RESPOND
DEMAND RESPONSE FOR ALL

# Integrated Demand REsponse SOlution Towards Energy POsitive NeighbourhooDs

## WP3 User engagement process

*T3.3 Detailing the user context and improvements of user interaction*

# D3.3 Findings and recommendations from focus groups on user context



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# EXECUTIVE SUMMARY

This deliverable is part of the project *Integrated Demand REsponse SOlution Towards Energy POsitive NeighbourhooDs* (RESPOND) and it reports the activities and findings from Task 3.3 *Detailing the user context and improvements of user interaction*. The main goal of this task was to collect data on the user context from the pilot sites in order to make it possible to adapt the tested demand response model to the specific locality and the users' everyday practices. The goal of this was to ensure that the pilots will work in actual user context and to avoid unsuitable design features that could cause participant dropout. The qualitative method of focus groups has been used to collect feedback, knowledge and recommendations from the prospective users of the RESPOND solutions and mobile app. Focus groups is an ideal method for collecting detailed feedback from a group of people on a chosen topic.

Focus groups with local pilot site participants (residents) were carried out at the pilot sites in Madrid, Aarhus and on Aran Islands. The findings from the focus groups formed the basis of the analysis and development of recommendations on how to design the RESPOND solutions and the mobile app in order to optimize usability and user engagement.

The findings and general recommendations are summarized in relation to the following overall themes (Section 3):

- Demand response of electricity consumption in general
- Dynamic electricity pricing
- Demand response to optimize self-sufficiency
- Efficiency and demand response related to cooling
- Existing preferences/habits regarding heating
- Demand response for heating
- Feedback on preliminary version of RESPOND mobile app

Without going into detail with all the findings related to the above themes, key observations from the focus groups, with implications for the final design of RESPOND demand response solution and mobile app, are:

- Dishwashing and laundry come up across all sites as the types of electricity consumption that the focus group participants find most likely and practical to time-shift. Other types of electricity consumption are found to be difficult to time-shift. However, the Madrid focus group participants appear to be those most inclined to consider also time shifting other electricity-consuming activities.
- The focus groups show that whether people are working or not (i.e. at home or not during daylight hours) is important for how difficult and realistic it is perceived to time shift

consumption, although this might be less decisive in the Madrid case as many households here have housekeepers staying at home during the day.

- With regard to automation or remote control of demand response actions (e.g. time shifting dishwashing), the focus groups come up with mixed results. Many favour the idea of automation or remote control, but several also find it attractive if they just can get notifications/recommendations via the mobile app about when it is optimal for them to consume energy.
- With regard to variable electricity prices (dynamic pricing), the consensus across focus groups is that real-time pricing is too difficult to follow, while many find the static Time-of-Use pricing much simpler and easier to follow (e.g. to build daily routines around). Peak Production Rebates also got a positive reception on general, especially in Aarhus as this scheme could help them optimise the consumption of their local renewable electricity production (PVs)
- Money saving is in general seen as a key motivational driver for changing daily habits and do demand response actions. However, also other motivational drivers are mentioned such as doing something good for the environment or the positive feeling of consuming local renewable energy. The latter seems to be another important motivational driver that might have a similar strength as money savings. Some participants even found it motivating to compete with others to be best at consuming local renewable energy. Thus, information about self-sufficiency is important to integrate in the RESPOND solutions and mobile app.
- In Madrid, demand response of air cooling was discussed. Consensus was that at least some of the cooling could be time shifted (e.g. by using mechanical ventilators instead of air conditioning).
- The Aarhus focus group on heating shows a high diversity between households regarding heating practices and preferences as well as often idiosyncratic approaches of the individual households on how to control and adjust heating. This diversity needs to be considered when designing the RESPOND solution and mobile app, as these must be flexible to accommodate to various heating practices and control routines.
- The RESPOND demand response solution for heating, which is going to be trialled in Aarhus, was overall well-received by the Aarhus focus group participants. There is agreement that the demand response scheme (temperature set-back in morning hours with a short pre-heating before set-back) must be automated. Also, it should be easy to "override" the automated control in cases of deviations in peoples' daily routines or if they feel the temperature is not as desired.
- The focus groups provided much feedback on the preliminary RESPOND mobile app design. Some of the key recommendations and observations are: The app should not be too complicated to use and navigate in, although it might be a good idea to have "two levels" of user interfaces to accommodate different user needs: One simple level with access to key features and information for the household (a kind of "dashboard"), and another level with more detailed information, settings and control features. The latter is

for the more advanced and/or engaged users. Across focus groups, there was also a widespread interest in getting access to appliance-specific breakdowns of the electricity consumption of households. The idea of comparing the energy performance of the individual household to the performance of neighbours got a mixed reception; comparing the level of individual self-sufficiency was the type of comparison that attracted most interest. Furthermore, the idea of recommendations and notifications on, e.g., optimal demand response actions was in general well-received. See Section 3.7 for further details on the specific features of the mobile app.

The deliverable concludes with presenting four different usage scenarios. The aim of this is to "translate" the findings from the focus groups into a limited number of scenarios with recommendations on how the design of the RESPOND solutions in general – and the RESPOND app specifically – can be tailored/adapted to the everyday practices, needs and wishes of the residents (as reported in the focus groups). Each scenario focuses on one specific usage (feature/function) of the RESPOND demand response solution and app. The scenarios are brief (condensed) descriptions of how certain functions/services (to be developed in RESPOND) could be experienced from a user perspective (i.e. the perspective of the pilot site residents). The four scenarios are: 1) demand response of heating; 2) Peak production rebates and local demand response; 3) demand response of cooling; and 4) Automated and remote control of appliances.

Finally, the deliverable concludes with some proposals for competitions that might be set up at the local pilot sites in order to promote the pilot households interest and engagement in the RESPOND demand response solutions and mobile app.

# TABLE OF CONTENTS

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ALBOA | Almen Boligorganisation Aarhus |
| DR | Demand Response |
| DHW | Domestic Hot Water |
| DSM | Demand-Side Management |
| ICT | Information and Communication Technologies |
| PPR | Peak Production Rebates |
| PV | Photovoltaics |
| RTP | Real-time pricing |
| ToU | Time-of-Use (pricing) |
| WiFi | Wireless Fidelity (radio wireless local area networking) |

# 1. INTRODUCTION

This deliverable D3.3 *Findings and recommendations from focus groups on user context* presents the work and findings of Task 3.3 *Detailing the user context and improvements of user interaction*, which is part of WP3 *User engagement process* of the RESPOND project.

The aim of Task 3.3 was to collect data on the user context from the pilot sites needed for adapting the tested demand response (DR) model to the specific locality and actual users' everyday practices. The goal of this is to ensure that the RESPOND DR solutions and mobile app will work in actual user context and to avoid unsuitable design features that do not engage users and could cause participant dropout. Activities undertaken in Task 3.3 have also focused on collecting qualitative data on user experiences that contributes to the pilot evaluation and further design improvements of the DR model (input for WP6 *Validation and replication of project results*).

More specific, Task 3.3 has carried out focus groups with participants from the pilot site households in Madrid, Aarhus and on Aran Islands. The aim of the focus groups has been to collect the pilot site participants' reactions and perspectives in relation to performing DR in relation to heating/cooling and electricity consumption (appliance use). This has included presenting preliminary concepts of the RESPOND solutions to get the participants feedback on how they think these will fit with their own everyday life and daily practices (e.g. in relation to their needs of thermal comfort). Another aim of the focus groups has been to get the participants' comments on a preliminary version ("mock-up") of the RESPOND mobile app in order to get their feedback on the usability of the app and their suggestions for possible improvements. The outcome of the focus groups provides a better understanding of the user context and feed into the final design of the DR solution.

Below, the procedure of the work in Task 3.3 is described in more detail. The following section (Section 2) presents the applied focus group method and the specific design of the focus groups carried at the pilot sites. Section 3 presents the focus group findings and analysis. This section gives a detailed insight into what the focus group participants think about the RESPOND solutions, how the solutions fit with their own everyday practices and their suggestions about improvements that would make the solutions work better for them. The section includes concrete comments and recommendations related to the specific features of the RESPOND mobile app. On basis of the focus group findings, Section 4 develops four usage scenarios. The aim of these scenarios is to translate the findings into more tangible recommendations about how the RESPOND solutions and the RESPOND app should be designed in order to optimize user friendliness and user engagement. The scenarios take into account the everyday setting of the pilot participants. The scenarios should inform the final design of the solutions by being condensed representations of the user needs and considerations.

## 1.1 PROCEDURE OF TASK 3.3

The focus groups were carried out by the local pilot partners (FEN in Madrid, ARAN on Aran Islands and AURA – in collaboration with AAU – in Aarhus). In order to ensure consistency across pilot sites regarding how the focus groups were carried out, a detailed guideline on the focus group design (including practical advices on how to carry them out) was prepared by AAU. The pilot partners reviewed a draft of the guideline for comments and suggestions.

The final guideline was ready by March 2019 and has been included in this deliverable as Appendix 1.

In order to tailor the individual focus groups to the local context of the pilot sites, the pilot partners prepared the topics to be discussed in the local focus groups by modifying the topics suggested in the general guidelines (Appendix 1). For instance, DR of heating is less relevant to discuss in Madrid than in, e.g., Aarhus due to differences in weather and climate. Instead, it is more relevant to discuss DR of air cooling in Madrid, and therefore one of the focus groups in Madrid focused on the participants' view on DR of heating, while one of the Aarhus focus groups focused on heating instead (cooling is not relevant in a Danish context). By tailoring the specific focus group topics and questions to the local settings of the pilots, it was ensured that the focus group discussions would be relevant to the participants and provide the relevant findings for the final analysis and recommendations. The design of the individual focus groups, including the wording of topics and questions posed to the participants, is reported Section 2.2.

The focus groups in Aarhus were carried out in January 2019 on basis of a preliminary version of the focus group guidelines. The Aarhus focus groups were carried out earlier than in Madrid and on Aran Islands in order to make it possible to incorporate the experiences from Aarhus in the final guidelines. The focus groups in Madrid were carried out in May 2019, while the focus group on Aran Islands was carried out in July 2019. In total, 37 RESPOND participants from the local sites took part in the focus groups; 24 men and 13 women.

In order to ensure consistency in how the findings from the focus groups were reported to AAU for the final (comparative) analysis, AAU developed a guideline/template on how the pilot partners should prepare the summaries of the individual focus groups (see Appendix 2).

On basis of the summaries from the individual focus groups, AAU prepared the final analysis and recommendations reported in this deliverable.

# 2. METHODS AND FOCUS GROUP DESIGN

To provide empirical input from the coming users (participating households) on the user context of the app and what they think about the user interfaces and the DR design, focus groups were established at the three pilot sites.

Since the expertise on how to perform focus groups is situated at AAU in Denmark, a detailed guideline was prepared, see Appendix 1, to be followed by local project participants at the pilot sites in Madrid and at Aran Islands, as well as in Aarhus. The following section is a shortened version of the guideline to provide an overview of the method used.

## 2.1 INTRODUCTION TO FOCUS GROUPS AS A QUALITATIVE METHOD

### 2.1.1 WHAT IS A FOCUS GROUP?

A focus group is a moderated group discussion about a chosen subject. In our case, the subject was the planned DR solution (including mock-ups of the mobile app user interface) and what the households think about taking active part in DR actions. In the focus group, the discussion among the participants takes departure in a limited number of topics, each with predefined questions. Focus groups typically last 1-2 hours and are moderated by 1-2 persons, so called “moderators”, in our case researchers and/or staff from the local pilot site partners. As a “moderator” of a focus group, one’s main objective is to keep the discussion running (ideally without influencing the participants’ statements) and keep the discussion within the theme of the focus group. Part of the moderators’ task is to create a relaxed and inclusive atmosphere so that all participants feel safe and comfortable to contribute to the discussion.

How to prepare and carry out the focus groups are detailed in Appendix 1, under the following headlines:

- Doing focus groups – the role as moderator
- How to handle late arrivals?
- How to handle persons who dominate the discussion?
- Being two moderators?
- How to introduce the focus group to the participants?
- How to finish the focus group (“outro”)
- How to recruit the participants? And avoid absence?
- Make a clear appointment and inform clearly about time, place etc.
- Time and place

### 2.1.2 DOCUMENTING THE FOCUS GROUPS

The focus groups were recorded on Dictaphone (audiotaping) for later preparation of focus group summaries and analysis. However, one exception from this was the focus groups in Madrid, where recording was not done because the local pilot site partners judged that the pilot site participants would feel it uncomfortable to be recorded. Instead, detailed written summaries of the discussions were done during the focus groups.

## 2.2 THE DESIGN OF THE RESPOND FOCUS GROUPS

At each of the three pilot sites, focus groups were carried out with different local participants. The specific topics and questions discussed at the focus groups for each pilot site were adjusted to the specific local site context and is reported below. The following is an overview of overarching topics covered by the five individual focus groups at the three pilot sites:

| **Topic** | **Aran Islands** | **Madrid** *Cooling/DHW* | **Madrid** *Electricity* | **Aarhus** *Electricity* | **Aarhus** *Heating* |
|---|---|---|---|---|---|
| DR to optimize self-sufficiency from local energy production (solar power and heat) | Yes | Yes | No | Partly | No |
| Efficiency and DR related to cooling | No | Yes | No | No | No |
| DR of electricity consumption in general | Partly | No | Yes | Yes | No |
| Dynamic electricity pricing schemes | No | No | Yes | Yes | No |
| Existing preferences/habits regarding heating | No | No | No | No | Yes |
| DR solution for heating | No | No | No | No | Yes |
| Feedback on RESPOND app | Yes | Yes | Yes | Yes | Yes |

The results from the focus group discussions of the above topics are presented in section 3.

Below is an outline of the specific topics and questions discussed at the three pilot sites. At each pilot site, the moderator introduced the topic by a discussion starter and kept the discussion going by a series of follow-up questions. A detailed description of the methods and questions used at the five focus groups are in their full length presented in Appendix 3 to 7.

### 2.2.1 AARHUS (DENMARK)

The two focus groups in Aarhus were performed by the experts on focus group from AAU, and were the first to be performed. Therefore, the method used here were used as part of developing the guidelines, Appendix 1, that the other pilot site partners should use when performing focus groups in Madrid and at Aran Islands.

#### FOCUS GROUP ON DR IN RELATION TO ELECTRICITY CONSUMPTION

This focus group related to the RESPOND measures targeted DR actions in relation to electricity consumption for other purposes than heating (i.e. mainly appliance use). As the pilot households are expected to take part in some amount of “active (manual) DR actions”,

this was the topic of this focus group. Focus was on how the participants perceive (understand) this, what they think about it and how it will fit into their daily habits and practices? The discussed topics moved from a general discussion of DR and time shift of own energy consumption over discussing alternative variable pricing schemes to discussing the specific RESPOND solution and app.

**Time, place and participant recruiting**

The focus group took place on Wednesday 30 January 2019 from 6.30 pm to 8.10 pm at the "common room" called "Ny & Næ" situated inside the ALBOA settlement. The participants were tenants of the ALBOA housing association who are RESPOND pilot families. They were recruited through a written invitation sent by email to the pilot households about a month in advance of the planned focus group. Before sending the invitation, the 20 pilot households were divided into two groups of equal size (one group were invited for this focus group, and the other for the focus group on heating).

The group division was done strategically in order to obtain a diverse composition of each focus group regarding age, family type, household size, educational background and ethnicity. Sandwiches, chocolate, coffee and soft drinks were offered at the focus groups to help motivate tenants to participate, because the time of the meeting coincided with the typical dinner time for Danish families.

**Participants**

All participants were from the same settlement. There were 6 men and 2 women representing 6 households since two couples participated. Two of the represented households had children living at home, while three households included retired people. The last household included a couple in their working age, but with no children living at home.

**Group process and dynamics**

All participants arrived on time. During the focus group, there were no problems with unexpected interruptions or noise from outside. Overall, the physical surroundings for the focus group were very suitable for the purpose and well known by the participants.

The local contact person welcomed the participants and introduced the evening's program and gave a brief status of the RESPOND activities in the settlement including the installation of the new hardware. In the beginning, the tenants talked freely about the installed devices and their concern/questions were handled. It all happened in a good mood and generated some laughs. During this introduction the participants were served sandwiches and drinks. After the general introduction, the lead moderator introduced the procedure of the focus group (what is a focus group, what to expect, an overall introduction of the three topics, etc.). After this, the focus group discussions began (see later summaries of these).

During the focus group discussion, the participants alternated between directing their talk towards each other or to the moderators, respectively. However, they were in general good at commenting on each other's statements. In this way, the focus group succeeded in creating several instances of shared discussion and elaborations among the participants.

We had one deviation from the original planned procedure (cf. the focus group guide) as the main moderator at the beginning of the focus group forgot to let the participants introduce themselves. Thus, the presentation round was carried out between topic 1 and topic 2 instead. This was not ideal, but it did not seem to have a serious impact on the discussions.

Overall, the focus group discussions happened in a good mood and often with laughs and friendly teasing. In total, including the moderators' introduction, the focus group lasted 1 hour and 32 minutes.

**Topics and discussion starters**

Discussion starter and follow-up questions for **Topic 1: General attitude towards demand response**:

a. Discussion starter: We are getting more and more renewable energy into the energy system. Much of the renewable energy – for instance wind and sun – is difficult to control and the production of energy is intermittent. This creates a new challenge: Sometimes we produce more energy than is needed – and at other times the energy consumption exceeds the energy we get from renewable energy sources. Therefore, there is a need to make consumption follow production. One way is to make households shift their consumption in time, so they move some of their consumption from hours with little renewable energy to hours with much renewable energy. For example moving consumption to night hours when the wind blows or to midday hours when the sun shines. *Discuss what you think about the idea of moving your own electricity consumption in time?*

b. Follow-up questions (comments to moderator on how to moderate in brackets []):

   I. Discuss what types of electricity consumption you *would be able to* shift in time in your own household? [If people are finding it difficult to come up with ideas, introduce a few examples – e.g. laundering or dishwashing?]

   II. What challenges do you think could be related to time shift your consumption?

   III. Discuss what types of electricity consumption you *would be willing to* time-shift in your own everyday life?

   IV. What would motivate you to time shift your consumption? [Should be open – try not to "steer" the discussion from the outset by giving examples like money saving or the environment. Save these examples to later, if needed to activate the discussion.]

   V. What types of electricity consumption would you not be able to time shift? Why not?

Discussion starter and follow-up questions for **Topic 2: Discussion of alternative ToU pricing schemes**:

a. Discussion starter: Three different forms of Time-of-Use (ToU) pricing are presented to the participants for discussion. Each form of ToU pricing is illustrated on a sheet of paper (see Appendix 4), which are spread out on the table to support the discussion among the participants. The Topic begins with a general introduction by the moderator: "Today, most households have a fixed price, which means that they pay the same price for electricity regardless of when they consume it. However, it is suggested to introduce variable electricity prices to regular customers in the future. I.e. prices that in one way or the other varies according the patterns of renewable electricity production. The assumption is that this will help to motivate people to start time-shifting their own electricity consumption to save money by consuming at hours with low prices in order to better match the intermittent production from renewable energy sources. In this topic, we are going to discuss what you think about this on basis of three different suggestions to variable price models…"

   Following this general introduction, the moderator introduced the three different ToU schemes, which are:

   i. Scheme 1 – Real-time pricing (RTP): The price of electricity reflects the present (real-time) balance between production and consumption of the overall energy system. I.e. prices change on an hourly basis and can only be predicted about 24 hours ahead. Prices reflect the status of the national electricity system.

   ii. Scheme 2 – Static ToU pricing: The 24h day is divided into a few time intervals with different prices. E.g. low during night hours and extra high during peak hours in the morning and evening. The prices and time intervals are the same every day. Prices reflects the status of the national electricity system.

   iii. Scheme 3 – Peak Production Rebates (PPR): In this scheme, the price is in general flat, but during situations with a particularly high *local* renewable energy production (from solar or wind power), the residents are offered considerably lower prices for consumption in these hours. Residents are informed up to maximum 12 hours before the PPR. Prices reflect local renewable power production.

   Following this introduction, the moderator asks this discussion starter question: *What do you think about these three alternative pricing schemes? What would be pros and cons for each of them?*

b. Follow-up questions:

   i. Is there one of the schemes you would favour personally? And why?

ii. Could you be interested in opting into one of these schemes, if it was offered to you?

iii. If thinking of your daily life and if trying to follow one of these schemes, which one do you believe will fit best to you and your way of living? Why and how?

iv. Do you have any ideas on how these schemes could be improved in order to make them (more) attractive to you?

v. Do you have suggestions for other types of schemes that would be more attractive?

Discussion starter and follow-up questions for **Topic 3: Discussion of RESPOND solution and mobile app**:

a. Discussion starter: The participants get a few hands-outs spread out on the table (see Appendix 4) showing a selected number (4-6) of functionalities (i.e. "pages") in the mobile app. The moderator briefly explained the overall DR approach to be utilized within the pilot site and the functionalities of each of the selected mock-up mobile app pages. After this presentation, the following discussion-starter question were asked: *Please, consider how you could personally make use of this and discuss your immediate reactions to it. What do you think about it? How would this fit with your everyday life at home and in your family?*

b. Follow-up question:

   i. What do you think about the design of the mobile app? Does it make sense to you? Something that's difficult to understand? Any suggestions for improvement?

## FOCUS GROUP ON DR IN RELATION TO HEATING

This focus group related to the RESPOND measures targeted DR actions in relation to heating dwellings (cooling is normally not used in Danish dwellings). This was the topic of the focus group, as the Aarhus pilot households are planned to take part in some amount of automated DR actions. The DR actions will relate to the control of heating (heating and domestic hot water are provided by a district heating company) - allowing the tenants to individually adjustment of the temperature level combined with automatic switching off the heat shortly in the morning to reduce the peak consumption of district heating. Focus was on how the participants perceive (understand) this, what they think about it and how it will fit into their daily habits and practices. The discussed topics moved from a general discussion of DR and time shift of their own energy consumption to discussing specific RESPOND solutions and app functionalities.

### Time, place and participant recruiting

The focus group took place on Tuesday 29 January 2019 from 6.30 pm to 8.10 pm at the "common room" called "Ny & Næ" situated inside the ALBOA settlement. The participants were tenants of the ALBOA housing association and among the participating RESPOND pilot families. They were recruited through a written invitation sent by email to the pilot households about a month in advance of the planned focus group. Before sending the invitation, the 20 pilot households were divided into two groups of equal size (one group was invited for this focus group, and the other for the focus group on electricity).

The group division was done strategically in order to obtain a diverse composition of each focus group regarding age, family type, household size, educational background and ethnicity. Sandwiches, chocolate, coffee and soft drinks were offered to help motivate tenants to participate, because the time of the meeting collided with the typical dinner time for Danish families.

### Participants

All participants were from the same settlement. There were 4 men and 5 women representing 7 households since two couples participated. Four of the represented households had children living at home, while two households included retired people. The last household included a couple in their working age, but with no children living at home.

### Group process and dynamics

All participants arrived on time except one that arrived around six minutes after everybody else were seated, but before the topics to be discussed were introduced. Overall, the physical surroundings for the focus group were very suitable for the purpose and well known by the participants. There were no problems with unexpected interruptions or noise from outside during the focus group meeting.

The AURA contact person welcomed the participants and introduced the evening's program, the lead moderator and co-moderator, and gave a brief status of the RESPOND activities in the settlement including the installation of the new hardware. To begin with, the tenants talked freely, mainly with the local contact, about the installed devices, and their concerns/questions were handled. There were some talking about the devices, e.g. they do not look good and some needed ("sticky") tape for mounting them securely to the wall. It was asked if the plugs can be moved, but since some plugs are used as "extenders" for the internet (data)connection, it may not be a good idea to move them to another electrical device (the intention is that plugs shall be used on washing machine, dryer and dishwasher).

After the introduction, the lead moderator introduced the procedure of the focus group (what is a focus group, what to expect, an overall introduction of the three topics, etc.). After this, the focus group discussions began.

During the focus group discussion, the participants alternated between directing their talk towards each other and to the moderators, respectively. In general, they were good at commenting on each other's statements. In this way, the focus group succeeded in creating several instances of shared discussion and elaborations among the participants. One of the

reasons for this might be that they all knew each other well on beforehand, e.g. from a lunch club. Overall, there was a cheerful mood among the participants, including some chitchatting and "friendly teasing" of each other. In total, including the moderators' introduction, the focus group lasted 1 hour and 40 minutes.

**Topics and discussion starters**

To better understand how to design solutions that fit well into existing heating practices, the focus group started with a more general discussion of the participants' existing habits and preferences regarding heating (Topic 1). Then followed two topics that explored the participants general attitude to time-shifting heating (Topic 2) and their thoughts on the specific RESPOND solution and app specifically (Topic. 3).

Discussion starter and follow-up questions for **Topic 1: Existing preferences and habits regarding heating**:

a. Discussion-starter: How do you experience the heating in your current dwelling? Is it something you are thinking about?
    i. Do you or other members of your household sometimes feel it too hot or too cold? In what situations? Who? And what do you do then?
b. Discussion-starter: How do you decide what temperature you prefer at home? And why that specific temperature?
    i. Do you heat all rooms in the same way (same temperature)? Or do you have different temperatures in different rooms? Why?
    ii. How do you air your home? In what situations do you open windows or doors to air?
c. Do you sometimes turn up or down the heat, i.e. adjusting the thermostat settings? When and why? And who?
    i. Do you turn up or down the heating (and temperature) on a day-to-day or week-to-week basis? How and why? Or do you keep the same temperatures and settings without adjusting them on a continuous basis? Why?
    ii. Who is in general controlling the heating (or cooling) at your home? Is it something that all members of your household do? Or is it specific persons? Why?

Discussion starter and follow-up questions for **Topic 2: General discussion of participants' reactions to the idea of time-shifting heating**:

a. Discussion starter: The moderator explained the underlying idea and concept behind time-shifting heating (no specific focus on RESPOND app; see Topic 3). For various reasons, the district heating suppliers would like to make it possible to time-shift some of the heating in homes. The most important reason for this is

that the suppliers in various areas are experiencing a problem with delivering enough heat (e.g. if there has been new-built of homes) – especially in the morning when the heat consumption peaks due to showering etc. This means that the suppliers either have to invest in upgrading the pipes in the ground (which might cost a lot of money and make the heat more expensive for customers) or – alternatively – find ways to time-shift some of the consumption away from the peak hours. One way to do the latter is to install equipment in homes that can control the heating in the morning. In this way, the company could turn off the heat shortly during the few hours with peak consumption, e.g. between 6 and 9 am. Of course only with the prior acceptance from the tenants. For buildings like those here in ALBOA, this would only result in a limited drop in temperature during the hours when the heating is turned off. Roughly, the temperature drops about 1 degree Celsius per hour. To maintain the temperature within a comfortable range the temperature may be slightly raised before turning off the heat. In RESPOND, we will try out such an approach here in ALBOA…

Discussion-starter question: *What do you think about this approach? How would this fit with the daily routines and needs of you and your family? Pros or cons?*

b. Follow-up questions:

   i. Would you be interested in taking part in this sort of scheme (if you were not pilot family in the RESPOND project)? What could make it interesting for you to take part in this type of scheme?

   ii. What would be the most important challenges in relation to time shifting heating? And what could be done to handle these challenges?

   iii. Could there be situations where turning off the heating in the morning would contradict with other considerations or needs?

   iv. Would it make a difference for your experience of such a scheme whether it is weekday or weekend? Or holiday or not?

Discussion starter and follow-up questions for **Topic 3: Discussion of RESPOND solution and mobile app**:

a. Discussion starter: The moderator introduces the RESPOND app by placing a few hand-outs on the table that show selected mobile app functionalities, see Appendix 3. The moderator briefly explains the pages. After this short introduction, the moderator asks the following discussion-starter question: *Please discuss what you think about this? You can discuss both the design of the app and its functionalities.*

b. Follow-up questions:

   i. What functionalities do you think you would find interesting to use?

   ii. What do you think about the design of the mobile app? Does it make sense to you? Something that is difficult to understand?

   iii. Any suggestions for improvement?

   iv. Would you be interested in getting information or recommendations on your heat and electricity consumption via the mobile app (e.g. compared to the energy consumption of your neighbours)? What sort of feedback? And how often?

   v. Would it be possible to communicate about the time-shift of heating, as we talked about before, by using the App? What functionalities shall be available if all communication shall be handled through the App?

### 2.2.2 MADRID (SPAIN)

#### FOCUS GROUP ON ELECTRICITY FOR ELECTRIC APPLIANCES

This focus group related to electricity for electric appliances. The aim of the focus group was to collect participants' feedback, comments, relevant routines and habits in order to consider this valuable information for the development of RESPOND solution design. The focus group covered topics related to electricity consumption and DR, different alternative dynamic pricing schemes and the RESPOND solution/mobile app.

**Time, place and participant recruitment**

The focus groups took place on Thursday 9 May 2019 in the afternoon at a "common area" situated inside the pilot site. The room is usually used for neighbourhood meetings and it was considered as an adequate place because of its proximity to the participants' home location and also because of the familiarity that the participants have with the space chosen. Also, it was easy and practical for all participants to attend. The participants were RESPOND pilot site families that live in the dwellings.

The recruiting was done during a neighborhood's meeting hold about one and a half month in advance of the planned focus group. In addition, about a week in advance of the meeting date, an invitation letter was sent to the participants and a poster was hung in a visible place of the interior of the pilot building with the purpose of informing them about the time and division of groups.

The households have similar characteristics regarding social, economic status and ethnicity, and they are either retired people or families composed by couples and in some cases children. So we strategically divided the groups in order to balance retired individuals and working individuals, splitting them into the two groups.

The 10 pilot households were divided into two groups of equal size and one group was invited to the electricity for electric appliances focus group and the other to the cooling/DHW focus group (see later).

The time of the meeting was the afternoon, which usually is time of busy activities for the participants, as some of them have children in the families, are at work/coming back from work, exercise or have responsibilities to do. But anyhow, the vast majority of the invited families attended to the meeting and all participants arrived on time. It should be noted that some participants invited to the second focus group at 6.00 pm arrived at 5.00 pm, so there were some spectators during the first focus group hold at 5.00 pm. This could indicate that the event generated some curiosity and expectations, or at least the invited participants were willing to have a good time among neighbors having afternoon snacks.

