Ref. Ares(2022)2371166 - 30/03/2022

www.sender-h2020.eu

SENDER

Co-creation workshops report

Deliverable D2.2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 957755 (SENDER). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

Deliverable D2.2

Co-creation workshops report

Organisation: NTNU

Main authors: William Throndsen, Marjolaine Farré (TRIALOG)

Date (31/03/2022)

DELIVERABLE D2.2 – VERSION 1.0

WORK PACKAGE N° 2

Nature of the deliverable		
R	Document, report (excluding the periodic and final reports)	X
DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

Dissemination Level		
PU	Public, fully open, e.g. web	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Quality procedure			
Date	Version	Reviewers	Comments
22.03.22	0.1	Giorgos Pitsiladis (HPT)	Review for submission to EC
23.03.22	0.1	Jason Tsahalis (PARA)	Review for submission to EC
30.03.22	1.0	Joseph Negreira (SIN)	Final review and submission

Acknowledgements

This report is part of the deliverables from the project “SENDER" which has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 957755.

More information on the project can be found at https://www.sender-h2020.eu.

Executive summary

Financed by the European Commission under the H2020 program, the goal of the SENDER project is to foster sustainable innovation in the energy market, with explicit focus on energy services like demand response (DR), home automation and novel ways of producing electricity locally (prosuming) and trading between neighbours.

This deals directly with end use of electricity in the everyday life, and for this reason the SENDER project has as one of its main goals to enroll customers in a co-creation process in order to make sure the solutions developed are not imposed on end users in a top-down fashion, but that it also consider the needs and concerns of end users. End users are one of the central actors in the future energy system, and co-producing solutions with them helps ensure they will have a lasting and robust role.

The work undertaken in WP2 is part of the Analyse and Define steps of the SENDER project. Here, the co-creation is set up, and the focus on consumers placed at the center of the whole project. Through the co-creatoin steering group (CCSG), WP2 acts as a bridge between the technical parts of the project through dedicated workshops ensuring use and acceptance of technological solutions that are developed.

In the following, discussions from co-creation workshops (CCWS) are described in detail, providing insight into what end users had to say about the use cases that has been defined in SENDER so far. This insight will be brought to bear on the final definition work, the end point of which is a jointly accepted and consumer-centric definition for the SENDER implementation and demonstration.

Table of contents

Acknowledgements 3
Executive summary 4
List of Figures 5
1. Introduction 6
1.1 About SENDER 7
2. Demonstration sites 8
2.1 Alginet, Spain 8
2.2 Weiz, Austria 9
2.3 Otaniemi, Finland 9
3. Use case methodology 11
3.1 Generic use cases 11
3.2 Co-creation process 12
3.2.1 Co-creation steering group 12
3.1.2 Co-creation workshops 14
3.1.3 Use case scenarios 15
4. Results 17
4.1 Maximizing Renewable Energy Sources 17
4.2 Building as a Battery 19
4.3 Peer-to-peer Trading 24
4.4 EV Charging 29
5. Summary of findings and next steps 32
4.1 Maximizing Renewable Energy Sources 33
4.2 Building as a Battery (BaaB) 33
4.3 Peer-to-peer Trading 34
4.4 EV Charging 35
4.5 Next steps 35

List of Figures

Figure 1: 5-helices co-creative innovation development and replication process 11
Figure 2: The co-creation actors and process 12

1. Introduction

This deliverable is a detailed summary of the results from the SENDER co-creation workshops (CCWS), one of which was convened at each demonstration site during the previous year.

During the work of WP2, the co-creation steering group (CCSG), involving the demonstration partners, SENDER solution providers, other experts, and end users, was defined and convened.

The work done by the CCSG laid the foundation for the development of a set of use cases to guide the technology development and implementation of the project based on a co-creation process. The final iteration of the resulting use cases can be reviewed in deliverable D2.4.

The purpose of the co-creation process is to involve and engage end users with the SENDER solutions in order to bring their insight to bear on the technology development within SENDER. This will ensure the solutions that we develop are user-centric, and that allow for further collaboration between the project and end users.

In the work leading up to the CCWSs, the use cases iterated in D2.4 were developed into a set of scenarios describing in narrative form how SENDER solutions can be imagined to possibly work in an everyday, household setting of the life of end users. This was necessary to start the co-creation process and provide end users with something to engage with.

The resulting workshops produced interesting discussions between end users and experts. This in turn has provided us with a thick description of end users' thoughts and preferences regarding a likely future where SENDER solutions have been implemented in their homes. This is a future in which some new decisions about energy consumption must be made – and others may be left entirely to the solutions that SENDER is developing.

This report will be useful as input about consumer preferences into the work in SENDER that is dedicated to finalizing the consumer-centric the of use cases for the SENDER implementation, i.e. WP3 on *Specification of a pro-active demand response system with consumers* and WP4 on *Policies, regulations, cyber security and data protection with consumers.*

Furthermore, the consumer preferences described in this data will be valuable for the work on technological solutions in WP5 *Consumer patterns modelling* and WP6 on *Technological development and interoperability* as well.

Finally, this report will provide useful data on what to take into consideration when implementing SENDER solutions, business models and enrolling customers in the demo sites, and thus be of value to WP7 *Demonstration and monitoring of the results* as well as WP8 on *Business model exploitation and roadmap.*

1.1 About SENDER

As the European Union moves towards sustainable energy, co-creation is the future of the energy service market. This entails a shift in the balance of power, turning customers into a new generation of collaborators and putting them at the heart of the energy sector. The EU-funded SENDER project will develop energy service applications for proactive demand response (DR), home automation convenience and security mechanisms. By engaging customers in a co-creation process, the project will shift DR from a reactive to a proactive approach. Consumer data will be collected and processed to identify typical consumption patterns, mirror them by digital twins (DTs) based on artificial intelligence technologies and aggregate the DTs' supply/demand characteristics.

2. Demonstration sites

This section recaps a presentation, also available in D2.4., of the three demonstration sites as well as the expectations of the pilot partner towards SENDER.



2.1 Alginet, Spain

The Spanish demonstration site will be based in Alginet, a village located 25 km from Valencia, in the east of Spain, with 13000 inhabitants. The distribution network in Alginet has a special particularity: it is owned by the end users through a cooperative. Currently, the Cooperative supplies 46 million kilowatts hour annually by means of 40 centres of transformation, with an installed power of 18000 kW and almost 6000 users benefit from the smart meters deployed by the electric cooperative, as well as other services and actions that the cooperative initiates to benefit its end users. Apart from the main basic activities of commercialization and distribution of electric energy, the cooperative group also plays a major social role in the town by investing and redistributing their benefits among the end users.

Our pilot partner in the project is Alginet Distribución Energía Eléctrica (ADEE), the local Distribution System Operator (DSO). In a context of continuously increasing, highly distributed renewable generation and the rise of e-mobility, ADEE is expecting new patterns of consumption and generation. The partner is thus interested in improving its forecasting as well as studying the value of Demand Response on congestion management and grid balancing. As a cooperative, ADEE is also interested in proposing new services to its consumers and thus taking the role of an ESCO (Energy Service Company): ADEE would like to promote individual self-consumption as well as energy efficiency and to foster changes in consumers' behaviors. Finally, as new dynamic tariffs recently appeared in Spain, meaning a potential higher electricity bill for end-users, ADEE would like to propose a service to minimize the bill of its consumers.

2.2 Weiz, Austria

The W.E.I.Z. demonstration site is located in the eastern part of Styria, about 30km from the provincial capital Graz. The pilot area includes the municipality of Weiz (11700 inhabitants), as well as the six neighbouring municipalities and a total of 26000 inhabitants. The municipality of Weiz is strongly influenced by its industrial locations and its large leading companies. In this context, the municipality of Weiz is seen as a centre that provides numerous important functions (schools, shopping, authorities, entertainment, hospitals, etc.) for the households of the neighbouring municipalities. The continuing expansion of the urban area and the resulting spatial planning developments regarding "working" and "living" in an organized development process open up special potentials of intelligent and sustainable development goals. With this in mind, numerous new projects and the systematic expansion of large-scale photovoltaic systems together with electricity storage systems, e-car charging stations and e-car sharing are being implemented in downtown Weiz.

