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Integrated local energy systems (EIs)

RENergetic

Community-empowered Sustainable Multi-Vector EIs

Project Nº 957845

D2.1 - Preliminary evaluation of EI community and co-design implementations

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Executive Summary

The preliminary evaluation of EI community and co-design implementations is intended to provide a coherent summary of approaches to communication, information, and interventions to shape communities within Energy Islands, with an emphasis on behavioral and psychological perspectives. Therefore, this document includes theoretical considerations and lessons learned from previous research, as well as a practical approach and initial experiences gained within the project. The main goal of this document is to provide recommendations for structured stakeholder engagement, to classify them from a psychological perspective and to describe as well as evaluate previous co-design activities in the project.

In the first section, the focus is on analyzing the motivators and barriers of key stakeholders. First, the relevance of the collective approach and social identity as an important element for pro-environmental behavioral change, acceptance of technologies and motivation for community participation in an energy island is highlighted. Then, we analyze previous research approaches for Demand Response systems in households (including heating) and for electric vehicle use, as these technical approaches are central for RENergetic. From this, we derive recommendations for incentives and communication approaches in the pilot sites. To validate the theoretical results and to classify motivators and barriers in the specific stakeholder context of the pilot sites of REnergetic, the results of semi-structured interviews are summarized afterwards.

The second section deals with the economic valuation of the needs for local stakeholders. For this purpose, we present the strategies used to identify business needs of local stakeholders and the economic value these stakeholders put on the quality of their living and working environment. This leads us to the concepts of “economy of quality”. We explore existing measures for this concept and suggest future approaches concerning the economic needs of local stakeholders.

The third section then focuses on the concept of energy hubs. Here, a hybrid approach is pursued within the project, which considers both physical and virtual aspects. For the physical aspect, we present our developed concept of the physical installations: theoretical background, concept development and requirements are used to propose a RENergetic approach for such installations as 'Energy Hub' meeting spot. This is complemented by the presentation of the virtual component: For this, we eloborate our recommendations and collaboration for digital communication with WP3.

Finally, the last section displays the implementation of concrete interventions and co-design activities within the pilot sites with the project partners. Here, we present the heat DR trial conducted in Ghent and discuss its first results and conclusions. Furthermore, we describe the implementation of an ‘Energy Vision Game’ in Segrate and a summary of the results is presented. We also outline a recently developed study on the acceptance of heat DR, which will be surveyed with a representative panel. Subsequently, we sketch ideas and concepts for further pilot-specific (e.g. implementation of a heat DR trial in Poznan) as well as project-wide interventions.

The objective of RENergetic is to demonstrate the viability of so-called “urban energy islands”. Energy islands seek to achieve the highest possible degree of self-sustainability with regards to the supply of its energy demand, be it electricity or heat through local renewable resources. At the same time an urban energy island may offer ancillary services to the public grid surrounding it.

These islands place the consumer at the centre of the energy transition, giving them an active part in energy communities capable of producing their own energy, sharing the surplus with the rest of the public grid and optimizing consumption. RENergetic will demonstrate that Urban Energy Islands increase both the amount of renewables in these areas and the energy efficiency of local energy systems. RENergetic will demonstrate the viability of this energy islands in three site pilots, each of them of a different nature: New Docks, a residential area in Ghent – Belgium, Warta University Campus in Poznan, Poland and San Raffaele Hospital and its investigation and research campus in Segrate-Milan, Italy. The impact of the Urban Energy

Islands is assured as technical, socio-economic and legal / regulatory aspects are considered while safeguarding economic viability.

RENergetic will be carried out over the stretch of 42 months involving 14 European partners: Inetum (Spain, France, and Belgium), Clean Energy Innovative Projects and Gent University (Belgium), Poznan University of Technology, Veolia and Poznan Supercomputing and Networking Center (Poland), Ospedale San Raffaele, Comune di Segrate and University of Pavia (Italy), Energy Kompass GMBH (Austria), the University of Mannheim and the University of Passau (Germany), University of Stuttgart (Germany) and Seeburg Castle University (Austria).

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Table of Acronyms and Definitions

Acronym	Definition
EI	Energy Island
EV	Electric Vehicle
DR	Demand Response
PEB	Pro-environmental Behavior
PEV	Plug-in Electric Vehicle
PI	Physical Installations
PSoC	Psychological Sense of Community
RCT	Randomized Control Trial
UCC	Utility controlled-charging

I. Introduction

I.1. Purpose and organization of the document

The aim of this document is to provide an assessment of the energy island communities and collective actions along the different tasks of WP2 together with the pilot project. This assessment is based on literature reviews, co-design activities with project partners, and field research conducted. The document will serve to summarize the contribution to pilot-specific stakeholder understanding and provide insights on how to inform and include household and community members. We will also describe and evaluate the approaches and measures already implemented and/or developed as part of the project. The goal of all described approaches is to enable community development on energy islands and to give scientifically and experientially based recommendations from a psychological perspective. To this end, we will provide an overview of the contributions to the different tasks in WP2.

First, in **II.1.**, we present the theoretical foundations for the implementation of concrete actions in RENeregtic: For this purpose, experience from research will be drawn upon, focusing in particular on the components relevant to the project. Results of these studies and recommendations will be summarized, and transferred through a first analysis in the context of the pilot sites themselves: For this, we discuess the results of semi-structured stakeholder interviews on the acceptance of relevant technological concepts in **II.2.** These considerations reflect Task 2.1 In the following section **III**, reflecting Task 2.2, the approach followed in WP2 for the evaluation of economic stakeholder needs is presented and we outline future implementation possibilities.

The two following sections will then focus on translating the previous results into actions within the pilots (Tasks 2.3, 2.4): Section **IV** focuses on the concept of Energy Hubs, looking at both the physical and virtual communication side. This is followed by section **V**, describing the co-design activities that have been implemented and planned together with the pilots: both interventions that have already taken place and their results are discussed, as well as actions planned for the future.

I.2. Scope and audience

The audience for this document can be categorised in three different groups:

- The consortium members of the RENergetic project, specifically partners responsible for the pilots, and development of KPIs;
- Policymakers, specifically those with an interest in creating a more participatory energy communities that suits the needs of a variety of subpopulations;
- Researchers of academic and industry organizations, with an interest in collective actions, energy communities as well as motivators and barriers to joining energy communities or with a specific interest in demand response behaviors and the implementation and acceptance of physical installations and energy community hubs and events.

A wider audience is invited to use the here presented document to gain an overview over which motivators and barriers are relevant for energy community creation and the participation of individuals in collective actions, as well as acceptance in relation to heat demand response, the installation of physical hallmarks, and the creation of energy hubs around such.

A main objective of the RENergetic project is to move society towards a more community-oriented energy usage, so the overview over literature in this area, proposal how to facilitate energy hubs and ideas around co-design activities should facilitate this.

II. Adapting Insights from previous actions and interventions

People play a central role in the implementation of an Energy Island (EI). Technology acceptance, the motivation of people to commit themselves to their EI, to develop it further and to contribute to collective actions are key for a local energy transition. In particular, the acception of more sustainable technologies and, in addition to pure awareness, a willingness of people to change behavior in a more pro-environmental direction are central. We will therefore first review some psychological concepts supporting this attitude and behavior shift in general. Furthermore, for the main objectives of RENergetic, it is important to use previously carried out actions, research and interventions to gain insights into what has been achieved and what works/what doesn't work in the main areas we concentrate on within the project. These main areas relate to collective actions towards more pro-environmental behavior, to acceptance and behavior change relation to Demand Response (DR) and how people can be motivated to participate in such actions. Following this, we will first stress the relevance of collective actions and social identity for building up a community within the EIs and then review existing evidence of household DR (heat and electricity) and EV DR (Section 1). Additionally, for heat DR and EV DR, which were identified as key actions which require user involvement for the project, we conducted semi-structured interviews with relevant stakeholders, which provide a concrete view of motivators and barriers for the local communities (Section 2).

II.1. Section 1: Insights from previous research and interventions

II.1.1. Collective action for EI communities

EIs can contribute to the local energy transition from a socio-psychological perspective: evidence shows that participatory and community-based approaches in the diffusion of renewable energy technologies promote broader acceptance and support innovation [1]. The feeling of being part of a movement increases social acceptance as well as identification and participation in local energy movements [2]. Beyond private sphere pro-environmental behaviors, an EI can therefore enable and foster collective action towards the local energy transition as a form of collective pro-envrionmental behavior (PEB).

For consistent pro-environmental behavior (PEB), social identity plays a key role: A social identity related to a local community engaging in pro environmental energy actions can influence people's behavior directly: The social identity model for pro-environmental actions (SIMPEA) [3] describes the relevance of social identity related factors (e.g. social identification, collective emotions, social norms) for pro-environmental decision-making and collective action. A meta-analysis [4] demonstrated the link between social identification with a pro-environmental group and intention for pro-environmental collective action within this group. The correlation found was even stronger for collective than for private sphere behaviors. Another recent meta-analysis [5] confirms the strong association between both group and individual identity and PEB. Also, social identification with an energy community was found to be among the strongest motivators to become a part of this community [6] and identification with an energy community was found to be positively related to initiative involvement [7].

On the other hand, deciding for a certain behavior as a ‚first step' can also increase the feeling of sharing a pro-environmental social identity: „the adoption of an initial PEB may act as a gateway to the adoption of more challenging and potentially impactful behaviors (…) by reinforcing an emerging or pre-existing environmental identity." [8] (p. 131). This in line with self-perception theory, which explains the tendency to observe and evaluate one's own environmentally friendly behavior in a certain context and infer attitudes and self-image towards being more environmental friendly from this action [9]. Thereby, a stepwise approach of an EI can lay a foundation for the development of a social identity related to this island, which can then reinforce social norms and community identification. Collective actions, even in smaller group activities can help foster a social identity which then translates the social norm in other group situations [10]. Based on the stepwise approach, concepts that have been identified as particularly relevant for community interaction in the project will now be examined: First, the concept of a physical space and sense of community through place attachement, followed by the concepts of household DR and EV DR.

II.1.2. Household DR

The following chapter summarizes previous scientific findings on the topics of DR in households. It will as well contain a subsection of heat DR, as this should be considered a delineated form of demand response, especially in terms of its motivators and barriers. The aim is to draw conclusions what incentives work from a psychological perspective as well as to expose possible obstacles that might emerge such as contradicting effects or boomerang effects. Based on this, we can build a framework of effective approaches and form hypotheses on how to overcome obstacles or at least take them into account.

II.1.2.a. Household Electricity DR

In the context of DR, the degree to which a user is involved can vary between different forms of DR. The higher the level of automation, the lower the level of enduser involvement, as demonstrated in Figure 1. However, a lower level of involvement does not necessarily mean a lower need for acceptance by households: rather, an agreement to the associated decrease of control through greater automation is required [11].

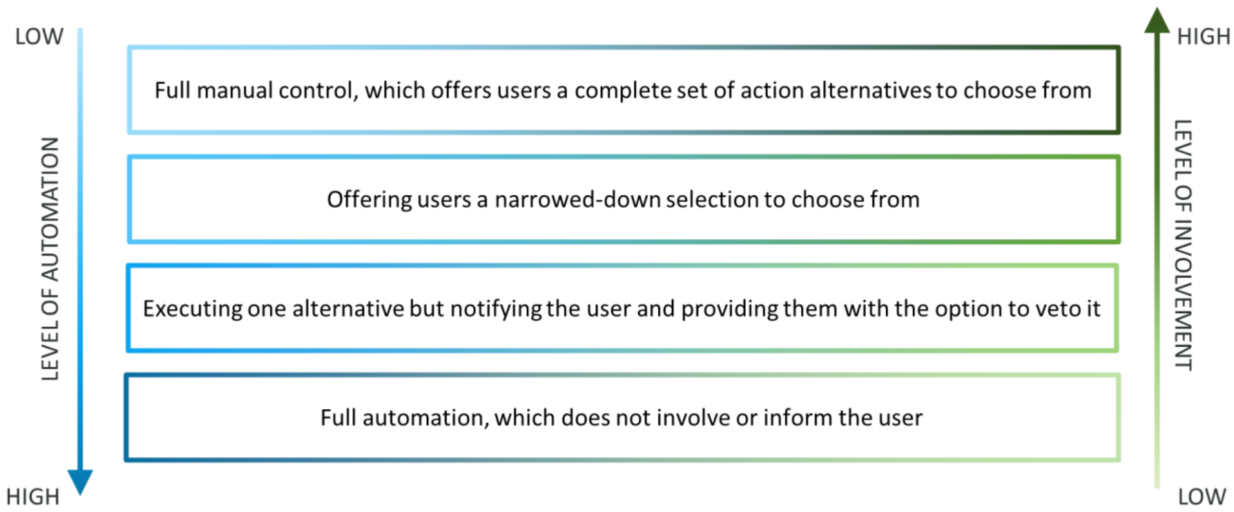
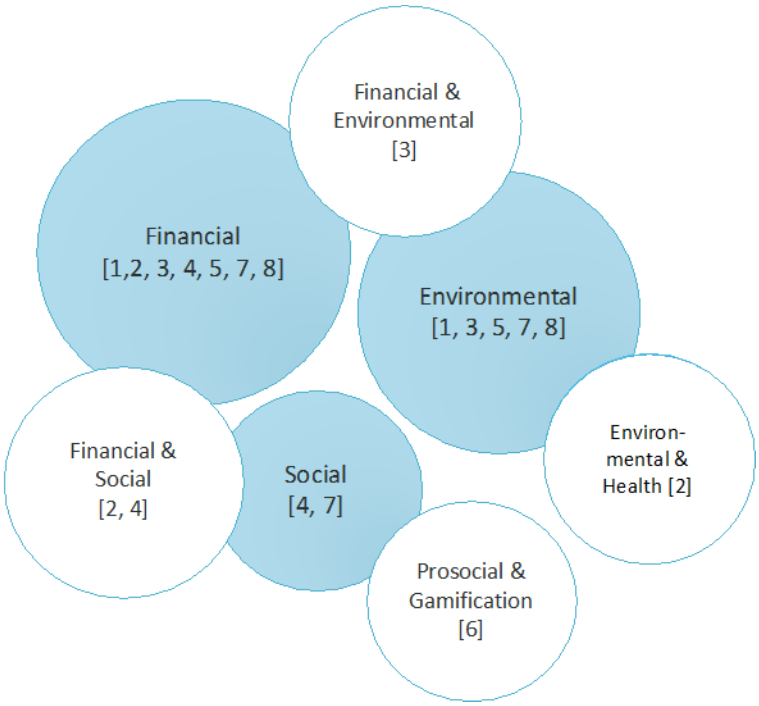


Figure 1. DR concept of automation and involvement, based on [11], [12]

In order to better understand when and in which context, and especially with which incentives, people are willing to accept different scenarios of demand response, the literature shows mixed results in previous studies on acceptance of DR related/ smart appliances in households.

Most of the studies presented in this section are field studies observing households in different countries over several weeks using different incentives in order to find out what works best to positively influence people to save more energy or electricity in their household. These are complimented by to online experimental studies.

Figure 2 gives an overview of the types of incentives used in the contemplated studies. As the graphic demonstrates, most studies look at financial incentives, comparing these with environmental incentives, while some also take social incentives into account. Furthermore, some studies focus on mixed incentives, expecting them to work better than stand-alone incentives.



[1] = [13]; [2] = [14]; [3] = [15]; [4] = [16]; [5] = [17]; [6] = [18]; [7] = [19]; [8] = [20]

Figure 2. Incentives compared in the reviewed studies.