**Participants**

All participants were from the same building. There were 5 men and 2 women representing 5 households since two couples participated.

Three of the represented households had children living at home, while two households included retired people with no children at home. So, we had a sample composed by a mix of retired people and adults with children living at home. To be noticed the high percentage of dwellings with housekeeper helping with the home duties at least some hours per day.

**Group process and dynamics**

The local contact welcomed the participants in a relaxed atmosphere. At the beginning of the meeting, the participants talked among themselves and with the organizers. Then, all sat down. There was a table with material for the focus groups. The participants sat down at the front rows, the moderator and co-moderator were situated behind the table, the minute taker was situated at the last row, behind all participants.

A brief informal round of presentations was done. The co-moderator presented the lead moderator (who was the only person that is not familiar for the participants). The minute taker briefly commented about the actual status of the RESPOND project, and afterwards, all invited participants were invited to present themselves (name and if possible, informing about number of habitants at home, employ/retired situation, housekeeper (yes/no). All participants collaborated and presentations proceed smoothly.

Afterwards, the moderator introduced the focus group (what it was, what to expect), he explained the dynamic. After this, the focus group discussions began.

The focus group proceeded in a cheerful, relaxed mood. Participants were in a collaborative mood, they seemed to be comfortable.

**Topics and discussion starters**

Discussion starter and follow-up questions for **Topic 1: Demand Response introduction**:

a. The energy grid is gradually changing, going to a greener model direction, where consumers have a more participative role in the system and are becoming even producers, so-called ”prosumers”. This new model implies to make some changes in the way of consuming energy as the production/consumption curves need to be balanced. *What do you think about the idea of changing the times of your own electricity consumption?*

b. Follow-up questions:

    i. We asked for types of electricity consumption.

    ii. Time-shifting and other possibilities (suitable devices): Which appliances would you be able to really time-shift?

    iii. Motivations: What are the motivations for time shifting?

    iv. Availability?

    v. Suggestions?

Discussion starter and follow-up questions for **Topic 2: Discussion of alternative pricing schemes**:

a. The lead moderator introduced the theme explaining that we are used to have fixed prices for domestic use of electricity and there are other possibilities of variable prices that could help people start being more flexible and make them change their consumption patterns with the motivation of consuming greener energy, as well as, for cost savings. He showed the participants three different alternatives models of Time-of-Use pricing schemes:

    i. Scheme 1 – Real-time pricing (RTP): Electricity price varies from hour to hour and in different ways from day to day. The electricity prices of the next day is announced the day before.

    ii. Scheme 2 – Static ToU pricing: The electricity varies a few times a day and follows a static scheme. Same scheme every day.

    iii. Scheme 3 – Peak Production Rebates (PPR): Fixed flat electricity price except rebates in cases of local surplus of wind or solar power. The hours of rebates (lower price) is announced the day before.

Following this introduction, the moderator asked the following discussion-starter questions: *Do you think variable prices schemes could be an option instead of fixed prices? Do you find advantages?*

b. Follow-up questions:
    i. Types of pricing. Is there one of these schemes you would favour personally? Why?
    ii. Current situation. What tariff do you currently have?
    iii. Do you think you could get used to a tariff with variable prices?
    iv. Preferences?
    v. Suggestions?

Discussion starter and follow-up questions for **Topic 3: Discussion of RESPOND solution and mobile app**:

a. Discussion starter questions: The participants got some mock-ups from the RESPOND mobile app functionalities, see Appendix 6, and the moderator asked them about their opinion and feedback.
b. Follow-up questions:
    i. What would you like to see in the mobile app? [The start page mock-up was shown to the participants.]
    ii. [Other mock-up pages were shown to the participants] and a discussion about user interface/design was opened.
    iii. Feedback messages. Which kind of notifications would you like to see?
    iv. Control actions related to electricity for electric appliances. Which kind of automated control actions do you believe you could allow/follow? We provided examples. Which kind of recommendation do you think you could follow? We provided examples.

### FOCUS GROUP ON COOLING/DHW

This focus group related to cooling and Domestic Hot Water (DHW).

The aim of the focus group was to collect participants' feedback, comments, relevant routines and habits in order to consider this valuable information for the development of RESPOND solution design. The purpose was, in other words, to review, adjust and validate the previous ideas that RESPOND consortium had for the DR actions and the functionalities of the mobile app. For this purpose, the moderator raised questions to discuss about cooling patterns and DR, the use of DHW and DR and feedback on the RESPOND solution/mobile app.

### Time, place and participant recruitment

The focus groups took place on Thursday 9 May 2019 at a “common area” situated inside the pilot site. The room is usually used for neighbourhood meetings and it was considered as an adequate place because of its proximity to the participants’ home location and because of the familiarity that the participants have with the space. Also, we tried to make it easy and practical for all participants to attend. The participants were RESPOND pilot families that live in the dwellings.

The recruiting was done during a neighborhood’s meeting hold about one and a half month in advance of the planned focus group. In addition, about a week in advance of the meeting date, an invitation letter was sent to the participants and a poster was hung in a visible place of the interior of the pilot building with the purpose of informing them about the time and division of groups.

The households have similar characteristics regarding social, economic status and ethnicity, and they are either retired people or families composed by couples and in some cases children. Therefore, we strategically divided the groups in order to balance retired individuals and working individuals, splitting them into the two groups.

The 10 pilot households were divided into two groups of equal size. One group was invited to the electricity for electric appliances focus group and the other group to the cooling/DHW focus group.

The time of the meeting was the afternoon, which usually is time of busy activities for the participants, as some of them have children in the families, are at work/coming back from work, exercise or have responsibilities to do. But anyhow, most of the invited families attended to the meeting and all participants arrived on time.

### Participants

All participants were from the same settlement. There were 4 men and 2 women representing 4 households since two couples participated.

Two of the represented households had children living at home, while two households included retired people with no children at home.

### Group process and dynamics

The local contact welcomed the participants in a cheerful and relaxed atmosphere. Some participants were already in the room as spectators of the first focus group on electricity appliances held one hour before (see earlier). The participants were talking among them and with the organizers. Then, all sat down. There was a table with material for the focus groups. The participants sat down at the front rows, the moderator and co-moderator were situated behind the table, the minute taker was situated at the last row, behind all participants.

A brief informal round of presentations was done. The co-moderator presented the lead moderator (who was the only person that is not familiar for the participants). The minute

taker briefly commented about the actual status of RESPOND project and afterwards all invited participants were invited to present themselves (name and if possible, informing about number of habitants at home, employ/retired situation, housekeeper (yes/no). All participants collaborated and presentations proceed smoothly.

Afterwards, the moderator introduced the focus group, he explained the dynamic (that consisted in three topics with a starter question and follow-up questions. After this, the focus group discussions began.

The participants seemed to be comfortable. The dynamic scheduled was followed: the moderator presented the topic to be discussed, then he raised the starter question and the participants answered, moreover the follow-up questions were raised followed by the participants' answers.

**Topics and discussion starters**

Discussion starter and follow-up questions for **Topic 1: Preferences and habits about cooling**:

a. In Madrid city we have warm/hot weather conditions during several months every year, the temperatures are even increasing with the global climatic changes, during this period of time, people consume a high volume of energy used to cool their houses. The idea is to consume energy in a more efficient way in order to contribute to the preservation of the planet resources and to take care of the environment. Besides, an efficient management of the energy contributes to economic savings. *Do you think you could change some habits related to cooling of your houses?*

b. Follow-up questions:

   I. Cooling schedules?

   II. Could these schedules be time-shifted? How and when? Disadvantages?

   III. All the house at the same temperature?

   IV. Temperature settings reasons and people in charge?

   V. Suggestions?

Discussion starter and follow-up questions for **Topic 2: DHW time-shifting indexes to thermosolar production**:

a. The lead moderator introduced the topic explaining that it would be interesting to encourage the consumption of DHW when the thermosolar installation is producing energy. He explained that an energy grid with an increasing percentage of renewable energy requires time-shifting schedules to adapt the consumption curve to the generation curve in order to balance the energy system. *He asked if they would be able to adapt their DHW consumption habits to new routines on the thermosolar basis?*

b. Follow-up questions:
    i. DHW consumption patterns: When do they use DHW (and for which purposes)?
    ii. DHW time-shifting: Could some of this DHW be shifted in time? What consumption and how? And if not, why not?
    iii. Thermosolar generation satisfaction: Are you happy with the available temperature? And the "reaction time" since they open the tap and the hot water achieves the desired temperature?
    iv. Suggestions?

Discussion starter and follow-up questions for **Topic 3: Discussion of RESPOND solution and mobile app**:

a. Discussion starter: The participants got some mock-ups from the RESPOND mobile app functionalities, see Appendix 5, and were asked for their feedback.
b. Follow-up questions:
    I. What would you like to see in the mobile app? [The start page mock-up was shown to the participants.]
    II. [Other mock-up pages were shown to the participants] and a discussion about user interface/design was opened.
    III. Feedback messages. Which kind of notifications would you like to see?
    IV. Control actions related to cooling/DHW. Which kind of automated control actions do you believe you could allow/follow? Which kind of recommendations do you think you could follow?

### 2.2.3 ARAN ISLANDS (IRELAND)

#### FOCUS GROUP ON DR IN RELATION TO ENERGY CONSUMPTION

This focus group related to the DR actions in relation to electricity/hot water consumption among the participants of the RESPOND project on the Aran Islands. There are several types of households participating in RESPOND on Aran. They can be broken down into homes with PV panels and homes with solar thermal panels. DR functions and flexibility are mostly available to households who produce their own electricity as it has the most flexible usage. Householders with solar thermal panels are more restricted in terms of DR functions as time shifting the hot water produced is more difficult. This group discussed two topics: 1) Time shifting of the energy (electrical or thermal) produced by the renewable installations on each individuals home. 2) The RESPOND solution and app (Functions and Capabilities).

### Time, Place and Participant recruiting

This focus group took place on Tuesday the 30th July in the evening. All Aran Islands participants in the RESPOND project were invited to participate in this focus group. This was done to allow for the maximum possible attendance as the focus group was conducted during the busiest time of year, in the middle of the tourist season. Most of the participants are involved in one way or another with the tourist season, or act as hosts to teenagers during the summer months who come to the island to learn the Irish language.

All participants were invited personally by phone call where possible or else by text message by the local project leader/lead moderator, who outlined the reason for the focus group and explained its importance to the project. It was held in Halla Rónán, the local community hall on Aran. To try and ensure a good turnout, participants were told that we would aim to keep the focus group to one hour.

### Participants

There were seven participants at this focus group, representing six of the 12 households, one couple participated. There were 5 males and 2 females in total. The participants covered a wide range of demographics, some were retired/working/self-employed, ranging in age from late teens to early seventies. Some participants had adult children living at home.

This focus group was led by a lead moderator and two co-moderators. One of the co moderators was newly appointed by the Aran Pilot Site manager to complete the outstanding RESPOND installation at the Aran Pilot just the week before the focus group and attended the focus group to take notes. The other co-moderator helped to facilitate the focus group and co-moderated also.

### Group Process and Dynamics

Most participants arrived on time, however two arrived only for the second discussion topic. Overall, the focus group was very informal with a pleasant, friendly atmosphere, and mostly led by the participants themselves. All participants provided valuable feedback and opinions on the topics.

The lead moderator, who has been the RESPOND contact person until now, welcomed the group and introduced the other two co-moderators. As the Aran pilot is a very small community, all participants and moderators were known to each other before the RESPOND project. The lead moderator also gave an outline of the status of the project relating to the Aran Pilot and the timeline expected for the installations to be completed. At first, the participants talked freely about the project and also some topics not related to the project but to island life in general, this helped to keep the mood of the session very informal and relaxed.

The lead moderator then introduced the agenda for the session and gave a brief explanation of both topics of discussion that were planned and explained that the session should stay very informal and that people were welcome to speak freely. The lead moderator also explained that in order to summarise the session afterwards, one of the moderators would be taking some notes during the session and that she would like to audio record the focus

group. The lead moderator reassured everyone that all participants would be anonymised and only she would be listening to the recording afterwards.

The focus group went very smoothly for the most part, with all participants in a jovial mood and very open to the suggestions of others. Most participants agreed on almost everything throughout the session. The entire focus group lasted about 1 hour and 10 minutes from beginning to end.

**Topics and discussion starters**

Discussion starter and follow-up questions for **Topic 1 General attitude towards demand response**

a. Discussion starter: The renewable energy systems installed in each of your homes comes from solar, which can be difficult to control and is very intermittent. Often there is a surplus of 'free' energy, and at other times (often when it is needed) there is a deficit. One way to combat this is to time shift some of the consumption within a household to make sure you are getting the benefit of the renewables you have invested in. For example, moving certain consumption to the middle of the day for PV, or using hot water in the evening rather than during the day (so that as much as possible of the energy used to heat it is from the sun, and not from a top up with the immersion heater/boiler/heat pump etc).
b. Follow up questions:
    I. What types of consumption would you be able to/willing to time shift?
    II. What is the biggest consumers of electricity/hot water in your household? Could that be time shifted?
    III. What challenges would arise from this?
    IV. What would be the biggest motivation for you to time shift some of your consumption?

Discussion starter and follow-up questions for **Topic 2 Discussion on RESPOND solution and mobile app**:

a. Printed versions of the mock-up of the RESPOND app were distributed to the participants showing some of the proposed functionalities available in the mobile app, see Appendix 7. The lead moderator explained each of these functionalities in turn. Participants were asked their immediate reaction to the mock-up.
b. Follow up questions: What do you think of the design of the app? Is there anything you don't understand? Is there anything you think could be improved? Would you be willing to allow remote controlling of the appliances in your home? (either remotely operated by you or automatically set to turn on/off through the app itself).

# 3. FOCUS GROUP FINDINGS, ANALYSIS AND RECOMMENDATIONS

A template on how to prepare a focus group summary was made by the experts from AAU to make sure that the data analysis followed the same outline, see Appendix 2. The template outlines the different sections of the summaries and briefly describes the focus and content of each section. For further inspiration on how to write the summaries, the summaries from the Danish focus groups, Appendix 3 and 4, were also distributed as they were finished first.

The findings and analysis from the five focus groups in their full length are presented in Appendix 3 to 7.

The findings and analysis of the five focus groups are summarised and discussed under the following seven overarching topics:

- DR of electricity consumption in general
- Dynamic electricity pricing
- DR to optimize self-sufficiency
- Efficiency and DR related to cooling
- Existing preferences/habits regarding heating
- DR solution for heating
- Feedback on RESPOND app

The chapter concludes with summarizing the main conclusions and the implications (recommendations) of these for the final design of RESPOND DR solution and mobile app.

## 3.1 DR OF ELECTRICITY CONSUMPTION IN GENERAL

The theme of time-shifting electricity consumption in order to help balance generation and demand at the overall (system) level was a separate discussion topic at the Madrid and Aarhus focus groups on electricity. Also, the theme was partly discussed in the Aran Islands focus group (as part of the topic on general attitudes towards DR) even though this was specifically framed in context of local micro-generation, cf. section 3.3). In this section, we report and compare the findings from the focus groups discussions.

**Dishwashing and laundry come up across all sites as the types of electricity consumption that are most likely and practical to time-shift.** On Aran Islands, several households have already been making efforts to time shift their energy consumption, including time-shifting laundry and dishwashing, which is related to the fact that these households are prosumers (solar power and heating). A primary motivational driver for the Aran Island homes to time shift their consumption is that there are no feed-in tariffs in Ireland

for prosumers, which means that households do not get paid for delivering surplus electricity to the grid from PV. This appears to be a strong incentive. One participant, who have time-shifted laundry and dishwashing for some time, explains that this has been very successful and resulted in a decrease in their bills over time.

That dishwashing and laundry (washing machine and tumble dryer) are the activities that the participants almost immediately identify as possible subjects for time shifting might reflect that this is types of consumption that is less time critical compared to other types of consumption (e.g. preparing dinner) – and that can partly be automated (using timers) with regard to postponed start. Different from Aarhus and Aran Islands, many of the Madrid pilot homes have housekeepers, who typically do the laundry during the mornings. On one hand, this might imply greater flexibility regarding time shifting laundry compared to households with adults working outside home and no housekeeper (depending on the daily time schedules of the housekeepers). However, it also involves an extra layer of dialogue between the homeowners and the housekeeper regarding the planning the timing of these activities.

The focus group participants in general find it **hard to come up with other suggestions of consumption that can be time-shifted** apart from their use of dishwashers, washing machines and tumble dryers. The reason for this seems to be that almost all other types of household electricity demand relates to activities or tasks that have a very limited time flexibility. For instance, one participant in the Danish focus group first suggests that retired people, who often stay at home during daytime, could prepare dinner (hot meals) during the day instead for the supper in the evening (which is the usual routine). However, this is promptly rejected by another participant (also being retired): “No! In that case you would not be able to make all the other things one need to do [during the daylight hours]”. This illustrates how changing the timing of one activity (like preparing the hot meal) influences the timing of other activities (like doing the shopping or socializing during the day).

In this regard, the focus group participants in **Madrid appear to be those most inclined to consider also time shifting other electricity-consuming activities than only dishwashing and laundry**. Other appliance usage that could be time-shifted to some extent is the use of especially cooking appliances such as “multi cookers”, oven and stove. Less flexible appliance uses involves hair driers, baby bottle warmers. It is interesting that the Madrid participants are more inclined to time-shift also cooking of hot meals as compared to the focus groups in Aarhus and on Aran Islands. It is not clear what makes this difference, but one can speculate whether the presence of a housekeeper, who often also has responsibilities related to cooking, might play an important role. These housekeepers must be taken into account in relation to time shifting dishwashing and laundry.

On Aran Islands and in Aarhus, the focus groups have a strong consensus about **the importance of whether people are working or not regarding how difficult it is to time shift electricity consumption**. As one of the Aarhus participants say: “You are not watching the television while you are at work [during daytime]”. Another participant adds that for retired people it is easier to time shift consumption: “To us staying at home during the day, it is easier.” This is an observation that is repeated several times throughout the focus group

as well as made in the Aran Islands focus group. However, **the Madrid focus group stands somewhat out, as the importance of employment outside home is not singled out as a problem**. Almost contrary to the Aran Islands and Aarhus, the Madrid focus group actually points to young adults as being more likely to participate in DR, because they are more acquainted with new technology such as mobile apps (applied in RESPOND for DR) compared to retired people. In Aarhus and on Aran Islands, the opposite conclusion is reached as the consensus is that retired people (or people without work) will find it easier to do time-shifting because they are at home during much of the day and no children living at home. Again, the difference between the Madrid and the two other pilot sites might relate to the fact that most Madrid pilot households have housekeepers (especially those with working adults and children).

Across all sites, **consensus is reached that price (economic savings) is seen as the main incentive for making them time shift the electricity consumption**. Closely related to saving money is getting the return on initial investment in PVs mentioned on Aran Islands. Other benefits mentioned in all focus groups, but less heavily voiced than the economic benefits, are **doing something good for the environment or saving resources**. To some participants, non-economic reasons can actually be felt as more important than the economic (alone). For instance, one participant in the Aarhus focus group states that it can be a motivation to her to “consume less of our resources”. Thus, she would be happy with doing the laundering during the night hours and put up the wet clothes for drying (on a clothesline) in the morning if this saves resources: “But then we need to know when we should do things. But then I would go far in order to move consumption, because I can see that our resources are scarce.” Even if this type of statements did not reach consensus in the focus groups, implying that they are not shared by the majority, it is important to consider that there might also be other motivational drivers behind households’ engagement in DR programmes than the pure economic reasons.

Some participants suggest that **automation or remote control** of appliances via an app would be a help in relation to time-shifting electricity consumption. Particularly the participants in the Aarhus focus group discussed this in some detail and, for instance, one participant suggested an app that can start the dishwasher and washing machine automatically when there is excess of renewable power in the system. Similarly, the idea of automated DR function in the mobile app also attracted considerable attention in the Aran Islands focus group. Here, many participants appeared to be interested in a solution that would make it possible for them to load a machine in the morning or evening before, and once there is sufficient power (own micro-generation) the machines should automatically begin to run. Some participants think thought that this would make time-shifting easier and one participant said that this would solve his issue of being gone all day. The interest in automation was so strong in the Aran Islands that the participants agreed that an automatic function as the described would be of most benefit to them all. The strong interest in automation features on Aran Islands might partly be due to these households being the only RESPOND participants with own renewable energy production on their premises (in Aarhus and Madrid, these renewable energy technologies are shared), which – together with no

feed-in tariff for PVs – makes it very attractive to them to optimize consumption of their own generated energy. See also later section 3.3 on self-sufficiency.

However, it does not seem to be everybody who find the idea of automation attractive. Thus, other participants in the Aarhus focus group think that **recommendations or notification**s via the mobile app with information about when it is best to do the laundry or dishwashing might work as well or even better than automation. As one participant says: "If this app could tell me that today at 2 pm it is a good idea to do the [clothes] washing, then I could set [the timer of] my washing machine to start at 2 pm. I don't need to have it to do it automatically [for me to do it]." Similarly, the Madrid participants, who were generally motivated to time shift their consumption, also called for guidance to concretely make it as they found it a bit complicated to do. Thus, there appears to be more interest in recommendations/notifications on when to consume (or not) than automation across the focus groups.

## 3.2 DYNAMIC ELECTRICITY PRICING

Alternative dynamic electricity pricing schemes (time-variable pricing schemes) were discussed in the Madrid and Aarhus focus groups on electricity consumption. **Initially, the idea of variable prices was met with some scepticism in both focus groups**. Madrid participants thought that dynamic pricing requires more engagement, follow-up on information about prices, are too complicated to follow and that existing schemes (with low night-tariffs) in Spain does not fit well with the everyday life and consumption patterns of families. The Aarhus participants had similar reservations about dynamic pricing. Another concern raised in this group was whether time shifting consumption in households makes a significant difference on an overall (system) level.

The participants in both focus groups were presented to three different types of dynamic pricing schemes for discussion and comments: Real-time pricing (RTP), Static Time-of-Use pricing (static ToU) and Peak Production Rebates (PPR).

The idea of **RTP caused widespread scepticism among the participants** in both focus groups. Thus, the immediate reaction of one participant in the Aarhus focus group was: "Never! I simply wouldn't bother [to do] that!". Prices that changes from hour to hour and day to day represent an "information overload" to this participant. Other participants agreed, and there appears to be a consensus in the focus group that real-time pricing is too complicated to follow. Similarly, the Madrid participants stated that it is difficult to follow RTP as one has to check the prices the day before on a daily basis and it is hard to schedule everyday routines on a daily basis.

Some Aarhus participants suggest that real-time pricing might be feasible if the mobile app could help with recommendations on when it is smartest to wash clothes or if the time-shifting could be automatized so that one doesn't need to (actively) follow and adapt to the variable prices. This could apply to dishwashers and washing machines.

Both focus groups discuss how big the economic incentive should be for the participants to consider moving consumption in time. In Madrid, the idea of "free energy" during certain

hours could be a motivation for the participants to move energy consumption. In Aarhus, the consensus seems to be that the price difference must be high – and higher than 1 DKK [per kWh] between lowest and highest prices. As one participant said, he should save more than 1,000 DKK (about 140 euro) per year before he would be interested at all.

Thus, both focus groups confirm the previous observation (section 3.1) that **price (cost savings) is seen as the main incentive for DR by the participants**. However, one of the participants in the Aarhus focus group offers an alternative perspective and suggests that one should think of DR in the same way as why people do waste sorting: "That's not the big money to us neither [means that they don't save much money by sorting their waste], right, that's [about] an attitude. Maybe one should think about it in this way – that it is not only about money, but that it is also a good thing [i.e. the right thing] to do." This statement receives some sympathy from other participants, although it is stated by another participant that an important difference to waste sorting is that it takes much more effort to time shift consumption – for instance if you have children who need to go to school at a specific time and who consumes much of the electricity. Another participant follows up on this as he suggests that waste sorting did not become a success before it was made easy to do by getting different waste bins in your home (for different waste fractions). Similarly, it needs to be easy for people to time shift consumption before they will do so. The participant, originally offering the alternative perspective, agrees with this, but at the same time sticks to the idea that people might still do some efforts in order to make their habits follow their attitudes (even if this is not about saving money): "If this app could tell me that today at 2 pm it is a good idea to do the [clothes] washing, then I could set [the timer of] my washing machine to start at 2 pm. I don't need to have it to do it automatically [for me to do it]."

In a way, this discussion represents a classical discussion of whether people (should) do the right thing – such as saving energy or the environment – for their personal benefit (which represents a so-called utilitarian ethics) or because it is the "right" or (morally) "good thing" to do (i.e. following the "ethics of duty", often called duty-based ethics or deontological ethics). These are two different ways of thinking about morals and why people do (or should do) as they do – and they are both valid in the sense that they co-exist and play a role in the life of most people (although in different ways and different balances from person to person). This should probably also be reflected in the design of the RESPOND mobile app, as this should **not only include money saving as the only motivational driver behind user engagement in DR actions, but also address other values or aspects such as the contribution of individual actions to reduce resource consumption and/or pollution or performing as a "good citizen"**.

Compared to RTP, **the alternative of static ToU pricing got a much more positive reception** and both focus groups agreed that this was a much more simple and easier scheme to follow. The main advantage is that it is the same scheme every day, so once the price ranges have been learned, it would be easier to time-shift and develop new routines. In Aarhus, one participant in particular liked the regularity of the scheme because: "Why should you go to a [phone] app to control your [electricity consumption]… There's bloody enough of that sort of things already." Another participant adds that static ToU would also be easier to make one's children to learn and follow.

Also the **PPR scheme got a relatively positive reception** in both focus groups. However, especially the Aarhus participants found this scheme meaningful as they have local renewable electricity generation (PV panels). Thus, they think that PPR could help increase the self-consumption of their own generation, which would also be an economic benefit to themselves and their housing association (see also next section on optimising self-sufficiency). In comparison, the Madrid housing estate does not have their own micro-generation of electricity, which makes the benefits of PPR less obvious to the participants. This indicates that PPR might be best applicable to optimise local self-sufficiency (next section).

Interestingly, the presentation of the PPR scheme caused a longer and somewhat excited discussion in the Aarhus focus group on whether the focus should be on optimising grid balance and consumption of renewable energy on a small-scale level (e.g. individual buildings or neighbourhoods) or rather on a regional or national system level (macro-scale). Seen from the latter perspective, local optimising and grid balancing can be seen as a "sub-optimization", as the surplus PV electricity generation of e.g. ALBOA might be more effectively utilised if supplied to other consumers than if ALBOA time-shift their own consumption to midday hours. **There appears to be an ambivalence between an overall system perspective and the local perspective**, which was reflected in the focus group participants' discussion. Clear consensus was not reached, although there was sympathy towards the idea of local PPR among several participants. As one participant suggested: Since they (the housing association) have paid for their own solar PVs, it "makes good sense" that they "harvest" the benefits from their own production of electric power.

Overall, there is an **inclination towards PPR as being the most attractive dynamic pricing scheme in the Aarhus focus group**, while the **static ToU is the most appealing scheme to the Madrid focus group**.

## 3.3 DR TO OPTIMIZE SELF-SUFFICIENCY

The idea of optimizing self-sufficiency through DR was discussed in the focus groups on electricity in Madrid and Aarhus as well as the focus group on Aran Islands. Across all sites, the **pilot participants in general find it appealing to consume their "own" energy**. **Saving money plays an important role as the participants' stated motivation for time-shifting consumption** in order to optimize self-sufficiency. Thus, the Aran Islands households have not feed-in tariffs, which means that every kWh delivered to the grid is essentially a "lost kWh" in economic terms. This represents a strong motive for trying to shift some of their electricity consumption to daylight hours.

Similar in Aarhus, although the economic benefits for the individual resident is complicated somewhat by the ALBOA PV panels being owned collectively by the residents (i.e. owned by the housing association). As it is now, the residents pay a fixed rate to the housing association for their electricity consumption. Thus, if the residents start moving consumption to daylight hours with excess PV generation, it will be the housing association that saves money from the increased self-sufficiency. The saved money will effectively decrease the

payback time for the housing association's investment in the PVs. Once the investment is payed back, the money saved will benefit all residents of the housing association through lower rents or electricity costs. In this way, there is no direct economic benefits allocated to the residents for individual DR actions in the current model. However, the focus group participants discussed the possibility of introducing dynamic pricing schemes for the settlement of accounts of individual households, which would incentivize DR actions among the residents. This was perceived as an attractive solution by several of the focus group participants, although – as is also noted by one of the participants – this might prolong the pay off period of the loans taken to invest in the PV panels. Thus, **developing a dynamic pricing model for the ALBOA residents' electricity consumption implies finding the right balance between allocating the economic benefits of DR between the housing association and the single households**, i.e. between the collective and the individual level.

In the Madrid focus group, economy and saving money was identified as the key driver for time shifting consumption. However, as the local renewable energy production at the Madrid pilot site comes from solar heating, which is easier to store than electricity, the need for self-sufficiency is obviously not felt as urgent as is the case on Aran Islands (with mixed heat and power generation) or particularly in Aarhus.

In addition to saving money, **another motivational factor for performing DR actions to optimize self-sufficiency seems to be the "good feeling" of consuming one's "own" renewable energy**. At least, this is mentioned in the Aarhus focus group when the moderator asks whether it makes any difference to the participants that the electricity is locally produced. The question results in mixed reactions. To some it doesn't make any difference, but to what seems to be the majority, producing one's own power is something that they are proud of. This can probably also partly explain, why many of the participants seem to find it **attractive if the RESPOND mobile app could provide information about how much of their own electricity consumption (e.g. in a given day or week) that has been covered with their own, local PV power**. This seems also to be experienced by the participants as a potential motivational factor to increase their DR efforts and self-sufficiency. One participant thinks that this would make one feel better about oneself and another adds that it would give one a "good conscience". A third participant compares the motivational factor of the PV self-sufficiency information with people who do self-monitoring, e.g. in relation to health and how many steps they make. Another participant adds that "we are proud of our solar cells – and if you could get information about how much [PV] power you consume yourself, this would be great". Finally, it is suggested that **prizes could be awarded** (gold, silver and bronze) to those who are best at consuming the local PV power.

