Grant number: 769016
Project duration: Sept 2018 - Aug 2021
Project Coordinator: Joe Gorman, SINTEF

HORIZON 2020: Mobility for Growth
MG-4.2-2017
Supporting Smart Electric Mobility in Cities
Project Type: Innovation Action

GREEN CHARGE

greencharge2020.eu

GreenCharge Project Deliverable: D2.10

Implementation Plan for Bremen Pilot

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2020 CiViTAS Cleaner and better transport in cities

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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.

For more information

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Executive Summary

In this document we describe for the Bremen pilot the requirements and current planning regarding implementation and operation of charging systems for electric vehicles (EV) combined to photovoltaic (PV) energy supply and public transport.

In the previous D2.9 the pilot site Bremen has been described in detail and 4 use cases have been defined. These use cases are covering some of the proposed GreenCharge scenarios with the following 2 typical situations often found in the context with EV charge management:

- Firstly, business areas create commuter traffic. An increasing number of involved EV's is expected. This brings about driver needs regarding charging at the workplace using PV supply coupled to stationary energy storage.
- Secondly, combining the charging needs for shared EVs with EVs owned by private residents and/or with public transport aspects are challenging, because many types of users and stakeholders are involved.

To reflect these 2 situations in the pilot, 2 suitable "combi-sites" in Bremen have been chosen consisting of

a. station-based EV-sharing sites (2) for testing use cases relevant for public users and
b. private (corporate) sites (4) to implement business-related use cases with employees.
It is outlined, which of these 6 charging stations still need modification/reconfiguration in order to start the pilot in 08/2019 (M12). Currently, for a) and b) 2 different backend solutions are operational.

The following technical requirements must be considered for implementation:

- Technical real-time data from both the charging points and the shared EV's with individual time resolution must be acquired and stored locally.
- The interoperability must be realized between car-fleet management system and charge management system (charging station backends) – at least. Further options are also described, while having a lower priority in the implementation process.
- User interfaces (UI) are needed for all use cases. The running booking App of Move-About is the only UI in operation for the involved shared EV's and couples to the EV-fleet management system. Additional channels of direct communication between EV user and charging station must be implemented.

To meet these requirements, respective Hardware and Software (backends, Apps, Aggregator) must be adjusted for the 6 charging stations. The involved h/w and s/w components are listed and justified. They will be described in detail in D2.11 (pilot component preparation).

Moreover, the most important results of the first stakeholder workshop held in Bremen 06.12.2018 were considered, when defining the initial steps needed for implementation of the Bremen pilot as part of a GreenCharge 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.

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List of Abbreviations

Table 1 List of abbreviations

Abbreviation	Explanation
API	Application Programming Interface; used here in the context of communication between Charging station backend and CarSharing computer
CaW	Charge at Work (name of demonstrator)
CMS	Charge Management System
CS	Charging Station (in general providing several charging points)
CP	Charging Point (with cable connection to a charging station)
CPO	Charging Point Operator
EMP	Electric Mobility Provider
EV	Electric Vehicle (in D2.10 passenger cars only)
OCPP	Open Charge Point Protocol (for communication between EV, CS and CS-network)
OEM	Original Equipment Manufacturer (in this context automotive companies integrating/labelling supplied EV-batteries)
PCS	Public Car-Sharing
POC	Point Of Contact (responsible person in the cooperating entity/company)

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1 About this Deliverable

1.1 Why would I want to read this deliverable?

You should read this document to get an understanding of how the demonstration activities are implemented at the Bremen pilot site. This includes the scope, limitations and details regarding the tests to be carried out.

1.2 Intended readership/users

This report is intended for all project partners that are in involved in the definition, simulation, and testing of use cases in the various e-mobility scenarios. Further, it is relevant for all stakeholders in Bremen, in particular those dealing with charging infrastructure, CarSharing, and renewable energy issues. Finally, reading the document should be useful for respective actors in the uptake cities group.

1.3 Other project deliverables that may be of interest

- **D1.1 -** Describes the internal procedures for dealing with the collection and handling of data from the pilots in order to make them as open research data, including the necessary permissions for handling private data, and the necessary forms of informed consent and documentation of technical solution for secure data storage.
- **D2.9 Description of Bremen Pilot and User Needs -** Describes the Bremen pilot in terms of challenges, user needs, use cases, scenarios, stakeholders and locations to be involved and the baseline at starting point of project
- **D2.11 Pilot Component Preparation for full scale pilot (Bremen) -** Deployment and testing of software and hardware components to be used in the pilot, to prepare for the full-scale implementation of the Bremen pilot
- **D2.**12 Full-Scale Pilot Implementation for Car Sharing - Integrated smart charging solution installed for car-sharing, including charging infrastructure and 2nd use EV-battery storage.
- **D2.13 Final Report for Bremen Pilot: Lessons learned and Guidelines -** Describes the Bremen pilot, including the implementation, operation, the tests carried out, services and the data collected. Describes lessons learned and guidelines for car-sharing.

1.4 Other projects and initiatives

At the CarSharing workshop within the H2020-project “STARS” (organized in Bremen 24.01.2019) interim results have been presented. From these it can be concluded, e.g., that free-floating CarSharing is much less effective than station-based CarSharing regarding the reduction of privately owned cars in cities (in Bremen all CarSharing activites are station-based). This is in line with the decision not to consider free-floating car-sharing as a use case in the Bremen pilot.

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2 Overview of the pilot site in Bremen

See "D2.9 Description of Bremen Pilot and User Needs" for a more detailed description of the pilot site and the surroundings. Only a short summary is given here.

The pilot site Bremen consists of a variety of charging stations addressing different types of users and are therefore embedded in different environments. These stations apply basically to CarSharing of users w/o own car, to sporadic usage in the combination with public transport and to commuters travelling/charging at work on a regular basis. Charging stations are either integrated in the grid of local electric utility company or are part of the local grid in a quarter area. Green Charging in 2 typical situations will be piloted in Bremen:

1. Charging stations on public ground (managed by MOVA):

Before GreenCharge started, booking of charging stations was not needed for shared EV's, since each car was attributed to one specific parking/charging place. Making these places available to other users during usage time of the shared EV should be attractive for the station operator, since free parking/charging capacity can be utilized.

2. Charging stations on private ground (managed by PMC):

Commuters travelling to work may charge their EV on the premises of the employing entity. This addresses the situation found in many business areas, where charging stations are part of a local electric grid. Smart charging capability would decrease cost of power supply. The rules for priority charging can be set by the employer and is a typical use case for charging on private ground. In the Bremen pilot the combined usage of several charging stations located at different working buildings in a well-defined area will be tested (campus of Bremen University).

