Grant number: 769016
Project duration: Sept 2018 - Feb 2022
Project Coordinator: Jacqueline Floch, SINTEF

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

greencharge2020.eu

GreenCharge Project Deliverable: D2.7

Technical Monitoring Report and Feedbacks (Oslo)

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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

The deliverable presents intermediate results from the Oslo Pilot and describes collected data fort the OSLO pilot. The deliverable contributes to the final report for the pilot, *D2.8 Final report for Oslo Pilot: Lessons Learned and Guidelines*.

The Oslo pilot consists of three demonstrators; Demonstrator 1 implements smart management of charging in the garage (OSL.D1), Demonstrator 2 implements booking and roaming facilities for publicly available outdoor chargers (OSL.D2) and Demonstrator (OSL.D3) monitors electricity used for heating loads in 10 apartments and electricity used for providing common domestic hot water production for the housing cooperative in five locations. Hence, OSL.D3 is not considered a full demonstrator but complements OSL.D1 and OSL.D2 to demonstrate a complete energy smart neighbourhood (ESN). The main purpose of OSL.D3 is to collect research data for simulation purposes.

Despite the delay in start-up of demo, there has been collected a vast amount of datafiles, and we have gained experience in handling challenges related to data communication, software development, hardware, communication and juridical issues.

Data is collected in accordance with the "Research Data" document provided in deliverable *D5.6 Open Research data* as part of WP5. The static data includes information for the installed hardware (Device models and Individual devices). For these files technical data is collected and the files are created manually. The information is added to the log files with a script. The log-file data includes both static metadata and logged values. All data is uploaded to a common SFTP fileserver and stored under 5 subdirectories. The logged data files containing time-series data are stored under the directory *//shared/research_ data/recordings_logs,* and the static data is stored under directory //shared/research_ data/devices. All files from the Oslo demo contain "*P1*" into the filename (see appendix B).

The device model data (static) are technical data from heating cooling devices, PV panel models, battery models, inverter models, sensor models and EV models. The information is added manually to the files.

Static data on EV models is collected from the EV owners, but some technical data like battery capacity and car model were unknown to some EV owners. The missing data were eventually provided by the residents and the board members at the Røverkollen housing cooperative.

Weather data (both measured and predicted) is provided by eSmart systems and is uploaded regularly. Initially there where several errors in data structure and filenames. These issues were however corrected during the data collection period.

The average grid mix data is collected by SINTEF based on data from the Norwegian Water Resources and Energy Directorate (NVE). NVE provides yearly statistics on the "product declaration of electricity" used in Norway. The electricity is a mix of electricity produced from renewables, nuclear power, and fossil fuels.

Data on electricity prices are key to the demonstrators and is collected by eSmart Systems from Nordpools data portal. The data is downloaded automatically and uploaded manually to the file server.

<u>Main challenges for the Oslo Pilot.</u>

During the intermediate stage several Baseline data have been collected. Because OSL.D1 and OSL.D2 required profound technology development and software integration, the demonstrators were not operative at the time of the delivery. Lacking results, this deliverable could not discuss first experiences of the smart energy management of D1 or the booking and roaming services of D2. Both OSL.D1 and OSL.D2 depend on that the EV-users use the ZET.Charge App. The main blockers for delay of demo startup, were issues related to the development of the app and integration of the back-end systems of the different project partners.

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Challenges when collecting the Baseline data were sometimes of technical nature, but the most reoccurring challenge was that partners failed to deliver data on time and with the specified file structure and filename. This led to manual additional work to adjust several the data files.

During the intermediate stage, the board at Røverkollen housing cooperative have been of great importance for the project and the residents, providing both practical assistance as well as on-site operational insights on the technical hardware and software during implementation. They have provided access to testing and assisted in collecting missing device data from several EV users.

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List of Abbreviations

Table 1: List of abbreviations

Abbreviation	Explanation
BMS	Battery Management System
CMS	Charge Management System
CP	Charge Point
D1, D2 and D3	Demo 1, Demo 2 and Demo 3 for the Oslo pilot
EMS	Energy Management System
ESN	Energy Smart Neighbourhood
EV	Electric Vehicle
KPI	Key Performance Indicator
NEMS	Neighbourhood Energy Management System
PV	Photovoltaics
SoC	State of Charge
UUID	Universally Unique Identifier

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List of Definitions

Table 2: List of definitions

Definition	Explanation
Booking	Reservation of charge time at specific locations
eRoaming	Charging anywhere independent of provider
Energy Management System	System implementing energy management of energy loads at a location, e.g. in demonstrator 1 (garage).
KPI	Key Performance Indicator used to quantify the impact of a Measure.
Log-file	File with monitored data from pilot site collected via software
Neighbourhood Energy Management System	An ICT system implementing the smartness of an energy smart neighbourhood
Photovoltaic	Photovoltaic panels (solar cell panels) convert light into electricity using semiconducting materials

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1 About this Deliverable

1.1 Why would I want to read this deliverable?

This deliverable is a technical report describing the status of the Oslo pilot at an intermediate stage. It presents monitored energy loads for baseline data and results from first tests of smart energy management. Further, the deliverable describes the data collection process for the pilot, challenges related to both implementation of technologies in the pilot and from data collection, feedback mechanisms and lessons learned.

The report will contribute to the final report for the pilot, D2.8 Final report for Oslo Pilot: Lessons Learned and Guidelines.

1.2 Intended readership/users

The deliverable will mainly be of interest for project partners in GreenCharge. It will be useful for the partners involved in data evaluation and for those involved in the final report for the Oslo pilot.

It can also be of interest for other projects dealing with collecting large amounts of research data as the deliverable describes the processes, challenges and lessons learned from collecting data from the pilot.

1.3 Structure

In Green Charge there are three pilot sites, in addition to the one in Oslo, there are one pilot in Bremen and one pilot in Barcelona. The two other pilots will have a similar deliverable and the structure of these deliverables have been coordinated. This will deliverable have the same structure as deliverable D2.13 *Technical Monitoring Report and Feedbacks (Bremen)* and D2.20 *Technical Monitoring Report and Feedbacks (Barcelona)*.

1.4 Other project deliverables that may be of interest

The following deliverable can be useful to read in order to get a complete overview of the development of the Oslo pilot, the stakeholders and to understand the structure of the data collection prosess.

- **D2.3 Description of Oslo Pilot and User Needs** – This deliverable describes the Oslo pilot in terms of challenges, user needs, use cases, scenarios, stakeholders and locations to be involved and the baseline.
- **D2.4 Implementation Plan for Oslo Pilot** – this deliverable describes the planning of the tests to be carried out at the pilot site. It includes scenarios to be demonstrated, time schedules, stakeholders and locations selected, users selected for workshops and for testing, hardware and software to be installed, tests to be run and data to be collected, etc.
- **D5.6 Open Research Data** – this deliverable describes the data collected from the pilots and structured for further research on the effects of eMobility in cities according to the Data Management Plan (D1.1)
- **D6.3 Intermediate Evaluation Result for Stakeholder Acceptance Analysis -** Describes evaluation results and lessons learned from stakeholder acceptance analysis providing feedback to further refinement of business model designs and technology prototyping.

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2 Pilot description

In the Oslo Pilot there are two main demonstrators; the parking garage (OSL.D1) demonstrating Energy Smart Neighbourhood and flexible charging for several charging points installed in a garage, and the outdoor charging points (OSL.D2) demonstrating charge station operations, booking and roaming. The Oslo pilot also has a third demonstrator (OSL.D3) where only measurement data is collected from common hot water tanks, and energy meters/sensors in 9 apartments. For D3 the collected data will be used in simulations. See *D2.3 Description of Oslo Pilot and User Needs* for more detailed description of the pilot site, Røverkollen Borettslag, the surroundings and the baseline for the pilot.

In Green Charge project description, there are seven innovation scenarios. For the Oslo pilot the following innovation scenarios are described as relevant; Charging at booked charging station, Home charging, V2G and Reacting to Demand Response request.

2.1 Challenges of implementing and activating the pilot

D1 is about implementing smart charging in the garage. The residents with EVs have their own ChargePoint, and normally charge by using and RFID card. Smart Charging involves using the ZET-App. When developing the App, a reoccurring problem has been trouble with data communication between the different back-end systems. The problems occurred when the ZET back-end system needed to communicate with Fortum, the CPs and the Hubject's back-end system. A much more extensive communication between partners than anticipated was necessary to solve these issues.

eSmart, ZET, Hubject and Fortum are not associated companies, and they may lack resources to work full-time on development for GreenCharge. The partners are commercially driven companies that also have other responsibilities and clients to follow up. We believed that some of the delays in the development and start-up of the demos can be explained by these reasons.

Since the companies are not associated it is more time-consuming coordinating the work between them. When discovering an error in development, the time it takes between reporting an addressing the error could be days/weeks. A dedicated person to coordinate this work is recommended.

2.2 Implemented technologies

See *D2.3 Description of Oslo Pilot and User Needs* and *D2.4 Implementation Plan for Oslo Pilot* for a detailed description of the pilot, plan for implementation of hardware and software to be installed, the tests to be carried out and data to be collected. D2.4 presents the initial implementation plan for the Oslo Pilot.

Table 3 presents the status of technologies that have or is still to be implemented. The overview is based on the Technological requirements from *D2.2 Description of Oslo Pilot and User Needs* and also includes technologies that have been left out.

<u>Hardware and Software</u>

Table 3 Status of technologies Oslo Pilot

Technology	OSL.D1	OSL.D2	OSL.D3
Charge Points / Charging infrastructure	Sept. 2019 - 39 CP installed Aug. 2020 - +16 CP installed (55 total)	Existing CP replaced with four new CP in march 2020	NA

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Technology	OSL.D1	OSL.D2	OSL.D3
PV panels	Installed sept. 2019	NA	NA
Stationary battery	Installed sept. 2019 data from March 2021	NA	NA
HAN-port main meter	Installed 2020.	NA	NA
Charge Management System (CMS)	Tested during development	NA	NA
Energy Management System	Implement when LMS is deactivated and App usage start (start of demo)	NA	NA
Charging App (for user interaction)	From sept. 2019 - Fortum Charging APP under development. From March 2020 – development of new GC App by ZET.	From March 2020 – development of new GC App by ZET.	NA
Integration EMS – CMS	LMS deactivated – EMS-CMS should be integrated at startup.	NA	NA
Integration EMS – the local integration partner	LMS deactivated – EMS-CMS should be integrated at startup.	NA	NA
eRoaming platform	NA	Not implemented – planned?	NA
Booking system	NA	Implemented in App	NA
Equipment for energy measurements	NA	NA	15 Des. 2020 – FutureHome Hub og energy monitoring installed in eight apartments. Sodvin energy meters installed for monitoring of DHW.

