driver and the energy grid which was planned to be shown in Italy.

During the development of the project this initial schedule has slightly changed to assure a further validation of the Mobincity system taking advantage of all the information available and the existing infrastructure in Slovenia, Italy and Spain. This way a third pilot was included in Spain where an advanced traffic information provider was owned by one of the Mobincity Spanish partners. The Slovenian pilot also enlarged its scope and included in the pilot the interaction of the Mobincity system with the energy infrastructure in order to use the charging infrastructure owned and managed by the Slovenian partners of the consortium.

After this adaptation of the planning experience the Slovenian pilot has shown and validated the FEV interaction with the driver, the transport infrastructure and also de energy infrastructure. The Italian pilot has shown and validated the FEV interaction with the driver and energy grid as it was initially planned. Finally, the Spanish pilot has shown and validated the FEV interaction with an advance traffic infrastructure. The scope and results of the field tests performed in each pilot will be explained in more detail in the following subsections.

Therefore, during the system validation in the pilots of Slovenia, Italy and Spain the device under test has been identical in all the cases. Only the adapters interacting with the transportation and energy infrastructure have been accommodated to work with the Slovenia, Spanish and Italian agents.

Ljubljana Pilot

The Slovenian pilot has been the most complete demonstration scenario of the Mobincity project. The on-board components (OIS and MIA) were installed in the Oprema FEV prototype and have been able to interact with the FEV MCS to obtain information from the car. All the information providers have been available, except the traffic information provider, so the Mobincity user (through the Smartphone App or the OIS) has been able to access to the transport infrastructure information. Also some components regarding the energy infrastructure have been available to work as part of the Mobincity system (EVSE, EVSE Operator and LAC) and to interact with the DER Operator as an external actor. The CIPT has been also tested in the Slovenian pilot with real electric and demographic data from the city of Ljubljana.

As regards the interaction of Mobincity system with energy infrastructure the interconnected operation of all involved system was successfully proven during lab tests in WP6 and confirmed by means of the field tests. The field test architecture with associated information flow is presented on Figure 14.

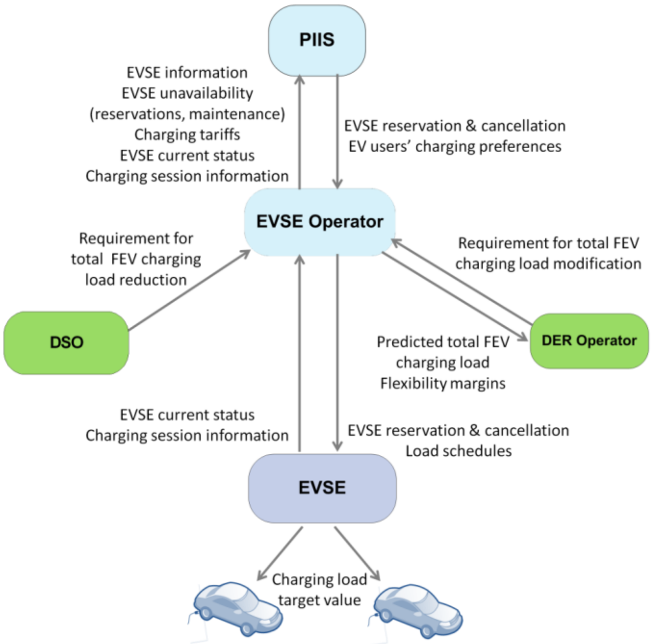


Figure 14: Field Test Architecture in Ljubljana.

All tests executed confirmed a correct operation of EVSE Operator's algorithms and communication to external actors (PIIS, DER Operator and EVSE). The FEV charging schedules were correctly calculated with consideration of FEV users' needs, FEVs' technical characteristics and requirements given by DSO and DER Operator. These tests were also executed using controllable FEVs (Renault ZOE and Mercedes SMART). The FEVs were charging at Elektro Ljubljana owned EVSE at Cigaletova Street. The whole testing procedure was checked and the FEVs properly reacted to charging schedules (load set points) calculated by EVSE Operator based on requirements for load modification communicated by DSO (simulated) and by DER Operator:

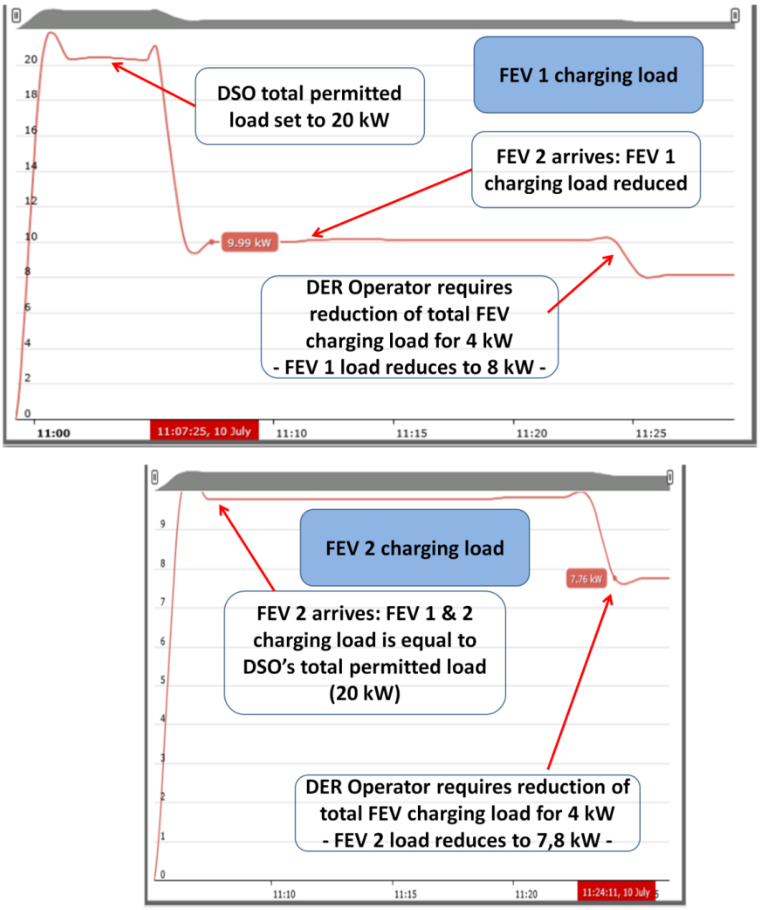


Figure 15- FEV charging load curves

Within Pilot Ljubljana also the verification of algorithms for charging infrastructure planning (PIIS) were verified. Elektro Ljubljana d.d. has delivered all input data needed for operation of the CIPT algorithm (power grid topology and technical characteristics, demographic data, parking spots data and RES data - typical load profiles). ITE performed the validation of the CIPT considering four different scenarios regarding the EV penetration (low – 1000 EVs, medium 5000 EVs and high 25000 EVs) and the contribution of DER.

Regarding the interaction of Mobincity with the car, the Oprema FEV prototype was equipped with the components developed in the scope of the Mobincity project: FEV MCS, MIA and OIS. Also the Smartphone App was adjusted to work under Ljubljana transport infrastructure premises. The Mobincity cloud (PIIS and STM) was also adapted to the Slovenian information providers and the trip planning algorithm was optimised for the scope of the pilot in the city of Ljubljana. This integration was only possible thanks to a intense and close collaboration between Fraunhofer (MIA), CIT (STM+PIIS), Oprema (FEV MCS and FEV prototype) and ITE (user interfaces: Smartphone App+OIS).

This real integration of the Mobincity components into a FEV allowed the Mobincity consortium to test in a real environment the main functionalities that the system may provide to the user. As an initial stage, a partial validation set of tests was performed to make sure that some functionalities such as recovering and updating the route from the Smartphone to the OIS or the reservation module were working properly as a basis for the second test set successful performance.