Figure 1 Pilot Site Bremen Charging Stations

Map source: OpenStreetMap; Open Database License 1.0; Datasource: PMC/MOVA; The charging stations marked in red and light blue are managed by PMC and MOVA, respectively

Altogether 6 charging stations are currently involved in the Bremen pilot. In addition to these there exists a slight chance to make use of an even larger system of charging stations (within the "red" area in fig.1) that will be established in 2020. Although these would be operated with even a different backend solution, the use case UC#1 "Booking Enforcement for priority charging" could be tested there in a much more realistic way than with a distributed variety of charging stations across the university campus.

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3 Pilot description

3.1 Use cases to be demonstrated

The following use cases derived from scenarios 3, 4, and 7 in the DoW will be demonstrated and tested in the Bremen pilot (see also 4.3 Use Cases and User Needs in D2.9):

- Use Case #1: Booking enforcement for priority charging for a pre-defined group of EV's/persons (e.g., business cars, VIP owners, visitors);
- Use Case #2: Commuters charging at work via PV energy supply;
- Use Case #3: EV CarSharing combined with public transport "mobil.punkt" (innovative "Mobility as a Service" - MaaS);
- Use Case #4: EV-CarSharing in a residential neighbourhood.

A more detailed description of these use cases and their basic flows can be found in the Appendix of D2.9.

3.2 Charging stations and their preparation plan for the pilot

3.2.1 Public EV-sharing stations

Public charge points

1. Kissinger Straße/Utbremer Ring
2. Ricarda-Huch-Str. ("mobil.punkt")

Table 2 pilot sites - public charging points *(operator: MoveAbout)*

#	Type	name/location	charger	power limit	Employed in Use case
#5	public	**KISSINGER** Kissinger-Str./Utbremer Ring	22kWac / type 2 / mode 3	22 kW	#4
#6	public	**RICARDA-HUCH** Ricarda-Huch-Str.	22kWac / type 2 / mode 3	22 kW	#3

3.2.2 Corporate EV charging stations

Since several charging locations at the university campus are involved, the system needs an integrating backend software. The ENCORE aggregator based on the existing proprietary ENCORE backend developed by the PMC member company AenonDynamics and licenced by PMC eG has exactly that objective. PMC in cooperation with AenonDynamics will implement this backend for 3 sites. The site "IFAM-2" is devoted to traveller use case, which might come into play in a later stage of the project.

Private charging stations (CS)

1. Parkallee-1 (underground garage, access via garage door opener/RFID)
2. Galileo-Residenz (@student dormitory; access via car park barrier/RFID)
3. IFAM-1 (on main parking place; access via car park barrier/RFID or speaker)
4. IFAM-2 (side parking area; access w/o barrier).

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Table 3 pilot sites - corporate charging stations *(for commuters, charging at work - use case #2)*

CS	Type	Location	Charger	Total kW limit	Employed in Use case
#1	private	**PARKALLEE-1** Parkallee 301 (garage)	2x22 kW ac / type 2 / mode 3 2 x 3,7 kW CEE / mode 2	22 kW	#2
#2	private	**GALILEO-1** Fahrenheitstr.19	2x22 kW ac / type 2 / mode 3	30 kW	#2
#3	private	**IFAM-1** Wiener Str.12	2x22 kW ac / type 2 / mode 3	22 kW	#2
#4	private	**IFAM-2** Wiener Str.17	43 kW ac / type 2 / mode 3 50 kW CCS and CHAdeMO	100 kW	#2

However, for piloting use case #1 (priority charging) further actions would be needed and are still under debate regarding access of charging points provided from another project outside GreenCharge, and regarding data collection via backend s/w that would not originate from PMC. This option will be expected operating by 05/2020. Given the chance to use this charging infrastructure, the use case #1 is kept on hold.

3.2.3 Timelines

The following Table 4 informs about status and timelines for the Component preparation activities of the charging stations as part of full-scale pilot. User recruitment occurs in parallel to the indicated preparation work at the charging stations.

Table 4 Current status of charging stations for usage within the Bremen pilot

CS #	Software (s/w)	Hardware (h/w)	Administrative	CS ready-for-usage
1	Local connection between charge points and backend must be implemented (gridctrl.aggregator)	Smart meter and charge controller upgrade required	Technical acceptance; System validation	07/2019
2	An OCPP-1.6 endpoint has to be implemented within gridctrl.aggregator (cloud)	Current charging station must be replaced by a more modern version	Technical acceptance; System validation	06/2019
3	Local connection between charge points and backend has to be implemented (gridctrl.aggregator)	Smart meter and charge controller upgrade required	Technical acceptance; System validation	08/2019
4	OCPP-1.5 uplink to encore.gridctrl (cloud; configuration task)	Integration of external smart meters (optional) to acquire high resolution data	Agreement with owner pending; System validation	06/2019
5	Backend from Meshcrafts AS	CPs operational; to be tested in combination with backend s/w	License from Meshcraft AS still pending	05/2019

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CS #	Software (s/w)	Hardware (h/w)	Administrative	CS ready-for-usage
6	Local connection between charge points and backend to be slightly adjusted	Current charging station can be used as is; Smart meter and charge controller upgrade useful in a later stage of implementation	Agreement with stakeholder SWB with respect to charging data needed	04/2019
	ready-to-use; just little adjustments needed			
	Redesign/adaption work in **s/w** needed for usage in pilot			
	Redesign/adaption work both in **s/w and h/w** needed for usage in pilot			

3.3 Target users and stakeholders

3.3.1 Target users

For the PMC demonstrator (involving charging sites #1-4), users that would run the pilot (ca. daily use) are:

1. Commuters (employees and students) travelling to their workplace within the university campus. This is the largest user group bringing typically their own EV (if not leased) or are using business EV's. They would be engaged in testing the 2 use cases UC#1 and 2.
2. Visitors would come along occasionally using a private/business EV and would need priority charging. The hosting employee must take care and be informed about the charging needs of his/her guest.

For the MOVA demonstrator (involving charging sites #5 and 6), users that would run the pilot (weekly/monthly use) are mainly:

1. residents living near the EV CarSharing stations (maximum distance ca. 300m) testing use case UC#4;
2. citizens with own EV living in the neighbourhood should be allowed to use the charging stations for the period of time, when shared EV's are absent. It will be challenging, however, to deal with unexpected early return of the shared EV.
3. citizens without own car, who use the public hubs "mobil.punkt" as an additional mobility option testing use case UC#3.

3.3.2 Other stakeholders

Another group of stakeholders needed to run the pilot is composed out of companies for facility management and buildings (Gewoba, Ecotec), the local utilities (SWB), and public transport operator (BSAG).

