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D4.16 Report on Smart personal EV charger system in operation

WP4, Task 4.7

Transition of EU cities towards a new concept of Smart Life and Economy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Project Acronym	mySMARTLife	
Project Title	**Transition of EU cities towards a new concept of Smart Life and Economy**	
Project Duration	1st December 2016 – 30th November 2021 (60 Months)	
Deliverable	D4.16 Report on Smart personal EV charger system in operation	
Diss. Level	PU	
Status		Working
		Verified by other WPs
	■	Final version
Due date	30/11/2017	
Work Package	WP4 Demonstration in Helsinki	
Lead beneficiary	SAL	
Contributing beneficiary(ies)	Forum Virium Helsinki Oy (FVH)	
Task description	**Task 4.7**: Sustainable Mobility and Electrical Mobility - SMART MOBILITY [VTT] (FVH, HEL, HEN, HMU, SAL, CAR) With the large up-take of electric buses, the road-based mobility system in Helsinki becomes electric. Both the uptake and the monitoring of the charging infrastructures for this fleet, as well as demonstrations with all-electric fleet, are taken. **- Subtask 4.7.3**: eCar sharing definition and deployment. FVH and SAL will lead the eCar sharing concept will be defined and deployed, including the definition of smart personal EV charger system that will be put in operation.	

Date	Version	Author	Comment
24/10/2017	0.1	Radovan Janoso (SAL)	Structure of the deliverable and work planning
30/10/2017	0.2	Radovan Janoso (SAL)	Added eCar sharing concept as provided by Timo Ruohomäki
02/11/2017	0.3	Radovan Janoso (SAL)	Ready for review
29/11/2017	0.4	Radovan Janoso (SAL)	Modifications based on comments from reviewers
30/11/2017	0.5	CARTIF	Final internal check

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Abbreviations and Acronyms

Acronym	Description
EV	Electric Vehicle
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy (the project)
OCPP	Open Charge Point Protocol
UI	User Interface

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1. Executive Summary

This deliverable describes the approach to create a solution for personal EV charging considering grid load balancing and variable price of electricity, as well as eCar sharing concept. Initial findings about standards and market readiness is presented. A plan to develop the service is defined further in this document. In addition, impact of charging optimisation on city and country level from viewpoint of better grid utilization is indicated.

Salusfin asked to extend subtask 4.7.3 delivery through an amendment process due to the unavailability of EV charging units with standardised communication protocol (ISO/IEC15118). Such protocol provides needed information about EV and its battery and charging status that simplifies solution implementation considerably.

Moreover, in relation to this deliverable, the definition, deployment and monitoring of the EV charger system as part of the eCar sharing concept to be defined in Helsinki (Subtask 4.7.3: eCar sharing definition and development) is developed simultaneously with deliverables D4.11, D4.14 and D4.17 and the IoT services for innovative mobility. These deliverables have a due date already established in the current description of the action in month 24 and month 36. Thus, in order to align reporting of this deliverable to these developments, a new due date is required.

Considering that an Amendment was requested in September (month 10) and that the process of negotiation and approval can still take several months, it was agreed with the Project Officer to submit an interim report at the original due date, including in the description the design of this innovative equipment. In this Amendment, a new due date in month 36 is requested to provide the final design and explaining how this is operated in the new eCar sharing concept in Helsinki.

Thus, the new final due date is requested to be established at month 36. Proposed schedule in Amendment for this deliverable is M36.

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2. Introduction

2.1 Purpose and target group

This deliverable provides concepts of personal EV charging process modification to optimize grid utilization, charging costs and concept of eCar sharing. Plan how to proceed is presented. Initial analysis of needs to build solution is included pointing out on readiness of various building blocks.

2.2 Contributions of partners

The following Table 1 depicts the main contributions from participating partners in the development of this deliverable.

Table 1: Contribution of partners

Participant short name	Contributions
FVH	Contributing partner
SAL	Main responsibility for delivery

2.3 Relation to other activities in the project

The following Table 2 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the mySMARTLife project and that should be considered along with this document for further understanding of its contents.

