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www.civitas.eu

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About GreenCharge

GreenCharge takes us a few important steps closer to achieving one of the dreams of modern cities: a zero-emission transport system based on electric vehicles running on green energy, with traffic jams and parking problems becoming things of the past. The project promotes:

Power to the people!	The GreenCharge dream can only be achieved if people feel confident that they can access charging infrastructure as and when they need it. So GreenCharge is developing a smart charging system that lets people book charging in advance, so that they can easily access the power they need.
The delicate balance of power	If lots of people try to charge their vehicles around the same time (e.g. on returning home from work), public electricity suppliers may struggle to cope with the peaks in demand. So we are developing software for automatic energy management in local areas to balance demand with available supplies. This balancing act combines public supplies and locally produced reusable energy, using local storage as a buffer and staggering the times at which vehicles get charged.
Getting the financial incentives right	Electric motors may make the wheels go round, but money makes the world go round. So we are devising and testing business models that encourage use of electric vehicles and sharing of energy resources, allowing all those involved to cooperate in an economically viable way.
Showing how it works in practice	GreenCharge is testing all of these innovations in practical trials in Barcelona, Bremen and Oslo. Together, these trials cover a wide variety of factors: *vehicle type* (scooters, cars, buses), *ownership model* (private, shared individual use, public transport), *charging locations* (private residences, workplaces, public spaces, transport hubs), energy *management* (using solar power, load balancing at one charging station or within a neighbourhood, battery swapping), and *charging support* (booking, priority charging).

To help cities and municipalities make the transition to zero emission/sustainable mobility, the project is producing three main sets of results: (1) *innovative business models*; (2) *technological support;* and (3) *guidelines* for cost efficient and successful deployment and operation of charging infrastructure for Electric Vehicles (EVs).

The *innovative business models* are inspired by ideas from the sharing economy, meaning they will show how to use and share the excess capacity of private renewable energy sources (RES), private charging facilities and the batteries of parked EVs in ways that benefit all involved, financially and otherwise.

The *technological support* will coordinate the power demand of charging with other local demand and local RES, leveraging load flexibility and storage capacity of local stationary batteries and parked EVs. It will also provide user friendly charge planning, booking and billing services for EV users. This will reduce the need for grid investments, address range/charge anxiety and enable sharing of already existing charging facilities for EV fleets.

The guidelines will integrate the experience from the trials and simulations and provide advice on localisation of charging points, grid investment reductions, and policy and public communication measures for accelerating uptake of electromobility.

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Executive Summary

This report presents the methodology designed to evaluate the effect of innovation and the stakeholder acceptance about the integrated technologies and business models introduced by the GreenCharge project.

The presented methodology is based on the CIVITAS evaluation framework, which is introduced in the document, and is specialized according to the GreenCharge requirements.

The reader will identify in this document an easy and direct way the "measures" put in place by GreenCharge in the different Pilots and how they will be evaluated. In particular, this document provides an extensive list of Key Performance Indicators (KPIs) and which of them will be evaluated in each Pilot to provide a quantitative estimation of impact of technology innovation.

The users will find KPIs which belong to the CIVITAS evaluation framework, and new defined KPIs, which are relevant to e-mobility innovation.

Three evaluation methodologies will be used to estimate KPIs: evaluation based on automatic computation from data collected in Pilots, evaluation based on simulation and evaluation based on analysis of surveys and interviews delivered to involved stakeholders and volunteers.

The report describes both for project partners and for interested readers respectively how to deliver and how to present evaluation results. The detailed schedule of data collection and evaluation activities have been planned in collaboration with implementation activities.

Finally, a preliminary requirement analysis of simulation and a dashboard design for KPIs presentation are discussed.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

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List of Abbreviations

Table 1: List of abbreviations

Abbreviation	Explanation
KPI	Key Performance Indicator
LEM	Local Evaluation Manager
ML	Measure Leader
PEM	Project Evaluation Manager
CP	Charging Point
CPO	Charging Point Operator
DoW	Description of Work
SoC	Status of Charge
RES	Renewable Energy Source
V2G	Vehicle to Grid

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List of Definitions

Table 2: List of definitions

Definition	Explanation
Measure	Any integrated technology, business models or general activity implemented to improve sustainable mobility. Note: The word "measure"sometimes causes confusion because it sounds like a way of "measuring" something. In the context in which it is used here, it does not refer to any way of measuring, or metrics. The extent to which a measure succeeds in achieving its objective is assessed using KPIs – see below.
Impact Evaluation	Evaluation of a wide range of technical, social, economic and other impacts of the measures (focused measures or packages of measures) arising from implementation by cities.
Process evaluation	Evaluation of the processes of preparation, implementation and operation of measures, including the roles of information, communication and participation.
KPI	Key Performance Indicator used to quantify the impact of a measure.
DoW	Description of Work – formal plan describing the activities to be carried out in the project and the concrete results to be produced.
PEM	Project Evaluation Manager: role defined at beginning of the project. The manager is responsible for coordination of evaluation activities across all WPs. The manager leads and is assisted by an Evaluation Task Force.
V2G	Vehicle to Grid. The capability of an electric vehicle to behave as a stationary battery, returning accumulated energy to the grid
Smart Energy Neighbourhood	A microgrid composed of smart buildings, charging stations and other energy consumers and producers that use an ICT infrastructure and a centralized or distributed energy management systems to optimize energy usage.

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1 About this Deliverable

1.1 Why would I want to read this deliverable?

You will find this deliverable useful if you are interested to understand the evaluation process and evaluation results of technology innovation and integration of the GreenCharge project.

It is essential reading for project partners involved in collecting required data in operating pilots as it describes:

- what data needs to be collected;
- how to compute and present quantitative indicators using the data collected;
- how to estimate the impact/effect of the innovative technology and business models they operate.

1.2 Intended readership/users

- Project partners who are involved in implementation and evaluation activities.
- External readers who are interested to understand the evaluation process and evaluation results of technology innovation and integration of GreenCharge project.
- E-mobility operators might be interested to read this document to understand how to evaluate actions they are going to plan or operate
- It could also be relevant to municipalities which might understand which measures they could implement, or it would profitable to implement for them, according to the KPIs they are interested to improve.

1.3 Structure

The document is organized in three parts. The first part (Chapters 1-2) introduces the CIVITAS evaluation framework and the GreenCharge evaluation methodology based on it.

The second part (Chapters 3-6) describes the list of measures, the evaluation process and key performance indicators selected and/or defined for the GreenCharge evaluation activities in each pilot. In this part, also the time schedule is presented.

In the last part (Chapters 7-8) data requirement analysis for simulation and dashboard design for result retrieval and presentation are described.

1.4 Other project deliverables that may be of interest

- This document provides information that will influence design of the *Simulator and Visualisation tools* that are provided by deliverables *D5.2 and D5.3.*
- This document provides inputs to *Deliverables 5.4/5.5: Intermediate/Final Results for Innovation Effects Evaluation*, which will report the application of the designed methodology to the evaluation of business models and technology integration.
- This document is complemented by *Deliverable 6.2: Data collection and Evaluation Tools*, that will describe which data and which tools will be used for evaluation of stakeholder acceptance.
- This document is an input for *Deliverables 6.3/6.4 on intermediate/final stakeholder acceptance evaluation*, which will report the application of the designed methodology to the evaluation of business models and technology integration.
- *Deliverables 2.4/2.10/2.17 Implementation plan for the Oslo/Bremen/Barcelona pilots* describe the methods for data collection in the pilots, and have been taken into account in development of this deliverable.

1.5 Other projects and initiatives

H2020 – CIVITAS project (City VITAlity and Sustainability – https://civitas.eu)

The GreenCharge project has adopted, specialized and extended the CIVITAS evaluation framework.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

1.6 Evaluation of technologies

The implementation of business models in the context of e-mobility has been supported by the GreenCharge project through the integration and exploitation of innovative technologies that are provided or developed by involved partners. Our purpose here is to evaluate how much such innovation can contribute to improve the impact on e-mobility by this kind of technological innovation.

Not every technology will be used in each business model or in each pilot, but an objective of the evaluation is to estimate the impact that the specific technology can provide when it is used in a certain pilot to implement a specific business model. On the other hand, even if some technologies are not directly used to implement a business model, their impact on e-mobility will be evaluated as well.

Hence it is relevant here to define key performance indicators (KPIs) that allow to measure the impact improvement by the utilization of one or more GreenCharge enabling technologies, and to map them with respect to the pilots.

1.7 Evaluation based on stakeholders acceptance

The measures to be applied involve human interaction, thus they will not succeed if they are not accepted by the stakeholders. A specific measure may affect several stakeholders. For instance, a new bus line affects not only the passengers that take the bus, but also the public transport operator, users and operators of other transport modes, neighbours, and possibly others too. It is important to evaluate the impact on the target users, but also any side effects that the measure may cause.

Stakeholder acceptance can be evaluated in a quantitative and qualitative manner. Acceptance can be derived from automatically collected data, such as number of uses. However, the most common mechanism to collect stakeholders acceptance is by collecting inputs from users using surveys, questionnaires and interviews. These are mechanisms that will be extensively used in GreenCharge to collect the data to compute the corresponding KPIs defined to evaluate stakeholders acceptance. Age, gender and other personal information may play a role in the results, a protocol will be established to comply with data protection rules as stated in the data management plan.

1.8 Evaluation of Business Models

According to the GreenCharge methodology for designing of business models, the following parameters are taken into account for their definition and comparison:

- Efficiency
- Acceptability
- Scalability
- Sustainability
- Business value

Details are provided in *D3.2 - Initial Business models*.

The evaluation methodology and framework will allow for evaluating the impact of business models on e-mobility in terms of the relevant criteria listed above.

In each pilot the evaluation methodology will change according to the available implementation and the specific business model.

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Table 3: Business models evaluation.

Business Model	Pilot	Automatic data processing	Simulation	Survey
Rewarding prosumers	Oslo, Bremen	X		
Pay for priority booking	Oslo, Bremen	X		
Rewarding sharing of private charging points	Oslo, Bremen, Barcelona	X		
EV/e-bike sharing integrated in housing development	Bremen	X		
Pay for occupying charging point while not charging	Oslo, Bremen			X
Rewarding V2G	Oslo, Bremen, Barcelona	X	X	
Other digital available business	Oslo, Bremen, Barcelona	Not yet defined	Not yet defined	Not yet defined

1.9 Process Evaluation

Process evaluation focuses on the internal dynamics and actual operations of a measure in an attempt to understand its strengths and weaknesses [3].

It puts an emphasis on looking at HOW an outcome is produced, rather than measuring its impact.

Thereby, it is less interested in the formal activities (the evaluation plan) and anticipated outcomes, but it investigates informal patterns and unanticipated consequences in the full context of the measure implementation and development.

The process evaluation searches for explanations on the delays, changes, failures but also success of the measure. Therefore, if process evaluation is conducted during the measures development phase as well as later it can provide useful information for improvement.

Finally, process evaluation usually includes perceptions of people close to the measure about how things are going or went.

In this document we will identify drivers, barriers, facilitators, risks and supporting activities identified in each Pilot of GreenCharge project. They will be monitored and evaluated during the implementation and operation phases.

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2 Evaluation Methodology

The GreenCharge evaluation methodology will be based on the CIVITAS[1] Evaluation Framework,

CIVITAS is a network of cities for cities dedicated to cleaner, better transport in Europe and beyond. Since it was launched by the European Commission in 2002, the CIVITAS Initiative has tested and implemented over 800 measures and urban transport solutions as part of demonstration projects in more than 80 Living Lab cities Europe-wide.

GreenCharge has adopted and customized the CIVITAS Evaluation Framework, focusing on e-mobility, in order to exploit the valuable results of that project in terms of methodology and procedures, but also to contribute through its Pilots to the CIVITAS network being compliant with the requirements for participation.

2.1 Approach

The GreenCharge evaluation methodology uses the CIVITAS Evaluation Framework. It defines methods and provides templates to monitor and evaluate impact of the project and innovation process.

The CIVITAS evaluation framework deals with innovation and impact on public transportation. In GreenCharge we will focus on sustainable electric mobility.

The GreenCharge partners have started by the take-up of the framework adapting the Key Performance Indicators (KPIs) to evaluate impact of technology and impact on stakeholder activities in the context of e-mobility when new business models have to be experimented.

Use of the CIVITAS Evaluation Framework was not planned in the GreenCharge proposal, but a decision was taken early in the project to adopt it. This change of direction and emphasis compared to the original project plan led to the need to re-schedule some tasks.

Finally, it is important that readers understand that the approach presented here has not been designed to evaluate the results of GreenCharge project itself, but rather to support projects activities to achieve a higher level of quality of results.

2.1.1 CIVITAS Evaluation Framework

Evaluation is a key part of all the projects within CIVITAS, since it is important to understand the nature and extent of the impacts made by the measures introduced by the cities. The aim of the evaluation task is to ensure that the evaluation is undertaken in such a way that it is consistent with evaluation of other projects and provides enough evidence for solid comparison. The general outline of the evaluation framework within CIVITAS is illustrated in Figure 1: describing main steps and responsibilities in the process.

[1] https://civitas.eu/

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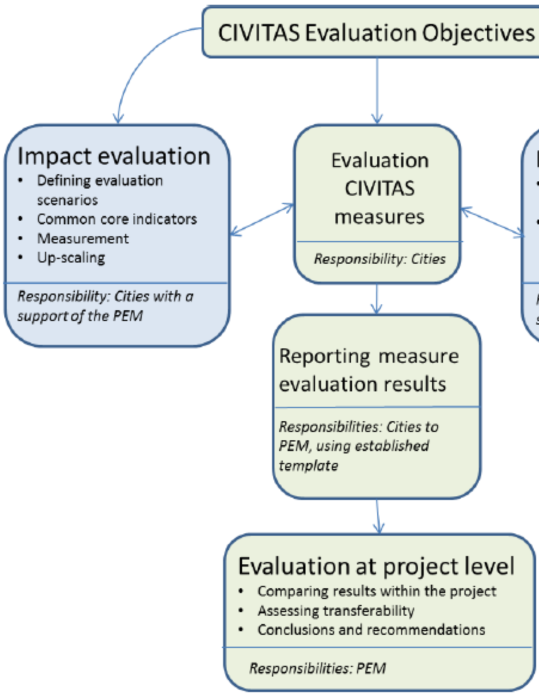

Figure 1: The CIVITAS evaluation process.