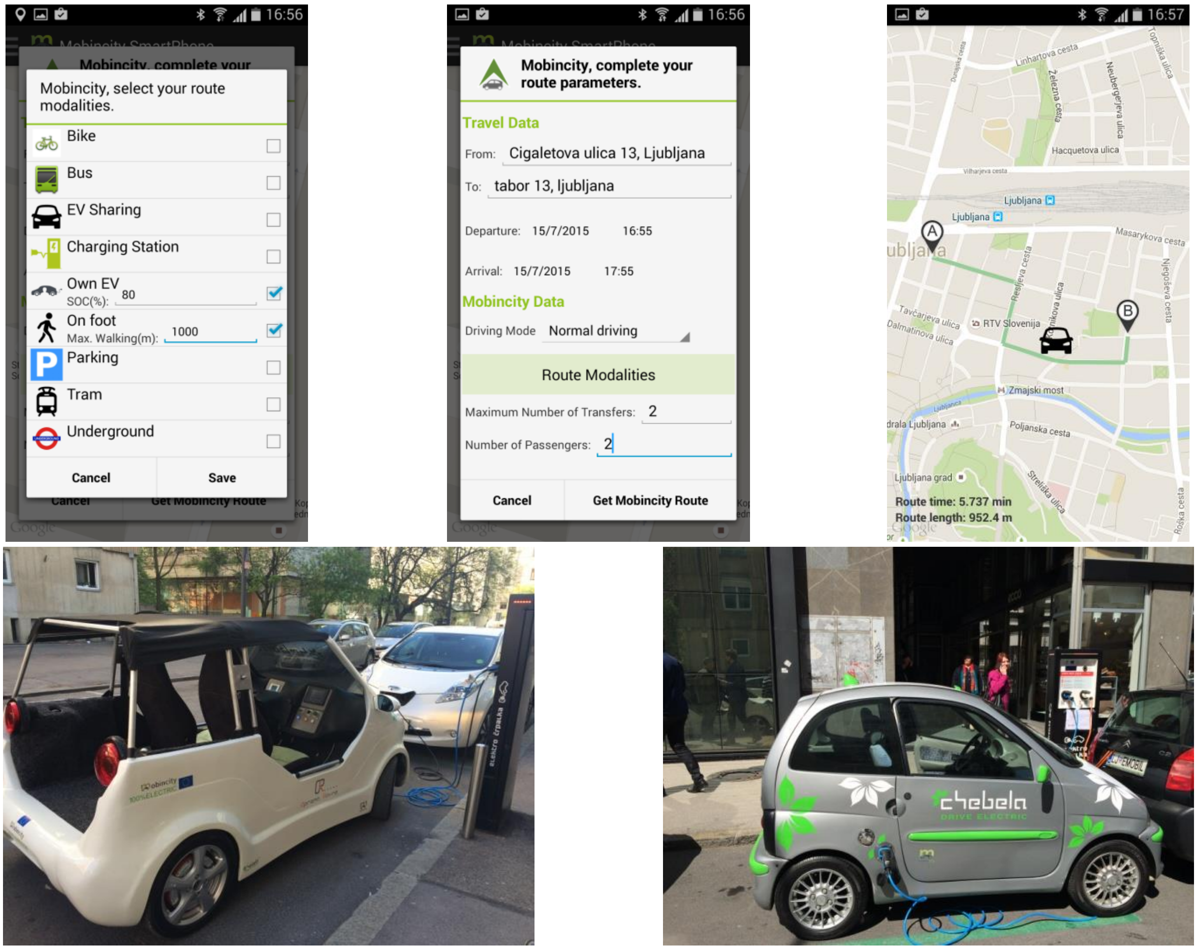
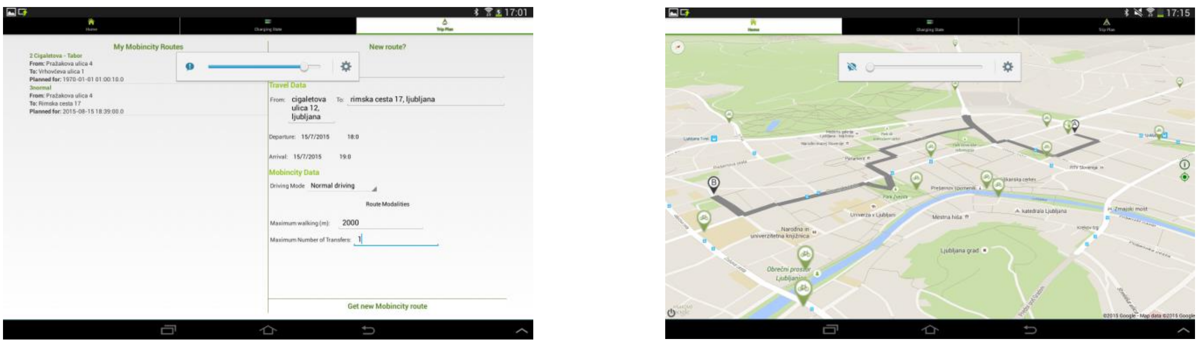


Figure 16: Partial validation tests in Ljubljana Pilot.

The second group (system integration) of field tests was focused on testing long-chain Mobincity functionalities involving almost all the components and actors available for the pilot. The main functionalities of the Mobincity system will be tested including the trip planning and the re-routing processes. It was successfully tested the re-routing to avoid accidents, to help the user when he does not follow the route and when there was not enough battery in the car to reach the destination point. The performance of the different driving modes to limit the energy consumption of the car if required were also tested in this second group of field tests.



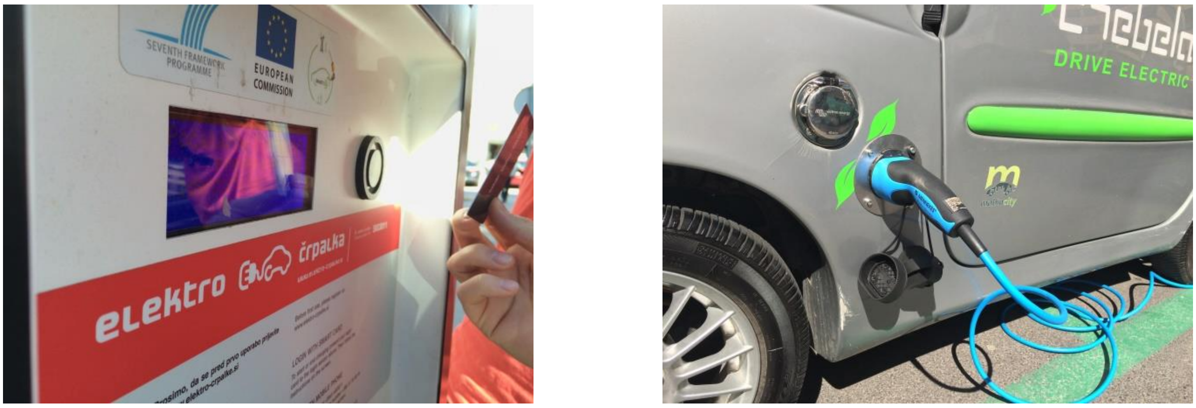


Figure 17: Integration tests in Ljubljana Pilot.

The following table gives an overview of the field tests performed in Ljubljana Pilot (further described in D7.2):

Pilot	Type of Test	ID	Name
Slovenia	Partial Validation	FT-1P-01	CIPT validation with real data
		FT-1P-02	Trip planning: testing user preferences
		FT-1P-03	Trip planning: recovering and updating saved routes
		FT-1P-04-01	Testing parking reservation (without EVSE)
		FT-1P-04-02	Testing parking reservation (with EVSE)
		FT-1P-05	Interaction of Mobincity with the vehicle
		FT-1P-06	Testing the charging scheduling
	System Integration	FT-1S-01	Trip planning: avoiding accidents
		FT-1S-02	Trip planning: testing comodality
		FT-1S-03	Re-routing on driver's request
		FT-1S-04	Re-routing on FEV MCS request
		FT-1S-05	Re-routing on PIIS request
		FT-1S-06	EV Charging Load Re-Profilling on DER Operator's Request

Table 2: Summary of the Slovenian Pilot field tests.

Italian Pilot

The Italian pilot, conducted by Enel in strict collaboration with CRAT, is aimed at testing the advanced load management algorithms developed in Mobincity project (see in particular Deliverables D3.3 and D3.4) for a soft and smart interaction between multiple EVs and the distribution grid during charging. Pilot Italy involve EVSE installed in ENEL's lab testing facilities and EVSE operated on the field, which have been readdressed from the ENEL's operation environment to the ENEL's "pre-operation" (i.e. testing) environment upgraded with the Mobincity software modules providing smart charging functionalities. In the following the activities performed by CRAT and Enel are reported.

CRAT activities deployment has been mentioned below:

- Technical support for EMM upgrade.
- Definition of system integration tests cases.