The above indicates that dynamic pricing in combination with micro-generation (prosumption) can be a strong motivational factor for people to engage themselves in DR actions. Saving money appears to be a strong motivational component for this, although producing your own energy and optimize self-sufficiency is also something that is meaningful to people and worth striving for.

**Time-shifting of Domestic Hot Water** (DHW) was discussed in the focus group on Aran Islands and one of the focus groups in Madrid. In Madrid, solar heating represents the local renewable energy production, which makes the discussion of time-shifting DHW to increase self-sufficiency relevant. Similarly, some of the households on Aran Islands also have solar heating, while the Aarhus pilot site only includes solar power (and heat is supplied from district heating).

Interesting differences are found between Aran Islands and Madrid with regard to the participants' willingness to consider time-shifting showering (which represents one of the main consumers of DHW in homes). The Aran Islands participants found it difficult to time-shift DHW consumption, in particular showering, as this is regarded as fixed by other (collective) time schedules like school and work hours and therefore not time flexible. For the same reason, several participants suggest that is a more realistic strategy to use local storage (e.g. water tanks) to increase self-sufficiency by storing solar heat. Several of the participants already have water tanks installed for the same purpose.

In Madrid, the participants were happy about the rooftop solar panel installation and they appreciated its environmental benefits and related gas savings. For the same reason, they were **sympathetic towards the idea of time-shifting DHW consumption** (including time-shifting showering, as mentioned, see also below).

Today's DHW consumption of the residents typically have the following time-patterns:

- Showering: For residents in work, this is typically done at nights from Monday to Friday and in mornings on the weekends. For retired people, the timing is less fixed: some does it at night always, others in mornings. For children, it happens in the evenings.
- Dishwashing (by hand): This is done "when necessary".
- Cooking: Some DHW is also consumed during this activity. In homes with adults working, the hot water is consumed during mornings if it is the housekeeper who cooks; otherwise during afternoons/evenings if it is the residents (owners) who cook. For retired people, cooking usually happens in the mornings.
- Cleaning: This usually happens during mornings.

Regarding time-shifting DHW consumption, the participants believed that the showers can be shifted in time for some, although it will be difficult to many. For children, it is difficult to time-shift showers on weekdays, but it would be easier on weekends.

In comparison, the participants believed it would be easier to time-shift dishes, cooking and cleaning (the latter probably the most time flexible activity).

## 3.4 EFFICIENCY AND DR RELATED TO COOLING

As the need for cooling (air conditioning) is little at the northern latitudes of Ireland and Denmark, and cooling of residential homes therefore are rare, the **Madrid focus group was the only one addressing efficiency and DR related to space cooling**.

The focus group participants were asked to discuss whether they believed that they could change habits related to cooling in order to increase the energy efficiency of their use of cooling. On the one hand, some participants believed that they already took well care of the energy consumption for cooling their homes. On the other hand, other families stated that they were aware that the energy consumption in too many occasions was incorrectly managed or could be controlled in a more efficient way. Thus, they believed they could improve the energy efficiency by changing habits. In general, **all agreed that there is much to learn about energy efficiency**. So, in general, they were all willing to make efforts and they believed they could change some habits and routines with the purpose of saving energy consumption.

**The usage pattern for cooling changes with the season of the year**. Air-conditioning, ventilators or other cooling appliances are **mainly used during the summer period, particularly in the hottest months** (July and August). In spring months, cooling is only used in peak hot hours, while cooling is applied for longer periods during the summer months. Air-conditioning is **mainly used during afternoon hours**.

Some families regularly use ventilators instead of air-conditioning to save energy, while other of the families do not. All families keep their homes well ventilated during the coldest hours of the day (in the morning and at night) in order to cool down the home, and they all turn off air-conditioning before leaving home. It is **typically the adults (homeowners) who control the cooling** in the dwellings. In some cases, also the housekeepers or children can manipulate the temperature settings.

The idea of time-shifting cooling was relatively well received by the participants. Thus, consensus seemed to be that **at least some of the cooling could be time-shifted or made less energy consuming**. The participants' suggestions for improving energy efficiency and time-shifting consumption included: regulating the set-point temperature, switching off/on the air conditioner when people are not at home or when it is not really necessary or shifting to appliances with a higher energy efficiency (ventilators instead of air conditioner). All these actions could be done at any time really. However, it would not come without some disadvantages for the thermal comfort of the residents. But as one participant said, sometimes a little less comfort could bring more benefits in the shape of saving money or the environment. However, **maintaining the right thermal comfort levels are important in families with children or elderly persons**.

The idea of having a **competition** among the neighbours about time-shifting their electricity consumption, in particular related to cooling, was well received and the participants believed that they would take part in this.

## 3.5 EXISTING PREFERENCES/HABITS REGARDING HEATING

As the pilot site in Aarhus is going to test DR in relation to heating, the focus group on heating had a separate topic addressing existing heating preferences and habits of the participants in order to provide a knowledge basis for the design of the DR programme.

The focus group showed that the heating preferences and practices differed substantially between the participants: Some are adjusting the **thermostats** of the individual radiators daily, while others almost never touch the thermostats. Around half of the participants **heat** all rooms and have nearly the same **temperature** in all rooms, whereas the rest have different temperatures in different rooms (all zone heating versus differentiated heating). Some have even completely switched off the heat in the rooms that are not in use. Also, some participants have a lot of heat supplied in the basement and find that this is basically sufficient to supply the rest of the house, whereas others only have little heat in the basement. Some residents **dry their washing clothes** in the basement, which might also be a reason for having heat turned on here. Finally, some participants keep the doors continuously open between rooms, while others close the doors (e.g. to avoid draught).

Some of the participants like to **sleep in a cold room** and with the bedroom windows open during the night (this appears to be a rather common practice in Danish homes). For instance, one of the couples present in the focus group explained that they turn off the heat and open both windows in the bedroom in the evening. Next morning, they close the windows again and turn on the heat so that there is no condensation in the down comforters.

Another important observation is that the participants (who live in almost identical apartments) **do not have identical heating system**, e.g. they do not have the same number of radiators in the basement. It depends on whether they themselves or former residents have made changes to how it was from the start.

The participants have **different experiences of whether it is warm enough in their dwelling**. Some experience that it is cold and that the windows and doors leak, and they want improvements. Some participants particularly experience problems on **cold (and windy) winter days**. The problem seems to be that the radiators have too low capacity to deliver the needed energy. One participant speculates that this might be because the heating system and radiators originally was planned for a higher supply temperature of the district heating water than the temperature supplied today. The experiences of feeling too cold also seems to happen **particularly in the evenings** – some suggest that this might partly be related to (bodily) inactivity (e.g. when sitting in the sofa). It is mentioned that problem with instances of feeling cold might be solved if the building was renovated, including installing new energy efficient windows.

Overall, it seems clear that there is room for improvements of the temperature conditions in the participating apartments. This may be provided through technical improvements of the heating system, windows and better insulation, but the residents' behavior also plays a vital role in achieving an optimal situation that take both energy consumption and indoor environment into consideration.

It is clear from the focus group that some have good insights into how the heating system works and some have rather firm opinions about how it should run (and what heating habits that should be applied). Not necessarily in the same way as it is normally recommended by knowledge institutions that do research in the different aspects of the indoor environment, including temperature and humidity conditions as well as energy consumption in homes. **The diversity in heating practices and preferences as well as the (partly idiosyncratic)**

**approaches to control and adjust heating is something that needs to be taken into consideration when designing the RESPOND mobile app and the heating DR program**. Thus, there should be a certain **flexibility in relation to let the users decide the timing and temperature set-points** of the set-back in the morning – a flexibility, which takes into account also the variations in habits from day to day (e.g. how the homes are used). These aspects are detailed further in next section.

## 3.6 DR SOLUTION FOR HEATING

In the Aarhus focus group on heating, the possible design of a DR programme based on morning set-back of the heating of the homes was discussed in detail as this is planned to be deployed at the Aarhus pilot site.

The proposed DR programme was **reasonably well received**. There was agreement that it must be automated, so that the residents do not have to turn on/off the heat themselves. As one of the participants said, she could not imagine herself running throughout in the mornings and adjusting the thermostats. The solution **must be completely automatic**.

There was some concern that it would be **too cold in the morning**, but if the DR programme could be designed so that the home was **heated a little extra** (e.g. 1-2 degrees Celsius) **before turning off the heat**, this could help avoid feeling cold in the morning and it was viewed as an acceptable solution by the participants. Some even seemed to like the idea of it being (extra) warm when getting up in the morning.

The concept of **time-shifting heating must be flexible as the residents' daily routines on weekdays and weekends are not the same**. Thus, people (in work or education) tend to get up later in the morning on weekends than on weekdays. For instance, one participant explains that he and his children gets out of bed late in weekends, and he would be annoyed if it was cold when they get up. Similar situations could happen during **holidays** or if home on weekdays due to **illness**. In these situations, it should be possible to avoid feeling cold due to the DR programme by interrupting the DR cycle. Another type of variation in daily routines relate to **divorced parents with children**; e.g. if a parent has children from a previous relationship who live with him/her every second week – then it must be possible to control the DR programme in terms of weekday, time range and temperature level.

Two different (but complementary) ideas of how to achieve the above flexibility were discussed: First, the moderators suggested that it should be **possible to switch off the DR programme (cycle) for, e.g., the next 24 hours** after which it runs automatically again. This was well received by the participants. Second, it appears from the focus group that the RESPOND mobile app should make it possible for the households to set up **DR schedules that can vary with regard to weekday** (either differentiating between weekdays/weekends or – probably better – for the individual weekdays Monday through Sunday). It should also be possible to **set temperature ranges** (i.e. the accepted maximum drop in temperature) and – if possible – to control the temperature in different rooms, in order to meet the residents' current behaviour.

In continuation of the above observations, the focus group participants agree that the mobile app must not be complicated; some residents would like to be able to "nerd with it", but the majority are in favour of a simple/user-friendly solution. To accommodate these somewhat conflicting interests, **the participants argued for two levels in the mobile app**: A simple overview (a "dashboard") combined with the possibility of being able to go deeper into the app for more detailed (control) levels.

Some participants see a value in the app showing the temperature of the different rooms. They would like to follow the temperatures on a frequent basis, e.g. to become aware of whether you have heat on and whether it is necessary. As one participant explained: "What I really think, it's to be able to assess – when I get up in the morning – I just got out of my hot bed – is there really cold in the room? Or is it just me that is cold? Or when my children jump around without clothes and I think it looks cold, is it – then – because the room is actually hot? So that I have something to judge from, because right now I turn up [the heat] when I'm cold and turn down again when it gets really hot." However, this sort of **detailed monitoring of the temperatures of the home might only appeal to a small sub-set of residents**; at least the idea of this participant was not followed up by many other focus group participants.

With regard to the **level of interaction with the mobile app** on the heat DR programme: One resident described honestly that for her it just needs to be up and running rather fast – she could accept a running-in (start-up) period, but "then I just don't want to deal more with it, then it shall just be going". She just needs to find out about the relevant settings (e.g. accommodate the DR cycle to her needs and daily routines), and then it must take care of itself. Many of the other participants seem to think in the same way.

The focus group participants also discussed what could motivate them to participate in a DR programme on heating: The economic and environmental aspects were brought into play by some, and others asked "what's in it for me"? Individual heat billing and better comfort and being in control [of temperature] are mentioned as motivating factors that can make it interesting to use the app.

## 3.7 FEEDBACK ON RESPOND APP

In all focus groups, the participants were shown a selected number of screens of the planned RESPOND app and asked to comment on these. This section summarizes the responses to these screens.

### 3.7.1 COMPREHENSIBILITY

Across focus groups, the participants in general seem to find the content of the app screens (mock-ups) comprehensible, even though some had to be explained to them by the moderators. One comment in the Aran Islands focus group was that it is important for the graphs etc. displayed in app to be easily comprehensible. A similar comment was made in the Madrid focus group on electricity; here, the participants would like simple graphic

representations of the consumption by home (average of the consumption per hour, per day, per week and per month), and also graphs of the consumption by devices and comparison with neighbours.

However, the concern related to whether older people would find it easy to understand, navigate and use the mobile app was raised in both the Aran Islands and Madrid focus groups (but not in the Danish groups).

It is a general comment across focus groups that the mobile app needs to be simple to navigate and understand. And if more advanced levels are needed or expected, these should ideally be accessible at a level "below" a simple "dashboard" level (see also discussion of this in Danish focus group on heating, see section 3.6).

### 3.7.2 START PAGE

By most focus groups, the start page was found to be easy and intuitive to understand. However, the Madrid focus group on cooling/DHW suggested more simple icons to make the navigation easier. Despite this, they also found the start page intuitive.

Further, the focus group suggested to include also notifications and recommendations on the start page – e.g. the most recent and/or still relevant notifications – as this might be the primary interaction with the app for most users.

### 3.7.3 APPLIANCE-SPECIFIC BREAKDOWN OF ELECTRICITY CONSUMPTION (DEVICES)

Several participants across all focus groups (except the Madrid focus group on cooling/DHW) expressed an interest in an appliance-specific breakdown of their electricity consumption. Thus, this appealed to all participants in the Aran Islands focus group and it was also one of the ideas attracting most interest and enthusiasm in the Aarhus focus groups. Similarly, appliance-specific consumption data was among the three things that the Madrid focus group on electricity identified as the most appealing.

To accommodate appliance-specific breakdown, it was discussed in the Aarhus focus group on electricity that the households should be supplied with one smart plug that they could move freely between appliances (to measure the electricity consumption of different appliances).

The Madrid focus group on electricity pointed to the need of real-time data for the appliance-specific data. Further, the other Madrid focus group suggested to include simple and recognizable icons linked to the devices (for easier identification and navigation).

### 3.7.4 COMPARING WITH NEIGHBOURS/NEIGHBOURHOOD

The idea of comparing the energy performance of the individual household to the performance of neighbours got a mixed reception. In the Aran Islands focus group, the idea attracted some interest, but did not seem to be something that would inspire them to

increase their energy efficiency efforts in general. However, the participants showed interest in knowing the level of self-sufficiency for their own home, and this also seemed to be indicator that they might be most interested in comparing to their neighbours.

In Madrid, comparing with neighbours (neighbourhood average) appears to attract some attention, although a concern with privacy was raised with regard to sharing too detailed information with their neighbourhood.

In the Aarhus focus group on electricity, the participants were not particular interested in comparing their own consumption with neighbours – and if so, this should ideally be with neighbours that are like themselves (similar household size and perhaps similar age composition). However – and somewhat similar to the Aran focus group – information about the degree of self-sufficiency with local produced power (PVs) at the individual household level is something that they found interesting. This could also be a motivational factor to increase the share of PV power of the energy consumption of one's household. High self-sufficiency appears to be something that provides the participants with a feeling of "good conscience" and makes them feel good about themselves. One participant even suggest that prices could be awarded (gold, silver and bronze) to those who are best at consuming local PV power. Another participant compares the motivational factor of having access to one's individual self-sufficiency share and being able to compare with others (e.g. neighbourhood average) and perhaps share one's performance status with others with people who do self-monitoring, e.g. in relation to health and how many steps (pedometer apps) they make. Finally, one participant adds that "we are proud of our solar cells – and if you could get information about how much [PV] power you consume yourself, this would be great." It seems from these statements that the motivational factor of comparing with others (neighbours) is high in relation to self-sufficiency, whereas the interest of other types of comparisons (e.g. energy consumption) is low.

In the Aarhus focus group on heating, the reception of the idea of comparing energy consumption with others got a mixed reception ranging from some participants showing disinterest ("I couldn't care less") to some shoving enthusiasm ("I think it could be very funny").

### 3.7.5 RECOMMENDATIONS / NOTIFICATIONS

Overall, the idea of recommendations and notifications were well-received across focus groups. In the Madrid focus group on electricity, the participants would prefer simple alerts about when it is best to consume electricity at low price – or the opposite (warning) if high prices. In the Madrid focus group on cooling/DHW, it was suggested to include notifications about comfort (e.g. if bad), price information (alerts of major changes in prices) and production values for the solar heating if extreme conditions (i.e. low/high energy production). Further, recommendations on time-shifting DHW and cooling consumption was also welcomed and they believed they would try to follow these as much as possible. In the Aarhus focus group on heating, it was also suggested to include warnings/notifications

related to the indoor environment; e.g. warnings if the humidity is too high (including a recommendation to air, e.g. opening windows).

### 3.7.6 AUTOMATION

As already described in section 3.1, the possibility of automation with regard to time-shifting appliance use got much attention in the Aran Islands focus group and was also somewhat well received in the Aarhus focus group on electricity. Comparing these two focus groups indicates that the interest in time-shifting in general – and automation specifically – might to some extend depend on how much one personally benefits from this. Thus, as the Aran Islands pilot households own their PV and solar heating panels themselves, the interest in optimizing self-sufficiency is high here, which makes time-shifting by automation particularly interesting.

In the Madrid focus group on electricity, where was some interest in automation – particularly related to the dishwasher and control of light intensity and temperature of rooms. However, overall, they preferred recommendations for “manual” DR rather than automated actions.

The Madrid focus group on cooling/DHW was in favour of some automation of the cooling, and they would allow RESPOND to regulate the temperature of the air conditioner with previous notification (and acceptance?) via the app.

### 3.7.7 PRICES

Both Madrid focus groups found the *Energy prices* page difficult to understand and interpret. They did not find it useful to show information per hour without indicators that explain to non-technical people whether a value is a low, medium or high price. In the focus group on electricity, the moderator suggested to insert colours as background for the values, for example green-orange-red for low-medium-high prices. This idea was well-received.

A participant said he would rather prefer to have only simple notifications like ”the price is much lower now for three hours” or ”the price is high for the next two hours” (instead of having to check-up on the prices regularly himself via the app). Similarly, another participant said she does not have the technical knowledge to understand the price table, so she would also like to receive practical messages.

### 3.7.8 COMFORT

The information about the comfort (indoor environment status) of the home was in general well-received. For instance, the Madrid focus group on cooling/DHW found the indicators useful and clear, but missed the VOC indicator (probably because this was not shown on the screen shot). Also, one participant in the Aarhus focus group on heating found it interesting to be able to see the historic development in indoor temperatures. In the same

focus group, it is suggested that information on indoor environment might be one of the things that can spur interest in and use of the mobile app.

### 3.7.9 WEATHER FORECAST

The local weather forecast got a mixed reception. To many, it does not seem to be relevant or something they are going to use (other dedicated weather forecast apps already exist). On the other hand, some thought that it did not do harm as such (meaning that they would not be annoyed by it). The most positive reception of the weather forecast appears to be in the Madrid focus groups.

In the Madrid group on electricity, it was suggested to change the weather forecast information from week numbers (e.g. 24, 25, 26) to individual days by week. However, this comment might reflect a misinterpretation of the mock-up screen, as the dates shown is the days of the calendar month. This might be redesigned to avoid misinterpretation.

### 3.7.10 GENERATION

The Madrid focus group on cooling/DHW commented that it was not clear if the information is related to the energy that the solar heating installation generates.

### 3.7.11 INTEREST WEARS OFF AFTER SOME TIME

Some participants stated that people's interest in new apps might wear off after some days. For instance, one of the participants in the Aran Islands focus group stated that he loved technology himself, but he finds that sometimes people may lose interest once the novelty of a device/app wears off. Personally, he expected to use the app for the first few days, and possibly use the remote operating function too, but that he was likely to forget about it after a while and not use it to its full potential.

### 3.7.12 INTERNET SPEED

A concern specific to the Aran Islands was whether the slow internet speeds on the island may affect the functionality of the apps for some households. Thus, it is important that the mobile app does not require too high internet capacity.

## 3.8 CONCLUSIONS AND RECOMMENDATIONS FROM FOCUS GROUPS

The findings related to the above themes can be summarized in the following conclusions, which at the same time have implications for the final design of the RESPOND DR solution and mobile app and therefore also acts as recommendations for the final design of these:

- Dishwashing and laundry come up across all sites as the types of electricity consumption that the focus group participants find most likely and practical to time-shift. Other types of electricity consumption are found to be difficult to time-shift. However, the Madrid focus group participants appear to be those most inclined to consider also time shifting other electricity-consuming activities.
- The focus groups show that whether people are working or not (i.e. at home or not during daylight hours) is important for how difficult and realistic it is perceived to time shift consumption, although this might be less decisive in the Madrid case as many households here have housekeepers staying at home during the day.
- With regard to automation or remote control of DR actions (e.g. time shifting dishwashing), the focus groups come up with mixed results. Many favour the idea of automation or remote control, but several also find it attractive if they just can get notifications/recommendations via the mobile app about when it is optimal for them to consume energy.
- With regard to variable electricity prices (dynamic pricing), the consensus across focus groups is that real-time pricing is too difficult to follow, while many find the static Time-of-Use pricing much simpler and easier to follow (e.g. to build daily routines around). Peak Production Rebates also got a positive reception on general, especially in Aarhus as this scheme could help them optimise the consumption of their local renewable electricity production (PVs)
- Money saving is in general seen as a key motivational driver for changing daily habits and do DR actions. However, also other motivational drivers are mentioned such as doing something good for the environment or the positive feeling of consuming local renewable energy. The latter seems to be another important motivational driver that might have a similar strength as money savings. Some participants even found it motivating to compete with others to be best at consuming local renewable energy. Thus, information about self-sufficiency is important to integrate in the RESPOND solutions and mobile app.
- In Madrid, DR of air cooling was discussed. Consensus was that at least some of the cooling could be time shifted (e.g. by using mechanical ventilators instead of air conditioning).
- The Aarhus focus group on heating shows a high diversity between households regarding heating practices and preferences as well as often idiosyncratic approaches of the individual households on how to control and adjust heating. This diversity needs

to be considered when designing the RESPOND solution and mobile app, as these must be flexible to accommodate to various heating practices and control routines.

- The RESPOND DR solution for heating, which is going to be trialled in Aarhus, was overall well-received by the Aarhus focus group participants. There is agreement that the DR scheme (temperature set-back in morning hours with a short pre-heating before set-back) must be automated. Also, it should be easy to "override" the automated control in cases of deviations in peoples' daily routines or if they feel the temperature is not as desired.
- The focus groups provided much feedback on the preliminary RESPOND mobile app design. Some of the key recommendations and observations are: The app should not be too complicated to use and navigate in, although it might be a good idea to have "two levels" of user interfaces to accommodate different user needs: One simple level with access to key features and information for the household (a kind of "dashboard"), and another level with more detailed information, settings and control features. The latter is for the more advanced and/or engaged users. Across focus groups, there was also a widespread interest in getting access to appliance-specific breakdowns of the electricity consumption of households. The idea of comparing the energy performance of the individual household to the performance of neighbours got a mixed reception; comparing the level of individual self-sufficiency was the type of comparison that attracted most interest. Furthermore, the idea of recommendations and notifications on, e.g., optimal DR actions was in general well-received. See previous Section 3.7 for further details on the specific features of the mobile app.

Further recommendations for the design of the RESPOND solution and mobile app can be found in the next section, which presents four different usage scenarios and proposals for competitions at the pilot sites.

# 4. USAGE SCENARIOS

The aim of this chapter is to "translate" the key findings from the focus groups to a limited number of scenarios on how the RESPOND solutions in general – and the RESPOND app specifically – can be tailored/adapted to the everyday practices, needs and wishes of the citizens. Each scenario focuses on one specific usage (feature/function) of the RESPOND DR-solution and app.

Each usage scenario is a brief (condensed) description of how a certain function/service (to be developed in RESPOND) could be experienced from a user perspective (i.e. the perspective of the pilot residents). In other words, it is descriptions of how a user interacts with the given solution and how s/he experiences it. Thus, it is a "visualization" of the solutions, which are reflecting the users' own needs, practices, wishes and suggestions (cf. the focus groups). The scenarios are developed to be as concrete and specific as possible in explaining (exemplifying) the possible and ideal user interactions with app and RESPOND DR solution.

The wider aim of the scenarios is to be an inspiration for the final development of engaging RESPOND mobile app and DR solutions in order to ensure that the final app and solutions are as user-friendly and relevant for the user context as possible.

In addition to the following four user scenarios, we also include suggestions on competitions that can help ensure user engagement at the pilot sites (Section 4.5).

## 4.1 USER SCENARIO #1: DR OF HEATING (AARHUS)

- The **technical purpose** of this scenario is to move energy consumption for heating in time through temperature setback in the morning hours (including a brief "pre-heating" of the rooms just before the setback begins).
- **User practices and the users' interaction with RESPOND solution and app**: This part describes *what* the users do and experience *when* and *how*?
    - **Installing and setting up the app**: When the users install the app on their smart phone, they are asked whether they want to participate in the DR programme "Move your heat consumption and reduce the morning peak". By accepting with "Yes", the user accept that the RESPOND solution can turn down the heat during the morning hours (between 6 am and 9 am). This should correspond to a gradual decrease in indoor room temperature of about 1 degree Celsius per hour. After accepting the DR programme, the user is asked what the maximum temperature drop s/he will accept in the morning. Default could be – for instance – 2 (3) degrees Celsius. The user choose an answer, and is then asked if s/he wants the system to increase (boost) the indoor temperature shortly before the temperature setback begins in the morning? This could be combined with asking whether s/he wants a temperature increase of maximum 1 or 2 degrees Celsius.
        - Should it be possible to exclude specific rooms from being included in the DR programme? For Instance the kitchen, living room or bedroom?
    - **The daily interaction with and use of the DR solution and mobile app**:
        - Normally, the automated heat DR programme runs "by itself" in "the background". Thus, the users are not expected to interact with the system on a common basis.
        - Some days – especially on cold and/or windy winter days – the temperature might drop fast during the temperature setback and reach an uncomfortable level (i.e. being too cold). When this happens, the users (residents) can open the app and select the option: "Stop morning setback". If activated, the morning setback is stopped and the thermostats of the home returns to the original "normal" set-point that apply outside the time interval when the setback cycle is activated.

- Technical question: What happens if the residents regulate the temperature set-point directly on the thermostats during the morning setback cycle? Will this interrupt the cycle?
- General technical question: Will all household members (parents and children) have access to the app and controlling the DR programme via their individual phones? This should be possible! Otherwise (if only one household member have access to the app), the risk is that this will cause problematic situations – e.g. if the person with app access is not at home at a time when other family members are experiencing inconvenience with the DR programme – that eventually could lead pilot households to give up on the DR programme and opt out of the pilot.

- Sometimes the household have visits of guests who stays overnight. They sleep in the living room and may stay at home while the residents are away for work or school (e.g. grandparents attending a sick grandchild). In these situations, the hosts would not like the guest to experience the inconvenience of the morning setback (that may result in a slightly chilly home during the morning). Therefore, the hosts can cancel the next morning's temperature setback cycle. This is done by opening the app and activate the function called "Omit morning setback for the next 24 hours". This cancels the morning setback. When the 24 hours has passed, the RESPOND system returns to the ordinary programme with morning setbacks (if not the omit-function is activated again).
- The residents' preferences and needs with regard to heating and preferred indoor temperatures can vary over time – and sometimes from season to season or week to week (e.g. if a parent has his/her children from a previous relationship staying at his/her home every second week). Therefore, it is important that the morning setback always happens relative to the actual set-point (at a given time) on the individual thermostats. In other words, if a resident at some point in time increases the temperature set-point in the living room from, e.g., 20 degrees to 22 degrees by adjusting the thermostat, then the morning setback (the originally accepted X degrees maximum temperature reduction from installing the app, see above) happens relative to this new temperature set-point. And when the morning setback cycle ends (e.g. at 9 am), the temperature set-point of the given thermostat returns to the setpoint from just before the morning setback cycle started (i.e. 22 degrees Celsius).
- People do have different temperatures in different rooms. The morning setback happens relative to the specific temperature (setpoint) of the specific radiator (room).
- Some days, the residents will be at home in the morning, e.g. due to sickness or holidays. In these cases, they might not like to have the

temperature going down in the morning hours, and therefore they can abandon the setback cycle preliminarily either the day before by activating the "Omit morning setback for the next 24 hours" or by activating the "Stop morning setback" in the morning during the setback cycle.

## 4.2 USAGE SCENARIO #2: PEAK PRODUCTION REBATES AND LOCAL DR (AARHUS)

- The **technical purpose** of this usage scenario is to optimize consumption of locally generated PV power within the ALBOA housing association. Thus, the aim is to optimize self-sufficiency and avoid exporting excess PV power generation to the grid. The scenario is based on the RESPOND platform and mobile app providing recommendations to the residents on when it is feasible for them to increase consumption of electricity through time-shifting consumption from other hours. A key motivation for this will be lower customer electricity prices through the Peak Production Rebates (PPR), which was perceived as the most attractive dynamic pricing scheme in the Aarhus focus group on electricity.[1] Another key motivation is that the residents, by time-shifting consumption to PV peak-production hours, can increase the share of PV power in their individual electricity consumption – this was something that also appeared to be appealing to the residents at which could be utilized in a competition between neighbours on having the highest PV share (see also section 4.5). Furthermore, if the price scheme is designed in the right way, time-shifting consumption to PV peak-hours can benefit both the individual households as well as the housing association, which also can be a motivation for the residents as they in this way contribute to the common good of the housing association.

  This scenario might resemble the Usage Scenario #4 (see later), but main differences is that this scenario is based entirely on recommendations for active (manual) DR actions and that the aim is to optimize self-sufficiency on a community level (housing association) than on a household level (as on the Aran Islands). However, it might be considered to combine these two scenarios into one technical solution offered both residents at both places.

- **User practices and the users' interaction with RESPOND solution and app**: This part describes *what* the users do and experience *when* and *how*?
  - **Installing and setting up the app**: When installing the RESPOND mobile app, the user is asked if s/he wants to get notification via the app when it is best to

[1] For practical reasons, the PPR might be administered as a "bonus" that the pilot households can earn by shifting consumption to hours with excess PV generation. The "bonus" can when be payed to the residents at the end of the pilot.

consume electricity due to excess production of power from the local PVs and the electricity price is low. If s/he accepts, this notification module is activated.