Our pilot partner in the project is the Weizer Energy and Innovation Centre (W.E.I.Z.-FE), a regional contact point for the main topics "Energy" and "Innovation". The main objective of the partner regarding SENDER is to optimize the electricity use in the region and can be decomposed as follows:

- To foster changes in consumers' behaviours, in terms of heating, cooling and lighting, through remote monitoring/controlling and energy efficiency promotion
- To promote energy management systems to optimize energy efficiency, either by automatic control of devices (e.g., washing machine) or by sending notifications to end-users, in case they do not trust or want an automatic system
- To maximize self-consumption of the power generated by PV systems
- To propose smart charging to EV drivers (living in the municipality and commuters)

2.3 Otaniemi, Finland

The Finnish pilot site is in Espoo, Southern Finland, close to the capital city of Helsinki. More specifically the pilot area is called Otaniemi, which is a cape on the shores of Baltic Sea. Otaniemi forms a campus district with 5,2 km2 area in total. Around 3500 people live in the area, but more importantly, about 15000 people come here daily for work. The area is composed of university buildings and several companies' offices. Services such as shopping centres and restaurants are also found in the area. Otaniemi is also served by a subway line connecting the area to Helsinki city centre. In 2018, the Smart Otaniemi Innovation Ecosystem has been implemented in the area: its role is to manage the development of smart energy systems in Otaniemi (flexibility, smart mobility, district heating, data sharing, etc.).

Our pilot partner in the project is VTT Technical Research Centre of Finland Ltd (VTT), an impartial non-profit Research and Technology Organization. Through SENDER, VTT would like to study the integration

of EVs in Demand Response scheme and see the whole value chain run, from EV users with specific needs to (sub-)aggregators and other system operators benefitting from EV-based flexibility (e.g., for the Fingrid FCR-N market). SENDER could also help in minimizing the electricity bills of EV drivers and maximizing the use of renewable energy sources to charge the car, while ensuring EV drivers' satisfaction is met (EV charged at its departure time). Last, VTT is interested in piloting Vehicle-to-Grid (V2G) to add value to any of the selected use cases.

3. Use case methodology

This section provides a recap of the methodology, some of what was already described in D2.4, and which has been used to define the use cases to implement in SENDER. It also adds details about the co-creation workshops and data collection procedures.

As described in the Grant Agreement of the project, SENDER applies a Quintuple Helix innovation model combined with a user-centric innovation development process as shown in Figure 1.

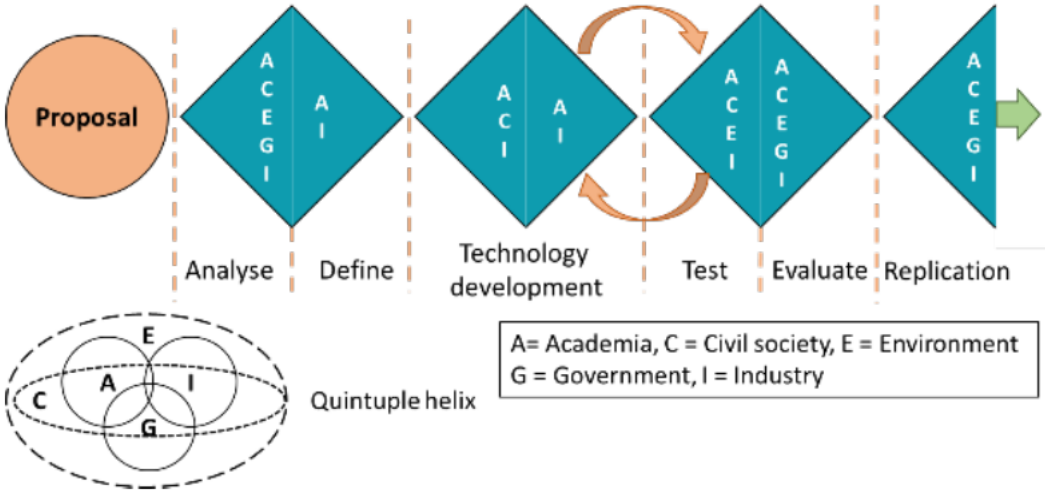

Figure 1: 5-helices co-creative innovation development and replication process

During the analysis phase, SENDER strived for the set-up of a co-creation process that puts consumers at its centre and involves also the perspectives of academia, environment, government and industry on the SENDER solution. As a first step, experts of the consortium outlined state of the art insights on consumer-centric demand response systems through the presentation of generic use cases to the co-creation steering group (see 3.1). Based on the manifestation of the stakeholders (see 3.2.1) and consumers (see 3.2.12) preferences regarding those generic use cases and the SENDER solution components, jointly accepted and consumer-centric use cases for the SENDER implementation have been defined.

3.1 Generic use cases

As stated in the Grant Agreement of the project, SENDER has the ambition to put consumers at the heart of the energy market by engaging them in a co-creation process with other actors from the

energy domain during the specification of pro-active DR mechanisms to cater for the consumers' long-term incentivization. Use cases to demonstrate in SENDER should thus be based on the outcomes of co-creation. To ensure an effective discussion with stakeholders and final end-users, experts of the consortium presented a set of generic and technology-agnostic use cases for the Smart Home domain to the co-creation steering group to outline state of the art insights on consumer-centric demand response systems.

To select the generic and technology-agnostic use cases to present in co-creation, we screened several sources and conducted a first assessment to check that the considered use cases were in line with the objectives set in the Grant Agreement and feasible with regards to the core innovations and actors involved in the project. For a complete summary of the selection process, as well as an overview of use cases, please refer to SENDER deliverable 2.4.

3.2 Co-creation process

SENDER uses co-creation processes to develop consumer engagement, ensuring that customers become collaborators in the design of energy services and ensuring the alignment of the use cases with the needs, expectations, and concerns of the local population. These co-creation mechanisms are two-fold: co-creation steering groups and co-creation workshops.

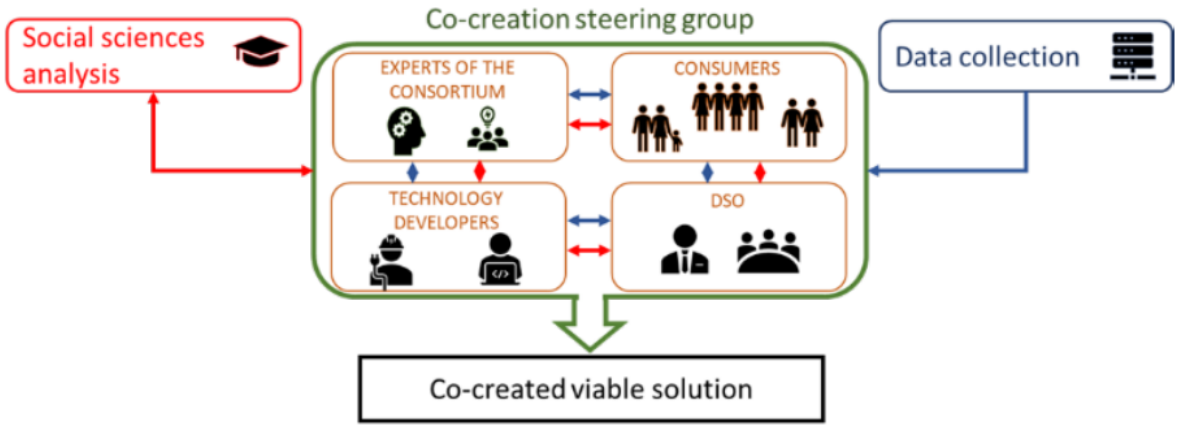

Figure 2 The co-creation actors and process

3.2.1 Co-creation steering group

The co-creation steering group (CCSG) gathers the main stakeholders of SENDER: technology and service providers, public regulators, and end-users. These stakeholders mainly represent the three demonstration sites chosen for the project: Alginet, Weiz and Otaniemi, and is composed of both

SENDER partners and external actors (see deliverable D2.1 for the list of participants). The CCSG gathered a first time in March 2021 and will gather several times throughout the project to ensure partnership with and insight from stakeholders of all the targeted audience.

