eCHARGE 4DRIVERS

Deliverable 6.1

eCharge4Drivers Impact Assessment Methodology

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List of abbreviations and acronyms

Abbreviation	Meaning
AC	Alternating current
BSS	Battery Swapping Station
CPO	Charging provider operator
DC	Direct current
eMSP	Electric mobility service provider
EV	Electric vehicle
ISO	International Organization for Standardization
KPI	Key Performance Indicator
L(EV)	Light electric vehicle
L1e	Light two wheels powered motorcycle
L3e	Two-wheels motorcycle
PnC	Plug and charge
PV	Photovoltaic
QoE	Quality of Experience
SoC	State of charge

EXECUTIVE SUMMARY

This document aims to define the eCharge4Drivers methodology for assessing the impact of the different technologies and services demonstrated within the eCharge4Drivers project. It is also fundamental to specify the expected positive outcome for each use case that will be demonstrated for each impact area. To evaluate the outcome of each use case two sets of KPIs have been identified. The first set of KPIs, here called quantitative, will be measured using field data collected by CPOs' and eMSPs' systems. The second set of KPIs named qualitative will be calculated using information collected through surveys and interviews catered to EV users, stakeholder, and policy makers.

Chapter 1 briefly introduces the objectives and the structure of this document.

Chapter 2 presents the plan of activities that led to the definition of the methodology that will be used to evaluate the impact of the demonstrations. It expands on the lessons learnt from other activities in the project and identify the necessary information as well as methodological steps to quantify the impact of each use case.

Chapter 3 outlines the use cases highlighting the objectives and providing the ground for the evaluation. The extensive list of use cases is broken down in 3 families in relation to different typologies of business use cases.

In Chapter 4 the impact areas and related study questions are introduced along with the KPIs identified at the project level. The section dedicated to the KPIs is divided in quantitative and qualitative. The former are measured using data collected from charging points, and back-end systems operated by CPOs and eMSPs, while the latter are measured with data collected through survey and interview forms. While quantitative KPIs will mainly be used to assess the Usage and Technical Performance impact areas, the qualitative KPIs will be used for assessing the impact areas related to the Quality of Experience and Acceptance of the demonstrations. Qualitative KPIs will be used to assess more in general the users' experience of the technologies and services implemented within the eCharge4Drivers context.

Chapter 5 contains the entire framework for evaluating the technical performance of the use case. It is broken down in 2 sections. The former presenting for each use case the complete list of study questions and KPIs that will be used in the selected pilot sites, while the latter presenting the specific set of study questions, successful outcome and selected KPIs for each use case at each pilot site. When needed, specific study questions and KPIs have been identified and reported for each use case.

The annexes of this document detail the complete definition of the KPIs at project level as well as the use-case specific KPIs.

This deliverable provides important information for the next activities related to the evaluation of the impact of the solutions implemented in the eCharge4Drivers project. Indeed, this deliverable includes the presentation of the existing relations between each study question and measurable outcomes that will be quantified using the KPIs described in detail. Moreover, the deliverable introduces the methodology for impact assessment of the 3 different clusters of use cases as well as the survey and interview forms that will be used to collect qualitative information so that the necessary steps that need to be undertaken are clear.

INTRODUCTION

1.1 Project introduction

eCharge4Drivers is an H2020 project running from June 2020 to May 2024 and deployed by a consortium of 32 partners. Charging an electric vehicle (EV) is still not as convenient as refuelling a conventional vehicle, potentially posing a barrier to increase the market uptake of EVs. eCharge4Drivers works to substantially improve the EV charging experience within cities and for long trips. The project will develop and demonstrate user-friendly charging stations and innovative charging solutions as well as smart charging services for the users. By capturing users' perceptions and expectations on the various charging options and their mobility and parking habits, eCharge4Drivers will organise demonstrations in 10 areas across Europe, including metropolitan areas and Trans-European Transport Network (TEN-T) corridors. Charging stations in these areas will offer user-friendly and convenient functionalities for EV drivers of passenger and light vehicles and motorcycles, such as direct payment methods and bigger, user-friendly displays. Using the knowledge generated, the project will also propose an EV Charging Location Planning Tool, fostering the broad implementation of charging infrastructure in Europe.

1.2 Purpose of the deliverable

The main objective of this task is to develop the framework for the evaluation of the demonstrated charging systems, solutions and services and the assessment of their impact on user experience and acceptance of EV charging technologies and electromobility in general.

The KPIs selected in D1.1 are complemented with additional KPIs that are relevant to assessing the technical performance of the demonstrated systems and solutions as well as their operational and economic functions. Another objective is the definition of the data to be recorded to calculate each KPI as well as the formula to compute them. Furthermore, it defines the data format and the necessary sample sizes to get significant results as well as the level of aggregation of the data (e.g. charging site, the duration, etc.) that will be collected via the back-ends of the CPOs and eMSPs in the consortium. Questionnaires and interview forms are developed to collect qualitative data via surveys and interviews.

The objectives related to this deliverable have been achieved in full and as scheduled.

1.3 Intended audience

Deliverable D6.1 is a public document aiming to provide to e-mobility related stakeholders (CPOs, eMSPs, Pilot Sites, and to a broader extent to researchers) a methodology to evaluate the overall performance of the eCharge4Drivers project as well as each use case that will be demonstrated. It will evaluate technical performance of the technology applied in each use case as well as it will consider users' perspective and concerns towards developing user-centric charging technologies and services. The application of six different impact areas and corresponding KPIs presented in this deliverable will ensure that diverse aspects are considered for the evaluation of the eCharge4Drivers solutions towards improving both technical performance and charging experience.

1.4 Structure of the deliverable and its relationship with other work packages and deliverables

The task activities leading to deliverable D6.1 require the coordination across many other tasks. Thus, T6.1 activities are central for the entire project, and they receive inputs from several completed tasks. Table 1 summarises the key dependencies of this task with the other project tasks.

Inputs from:	• **WP1**
	  • **Task 1.1**: The lists of study questions and KPIs defined in this task will be exploited and extended for defining the questionnaire for evaluation purposes.
	  • **Task 1.2**: The list of questionnaires defined in this task for capturing the user charging expectations will be exploited and extended for assessing user experience on the project developments.

Outputs to:	• **WP4**
	  • The types of aggregate objective data (like charging location, duration, etc.) to be collected via the back-ends of the CPOs and eMSPs in the consortium sites will be defined in T6.1.
	• **WP5**
	  • **Task 5.3:** The questionnaire and interview forms to be used within the framework of T5.3 will be defined in T6.1.
	• **WP6**
	  • **Task 6.3**: The evaluation criteria defined in task 6.1 will be exploited in task 6.3 for assessing the performance of the project developments and to evaluate their impact on user experience, acceptable etc.

Table 1: Dependencies with other WPs and tasks

METHODOLOGY

This chapter defines the methodology that will be used to evaluate the impact of the eCharge4Drivers solutions which will be demonstrated in the project pilot sites. It elaborates on the lessons learnt from previous tasks and defines the methodological steps to be undertaken and the necessary information to quantify the impact of each use case.

2.1 Plan of action

To refine the eCharge4Drivers methodology for impact assessment, four main steps have been established and they are explained in detail in the next sections. The image below presents the relation between the work step and the chapters of this deliverable.

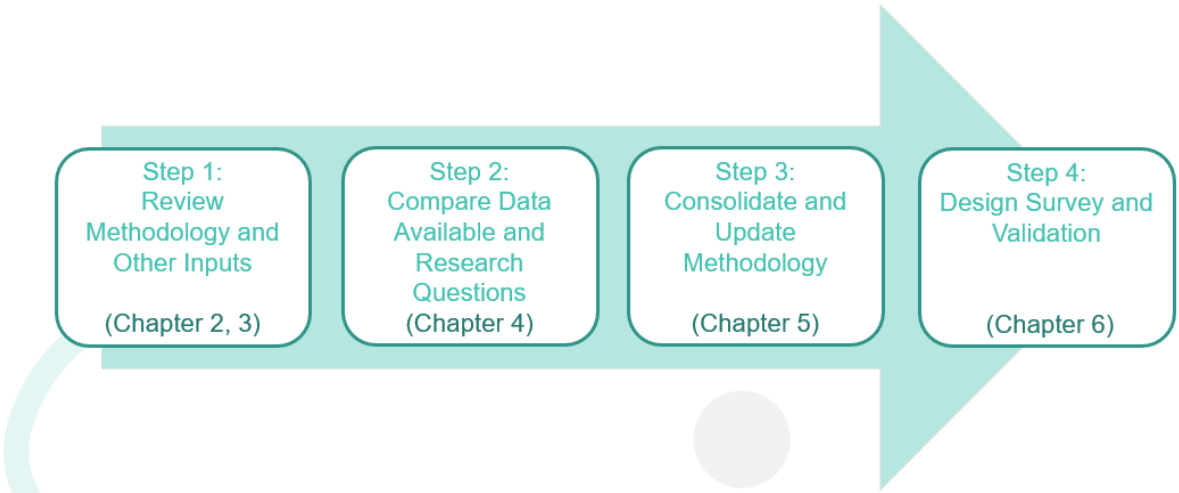

Figure 1: Plan of action

2.1.1 Methodology review and inputs from other tasks

The first activity is to carefully review the identified impact areas, research questions and KPIs in WP1 (D1.1). This review process comprises the analysis of the use cases' descriptions and scopes contained in D1.3 as well as of the impact KPIs defined in the Grant Agreement for the entire project. Furthermore, the scope of this task requires the review and expansion of the KPIs collected through the survey and the analysis of the results contained in D1.2 with a particular focus on KPIs for assessing the technical performance of the demonstrations.

The main outputs of this activity are i) preliminary list of KPIs available at each pilot site, ii) a preliminary list of study questions to be used to evaluate the use cases, and iii) a list of the descriptions and scopes of the eC4D use cases to be evaluated along with the goals to be achieved at project level. For the detailed definition of the KPIs, the template presented in Table 2 was created and distributed among project partners. The updated definition of the KPIs contains specific information on data needed to compute KPIs, procedure to compute the KPI, and other KPI's specific information such as data type, data source, time of the measurement, and granularity.

KPIs TEMPLATE	
KPI ID:	Unique identifier. It contains alphanumeric values. The letters identify the impact areas while the number represent a sequential value assigned starting from 1.
KPI name:	The name of the KPI.
Description:	Short description of the purpose of the KPI (e.g. the count of user per charging option per day).
How to measure the KPI:	Procedure and calculation to be performed to compute the KPI.
Unit metric:	The unit metric in which the KPI will be expressed (e.g. number of users).
Data type:	Describe the data type of the KPI (e.g. integer, float, categorical-ordinal).
Data needed to calculate KPI:	Provide a list of data needed to compute the KPI (e.g. charging session unique identifier, starting time of the charging session, etc.).
Data source:	Identify the source of the data needed. It could be the charging station, an application back end or any other device\sensor.
Data provider:	Identify the role of the partner responsible for data collection at the source and data transfer (e.g. CPO\eMSP).
Pilot sites:	The list of pilot sites that will provide the KPI.

Table 2: Template for KPIs' definition and validation

2.1.2 Select study questions based on use case and area of impact

The second step entails the comparison of the data collected from pilot sites and the study questions that will be used to evaluate each demonstration. The study questions are divided in 6 impact areas (i.e. Usage, Quality of Experience, Acceptance, Economy and Market, Environment and Society, and Technical) as defined in D1.1 and they have been further detailed by the partners to reflect the needs of the evaluation based on the specificity of each solution developed in the eC4D project. **The output of this second activity is the updated list of study questions that will be used to assess the use cases at each pilot site.**

2.1.3 Define evaluation forms to assess technical performance for each use case

The third step encompasses a set of activities aimed at identifying clear instructions to assess each use case. To do so, the expected successful outcome for each previously selected study question has been identified by the partners involved in the use case demonstrations. The successful outcome has been chosen based on the causal impact of the use cases that will be implemented in consideration of the scope defined in D1.3. **The output of this activity is a complete set of successful outcomes and KPIs used to assess the impact of each use case for each pilot site.** Below is a template used to collect the inputs from the partners from each pilot site.

TEMPLATE TO EVALUATE USE CASE	
Description\Scope:	Main purpose of the evaluation. Include project level KPI
Area of Impact:	The impact area under which the use case will be evaluated
Study Questions:	Short description of the purpose of the KPI (e.g. the count of user per charging option per day)
Successful Outcome:	The expected positive outcome caused by the eC4D solutions being evaluated
Selected KPIs:	The Key Performance Indicator used to monitor the degree to which the use case achieves the expected outcome
Pilot sites:	The list of pilot sites that will test the same use case

Table 3: Template to evaluate use case

2.1.4 Define forms to assess user experience by use case typology

The fourth step focuses on collecting the information needed to evaluate the use case and that cannot be measured through data collected from sensors or other systems. For this purpose, survey and interviews forms have been designed and they will be used to collect information from EV\LEV users as well as from other stakeholders interested in the eC4D's solutions. Given the diversity of solutions to be demonstrated, they have been grouped by product type (i.e. technology, services, or tool for policy making). Each use case in the project will relate to only one product type and form type. Each form contains a set of questions to collect qualitative information to be used to compute qualitative KPIs. The output of this activity is a complete set of question for 2 survey forms that will be used to assess the impact on user experience of technology and services, respectively, and an interview form for the impact of tools for policy making.

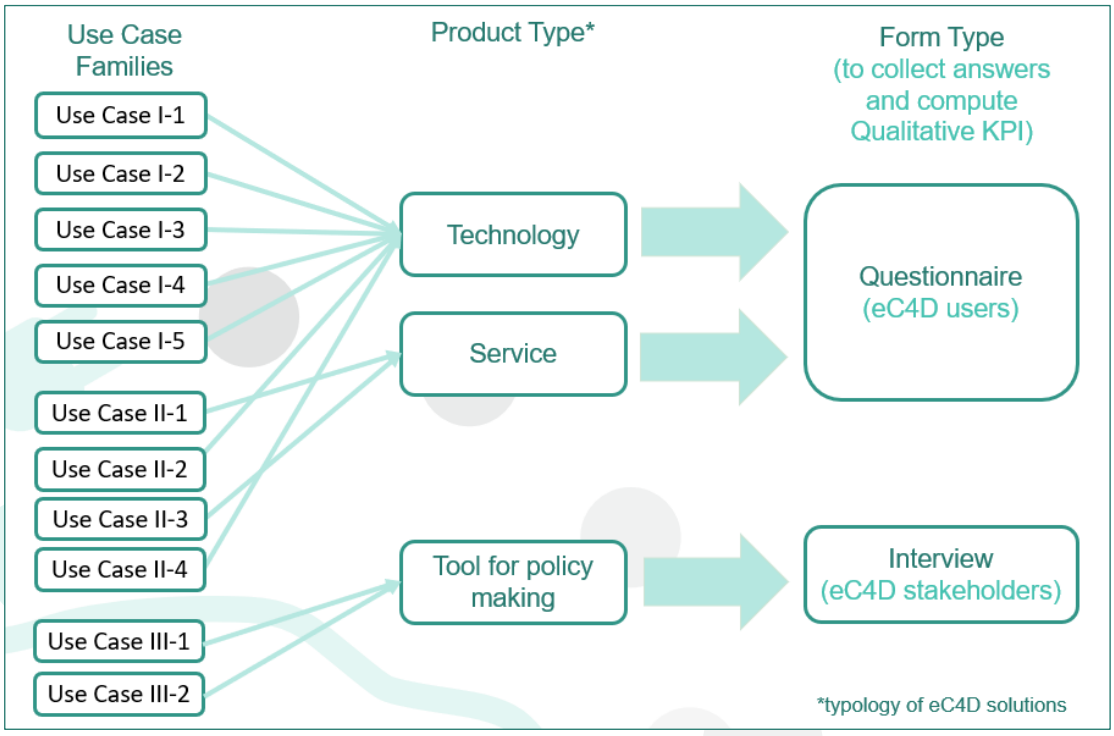

Figure 2: Form typology to collect answers per use case

2.2 Methodology

The updated methodology for impact assessment of the eCharge4Drivers project and use cases follows 2 main logical steps. Each step is broken down in different phases. The first step defines the impact areas and evaluation methods, while the second one identifies the study questions, successful outcomes of the evaluation and KPIs used to assess the outcome. A description of each phase is provided below, and Figure 4 shows the connections between each step and phase of the methodology for the evaluation.

1. **From Use Case Objectives and Goals to Impact Areas:** The first step entails the identification of the objective of each use case and corresponding impact areas (goals of the evaluation and impact areas sections in the figure 4). This step is completed by mapping the objectives of each use case with a set of expected impact areas. Depending on the selected impact areas different data collection methods should be considered (i.e. from sensors\device\back-end or survey\interview form).