II.1.2.a.1. Incentives

Standing alone incentives. Field research in Denmark investigated load-shifting flexibility of energy consumption in households [13], [15]. In a first study [13] 1802 customers were divided into three groups with financial motives (rebates of 5 % vs. 20 % vs. 50 %) and four groups with environmental motives (promise of environmentally friendly energy in slightly different wordings). Participants received prompts via text messages for about nine months, asking them to move their power usage into or away from a certain time slot during the day (vs. control group who did not get any instruction). Additionally, they were reminded of their program (group). As a monthly feedback of their achievement, participants were only reported the relative amount of energy they had moved, not the absolute numbers. Results show that participants were more flexible to load-shift into a time period than shifting away from a peak consumption time. This might be because load-shifting into is simpler, and the potential amount saved is expected to be larger. Furthermore, load-shifting into a time period leads to a lower consumption during neighboring periods, while for load-shifting away from a time period there is mixed evidence for demand increases in neighboring periods. These results hold for both types of groups, yet groups themselves were not statistically compared to each other.

A subsequent study [15] can confirm these findings. Over 8 weeks, a sample of 1488 households was incentivized to again move their energy consumption into or away from different time slots. Here the sample was divided in 11 groups: 3 groups receiving a text message with financial motives, 6 groups receiving texts with mixed financial and environmental motives and 2 groups receiving texts with solely an environmental motive (for content of the motives see above). The results indicate that households on average are more willing to postpone consumption relative to moving planned consumption closer to the present as they were more willing to reduce their consumption in 10-13h when an “move into” text for the later periods was sent than increasing their consumption in the same time interval when they received an “move away” text for a later period. Comparing the different groups, the mixed incentive seems to work best: combined incentive led to the highest flexibility (e.g. 8% increase in the morning hours).

A similar study [17] compares environmental and financial incentives for reducing electricity consumption at peak hours but adds immediate feedback via signal curves. A sample of 136 households was equipped with signal curves either framed as showing the hourly dynamic electricity price or as expressing the current environmental impact. The price signal resulted in the strongest decrease of consumption across all types of households, yet there was no statistically significant difference to the environmental group, showing that both incentives are effective for motivating people to shift their consumption from peak hours to off-peak hours.

When it comes to purely motivational aspects, people seem to show a slightly different pattern [20]. In an online survey conducted in the US, 1072 participants rated their willingness to enroll in energy saving programs. The programs were differently advertised, presenting the monetary vs. environmental benefits vs. both at the same time. One could expect the latter as promoting the highest willingness to join, still emphasizing environmental benefits alone turned out to achieve the highest willingness rates. One could argue that people might prefer picturing themselves as environmentally friendly over being cost-orientated, but only when it comes to action, they realize the impact changing their consumption behavior would have on their daily routines.

Another online experiment [19] puts social incentives into consideration. In a scenario-based online-experiment with 171 participants conducted in Germany, flexibility in running one's dishwasher and washing machine was tested in three contexts vs. a control group. In the intervention groups, different framings were used, promoting financial (cost-saving) vs. environmental vs. social benefits of load-shifting one's device use. In line with the previously described findings, the financial framing resulted in the strongest increase in flexibility and the environmental framing could also significantly increase flexibility but had a smaller impact in comparison. The social framing resulted in a slight increase in flexibility running the washing machine, but a slight decrease running the dishwasher. Schaule and Meinzer (2020) therefore suspect a boomerang effect of the framing nudge, meaning the persuasive message produces attitude change in the direction opposite to that intended.

Mixed incentives. We further want to look at studies that use mixed incentives, that emphasize different benefits at the same time. This approach seems to be highly promising, as it seems to yield better results than standing-alone incentives [15].

In an 8 week-long Japanese field study [16] with 236 households participating, the operationalization of a social incentive was implemented by a comparative feedback group, who received information about the electricity consumption of other households. This group was compared with a reward-group, who got promoted the gain of 200 yen per 1% in reduction, as well as a control group who received no message. No matter the message, all groups could save the same amount of money. The average saving rate was highest in the feedback group (8.2%), followed by the reward group (5.9%) and the control group (1.7%). This shows that a mixed incentive of financial and social incentives can achieve higher results than a sole incentive.

Considering both financial and social as well as environmental and health mixed incentives [14], 118 participants in a field study got real-time access to detailed appliance-level information regarding their electricity consumption. In addition, one intervention group received cost-framed feedback including a comparison to the top 10% similar, most energy-efficient neighbors, and the other intervention group received an environmental and health framing portraying the weekly emissions and a listing of particular health consequences, e.g., childhood asthma and cancer. The financial and social feedback incentive led to increased electricity use relative to the control group and was ineffective for the most energy-intensive households. In contrast, the environmental and health incentive achieved a significant reduction in consumption of 8.2%, suggesting both increased load-shifting behavior and conservation behaviors.

A field study in the US with a huge sample of 16149 households [18] tested a prosocial and gamification orientated program. Inhabitants of the city of Burlington, Vermot were encouraged to significantly reduce their energy consumption during annual peak times via promotion on official channels like Twitter or via Email newsletters. If they could achieve this aim, the municipally-owned utility would donate 1000 $ to a local charity. Results show promising effects of the program. The percentage in increase of energy consumption was significantly lower in 83.33% of events data was collected for. This also included a significant decrease in energy usage during peak times of 13.5%. Therefore, social incentives might be effective after all if they are framed as collective goals rather than comparisons to one's neighbors.

II.1.2.a.2. Target-groups / types of households

Some of the papers presented also give further insights into specificities of households that could have influence on the effectiveness of incentives. For example, framing reduction in consumption as beneficial for health (e.g. less cancer and childhood asthma) and the environment was especially effective for families (collectively up to 19% energy savings) [14]. Also, women and elderly people are more willing to be flexible when it comes to load-shifting (3%, 0.2%) [15]. When it comes to household sizes, regardless of incentive (financial vs. environmental) the largest impact on reduction can be achieved among single households (mean reduction of 16%) and rental households (mean reduction of 15%) [17]. In larger households it seems to be more difficult to control energy consumption [15]–[17]. Furthermore, it was found that households having a high New Ecological Paradigm score (that is, have strong environmental preferences) are more likely to respond to the financial reward program [16].

II.1.2.a.3. Implications

To conclude, environmental incentives might not be as easy to grasp and quantify as financial incentives. One could say they are not as tangible. Environmental incentives might be rather about whether people are overall aware of the benefit or not, not so much the extent to it. Yet there also is a risk of moral licensing when people are incentivized to lower their energy consumption in a certain area of life only.

Financial incentives seem to generally work but should be high enough to be attractive to users. Also, the target-group should be considered: for early adopters and other households with a high socio-economic status saving money might not be as important. From the presented studies when can infer that the type of household considered plays a significant role. Therefore, user-friendly designs of smart applications are necessary.

A mix of financial and environmental incentives seems more beneficial than stand-alone incentives as financial incentives could wear out after a while, so that an additional motivation to save is required. On top of that, a mix of environmental and health benefits seems especially beneficial. Gadgets with real-time representation of appliances' energy consumption could be helpful to have a better understanding of the opportunities for saving energy than showing overall reduction results as it was the case in the vast majority of the presented field studies [14].

II.1.2.a.4. Summary of results

Figure 3 displays the allocation of studies where incentives have proven effective for Household DR along their type of incentive: either financial, environmental or mixed. Figure 3 displays a summary of the results described in the former section.

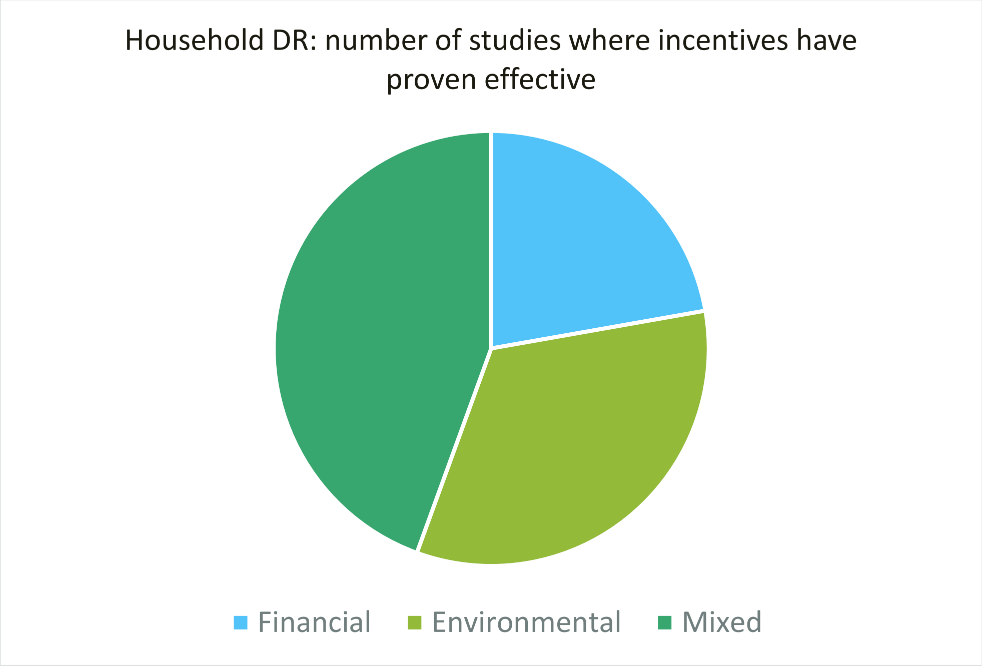


Figure 3. Household DR: number of studies where incentives have shown effective.

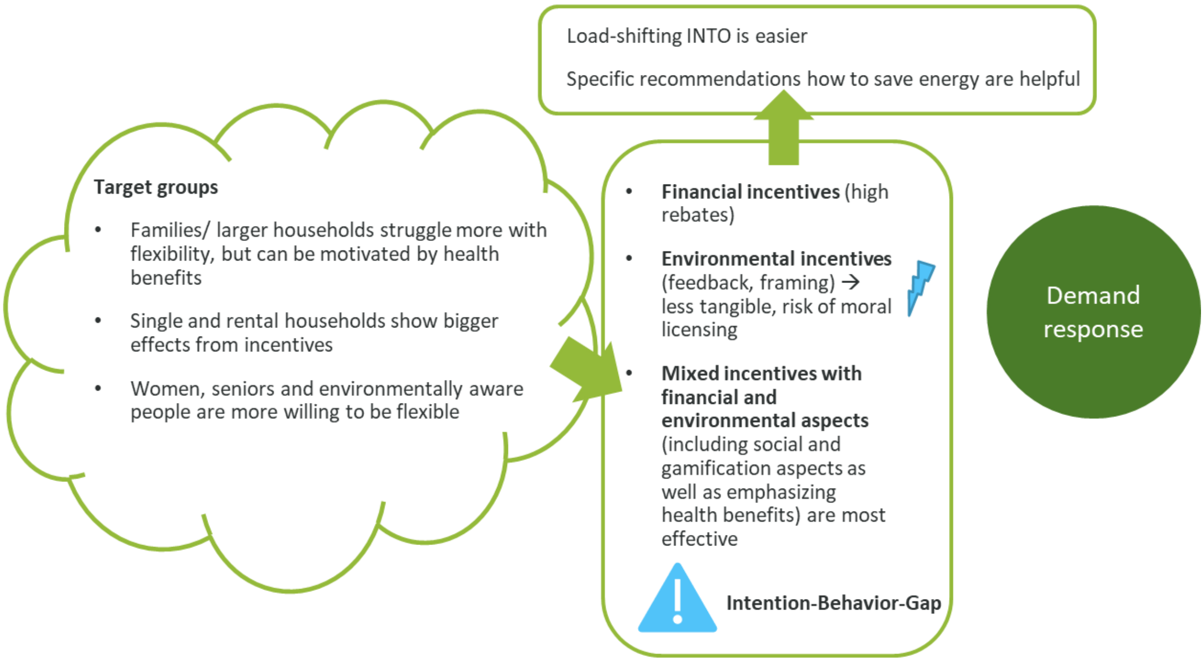


Figure 4. Summary of results regarding findings on Household DR

II.1.2.b. Heat DR

DR in heating has to be considered delineated from household electricity DR, as evidence indicates that acceptance of varies between different scenarios of DR, showing that acceptance for heating is lower than for more flexible electric devices [21]. Summarized in Table 1, research as well suggests a rising level of automation for DR in heating [12]. In most research, DR in heating is examined through a smart thermostat, optimizing the indoor temperature through a rather high level of automation.

Table 1. Level of automation for DR in heating [12]

Low Level of Automation	Automation Level 2/4	Automation Level 3/4	High Level of Automation
The radiators that heat the rooms can be turned on and off by the occupant depending on their own preference. The user may need to perform this often, even several times a day, if the outside temperature or other factors change. There are no thermostats in the system for sensing and controlling the room temperature	The heating system is equipped with thermostats which keep the room temperature in a level that is satisfactory on average. The occupant can alter the temperature within a degree or two Celsius by adjusting the thermostats. If the occupant has restrictive requirements on room temperature, they need to adjust the settings occasionally	The heating system is equipped with thermostats that keep the room temperature at 21–22ºC. The occupant can adjust the temperature between 19 and 24ºC. The control system keeps the room temperature close to the chosen value until the setting is changed	The heating system is fully automatic. It keeps the room temperature at a level (21–22ºC) that is comfortable for an average occupant. The heating system does not allow the occupant to adjust the temperature

Studies examining the acceptance factors, motivators, and barriers to DR in heating have been rare. Nevertheless, we give a brief summary of the most important findings and cite individual example studies that generate important learnings for our project.

An online survey on direct load control programs in the UK [22] compared financial incentives with control incentives in the context of heating and investigated the general acceptance of such programs. The baseline showed a positive response from participants to the concept of automatic switch and a smart thermostat, and this rate could be increased by both financial incentives and an 'override option'. However, it was found that the override option actually outperformed the financial incentives. Another study examining various DR scenarios (including: heat DR), showed that privacy concerns correlated negatively with acceptance, especially in scenarios with high automation [23]. In addition, the relevance of control beliefs was again emphasized. In another survey on the willingness of individuals to participate in a DR program related to heating and hot water, cost savings and emissions savings were cited as the main motivators. Barriers again included loss of control, or loss of comfort in terms of water and room temperature [24]. A review on acceptance of automation in the context of demand response [11] concludes that especially in heating it is key that no strong temperature changes or negative influences on other comfort related elements are associated with DR. In addition, the relevance of control is again emphasized: the authors conclude from the literature that users with a higher sense of control are more likely to allow larger temperature fluctuations and potential comfort changes [11].

More specific to the context of smart heating through a smart thermostat, more evidence can be found. Here, it appears that savings that can be gained from the technology play an important role, as well as low associated costs [25]. In addition, several studies [26], [27] show that concepts of technology acceptance increase adoption and / or intention to adopt of smart thermostats: The ‘Unified Theory of Acceptance and Use of Technology’ (UTAUT model) of Venkatesh et al [28] is mostly used, which explains the acceptance of a technology based on its perceived effectiveness, effort expectancy, social influence, hedonic motivation and facilitating conditions.The strongest effects are found here for performance expectancy [26],

[27] hedonic motivation [26] and social influence [27]. These results are also consistent with the fact that consumer innovativeness and knowledge of how to use technologies play an important role on the part of the end user [25], [29].

Two studies that implemented DR in heating and cooling in a public context, respectively, also examined the responses and acceptability of measures beyond intention. In a field study implemented in a university on cooling [30], results showed that thermal comfort and acceptance for demand response was only acceptable in a certain temperature ranges. Whenever the temperature was outside this range, i.e. being too hot, it led to significant reduction of thermal comfort and acceptance. In a study conducted in office building on changing default settings of smart thermostats [31], smaller reductions in the default setting indeed resulted in lower energy consumption and an adaptation to temperature on part of the staff affected. On the other hand, the study demonstrated that larger reductions in the default setting led to reactance: people, who were able to override the default setting, changed towards a higher temperature setting (and thus energy consumption), not only compared to the lower default setting but also in comparison to the standard default setting of before the trial. Figure 5 depicts the results.