The evaluation task has been divided into two objectives: impact evaluation and process evaluation.

- Impact evaluation includes the evaluation of a wide range of technical, social, economic and other impacts resulting from the measures being implemented by the cities. It involves the selection of the quantitative indicators from the CIVITAS list and their measurement through 'before' and 'after' surveys.
- Process evaluation involves the evaluation of the processes of preparation, implementation and operation of the measures including the roles of information, communication and participation. It includes the collation and analysis of activities engaged in throughout the whole process to understand more clearly why measures succeed or fail.

The results of both impact and process evaluations are then drawn together to provide a comprehensive evaluation on project level. This should provide the necessary knowledge to determine the effectiveness of specific measures and packages of measures and so help to identify good practice and the potential for its transferability to other cities across Europe.

A list of general indicators and e reporting templates are part of the frameworks. Selected CIVITAS indicators and new ones defined in Greencharge are described in Section 3. For a detailed guide for the definition of KPIs the reader can refer to [4].

2.1.2 The GreenCharge take-up of the Framework

An Evaluation Task Force with representatives from WP2 (Pilots in Living Labs), WP5 (Innovation Effects Evaluation) and WP6 (Stakeholder Acceptance Evaluation) has been set-up to coordinate the evaluation related activities in WP5 and WP6.

The task force has meetings/telcos once a month or according to agreements to:

- Ensure that the CIVITAS methodology is followed
- Represent the project in CIVITAS with respect to evaluation
- Review the local indicators to ensure that they are coordinated across the pilot sites and compliant with the CIVITAS methodology

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The take-up of the CIVITAS evaluation framework has started from the study of CIVITAS "Refined CIVITAS process and impact evaluation framework"[2]. Impact evaluation and process evaluation methodologies have been investigated.

SUN and EURECAT have started the revision of CIVITAS KPIs defined in the ANNEX1 (Indicator Definition & Methodology Sheets) of CIVITAS D3.2. Those KPIs that are relevant to the GreenCharge project have been selected and in some cases extended, and methods of measurement have been revised.

The list of KPIs has been shared with representatives of the Pilots in order to ensure relevance and to integrate the list with new ones. Each pilot confirmed that it would be feasible to evaluate the KPIs and that the measures to be carried out could lead to improvements in the KPIs.

The final list of KPIs is described in the Section 5 of this document.

2.2 Roles

The following roles have been defined for the evaluation activities based on the corresponding responsibility roles defined in the CIVITAS Evaluation Framework.

Site Coordinators (SC) (one at each pilot site) is the leader of the tasks 2.2.1, 2.3.2 and 2.4.1and will coordinate the implementation of the pilot. The SCs will be:

- OSLO in Oslo
- PMC in Bremen
- EUT in Barcelona

Local Evaluation Managers (LEM) (one for each pilot) is a local representative in WP2 and will handle the evaluation related to activities in the 2.x.1 and 2.x.2 tasks (x=1,2,3). The LEM will plan and coordinate the data collection process and will in collaboration with Task 5.1 and Task 6.1 select and adapt the local indicators from the *overall project indicators*. The LEMs will be:

- SINTEF in Oslo
- PMC in Bremen
- EUT in Barcelona

Measure leader (ML) (one for each pilot) is the leader of the 2.x.3 task (x=1,2,3) and is responsible for the data collection at a pilot site, as defined by the local indicators (defined by Task 5.1 and Task 6.1) and the data collection process plan defined by the LEM. The MLs will be:

- SINTEF in Oslo
- PMC in Bremen
- EUT in Barcelona

Project Evaluation Manager (PEM) leads the Evaluation Task Force.

The **Evaluation Task Force** consists of:

- PEM (the leader of the Task Force) (SINTEF)
- The leader of Task 5.1 (SUN)
- The leader of Task 6.1 (EUT)

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[2] Dirk Engels. (2017) D3.2 Refined CIVITAS process and impact evaluation framework, deliverable of CIVITA SATELLITE project. https://civitas.eu/sites/default/files/MOBILIS%20Evaluation%20report%2020%2004%2009.pdf

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- All LEMS
- The leader of WP3 (for coordination of the business model evaluations)

2.3 Evaluation Methods

2.3.1 Evaluation of technology based on automatic data processing

In GreenCharge Pilots users' behaviours and energy utilization in charging stations will be monitored. Data will be collected automatically, e.g., via system logs, user Apps, while different business models and supporting innovative solution are applied. Data analytics and numerical models will be used to evaluate KPIs.

2.3.2 Evaluation of technology based on simulations

In order to overcome limitation of Pilots in terms of scalability, configuration, data availability, regulation, and time and effort constraints, we will use a simulation approach.

This kind of approach will also allow for evaluation of KPIs at design time, when it needs to predict the return of investment or to optimize the dimensioning and positioning of new charging stations, as well as the acquisition of new e-vehicles. In particular, the CoSSMic simulator[3] allows for the estimation of energy related KPIs, such as self-consumption from Renewable Energy Source (RES). The main objective here is to evaluate the impact on effective utilization by the exploitation of Smart Energy Neighbourhood technologies to innovative business models for e-mobility.

2.3.3 Evaluation using data collection surveys

In order to collect stakeholders' feedback, GreenCharge will use surveys and questionnaires. The objective of the surveys is to gather user needs and expectations before the deployment of the measures to be applied, and to monitor them during and after implementation of the measures.

The mechanisms envisioned to collect feedback are the following:

- Surveys with physical presence: they can be delivered in events organized by the project or by third parties. Information may be gathered on paper or using tablets or similar electronic equipment.
- On-line surveys: to facilitate the participation of users at their pace, avoiding the inconvenience of be present at a specific time and place. The surveys will be delivered either as a link to an on-line survey tool (details on the tools will be provided in *D6.2 Development of tools and methods for data collection and analysis*) or as part of the apps to access any service from GreenCharge.
- Focus groups: the information generated during a discussion in a focus group is much richer than the answers that can be provided in a survey, however engaging participants to attend to a focus group is challenging.
- Interviews: they are more suitable when there is an individual stakeholder to interview, rather than a group of users. Access to the stakeholders may be simplified if interviews are arranged in their premises or by phone.

2.3.4 KPIs revision and new KPIs definition

The CIVITAS KPIs have been selected, revised for the evaluation purpose of GreenCharge, and specialized for each Pilot, when it was necessary.

The KPIs have been reviewed by each Pilot independently, in fact they have to assure they can collect data and measure them according to the defined methodology or they can propose alternatives.

[3] Amato, A., Aversa, R., Di Martino, B., Scialdone, M., Venticinque, S. A simulation approach for the optimization of solar powered smart migro-grids (2018) Advances in Intelligent Systems and Computing, 611, pp. 844-853.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

2.3.5 Assessment of the baseline values of KPIs

The list of KPIs have to be amended by the LEM and by the ML leader, who must guarantee the possibility of measuring them or of collecting required data.

The LEM must specify for which KPIs it is possible to assess the baseline value in her Pilot, when and how.

2.3.6 Review of KPIs Target Value methodology

Estimating a KPI Target Value is a relevant activity that contributes to raise the ambition, allows for reasoning on feasibility criteria and for reducing risks.

Some KPIs, and the related Target Values were already defined in the project proposal. It was necessary to review them to check whether, more than a year later, they remained valid. The review process confirmed that they remained valid. For the new KPIs that were defined it was necessary to develop new estimations, both in term of baseline values and target values.

2.4 Evaluation of results

Evaluation of results consists of both a quantitative and a qualitative analysis of the difference between the assessed baseline value and the estimated intermediate and final values for a subset of defined KPIs, which will be evaluated in different Pilots according to the relevance and to the experimented innovative technologies and business models.

As is shown in Figure 2, when this comparison is feasible, the evaluation of other factors, such as barrier or facilitators, will allow for isolating the contribution related to the innovation introduced by GreenCharge technology. The value measured before that the implemented measure is operated is necessary to estimate the room for improvement and to compare the baseline value with the outcome of the project. Identification and observation of other factors are part of the process evaluation and are used to discriminate the impact of the process from effects which are related to the business as usual.

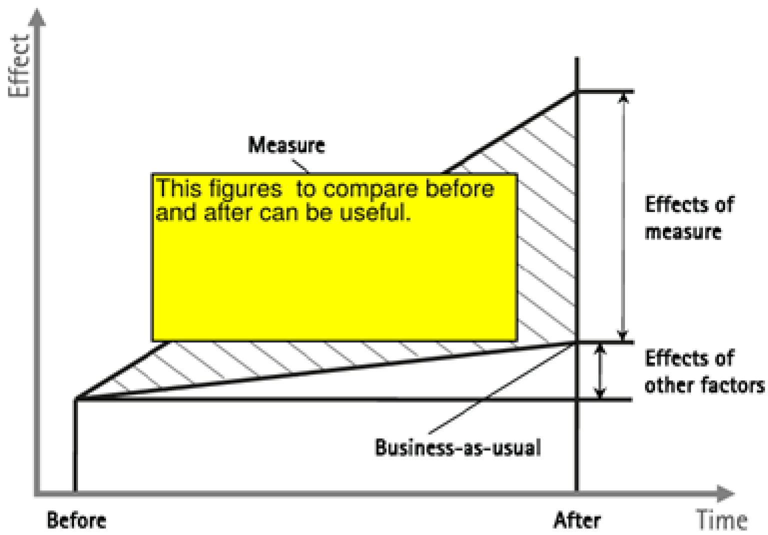

Figure 2: Evaluation of results

Another useful comparison is the one between the resulting values and target values identified before the implementation as the expected impact before.

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3 Key Performance Indicators for Impact Evaluation

The impact on e-mobility by technology innovation and the stakeholder acceptance need to be clearly estimated quantitatively. Key Performance Indicators represent relevant metrics for this purpose. Here we will have the definition of KPIs, which are of interest for each pilot and the general ones, which are common to all pilots.

Table 4 summarizes the KPIs. They are described in much greater detail in the sections which follow. They are grouped according to the related category. Some of them refer to the original CIVITAS KPIs list defined in the *Indicator Definition & Methodology Sheets* (IDMS) of Civitas Evaluation Framework.

Table 4: List of KPIs

Indicator	Sub-category	Impact Aspect
Category: Transport System		
GC5.1: Number of EVs	eMobility	EVs
GC5.2: Number of parking spaces with charging plug	eMobility	Charging availability
GC5.3: Utilization of charging points	eMobility	Charging availability
GC.15 car share e-cars per capita	eMobility	Charging availability
Category: Energy		
GC5.4 Share of battery capacity for V2G	eMobility	V2G
GC5.5 Charging availability	eMobility	Charging availability
GC5.9 Energy mix	Fuel consumption	Share of energy from local RES in neighbourhood grid
GC5.13 Charging flexibility	eMobility	Flexibility
GC5.10 Peak to average ratio	Fuel consumption	Burden on grid
GC5.14 Self Consumption	Fuel consumption	Share of energy from local RES in charging.
Category: Economy		
GC5.6 Average operating costs for charging infrastructure	Cost	Operating costs
GC5.7 Capital investment costs	Costs	Investment for acquiring and installing equipment
GC5.8 Average operation revenue of charging service	Benefits	Operating revenues
GC5.11 Savings	Benefits	Increase savings using local produced energy with smart charging
Category: Environment		
GC5.12 CO2 emissions	Pollution/Nuisance	Emissions

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Indicator	Sub-category	Impact Aspect
Society-people		
GC6.1 Awareness level	Acceptance	Awareness
GC6.2 Acceptance level	Acceptance	Acceptance level
GC6.3 Perception of level of (physical) accessibility of service	Accessibility	(Physical) accessibility of service
GC6.4: Operational barriers	Accessibility	Operational accessibility to (transport) services
GC6.5: Relative cost of the service	Accessibility	Economic accessibility of (transport) services
GC6.6: Shared e-vehicles and stations/operators per capita	Accessibility	Vehicles availability
GC6.7: Average number of trips per person	Mobility demand	Total travel demand/need

3.1 General KPIs

Here we use the indicator sheet from the CIVITAS evaluation framework to detail each focused KPI of the GreenCharge project.

3.1.1 Transport System KPIs

Key Indicator GC5.1	**Number of EVs**
Category	Transport system
Sub-category	eMobility
Impact aspect	Number of EVs
Context and relevance	It can be relevant to measure within a defined area • The number of EVs in general • The number of EVs with respect to the total number of vehicles (%). • How many EVs are private, and how many owned by e-sharing companies. • The number of EVs that citizens plan to buy.
Definition	The number of electric vehicles (EVs) using the charging points in an area during a defined period. **Unit:** Number or percentage.
Measurement	• **Method**: • Statistics can be available and can be used for scalability measures. • The number of shared EVs can be made available from the operators (eventually GC partners).

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	• The number of EVs a community plan to buy can be measured by survey or interview. • **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). Where appropriate, data could also be collected on an annual basis. • **Area of measurements:** GreenCharge Pilots.
References	• GreenCharge
Comments	

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Indicator GC 5.2	**Number of charging points**
Category	Transport system
Sub-category	eMobility
Impact aspect	Charging availability
Context and relevance	It is relevant to know for a defined area • How many charging point (CPs) are already available for charging • How many new CPs are installed • How many CPs are private • How many CPs are shared • How many new CPs are planned to be installed in next time period
Definition	The number of charging points in a defined area. **Unit**: Number

Measurement	• **Method**:
	  • Open data, or statistics from municipalities of Pilots
	  • Interviews, or public info, from charging companies in a Pilot/City
	  • Charging points of GC Pilots
	  • Each pilot should count the number of parking spaces, number equipped with/without charging point and provide information about type (private/shared/max power) and location.
	• **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). Where appropriate, data could also be collected on an annual basis.
	• **Area of measurements:** GreenCharge Pilots.