- **The daily interaction with and use of the DR solution and mobile app**: On days with a predicted local PV power production that exceeds the predicted power consumption of the ALBOA housing association, the residents get a notification via the app. The notification is issued the evening before the predicted PV surplus production event. The user gets the notification: “Tomorrow between [hour] and [hour], there will be a surplus production of solar power. Consider moving electricity consumption to these hours to utilize the PV power and save money.” The notification is sent the evening before in order to make it possible for the households to plan and prepare for DR actions. Preparation could include to load the washing machine with clothes and programme a delayed start for the next day – or avoid running the dishwasher after dinner and instead postpone this to the next day during the peak-production hours. As dishwashing can be assumed to be among the most likely types of consumption to be postponed, it is important that the notification is issued before people finish dinner and typically would run the dishwasher. In a Danish context, this would ideally be at 18 at the latest.
    - The notification of the next day’s peak-power production should be combined with the option: “Click here if you would to get a reminder when the peak-power production begins tomorrow”. If the user chose this option, s/he will get a notification the next day when the predicted peak-power production period begins. This type of notification can be a help for people, who stay at home during the daylight hours, to remember to do manual DR actions (such as starting the dishwasher or doing other things that consumes electricity). By making it optional, it is also avoided to overburden users with too many or irrelevant notifications (e.g. if the users are away from home due to work and therefore would find this notification irrelevant and possibly annoying).
    - It might be considered to include also recommendations (“tips and tricks”) on how to do DR actions. This could be added as another option in the notification issued the evening before a peak-production event. If chosen, the user could access a page in the app with some suggestions on electricity consumption that could be considered for time-shifting (DR). For instance using delayed start of dishwashers, washing machines or tumble dryers, doing vacuuming-cleaning, charging batteries (e.g. e-bike or electric car), etc.
    - Some sort of feedback to the users (households) on their performance should be considered, as this can work as a motivation for continuing DR actions. In this case, relevant types of feedback would be either information on the money saved by doing DR and/or how well the household perform in relation to increase the level of self-sufficiency. The latter idea is elaborated further in Section 4.5.

## 4.3 USAGE SCENARIO #3: DR OF COOLING (MADRID)

- The **technical purpose** of this usage scenario is to support the Madrid households in performing DR in relation to cooling. The Madrid focus group on cooling demonstrated willingness among the participants to time-shift some of their energy consumption related to cooling, which are either supplied by air conditioning or ventilators. Some of the families use the latter as a way of reducing the use of their air conditioner, which has a high energy consumption level. The idea is to use mobile app recommendations to make the users aware of when it would be advisable to reduce energy consumption for cooling. The option of combining notifications with an option of remote control (e.g. being able to turn off the air conditioning while away from home) has also been considered, but has been evaluated as less relevant as all focus group participants report that they turn off air conditioning while they are away from home. Also, there might be risks of inconvenience and conflicts if a member of the household controls the air conditioning while being away from home and while another person (e.g. another household member or the housekeeper) are at home.

  Furthermore, it must be decided on basis of what technical parameter and which technical criteria the recommendations should be issued. For instance, is the key parameter the real-time customer electricity price? In that case, a threshold value should be decided, which means that if the electricity price exceeds this threshold value, the users will receive an app notification with a recommendation on doing DR actions.

- **User practices and the users' interaction with RESPOND solution and app**: This part describes *what* the users do and experience *when* and *how*?

  - **Installing and setting up the app**: When installing the RESPOND mobile app, the user is asked if an air conditioner is installed in his/her home. If the user answers "yes", the user is asked if s/he would like to receive recommendations (mobile app notifications) when it is advisable to avoid or reduce energy consumption for air conditioning. If the user answers yes to this, the recommendations module on air conditioning of DR is activated.

  - **The daily interaction with and use of the DR solution and mobile app**: On days with low grid load and/or low electricity prices, the user of the RESPOND mobile receives no notifications. However, if the grid load and/or the electricity price exceeds a certain level, the user gets an app notification recommending him/she to reduce the use of air conditioning, if possible. Either by turning off the air conditioning or increase the set-point temperature. The notification also includes an estimate of the time period for the DR action in order to make it possible for the user to decide on how long to reduce consumption. So, the notification could be something similar to (the choice of version depends on whether the key parameter is the customer price or the level of grid load): a) "The electricity price is high at the moment. If you are using air conditioning, you might

consider turning it off or increase the temperature setpoint in order to save energy and money. The electricity price is estimated to be high for the next X hours". Or b) "The electricity grid is heavily loaded at the moment. If you are using air conditioning, you might consider turning it off or increase the temperature setpoint in order to save the grid and the environment. The grid load is estimated to be high for the next X hours".

It might be considered to combine this usage scenario with a competition on DR of cooling among the neighbours taking part in the pilot. The Madrid focus group participants expressed positive attitudes towards the idea of such a competition. See also section 4.5.

## 4.4 USAGE SCENARIO #4: AUTOMATED AND REMOTE CONTROL OF APPLIANCES (ARAN ISLANDS)

- The **technical purpose** of automated and remote control of appliances is to enable DR through either automatic control of appliances or by making it possible for residents to turn on/off appliances while not at home. This addresses the fact that people with a work outside home are typically not at home during daylight hours, which was one of the key obstacles to DR identified across all focus groups. The overall aim is to increase the level of self-sufficiency based on the residents' own generation of electricity from PV panels.
- **User practices and the users' interaction with RESPOND solution and app**: This part describes *what* the users do and experience *when* and *how*?
    - **Installing and setting up the app**: Prior to the installation and use of the mobile app, smart plugs have been installed in the home. The smart plugs can be controlled (turned on/off) via the mobile app or by the RESPOND platform (if the residents allow this).
    - **The daily interaction with and use of the DR solution and mobile app**: On the evening before or in the morning of days with a predicted surplus generation of local renewable energy (e.g. days on which the local weather report predicts much sun during midday hours), the residents get a notification via the app informing about the predicted surplus generation and recommending the residents to shift consumption to these hours (if possible for them). Getting the notification the evening before or in the early morning hours make it possible for the users to prepare for DR actions. Thus, they might prepare (load and programme) the dishwasher or the washing machine in the morning before they leave home for work or school. When they get the notification of "surplus production ahead", they should be given two options (both optional): 1) "Notify me when it is best to

consume energy" or 2) "Grant permission for RESPOND to start device automatically when it is optimal to consume energy".

If option 1 is chosen, the user will receive a notification via the mobile app when there is a surplus generation of energy: "There is a surplus of energy – so it is a good idea to consume energy now". When the user gets this message, s/he can activate (turn on) one or more smart plugs via the mobile app. In this way, they can manually – but via remote control – start the dishwasher or washing machine that was prepared in the morning.

If option 2 is chosen, the user is then asked: "What device should be started automatically?" Here, the user can choose the relevant device among the list of predefined devices with related smart plugs. When the user has chosen a device, s/he is asked: "At what time should the device be started at the latest?" The user types/choose the latest hh:mm for start. This feature is to avoid possible inconvenience to the user – e.g. if the washing cycle needs to be finished before a certain time, because the user cannot hang up clothes later in the afternoon. When the latest start time has been chosen, the user gets a message confirming that the selected device will be started automatically, but no later than hh:mm.

In relation to option 2, it is important that the user can always cancel the automated start of the device (the activation of smart plug). People's plans may change and unexpected things can happen, and the RESPOND system must be flexible with regard to this. Also, the app should give a notification when the selected device is started (to make the user aware that this has happened).

- Above, controlling the dishwasher and washing machines have been used as examples. However, other devices could also be controlled if possible and relevant (e.g. charging batteries).
- A critical technical prerequisite for making the automated or remote control of appliances such as dishwashers and washing machines possible is that these machines can start their cycles when turned on via the smart plug. This will depend on the specific model, but many washing machines and dishwashers do not start up when the outlet is switched on. This represents a critical, technical challenge to this usage scenario.

## 4.5 COMPETITIONS TO PROMOTE USER ENGAGEMENT

### 4.5.1 COMPETITION ON DR OF COOLING

The Madrid focus group on cooling appreciated the idea of setting up a competition in relation to DR of cooling. This might be utilized in the RESPOND pilot by setting up a competition among the participating households on who's best at reducing/time-shift their

energy consumption for cooling in peak-hours. As the need of air conditioning is highest during July and August, the competition could run throughout these two months. One might consider awarding monthly prizes (making it two prizes over the pilot period).

Ideally, the pilot participants should be able to follow their own performance and compare this to the average of the neighbours. It might be an idea to make it possible to compare the individual performance with both the average performance of the neighbours and the performance of the 20% best performing (similar to the suggested idea in Figure 1 below). This, in order to utilize the effect of the normative social influence (see description of this in RESPOND deliverable D3.2 *RESPOND user engagement strategy*, Section 6.5).

A technical question relates to how to calculate the size of the DR actions of the individual households. This might be done in different ways, but one approach could be to calculate the reduction in power consumption in hours during DR events by comparing the household's consumption during the event to the average consumption for the same hours in the same month the year before. The latter would be the baseline. The realized peak shaving (in percentage of the baseline load profile for the same hours) can then be compared to the realized peak reduction of the neighbours (all neighbours in average and for the 20% best performing).

### 4.5.2 COMPETITION ON SELF-SUFFICIENCY

In the Aarhus focus group on electricity, the participants appeared to find it particular interesting to know how much of their individual (household) electricity consumption that was covered by their local PV power production. They also seemed to find it interesting to be able to compare their own performance to their neighbours. Thus, a competition on who's best at consuming the local PV power seems to be something that can spur interest and engagement among the pilot participants.

For this reason, the RESPOND app should ideally be able to provide the uses with information about the share of PV power in their own electricity consumption. This could be calculated on daily, weekly and monthly basis, and the share of the individual household could then be compared to the average of the neighbourhood as well as the average of the 20% top-performers (i.e. those with the highest share of local PV). In this way, the neighbourhood comparison would draw on normative social influence to create an incentive (or even competition among neighbours) for getting higher local RE-share percentages.

The following figure illustrates the principles of this approach.

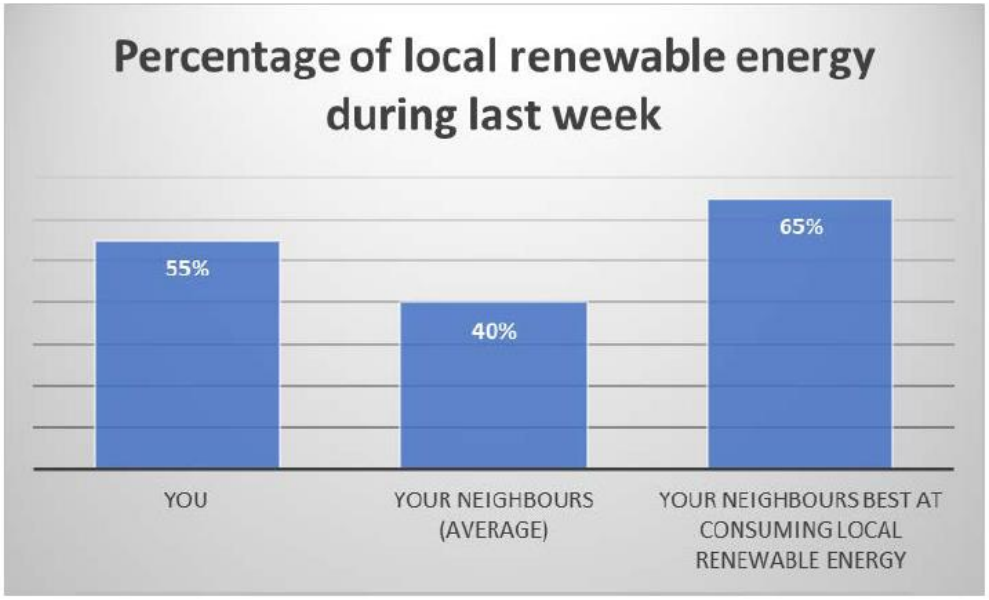


**FIGURE 1: EXAMPLE OF HOW THE NEIGHBOUR COMPARISON OF THE INDIVIDUAL HOUSEHOLD COULD LOOK LIKE.**

If it is decided to set up a competition on who's best at consuming local PV power, the app should ideally also provide information about the ranking number of the individual household ("You are the X best to consume local PV power").

Again, there is a technical question relating to how the share of PV power for the individual households is calculated. In principle, this can be done if the following is known: The hourly PV-share of the housing association (can be calculated on basis of data on PV power production per hour and the total consumption of the housing association per hours) and the electricity consumption of the individual RESPOND pilot households per hour.

# APPENDIX 1: GUIDELINES FOR FOCUS GROUPS AT PILOT SITES

## WP3 (T3.3): Guidelines for focus groups at pilot sites

This document presents the guidelines for the focus groups to be carried out at the pilot sites in Spring 2019.

The focus groups are an essential part of the *T3.3 Detailing the user context and improvements of user interaction* and also an essential input for the T3.4 on smart mobile client and personal assistant as well as the development of the DR platform in general. The aim of the task is to provide empirical input from the coming users (participating households) on the user context and what they think about the user interfaces and the DR design.

Besides AAU (task leader), T3.3 involves the "site partners" (FEN, AURA/ALBOA, ARAN), who are going to carry out the focus groups and report the findings to AAU for final analysis.

At each pilot site, two focus group interviews are carried out in order to address the specific and relevant issues of that site. In this document (in particular in Section 2), the Danish focus groups are used as an example/guide and inspiration. In Denmark, one focus group focused on demand response in relation to *electricity consumption* and the other focused on demand response in relation to *heating* (including indoor environment aspects). According to the Grant Agreement, one focus group should focus on heating, while another should focus on electricity.[2] In addition, an important aim of the focus groups, according to the GA, is to get the participants' feedback on a first version of the RESPOND demand response solution.

Participants in both focus groups should ideally be recruited among the group of households who have been selected for the pilot. Each focus group should involve 7-10 participants.

In the focus groups, the participants will discuss, among other things, the mobile app mock ups in order to provide their perspectives and comments on how these will fit into their existing daily practices and habits – and possible suggestions for design improvements. The focus groups are recorded and analysed. The results of the focus group discussions will feed into the further development of the user interface (smart client and personal assistant) and the overall DR platform.

This document describes how to prepare and carry out the focus groups. Section 1 is a general introduction to the method (including how to prepare focus groups etc.), while Section 2 presents the topics to be discussed in the two RESPOND focus groups (example based on the Danish activities carried out in January 2019).

[2] From the Grant Agreement (p. 17): "One focus group focuses specifically on electricity (appliance) DR, while the other focuses on heating DR (including comfort aspects)."

# 1. Introduction to the focus group method and how to perform them

## 1.1 What is a focus group?

A focus group is a moderated group discussion about a chosen subject. In our case, the subject is the planned DR solution (including mock-ups of the mobile app user interface) and what the households think about taking active part in demand response actions. In the focus group, the discussion among the participants takes departure in a limited number of predefined questions (topics). Focus groups typically last 1-2 hours and are moderated by 1-2 persons (in our case staff from the local site partners). As a "moderator" of a focus group, one's main objective is to keep the discussion running (without influencing the participants' statements too much) and keep it within the theme of the focus group. Part of the moderators' task is to create a relaxed and inclusive atmosphere so that all participants feel safe and contribute to the discussion.

How to prepare and carry out focus groups are detailed in the following sub-sections.

## 1.2 Doing focus groups – the role as moderator

With regard to how (more specifically) to moderate focus groups, Puchta & Potter (here referred from Halkier 2008) point out four different preconditions that are important for a successful focus group and that it is the moderators' role to ensure:

- *Informality* in order to make the focus group safe and "inviting" for the participants active participation. The moderator can ensure informality in different ways, e.g. through his/her way of speaking, choice of clothes etc.
- *Active participation*. The moderator should ensure that all participants take an active part in the discussion, e.g. by inviting persons, who have not said much for a longer period, to express their views or to say if they agree or disagree with the others' statements.
- *Focus on the topic* of the focus group. The moderator should help to keep the discussion "on track", e.g. by reminding the participants of the discussion topic if their discussion moves away from it.
- Providing a *variety of different opinions and experiences* regarding the topic. Here, the role of the moderator can be to challenge the consensus of the focus group participants, if this consensus appears early in the discussion or seems created by influence from dominating participants.

The literature on focus group methods often distinguishes between two kinds of moderator intervention: Probing and prompting.

*Probing* is invitations to the participants to go into further detail with a specific issue or description; e.g. by asking "please, could you tell more about this?" Probing can also be done through non-verbal gestures such as nodding (e.g. if the moderator wants a participant to explain a particular viewpoint more in detail or to invite a participant, who has previously not participated much in the focus group, to go on with his/her contribution to the discussion).

*Prompting* is typically follow-up questions that aim at making the participants to think of other aspects that are (also) relevant for the topic. An example in relation to RESPOND could be, if the participants for some time have talked about the difficulties of time-shifting daily energy consumption such as laundering or dishwashing; in this case, the moderator could follow up with questions like "can you think of ways to make it easier to (remember to) time-shift your energy consumption?". By asking this question, the moderator can prompt the participants to shift focus to another aspect of demand response and time shifting; i.e. from the difficulties to measures, new routines or other things that could make it easier to do.

Having this overall description of the role of the moderator in mind, the following presents some specific ideas and recommendations on how to create a good focus group discussion and handle specific situations that might occur during the focus group session.

### How to handle late arrivals?

First of all, late arrivals should be avoided. Therefore, consider a strategy on how to minimize the risk of late arrivals (or people forgetting to attend the meeting). For instance, send an email ("a kind reminder") with information on data and place a few days before the focus group takes place.

However, even with a strategy on avoiding late arrivals, there is still a risk of one or two participants arriving late. Therefore, think about how to handle this. Typically, it is a good idea to start the focus group with practical things like offering people a cup of coffee/tea before your introduction to the focus group (and presentation round). This gives a few extra minutes for late arrivals.

If a participant arrives after you have commenced the focus group, try to make his/her arrival as little a disturbance as possible. Greet discreetly and indicate where s/he can sit – and when there is a natural break, say welcome to him/her, briefly inform him/her about what is taking place and ask him/her to briefly introduce him-/herself.

### How to handle persons who dominate the discussion?

It happens that a single person (or a few persons) dominates the focus group discussion. Reasons for this can be, among others, that s/he is talking much or an uneven social status (e.g. if s/he has an academic background).

In this kind of situations, it is important that the moderator ensures space for also the other participants. This can be done, for instance, by actively inviting those, who do not say much, to contribute. For instance by asking: "What about you, Maria, what do you think about this? Do you agree with Peter, or?"

Alternatively, the moderator can also ask more generally (instead of addressing his/her question to one specific person) by asking: "What about those of you, who have not said much yet – what do you think about this?" Or the moderator can also more explicitly address the problem of one/few persons talking most of the time, e.g. by asking: "Until know, it has mostly been Peter who has talked, but we would also very much like your others' comments and input to the topic. So what do you think?"

How to handle dominating participants depends on the specific situation, the personality of the participants (including the dominating person) as well as the moderators own feeling about what works best for her/him.

### Being two moderators?

If you are two moderators, it is important to make a clear agreement about the division of roles and responsibilities before the focus group. Also, this should be explained explicitly to the participants in the introduction to the focus group, so that the participants are not confused by different moderator roles.

It is recommended that one person is allocated the main responsibility for moderating (including taking decisions on when to move on to next topic etc.), while the other person can be supporting the "leading moderator" in relation to follow-questions, probing and prompting. Important is also to have a person that is time keeper and takes notes about details related to the process of the focus group (e.g. the interaction of the participants). Typically, this could be the role of the co-moderator.

## 1.3 How to introduce the focus group to the participants?

Of particular importance is how the moderator introduces the focus groups. The introduction sets the framework for the rest of the focus group and is therefore crucial. Focus group introductions should include the following four elements:

1. A brief presentation of the project (aim and focus)
2. A "round of presentations" (each participant and the moderator(s) present him-/herself in few words)
3. Introducing the topic of the focus group (what the focus group is about)
4. Explaining what a focus group is – including explaining expectations to the role as participant as well as the moderator(s)

The introduction to the focus group (point 4) should be short and to the point. An example of an introduction could be the following (based on example in Halkier 2008, but adapted to our project – and translated to English):

- This interview is different from what you normally associate with an interview, where the interviewer is asking a lot of questions all the time.
- Today, it is mostly you who are going to talk and discuss with each other.
- We have X topics, which you are going to discuss one by one.
- You run the discussion yourself. If you get off the track, if you run out of things to say or if not everyone gets the chance to contribute to the discussion we [the moderators] might enter your discussion, but otherwise, you run the discussion on your own.
- Imagine this to be somewhat like an ordinary talk/discussion between yourself – for instance at a café or if you were visiting each others at home.
- We are interested in both your personal experiences with the topics as well as your opinions.
- All kinds of experiences and opinions are welcome and equally important. There is no "right" or "wrong" answers.

## 1.4 How to finish the focus group ("outro")?

When the focus group has covered all prepared topics and people seem to have not more to offer to the discussion (or if the time is up), the moderators conclude the discussion by:

- First asking, if there's anything that some of the participants might have been thinking about as important to the topics, and which they might want to mention before the closing of the focus group?
- When, if no more is mentioned and people seem satisfied, thank the participants for their valuable contributions and briefly explain (again) how their contributions to the focus group will contribute to the further work of the project.
- "Thanks and goodbye"

## 1.5 How to recruit the participants? And avoid absence?

As noted by Morgan, "inadequate recruitment efforts are the single most common source of problems in focus group research projects" (Morgan 1997: 38). Thus, a recurrent problem of focus groups is the problem of persons who are not showing up at the focus group. Therefore: "Simply locating participants and getting them to agree to show up is often not enough; instead, it is essential to develop careful procedures that ensure that enough participants actually do show up for each group" (ibid.).

For the same reason, it is very important that each pilot partner think through and develop a strategy tailored to the local context on how to recruit focus group participants as well as how to avoid the problem of absence.

With regard to the recruiting of participants, it is recommended to avoid recruiting participants (for the same focus group) that know each other *too well* on beforehand. If all participants in a focus group know each other on beforehand (are acquaintances), there is a risk that the focus group discussion will be influenced too much by taken-for-granted understandings and already established inter-personal relations (roles). On the other hand, and for good reasons, it might be a practical problem to ensure that all participants are strangers to each other in our case, as the prospective participants are all from the same building(s) or local area. But still, it would be an idea to "separate" close friends or relatives by dividing them in the two focus groups.

### Make a clear appointment and inform clearly about time, place etc.

This might sound very simple and trivial, but it is very important to make a clear appointment with the persons that show interest in participating in the focus groups. This includes clear information about time and place for the focus group – and about what is expected from the participants.

In the Aarhus focus groups (carried out in January 2019), we sent an invitation by email to the pilot households about a month in advance of the planned focus groups. A translated version of the invitation email is included in Annex, p. 12, for inspiration.

Before sending the invitations, we divided the RESPOND households into two groups, and each group was invited for at specific focus group (either the focus group on heating or electricity). The households were divided strategically in order to obtain a diverse composition of each focus group regarding age, family type, household size, educational background and ethnicity. In this way, we wanted to avoid a group of too like-minded participants, which could threaten the dynamic of the focus groups and make the outcome of them less representative for the diversity of households and user needs and situations. In total, 14 families were present in the two focus groups (typically by one member, although four families were present with two members/the couple). Overall, we achieved a relatively high diversity, although none of the families with an ethnic background other than Danish participated.

### Time and place

The choice of location is important in several ways. First, it is important to choose a place that feels comfortable and safe for the participants. This could, for instance, be at a local communal house or room. Second, it is important that it is easy for the participants to get to the location.

The time of the focus group is also essential. The focus group should start at a time that is convenient for the participants. If the RESPOND participants are working, the focus groups obviously need to be performed outside normal working hours. Whether it should be late afternoon or in the evening depends on the daily (family) rhythms of the families, which local pilot partners should be best at judging.

## 1.6 Documenting the focus groups

The focus groups should be recorded on Dictaphone (audiotaping) for later preparation of summaries and analysis. Remember to check that the technical equipment works properly before start of the focus groups.

## 1.7 Final comments on the format of the focus groups

- No. of participants: Between 6 and 10 would be ideal. If you expect a certain drop-out, better aim for 10 participants. 1-2 participants per household.
- Aim for a fair gender balance. It might not be possible to get a 50/50 balance, but ensure a representation of both genders.
- Aim for a mixed composition of each focus group regarding age and family type.
- Duration: About 1.5 hours.
- Consider when (time of the day) would be most convenient to most people. Including how to accommodate to the daily schedule of parents with (small) children living at home (if relevant).
- Recruit participants through personal invitations. Consider offering lunch or a light dinner as part of the focus group (before or after the focus group) – and include this information in the invitation. Experience tells that this can be a good incentive to motivate people to show up.
- Participants should be placed around a (big) table so that everybody can see and hear everybody.
- Focus group meetings are recorded for later analysis (remember to get the consent a priori at the meeting)
- Maximum three moderators from RESPOND (if small focus group sizes, preferably just two).

# 2. Topics and questions for the RESPOND focus groups

At each pilot site, two different focus groups are carried out (with different participants): One focusing on DR in relation to electricity consumption and another focusing on DR in relation to heating (cooling, if relevant). The topics and questions to be discussed at these two focus groups will be the same for all sites (although there might be a need to adjust the questions to the local site context).

Below is an outline of the topics and questions to be discussed at the two different focus groups.

Note that each focus group should include an introduction and an "outro" (debriefing) – see more about how to prepare and perform these in previous sections 1.3 and 1.4). The introduction should

take about 15 minutes in total (including a round of presentations), while the outro should take about 5 minutes. With a planned total duration of the focus group of 1½ hour, this leaves about 1 hour and 10 minutes left to the discussion of the topics detailed in the following.

## 2.1 Focus group 1: DR in relation to electricity consumption

This focus group relates to the RESPOND measures targeted demand response actions in relation to electricity consumption for other purposes than heating (i.e. mainly appliance use). As the pilot households are expected to take part in some amount of "active (manual) DR actions", this will be the topic of this focus groups. Focus will be on how the participants perceive (understand) this, what they think about it and how it will fit into their daily habits and practices?

The topics to be discussed (see below) moves from a general discussion of demand response and moving own energy consumption over discussing alternative variable pricing schemes to discussing the specific RESPOND solution and app.

Topics and discussion starters:

1. **Topic 1: General attitude towards demand response** (duration: ~20 min.)
    a. Discussion starter: We are getting more and more renewable energy into the energy system. Much of the renewable energy – for instance wind and sun – is difficult to control and the production of energy is intermittent. This creates a new challenge: Sometimes we produce more energy than is needed – and at other times the energy consumption exceeds the energy we get from renewable energy sources. Therefore, there is a need to make consumption follow production. One way is to make households shift their consumption in time, so they move some of their consumption from hours with little renewable energy to hours with much renewable energy. For example, moving consumption to night hours when the wind blows or to midday hours when the sun shines. *Discuss what you think about the idea of moving your own electricity consumption in time?*
    b. Follow-up questions (comments to moderator on how to moderate in brackets []):
        i. Discuss what types of electricity consumption you *would be able to* shift in time in your own household? [If people are finding it difficult to come up with ideas, introduce a few examples – e.g. laundering or dishwashing?]
        ii. What challenges do you think could be related to time shift your consumption?
        iii. Discuss what types of electricity consumption you *would be willing to* time-shift in your own everyday life?
        iv. What would motivate you to time shift your consumption? [Should be open – try not to "steer" the discussion from the outset by giving examples like money saving or the environment. Save these examples to later, if needed to activate the discussion.]
        v. What types of electricity consumption would you not be able to time shift? Why not?
2. **Topic 2: Discussion of alternative Time-of-Use (ToU) pricing schemes** (duration: ~20 min.)
    a. Discussion starter: Three different forms of Time-of-Use pricing are presented to the participants for discussion. Each form of ToU pricing is illustrated on a sheet of paper (see page 13-15 of this document, the illustrations are printed and handed out to the participants, one by one, as the three different ToU schemes are introduced), which are

spread out on the table to support the discussion among the participants. The Topic begins with a general introduction by the moderator: "Today, most households have a fixed price, which means that they pay the same price for electricity regardless of when they consume it. However, it is suggested to introduce variable electricity prices to regular customers in the future. I.e. prices that in one way or the other varies according the patterns of renewable electricity production. The assumption is that this will help to motivate people to start time-shifting their own electricity consumption to save money by consuming at hours with low prices in order to better match the intermittent production from renewable energy sources. In this topic, we are going to discuss what you think about this on basis of three different suggestions to variable price models…"

Following this general introduction, the moderator introduces the three different ToU schemes, which are:

i. Scheme 1 – **Real-time pricing** (RTP): The price of electricity reflects the present (real-time) balance between production and consumption of the overall energy system. I.e. prices **change on an hourly basis** and can only **be predicted about 24 hours** ahead. Prices reflect the status of the national electricity system.
ii. Scheme 2 – **Static ToU pricing**: The 24h day is divided into a limited number of time intervals with different prices. E.g. low during night hours and extra high during peak hours in the morning and evening. The **prices and time intervals are the same every day**. Prices reflects the status of the national electricity system.
iii. Scheme 3 – **Peak Production Rebates** (PPR): In this scheme, the price is in general flat, but at **situations with a particularly high *local* renewable energy production** (from solar or wind power), the residents are offered considerably lower prices for consumption in these hours. Residents are informed up to maximum 12 hours before the PPR. Prices reflect local renewable power production.

Following this introduction, the moderator asks this discussion starter question: *What do you think about these three alternative pricing schemes? What would be pros and cons for each of them?*

b. Follow-up questions:
   i. Is there one of the schemes you would favour personally? And why?
   ii. Could you be interested in opting into one of these schemes, if it was offered to you?
   iii. If thinking of your daily life and if trying to follow one of these schemes, which one do you believe will fit best to you and your way of living? Why and how?
   iv. Do you have any ideas on how these schemes could be improved in order to make them (more) attractive to you?
   v. Do you have suggestions for other types of schemes that would be more attractive?