- **Gewoba** (housing company) uses the availability of CarSharing with EV's near their blocks of flats as additional incentive to resident customers w/o own car or as replacement of a second own car (interested in results of use case #4);
- **Ecotec** is interested in developing mobility concepts that integrate CarSharing, public transport, and biking for the users in a combined office/residential quarter (interested in results of use case #3);
- **Local utilities** (SWB) is interested in smoothening load peaks in electricity nets by smart power supply of a net of charging stations operating throughout the city of Bremen (interested in the results of all 4 use cases);

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- **Public transport** (BSAG) is interested in enhancing the number of customers using city-bound trams/buses starting at “mobil.punkt” CarSharing stations (interested in results of use case #3).

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4 Stakeholder involvement and user recruitment

4.1 The local reference group

In the first workshop for the Bremen pilot (06/12/2018) the business case "EV-CarSharing" has been developed starting from a very wide perspective. Representatives from 12 Bremen organisations were participating in this event (a constitutional meeting was already held in the proposal phase of the project). Conclusions derived from this workshop can be summarized as follows:

1. Battery storage for green energy shall be considered on each step of the value chain;
2. The backend aggregator of charging points must ensure the guaranteed availability for charging for both types of charging stations - public/private;
3. Interoperability must be in place, esp. for the public sites.

The Bremen pilot will consider these results by adjusting the planned implementation, e.g.,

- Operation of CS #3 ("IFAM-1") will include stationary battery storage (PMC);
- The ENCORE aggregator will consider more than just 1 charging station (PMC);
- Interoperability of charging stations, which are currently operated in a separate way, will be tested for both involved CarSharing-sites (MOVA).

It was agreed that in the next workshop (by end of 2019) the perspective of the LRG members from the housing and building management branch should be put into the focus. This should support them in finding new mobility concepts, when trying to combine major aspects connected to EV-sharing, public transport (electric buses), and small electric vehicles (e-bikes, etc.).

A prominent example of highly topical interest is the development of a combined resident/business (office) quarter in the former harbour area of Bremen (district "Überseestadt"). The planned mobility concepts could profit from some GreenCharge results that are derived, e.g., from the mobil.punkt approach or the topic "Charging in a Garage" (Oslo).

4.2 User recruitment initiatives

Since currently the number of EV drivers using public CarSharing (PCS demonstrator) and the corporate EV charging options are fairly low, some initiatives are planned to recruit more registered users:

4.2.1 mobil.punkt demonstrator

To further increase the number of people that are using the service provided at the mobility points the following activities are planned:

- Additional advertisements/information in local newspaper;
- Informing directly at the charging points (e.g., via sticker/QR-tags) about these mobility access points;
- Incentives (tbd) for interested users that are willing to register.

4.2.2 Public CarSharing (PCS) demonstrator

Currently there are just 8 users registered at MOVA for CS#6 KISSINGER. To increase the number of registered PCS users some promotional actions are planned, e.g.,

- offering test drives, which also would reduce the level of general reluctance by the residents regarding EV's;
- Residents will be informed about the provided services with a set of informal discourses. The event will be promoted by the local press (Weserkurier);

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- Flyers will be distributed to residents living in a relevant surrounding of that particular charging station.

4.2.3 Charge@work demonstrator

Currently there are only 4 users with own EV's on the corporate site that are willing to participate in the project regarding charge@work. The following activities are planned to find more users that can be contracted by PMC under the framework of GreenCharge:

- With permission of the institution, employees will be addressed via email explaining the purpose of the project and the positive effect potential users would create via participation. Having identified a minimum of 5 potential users in addition to the already existing, a kick-off meeting would be organised to go into the organisational and technical details for participation. Contracts will be signed individually;
- The participants would be interviewed before starting the demonstrator, after 1 year, and at the end of the project. The contents of the respective survey would be harmonized with those of the other 2 demonstrators in the Bremen pilot.

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5 Implementation requirements

5.1 Overall architecture

The overall architecture for implementing GreenCharge services is shown in Figure 2:

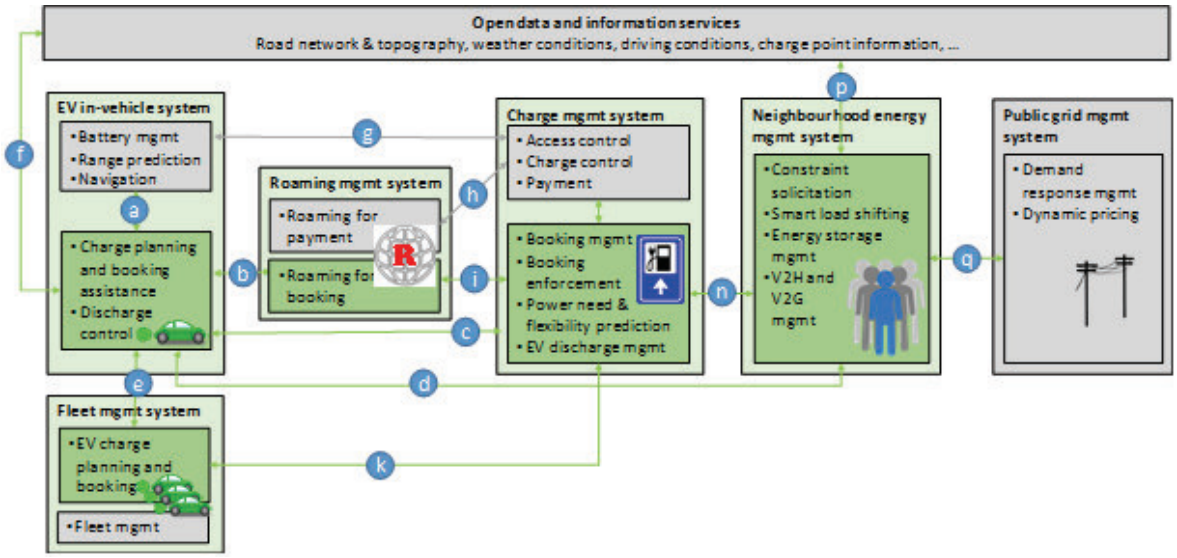

Figure 2 Green Charge architecture sketch (copied from DoW)
(The boxes highlighted in "green" are directly relevant for GreenCharge implementation.)

The implementation work in the Bremen pilot involves basically the following components of the GC system:

1. EV in-vehicle system (-> charge planning; control of SoC)
2. Fleet management system (-> charge planning; EV-booking)
3. Charge management system (-> booking management; booking enforcement).

Moreover some more aspects might come into play that are related to

4. Roaming management system (-> booking of charging point)

The usage of the related interfaces (see labels on arrows in the above figure) are described in Table 5 and will be completed in an up-dated version.