The first co-creation steering group was dedicated to the definition of the use-cases of the SENDER solution. It was attended by ADEE, ECO, HPT, NTNU, VTT, WEIZ, SIN, TRIALOG, Väre and two end users from the Finnish demo site. This secured participation from demo sites, SENDER technology work package leaders, end users (partially), energy cooperative, DSO, and supplier. Representation of aggregator and consumer organization was missing.

First, demonstrators and stakeholders were presented, after which the technological solutions of the SENDER project was presented by respective WP leaders. The CCSG then matched stakeholders with solutions according to relevance, and in parallel sessions divided by demonstration site, a brainstorming session was conducted to further iterate use cases and relevant needs and concerns. Finally, an end user evaluation was conducted to review the final use cases and results from brainstorming sessions.

The stakeholders involved presented somewhat different needs and concerns. This means the SENDER solutions are of interest to them in different ways. Notably, in Finland, VTT has several testbeds for EV charging and V2G, and are mainly interested in how SENDER solutions can empower users with timely charge rates, minimization of electricity bills and maximization of renewable energy use. WEIZ was focused on piloting direct connections between solar PV installations and households and other buildings and have an interest in turning households into prosumers. ADEE and Alginet, with their 6000-user strong cooperative, was interested in energy efficiency, peak shaving and maximizing self-consumption. However, doubling as a DSO, they were also interested in forecasting, flexibility, grid balancing and congestion issues.

In response to the presentations of SENDER solutions, many concerns were raised, both from stakeholders, technical team, and end users. In relation to P2P trading solutions, challenges were identified relating to market regulation. The concept of digital twin especially raised some questions by end users, who had not heard about this before. Concerns related to details about information gathering, monitoring and privacy. End users were also somewhat concerned about their role vis-à-vis demand response solutions, and whether “responding” in this case would entail having to undertake any specific actions. Please note that the security and privacy aspects will be addressed in task 4.2, which purpose is to define and apply a security and privacy practice. A Security and Privacy Plan (SPP) will be created in each pilot to analyze the related risks and propose some measures to provide the necessary cybersecurity capabilities. Please refer to Deliverable 4.2 for further details. Furthermore, Deliverable 3.4, presenting the IoT package to be installed in pilot households, includes a Data Protection Impact Assessment (DPIA) to ensure the data security and privacy of final end-users at every stage of the project.

The discussions ensuing in the brainstorming sessions identified several of the most important needs and concerns of the CCSG attendees. Based on the recommendations of the CCSG, six possible use cases were made that reflect on the variation in stakeholder needs and concerns. Through follow up work with relevant stakeholders in the period following the first CCSG and to the release of this report, these were reduced to five use cases, the final iterations of which are described in deliverable D2.4. The four main use cases are described below, however the last use case, related to additional services, was left out due to the workshop format, constrained as it was by online attendance and time limit. This decision was also supported since many of the technologies that would enable the SENDER core solutions, like monitoring by motion and temperature sensors, automated decision making based on machine learning and the digital twin, will be discussed extensively in the main four scenarios.

3.1.2 Co-creation workshops

During 2021, a Co-creation workshop (CCWS) was held at each of the three demo sites with end users and some local experts (from technology/service development and energy sector) recruited locally. In Otaniemi, Finland, the workshop was convened in the spring of 2021 and gathered 9 attendees, 3 of which were experts. The Austrian demo, convened by Weiz in the summer of 2021 convened 17 people, 5 of which were experts. The Spanish demo, Alginet, convened in the fall of 2021 and gathered 20 people, all lay people. In total, 46 people were involved in the co-creation workshops, 9 of which were experts. The groups were also attended by WP2-leader from NTNU, one representative from SIN and one, sometimes two from TRIALOG.

CCWSs were recruited, convened, and organized by the local demonstration partners. Within WP2, four scenarios were crafted that summarizes the use cases described in deliverable D2.4. They describe in narrative form how the SENDER solutions might realistically enter the everyday life of households and forms the basis on which end user discussion and engagement is manifested in workshops. These scenarios were presented to end users in each demonstration site in online workshops. The online format was unfortunately necessary due to restrictions caused by the COVID-19 pandemic. The goal was to gauge acceptance of the use cases in their final iteration, and also to enable input from users and further facilitate the co-creation process. The sessions were held in the local languages and discussions recorded, whereby attendants provided their consent by staying in the workshop. Recordings were transcribed verbatim and translated by professional language experts. The resulting data was analysed according to country and references relevant to the analysis were extracted from the discussion transcript using nVivo and coded according to the four scenarios. This created a basis for the analysis, which is presented in section 4. The four scenarios and attendant follow-up questions which were employed by workshop organizers are presented here.

3.1.3 Use case scenarios

Scenario one, “Maximizing renewable electricity use, reducing cost and emissions”, described how with the help of SENDER solutions and faced with intermittent renewable energy sources, end users would be able to maximize renewable electricity use, reducing cost and emissions. In order to elicit responses about this scenario, questions were asked about how electricity was used and whether some of it was flexible, and to what extent users were interested in acting in order to synchronize consumption with local production and low prices.

Discussion and follow-up questions were asked, along the lines of the following:

- What are your main uses of electricity? Is this something that can be moved to other times?
- What if it reduces the network cost?
- Would you be interested in provided this service if it made it more likely that a larger share of renewables was used in a certain day?

Scenario two, “Building as a Battery (BaaB)”, was presented to examine the appeal of the Building as a Battery concept to end users. It introduced the building management system, it’s relation to the wider grid, and how it can provide flexibility services by employing the household as a battery, for instance by scheduling water heating to periods of the day when users are at work. Questions were asked to gauge the interest in users of relinquishing control over certain consumption to enable BaaB.

Discussion and follow-up questions were asked, along the lines of the following:

- Are you OK with these decisions being made for you?
- Even if you would not notice any effect?
- If not, would you want it to ask you permission every time? I.e., through an app?
- Will you need to know in real time and approve for each instance, or is it fine if you can just review it at a later time?

Scenario three, “Peer-to-peer trading”, described how peer-to-peer-trading would work in a neighbourhood, where the building management system once again made some decisions of how to distribute locally produced renewable power between houses in the neighbourhood. Questions were asked to gauge how users considered the importance of compensation for allowing their PV to power the houses of neighbours and feeding back into the grid, as well as interest in prioritizing electricity output from neighbours for their own use.

Discussion and follow-up questions were asked, along the lines of the following:

- Would you need compensation for putting the electricity you yourself cannot use back into the grid? (PVs can be an expensive investment.)
- What about providing your neighbour’s house with your surplus electricity instead?

- What if it was the other way around? Would you be flexible to make sure you consume your neighbour's surplus electricity?

Scenario four, "EV charging", presented a case where the end user arrives home to plug in their EV for charging, and a busy afternoon of household activity ensues, raising the aggregate demand of the household to very high levels. At the same time, the building management system is requested by the network operator to aid in alleviating grid congestion, and thus to start scheduling several demand instances in the household like charging, water heating, and room temperatures. Questions were then asked to gauge end user's sensitivity to the building management system acting on behalf of the network operator by rescheduling some demand (i.e charging, water heating, room temperature) in the household for short periods of time.