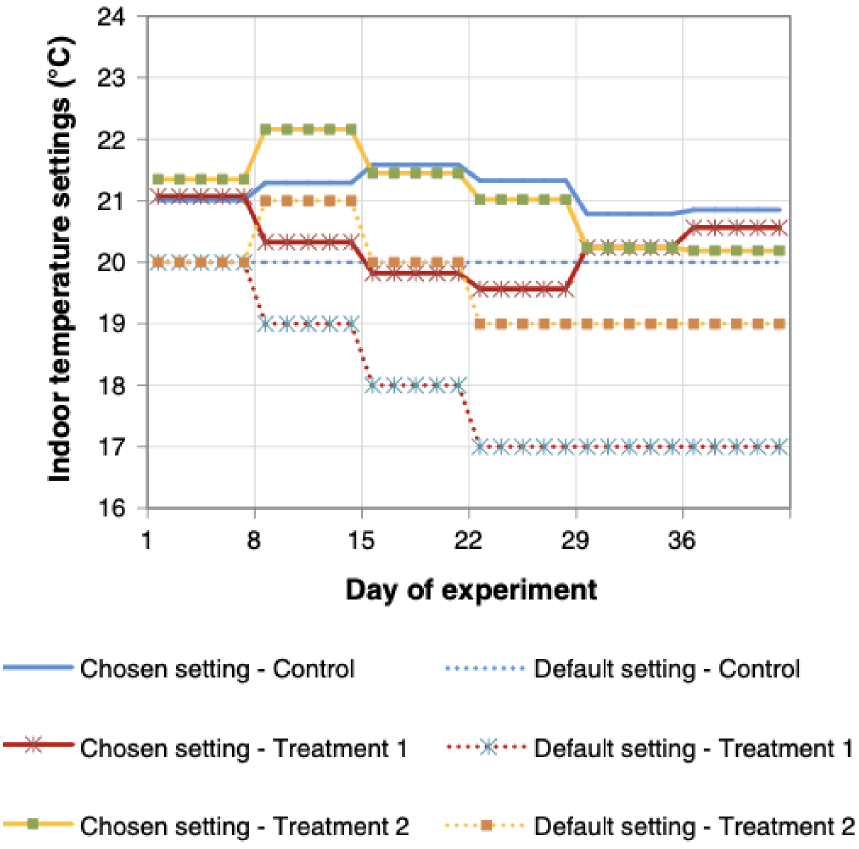


Figure 5. Results of smart thermostat default setting change [31]

We can conclude from these studies that a higher acceptance of DR in heating is associated with higher feeling of control, mainly through e.g. an override option and lower comfort and convenience impact. Additionally, potential compensations for inconveniences and lower privacy concerns can strengthen intention for DR in heating. Additionally, whenever DR in heating is implemented through a smart thermostat, concepts of technology acceptance and the innovativeness of the adopter play a role. The field studies furthermore demonstrate that DR in heating is only acceptable within a certain range, also to counteract any reactance or rebound effects.

II.1.3. EV DR

Recent research and findings about incentives for smart charging of electric vehicles mostly concentrates on the efficacy of financial incentives and is conducted in online surveys and experiments.

II.1.3.a.1. Incentives

In a web-based survey and stated choice experiment [32], PEV buyers' acceptance of utility-controlled charging was tested with a sample of 1470 participants in Canada who recently purchased a new vehicle. In order to identify the potential early mainstream PEV market, the sample was divided into subsamples resulting in an early mainstream PEV buyer sample of 530 participants (36% of the total sample). In the choice experiment, each choice set presented the respondents' current home electricity situation and two hypothetical UCC alternatives that they might enroll in. Participants repeated the choice sets imagining oneself in two different PEV scenarios. In the first scenario, UCC programs were presented for a PEV that participants had designed in a lower price PEV design exercise. The second scenario choice set was framed as if the participants owned a 240 km range EV version of their base vehicle. Across the subsample of potential early mainstream PEV buyers, cost incentives (reduced electricity bill) were more effective at incentivizing consumer enrollment in a UCC program (both scenarios) than environmental benefits (increased use of renewable electricity). The best option would be to use environmental benefits as a booster, though. Regarding acceptance, results show that 53% of the early mainstream respondents would voluntarily enroll in a UCC program.

Another online experiment [33] found further evidence for the effectiveness of financial incentives. The study tested nudges to promote charging flexibility on 164 BEV users in Germany. Three scenarios (car trips e.g., to workplace) were shown to participants. Compared to a control group with a neutral interface, three different nudges were applied via different framings, each promoting either financial, social or environmental benefits. Results show that goal-framing on monetary benefits fostered charging flexibility compared to a neutral interface. No such effects were found for a social or environmental framing. In contrast, framings on the social aspects of the common use of shared resources like the electricity grid, even reduced flexibility, which can be considered a rebound effect.

A laboratory study [34] tested financial and environmental incentives on the choice of a driving route (green vs. fast route) in a fictious navigation situation. The randomized controlled trial (RCT) was conducted with 173 participants in Germany. Financial and environmental incentives were both shown to be effective, but no statistically significant difference between the two was found. Interestingly, also various magnitudes of the incentives (different prices or different amounts of CO2 saved respectively) did not cause variation in the effects.

A somewhat similar result was found in an online study [35]. In a RCT study, the authors offered 305 Dutch drivers environmental vs. financial feedback on eco-driving behaviors. Savings were perceived to be more worth the effort when feedback is provided in terms of environmental (CO2 emissions) rather than financial units (euros), which provides support for environmental incentives. Yet, the intention to adopt eco-driving behaviors such as avoiding idling, avoiding overtaking and speed reduction was mainly sensitive to the presence of feedback per se, rather than the content of the feedback itself.

In a RCT field study [36] an intervention mail was sent to 159 EV drivers and customers of a charging service provider, informing about cost-free and green charging behavior. Following this mixed incentive ("free when green") eight times more charging processes were conducted during pre-specified event periods with low carbon intensity compared to a same sized control group that did not receive such a mail. Thus, the positive effects of combined incentives seem to play an important role also in the context of EV charging.

Based on research on a focus group discussion (N=7) and online surveys in Germany with choice-based conjoint analyses (N=217, N=62) a smart charging system was developed and tested in a 1-year field study [37]. Preferences, expectations and attitudes regarding smart charging as well as acceptance, charging behavior, experiences and future requirements were evaluated in surveys. Monetary incentives turned out to be the most attractive reward compared to environmental-related or BEV-related incentives. The survey results also showed that financial benefits and connection time with the grid are of higher importance for the incentive scheme than the effort of adjusting settings and the flexibility of departure time. In the field trial with 10 BEV drivers [38], participants drove BEV equipped with smart charging technology for five months. Users could adjust settings which determined the charging process via a smartphone application. To evaluate their experiences, both at the beginning and end of the trial, drivers conducted questionnaires and participated in structured interviews. After experiencing smart charging, the effort expended was evaluated higher and the money one could save lower in comparison to the expectations drivers had before the trial. But still, participants stated the cost-benefit-balance as equalized.

A survey with a sample of 237 early adopters in Germany on the factors for the acceptance of smart charging [39] found that the majority of participants would request a (high) discount (average rebate of around 20%), yet there is also substantial number that do not prefer a discount at all. This supports the notion that financial incentives in other studies might have been too low to show larger effects. On top of that, positive effects on grid stability, integration of renewable energy sources and environmental friendliness turned out to be stronger influential factors on acceptance than lower financial costs. However, it should be kept in mind, that the samples in explicitly consisted of early-adopters and therefore results may not be applicable be for the general population.

Looking at infrastructural aspects, a non-interventional field study [40] analyzed charging behaviors at public charging stations in the Netherlands using a sample of 20 856 charging sessions at charging stations with a pay less when charging during day-time policy. The implementation of this daytime charging policy led to a 3.6 % less increase in occupancy during evening peak hours (modest but significant effect). Furthermore, longer EV-connection times were the result of a sample of over 1.7 million charging sessions with free parking for EVs in a zone which requires paid parking for conventional cars. In a subsequent stated choice experiment, 149 participants were asked to rate their purchase intention for an EV under different parking policies. Here, placement strategy of charging stations turned out to be the policy with the largest effect on EV purchase intention. This effect is nearly twice as big in comparison e.g. with a parking free policy and almost three times larger than the effect of the exclusive availability of parking spots for EVs. Hence, fostering infrastructure could be just as an effective incentive as financial incentives.

A small field study (N = 15) in the US tested a new approach of incentive systems [41]. Through high solar consumption ratios, that is using renewable energy for charging in the past, prioritized access to charging processes could be gained at a charging box collectively shared by participants. In an additional simulation, participants had the opportunity to gain and trade with a cryptocurrency. This prioritization led to a statistically significant increase of the solar-score (37%) (be aware: It was only tested with 15 participants who arrived at different times at one charging box). The simulation of the additional cryptocurrency-incentive which should boost the effect showed that the incentive scheme works, but empirical testing would be needed to confirm results.

II.1.3.a.2. Target groups

[32] structured their sample into PEV pioneers, early mainstream und late mainstream, trying to find out about specific target group needs for interventions. Looking at the characteristics of their early mainstream subgroup, they found the following: The renewable focused (19%) subgroup was less concerned about privacy. Here environmental incentives could work best. The cost motivated (27%) subgroup was more likely to be technology orientated, less altruistic, sensitive to costs and showed the least willingness for a minimum charge level. Here, financial incentives would probably work better. The charge-focused (33%) subgroup found a minimum charge level very important, but environmental benefits play a non-significant role. The anti EV (23%) subgroup had a negative preference for adopting smart charging and using renewables. They were more likely to be older and less likely to have a bachelor’s degree. To conclude,

different ages and education levels might need different and specifically targeted incentives, which might also explain the varying results for the effectiveness of incentives.

Schmalfuß et al. (2015) point out motivations relevant to PEV pioneers that might give insight on which aspects to emphasize in incentives. Primary motivators stated by the participants are ecological motives and acting to improve society's and one's own well-being. Identified motivation (e.g., the feeling of doing something good) and intrinsic motivation (e.g., pleasure) were found to be of highest relevance. Introjected regulation (e.g., the tendency to feel bad when not using smart charging), was found to be of less relevance and was even experienced as less relevant after the testing phase, as there was a large negative effect.

II.1.3.a.3. Implications

Concluding, financial incentives seem to be quite effective when the rebate is of a significant size. Still, when meeting the right target group, environmental incentives show effective as well. Adding to that and similar to the results found for heat demand response, stressing health benefits could be a way to more successfully communicate environmental benefits to EV users [33].

Regarding aspects of the program itself, smart charging systems have to provide user guidance and assistance in minimizing effort for the user and should consider the users' objectives regarding the charging process [42].

So far, three factors are used as incentives in smart-grid projects in European countries: reduction of bills/more control over consumption, environmental concerns, and higher comfort [43]. Successful strategies need to take into consideration different consumer motivational factors and need to focus on building trust and confidence [43]. Likewise, it was found that the third party (between user and provider) involved in utility-controlled programs must be considered trustworthy [32].

Highlighting the importance of fostering infrastructure, a qualitative review compares policies for smart EV charging in several European countries and US states in sight of the effect these have on consumer behaviors [44]. Results show that three policy strategies seem to be most effective for promoting smart charging: cost-reflective pricing (time-varying tariffs), intelligent technology (automated processes in order to make smart charging easier and less attention-consuming for users), and integrated infrastructure planning (infrastructure serving mobility demands, e.g. workplace charging).

II.1.3.a.4. Summary of results

Figure 6 displays the allocation of studies where incentives have proven effective for EV DR along their type of incentive: either financial, environmental or mixed. Figure 7 displays a summary of the results described in the former section.

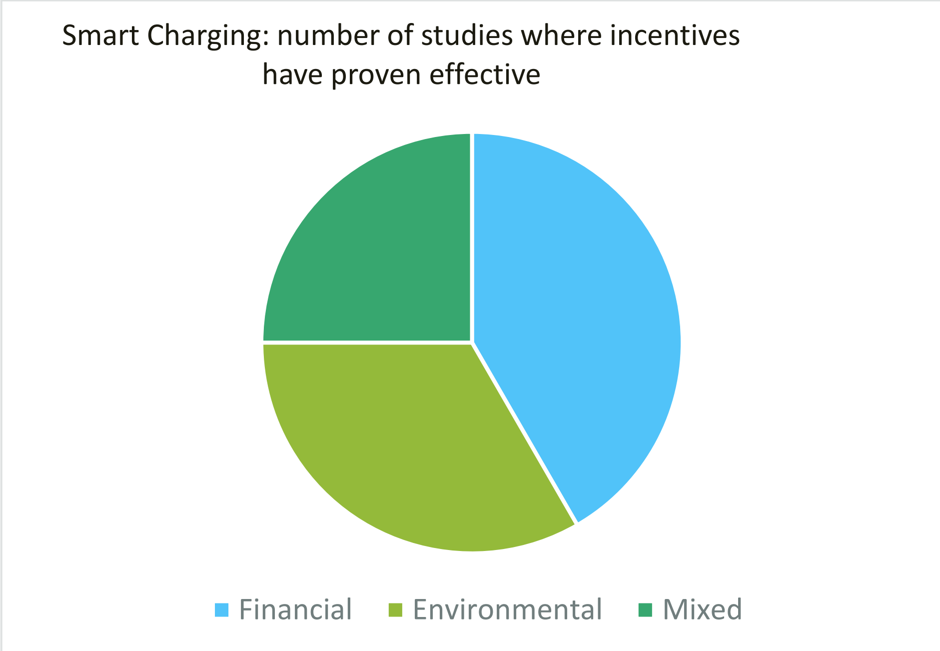


Figure 6. EV DR: number of studies where incentives have shown effective.

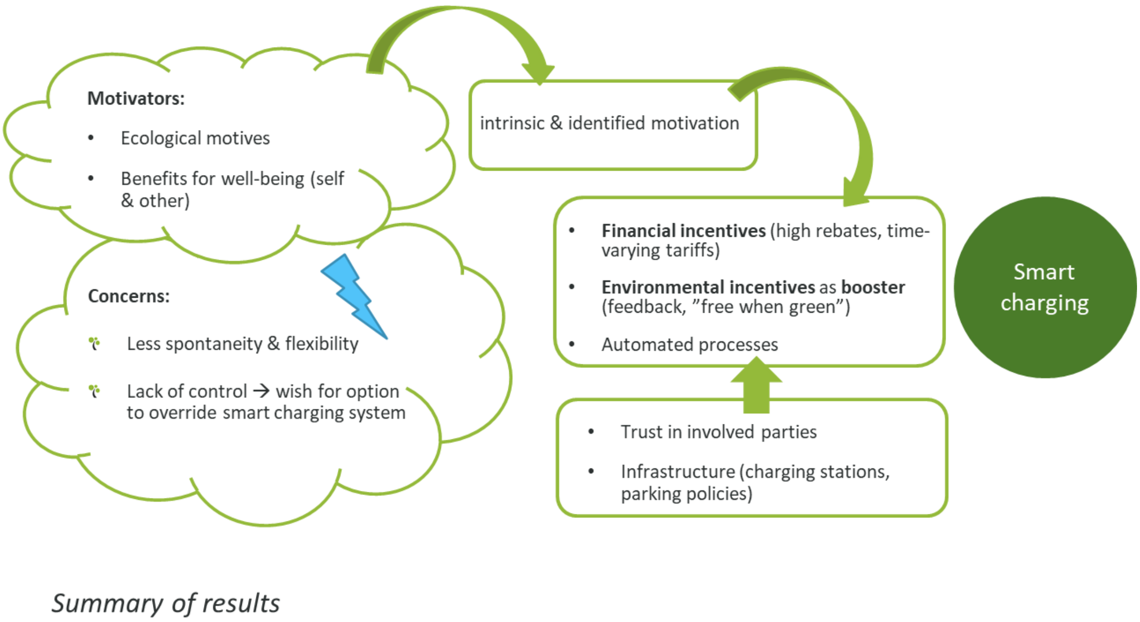


Figure 7. Summary of results regarding findings on EV DR.