**3. Topic 3: Discussion of RESPOND solution and mobile app** (duration: ~20 min.)

a. Discussion starter: The participants get a few hands-out (to be spread out on the table) showing a selected number (4-6) of functionalities (i.e. "pages") in the mobile app (see Annex p. 19-25 of this document). The moderator briefly explains the overall DR approach to be utilized within the pilot site and the functionalities of each of the selected mock-up mobile app pages. This should not take longer than 4-5 minutes. After this presentation, ask the following discussion-starter question: *Please, consider how you*

*could personally make use of this and discuss your immediate reactions to it. What do you think about it? How would this fit with your everyday life at home and in your family?*

b. Follow-up questions:
    i. What do you think about the design of the mobile app? Does it make sense to you? Something that's difficult to understand? Any suggestions for improvement?

---

**Issues and questions to be considered and discussed (in Eibar):**

- Needs for adapting topics/questions to local context of Madrid and Aran Islands? E.g.:
    - Consider to adjust the ToU pricing schemes (Topic 2) to what would be relevant at the local site. For instance, while the electricity load peak hours in Denmark are in the late afternoon/early evening, this is rather later in Spain – thus, the hours with high prices should be adjusted to reflect the actual load profiles of the Spanish electricity grid.
    - Consider selection of app functionalities/"pages" for discussion in Topic 3. Should be relevant for the local site.
- Other issues/questions?

---

## 2.2 Focus group 2: DR in relation to heating consumption

This focus group relates to the RESPOND measures targeted demand response actions in relation to heating (cooling). In Aarhus, this relates to the control of heating (heating and domestic hot water) – allowing the tenants to individual adjustment of the temperature level combined with automatic switching off the heat shortly in the morning to reduce peak consumption of district heating. On Aran islands, this might relate to automated (external) or manual control of heat pumps (?) and in Madrid manual control of cooling (and heating) (?). Focus will be on what the participants think about these ways of controlling heating to allow for time-shifting heating. How this will fit into their existing daily practices and their existing preferences and habits regarding heating (cooling) and their thermal indoor environment.

To better understand how to design solutions that fit well into existing heating practices, the focus group starts with a more general discussion of the participants' existing habits and preferences regarding heating (and cooling). Then follows two topics that explore the participants general attitude to time-shifting heating and their thoughts on the specific RESPOND solution and app specifically.

In the following, especially Topic 2 should be tailored to the local context in order to ensure a relevant discussion. Below, the Topic 2 is tailored to the local context of the Aarhus pilot as an example. What to include for Aran Islands and Madrid should be discussed at meeting in Eibar.

Topics and discussion starters:

1. **Topic 1: Existing preferences and habits regarding heating (and cooling)** (duration: ~20 min.)
    *This topic is divided into three sub-topics a-c (each including a number of follow-up questions):*
    a. Discussion-starter: How do you **experience the heating** in your current dwelling? Is it something you are thinking about?

i. Do you or other members of your household sometimes feel it too hot or too cold? In what situations? Who? And what do you do then?

b. Discussion-starter: How do you **decide what temperature** you prefer at home? And why that specific temperature?
    i. Do you heat all rooms in the same way (same temperature)? Or do you have different temperatures in different rooms? Why?
    ii. How do you air your home? In what situations do you open windows or doors to air?

c. Do you sometimes **turn up or down the heat**, i.e. adjusting the thermostat settings? When and why? And who?
    i. Do you turn up or down the heating (and temperature) on a day-to-day or week-to-week basis? How and why? Or do you keep the same temperatures and settings without adjusting them on a continuous basis? Why?
    ii. Who is in general controlling the heating (or cooling) at your home? Is it something that all members of your household do? Or is it specific persons? Why?

2. **Topic 2: General discussion of participants' reactions to the idea of time-shifting heating** (duration: 20-30 min.)
    a. Discussion starter: The moderator explains the underlying idea and concept behind time-shifting heating (no specific focus on RESPOND app; see Topic 3 for focus on app). For various reasons, the district heating suppliers would like to make it possible to time-shift some of the heating in homes. The most important reason for this is that the suppliers in various areas are experiencing a problem with delivering enough heat (e.g. if there has been new-built of homes) – especially in the morning when the demand for heat peaks due to many people taking bath more or less simultaneously etc. [hand out and explain the figure on p. 16]. This means that the suppliers either have to invest in upgrading the pipes in the ground (which might cost a lot of money and make the heat more expensive for customers) or – alternatively – find ways to time-shift some of the consumption away from the peak hours. One way to do the latter is to install equipment in homes that can control the heating in the morning. In this way, the company could switch off the heat shortly during the few hours with peak consumption, e.g. between 6 and 9 am [hand out and explain the figure on p. 17]. Of course, only with the prior acceptance from the tenants. For buildings like those here in ALBOA, this would only result in a limited drop in temperature during the hours when the heating is switched off [hand out and explain the figure on p. 18]. Roughly, the temperature drops about 1 degree Celsius per hour. To maintain the temperature within a comfortable range the temperature may be slightly raised before turning off the heat. In RESPOND, we will try out such an approach in ALBOA…

    Following this presentation, ask the discussion-starter question: *What do you think about this approach? How would this fit with the daily routines and needs of you and your family? Pros or cons?*

    b. Follow-up questions:
        i. Would you be interested in taking part in this sort of scheme (also if you were not pilot family in the RESPOND project)? What could make it interesting for you to take part in this type of scheme?

ii. What would be the most important challenges in relation to time shifting heating? And what could be done to handle these challenges?
iii. Could there be situations where switching off the heating in the morning would contradict with other considerations or needs?
iv. Would it make a difference for your experience of such a scheme whether it is weekday or weekend? Or holiday or not?

3. **Topic 3: Discussion of RESPOND mobile app** (duration: ~20 min.)
   a. Discussion starter: The moderator introduces the RESOND app by placing a few hands-out on the table that show selected mobile app functionalities [see p. 26-32]. The moderator briefly explains the pages. After this introduction (lasting maximum 4-5 minutes), the moderator asks the following discussion-starter question: *Please discuss what you think about this? You can discuss both the design of the app and it's functionalities.*
   b. Follow-up questions:
      i. What functionalities do you think you would find interesting to use?
      ii. What do you think about the design of the mobile app? Does it make sense to you? Something that's difficult to understand?
      iii. Any suggestions for improvement?
      iv. Would you be interested in getting information or recommendations on your heat and electricity consumption via the mobile app (e.g. compared to the energy consumption of your neighbours)? What sort of feedback? And how often?
      v. Would it be possible to communicate about the time-shift of heating, as we talked about before, by using the App? What functionalities shall be available if all communication shall be handled through the App?

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**Issues and questions to be considered and discussed (in Eibar):**

- Needs for adapting topics/questions to local context of Madrid and Aran Islands?
  - In particular Topic 2: What kind of RESPOND actions/measures will be related to the heating (cooling) of homes in Madrid and on Aran Islands? If none, should the focus groups focus more on the kind of feedback in relation to monitoring indoor temperature and air quality be the primary focus instead?
  - Consider selection of app functionalities/"pages" for discussion in Topic 3. Should be relevant for the local site.
- Other issues/questions?

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## 3. Literature


Halkier, Bente (2008): *Fokusgrupper* (second edition). Copenhagen: Forlaget Samfundslitteratur.

Lezaun, Javier (2007): "A market of opinions: the political epistemology of focus groups". *The Sociological Review* 55(Issue supplement s2): 130-151.

Morgan, David L. (1997): *Focus groups as qualitative research (second edition)*. Thousand Oaks, CA: SAGE publications.

Annex

Aarhus 10. January 2019

## Invitation

Dear *Name* *(RESPOND contact person)*

We would like to invite you to a cozy evening together with other RESPOND families.

**Wednesday 30. January kl. 18.30**

In the common room Ny & Næ, Nyringen 5 (in the basement)

We are going to tell you about what you can expect to happen in the RESPOND project in 2019, and in which manner you will be involved.

Attending the meeting will be researchers from Aalborg University. They will be conducting interviews with you in groups. Their interview will consist of, among other things, questions about the App and the project so far. Which App features provide the most crucial information for you? The event lasts about 2 hours.

We will be serving food and refreshments. So no need to eat supper beforehand.

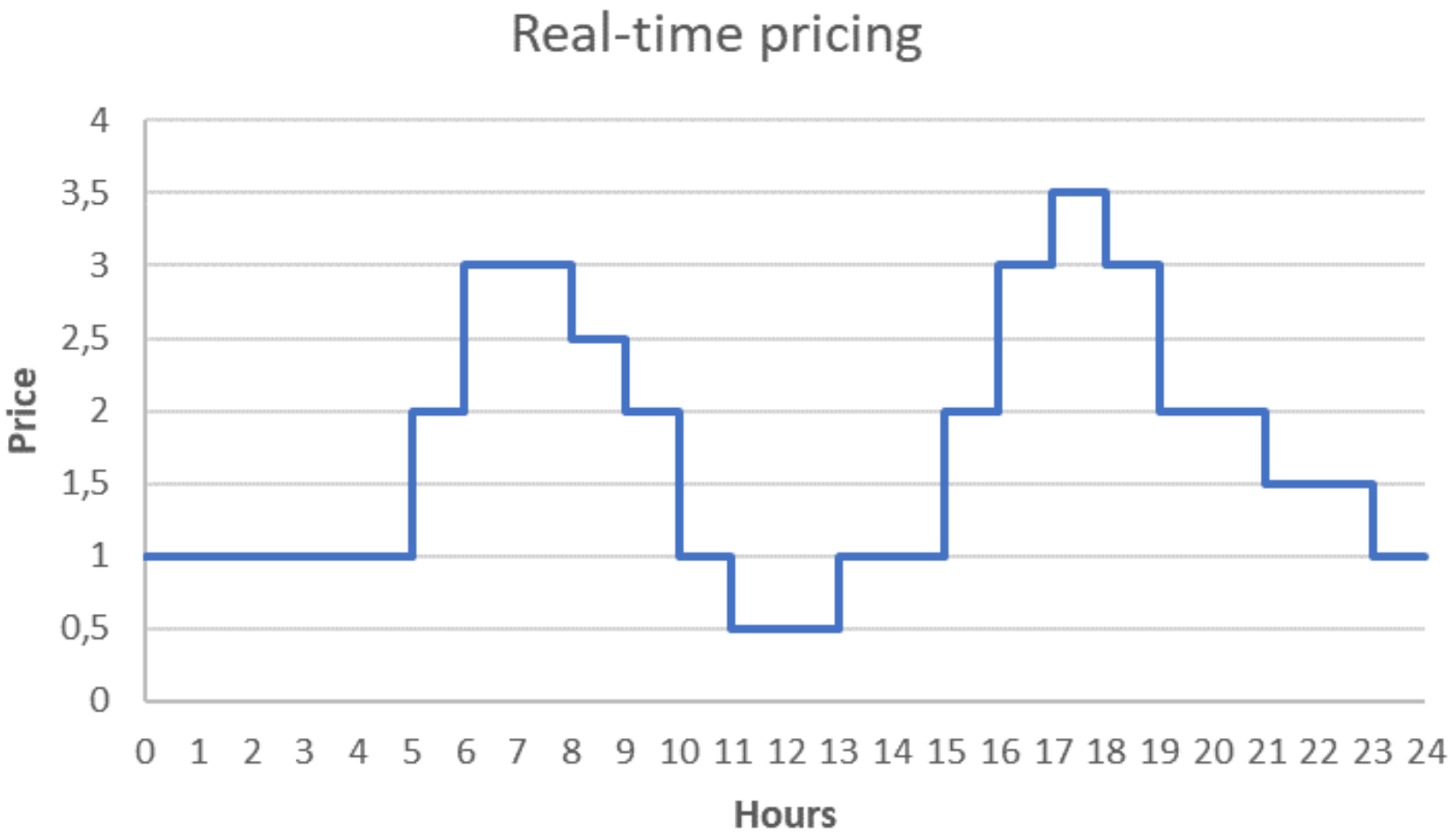
*For the sake of meals and practical planning, we would like to know if you are coming – please inform us before Monday 21 of January*

Do you have any questions or already know that you unable to attend this event please call or write to me at lsr@aura.dk of Tel. No. 51176175.

Best Regards

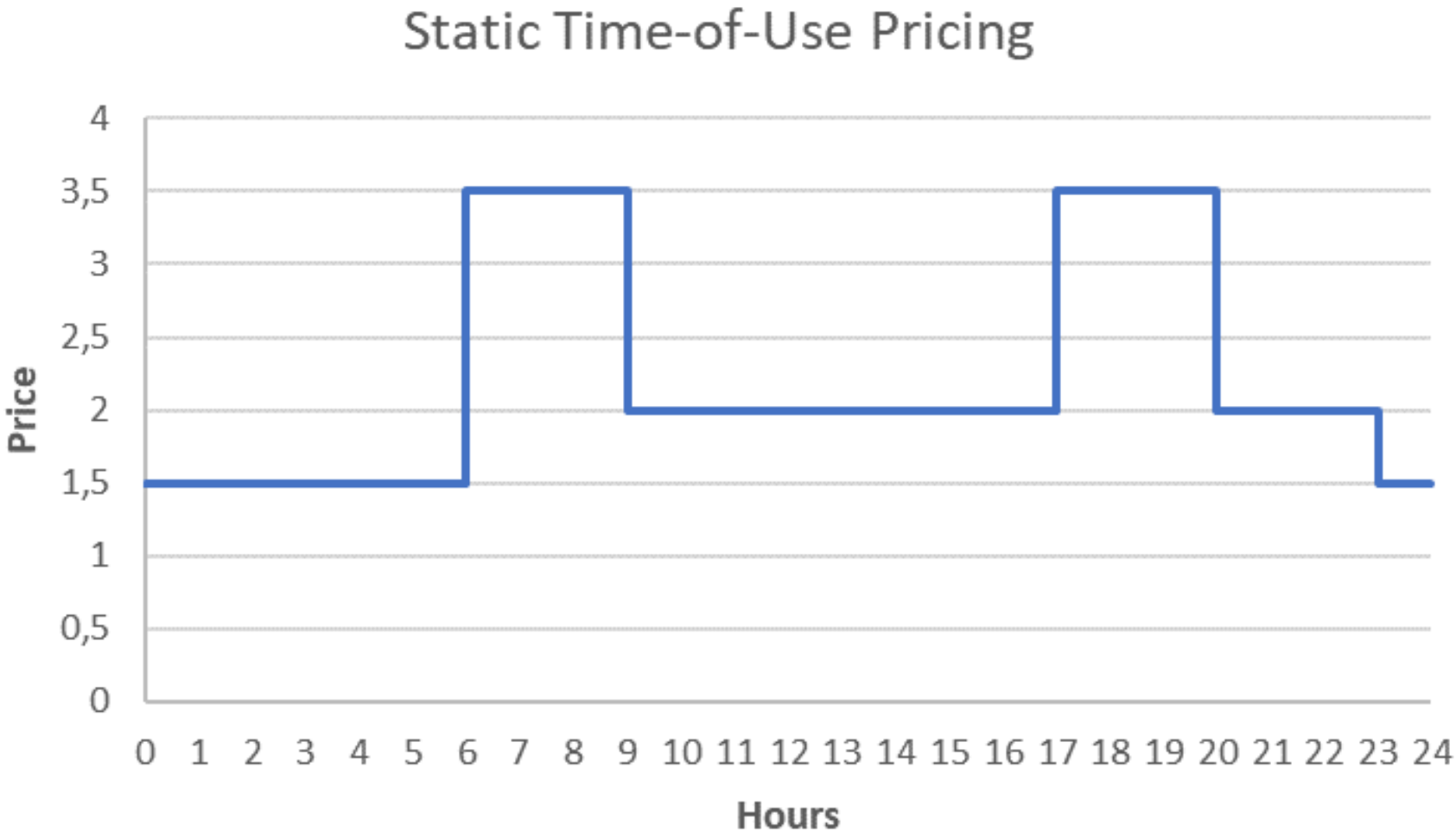
Lisbet Stryhn Rasmussen

AURA Rådgivning



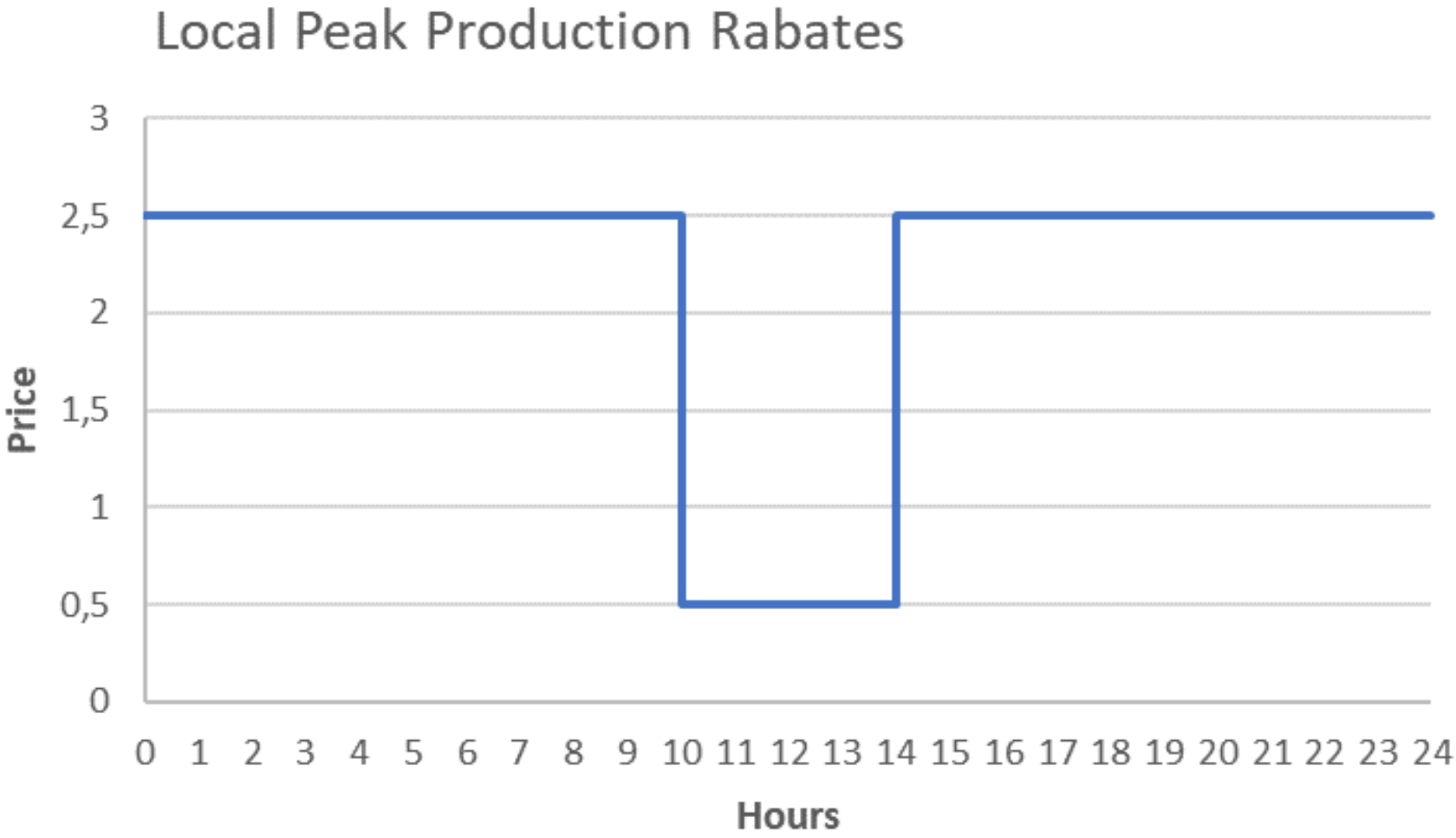

Electricity price varies from hour to hour – and in different ways from day to day,

The electricity prices of the next day is announced the day before.




The electricity price varies a few times a day and follows a static scheme.

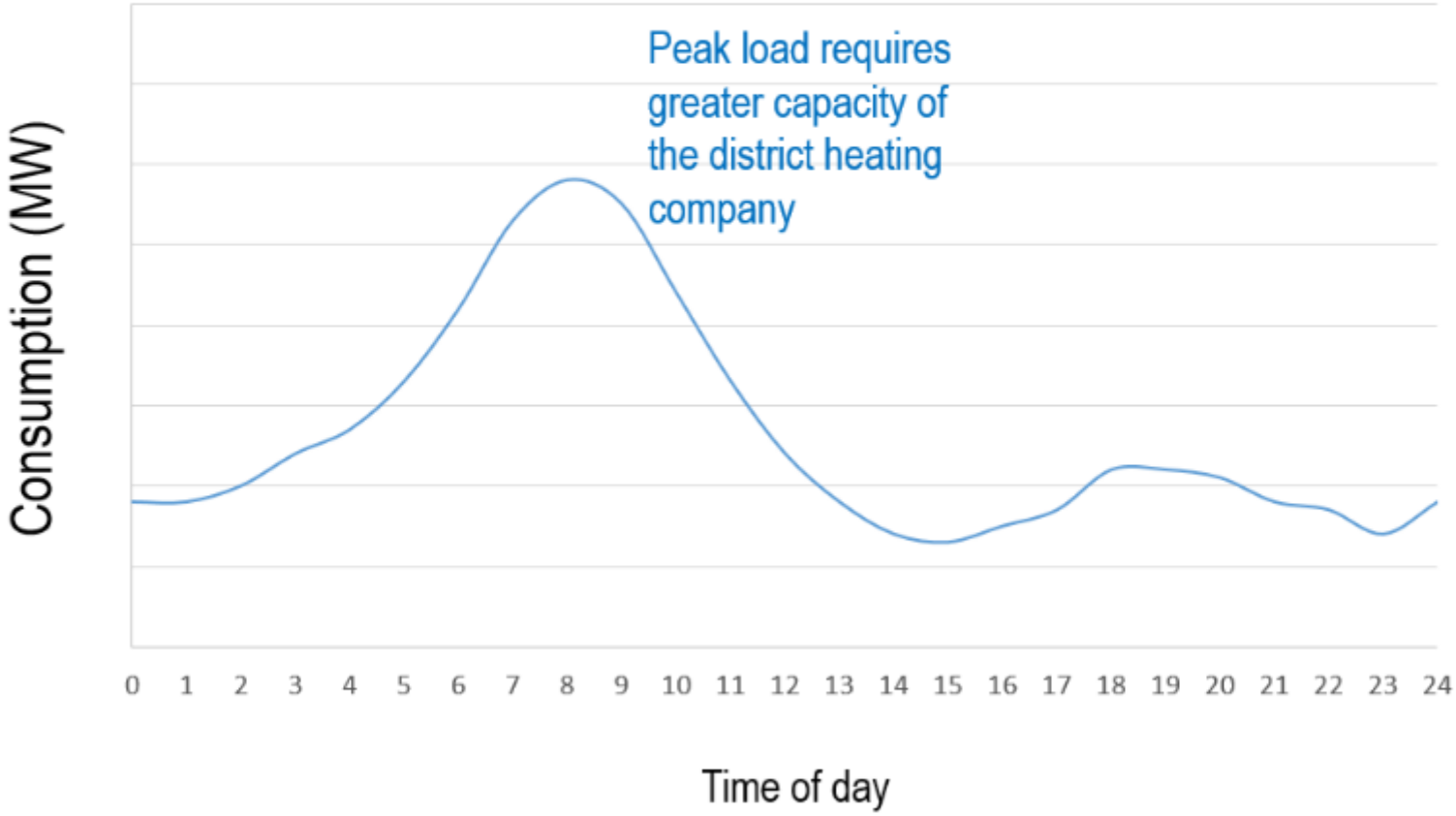
Same scheme every day.



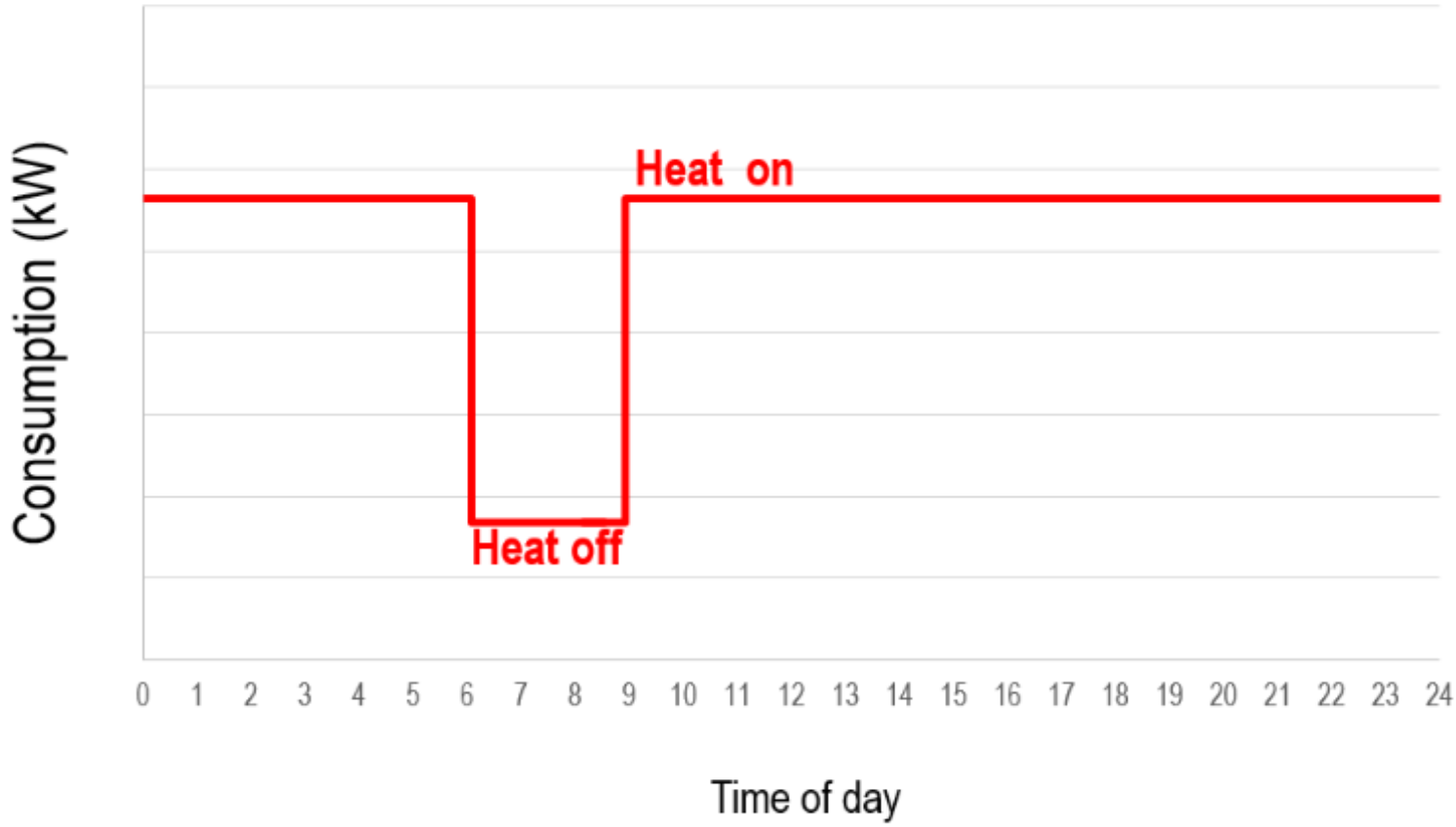

Fixed (flat) electricity price – except rebate in cases of local surplus of wind or solar power.

The hours of rebate (lower price) is announced the evening before.