Discussion and follow-up questions were asked, along the lines of the following:

- What do you think about letting the management system take control of your indoor temperature for short periods of time?
- What if you come home, and the car is at 15%? You have programmed it to charge during the night to save money. Is this feasible?
- In general, how interested are you in being in control of these processes?
- What is needed for you to trust the energy management system to do it for you?

4. Results

The following sections present results from the workshops and the main topics from the discussions on each use case scenario in the form of verbatim quotes from workshop participants. Unfortunately, due to the online format and mixing of online and physical format, transcribers were unable to consistently assign statements to their owners. To remedy this somewhat, quotes are separated by designations indicating the country of the person stating it and a number indicating their place in the order of references for each topic, as they appear in the transcripts. The numbers are reused for new topics and may not indicate the same speaker. When a letter is added to the numbers, this signifies a conversation within the same reference between two people. It should also be noted that even though the headlines refer to the topics of the discussions that are referenced, some of the other solutions will invariably be taken into discussions where they are not the main topic of discussion.

4.1 Maximizing renewable energy sources

This use case scenario discussed how a household would be able to employ SENDER solutions to make sure they were maximizing the use of renewable energy sources, as opposed to not implementing any measures and simply consume whatever was available thereby increasing the chance of consuming fossil fuels. Of course, ideally speaking, mostly everyone was for this scenario. However, like evidenced by this Finnish participant, users may be wary of committing to any kind of flexibility or use-shift scenario without first getting a clear idea of the risk of inconvenience:

> Perhaps, with regard to the issue of affecting one's own use and distribution of electricity, I notice that a lot of people are open to the idea, and that's how I answered, too, but at the same time I also thought that the inconvenience related to this should be reasonably small, of course. If you can influence or affect the issue, but it doesn't require any process diagrams or reorganization, then it's an option that makes sense, but, however, the reality is that life is complicated and time is limited, so if it takes a lot of effort, it's possible that people will choose the option that is the easiest, even if it means a slightly higher electricity bill. (Finland 1)

Differences of opinion did arise once the idea of having to make changes in everyday routines and living. For instance, a regular way of thinking about this is to try to create a mental map over which appliances in the house that would be available to offer up in case it would be a good idea to postpone consumption, thereby increasing the chances of consuming from renewable sources. This Austrian workshop participant said the following:

> Just thought of the washing machine, that will probably be confined to just the washing machine, because I have to cook at noon when the kids get home. I can only charge my E-car in the evening when I'm back home because I'm on the road all day. The vacuum cleaner, which might run on its

> own, we'd have a chance there. The refrigeration for cold storage at home, it runs all day, I can't control anything about that. You might have a just few appliances (Austria 1).

This participant observes that many appliances are outside the range for flexibility, whereas some appliances and consumption could more easily be imagined as possible to shift. The discussions regarding this issue were similar in the Spanish workshop:

> […] it depends on what we're talking about. If we're talking about the water heater, I do see flexibility, but for example, if we're talking about the oven, a little less, because of course, you want to do your cooking when it's eating time. I do have some flexibility, but I think a little less. (Spain 2)

Sentiments toward this were quite similar in Spain, where discussions were strongly oriented towards convenience. On the issue of shifting consumption to accommodate for renewable energy consumption, a Spanish workshop participant had this to say:

> If it doesn't cause too many issues, too many inconveniences, then yes. If it were very inconvenient, then no. [subject asked to explain] I mean, if I'm taking the electric car and I have to choose whether to charge it now or later, if I don't have to use it within the next hour, it's all the same to me. I would wait until later. But if I plan to use it, I wouldn't wait and go out an hour later just so I can charge it when it's cheaper or when there's more flexibility – which is the idea. I don't know if I've explained it well. (Spain 1)

This is also related to the activity of showering, regarding which one workshop participant in Spain said that "*for me, even if the system tells me it would be best if I showered at X time, I would do it [regardless]*". (Spain 4)

One issue that was explored in the workshops was whether users would be interested in shifting consumption for the sake of correcting grid imbalances. People in general do not seem very familiar with such a way of thinking, and those who are vocal about it will tend to be negative:

> I would not reduce my consumption in order to reduce the load on the electrical grid. I don't feel like this is particularly relevant to me. For me the money part would be relevant. But on the other hand, these financial contributions are ultimately quite small in these, in one's electrical bill; at least for me, one thought I had was that I have to share is that, yeah, at least this remote working has improved the possibilities for flexibility because people are at home more. But before, there would not have been as many possibilities to be flexible with use of electricity. (Finland 2)

In general, some other topics discussed related to some facts of life which affect flexibility potential, like having kids and working from home or not. Furthermore, some users were in fact quite eager to have the kinds of capacities the SENDER solutions provided, and understood their potential easily for instance in the case of one pool-filtration and heating system:

> In my case, I have a pool filtration system that's programmed so that it turns on at night, because it's cheaper that way. And also, the water heater, I've programmed it so that it doesn't heat up the water at night. It's what you've been saying more or less, no? (Spain 3)

As evidenced by this quote, in some cases users are already practicing load shifting and self-curtailing, and they understand the reasons why this is sometimes beneficial. Conversely, in another statement, the system being discussed was perfectly suited for load shifting by SENDER solutions, but this time the user had trouble actually seeing how this could be load-shifted at all:

> We have direct electrical heating, so I have been wondering, since our heating bill in the winter is between 200 and 300 euros per month, can this be used to benefit us in heating in any way? Because, when the temperatures are below freezing, the heating must be on continuously. Can this system be utilized at any level for this? Because then in the summer, the heat is not turned on at all. (Finland 3)

This indicates there is some work to be done on some user's mental maps, which is something which may warrant consideration by the SENDER project in the implementation phase.

Finally, the discussion sometimes was related to storage, and how storage would indeed make the manual labor of load shifting less relevant, since renewables could be stored when produced and consumed at a later time: For instance, an Austrian participant had this to say about this:

> It's not just about turning on devices. One must also consider, does one only switch on a device when energy is needed, but maybe also to store energy. An energy buffer comes to mind. (Austria 2)

This might indicate a "solution" to the problem of inconvenience, and that providing the opportunity of storage to end users may be a welcome offer when the alternative is that they would otherwise need to load-shift manually.

4.2 Building as a Battery

An issue that was often recurring in a fashion similar to the first scenario dealing with load shifting and RES maximizing, was that of who would be in control and the degree of autonomy of the SENDER solution.

> It's becoming clear from the responses that it's okay for the system to make decisions for you as long as it does not affect your living comfort. At least not in a negative way. And then for the question regarding flexibility. There are answers in all directions. Some people would want to have

> to give their permission to flexibility, and others would prefer to give control to the service. (Finland 1 – supervisor)

In many cases, participants voiced a bit of skepticism toward relinquishing control to an automated system. This does not mean that they did not appreciate a degree of automation, however they would need to be able to set some parameters this automation would need to follow:

> You've said that the transmitter box has control over the system, but that the one really in control would still be me. So that I still control it, that I can say, okay in winter I'm home at 5 pm, and the heating system turns on at 4.30 pm. So, when I come home the garage is already well heated, and I don't have to sit at home in a jacket waiting until the heating system warms up. Because my digital twin knows when I usually come home. (Austria 1)

When discussing the topic of Building as a Battery, it became evident that most people do not distinguish the way this concept is manifested in life much compared to general load shifting and automation, similar to what was discussed in the case of maximizing renewable energy sources:

> For example, if you are going to drive somewhere and your battery is dead [in the case EV is an asset for BaaB] and it is necessary to charge it then this would not work in all situations you need to have the ability to override it in certain situations. So even if you let automation do the work you need to have the ability to override or bypass the decision. Or make settings for each device, so that this particular device can be controlled automatically but not the car; or it can depend on the day. (Finland 3)

Other people had no qualms relinquishing control in certain situations:

> It would be a possibility, you receive a suggestion, now is the ideal time to start your washing machine. And by doing that you save energy in that time span. I'm not there today, turn everything down or do whatever you want. (Austria 7)