Table 2: Relation to other activities in the project

Deliverable Number	Contributions
D4.1	This deliverable defines approaches to optimise usage of produced electric energy considering EV charging point of view
D4.11	This deliverable defines the methods to provide data on urban platform defined in D4.11

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3. Concepts

3.1 Personal EV charging concept

Personal EV charging approach typically follows two common patterns:

1. EV starts to be charged immediately when it is plugged into charging point.

2. EV starts to be charged from defined time (if either EV software allows user to configure charging time or there is a control of charging point).

In both cases there is rather limited control over charging process. If there is no need to charge personal EV immediately modification of charging process allows to bring savings to end users as well as on higher scale it provides local load management and has positive effect on grid utilization. To achieve savings for end users precondition is that user has contract based on electricity spot market prices. Fluctuations in electric energy price on spot market can vary quite noticeably as it is demonstrated on snapshot of hourly prices from Nordpool spot market

EUR/MWh

All hours are in CET/CEST. Last update: **Today 12:42 CET/CEST**.

	31-10-2017	30-10-2017	29-10-2017	28-10-2017	27-10-2017	26-10-2017	25-10-2017	24-10-2017
00 - 01	28,80	3,00	25,52	24,18	26,53	26,16	25,80	29,58
01 - 02	28,63	2,99	24,11	24,76	25,39	25,05	19,27	29,35
02 - 03	28,60	3,37	23,02	23,52	25,43	24,95	18,32	28,90
02 - 03	-	-	21,63	-	-	-	-	-
03 - 04	28,39	4,05	18,71	22,27	25,06	25,43	19,50	28,82
04 - 05	28,89	4,89	21,00	22,13	25,38	26,39	23,95	28,97
05 - 06	30,34	25,59	20,10	23,98	31,89	28,44	27,34	36,56
06 - 07	34,83	28,42	21,02	25,23	40,49	34,87	33,68	48,00
07 - 08	38,73	33,54	22,50	25,32	46,68	39,07	35,02	48,58
08 - 09	41,09	33,54	21,34	26,02	45,09	40,50	35,08	56,87
09 - 10	40,45	33,97	25,45	26,27	43,90	40,43	35,01	52,88
10 - 11	40,40	33,89	25,93	26,26	42,53	40,42	33,88	63,82
11 - 12	41,43	33,84	25,40	26,10	42,42	40,50	33,39	52,88
12 - 13	41,03	33,89	24,92	25,79	42,17	41,21	32,92	52,72
13 - 14	40,99	33,56	24,13	25,66	40,50	41,12	33,60	44,70
14 - 15	38,24	33,55	22,88	25,44	39,44	40,57	32,02	44,11
15 - 16	39,05	33,55	24,13	25,89	38,05	39,89	31,12	40,86
16 - 17	42,45	36,81	25,53	27,47	37,95	39,92	31,02	45,67
17 - 18	46,96	39,90	27,13	29,26	40,14	42,47	34,91	49,03
18 - 19	47,36	35,91	27,62	32,09	42,17	48,01	38,21	60,98
19 - 20	40,44	30,57	28,23	27,68	39,79	40,94	34,63	47,57
20 - 21	31,27	29,79	24,85	26,76	29,98	34,86	29,91	30,28
21 - 22	30,19	29,68	19,96	25,91	26,94	31,84	29,43	29,74
22 - 23	29,58	29,26	17,86	24,78	25,80	29,01	28,22	28,91
23 - 00	28,88	28,52	17,60	22,18	20,45	27,52	27,10	27,02

Figure 1: Nordpool spot market prices

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Service uses information about electricity hourly spot market prices, EV battery capacity, EV battery charge level, charging point capacity and time available for charging process to calculate most cost efficient way to charge EV. Considering all needed input variables there are certain requirements for charging point which shall provide necessary information about connected personal EV.

With increasing amounts of personal EVs there is benefit of charging optimization service in increase of produced electric energy utilization. As most of optimized personal EV charging will happen during times when cost of electricity is low which is clear indication from production side of need to use energy. That way we will lower demand for energy during “peak” (expensive) hours and therefore avoid need to produce more energy to satisfy demand. Such approach will have then direct impact on produced CO2 emissions as well as on grid utilization.