2. **From Impact Areas to Study Questions, Successful Outcomes and KPIs:** The second step is divided in 3 phases. Depending on the selected impact areas and use cases' objectives, a set of relevant study questions will be selected by each partner involved in the demonstrations. For each study question, partners defined a measurable outcome in accordance with the scope of the use case and a set of KPIs that will be used to monitor and assess the outcome. Depending on the impact areas to be assessed as well as the availability of the data from sensors\device\back-end, the selected KPIs will be quantitative or quantitative.

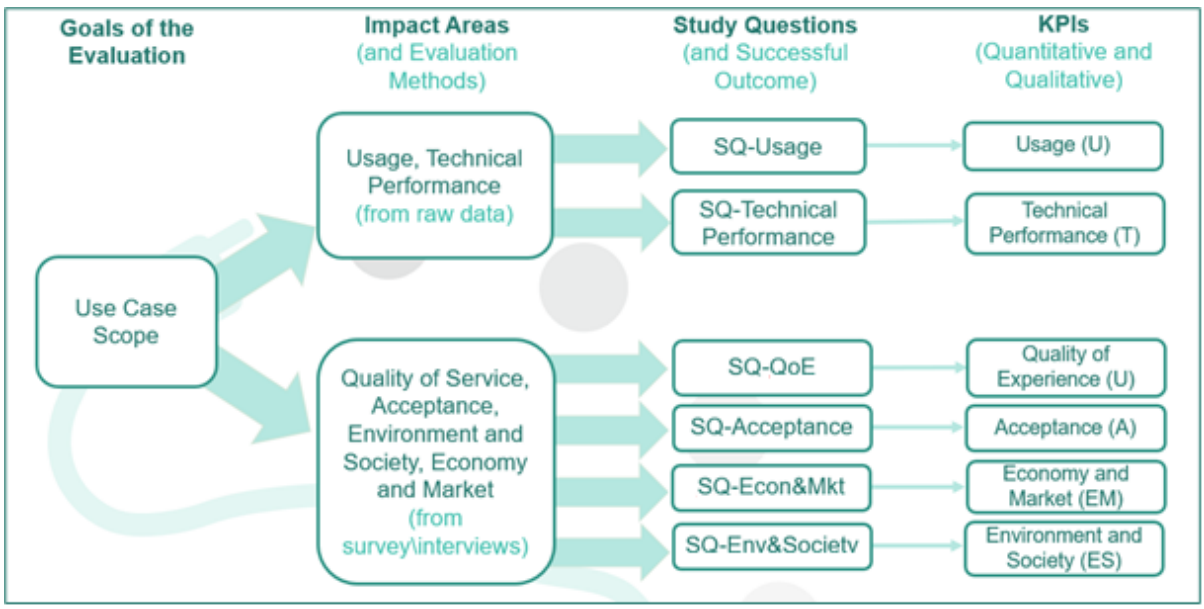

Figure 3: Methodology

USE CASES

The vision of eCharge4Drivers is to focus on the users and substantially improve the EV charging experience, within cities and on long trips, making it at least as convenient as refuelling an ICE vehicle, and to support investors and authorities to deploy new charging infrastructure and services in a user-centric and sustainable way.

This chapter provides an overview of the use cases that will be demonstrated in eCharge4Drivers and introduces the general features of the sites in which the demonstrations will occur.

3.1 Business use cases

This section aims to provide the eCharge4Drivers business use cases as these were identified from the completed use case description template for the demonstration sites. The domains to focus on, identified in respect to the project's scope as it is illustrated in Figure *4*, are:

- the **infrastructure domain** offering diverse charging technologies to serve mobility energy needs of passenger and light EVs,
- the **e-mobility service domain** offering user-centric emobility charging services facilitating user's accessibility to and exploitability of the charging network as well as improving user's charging experience,
- the **planning domain** offering tools for planning the charging network in an efficient and sustainable way as well as define tariff and incentive policies towards promoting e-mobility concept.

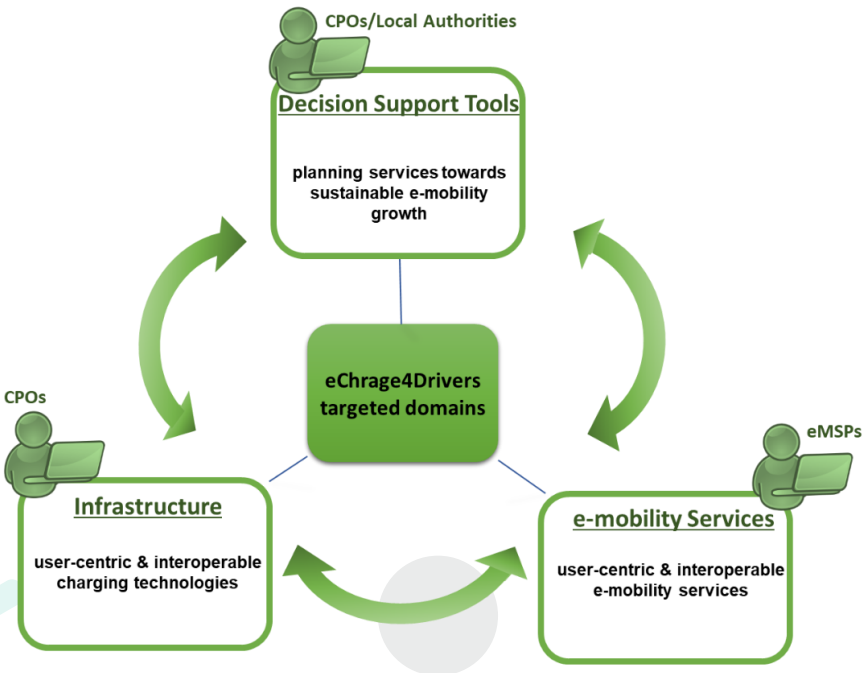

Figure 4: eCharge4Drivers targeted business domains

3.1.1 Business use case - Infrastructure

The scope of this business use case is to design and develop user-centric and interoperable charging solutions for passenger and light EVs.

The proposed charging solutions are designed in respect to the users' charging needs and concerns as well as the charging expectations of non-EV users as regards their driving range anxiety. Such charging technologies should serve user's charging needs for their mobility by offering a variety of charging levels and plug types. Moreover, the charging solutions should offer a wide range of charging options (i.e. medium to slow charging) considering the targeted trip range (inner-city or inter-city mobility) as well as the availability of installation space.

Furthermore, towards improving user's charging experience, a more user-friendly interaction between the charging infrastructure and the EV users is needed. This can be realised via large screen integrated on the front side of the charging infrastructure providing to EV users useful information prior, during and after the charging process.

The proposed charging infrastructure should be interoperable interfacing with technologically diverse EVs and CPO backends. This can be ensured by the implementation of the e-mobility international standards and open communication protocols widely adopted by the emobility industry.

In this respect, several HLUCs have been identified in order to serve the aforementioned objectives:

- **Use Case I-1:** User-friendly, low and high-power charging stations for passenger & L3e vehicles with enhanced user interfaces
- **Use Case I-2:** Multi-user master station with multiple DC power charging points for passenger and L1e EVs
- **Use Case I-3**: Battery sharing concept for L1e vehicles
- **Use Case I-4:** Charging points on lamp posts

3.1.2 Business use case – e-mobility Services

The scope of this use case is to design and develop user-centric and interoperable e-mobility services which will facilitate users' accessibility to and exploitation of the charging infrastructures.

The authorisation process of the user for pugging the EV to the charging station is an important factor directly affecting the user's charging experience. The scope of this project is to offer the same quality of services to the user wherever he is connected either by authorising user via an RFID card or by authorising the vehicle itself (ISO15118 PnC).

The proposed suite of e-mobility services aims to improve users charging experience and facilitate the smooth transition from the old habits of refuelling a conventional vehicle within a few minutes to the upcoming reality of charging the EV battery within few minutes up to a few hours. To facilitate this transition, the e-mobility services should allow users to identify the most convenient technology and location from charging his/her EV in order to continue the trip or combine charging with other activities (ex. shopping, leisure activities etc.).

Reserving the charging option of your preference is important in order to minimise the waiting time for charging in occupied charging station and facilitate a better exploitation of the most popular charging locations.

There are a lot of surveys indicating that the non-commuting period of the EV covers more than 90% of the day. This means that EVS remain parked for longer time periods compared to the one requested for being fully charged. Thus, the idle battery of EVs can be utilised from providing flexibility services to the different stakeholders. Such services aim to shift the charging demand in different time periods towards serving different business objectives, ex. shaving the peak of charging demand, minimise charging cost, charging with green energy, etc.

In this respect, a number of HLUCs have been identified in order to serve the aforementioned objectives:

- **Use Case II-1:** Advanced charging authentication - ISO15118PnC
- **Use Case II-2:** Enhanced booking service enabling better exploitation of the public charging network
- **Use Case II-3:** Advanced routing service facilitating EV user's accessibility to the public charging network
- **Use Case II-4:** Smart charging suite unlocking new business opportunities

3.1.3 Business use case – Decision Support Tools

The planning of the public charging network is crucial to complement the home charging. The distribution of the charging infrastructure within a specific area is a multi-parametric problem which requires good understanding of the local specificities and estimation of the charging needs of the local community as well as the commuters. Moreover, the tariff schemes and incentives to be adopted at local or regional level are important, on one hand, to promote e-mobility concept and, on the other hand, to ensure the proper exploitation of the charging network by imposing penalties or time-based tariffs.

In this respect, two HLUCs have been identified in order to serve the aforementioned objectives:

- **Use Case III-1**: EV Charging location planning tool
- **Use Case III-2**: Incentives schemes and tariff structures towards emobility sustainability

3.2 Use case overview

3.2.1 Use case Family 1: User-centric and interoperable charging technologies

3.2.1.1 Use Case I-1: User-friendly, low and high-power charging stations for passenger & L3e vehicles with enhanced user interfaces (ABB)

Scope

This use case aims to design and develop attractive, user-friendly, modular, and scalable charging stations for passenger cars and motorcycles (L3e category with IEC 62196 connector). Enhanced user interfaces will be integrated on the charging stations enabling EV drivers to charge their vehicles in a quite easy, intuitive way, with clear information about the charging before, during and after the charging session. Transferability and deployment of the proposed charging solutions will be facilitated by developing a special container comprising diverse charging technologies and outlets.

Objectives

The objective of this use case is to offer integrated and flexible charging solution by providing user-friendly and modular charging stations supporting different charging rates for passenger and L3e vehicles within a container. More specifically, the proposed charging solutions offer:

- Multiple charging technologies, in terms of power rates and outlets, for passenger and L3e vehicles
- Enhanced user interfaces for clear information about the charging before, during and after the charging session
- Standardized interfaces with passenger EVs (ISO 15118) and CPO backend-systems (OCPP)
- Improved transferability and deployment via integrated charging containers combining charging technologies in respect to demo area needs.
- Site power management system for optimising the power distribution over multiple charging outlets.

Stakeholders

- **EV user**: improving charging experience by offering enhanced charging information and guidance before, during and after the charging session as well as a variety of charging rates serving different mobility needs
- **EVSE manufacturer**: new design of the future generation of user-friendly charging stations offering multiple charging rates for passenger and L3e vehicles being equipped with advanced user interfaces and interactive screens and implementing the latest emobility standards (ISO 15118, OCPP 1.6 or later).
- **CPO/eMSP**: increase their competitiveness by offering advanced user-friendly charging solutions (AC and DC mode) with fully customisable user interfaces (look & feel and content), providing enhanced charging information based on the ISO 15118 interface between EV and EVSE.

Short narrative

This use case offers user-friendly, modular and scalable charging solutions which can be packed in a special container facilitating the transferability and deployment of a mixture of charging technologies offering multiple charging powers and outlets for passenger and L3e EVs. A site power management module monitors and controls the charging power flows among the diverse charging outlies to avoid overloading events. The charging stations are equipped with ergonomically sized touch displays and sophisticated graphical user interfaces design on touch-display, customisable by CPOs and eMSPs for offering information and guidance to EV users prior, during and after the charging session. All the charging stations implement standardised interfacing for communicating with the EV (ISO 15118) and the CPO platform (OCPP).

3.2.1.2 Use Case I-2: Multi-user master station with multiple DC power charging points for passenger and L1e EVs (PWD)

Scope

The scope of this use case is the design and development of a user-friendly master station serving multiple output charging points for passenger and light EVs. The master station will offer different payments means, a user-friendly human machine interface (HMI) with touch buttons and status LED indicators for each charging point.

To facilitate the bidirectional energy exchange between an electric vehicle (EV) and a V2G charger, RB will provide EVs (prototype), supporting bidirectional feature, to be used for testing the V2G charging points that will be developed by PWD.

In addition, the connection between the charging station and the light EV will be realised via a DC plug BUS interface (new for eC4D Project).

Users will be able to request access via a physical card or via a smartphone application and to remotely monitor and control the charging process. Interfaces supporting standard communication will be developed, including interfaces to the EV according to ISO 15118 and interface to the CPO and eMSPs back-ends according to OCPP protocol.

Objectives

The objective of this use case is to design and develop a modular and integrated multi-output charging points to minimize the overall infrastructure, including master station and multi-output charging points. A multi-output master station will be designed to serve multiple types of low power DC charging points for different vehicle technologies (passenger and L1e vehicles). The developed stations will provide the technologies enabling the bidirectional power flow between EVs and the electricity grid for passenger cars. This solution will provide:

- A user-friendly master station connected 8 charging points. (2 unidirectional 45 kW charging points, 2 bidirectional 20 kW charging points and 4 unidirectional 1.5 kW charging points for LEVs)

- The master station offers different payments means, a user-friendly HMI with touch buttons and status LED indicators for each charging station.
- Users can request access via a physical card or via a smartphone application and to remotely monitor and control the charging process.
- Interfaces supporting standard communication will be developed, including interfaces to the EV according to ISO 15118 and interfaces to the CPO and eMSPs back-ends.

Stakeholders

- EVSE manufacturer: new design of user-friendly modular and interoperable charging stations offering multiple charging technologies and plugs via a central multi-output charging points towards minimising the infrastructure cost.
- EV user: improving charging experience by offering different plug options, lowering charging costs related to CAPEX, offering diverse payment options and attractive HMIs.
- EV manufacturers*:* design and development of bidirectional feature via Combo CCS connector to allow the battery on-board to inject the power to the grid.
- CPO/eMSP: increase their competitiveness by offering advanced user-friendly charging solutions (DC mode) with attractive user interfaces.

Short narrative

This use case aims the design and development of a user-friendly master station serving multi-output charging points. The master station will offer different payments means, a user-friendly HMI with touch buttons and status LED indicators for each charging station. Different authentication options (ex. Physical card, smartphone application) will be offered to end-users. A charging management system (CMS) and a Local Grid Operator (LGO) will monitor and control the power flows between the different supply options, i.e. electricity grid, distributed renewable energy sources and battery storages.

Two charging technologies for passenger and L1e vehicles will be developed by PWD and will be integrated in the master station: a bidirectional low power DC charging station for passenger EVs and a unidirectional low power DC charging station from L1e vehicles. The respective ISO 15118 interfaces will be implemented via the Combo-CCS protocol for the charging stations (PWD) and the passenger vehicles (RB) enabling enhanced information and bidirectional power flow. The EnergyBus open protocol will be implemented by PWD and SCUTUM for the interfacing of the L1e vehicles with the new low power DC charging stations.

3.2.1.3 Use Case I-3: Battery sharing concept for L1e vehicles (SCUTUM - Swobbee)

Scope

The scope of this use case is to design and develop a battery sharing service for LEVs by SCUTUM and Swobbee, which allows users of L1e vehicles to swap their empty battery with a fully charged one within a few minutes. Practically, a network of off-street battery swapping stations will be developed facilitating the battery swapping process for LEVs towards improving users' charging experience and minimising the charging time which is comparable to the respective one for conventional refuelling.

Objectives

The main objective of this use case is to develop battery sharing concept (Battery as a Service -BaaS) which unlocks new business opportunities, such a battery leasing for L1e vehicles, and evaluate the user acceptance towards this innovative approach.

Stakeholders

- LEV users: Private, sharing, delivery & fleet users who can benefit from such innovative technologies and improve their charging experience.

- EVSE Manufacturers: offering new competitive user-centric charging stations for LEV's.
- Battery Manufacturers: Design best removable batteries with high capacity for a large autonomy.
- EMSP/CPOs: Offering innovative charging services in terms of technologies and services for LEV towards increasing their competitiveness and their market share.