<u>Data sources</u>

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Table 4 Status data sources

Data sources	OSL.D1	OSL.D2	OSL.D3
Parking garage main meter	From jan. 2020 – Meter readings from HAN-port received	NA	NA
Indoor charge points 1-X meter reading	From Oct. 2020 - meter readings from Fortum received by ZET and eSmart	NA	NA
PV production	From jan. 2020 – meter readings	NA	NA
Battery utilisation	In progress –eSmart receives reading, data to be uploaded.	NA	NA
Battery status/ State of Charge (SoC)	In progress - eSmart receives reading and data to be upload regularly.	NA	NA
EV state of charge (battery content in kWh) when charging session is started (reported by the user)	From GC APP – Expected at demo launch when users register.	From GC APP – Expected at demo launch when users register.	NA
Heat cable power reading	Data available, uploaded be Sodvin	NA	NA
Outdoor charging point meter reading	NA	Oct. 2020 - meter readings from Fortum received by ZET/ eSmart.	NA
Building main meter reading	NA	NA	15. Des. 2020 – meter reading from eight apartments. Meater readings from all main meters – can be download from HafslundData or ELHub.
Building water heating meter reading	NA	NA	Meater reading from Sodvin for DHW.
Power tariffs	From Housing cooperative agreement with DSO	From Housing cooperative agreement with DSO	From Housing cooperative agreement with DSO

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Data sources	OSL.D1	OSL.D2	OSL.D3
Electricity prices in the spot market	From eSmart system/ Nordpool	From eSmart system/ Nordpool	From eSmart system/ Nordpool
Retail prices of electricity	From Housing cooperative agreement with retailer	From Housing cooperative agreement with retailer	From Housing cooperative agreement with retailer

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3 Decided measures and KPIs for Oslo Pilot

See *D5.1 & D6.1 Evaluation Design/ Stakeholder Acceptance Evaluation Methodology and Plan* for description of measures and key performance indicators (KPI) for the GreenCharge project and for each of the pilots.

3.1 Measures for Oslo Pilot

For the Oslo pilot three measure have been decided related to the KPIs.

- GC.M1: Smart charging in garage in apartment building (Røverkollen)
- GC.M2: Sharing of private charging points (Røverkollen)
- GC.M3: Optimal use of energy (Røverkollen)

3.2 Indicators from D5.4/D6.3

Table 5 presents the indicators for the demos D1 and D2 in the Oslo pilot as defined in deliverable D5.4/D6.1, including the related measures and categories for the indicators. The table also shortly presents the data that needs to be collected for deciding or calculating the indicators and how this data is used to get a result or decide the result of the indicator.

Table 5 List of decided KPIs

Demo	KPI	Description (measure)	Category	Data collected from pilot site	How indicator/ measure is decided
D1	GC5.1	Number of EVs (GC.M1)	Transport	Number of EVs	Registered at pilot site
	GC5.2	Number of charging points (GC.M1, GC.M2)	Transport	Number of individual CPs / activated CPs	Registered at pilot site
	GC5.3	Utilization of charging points (GC.M1, GC.M2)	Transport	Log entries: Reservation/ booking events EV charging session	Calculated
	GC5.5	Charging availability (GC.M1, GC.M2)	Energy	Log entries: Reservation/ booking events EV charging session	Calculated
	GC5.4	Share of EVs capacity by V2G (GC.M1)	Energy	Log entries: EV charging session	Simulation
	GC5.13	Charging flexibility (GC.M1)	Energy	Log entries: Reservation/ booking events	Simulation

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Demo	KPI	Description (measure)	Category	Data collected from pilot site	How indicator/ measure is decided
				EV charging session	
	GC5.9	Energy mix (GC.M1, GC.M3)	Energy	Log entries: Energy import/ export Grid mix in public grid Battery session Solar plant session	Calculated and simulation
	GC5.10	Peak to average ratio (GC.M3)	Energy	Log entries: Energy import/ export Battery session Solar plant session	Calculated and simulation
	GC5.6	Average operating costs for charging infrastructure (GC.M1, GC.M2, GC.M3)	Economy	Information on costs from housing cooperative	Calculated
	GC5.7	Capital investment costs (GC.M1, GC.M3)	Economy	Information on costs from housing cooperative	Calculated
	GC5.8	Average operation revenue (GC.M2)	Economy	Information on costs from housing cooperative	Calculated
	GC5.11	Savings (GC.M3)	Economy	Information on costs from housing cooperative	Calculated
	GC5.12	CO2 emissions (GC.M3)	Environment	See Energy mix	Calculated from energy mix
	GC6.1	Awareness level (GC.M1, GC.M2)	Society	-	Surveys/ Interviews
	GC6.2	Acceptance level (GC.M1, GC.M2)	Society	-	Surveys/ Interviews
D2	GC5.1	Number of EVs (GC.M1)	Transport	Number of users of GC App	Calculated

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Demo	KPI	Description (measure)	Category	Data collected from pilot site	How indicator/ measure is decided
				Metadata on EVs from GC App	
	GC5.2	Number of charging points (GC.M1, GC.M2)	Transport	Number of CP	Registered at pilot site
	GC5.3	Utilization of charging points (GC.M1, GC.M2)	Transport	Log entries: Reservation/ booking events EV charging session	Calculated
	GC5.5	Charging availability (GC.M1, GC.M2)	Energy	Log entries: Reservation/ booking events EV charging session	Calculated
	GC5.9	Energy mix (GC.M1, GC.M3)	Energy	Log entries: Grid mix in public grid	From log entries on grid mix in public grid
	GC5.6	Average operating costs for charging infrastructure (GC.M1, GC.M2, GC.M3)	Economy	Information on costs from housing cooperative	Calculated
	GC5.7	Capital investment costs (GC.M1, GC.M3)	Economy	Information on costs from housing cooperative	Calculated
	GC5.8	Average operation revenue (GC.M2)	Economy	Information on costs from housing cooperative	Calculated
	GC5.12	CO2 emissions (GC.M3)	Environment	See Energy mix	Calculated from energy mix
	GC6.1	Awareness level (GC.M1, GC.M2)	Society	-	Surveys/ Interviews
	GC6.2	Acceptance level (GC.M1, GC.M2)	Society	-	Surveys/ Interviews

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3.3 Data collected by software according to the research data document

Data is collected in accordance with the "Research Data" document provided in deliverable *D5.6 Open Research data* as part of WP5. See appendix B for examples of logfiles on the SFTP server.

Baseline data is data collected before startup of smart energy management and before startup of demo.

All data before demo was started can therefore be considered baseline data.

Research data from with all GC-technology implemented is to be collected from startup of demo.

Table 6 lists the log-files for the demonstrators in the Oslo Pilot. The collected data will be used for KPI calculations and the simulation scenarios in WP5 *(D5.4 Intermediate Result for Innovation Effects Evaluation, D5.5 Final Result for Innovation Effects Evaluation)*.

Table 6 Logfiles to be collected

Demo	What	Responsible	Time period of log-files	Number of Data points/ sessions	Number of log files
D1	Number of EVs	Røverkollen brl	-	-	X
	Number of charging points	Røverkollen brl	-	-	X
	Reservation/booking events	ZET	1 / booking event	X bookings for Y EVs	X*Y
	EV charging/ dischargning [kWh/ kW]	ZET	1 / charging session	X sessions from Y charging points.	X
	PV plant [kWh/15 min]	eSmart	1 / month (every 15 minute)	X months from 1 PV plant	X
	Battery charging/ discharging [kWh/15 min]	eSmart	1 / month (every 15 minute)	X months from 1 battery module	X
	Energy import/ export from grid [kWh/15 min]	eSmart	1 / month (every 15 minute)	X months from 1 main meter	X
	Average grid mix in the public grid	SINTEF	1/ year (average)		
	Energy cost from public/ local grid [EUR/kWh]	eSmart	1 / month	X months from 1 location	X
	Predicted weather data	eSmart	1 / month	X months for Y weather types	X*Y
	Measured weather data	eSmart	1 / month	X months for Y weather types	X*Y

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Demo	What	Responsible	Time period of log-files	Number of Data points/ sessions	Number of log files
D2	Reservation/ booking events	ZET	1 / booking event	X bookings for Y EVs	X*Y
	EV charging/ dischargning [kWh/ kW]	ZET+Fortum	1 / charging session	X sessions from 4 charging points.	X
	Energy import/ export from grid [kWh/15 min] from D1	eSmart from D1	1 / month (every 15 minute)	X months from 1 meter	X
	Energy cost from public/ local grid [EUR/kWh]	eSmart from D1	1 / month	X months from 1 locations	X
	Payment	ZET	1 / charging session	X sessions from 4 charging points.	X
D3	Heating session in apartments	SINTEF	1 / month	X months from Y (sub-)locations	X*Y
	Temperature sensor data	SINTEF	1 / month	X months from Y (sub-)locations	X*Y
	Heating session DHW	SINTEF (Sodvin)	1 / month	Y months from Y heating devices	X*Y

4 Description of collected data

4.1 Description of the process of data collection

SINTEF is responsible for the data collection and the control of data received from other project partners in the pilot. For the Oslo pilot both static data with information on equipment and systems, and log entries with logged data have been collected. The static data includes information for the *Device models* and *Individual devices.* For these files technical data have been collected and the files created manually.

The log-file data includes both static metadata and logged values. The metadata have been created manually and/ or added to the log files with a script.