References	• GreenCharge
Comments	

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Indicator GC 5.3	**Utilization of charging points**
Category	Transport system
Sub-category	eMobility
Impact aspect	Charging availability
Context and relevance	It is relevant how much a charging point is used with respect to • The time EVs are connected during a specific time span • The time the EVs are charging compared to the total connected time • The energy EVs are charged with per connected time unit • The energy EVs are charged with compared to the total charging capacity
Definition	The utilisation of the charging point as seen from the service perspective both with respect to the occupancy ratio (an EV is connected), the time used for charging (EVs may not charge the whole time they are connected), and the utilisation of the charging capacity with respect to energy. **Unit**: Connected time/Time span, Charging Time/Connection time, Charged Energy/Connection time, or Charged Energy/Charging Capacity
Measurement	• **Method**: • *Indirect:* ○ Surveys delivered to charging operators reporting (daily, monthly, …) charging capacity and (daily, monthly, …) energy charged. • *Direct*: ○ Charging system: power time-series measured at charging points, (connection and disconnection time to be compared with booking time, considering power constraints that might cause plugged EVs to wait to charge). ○ Data on bookings from booking system: all bookings should be logged. • **Frequency**: Measurements should be made before measure is introduced (baseline) and at after a measure is applied. • **Area of measurements:** GreenCharge Pilots.
References	• GreenCharge
Comments	The data to be collected must be detailed, including charging profile for the whole connection period.

Indicator GC5.5	**Charging availability**
Category	Transport system
Sub-category	eMobility
Impact aspect	The charging service level offered to the users, who would like to avoid waiting time and to charge as much energy they need.
Context and relevance	It is relevant to compare the utilization of charging point with the quality of service offered to the user in terms of time/distance covered for charging.
Definition	The availability of charging services as seen from the EV user's perspective measured by means of • waiting times • energy transferred to the EV battery compared to energy demand • share of CP booking requests when a CP is available according to request • share of charging when EV is charged according to the charging demand **Unit**: Waiting Time (sec), ChargedEnergy/ChargeDemand, or ShareOfChargingOK
Measurement	• **Method**: Historical data from e-car sharing GC partners. Power time-series measured at charging points. GPS data from tracking systems of e-cars where available. • **Frequency**: Measurements should be at beginning of the project and continuously where it is possible. • **Area of measurements:** GreenCharge Pilots
References	• GreenCharge
Comments	

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3.1.2 Energy KPIs

Indicator GC 5.4	**Share of battery capacity for V2G**
Category	Energy
Sub-category	eMobility
Impact aspect:	V2G
Context and relevance	It is relevant to know how much energy storage capacity in EV batteries that can be used to provide energy flexibility, e.g. to increase consumption of green energy and to reduce power peaks.
Definition	The amount of energy in or share of capacity in EV batteries that can be used to accumulate energy-surplus, and to return it when needed. **Unit**: kWh or Percentage of total EV battery capacity
Measurement	• **Method**: • Calculation of available V2G energy at the charging point based on. ○ Minimum charging level demand ○ Battery state of charge (SOC) if available for all EVs (for calculation of prognosis). If not available, there are some optional ways that are not ideal: Users must provide state of charge via App (%); use historical data for the charging point (same EV every time) ○ Battery capacities manually defined via App (and verified by the charging system - based on maximum charging). ○ Charging profiles for the whole connection period to be able to estimate how the EVs can be charged and discharged and charged, etc. in the connection period. • Simulation changing the ratio of EVs that can behave as a stationary battery based on ○ Historical data on charging profiles ○ Parameters defining battery capacities (based on statistics on battery capacity), number of EVs, minimum charging level ○ National statistics about EV models, scaling down at pilot level (to estimate storage dimension and V2G capability) • **Frequency**: Measurements/Simulation should be made with different parameters when suggested by business models or by indication from users' surveys. • **Area of measurements:** GreenCharge Pilots
Reference	• GreenCharge
Comments	

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Indicator GC5.13	**Charging Flexibility**
Category	Energy
Sub-category	eMobility
Impact aspect	Charging
Context and relevance	When the EV user allows flexible charging, this will facilitate Energy Smart Neighbourhood (ESN), i.e. that the charging system to adjust charging time to peak loads, energy tariffs, etc.
Definition	Different types of flexibility should be measured: • How much flexibility the EV user is willing to provide with respect to when the charging can be accomplished. • The actual flexibility that the system could have utilised **Unit**: • Flexibility provided by user = (Time from plug-in to time to reach target SOC/Minimum time period needed for charging) * (battery capacity - minimum charging level demand) • Actual flexibility = (Time from plug-in to time for disconnection/Minimum time period needed for charging) * (battery capacity - minimum charging level demand)
Measurement	• **Method**: • *Indirect:* ○ Historical data on charging behaviour (connection time and consumption, etc.) ○ Surveys delivered to EV users about charging habits and preferences, willingness to use flexible charging, savings wanted in return of flexibility, etc. • *Direct - for each App-user:* ○ Minimum state of charge (SOC) demand (provided via App) ○ Plug-in time (from charging system) ○ The time to reach the target SOC (from App). It should be possible to define default values for different days. ○ Current battery SOC (for calculation of prognosis). If this is not available, there are some optional ways that are not ideal: Users must provide SOC via App (%); use historical data for the charging point (same EV every time); interaction with EV manufacturer's app. ○ State of charge at time of unplugging (provided via App) ○ Battery capacity (defined via App). • *Direct - optimal flexibility* ○ Charging profiles for the whole connection period - how the EVs is charged during the connection period. • **Frequency**: Measurements should be at beginning of the project by indirect methods and yearly by direct methods. • **Area of measurements:** GreenCharge Pilots
References	• GreenCharge
Comments	

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Indicator GC 5.9:	**Energy mix**
Category	Energy
Sub-category	Energy consumption
Impact aspect	Energy consumption
Context and relevance	To decide how green the energy used is.
Definition	Provides information on the share of different energy sources in the energy provided for a time period, preferably a whole year to see the differences between seasons, optionally 6 months (from/to mid-summer). **Unit:** kWh or percentage per energy source (Monthly energy charged from all types of energy sources)
Measurement	• **Method**: • *Indirect:* ○ Hourly energy consumed in building, and in EVs, and compare this with hourly energy exchanged by the overall neighbourhood and the grid (imported from or exported to the grid). The difference will indicate the contribution from PV and/or battery. (The PV production must also be measured to find the share of RES from the stationary battery.) ○ Electricity bill. ○ Simulations. Simulations must be repeated with/without smart management, with/without additional charging point, V2G enabled e-cars, with/without additional RES. ○ Report on energy mix from DSO • **Frequency**: Measurements should be at beginning of the project, during the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	Derived from CIVITAS KPI Fuel mix
Comments	RES to battery (V2G included) will increase RES consumption

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Indicator GC 5.10	**Peak to average ratio**
Category	Energy
Sub-category	Energy Consumption
Impact aspect	Burden on grid
Context and relevance	It is relevant to reduce peak loads, to increase savings and to reduce grid losses.
Definition	The ratio of the highest energy peak to its average value, used as a measure to indicate the variability of the energy use. **Unit:** kW (Power peak), % (kW Peak/Average kW, in different time slot, monthly, day of week, ...)
Measurement	• **Method**: • Measure power peak from/to the grid of the NEMS (the grid meter) • Bills can be used only for estimating the average kW • Simulations to capture dependency on different parameters, such as local RES capacity, number of EVs, storage capacity/V2G, provided flexibility … • **Frequency**: Measurements should be at beginning of the project, during the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	• GreenCharge
Comments	

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Indicator GC 5.14:	**Self-consumption**
Category	Energy
Sub-category	Energy consumption
Impact aspect	Share of energy from local RES
Context and relevance	It is relevant to reduce CO2 emission and grid fee.
Definition	The amount of energy produced locally that is consumed locally, or the share of the total energy consumption that is locally produced. **Unit:** KWh or percentage (Monthly energy charged from RES, or V2G over total)
Measurement	• **Method**: • *Direct*: ○ KWh from local RES/Total KWh used (self-consumption) • *Indirect:* ○ Electricity bill. ○ Simulations. Simulations must be repeated with/without smart management, with/without additional charging point, V2G enabled e-cars, with/without additional RES. • **Frequency**: Measurements should be at beginning of the project, during the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	• GreenCharge
Comments	

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3.1.3 Economy KPIs

Indicator GC5.6	**Average operating energy costs for charging infrastructure**
Category	Economy
Sub-category	Cost
Impact aspect	Operating costs
Context and relevance	It is relevant to investigate the changes in operating costs as an effect of smart energy management and sustainability of business models.
Definition	This is the measures with direct relation to the operation of the charging infrastructure defined as the ratio of the total operating costs incurred by a charging infrastructure for a period (day, week, month, etc.) divided by the total energy provided for charging via the infrastructure in the same period. Operating costs are personnel costs for the operation of the charging infrastructure, energy costs and maintenance costs. **Unit:** € per kW (operation cost to operate a charging capacity of kW), or € per kWh (Monthly cost/ Monthly charged kWh)
Measurement	• **Method**: • *Energy cost*: ○ Energy bills ○ Energy tariff and power time series • *Others*: ○ An estimation of costs to operate charging infrastructure. • **Frequency**: Measurements should be at beginning of the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	• GreenCharge
Comments	

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Indicator GC5.7	Capital investment cost
Category	Economy
Sub-category	Cost
Impact aspect	Investment for acquiring and installing equipment
Context and relevance	This indicator focuses on the capital costs as a result of measure(s) and, therefore, on the economic perspective of the intended measure packages. Two cost categories are distinguished: • Capital investment costs in infrastructure, equipment, vehicles • Preparation and design costs. The inclusion of the economic perspective of new measure(s) is important for a complete sustainable development assessment.
Definition	Capital investment cost is defined as the total capital costs for purchase of infrastructure and equipment. It can also include the total costs spent in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation. The costs can be the total capital investment costs, or these costs can be measured as cost per kWh or costs per CP. **Unit:** € per kW (capital investment for infrastructure that can deliver a charging capacity of kW), or € per charge point.
Measurement	• **Method**: • Get cost information from market, and from business partners. • Simulation can be used to dimension the equipment, but costs must be estimated by stakeholders • **Frequency**: Measurements should be at beginning of the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	Derived from CIVITAS KPI Capital investment cost
Comments	

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Indicator GC5.8	**Average operating revenue**
Category	Economy
Sub-category	Benefit
Impact aspect	Operating revenues
Context and relevance	This indicator focuses on the operating revenues as a result of measure(s) and, therefore, on the economic perspective of the intended measure packages. It is for example relevant to estimate sustainability and impact of business models. It could be revenues for sharing private charging points, or for smart charging for EV Fleet Operators. Many measures will have direct or indirect impacts on operating revenues, including demand change and changed costs (e.g. due to self-consumption).
Definition	Average operating revenue is defined as the ratio of total income generated divided by the total kWh charged in a given time period (for example day, week, month or year). So: A = B / C where: • A = Average operating revenue for the service (€ per kWh) • B = Total operating revenue for the service (€) • C = Total number of kWh for the service **Unit:** € per kWh (Monthly revenue/ Monthly charged kWh), revenue improvement (percentage)
Measurement	• **Method**: • *Direct:* ○ Pilots operate GC solutions and communicate revenues changes ○ Simulation results, or measures, in terms of self-consumption, total energy charged, V2G revenues are used to calculate revenues. • **Frequency**: Measurements should be at beginning of the project and at the end. • **Area of measurements:** GreenCharge Pilots
References	• Derived from CIVITAS KPI Average operating revenue
Comments	

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Indicator GC 5.11	**Savings**
Category	Economy
Sub-category	Benefits
Impact aspect	Increase savings due to new measure(s)
Context and relevance	Savings are an important motivation for citizens when it comes to smart charging and can be used to induce behaviour changes. It is relevant to measure the savings achieved due to new measure(s).
Definition	Savings are defined as the difference between costs without and with new measure(s) per kWh charged in a given time period (for example day, week, month or year). So: A = (B-C) / D where: • A = Savings per kWh charged • B = Costs without new measures (€) • C = Costs with new measures (€) • D = Total kWh charged **Unit:** €/kWh (money saved per charged kWh), % (percentage of kWh charged from RES)

Measurement	• **Method**:
	  • Direct measures of consumption and local production (self-consumption).
	  • Energy loss calculated from other measured parameters (power peak) and heuristics or mathematical models.
	  • Electricity bill.
	  • Simulations
	• **Frequency**: Measurements should be at beginning of the project, during the project and at the end.
	• **Area of measurements:** GreenCharge Pilots

References	• GreenCharge
Comments	

3.1.4 Environment KPIs

GreenCharge is aware of the wider environmental impacts of electric mobility, but these will not be evaluated at the pilot project level. We will investigate the possibility to compute the reduction of CO2 emissions that can be obtained when dirty energy usage can be reduced by technology innovations, such as smart neighborhood, improved RES utilization, V2G, etc… The reader should be referred to some relevant documents for information on wider life cycle environmental impacts of electric mobility [1], [2].