- Definition of field tests cases.
- Execution of system integration and field test cases

Next image summarise the main activities management by ENEL within the Italian pilot:

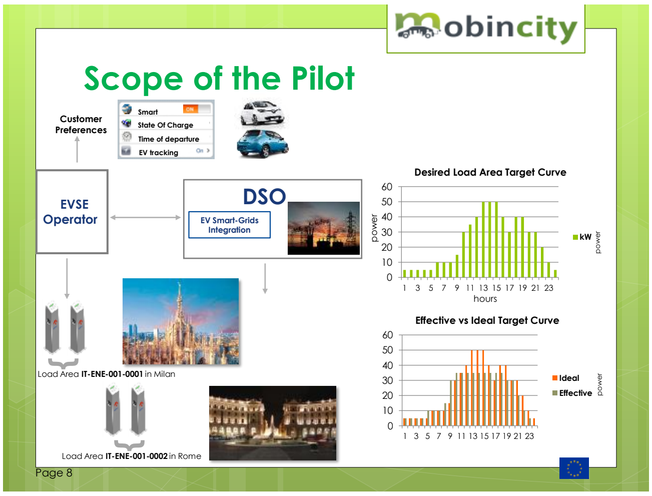


Figure 18: Rome Scope Pilot.

ENEL managed the steps described below:

- Availability of 4 EVs at the desired initial state of charge (SOC) as specified in the test cases.
- Uplink communication working of all 4 charging stations with the test back-end system used for the pilot demonstration.
- Acknowledge, analyze and react to misleading / unexpected EVs behaviors (e.g. switch from single phase to three phase, frequent stand-by)
- Environmental conditions (e.g. external temperature)

The following table gives an overview of the field tests performed in the Italian Pilot (further described in D7.3):

Pilot	Type of Test	ID	Name
Italy	Partial Validation	FT-2P-01	Day ahead macro load area configuration
		FT-2P-02	Dynamic schedule of charging sessions
		FT-2P-03	EV charging load re-profiling on system operator's request
	System Integration	FT-2S-01	Single EV - Characterization of EV parameters and performance under charging
		FT-2S-02	Single EV - Scheduling of charging session
		FT-2S-03	Multi EVs - Scheduling of charging sessions
		FT-2S-04	Multi EVs - EV charging load reprofiling

Table 3: Summary of the Italian Pilot field tests.

Valencia Pilot

During this period the Valencia pilot site has been implemented and integrated to Mobincity System completely. In order to ensure optimal UTMS integration to Mobincity system and its results, the Valencia deployment has been testing during July, this activities was performed in order to ensure provide real traffic information to Mobincity according with the specific architecture of UTMS and the Field test defined to Valencia Pilot. Figure 19 describes the STM architecture.

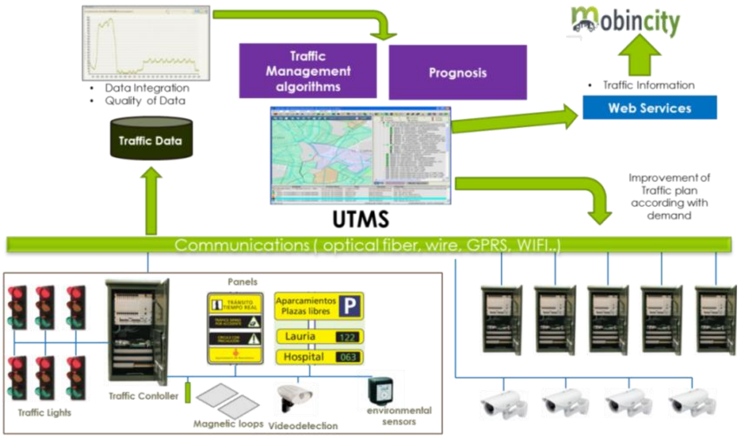


Figure 19. UMTS Architecture.

The field test applied has been divided in two stages: Partial Validation and System Integration. The results obtained after the system integration have been executed satisfactory and the real traffic information have been integrated in the Mobincity system, the field test applied was mentioned in the table below and the detailed information for this field test will be described in D7.5

Pilot	Type of Test	ID	Name
Spain	Partial Validation	FT-3P-01	Clustering algorithms validation with real data
		FT-3P-02	Testing the prognosis algorithms
		FT-3P-03	Trip planning: testing user preferences
		FT-3P-04	Trip planning: recovering and updating saved routes
		FT-3P-05	Trip planning pattern selector
		FT-3P-06	Testing parking reservation (without EVSE)
	System Integration	FT-3S-01	Trip planning: avoiding accidents
		FT-3S-02	Trip planning: testing comodality
		FT-3S-03	Re-routing on driver's request
		FT-3S-04	Re-routing on PIIS request

Table 4: Summary of the Valencia Pilot field tests.

Next Figure 20 shows some images obtained with the Mobincity App for Valencia Pilot.

Traffic Data Gathered

In addition to magnetic loops data gathered by traffic regulators, the flow video analysis will be use to enrich the traffic data usable for traffic management in real time e.g. counting, velocity, vehicle detection (Number of Vehicle by lane, Velocity

average by lane, Time average among vehicles)

Figure 20. Real Traffic Information gathered

Prognosis Information

UTMS integrates the traffic data gathered and determines the quality of the traffic sensor data. Treatment, depuration, substitution and integration of the data from measurement point in order to obtain enhance quality for city mobility. The Mobincity System are available to show reports generation and day type management

Figure 21. Prognosis information Provided

Parking Information

The Parking information deployment in Valencia are available to provide real time traffic information of any parking allocated in Valencia. This kind of information must contribute to reduce the traffic jam within a city

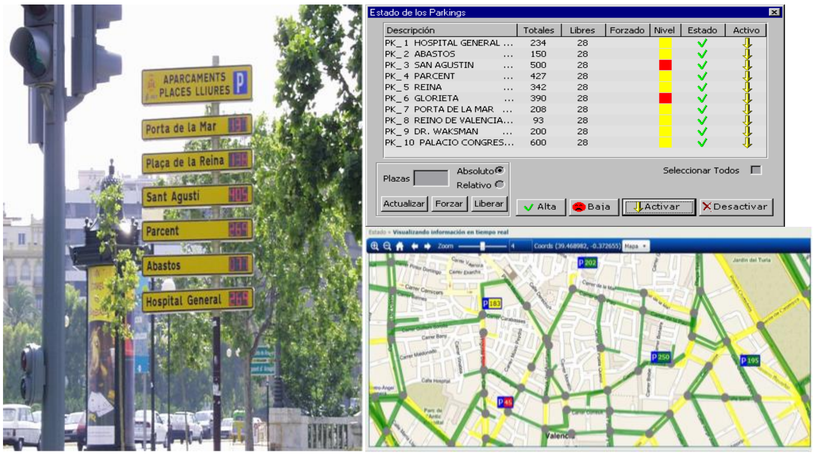


Figure 22 Parking Information Provided

Customer perception

The perception of the Mobincity system was analysed using Focus Group discussion methodology as it was seen as the best way to gather information about the relation of the volunteers with e-mobility technology and their expectations for an e-mobility platform. A Focus Group discussion means a moderated discussion with 3-10 persons, representing the targeted group. Compared to an interview with a structured questionnaire this methodology will deliver more in depth information as group dynamics will give good insights. The duration is about 2-3hours.

The general structure of those discussions was:

1. Short introduction of the respondents.
2. “Warm up”: Discussion about mobility in general.
3. Project presentation.
4. Practical tests using the Smartphone App and OIS with project smartphones and tablets.
5. Discussion about impression and handling.
6. Closing round.

Table 5: Focus Group discussion: Mobincity project presentation.

Technomar and ITE coordinated this activity that was performed once in each pilot site: Ljubljana, Italy and Valencia. The results of the Focus Group discussion have been included in deliverable D7.4 organised by country. ITE, CRAT and Elektro Ljubljana conducted the Focus Group discussion in Valencia, Italy and Ljubljana, respectively.

Figure 23: Italian and Spanish Focus Group discussion performance.

Although each pilot experience had its own deliverable to report individually the objectives and results of the field tests, D7.4 also includes a summary of each pilot and an explanation of the final Mobincity system development that can be easily compared with the preliminary designed included in section 5 of D1.1 made at the first stages of the Mobincity project.

WP8 Dissemination and Exploitation

The main objective of WP8 dissemination was to communicate the scientific and technological project results to the European scientific and research communities so that the project results can be used and become the basis for further research. In the case of S&T especially the publication of peer reviewed publications was of essential importance. But also the support and writing of bachelor, master and PhD theses was an important contribution to the MOBINCITY S&T activities.