Table 7 Data collection

File type	Data file	D1	D2	D3	Comment
Device models	Heating/Cooling device models	-	-	x	Created manually from technical description and data sheets for installed system from FutureHome and Sodvin.
	PV panel models	x	-	-	Created manually from technical description and data sheets for installed system from OneCo.
	Battery models	x	-	-	Created manually from technical description and data sheets for installed system OneCo.
	Inverter models	x	-	-	Created manually from technical description and data sheets for installed system from OneCo.
	Sensor models	-	-	x	Created manually from technical description for installed system from FutureHome and Sodvin.
	EV models	x	x	-	For D1: created manually based on information on EV types collected from *Elbilforeningen*. EV models included in common database for all pilots in GC.
Individual devices	Individual software system	x	x	x	D1: created manually. Software by eSmart and ZET D2: created manually. Software by ZET and Hubject. D3: created manually. Software by FutureHome and Sodvin.

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	Location	x	x	x	Created manually.
	Individual Heating/ Cooling devices	-	-	x	Created manually from technical description and data sheets for installed system from FutureHome and Sodvin.
	Individual Solar plants	x	-	-	Created manually from technical description and data sheets for installed system from OneCo.
	Individual Stationary Batteries	x	-	-	Created manually from technical description and data sheets for installed system from OneCo.
	Individual Sensors	-	-	X	Created manually from technical description for installed system from FutureHome and Sodvin.
	Individual EVs	x	x	-	Collected automatically through ZET.Charge. Will be collected by ZET by information given by user in GC App for D1 and D2.
	Individual Charge points	x	x	-	Created manually. CPIDs received from Fortum. CPIDs anonymized with UUID and uploaded to SFTP-server.
	Individual energy metres	x	x	x	Created manually
	Individual price lists	x	x	x	Created manually Common price lists for all GC pilots to be created by PNO.
	Individual tariff scheme	x	x	x	Created manually Common price lists for all GC pilots to be created by PNO
Logfiles	Metadata on reservation/booking events	x	x	-	*Not yet available* Will be uploaded by ZET.
	EV charging/ discharging sessions	x	x	-	*Not yet available* Will be uploaded by ZET.

					The charged energy in the EV – the charging load profile (time-series) – is calculated based on the meter value collected by Fortum each 15 min. The load profile is then the difference between each 15 min of the meter value's accumulated energy use. The meter value is pushed from Fortum to ZET and ZET calculates the charging profile before uploading it to the FTP-server for research data
	Heating/cooling sessions	-	-	x	Two type of logfile-sets. Logfiles for apartments: SINTEF extracts logged energy use for heating devices from FutureHomes system. Logfiles for DHW: Sodvin uploads logged data from the DHW tanks once a month.
	Washing machine/dish washer sessions	-	-	-	Will not be collected.
	Solar plant sessions	x	-	-	Collected automatically by eSmart system and uploaded manually. Data for produced and accumulated energy in kWh/15 min.
	Battery sessions	x	-	-	Collected automatically by eSmart system and uploaded manually.
	Metadata on payment information	x	x	-	*Not yet available* Will be uploaded by ZET.
	Energy import and export	x	-	-	Collected automatically by eSmart system and uploaded manually.
	Average grid mix in public grid	x	-	-	*Yearly values from NVE. SINTEF provides data.*
	Variable energy cost in local grid and public grid	x	-	-	eSmart uploads data
	Predicted weather data	x	-	-	Collected automatically Predicted and collected by eSmart system for D1. Uploaded manually.
	Measured weather data	x	-	-	Collected automatically by eSmart system and uploaded manually.

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	Sensors	-	-	x	Logfiles for apartments: SINTEF extracts logged temperatures for heating devices from FutureHomes system.

4.2 Description of challenges regarding data collection

The process with getting the pilot and demos up and running for the research data collection to start have been more challenging than expected. The challenges can be split in two:

1. Challenges directly related to collection of research data
2. Challenges related to an operative pilot to generate research data

Table 8 Challenges regarding data collection

What	Description	Consequence
1. Challenges directly related to collection of research data		
Common data structure of research data: - File format - File format for simulations	A common structure for all research data files have been created in the project, for both static data and for log-files. The final format of research data files are described in deliverable *D5.6 Open research data.*	Several reviews and updates on format for the research data should be, both for static data (device models/ individual entities) and monitored data (log-files) have been challenging as most of the static data and the metadata in the log-files have been registered manually. Test data was created at the implementation phase of the project. Changes through the process for static data include format for timestamp for entry and exit time, namecode for demo / location name, how to handle empty cells. Suggestions for improvements for future projects: Deciding and lock the format before starting manual data collection process. If files are collected and update automatically new changes on format might be less challenging. Test data should be created and tested as early as possible in a project to decide on the final format of research data.

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What	Description	Consequence
		Available log-data and historical data but challenges related to specific need for file format leads to delay in uploading of the log-data. When delay in pilot – down-prioritizing of uploading and creating log-files with the correct file format. Deviation between how the log-files are created in the partners system and how the file-format needed to be for uploading leads to missing collection of data even though the data is available
Delayed operative pilot and demonstrators.	The demonstrators in the Oslo pilot not started resulting in no data	A shorter data collection period and test period for smart management, business models etc. which might reduce the total quality of the collected data as it has fewer representative months. Test period should have been running for at least a year.
Corona	Due to Corona and more use of home office and less leisure activities – change in driving habits	Collected baseline data not representative for a normal driving pattern, or according to answers in previous surveys.
Partner not delivering data	Data late due to partner forgetting or neglecting to deliver data	Data missing on servers. Time consuming to figure out where data is located and getting new deliver.
2. Challenges related to an operative pilot to generate research data		
Change of partners / roles in	Need for reduced responsibility and change of partner/ role almost two years in to the project. New partner needed to be found in order to implement the planned measures. ZET replaced Fortum on several tasks – from February 2020. Change of contatct/responsible person within the different partners lead to delays etc. New contact needs time to get involved in project.	The change in responsibility and role lead to need for new development (GC App). This also increased the need for new interaction, creating new APIs and onboarding in systems that were not in the original plan. There have been challenges related to managing the data flow of needed research data between the partners in the project.

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What	Description	Consequence
Few users of ZET.Charge.	The ZET.Charge app was launched to all the owners of a CP in the garage at Røverkollen (D1) at 16. March 2021. A total of 25 persons tried the app (out of 42 active CPs), but since the demo was not operational at that time, no real data was produced.	Lack of users means that data related to charging habits and user needs before the smart managements was enabled is missing. The lack of App users does not affect the data collection on charging sessions (as this is saved by ZET) but data on reservation/ booking events is missing. Possible reasons for low number of users: Enabling of smart charging was delayed after launching of the app and the user gets the same amount of charging power regardless of the app being used or not. User interface: the project received feedback from users that the interface and functionality is not working as it should. Information might not have reached all of the users: at the information meeting there were only 16 participants out of 42 users with active CP. Slow response time for support. The support service for the app is not operational 24/7 and it takes several days before the users gets reply on reported issues.
Communication with CP	Installed CPs in the garage not ready for receiving signals from Charge Management System.	Delayed start-up
Software		APIs not open. Need for creating new APIs for data transfer and communication. This also applies to the installed hardware: CPs, batteries, app. Also errors in App has given some wrong calculations to eSmart. These problems where only discovered when doing live

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What	Description	Consequence
		testing of the App on demo site with EV.
Onboarding	Difficult to get all the companies working together. Onboarding takes time. Have had difficulties finding common communication platform.	Delay in testing and start-up. Errors in App, software integration, and firmware in the charging points are time consuming to identify and to solve.
Contracts between partners	The contract has been delayed several times due to errors in text in contract., It has been sent back and forth between partners several times (between ZET and Fortum)	Delay in signing of contracts for data sharing and monetary transactions delayed the activation of the demo.

4.3 Data quality assurance

SINTEF will do the final quality assurance of the collected research data. The quality and reliability of the acquired data will be reviewed.

4.4 Data processing

Some of the collected research data can be linked directly to persons and contains information that is covered by GDPR. For this type of research data signed consent forms have been collected before the data collection started and applies to the following:

- D1: All charging point owners with an activated charge point
- D2: Users of App
- D3: Apartment owners where data is being logged for collection of energy use in apartments.

In addition to receiving consent for collecting specific data from the demos, the collected research data needs to be anonymized before it is uploaded to the research data server. The data have been anonymized as described in 1.2.3 Anonymisation process in the "Research data" document and elements that can be connected to a person/ resident in the housing cooperative have been replaced with an UUID.

A mapping table of all elements (models, individual, logfile) have been created containing an overview of how the different elements is connected and what their defined IDs are. Table 9 describes what and how the data elements have been anonymized.

Table 9 Anonymisation of research data

Filetype	Data element	Replacement	Comment
Device models			
EV model	EV model	UUID	A common EV model database for the three pilots have been created. EV models are replaced with UUID so that models that are not frequently used appear anonymous.

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Filetype	Data element	Replacement	Comment
Heating/ cooling model Battery model Inverter model PV panel model Sensor model	IDs	No replacement	
Individual			
EV	EVID	UUID	One entry in the table per private Individual EV. The link to the physical EV is removed, and a link to the anonymous EV model is established.
	EV model	Corresponding UUID from EV model file	
Charge point	CPID	UUID	One entry in the table per *private* CP. The links to the physical CP are removed.
	CP name	UUID	
Software system	SWID	No replacement	
Sensor	SensorID	UUID	UUID for D3 (apartments)
Heating/ cooling device	HCID	UUID	UUID for D3 (apartments)
Energy metres	MeterID	UUID	UUID for D3 (apartments)
Location Stationary batteries Solar plant Tariff scheme Price list	IDs	No replacement	
Log files			
EV charging/ discharging session	CPID EVID	UUID	*Not received yet*
Reservation/booking events	EVID	UUID	*Not received yet*
Heating/ cooling session	HCID Location	UUID	*Not received yet* UUID for D3 (apartments) No replacement for D1
Energy import/ export	MeterID	UUID	*Not received yet* UUID for D3 (apartments) No replacement for D1 and D2
Payment	CPID	UUID	*Not received yet*
Battery session Solar plant session Cost of energy from public gird Cost of energy from local grid Predicted weather data Measured weather data	IDs	No replacement	

Examples of logfiles can be seen in Appendix B.

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 Mechanisms for collecting feedback

User perspective

The user perspective and the experience from the users of the demonstrator are an important part of the project, and is an important part of evaluating the success of the project. For collecting this relevant feedback there have been implemented several mechanisms summarized in Table 10.