Even so, the discussion went on to reveal that even this would not be perfect:

> Maybe I'll work 1-2 hours overtime and come home late, then it would already be warmed up. Great scenario. Despite having a cold, I still go to the office in the morning. I then realize it's not going to work out and I come home earlier, to a cold apartment. To what extent can I intervene so that it warms up relatively quickly, or can I not intervene at all? I should already have the control. (Austria 1)

Again, in a similar fashion to the discussion about convenience, some participants argued that if users deviate from routine, the SENDER system making autonomous decisions may produce inconvenience:

> There is no advantage at all, if I've already gone home sick and then my management system says sorry to me. But if the temperature is lowered to 18 degrees instead of 22 degrees, for example, that's pretty uncomfortable. (Austria 2a)

However, some users expressed a distinct level of optimism regarding what an ecosystem of smart home devices could accomplish together with the SENDER solution:

> That's exactly the discussion, I set the digital twin into action. It observes my environment and knows how warm or cold it is in my apartment. If I take this even further and say, now I also have a pulse watch, and this data flows into it, then the digital twin immediately knows that I'm not feeling well. (Austria 2b)

There is perhaps a slight indicator here of a possibility for inserting wearable technology and fitness monitors into the SENDER eco-system, thus producing something useful related to the health topic.

The discussion regarding the balance between control and autonomy was often developed into a discussion dedicated to how, in the case the user would be allowed any measure of control, this would be brought to bear on the SENDER systems. One respondent was asked how they would like to control the system, and answered like this:

> I don’t know, some kind of application. It doesn’t matter to me, really. On the other hand, I would like to have something on the wall, because I hate the fact that everything is an application nowadays and you always need to have your phone with you, and you always need to be looking for it. Furthermore, if it were on the wall at your home, it could be both as an application and some gadget on the wall at home. And if you need to make some adjustments then even the children would be able to use it. I'm not sure how much this would affect everyday life but what I was thinking about was this is this would only be controlled by adults otherwise. On the other hand, I don't know where children would need to use it. But if you get a babysitter for example grandmother and if you were somewhere else then and outside it would be able to adjust those things Without you having to be involved making adjustments regarding something like the washing machine or something. (Finland 4)

A number of concerns is evident in this quote, which seems important to users, especially one that is somewhat experienced with technology use. Firstly, the phone does not seem to always be an ideal medium, since it is not always carried along with the users, and the user suggests the system should be able to be manipulated by people who are not “on-boarded” and where the installing of apps and creation of user accounts and sharing of passwords would not be ideal or desired, such as children, babysitters and other visitors. The solution suggested for this is something mounted on the wall that can be used to monitor and input simple adjustments by users other than the “administrator”.

Furthermore, the discussions touched upon how users relate to what actually happens in the home when control has been exerted on the system. In other words, the system should not only cater for a level of control, but also provide a means of monitoring the effects of input:

> It should have some default settings but nevertheless you would be able to watch what these selections mean in practice, and you would be able to change the parameters if you wish. But I agree with the majority here that real-time tracking is a little difficult. I don't think it makes sense for it to be beeping in your pocket all the time or having a device making noises on the wall of your house, but it would be nice to be able to modify or adjust settings as you… To see the effect of a setting after using it. It would be nice to be able to adjust them afterwards. (Finland 5)

Another issue which is touched upon here is that "beeping in your pocket" at all times of the day is something users are not interested in, and that a monitor system should not be invasive or obtrusive in any way. A level of discreetness to the way in which the system attempts to attract the attention of users for inputting some decision to load-shift or not, seems desirable.

Moving along the spectrum of this issue of the attention of users, it needs to be mentioned that some of them were also very sceptical about being involved in matters of the energy consumption of their home and appliances at all. This person, for instance, was worried that having to have to deal with building management technology like the SENDER solution was becoming obligatory in the future, and wondered whether it was possible to opt out of it all:

> Sorry can I ask, do you think is it inevitable that this flexibility thing will interfere like our normal life of normal people at some point at some level anyway or can it be so that these things will be handled automatically completely one way or another so that only the people that are really interested in these kinds of benefits economic benefits or climate change and possibilities to affect those things would have access to make decisions in regards to these flexibility things or is it inevitable that all of us will become used to having control of these things and you know so on? (Finland 6)

This indicates that for some people, spending a lot of time and attention on a energy management system at home would be for the specially interested, and that they would prefer this to be automated as much as possible. Again, this is reflected in the following quote comparing home automation with investing. Again, it comes down to making some simple decisions based on some information at a certain point in time, and then allowing oneself to "forget about it".

> Well, it's hard for me to believe that I would ever be so interested in those decisions as an active player in such a way that it would intervene in my daily life with all its questions. It's like in investing, in my opinion, even though there is financial gain that can be obtained, and the more time, effort and learning you put into it, the more you can get, I would nevertheless prefer a passive investment strategy, in which I go ahead with safe selections, and it doesn't affect my daily life, except... As a point of general interest, I would learn where I could save electricity or what things I

> could earn from, and then learn about those and think, ok, do these suit my use profile, so to speak, and then make some individual active adjustments, or take the control into my hands in some certain category, but for the most part, I would prefer that the technology and intelligence be so good that I could be confident that 80% of the optimization would occur without regard for my active action. (Finland 2)

In the case of this person, it seems their ability to conscientiously forget about these issues, is down to being able to trust the system to optimize at least up to 80%.

For other people, the concept of a system autonomously controlling one's home also gave rise to some concerns about cybersecurity, and what would happen if for some external reason, like a disaster, a user's influence over the SENDER solutions would be incapacitated:

> Another topic, worst case scenario what happens in case of power failure, a complete global failure? Is there blackout protection? Can the devices be accessed even in these instances? Is there a security system for the Sender-box? Perhaps I have young children or a vulnerable person in my care, I need warm water to wash them. I would be interested in that. How would that work? […] Exactly, the question was, am I then autonomous? Can I still control the whole thing individually as a household, in some way energy efficiently? Or does it have no advantageous effect for me and so I say, okay, I'm just like everyone else with no electricity. (Austria 4)

The issue of even the physical protection of the box itself was important for some, likening the SENDER box in charge of one's electricity system to a safe containing valuable:

> I'm very cautious about Cybersecurity. Namely, how is access to the transmitter box regulated, how strongly is it secured, how easily can I get in there? Do I keep my Sender-box in the garage or somewhere with a door that is open all day? Or do I encase it in concrete? (Austria 3a)

> If an external person could access it and make it cold in your house, it shuts down and nobody knows why. Of course, that must be secured and monitored accordingly. (Austria 3b)

Finally, a large part of the discussions, primarily in Austria, were dedicated to how the SENDER system connected to the house would relate to an island scenario, and security of supply in the case of a blackout.

> Then we will be assisted by the Sender-box, that means the transmitter gets a signal and now I switch to emergency mode. That means I'm taking myself off the grid and the transmitter box automatically accesses my private storage and I draw my power from there until the public grid is back up. And the advantage of that would be that there really is blackout protection. With these transmitter boxes, we could potentially reduce the interconnected energy communities to the point where one source is enough for many. (Austria 5)

This was mentioned elsewhere as well, as some users exhibited a competence in this area, for instance in the case of this person who was already using solar PV to power the water heater and was on a mission to use locally produced RE to make them energy independent:

> I already have solar panels installed for the water heater, but I was thinking of installing them also for the overall power supply, so the whole house runs on solar power. (Spain 1)

It is also worth mentioning that the discussion sometimes went in the direction of demanding solutions of the kind that the SENDER project is already pursuing, and which is more extensively covered in the next topic on Building as a Battery. For instance, one participant recommends this course of action:

> Has there been any thought given to modelling behaviours within a single community and taking advantage of this in the optimization of its own electricity production and consumption? For example, if one family in the neighbourhood has a traditional daily rhythm and another family that works late Into the Night Could the consumption of the electricity produced be automatically evened/balanced between these example families? For example, if both families have solar panels, but they produce electricity between 9 am and 8 p.m. One of the families consumes electricity from the panels between 9 a.m. and 2 p.m. and the other family Uses electricity between 2 p.m. and 8 p.m. And if there is need for additional electricity it would come off the public grid. (Finland 7)

In general, the concept of BaaB caused people to have quite differing opinions and have discussions focusing on the balance between their own control of their house and the autonomy of SENDER solutions. Paradoxically, even though a level of control was desirable, interacting with devices in order to respond to notifications and manage settings seems less interesting to users. A universal solution that could be used by visitors and children was also desirable. Overall, an option to override automation seemed important, but a golden rule, according to one user, is an optimization of about 80% of resources by automation.