Short narrative

This use case aims to provide an innovative battery exchange service. The Battery Swapping Station (BSS) is designed on the principle of "Battery as a Service" (BaaS) decoupling the ownership of the battery from its use. The user can insert one or more discharged or partially discharged batteries into the charge module and remove the charged batteries from another. The proposed solution offers L1e users the possibility of changing the battery in a matter of minutes and having a fully charged one to continue the journey. The concept of battery exchange unlocks new business opportunities, such as leasing batteries to reduce the initial cost of buying an L1e vehicle, facilitating the promotion of the concept of (micro-) mobility in urban environments.

3.2.1.4 Use Case I-4: Charging points on lamp posts

Scope

The scope of this use case is to capture the user acceptance towards the charging points on the lamp posts.

Objectives

The objective of this use case is to examine the feasibility of the charging points on lamp posts in city areas where there is no or limited space for installing charging stations on the pavements and analyse the user acceptance.

Stakeholders

- **Passenger EV users**: enjoy an additional charging option
- **EVSE Manufacturers**: offer new competitive user-centric charging option for passenger EV's
- **Municipalities**: give a 2nd utility to lamp posts not in used during the day, while providing additional charging options to inhabitants
- **EMSP/CPOs**: provide an innovative charging option, increasing their image and competitiveness

Short narrative

Lamp posts are street furniture which has the advantage to be connected to the grid. The implementation of this type of installation on an existing streetlight must consider the capacities of the electricity network and the adaptation needs of the electricity subscription, the availability of a parking space nearby. The recharging power must in all cases be limited to 3.7 or 7.4 kVA maximum and not disturb public lighting. It is possible to allow recharging only when the lighting is off to limit the power subscribed.

3.2.2 Use case family 2: Advanced user-centric and interoperable e-mobility services

3.2.2.1 Use case II-1: Advanced charging authentication - ISO15118PnC

Scope

The scope of this use case is to provide the user with a seamless experience and more secure authentication and authorization process to access the public charging infrastructure. This can be achieved by automatically identifying the vehicle on behalf of the user at the charging point and authorizing it to receive energy to charge its battery.

Objectives

The goal of this use case is to provide more seamless and secure access to public charging infrastructure using Plug&Charge technology.

Stakeholders

- **EV user**: improving charging experience since authentication process does not require any RFID card or mobile app, it is done automatically by the vehicle itself.
- **EVSE manufacturer**: facilitator of the ISO15118 PnC concept by integrating the respective certificates for authorization to the vehicle system.
- **CPO/eMSP**: offering advanced authentication services to its customers and facilitating the information flow among EV-eMSPs-Certification authorities. The usage rate of their charging network will be increased due to eased accessibility.

Short narrative

This use case aims at providing seamless yet safe access for the user to the public charging infrastructure. This is made possible by enabling the vehicle and the charging point with Plug&Charge (PnC) technology. Seamlessness is established by automating the authentication and authorization process. In this case, the user can simply plug in their vehicle, and the charging process is started without the need for any authentication means such as RFID cards or mobile applications. PnC also ensures that access to the network is secure. This is made possible using cryptographic encryption for communication between the electric vehicle and the power grid, which is standardized in the ISO 15118 norm.

3.2.2.2 Use Case II-2: Enhanced booking service enabling better exploitation of the public charging network

Scope

The scope of this use case is to develop a booking service which facilitates EV users to reserve a charging station based on their charging preferences and needs. The user interface of the booking service will allow user to select, from a list of available charging stations, the most preferable one in terms of technology, energy and mobility needs. Interoperable interfaces are required between the booking service and the CPO backend system in order to communicate user's reservation requests to the CPO, who is responsible for managing reservations at the charging station level.

Objectives

The objective of this use case is to design and develop an interoperable booking service which will improve EV user's charging experience and avoid wasting time in front of an occupied charging station. Short-term and long-term reservations are considered with specific functional requirements and restrictions for serving different mobility needs (i.e. urban mobility, inter-city and long trips).

Business Actors

- **EV user**: enjoy reservation capabilities for improving charging experience for better exploitation of the charging network and waiting time minimisation to occupied charging stations
- **EVSE manufacturer**: facilitator of reservation functionality at charging station level
- **CPO:** facilitator of the reservation functionality by providing the respective interoperable interfaces for booking and occupancy status of the charging stations**.**
- **eMSP**: increasing competitiveness by offering booking service to EV users.

Short narrative

The Enhanced booking service is offered to private users of passenger EVs to book a CP based on enhanced information. The user calls the booking service in order to reserve the CP in long or short term, based on the preferences. The booking service asks the CPO/s about the availability of CPs and provide the list of CPs to the user/driver with related information. The user/driver selects the preferred

CP and the preferred available time slot, and the booking service asks the CPO for its reservation. The reservation is confirmed/rejected by the CPO.

3.2.2.3 Use Case II-3: Advanced routing service facilitating EV user's accessibility to the public charging network

Scope

The scope of this use case is to design and develop a routing service which allows a user to navigate from his/her current position to the desired destination considering the mobility charging needs of his/her electric vehicle, his/her charging preferences in terms of charging technologies, charging power, energy prices, etc., his/her personal interest such as vicinity with restaurants, commercial site, cultural sites and, finally, the occupancy of the charging stations based on real field data or estimated one. The advanced routing service outputs a set of suggested routes that best fit EV user's profile, i.e., needs and preferences.

Objectives

The objective of this use case is to facilitate EV user's accessibility to the charging network by introducing an enhanced routing service which offers dynamic and personalised routing profiles in respect to user charging needs, preferences, mobility restrictions and charging network availability.

Stakeholders

- **EV user**: facilitating EV user's accessibility to the charging network based on user's preferences and charging network availability.
- **CPO:** facilitating routing services by providing the availability of the charging stations (in real-time)**.**
- **eMSP**: offering routing service to EV users increasing, thus, its competitiveness.
- **Roaming Service Provider:** facilitates the interoperable exchange of data between CPOs and Service Providers

Short narrative

This use case aims to provide an enhanced route planner which takes into account user preferences and charging station availabilities. In particular, the enhanced planner will consider several user's specific requirements, wishes and habits, such as: the type of plug, type of charging station (fast, super-fast), price, RES characteristics, vicinity with restaurants, commercial villages, cultural sites, etc. The service will take advantage from the real-time availability information of the charging stations or predicted occupancy from historical data, to propose optimized routes for the user. Different routes will be suggested and displayed (route + charging stops + timing) from standard profiles (fast traveller, cultural interest, shopping interest, etc.). The user will be able to select a single route among the displayed options. Additionally, an innovative service consisting of a multi-users route planner prototype will be developed to match the contemporary demand of charging stations by the users (related to their route and timing), with the real availabilities of charging stations.

3.2.2.4 Use Case II-4: Smart charging suite unlocking new business opportunities

Scope

The scope of this use case is to design and develop smart charging concepts which will facilitate the exploitation of the charging flexibility offered by EV users during non-commuting hours. The smart charging profiles are defined based on the business objective they aim to serve and the mobility restrictions as well as charging preferences of the EV users. The charging profiles might be decided centrally by the services offered by a Service Provider or by the user itself in respect to incentives.

Objectives

The objective of this use case is to design, develop and deploy smart charging services serving diverse business objectives by managing the spatial and temporal flexibility offered by the EVs when they are parked in respect to EV users' preferences and constraints. The business objective to be served are:

- **Power constrained smart charging concept** aiming to avoid synchronised charging of EV fleets reducing thus the EV charging peak demand which entails local infrastructure upgrades and impacts highly the operation of the distribution grids
- **Smart charging towards cost minimization** aiming to facilitate the implementation of new tariff schemes such as dynamic pricing and minimise the overall charging cost of EV users
- **Smart charging against battery ageing** aiming to define the optimal charging profile for improving battery performance and life
- **Smart charging under microgrid context** aiming to manage the charging demand with the local renewable sources and the distributed static battery capacities in a coordinated and cost optimal way
- **Smart charging towards EV/RES synergy** aiming to allocate charging demand to time periods when the renewable energy production is available in order to maximize the local self-production.

Stakeholders

- **EV user**: offering the flexibility, which permits to manage the optimized smart charging profile by the services provider.
- **eMSP**: offering smart charging services to EV users serving different business objectives increasing, thus, its competitiveness.
- **CPO**: operating the EV charge infrastructure
- **Roaming Service Provider:** facilitates the interoperable exchange of data between CPOs and Service Providers

Short narrative

The aim of this use case is to design and develop a suite of smart charging services serving different business objectives. The services must be user-centric in terms that user's mobility needs and charging preferences are prioritised when a smart charging profile is defined. The interaction of the EV user with the smart charging services is realised via a user interface (ex. mobile app). This user interface allows user to express their preferences while they are receiving information about the charging process before, during and after this is realised. This allows users to be active and have full monitoring of the way a smart charging service manages his/her battery. The deployment and communication of the smart charging profile from the Service Provider's level down to vehicle a series of interactions among the systems of different emobility actors are required. All these interactions must conform to the international standards and open communication protocols.

These smart charging services could offer new possible business opportunities or new possible business models to be designed between the different actors such as the EV user, the CPO, the local grid operator, etc. as summarized in the following table:

Smart Charging Service Suite	Business Opportunities / Business Model
Smart Charging by the EV user	Possible cost reduction for charging session due to the flexibility given by the EV users and increase of customer loyalty through access to enhanced information during the charging session
Power Constrained Smart Charging	Ability to reduce the subscribed power at the site, thus reducing costs and avoiding penalties for exceeding the subscribed power. Or, in other words, more electric cars to be charged with limited grid hosting capacity
Smart Charging towards cost minimization	Opportunity to minimize the charging cost based on the flexibility given by the EV users and the dynamic pricing of the electricity
Smart Charging within the micro grid context	Opportunity in minimizing the operational cost and the impact on the local grid in the case of the fast charger used, by using an optimal control on all local assets (PV, battery, local load)
Smart Charging towards EV/RES synergy	Possibility to decarbonise and to reduce the cost of the charging session by using locally produced energy, e.g., from a photovoltaic plant.
Smart Charging for better battery ageing mitigation	Possibility to extend the life of the battery
V2X Smart Charging	New business model to develop between EV owner and grid operator, where the vehicle battery would provide a additional services, besides mobility

Table 4: Possible business opportunities / Business models

3.2.3 Use case family 3: Decision Support tools towards sustainable emobility growth

3.2.3.1 Use Case III-1: EV Charging location planning tool

Scope

The scope of this use case is to design and develop a location planning web-tool that enables stakeholders to plan the roll-out of charging infrastructure in an area considering the local specificities and charging needs. The user should be able to parameterize the tool by selecting different options, such as which charging options to include in the analysis (i.e., standard charging, fast charging). The estimation of the local charging needs is a requirement for planning a charging network implying that the user should provide the necessary datasets.

The output of the tool is a set of optimal locations where the charging infrastructures should be installed and the mix of technologies to be considered.

Objectives

The objective of this use case is to design and develop a web-tool that facilitates the deployment of different types of charging infrastructure in areas (i.e., cities, regions, countries) based on the existing charging infrastructure and the current as well as the future charging demand.

Stakeholders

- **CPO / Local authorities:** Potential users of the planning tool for developing new or expanding the existing charging network in the most efficient and sustainable way.

Short narrative

This use case aims at providing a location planning web-tool that can be used to identify locations that are suitable for deploying new charging infrastructure based on the current EV adoption and existing charging infrastructure in that area and the expected future charging demand. This tool supports actors that are responsible for the deployment of charging infrastructure. It comprises three main parts:

- A **demand model** that uses user input to assess the current and future charging demand in the area,
- A **location planning algorithm** that uses the demand model to identify optimal locations for the deployment of future charging infrastructure in the area,
- A **user interface** that presents the tool in a user-friendly way, that enables to run the algorithm without prior knowledge of the algorithm's internal working and that displays the output in a comprehensible manner.

3.2.3.2 Use Case III-2: Incentives schemes and tariff structures towards emobility sustainability

Scope

The scope of this use case is to understand the existing and design new incentives and tariffs applied to users charging an electric vehicle to the charging points (CP) operated by the actors of the pilot site. The new tariff schemes and incentives can refer to on-street CP and/or off-street CP. The design of tariff and incentives and the pilot itself will have to comply with the institutional frame of each site. For this reason, some pilots may need to be executed with a defined set of users and/or in a testing environment.

Objectives

The main objective of the use case is to analyse if new incentives and changes on the tariff structure and/or profile have any impact on the user's behaviour and analyse how people adapt their charging habits. The new incentives and tariffs should consider the a-priori analysis of the tariff structure trend collected for the surveys and interviews conducted at pilot sites.

Stakeholders

- EV users being offered new tariff structures and incentives better reflecting their expectations
- Public Authorities to better understand user's expectation towards tariff schemes and incentives in order to promote e-mobility concept.
- CPO and eMSP to adopt new tariff schemes which better reflects users' expectations.

Short narrative

It is expected that by adapting the incentive schemes and tariff structure, the user will change their habits looking for better conditions to charge the electric vehicle.

In some cities changes in tariff structure have already taken place: electricity consumption when charging an EV used to be free of charge, ex until January 2021 in Barcelona. At that point, a tariff structure was introduced to charge the user for the electricity used, which resulted in an important change of the EV users' behaviour.

With this premise, the CPOs and eMSPs, supported by local authorities, can adjust these structures and/or amounts to promote charging the vehicle in certain hours or locations. For example, it might be desirable to bring charging demand to off-street CP instead of on-street CP. Or the CPO might prefer a more homogeneous charging demand throughout the day in order to avoid peaks and overdimensioning the charging facilities. These are two examples that can be favoured via tariffs and incentives.

In this use case, the experiences collected by the a-priori analysis of the tariff structure trend collected form the surveys and interviews conducted at pilot sites (deliverable D2.2 "Accessibility, requirements, tariff schemes and incentives") will be put into practice to see how, by adjusting incentives and tariffs related to charging activities, users adapt their charging habits.

PROJECT LEVEL – STUDY QUESTIONS, KPIS AND IMPACT AREAS IN THE ECHARGE4DRIVERS CONTEXT

This chapter provides an overview of the impact areas and study questions that will be used to evaluate the use cases that will be demonstrated in eCharge4Drivers. It also introduces the KPIs used to assess the successful outcome of the demonstrations that will be tested.

4.1 Impact areas and study questions at project level

The aspects of each use cases that will have a greater impact on technical performance and usage will be evaluated using KPIs that are computed using data collected from sensors, devices and applications back ends while those that have a higher impact on quality of experience, acceptance as well as other aspects related to society, market and environment will be evaluated using KPIs that are calculated using the answers collected with surveys and interviews. For simplicity, the KPIs have been split in "quantitative" and "qualitative" based on the data source and data type. While quantitative KPIs are computed using data collected from legacy systems of CPO's/eMSPs, the qualitative KPIs are calculated from EV users' answers to the surveys. In the next subsections the main study questions are reported categorised per impact area.

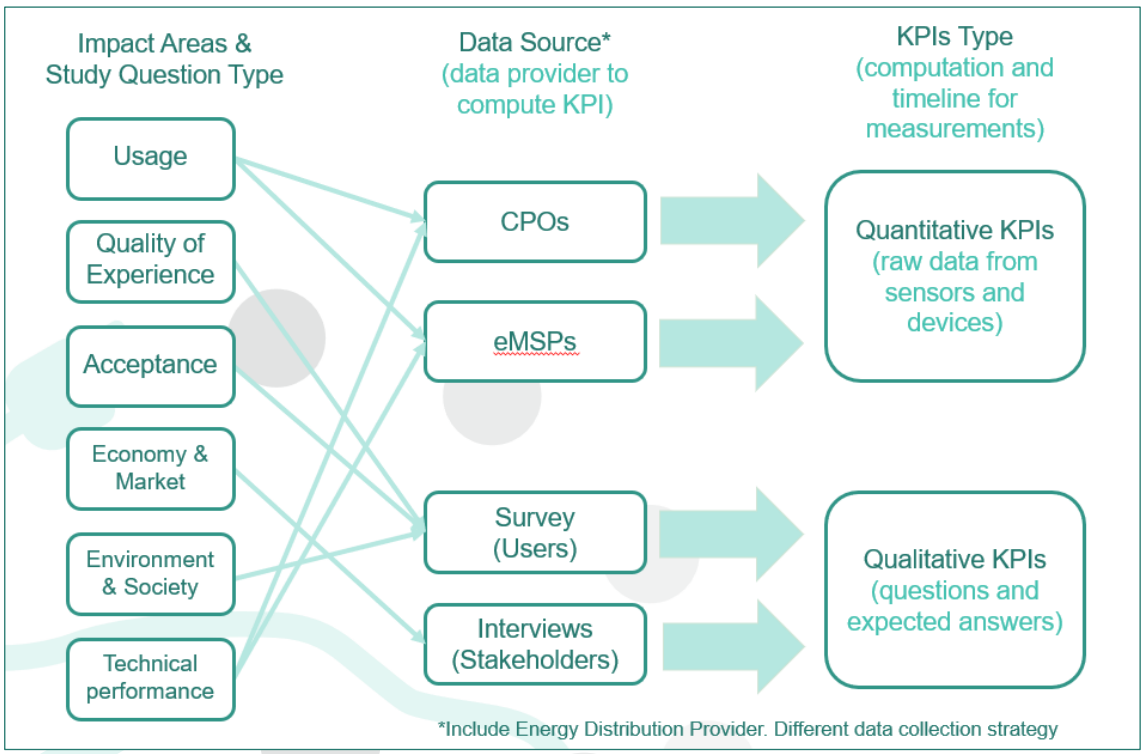

Figure 5: Study questions mapping to KPIs' typology (quantitative and qualitative)

4.1.1 Impact Area: Usage

This section identifies study questions that will be used to evaluate the way users utilize the charging infrastructure and the respective technologies and services. Table 5 reports the study questions and the data source for each question identified in the impact area so called "Usage".