Table 10 Mechanisms for collecting feedback from users

Mechanism	Date / when?	Type of user/ Who?	Type of feedback and how it is handled
Survey 1	Nov. 2018	All residents of the housing coop.	Surveys was sent to all the residents in November 2019. 81 persons of total 246 answered the survey. Input to WP 6
Interviews	Des. 2019	A selection of residents in the housing cooperative	Interviews with people in the housing cooperative was carried out in November 2019. The results from the interviews are presented in D6.3.
Survey 2	Des. 2019, Mar. 2020	All residents of the housing coop.	Surveys was sent to all the residents in November 2019 and 24 persons answered. Due to low number of answers the same survey was sent out in March 2020 to those who did not answer where 33 persons answered. 57 persons of 246 answered the survey. The results from the surveys presented in D6.3.
E-mail	Available through the whole project	All residents of the housing coop.	Email: greencharge@roverkollen.no The housing cooperative has set up an email account specific for the Green Charge project where all the residents can send questions, feedback etc.to the board. This is not for reporting technical problems which should be handled by the technology partners. The following have access to the email account: Board of housing coop. and SINTEF.
Questionnaire in GC App	Planned but not implemented		For D2. To get feedback for the users of the outdoor chargers in D2 it was originally planned to include a questionnaire in the GC App. Not implemented.
Housing Coop. webpage			Not used
Local reference group	23rd Nov 2018	3rd parties, e.g. interest groups and other EV stakeholders. (see	Reference group meetings (stakeholders outside of GC). 1st reference group meeting

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Mechanism	Date / when?	Type of user/ Who?	Type of feedback and how it is handled
		participant list in Appendix A)	was held in 23rd Nov 2018. One additional meeting is planned.
Initial user testing of GC App	From release of early version of App.	Test users with CP in D1 and D2.	Feedbacks to be given on email. Email: team@zet.technology
Information meeting / launch of App	16 March 2021	Users of D1 (with private charging points)	Digital information meeting at Teams for launching ZET.Charge for charging on private CPs in D1. 16 participants from Røverkollen. Presentation + Q&A sent to all owners of private CPs after the meeting.
Information letter D2	Planned for Oct 2021	Potential users of D2	Information letter to potential users in the neighbourhood. Information letter published at the webpage for the Norwegian EV association. The CPs for D2 should be made visible in the public apps so that all EV users can find the CPs.
Direct communication with Røverkollen Housing Cooperative	Regularly from project start	Chairman of the Housing Cooperative.	E-mails, phone calls, physical meetings, digital meetings. Monthly communication, sometimes weekly and even daily. This communication has been crucial for the implementation of the pilot, and shows the importance of user participation for the success of GreenCharge.
Survey 3	Planned Dec 2021	All residents of the housing corp.	Email: greencharge@roverkollen.no The housing cooperative has set up an email account specific for the Green Charge project where all the residents can send questions, feedback etc.to the board. This is not for reporting technical problems which should be handled by the technology partners.

Mechanism for collecting technical feedback and feedback of the data collection process from the project group

This is also handled in deliverable *D5.4/D6.3 Intermediate evaluation results*.

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The data was mainly manually collected and data providers had to be regularly reminded on how and where to deliver the data. The communication was mainly done by:

- Direct telcos and e-mails
- Focus group meeting:
    - planning on having a focus group meeting with all partners for the Oslo Pilot with focus on the data collection process and challenges related to this. Will be in the beginning of the operation phase.
- Weekly meetings:
    - Weekly status meetings - *[GC] plan towards fully operative OSL.D1 and OSL.D2* – where both implementation and research data collection were addressed. The first meeting: 5. February 2021. Last meeting was in January 2022 when App was sent to approval in Appstore and GooglePlay.

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6 Monitored data

This chapter presents some of the data that has been collected in the Oslo demo 1 in 2021. The intention is that this deliverable not only describes the data collection, but also presents some examples of the collected data.

6.1 EV charging

Charging reports provided by charge point operators (CPOs) have information for each charging session on start and stop time, and energy charged (in kWh). However, the charging load profile, i.e. the hourly electricity consumption of the charging event is unknown. To evaluate the self-consumption of local RES and the impact of the garage's peak load charging load profiles are needed.

In the following, data from 2021 is presented which reflects normal charging. Figure 1 shows charging profiles for three different EV models (probably with different battery size) over five days in March 2021. The three models are; Nissan Leaf (blue), Tesla Model 3 (yellow), a plug-in hybrid (black). The charging profiles are presented to show how different they are, with respect to both power demand and time-duration.

As the figure shows, the charging of the Tesla is done with a higher power, limited by the maximum power of the charging point (CP) at 7,4 kW. The plug-in hybrid car is receiving some smaller amount of power throughout the whole period, except from three peaks of 3,4 kW. This might be due to errors in the data.

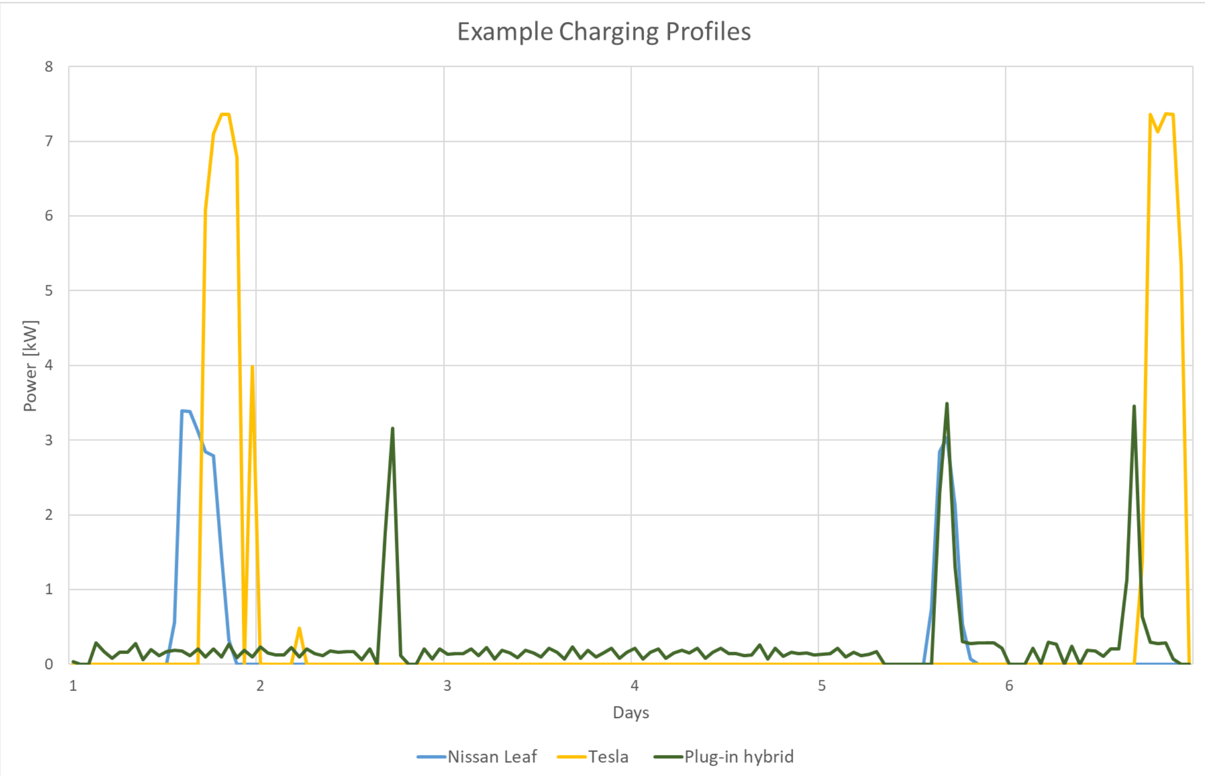

Figure 1 Charging profiles – examples of three EV models

Figure 2 shows total charging in the garage (D1) for a week in January 2021 (11-17 January) separated on 30 different EVs. Both the EV charging and the main meter had the highest peak in this week on 15th January at 2100 hrs. The registered charging peak is 51,8 kW. At the time of the peak, a total of 15 EVs were charging. The peak in January 2021 for the main meter in the garage occurs at the same time (as seen in Figure 5) and at this time the EV charging contributes to 33 % of the total consumption (peak load) in the garage.

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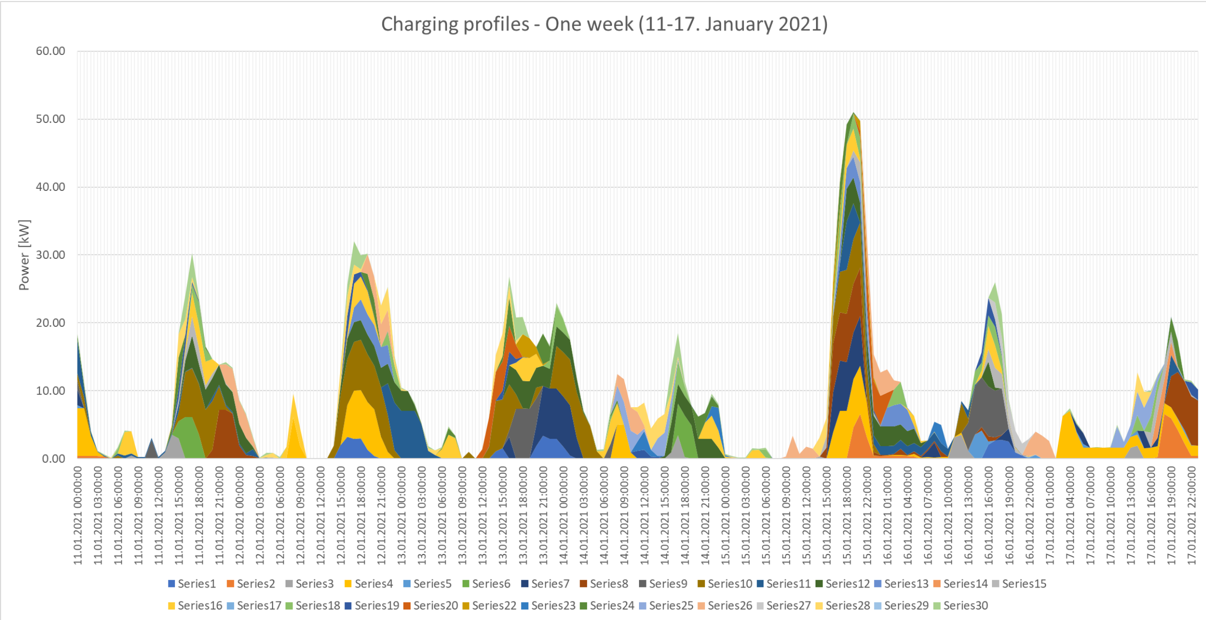

Figure 2 Collected charging profiles from 30 EVs in D1, 11th – 17th Jan 2021.