In addition, first energy utility companies in Finland started to introduce so called power charge concept where customer is additionally billed based on highest consumption. Optimization service shifts consumption and consequently lowers power charge fee.

3.2 eCar sharing concept

The planned eCar sharing concept aims to fill the gap between public and commercial car charging stations and private, personal car charging. The intended target market could as an example include housing cooperatives that purchased a car for shared use for their own shareholders.

The car would in such case be seen as similar shared resource than Flexispaces or other rental spaces. The housing cooperative could use the same Flexispace booking system that they use for the house communal space or meeting room. The booking system would then not be involved with any financial transaction since the use of shared vehicle could be charged in similar fashion than any other shared commodity in the building such as water or cleaning of the communal areas.

In order to track the mileage the car has been used by each shareholder, an API is required to collect the meter readings from the vehicle after every charging event. For this purpose, the OCPP - protocol and/or ISO/IEC 15118 vehicle-to-grid charging protocol should provide the information required. The same interface could also be used to collect pre-emptive maintenance information in order to ease and outsource the service of the communal car.

The API defined as part of this deliverable would have an endpoint on the Urban Platform (See Deliverable D4.11 for details). The urban platform shall have the capability to manage data streams from personal EV chargers as personal data according to the definitions of the General Data Protection Regulation (GDPR). The platform would then associate the data stream with the owner of the car, who only can give the consent to use the data in other services or research. The urban platform also provides the mechanisms to associate the data streams with various types of services that can be about data analysis, visualisation or integration to other services.

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3.3 Personal EV charger solution description

Solution landscape consists of following parts:

- Personal EV charger solution:
  - Personal EV charging unit
  - Cloud service
  - UI part
- External entities:
  - Personal EV
  - Customer's mobile phone / tablet / computer (device through which personal EV charger is operated)
  - Electricity spot market price service (Nordpool in Finland)
  - EV charger manufacturer's / operator's cloud
  - (optional) Weather service to add additional optimization parameter for charging personal EV taking into account effect of cold / hot climate

Relations between components are described in following figure.