Table 5 Usage of interfaces in the Bremen pilot

Label	Interface usage	
c	Charge planning and booking information inputted by the EV driver via App must be matched with the available options given by the CMS	
g	EV driver opens App with a charging request and enters the time, when the EV is going to leave the site. CMS (charge management system) grants charging time.	
k	When booking an EV for a certain time of day, the CMS must ensure that at the end of this time period the EV can be fully charged; if this is not possible (time too short) a response is needed back to the fleet mgmt. – another car from the pool is suggested to the customer.	

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5.2 Data collection requirements

5.2.1 Data sources and required resolution

Data from the various charging sites need to be collected by various actors – from the user, but also automatically collected from the EV's/CS's. The expected resolution depends on the data source. Estimate figures are given in Table 6. together with the access mode for data acquisition (demonstrators are abbreviated as follows: PCS – Public CarSharing; CaW – Charge@Work).

Table 6 List of data sources required for Bremen pilot

#	Data source	Sampling rate	Demon-strator	Access of data Mode of acquisition
#1	Data from charging infrastructure; sampling starts on connection	10/min	CaW (PMC)	CMS stores data as time series via database (SQL)
#2	Metering data; sampling starts on connection	10/min	CaW (PMC)	CMS stores data via database (SQL)
#3	Usage data	1/min	CaW (PMC)	CMS stores data via database (SQL)
#4	Efficiency data	1/min	CaW (PMC)	CMS stores data via database (SQL)
#5	Data from solar energy supply	10/min	CaW (PMC)	CMS stores data via database (SQL)
#6	Data from stationary battery	1/min	CaW (PMC)	CMS stores data via database (SQL)
#7	Data from EV battery; SoC and/or remaining km given by EV	Each use (ca. 1/day)	CaW PCS	Input requested from driver
#8	Price tariffs	1/day	mobil.punkt PCS	Fixed (contract with supplier)
#9	Energy mix	1/month	mobil.punkt PCS CaW	Fixed (contract with supplier)
#10	User-ID of Charge@work	n.a.	CaW	User registered by PMC (only accessible by PMC)
#11	User-ID of CarSharing EV's	1/month	PCS	Registered by MOVA (only accessible by MOVA)
#12	Owners of private EV's using public charging stations	1/month	PCS	Registered by MOVA (only accessible by MOVA)
#13	State of Charge (SoC)	10/h	PCS	CarSharing System

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#14	Estimation of km-range	n.a.	PCS	Derive from SoC
#15	Geolocation	1/min	PCS	CarSharing System
#16	Driving patterns	1/min	PCS	CarSharing System
#17	Users changing from or to public transport	1/month	mobil.punkt PCS	CarSharing System and open API of public transport operator (anonymized)

5.2.2 Data storage requirements

Technical data from charging points are acquired with high resolution only, if a charging event has been started. During times, when the CP is not used, no such high resolution is needed. It is expected that for data storage an overall capacity of about 450 GB/year is needed, i.e.:

1. Produced data: 150 GB /year
2. For data backup: 300 GB /year

A suitable storage device for the produced data and the data backup will be allocated for this purpose at the premises of both "technical" partners in Bremen, PMC and Move-About.

5.3 Interoperability requirements

The Hubject eRoaming system should be used to enable external off-site charging for commuters (roaming). This will allow cross-country interoperability of payment and booking as well as facilitate interoperability between different pilots. It enables the alignment with the "Digital Single Market Strategy" and facilitates improvement of the attractiveness of EVs for widespread use among private users and business.

In this case, the partners of this demonstrator case will take the roles as a CPO and an EMP by providing charging services and mobility services, respectively. Using the eRoaming services, the demonstrator ensures interoperability beyond the demonstrator itself. This means, that other EMP provider can offer their customers to charge to the charging stations owned by the CPO partners of the Bremen Pilot, but also the user of the Bremen Pilot can charge on other charging stations connected by the eRoaming platform. Furthermore, external EV drivers, who already have contracts belonging to the intercharge network can use the charging station of the pilot, which will increase the utilization rate and generate potential income. The eRoaming platform provided by Hubject enables the following processes:

- Ensuring the interoperability of the public and semi-public infrastructure through promotion of accepted standards within the network and open business user interfaces to the platform
- Simplification of authentication and authorization procedures through a trustworthy instance as well as safekeeping of sensitive data through the uncoupling of personal data and anonymous user data
- Automation of contract-based business relationships between power suppliers, car manufacturers, infrastructure service providers as well as further mobility business parties

5.4 User interfaces

No user interface is required for the charging stations on private ground managed by PMC. Activation is by RFID or just by a mechanical switch. Thus, dedicated user groups (e.g., employees) can be enabled to use these charging points, which are all combined with an individual and reserved parking bay. Priority charging will be realized by web-managed booking. A dedicated mobile App development is not projected at PMC.

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Move-About uses RFID to communicate with their charging stations, which are assigned to reserved parking spots. RFID-chips are also used to open or lock the car. EV's, all owned by Move-About GmbH, can be booked either via a web-based platform or via a booking App.

5.5 Hardware and software requirements

The GreenCharge partners PMC and MOVA are providing different types of h/w and s/w to be implemented in the Bremen pilot. There are additional requirements needed for the implementation phase of the Bremen pilot, which are described roughly in the following:

5.5.1 charge@work demonstrator (PMC)

The charging stations CS#1-4 have to be connected to the gridctrl.ENCORE backend. Charging and metering data are processed and made available for user App. For this the following capabilities are required

1. smart metering for all the charging points;
2. data storage system (cloud) including
    - MariaDB (enterprise grade) - leading open source database derived from MySQL;
    - InfluxDB - open-source time-series database, optimized for fast storage and retrieval of time-series data, esp. for operations monitoring and storage of sensor data;
    - Elasticsearch (SQL search engine);
3. Sensors for parking spots (occupied/vacant);
4. Marking of EV-reserved areas.

Exemplified by the sub-system CS#3 (IFAM-1), in figure 3, both the flows of data (blue arrows) and of power (black arrows) are indicated in the sketched gridctrl.aggregator component.

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.