6.2 Energy use

January and February are normally the coldest months in Oslo. As D1 uses electricity for heating purposes these months represent the period where the peak power for the garage occurs.

Error! Reference source not found. shows energy consumption in Demo 1 before implementation of EV c harging infrastructure from Dec 2018 to Feb 2019. Here, the peak load is identified at 99 kW.

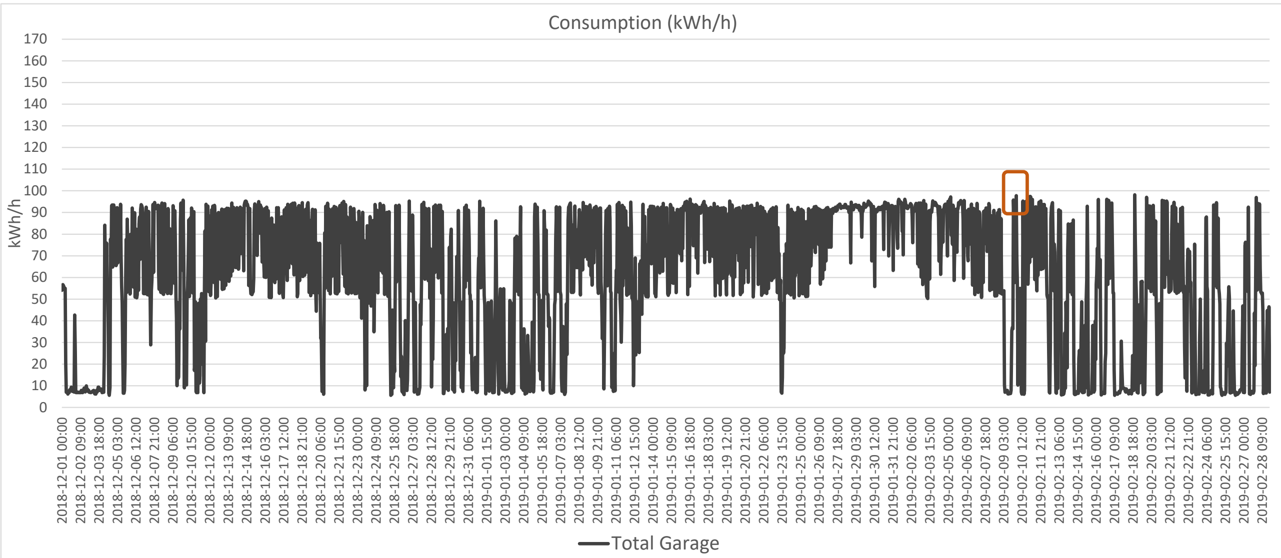

Figure 3 D1 total energy consumption <u>prior to GreenCharge implementation</u>, Dec 2018 – Feb 2019

Figure 3 shows energy consumption of the main meter in the garage (D1) from Dec 2020 to Feb 2021 after installation of EV charging infrastructure with 30 CPs. Here, the peak power is identified to occur on 15th January at 2100 hrs, with a value of 156 kW. Compared to the energy consumption prior to installation of CPs in the similar period (Dec 2018-Feb 2019) the peak power is increased by 58 % from 99 kW to 156 kW. This increase is identified as being caused by the EV charging (see also Figure 2).

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Further, the peak power of the garage as such is increased from 99 kW to 114 kW. This difference might be due to increased consumption for the heating cables (new sensors were installed on 15th Oct 2020), and/or losses in cables and fuses inside the garage as the EV consumption is measured at each CP.

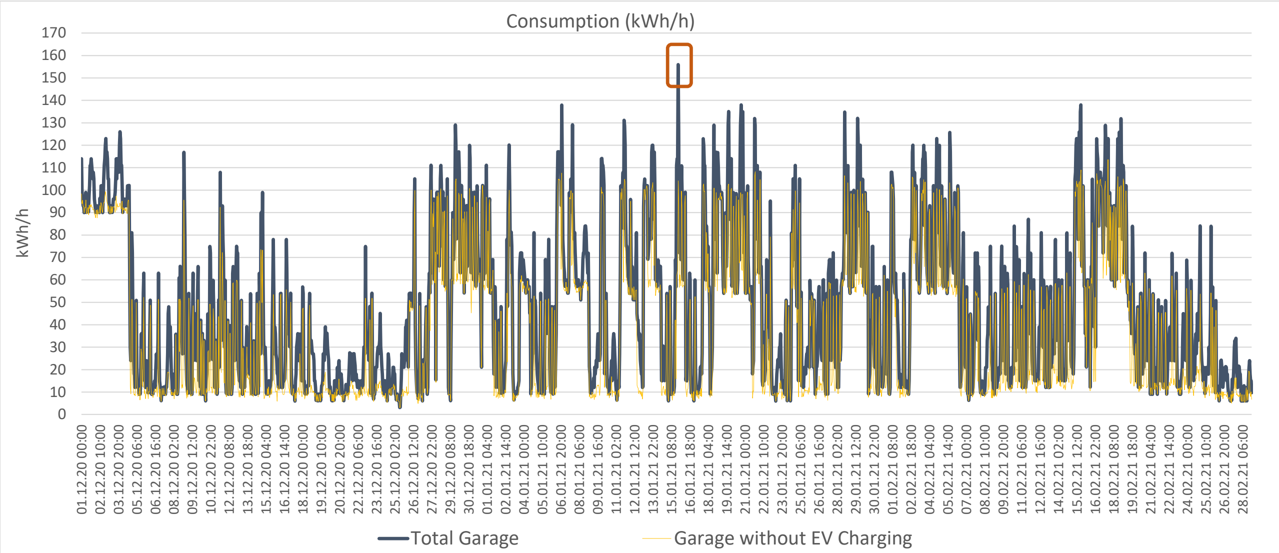

Figure 4 D1 energy consumption with 30 EVs, Dec 2020 – Feb 2021.

When the NEMS is activated, the current peak load of 156 kW is expected to become much lower, and possibly become as low as 114 kW, if the registered user requirements (plug-in duration and charging demand) allow for moving the EV charging away from the hour the peak occurs. In other words, to move the read area in Figure 5 away from the peak so that the EVs are charged at a later time (after 2100 on 15th January).

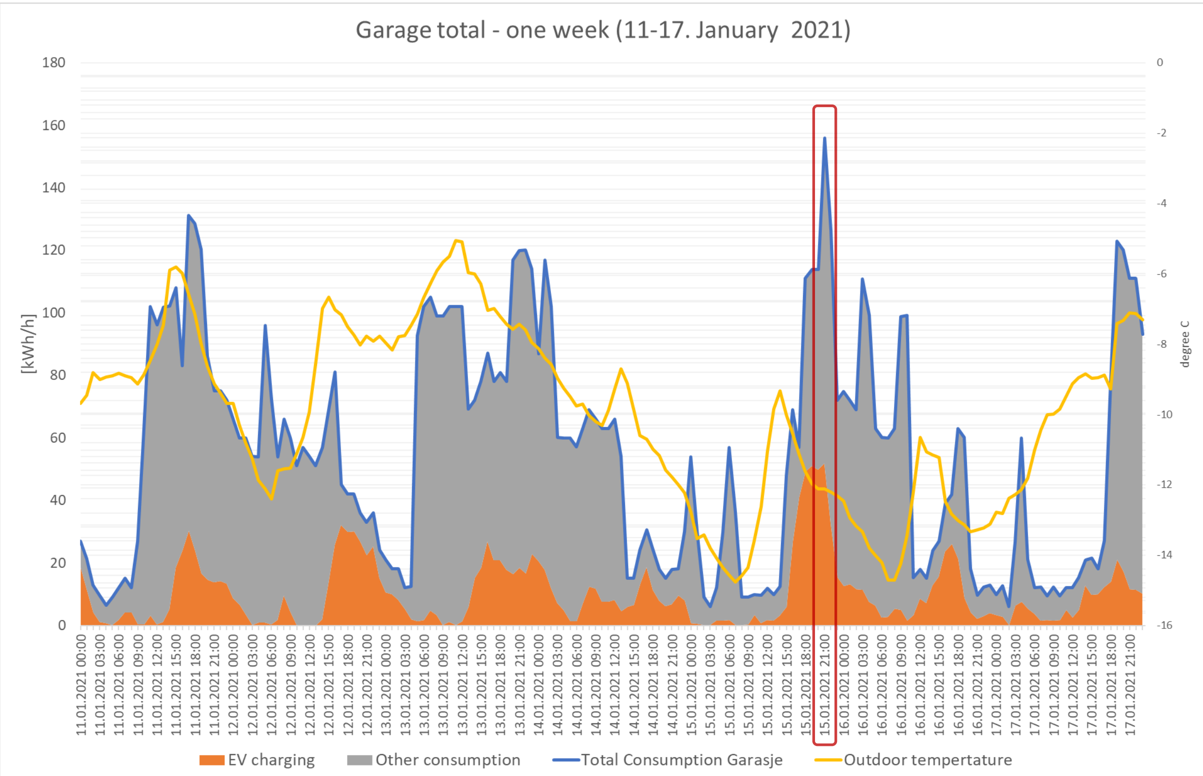

Figure 5 D1 total energy consumption, 11th -17th Jan 2021

6.3 Production

In D1, there is a rooftop mounted PV system of 70 kWp installed. Monthly energy production is shown in Figure 6 from April to September 2020. Compared to the estimated production calculated for the delivered system, the production so far in 2020 is lower than expected.

In 2020, June was the month with the highest total production and the profiles for the last seven days of the month is shown in Figure 7 Solar energy production profile, one week in June.