In total there have been submitted and accepted 16 peer reviewed publications, comprising one peer reviewed article in a scientific journal, two articles in specialist books and 13 conference publications which have been also presented to a large experts auditorium (see more details in Annex A). Regarding the support and writing of bachelor, master and PhD theses there have been six theses performed in SAPIENZA, which have been publicly presented in dedicated oral sessions. Here a short overview of this scientific work:

- Fabio Purificato, "Metodologie di bilanciamento per la ricarica dei veicoli elettrici in ambito Smartgrids",
  Master degree in Systems Engineering, 2013
- Advisor: Prof. Francesco Delli Priscoli,
  Co-advisor: Dr. Andrea Mercurio and Dr. Alessandro Di Giorgio.
- Deola D., "Progetto e simulazione di un sistema di controllo per la ricarica dei veicoli eletrici nelle reti di distribuzione",
  Master degree in Systems Engineering, 2013
  Advisor: Prof. Francesco Delli Priscoli
  Co-advisor: Dr. Alessandro Di Giorgio. Relevant to WP 3.
- Marinelli D., "Progettazione e sviluppo di un sistema di trip planning e routing per la gestione ottima dei veicoli elettrici",
  Master Degree in Systems Engineering, 2013

Advisor: Prof. Francesco Delli Priscoli,
Co-advisor: Dr. Silvia Canale. Relevant to WP 5.

- Tortorelli A., “Demand Side Management nell’ambito dell’ambito dell’elettromobilità: algoritmi di gestione dell’active demand”,
  Bachelor degree in Engineering in Computer Science and Control Engineering, 2013
  Advisor: Prof. Francesco Delli Priscoli
  Co-advisor: Dr. Andrea Mercurio. Relevant to WP 3.

- Liberati F., “Model Predictive Control-based Demand Side Management in Smart Grids”,
  Ph.D. thesis in Systems Engineering, 2015
  Advisor: Prof. Francesco Delli Priscoli,relevant to WP 3.

- Zuccaro L., “Resource allocation algorithms in energy, IT and telecommunication networks”,
  Ph.D. thesis in Systems Engineering, 2015
  Advisor: Prof. Francesco Delli Priscoli, relevant to WP 3.

1.1.3 POTENTIAL IMPACT OF THE PROJECT

In order to estimate the potential impact of MOBINCITY there has been carried out an impact assessment. It comprises of an analysis and identification of impact relevant results within all work packages, the identification and establishing of key performance indicators (KPI) and the measurement of the values of the identified KPIs. The impact assessment was based on the recommendations of IAIA (International Association for Impact Assessment).

IA aims to:

- provide information for decision-making that analyses the biophysical, social, economic and institutional consequences of proposed actions;
- promote transparency and participation of the public in decision-making;
- identify procedures and methods for the follow-up (monitoring and mitigation of adverse consequences) in planning and project cycles; and
- contribute to environmentally sound and sustainable development

Transferred to MOBINCITY this IA is of enormous importance for the decisions regarding the further exploration of the project results. Therefore a WP Impact Assessment questionnaire has been elaborated in order to identify the relevant AI for each Work Package. Below are the results of the impact assessment:

The Micro and Macro Economic Impact for the Partners has been ranked on a scale from 0 to 3. 0 means there is no impact, 3 means there is very high impact. The following table shows the average from all interviewed partners and experts for the micro and macro economic impacts. The strongest impact will be the future benefits for the exploitation partners, but also all other future indicators will be expected as quite good. (See details in Figure 24Figure 24)

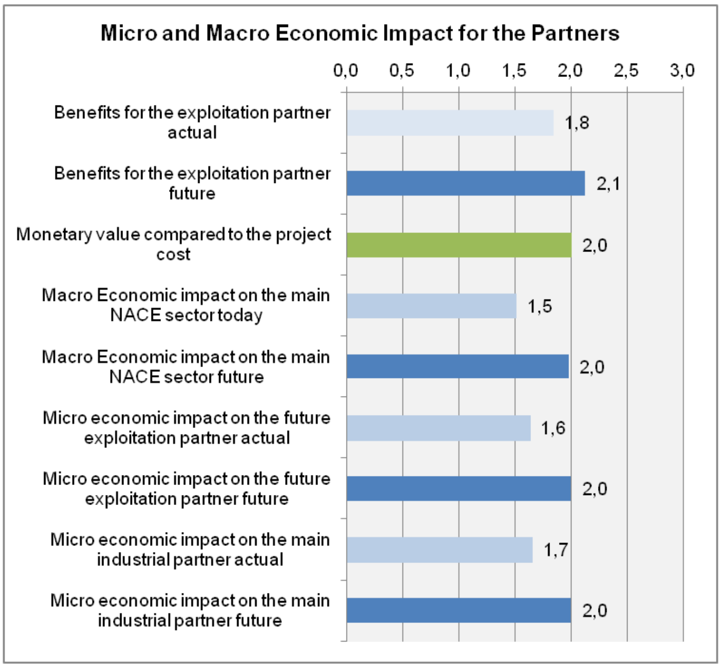


Figure 24: Micro and Macro Economic Impact for the Partners

Regarding the key financial impact only one partner was able to quantify his expected impact. That's the reason why the key financial impact is quite low and far less than the potential of 3.5 Mio. Euro which was calculated for a commercial version of MOBINCITY in the business plan. (See details in Figure 25)

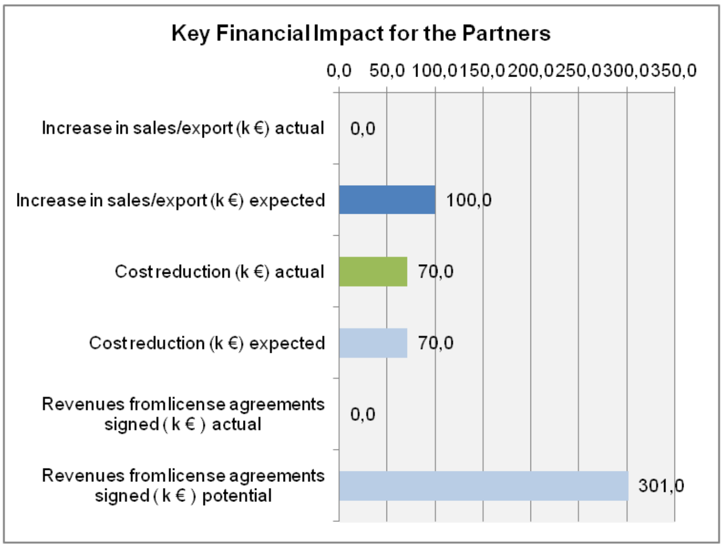


Figure 25: Key Financial Impact for the Partners

Regarding the commercial impact in percentage the partners where able to give us more reliable numbers. So they think that within the next 3-5 years the sales of exploitation partners will increase significant by 76% and also MOBINCITY will help them to gain up to 30% market share. (See details in Figure 3)

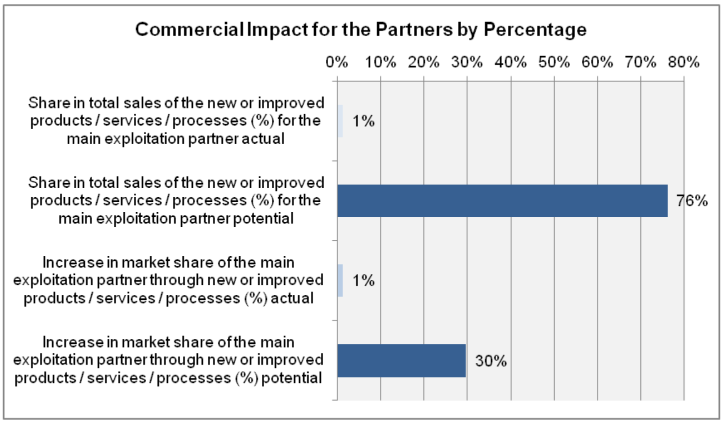


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Figure 26: Commercial Impact for the Partners by Percentage

A very promising impact could already be achieved in the field of human resources. So more than 9 new jobs have been created because of MOBINCITY and additional 15 jobs will be created in the next 3-5 years. On the other hand, MOBINCITY helped to save until now 7 jobs and in the future another 10 jobs will be safeguarded. (see details in Figure 4)

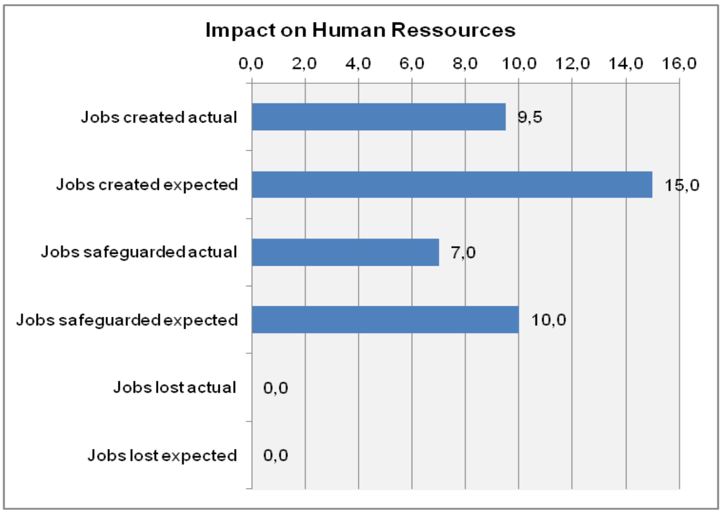

Figure 27: Impact on Human Ressources

Regarding the environmental and society impact the partners and experts are convinced, MOBINCITY will have a good impact to improve Science and Technology in the future followed by an also good environmental impact and MOBINCITY will also have good influence on environmental regulatory & legislative activities. (see details in Figure 5)