4.3 Peer-to-peer Trading

The discussions around the topic of P2P trading and the digital twin was characterized by some positive sentiments by participants but also caused them some confusion and the discussion would often revert to rounds of questions being asked to conveners. This could be an indicator that the concept in this scenario due to its cutting-edge nature, is something most end users have little knowledge about. Even so, people argued warmly for sharing electricity between neighbours, which in and by itself is a rather simple concept in theory, but that gets very technical in practice. This is a quote that shows some of the confusion which arose:

> There is nothing more senseless than feeding the surplus electricity into the grid for many reasons, among other things. Also due to the question, whether the net in this capacity can always compensate. That means if I can decentralize using the electricity and pass it on directly to other households, without feeding it into the grid beforehand. I feed it into the net before, that probably contributes to network stability. On the other hand, surplus electricity, why should I not make it available to the neighbours? Whether it is regulated, or over the net. (Austria 1)

As is apparent in this quote, a mix-up quickly arises when discussing how trading electricity between neighbours works. Often the participant will prefer sending the electricity directly to the neighbour, bypassing the grid. But, we may see a situation where the electricity will need to travel the grid to get to the neighbour anyway. Many participants would focus on how p2p sounded complicated:

> In my opinion this sounds complicated. To start selling to your neighbours. And maybe, in general, there are so many different levels of technology users. Would there be enough people who would participate? Maybe it would be easier to just sell back to the grid. There would have to be a lot of solar panels to have a significant economic impact. (Finland 4)

This participant has a sense that involving other people such as neighbours in a straightforward affair of electricity trading with the grid will complicate things. Indeed, this sense of complicatedness is also apparent in the following statement:

> [Participant] Wouldn't that also provoke conflicts? If you promised me that I will have so and so much savings if I join you, and then I do not get as much as promised, because you consume it yourself? […] the costs, there will probably be connection costs too, for these connections that have to be made?
>
> [Expert] No, it goes through the public grid. No direct line, in between there are public power poles.
>
> [Participant] Oh, then I understood it wrong. I thought it was directly connected. (Austria 2)

Furthermore, in some cases it was quite clear that some of the participants were completely unable to see the point of P2P trading at all, given that the contributions of electricity this would provide would be negligible:

> And for me it's a little bit difficult to understand why we are even talking about such small units, talking about such close parties, such as neighbours etc. What is the meaning or significance of this? Is the point here to think that, psychologically, it would somehow be more pleasant to sell and buy from your neighbour? What is the idea behind this? To talk about someone familiar to us, as a party to a transaction? Is it a question of physical proximity? Is there some significance in terms of this technology? (Finland 11)

It was not always easy for experts and workshop conveners to answer these questions succinctly, so the discussions often revolved around general conceptualizations of how P2P can be implemented, ultimately provoking even more questions. In some cases, *many* questions:

> I've also imagined this model with the highway. Have a nicely developed highway, but the roads leading to it may be gravel roads. To what extent has that been taken into account? This is question number one. Question number 2: what is the legal situation? There is a change of tenant, for example. So, I assume that I do not necessarily have to be the owner of a house, but I can also be a tenant. What if someone dies, a whole new tenant comes in, what happens then? Do I have to pay costs, or am I obligated to participate in their renewable energy? Must I also attach solar panels to my house. That was three questions actually! (Austria 3)

This participant sums up just a few of the questions which would serve to bring across the feeling of inquisitiveness and somewhat scepticism that this whole thing would be too complicated to even know where to begin. The above quote related to legal matters, but of course there are technical parameters as well, further adding to the strain on grasping this concept. In these cases, the debate would circle around how electricity would be traded in practice between neighbours:

> Have you thought about these kinds of models in which the electricity would be transmitted within your neighbourhoods grid and in which everyone would have a storage of solar power and you would share the energy in a specific order, or would the idea be that you would engage in trade between your neighbours? (Finland 2)

The discussion would then revolve around "the logic of trading" and attempt to resolve whether people would engage in trade in practice, or if it would be more like a system based for instance on blockchain, measuring and monitoring the trade or sharing of electricity between the neighbours, automatically transferring from one house to another house and the blockchain constituting the bookkeeping between trades. Even one of the experts would get curious about what this would look like in the future:

> There was a question for me that have we been thinking in our Sender Consortium about peer-to-peer trading, that is it going to be based on a marketplace where you could trade with electricity or is it more like blockchain technology such that the allocation or trades are automated events and the blockchain technology only keeps track of who has given what and who has received what. So, do we think that in this scenario the trading would be somewhat active […] or would it just happen automatically, and the technology would only keep track of what has been happening? (Finland 3)

These kinds of questions produced discussions between experts and users that indicate that the experts in this case were not far removed from the users, as can be seen in this exchange:

> [Participant] Apart from that, the question for me is, if there is only one producer and 3 consumers, how do I regulate it? What if there are 3 producers and 1 consumer? Who supplies the consumer and on what terms? Are there privileges on electricity supplies when it's sold?
>
> [Expert] That will also be clarified, because do I have to take it or can I also say, I don't need it right now! That also still needs to be thought about.
>
> [Participant] That was exactly my thought! (Austria 4)

When discussing the positive aspects of the P2P trading scenario, participants would sometimes point to the societal benefits of sharing between neighbours, and how "short-travelled electricity" would be resource saving. This is exemplified in the following statement made by an Austrian participant:

> It would also be resource saving to join forces with the neighbours in pairs, to join together. Only one builds a PV plant, somewhat larger, both neighbours install a small 5kw unit or connects themselves perhaps to a larger system and rent a module or obtain the electricity from there, rather than that every single-family house in Austria has to install a PV system. It would be economical and resource-saving. (Austria 8)

In general, these kinds of statements were numerous in the Austrian context, possibly due to its rural geographical context compared with the other two. This perhaps also ties in with the discussions on some of the other topics, where Austrians again were considering how SEDER solutions could help with going off the grid and even serve as blackout protection.

Also, similar to the other scenarios, discussions often would return to the ever-central topic of convenience. Mainly, in the context of P2P trading, if trading electricity with your neighbour is experienced in the same way as in the conventional context, selling to a neighbour would be all right. If it was equally easy, it would make no difference:

> Do you feel like there would be any significance as a matter of principle whether you sell to the grid or to your neighbours if it is equally easy? In that kind of case, it wouldn't matter. If it would be equally easy to me either way it wouldn't matter. (Finland 5)
>
> […] Perhaps the main point of these comment is that convenience is gold. If you don't have to think about your neighbour's schedule, or how you will share electricity with your neighbour, but would instead be able to get rid of your own surplus, and getting the maximum benefit of it, maybe that would, after all, be the preferred/favourable option. (Finland 13)

One thing is the experience or, rather, the non-experience of P2P trading. Another topic that was discussed was of course that of cost, money, and settlement practice. Some users were quite "philanthropic", like this one:

> Yes, I would be interested. If I had solar panels, I would either give the energy for free or I would sell it, depending on the neighbour's needs, on his current financial situation. And if I didn't have solar panels, I would buy it from the neighbour. (Spain 1)

However, when it comes to money, the majority would prefer to sell their surplus electricity to the highest bidder. Selling to the neighbour was out of the question if the grid would pay better. However, both being equal, the neighbour was in fact preferred.