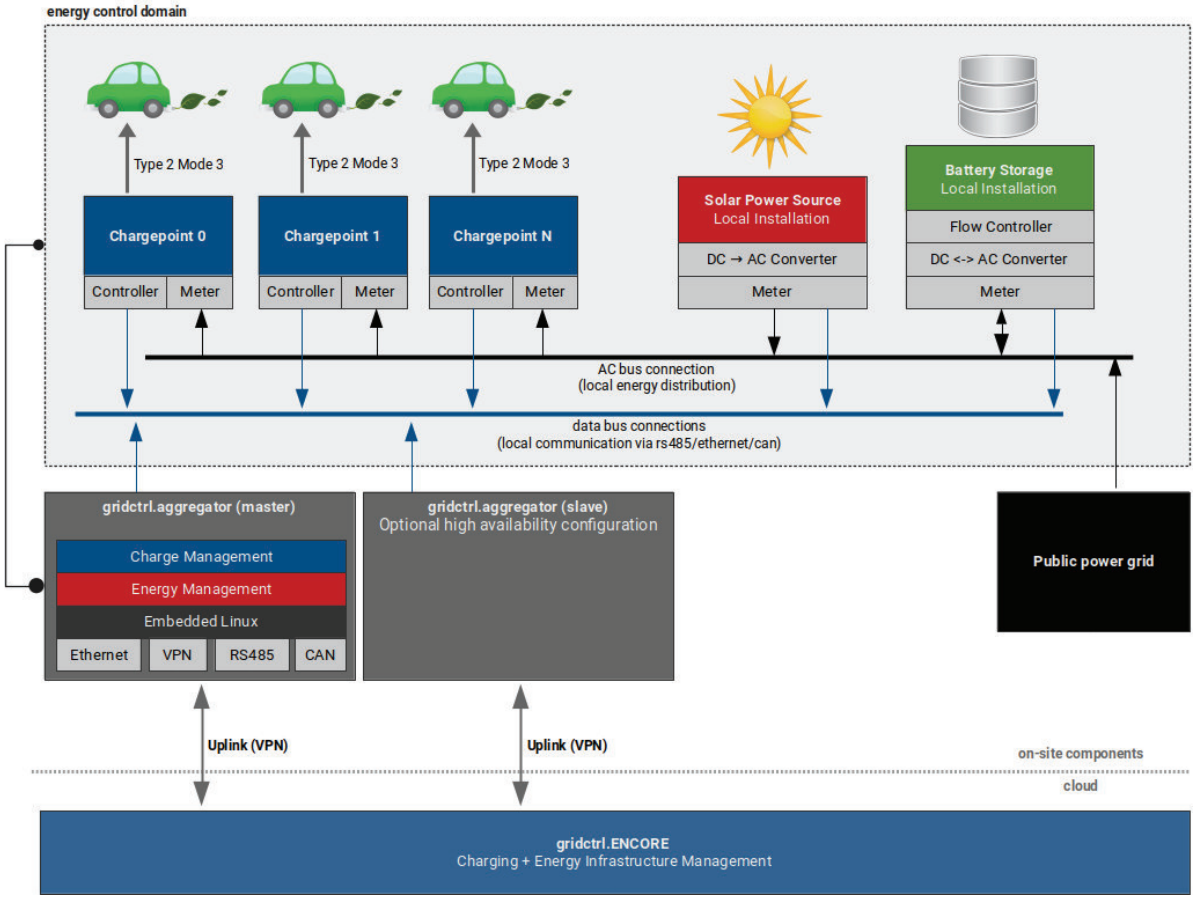

Figure 3 Charging station CS #3 (IFAM-1): on-site grictrl.aggregator

5.5.2 Public CarSharing (PCS) demonstrator (MOVA)

Referring to D2.9 (chapters 4.3 and chapter 5), a system is required that allows communication between the following sub-systems:

- CarSharing-Computer,
- booking platform,
- Charging station backend (representing also a parking spot),
- public transport system.

Relevant functions must be implemented in a mobile App.

Move-About will use “Ota Keys” (CarSharing hardware), “GTS” (CarSharing software) and link them to the “SmartCharge”-backend operated by Meshcrafts. They are all working with straightforward structured API documentations and an open communication protocol, which makes it easy to add further system components, once needed. The communication is supposed to work as sketched in figure 4.

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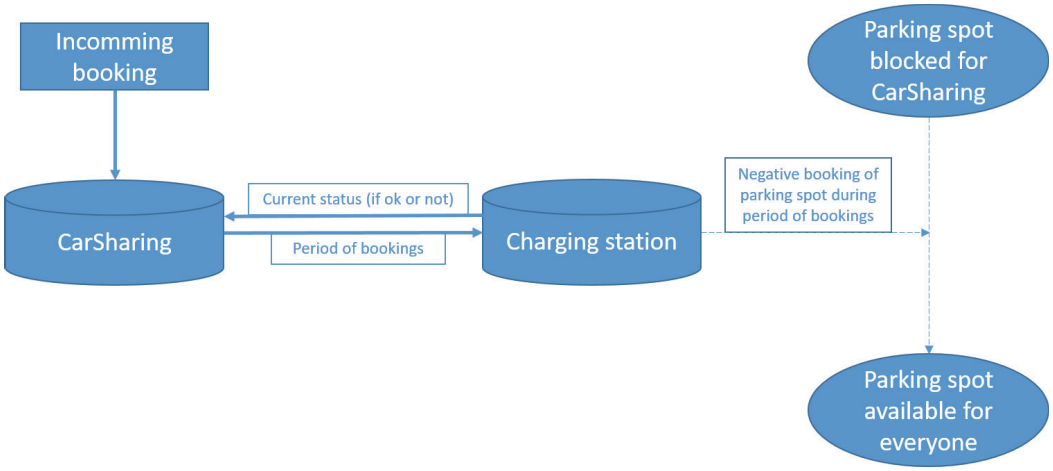

Figure 4 Communication between CarSharing system and charging station

5.5.3 mobil.punkt demonstrator

Since closely related to PCS, the requirements of the mobil.punkt demonstrator is similar to the needs of the PCS demonstrator as described in 5.5.2. The new system will mirror the mobil.punkt to the PCS frontend and will allow convenient EV booking. Because of the geographical proximity to public transport, the PCS-System will show an actual timetable to provide “mobility-as-a-service" (MaaS) as well.

5.6 Selection of Hardware (h/w) and Software (s/w)

5.6.1 Hardware components involved in the Bremen pilot

The most important hardware needed to start the Bremen pilot are summarized in Table 7 and will be described in more detail in D2.11.

Table 7 Hardware components used in Bremen pilot

#	component	Reason for usage	Who
1	CS#1 PARKALLEE	The large display is useful for visual interaction with user to give infos regarding operation of CS	PMC
2	CS#2 GALILEO	wallbox allowing payment service for dedicated user group	PMC
3	CS#3 IFAM-1	2 wallboxes allowing usage of on-site PV energy and battery storage	PMC
4	CS#4 IFAM-2	ac/dc charging station needed for fast immediate priority charging	PMC
5	CS#5 RICARDA-HUCH	“mobil.punkt”-station to combine usage with public transport; it is the nearest one to CS KISSINGER	MOVA
6	CS#6 KISSINGER	Multiple (3) wallbox station for neighbourhood usage	MOVA

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7	PV-carport	For usage of on-site generated PV power - max 4,7kW - for EV's only	PMC
8	Battery storage system	2nd life batteries as buffer storage system consisting of used car batteries, i.e., ZEBRA + Li-ion; an option to be tested comprises slow re-charging (PV) and semi-fast EV charging	PMC
9	Ota Key	CarSharing h/w needed to enable/unlock EV for user	MOVA
10	EV fleet	EV's available for station-based CarSharing at the 2 sites RICARDA-HUCH and KISSINGER	MOVA

5.6.2 Software components involved in the Bremen pilot

The software components to be implemented for testing the Bremen pilot are listed in Table 8. They will also be described in more detail in D2.11.