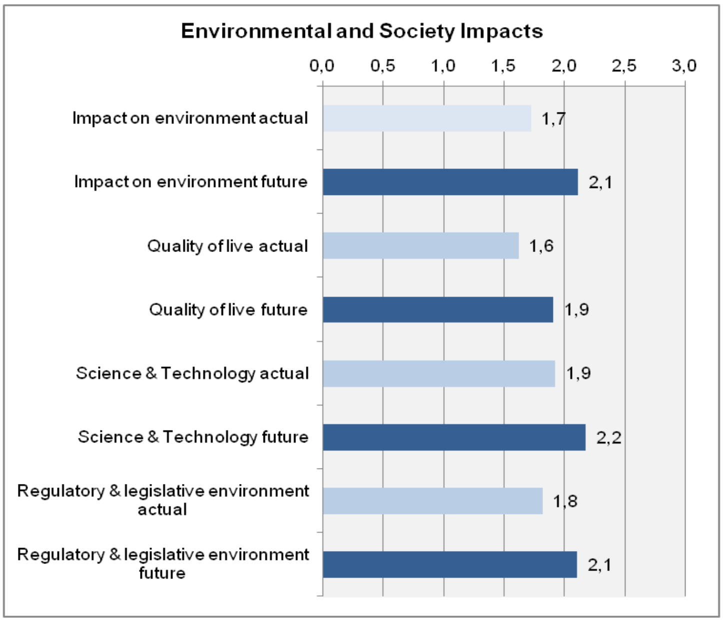

Figure 28: Environmental and Society Impacts.

MOBINCITY has a strong impact on energy saving which can be improved by 45% because MOBINCITY helps to increase the range of EVs which will make EVs competitive against cars with combustion engine. This improved range will also help to keep batteries small and therefore the waste of dead batteries will be by 8% less than without MOBINCITY. (see details in Figure 6)

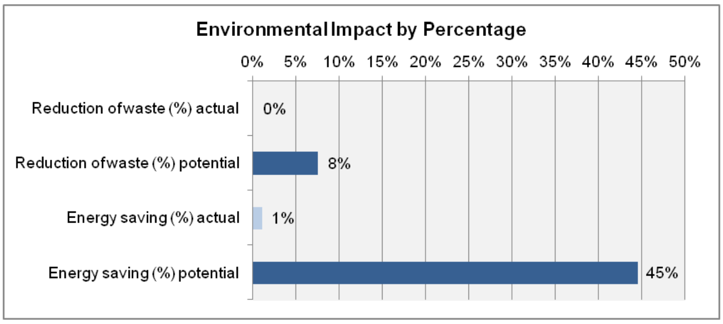

Figure 29: Environmental Impact by Percentage

Regarding the Quantitative Tangible Outputs the partners and experts see the strongest potential in the future number of MOBINCITY license agreements. There in the next 3-5 years up to 33 licenses e.g. for municipalities are expected. This is followed by 18 new software packages and services and 16 improved software packages and services. Also the respondents expect that in the future up to 8 patents and 3 copyrights and trademarks will be applied.

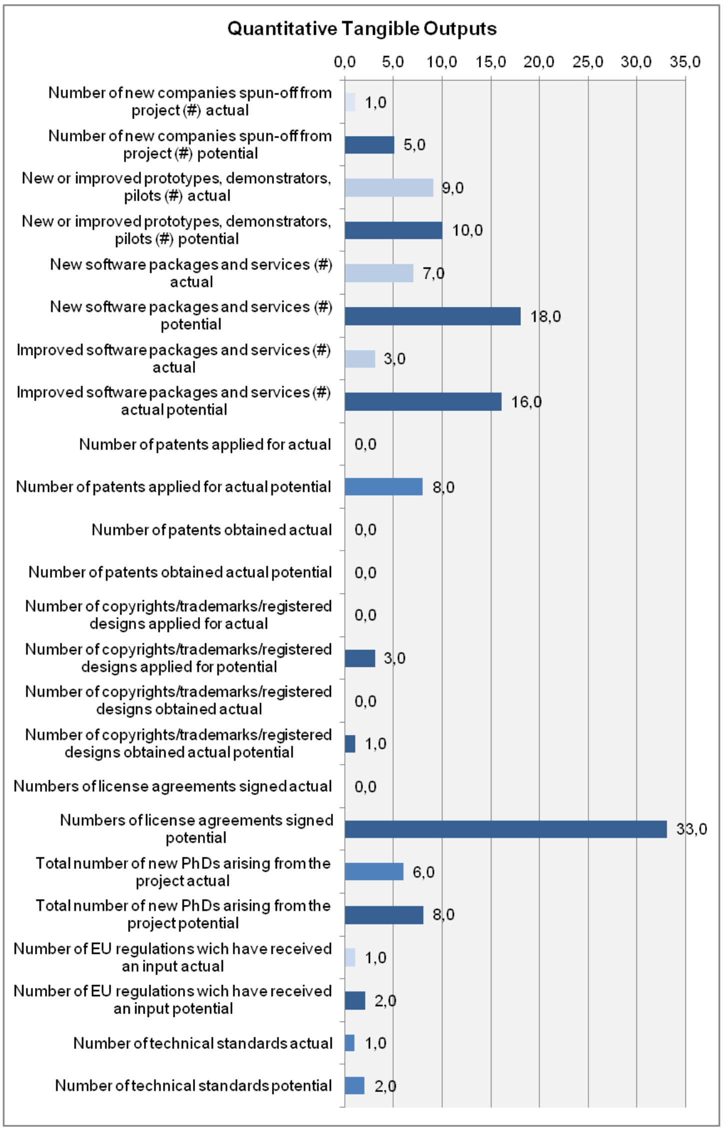

Figure 30: Quantitative Tangible Outputs

Today MOBINCITY is has already a strong impact in PhDs, master and bachelor theses. Up to now already 6 theses have been arisen and up to 8 will be expected. Also the number of 9 improved prototypes, demonstrators and pilots shows how intensive the development of MOBINCITY is being driven by the consortium members.

Even on new company has been spun-off from the project. Applied Research To Technologies s.r.l. (Ares2T), an Italian SME has been established in September 2013 as a CRAT "spin-off". (see details in Figure 7)

1.1.4 FURTHER INFORMATION

A further description of the project, the partners, and public deliverables can be found at: http://www.mobincity.eu/

Mobincity project also has its own profile in social networking:

- Facebook: https://www.facebook.com/mobincity
- Youtube: https://www.youtube.com/channel/UCTaIQf06VKmnE99t7AEi7Bg

4.2 Use and dissemination of foreground

The purpose of the dissemination was to raise awareness of the MOBINCITY project and its outcomes. The key target groups for the dissemination were major stakeholders and experts like electricity providers, car OEMs, EV manufacturers, regulatory bodies, research community, EU authorities, as well as operating companies of public traffic, NGOs and the general public. The main target groups for internal communication were partners, executives and the members of the consortium.

The major target of the dissemination was to communicate the project results to the European scientific and research communities so that the project results could be used and become the basis for further research. Moreover, it was disseminated within the industry in order to ease the exploitation stage. It also included the realization of a project website and its diffusion; the elaboration of publications, visit of fairs and conferences and the organization of at least two events.