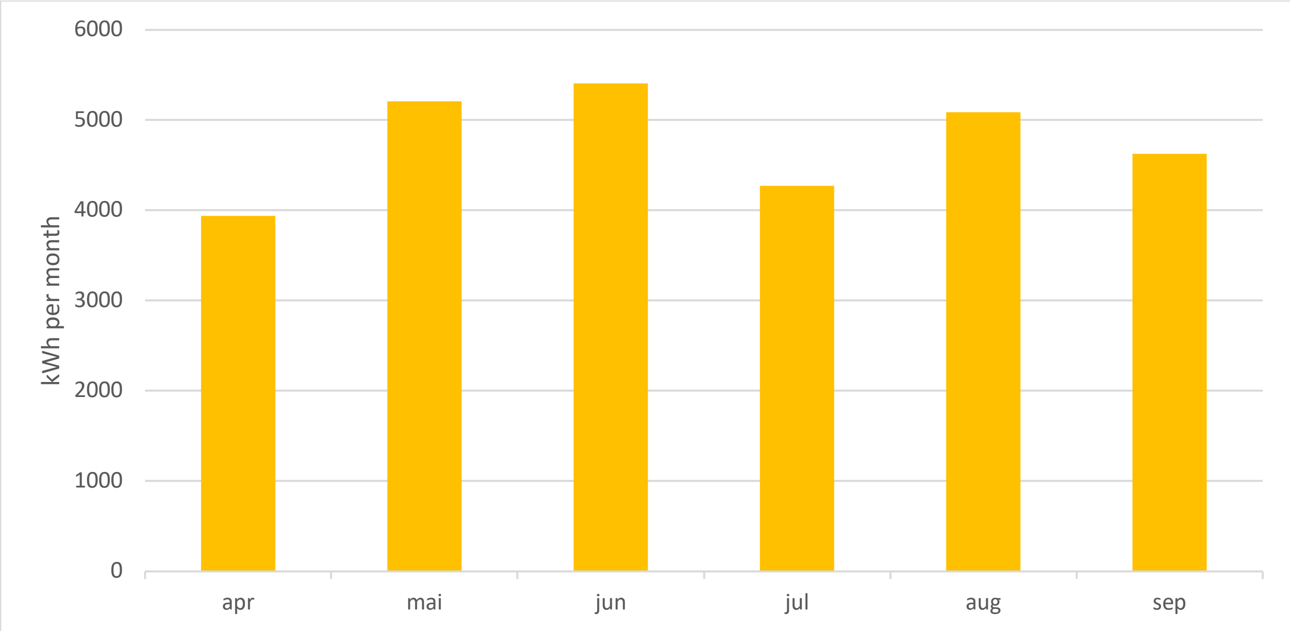

Figure 6 Monthly solar energy production, Apr – Sept 2020 (kWh per month)

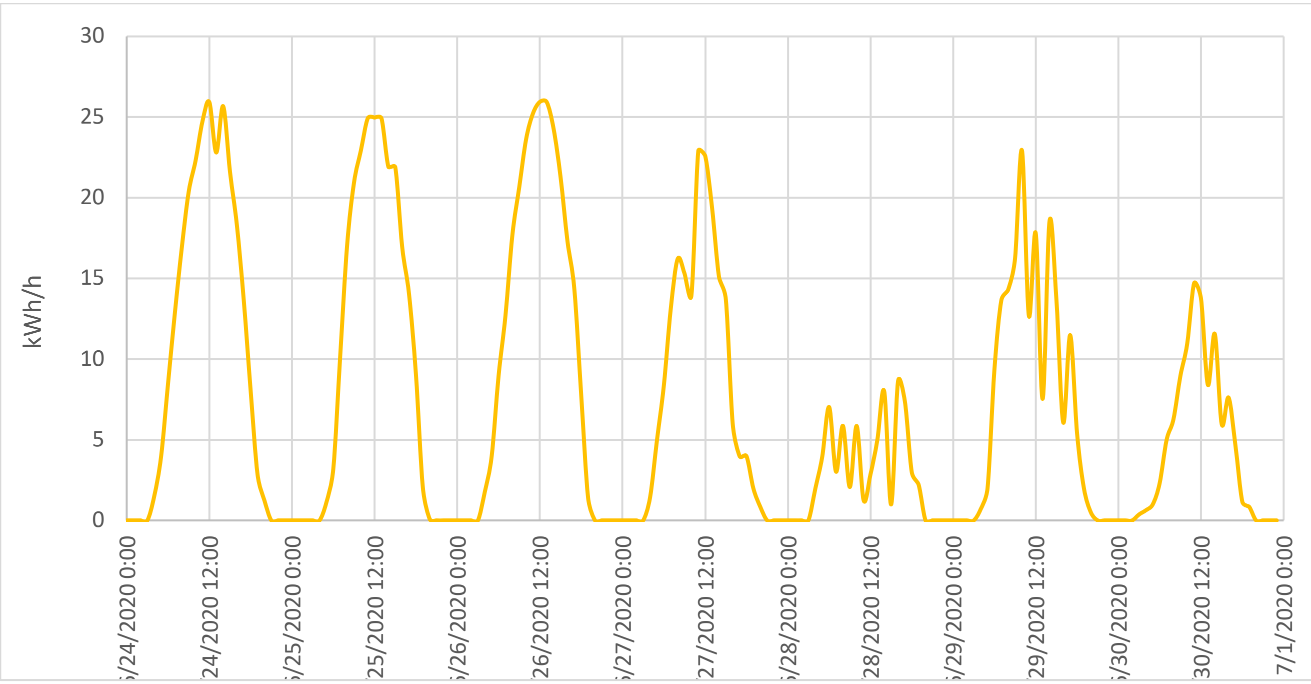

Figure 7 Solar energy production profile, one week in June (kWh/hr)

6.4 Installed and activated charging Points (CPs)

The GreenCharge project made the electric infrastructure inside the garage ready for EV charging by increasing fuse capacity and installing new cables to each parking place.

The residents at Røverkollen Housing Cooperative were given an offer to buy their own CP at a discounted price. Several residents accepted the offer although they did not possess an EV at the moment, but had clear plans of buying one. As a result, the number of installed CPs was larger than those who were activated. Please see further details in Figure 8. In 2021, 65 of 230 parking places (28%) had a CP installed, and 20 % of the parking places had an activated CP.

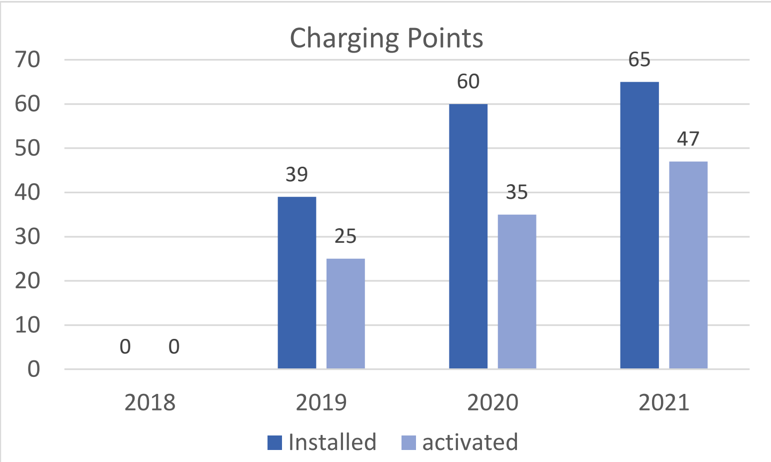

Figure 8 Installed and activated charging points (CP) in D1.

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7 Smart management system

The smart energy management system (EMS) is to be implemented in demo 1 (D1). The quality and the result of the EMS are presented in deliverable *D5.5/D6.4 Final evaluation results*.

The evaluation of the energy management system will be based on several KPIs. Baseline data is used to provide a starting point, and hence evaluate the effect of the EMS. However, it has been challenging to define what is "Baseline" in the context of the EMS. There are two ways of defining the Baseline:

- Baseline0 scenario: pre-GreenCharge without EVs, PV, battery and EMS system
- Baseline1 scenario: GreenCharge with EVs, PV and battery, but *without* EMS system
- GreenCharge scenario: GreenCharge with EVs, PV, battery and EMS system

In both baselines, there is no EMS system involved. However, in Baseline0 there are no EVs either, meaning there are no assets to control in a smart way, and the energy consumption of the Demo is much lower compared to when including the EVs. Calculating the KPIs for the EMS evaluation using Baseline0 would be unfair as the EMS cannot reduce energy consumption, only move it in time. Hence, it is Baseline1 that will be used for evaluating the EMS. That is, calculating e.g. self-consumption of local RES and peak loads for Demo 1 when including EVs and on-site PV, comparing with and without an active EMS system.

Baseline data has been and will be collected right up until the EMS is activated. It is expected that the activation will be done in Jan/Feb 2022, and hence, the availability of data for evaluation will be limited. Those KPIs that cannot be measured will be simulated. Please see more details in *D5.5/D6.4 Final evaluation results*.

Important KPIs for evaluation of the EMS, where the Baseline is prior to enabling of the smart energy management:

- Charging availability
- Charging flexibility
- Energy mix
- Peak to average ratio
- Self-consumption
- CO2 emissions
- Average operational costs

7.1 Enabling smart energy management system in D1

The assets in the garage contain local on-site solar energy (70 kWp), stationary battery (50 kWh) in addition to the usual energy demand of the garage (lighting, electric gates and electric heating) and the EVs. These assets are connected in the smart management system, which controls how the EVs can be charged. The EMS thus decides at what time and how much power each car should receive every 15 minutes. The EMS system ensures that:

1) as much of the local PV is utilised (maximisation of self-consumption), and that
2) the peak load (measured at the grid connection in Figure 9) is kept as low as possible.

Both these measures will save costs for the Housing Cooperative, and consequently also for the EV users. Utilising the locally produced PV electricity will reduce the purchased electricity from the grid, and since the electricity costs are also related to the monthly peak power of the garage (NOK/kW per month), keeping the peak load as low as possible will save costs.

Figure 9 shows a schematic overview of the components in the garage. The red dots depict where data is transferred every 15th min. Due to challenges with finding a sensor that could monitor the heating cables, and the different providers of the PV and stationary battery, the gathering of data have been challenging. Below is an overview of the different providers that pushes data every 15 min.