Study Question ID	Study Question	Data source
SQ-U-1	How does the use of the charging options change with eCharge4Drivers?	CPOs
SQ-U-2	How does the efficiency of the charging solution change with eCharge4Drivers?	CPOs
SQ-U-3	How does the use of the app-based services change with eCharge4Drivers?	eMSPs
SQ-U-4	Does eCharge4Drivers change the users' payment preferences for the EV charge?	eMSPs
SQ-U-5	Does eCharge4Drivers improve the availability of the charging infrastructure?	CPOs and eMSPs
SQ-U-6	Do eCharge4Drivers' solutions impact users' charging behavior?	CPOs, eMSPS, and Survey
SQ-U-7	How versatile the batteries with output converter are in domestic and professional uses in BSS (Battery Swapping Station) transaction?	Not applicable
SQ-U-8	What are the reasons leading users to charge the (L)EV?	Survey
SQ-U-9	What is the users' motivation of using the service?	Survey
SQ-U-10	Are users willing to say how long will they be parked, and which is their state of charge when they arrive at the parking to be able to plan the charging of the different users parked?	Survey
SQ-U-11	What are the users' reasons to use smart charging services?	Survey
SQ-U-12	What is the users' motivation of using the app-based services?	Survey
SQ-U-13	Is the overall swapping experience more pleasant than refuelling at a gas station? (battery swapping stations)	Survey

Table 5: Usage study questions and data collection source

4.1.2 Impact Area: Technical Performance

This section identifies study questions that will be used to evaluate the technical performance of the developed system. Table 6 reports the study questions and the data source for each question identified in the impact area referring to "Technical Performance".

Study Question ID	Study Question	Data source
SQ-T-1	Do eCharge4Drivers' solutions achieve lower electricity cost?	CPOs
SQ-T-2	Do eCharge4Drivers' solutions have more efficient distribution of the power?	CPOs

SQ-T-3	Do eCharge4Drivers' solutions increase the use of locally produced electricity?	CPOs
SQ-T-4	Do eCharge4Drivers' solutions reduce technical problem, thus more reliable for the user?	CPOs and eMSPs
SQ-T-5	Do eCharge4Drivers' solutions reduce the number of failure and unscheduled maintenance?	CPOs and eMSPs
SQ-T-6	Do eCharge4Drivers' solutions impact users' charging behavior?	Survey

Table 6: Technical performance study questions and data collection source

4.1.3 Impact Area: Quality of Experience

This section identifies study questions that will be used to evaluate the impact on the users' satisfaction and perceptions on the different aspects of the charging experience. Table 7 reports the study questions and the data source for each question identified in the impact area so called "Quality of Experience" (QoE).

Study Question ID	Study Question	Data source
SQ-QoE-1	Are users satisfied with the charging option?	Survey
SQ- QoE-2	Which is the users' experience in terms of charging options' availability?	Survey
SQ-QoE-3	Are users satisfied with the charging services?	Survey
SQ-QoE-4	Are users satisfied with the information provided by the charging options and by the charging services?	Survey
SQ-QoE-5	What is the user's experience in terms of charging systems' readiness to be used?	Survey
SQ-QoE-6	What is the users' experience with the charging infrastructure accessibility?	Survey
SQ-QoE-7	How does the perception of charging point data management change with eCharge4Drivers?	Survey
SQ-QoE-8	What is the users' experience in terms of range anxiety?	Survey
SQ-QoE-9	What is users' expectation of information provided by app-based services that could potentially change their travel plans with (L)EV?	Survey
SQ-QoE-10	Are users satisfied with the tariff structure of the app-based services?	Survey
SQ-QoE-11	What is the users' expectation concerning the time performance of the battery swapping stations?	Survey

Table 7: Quality of Experience study question and data collection source

4.1.4 Impact Area: Acceptance

This section identifies study questions that will be used to evaluate the impact on users' attitude related to the charging infrastructure, to the services and technologies, and more in general toward electro-mobility. Table 8 reports the study questions and the data source for each question identified in the impact area related to users' Acceptance.

Study Question ID	Study Question	Data source
SQ-A-1	Are eCharge4Drivers charging options and services accepted by users?	Survey
SQ-A-2	Would users recommend others to use products and services provided by their CPOs and eMSPs?	Survey
SQ-A-3	Does eCharge4Drivers affect users' acceptance of electromobility in general?	Survey

Table 8: Acceptance study question and data collection source

4.1.5 Impact Area: Economy and Market

This section identifies study questions that will be used to evaluate whether the project enable market takeover of public charging infrastructure and whether it introduces marketable business cases for suppliers of the charging infrastructure (both technologies and services). Table 9 reports the study questions and the data source for each question identified in the impact area so called "Economy and Market".

Study Question ID	Study Question	Data source
SQ-ECON&MKT-1	Do technological advancements by eCharge4Drivers open to new business opportunities?	Interview
SQ-ECON&MKT-2	Does eCharge4Drivers enable economic advantages to CPOs and eMSPs?	Interview
SQ-ECON&MKT-3	Does eCharge4Drivers enable more investments?	Interview

Table 9: Economy and market study question and data collection source

4.1.6 Impact Area: Environment and Society

This section identifies study questions that will be used to evaluate whether the project can achieve sustainability improvements and if it can stimulate electric mobility within society. Table 10 reports the study questions and the data source for each question identified in the so called "Environment and Society" area.

Study Question ID	Study Question	Data source
SQ-ENV&SOC-1	Does eCharge4Drivers contribute to a wider spread of (L)EVs?	Survey
SQ-ENV&SOC-2	Is the charging infrastructure respectful of the environment?	Survey

Table 10: Environment and society study question and data collection source

4.2 KPIs at project level

In this section of the deliverable are shown the quantitative and qualitative KPIs as previously defined at the project level. For more detailed information on the measurements and the data needed refer to Annex 1 of this deliverable.

4.2.1 Quantitative KPIs

Quantitative KPIs are computed using data gathered by 2 different providers: CPOs and eMSPs. In the next sections are provided a list of the KPIs for each provider. Table 11 and Table 12 reports the lists of KPIs that will be measured by CPOs and eMSPs.

4.2.1.1 CPOs

The tables below show the quantitative KPIs that will be computed with the data provided by the charging provider operator.

KPI ID	KPI Name	Description
T-1	Cost reduction due to balancing	The difference in price between 2 different charging options, one using balancing and the other one without
T-2	Complaint's rate	Number of complaints for the charging station received / total uses of the charging stations per week
T-3	Technical problems reported during the charging experience	Average weekly technical problems reported by the charging station
T-4	Grid power peak	The average of the daily highest electrical power demand
T-5	Power peak cost	The average cost of the daily highest electrical power demand
T-6	Power peak to average ratio	The ratio between the daily highest electrical power demand and the average
T-7	Electricity cost on the spot market	The cost savings for electricity on the market
T-8	Power quality	The comparison between two accurate voltmeters measuring the same system voltage
T-9	Number of scheduled/unscheduled maintenance	The number of scheduled and unscheduled maintenance at each charging site in a month
T-10	Number of failures	The number of failures due to vehicle, battery, charging point, and grid at each charging site in a month
T-13	Share of energy from local resources in charging	The amount of energy used to charge the vehicles that was produced from local resources
T-15	Technical problems reported by the "Plug and Charge" service	Technical problems reported registered in the standard ISO15118
T-22	Self-consumption	The relative amount of energy produced locally which is consumed locally by charge the vehicles which is supplied

T-23	Peak Demand unsatifaction rate	The number of times the the peak power demand by drivers the smart charging cannot be satisfied due to grid constraints
T-24	Average cotracted grid power per charge point	Sizing parameter indicating what power contract should be subscribed for a given amount of charge point
U-1	Loyalty to the same charging site	The number of users who charge electric vehicle at the same charge site more than 2 times in a month
U-2	Frequency of use of charging options	The number of daily uses of each charging option at each charging site in a month
U-3	Average time needed to charge the vehicle	The average time per charge by charging option at each charging site in a month.
U-4	Average time occupancy	The average time the parking spot pertinent to the charging station is occupied by charging option at each charging site in a month.
U-5	Availability rate	The percent of the time that charging stations are available for use at each charging site in a month.
U-6	Unavailability rate	The percent of the time that charging stations are not available for use at each charging site in a month.
U-7	Average usage ratio of charging station	The time the vehicle is connected for charging over the total available time
U-8	Average unavailability ratio due to technical issues	The time the charging station is not available (out of service) over the total available time
U-10	The versatility of battery swapping stations	The average time of domestic use of a battery with converter DC-AC versus average time of professional use of a battery with converter DC-AC
U-11	Availability of fully charged batteries for swapping	State of Charge of batteries in the station at the time of booking request
U-12	Battery swapping time	The average time for swapping the batteries at each charging site in a month per charging site (or time to exchange battery including user identification time and check out)

Table 11: KPIs list collected by CPOs

4.2.1.2 eMSPs

The tables below show the quantitative KPIs that will be computed with the data provided the charging provider operator.

KPI ID	KPI Name	Description
T-16	Technical problems reported by app-based services	The average number of daily technical problems reported by the app-based services per week

T-17	Technical problems reported during the payment	The share of technical problems reported related to the app payment service per week
T-18	Technical problems reported during the use of the route planner	The average technical problems reported by the route planner per week
T-19	Technical problems reported during the reservation	The average technical problems reported by the booking service per week
U-13	New app users	The number of applications downloaded by week
U-14	Users uninstalling the app	The number of applications uninstalled by week
U-15	Frequency of use of app-based - booking service	The average number of daily usages of the booking service by week
U-16	Frequency of use of app-based - payment service	The average number of daily usages of the payment service by week
U-17	Frequency of use of app-based - route planner	The average number of daily usages of the route planner by week
U-18	Frequency of use of app-based - available charging station finder	The average number of daily usages of the service to find an available charging station (no booking) by week
U-19	App-based payments per user	The number of payments processed through the app per user each week
U-20	App-based payments per charging option	The percentage of payments processed through the app for each charging option by week
U-21	App-based services and total charging ratio	The percentage of charging sessions being realised by using the app-based services* per week

Table 12: KPIs list collected by eMSPs

4.2.2 Qualitative KPIs

Table 13 below show the list of study questions that will be assessed with qualitative KPIs. To each study question is associated the identifier of the KPI that will be used and they are described in the next following sub-sections.

Study Question ID	Study question	KPI ID
SQ-U-8	What are the reasons leading users to charge the (L)EV?	U-25
SQ-U-12	What is the users' motivation of using the app-based services?	U-26
SQ-QoE-1	Are users satisfied with the charging option?	QoE-1
SQ-QoE-2	Which is the users' experience in terms of charging options' availability?	QoE-2

SQ-QoE-3	Are users satisfied with the charging services?	QoE-3
SQ-QoE-4	Are users satisfied with the information provided by the charging options and by the charging services?	QoE-4
SQ-QoE-5	What is the user's experience in terms of charging systems' readiness to be used?	QoE-5
SQ-QoE-6	What is the users' experience with the charging infrastructure accessibility?	QoE-6
SQ-QoE-7	How does the perception of charging point data management change with eCharge4Drivers?	QoE-7
SQ-A-1	Are eCharge4Drivers charging options and services accepted by users?	A-1
SQ-A-2	Would users recommend others to use products and services provided by their CPOs and eMSPs?	A-2
SQ-U-9	How do they use the tool/schemes in their current business/plans?	U-27
SQ-ECON&MKT-4	How do the tool/schemes help with their business/plans?	ECON&MKT-1
SQ-ECON&MKT-5	Are the tool/schemes meeting their expectations?	ECON&MKT-2

Table 13: List of questions to be evaluated using information collected with surveys and interview

4.2.2.1 Survey Forms

Given the different characteristics of use cases demonstrating technology compared to services, 2 different survey forms will be delivered to EV users: the first one refer to the technology products, while the second to services. Table 14 and Table 15 below show the qualitative KPIs for evaluating respectively technology and services demonstrated within the context of eCharge4Drivers' use cases. These 2 tables report the questions to be included in the survey that will be used to collect the information needed to compute the qualitative KPIs.

4.2.2.1.1 Survey for Technologies

Table 14 shows the qualitative KPIs that will be computed with the data provided by the users to evaluate the technologies demonstrated in eCharge4Drivers. It also includes the questions that will be asked to the technology's users. From the users' answers will be possible to gather the necessary information to compute the qualitative KPIs that will be used to evaluate the following use cases: UC I-1, UC I-2, UC I-3, UC I-4, UC II-1, UC II-4.

KPI ID	Question to be asked	Sub-questions	Type of answers expected
U-25	If I have to describe my charging behavior: "I charge my <vehicle> ..."	Yes (10)	Ordinal Values from "strongly agree" to "strongly disagree"
QoE-1	Satisfaction: Perceived Value	Yes (5)	Ordinal Values from "strongly agree" to "strongly disagree"

	Satisfaction: Loyalty	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”
	Satisfaction: Customer satisfaction	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
QoE-2	How long have you had to wait at most to be able to use a public charging point?	No	Time ranges of 15 minutes (4 ranges, plus never waited)
QoE-4	I am more satisfied with the information provided by the <Charging technology>than with other charging options	No	Ordinal Values from “strongly agree” to “strongly disagree”
	Physical characteristics: Tangibility	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”
QoE-6	In the last month, how frequent did you have to wait at a charge point because of…	Yes (3)	Ordinal Values from “daily” to “less than once a month”, plus “never”
	I am more satisfied with the accessibility of the <Charging technology> than with other charging options	No	Ordinal Values from “strongly agree” to “strongly disagree”
QoE-5	I am more satisfied with the authentication system in the <Charging technology> than with other charging options	No	Ordinal Values from “strongly agree” to “strongly disagree”
	Have you experienced any problems with the <CPO>?	No	Binary answer (yes or no)
	Problems: Responsiveness	Yes (5)	Ordinal Values from “strongly agree” to “strongly disagree”
	Problems: Contact	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Problems: Compensation	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Physical characteristics: System Availability	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”
	Online characteristics: Reliability	Yes (6)	Ordinal Values from “strongly agree” to “strongly disagree”

QoE-7	Online characteristics: Privacy	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
A-1	Behavioural intention to use the system	Yes (3)	Multiple answers possible (5)
	Performance expectancy	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Effort expectancy	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Social influence	Yes (5)	Ordinal Values from “strongly agree” to “strongly disagree”
	Facilitating conditions	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”
	Hedonic motivations	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Price Value	Yes (5)	Ordinal Values from “strongly agree” to “strongly disagree”
A-2	Satisfaction: Loyalty	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”

Table 14: Questions to collect data needed to compute KPIs to assess technologies

4.2.2.1.2 Survey for Services

Table 15 shows the qualitative KPIs that will be computed with the data provided by the users of the services demonstrated in eCharge4Drivers. It also includes the questions that will be asked to the technology’s users. From the users’ answers will be possible to gather the necessary information to compute the qualitative KPIs that will be used to evaluate the following use cases: UC II-2, UC II-3.