Table 8 Software components used in Bremen pilot

#	s/w-component	Reason for usage	Who
1	gridctrl.ENCORE	Proprietary backend that allows to adapt/implement pilot-specific requirements for use case testing – source code available from PMC-member company;	PMC
2	gridctrl.aggregator	s/w-extension of ENCORE that will allow to manage different charging stations, e.g., CS-IFAM1 and CS-PARKALLEE; source code available from PMC-member company;	PMC
3	GTS	CarSharing Software that enables booking and fleet management	MOVA
4	"SmartCharge" backend	CMS (Charge Management System) of CS-KISSINGER operated by Meshcrafts AS;	MOVA

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6 Implementation plan

6.1 Organisation of implementation

The following GreenCharge partners are responsible for implementation of the Bremen pilot:

- Freie Hansestadt Bremen/SUBV (BREM)
- MoveAbout GmbH (MOVA)
- Personal Mobility Center NordWest eG (PMC)

The following roles have been defined in relationship to the Bremen pilot (based on CIVITAS evaluation framework, see [1]):

***Table 9** GC partners' roles in Bremen pilot*

Role	Organisation	Responsibility
Site Coordinator (SC)	PMC	Coordinate the implementation of the pilot.
Local Evaluation Manager (LEM)	PMC	Handle the evaluation related activities. Plan and coordinate data collection process and in collaboration with Task 5.1 and 6.1 select and adapt the local indicators from the overall project indicators.
Measure leader (ML)	PMC	Responsible for data collection as defined by the local indicators (defined by Task 5.1 and 6.1) and the data collection process plan defined by the LEM.

The SC, LEM, and ML report to the WP2 leader. In addition, a WP2 task force has been established to coordinate and exchange information between the different pilot sites. This task force has biweekly telephone conferences. In these meetings all task leaders and editors of the deliverables are expected to be present.

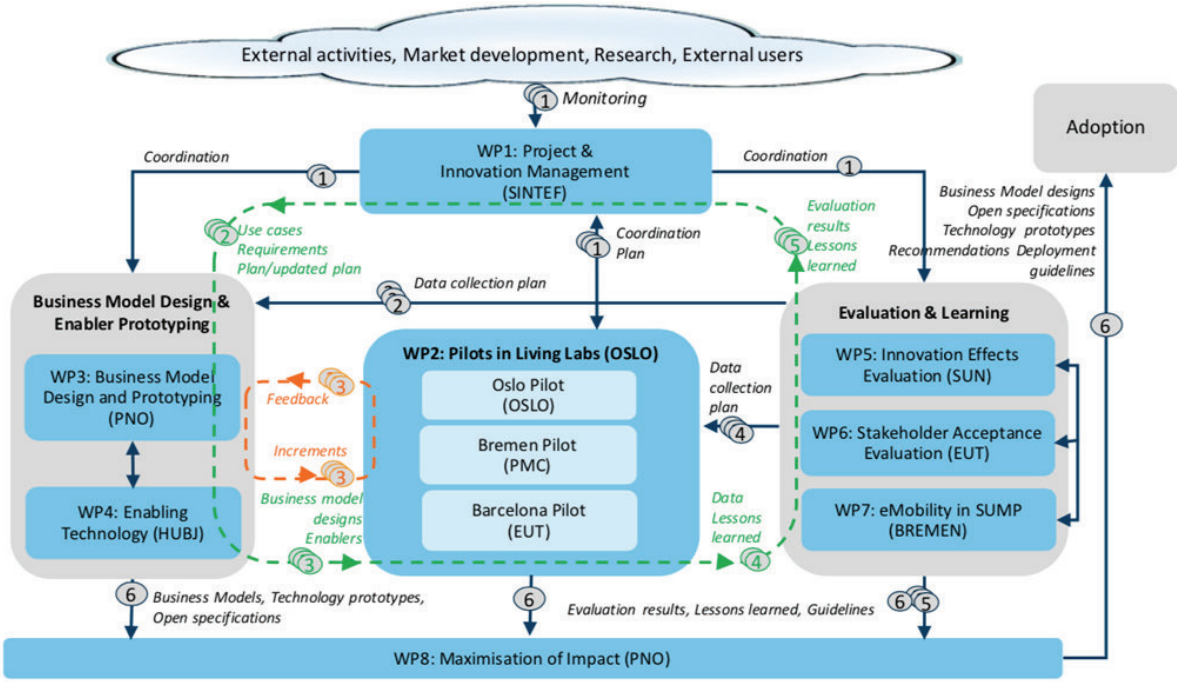

Figure 5: GreenCharge work package structure and interfaces (from DoW)

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The main inputs relevant to this implementation plan (D2.10) is:

- From WP5: KPI and data collection plan providing input to data collection requirements
- From WP3: Business model designs
- From WP4: Interoperability requirements and technology prototypes.

N.b.: Use cases for the Bremen pilot are described in the Appendix of D2.9. Currently there are 4 use cases defined.

6.2 User recruitment plan

Move-About GmbH has nearly 600 registered users in Bremen. At the 2 pilot sites managed by Move-About (CS#5,6) approximately 12 users from the surrounding area are using the provided CarSharing EV's. It is expected that the number of users will further increase due to a project-extension at CS#5, where an additional building is under construction by the stakeholder Gewoba (see figure 6). Here the number of residents will increase due to a beneficent pricing option. In addition, extra marketing events at both pilot sites are planned to acquire even more potential users. This initiative is planned for summer 2019.

Figure 6 Project extension at CS#5 (KISSINGER)

PMC eG is managing CS#1-3 (agreement for CS #4 is still pending). There are 5 users of EV's employed at University campus entities, who are currently using one of these charging stations 2-4 times a week. This fairly low number of users must be doubled at least (>10) before starting the pilot and test use cases UC#1 and UC#2, because only then meaningful statistical results can be expected. We are about to do this by direct user acquisition via personal contacts. Since PMC is also member of the Technologiepark Uni Bremen e.V., a network of entities/companies around the University campus, we may use some of the partner newsletter for advertisement. We expect that this initiative will end successful by 07/2019.

BREM (City of Bremen) will support user acquisition via their newsletter channel or similar tools.