Indicator GC5.12	**CO2 Emissions**
Category	Environments
Sub-category	Pollution/Nuisance
Impact aspect	Emissions
Context and relevance	Carbon dioxide is the most significant greenhouse gas, contributing about 80% of total EU greenhouse gas emissions, and transport is one of the main sources for CO2 emissions. Measures promoting eMobility will have impacts on CO2 emissions directly (through use of cleaner energy and vehicles) or indirectly (e.g. congestion reduction through use of shared EVs). This indicator can be used to assess the impacts of such measures on CO2 reduction. With eMobility the CO2 emissions depend on the energy mix used. Smart and green charging with optimal use of locally produced energy from RES is utilised can reduce emissions.
Definition	CO2 emissions is defined as the average CO2 emissions per EV km. We focus on • The reduced emissions for EV charged by the charging infrastructure provided compared to charging infrastructure using energy from the distribution grid. • The reduced emissions for EV charged by the charging infrastructure compared with a vehicle using fossil fuel. **Unit**: g CO2/km
Measurement	• **Method**: Data on the CO2 intensity in the electricity distribution grid for different countries is available. Likewise, the average emissions from fossil fuelled vehicles or other usual mode of transport. The CO2 reductions can be calculated based on the amount of self-consumption of energy from local RES. • **Frequency**: Measurements should be made at least twice, i.e. before the measure is introduced (baseline) and at the end of the project (ex-post), or once a year during the project where appropriate. • **Accuracy**: as good as can be obtained within limits of models/resources available
References	Derived from CIVITAS KPI no 24 CO2 Emissions, adapted to eMobility.
Comments	

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3.1.5 Society-people KPIs

Key Indicator GC6.1	**Awareness level**
Category	Society-people
Sub-category	Acceptance
Impact aspect	Awareness
Context and relevance	People are more likely to take advantage of new measures or services if they are aware of them, i.e. if they are informed about the benefits of EVs or existence of EV sharing services. Service providers or authorities with an interest in an increased awareness of new measures may initiate information campaigns in order to raise awareness of the new integrated measures among potential users. Information regarding these measures may be disseminated by means of advertisements, leaflets, posters, etc. In this context, the core indicator will show what percentage of people has been reached and to what extent they have gained knowledge about the new measures, and thereby, whether or not (or to what degree) such an information campaign has been successful. The core indicator intends to assess whether the awareness of the policies and integrated measures (integrated measure package) has changed since they were implemented.
Definition	Awareness level is defined as the percentage of the target population with knowledge of a measure on account of provided information. This indicator is used to assess the awareness of the general public or a particular target group on measures. **Unit:** Percentage of people (within the group) aware of measure X (possible different levels of awareness 1 to 3 or 1 to 5).
Measurement	• **Method**: • Surveys. • Visits to the webpage. • Number of new registrations after a campaign. • **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). It seems also appropriate to measure the impact after each campaign or event. • **Area of measurements:** GreenCharge Pilots.
References	Derived from CIVITAS KPI Awareness level
Comments	

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Indicator GC6.2	**Acceptance level**
Category	Society-people
Sub-category	Acceptance
Impact aspect	Acceptance level
Context and relevance	Awareness (GC 6.1) and acceptance are closely related and should be analysed in conjunction. Those aware of a measure may or may not be satisfied with its existence and/or use. The core indicator intends to assess satisfaction with the existence and/or use of the measure.
Definition	Acceptance level is defined as the percentage of the target population who favourably receive or approve the measure. This indicator is used to assess the acceptance levels of general public or target groups on measures. **Unit:** Share of people with different levels of acceptance (from 1 to 10)
Measurement	• **Method**: • Face-to-face interviews and/or online surveys • Understanding level (% of users with good understanding of the measures) • Usefulness level (% of users feeling measure is useful) • Willingness to change (% of users likely to change mobility behaviour) • **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). Where appropriate, data could also be collected on an annual basis. • **Observed group**: Oslo: Inhabitants of flats, but perhaps also other parties involved (such as housing association, or charge point operator) Bremen: Citizens Barcelona: Citizens • **Area of measurement**: Demonstration area
References	Derived from CIVITAS KPI Acceptance level
Comments	

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Indicator GC6.3	**Perception of level of (physical) accessibility of service**
Category	Society-people
Sub-category	Accessibility
Impact aspect	(Physical) accessibility of service
Context and relevance	The main barriers to social inclusion in eMobility are accessibility and affordability. In terms of social inclusion and accessibility, this indicator concentrates on spatial accessibility and assesses the extent to which user perception of spatial accessibility changes compared to the situation prior to the implementation of the measure Accessibility in the context of this core indicator is limited to the spatial access to the service. User perception of accessibility should thus focus on such spatial dimension and disregard other accessibility factors such as economic (price of using the service in relation to personal income) or physical (e.g. problem-free access to charging services) accessibility. Spatial accessibility not only includes the distance to the closest charge point, but also the convenience of getting there.
Definition	Perception of service accessibility is defined as the user's perception of the physical accessibility of the service. This concern, for instance, the convenience of getting to the service, to use the service, etc. **Unit**: index of "accessibility perception" on a 5-point scale
Measurement	• **Method**: • Surveys with a 5-point Likert scale. • Interviews • Usage • **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). It seems also appropriate to measure the impact after each campaign or event. • **Area of measurements:** GreenCharge Pilots.
Reference	Derived from CIVITAS KPI No. 3 Perception of level of (physical) accessibility of service. instead of concentrating in transport we should focus on the services delivered by the project (sharing e-scooter service, charging points, …)
Comments	

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Indicator GC6.4	**Operational barriers**
Category	Society-people
Sub-category	Accessibility
Impact aspect	Operational accessibility to (transport) services
Context and relevance	Having a charging point and an EV is not a sufficient condition for eMobility. Other barriers have still to be overcome to make use of it or prefer it over other transportation modes. Certain knowledge is necessary to operate or make use of eMobility. Training and information should help to overcome this barrier and enable real equal accessibility for all citizens.
Definition	The operational accessibility to eMobility, as the average reported convenience **Result:** Qualitative study of barriers to eMobility (split by type of barrier)
Measurement	• **Method**: • Surveys. • Interviews • Usage. • **Frequency**: Measurements should be made at least twice during the project, i.e. before CIVITAS measure is introduced (baseline) and at the end of the project (ex-post). It seems also appropriate to measure the impact after each campaign or event. • **Area of measurements:** GreenCharge Pilots.
References	Derived from CIVITAS KPI No. 4 Perception of Operational Barriers. Instead of concentrating in transport we should focus on eMobility
Comments	

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Indicator GC6.5	**Relative cost of the service**
Category	Society-people
Sub-category	Accessibility
Impact aspect	Economic accessibility of (transport) services
Context and relevance	This core indicator provides useful information in the context of eMobility and social inclusion. There are many categories of social inclusion, namely physical, geographical, exclusion from facilities, time-based exclusion, fear-based exclusion, economic exclusion and spatial exclusion. In terms of social inclusion and accessibility, this indicator concentrates on economic accessibility. Many measures may have impacts on the access to eMobility. These include access to EVs, the availability of charging infrastructure, the availability and access to shared EVs, costs, and promotion of eMobility. The core indicator can be used to addresses the charging cost in proportion to average personal income.
Definition	Relative cost of charging service is defined as the average service as a percentage of the average personal available income. **Unit:** % or percentage-based index
Measurement	• **Method**: • Surveys • Interviews. • Usage • Incomes may be retrieved from statistics • **Frequency**: Measurements should be made at least twice during the project, i.e. before measure is introduced (baseline) and at the end of the project (ex-post). It seems also appropriate to measure the impact after each campaign or event. • **Area of measurements:** GreenCharge Pilots.
References	• Derived from CIVITAS KPI No. 5 Relative cost of the service
Comments	

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Indicator GC6.6	**Shared EVs per capita**
Category	Society-people
Sub-category	Accessibility
Impact aspect	Vehicles availability
Context and relevance	One shared EV may replace several individually owned vehicles. Vehicle sharing reduces the mileage driven and increases the use of other modes such as walking, cycling and public transport.
Definition	This indicator is derived by dividing total target group by the number of shared EVs. EVs may be shared electric bikes, scooters of cars available on street for users (who sometimes must go through a registration process and pay a registration fee) to hire. **Unit:** Number of shared EVs per 1000 persons per EV category
Measurement	• **Method**: This indicator is derived by dividing driving age population (18 and over) by the number of shared EVs available from service providers. • **Frequency**: Measurements should be made at least twice during the project, i.e. before CIVITAS measure is introduced (baseline) and at the end of the project (ex-post). It seems also appropriate to measure the impact after each campaign or event. • **Area of measurements:** GreenCharge Pilots.
References	• Derived from CIVITAS Bike sharing and stations per capita
Comments	

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

3.2 Measures and KPIs for Pilots

In GreenCharge measures are activities used to deploy and support innovative technologies and associated business models.

Evaluation activities are designed here to evaluate the impact of single or aggregated technology innovations when they are used for business model operation in each Pilot.

Business models will be designed and refined in WP3 exploiting local workshops and through multiple rounds which allow for the collection of specific requirements of each Pilot and for the selection of available/relevant technology.

Hence, the measures to be evaluated, in terms of integrated technologies and prototypes, as well as the designed and operated business models, will change from Pilot to Pilot.

3.2.1 Measures and KPIs in Oslo Pilot

Here we present the "focused" KPIs for the Oslo Pilot, with specific information about related measures, sub-measures and data sources, where they are available.

Table 5: Focused KPIs in Oslo Pilot

Measure	Sub-Measures	Indicators
GC.M1: Smart charging in garage in apartment building (Røverkollen)	1. Charging infrastructure with flexible charging support 2. V2G support 3. Business model for charging 4. Business model for sharing investment costs for charging infrastructure in apartment building	**Category: Transport system – eMobility** • ***Key ind. no GC5.1***: Number of EVs. Also, the number of new EVs (ordered and/or bought) after the implementation of the pilot is relevant. ○ Data (baseline included) collection through request of data from NPRA (number of EVs, if possible, also the registration numbers), counting and user survey ○ Count number of EVs and total number of cars after implementation to verify numbers and to detect leased EVs. • ***Key ind. no: GC5.2.*** Number of charging points. ○ Visual counting (baseline: 0) • ***Key ind. no: GC5.3***. Utilization of charging points. ○ Measure plug-in-time and charging-time (continuous logging by CPO's systems). • ***Key ind. no: GC5.13.*** Charging flexibility. ○ Baseline: No flexibility ○ Data from CPO's system **Category: Energy - eMobility (WP5)** • ***Key ind. no: GC5.4.*** Share of EVs capacity by V2G. ○ Total V2G capacity (kWh for storing, kW to feed) and number of vehicles. ○ Simulation • ***Key ind. no: GC5.13.*** Charging Time. ○ Direct from App/back-system of CPO • **Key ind. no: GC5.9** Energy mix. ○ Baseline: Energy mix in distribution network

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

<table>
<tr><th>Measure</th><th>Sub-Measures</th><th>Indicators</th></tr>
<tr><td></td><td></td><td>
Calculate mix of energy from PV and grid within NEMS
Simulation for the whole neighbourhood
Key ind. no: GC5.5. Charging availability.
Data from CPO's system on energy booked and provided
Simulations with artificial constraints on energy availability
Category: Economy – Costs (WP5)
Key ind. no: GC5.6. Average operating costs for charging infrastructure.
Data from housing cooperation
Data from charging point operator
Key ind. no: GC5.7. Capital investment.
Data from business partners
Category: Society-people (WP6)
Key ind. no: GC6.1 & 6.2 Awareness and acceptance level
Survey will be based on the completed survey from Nov 2018 with additional questions.
Interviews (details to be decided) to get baseline, first experience and understanding (awareness). Conducted with 1) Housing cooperative board, 2a) residents with EV & charging point, 2b) residents with charging point but without EV, 2c) residents without EV & charging point. The interview will be conducted as individual or group interviews.
Number of registered users of the charging App.
</td></tr>
<tr><td>GC.M2:Sharing of private charging points (Røverkollen)</td><td>
Booking of private charging points
Roaming service
Business model for shared use of charging points
</td><td>
Category: Transport system – eMobility (WP5)
Key ind. no: GC5.2. Number of charging points
Visual counting (baseline: 4)
Key ind. no: GC5.3. Utilization of charging points.
Baseline: Data from housing cooperative's spread sheet for booking
Data from CPO's systems
Key ind. no: GC5.5. Charging availability.
Data on CP availability from App (smiley, etc.) provided during booking
Data on waiting time from App (simple survey with minutes, etc.) provided at start of charging
Category: Economy – Costs (WP5)
Key ind. no: GC5.6. Average operating costs for charging infrastructure.
Data from housing cooperation and charging point operator
Category: Economy – Benefits (WP5)
Key ind. no: GC5.8. Average operation revenue.
Baseline: Current subscription fees
Data from housing cooperation and charging point operator
</td></tr>
</table>

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Measure	Sub-Measures	Indicators

		Category: Society-people. Physical accessibility.
		• ***Key ind. no: GC6.1 & 6.2.*** Awareness and acceptance level
		  ○ The user survey will contain questions on whether the residents are aware of the public charging points, and if they recommend it to their guests and other neighbours.
		  ○ Send survey to external users of the App

GC.M3:Optimal use of energy (Røver-kollen)	1. Neighbourhood energy mngt (NEM) system
	2. PV an storage in neighbourhood
	3. Business models for prosumers/ Use of PV energy
	4. Business model for flexible energy demand
	5. Business model for shared use of energy from local RES and storage
		Category: Energy - Energy consumption (WP5*)*
		• ***Key ind. no: GC5.9.*** Energy mix.
		  ○ Baseline: From DSO
		  ○ For garage: Data from energy management system
		  ○ For neighbourhood: Simulations
		• ***Key ind. no 5.10***. Peak to average ratio.
		  ○ Baseline: Data of load profiles from historical data from the garage without charging from metres/DSO – before start of pilot.
		  ○ For garage: Data from energy management system
		  ○ For neighbourhood: Simulations
		Category: Economy – Costs (WP5)
		• ***Key ind. no: GC5.6.*** Average operating costs for charging infrastructure
		  ○ Data from housing cooperation and charging point operator
		• ***Key ind. no: GC5.7.*** Capital investment costs
		  ○ Data from business partners
		Category: Economy – Benefits (WP5)
		• ***Key ind. no: GC5.11.*** Savings
		  ○ Data from housing cooperation
		Category: Environment – Emissions (WP5)
		• ***Key ind. no: GC5.12*** CO2 emissions (% CO2 saved, increasing self-consumption)
		  ○ Baseline: Use CO2 intensity in distribution net (from DSO) and emissions from fossil cars (based on statistics)
		  ○ Calculate emissions from EVs charged by energy from distribution network.
		  ○ Calculate emissions from EVs charged by smart charging.
		Category: Society-people (WP6)
		• ***Key ind. no: GC6.1 & GC6.2*** Awareness and acceptance level
		  ○ We will ask the residents about their expectations to the charging system, and acceptance to not being charged right away if the smart NEMS suggest otherwise. Example: if you park your car with expected departure time the next day, and suddenly, you need the car earlier (at 22 hrs); will you accept that the battery is at the same SOC as when plugged in or do they expect at least some increase in SOC.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Measure	Sub-Measures	Indicators
		○ Ask about the users' wishes for information on utilisation of RES, and to which extent is this a motivation for choosing flexible charging/not choosing priority charging? Example: what is more important: That the PV is used for the garage building for heating etc. or for EV-charging? ○ Are the residents aware of the smart NEMS; including the RES and battery? Have they talked about these solutions with people outside and inside Røverkollen?

3.2.2 Measures and KPIs in Bremen Pilot

Here we present the "focused" KPIs for the Bremen Pilot, with specific information about related measures, sub-measures and data sources, where they are available.