KPI ID	Question to be asked	Sub-questions	Type of answers expected
U-25	If I have to describe my charging behavior: “I charge my <vehicle> ...”	Yes (10)	Ordinal Values from “strongly agree” to “strongly disagree”
U-26	For which type of travel do you use the <Charging service>…	No	Multiple answers possible (5)
QoE-2	How long have you had to wait at most to be able to use a public charging point?	No	Time ranges of 15 minutes (4 ranges, plus never waited)

	The <Charging service> helped me find an available charging station more than other services.	No	Ordinal Values from “strongly agree” to “strongly disagree”
QoE-3	I am more satisfied with the <Charging service> than with other available charging services	No	Ordinal Values from “strongly agree” to “strongly disagree”
	I am satisfied with the <Charging service>	No	Ordinal Values from “strongly agree” to “strongly disagree”
	Are you satisfied with the overall quality of the <Charging service>	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
QoE-4	I am satisfied with the information provided by the <Charging service>	No	Ordinal Values from “strongly agree” to “strongly disagree”
A-1	Behavioural intention to use the system	Yes (3)	Multiple answers possible (5)
	Performance expectancy	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Effort expectancy	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Social influence	Yes (5)	Ordinal Values from “strongly agree” to “strongly disagree”
	Facilitating conditions	Yes (4)	Ordinal Values from “strongly agree” to “strongly disagree”
	Hedonic motivations	Yes (3)	Ordinal Values from “strongly agree” to “strongly disagree”
	Price Value	Yes (5)	Ordinal Values from “strongly agree” to “strongly disagree”

Table 15: Questions to collect data needed to compute KPIs to assess services

4.2.2.2 Interviews Forms

The goal of the interview is to know what the stakeholders’ thoughts on the tools are, to explore their opinions and to understand in depth what they experienced. From the participants’ answers will be possible to gather the necessary information to compute the qualitative KPIs that will be used to assess UC III-1 and UC III-2. Workshops with focused groups will be scheduled in order to ensure that all the potential stakeholders are involved, i.e. CPOs, eMSPs, local authorities, EV users etc. The context of the interviews will be dynamically defined in respect to the type of the focused group to be interviewed.

Table 16 shows the qualitative KPIs that will be computed with the information provided by the stakeholders answering to the interviews. The overall goal of the interview form is to know what features of the tools the stakeholders find more helpful and what is helping in growing their business as well as what should be improved. The current list of KPIs is going to be extended based on the stakeholders’ expertise within Task 5.2 and Task 6.3.

KPI ID	Question to be asked	Sub-questions	Type of answers expected
U-27	Has the tool/schemes improved their willingness to invest in extending their business activities/plans with respect to charging infrastructure?	Yes (3)	Multiple answers possible (5)
ECON&MKT-1	What perceptions concerning new business opportunities do the tool/schemes provided to them?	No	Provide details about the opportunities
ECON&MKT-2	Are you satisfied with the tool?	No	Ordinal Values from “strongly agree” to “strongly disagree”

Table 16: Questions to collect data needed to compute KPIs to assess policy making tools

The key mechanism for assessing the decision support tools will be the SWOT analysis which is a strategic framework for identifying the strengths, weakness, opportunities and threats of proposed decision tools. The strengths will allow us to identify the advantages of the proposed decisions tools and how these tools facilitate the decision-making strategy of stakeholders compared to their existing practices. The weaknesses will allow service providers to understand potential areas of improvement. The opportunities analysis will facilitate the identification of potential gaps between the offered services and the market needs and how the EU/national emobility policies towards the transition to an environmentally neutral transportation can benefit the market introduction of these tools. Since the emobility sector is a dynamically growing, the adaptability of the decision support tools to the new e-mobility conditions and charging needs is one of the most critical aspects to be considered.

Figure 6 SWOT analysis for assessing the decision support tools

PERFORMANCE EVALUATION FRAMEWORK

This chapter provides detailed information on how to carry on the performance evaluation of each use both at the use case and pilot site levels. When necessary, it also introduces study questions and KPIs specific to a particular use case in consideration of different objectives to be achieved by each pilot site. It ultimately provides a complete list of study questions, successful outcome and KPIs that will be used to assess the impact of the demonstrations that will be tested.

5.1 Study questions and KPIs specific at use case level

5.1.1 Use Case I-1 User-friendly, low and high-power charging stations for passenger & L3e vehicles with enhanced user interfaces (ABB)

The power charging stations (both low and high) for passenger & L3e vehicles with enhanced user interfaces use case is going to be evaluated using study questions and KPIs collected from the 5 pilot sites testing these technologies. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3 (Section 3.2.1.1). It also requires the definitions of specific KPIs listed presented here and described in detail in Annex 2. All the above information is reported and summarized in the tables below reporting the use case evaluation summary (Table 17) and the use case specific KPIs (Table 18).

UC I-1	Power charging stations for passenger & L3e vehicles with enhanced user interfaces
Pilot Sites:	Austria, Grenoble, North Italy, Turkey, Zellik, Barcelona
Project specific study questions:	SQ-U-1, SQ-U-2, SQ-U-5, SQ-U-6, SQ-T-1, SQ-T-2, SQ-T-3, SQ-T-4, SQ-T-5
Project level KPI:	U-1, U-2, U-3, U-4, U-5, U-6, U-7, T-2, T-9, T-10, T-14, T-18, T-22, T-23, T-24
Use case and site specific KPI.	T-1-ZEL, T-4-ZEL, T-5-ZEL, T-8-ZEL, T-13-ZEL, T-14-ZEL, T-14-CEA

Table 17: Power charging stations for passenger & L3e vehicles with enhanced user interfaces evaluation summary

KPI ID	KPI Name	Description
T-1-ZEL	Electricity bill reduction due to local balancing	The difference in electricity cost for the CPO/site between applying smart charging and not applying smart charging
T-4-ZEL	Grid Power Peak Reduction	The average of the reduction in peak power
T-5-ZEL	Power Cost	The average cost electrical power demand according to local peak power tariffs
T-8-ZEL	Power Quality	Influence of smart charging on voltage drop
T-13-ZEL	Share of energy from local resources in charging (self-sufficiency)	The relative amount of energy used to charge the vehicles that was produced from local resources

T-14-ZEL	Charging flexibility	Variation in the minimum state of charge demand
T-14-CEA	Charging flexibility	Extra time for charging for each charging session

Table 18: Power charging stations for passenger & L3e vehicles with enhanced user interfaces specific KPIs

5.1.2 Use Case I-2: Multi-user master station with multiple DC power charging points for passenger and L1e EVs (PWD)

The multiuser station with multiple DC power charging points for L1e EV's passengers use case is going to be evaluated using study questions and KPIs collected from the 1 pilot site testing these technologies. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3 (section 3.2.1.2). It also requires the definitions of specific KPIs presented in Table 20 and described in detail in Annex 2. All the above information is reported and summarized in the table below reporting the use case evaluation summary (Table 19).

UC I-2	**Multi-user master station with multiple DC power charging points for passenger and L1e EVs (PWD)**
Pilot Sites:	Zellik
Project specific study questions:	SQ-U-1, SQ-U-3, SQ-U-4, SQ-T-2, SQ-T-4, SQ-T-5, SQ-T-6
Project level KPI:	T-2, T-3, T-9, T-10, T-15, T-16, T-17, T-19, U-1, U-2, U-3, U-4, U-5, U-6, U-7, U-8, U-13, U-16, U-19, U-20, U-21
Use case and site specific KPI.	T-14-ZEL, T-21-ZEL

Table 19: Multi-user master station with multiple DC power charging points for passenger and L1e EVs evaluation summary

KPI ID	KPI Name	Description
T-14-ZEL	Charging flexibility	Variation in the minimum state of charge demand
T-21-ZEL	Compactness of the MultiCharging station	The smaller footprint of the Multi-charging station

Table 20: Multi-user master station with multiple DC power charging points for passenger and L1e EVs specific KPIs

5.1.3 Use Case I-3: Battery sharing concept for L1e vehicles (SCUTUM - Swobbee)

The battery sharing for L1e vehicles use case is going to be evaluated using study questions and KPIs collected from the 2 pilot sites testing these technologies. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3 (section 3.2.1.3). All the above information is reported and summarized in the table below reporting the use case evaluation summary (Table 21).

UC I-3	**Battery sharing concept for L1e vehicles (SCUTUM - Swobbee)**
Pilot Sites:	Barcelona, Berlin

Project specific study questions:	SQ-U-1, SQ-U-3, SQ-U-5, (SQ-U-7), SQ-T-4, SQ-T-5, SQ-T-6
Project level KPI:	T-2, T-9, T-10, T-16, U-1, U-2, U-3, U-4, U-5, U-6, U-7, U-8, U-9, U-11, U-12, U-13, U-14, U-18, U-21

Table 21: Battery sharing concept for L1e vehicles evaluation summary

5.1.4 Use Case I-4: Charging points on lamp posts

The charging point on lamp posts use case is going to be evaluated using study questions and KPIs collected in the pilot site in Grenoble testing this technology. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3 (section 3.2.1.4). All the above information is reported and summarized in the Table 22: Charging point on lamp posts evaluation summary below.

UC I-4	Charging points on lamp posts
Pilot Sites:	Grenoble
Project specific study questions:	SQ-U-1
Project level KPI:	U-1, U-2, U-3-CEA

Table 22: Charging point on lamp posts evaluation summary

5.1.5 Use Case II-1: Advanced charging authentication - ISO15118PnC

The advanced charging authentication ISO15118 use case is going to be evaluated using study questions and KPIs collected from the 6 pilot sites testing this technology. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3. Some objectives related to KPI7 in the grant agreement defines a minimum number of CPOs and OEMs that should ask to implement the guidelines to implement ISO 15118 using project guidelines and the achievement of this goal will be evaluated in WP8 (Table 23). It also required the definitions of specific KPIs presented below (Table 25) and described in detail in Annex 2. All the above information is reported and summarized table below reporting the use case evaluation summary (Table 24).

KPIs from Grant Agreement related to advanced charging authentication ISO15118 use case			
Expected impact from the call	**KPI GA**	**Description**	**KPI Project**
Improve interoperability of vehicle-to charger and charger-to infrastructure communication	KPI 7	At least 6 CPOs and at least 3 OEMs have asked to join the project Observer Group to implement ISO 15118 using the project guidelines.	Number of OEM asking to implement ISO15118 using guidelines (will be defined and assessed in WP 8)

Table 23: Project level KPIs (as per Grant Agreement)

UC II-1	Advanced charging authentication ISO15118 PnC
Pilot Sites:	Austria, Barcelona, Greece, North Italy, Turkey, Zellik

Project specific study questions:	SQ-U-1, SQ-U-2, SQ-U-3, SQ-U-4, SQ-U-5, SQ-T-4, SQ-T-5, SQ-T-6
Project level KPI:	U-1, U-2, U-3, U-4, U-5, U-6, U-7, U-8, U-13, U-14, U-15, U-16, U-17, U-18, U-19, U-20, U-21, T-2, T-3, T-9, T-10, T-14, T-14-ZEL, T-15, T-17, T-18
Use case specific KPI.	T-14-ZEL, T-25-ABB, T-26-ABB, T-27-ABB

Table 24: Advanced Charging Authentication ISO15118 PnC evaluation summary

KPI ID	KPI Name	Description
T-14-ZEL	Charging flexibility	Variation in the minimum state of charge demand
T-25-ABB	Successful PnC charge sessions	The percentage of the successful PnC charging sessions in selected time period
T-26-ABB	PnC charge sessions failed on authentication	The percentage of PnC charge sessions failed on authentication in selected time period
T-27-ABB	PnC charge sessions failed on charging	The percentage of the failed PnC charging sessions failed on charging in selected time period

Table 25: Advanced authentication ISO151181 PnC specific KPIs

5.1.6 Use Case II-2: Enhanced booking service enabling better exploitation of the public charging network

The booking service use case is going to be evaluated using study questions and KPIs collected from the 6 pilot sites testing this technology. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3. All the above information is reported in Table 26.

UC II-2	Booking Service
Pilot Sites:	Barcelona, Bari, Greece, Grenoble, Turkey, Zellik, Berlin, Austria
Project specific study questions:	SQ-U-3, SQ-T-4
Project level KPI:	U-13, U-14, U-15, (U-16), U-18, (U-19, U-20,) U-21, T-16, (T-17), T-19

Table 26: Booking service evaluation summary

5.1.7 Use Case II-3: Advanced routing service facilitating EV user's accessibility to the public charging network

The routing service use case is going to be evaluated using study questions and KPIs collected from the 5 pilot sites testing this technology. The use case entails objectives to be achieved at the site levels and they are described in Chapter 3. It also required the definitions of specific study questions (Table 28) and KPIS (Table 29). All the above information is summarized in Table 27.

UC II-3	Route Planner
Pilot Sites:	Barcelona, Bari, Greece, North Italy, Turkey

Project specific study questions:	SQ-U-3, SQ-U-5, SQ-T-4
Use case specific study questions:	SQ-RoutePlanner-U-1, SQ-SmartCharging-U-2, SQ-SmartCharging-T-1, SQ-SmartCharging-T-2, SQ-SmartCharging-T-3
Project level KPI:	U-5, U-13, U-14, U-15, U-16, U-17, U-18, U-21, T-2, T-16, T-18, T-19
Use case specific KPI.	U-17-ELECTROMAPS, T-28-ELECTROMAPS, T-29-ELECTROMAPS, T-30-ELECTROMAPS, U-36-ELECTROMAPS

Table 27: Route planner evaluation summary

Study question ID	Use case specific study question	Data source
SQ-RoutePlanner-U-1	How frequently do the users consult the EV routing services?	eMSPs
SQ- RoutePlanner-U-2	What is the users' motivation of using the app-based services?	Survey
SQ- RoutePlanner-T-1	Do eCharge4Drivers' solutions reduce the time used to find an EV charging station?	Survey
SQ- RoutePlanner-T-2	Do eCharge4Drivers' solutions help to plan the activities with the EV?	Survey
SQ- RoutePlanner-T-3	Do eCharge4Drivers' solutions help to perform long-range trips with the EV?	Survey

Table 28: Route Planner use case specific study questions

KPI ID	KPI Name	Description
U-17-ELECTROMAPS	Use of the service	The number of petitions to run the service
U-36-ELECTROMAPS	Use of the service	Check if the original purpose of the service matches with the answers provided by users of the service
T-28-ELECTROMAPS	Efficiency of the service (I)	The quantity of time saved by users when operating with the service
T-29-ELECTROMAPS	Efficiency of the service (II)	Analyse the answers provided by users of the service.
T-30-ELECTROMAPS	Efficiency of the service (III)	Analyse the answers provided by users of the service and analyse the size of long-range trips with EVs

Table 29: Route Planner specific KPIs

5.1.8 Use Case II-4: Smart charging suite unlocking new business opportunities

The smart charging use case is going to be evaluated using study questions and KPIs collected from the 4 pilot sites testing this technology. The use case entails objectives to be achieved at the project level (Table 30) as well as at the site levels (see Chapter 3). It also required the definitions of specific

study questions (Table 32) and KPIs (Table 33). All the above information is reported in the following sections and summarized in Table 31.

KPIs from Grant Agreement related to Smart Charging Use Case			
Expected impact from the call	**KPI GA**	**Description**	**KPI Project**
Better grid integration of high-power chargers	KPI 8	Power from grid does not exceed 30% of limit at peak demand using the micro grid management system approach from Task 3.2.	Peak Power Reduction (T-4-ZEL), Power Qy (T-6-ZEL)
	KPI 9	The combined nominal power of the installed charging stations can exceed the maximum allowed power of the grid by at least 200% using the micro grid management system approach from Task 3.2.	Peak Demand Unsatisfaction Rate (T-23)

Table 30: Project level KPIs (as per Grant Agreement)

UC II-4	**Smart Charging**
Pilot Sites:	Barcelona, Grenoble, Luxembourg, Zellik, Austria
Project specific study questions:	SQ-U-1, SQ-U-5, SQ-U-6, SQ-T-1, SQ-T-2, SQ-T-3, SQ-T-4, SQ-T-5
Use case specific study questions:	SQ-SmartCharging-U-1, SQ-SmartCharging-T-1, SQ-SmartCharging-T-2, SQ-SmartCharging-T-3, SQ-SmartCharging-T-4
Project level KPI:	T-2, T-3, T-4, T-5, T-7, T-9, T-10, T-13, T-22, T-23, U-1, U-2, U-3, U-4, U-5, U-6, U-7, U-8
Use case specific KPI.	T-1-ZEL, T-4-ZEL, T-4-LUX, T-5-LUX, T-5-ZEL, T-6-ZEL, T-13-LUX, T-13-ZEL, T-13-CEA, T-14-ZEL, T-14-CEA, T-21-ZEL, U-3-CEA, U-23-CEA, U-24-CEA

Table 31: Smart Charging evaluation summary

Study question ID	**Use case specific study question**	**Data source**
SQ-SmartCharging-U-1	Do Smart Charging users are willing to say how long will they be parked and which is their SoC when they arrive at the parking?	eMSPs, Site Owner
SQ-SmartCharging-T-1	Does Smart Charging allow for sourcing electricity at lower average prices on the electricity market?	CPOs, Site Owner
SQ-SmartCharging-T-2	Does Smart Charging allow for usage of more locally produced renewable electricity?	CPOs, Site Owner
SQ-SmartCharging-T-3	Does Smart Charging allow for reducing the power peak cost?	CPOs, Site Owner

SQ-SmartCharging-T-4	Does Smart Charging solution using micro grid management increase power availability of the installed charging stations?	CPOs, Site Owner

Table 32: Smart Charging specific study questions

KPI ID	KPI Name	Description
T-1-ZEL	Electricity bill reduction due to local balancing	The difference in electricity cost for the CPO/site between applying smart charging and not applying smart charging
T-4-ZEL	Grid Power Peak Reduction	The average of the reduction in peak power
T-4-LUX	Grid Power	The average of the daily electrical power demand
T-5-LUX	Power Cost	The avoided cost linked to the peak tariffs for the use of the electricity transmission and distribution network as published by ILR (link)
T-5-ZEL	Power Cost	The average cost electrical power demand according to local peak power tariffs
T-8-ZEL	Power Quality	Influence of smart charging on voltage drop
T-13-LUX	Share of energy from local resources in charging	The amount of energy used to charge the vehicles that was produced from local resources
T-13-ZEL	Share of energy from local resources in charging (self-sufficiency)	The relative amount of energy used to charge the vehicles that was produced from local resources
T-13-CEA	Self- production ratio	The amount of energy used to charge the vehicles that was produced from local renewable energy resources over the total energy transferred
T-14-ZEL	Charging flexibility	Variation in the minimum state of charge demand
T-14-CEA	Charging flexibility	Extra time for charging for each charging session
U-3-CEA	Average energy charged per session	The average energy per charge by charging option at each charging site in a month
U-23-CEA	Users flexibility in providing charging plan through mobile app	The number of users who give the information related to their charging plans (i.e. SOC at arrival, desired departure time, desired final SOC)
U-24-CEA	Quality of charging service	Ratio of vehicles that leave with the same state of charge they would have had if no smart charging was performed

Table 33: Smart Charging specific KPIs

5.1.9 Use Case III-1: EV Charging location planning tool

The EV charging location planning tool use case is going to be evaluated using interviews distributed to local stakeholder and policy makers in 2 pilot sites testing this technology. The use case entails objectives to be achieved at the site levels (see Chapter 3). It also requires the definitions of specific

forms to collect information from stakeholders (see section 3.2.3.1). The evaluation methodology is reported in Table 34. The successful outcomes expected at the completion of the use case will be further defined in another task.