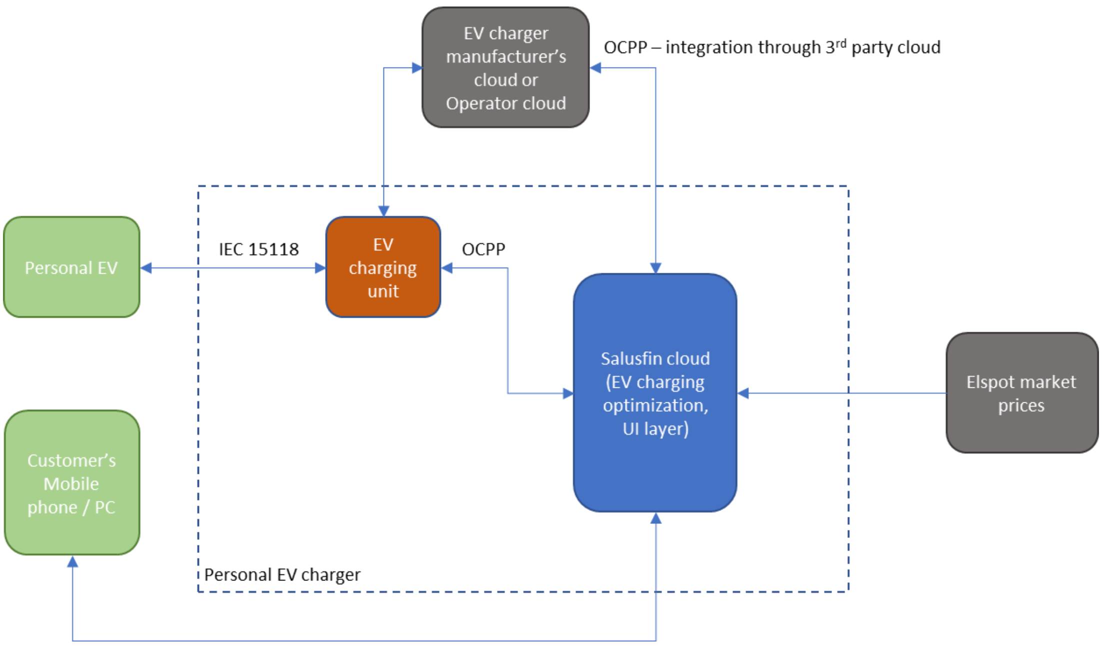

Figure 2: Personal EV charger solution components

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Crucial component in diagram above is EV charger that shall be capable of communication with EV through standardised protocol (ISO/IEC 15118). This protocol allows charging unit to communicate with personal EV and provide all necessary data that are needed for optimization service. Communication between EV charger and Salusfin cloud optimization service shall be performed using OCPP protocol that has been widely accepted in Europe and many other countries. There will be either direct connection from EV charger to Salusfin cloud or there is an option to connect through EV charger manufacturer’s cloud or operator.

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4. Current status and plans

4.1 Current status

Currently we have ongoing pilot with two EVs using standard wall socket charger controlled via Salusfin smart plug. There is no communication between EV and Salusfin cloud therefore charging process uses preconfigured charge level and battery capacity based on vehicle used. Optimization takes into account electricity spot price and uses that to control charging process. Data about charging process is being collected on Salusfin cloud.

Following graph contains example of single charging session where personal EV was connected to charger at 17:00 of local time and optimisation process selected best charging time according to electricity price. Capacity of personal EV battery, it's initial charge level and time when battery shall be fully charged (08:00 local time) are preconfigured.