Table 6: Focused KPIs in Bremen Pilot

Measure	Sub-Measures	Indicators
GC.M4: Booking for priority charging	1. Multi-station charging facility on company ground 2. Multi-site CS distributed across site-area (campus)	**Category: Transport system – eMobility (NEW) (WP5)** • ***Key ind. no: GC 5.1.*** Number of EVs • ***Key ind. no: GC 5.2.*** Parking with charging **Category: Economy – Costs (WP5)** • ***Key ind. no: GC 5.6.*** Average operating costs • ***Key ind. no: GC 5.7.*** Capital investment **Category: Energy - Fuel consumption (WP5*)*** • ***Key ind. no: GC 5.10.*** Peak to average ratio • ***Key ind. no: GC 5.12.*** Vehicle fuel efficiency
GC.M5: Charging via PV energy supply	1.Charging infrastructure with PV support 2. stationary buffer battery usage	**Category: Transport system – eMobility (NEW) (WP5)** • ***Key ind. no: GC 5.1.*** Number of EVs • ***Key ind. no: GC 5.2.*** Parking with charging **Category: Economy – Costs (WP5)** • ***Key ind. no: GC 5.7.*** Capital investment **Category: Energy - Energy consumption (WP5*)*** • ***Key ind. no: GC 5.10.*** Peak to average ratio • ***Key ind. no: GC 5.11.*** Saving
GC.M6: EV Car Sharing in residential neighbourhood	1. Combine with public transport 2. Combine with public EV charging	**Category: Transport system – eMobility (NEW) (WP5)** • ***Key ind. no: GC 5.1.*** Number of EVs • ***Key ind. No: GC 6.6.*** Shared EV's per capita Data from vehicle registration office and statistics **Category: Economy – Costs (WP5)** • ***Key ind. no: GC 5.6.*** Average operating costs • ***Key ind. no: GC 5.7.*** Capital investment

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Measure	Sub-Measures	Indicators

		• ***Key ind. no: GC 5.15.*** Car sharing development and impacts
		Category: Society-people – Acceptance (WP6)
		• ***Key ind. No: GC 6.1.*** Awareness level
		  ○ Data from MOVA users through survey/interviews
		• ***Key ind. No: GC 6.2.*** Acceptance level
		  ○ Data from MOVA users through survey/interviews and records of backend-system
		• ***Key ind. No: GC 6.4.*** Operational barriers
		  ○ Data from MOVA users through survey/interviews and records of backend-system

3.2.3 Measures and KPIs in Barcelona Pilot

Here we present the "focused" KPIs for the Barcelona Pilot, with specific information about related measures, sub-measures and data sources, where they are available.

Table 7: Focused KPIs in Barcelona Pilot

Measure	Sub-Measures	Indicators

GC.M7: Smart charging for a e-scooter sharing service	1. Charging infrastructure based on battery swapping
	2. Multi-site charging infrastructure for e-scooter fleet
	3. Business model for smart charging management
		Category: Transport system – eMobility (WP5)
		• ***Key ind. no: GC5.1***. Number of EVs (e-scooters).
		  ○ Data from MOTIT
		• ***Key ind. no: GC5.2.*** Number of charging points (with battery hubs with smart charging)
		  ○ Data from MOTIT (baseline: 0)
		• ***Key ind. no: GC5.3.*** Utilization of charging points (battery hubs)
		  ○ Baseline: Data from MOTIT
		Category: Energy - eMobility (WP5)
		• ***Key ind. no: GC5.13.*** Charging Flexibility.
		  ○ Direct from MOTIT back-system
		Category: Economy – Costs (WP5)
		• ***Key ind. no: GC5.6.*** Average operating costs for charging infrastructure.
		  ○ Data from MOTIT
		• ***Key ind. no: GC5.7.*** Capital investment costs.
		  ○ Data from MOTIT
		• ***Key ind. no: GC5.8.*** Average operating revenue
		  ○ Data from MOTIT
		• ***Key ind. no: GC5.11.*** Savings.
		  ○ Data from service operator (MOTIT) taken from electricity bill and energy monitoring data
		Category: Environment – Emissions (WP5)
		• ***Key ind. no: GC5.12.*** CO2 Emissions.

<table>
<tr><th>Measure</th><th>Sub-Measures</th><th>Indicators</th></tr>
<tr><td></td><td></td><td>
Data from MOTIT taken from energy saved in trips from MOTIT staff
Category: Society-people – Acceptance (WP6)

Key ind. no: GC6.2. Acceptance level.
Data from MOTIT staff and management through interview
Key ind. no: GC6.4. Operational barriers.
Data from MOTIT staff and management through interview

</td></tr>
<tr><td>GC.M8: Incentivize dropping of e-scooters nearby battery hubs</td><td>
1. Incentives scheme definition
2. Adjust battery collection policy
3. Business model for collaborative battery swapping
</td><td>
Category: Transport system – eMobility (WP5)

Key ind. no: GC5.1. Number of EVs (e-scooters).
Data from MOTIT
Key ind. no: GC5.2. Number of charging points (with battery hubs with smart charging)
Data from MOTIT (baseline: 0)
Key ind. no: GC5.3. Utilization of charging points (battery hubs)
Baseline: Data from MOTIT
Key ind. no: GC5.5. Charging availability (slots available in the battery hubs to leave the battery)
Baseline: Data from MOTIT

Category: Energy - eMobility (WP5)

Key ind. no: GC5.13 Charging Flexibility.
Direct from back-system

Category: Economy – Costs (WP5)

Key ind. no: GC5.6. Average operating costs for charging infrastructure.
Data from MOTIT back-end system
Key ind. no: GC5.7. Capital investment costs.
Data from MOTIT
Key ind. no: GC5.8. Average operating revenue
Data from MOTIT
Key ind. no: GC5.11. Savings.
Data from service operator (MOTIT) taken from energy and trips saved

Category: Environment – Emissions (WP5)

Key ind. no: GC5.12. CO2 Emissions.
Data from MOTIT taken from energy saved in trips from MOTIT staff

Category: Society-people – Acceptance (WP6)

Key ind. no: GC6.1. Awareness level.
Data from MOTIT users through surveys and other communication means at customer disposal
Key ind. no: GC6.2. Acceptance level.
Data from MOTIT users through surveys and records from the back-end system
Key ind. no: GC6.3. Perception of level of (physical) accessibility of service.

</td></tr>
</table>

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Measure	Sub-Measures	Indicators
		○ Data from MOTIT users through surveys and records from the back-end system • ***Key ind. no: GC6.4***. Operational barriers. ○ Data from MOTIT users through surveys and records from the back-end system • ***Key ind. no: GC6.5***. Relative cost of the service. ○ Data from MOTIT users through surveys and records from the back-end system • ***Key ind. no: GC6.6***. Shared EVs per capita. ○ Data from MOTIT and statistics
GC.M9: Optimal use of energy GC.M9.1: MOTIT e-scooter sharing service GC.M9.2: Eurecat premises GC.M9.3: St. Quirze e-bike sharing service	1. Neighbourhood energy mngt system 2. PV in neighbour-hood 3. Smart charging management with PV and stationary battery (only for GC.M9.3) 4. Business model for flexible energy demand	**Category: Energy - Energy consumption (WP5)** • ***Key ind. no: 5.9***. Energy mix (share of energy from local RES in neighbourhood grid). ○ Measurements and simulations • ***Key ind. no 5.10.*** Peak to average ratio. ○ Baseline: Measurements of profiles from historical data without charging. ○ Baseline: calculation of profiles with charging based on charging profiles. ○ Measurements with smart charging. ○ Simulations. • ***Key ind. no: GC5.13.*** Charging Flexibility. ○ From Back-end system, historical records and surveys ○ Measurements and simulations • ***Key ind. no 5.14.*** Self-consumption. ○ Baseline: From historical records or 0 (when PV installation is part of the measure). ○ Measurements with smart charging. ○ Simulations. **Category: Economy – Costs (WP5)** • ***Key ind. no: GC5.6.*** Average operating costs for charging infrastructure. ○ Data from service operator (MOTIT, EURECAT, St.Quirze) • ***Key ind. no: GC5.7.*** Capital investment costs. ○ Data from technology providers (MOTIT, ATLANTIS, ENCHUFING, EURECAT) • ***Key ind. no: GC5.11.*** Savings. ○ Data from service operators (MOTIT, EURECAT, St. Quirze) taken from energy costs **Category: Environment – Emissions (WP5)** • ***Key ind. no: GC5.12.*** CO2 Emissions. ○ Data from MOTIT taken from energy produced and consumed
GC.M10: Corporate charging points booking system	1. Booking of charging points 2. Monitoring of praises and claims	**Category: Transport system – eMobility (WP5)** • ***Key ind. no: GC5.1***. Number of EVs (cars owned by employees). ○ Data from employees through survey • ***Key ind. no: GC5.2.*** Number of charging points open to employees

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Measure	Sub-Measures	Indicators
		○ Data Eurecat infrastructure department • ***Key ind. no: GC5.3.*** Utilization of charging points ○ Baseline: Eurecat infrastructure department; during demonstration data extracted from the monitoring system to be deployed • ***Key ind. no: GC5.5.*** Charging availability (how easy is to access a charging point when needed) ○ Data from the booking system to be deployed (base line: 0 - not available) **Category: Energy - eMobility (WP5)** • ***Key ind. no: GC5.13.*** Charging Flexibility. ○ Direct from booking system to be deployed **Category: Society-people – Acceptance (WP6)** • ***Key ind. no: GC6.1***. Awareness level. ○ Data from EURECAT employees through surveys • ***Key ind. no: GC6.2***. Acceptance level. ○ Data from records of the booking system and direct communication • ***Key ind. no: GC6.3***. Perception of level of (physical) accessibility of service. ○ Data from EURECAT employees through surveys and direct communication • ***Key ind. no: GC6.4***. Operational barriers. ○ Data from EURECAT employees through surveys and direct communication • ***Key ind. no: GC6.5***. Relative cost of the service. ○ Data from EURECAT employees through surveys and direct communication
GC.M11: Last mile e-bike sharing service	1. E-bikes tracking system 2. Monitoring of e-bikes usage 3. Anti-theft system (improving security) 4. Analysis of different charging profiles on battery's health 5. Business model for an e-sharing service	**Category: Transport system – eMobility (WP5)** • ***Key ind. no: GC5.1***. Number of EVs (e-bikes). ○ Data from St. Quirze (service promoter) • ***Key ind. no: GC5.2.*** Number of charging points ○ Data from Enchufing • ***Key ind. no: GC5.3.*** Utilization of charging points ○ Data from back-end system. Baseline is unknown (the system is not monitored), first data collected by the back-end system to be deployed will be established as baseline. **Category: Society-people – Acceptance (WP6)** • ***Key ind. no: GC6.1***. Awareness level. ○ Data from users through surveys • ***Key ind. no: GC6.2***. Acceptance level. ○ Data from records of the back-end system and surveys to users and stakeholders • ***Key ind. no: GC6.3***. Perception of level of (physical) accessibility of service. ○ Data from users through surveys • ***Key ind. no: GC6.4***. Operational barriers.

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Measure	Sub-Measures	Indicators
		○ Data from users and stakeholders through surveys • ***Key ind. no: GC6.5***. Relative cost of the service. ○ Data technological partners and stakeholders (St. Quirze municipality, factories, railway operator) • ***Key ind. no: GC6.6***. Shared EVs per capita. Data from St. Quirze municipality and statistics

3.2.4 KPIs overview for all pilots

In Table 8 we present an overview of the list of KPIs which have been considered relevant for each pilot. Columns 2-7 indicate, for each pilot, whether it is able to measure and improve the related KPI. Oslo has specified also the related measures. Barcelona has identified the demonstrator.

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Table 8: Focused KPIs and target values

	Measurability (has/can/will)			Improvement		
Indicators	**Oslo**	**Barcelona**	**Bremen**	**Oslo**	**Barcelona**	**Bremen**
GC5.1	**M1:** Smart charging in garage in apartment building	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service	**M4**: Booking for priority charging **M5**: Charging via PV energy supply **M6**: EV Car Sharing in residential neighbourhood		x	
GC5.2	**M1:** Smart charging in garage in apartment building **M2:** Sharing of private charging points	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service	**M4**: Booking for priority charging **M5**: Charging via PV energy supply	x	x	x
GC5.3	**M3:** Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service			x	
GC5.15			**M6**: EV Car Sharing in residential neighbourhood		x	
GC5.4	**M1:** Smart charging in garage in apartment building					
GC5.5	**M2:** Sharing of private charging points	**M8**: Incentivize dropping of e-scooters nearby battery hubs				

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	Measurability (has/can/will)			Improvement		
Indicators	**Oslo**	**Barcelona**	**Bremen**	**Oslo**	**Barcelona**	**Bremen**
		M10: Corporate charging points booking system				
GC5.13	**M1:** Smart charging in garage in apartment building	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M9**: Optimal use of energy **M10**: Corporate charging points booking system				
GC5.6	**M1:** Smart charging in garage in apartment building **M2:** Sharing of private charging points **M3:** Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M9**: Optimal use of energy	**M4**: Booking for priority charging **M6**: EV Car Sharing in residential neighbourhood			x
GC5.7	**M1:** Smart charging in garage in apartment building **M3**: Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M9**: Optimal use of energy	**M4**: Booking for priority charging **M5**: Charging via PV energy supply **M6**: EV Car Sharing in residential neighbourhood			x
GC5.8	**M2:** Sharing of private charging points	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs				
GC5.9	**M1:** Smart charging in garage in apartment building **M3:** Optimal use of energy	**M9**: Optimal use of energy				
GC5.10	**M3:** Optimal use of energy	**M9**: Optimal use of energy	**M4**: Booking for priority charging **M5**: Charging via PV energy supply			

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	Measurability (has/can/will)			Improvement		
Indicators	**Oslo**	**Barcelona**	**Bremen**	**Oslo**	**Barcelona**	**Bremen**
GC5.14		**M9**: Optimal use of energy				
GC5.11	**M1:** Smart charging in garage in apartment building **M3:** Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M9**: Optimal use of energy	**M5**: Charging via PV energy supply			
GC5.12.1	**M3:** Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M9**: Optimal use of energy	**M4**: Booking for priority charging			
GC5.12.2	**M3:** Optimal use of energy					
GC5.12.3	**M3:** Optimal use of energy					
GC5.12.4	**M3:** Optimal use of energy					
GC5.12.5	**M3:** Optimal use of energy					
GC6.1	**M1:** Smart charging in garage in apartment building **M2:** Sharing of private charging points **M3:** Optimal use of energy	**M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service	**M6**: EV Car Sharing in residential neighbourhood			
GC6.2	**M1:** Smart charging in garage in apartment building **M2:** Sharing of private charging points **M3:** Optimal use of energy	**M7**: Smart charging for a e-scooter sharing service **M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service	**M6**: EV Car Sharing in residential neighbourhood			
GC6.3		**M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service				
GC6.4		**M7**: Smart charging for a e-scooter sharing service	**M6**: EV Car Sharing in residential neighbourhood			

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

	Measurability (has/can/will)			Improvement		
Indicators	Oslo	Barcelona	Bremen	Oslo	Barcelona	Bremen
		M8: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service				
GC6.5		**M8**: Incentivize dropping of e-scooters nearby battery hubs **M10**: Corporate charging points booking system **M11**: Last mile e-bike sharing service				
GC6.6		**M8**: Incentivize dropping of e-scooters nearby battery hubs **M11**: Last mile e-bike sharing service				

In Table 9 the subset of KPIs that were already defined in the GreenCharge proposal are listed with the degree of improvement estimated in the proposal.