II.2. Section 2: Analysing the needs of local stakeholder groups and key individuals

II.2.1. Stakeholder interviews

Semi-structured interviews were conducted to validate the results found in literature, especially on heat DR and EV DR in the different pilots. For all pilots, a list of interview partners was proposed in order to ideally include different perspectives in the interview. In addition, interview guidelines were created that included both a scenario of heat DR and a scenario of EV DR, as well as an interview guideline questions. The interview questions focused primarily on potential motivators for such a system, barriers, and possible features that individuals would envision or desire. The interview guidelines for both interview types are provided in the appendix.

II.2.1.a. Heat DR Interviews

For heat DR Interview, the following scenario was described to participants. The scenario was always adapted to the stakeholder context, so there were light adaptions in scenarios for other stakeholders than residents:

> **SCENARIO HEAT DEMAND RESPONSE (for residents)**
>
> Demand response can be used for heating. Sometimes a heat manager might need their customers to use less energy for heating: For example, because in that moment, heat production is very difficult, or everyone is using a lot of energy at the same time. It could be helpful for an automated system to adjust the temperature setting in the building for a short period of time using a remote signal. Most likely for the consumer, this drop in heat would be very small, less than one degree, and within a pre-defined temperature band (such as 19 -21 degrees). This temperature band would be defined by you in advance and the option to override the automated optimization would always be available.

Within the Pilot sites and through the implementation of the project partners, eighteen people were interviewed for heat DR (Total N = 18; Poznan = 6, Segrate & Milano = 8, Ghent = 4). These interviews comprised different stakeholder groups: students, municipality technicians, staff and teachers, resident students, researchers as well as local politicians.

The first research question asked for the perceived advantages and potential motivators for DR in heating. The most frequently mentioned could be allocated along these four main motivators:

- Financial: Any kind of expected financial benefit or financial incentive for either the hospital/university or the individual
- Environmental: All motivations in relation to reduced emissions / more renewable source use
- Social: E.g. comparisons or collectively acting along values (also for image)
- Technological: Communication, efficient control, having an intelligent tool

Additionally, some further concepts like corporate benefits, physical comfort or potential heakth benefits were named. Figure 8 shows some quotes from the interviews, asking for motivators of heat DR.

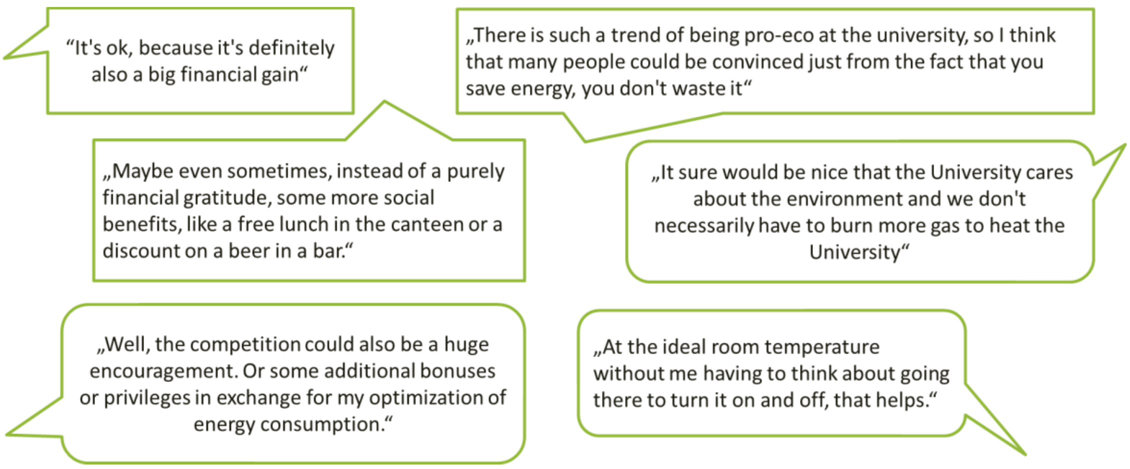


Figure 8. Quotes from interviews: motivators for Heat DR.

The second research question asked for the perceived disadvantages and potential barriers for DR in heating. The most frequently mentioned could be allocated along these four main motivators. Comfort was found to be one of the most frequent mentioned barriers: Some participants described the worry of the temperature being too cold or concluded that comfort matters more than potential benefits. Other barriers that were named were control issues, i.e. the fear of not being in control of the temperature and extra hassle, that could be caused by heat DR. Less frequently mentioned were barriers like technological barriers or economic costs. Figure 9 again shows some quotes from the interviews.

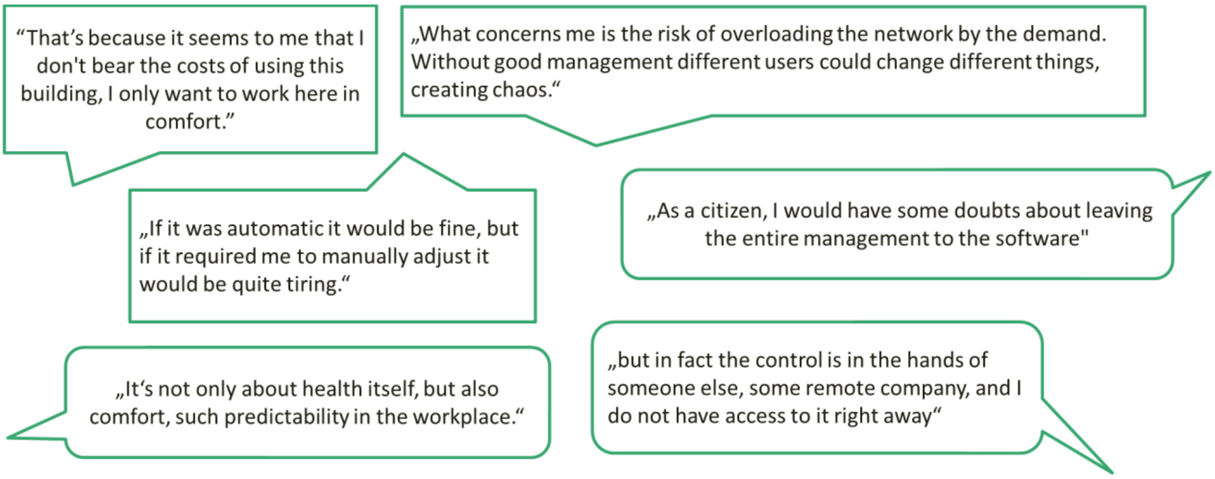


Figure 9. Quotes from interviews: barriers for Heat DR.

The third research question was mainly related to the desired functionalities of such a heat DR system. Here, mainly four main components were mentioned: Interaction, i.e. the possibility for exchange and contact; information on benefits, i.e. the monitoring of emissions and savings; data about the system, such as live information or forecasting; and social information, such as social comparisons.

II.2.1.b. EV DR Interviews

For EV DR, the same interview partners as before answered questions about an EV DR System when applicable. This led to a sample of thirteen people being interviewed for EV DR (Total N = 13; Poznan = 6, Segrate & Milano = 3, Ghent = 4). The scenario for smart charging, which is the main focus of EV DR in the project, is described in the following:

SCENARIO EV DEMAND RESPONSE

Demand response can be used for EV charging, often also called smart charging. The goal of such smart charging is to control the charging in terms of timing and/or power, i.e., basically when and how fast the battery of your car is being charged while the car is parked. One reason could for example be to use more of renewable energy when it is available.

At the charging stations, you could be asked to make the choice whether you need to "fill up the car" as fast as possible or whether you are more flexible; in the flexible selection, you can input a time at which you will pick up the car. In this case, the system can then adjust when and/or how fast the charging is executed so that the use of renewable energy is optimized and the grid is less stressed (for example if it's a time of high demand and everyone else is charging too).

For this high automation smart charging, motivators and barriers as well as functions were examined. Motivators that were frequently named were mostly referring to predictability and reliability, as well as availability of charging spot. Contrary, barriers comprised mostly uncertainty but also potential time loss or damages caused by smart charging. Some quotes of motivators (green) and barriers (blue) are given in Figure 10.

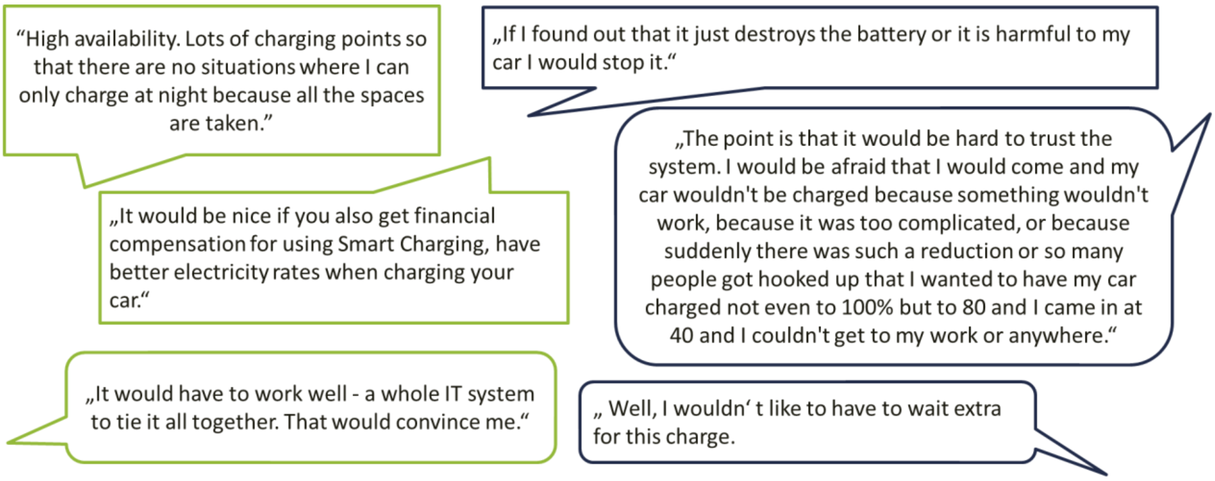


Figure 10. Quotes from interviews: motivators (green) and barriers (blue) for heat DR.

When it comes to desired functionalities of EV DR, the given suggestions can be classified mainly into the following categories: Process information, i.e. live data about charging status and / or notifications; forecasting information on price or renewable energy availability, support in the form of behavior recommendations or alternatives and savings reached through EV DR in terms of money and Co2 emissions.

III. Economic valuation of the needs for local stakeholders

For economic valuation of the needs for local stakeholders, we focused on identifying (1) specific business needs of local stakeholders and (2) the economic value these stakeholders put on the quality of their living and working environment, which can be referred to as "economy of quality". Potential approaches for these two goals have been assessed.

III.1. Review of existing work on business needs for LEC stakeholders

Concerning the identification of specific business needs of local stakeholders, approaches have been considered from previous work within RENergetic (within WP2 and WP7) as well as literature research.

Within the context of WP7, preliminary value networks have been described for all pilot cases. The value networks have been considered within WP2 with the focus on different elements in the business case for different kinds of stakeholders, revealing also their specific needs. Special attention went to the differentiation between public and private stakeholders.

In order to identify in a more general way the main differences in the needs for and public and private LEC stakeholders, some focus was put on different business logics. Therefore, we conducted a literature review based on the difference between “public versus private stakeholders” or stakeholders with a “commercial logic versus societal logic”. This perspective may help to explain the goals and activities of the stakeholders and how they may be linked to certain company characteristics. Expected benefits and needs also depends on these logics (in a qualitative way), showing socio-economic interests in case of social welfare logics versus pure economic interest in case of commercial logics.

The interviews performed in the context of task 2.1 have been assessed based on their potential to provide general insights in stakeholder needs. Although very interesting findings popped up, they cannot be generalized based on the current amount of respondents. Dedicated interviews might be better suited for revealing the required information.

III.2. Review of existing work on economy of quality

Concerning the economy of quality, explorative desk research has been done, focusing on identifying approaches for economic valuation of value perceived by different stakeholders.

Existing measures for the “economy of quality” have been explored.

- The Economics of Quality (The Implementation and Economic Impact of Quality Management in the Homebuilding Industry) links to the Building America program of US Dept of Energy. It goes much broader than only energy and has a lot of impact on quality measures (standards, testing, etc). It can actually be seen as a framework for quality management during the building process and it is therefore not so relevant for assessing the value (benefits/needs) of the solution. Moreover, its application would required to measure a lot of data.
- The Quality of Life (QUALI) is a metric from medical world, indicating the quality of life at the end of life. It is clearly not applicable as such in the LEC context and would require a lot of data would be needed to define something like this for the case of quality of life based on energy situation in the home. Development of such a measure is clearly beyond the scope of this project

Also quality measures based on operational improvements have been considered. Based on business process modelling or flowchart-based modelling, the impact of e.g. demand response measure on the typical processes performed by different stakeholders could be indicated. This would require to get a full understanding of the different steps required in a certain process: Who performs the activities? What is the time/resources needed per activity? What can be gained by the suggested solution (in relation to some baseline)? This would require to model processes in detail, based on stakeholder interviews. We do not believe this will lead to usable results. We foresee the quality impact of operational improvements will be limited in the overall quality experience. A lot of the quality experience is rather intangible. Therefore, we consider this approach not suitable for the current task.

The need for economic evaluation in absence of clear financial measures is not unique to the RENergetic context. The shadow pricing approach can potentially be useful here. A shadow price is an estimated price for something that is not normally priced or sold in the market. However, shadow pricing is inexact as it relies on subjective assumptions and lacks reliable data to fall back on. Shadow pricing is frequently used by economists to determine the value of public infrastructure projects like public parks and transportation. Insights from the interview and literature research can potentially be used to build “shadow prices” for benefits and needs experienced by users of the LEC.

III.3. Suggested future approach concerning the economic needs of local stakeholders

Based on the literature review concerning ways to evaluate qualify of life for LEC stakeholders, pure quantification methods (economy of quality, quali, operational modeling) do not really seem appropriate in the context of this task. Quantification of these metrics in a bottom-up fashion would require a lot of data. Such extensive surveys/interviews are not in scope of the project. Shadow pricing seems the only possible approach in case we want to include perceived quality in a numerical economic assessment.

Next steps will focus on approaches that do not rely on quantitative input data, but rather start from qualitative assessment by stakeholders, as depicted in Table 2. The social KPIs as defined in WP7 can form one part of input here. Future stakeholder interviews will aim at understanding the trade-off between perceived quality and value lost on other fronts (e.g financially). The deep diving community engagement workshops planned in the Ghent pilot will form one starting point.

Table 2. Qualitative assessment approaches.

Approach	Attention domain		Input data		Data available within RENergetic			To be used for future steps with T2.2
	business needs for stakeholders	Economy of quality	qualitative	quantitative	yes	no	can be collected	
Value network analysis	X		X		X			Yes
Business logics	X		x				X	potentially
The Economics of Quality		X		X		X		No
The Quality of Life		X		X		X		No

Operational modelling		X	X	X		X		No
Shadow pricing		X	X	X			X	potentially
Analysis of previous survey and interviews within WP2	X	X	X			X		No
Deep diving community engagement workshops	X	X	X	X			X	yes

IV. CREATING HUBS FOR EI COMMUNITIES

RENergetic offers a wide-spread set of methods to engage people for the EI. All of them involve the need for communication. This need can be fulfilled by physical meetings that imply the need for a physical hub and meeting & information space. Additionally, this need is fulfilled by digital communication, which in the organization structure of RENergetic means a high overlap with the work done in WP3. This chapter introduces both spheres, the physical and the virtual sphere from a psychological point of view.