UC III-1	Location Planning
Pilot Sites:	North Italy, Luxembourg, Barcelona
Data collection:	Interviews delivered to local stakeholders and policy makers
Impact area:	Usage and Market and Society
Study questions	See interview form in section 4.2.2.2

Table 34: Location Planning tool evaluation methodology

5.1.10 Use Case III-2: Incentives schemes and tariff structures towards emobility sustainability

The incentives schemes and tariff structures towards emobility sustainability use case is going to be evaluated using interviews distributed to local stakeholder and policy makers in 4 pilot sites testing this technology. The use case entails objectives to be achieved at the site levels (see Chapter 3). It also requires the definitions of specific forms to collect information from stakeholders (see section x.y) and emobility users as well as KPIs from field data defined at the project level (see Chapter 4). The evaluation methodology is reported in Table 35. The successful outcomes expected at the completion of the use case will be further defined in another task.

UC III-2	Incentives Schemes and Tariff Structures
Pilot Sites:	Barcelona, Zellik, Bari
Data collection:	Interviews delivered to local stakeholders and policy makers, survey delivered to EV users, and field data of selected use cases for which incentives schemes and tariff
Impact area:	Usage and Market and Society
Study questions	See interview form in section 4.2.2.2 and survey form in 4.2.2.1.2

Table 35: Incentives Schemes and Tariff Structures evaluation methodology

5.2 Study questions, successful outcomes and KPIs per pilot site

5.2.1 Austria

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Austria.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to another standard solution/benchmark.	U-1, U-2, U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5, U-6, U-7
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Do eCharge4Driver solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to other solution/benchmark.	T-14

Table 36: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in Austria

UC II-1:Advanced charging authentication ISO15118 PnC		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark .	U-1, U-3
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to other solution/benchmark .	T-2, T-3, T-17
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to other solution/benchmark .	T-10

Table 37: Advanced charging authentication ISO15118 PnC use case evaluation in Austria

UC II-4: Smart charging suite unlocking new business opportunities		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3
Do eCharge4Drivers' solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to other solution/benchmark.	T-14
Does Smart Charging allows for usage of more locally produced renewable electricity?	Increased share of energy from local renewable resources in charging.	T-13
Does Smart Charging allows for sourcing electricity at lower average prices on the electricity market?	Lower average electricity cost in EUR/ kWh on the spot market compared to hypothetical charging sessions without the smart charging.	T-7

Table 38: Smart Charging use case evaluation in Austria

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-17

Table 39: Booking service use case evaluation in Aistria

5.2.2 Barcelona, Spain

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Barcelona.

UC I-3: Battery sharing concept for L1e vehicles (SCUTUM - Swobbee)		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to another standard solution/benchmark.	U-1, U-2, U-3, U-4
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-7, U-8, U-9

Table 40: Battery sharing concept for L1e vehicles use case evaluation in Barcelona

UC II-1: Advanced charging authentication ISO15118 PnC		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3
Does eCharge4Drivers change the users' payment preferences for the EV charge?	Register an increase in number of payments per customers and per charging option.	U-19

Table 41: Advanced charging authentication ISO15118 PnC use case evaluation in Barcelona

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-15, U-18, U-21
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to other solution/benchmark.	T-2

Table 42: Booking service use case evaluation in Barcelona

UC II-3: Route Planner		
Study Question	**Successful Outcome**	**KPIs**
How frequently do the users consult the EV routing services?	Register an increase in numbers of use of the routing service	U-17-ELECTROMAPS
What is the users' motivation of using the app-based services?	Understand the usability of the services in the reality	U-36
Do eCharge4Drivers' solutions reduce the time used to find an EV charging station?	Decrease the time used to search and find charging stations	T-28-ELECTROMAPS
Do eCharge4Drivers' solutions help to plan the activities with the EV?	Confirm the correct performance of the original purpose of the service	T-29-ELECTROMAPS
Do eCharge4Drivers' solutions help to perform long-range trips with the EV?	Confirm the correct performance of the original purpose of the service and understand the size of the long trips done with EVs	T-30-ELECTROMAPS

Table 43: Route planner use case evaluation in Barcelona

UC II-4: Smart charging suite unlocking new business opportunities		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3-CEA, U-24-CEA
Do eCharge4Drivers users are willing to say how long will they be parked and which is their SoC when they arrive at the parking?	Register an increase in number of users who use the mobile application to give this flexibility to be able to plan the charging of the different users parked.	U-23-CEA
Do eCharge4Drivers' solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to other solution/benchmark.	T-14-CEA
Does Smart Charging allows for sourcing electricity at lower average prices on the electricity market?	Register a reduction in costs since the beginning of the demonstration or in comparison to another solution/benchmark.	T-7, T-24
Does Smart Charging allows for usage of more locally produced renewable electricity?	Register an increase in the usage of locally produced electricity since the beginning of the demonstration or in comparison to another solution/benchmark.	T-13-CEA

Table 44: Smart Charging use case evaluation in Barcelona

5.2.3 Berlin, Germany

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Berlin.

UC I-3: Battery sharing concept for L1e vehicles (SCUTUM - Swobbee)		
Study Question	**Successful Outcome**	**KPIs**
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-2, T-16
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to another solution/benchmark.	T-9, T-10
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark.	U-1, U-2, U-12
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5, U-6, U-8, U-11

How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-18, U-21

Table 45: Battery sharing concept for L1e vehicles use case evaluation in Berlin

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-15, U-18, U-21
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-16, T-19

Table 46: Booking service use case evaluation in Berlin

5.2.4 Bari, Italy

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Bari.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to another standard solution/benchmark.	U-1, U-2, U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5, U-6, U-7
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Do eCharge4Driver solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to other solution/benchmark.	T-14

Table 47: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in Bari

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-15, U-18, U-21
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-16, T-19

Table 48: Booking service use case evaluation in Bari

UC II-3: Route Planner		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-17, U-18, U-21
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-16, T-18, T-19

Table 49: Route planner use case evaluation in Bari

5.2.5 Greece

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Greece.

UC II-1: Advanced charging authentication ISO15118 PnC		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark.	U-1, U-3
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to other solution/benchmark.	T-2, T-3, T-17
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to other solution/benchmark.	T-10

Table 50: Advanced charging authentication ISO15118 PnC use case evaluation in Greece

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-17

Table 51: Booking service use case evaluation in Greece

UC II-3: Route Planner		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to other solution/benchmark.	T-2, T-18

Table 52: Route planner use case evaluation in Greece

5.2.6 Grenoble, France

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Grenoble.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark.	U-1, U-2, U-3-CEA
Do eCharge4Drivers' solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-2
Do eCharge4Drivers' solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to other solution/benchmark.	T-9, T-10
Do eCharge4Driver solutions impact users charging behaviours?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-14-CEA

Table 53: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in Grenoble

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-17

Table 54: Booking service use case evaluation in Grenoble

UC I-4: Charging Point on Lamp Post		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3-CEA

Table 55: Charging point on lamp posts use case evaluation in Grenoble

UC II-4: Smart charging suite unlocking new business opportunities		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3-CEA, U-24-CEA
Do eCharge4Drivers users are willing to say how long will they be parked and which is their SoC when they arrive at the parking?	Register an increase in number of users who use the mobile application to give this flexibility to be able to plan the charging of the different users parked	U-23-CEA
Do eCharge4Drivers' solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-14-CEA
Does Smart Charging allows for usage of more locally produced renewable electricity?	Increased share of energy from local renewable resources in charging.	T-13-CEA
Does Smart Charging allows for sourcing electricity at lower average prices on the electricity market?	Lower average electricity cost in EUR/ kWh on the spot market compared to hypothetical charging sessions without the smart charging.	T-7, T-24

Table 56: Smart Charging evaluation summary in Grenoble

5.2.7 Luxembourg

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in Luxembourg.

UC II-4: Smart charging suite unlocking new business opportunities		
Study Question	**Successful Outcome**	**KPIs**
Do eCharge4Drivers' solutions impact users charging behaviors?	The indicated time of the stay at the demo site (equals to the projected connection time of the vehicle) is significantly longer than the required recharging time of the vehicle arriving with the same SOC, if it was recharged instantly.	U-23-CEA
Do eCharge4Drivers' solutions have more efficient distribution of the power?	The peak power with the demonstrated smart charging option was significantly lower than compared to a hypothetical instant charging at the same site	T-4-LUX, T-5-LUX, T-7
Does Smart Charging allow for usage of more locally produced renewable electricity?	The average percentage of locally produced renewable electricity is maximized with the smart charging option as compared to a hypothetical instant charging at the same site	T-13-LUX
Does mart Charging allow for reducing the power peak cost?	The peak power component of the grid tariff has been lowered with the charging option compared to a hypothetical (instant) charging at the same site.	T-5-LUX
Does Smart Charging allow for sourcing electricity at lower average prices on the electricity market?	Lower average electricity cost in EUR/ kWh on the spot market compared to hypothetical charging sessions without the charging option	T-7

Table 57: Smart Charging evaluation summary in Luxembourg

5.2.8 North Italy

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in the site in North Italy.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-4, U-5, U-7
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-18

Table 58: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in North Italy

UC II-1: Advanced charging authentication ISO15118 PnC		
Study Question	**Successful Outcome**	**KPIs**
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-4, U-5, U-7
Do eCharge4Driver solutions reduce technical problem thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-15, T-17, T-18, T-26-ABB, T-27-ABB
Do eCharge4Drivers' solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-25-ABB

Table 59: Advanced charging authentication ISO15118 PnC use case evaluation in North Italy

UC II-3: Route Planner		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16, U-17, U-18
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-18

Table 60: Route planner use case evaluation in North Italy

UC II-4: Predictive Diagnostic Service		
Study Question	**Successful Outcome**	**KPIs**
Does eCharge4Drivers solutions increase the battery lifetime?	Register an increase of the lifetime of the vehicle battery along the life of the vehicle itself (Percentage of state of health greater than 5%).	T-31-CRF
Does eCharge4Drivers solutions reduce the charging time of the battery?	Register a reduction of time during charging phase of the vehicle itself (Percent of Charging time lower than 5%).	T-32-CRF

Table 61: Predictive diagnostic use case in North Italy

5.2.9 Turkey

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in the site in Turkey.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to another standard solution/benchmark.	U-1, U-2, U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5, U-6, U-7
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Do eCharge4Driver solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-14

Table 62: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in Turkey

UC II-1: Advanced charging authentication ISO15118 PnC		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark.	U-1, U-2, U-3
How does the efficiency of the charging solution change with eCharge4Drivers?	Register a decrease of the time needed to charge compared to other standard solution/benchmark and a decrease in the time needed to support the local grid.	U-3
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5, U-6, U-7
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16, U-17, U-18

Does eCharge4Drivers change the users' payment preferences for the EV charge?	Register an increase in number of payments per customers and per charging option.	U-19, U-20
Do eCharge4Driver solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-14
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-18, T-25-ABB, T-27-ABB

Table 63: Advanced charging authentication ISO15118 PnC use case evaluation in Turkey

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16, U-18
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	not selected

Table 64: Booking service use case evaluation in Turkey

UC II-3: Route Planner		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-14, U-15, U-16, U-17, U-18
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-5
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-18

Table 65: Route planner use case evaluation in Turkey

5.2.10 Zellik, Belgium

This section presents the tables containing the study questions and KPIs to evaluate the impact of the use cases that will be demonstrated in the site in Zellik.

UC I-1: Power charging stations for passenger & L3e vehicles with enhanced user interfaces		
Study Question	**Successful Outcome**	**KPIs**

How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3
Do eCharge4Drivers' solutions achieve lower electricity cost?	Register a reduction in costs since the beginning of the demonstration or in comparison to another solution/benchmark.	T-1-ZEL, T-5-ZEL
Do eCharge4Driver solutions have more efficient distribution of the power?	Register an increase in all selected KPIs (or specify which one in particular) since the beginning of the demonstration or in comparison to other solution/benchmark.	T-4-ZEL, T-21-ZEL, T-8-ZEL, T-22, T-23
Do eCharge4Drivers' solutions increase the use of locally produced electricity?	Register an increase in the usage of locally produced electricity since the beginning of the demonstration or in comparison to another solution/benchmark.	T-13-ZEL, T-22
Do eCharge4Drivers' solutions impact users charging behaviors?	Register a change in users' charging flexibility.	T-14-ZEL
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-2, T-3
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to another solution/benchmark.	T-9, T-10

Table 66: Power charging stations for passenger & L3 vehicles with enhanced user interfaces use case evaluation in Zellik

UC I-2: Multi-user master station with multiple DC power charging points for passenger and L1e EVs (PWD)		
Study Question	**Successful Outcome**	**KPIs**
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-2, T-3, T-15, T-16, T-17, T-19
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to another solution/benchmark.	T-9, T-10
Do eCharge4Driver solutions impact users charging behaviors?	Register an increase of the demand for charging since the beginning of the demonstration or in comparison to another solution/benchmark.	T-14-ZEL
Do eCharge4Driver solutions have more efficient distribution of the power?	Register an increase in all selected KPIs (or specify which one in particular) since the beginning of the demonstration or in comparison to other solution/benchmark.	T-24-ZEL

How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers) and a decrease of the time needed to charge compared to other standard solution/benchmark .	U-1, U-2, U-3
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-16, U-21
Does eCharge4Drivers change the users' payment preferences for the EV charge?	Register an increase in number of payments per customers and per charging option.	U-19, U-20
Does eCharge4Drivers improve the availability of the charging infrastructure?	Register an increase in availability of charging station and/or a reduction in the occupancy over time.	U-4, U-5, U-6, U-7, U-8

Table 67: Multi-user master station with multiple DC power charging points for passenger and L1e EVs use case evaluation in Zellik

UC II-2: Booking Service		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-15, U-18, U-21
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-16, T-19
How does the use of the app-based services change with eCharge4Drivers?	Register an increase in number of users, in users per unit of time and in realizing a greater number of charging session using app-based services during the period of observation.	U-13, U-15, U-18, U-21

Table 68: Booking service use case evaluation in Zellik

UC II-4: Smart charging suite unlocking new business opportunities		
Study Question	**Successful Outcome**	**KPIs**
How does the use of the charging options change with eCharge4Drivers?	Register an increase in customers (both number of daily costumer as well as number of loyal customers).	U-1, U-2, U-3
Do eCharge4Drivers' solutions achieve lower electricity cost?	Register a reduction in costs since the beginning of the demonstration or in comparison to another solution/benchmark.	T-1-ZEL, T-5-ZEL
Do eCharge4Driver solutions have more efficient distribution of the power?	Register an increase in all selected KPIs (or specify which one in particular) since the beginning of the demonstration or in comparison to other solution/benchmark.	T-4-ZEL, T-21-ZEL, T-8-ZEL,

		T-22, T-23
Do eCharge4Drivers' solutions impact users charging behaviors?	Register a change in users' charging flexibility.	T-14-ZEL
Do eCharge4Driver solutions reduce technical problem, thus more reliable for the users?	Register a reduction of the number of technical problems since the beginning of the demonstration or in comparison to another solution/benchmark.	T-2, T-3
Do eCharge4Driver solutions reduce the number of failure and unscheduled maintenance?	Register a reduction of the number of failures and scheduled/unscheduled maintenance since the beginning of the demonstration or in comparison to another solution/benchmark.	T-9, T-10
Do eCharge4Drivers' solutions increase the use of locally produced electricity?	Register an increase in the usage of locally produced electricity since the beginning of the demonstration or in comparison to other solution/benchmark.	T-13-ZEL, T-22

Table 69: Smart Charging evaluation summary in Zellik

CONCLUSION

This document provides the framework for eCharge4Drivers partners and for external stakeholders to assess the impact of each use case that will be demonstrated within this project. It inherited from previous deliverables a preliminary analysis of the areas that will be impacted the most by the demonstrations, a set of study questions and a preliminary list of KPIs. The main contribution of this document is to provide a sequence of logical steps necessary to assess each use case that start with the association between use case objectives, study questions and successful outcome to be expected. Each outcome is then quantified using KPIs that will be measured with the data collected from CPOs, eMSPs, and other systems owned by the pilot site. The KPIs are presented with greater detail compared to previous deliverable and the list of KPIs has been expanded with a greater focus on the technical performance of the demonstrations. Furthermore, pilot site contributed by identifying use case and site specific KPIs. The contents of this document are useful not only for eCharge4Drivers partners but also for external stakeholders dealing with the development of charging technologies and e-mobility services.