Table 9: KPIs defined in project proposal

KPI	Improvement
GC5.3 Utilization of charging points	Doubled utilization of charging points. (page 3)
GC5.4 Share of battery capacity for V2G	10% users allow V2G sharing (page 24)
GC5.5 Charging availability	No waiting time in 95% of cases by booking.
GC5.9 Energy mix	50% increase of RES utilization (page 3)
GC5.10 Peak to average ratio	Deployment of new charging point without increase of power peak (page 3); 20% reduction of power peak (page 23)
GC5.12 CO2 emissions	40 % of reduction (page 23)

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3.3 Initial, Intermediate and final reporting

The evaluation methods for each pilot are described in Section 6. The reporting of evaluation results will be compliant with the CIVITAS guidelines.

The CIVITAS Frameworks provide a template for reporting evaluation of measures. It is attached to this document as *Annex 1: GreenCharge Evaluation Reporting Template.*

A reporting document should be prepared for each measure. The editing of the report will be incremental.

The initial report will include a short abstract about the measure description and of process implementation. Moreover, it will define objectives and quantifiable targets. Finally, it will contain the list of relevant KPIs, the identified barriers and drivers and a table of risk from the implementation plan.

The intermediate reports will complete the assessment of baseline values for the KPIs and the measures after that the data collected after the intermediate milestone have been made available and elaborated for evaluation findings. Lesson learned will be included and barrier, driver, supporting activities will be eventually updated.

The final reports will integrate new evaluation findings, updating lesson learned and integrating conclusion.

The time schedule of evaluation activities, including data collection, evaluation and reporting is described in Section 5.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

4 Scoping of Process Evaluation Activities: Methods and Risks

Drivers, barriers and risks, as well the required evaluation supporting activities, are obviously different for each pilot. Here we identify the ones that have been considered worth to be monitored and investigated during the process evaluation activities of the specific pilot.

4.1 Process evaluation in Oslo Pilot

4.1.1 Drivers encountered

Incentives and policy for EVs will be collected from the governments web page on transport:

https://www.regjeringen.no/no/tema/transport-og-kommunikasjon/nasjonal-transportplan/id2475111/

These policy descriptions do also take consideration of how EU-policy affects Norwegian plans for implementation of Evs.

In addition, we will collect information on how housing co-operatives should act in accordance with this policy, from the web page of the Co-operative Housing Federation of Norway (NBBL):

https://www.nbbl.no/Aktuelt/articleType/ArticleView/articleId/10827/NBBL-har-fatt-gjennomslag-for-krav-om-sttte-til-lading-av-elbil-i-borettslag-og-sameier

The relevance of this information will be evaluated especially for the pilot housing cooperative.

4.1.2 Barriers Encountered

Barriers on societal levels are risks for policy changes for Evs in Norway. A barrier for further introduction of Evs in the Norwegian car market, might be a policy change with more focus on collective transport than personal Evs. Then the financial support for Evs will be reduced.

4.1.3 Risks in implementation of measures

The following risks for implementation of the measures in the pilot housing co-operative are detected:

1. Technical risks:
    - Cannot get correct State of Charge (SOC). The residents do not enter correct SOC via the user interface and SOC cannot be accessed from the Evs.
2. Economical risks:
    - The costs are higher than expected, and the measures have to be reduced.
    - The housing co-operative board decides to reduce/ take away their investment in the measures on charging solutions.
    - The municipality decides to take away all/ some of the economic support for the EV charging in the housing co-operative.
    - Increasing electricity costs, the residents will use other types of transport.
3. Behavioural risks:
    - The residents will not use the charging solution; they find the user interface too advanced.
    - There are no Evs bought after spring 2019 among the residents.

All these risks will be diminished if the stakeholders are followed closely and the communication is kept open during the implementation and operating phase. Survey and interviews of the residents will be used to follow-up on the behavioural risks of implementation.

4.1.4 Quality and influence of supporting activities

The following supporting activities are planned to secure the quality of the measures in the Røverkollen pilot:

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a. Meeting with the residents in Røverkollen pilot the 23rd of April 2019. Presentation of GreenCharge and the pilot measures.
b. Feedback on the charging infrastructure and on the housing co-operative's web-page.
c. New survey on awareness and practice on EVs in Des 2019 will give feedback on the charging solutions.
d. Group-interviews with residents in Nov 2019 will give feedback on the charging solutions.

The time schedule of evaluation activities, including data collection, evaluation and reporting is described in Section 5. The evaluation methods for each pilot and additional details about the scheduled activities are described in Section 6.

4.2 Process evaluation in Bremen Pilot

4.2.1 Drivers encountered

The only incentive for EV users in Bremen is free parking, but only if charging is at publicly accessible CP's. This applies during the day for max. 3h, as well as overnight (18-6). There are no further incentives for EV's, like in some other cities throughout Germany. The reason behind this is that Bremen is aiming at less cars in the city. This objective can be met easier by fostering Car Sharing and not just by switching from conventional to electric cars.

However, semi-public CP's installed, e.g., at supermarket-sites, may give more incentives for EV's. It is up to the CP owner (CPO), whether or not electricity is for free in addition to free parking.

4.2.2 Barrier Encountered

The cost of a new EV is a barrier (but not only Bremen-specific). Typically, a surplus of 10-15 T€ compared to equivalent cars with combustion engine.

Cost of energy is also a barrier. Currently the price for charging at publicly accessible CP's varies from 0 to 0.89€ per kWh, the latter number being 3 times the price of residential electricity.

Another barrier is for the CPOs, who are requested to proof legal conformity of their CPs as a prerequisite for invoicing users per kWh. Only recently, the amount of charged kWh can be invoiced - provided that the CP is furnished by a legal conformity device for measuring the consumed kWh's (of course, giving energy for free is legally allowed - always).

However, for none of the CPs operated by the Bremen partners, users would be charged for electricity (they are only charged for the time of sharing the EV). Insofar it is irrespective whether or not the CPs meet legal conformity standards in the project.

4.2.3 Risks in implementation of measures

Some planned pilot activities turn out to be more difficult than planned to implement in a practical pilot. OEMs deny direct access to battery status of EVs. No access to Application Programming Interfaces (APIs) makes it difficult to integrate various components. Inadequate data collected in the pilots to support the evaluation.

Number of users remain too low for a statistical evaluation of usage data. However, this risk is mitigated by gradual increase of number of users during the initial piloting phase rather than waiting for the number of users being high enough for statistically relevant evaluation (ca. >20 would be needed).

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4.2.4 Quality and influence of supporting activities

Users of eCarSharing and private EV-owners will be interviewed for their perception of charging procedure after the initial phase has ended (ca. 08/2020), in order to better assess remaining obstacles and conflicts. Pilot is planning to couple this with an on-site promotional event.

The time schedule of evaluation activities, including data collection, evaluation and reporting is described in Section 5. The evaluation methods for each pilot and additional details about the scheduled activities are described in Section 6.

4.3 Process evaluation in Barcelona Pilot

4.3.1 Drivers encountered

One of the most important drivers are subsidies to promote the purchase of EVs and charging infrastructure. In particular, we will monitor the conditions of the programme MOVES (yearly edition) promoted by the Spanish government. This programme might help that more employees replace their old ICE cars by e-cars. Additionally, Eurecat might deploy charging points to visitors (and open to other companies) if the subsidy for the installation of public charging infrastructure is granted.

Announced measures to banned combustion vehicles by 2050 may help to consider the purchase of low-emission cars, but the regulation is not in place and will depend very much on the support of the different parties in the government and the pressure of cars manufacturers.

At regional level, other programmes and incentives are in place to promote use of renewable energy sources and self-consumption (ICAEN: Catalan Institute of Energy). It will be important to monitor the progress to find the opportunity to install additional PV panels in some premises in the demonstrator.

Finally, at local level (Diputació Barcelona) has had programmes to subsidise the purchase of e-bikes. The measure might foster the increase of e-bikes in the e-bike sharing service in St. Quirze demonstrator either bought by the municipality, the factories or the users themselves.

Besides, the openness of St. Quirze municipality to participate is one of the best drivers to demonstrate many objectives in one demonstrator and to minimize the risk if one of the other demonstrator fails or does not work as expected.

We will include up-to-date information about electromobility incentives in the communication channels to be used during the project to raise awareness among potential users.

4.3.2 Barriers Encountered

One of the main barriers is the energy market regulation. Since very recently taxes applied to energy generated by RES, and the regulation about self-consumption was unclear. The new regulation should ease the deployment of collectively shared PV installations at community level (building). However, the energy flexibility market is not open (only big players can participate) and the aggregator role is not defined in Spain.

The cost of e-cars compared to gasoline or gasoil fuelled cars is a big barrier for a massive penetration of EVs, and with a low penetration of EVs the sustainability of electromobility service providers is compromised.

4.3.3 Risks in implementation of measures

The main risk in the three demonstrators is not having a number of users high enough to collect data that are statistically representative.

Regarding the usage of the services, the incentives in place and the trend observed in the EV sales and mobility patterns are indicators that show that this risk is moderate and might change to low if the incentives are kept in place.

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Regarding the participation in surveys and questionnaires, the proximity to the groups we are approaching should have a positive effect in the success ratio compared to average response ratio. Yet, whenever possible, we will prioritise face-to-face interviews and focus group to gather information. Although there is no budget to compensate participants for their time, some profiling articles may be delivered as a small present.

4.3.4 Quality and influence of supporting activities

As introduced in the previous section, we will be very active in communication and dissemination campaigns and in organising focus groups and workshops to engage the users. In fact, we have already started with several interviews to stakeholders and users to get their requirements and take them into account in the services to be integrated.

Additional activities will support the launch of every service to explain first-hand the operation and improvements done. We envision that the close relation to the users will facilitate the gathering of information and to keep the level of interest high.

The time schedule of evaluation activities, including data collection, evaluation and reporting is described in Section 5. The evaluation methods for each pilot and additional details about the scheduled activities are described in Section 6.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

5 Schedule of evaluation activities

In each Pilot the schedule of evaluation activities will follow the timeline model defined by the CIVITAS project[4]. Each Pilot detailed the time schedule of implementation and evaluation activities in the related deliverable of WP2 according to the Gantt and the milestones defined into the DoW. The milestones related to data collection correspond to the availability of all data which are required to start evaluation. Of course, multiple events, such as workshops or delivery of survey, can be spread during the operation of the pilots. Some time schedule details are provided in Section 4 and in Section 6.

The implementation plan of Oslo Pilot is detailed in Table 5 of D2.4. In Figure 3 we show, for the three measures to be evaluated, the related evaluation plan. From October 2018 to April 2019 (**MS1)** the planning and design are developed. From April 2019 to August 2019 (**MS2)** the implementation activities are performed. The Baseline data are collected in July 2019 (**B**). Pilot Operation starts in August 2019 (**MS3-OP**). During the Pilot operation three milestones (**I1-I3**) are planned for data collection, respectively on January and June 2020 and on February 2021. Milestones for evaluation activities (**M1-M3, Mv**) are scheduled after each data collection. **Mv** will care also about validation comparing baseline data, intermediate data and evaluation results. One final evaluation (**Mf**) will summarize results and draw conclusions.

The implementation plan of Bremen Pilot is detailed in Table 14 and Table 15 of D2.10. In Figure 4 we show, for the three measures to be evaluated, the related evaluation plan. From October 2018 to April 2019 (**MS1)** the planning and design are developed. From April 2019 to August 2019 (**MS2)** the implementation activities are performed. The Baseline data are collected in July 2019 (**B**). Pilot Operation starts in August 2019 (**MS3-OP**). During the Pilot operation two milestones (**I1, I2**) are planned for data collection, respectively on January and on February 2021. Milestones for evaluation activities (**M1, M2, Mv**) are scheduled after each data collection. **Mv** will care also about validation comparing baseline data, intermediate data and evaluation results. One final evaluation (**Mf**) will summarize results and draw conclusions.

The implementation plan of Barcelona Pilot is detailed in Table 15-17 of D2.17. In Figure 5 we show, for the three measures to be evaluated, the related evaluation plan. From October 2018 to April 2019 (**MS1)** the planning and design are developed. From April 2019 to September 2019 (**MS2)** the implementation activities are performed. The Baseline data are collected in September 2019 (**B**). Pilot Operation starts in September 2019 (**MS3-OP**). During the Pilot operation two milestones (**I1, I2**) are planned for data collection, respectively on January and December 2020. Milestones for evaluation activities (**M1, M2, Mv**) are scheduled after each data collection. **Mv** will care also about validation comparing baseline data, intermediate data and evaluation results. One final evaluation (**Mf**) will summarize results and draw conclusions.