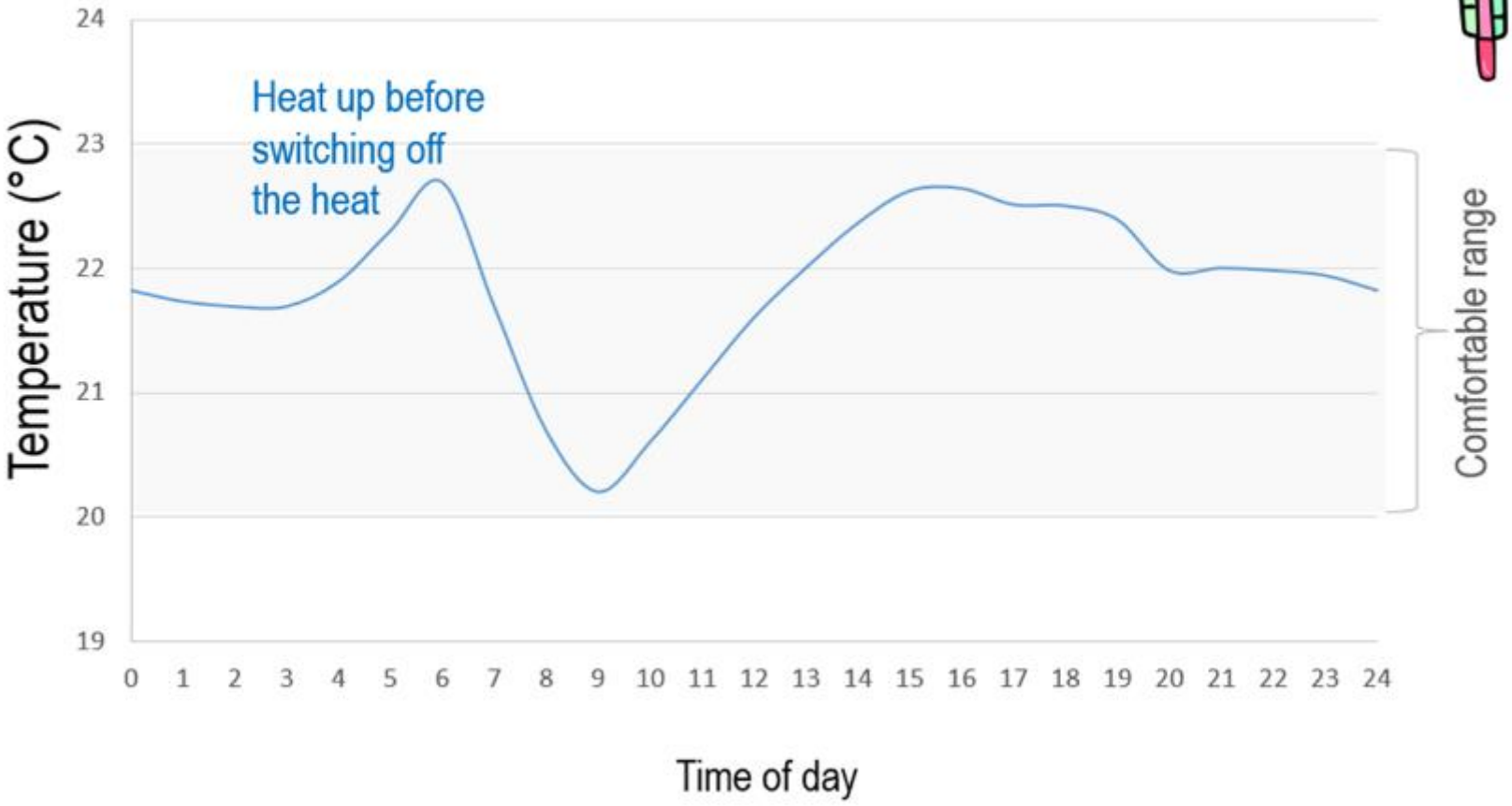
# Heat and hot water supplied by district heating company



# One possible solution is to switch off the heat briefly



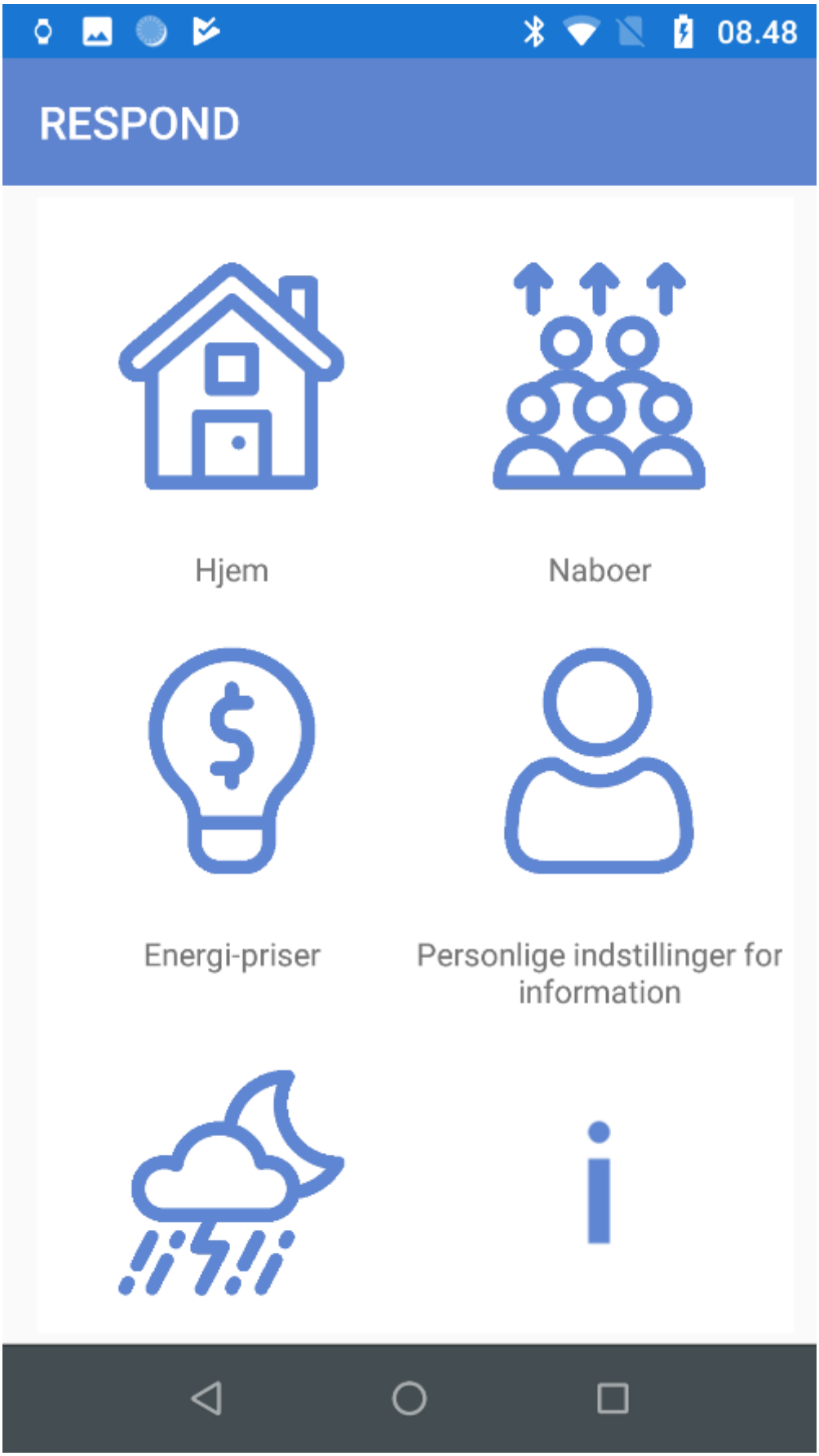
# The temperature in the dwelling



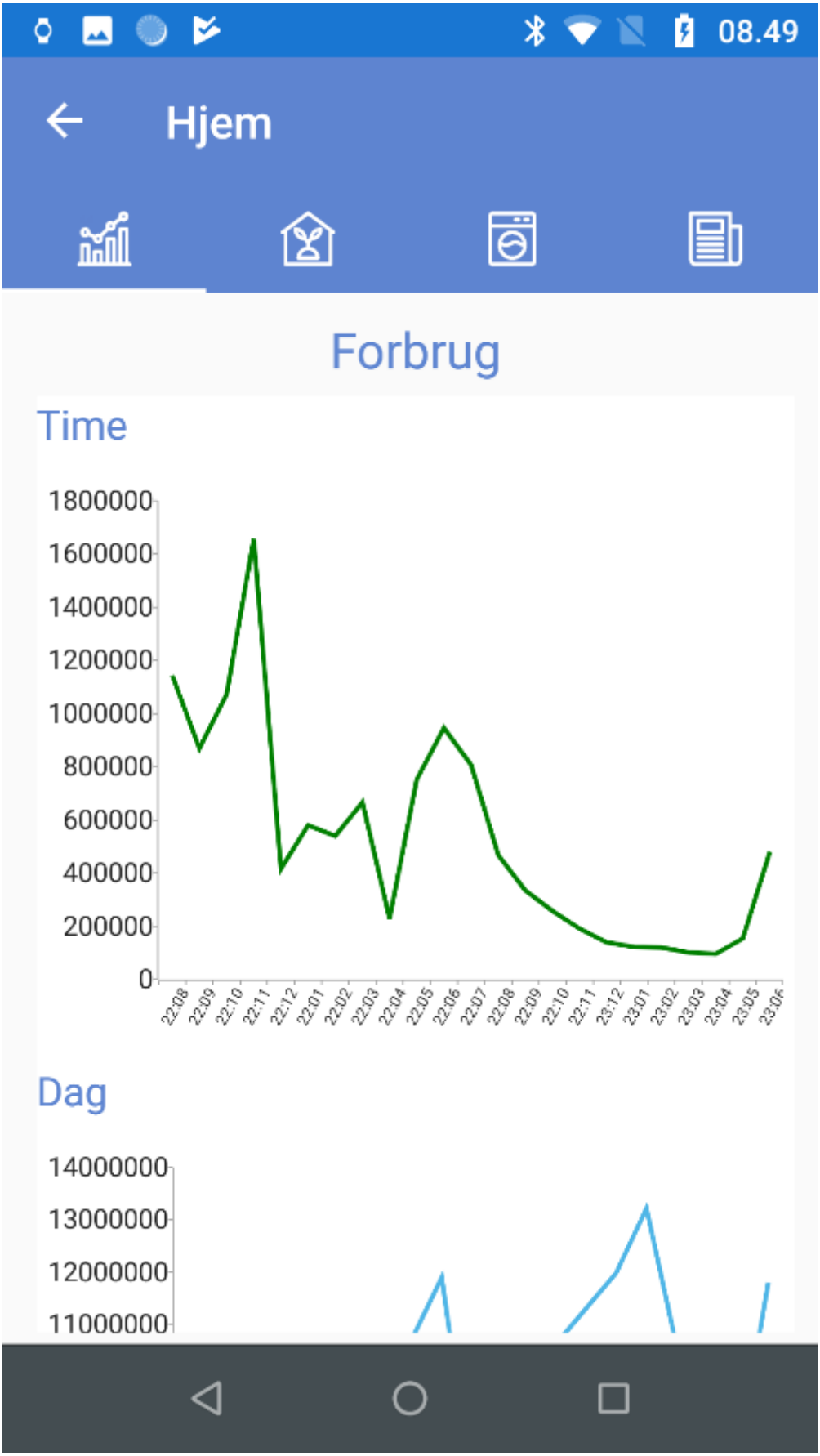
# Hands-out in relation to discussion of mobile app in focus group on electricity consumption

*The following six pages are the hand-outs related to the focus group on electricity and appliance use.*

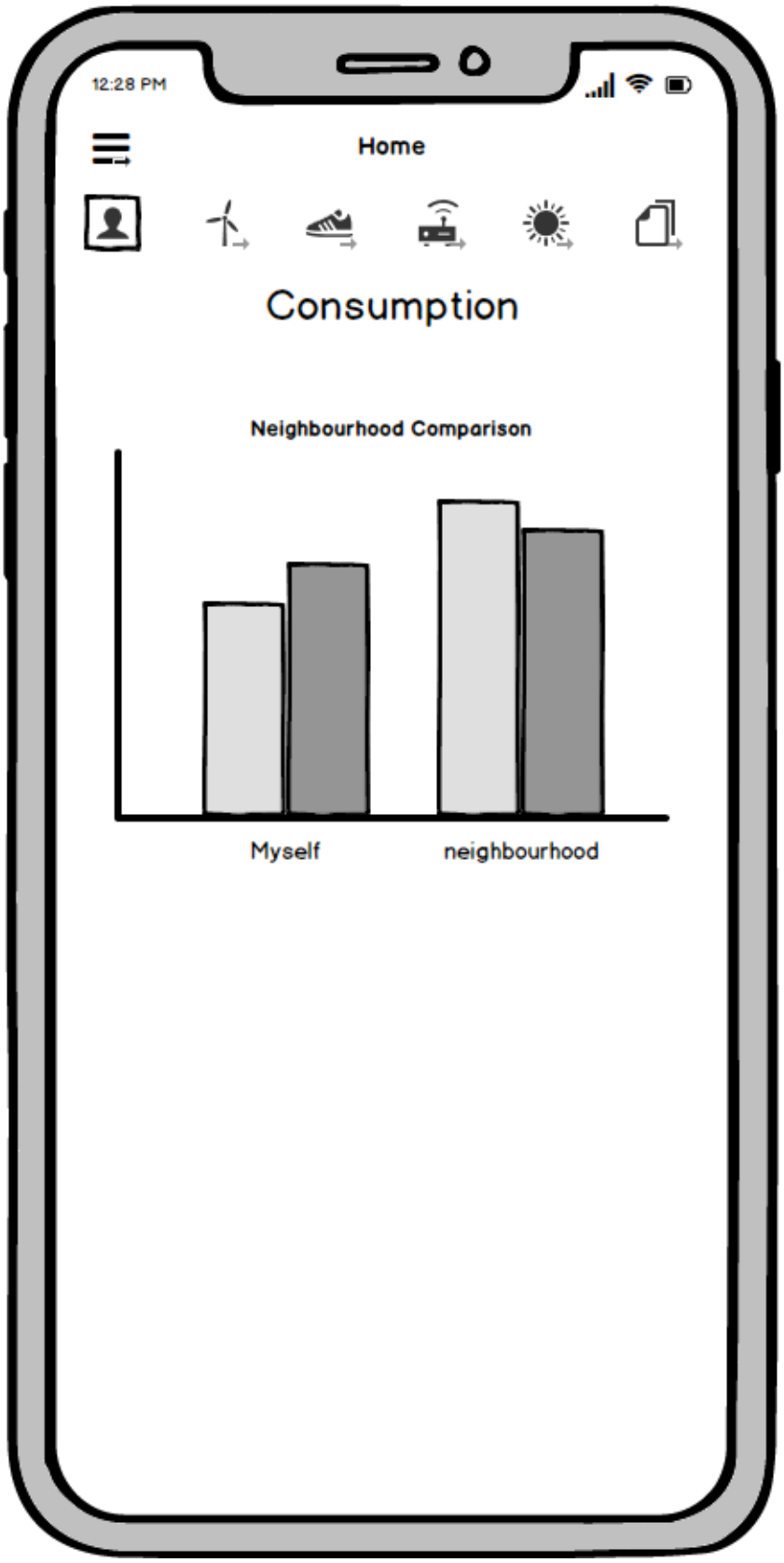
Start page


08.48
RESPOND
Hjem
Naboer
Energi-priser
Personlige indstillinger for information

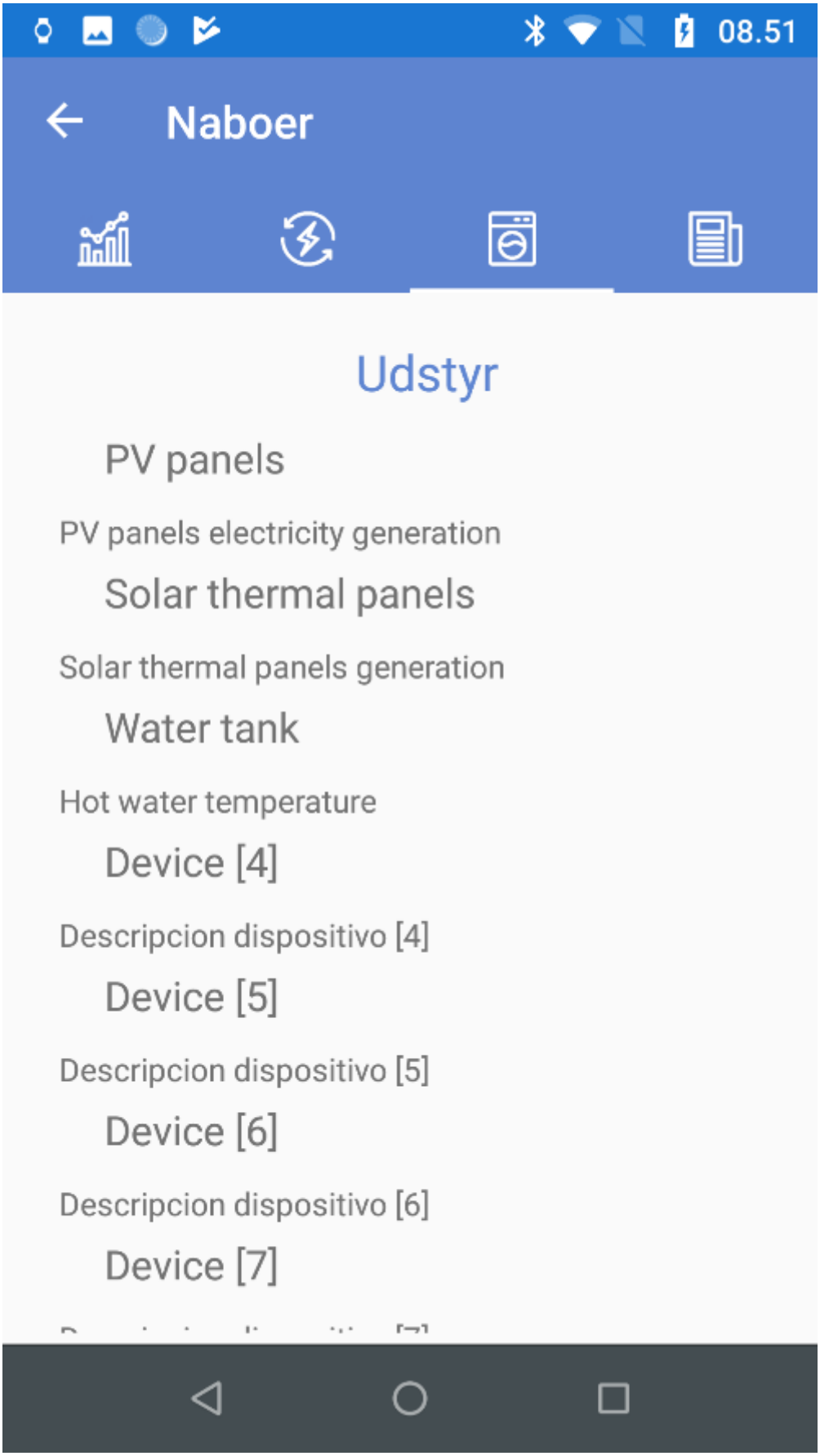
Consumption at home



Comparison with neighbours

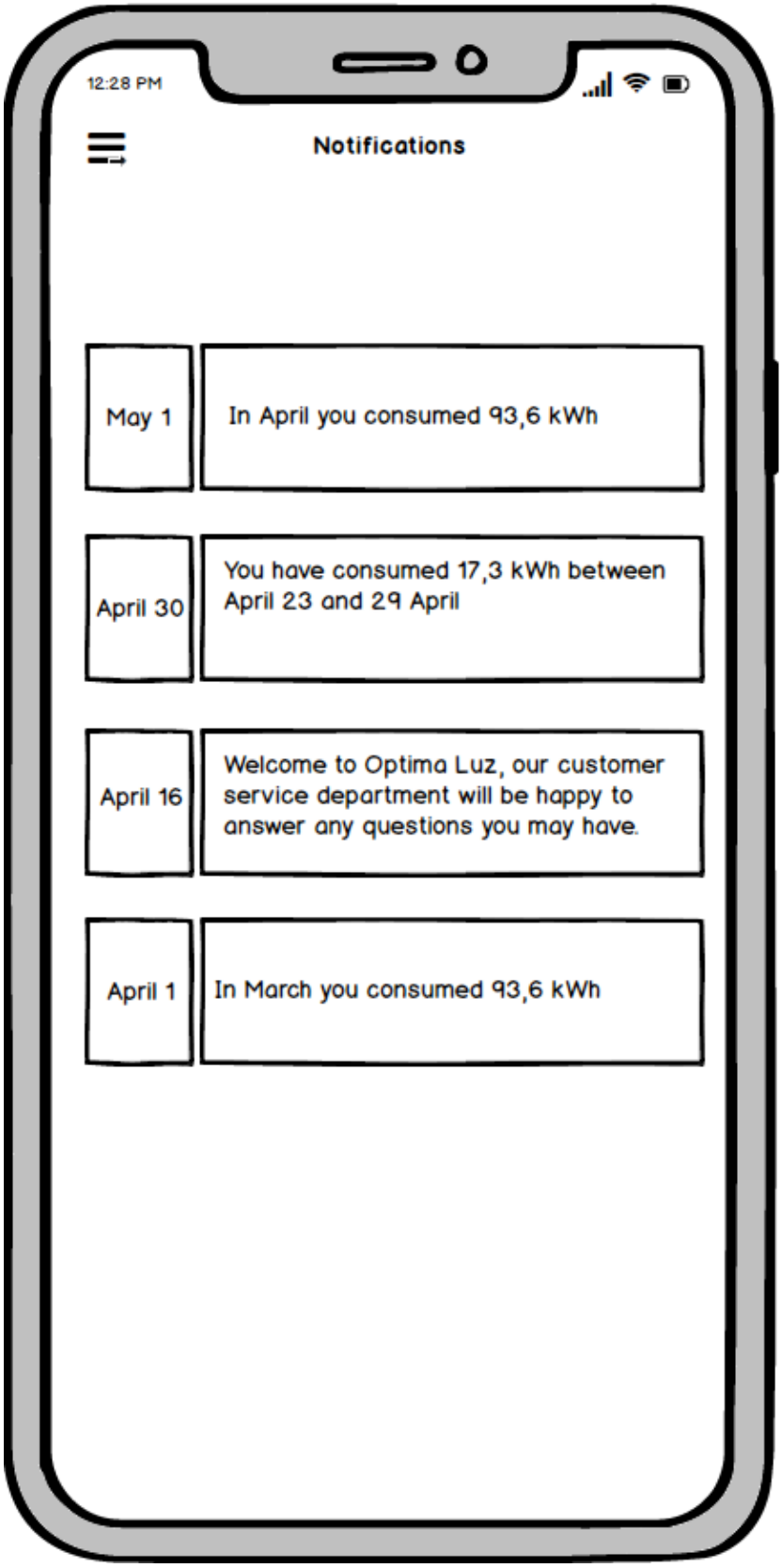


Equipment and their consumption/production



Local weather report

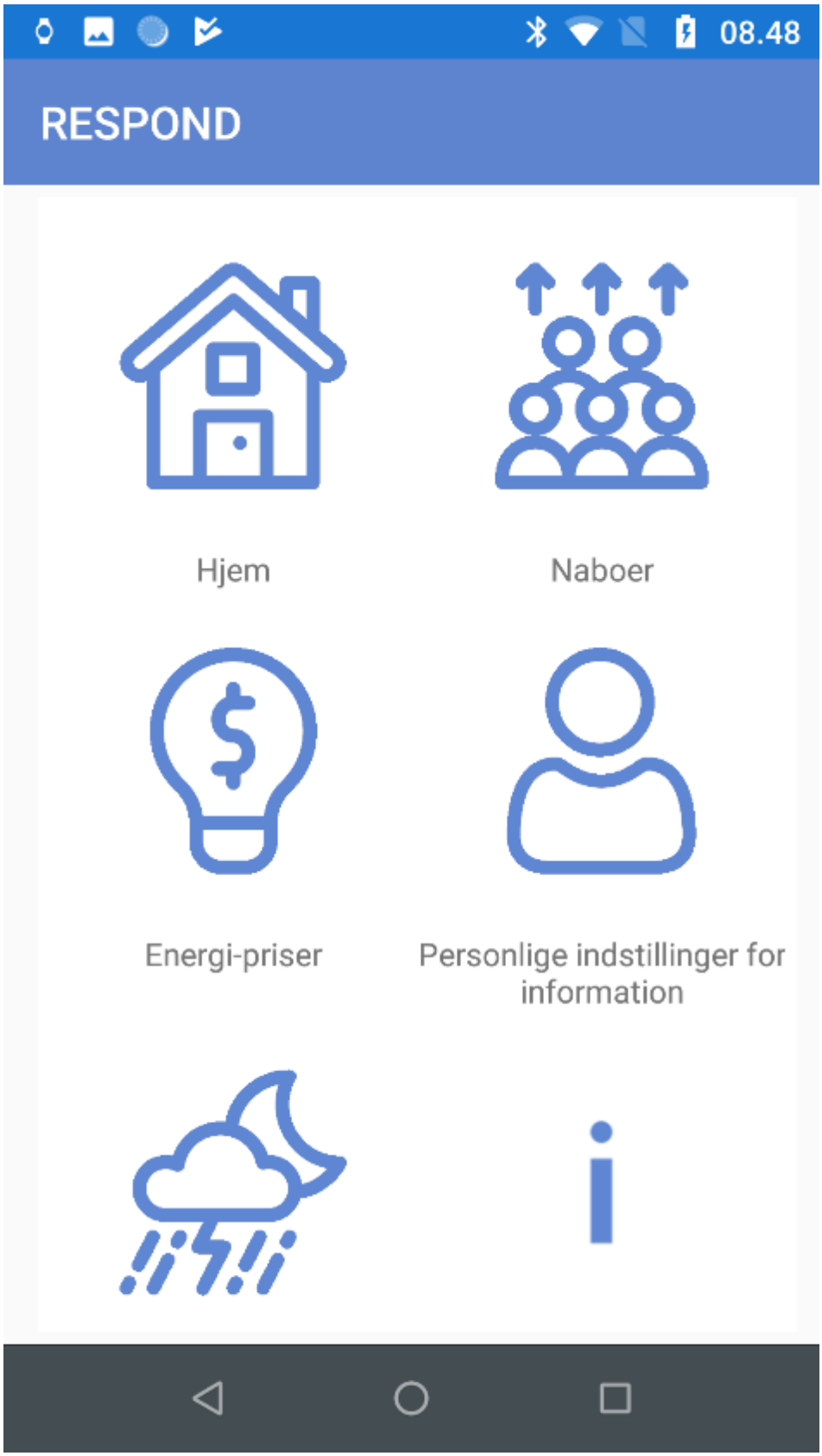
Notifications and recommendations



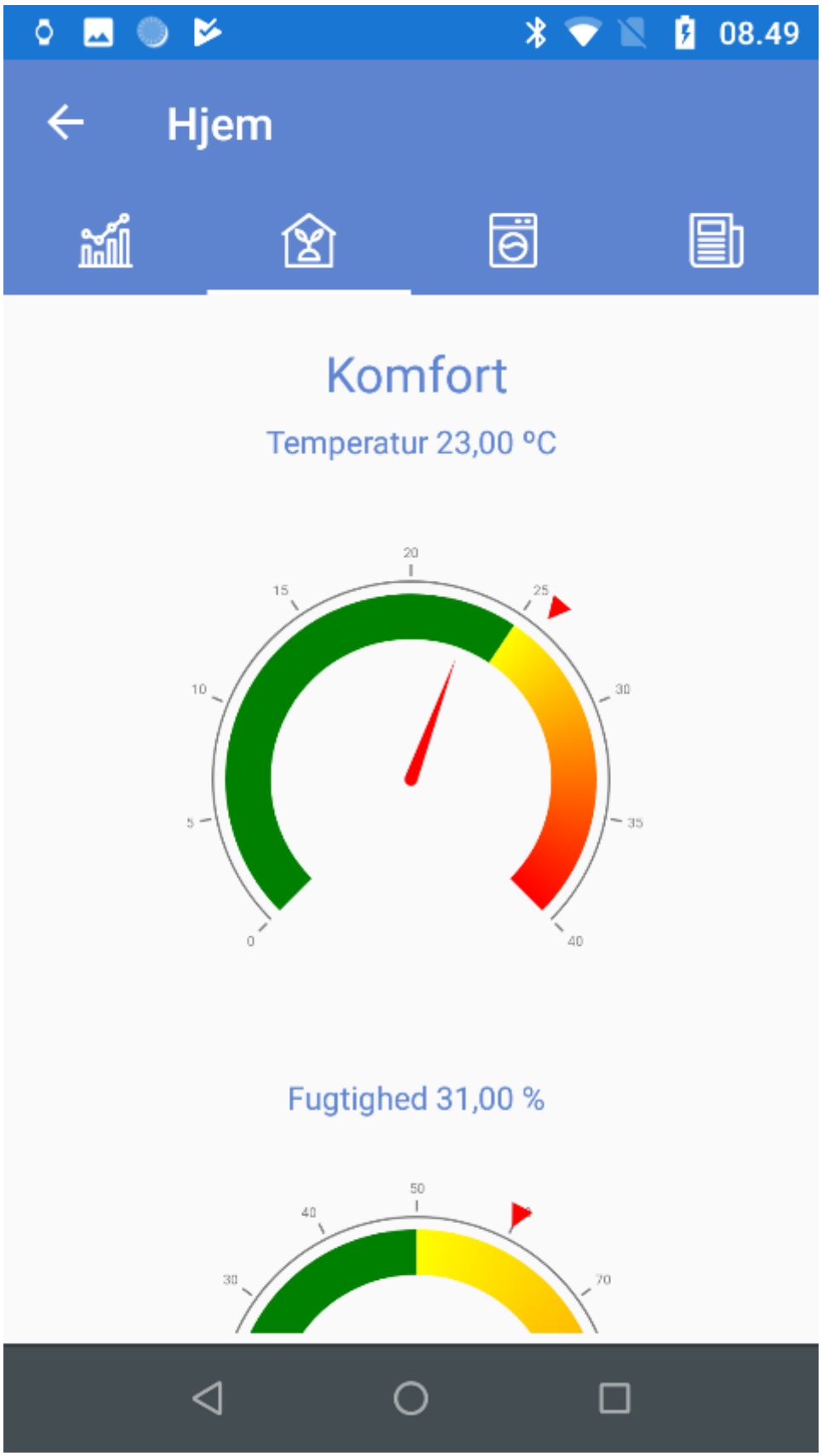
# Hands-out in relation to discussion of mobile app in focus group on heating

*The following six pages are the hand-outs related to the focus group on heating.*