The methodology adopted for assessing the eCharge4Drivers impact is built up in two phases. The first one focuses on mapping the use case objectives and goals with study question, and the second one identifying measurable successful outcomes and KPIs. The first phase focuses on the identification of the objectives that each use case is supposed to achieve by the end of the project and has been completed mapping the objectives of each use case with study questions, each one referring to one impact areas. The second one focuses on the association of measurable outcome with KPIs in accordance with the scope of each use case. Project partners have selected and identified study question, successful outcome and KPIs that will be used to monitor and assess the outcome of each use case for which they are responsible.

In addition to the study questions and KPIs, a survey and interview forms have been defined. Two set of survey are necessary to assess the users experience with the technology and services demonstrated in the project and their aim is to capture the EV users' perspective on the functional requirements of the eCharge4Drivers solutions as well as user's experience and attitude towards the demonstrated systems and services.

The quantitative and qualitative data required for the calculation of the proposed eCharge4Drivers KPIs will be collected via surveys, which will be conducted in demonstration areas, and/or will be provided in pseudonymised format by the CPOs and eMSPs of the eCharge4Drivers'consortium. For the data collection as regards charging preferences and concerns via surveys, user engagement is a very important task. For the data collection from CPOs and eMSPs from demonstration areas, the availability and quality of data are crucial factors for the extraction of mobile/parking and charging profiles. Data availability and quality are proved to be highly dependent on the maturity level of the e-mobility situation. The evaluation framework defined in this document will be exploited to assess the impact of the eCharge4Drivers solutions at pilot sites.

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6. eCharge4Drivers, D1.3: Use cases for the demonstration

ANNEX 1: PROJECT LEVEL KPIS

Technical KPI at project level:

KPI T-1	Cost reduction due to balancing
Description:	The difference in price between 2 different charging options, one using balancing and the other one without.
How to measure the KPI:	Subtract the average price per KW per day in a week of the charging option with balancing to the average price per KW per day in a week of the charging option without balancing.
Unit metric:	Money savings (Euro per kWh)
Data type:	Float
Data needed to calculate KPI:	Balancing price (€/kWh), Price without Balancing (€/kWh).
KPI measurement:	Each month since the demonstration starts.

KPI T-2	Complaints rate
Description:	Number of complaints for the charging station received / total uses of the charging stations per week.
How to measure the KPI:	Divide the sum of the technical problems reported during the charging experience in a week by the number of charging sessions in the same week.
Unit metric:	Share of charging session with technical problems per week (%).
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Complaint unique id; Timestamp, Total number of charging sessions.
KPI measurement:	Each month since the demonstration starts.

KPI T-3	Technical problems reported during the charging experience
Description:	Average weekly technical problems reported by the charging station.
How to measure the KPI:	Divide the sum of the technical problems reported during the charging experience in a month by the number of weeks in the same month.
Unit metric:	Technical problems per week.
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Complaint unique id; Timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-4	Grid Power Peak
Description:	The average of the daily highest electrical power demand.
How to measure the KPI:	Divide the sum of the highest power demanded each day in a week by the number of days in the same week.
Unit metric:	Peak demand (kW).
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Power demand; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-5	Power Peak Cost
Description:	The average cost of the daily highest electrical power demand.
How to measure the KPI:	Divide the sum of the daily electricity costs at the power peak in a week by the number of days in the same week.
Unit metric:	Euros per kW at the peak (€/kWp).
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Peak demand timestamp; Electricity price; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-6	Power Peak to Average ratio
Description:	The ratio between the daily highest electrical power demand and the average.
How to measure the KPI:	Divide the the highest power demanded in a week by the average power demanded in the same week.
Unit metric:	Power peak to average ratio (kWp/KW).
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Power demand peak; Power demanded; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-7	Electricity cost on the spot market
Description:	The cost savings for electricity on the market (day-ahead market for the regulatory zone of reference), due to greater availability of electricity from renewable sources fed into the grid.

How to measure the KPI:	Difference between electricity prices for charging session for A) the use of Smart charging, and B)the use of an hypothetical Instant Charging. The electricity prices for session are calculated as average consumption over 15 minutes for all charging points and multiplied by electricity unit price according to market data, then average over a month. The electricity prices for Instant Charging session are calculated considering that the vehicle is charged with the maximum current that has been observed during the smart charging session and lasting the same amount of time.
Unit metric:	Euros saved per charging session (€ per session)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charger, Transaction unique id, Timestamp, start, max current applied, actual current, consumption per charging session, DayAhead60minDeLu.
Data sources:	Charging station, REST API (ENTSO-E Transparency)
KPI measurement:	Each month since the demonstration starts.

KPI T-8	**Power quality**
Description:	The comparison between two accurate voltmeters measuring the same system voltage
How to measure the KPI:	Subtract the average system voltage of the electromechanical movement meter to the average voltage system measured by a high-quality digital meter (true-RMS)
Unit metric:	Power Quality (volt)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; System Voltage Electromechanical Movement; System Voltage RMS; Charging session timestamp
KPI measurement:	Each month since the demonstration starts.

KPI T-9	**Number of scheduled/unscheduled maintanance**
Description:	The number of scheduled/unscheduledmaintenance at each charging site in a month.
How to measure the KPI:	Sum the number of scheduled/unscheduledmaintenance at each charging site in a month.
Unit metric:	Number of scheduled/unscheduled
Data type:	Integer
Data needed to calculate KPI:	Charging site unique identity; Scheduled Maintenance; Unscheduled Maintenance; Charging session timestamp.

KPI measurement:	Each month since the demonstration starts.

KPI T-10	Number of failures
Description:	The number of failures due to Vehicle, Battery, Charging Point, and Grid at each charging site in a month.
How to measure the KPI:	Sum the number of failures due to Vehicle, Battery, Charging Point, and Grid at each charging site in a month.
Unit metric:	Number of failures
Data type:	Integer
Data needed to calculate KPI:	Charging site unique identity; Failure ID; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-13	Share of energy from local resources in charging
Description:	The amount of energy used to charge the vehicles that was produced from local resources.
How to measure the KPI:	Divide the sum of electricity used to charge the vehicles that was produced from local resources over the total amount of electricity used to charge all the vehicles at the same charging site during the same month.
Unit metric:	Kilowatt-hour (kWh)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Energy from local resources; Energy from non-local resources, Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-15	Technical problems reported by the "Plug and Charge" service
Description:	Technical problems reported registered in the standard ISO15118.
How to measure the KPI:	Sum the number of technical problems reported registered in the standard ISO15118 at each charging site in a month.
Unit metric:	Number of technical problems
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; TechnicalProblemISO151118; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-16	Technical problems reported by app-based services
Description:	The average number of daily technical problems reported by the app-based services per week.
How to measure the KPI:	Divide the sum of the technical problems reported by the app-based services per week by the number of days in the same week.
Unit metric:	Number of technical problem per day
Data type:	Float
Data needed to calculate KPI:	Technical Problem ID, Technical Problem timestamp, Technical Problem typology.
KPI measurement:	Each month since the demonstration starts.

KPI T-17	Technical problems reported during the payment
Description:	The share of technical problems reported related to the app payment service per week.
How to measure the KPI:	Divide the sum of the technical problems related to the app payment service per week by the total number of technical problem in the same week.
Unit metric:	Share of technical problem related to the app-based payment service (%)
Data type:	Float
Data needed to calculate KPI:	Payment session ID, Payment Session timestamp, Technical Problem Payment ID, Technical Problem Payment timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-18	Technical problems reported during the use of the route planner
Description:	The average technical problems reported by the route planner per week.
How to measure the KPI:	Divide the sum of the technical problems related to the route planner per week by the total number of technical problems in the same week.
Unit metric:	Share of technical problem related to the route planner (%)
Data type:	Float
Data needed to calculate KPI:	Route Planner Session ID, Route Planner Session timestamp, Problem Route Planner Session ID, Problem Route Planner Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-19	Technical problems reported during the reservation

Description:	The average technical problems reported by the booking service per week.
How to measure the KPI:	Divide the sum of the technical problems related to the booking service per week by the total number of technical problem in the same week.
Unit metric:	Share of technical problem related to the booking service (%)
Data type:	Float
Data needed to calculate KPI:	Booking Session ID, Booking Session timestamp, Problem booking Session ID, Problem Booking Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-22	Self-consumption
Description:	The relative amount of energy produced locally which is consumed locally by charge the vehicles which is supplied.
How to measure the KPI:	Divide the sum of electricity produced electricity used to charge the vehicles with the total amount of electricity produced locally.
Unit metric:	Percentage (%)
Data type :	Float
Data needed to calculate KPI:	Charging site unique identity; Energy from local resources; Energy from non-local resources, Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI T-23	Peak demand unsatifaction rate
Description :	The number of times the peak power demand by drivers the smart charging cannot be satisfied due to grid constraints.
How to measure the KPI :	Divide the number of times the charging energy demand leads to power needs exceeding the grid connection per unit time.
Unit metric :	integer
Data type:	Float
Data needed to calculate KPI:	To be defined.
KPI measurement:	Each month since the demonstration starts.

KPI T-24	Average subcribed grid power per charge point
Description:	Sizing parameter indicating what power contract should be subscribed for a given amount of charge point.

How to measure the KPI:	Divide the subscribed grid power by the sum of the charge point maximum power.
Unit metric:	Share of subscribed power over total (%)
Data type:	Float
Data needed to calculate KPI:	Charge point max power and CPO power contract.
KPI measurement:	Each month since the demonstration starts.

Usage KPI project level

KPI U-1	Loyalty to the same charging site
Description:	Number of users who charge electric vehicle at the same charge site more than 2 times in a month.
How to measure the KPI:	Sum the number of users that charge more than 2 times in a month their vehicles at the same charging site.
Unit metric:	Number of users/vehicles
Data type:	Integer
Data needed to calculate KPI:	User unique ID, or vehicle unique ID, Charging site unique identity, Charging session start time, charging session finish time, Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-2	Frequency of use of charging options
Description:	Number of daily uses of each charging option at each charging site in a month.
How to measure the KPI:	Sum the number of users per each charging option at each charging site in a month.
Unit metric:	Number of users/vehicles
Data type:	Integer
Data needed to calculate KPI:	Charging site unique identity; charging option; start time; finish time, Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-3	Average time needed to charge the vehicle
Description:	Average time per charge by charging option at each charging site in a month.

How to measure the KPI:	Divide the sum of time needed to charge all the vehicles using the same charging option in a month by the total number of vehicles that used the same charging option at the same charging site during the same month.
Unit metric:	Time per charging option (minutes/hours)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging option; Start time; Finish time; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-4	**Average time occupancy**
Description:	The average time the parking spot pertinent to the charging station is occupied by charging option at each charging site in a month.
How to measure the KPI:	Divide the sum of the time each vehicle is parked to charge (using the same charging option) in a month by the total number of vehicles that used the same charging option at the same charging site during the same month.
Unit metric:	Time per charging option (minutes/hours)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging option; Plug-in time; Unplug time; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-5	**Availability rate**
Description:	The percent of the time that charging stations are available for use at each charging site in a month.
How to measure the KPI:	Divide the sum of the time charging stations that are occupied by the total time the charging stations is available, then multiply by 100.
Unit metric:	Percent of time charging stations are available (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging station availability; Charging session start time; Charging session finish time; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-6	**Unavailability rate**

Description:	The percent of the time that charging stations are not available for use at each charging site in a month.
How to measure the KPI:	Divide the sum of the time charging stations that are not occupied by the total time the charging stations is available, then multiply by 100.
Unit metric:	Percent of time charging stations are not available (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging Station availability; charging session start time; charging session finish time; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-7	**Average usage ratio of charging station**
Description:	The time the vehicle is connected for charging over the total available time.
How to measure the KPI:	Divide the sum of the time each vehicle is connected to the charging station per charging option in a month by the total time all the charging stations of the same options are available at the same charging site in a month.
Unit metric:	Percent time available per charging option (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging station availability; charging session start time; charging session finish time ; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-8	**Average unavailability ratio due to technical issues**
Description:	The time the charging station is not available (out of service) over the total available time.
How to measure the KPI:	Divide the sum of the time each charging station is not available per charging option in a month by the total time all the charging stations of the same option are available at the same charging site.
Unit metric:	Percent time unavailable per charging option (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charging station availability; charging session start time ; charging session finish time ; Charging session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-10	The versatility of battery swapping stations
Description:	The average time of domestic use of a battery with converter DC-AC versus average time of professional use of a battery with converter DC-AC.
How to measure the KPI:	Subtract the average time to charge the batteries at home to the average time at the charging station per week.
Unit metric:	Time savings (minutes per charge)
Data type:	Float
Data needed to calculate KPI:	Time charging home; Time Charging Station; Number Of Charging Sessions at Home; Number Of Charging Sessions at Station, Charging Session Timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-11	Availability of fully charged batteries for swapping
Description:	State of Charge of batteries in the station at the time of booking request.
How to measure the KPI:	Divide the sum of fully charged batteries over the total available batteries at the charging site.
Unit metric:	Share of fully charged batteries (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Booking Request Time; State Of Charge, Batteries Available.
KPI measurement:	Each month since the demonstration starts.

KPI U-12	Battery Swapping
Description:	The average time for swapping the batteries at each charging site in a month per charging site. (or time to exchange battery including user identification time and check out).
How to measure the KPI:	Divide the sum of the time needed to complete the operation in a month by number of charging session in the same month. (or time at the battery swapping station).
Unit metric:	Average time to swap batteries (minutes/swapping)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity, Charging Session Start Time, Vehicle Parking Time, Vehicle Leaving Time.
KPI measurement:	Each month since the demonstration starts.

KPI U-13	New app users
Description:	The number of applications downloaded by week.
How to measure the KPI:	Divide the sum of the applications downloaded per week by the number of days in the same week.
Unit metric:	Number of downloads (downloads per day)
Data type:	Float
Data needed to calculate KPI:	Download Session Date.
KPI measurement:	Each month since the demonstration starts.

KPI U-14	Users uninstalling the app
Description:	The number of applications uninstalled by week.
How to measure the KPI:	Divide the sum of the applications downloaded per week by the number of days in the same week.
Unit metric:	Number of uninstalled applications (uninstall per day)
Data type:	Float
Data needed to calculate KPI:	Uninstall Session Date.
KPI measurement:	Each month since the demonstration starts.