[4] Annex_2, civitas_measure_evaluatioon_planning_and_monitoring_scheme.xslx

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

			2018				2019												2020												2021								
Oslo			Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		project months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Activities per measure or/and Integrated Packages of measures																																							
GCM1	Smart charging in garage in apartment building	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1					I2								I3							
		reporting																			M1						M2								M3		Mv		Mf	
GCM2	Sharing of private charging points	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1					I2								I3							
		reporting																			M1						M2								M3		Mv		Mf	
GCM3	Optimal use of energy	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1					I2								I3							
		reporting																			M1						M2								M3		Mv		Mf	

Figure 3: Time schedule of the Oslo Pilot

			2018				2019												2020												2021								
Bremen			Sep	Oct	Nov	Dec	Jan		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		project months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Activities per measure or/and Integrated Packages of measures																																							
GCM4	Booking for priority charging	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1													I2							
		reporting																			M1														M2			Mv		Mf	
GCM5	Charging via PV energy supply	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1													I2							
		reporting																			M1														M2			Mv		Mf	
GCM6	EV Car Sharing in residential neighbourhood	stages		DE					MS1	MS2				MS3-OP																									
		data collection											B						I1													I2							
		reporting																			M1														M2			Mv		Mf	

Figure 4: Time schedule of the Bremen Pilot

Barcelona			Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		project months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Activities per measure or/and Integrated Packages of measures																																							
GC.M10	Eurecat Demonstrator	stages		DE					MS1	MS2					MS3-OP																								
		data collection													B				I1											I2									
		reporting																			M1											M2				Mv		Mf	
GC.M11	St. Quirze e-sharing	stages		DE					MS1	MS2					MS3-OP																								
		data collection													B				I1											I2									
		reporting																			M1											M2				Mv		Mf	
GC.M7-8	MOTIT Demonstrator	stages		DE					MS1	MS2					MS3-OP																								
		data collection													B						I1									I2									
		reporting																						M1								M2				Mv		Mf	

Figure 5: Time Schedule of the Barcelona Pilot

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

6 Data Collection Activities

Here we list those data which are strictly necessary for evaluation of KPIs selected in each Pilot. It needs also to define when they will be collected and with which frequency. The data model and the interface are defined in WP2. It needs to define how the will be made available to the evaluation tasks.

The collection of research data for evaluation purpose will accomplish the plan defined in the deliverable *D1.1 Data Collection plan* of the GreenCharge project depicted in Figure 2.

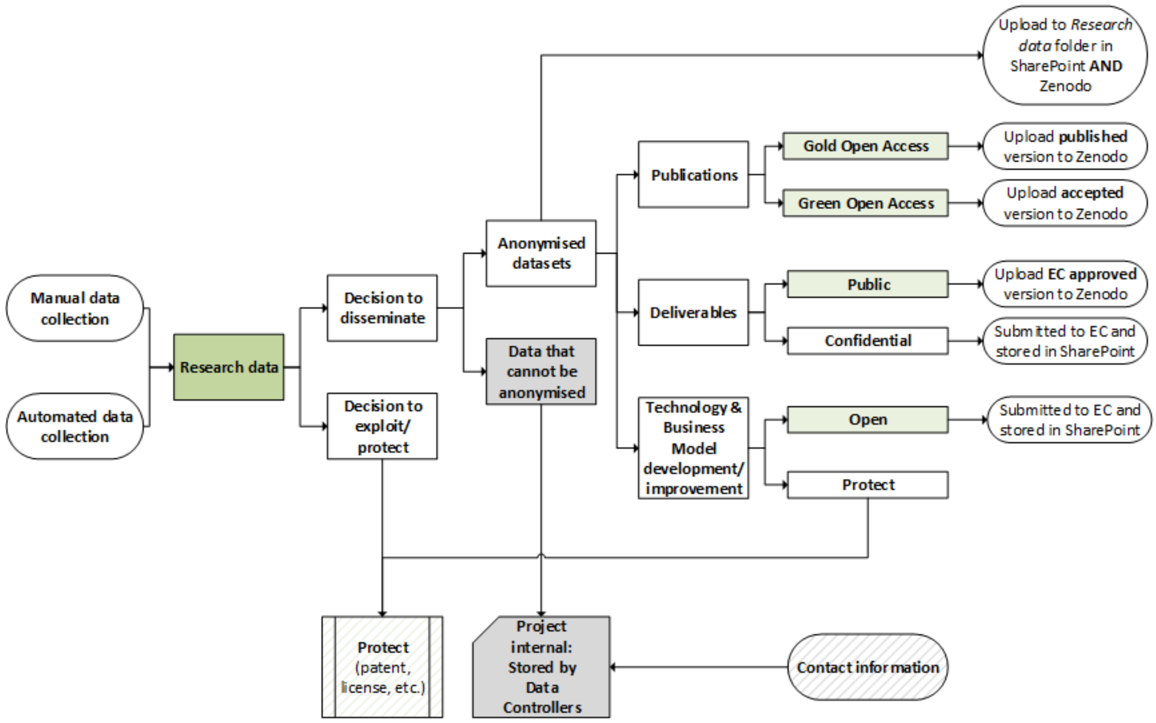

Figure 6: GreenCharge data management plan.

Collection of research data will be handled in accordance with the General Data Protection Regulation (GDPR). In particular it will be compliant with ethical principles and procedures, according to the specific guidelines defined into the GreenCharge deliverable *D9.1 Ethics*.

6.1 Methods for data collection

Different methods for data collection will be necessary to perform evaluation activities and compute selected KPIs. Automatic computation of KPIs, simulation and survey analysis will be combined in each pilot differently according to the related implementation details and the target KPIs.

6.1.1 Combined KPIs, data requirements and tools in Oslo Pilot

The following methods for data collection will be used in the Oslo pilot:

- Survey (questionnaire): A survey will be conducted in Dec 2019/Jan 2020. The survey will be based on the completed survey from Nov 2018 with additional questions. The user survey will include questions about the publicly available 4 semi-fast charging points and each resident's impression of public use.

  The user survey (conducted in Nov/Dec 2019/jan2020) will contain questions on whether the residents are aware of the public charging points, and if they recommend it to their guests and other neighbours. We will ask the residents about their expectations to the charging system, and acceptance to not being charged right away if the smart NEMS suggest otherwise. Example: if you park your car with expected departure time the next day, and suddenly, you need the car earlier (at 22 hrs); will you accept that the battery is at the same SOC as when plugged in or do they expect at least some increase in SOC. We will ask about the users' wishes for information on utilisation of RES, and to which extent is this a motivation for choosing flexible charging/not choosing priority charging? Example: what is more important: That the PV is used for the garage building for heating etc. or for EV-charging? We will ask if the residents are aware of the smart NEMS; including the RES and battery? Have they talked about these solutions with people outside and inside Røverkollen? These questions will be asked in conjunction with the user survey (conducted in Nov/Dec 2019/Jan2020) and optional interviews in Nov 2019.

- Focus group interviews: Interviews (optional) will be conducted in Nov 2019 on motivation, first experience and understanding (awareness) of the charging infrastructure. The group interviews will be conducted with

  - 1) Housing cooperative board,
  - 2a) residents with EV&charging point,
  - 2b) residents with charging point but without EV,
  - 2c) residents without EV&charging point.

  The interviews will be conducted as individual or group interviews.

6.1.2 Combined KPIs and data requirements and tools in Bremen Pilot

In the Bremen Pilot 4 Corporate charging station will be monitored updating the existing smart meters or installing external ones for collecting high resolution energy readings.

Automatic collection is planned in D2.10[5] for the following classes of data:

- charging infrastructure (sample starts on connection, sensors for parking spots, reservation)
- metering data (sample start on connection)
- usage data
- efficiency data
- energy production from solar energy supply
- data from stationary battery
- data from EV battery (SoC and/or remaining km given by EV)

Sampling resolution and technology storage have been identified for this class of data.

6.1.3 Combined KPIs and data requirements and tools in Barcelona Pilot

The following methods for data collection will be slightly different for the three demonstrators in the Barcelona pilot.

[5] GreenCharge deliverable D.10 – Implementation plan for Bremen Pilot.

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MOTIT demonstrator:

- Automated data collection: energy readings from the battery hub will be extracted from the energy monitor system (to be installed), SoC for batteries will be extracted from the existing monitoring system, electricity price tariff, weather information and energy mix for carbon footprint calculations will be obtained through an automatic process to interface third party services through an API.
- On-demand data collection: specific data needed for the calculations of KPIs such as number of EVs, operational costs, tariff schemes, schedules and alike will be provided by MOTIT at the starting, in the middle and at the end of the piloting phase
- Feedback from users will be collected using the existing communication channels for MOTIT customers (app, email and phone) during specific campaigns.

EURECAT demonstrator:

- Automated data collection: energy readings from the charging points will be extracted from the energy monitor system (to be installed), energy consumption and production readings from building will be collected interfacing the existing BMS, bookings will be collected through the booking management system to be deployed, electricity price tariff, weather information and energy mix for carbon footprint calculations will be obtained through an automatic process to interface third party services through an API.
- On-demand data collection: SoC for the car batteries from Eurecat employees will be provided by users through an app; specific data needed for the calculations of KPIs such as number of EVs, operational costs, tariff schemes, schedules and alike will be requested to Eurecat facility manager and to users via surveys. A survey will be organised at the beginning of the piloting phase (October 2019).
- Feedback from users will be collected using focus groups, interviews or surveys after the first iteration and at the end of the piloting phase. Additional feedback can be provided at any time by users using the app or by direct contact (mail or phone) to the pilot coordinator, especially to report bugs or errors in the system.

St. Quirze e-bike sharing service:

- Automated data collection: energy readings from the charging points, stationary battery and PV panel will be extracted from the energy monitor system (to be installed), SoC for the bike batteries will be obtained by interfacing the battery management system and geo-location will be obtained through trackers to be installed in the bicycles; specific data needed for the electricity price tariff, weather information and energy mix for carbon footprint calculations will be obtained through an automatic process to interface third party services through an API.
- On-demand data collection: specific data needed for the calculations of KPIs such as number of EVs, operational costs, tariff schemes, and schedules will be requested to St. Quirze municipality at the beginning of the piloting phase (October 2019) and at the end of each iteration.
- Feedback from users will be collected using focus groups, interviews and surveys at the beginning of the piloting phase, in the middle and at the end of the piloting phase. A first focus group was planned in May; however due to unavailability of participants it was converted into a survey for their convenience. Additional feedback can be provided at any time by users using the app or by direct contact (mail or phone) to the pilot coordinator, especially to report bugs or errors in the system.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

7 Design of visualization tools

The Visualization tool will allow for retrieving and comparing evaluation results by one user friendly interactive dashboard. Here we present a list of mock-ups that allow to easily navigate the evaluation results navigating and visualizing KPIs defined in Chapter 3. Also related information such as meta-data and raw data will be linked, but the access rights will be managed by a suited access control mechanism and required policies.

A first mock-up is shown in Figure 7.

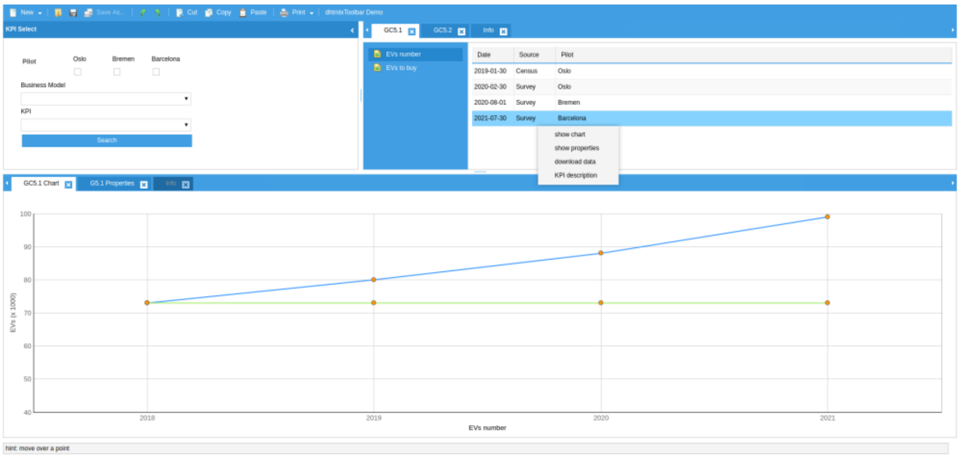

Figure 7: Main dashboard mock-up.

The web layout is composed of three different cells.

A first row contains a web form on the left to search for the evaluation results using different criteria:

- Pilot
- Business model
- Date

Evaluation results will be presented per KPIs. It means that for each KPIs a list of evaluated values will be retrieved.

The access to some KPIs and related data must be granted according to a defined authorization policy, after an eventual authentication and identification phase.

The list of evaluation results will be presented per KPI, and can be ordered per date, per Pilots or data source.

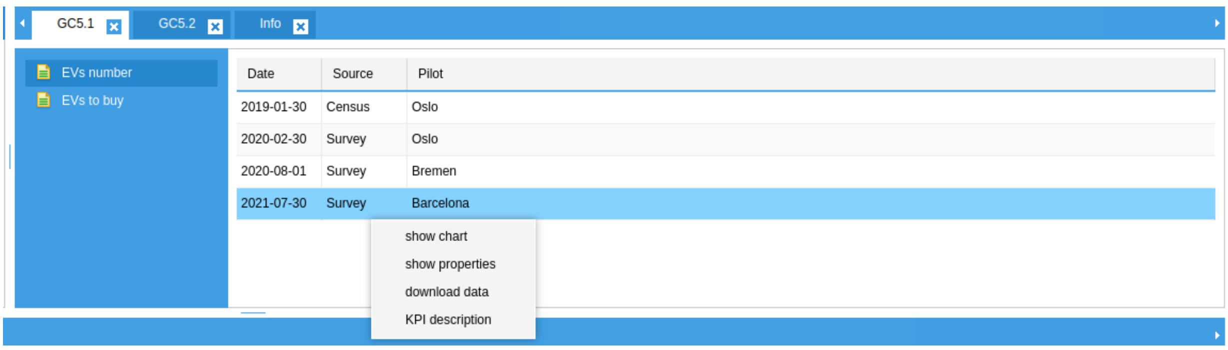

Figure 8: List of KPIs measurements.

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A context menu allows for visualizing the KPI description, a chart, and properties of that evaluation activity or to download open data. Maybe also intermediate data should be visualized. Visualization will be described as type of charts, input data and labels of axis, measures unit.

An example of chart is shown in Figure 9.