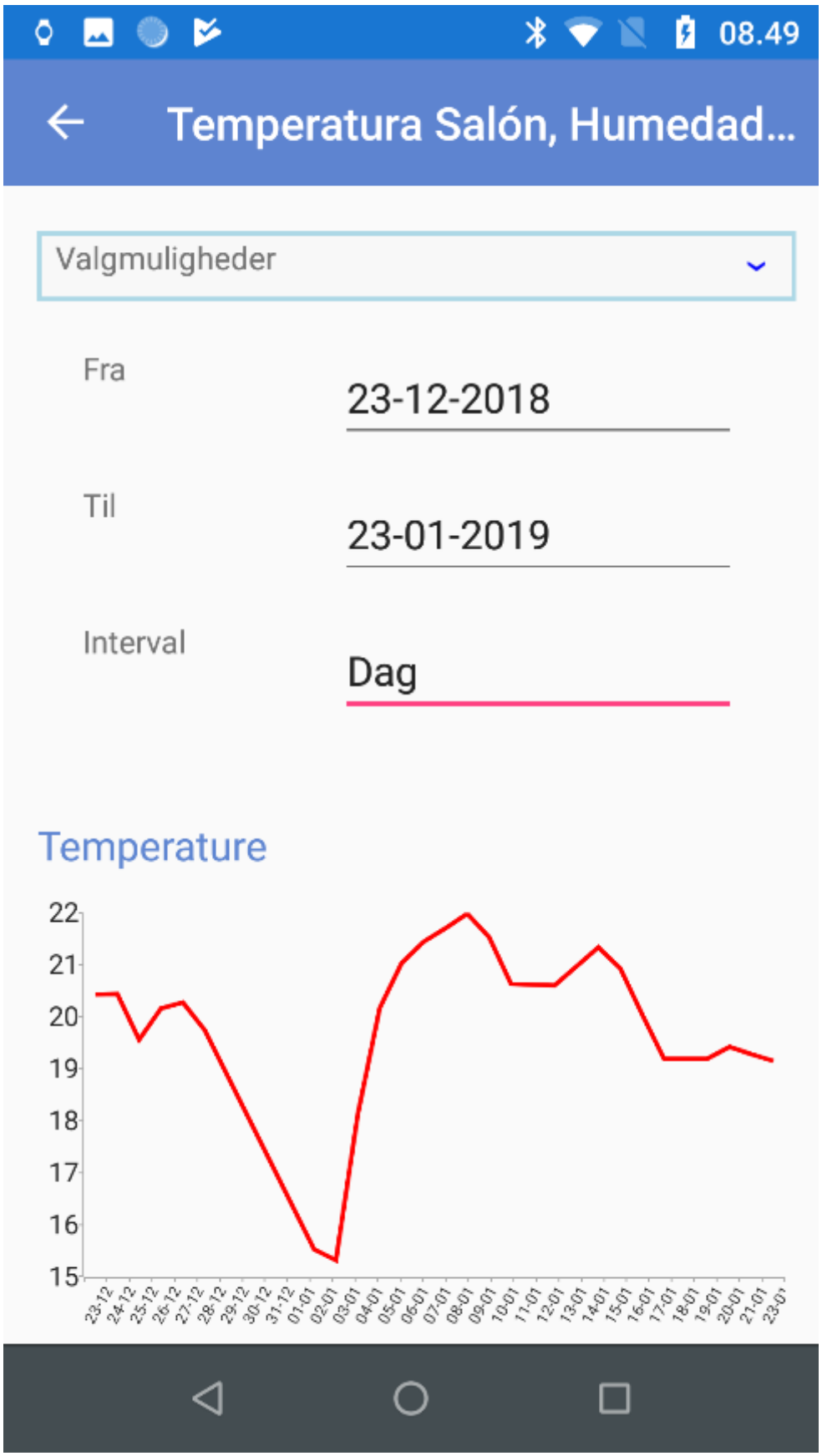
Start page


08.48
RESPOND
Hjem
Naboer
Energi-priser
Personlige indstillinger for information

Temperature and air humidity at home

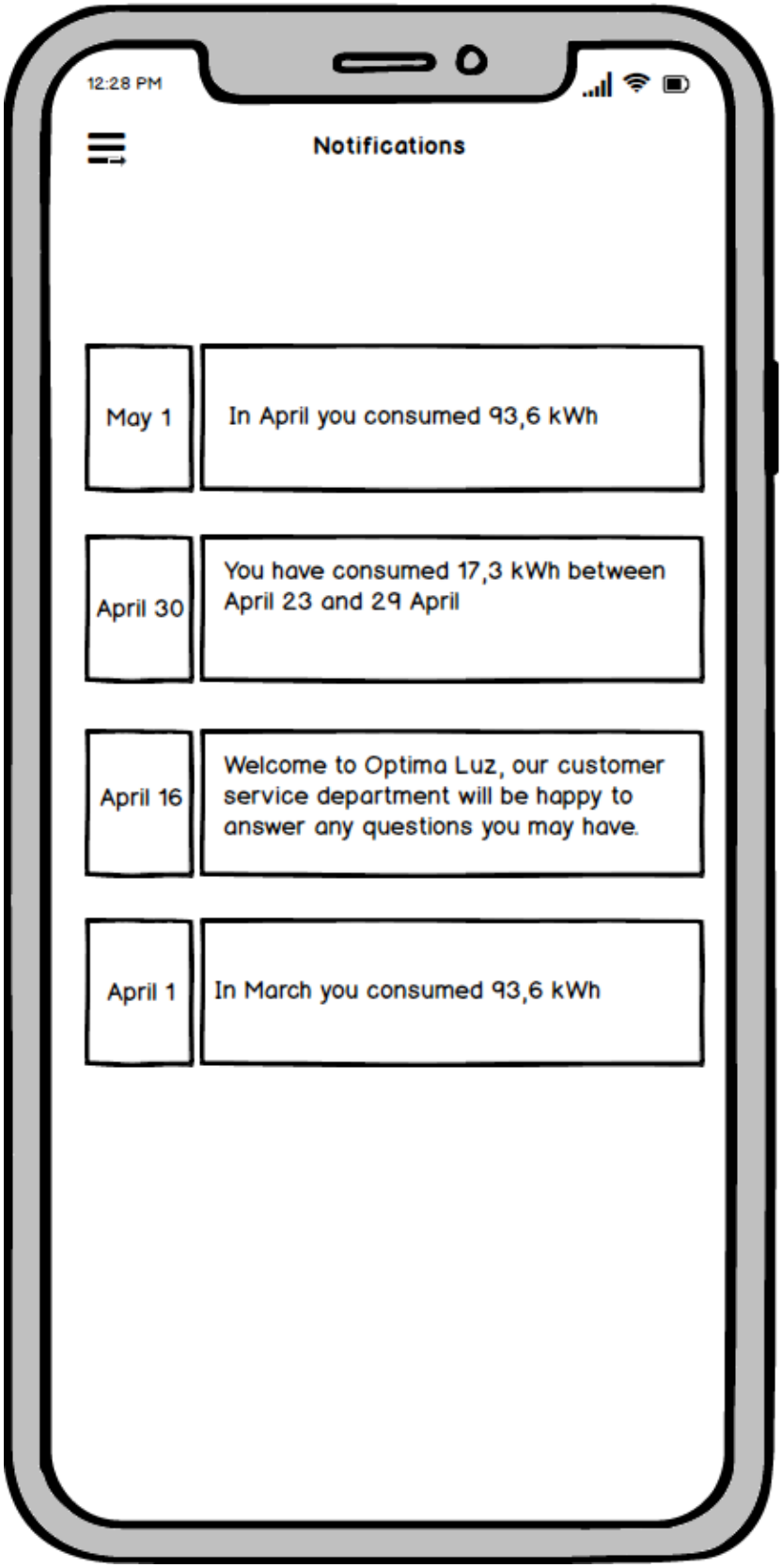


Temperatures of the different rooms at home



Local weather report

Notifications and recommendations



Mobile app functions to control heating

**Which fundtions do you wish?**

*For instance:*

- Settings with preferred maximum and minimum temperatures?
- Permission for every time the heat is turned down?
- Automatic control, but with the option of temporary turning of the morning set-back?
- Other things?

# APPENDIX 2: TEMPLATE FOR THE FOCUS GROUP SUMMARY

## Template for the focus group summary

*For each of the WP3 focus groups, the local site partners should prepare an English summary and email this to AAU for the overall analysis and global conclusions. The summaries from all focus groups and sites should follow the same basic structure in order to facilitate the final analysis. This document is the template that the site partners should use when preparing the summaries. The template outlines the different sections of the summaries and briefly describes the focus and content of each section. For further inspiration on how to write the summaries, you might also look at the summaries from the Danish focus groups. If you have any questions, please don't hesitate to contact AAU. Good luck!*

The aim of the summaries is to document and report the observations/findings from the individual focus group discussions. One summary is prepared per focus group. The summaries form the input for the overall analysis (carried out by AAU), which focuses on important insights that should be taken into account in the design of the final RESPOND app and the related technical solutions. In other words, the aim of the analysis (and the individual focus groups) is to collect the participants' feedback and comments on our previous ideas for RESPOND solutions as well as other information about daily consumption habits/patterns that can be essential to take into account in the final design of the solutions.

The individual focus group summaries should be written on basis of the focus group audio recordings.

Ensure that all participants are anonymized in the summaries. I.e. do not use their real names and take also care not to include personal information that would make it possible for others to identify them.

In the following is the template to be used for each of the focus group interviews to prepare the summary. It includes an introduction and four numbered paragraphs. For each section, you will find some overall instructions on the content and how to prepare it (the grey text boxes). After finalising the summary, you should delete these boxes (as well as this introductory text)!

# Summary and analysis of focus group on [subject] in [place/pilot site]

## Focus group at xx: subject title…

This focus group related to…

Explain aim and topic of focus group

## 1. Time, place and participant recruitment

Include information about:

- Time and date of the focus group
- Where it took place
- How the participants were recruited (e.g. personal invitation, letter, email invitation or…)
- Incentives for participation, if any. E.g. free lunch/dinner or…
- Any other information relevant in relation to time, place and recruitment

## 2. Participants

Include information about:

- Number of participants
- The gender distribution (how many men and how many women)
- Number of households represented (there might be more than one participant from some households)
- General (qualitative) comment on the participant sample with regard to age and composition of represented households. E.g. only retired people, a mix of retired people and adults with children living at home, or…
- Make a list of the participants (see Danish summaries on how to do this!). Remember to anonymize and limit detail of information on individual participants/households in order to ensure anonymity.
- Specify who was moderator(s). If more than one, include a short description of their roles, e.g. who was the lead moderator.

## 3. Group process and dynamics

Make a brief description of how the focus group went (the progress):

- Who welcomed/introduced the focus group, and what was the participants told in the beginning (the introduction).
- Describe how the discussions of the topics of the focus group went. Did people in general engage by discussing with each others (i.e. directing their talk towards each other)? Or did the participants mostly direct their talk to the moderator(s)? Did all participants participate in discussions? Or only a few? (In the latter case: Indicate who?)

- Describe how the overall "mood" of the group was during the discussions. For instance: Was it good and "cheerful"? Was it relaxed? Did the participants seem comfortable about the setting and did they appear to trust each other? Or was the participant not relaxed or did any "bad atmosphere" occur? (If the latter, please include a few thoughts on why this might have happened)
- Describe if there were any deviations from the originally planned procedure. (For instance, in the Danish focus group on electricity, the moderator forgot to begin with a round of participants presenting themselves, which was therefore done later in the focus group)
- Describe any other relevant comments on the focus group process and the (inter-personal) dynamics of the focus group.
- You *might* include a sketch of the table and where people were sitting, like we did in the Danish focus group summaries. However, this is entirely optional! We included it in the Danish summaries because it helped us to remember "who was who" during or work with preparing the summaries.

# 4. Summary of focus group discussion

While the first three numbered sections focus on the process and setting of the focus group (including how people was recruited, how the focus group went on, etc.), this section focuses on *the content* of the focus group discussions. The section should be divided into a number of sub-sections (4.1, 4.2, etc.), one for each of the overall topics that were discussed. We recommend you to have a look at the Danish summaries for inspiration on how to prepare the summaries.

Each sub-section (topic summary) contains three parts:

1. Discussion starter and follow-up questions: The original discussions-starter and follow-up questions (copied in – and translated to English, if needed – from your original focus group plan).
2. Summary: The summary of the discussions (this is the main part). The following guidelines should be considered when writing this summary: 1) First of all, you do not need to write all that was said (this would make the summary very long!). You should only write what is relevant; i.e. the participants' answers to the questions of the topic as well as other statements/themes that might have come up during the discussion that (one way or the other) are relevant to the topic or to the design of the RESPOND solution and app. 2) Secondly, report the content of what was said as "loyal" as possible; i.e. take care not to introduce mis-interpretations in your summary of the discussions and people's statements. 3) If a participant make a particular interesting statement, or say something that nicely summaries a longer discussion, you might include this as a quote (marked with quotation marks, "I suggest to…"). In that case, please be very careful to make an exact transcription of what was said.
3. Analytical observations: You conclude each topic summary with a brief sub-section with your own "Analytical observations". This is where you can add your personal interpretations of (or comments to) what the participants have said or discussed. This can also be your thoughts about possible implications of what was discussed about the design of the RESPOND solution and mobile app. These comments will be included in the final overall analysis of all focus groups.

## 4.1 Topic 1: xxxxxxxxx

*Discussion starter and follow-up questions:*

*Summary:*

*Analytical observations:*

### 4.1 Topic 2: xxxxxxxxx

*Discussion starter and follow-up questions:*

*Summary:*

*Analytical observations:*

### 4.1 Topic 3: xxxxxxxxx

*Discussion starter and follow-up questions:*

*Summary:*

*Analytical observations:*

### 4.1 Topic 4: xxxxxxxxx

*Discussion starter and follow-up questions:*

*Summary:*

*Analytical observations:*

*THC & HNK (AAU) – May 9, 2019.*

# APPENDIX 3: SUMMARY AND ANALYSIS OF FOCUS GROUP ON HEATING IN AARHUS

## Focus group at ALBOA: DR in relation to heating

This focus group related to the RESPOND measures targeted demand response actions in relation to heating dwellings (cooling normally not used in Danish dwellings). This was the topic of the focus group, as the pilot households are planned to take part in some amount of "active (manual) DR actions". The DR actions will relate to the control of heating (heating and domestic hot water are provided by a district heating company) - allowing the tenants to individually adjustment of the temperature level combined with automatic switching off the heat shortly in the morning to reduce the peak consumption of district heating. Focus was on how the participants perceive (understand) this, what they think about it and how it will fit into their daily habits and practices. The discussed topics moved from a general discussion of demand response and time shift of their own energy consumption to discussing specific RESPOND solutions and app functionalities.

*This summary of the focus group is based on a more detailed summary of the focus group prepared by the AAU team. In this summary, we have condensed the discussions combined with analytical observations on basis of the discussions and how this information can be used for the design of the RESPOND solutions and app. In this summary, the participants have been anonymized using pseudonyms instead of real names and excluding personal data that can be used to identify the individual participants.*

## 1. Time, place and participant recruiting

The focus group took place on Tuesday 29 January 2019 from 6.30 pm to 8.10 pm at the "common room" called "Ny & Næ" situated inside the ALBOA settlement. The participants were tenants of the ALBOA housing association and among the participating RESPOND pilot families. They were recruited through a written invitation sent by email to the pilot households about a month in advance of the planned focus group. Before sending the invitation, the 20 pilot households were divided into two groups of equal size (one group was invited for this focus group, and the other for the focus group on electricity).

The group division was done strategically in order to obtain a diverse composition of each focus group regarding age, family type, household size, educational background and ethnicity. Sandwiches, chocolate, coffee and soft drinks were offered to help motivate tenants to participate, because the time of the meeting collided with the typical dinner time for Danish families.

## 2. Participants

All participants were from the same settlement. There were 4 men and 5 women representing 7 households since two couples participated (M3 and F5, M1 and F1). Four of the represented households had children living at home, while two households included retired people. The last household included a couple in their working age, but with no children living at home.

List of participants (anonymized; M = Male and F = Female) and a few biographical details from the informal presentation round the table:

- M1 (lives together with F1): Retired, often at home in the daytime.
- F1 (lives together with M1): Retired.
- F2: Live in a flat in a terraced house with her youngest son.
- M2: Live two persons in a flat in a terraced house, both retired, two times a week 15-22 family members gather to eat together in their dwelling (children and grandchildren), heats all rooms.
- F3: Lives alone with daughter half of the time, days are varying quiet a lot.
- M3 (lives together with F5): in terraced house, children half of the time, do not use first floor much, adjust the heat nearly on a daily basis.
- F4: Live in a flat in a terraced house, two adults, relatively regular living per week.
- F5 (lives together with M3): Live in a flat in a terraced house, working on most days, do not herself adjust the heat (handled by M3).
- M4: Two full time working adults (not at home during the day), two children, not all rooms are heated; do not switch off heat which is run in a constant way. Find it funny if it was possible to compare his own energy consumption with other people's consumptions, but also information on temperature and indoor environment could be interesting to monitor.

Focus group moderators:

- Lisbet Stryhn Rasmussen (local contact and co-moderator)
- Toke Haunstrup Christensen (lead moderator)
- Henrik N. Knudsen (co-moderator)

## 3. Group process and dynamics

All participants arrived on time except one that arrived around six minutes after everybody else were seated, but before the topics to be discussed were introduced. Overall, the physical surroundings for the focus group were very suitable for the purpose and well known by the participants. There were no problems with unexpected interruptions or noise from outside during the focus group meeting.

Lisbet, the local contact person, welcomed the participants and introduced the evening's program, the two moderators Toke and Henrik, and gave a brief status of the RESPOND activities in the settlement including the installation of the new hardware. To begin with, the tenants talked freely, mainly with Lisbet, about the installed devices, and their concerns/questions were handled. There were some talking about the devices, e.g. they do not look good and some needed ("sticky") tape for mounting them securely to the wall. It was asked if the plugs can be moved, but since some plugs are used as "extenders" for the internet (data)connection, it may not be a good idea to move them to another electrical device (the intention is that plugs shall be used on washing machine, dryer and dishwasher). It was agreed to ask Lisbet before moving any plug. It ended with a few tenants asking for more plugs to measure their electricity consumption on different devices. Lisbet underlined that they are very welcome to contact her directly with any questions. They were informed that thermostats and VOC sensors would be installed during March 2019. It all happened in a good mood and generated some laughs. Finally, it was underlined that the tenants shall live exactly as they

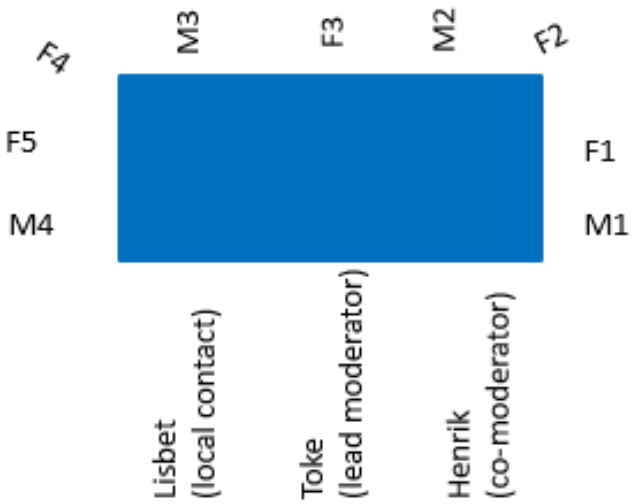
normally do during the next year. During this introduction, the participants were served sandwiches and drinks.

After the introduction, Lisbet gave the word to Toke, who introduced the procedure of the focus group (what is a focus group, what to expect, an overall introduction of the three topics, etc.). After this, the focus group discussions began (see later summaries of these).

During the focus group discussion, the participants alternated between directing their talk towards each other and to the moderators, respectively. In general, they were good at commenting on each other's statements. In this way, the focus group succeeded in creating several instances of shared discussion and elaborations among the participants. One of the reasons for this might be that they all knew each other well on beforehand, e.g. from a lunch club. During the first topic, in which they presented themselves and told about their use of heat, they tended to talk more directly to the moderators (Toke, Henrik and Lisbet), probably because we were the only persons who did not know them already. During the following topics, the moderator(s) played an active role in "steering" the discussions, although the participants often also commented on each other's statements. I.e. there were also some discussions between themselves. Overall a cheerful mood among the participants, including some chitchatting and "friendly teasing" of each other.

In total, including the moderators' introduction, the focus group lasted 1 hour and 40 minutes.

The participants ended up sitting mixed men and women around the table as shown here:




## 4. Summary of focus group discussions

The focus group dealt with what the participants think about different ways of controlling heating to allow for time-shifting heating. How this will fit into their existing daily practices and their existing preferences and habits regarding heating and indoor environment.

To better understand how to design solutions that fit well into existing heating practices, the focus group started with a more general discussion of the participants' existing habits and preferences

regarding heating (Topic 1). Then followed two topics that explored the participants general attitude to time-shifting heating (Topic 2) and their thoughts on the specific RESPOND solution and app specifically (Topic. 3).

## 4.1 Topic 1: Existing preferences and habits regarding heating

***Discussion starter and follow-up questions:***

a. Discussion-starter: How do you experience the heating in your current dwelling? Is it something you are thinking about?
    i. Do you or other members of your household sometimes feel it too hot or too cold? In what situations? Who? And what do you do then?
b. Discussion-starter: How do you decide what temperature you prefer at home? And why that specific temperature?
    i. Do you heat all rooms in the same way (same temperature)? Or do you have different temperatures in different rooms? Why?
    ii. How do you air your home? In what situations do you open windows or doors to air?
c. Do you sometimes turn up or down the heat, i.e. adjusting the thermostat settings? When and why? And who?
    i. Do you turn up or down the heating (and temperature) on a day-to-day or week-to-week basis? How and why? Or do you keep the same temperatures and settings without adjusting them on a continuous basis? Why?
    ii. Who is in general controlling the heating (or cooling) at your home? Is it something that all members of your household do? Or is it specific persons? Why?

***Summary:***

Toke (lead moderator) introduced the subject and discussion-starter of Topic 1.

M1 and F1 turn off the heat and open both windows in the bedroom in the evening. Next morning they close the windows again and turn on the heat so that there is no condensation in the down comforters. In another room there is no heat on. The thermostat is on 2.5 in the office on first floor. They rely on that the two radiators in the basement provide heat to the house, thermostat set at 3.25-3.5. They dry clothes in the basement. Doors are open, to "distribute the heat in the house". The radiator in the bathroom “runs only a little”, as they say "a large part of our heat consumption it is in the basement and maybe a little in the hallway too". The exterior doors are leaky.

F3 express that the current dwelling is one of the best places she has lived in with regard to heat and she does not get cold feet (here someone mention that they are experiencing cold feet). F3 finds it better than her childhood home in a detached house, especially considering that it is from the 70s. However, it gets cold by a leaking door in the entrance and by windows especially upstairs, "there is a cold bridge” from large window areas [sounds like cold experience due to cold surfaces]. It may be cold, but there is not draft. The heat is reasonably stable and the thermostat is on level 2 in the winter, not heated much in the basement.

Here M1 mention that they do not yet have energy glazing, and that it will help when they are changed. M1 then expresses that is funny to hear how different they use (and experience) the houses, and says "we probably have a down comforters (featherbed) that is thicker than yours" when they sleep with open windows.

M3, who has experience with restoring houses, has a theory about heat in his house. He explains that his radiators "really work hard [to warm up the living room]". He has permanently closed the door between living room and the hallway to avoid draft. He has only one radiator operating, which gives circulation [of air]. It is about closing doors, so that you avoid the air "flow through" the apartment.

M1 supplements with information that the radiators were dimensioned for higher (+10 degrees) supply temperature and that walls under windows are quite poorly insulated (maybe 75 mm of insulation) [Several of the others participants confirm that heat loss can be felt]. M1 has mounted thermostats that only goes up to 3 [on the scale]. On cold winter days the radiators could not deliver enough heat. M1 switched around the thermostats, so that the one which could go higher than 3 were mounted on the big radiator - it helped.

M3 explains that the cold wall can be fixed with a simple construction, an insulation plate with screws, insulating silver paper. That made the problem disappear immediately... Toke summarizes that there are different tricks, and participants mumble in agreement, which may be used by the housing association.

F2 mention that there is something about the housing association adjusting [the temperature] up and down so that with thermostat at 3 it suddenly becomes very cold late in the day. Maybe it is related to living in a flat at the end of the terraced houses – e.g. when many take a bath [at the same time].

Toke sum up the talk: 3-4 experience that it is cold occasionally. Comments from the participants: it is about inactivity, e.g. when sitting in sofa, LED bulbs do not heat much [compared to old light bulbs]. Toke: Is it cold at certain times? Some experience it most in the evening, and it is mentioned that it follows the temperature outside, it is cold when very cold/windy outside. M1 does not experience that it is cold. The radiators is different in the apartments, some have even themselves mounted radiators, everybody have radiators (one place) in the basement, different by the stairs.

Toke then asks participants if they have the same temperature throughout their apartments. Four or five have the same temperature, but the question trigger a series of comments. M3, like several other, heats the basement all year round – "it keeps moisture away from the cold walls and thereby avoids basement smell". F3 thinks it is not so effective if there is more heat in some rooms than others, e.g. if doors are closed. M2 had made a bedroom in the basement because of their many children, and uses the whole house. Now, when the children have moved away, M2 still uses the bedroom in the basement and another room in the basement is M2's office. M2 does not touch the radiator [thermostat] all year round, the door is open to allow heat to spread, and keep the basement dry. He repeats that they often have many people in the house (family visits), while they have the same temperature in all rooms as they would otherwise have to adjust [thermostats] several times during the week.

Toke asks who adjust the radiators depending on the season. About four mark that they do and it initiates a series of comments: M1: they [thermostats] close when they reach 21 degrees [so it is not necessary to adjust]. Toke: But someone turn off the heat, why? M3 replies that it is to be able to keep the door to the living room (and windows) open without radiators running. The thermostat is set to "frost" in the summer. You turn the heat off because you are of "the old school", who “do not want to heat for the sparrows” [old Danish saying]. M1 explains that there is no heat in the rooms they do not use. F3 wants to be able to regulate during the day (e.g. at night or when at work) - "so you can regulate it during the day" - like via an app and would like it equally warm and no more freezing. F3 responds by referring back to an experience from her childhood, where her parents, twenty years ago or so, installed such thermostats. Then there were some buttons so you could adjust something with time per day and such. Then if you were home, e.g. because you were sick or something, so at half past nine then it suddenly said "brrmmm" in the whole house and the temperature was lowered, and again later it said "brrrrr" again and then they raised the temperature [this initiated smile and a laugh around the table]. “That is the kind of regulation I would really like to have. It could be very useful to me, at least".

After this Toke closed Topic 1.

***Analytical observations***

The participants seemed interested and engaged in the topic in the focus group interview. Some have good insights into how the heating system works and some have rather firm opinions about how it should run. Not necessarily in the same way as it is normally recommended by knowledge institutions that do research in the different aspects of the indoor environment, including temperature and humidity conditions as well as energy consumption in homes.

The participants use the heat system/thermostats quite differently, from adjusting on a daily basis to nearly never touching the thermostats. Around half of the participants heat all rooms and have nearly the same temperature in different rooms, whereas the rest have different temperatures in different rooms. Some have completely switched off the heat in the rooms that are not in use. Some participants even say that they have a lot of heat supplied in the basement and that it is more or less sufficient to supply the rest of the house, whereas others only have little heat in the basement.

The participants (who live in more or less identical apartments) do not have identical heating system, e.g. they do not have the same radiators in the basement. It depends on whether they themselves or former residents have made changes to how it was from the start.

The residents have different experiences of whether it is warm enough in their dwelling. Some experience that it is cold and that the windows are leaky and they want improvements. Some are satisfied and they even sleep with open windows in winter. It is mentioned that it could be better after a renovation including new energy efficient windows and it was suggested that what is being discussed in the focus group is communicated to the housing association in order to achieve improvement.

Overall, it seems clear that there is room for improvements of the temperature conditions. This may be provided through technical improvements of the heating system, windows and better insulation,

but the residents' behavior also plays a vital role in achieving an optimal situation that take both energy consumption and indoor environment into consideration.

## 4.2 Topic 2: General discussion of participants' reactions to the idea of time-shifting heating

***Discussion starter and follow-up questions:***

a. Discussion starter: The moderator explains the underlying idea and concept behind time-shifting heating (no specific focus on RESPOND app; see Topic 3). For various reasons, the district heating suppliers would like to make it possible to time-shift some of the heating in homes. The most important reason for this is that the suppliers in various areas are experiencing a problem with delivering enough heat (e.g. if there has been new-built of homes) – especially in the morning when the heat consumption peaks due to showering etc. [hand out and explain the figure on p. 15]. This means that the suppliers either have to invest in upgrading the pipes in the ground (which might cost a lot of money and make the heat more expensive for customers) or – alternatively – find ways to time-shift some of the consumption away from the peak hours. One way to do the latter is to install equipment in homes that can control the heating in the morning. In this way, the company could turn off the heat shortly during the few hours with peak consumption, e.g. between 6 and 9 am [hand out and explain the figure on p. 16]. Of course only with the prior acceptance from the tenants. For buildings like those here in ALBOA, this would only result in a limited drop in temperature during the hours when the heating is turned off [hand out and explain the figure on p. 17]. Roughly, the temperature drops about 1 degree Celsius per hour. To maintain the temperature within a comfortable range the temperature may be slightly raised before turning off the heat. In RESPOND, we will try out such an approach here in ALBOA…

   Following this presentation, ask the discussion-starter question: *What do you think about this approach? How would this fit with the daily routines and needs of you and your family? Pros or cons?*

b. Follow-up questions:
   i. Would you be interested in taking part in this sort of scheme (if you were not pilot family in the RESPOND project)? What could make it interesting for you to take part in this type of scheme?
   ii. What would be the most important challenges in relation to time shifting heating? And what could be done to handle these challenges?
   iii. Could there be situations where turning off the heating in the morning would contradict with other considerations or needs?
   iv. Would it make a difference for your experience of such a scheme whether it is weekday or weekend? Or holiday or not?

***Summary:***

Henrik (lead moderator of topic 2) introduced the topic and explained the challenge to reduce the heat consumption peak in the morning mainly due to people showering (slide 1). A possible solution for reducing the peak could be to time-shift heating away from the period when most people a showering by switching off the heat shortly (slide 2). This action will lead to a relatively moderate drop in the indoor temperature (slide 3).

This introduction immediately led to a reaction and comment form F2, who cannot imagine that she should run around in the morning throughout the house and adjust the thermostats. There is immediately agreement around the table (everybody are nodding), that it must run completely automatically.

Henrik asks what the participants think about switching off the heat shortly in the morning, can it fit into the daily life? F5 suggests that if the heat is increased before [switching off] it will not be felt, and adds "as long as I do not have to get up at 4 am". M1 asks for clarification about the hot water and he is reassured that the temperature of the hot water is not lowered, and he says "then it will not affect us". F4 asks if you get a cold morning at home, if you are not going to work, and what about the weekend? Toke acknowledges the good points and asks: How do you look at it if the temperature falls 2 degrees when you are at home at weekdays? Henrik complements that just as you decide how hot it is, then you can also influence how much and how long the temperature is lowered. M4 emphasizes that it "does not look like that in the weekend". Here he gets out of bed later and the children are having showers at nighttime. He would be annoyed if it is cold. F4 or F2 ask if you can set the temperature a little higher earlier, so it still falls 2 degrees, but from 24 [degree] instead of 22, then the temperature does not fall to 20? M1 proposes humorously to carry out the "cold experiment" with them, and F1 complements that they "still have many sweaters that we never use". F4 or F2 speculate that "it must be possible that you can both choose weekday and time interval and temperature because we are as different as we are".