IV.1. Psychological Sense of Community and place attachement: The physical installations

> *Thus, it appears likely that there is a cyclical process at work, one in which connections to community lead individuals to help others and engage in social action which, in turn, further builds community connections and social capital. As a result of this self-perpetuating and accretionary process, social action becomes more likely and sense of community is increased. (Stürmer & Snyder, 2010, p.242)*

The Psychological Sense of Community (PSoC) is a specified extension of the concept Sense of Community [45] and consists of six key facets [46]: knowledge, conceptualization, identification, connection, success, and legacy.

A field-base experiment [47] with over 600 participants recruited through AIDS service organizations showed that overall PSoC was positively related to a range of prosocial actions including AIDS activism and activism in non-AIDS contexts: Participants who took part in a workshop session which addressed the six key facets of PSoC showed a significant increase in overall scores of PSoC measures, increased feelings of empowerment, efficacy, feelings of responsibility and confidence in participants knowledge about the community and its resources. It also generated increases in intentions to become involved in the community through diverse forms of social action (e.g. joining community groups and organizations, participating in social activism) and increased intentions to help and educate others in the community.

As the RENergetic EIs are or will be implemented in a geographically defined area, physical space is a core item defining the Sense of Community via a social and regional identity. This lead to the idea of providing a core physical space, a so-called physical installation (PI) to act as a representative and incorporation of both the social and the regional identity and represent the physical component of an Energy Hub. In the following, the facets of the PSoC according to Stürmer & Snyder will be related to this PI. Table 3 displays the translation of the siy key facets into the RENergetic context.

Table 3. Key facets for PSoC for RENergetic PIs

Facet	Explanation	Implementation in RENergetiic
Knowledge	Knowledge refers to the knowledge people must have about the community, who belongs to it and that community resources are available for all members.	At a RENergtic site, people have to be made aware of the EI project in their area and that all members jointly can benefit from it be is via cheap energy, independence from big companies, an improved notion of self-efficacy, a larger social network, support between the members and the opportunity to gain more knowledge and skills concerning the energy transition. A PI here supports through an additional communication interface functioning both as physical billboard and offering links to or even interaction with the web presence and through the opportunity to provide a physical space for drop-in events.
Conceptualization	Conceptualization involves redefining the relevant community in terms of broadening the inclusivity and knowing what features, attitudes, interests or characteristics are needed for entry.	At a RENergetic site, these aspects, mapped to the concept and the objectives of the EI, can be materialized through the PI, again both via the communication interface offered as well as through drop-in event.
Identification	Identification points out the affective reaction to being member of the community and the importance of membership to the identity. A shared identity might capitalize on existing identities and is defined by a common (co-created) narrative with collective goals. Local space related and ecological narratives have been found to be a powerful motivator for actual involvement [48], [49]	At a RENergtic site, a plethora of collective framing techniques will support the creation of a common and local identity, among them being common, local and achievable objectives and the creation of strong in-group social norms. This local identiy can be expressed through the specific design of the PI, e.g. using local colors or adding material hallmarks.
Connection	The fourth facet is labelled connection and refers to the affective bonds or attachments to the community. It is obviously closely related to the identification.	At a RENergtic site there must be a variety of opportunities to foster a feeling of connection. Digital communication can serve this purpose only very partially, complemented by physical interaction and drop-in events.
Success	Success involves the belief in the added value of collaboration. Success is thus turned into collective success and the feeling of collective efficacy. Working together exeeds the impact of working on your own. With increasing level of activity people	At a RENergtic site, collaboration is key for the evolvment of the EI towards it goals. This can be done through workshops at the physical installation as well as through individual decisions regarding e.g. room heating. Monitoring this commly achieved success is of utmost importance and can be expressed via different means. One

	can take over more responsibility, thus feeling empowerment and mutual concern.	public channel might be the representation of the current level of goal achievement at the PI, the communal meeting space, especially if it is presented in a way of an eye-catcher.
Legacy	The sixth facet is conceptualized as legacy. It is future-oriented and aimed at the responsibilities of current community members to ensure a viable, healthy and successful community for future members, but also associated with the rights of paving this way.	At a RENergtic site legacy means not only sustaining the “life” of the EI but also working towards replicability to empower neighboring and other communities to pursue a similar path. Thus research that is made within REnergetic will help other regions to push the energy transition also forward by learning from experiences. These aspects can be addressed by both, the physical installation and the drop-in event.

Regarding the role of physical space in a community, it was found that specific features of the social climate (e.g. quality of neighbourly relations, opportunity for participation) promote the development of a strong Sense of Community [50]. The authors analysed data collected as part of the Block Booster Project which was a multimethod, action study of the social effects, organizational dynamics, and viability of urban residential Block Associations conducted 1985-1986 in five neighbourhoods in Brooklyn and Queens, New York [51]. The clustered, resident survey data from 47 street blocks contained measurements of Sense of Community, Place attachment, Communitarianism, Community (block) satisfaction, Block confidence, Demographic variables, Collective efficacy, Participation in BA activities and Neighbouring behaviour over two points in time. Participation and Neighbouring had a strong connection to Sense of Community at individual and block level. A relevant factor in the relationship between individuals and the community which was found to have strong connections to SoC on the individual and block level is place attachment [50]. “Place attachment involves positively experienced bonds, sometimes occurring without awareness, that are developed over time from the behavioral, affective, and cognitive ties between individuals and/or groups and their sociophysical environment. These bonds provide a framework for both individual and communal aspects of identity and have both stabilizing and dynamic features” (p. 284) [52]

Additionally, two recent case studies [49] showed that place attachment can function both as a driver and as a source of protest. In these studies, interviews were conducted with residents in two rural communities in the Scottish Highlands where community organisations are developing renewable energy projects. Individuals with an attachment to human-based characteristics of place (built on social and functional properties of the environment) were more likely to support a local renewable energy project whereas individuals whose place attachment was based on the attachment to the landscape were more likely to oppose it. Newcomers were more likely to attach to the beauty of the landscape whereas people who showed a higher degree of localness showed also a stronger social and functional attachment. Active Participation and social bonds were indicators for the degree of localness.

IV.2. Physical Installations Module

IV.2.1. Concept

Building on these findings, physical installations (PI) will be designed and later constructed in order to both serve as communication interfaces and as meeting points so that they can ultimately help to engage current and potential members of the EI. In order to fulfil these basic functionality but also serve as a model for replicability of the RENergetic EI concept, PI are defined **as a physical place and an artifact that on the one hand represents the EI concept visually in the district and on the other hand, serving as a communication interface, allows low-threshold access to the EI concept and ideas as well as acting as a meeting place.** Based on this definition, the following requirements for a PI design were developed:

- High level of visual recognition factor
- Allows a comfortable physical lingering
- Offers information about RENergetic/the local EI
    - Without overloading people with information
    - With contact information at any time of the day (e.g. via QR code or an interactive display)
    - With the option to get more information upon interaction
    - With the option to get access to IT platform/app upon interaction
- Enables physical interaction among people
- Educational character e.g. via offering solar based electricity depending on solar irradiation

IV.2.2. Design Principles and Examples

Design principles for PI are based on the design principles for street furniture as proposed by [53], depicted in Figure 11.

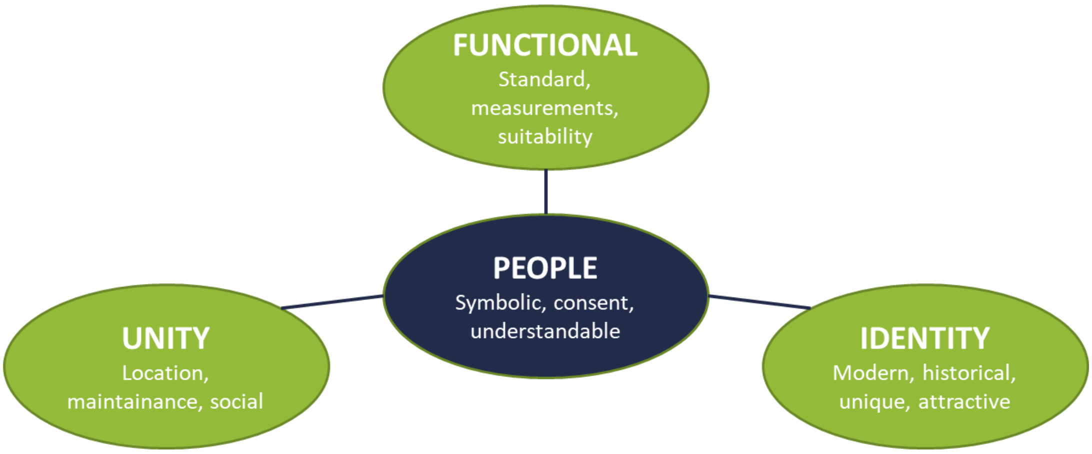


Figure 11. Design Principles of Furniture [53]

Functional means must be designed based on standards regarding suitability of material, form, usage, comfort, functional suitability and sizing.

Unity means that it the furniture should be integrated into the physical, social and architectural environment. This applies to color harmony or shapes, to sizing and the general architectural design.

Identity means for the installations to be integrated in the local and historical context be it traditions, life style and behaviour or the geographical environment.

All this, however, is only the means to the main cause of street furniture which is to be a place liked and accepted by the people it is intended for. This is why "People-oriented" is the main criteria which influences how much Street Furniture is liked by the people and to what extent it makes a difference.

Barriers that have to be taken into account when planning a physical installation are cost, approval of the city council or responsible entity of an EI and the construction process itself: should the construction be part of an engagement process, should it be done by a group of locals or is it to be set up by a craftsperson.

In the following, there is a small selection of examples for existing approaches that were used as a starting point for brainstorming.

IV.2.2.a. Social Aspects

The **'Happy to Chat' benches**[1] are a project that originated in New Castle (GB). They feature a simple sign which reads 'Sit here if you don't mind someone stopping to say hello'. Creating new meeting points for people to talk, they can also help integrating people with low income into the community as many of them cannot afford to go to regular meeting points like cafes or bars. Especially elder people and people who found regular meeting points too busy benefit from the project, but also the whole communities as it is designed to reduce loneliness and encourage community interaction.

The **Brothers in benches (Johannesburg, South Africa)**[2] have the aim of revitalizing public space and contributing to the community in innovative ways, street artists in Johannesburg designed modular urban furniture made by recycled wooden pallets. Each of the six units incorporates three interlocking components: In the center, there is a planter flanked by two benches with removable seats. Each one is on wheels and can be moved quickly and easily. The pop-up installation was rolled throughout the heart of Johannesburg to see the people interacting with it. They can be placed in different creative variations and bring 2 benefits for citizens: On the one hand, they create beautiful, cozy, easily changeable and relocatable places to stay and meet other people, and on the other hand, they bring a bit of green into the urban environment. The recycled wood material also makes them sustainable. The project was part of South Africa Absolut's residence program that gave six artists just two weeks to create community spaces.

Figure 12: Brothers in Benches, Southafrica[2]

In the first week of July 2021, the east Bavarian university association (Transfer and Innovation Ostbayern TRIO) organized so-called **"science bench[3]"** events in five cities. The citizens of Amberg, Deggendorf, Landshut, Passau and Regensburg had the opportunity to ask experts everything they ever wanted to know about the energy transition by sitting next to them on a bench in the middle of the city.

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[1] https://www.collaborativenewcastle.org/news/happy-to-chat-benches/

[2] https://www.designboom.com/design/r1-recycled-wooden-pallets-interlocking-mobile-benches-johannesburg-08-31-2014/

[3] https://www.easyres-project.eu/event/science-bench-passau/

The goal of the project was to connect with citizens in the region, to show them what options there are in the energy transition, how things are connected, what this means for them and also to give them the chance to talk about personal fears. This should be achieved through direct conversations at eye level.

IV.2.2.b. Electricity Supply Focus

One option for Smart Street Furniture is to set up solar benches which can produce their own energy, potentially including WiFi, wirless chargers or USB ports. These are not part of social projects, but rather set up in cities in order to offer additional services to the population.

A different solar-powered device are digital information signs[4] with apps that display, among other information, public transit times, weather, and events. Through the connection to the "internet of things" where different devices are wireless connected to exchange data, they help cities to make decisions about funding city developments, events, and other initiatives that impact the public.

Figure 13: Innovative Solar Tree Installation[4]

IV.2.2.c. Information and Engagement Focus

Figure 14: Infotainment on a Billboard Installation[5]

The final set of examples is aimed at a) informing and b) on top of this engaging people more thoroughly inte e.g. environmental or social information, education and a social, often human-lead communication.

Examples for installations that can help to educate citizens or children are interactive human powered science education installations. There are many options like a story ball that can tell stories or scientific contents or a whole playground that can be self-designed. It can playfully convey a specific scientific topic such as climate change or the energy transition.

The example shown here is an **interactive playground** in the Netherlands[5]. All of these installations are energy-self-sufficient. A very specific and successful concept of information combined with engagement is the co-called **"avenue of walking trees"** that has been realized in various cities in Germany, Austria, Switzerland, the Netherlands, Belgium and Poland. The first Wanderbaumallee project started 1992 in Munich.

The idea was to improve the urban climate and to create beautiful green places where people like to stay and meet in public. This was accomplished by planting trees in planters on rolling boards and moving them to different locations in the city where they were attached to streetlights or gutters for a certain period of time.

4 https://eduplaying.com/solar-tree/

5 https://eduplaying.com/custom-installations/

Figure 15: Avenue of Walking Trees, Cologne

Over the past 20 years, more than 60 Munich streets have been temporarily greened with 15 modules and 150 trees have been planted permanently. The initiators consider this as a success, as another strong concern was to promote permanent greening of the city. They also inspired other cities, which adopted and expanded the concept.

From a legal point of view, the modules are considered handcarts and can therefore be moved and parked on the road without registration according to the road traffic regulations. There is a preliminary agreement with the city of Cologne, in which it was stated that the Wanderbaumallee can wander in all city districts and stand at one location for 6-8 weeks at a time. In perspective, the city plans to adapt the special use statutes.

IV.2.3. RENergetic Solutions

There are generally two solutions for RENergetic PIs: one being a custom-made solution per pilot, e.g. if an initiative likes to design their own PI or there is an architectural chair at a local university that supports the idea. The second one is the design of a RENergetic PI that is adjustable and customizable and can be replicated anywhere. In the RENergetic approach both solutions exist alongside each other. Here the RENergetic modular design PI that was developed based on the requirements stated is being presented.

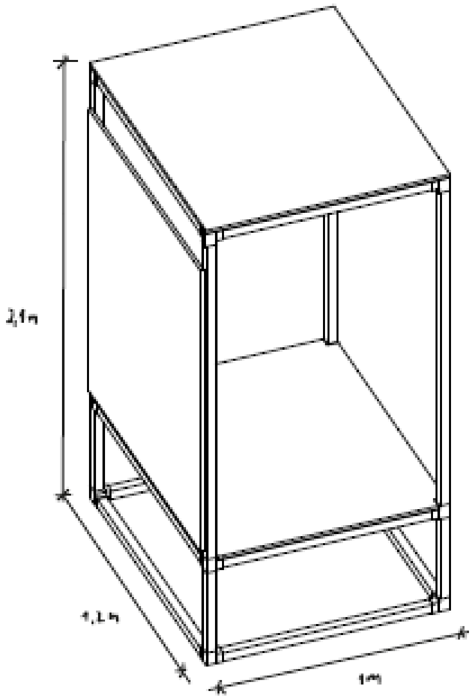
The approach to the RENergetic PI is a modular setting with a core module that can be adjusted with a set of different features and combined into a plethora of different installations of different sizes. It is designed to be weather-proof and thus to be displayed in the open, but due to the adaptable size it might also be installed inside a building.