> The truth is, if I buy it for 10 and then I sell it to the provider for 1, I would also sell it to the neighbour for 1, the same price the provider would pay for it. I would want to get the same price I get from the provider. I wouldn't be that… philanthropic. […] If it were the same price, I would prefer to sell it to him. Yes. And my idea would be to go to a cooperative for co-generation of electricity, but maybe that would be a little more ambitious. (Spain 2)

In the case of Spain, the participants would rather talk about energy cooperatives than communities than P2P, as cooperatives were perceived to be a desirable thing to have among participants in order to save money and secure independence from retailers.

> Sorry for being annoying, but this is something I had contemplated more than once on a personal level: doesn't the cooperative have a financial interest in promoting these types of things a little bit? Because surely the energy I generate will be cheaper for the cooperative than the one it must buy from Iberdrola or the energy provider company, which could be beneficial for all members of the cooperative. And even further than that, which would be a more ambitious step, [wouldn't it be beneficial] for the cooperative itself to hire the workers and buy the solar panels so that it's cheaper for everyone? (Spain 4)

The concept of energy cooperatives seems to be important in Spain these days, and when discussing P2P trading, in the minds of participants the two would quickly eclipse.

Some respondents were worried about petty conflict about money with neighbours, and thought the faceless grid a good idea neighbours are dealing with a neutral actor or player and not dealing with each other even if would cost a more, but they would be a neutral party in between who would manage all the agreements:

> This is an interesting topic and even difficult to think about. I haven't even considered this before. It evokes many thoughts. In some way, the practical and technical capability aspect is interesting, but maybe what I think about is the social psychological aspect, the idea of a faceless grid might be easier because of how small of matters can create disputes between neighbours, and why there are boundaries between building lots. What I am thinking is that in these kinds of questions, there is not necessarily any limit to how petty people can be. So, if there are new extra neighbourly relationships on top of all of the existing arrangements, It may depend on the community how well neighbours get along with each other, and, In general how much they want to deal with other. (Finland 6)

Finally, when the relationships between neighbours were settled, and the many questions about the practical and legal aspects of P2P trading went unresolved, the discussion would gravitate toward people agreeing that this whole thing was weird, pointless, but not objectionable if it did not cause inconvenience and quarrel among neighbours, and that probably this whole concept, if implemented, could not exist at all except if people had nothing to do with it:

> […] but in my opinion, this is about the technology built in the background, or how regulation will change. I don't see these as becoming relevant questions to the end user. (Finland 12)

4.4 EV Charging

The topic of EV charging and its role as an electricity storage asset at the household was discussed last, and due to this fact, many of the concepts, sentiments and ideas about smart charging overlap somewhat with the general idea of a smart, automated house. And so, it is evident that many of the notions being discussed when it comes to the other scenarios, also apply here – in a way, the car is just another appliance. The idea that the car is not being used all the time, and that especially at night, it can charge whenever, if it is ready for the morning drive:

> Maybe one thought I had was that if we are talking about delaying the charging of an electric car, is there some automation, so that if I plug it in in the evening and need a full charge by morning, and it recommends that the car should start charging at three a.m., will there be some kind of automation which would initiate the charging at that time? Do you know what I am trying to say? Will it be possible to automate it, so that it can be delayed, so for example, if I don't need something right now, like wash my clothing immediately but within two hours, can this somehow be automated? (Finland 1)

In the quote above, the user expresses a clear motivation to participate in demand response and make their EV available for this, and they are comfortable with the idea that they do not need their mobility at all times and that especially evening and night-time has flexibility potential without causing inconvenience. One participant, talking at some length, indeed overed a range of issues with EV charging, indicating how this is actually more or less integrated in the overall demand response mechanisms in the home.

> But as stated before, it is a very individual decision and I have tried out energy management myself, at home with the family, when I've said to my wife that we should time the laundry differently. She said the way she wants to do it is when it feels right. So, you see; certain things can be influenced, but certain things are not so easy to control in an automated way, due to personal habits. (Austria 1)

The participant goes on to admit they recognize the role of these scenarios for the climate transition objectives that are on the horizon for the long-term future, especially in terms of using cars as electricity storage:

> On the whole, it has to be said that this scenario is nevertheless a very important one. The energy turnaround, the further expansion, the forced expansion with our goals for 2030, 2040, 2050 that exist in the long term. It has to be said honestly, we will only be able to cover this by including electric cars in addition to the expansion of energy generation. If you now look at the increasing registration figures, due to the incentive subsidies, etc. This means that these energy storage systems in cars are an essential link to energy transition, so that we can coordinate generation and consumption with each other. But as I said, everyone wants to have an energy management system, whether local to their home or higher level. There are already too many systems where everyone wants to have sovereignty and control. I see this as a problem. There will probably have to be a return to basic possibilities. (Austria 1)

It is, however, worth noting what is mentioned last in this quote, and which does resonate with the discussion around the peer-to-peer trading scenario above: certain aspects of the smart technology development are potentially starting to get complicated for some people.

Even though we could say the EV is just another appliance, the question of being flexible with one's mobility nevertheless sparked some of the most controversial statements as compared to the other three scenarios. First, we have the standard objections voicing scepticism and concern about inconvenience, like in the following quote:

> I understand that. You must hang up the laundry, there are logistics behind it, especially if you work. When do I wash, when do I hang it up? If you have several children in the household, it is not so easy. One person needs the computer, the other something else. First you must get into a routine. (Austria 2)

But in addition to these somewhat mild concerns, more strongly voiced objections came up during the discussion of allowing flexibility into the realm of mobility:

> I could comment on this, until now, the examples have been about insignificant personal sacrifices, something that does not require any kind of active thought, or giving anything up, but this borders on my comfort zone, it's possible that there is no need to use the car, but the idea may, nevertheless, be upsetting in principle, because you never know when there is an unexpected but essential need to travel, and you have the extremely expensive car in the garage it would seem silly or foolish not being able to use it to the full extent. (Finland 3)

This comment is quite dense, and touches upon several issues which could potentially have an impact on EV charging flexibility. First, it shows that the mere *idea* of not being able to take the car out when one might like (or need) to might be sufficiently off-putting for flexibility to be rejected here.

Somewhat differently than, say a washing machine, the need to go driving may instantly present itself, while laundry obviously is less prone to instant emergencies and more part of long-term routine and planning. A second point this comment raises is the fact that the car is an expensive asset, and so the "ownership" of it may be too strong to allow a person to "share" it with the grid. But, again, some people can see a compromise here, indicating that at least one does exist in many cases:

> I myself thought that it depends on the car. But for example, my car has such a big battery that even with 15% charged I can go 50 km which should be enough for me, and I think that's enough to go to the store for example. You hardly ever must take a long trip unexpectedly, and if the family has two vehicles are they both going to be electric vehicles? For many people it won't be, at least not for us. So, you could use the other one. And so, it wouldn't be necessary to use the electric one. And you could set the system so that if you have an unexpected need to travel you could tell the system to that you need to go somewhere in an hour, then you could interrupt the flexibility and allow it to charge, or something. How quickly do you have a need to leave immediately? (Finland 5)

Clearly some people can see a compromise, but it is worth noting that it depends on many contingencies: planning, big batteries, short distance to store, two cars, etc. Another, similar statement, also covers a rather long list of contingencies for V2G flexibility to be acceptable:

> For me, if I can be sure that I'll have the service when I need it, that is, that I'll have the car charged when I need to get to work, if the system can prove to me that it's reliable, then I would allow it to manage it automatically. […] if it ensures that at 8:00 a.m. the car is charged, or that I have hot water when I want to shower at 6:00-7:00 a.m. before leaving the house and at 6:00 p.m. when I get back, well then, it can do whatever it thinks best or what it wants to do. There's also an intermediate option, that it doesn't make all decisions on its own, but it also doesn't need to ask me about everything. (Spain 1)

Again, and like what was discussed in the previous topics, a lot of flexibility and control to automation could be given by some end users, but they have a long list of parameters which must be obeyed, in this case related to routine-based activities and time of day. In any given scenario, a lot of consideration would need to be given to how users can easily input and control these parameters.