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Still we expect that during the running GreenCharge project the overall number of EV users employed at University campus entities will increase considerably, since new (and above all cheaper) e-car generations will enter the market. However, regarding this effect no estimate on timeline or numbers can be given at this point.

6.3 Use of Local Reference Group

A local reference group (LRG) was established in Bremen before starting the GreenCharge project. Recruitment to this reference group was through direct personal contact to Bremen-based companies, which are active in electric mobility topics. The LRG is considered to be a "breathing" assembly, i.e., members will leave, if they don't see a substantial benefit to their daily work anymore - others will come on board that have been acquired via (convincing) arguments for their future business.

By running the use cases, arguments can be derived for new business cases and/or for extension of the existent operational business of the LRG members. In-depth information on the outcome of the respective use case will be provided branch-selectively and summarized in a brief facts-and-figures conclusion. Only then the LRG members can profit from the pilot results in their respective business field.

6.4 Plan of supporting activities

According to the CIVITAS evaluation framework [1], evaluation comprises two complementary actions: (1) Impact Evaluation and (2) Process Evaluation. The process evaluation *involves the evaluation of the processes of planning, implementation and operation, aiming to understand why measures have succeeded or failed, including the roles of information, communication and participation*. This includes determining what effect various supporting activities have in implementing the measures and increase the envisaged impact.

For each of the following sub-sections, titled after each measure to implement in Bremen, an overview of the planned support activities is given. The measures and associated sub-measures are defined in GreenCharge deliverable D5.1/D6.1 "Evaluation Design / Stakeholder Acceptance Evaluation Methodology and Plan".

6.4.1 GC.M4 – Booking for priority charging

This measure is devoted to testing/implementing the use case UC#1 ("priority charging" within scenario SC#3). The supporting activities listed in Table 10 comprises a multiple of charging stations available for a specified user group (employees) with the following boundary conditions; (1) limited total power supply from internal grid, and (2) priority given to an EV-user-group specified/documented beforehand. These could be, e.g., visitors, VIPs, etc..

Table 10 Supporting activities for prevailing priority charging in a multi-station environment

Sub-measures	Risks	Supporting activities to approach target group	stage	Target group	Respon-sibility
multi-station charging facility on company ground	No agreement between CPO and PMC achieved	Direct negotiation and Telco-meetings	P, I	Partnering institution providing the CS-backend	SC + PMC
	Too few registered users taking part in long-term study	In-house email-circular to inform all employees of the charging opportunity and condition of usage	P, I	All company employees	SC + PMC

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	Official complaints of non-EV drivers for restricted parking	Direct communication to enhance understanding	O	Commuting employees w/o private EV	SC + employer official
multi-site CS distributed across site-area (campus)	technical standards for employed CS are incompatible with each other	Approach CP-owners and initiate s/w modification to ensure interoperability	P, I, O	CPO (charging point operator)	SC + PMC
	CS are available to employees of respective enterprise only	Workshop with members of the "Technology Park Bremen" to incentivize cross-usage of CPs	I, O	Officials of the members of Technology Park Bremen	PMC
	Pilot not anchored in the target group	Become member of the Technology park Bremen Organising webinar	I, O	Member group of Tech. Park Bremen e.V.	PMC (WP8)

P=planning phase, I=Implementation phase, O=Operation phase

6.4.2 GC.M5 – Charge@work via PV energy supply

These activities aim at integrating the charging for a group of buildings in a well-defined area – a situation typical in many business areas, where people drive-in for work in the morning and leave again in the evening. The Bremen Technology Park could develop as an excellent example for an integrated system of PV-energy supply and EV-charging in a multi-building commercial and light-industry area. The technological prototype will be a charging station (with 3 CP's) supplied from a PV carport and connected to a stationary energy storage that consists of used automotive batteries. It will pilot use case UC#2 referring to scenario SC#4.

Table 11 Supporting activities for EV-charging at work with PV-energy and flexible power

Sub-measures	**Risks**	**Supporting activities to approach target group**	**stage**	**Target group**	**Responsibility**
Charging infrastructure with PV support	Unknown options	In-house email circular to inform all employees of the charging opportunity for private-owned cars	P, I	all company employees	SC + company point of contact (POC)
	Users not willing to charge at that particular CS	Enhance convenience by ensuring a free parking space Include gamification elements in the reservation app Provide (minor) free-of-charge car service	I, O	Commuters with private EV	SC + POC
Stationary buffer battery usage	Not enough storage capacity installed	Searching ads in newspaper, via twitter and direct addressing for compatible extra battery	P, I	Drivers of old EV's, car dealer	SC

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	Not perceived as an added-value by user	Promotion via leaflet, newsletter Prepare comparison of grid power usage with and w/o (baseline) buffer storage for distribution to target group	I, O	All EV-drivers	ML+PMC
	Real-time SOC data not plausible or inconsistent	Regular consultation hours	I	All users	ML+PMC

6.4.3 GC.M6 – EV-CarSharing in a residential neighbourhood

Currently, CarSharing is offered by Move-About at parking sites that are exclusively reserved for CarSharing EV's. However, additional business can be created by offering the CarSharing sites to private EV owners for charging their EV temporarily. This refers to use case UC#4 ("EV-CarSharing in a residential neighbourhood") and to scenario SC#7 ("Mobility as a Service"). Being able to synchronize the booking events constitutes a major challenge that will be prototyped and tested at the charging site CS#6 "Kissinger". Here the 2 user groups, namely CarSharing customers and private EV owners from the residential neighbourhood, will use mutually the charging station owned by the CarSharing company Move-About.

Furthermore, this measure aims at the additional incentives, a public transport option nearby a CarSharing station might constitute for potential CarSharing users. It refers to use case UC#3 ("EV-CarSharing combined with public transport") and to scenario SC#7 ("Mobility as a service"). Technologically the many mobil.punkt sites that exist meanwhile throughout Bremen will be prototyped by the charging site CS#5 ("Ricarda-Huch").

Table 12 Supporting activities for EV-CarSharing in a residential neighbourhood

Sub-measures	**Risks**	**Supporting activities to approach target group**	**stage**	**Target group**	**Responsi-bility**
Combine eCarSharing with public transport (mobil.punkt)	Potential customers do not realise any advantage	Circular mail to CarSharing customers to inform them about new service options Advertising Leaflets Support in installing/using the respective application	P, I	eCarSharing customers	MOVA
	Non-availability of real-time digital timetable	Link public transport timetable to booking platform Acquire access to real-time schedule from public transport entity	P, I	eCarSharing customers	MOVA

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Combine with public EV-charging	Private EV-owners are continually blocking sites for shared EV's	On-site information event leaflets	I, O	Residents; Private EV-owners	MOVA
	Intentional occupation of charging sites	Installation of lockable detent	I, O	Residents, private EV owners, eCarSharing customers	MOVA
	Exact time of CP-availability not available	Link CMS to booking platform	P, I	Private EV-owners	MOVA

6.5 Risk Management

The table below summarises the identified risks that might become active during the implementation of the Bremen pilot (other risks related to process evaluation and implementation of support activities are described in the afore-mentioned *section 6.4 Plan for supporting activities*).