1.2.1 SECTION A (PUBLIC)

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers (if available)	Open access
1	*"Multi-Modal Trip Planning and Real Time Re-Routing integrating Electric Vehicle's Range Management and Charging"*	*Gambuti R. , Di Giorgio A., Canale S., Liberati F., Oddi G, Pietrabissa A., Suraci V., Delli Priscoli F.*	*IEEE Transactions on Automation Science and Engineering (T-ASE)*	*10th-T-ASE*	*Conference Publication IEEE*		*Submitted on July 2015*		*Up to now no DOI issued*	
2	*"Software for the optimal allocation of EV chargers into the power distribution grid"*	*A. Mocholí, C. Blasco, I. Aguado, F. Fuster*	*23rd International Conference on Electricty Disribution (CIRED 2015)*	*CIRED 2015*	*Conference Publication IEEE*	*Lyon*	*June 2015*		*Up to now no DOI issued*	
3	*"Real Time Optimal Power Flow integrating Large Scale Storage Devices and Wind Generation"*	*Di Giorgio A., Liberati F., Lanna A.*	*2015 IEEE Mediterranean Conference on Control and Automation*	*23rd Mediterranean Conference MED 2015*	*Conference Publication IEEE*	*Torremolinos*	*June 2015*		*Up to now no DOI issued*	
4	*"Electric Vehicle Trip Planning Integrating Autonomy Constraints and Charging Facilities"*	*Gambuti R., Canale S., Facchinei F., Lanna A., Di Giorgio A.*	*2015 IEEE Mediterranean Conference on Control and Automation*	*23rd Mediterranean Conference MED 2015*	*Conference Publication IEEE*	*Torremolinos*	*June 2015*		*Up to now no DOI issued*	
5	*"Electric Energy Storage Systems integration in Distribution Grids"*	*Di Giorgio A., Liberati F., Lanna A.*	*IEEE International Conference on Environment and Electrical Engineering*	*IEEE EEEIC 2015*	*Conference Publication IEEE*	*Rome*	*June 2015*	*1 - 6*	*arXiv:1506.04522*	YES

6	*"A Model Predictive Control-Based Approach for Plug-in Electric Vehicles Charging: Power Tracking, Renewable Energy Sources Integration and Driver Preferences Satisfaction"*	*Alessandro Di Giorgio, Francesco Liberati*	*Plug-In Electric Vehicles in Smart Grid: Charging Strategies*	*N.A.*	*Book Contribution Springer*	*Singapore*	*2015*	*203 - 240*	*DOI: 10.1007/978-981-287-317-0 http://dx.doi.org/10.1007/978-981-287-317-0_7*	NO
7	*"Electric vehicle charging load control according to the needs of users, DSOs and energy market*	*Mehle B., Ratej J., Krisper, U.*	*2015 CIGRE/ CIRED Conference publication*	*N.A.*	*Slovenian Committee CIGRE/ CIRED*	*Ljubljana*	*May 2015*	*224*	*ISBN 978-961-6265-26-3*	NO
8	*"Te Green Mobility Grid of the SmartCity"*	*Fernández V., Urbano R., Varesi A., Kremer Z.*	*INSTICC Book for the European Project Space "Cases and Examples – Barcelona"*	*N.A.*	*Book Contribution SciTePress*	*Portugal*	*April 2015*	*3 - 10*	*ISBN 978-989-758-034-5*	NO
9	*"Electric Vehicles Charging Control based on Future Internet Generic Enablers"*	*Lanna A., Liberati F., Zuccaro L., Di Giorgio A*	*IEEE International Electric Vehicle Conference*	*IEVC 2014*	*Conference Publication IEEE*	*Florence*	*December 2014*	*1 - 5*	*DOI: 10.1109/IEVC.2014.7056079*	YES
10	*"A Two-Step Process for Clustering Electric VehicleTrajectories"*	*Benítez, I.; Blasco, C.; Mocholí, A.; Quijano, A.*	*IEEE International Electric Vehicle Conference*	*IEVC2014*	*Conference Publication IEEE*	*Italy*	*December 2014*	*1 - 8*	*DOI: 10.1109/IEVC.2014.7056135*	NO
11	*"Near Real Time Load Shifting Control for Residential Electricity Prosumers under Designed and Market Indexed Pricing Models"*	*Di Giorgio A., Liberati F.*	*Applied Energy*	*Volume 128*	*Elsevier*	*Amsterdam*	*September 2014*	*119-132*	*DOI: 10.1016/j.apenergy.2014.04.032*	NO

12	*"Operational interfaces for EV Smart Charging across extended e-mobility value chain"*	*Coppola G., Caleno F., Casacchia T., Di Giorgio A., Mercurio A., Liberati F., Zuccaro L.*	*CIRED Workshop*	*Paper No 0270*	*Conference Publication*	*Rome*	*June 2014*	*1-5*	*http://www.cired 2014-workshop.org/presentations*	NO
13	*"The impact of the Fully Electric Vehicle demand in the spot market"*	*Aguado I., Soriano Borrull R., Quijano López A., Fuster Roig V.*	*International Conference on the European Energy Markets*	*EEM14 (11th International Conference on the European Energy Markets 2014)*	*Conference Publication IEEE*	*Krakow*	*May 2014*			NO
14	*"On-board stochastic control of Electric Vehicle recharging"*	*Di Giorgio A., Liberati F., Pietrabissa A.*	*Decision and Control*	*52nd IEEE Conference on Decision and Control 2013*	*Conference Publication IEEE*	*Florence*	*December 2013*	*5710 - 5715*	*DOI: 10.1109/CDC.2013.6760789*	NO
15	*"Optimal Fully Electric Vehicle load balancing with an ADMM algorithm in Smartgrids"*	*Mercurio A., Di Giorgio A.,Purificato F.*	*Control & Automation (MED)*	*2013 21st Mediterranean Conference on Control & Automation (MED)*	*Conference Publication IEEE*	*Chania, Crete*	*June 2013*	*119 - 124*	*DOI: 10.1109/MED.2013.6608708 http://arxiv.org/ftp/arxiv/papers/1305/1305.1044.pdf*	YES

16	*"Regulation of Angular Speed and Reactive Power for a Wind Turbine Applying Robust Feedback Linearization and H∞ Control"*	*Di Giorgio A., Mercurio A., Liberati F.*	*Control & Automation (MED)*	*2013 21st Mediterranean Conference on Control & Automation (MED)*	*Conference Publication IEEE*	*Chania, Crete*	*June 2013*	*1316 - 1321*	*DOI: 10.1109/MED.2013.6608890*	NO
17	*"Distributed Control Approach for Community Energy Management Systems in presence of storage"*	*Mercurio A., Di Giorgio A., Quaresima A.*	*Control & Automation (MED)*	*2012 20th Mediterranean Conference on Control & Automation (MED)*	*Conference Publication IEEE*	*Barcelona*	*July 2012*	*1303 - 1308*	*DOI: 10.1109/MED.2012.6265819*	NO

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities	Main leader	Title	Date	Place	Type of audience	Size of audience	Countries addressed
1	*Article in the magazine DNEVNIK*	*Elektro Ljubljana*	*Article about e-mobility and MOBINCITY: "I use/drive electricity"*	*Expected for 08.2015*	*Ljubljana*	*Expert*		*Slovenia*
2	*The MOBINCITY Green Tour*	*EIHP*	*Promotion tour from Zagreb – Monte Carlo – Aix En Provece – Provence – Barcelona – Valencia and back to Zagreb*	*23.07.-27.07.2015*	*Zagreb – Valencia*	*General Public*	*200*	*International*
3	*Workshop: MOBINCITY Final Management Workshop Valencia*	*ITE and Technomar*	*A one day MOBINCITY workshop was held to discuss the final project results with experts from Renault, Nissan, STS Control and GH Everdrive etc.*	*25.07.2015*	*Valencia*	*Expert*	*50*	*International*

4	*Article in the magazine Elektro novice, št.3/2015*	*Elektro Ljubljana*	*"MOBINCITY"*	*06/07.2015*	*Ljubljana*	*Expert*		*Slovenia*
5	*Conference: 2015 IEEE Mediterranean Conference on Control and Automation (MED 2015)*	*Sapienza (Uni Roma)*	*Presentation of MOBINCITY togetherin two different lectures (see also scientific publications)*	*16.06 – 19.06.2015*	*Torremolins*	*Expert*	*1.000*	*International*
6	*Conference: CIRED 2015, 23rd International Conference and Exhibition on Electricity Distribution*	*ITE*	*Presentation of MOBINCITY in the lecture "Software for the Optimal Allocation of EV Chargers into the Power Distribution Grid" and as poster session*	*15.06. – 18.06.2015*	*Lyon*	*Expert*	*1.300*	*International*
7	*15 IEEE International Conference on Environment and Electrical Engineering 2015*	*Sapienza (Uni Roma)*	*Presentation of MOBINCITY in the lecture "Electric Energy Storage Systems integration in Distribution Grids"*	*10.06.- 13.06.2015*	*Rome*	*Expert*	*250*	*International*
8	*Radio Report*	*ITE*	*Entrevista. En RNE. Interview of Sixto Santonja Hernández on MOBINCITY in public Spanish radio*	*06.2015*	*Valencia*	*General Public*	*530.000*	*Spain*
9	*Press Release*	*ITE*	*„El ITE reunirá en Valencia expertos e investigadores europeos en movilidad eléctrica en el Final Management Workshop del proyecto MOBINCITY"*	*06.2015*	*Valencia*	*Expert audience*	*50.000*	*Spain*
10	*Press Release*	*Technomar*	*European E-Mobility project MOBINCITY presents its results to a broad audience in a Final Management Workshop in Valencia at June 25th 2015*	*05.2015*	*Valencia*	*Expert audience*	*250.000*	*International*