Furthermore, the discussions show that even though people may be positively inclined to allowing their car to act in a V2G capacity, this would of course require them to leave the car in the driveway:

> There was one sentence which mentioned so-called V2G or vehicle-to-grid, in which [the SENDER box] even considered whether it should discharge the car battery and use it to cover the house's electrical consumption. […] I don't have anything against it. The only problem is I don't have an electric car. But in the future, it would be a good solution. To store the electricity in it during the day. But the only issue is that the car would have to be in the yard during the day, that's probably the only problem. But a good solution in my opinion. (Finland 7)

So, even though being positively inclined (and not owning an EV), the main problem here would be to have the car present, which of course for most people is not an option if they need to go to work – unless, of course, the work is at home:

> This is not very familiar to me, I have heard some bits and pieces from others, but I'm not very familiar with it. For example, how it would work in practice. But I see it as a possibility. For me for example I always work from home now, so my car is always in the yard. (Finland 8)

In summary, the discussion on EV charging and V2G has given evidence that many people are quite sceptical towards this because it infringes on the experience of mobility given to them by a costly investment into the expensive (and delightful) asset that is their car. A lot of people are willing to compromise, but this is dependent on both physical contingencies, like battery size, local geography; and routine based activity, like when they need to shower and go to work.

5. *Summary of findings and next steps*

The following is a summary of the findings, presented in short bullet point form. In general, it can be noted that much of the input from end users are based on faulty assumptions and, as discussions were semi-structured, some use cases belonging to certain topics would find their way into other topics. Even though comments and discussions sometimes were based in incorrect assumptions about the SENDER solutions, they should not be dismissed as they give the SENDER project valuable insights into what users do *not* understand, and where attention in the continued work of SENDER will need to be given to the learning processes as the project advances to the implementation phase.

4.1 Maximizing Renewable Energy Sources

- High support among most participants.
- However, users will be wary of committing before they have a clear understanding of the risk of inconvenience (even if there is none).
- Users will operate on a mental map of which appliances have flexibility potential, and which do not. These should be the focus of enrolment and implementation phase in SENDER.
- Such mental maps also contain which routines (i.e., washing clothes, bathing kids, making dinner, charging EV) have flexibility potential and not.
- Engaging in demand response to “help the grid” (i.e., alleviating congestion) did not resonate strongly in discussions, and tended to receive negative comments. Monetary and environmental arguments are more relevant.
- The concept of storage was popular and seen as a solution against inconvenience of load shifting.
- This indicates the mental maps of users can be expanded to also include this, often less intuitive, concept of load shifting, not only limited to battery storage, but also to thermal (water/space) storage and the concept of Building as a Battery.

4.2 Building as a Battery (BaaB)

- Users would be concerned about the relationship between user control and autonomy of the SENDER solutions that is posed by this concept.
- When discussing BaaB users generally had a very wide repertoire of opinions, from positive to negative.
- This indicates that for users to be able to accept the concept of BaaB in everyday life, this requires negotiation with the system about the level of autonomy and control.
- Quite simply, users will not accept anything less than ultimate control, even though a level of autonomy can be given to the system based on negotiations.
- Users will allow control over certain appliances to be relinquished most of the time, but the desire to have an override option remains strong.
- The reason for this is that even though routine is strong, once in a while something will happen (i.e. sickness, emergencies, etc.) which will require an override.

- Paradoxically, even though users were not so eager to relinquish control, neither are they eager to have a system in their lives that requires them to respond very often to requests and notifications.
- Some were interested in a central screen on the wall in the house, which did not require logging on so guests/children would be able to use it if necessary.
- Having it on the phone and "having to carry it around" and respond to "beeping in your pocket at all times of the day" brought on negative sentiments with some users.
- Users were interested in having some way of being aware when and which kinds of decisions were made by the building management system.
- Some users were worried about having to "engage too much", and that if they were less engaged, they miss out on for instance economic benefits. This indicates a "set and forget" mode for the less engaged users should be made possible, to make sure they do not feel robbed of benefits.
- As a rule, one user mentioned that 80% of optimization should be done automatically.

4.3 Peer-to-peer Trading

- A topic which was overall connected with mild positive interest, some curiosity, and quite a bit of confusion.
- People have many questions regarding P2P trading, spanning from legal aspects to practical matters of sharing connections (as opposed to trading via a legacy market) and settlement.
- This topic was considered in the most positive terms when it was described as the option to provide neighbours with surplus electricity.
- P2P trading was considered a way to avoid sending it back to the grid and the electricity supplier, thereby "robbing" them of a trade.
- For this reason, users were most positively inclined to a P2P network that directly connects neighbours.
- As evident in the above, many ideas and connotations that people have about P2P can be far removed from the reality in which it is to be employed by SENDER, and this will require a highly developed and focused messaging for them to not have the wrong idea.
- In general, P2P trading as a concept creates a lot of confusion with almost all respondents.
- Some were concerned that P2P would cause neighbours to become "business partners" and that this could make relationships in the neighbourhood more complicated; it is better with the "faceless grid".
- Some people were completely against P2P, and considered it a rather useless concept, mainly due to the small amounts in question.
- Some concern was also noted here in relation to how much time and effort this trading would require, or if it was automatic; the latter option being the preferable one.
- Ideas of short-travelled electricity, prosuming and islanding was popular within Austrian discussions. Spanish discussions focused on energy communities as cooperatives, a way of cultivating stronger independence from central energy suppliers.
- Selling to neighbours was only preferable if the compensation was at minimum the same as selling to the grid.

4.4 EV Charging

- In many ways, the car is just another appliance, and can be considered another asset in the portfolio of household appliances.
- Like the case of appliances and control/autonomy discussion from the BaaB topic, there is a need with most users to clarify the role of the EV as a DR asset through an initial negotiation to set some ground rules.
- In general, users are comfortable with the idea that they do not need their mobility at all times and that especially evening and night-time has flexibility potential without causing inconvenience.
- However, some users considered everything up to this discussion "insignificant personal sacrifices" but would draw the line at relinquishing control over the "extremely expensive car in the garage". This indicates some users have a different relationship with their car, and this may cause a lower flexibility potential in these cases.
- Most users were more pragmatic, however, as one hardly ever must take long trips unexpectedly.
- Users would be OK if they had 15% to go to the store unannounced and had the possibility to override in the event of planning longer trips.
- EV flexibility is connected to many contingencies, like ability to plan, battery size, distance to work, store and other facilities, number of cars.
- Routine-based activities (work, showering, etc.), time of day and work situation would also influence EV flexibility potential.
- Participating in V2G was considered difficult if the car was not in the driveway during the day.

4.5 Next steps

This deliverable has consisted of a summary of findings from the co-creation workshops in the SENDER project. End users were enrolled into the co-creation process by the help of the use cases developed in D2.4, and user engagement about SENDER solutions were secured by exposing them through semi-structured discussion in workshops to descriptions of these solutions in narrative form as they would appear in an everyday life setting of a household equipped with the SENDER solutions.

The result was 5-6 hours of engaged discussion about these solutions, and the provision of a sound empirical basis by which insights from users can be leveraged in the continued work in SENDER. The next step will be to evaluate these findings in the second co-creation steering group (CCSG) meeting, slated for early fall of this year. This will ensure insights herein will be carried over into the definition work packages (WP 3-4) and technology development work (WP5-6). Work in WP2 will then continue towards deliverable 2.3, which will be based on this deliverable and provide a detailed analysis of the results herein as well as the final conclusions from WP2 and the co-creation process.