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- PV production: sensor provided by **OneCo**. Pushes data to **eSmart System**.
- Battery status: sensor provided by **OneCo**. Pushes data to **eSmart System**.
- Electric heating cables: sensor provided by **Sodvin**. Pushes data to **eSmart System**.
- EV charging demand: **ZET** collects charging demand from *each user* when entering a booking that starts the charging session. Pushes data to **eSmart System**.
- Charged energy in EV: **Fortum** collects actual charged energy from each EV. Pushes data to **ZET and eSmart System.**

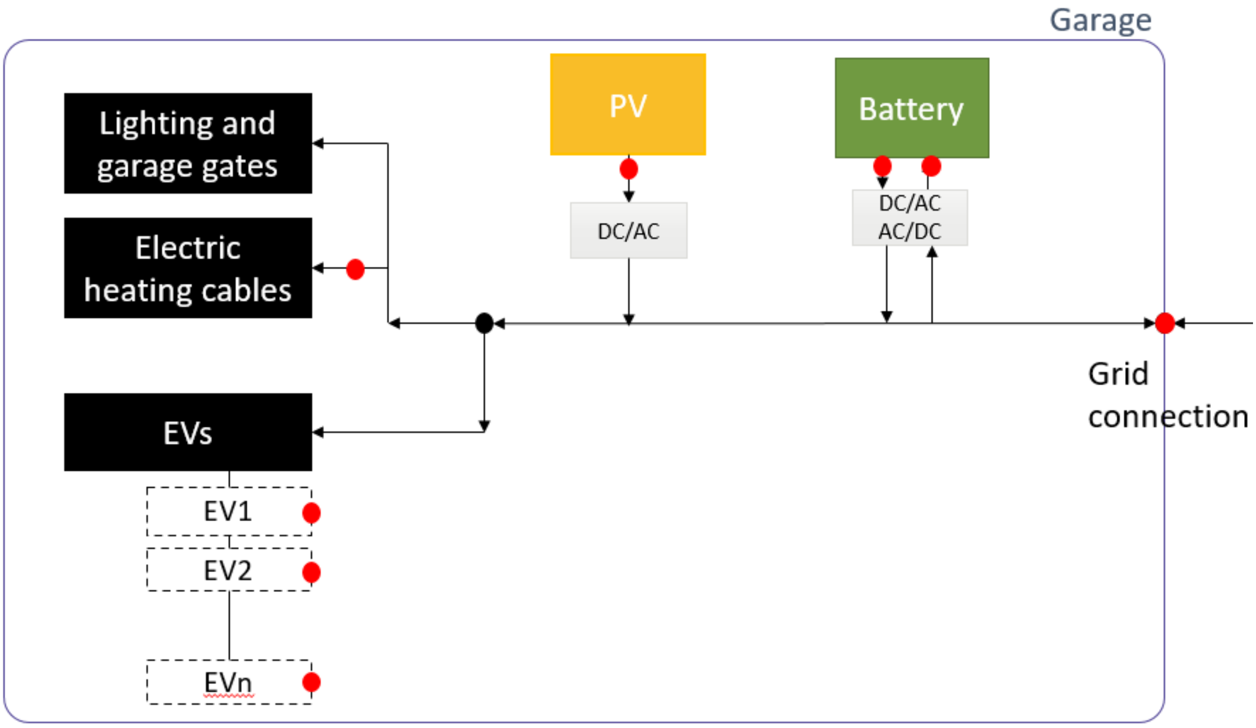

Figure 9 Overview of garage – Oslo Demo 1. Red dots indicate sensors for power measurements.

The EV charging demand is collected through an app that each EV user at Røverkollen has installed on his/her smart phone (either iPhone or Android). For the Oslo Pilot, the GreenCharge App developed by ZET collects the necessary data from the users to makes a charging plan. The collected data are as follows:

1. Start SOC (%)
2. Estimated time of departure
3. Target SOC (%) at departure
4. Option: Priority or Flexible charging

Figure 10 shows the data flow of D1, and who are responsible of pushing data to the next level (from top to bottom). The partners in GreenCharge that make Demo 1 happen are ZET, eSmart System and Fortum. Also external suppliers of hardware & software were necessary to enable the demo: OneCo (PV+Battery), FutureHome (sensor at the main intake), Sodvin (sensors for heating cables), Schneider Electric (CP hardware).

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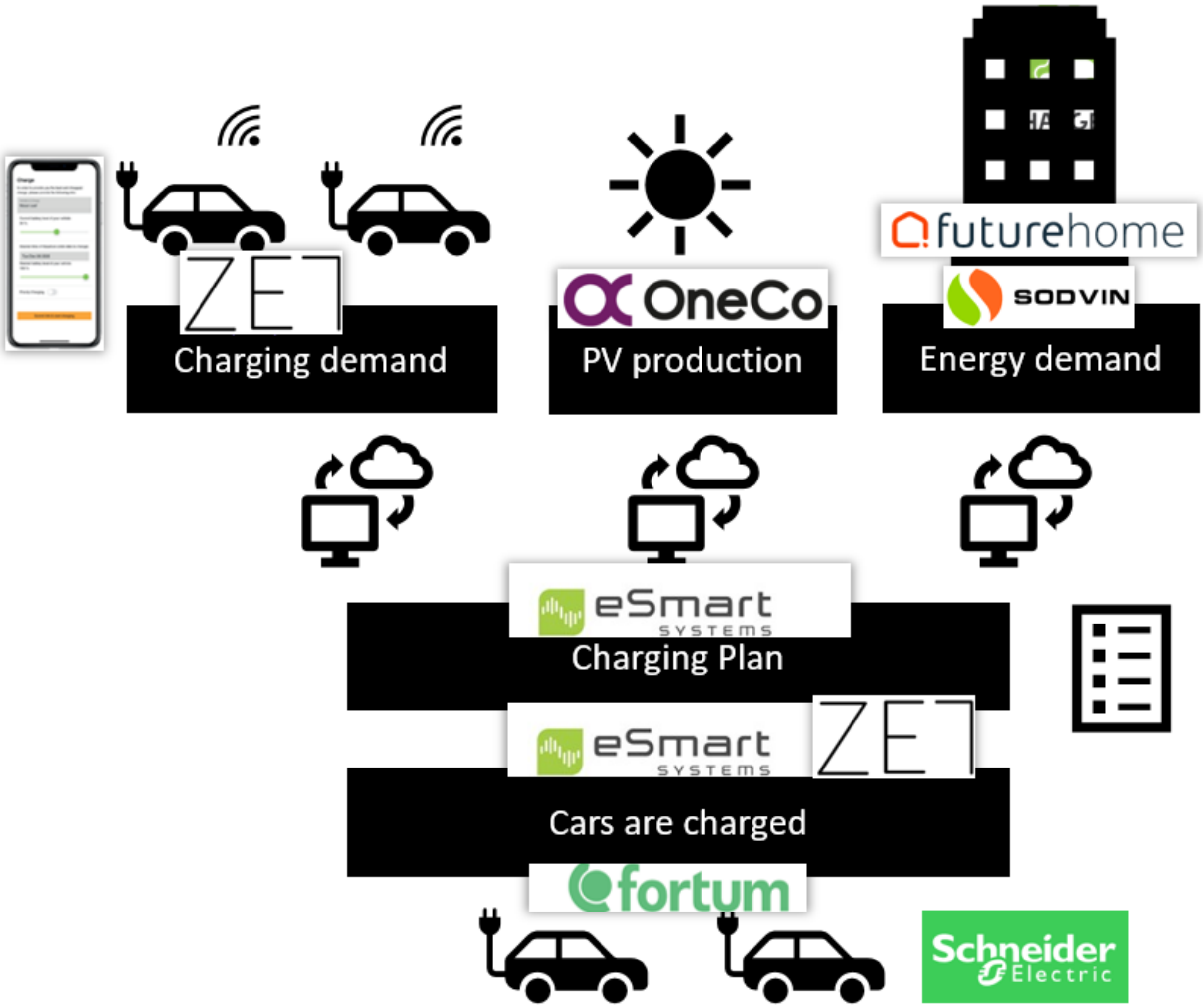

Figure 10 Data flow for Oslo Demo 1.

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8 Initial lessons learned of the technical system

8.1 Technology prototyping

There have been problems with getting the technical systems working (App, CPs, backend systems etc), and this lead to challenges in collecting data throughout the project.

The main challenges and lessons learned getting the pilot operative and collecting data, is related to development and communication.

When the pilot is operative the log-files for data collection should be generated by software and uploaded to the research data server. Also, historical data has been stored for the period before the pilot were operative.

Some important lessons learned regarding data collection:

- A common data structure is important when collecting a large amount of data. This structure needs to be decided and the format locked in sufficient time before the research data is generated in order to avoid to may changes and updates of uploaded data.
- Legal (juridical) ownership of data for sharing of data between partners. This is considered to have been a barrier. Data sharing agreements needs to be in place in order for the partners to share and open up for data flows between one another. This also includes the need for generating new APIs.
- Technology not "smart-ready". Installed technologies in the pilot are all commercially off-the-shelf technologies that are well developed technologies (e.g. battery and CPs) when operating on its own. But, to enable energy management and smart charging these technologies needs to be "open" of receiving external signal. This was more challenging than expected. For both CPs and batteries, the suppliers were not a partner in the project meaning that these suppliers don't have the same initiative to do development on their products and also that they need a contract and payment to do this.
    - Battery: The installed energy storage, batteries, where not prepared to be controlled by the energy management system.
    - CPs: The installed CPs have an integrated LMS (load management system) which was blocking the values in the charging plan sent to the CPs. To enable smart charging this LMS had to be deactivated.

Timeline for implementation. Change in roles and responsibilities leading to the project progress going back to point 3 in February 2020.

	Initial Plan (2019)		**Actual progress (2021)**
1	Hardware installation	Completed Sept. 2019	
2	Testing period	Sept. – Oct. 2019	
3	Software development	Sept. - Dec. 2019	Mar. 2020 – January 2022
4	Activate EMS/ smart charging	Dec. 2019	15. June 2021
5	Monitoring and data collection	Dec. 2019 – Dec. 2020	February 2022
	New definition on roles and allocation of responsibilities between partners	Feb. 2020	

The partners for the Oslo Pilot had weekly dedicated meetings to speed up the progress of development for both demonstrator 1 and demonstrator 2. It is considered to be crucial to have fixed platforms for partners and developers to communicate directly.. A suggestion for improvement is to set up dedicated workshops with the developers to solve issues, e.g. a whole day, in order for the developers to communicated directly and to allocate time and resources to the project.