KPI U-15	Frequency of use of app-based - booking service
Description:	The average number of daily usages of the booking service by week.
How to measure the KPI:	Divide the sum of the users per week of the booking service by the number of days in the same week.
Unit metric:	Number of daily users (users per day)
Data type:	Float
Data needed to calculate KPI:	Booking Session ID, Booking Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-16	Frequency of use of app-based -payment service
Description:	The average number of daily usages of the payment service by week .
How to measure the KPI:	Divide the sum of the users per week of the service for digital payment by the number of days in the same week.
Unit metric:	Number of daily users (users per day)

Data type:	Float
Data needed to calculate KPI:	Payment session ID, Payment Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-17	Frequency of use of app-based – route planner
Description:	The average number of daily usages of the route planner by week.
How to measure the KPI:	Divide the sum of the users per week of the route planner service by the number of days in the same week.
Unit metric:	Number of daily users (users per day)
Data type:	Float
Data needed to calculate KPI:	Route Planner Session ID, Route Planner Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-18	Frequency of use of app-based - available charging station finder
Description:	The average number of daily usages of the service to find a an available charging station (no booking) by week.
How to measure the KPI:	Divide the sum of the users per week of the service to find an available charging station (no booking) by the number of days in the same week.
Unit metric:	Number of daily users (users per day)
Data type:	Float
Data needed to calculate KPI:	Station Finder Session ID, Station Finder Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-19	App-based payments per user
Description:	The number of payments processed through the app per user each week.
How to measure the KPI:	Divide the sum of the payments per week of each app-based service by the total number of users per week.
Unit metric:	Number of payments per users (payments per user per week)
Data type:	Float
Data needed to calculate KPI:	User ID, Payment Session ID, Payment Session timestamp.
KPI measurement:	Each month since the demonstration starts.

KPI U-20	App-based payments per charging option
Description:	The percentage of payments processed through the app for each charging option by week.
How to measure the KPI:	Divide the sum of the payments in a week per each charging option by the total amount of payments per week.
Unit metric:	Share of payments by charging option (%)
Data type:	Float
Data needed to calculate KPI:	Payment Session ID, Payment Session timestamp, Payment type.
KPI measurement:	Each month since the demonstration starts.

KPI U-21	App-based services and total charging ratio
Description:	The percentage of charging sessions being realised by using the app-based services per week.
How to measure the KPI:	Divide the sum of the users per week of each app-based service by the total amount of charging sessions per week.
Unit metric:	Share of charging sessions realised through the service (%)
Data type:	Float
Data needed to calculate KPI:	Booking Session id, Booking Session timestamp, Charging Session id, Charging Session timestamp.
KPI measurement:	Each month since the demonstration starts.

ANNEX 2: USE CASE SPECIFIC KPIS

1. **Use Case Specific KPIs: Multi-user master station with multiple DC power charging points for passenger and L1e EVs**

KPI T-21-ZEL	Compactness of the MultiCharging station
Description:	The smaller footprint of the Multicharging station.
How to measure the KPI:	The dimension of the Multi Charging station - The dimension of the 8 individual charging station.
Unit metric:	Share of technical problem related to the booking service (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity, Dimension of master station, Charging points.
KPI measurement:	Each month since the demonstration starts.

2. **Use Case Specific KPIs: Smart Charging**

KPI T-1-ZEL	Electricity bill reduction due to local balancing
Description:	The difference in electricity cost for the CPO/site between applying smart charging and not applying smart charging.
How to measure the KPI:	Subtract the average price per KWh of the charging option with balancing to the average price per KWh of the charging option without balancing. The option without balancing can be through limited period of the same charging option without balancing applied or simulated according to actual demand without balancing.
Unit metric:	Money savings (Euro per kWh)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Power demanded, Electricity bill, Energy per charging session, Grid power .
Data source:	Charging station, Site owner
Data provider	CPO, Site owner
Pilot sites:	Zellik
KPI measurement:	Each month since the demonstration starts.

KPI T-3-CEA	Average energy charged per session
Description:	The average energy per charge by charging option at each charging site in a month.
How to measure the KPI:	Divide the sum of energy of all charging sessions per charging option at each charging site in a month by the corresponding number of sessions.
Unit metric:	Time per charging option (minutes/hours)
Data type:	Time
Data needed to calculate KPI:	Charging session timestamp, session's energy
Data source:	Charging station
Data provider	CPO
Pilot sites:	Grenoble, Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-4-LUX	Grid Power
Description:	The average of the daily electrical power demand.
How to measure the KPI:	Difference between daily average values of power consumption per site for A) a Smart Charging session and B) an hypothetical Instant

	Charging session (create one simulation for each Smart Charging session).The daily average is computed over measurements taken every 15 minutes for all charging points.
Unit metric:	Power (kW)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Smart charging power; simulated instant charging power; Charging session timestamp.
Data source:	Smart Charging Controller
Data provider	Site owner
Pilot sites:	Luxembourg
KPI measurement:	Each month since the demonstration starts.

KPI T-4-ZEL	Grid Power Peak Reduction
Description:	The average of the reduction in peak power.
How to measure the KPI:	The average relative difference between the peak power demand and actual peak power obtained through smart charging (balancing).
Unit metric:	Percentage (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Power demand; Charging session timestamp, grid power.
Data source:	Charging station, Site owner
Data provider	CPO, Site owner
Pilot sites:	Zellik
KPI measurement:	Each month since the demonstration starts.

KPI T-5-LUX	Power Cost
Description:	The avoided cost linked to the peak tariffs for the use of the electricity transmission and distribution network as published by ILR (https://legilux.public.lu/eli/etat/leg/rilr/2012/11/09/n1/jo Art. 2, Clients finaux 20kV).
How to measure the KPI:	Difference between electric bills for A) the use of Smart Charging, and B) the use of an hypothetical Instant Charging of the same amount of energy at the same site (create one simulation for each Smart Charging session). The electric bills are calculated every 15 minutes for all charging points and average over a year.
Unit metric:	Euros saved per year (€ per year)

Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charger, Transaction unique id, Timestamp, start, max current applied, actual current, consumption per charging session.
Data source:	Smart Charging Controller
Data provider	CPO, Site owner
Pilot sites:	Luxembourg
KPI measurement:	Each month since the demonstration starts.

KPI T-5-ZEL	Power Cost
Description:	The average cost electrical power demand according to local peak power tariffs.
How to measure the KPI:	Multiply the peak power tariff with the peak power (according to local tariffication calculation rules) and divide per consumed energy.
Unit metric:	Euros per kWh
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Peak demand timestamp; Electricity price; Energy per charging session, Power demanded, Grid power, Peak power Tariff.
Data source:	Charging station, Site owner
Data provider	CPO, Site owner
Pilot sites:	Zellik
KPI measurement:	Each month since the demonstration starts.

KPI T-8-ZEL	Power Quality
Description:	Influence of smart charging on voltage drop.
How to measure the KPI:	Voltage drop of voltage difference between applying smart charging and not applying smart charging measured at the grid supply.
Unit metric:	Volt
Data type:	Float
Data needed to calculate KPI:	Grid voltage
Data source:	Site owner
Data provider	Site owner
Pilot sites:	Zellik

KPI measurement:	Each month since the demonstration starts.

KPI T-13-CEA	Self- production ratio
Description:	The amount of energy used to charge the vehicles that was produced from local renewable energy resources over the total energy transferred.
How to measure the KPI:	Divide the sum of electricity used to charge the vehicles that was produced from local Renewable Energy Sources (RES) over the total amount of electricity used to charge all the vehicles at the same charging site during the same month.
Unit metric:	Share of Kilowatt-hour from renewable resources over total (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Energy from local resources; Energy from non-local resources, Charging session timestamp, Session power.
Data source:	Charging Station
Data provider	Site owner
Pilot sites:	Grenoble, Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-13-LUX	Share of energy from local resources in charging
Description:	The amount of energy used to charge the vehicles that was produced from local resources.
How to measure the KPI:	Difference in % of usage locally produced renewables from a virtual PV installation between the two cases: A) Smart charging: Logging on 15 min average values of the site power consumption (total of all charging points) and multiplied with the relative output of the virtual PV plant for each time step. B) Hypothetical instant charging: Creation of a hypothetical charging session for each true charging session: Considering that the vehicle would have been charged instantly with the maximum current that has been observed within the smart charging session, lasting until the same amount of energy was charged as in the true (smart) charging session, also multiplied with the relative output of the virtual PV plant for each time step.
Unit metric:	Percentage of local RES form VPP (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Charger, Transaction unique id, Timestamp, start, max current applied, actual current, consumption (in 15 min intervals per each Charger), relative output solar VPP.
Data source:	Charging Station, PV forecast via API

Data provider	Site owner
Pilot sites:	Luxembourg
KPI measurement:	Each month since the demonstration starts.

KPI T-13-ZEL	Share of energy from local resources in charging (self-sufficiency)
Description:	The relative amount of energy used to charge the vehicles that was produced from local resources.
How to measure the KPI:	Divide the sum of electricity used to charge the vehicles that was produced from local resources over the total amount of electricity used to charge all the vehicles at the same charging site during the same month
Unit metric:	Percentage (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; Energy from local resources; Energy from non-local resources, Charging session timestamp
Data source:	Charging station, Site Owner
Data provider	CPO, Site owner
Pilot sites:	Zellik
KPI measurement:	Each month since the demonstration starts.

KPI T-14-CEA	Charging flexibility
Description:	Extra time for charging for each charging session.
How to measure the KPI:	Difference between parking duration and full charge duration at maximum power.
Unit metric:	Time (hours, minutes, or seconds)
Data type:	Time
Data needed to calculate KPI:	Charging site unique identity; State Of Charge, Charging session timestamp; session power measurement
Data source:	Charging station, Site Owner
Data provider	CPO
Pilot sites:	Grenoble, Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-14-ZEL	Charging flexibility

Description:	Variation in the minimum state of charge demand.
How to measure the KPI:	Subtract the average minimum state of charge demanded in a period by the average minimum state of charge demanded the previous period at the same charging site.
Unit metric:	State of Charge (%)
Data type:	Float
Data needed to calculate KPI:	Charging site unique identity; State Of Charge, Charging session timestamp
Data source:	Charging station
Data provider	CPO
Pilot sites:	Zellik
KPI measurement:	Each month since the demonstration starts.

KPI T-31-CRF	**Battery Lifetime**
Description:	The difference in state of health between 2 different types of procedures to maintain battery lifetime (with and without predictive diagnostic).
How to measure the KPI:	Assuming SOH/% = 100*Qmax/Cr where: Qmax = The maximum charge available of the battery Cr = The rated capacity KPI = SOH/%_no_pred_diag - SOH/%_pred_diag where: SOH/%_pred_diag is the SOH of a battery charged by following the standard charging profile SOH/%_no_pred_diag is the SOH of a battery charged maintained following the predictive diagnostic tool/algo Both the batteries with and without predictive diagnostic algo are aged in laboratory through continuous charging/discharging cycles lasting some month.
Unit metric:	Percentage of state of health (%)
Data type:	Float
Data needed to calculate KPI:	108 Cells Voltage, Pack Voltage, Sum of cells voltage, Battery voltage HV, Current of the Battery Pack, SOC, 18 cell temperature signals, External temperature, Environment temperature, Max Voltage Battery, Min Voltage Battery, SOC max, SOC min.
Data source:	Back-end OEM (Cloud storage)
Data provider	OEM
Pilot sites:	North Italy
KPI measurement:	Each month since the demonstration starts.

KPI T-32-CRF	Battery Charging Time
Description:	The difference in charging time between 2 different types of procedures to maintain battery lifetime (with and without predictive diagnostic).
How to measure the KPI:	Assuming T is the charging time measured as the time required to fully charge a completely discharged battery. KPI = (T_pred_diag - T_no_pred_diag) / T_no_pred_diag * 100 Where: T_no_pred_diag is the time required to fully charge a completely discharge battery by following the standard charging profile. T_pred_diag is the time required to fully charge a completely discharge battery by following the charging profile obtained by the predictive diagnostic algo.
Unit metric:	Percentage of charging time (%)
Data type:	Float
Data needed to calculate KPI:	108 Cells Voltage, Pack Voltage, Sum of cells voltage, Battery voltage HV, Current of the Battery Pack, SOC, 18 cell temperature signals, External temperature, Environment temperature, Max Voltage Battery, Min Voltage Battery, SOC max, SOC min.
Data source:	Back-end OEM (Cloud storage)
Data provider	OEM
Pilot sites:	North Italy
KPI measurement:	Each month since the demonstration starts.

KPI U-23-CEA	Users' flexibility in providing charging plan through mobile app
Description:	The number of users who give the information related to their charging plans (i.e. SOC at arrival, desired departure time, desired final SOC).
How to measure the KPI:	Divide the number of users who give the flexibility by the total number of users at each charging site in a month.
Unit metric:	Share of users providing charging plans (%)
Data type:	Float
Data needed to calculate KPI:	Download Session date, Charging session unique ID
Data source:	Application back end
Data provider	eMSP
Pilot sites:	Grenoble
KPI measurement:	Each month since the demonstration starts.

KPI U-24-CEA	Quality of charging service

Description:	Ratio of vehicles that leave with the same state of charge they would have had if no smart charging was performed.
How to measure the KPI:	For each session, check if the final state of charge is the same as the one we would have had without smart charging. Ratio = number of sessions without degradation divided by total number of sessions. Can be evaluated for each day, week, month, year.
Unit metric:	Share of vehicles with same state of charge as no smart charging performed (%)
Data type:	Float
Data needed to calculate KPI:	Time of arrival and departure, energy quantity, power measurement
Data source:	Charging station
Data provider	CPO, eMSP
Pilot sites:	Grenoble, Barcelona
KPI measurement:	Each month since the demonstration starts.

3. Use Case Specific KPIs: Advanced Charging Authentication ISO15118

KPI T-25-ABB	Successful PnC charge sessions
Description:	The percentage of the successful PnC charging sessions in selected time period.
How to measure the KPI:	Divide the sum of the successful PnC test sessions by the total number of PnC sessions.
Unit metric:	Share of successful PnC Charging Session (%)
Data type:	Float
Data source:	Charging station
Data provider	CPO
Pilot sites:	North Italy, Turkey
KPI measurement:	Each month since the demonstration starts.

KPI T-26-ABB	PnC charge sessions failed on authentication
Description:	The percentage of PnC charge sessions failed on authentication in selected time period.
How to measure the KPI:	Divide the sum of the successful PnC test sessions by the total number of PnC sessions.
Unit metric:	Share of PnC Charging Session Failed on Authentication (%)
Data type:	Float

Data source:	Charging station
Data provider	CPO
Pilot sites:	North Italy, Turkey
KPI measurement:	Each month since the demonstration starts.

KPI T-27-ABB	PnC charge sessions failed on charging
Description:	The percentage of the failed PnC charging sessions failed on charging in selected time period.
How to measure the KPI:	Divide the sum of the failed PnC test sessions on charging by the total number of PnC sessions.
Unit metric:	Share of PnC Charging Session Failed on Charging (%)
Data type:	Float
Data source:	Charging station
Data provider	CPO
Pilot sites:	North Italy, Turkey
KPI measurement:	Each month since the demonstration starts.

4. Use Case Specific KPIs: Route planner (from field data)

KPI U-17-ELECTROMAPS	Use of the service (I)
Description:	The number of petitions to run the service.
How to measure the KPI:	To count per week the number of triggers of the routing service.
Unit metric:	Number of triggers (per week)
Data type:	Integer
Data needed to calculate KPI:	Route Service trigger
Data source:	Application back end
Data provider	eMSP
Pilot sites:	Barcelona
KPI measurement:	Each month since the demonstration starts.

5. Use Case Specific: Route planner (from survey)

KPI U-36-ELECTROMAPS	Use of the service (II)

Description:	Check if the original purpose of the service matches with the answers provided by users of the service.
How to measure the KPI:	To share a survey between users to know the real scenario of application of the services provided.
Unit metric:	Number of answers by real scenario
Data type:	Integer
Data needed to calculate KPI:	Route Planner users' answers
Data source:	Survey
Data provider	eMSP
Pilot sites:	Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-28-ELECTROMAPS	Efficiency of the service (I)
Description:	The quantity of time saved by users when operating with the service.
How to measure the KPI:	To share a survey between users to know the quantity of time (average) used with the service vs quantity of time (average) used without service.
Unit metric:	Time (minutes)
Data type:	Time
Data needed to calculate KPI:	Route Planner users' answers
Data source:	Survey
Data provider	eMSP
Pilot sites:	Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-29-ELECTROMAPS	Efficiency of the service (II)
Description:	Analyse the answers provided by users of the service.
How to measure the KPI:	To share a survey between users to know the efficiency of the scenario with service available vs service not available.
Unit metric:	Level of efficiency for each scenario
Data type:	Categorical
Data needed to calculate KPI:	Route Planner users' answers
Data source:	Survey
Data provider	eMSP

Pilot sites:	Barcelona
KPI measurement:	Each month since the demonstration starts.

KPI T-30-ELECTROMAPS	Efficiency of the service (III)
Description:	Analyse the answers provided by users of the service and analyse the size of long-range trips with EVs.
How to measure the KPI:	To share a survey between users to know the efficiency of the scenario with service available vs service not available. To ask for the total kilometres expected to do in the long-range trip.
Unit metric:	Trip length (km)
Data type:	Float
Data needed to calculate KPI:	Route Planner users' answers
Data source:	Survey
Data provider	eMSP
Pilot sites:	Barcelona
KPI measurement:	Each month since the demonstration starts.