11	*Leaflet*	*Technomar*	*Inivitation flyer for the Final Management-Workshop "Mobincity - Smart Mobility in Smart City" June 25th 2015 Valencia*	*05.2015*	*Valencia*	*Expert audience*	*1.500*	*International*
12	*Conference: CIGRE & CIRED 2015* *Conference on electric power systems*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G and ICT4EVEUE, by Elektro Ljubljana*	*26.05.2015*	*Ljubljana, Slovenia*	*Expert audience*	*300*	*Slovenia*
13	*Ph.D. thesis in Systems Engineering*	*Sapienza (Uni Roma)*	*Liberati F., "Model Predictive Control-based Demand Side Management in Smart Grids", Advisor: Prof. Francesco Delli Priscoli, submitted, relevant to WP 3*	*2015*	*Rome*			*Italy*
14	*Ph.D. thesis in Systems Engineering*	*Sapienza (Uni Roma)*	*Zuccaro L., "Resource allocation algorithms in energy, IT and telecommunication networks", Advisor: Prof. Francesco Delli Priscoli, submitted, relevant to WP 3*	*2015*	*Rome*			*Italy*
15	*Article in the magazine Naš Stik, issue No.1*	*Elektro Ljubljana*	*SMARTV2G , ICT4EVEUE, MOBINCITY: "Uspeh evropskega projekta" (Success of the European projects")*	*2.2015*	*Ljubljana*	*Public*		*Slovenia*
16	*Conference: AABC Europe 2015* *Advanced Automotive & Stationary Battery Conference*	*Technomar*	*Presentation of MOBINCITY in the lecture "Operation Methods for Vehicle to Grid EU Projects SMARTV2G and MOBINCITY"*	*26.1. - 29.1.2015*	*Mainz (Germany)*	*Expert*	*450*	*International*

17	*Conference: IEEE International Electric Vehicle Conference 2014*	*ITE*	*Presentation of MOBINCITY in the lecture ""A Two-Step Process for Clustering Electric Vehicle Trajectories"*	*17.12 - 19.12 2014*	*Florence*	*Expert*	*1.500*	*International*
18								
19	*Conference Električna mobilnost*	*Elektro Ljubljana*	*Presentation of e-mobility projects SMARTV2G , ICT4EVEUE, MOBINCITY*	*15.10.2014*	*Ljubljana*	*Expert*		*Slovenia*
20	*Conference Inovacije v energetiki (Brdo pri Kranju)*	*Elektro Ljubljana*	*Presentation of e-mobility projects SMARTV2G , ICT4EVEUE, MOBINCITY*	*08.10.2014*	*Ljubljana*	*Expert*		*Slovenia*
21	*Workshop: MOBINCITY Management Workshop Munich*	*Technomar*	*A one day MOBINCITY workshop was held to discuss the project results with experts from Continental, Denso, Qualcomm and Daimler*	*17.06.2014*	*Munich*	*Expert*	*50*	*International*
23	*MOBINCITY Video*	*Technomar*	*Production of the video: "What do users expect from future mobility?" with interviews of young people from all around the world*	*06.2014*		*Experts and public*		*International*
24	*Fair: Hannover Messe 2014, Fair for Industrial Automation, Energy, Industrial Supply*	*Fraunhofer ESK*	*Presentation of MOBINCITY together with SMARTV2G project at Fraunhofer ESK booth at the Hannover Messe*	*07.04. - 11.04.2014*	*Hannover*	*Expert audience and public*	*225.000*	*International*
25	*Conference: SmartGreens 2014, 4th International Conference on Smart Cities and Green ICT Systems*	*Technomar*	*Lecture "SMARTV2G and MOBINCITY" in the session European Project Space, own booth in the exhibition area by Technomar and CIT Development*	*03.04. - 04.04.2014*	*Barcelona*	*Expert audience*	*500*	*International*

26	*Leaflet*	*Technomar*	*Inivitation flyer for the Management-Workshop "Mobincity -* *Smart Mobility in Smart City" June 17th 2014 Munich*	*03.2014*	*Munich*	*Expert audience*	*1.500*	*International*
27	*Brochure*	*Fraunhofer ESK*	*"Smart Charging Infrastructure for E-vehicles" as Supporting material for the Hannover Messe 2014 and for demonstrations and presentations of MOBINCITY together with SMARTV2G*	*03.2014*		*Expert audience and public*		*International*
28	*MOBINCITY Video*	*Zabala*	*Production of the video: "MOBINCITY Smart Mobility in Smart City" with an animation of the MOBINCITY system architecture*	*03.2014*		*Experts and public*		*International*
29	*YouTube channels*	*Technomar and Zabala*	*Setup of two MOBINCITY channels at YouTube in order to disseminate video content*	*03.2014*		*Experts and public*		*International*
30	*Conference: En.grids 014 Conference of the Technological Platform for Smart Grids*	*Elektro Ljubljana*	*Presentation of MOBINCITY and SMARTV2G by Elektro Ljubljana*	*04.02.2014*	*Ljubljana*	*Expert audience*	*200*	*Slovenia*
31	*Facebook site*	*Technomar*	*www.facebook.com/mobincity bringing public MOBINCITY contents like events and videos closer to a young target group*	*1.2014*		*Experts and public*		*International*
32	*Conference: SEIMED Infoday HORIZON2020 for the ICTsector*	*CIT*	*MOBINCITY presented as a successful ICT solution applied on smartcities and mobility by ITE*	*30.01.2014*	*Valencia*	*Expert audience*	*300*	*Spanish*

33	*Conference: The 52nd IEEE Conference on Decision and Control*	*Sapienza (Uni Roma)*	*Presentation of MOBINCITY project within a 15 minute lecture*	*10.12. - 13.12.2013*	*Florence*	*Expert audience*	*1.400*	*International*
34	*Advertisement in Magazine "Automotive Industries"*	*Technomar*	*Smart Mobility in Smart City*	*12.2013*		*Experts*	*18.000*	*International*
35	*Article in Magazine "Be ENERGY"*	*ITE*	*Proyecto Mobincity, la major ruta de transporte sostenible en entornos urbanos* *(MOBINCITY, the major path of sustainable transport in urban environments)*	*12.2013*		*Experts*	*20.000*	*Spain*
36	*Conference: EVS27 - Electric Vehicle Symposium and Exhibition*	*Technomar*	*Common booth of MOBINCITY together with SMARTV2G at the Exhibition at the sector „Energy and Infrastructure – Smart grid, V2G", and oral lecture at Session Project dissemination by Sixto Santonja, ITE*	*17.11. - 20.11.2013*	*Barcelona*	*Expert audience*	*4.000*	*International*
37	*Fair: Egética-Expoenergética 2013, event specialized in the energy sector*	*ITE*	*Presentation of MOBINCITY together with SMARTV2G by ITE*	*13.11. - 15.11.2013*	*Valencia*	*Expert audience*	*1.000*	*Spanish*
38	*Conference: Energija 2013, 9th international Conference on T&D and electricity marke*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*20.11. - 21.11.2013*	*Portoroz, Slovenia*	*Expert audience*		*Slovenia*
39	*Conference: PIES 2013, 6th Consultation on IT in the energy industry*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*07.11.2013*	*Portoroz, Slovenia*	*Expert audience*		*Slovenia*

40	*Fair: eCarTec 2013, International Fair for Electro Mobility*	*Technomar*	*Presentation of MOBINCITY together with SMARTV2G by Technomar*	*15.10. - 17.10.2013*	*Munich*	*Expert audience and public*	*12.000*	*International*
41	*Conference: Inovacije v energetiki, 5th meeting of the Strategic Energy Business Innovation '13*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*09.10.2013*	*Brdo, Slovenia*	*Expert audience*		*Slovenia*
42	*Vehicle advertisement*	*Technomar*	*Branding of Technomar Van with MOBINCITY logo*	*09.2013*		*Public*		*Germany*
43	*Conference: MED13, 21st Mediterranean Conference on Control and Automation*	*Sapienza*	*Presentation of MOBINCITY together with SMARTV2G in two different lectures (see also scientific publications)*	*26.06-28.06.2013*	*Chania, Crete*	*Expert audience*	*1.000*	*International*
44	*Web statistics tool Dinastats*	*CIT*	*The reporting tool Dinastats has been introduced for web statistics*	*07.2013*				
45	*Article in Journal "The Parliament", issue 372*	*Croatian Telecom*	*"Hrvatski Telecom presents ICT solution for electric vehicles – MOBINCITY"*	*6.2013*		*Public press*	*50.000*	*International*
46	*Master degree in Systems Engineering*	*Sapienza (Uni Roma)*	*Fabio Purificato, "Metodologie di bilanciamento per la ricarica dei veicoli elettrici in ambito Smartgrids",* *Advisor: Prof. Francesco Delli Priscoli,* *co-advisor: Dr. Andrea Mercurio and Dr. Alessandro Di Giorgio.*	*2013*	*Rome*			*Italy*