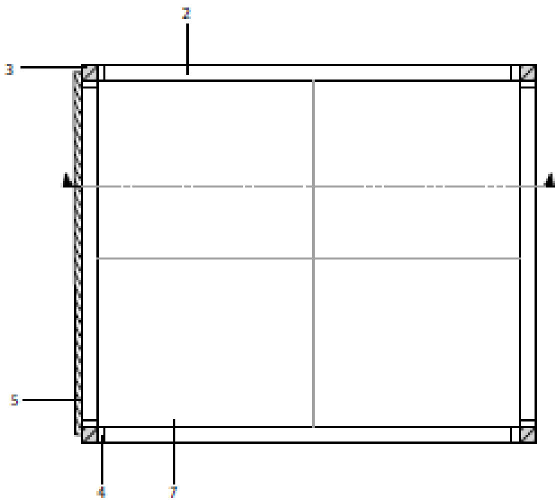
This core module has a base of 1,20m * 1 m and a hight of 2,10m. It can be entered from 2 sides; both inside and outside can be used for display of static or interactive information. The design is very simple and clear in order to allow for a customization of local initiatives and energy communities which fosters a psychological sense of community and helps creating a community identity. Construction data are given in the engineering detail drawing in Figure 17.

This core module can be equipped with several predesigned features:

- A solar cell on the ceiling to produce electricity which can be provided to e.g. a laptop or smartphone
- A seating plane to invite for lingering, accessible from two opposite sides
- A “table” plane that can be used either for working or presenting; also accessible from 2 sides
- Extra side planes to attach additional information.

The core modul comes with a stencil with the RENergetic logo to be attached to one of the information billboards.





physical installation legend

1 rooftop: plywood panel (treated)

2 beam: spruce-solidwood (treated, 40x40)

3 pillar: spruce-solidwood (treated, 40x40)

4 plug connection: metall

5 informationboard: plywood panel

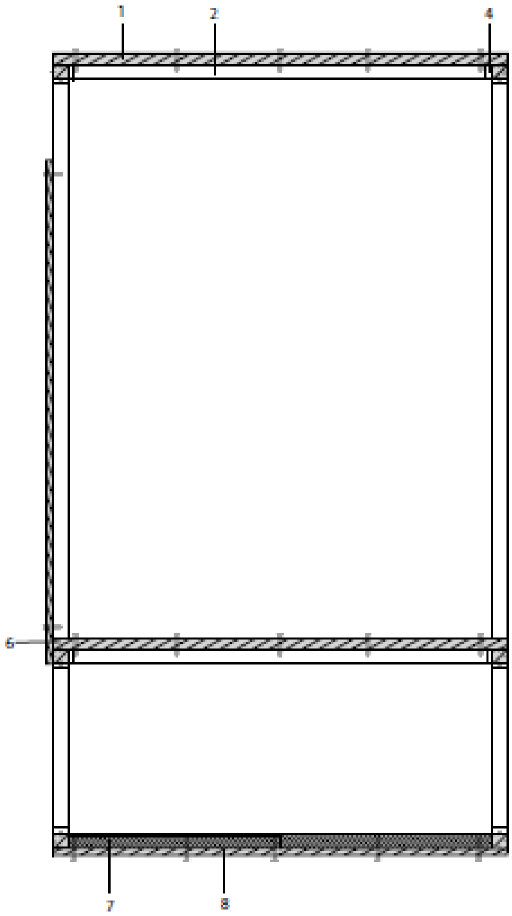
6 seat surface: plywood panel

7 foundation: flagstones (350kg)

8 bottom plate: plywood panel (treated)

potential addition: solar cell (not marked in the plans)

note: all values in millimeters



PROJECT	PINCIPAL	ARCHITECTS	**installation construction**
# installation ReEnergetic # location: Segrate (I)	#ReEnergetic	# Kensia Klinger # Hanna Dertinger # Bauhaus-Universität Weimar	technical drawings date: 31.01.22 site 1

Figure 16: Engineering Detail Drawing of RENergetic PI Solution

Different versions of the core module can be combined to form either just small info boxes or larger meeting spaces, as shown in Figure 18.

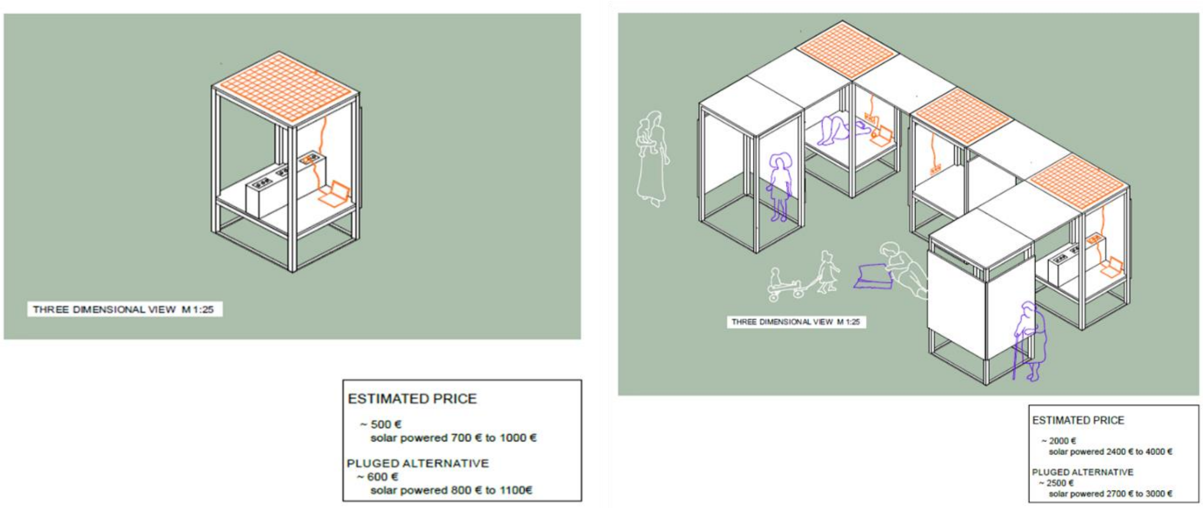


Figure 17: Different Physical Installations using Variants of the RENergetic PI Core Module

IV.3. Digital communication

Some decades ago, the PI would have been the main or even the sole means of communication and engagement of people. Today, the necessity of physical meetings is often being overlooked and replaced by digital communication. This, however underestimates people's need for physical interaction and personal bounding [54]. RENergetic uses both ways of communicating with people, selecting the best parts of both worlds. The connection between the physical and the digital communication is made by communication interfaces on the PI.

This PI communication interface offers a connection to digital services of the corresponding RENergetic site, first entering into a public web portal from which all kinds of interactive services as e.g. a user app to engage into common endeavors to save energy, implement manual demand response or educate against energy illiteracy.

In essence, this means that the PI digital interface offers a connection to the end-user front-end of the RENergetic IT system. There is obviously a high overlap with the WP3 task 3.6 of community engagement tools which is addressed through a high level of collaboration between these two workpackages on the frontend of the RENergetic IT system aimed at EI inhabitants (to be differentiated from the frontend aimed at EI technical and business managers). The success of RENergetic depends on a high level of inter- and even transdisciplinarity, for which the collaboration of WP2 & WP3 regarding the engagement tools is a very good example.This section gives a short introduction into this collaboration between psychological, engineering and computational science experts in the requirements engineering process; for the technical side please refer to the WP3 deliverable.

The requirements engineering process of the IT system from the beginning has been done in a user centric way, starting the the development of epics and user stories (see D3.1, chapters I and II). The transdisciplinary approach is explained for each step of the requirements process.

IV.3.1. Step 1: Definition of Epics

The way that epics (e.g. the heat DR epic) have been modelled includes not only computational concepts as optimization principles or rule-based concepts, but also the outcome of WP2 experiments (see section V.1) and literature analysis (see section II.1.2b) with regards to needs and constraints of people's activities. As an example, findings of the unified theory of acceptance and use of technology (UTAUT) [28] have been applied to this modelling step. e.g.

the requirement of end-users to overrule decisions made by a central optimization algorithm in order to maintain a feeling of control. For more information, please refer to section II.1.2b and D3.1, IV.4

IV.3.2. Step 2: Definition of User Stories from Epics

The user story approach to requirements engineering (see deliverable D3.1) puts the final end-user into the focus of an IT based system. It was chosen based on the RENergetic trans-disciplinary approach. The needs of users - in the case of RENergetic, these are the three general groups of “end-users of energy”, “EI managers” and the “sustainability evangelist” who represents EI environmental objectives – defines the system, hiding the logic in the back-end. These user stories were jointly discussed between members of WP2&3 as well as representatives of the pilot sites (WP4-6). Thus taking into account the multiple views of the different disciplines, to create some of these user stories used a lot of common effort.

IV.3.3. Step 3: Creating Mock-ups from User Stories

For instance, the user story that is aimed at engaging end-users into heating demand response in the beginning was based on a technical work that resulted in a red-light-representation of scarcity. This was then started to be poured into a mockup design process. It turned out however, that from a psychological point of view the resulting recommendations were unclear, so that in the end a simple arrow that point up or down informs users, if they should either increase their temperature for pre-heating to help using otherwise wasted “waste heat” or if the should decrease their temperature in order to avoid extensive usage of gas boilers (see Figure 19).

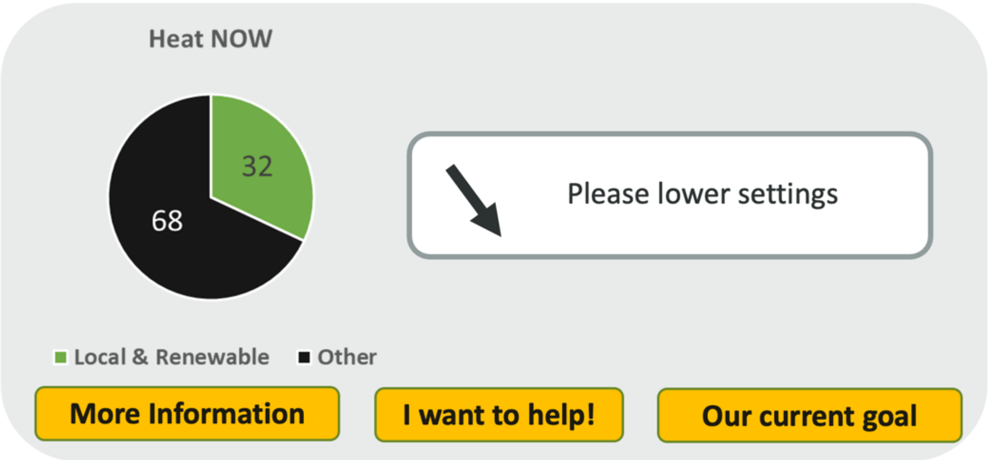


Figure 18: Draft of Mock-up for End-user Interaction for Heat Demand Response

IV.3.4. Step 4: Submitting Mockups for Implementation (Coding)

The last step in this process is the selection of a specific mockup design chosen from the various suggestions that were elaborated in a process of collaboration between the WPs 2-6. For the epic “Interactive Platform” this endeavor has been started with a testing process of various different end-user groups, e.g. the general public (representing passers-by), but also site members as inhabitants of the DuCoop area in Gent and technical students of PUT in Poznan. These tests are being carried through using interview guidelines created by WP2 personnel. The result of this step is the discovery of a high level of energy illiteracy in the general public which leads to a redesign process that strips the public version of the “interactive platform” from all complexity as shown in Figure 19.

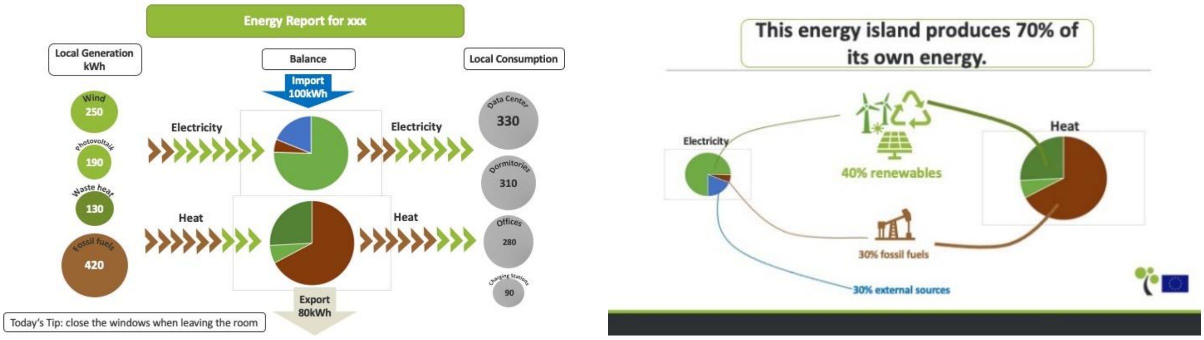


Figure 19: Mockup Drafts for Public before (left) and after (right) Testing with General Public Representatives.

V. CO-DESIGN ACTIVITIES PROJECT-WIDE AND AT THE PILOT SITES

V.1. Ghent Heat DR trial

V.1.1. Scenario

In the case of the Ghent Pilot and its waste heat supply of the soap factory ('Christeyns'), a special form of heat DR is emerging for the residents of the New Dokkens. The heat demand within New Dokkens shows clear heat demand peaks in the morning (between 8h and 10h), which cannot be met by the waste heat from Christeyns. In contrast, there is a greater supply of waste heat earlier in the morning (between 6h and 8h), which is not optimally utilized. Building on this opportunity, we developed a system of heat DR together with the Ghent project partner: With all households equipped with smart thermostats (= 48 households), we designed a trial that during the morning hours from 8h - 10h the heating is turned off (which only slightly affects the room temperature due to inertia). Instead, heating is shifted to before this peak, resulting in 'pre-heating'. This pre-heating should allow for peak reduction, better use of Christeyns waste heat, and mitigation of peak consumption between 8h and 10h. By such a measure we expected a very small impact on people's comfort. Accordingly, the households that were suitable for this scenario from a technical perspective were offered participation in a trial phase of this system. People could (a) opt out (b) compensate by overriding the thermostat, i.e., turning on/off. This enabling of overriding in the case of discomfort and complete transparency about the trial procedure aimed to create trust and allow feedback to be obtained later for this form of heat DR. The trial was conducted in the New Dokkens from end of January to end of March 2022.

V.1.2. Trial Concept

As the apartment number was too low for a regular randomized control trial (RCT) with different incentives and both ethical and logistic considerations did not allow for a control group design, we suggest a stepped wedge design, which is a more refined version of a randomized pre-post trial. Stepped-wedge randomized trial designs involve the sequential introduction of an intervention among participants (individuals or clusters) over a series of time points.

Accordingly, in the context of the New Dokkens, we proposed to address the tenants in successive weeks (steps = 12 households in each week for four weeks). By phasing in the measure in this way, tenants were part of a test phase in which they could gain experience and also had the opportunity to opt out of the trial. In addition, from a scientific perspective, the stepped wedge design allowed us to include time effects in the study. The procedure of the study is depicted in Figure 20.