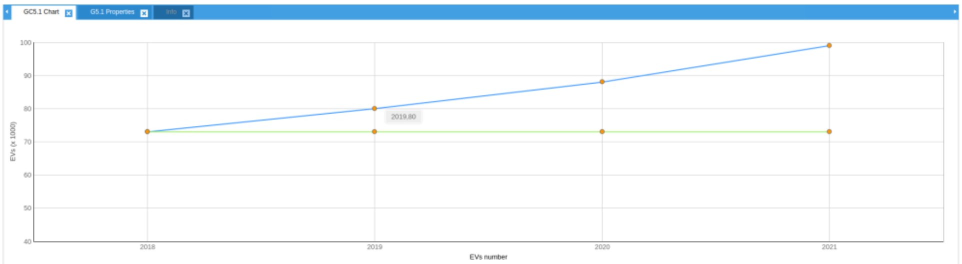
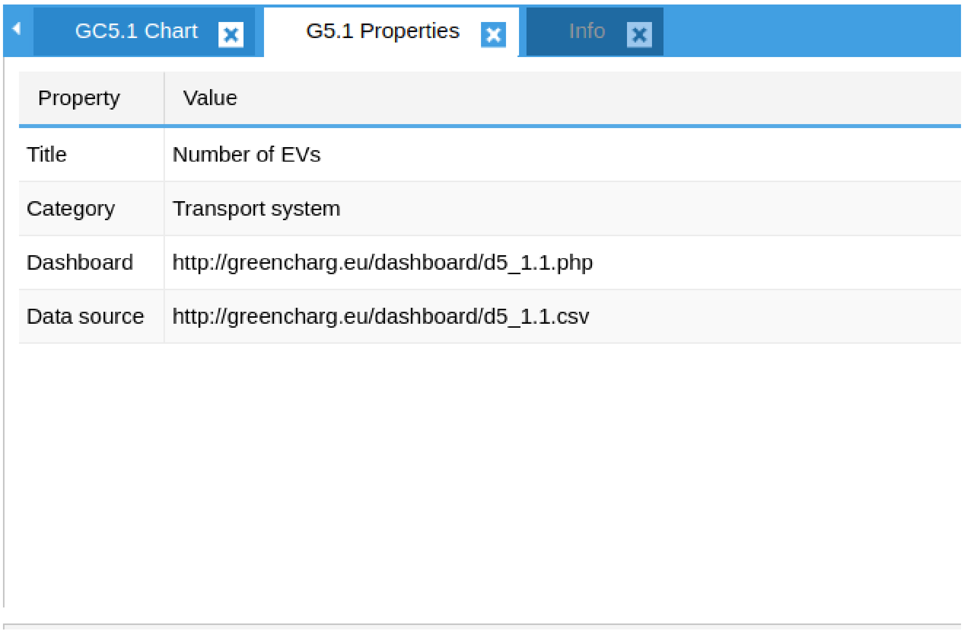


Figure 9: Business as usual compared to GreenCharge improvement of a KPI value.

In Figure 10 the property of a KPI evaluation result is shown. A number of properties will be added such as the reference to the indicator sheet and to the related official GreenCharge evaluation report.



Property	Value
Title	Number of EVs
Category	Transport system
Dashboard	http://greencharg.eu/dashboard/d5_1.1.php
Data source	http://greencharg.eu/dashboard/d5_1.1.csv

Figure 10: KPI evaluation property frame.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

8 Simulation requirements for evaluation

The GreenCharge simulator will allow to model and evaluate some relevant scenarios where smart EV charging strategies are integrated into a neighbourhood of energy sources, storages and consumers whose coordinated usage aims at lowering power peaks and at maximizing green-energy self-consumption.

In particular, simulation will be used to evaluate those scenarios which cannot be implemented in Pilots because of limited time, limited number of users and e-cars or charging stations, missing technologies such as V2G. What should be clear is that the simulator allows to optimize energy management by a load shifting that aims at lowering power peak and maximizing green energy consumption.

GreenCharge simulator will extend the CoSSMic simulator to include charging stations and EVs as actors of the CoSSMic neighbourhood and to provide outputs that allow to estimate some GreenCharge KPIs.

8.1 Data Requirements for evaluation based on Simulation

The simulation can be used to evaluate a scenario observed in the past changing or scaling some configuration parameters, which could be the available energy produced by PV panel, the number of EVs, the user flexibility, the scale-up of charging stations.

In order to configure a simulation scenario a number of inputs are needed to reproduce the observed reality.

Input can be extracted from automatically measured data or from surveys and can be variated using heuristics.

Input can be classified in static input, such as the number of households and appliances or charging point monitored in the households, and dynamic input, which are energy demand and the green energy production.

Static input will be collected from the analysis of the Pilots and preparing surveys for the stakeholders. Dynamic input have to be collected automatically, metering energy consumption and production in the Pilots.

A general simulation scenario includes a neighbourhood composed of micro-grids (households or charging stations).

Each micro-grid is characterized by some or all the following energy consumers or producers:

- Appliances with their energy demand
  PV panels, which produce green energy
- Energy storage, which can produce or consume energy
- Electric vehicles, which can be modelled as energy storage, but with their own energy demand.

Detailed information needed to build the simulation model of a neighbourhood, composed of households, charging stations and EVs are provided in D5.2.

8.2 What-If scenarios

Each GreenCharge Pilot is characterized by its own limitations which affect diversity, dimension and completeness of implementation, and of the related evaluation activities.

For this reason, the simulation will be considered to evaluate those scenarios which cannot be implemented in each Pilot.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Table 10: What-if simulation scenarios

What-if scenario	Pilots	Target KPIs	Additional data collection requirements
Baseline with no smart management	Oslo	***GC5.3, GC5.13, GC5.9, GC5.5***	No The simulator must switch of the smart energy management. Different grid capacities can be simulated.
Comprehensive neighbourhood	Oslo	***GC 5.10, GC 5.14, GC 5.9***	External data repository or analytical model of missing devices, users' behavior, environmental conditions or energy sources.
V2G	Oslo	***GC 5.9***	V2G specifications (discharging power, available percentage of storage) and users' availability to share their EV battery.
Scale ups #EVs	Oslo, Bremen	***GC 5.3, GC 5.13, GC 5.10***	Number of EV into the extended Pilot, predicted or planned number of EVs in the next future, specification of future EVs (battery capacity, charging power, energy requirements).
Scale ups #CP	Oslo, Bremen	***GC 5.3, GC 5.13, GC 5.10***	Number of Charging point into the extended Pilot, predicted or planned number of CP to be installed in the next future, specification of future CPs (charging power).
Scale ups #EVs in Eurecat premises	Barcelona	***GC5.9, GC5.10, GC5.12, GC5.13, GC5.14***	No
Scale ups #CPs in Eurecat premises combined with an increase of EVs	Barcelona	***GC5.9, GC5.10, GC5.12, GC5.13, GC5.14***	No

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

What-if scenario	Pilots	Target KPIs	Additional data collection requirements
Local RES to feed battery hub (MOTIT)	Barcelona, Bremen	***GC5.6, GC5.7, GC5.8, GC5.9, GC5.10, GC5.11, GC5.12, GC5.14***	Solar irradiation for the location of the battery hub premises, or time-series of electric energy obtained from PV plants.

8.2.1 Comprehensive neighbourhood

The diversity of appliances, infrastructures and observed behaviours (including weather conditions) can limit the execution and evaluation of GreenCharge measures in real Pilots. The exploitation of historical data or of analytic models of missing, but relevant features, can be used to enrich the simulation scenario reproducing what has been observed in Pilots with new missing elements.

8.2.2 Vehicle to Grid (V2G)

Neither most of the fleet of EV currently available in Pilots, nor the installed charging points support V2G technology. For this reason, it needs to use simulation to evaluate the benefit that such a technology can provide and how it can be exploited by GreenCharge business models and other innovations. Additional data to model and to simulate the V2G scenarios are the information about the features of current and the future V2G technology, the prediction of the amount of V2G EVs will be bought, the number of charging point supporting this technology, and finally the availability of users to share the storage of their EVs.

8.2.3 Scale ups #EVs

Simulation can be used to evaluate the impact of GreenCharge innovations when the number of EVs will increase. It allows to predict how the innovation effect evolves, but also to predict the sustainability and to plan necessary upgrade of the Grid and of the charging points.

8.2.4 Scale up #CP

Simulation can be used to plan, evaluating the effect in advance, the optimal upgrade of the charging infrastructure in terms of positioning and dimensioning the new charging points.

8.3 Simulation Data Sources

Input data for simulation will collected in Pilots. Simulation will use both raw data (e.g. time-series of consumed and produced energy) and KPIs values themselves.

Data collected in pilots will be used to emulate energy consumption and production of the Energy Smart Neighbourhood and to model occurrences of energy demand, such as bookings of charges.

KPIs values, such as user availability to share the storage of their EVs (GC5.4) or their private charging points can be used to model user's behaviours. User's plan to buy EVs (GC5.1) can be used to evaluate feasible scale-up of pilots.

8.3.1 Pilot data sources and resolution

A list of data source from GreenCharge Pilots, and the related resolution requirement is shown in Table 11.

EV geo-location and booking services, as well as the status of EV charge at booking time, allow for modelling the energy demand of EVs in the booking-based business model. Price tariffs allow to optimize the charging schedule, both at user's side and at charging provider.

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Forecasted weather information allow for predicting both energy production of Photovoltaic Panels and energy demand for heating or cooling. Actual weather information allows for evaluating the error of prediction.

Building energy reading and energy reading of single appliances, allows for modelling the energy demand of consuming devices and to eventually shift in time consumptions when renewable energy sources can meet the requirements.

In the same way, RES energy reading allows for verifying prediction and to evaluate the degree of self-consumption after the schedule.

Finally, charging point energy readings allow for modelling the energy demand for charging and, together with the booking information and the state of charge of EVs, to plan the optimal schedule of charge, including the opportunity to exploit the V2G option.

Table 11: Simulation data sources and resolution

Data source	Resolution Requirement for Simulation	Barcelona Compliance (D2.17)	Bremen Compliance (D2.10)	Oslo Compliance (D2.4)
EV geo-location	Up to 5 minutes	Source and resolutions		N.A.
Booking service	Asynchronous events	Source	Source	Not collected
State of EV Charge	At booking time, at plug-in time, at un-plug time	Source and resolution	Source and resolutions	Source (User input from App)
Price tariffs	Hourly	Source and resolution		Source (from 3rd party service)
Forecasted weather information	Hourly	Source and resolution		Source (weather service) and resolution
Actual weather information	Hourly	Source and resolution		Source (weather service) and resolution
Building energy readings (total consumption)	Up to 5 minutes	Source and resolution		Source (resolution: 15 min)
Appliance energy readings (device consumption)	Up to 5 minutes	N.A.		Source (heating cable) (resolution: 15 min)
RES energy readings (production)	Up to 5 minutes	Source and resolution	Source and resolutions	Source (resolution: 15 min)
Charging station energy readings	Up to 5 minutes	Source and resolution	Source and resolutions	Source (resolution: 15 min)

8.3.2 Aggregated Input from GreenCharge KPIs

The same KPIs computed to evaluate the impact of technology innovation in Pilots can be used to model realistic simulation scenarios and to generate synthetic energy profiles.

For example, the key indicator *GC5.1*can be used both to model the realistic scenario observed in a Pilot, and to forecast how the charging efficiency and the total charged energy will change scaling up the number of EVs according to the acquisition plan.

Here it is the list of KPIs which can be used to model and reproduce simulation scenarios.

- ***GC 5.1: EVs Number*** - existing or to buy
  - For evaluation
  - To scale
- ***GC5.2 Charging Points***
  - Numbers
  - Sharing
- ***GC 5.3: Utilization of charging points***
  - Current Energy demand from EVs and from the Neighborhood
  - Predict demand according to GC 5.1
- ***GC 5.13 Charging Flexibility***
  - Static information from EVs information
  - Information from users' flexibility
- ***GC 5.13 Time Flexibility***
  - Measures of parking time vs charging time
  - User's flexibility

8.4 GreenCharge KPIs evaluated by simulation

The output of a simulation provides information about the energy exchange between consumers, producers both in terms of time-schedule and of amount of energy.

Changing the simulation scenarios the output of simulation can be used to compute new values for some KPIs, such as:

- ***GC 5.3 Charged Energy***
- ***GC 5.13 Charging Efficiency***
- ***GC 5.9 RES Utilization***
- ***GC 5.9 V2G utilization***
- ***GC 5.10 Power Peak***
- ***GC 5.10 Average Peak***
- ***GC 5.14 Self Consumption***

Post-processing of simulation output can be used to compute addition KPIs such as CO2 emission, energy cost and saving (using tariffs information).

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9 Conclusions

In this section we provide some concluding remarks about the process of developing the approach described in this document, and its current status.

A decision was made early in the project to adopt the CIVITAS evaluation framework – something that was not foreseen in the DoW. A primary effect of this decision was a new organization of the overall GreenCharge evaluation activities according to the CIVITAS evaluation framework that suggested us to re-organize also the presentation of results, merging the D5.1 and D6.1 deliverable in one document. The work has been done by the contributing partners as it was defined in the DoW, with the same efforts. A secondary effect was a delay of the delivery date of this document, which was due to the necessity to learn and extend the CIVITAS framework for the GreenCharge objectives, but, in our opinion, allowed for improving the quality of results.

In fact, it required the involvement of all project partners who contributed to the design or to the application of the methodology. This allowed for making all GreenCharge contributors aware about how to organize their activities to foster the utilization of one common evaluation framework.

The development of this work required the nomination of an evaluation task force that has been in charge to guide and supervise the evaluation activities coordinating the activities reported in this deliverable with the other tasks and WPs. The evaluation task force will continue to guide and to monitor the application of the methodology and the development of evaluation activities.

A first result delivered by this document is a list of Key Performance Indicators. Some of them have been selected among the list of CIVITAS KPIs already available, extended to address GreenCharge requirements. New ones have been defined. The full list of 14 KPIs emerged by a participatory discussion that involved the representatives of the three Pilots.

The measures and sub-measures to be evaluated and the corresponding KPIs have been identified in each Pilot. Measures include implementation and operation of innovative technologies and of business models. Also target KPI values have already been defined where it has been possible.

The work has also identified barriers, risks and facilitator for the innovation process for the three Pilots.

Another result of coordinated activity is the time schedule of evaluation activities, which has been planned in collaboration with the tasks that are in charge to design the implementation plan in Oslo, Bremen and Barcelona. The time schedule has been released using the CIVITAS template.

The utilization of three evaluation tools has been planned according to the specific requirements of each Pilot: automatic elaboration of collected data, simulation and analysis of survey results.

The design of a visualization tool for the presentation of evaluation results has been provided by a list of mock-ups that implement web dashboards for the final users with public or restricted access., but a decision about the most effective technology for storing and presenting the research data has not been yet been taken.

We introduced "what if" scenarios to be simulated for each pilot, the related KPIs and the additional data that must be collected to facilitate the simulations.

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