47	*Master degree in Systems Engineering*	*Sapienza (Uni Roma)*	*Deola D., "Progetto e simulazione di un sistema di controllo per la ricarica dei veicoli eletrici nelle reti di distribuzione", Advisor: Prof. Francesco Delli Priscoli* *co-advisor: Dr. Alessandro Di Giorgio. Relevant to WP 3.*	*2013*	*Rome*			*Italy*
48	*Master Degree in Systems Engineering*	*Sapienza (Uni Roma)*	*Marinelli D., "Progettazione e sviluppo di un sistema di trip planning e routing per la gestione ottima dei veicoli elettrici", Advisor: Prof. Francesco Delli Priscoli, co-advisor: Dr. Silvia Canale. Relevant to WP 5.*	*2013*	*Rome*			*Italy*
49	*Bachelor degree in Engineering in* *Computer Science and Control Engineering*	*Sapienza (Uni Roma)*	*Tortorelli A., "Demand Side Management nell'ambito dell'ambito dell'elettromobilità: algoritmi di gestione dell'active demand", Advisor: Prof. Francesco Delli Priscoli, co-advisor: Dr. Andrea Mercurio. Relevant to WP 3.*	*2013*	*Rome*			*Italy*
50	*Article in Magazine: Elektro novice, No 3*	*Elektro Ljubljana*	*Projekti za energetsko učinkovitost* *(Projects for Energy Efficiency)*	*2013*		*Experts*		*Slovenia*
51	*Article in Magazine: Elektro novice, No 1*	*Elektro Ljubljana*	*Elektro Ljubljana še naprej tvorno sodeluje v projektih električne mobilnosti* *(Elektro Ljubljana still is actively participating in projects of electric mobility)*	*2013*		*Experts*		*Slovenia*

52	*Conference: CIGRE & CIRED 2013* *Conference on electric power systems*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*27.5. – 29.5.2013*	*Ljubljana, Slovenia*	*Expert audience*	*300*	*Slovenia*
53	*36th International Convention on Information and Communication Technology, Electronics and Mi-croelectronics MIPRO*	*Croatian Telecom*	*Presentation of MOBINCITY by Croatian Telecom HT*	*20.5. – 24.5.2013*	*Opatija, Croatia*	*Expert audience*	*1000*	*International*
54	*Fair: Sejem Dom - Home Fair 2013*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G at the booth of Elektro Ljubljana*	*12.3. – 17.3.2013*	*Ljubljana, Slovenia*	*Public*	*55.000*	*Slovenia*
55	*Conference: En.Odmev 13* *Conference on conventional energy*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*05.03.2013*	*Ljubljana, Slovenia*	*Expert audience*		*Slovenia*
56	*Conference: Forum Innovation III, Technology Screening, Future Scenarios, Best Practices*	*Technomar*	*Presentation of MOBINCITY together with SMARTV2G within a poster session by Technomar*	*26.02.2013*	*Nördlingen, Germany*	*Expert audience*	*150*	*German*
57	*Conference: En.grids 013* *Seminar on development of smart grids En.Grids 013*	*Elektro Ljubljana*	*Presentation of MOBINCITY together with SMARTV2G by Elektro Ljubljana*	*30.01.2013*	*Ljubljana, Slovenia*	*Expert audience*	*100*	*Slovenia*
58	*Leaflet*	*Technomar*	*"MOBINCITY – Smart Mobility in Smart City"*	*12.2012*		*Expert audience and public*		*International*

59	*Project web site*	*CIT*	*www.mobincity.eu* *publishing project overview, deliverables, summaries, technical documents, papers, news and events, videos and partners' profile*	*12.2012*		*Experts and public*		*International*
60	*Fair: eCarTec 2012, International Fair for Electro Mobility*	*Technomar*	*Presentation of MOBINCITY together with SMARTV2G at a common booth by Technomar and ETREL*	*23.10. – 25.10.2012*	*Munich*	*Expert audience and public*	*12.600*	*International*
61	*Project Logo*	*ITE*	*The MOBINCITY logo was designed at the begin of the project*	*10.2012*		*Experts and public*		*International*

1.2.2 SECTION B (CONFIDENTIAL[1] OR PUBLIC: CONFIDENTIAL INFORMATION TO BE MARKED CLEARLY)

Part B1

Template B1: List of applications for patents, trademarks, registered designs, etc.					
Type of IP Rights[2]:	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant (s) (as on the application)

[1] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

[2] A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

Part B2

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
Commercial exploitation of R&D results	Algorithm for FEV charging load scheduling	YES		EVSE Operator Control Centres, Smart grid applications	D35.1.3 - Distribution of electricity D35.1.4 - Trade of electricity H52.2.1 - Service activities incidental to land transportation	2015-2020	/	ETREL
Commercial exploitation of R&D results	New demand side management services based on PEV smart charging	No	-	The Smart Grid System	D35.1 - Electric power generation, transmission and distribution	From 2015 onward	Evaluating patents for 2016	CRAT (owner) Enel
Commercial exploitation of R&D results	New electric vehicles' trip planning and navigation system integrated with smart charging	No	-	Trip planner	Car Navigation	From 2015 onward	Evaluating patents for 2016	CRAT
General advancement of knowledge	New algorithms for smart charging and active demand services composition	No	-	The LAC and MLAA modules developed in Mobincity	D35.1 - Electric power generation, transmission and distribution	From 2015 onward	-	CRAT
General advancement of knowledge	New algorithms for PEVs navigation, including stops at charging stations	No	-	Smart navigation algorithm	Car Navigation	From 2015 onward	-	CRAT

ADDITIONAL TEMPLATE B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND

Description of Exploitable Foreground	Explain of the Exploitable Foreground
New demand side management services based on PEV smart charging	The Smart Grid System is an ICT module developed by CRAT in Mobincity in cooperation with Enel. The module is able to provide e-mobility and, more generally, active demand services to DSOs, EVSE Operators and other grid players, by adopting a flexible and highly interoperable REST-services approach. The exploitation of the product has already started during the time scope of Mobincity, aiming at its full future commercial development. As a matter of fact, CRAT personnel has been awarded (through the startup "ares2t" involving CRAT personnel) with a six-month grant (project "Charge Advisor", june-november 2015) by the cleantech acceleration programme INCENSE (http://www.incense-accelerator.com/), finalized to the acceleration of the product towards the market. Furthermore, contacts are already ongoing with Enel and other business partners, finalized to the establishment of future research and commercial ventures.
New electric vehicles' trip planning and navigation system integrated with smart charging	Contacts are ongoing (especially through the acceleration program "Charge Advisor" mentioned above) with European business partners to commercially exploit the trip planning module developed by CRAT in Mobincity. The navigation system has the distinctive feature of integrating the trip planning/navigation process with the smart charging one, thus presenting the user with a complete e-mobility solution.
New algorithms for smart charging and active demand services composition	CRAT has developed model predictive control algorithms for providing active demand services focused on e-mobility. In particular, the algorithms regard the smart scheduling of the recharging sessions (in compliance with drivers and DSO constraints and in respect to all the relevant technical constraints arising from the grid, the EV, etc.), and the composition of active demand products to be traded to solve possible grid unbalance occurrences, mismatch in power generation forecasting, etc. CRAT is currently employing the knowledge gained in the development of such algorithms for the establishment of research and commercial links with universities, research centres and companies, and for the participation in project proposals, especially in the H2020 framework.
New algorithms for PEVs navigation, including stops at charging stations	CRAT has developed a trip planning algorithm for PEVs, with the distinctive feature of enabling multimodality combined with the automatic planning of recharging stops at charging stations (in case they are needed to reach the destination). As for the knowledge gained in the design of algorithms for active demand services composition, the new knowledge in EV trip planning is facilitating the access in new project proposals opportunities.

PROJECT FINAL REPORT

Grant Agreement number: 314328

Project acronym: MOBINCITY

Project title: SMART MOBILITY IN SMART CITY

Funding Scheme: FP7-2012-ICT-GC

Period covered: **from** 01/07/2012 **to** 30/06/2015

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PROJECT FINAL REPORT

[3] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.