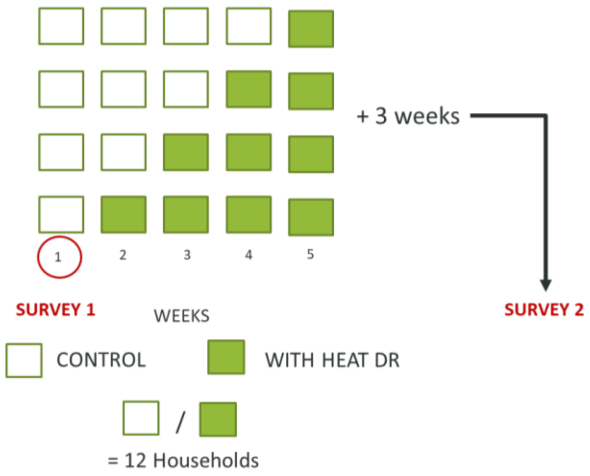


Figure 20. Study design for heat DR trial Ghent

The eligible households were first randomly assigned to four groups representing the four week stages of the stepped wedged design. Before the start of the trial, we sent out a survey which gave first indications of the planned test phase and mainly asked for social metrics and acceptance regarding the system. Subsequently, a flyer with the option to participate was sent to the households of each group, always with a week's interval, with all information related to the trial. Through a QR code on the flyer, the households could directly agree to participate. In the case of three days without feedback from a contacted household, the project partner then followed up again to see if there was interest in participating. If consent was given, the respective household was activated for the Heat DR system for the remainder of the existing trial time. Upon completion of the Trial, we sent a second survey to all participating households to allow for feedback and to all non-participating households to allow for group comparison.

The main goals of the study were to evaluate the benefits for the New Dokkens in terms of impact on Co2 emissions, as well as to better understand social motivators, barriers and impacts. The following research questions guided the trial:

- What is the adoption rate of such a heat DR program among New Dokkens households?
- What is the attitude of tenants towards such a system?
- What kind of potentially different compensatory behaviors do tenants exhibit when participating? What changes occur over time?
- What social factors (social cohesion, sense of belonging, perceived effectiveness) play a role for both acceptance and compensatory behaviors?

V.1.3. Incentives and information

To foster participation in the trial, we designed a flyer with all necessary information for participating households, for which we used a collective community framing (‘become a part of the community heat innovation’) and symbolic environmental incentives (‘only together we can make heating sustainable’). We also combined these incentives through strengthening a feeling of collective efficacy for Co2 reduction (‘the more households are in, the higher the effect’). Through a Q&A section of the back of the flyer, we applied principles of communication for trust, displaying transparency both about concept, technological implementation and timing of the trial. The flyer as well informed households about their possibility to overrule the automated setting, which was found to be an important condition for people to agree to heat DR concepts (see section 2.2 for more details). As the trial was designed in an opt-in style, a prompting QR Code made instant consent to participation available and contact details to our project partner offered an alternative way of agreeing to participation. The flyer is depicted in Figure 21.

Figure 21. Flyer for Ghent heat DR trial - frontside (left) and backside (right).

V.1.4. Metrics for Outcomes

To answer the research questions realted to the trial, different metrics are used to capture the outcomes. Next to the expected shifting of peak consumption, we were particlarly interested in acceptance rates and compensatory behaviors. Therefore, we checked for the acceptance rate, reflected by the amount of households agreeing to participate in relation to the amount of households being contacted. For this metric, we additionally assessed the 'way of opt-in': People could either opt in directly via the QR Code or through a personal contact of the project partner. For compensatory behaviors, we checked for all behavioral spillovers in household behavior, e.g. through an increased usage of warm water or overruling. These are depiected in Table 4.

Table 4. Metrics for potential compensatory behaviors in heat DR trial.

Metric	Granularity	Source	Availability
Electricity usage	Every 15 minutes (at least)	Grafana platform Digital meters	For the home-owners that decided to share this info
Warm water usage	1x per day	Grafana platform	For all users (depending on cloud connection)
Thermostat setting (the settings users choose)	Every 15 Minutes (at least)	Grafana platform	O/I for all users
Room temperature measured	Every 15 Minutes (at least)	Grafana platform	For users with home automation (OpenMotics)

Next to behavioral data, we also assessed social aspects, which were measured through a survey which was send both before and after the trial. We integrated concepts of the SIMPEA Model of collective action (e.g. social cohesion, collective efficacy beliefs), attitude towards the system and measures of thermal comfort next to demographical data.

V.1.5. Preliminary results

Initial results from the Ghent Trial show that the overall ask acceptance rate appears to be quite high: of 48 households that were approached, 37 ultimately decided to participate. One third of these agreed to participate directly via the QR code, while two thirds of the participating households only agreed through personal contact with the project partner. These descriptive statistics clearly show the important role that trust plays in the acceptance of such a system. The participation rate in the survey before the start of the trial was slightly lower (N = 21), with two-thirds male and one-third female participants. Most of the people who provided feedback on the survey came from two-person households. Figure 22 shows the described statistics.

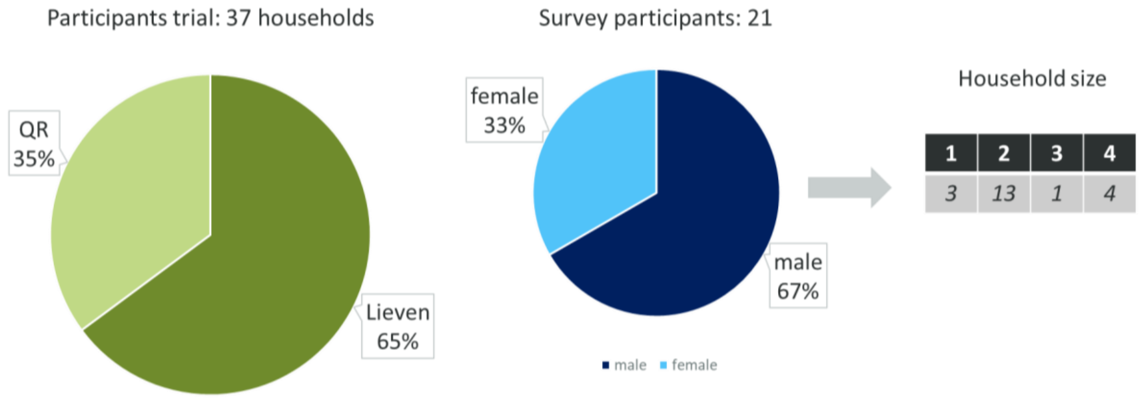


Figure 22. Participants of trial (left) and survey (right), with household size.

Since the evaluation of the second survey as well as the analysis of the behavioral data is still pending, only first analyses of the suryey data have been made so far. Figure 23 depicts the mean values of all included scales, all ranging from 1 to 7.

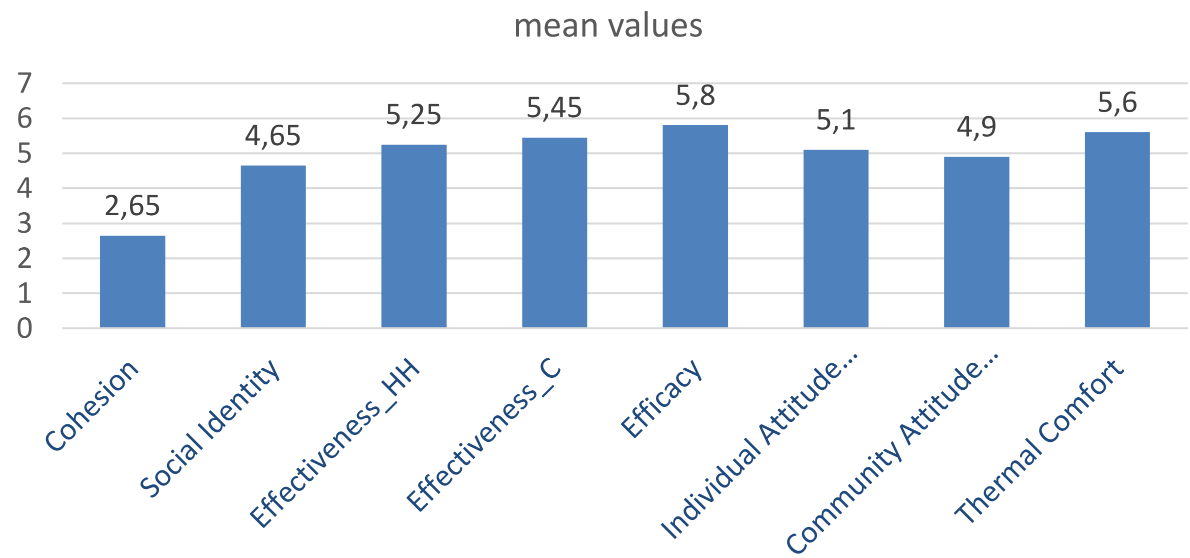


Figure 23. Mean values of all social aspects examined in the survey.

Here, in terms of people's attitudes toward such a system, is is apparent what is also reflected in the participation rates: On average, households have a rather positive attitude toward such a system (M = 5.1). In terms of perceived effectiveness, an interesting tendency emerges regarding the relevance of the action as a 'community' action: perceived effectiveness, i.e. the extent to which participants believe that (1) they as a community can actually make a difference by participating in Heat DR, is slightly higher than the belief that (2) they as an individual household can make a difference. This descriptive plot is shown in Figure 24.

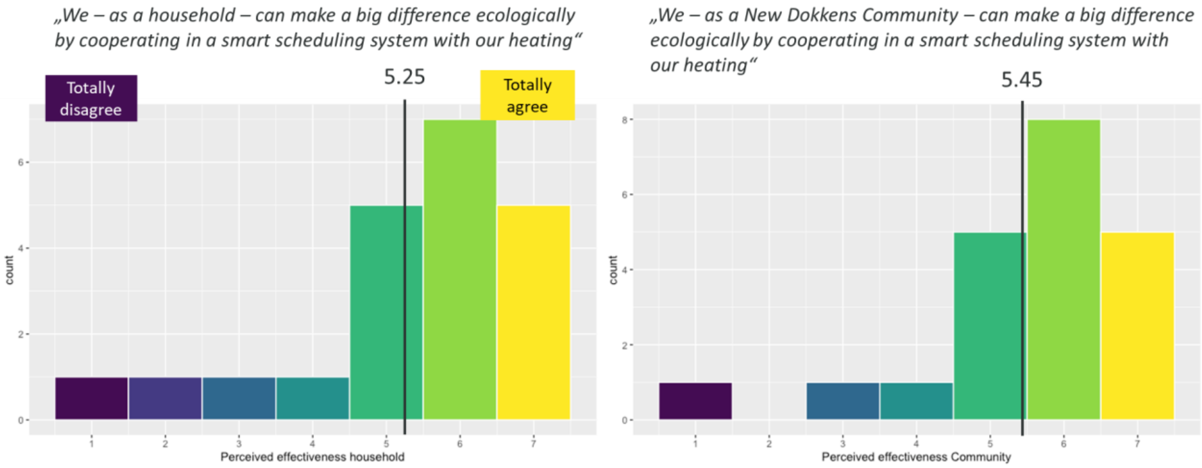


Figure 24. Descriptive statistics for 'personal effectiveness (left) vs. 'collective effectiveness' (right)

The next steps in the Ghent Trial will be to evaluate the behavioral data, measure the impact on CO2 reduction and success of peak shifting, and analyze the survey data in relation to the behavioral data shown (acceptance, other household behaviors).

V.2. Segrate Energy Game

V.2.1. Game concept

For the Segrate Pilot, citizen engagement plays a central role. To better understand the visions people have about their local energy transition in Segrate, we used a gamified approach to both engage the community to interact with the project and learn more about their priotities in local energy actions. This was enabled through an *’Energy Vision game’*, which was set up on a large scale on several boards and played on the public square of the city for several hours with interested passers-by. The game enabled decisions along four different aspects:

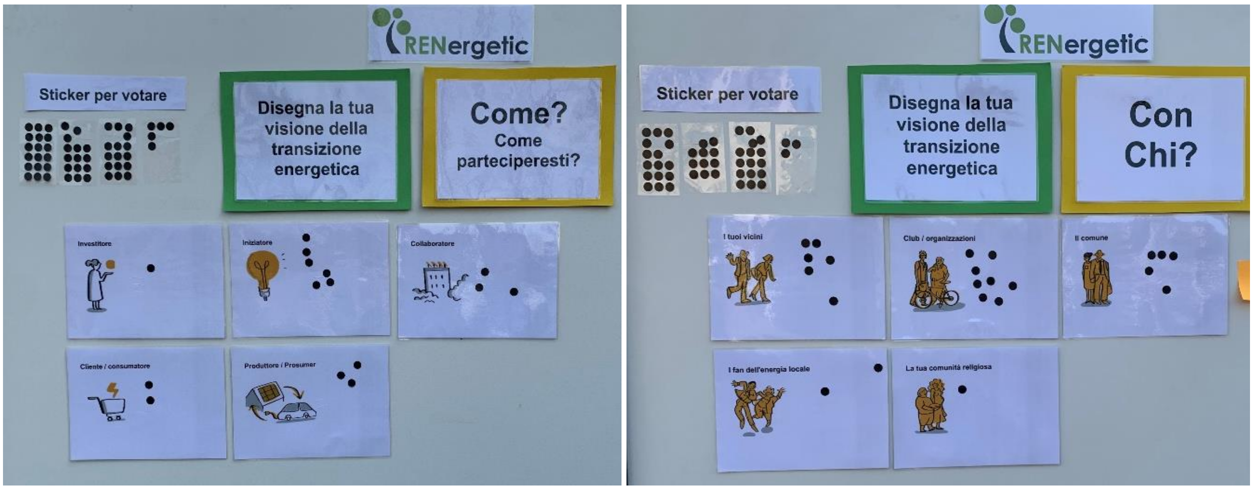
- Different actors, asking with whom people would organize their local energy transition together;
- Different roles, learning more about how people would participate;
- Ways of implementations, which refers to the types of actions people would support;
- Motivators, asking why people would take part

Several options were suggested and a voting system enabled people to set priorities and vote for (potentially more than one) factor. We were supported by local project partners to ensure a good communication with participants and possibilities for questions. Additionally, a ’children event’ happening at the same square and as well organized by the local project group supported to attract people into participation. The set-up of both activities is depicted in the following Figure 25.

Figure 25. Set-up of 'Energy Vision Game' in Segrate.

V.2.2. Game results

Game results were reported both through the voting preferences of people as well as through communication with the participants during the game: Participants were more likely to vote for technologies and actions that seemed more concrete and familiar to them: Here, solar energy on both public and private buildings played an important role. Participants saw themselves more as prosumers or even initiators in their local energy transition, and indicated that they wanted to do this primarily together with clubs / organizations or their neighbors. The clearest motivation to get engaged with a local energy transition was the fight against climate change, followed by social community reasons and energy self-sufficiency. However, caution must be used when interpreting these results: These only represent qualitative results from a very small sample. Nevertheless, the game stimulated many discussions and could provide some ideas as a first successful engagement activity. The voting results are displayed in Figure 26.