In Table 13, risks #1-4 are risks from the project description part of the grant agreement and identified as relevant for WP2 (same as for Oslo pilot and Barcelona pilot).

Table 13 Risk management Bremen pilot

Risk -#	Description	Mitigation measures
1	Some planned pilot activities turn out to be more difficult than planned to implement in a practical pilot.	• Assess possibility to change evaluation method; • Resort to simulation of the difficult parts that cannot be tested in pilots.
2	OEMs deny direct access to battery status of EVs	• Obtain the battery status indirectly, e.g. as reported by the users; • Use a mathematical battery model instead and calibrate the parameters of this model against the available EV models involved in the pilots.
3	No access to Application Programming Interfaces (APIs) makes it difficult to integrate various components	• Try to replace closed components with components that offer an open API; • Resort to simulation of difficult components, if no replacement can be identified.
4	Inadequate data collected in the pilots to support the evaluation	• Start analysis and evaluation in parallel with the pilots and implement modifications if necessary; • Supplement data with simulated measurements to give a more complete evaluation.
5	Number of users remain too low for statistical evaluation of usage data	• Start with acquired user group as scheduled; • Integrate new users acquired during the pilot test.

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Risk -#	Description	Mitigation measures
6	failure of important h/w (charging station, car-computer, etc.)	• Have important h/w ordered immediately for replacement; • Have spare parts ready (if not too expensive).
7	Acquired data get lost (erased by mistake)	• Establish routines for backup of collected data; • Establish plan for monitoring data collection process.
8	Time resolution of data acquisition turns out not to be appropriate for meaningful evaluation	• Change time resolution for future acquisition; • Check, whether previous data can be used in new format.

6.6 Time management

In the DoW the timing of workpackages and tasks is described together with the milestones. Nearly all these milestones are relevant for planning, implementation and operation of the Bremen pilot and listed in the following table together with relevant means of verification:

Table 14 GreenCharge milestones (extracted from DoW)

#	Milestone name	Due month		Means of verification
1	Pilots defined	M6	02/2019	○ Initial version of user needs, scenarios and use cases available
2	Initial components deployed	M7	03/2019	○ Individual prototype components deployed in pilots and testing started
3	Plans and requirements defined	M8	04/2019	○ Initial version of strategic plans for pilots, evaluation and data collection defined; ○ Initial requirements and architecture defined.
4	Initial business model design and prototype completed	M10	06/2019	(Not directly related to WP2)
5	Pilot operational	M12	08/2019	○ Testing and evaluation of the initial integrated models and prototype by pioneer users started; ○ Data collection started.
6	Revised business model design completed and prototype operational	M24	08/2020	○ Implementation of the refined and extended version of the integrated prototype based on evaluation operational; ○ Revised plans for pilot and evaluation based on inter-mediate evaluations completed; ○ Revised version of tools for simulation and visualisation operational.
7	Ready for final evaluations	M30	02/2021	○ Prototype system tested for more than one full year; ○ Refined tools for simulation and visualisation completed; ○ Data collection finalized.

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8	Project completed	M36	08/2021	○ Analysis of the data collected in the pilots and the simulation results, and assessment of KPIs completed and documented; ○ Recommendations and deployment guidelines finalised; ○ Final version of the integrated prototype including refinement and extensions integrated during the pilots released.

A more detailed short-term planning for getting the pilot started is provided in the following Table 15.

Table 15 Timing of items to be implemented in the Full-scale Bremen Pilot

Activity	Responsible Partner	Due month (tested)
1. Planning relevant for all 3 demonstrators		
Data formats to be used in automated data collection specified (for calculation of KPI's and in simulation)	SUN (Task 5.1)	07/2019
Automated data collection implemented in system components (in WP4)	WP4 partners	10/2019
Tools for data collection like interview guides and surveys established	EUT+SINTEF	10/2019
Workshop with users to discuss assessments, gain new drivers + mobiles, and explain changes in the planned 2nd phase	PMC+MOVA+ BREM	08/2020
Evaluation of 2nd phase: data, surveys, interviews	PMC+MOVA+ BREM	04/2021
Workshop presentation of final results (LRG, pilot partners, users)	PMC+MOVA+ BREM	07/2021
2. Planning for the Charge@work demonstrator		
Upgrade CS#1 including data display	PMC	07/2019
Upgrade CS#2 h/w for calibration-verified acquisition of charging data	PMC	07/2019
Reach agreement for usage of CS#4 with owner	PMC	07/2019
Upgrade CS#3 h/w	PMC	08/2019
Implement gridctrl.ENCORE backend for CS#1-4	PMC	09/2019
Testing of ENCORE backend system	PMC	09/2019
Extend 2nd life battery storage system in CS#3 to more than 70kWh	PMC	06/2020
Technical adjustments for starting the 2nd iteration phase	PMC	09/2020
3. Planning for the Public CarSharing demonstrator		

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Link CMS to booking platform	MOVA	06/2019
Implement “SmartCharge”-backend for CS#6	MOVA	07/2019
Change CarSharing s/w and h/w from “Miveo” to “GTS” and “OTA-Keys”	MOVA	07/2019
4. Planning for the mobil.punkt demonstrator		
Link CMS to booking platform	MOVA	05/2019
Implement “SmartCharge”-backend for CS#5	MOVA	06/2019
Change CarSharing s/w and h/w from “Miveo” to “GTS” and “OTA-Keys”	MOVA	06/2019
Integrate public transport timetable in booking platform (for use case UC#3)	MOVA	08/2019

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7 Conclusions

With the described implementation plan a feasible route has been outlined to demonstrate via some representative examples, how crosslinked mobility options in urban environment (CarSharing) and in office/business areas (commuter traffic) can be made more effective for usage of “green” energy. The most challenging part in the coming 2 years will be to consider unplanned and unexpected charging needs in a “normal” charging infrastructure. This is particularly true, when eCarSharing is coupled with charging needs from other EV-owners. In the Bremen pilot we will identify the actions that are particularly suitable for handling such situations – without engaging the towing service.

We expect that much more work is to be done, since some foreseeable options are outside the scope of the Bremen pilot. This applies especially to the interoperability between (a) charge management system (CMS) operating within the internal grid of a company with (b) local power utilities and/or operators of renewable electric energy sources.

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 References

[1] SATELLITE D2.3, *Refined CIVITAS process and impact evaluation framework*, 31.08.2017

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