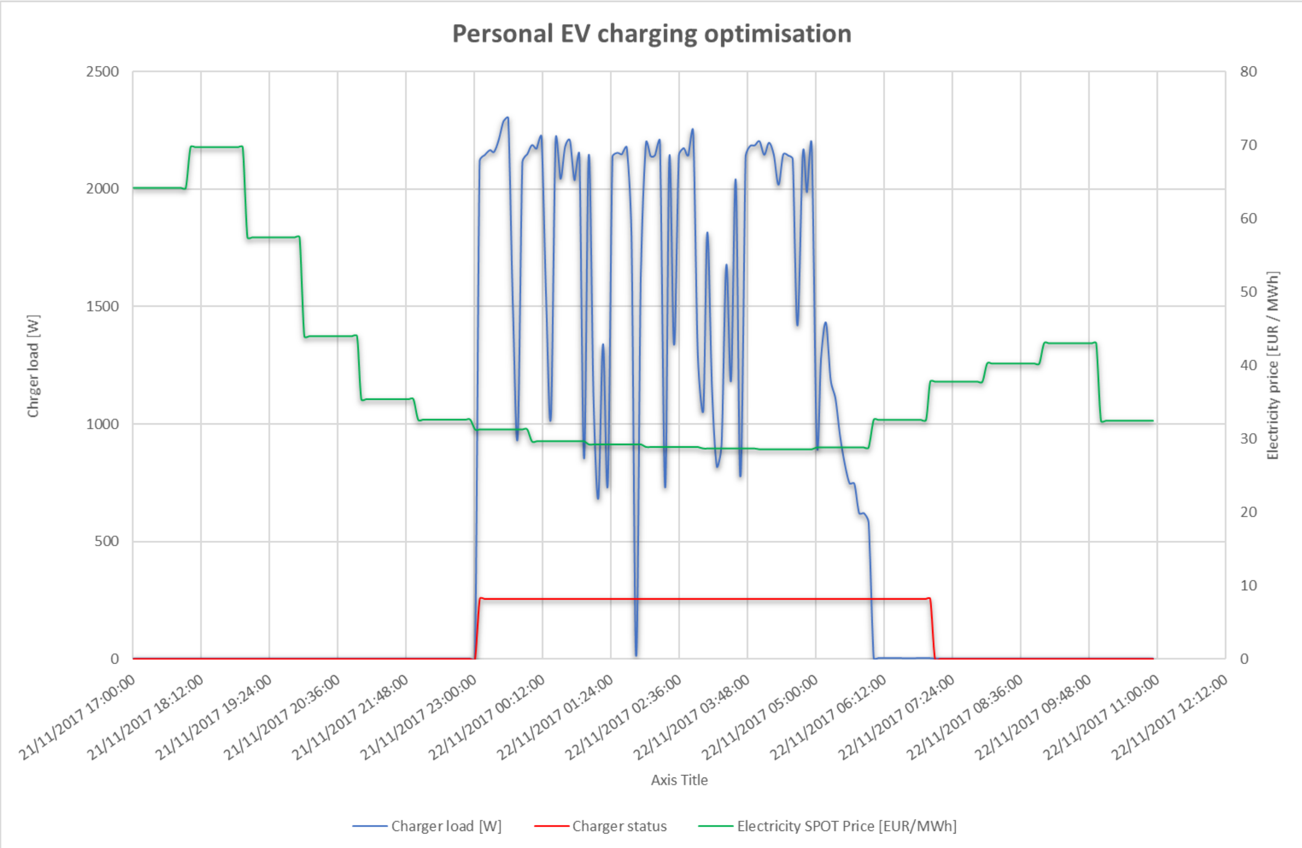

Figure 3: Personal EV charging optimisation – graph of collected data

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Green line in graph represents electricity price that varied between 28,71 EUR/MWh at its lowest value and 69,72 EUR/MWh at maximum price. Optimisation process calculated needed time to charge personal EV battery and such information was used to control charger status (ON/OFF) as seen on red line. Measured charger actual power consumption is represented by blue line.

4.2 Personal EV charger

Data exchange of required parameters for optimization service between vehicle (EV) and EV charger is crucial for service to perform with low dependency on end user. Aim is to build service that will be user friendly and require only necessary input from user. In this case only information when charging shall be completed and if optimisation service is enabled shall be requested. Therefore EV charger that has such capability is required and in order to allow service to be widely deployable we decided to focus on units that support international standard ISO/IEC 15118. Unfortunately there is no yet commercially available EV charging unit that has implemented ISO/IEC 15118 standard and that leads to need to extend timeframe to build solution.

4.3 Business models

The basic business model is based on HW & Services sales. In this case the HW would be gateway and charging station and possibly other components of energy management or security and safety areas.

Service fees are related to services used and fee covers the operation, maintenance and development. Service fee level varies depending on service type that customer subscribes to.

Salusfin can consider new types of business models like benefit based approach with consumers or revenue sharing with B2B partners.

Additional elements can come from Demand-Response / sub-aggregator-aggregator-electricity market approach where controllable load is offered to the markets and revenue would be shared between participants. In Salusfin case the controllable load can consist of EV-charging and e.g. electric floor heating.

4.4 Plan

Plan of upcoming activities includes:

- secure EV charger with support of ISO/IEC 15118
- design interface between EV charging unit and Salusfin cloud service
- design of optimization service (interfaces, backend functionality and UI layer)
- analyse data from ongoing pilot with single EV

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- in case EV charging unit with ISO/IEC 15118 implementation is still not available then selection of optional EV charging unit for piloting purposes needs to happen
- pilot user identification and selection
- business case creation
- sales preparation

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5. Conclusions

Aim of both concepts developed under task 4.7.3 and described in this document is to impact on carbon footprint. Either by providing shared personal EV to community as a service so it will increase utilisation of environmentally friendly means of transport. Or by personal EV charging optimization service where it will allow to consume electric energy during time of low demand therefore minimize need for energy during time when it is expensive. It will have as well direct effect on grid as peak loads generated by EV charging are shifted to time when there is less demand. As consequence there is as well benefit for end customer who will benefit from lower price per charge in case customer is having spot price tariff.

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6. References

ELSPOT Day-Ahead Electricity prices: https://www.nordpoolgroup.com/Market-data1/Dayahead/Area-Prices/ALL1/Hourly/?view=table

Open Charge Alliance – consortium behind OCPP protocol: http://www.openchargealliance.org/

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