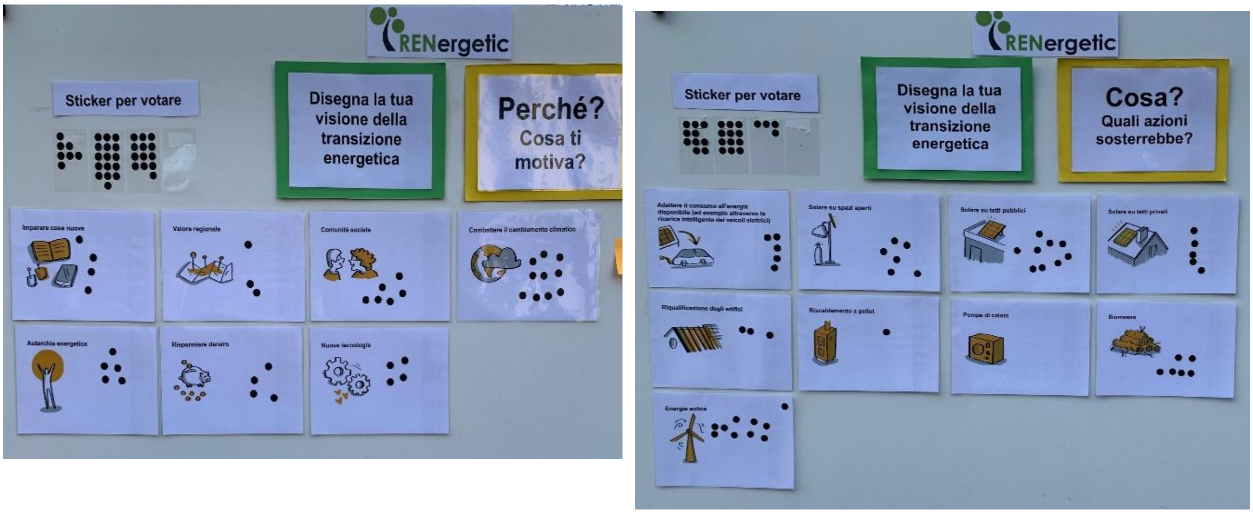


Figure 26. Voting results for roles (top left), actors (top right), motivators (bottom left) and actions (bottom right).

V.3. Survey about willingness to change behavior for heat DR

WP2 is currently in the final stages of preparation of a survey. In this survey, we will investigate whether individuals are willing to change their behavior in line with requirements set by the existing heat provision, i.e. participate in demand-response (DR).

The survey is currently planned to be carried out in five RENergetic relevant countries (Belgium, Poland, Italy, Austria, and Germany), with representative samples of 400 participants in each, to better understand barriers and motivators of agreement with heat DR.

In terms of content, participants will first be introduced to the concept of heat DR. For this, we are in the process of creating a story-board that will introduce the concept via a comic. Two fictional characters, Alice and Bob, will be confronted with the idea of turning their heat up or down depending on availability of heat in the grid (see Figure 27).

As part of the survey, there will be an intervention in the form of a 2x2 design, i.e. we will change the introduction on two factors – identity and regulatory focus. Each of these factors holds two levels. Identity will be varied by collective or individual identity. This means participants will either see a comic where the collective contribution is emphasized, or one in which the individual contribution is emphasized. Regulatory focus is a psychological concept of achievement motivation, and will be varied by prevention or promotion focus. This means participants will either see in the comic that Alice and Bob are accepting heat DR to prevent climate change, or to achieve gains. Based on the variation of these two factors, we will investigate which of them has a bigger effect to motivate participants to be more willing to themselves participate in potential head DR schemes in the future.

In terms of measurement, we will collect data on behavioral intentions, particularly what temperature band participants would feel comfortable accepting, and what would motivate them to adopt an automated adjustment of their temperature (for example saving money, protecting the environment, social motives) and what their main barriers are (for example comfort, loss of control, hassle). We would also check what alternative behaviors participants could imagine showing to increase their thermal comfort (wear a sweater, heating vest, hot-water bottles, warmer slippers, smart space heating devices). Finally, we will investigate believes about individual and collective effectiveness, norms and identity, as well as social cohesion and trust in people.

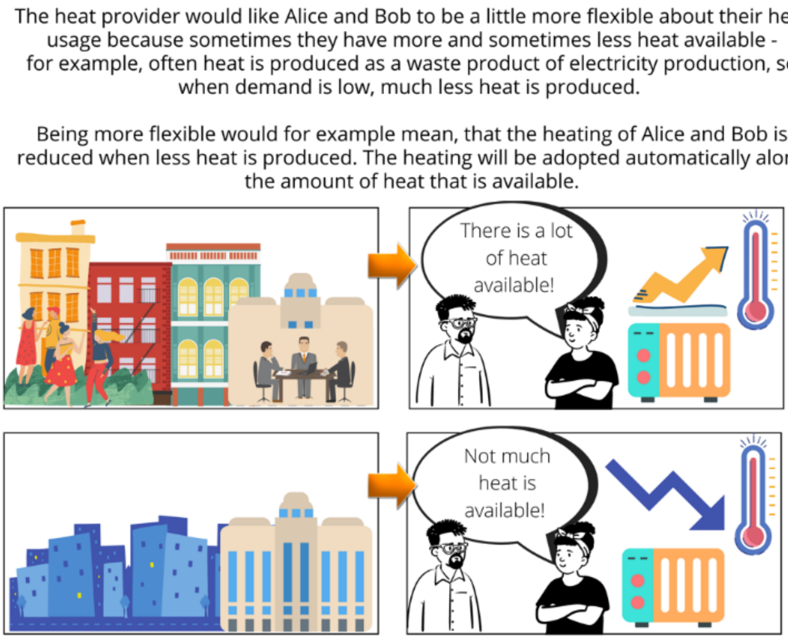


Figure 27. Preliminary example of a comic panel introducing the concept of heat DR to survey participants. Final version is currently under development.

The survey will be programmed in SoSci after storyboards are designed and is planned to run in summer 2022 with the support of a panel provider.

V.4. Future engagement activities

V.4.1. Co-creation events in Poznan accompanying the physical installation hub

In summer 2022, the first physical installation will be implemented in Poznan at PUT. Accompanying this physical installation will be a co-creation workshop with PUT students. Two student groups are targeted – firstly, students will be sought out to participate in set-up and arrangement of the physical installation itself. This group of students will be more activity oriented and will be asked to use tools and materials to help with and finalize the construction process. They will then collaborate with students who will be engaged specifically to help with the set-up of the content of the physical installation material. This second group will participate due to their motivation regarding climate change and interest in energy efficiency, and will contribute posters and information materials to display at the physical installation. These will include RENergetic related information, but can also showcase in-group related identity, and be related to university climate and energy-efficiency goals.

Following the set-up workshop, RENergetic members of Poznan will plan and carry out multiple co-creation events around the hub, showcasing some RENergetic findings and plans.

V.4.2. Social engagement Gent supporting BRIGHT

RENergetic's sister project BRIGHT[6] is currently designing a social engagement regular meeting at the New Dokkens in Gent to create a stronger feeling of community and draw individuals that want to be more directly involved in a variety of activities that can help energy

[6] https://www.brightproject.eu/

efficiency and improve on climate related goals. The current plan is to set up such a community meeting 3-4x per year. As part of the ongoing cooperation between the two projects, RENergetic will provide support for the development of these social engagement meetings in the form of internal workshops as needed. These workshops will serve to provide a post-event analysis of meetings that occurred, and introduce new tools and ideas how to engage members of the community better in the future.

V.4.3. Tools to replicate the Physical Installations

As part of the replication goals of RENergetic, WP2's Physical Installations will be agile, modular, and easily replicable across a variety of contexts. To facilitate replicability, set-up of the installations will be documented in a video, provided with detailed instructions on which materials are required and how to construct the installations from scratch.

V.4.4. EV Charging Flexibility Indication Gent

Part of RENergetic's goal is to enable EV smart charging, charging flexibility and EV demand response. As part of this epic, WP2 will aid in designing interventions that can support the implementation and testing of smart charging in the Gent pilot site. Options are to measure behavioral and attitude shifts when charging start is shifted, or interruptions during charging are introduced to increase charging flexibility. Behavioral shifts could for example be tested when information is be presented to EV drivers in different ways: important information could be highlighted for reasons of energy efficiency, grid stability or pricing. In Figure 28, we showcase a preliminary first design of one possible presentation option to highlight certain characteristics at the charging station for the user. Further designs and interventions will be planned in collaboration with project partners.

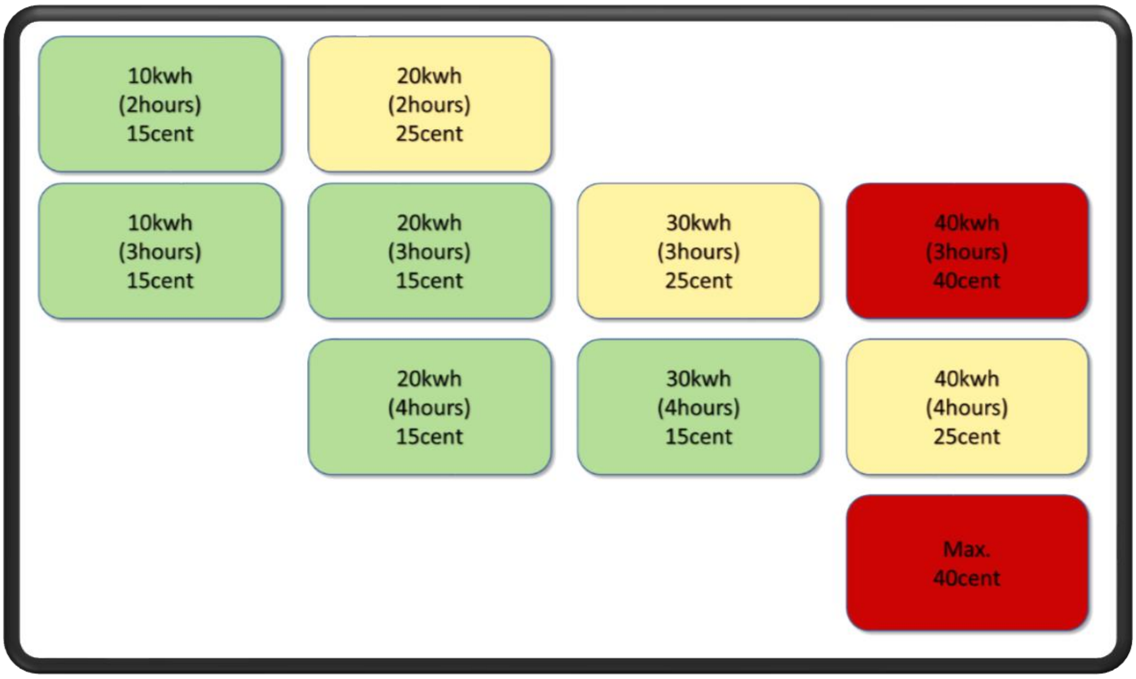


Figure 28. Preliminary design of EV DR charging selection options for customers; includes the charging speed, duration of charging and cost of charging. Color coding displays the currently optimal charging options for customers for easier selection.

V.4.5. Surveys at pilot sites

Surveys are planned at all pilot sites. In those pilot sites where heat demand response is an option (Gent, Poznan), we will provide a pilot-specific, adapted version of the heat demand survey described in IV.4. to get a better understanding about inhabitants' willingness to participante in heat DR.

In all pilot sites, we are considering conducting mini-surveys on collective actions, specifically social cohesion and efficacy. One such survey has already been conducted in Gent in tandem with the experimental heat DR intervention that was carried out there (see section IV.1). Another small survey is planned accompanying the physical installation set-up in Poznan in summer 2022. An EV charging flexibility trial in Gent will also be accompanied by a small survey if possible. Finally, in Segrate, a survey will be conducted to measure inhabitants' willingness to participate in co-creation activities.

VI. References and Internet Links

[IEEE citation style] https://library.concordia.ca/help/citing/ieee.php

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VII. Appendix

VII.1. Interview guidelines example

VII.1.1. Heat DR Interview: Residents (incl. resident students)

Explanation of Heat DR:

Demand response can be used for heating. Sometimes a heat manager might need their customers to use less energy for heating: For example, because in that moment, heat production is very difficult, or everyone is using a lot of energy at the same time. It could be helpful for an automated system to adjust the temperature setting in the building for a short period of time using a remote signal. Most likely for the consumer, this drop in heat would be very small, less than one degree, and within a pre-defined temperature band (such as 19 -21 degrees). This temperature band would be defined by you in advance and the option to override the automated optimization would always be available.

Motivation & Barriers

1. *From your point of view, what advantages would you expect from such an automatic regulation of your heat?*
    - *In general? (**Prompt**: Financial? Environmental? For building managers? Heat providers?)*
    - *What added value could it offer you personally? (**Prompt**: Save money? Help the environment? Cool gadget that lets you better steer your own heating?)*
2. *What would motivate you to accept such a heat demand response?*
    - ***Prompt**: Financial incentives? Environmental incentives? More control over the heat regulation, if tech allows it?*
3. *From your point of view, what would you worry about with such heat demand response?*
    - ***Prompt**: Privacy? Hassle? Too difficult? What others think, i.e. it gets too cold while you have visitors? Just generally worried? What emotions does it cause?*

Event-based requirement of Heat DR:

Sometimes, you might be asked to react to an event that requires you to manually lower your heating even lower than an agreed upon temperature span (for example if you had said 19-20 degrees, the system might ask you to lower it to 18 for the next hour). Would this affect your previous responses?

- ***Prompt**: More hassle? Too difficult? Definitely too cold now? Just generally worried? What emotions does it cause?*

Functionalities

4. *If heat demand response included an interface/dashboard with feedback: What kind of feedback would you like to receive?*

Alternative Behavior:

5. *If you were to allow the automated technology to sometimes reduce the temperature so that the room becomes cooler – How would you react? What alternatives would you resort to if you were cold?*

- **Prompts as examples**: put on a pullover / use a hot water bottle / manually override the system

VII.1.2. Stakeholder interview: EV Smart Charging

Explanation of EV Smart Charging:

Demand response can be used for EV charging, often also called smart charging. The goal of such smart charging is to control the charging in terms of timing and/or power, i.e., basically when and how fast the battery of your car is being charged while the car is parked. One reason could for example be to use more of renewable energy when it is available.

(1) Booking in advance:

You could for example have an app, where you can see a forecast for the availability of renewable energy for charging for the next day. This means you get an easily understandable graphic, which could for example be a red, yellow and green light for the time slots of the next 24hrs. This graphic or symbol will show you when charging is best for the use of renewable energy (green). The app will give you the possibility to book (reserve) a spot for your charging and show you when spots are already booked by others.

Motivation & Barriers

1. *From your point of view, what advantages would you expect from planning your charging based on signals about renewable energy as described? In general? (**Prompt**: Financial? Environmental? For managers? Energy providers?)*
    - *What added value could it offer you personally? (**Prompt**: Save money? Help the environment? Cool gadget that lets you plan your own charging?)*
2. *What would motivate you to book your charging in advance, based on signals about renewable energy?*
    - ***Prompt**: Financial incentives? Environmental incentives? More control over the charging process, if tech allows it? Less hassle with charging process? More security for a charging spot?*
3. *From your point of view, what would you worry about using such system for charging?*
    - ***Prompt**: Privacy? Hassle? Too difficult? Emergency charging? Just generally worried? What emotions does it cause?*

Functions:

4. *If you were to try out an app with this kind of charging system: What functionalities would you wish for?*

(2) Smart Charging at the stations:

At the charging stations, you could be asked to make the choice whether you need to “fill up the car” as fast as possible or whether you are more flexible; in the flexible selection, you can input a time at which you will pick up the car. In this case, the system can then adjust when and/or how fast the charging is executed so that the use of renewable energy is optimized and the grid is less stressed (for example if it’s a time of high demand and everyone else is charging too).

Motivation & Barriers

5. *From your point of view, what advantages would you expect from allowing flexible smart charging? In general? (**Prompt**: Financial? Environmental? For managers? Energy providers?)*
    - *What added value could it offer you personally? (**Prompt**: Save money? Help the environment? Cool gadget that lets you steer your own charging?)*
6. *What would motivate you to decide for the option where you charge your car flexibly based on the energy available instead of "as soon as possible"?*
    - ***Prompt**: Financial incentives? Environmental incentives?*
7. *From your point of view, what would you worry about deciding for flexible smart charging?*
    - ***Prompt**: Privacy? Hassle? Too difficult? Charge might not be enough for the next drive? Just generally worried? What emotions does it cause?*

Functions:

8. *If such smart EV charging would also include having a dashboard with feedback about your charging process and status: What kind of feedback would you like to receive?*