Lack of resources. The development in the demonstrators have been both challenging and time consuming that requires dedicated resources. To have resources working full-time on development for GreenCharge can be challenging for partners as they are commercially driven companies that also have other responsibilities and clients to follow up.

The demo is based on both software and technical systems working together. Trying to remove all obstacles during the implementation phase it is crucial to do several live, onsite tests with EV, CP and App. Some bugs and errors can only be found when trying all of the components together. Testing in virtual test environment only gets some part on the way

Feedback from users (testers) of the app has not been extensive, and user-friendliness of the App was therefore not addressed extensively. This is something to consider at an earlier stage, since implementation or alterations later in the App can prove difficult.

8.2 Business model prototyping

The initial business models developed for the Oslo pilot in the Green Charge project is described in deliverable *D3.2 Initial Version of Business Models*. This deliverable captures the first project results and the main practical learnings and tools from the first round of the business model workshops. Further developed business models are described in *D3.3 Revised Business Models*.

For the two demo cases (D1 and D2), the housing cooperative Røverkollen, is considered to be orchestrator of the business models. Table 11 shows what will be tested and the planned test period. The final result from the business model testing will be published in the final report *D3.4* at the end of the project.

For Demo 1 the following hypotheses will be tested:

- Willingness to pay more for priority charging in comparison with default chargin (default = flexible) (from d3.3 e. In the first month of this test the price for priority charging will be 25% higher than for default charging, in the second month this difference will be 50%, in the third month of this test the price for priority charging will be twice as high as the price for default charging.)
- Willingness to choose flexible charging by paying less.

For demo 2 the following will be tested:

- Willingness to pay more for a booking service (to book a timeslot for charging)

Table 11 Price models to be tested

	Business model / tests	Data collection period
D1	Baseline: 1,70 NOK/kWh (no payment for priority)	Q1 2022
	#1: 40 % higher cost for priority charging: • Priority: 2,50 NOK/kWh • Default (flexible): 1,70 NOK/kWh	16th June 2021
	#2: Reduced cost for being flexible: • Flexible: 1,70 NOK/kWh • Default (priority): 2,50 NOK/kWh	Not implemented
D2	Baseline: no booking- no charging	

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	Business model / tests	Data collection period
	#1: • Charging price: 3,5 NOK/kwh • No-show fee: 12 NOK/ hour* • Blocking fee: 25 NOK/ hour connected without booking.	February 2022
	#2: Higher price • Charging price: 20 NOK/hour booked • No-show fee:12 NOK/ hour* • Blocking fee: 25 NOK/ hour connected without booking.	Not implemented

**It is possible to cancel a booking. If the cancellation is done more than 1 hour before the booked time slot, no payment will be charges. If the cancellation is done less than 1 hour before the booked time slot, one hour will be charged.*

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9 Conclusions

This deliverable is a technical report describing the data collected and challenges getting the demo operational at an intermediate stage. The challenges with the structure of datafiles and data collection methods are discussed. Some of the reasons for delay of the start-up of the demoes are also discussed, and methods for feedback are listed. Some data from different energy loads (EV charging, energy use, production) are presented. This deliverable will contribute to further development and refinement of business models and technology prototyping.

The main challenge for the Oslo Pilot related to data (structure/collection) is that the demos have not been activated. For D1 we have been able to collect data on EV charging sessions, PV production and consumption in the garage, i.e. providing Baseline data. However, the evaluation of the smart charging system (NEMS) is challenging when it is not activated. D2 entails a booking system and payment linked to roaming for chargers that are publicly available. When the demo (D2) is inoperative, no data on the charging sessions are produced, and there is not data to be collected. Since the system is not activated, neither baseline data nor pilot data have been available for collection.

When the pilot is operating the log-files for data collection should be generated by software and uploaded to the research data server. This was however not the case. Static data, baseline data, weather data, logging data from the apartments are not dependent on D1 or D2 data and have been uploaded to the FTP servers.

The most common issues identified with data collection were to follow up partners so that the files are actually delivered, and to ensure that the data structure was as described in *D5.6 Open Research data.* It was necessary to double check that data continuously as some data might be missing (or wrong) due to hardware errors.

The reasons for why partners did not deliver data as requested could be several, but it is believed to be the following main reasons:

- No data available
- Data provider had insufficient understanding of what it means to be "responsible for delivering data"
- Data provider found it challenging to understand *how* to upload the data
- Data provider did not prioritize the delivery

A common data structure is important when collecting a large amount of data. This structure needs to be decided and the format locked in sufficient time before the research data is generated to avoid too many changes and updates of already uploaded data. The most common errors in the data structure of the delivered data were: wrong name of file, wrong name of demo, wrong time resolution, wrong value, wrong denomination. There are several reasons for these challenges:

- The person handling project data has not been given sufficient information about data structure and thus uploads files with errors.
- Requirements of data structure from SINTEF was unclear and/or altered several times.
- The data provider forgot to upload the data.

Some other important lessons learned:

PILOT IMPLEMENTATION

- Installed technologies in the pilot are all commercially off-the-shelf technologies that are well developed technologies (e.g. battery and CPs) when operating on its own. However, some technology is not "smart-ready". Implementation require cooperation of several different partner/companies.
- There should be as few involved partners as possible. There must be given a greater incentive to work with the project. Shared common interest in project success is required. The persons working with the

project should feel ownership to it and there must be enough available resources. New resources must be given proper education/information about project and responsibilities.

- Several partners require a strong leading partner/company that basically is in charge of everything. This leader/partner should handle all the parts of the system, and delegate a problem to the correct part. The demo was divided in technical, software and economical parts, and each partner had different task. If only one partner had all of the technical, software and economical responsibilities it would be much easier to correct errors, and the users would only have one partner to deal with.
- General communication within the project could be better if one had agreed on a common easy and fast communication platform. As an example: e-mail communication can be slow (days) and teams video meeting can be extremely time consuming.
- During the development and implementation of the pilot the board at Røverkollen, have struggled with technical, software, economic issues. It was unclear to them, whom to contact regarding the different issues, and feedback from them is that project like this need one single partner responsible for coordination of all this and this is one of the most important lessons learned.

DATA COLLECTION

- Common and known data structure is important, and each data provider should get a shortended version of the data structure document, explaining format and delivery method easily. These documents need to be forwarded to any new person being involved within the project.
- When data is being delivered, there should be a sent message or confirmation to the responsible person of data collection. Data check should be performed regularly.
- Partners are not fully aware of their responsibility to deliver data, and the data structure on files to be delivered
- Some of the data was to be delivered from a working App. The development and implementation of the app took a long time. These types of projects with both software and hardware working together need to be tested "live"
- The onsite testing of demo with App, CPs, EVs and all partners present was done at very late stage (too late). Tests like this are critical to finding bugs and errors in the system and must be done at all stages of development.

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A Appendix: List of participants at 1st Reference group meeting

Company name	Stakeholder	Description
Oslo Municipality	Partner	
Bymiljøetaten	Partner	
Oslo Municipality	Partner	
SINTEF	Partner	
SINTEF	Partner	
SINTEF	Partner	
SINTEF	Partner	
eSmartSystems	Partner	
Røverkollen Housing Ass.	Partner	
Røverkollen Housing Ass.	Partner	
Fortum Charge&Drive	Partner	
PNO	Partner	
PNO	Partner	
PNO	Partner	
Hubject	Partner	
Hubject	Partner	
StartUpLab	Reference group member	Incubator and early-stage investor
Klimaetaten	Reference group member	Oslo municipality, other department
Hafslund DSO	Reference group member	DSO – grid company
Hafslund DSO	Reference group member	DSO – grid company
Møller Gruppen	Reference group member	Automotive company
Nissan	Reference group member	Automotive company
OBOS	Reference group member	Housing Entrepeneur Society
Bravida	Reference group member	Electric service provider
Elbilforeningen	Reference group member	Non-profit organisation (interest organisation)

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B Appendix: Examples of log-files

Examples of the following:

EV charging/ discharging session:

/shared/research_data/recordings_logs/energy_consumption_production/ev_charging_discharging_sessions/LOG-P1D1-P1D1L1-20220126T142352-ENERGY-CHARGE-dfdeeec1.csv - john.thommesen@data.sintef.no - E...

Encoding Color

```
CPID;LOC;ChrgSessID;Time;EVID;PluginTime;PlugoutTime;SOCStart;SOCEnd;ChrgTime;MaxChACPower;MaxChDCPower;MaxDischACPower;MaxDischDCPower;SwID;PowerCh
dfdeeec1;P1D1L1;3002220001709813;20220126T143345;61f15bc982df832f1136029e;20220126T142352;20220126T153852;;;01:15:00;;;;;V2.0.5(15);9.085
20220126T142352;0.001
20220126T142852;0.608
20220126T143352;1.214
20220126T143852;1.821
20220126T144352;2.426
20220126T144852;3.031
20220126T145352;3.637
20220126T145852;4.243
20220126T150352;4.848
20220126T150852;5.454
20220126T151352;6.06
20220126T151852;6.665
20220126T152352;7.271
20220126T152852;7.875
20220126T153352;8.48
20220126T153852;9.086
```

Reservation/booking events:

Heating/ cooling session:

/shared/research_data/recordings_logs/energy_consumption_production/heating_cooling_sessions/LOG-P1D3-P1D

Encoding Color

```
HCID;SwID;Time;SetPt;AllowedDev;AST;AET
Hotwater2;SODVIN_v1;20220201T080000;60.0;null;20220101T000000;20220131T000000
20220101T010000;28849.86707
20220101T020000;28859.95481
20220101T030000;28867.54351
20220101T040000;28874.72978
20220101T050000;28880.65249
20220101T060000;28887.71919
20220101T070000;28894.61501
20220101T080000;28903.53127
20220101T090000;28911.28559
20220101T100000;28919.78088
20220101T110000;28929.60323
20220101T120000;28942.97599
20220101T130000;28954.87118
20220101T140000;28967.24724
20220101T150000;28977.30703
20220101T160000;28990.59035
20220101T170000;29007.71104
20220101T180000;29017.79472
20220101T190000;29027.88690
20220101T200000;29036.05340
20220101T210000;29045.51830
20220101T220000;29054.38369
20220101T230000;29063.02280
```

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