Henrik asks what it takes to make it an acceptable idea. F4 or F2 reiterates that one must be able to choose both day and time and temperature. M4 points out that the showers/the use of hot water are responsible for the peak (peak load) and the moderators agrees. M4 continues that the great effect lies in when the hot showers are taken. Here other participants supplement that it is probably difficult to control when people shower, as people, for example, have to look presentable at work. Henrik sums up that it is a major intervention in people's free life if someone determine when to take a shower. Toke clarifies that the concept is about the heat, and Lisbet adds that the app and measurements are only about heat (hot water is not measured). Toke asks if there are other issues to be taken into account, and several mention different spaces, as several have different heat/temperature in different rooms.

Then follows a period where the participants talk about it would be interesting to have measurements of temperature in the different rooms/floors of the dwelling. This could be used, for example, to become aware of whether you have heat on and whether it is necessary. M4, who originally suggested that you could have temperature data in all rooms, elaborates: "What I really think, it's to be able to assess - when I get up in the morning - I just got out of my hot bed - is there really cold in the room? Or is it just me that is cold? Or when my children jump around without clothes and I think it looks cold, is it – then – because the room is actually hot? So I have something

to judge from, because right now I turn up [the heat] when I'm cold and turn down again when it gets really hot, …. And now I keep all doors open in my house, because we use it all, and if I find something that is cold, then I turn up in that room, or down or whatever…. And it would give me a much better idea if whether it is a good idea, what I do, if I actually knew what the temperature is on the floor".

F3 asks whether the individual thermostats will connect to the [RESPOND] app (…) so that you can access each of them. F3 has previous experience (refer back to previous history of regulating the heat in the parents' house) that before turning down the heat it was turned up, it worked fine, "and then it was nice warm when you got up", so she expresses that it is not a problem and some of the participants indicate with positive sounds that they agree.

M4 says "if I can see on my app that I can make that difference [lower the peak] "then it is a motivation for me". M1 "still think it is interesting to include the hot water", it is good to be able to control the individual thermostats, but he thinks that it gets really interesting, if you can get an indication of when the hot water [consumption] peaks or when one self can advantageously take a shower - "when it is almost free to take a shower". Maybe showering can also be brought into play? There are slightly mixed attitudes about this among the participants, but some seem to find it ok to be informed and have the opportunity to also adapt the habits of showering.

M3 points out things to consider: the economic and environmental issues, take care the app does not become too complicated (beware of Mr and Mrs Jensen [alias Mr. and Mrs. Jones]). Henrik thanks for the input and leaves the focus group to reach a train.

Toke summarizes that simplicity is important. M4 does not agree. With reference to his new car, which he thinks is made too "primitive" in the attempt to make it simple, as he says, "I want to be able to do it all". One must be able to hit the target group. F3 points out that there is nothing wrong with making a simple user interface, and then have advanced settings. Another point that F3 emphasizes: To make people use the app etc. in the long run, is not just to get a top of a curve to move to find motivation. People have to get an increased control or comfort into their home. For example, make sure that the [heat] are not turned down in weekends, or if you have children every second week, it is [biip] smart if you can control the radiators to only be on in odd weeks (when no children) and control the temperature.

F4 agrees that the use is important, "but for me it just needs to be up and running, and then there will be a period where I go and find out such and such... And then I just don't want to bother more about it, it just has to run…". She just needs to find out the settings to suit her and then it must take care of itself. M1 adds that it would motivate with individual heat billing, as it is now with a common billing system, it is partly regulated outside the home. F4 also says that better comfort is an excellent "carrot" [in Danish "carrot" is slang for a reward]. M1 says, directed to Toke: "you don't care when you do not get something out of it", he agrees that it must be easy to turn the heat off, e.g. the night before and the next day, and then it goes automatic back afterwards, "could it be something?". M1 thinks this is a good idea, and based on the reaction of others it seems to be a sensible option. It seems that there is a broad consensus that the app must be for both the nerd and Mr. and Mrs. Jensen. M2 makes a comparison to modern cars where you can preset seats, and where there is an easy change to the person using the car. Maybe it is an opportunity with something in the app so that it is possible to name specific presets - "and then one could be called mother-in-law". F4 mentions economic incentives for solar cells and a better use of it, …, is the heat (or electricity) cheaper at some point, so it could be an incentive? Toke mentions that this is not the case at the present, but one can imagine it in a future solution. Toke sums up what can motivate: price, comfort (warm when getting up in the morning), and asks if there are other motivational factors. M1 mentions (with reference to the solar cells) that it is both the $CO_2$ accounting and that there is a little business in it, a little profit on solar cells, both aspects would be motivating (to him). F3 mentions Smart solutions (e.g. electricity bulbs with app) for "younger" people, optimize automatically, thinks it is cool if it only has to be done once and then it runs. M4 mentions that even though it is small, there is a financial gain, distributed among all 20 dwellings the effect is small. He thinks it is unclear what works with heat and indoor climate, the concept and meters can give some control (= that I can see if I do a difference in my home and whether there is a problem). M1 questions whether the technology is working, to which Toke responds a little openly: "yes and no". Lisbet explains that in the long term differentiated prices are also expected for district heating.

***Analytical observations***

The concept of time-shifting heating was reasonably well received. There was agreement that it must be automated, so that the residents do not have to turn on/off the heat themselves.

There was some concern that it would be too cold in the morning, but if it could be set so that it was a little warm before turning off the heat and so it is not cold when getting up, it seemed acceptable. Some even seemed to be able to see a quality in it being (extra) warm when getting up.

The concept of time-shifting heating must be flexible as the residents' weekdays/weekends are not the same, e.g. if you have children who live with you every second week, and it must be possible to control it in terms of weekday, time range and temperature level. The idea that it should be able to be switched off, e.g. the next 24 hours after which it runs automatically again was well received.

It must be possible to control the temperature in different rooms, in order to meet the residents' current behavior.

The app must not be complicated, but there are residents who would like to be able to "nerd with it", but the majority are for the simple/user-friendly solution. The residents argued for two levels: A

simple overview (a "dashboard") and the possibility of being able to go deeper into the app for more detailed (control) levels.

Some seemed to see a value in the app showing the effect of one's actions, e.g. the effect on the peak consumption - it can be a motivation in itself to see that one's action makes a difference…

One resident described honestly that for her it just needs to be up and running - she could accept a run-in period, but "then I just don't want to deal more with it, then it shall just be going…", she just need to find out about the settings, and then it must take care of itself.

The economic/environmental aspect was brought into play by residents, and "what's in it for me"? Individual heat billing and better comfort and being in control [of temperature] are mentioned as motivating factors that can make it interesting to use the app.

There were a few comments about bringing the hot water consumption into play, in terms of consumption and when hot water is used. However, there was agreement that it should be people's own choice when to take a shower.

## 4.3 Topic 3: Discussion of RESPOND solution and mobile app

***Discussion starter and follow-up questions:***

a. Discussion starter: The moderator introduces the RESOND app by placing a few hand-outs on the table that show selected mobile app functionalities. The moderator briefly explains the pages. After this introduction (lasting maximum 4-5 minutes), the moderator asks the following discussion-starter question: *Please discuss what you think about this? You can discuss both the design of the app and its functionalities.*
b. Follow-up questions:
    i. What functionalities do you think you would find interesting to use?
    ii. What do you think about the design of the mobile app? Does it make sense to you? Something that is difficult to understand?
    iii. Any suggestions for improvement?
    iv. Would you be interested in getting information or recommendations on your heat and electricity consumption via the mobile app (e.g. compared to the energy consumption of your neighbours)? What sort of feedback? And how often?
    v. Would it be possible to communicate about the time-shift of heating, as we talked about before, by using the App? What functionalities shall be available if all communication shall be handled through the App?

***Summary:***

Toke introduced the last Topic 3 and explained that parts of it has already been talked about and therefore it is ok that there is only about 10 minutes remaining for the topic. He also mentioned that work is underway on developing the app. He distributed and explained the six handouts with draft pages of the app. When explaining the possibility of making comparison with others, e.g. how much energy do people use on average, it came promptly from one of the participants "I could not care less" and from another "I think it could be very funny", and there is now a cheerful mood among the participants. One (who?) of the participants believes that it is the nature of man to compare himself with others, so he believes "that this button will be the one most often used".

Toke explained the different contexts and possibilities of the app: prices and personal settings, weather and comfort (temperature and RH), VOC sensor, temperature/humidity in a room. Possibility of feedback? What is your immediate response?

M4 (?) finds it super cool to see the temperature etc. in a room over time (history). In contrast, F4 is worried about thermostats. She is afraid the RESPOND system (and the new thermostats) means she has to deal with all thermostats and set them every day. It would be far too unmanageable. Toke tries to calm her down. F3 tells about her new (Danfoss) thermostats. Some participants find it nice that a temperature is shown on the thermostat instead of just a number (as is normal in Denmark, e.g. 1-5).

Toke asks if there is anything (of the suggested features) the participants will for sure never use. There is no agreement on this, but information of the weather you can get from many other apps.

A (confusing) discussion takes place about comfort, what is the relationship between heat and humidity? One finds that it could be interesting to change the heat if it could help with the humidity… It would be nice if it could help regulate… can it be done? The indoor climate could be a motivation for using the app, now, when it is not the money, F3 believes. M1 leaves and is thanked for his participation. M1 finds that he could use a warning if the humidity is too high, to remember to air out, now when you have sensors. F2 asks F3 if she think of a "guide" (in the app) that shows what happens (monitor) with the indoor climate, and F3 confirms. M1 explains that it gets dry when we warm the air, and that we get condensation in the basement in the summer.

Toke thanks for the contributions, but doesn't promise that everything will be incorporated into the app.

***Analytical observations***

A sum up of the wishes from the tenants for an App to be useful for them:

Looking at the mock-ups for the app did not initiate much. However, from the whole séance the following can be concluded about the app and installed hardware:

It must be simple and flexible to use and you have to be able to decide yourself the temperature level, when the heat is switched off, for how long and how much the temperature are allowed to fall.

It is desirable that the app etc. can add a feeling of being in control of temperature, indoor environment and energy consumption, as this is experienced as complex/difficult now.

Generally, some of the residents seem to vote for the idea of recommendations via the app. Feedback, e.g. about the humidity, in the form of a warning or a hint on when and how to air out is a possibility.

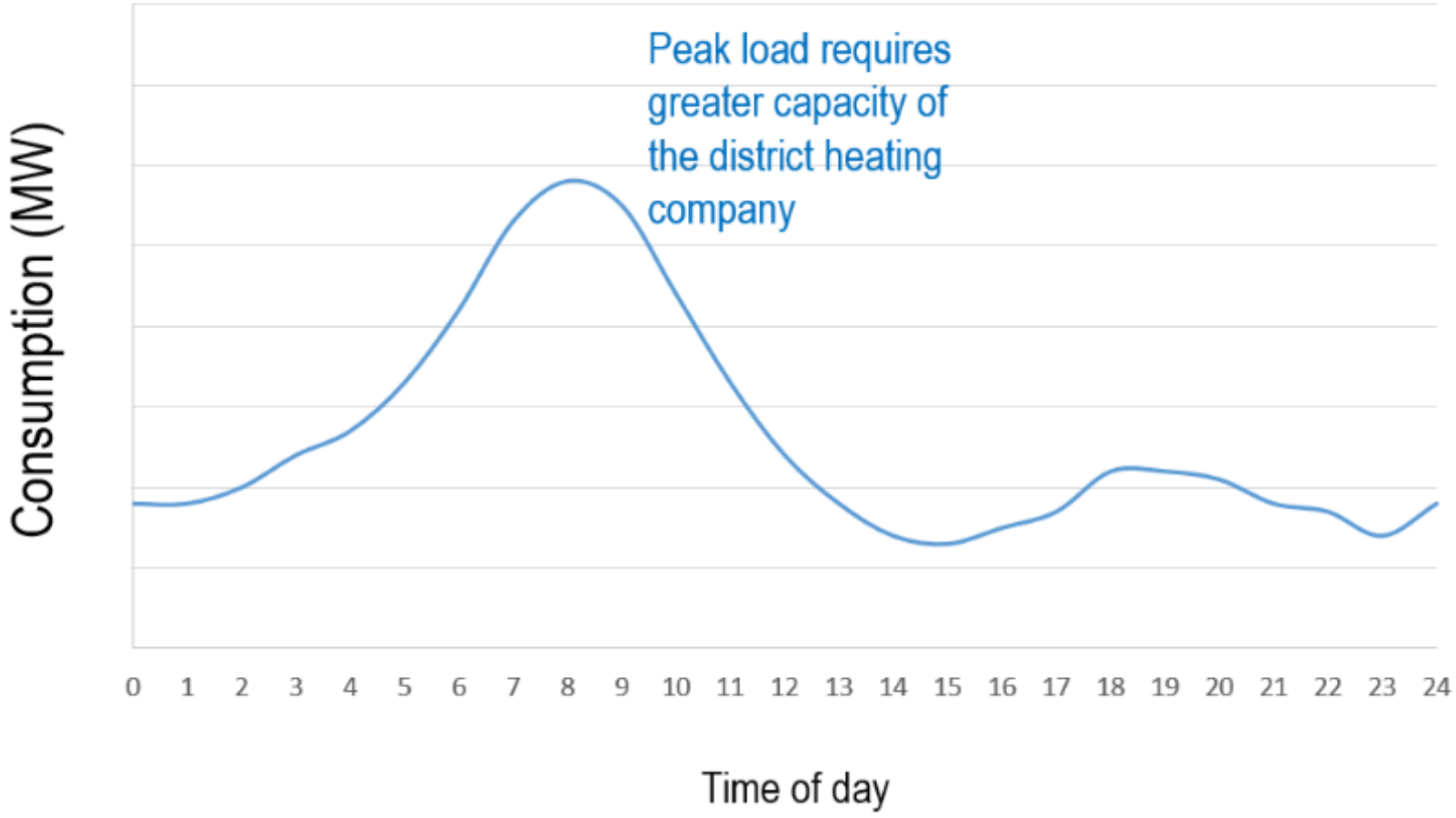
Some will find it beneficial to be able to see their own energy consumption, and it would be nice if there is a financial incentive and focus on consideration for the environment.

There is no clear consensus on whether it is interesting to compare one's own consumption with others. However, there seem to be more of the residents who might be interested in this part.

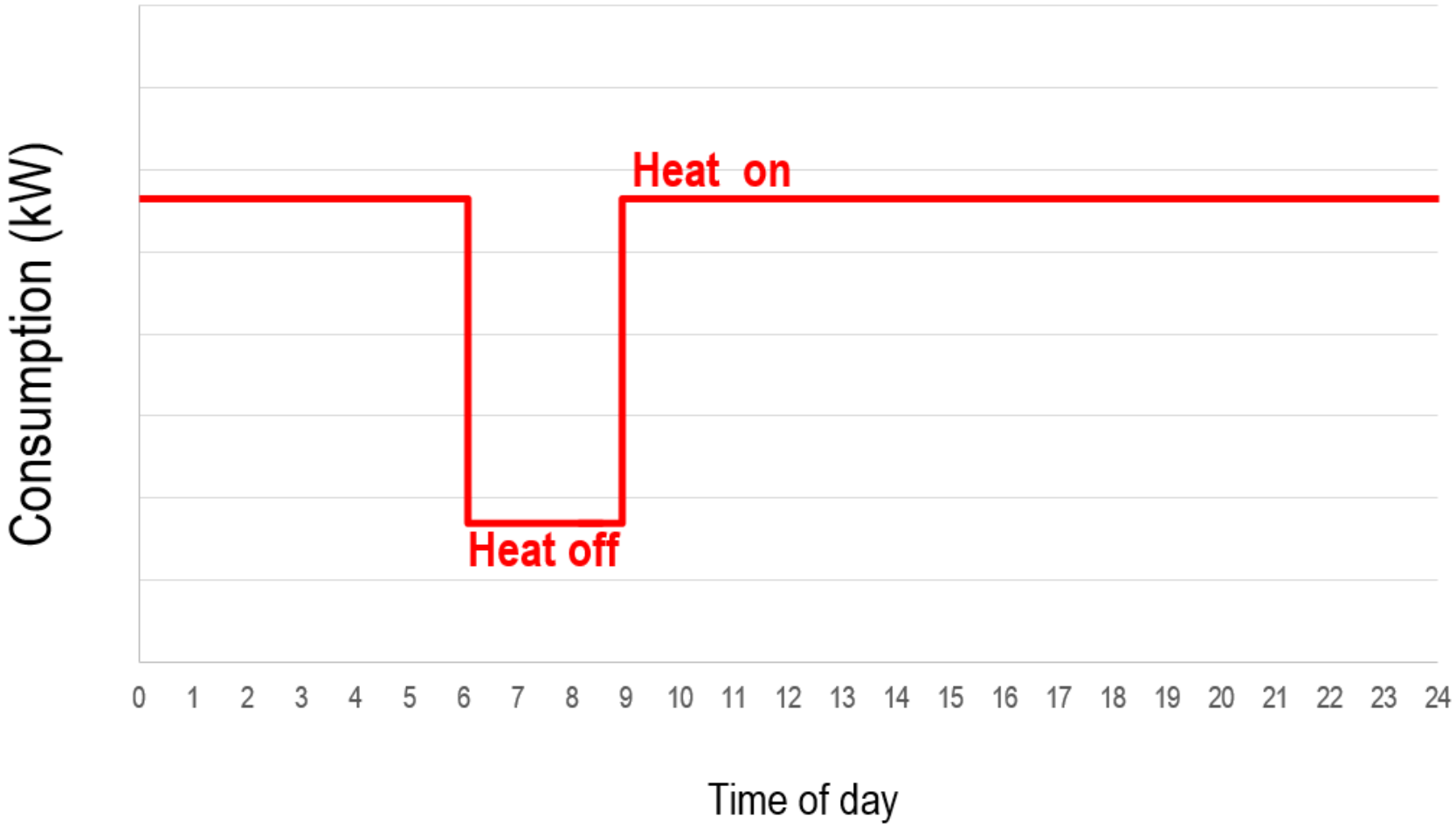
# Appendix: Hand-outs to support the discussions of Topic 2 and Topic 3

*The first three pages (slide 1-3) are the handouts related to Topic 2: General discussion of participants' reactions to the idea of time-shifting heating, the remaining six handouts relates to Topic 3: Discussion of RESPOND mobile app. The first three handouts (Topic 2) where originally presented in a Danish version, but are here shown in English.*

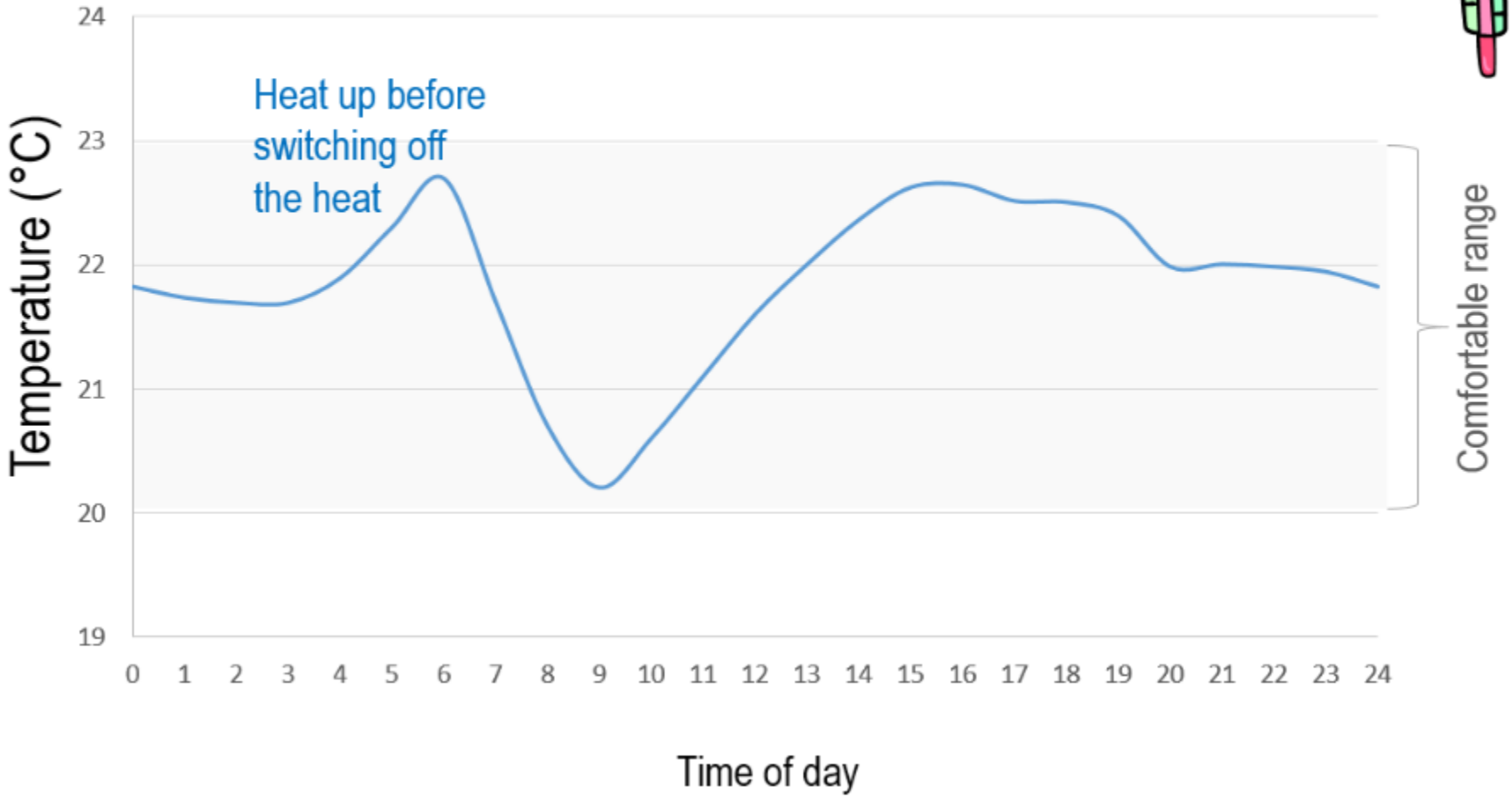
# Heat and hot water supplied by district heating company



# One possible solution is to switch off the heat briefly

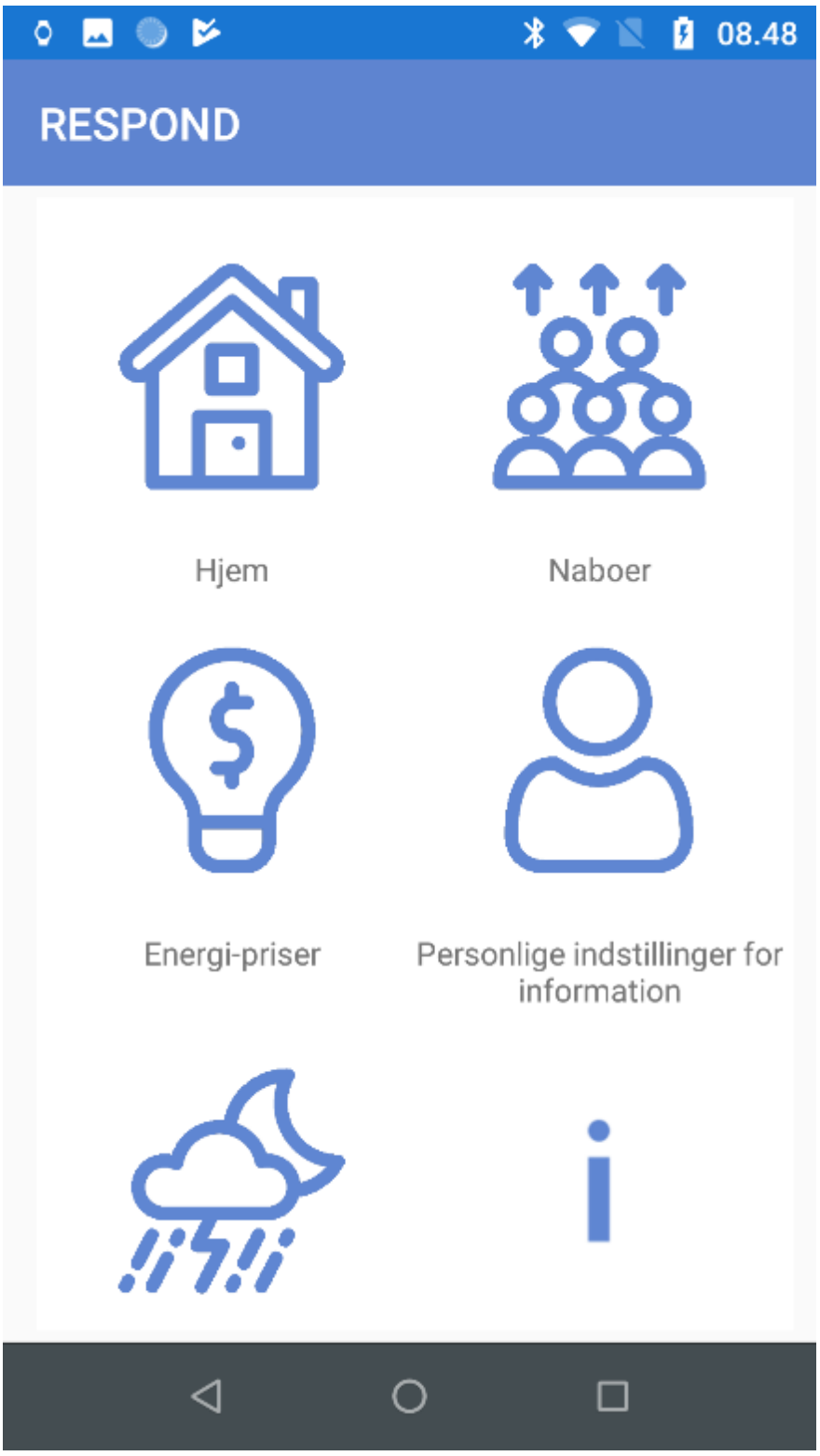


# The temperature in the dwelling

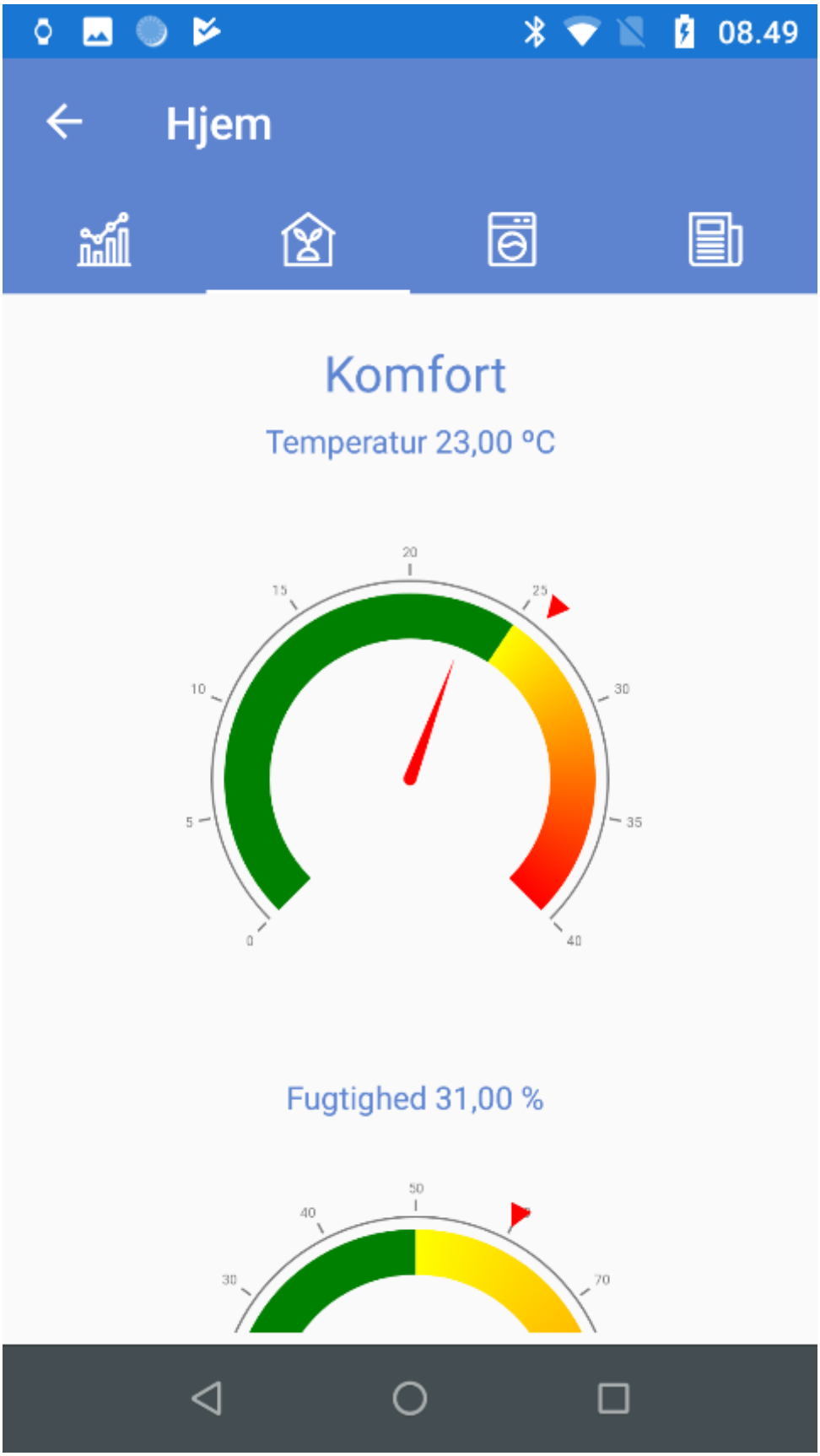


Hand-outs in relation to the discussion of the mobile app

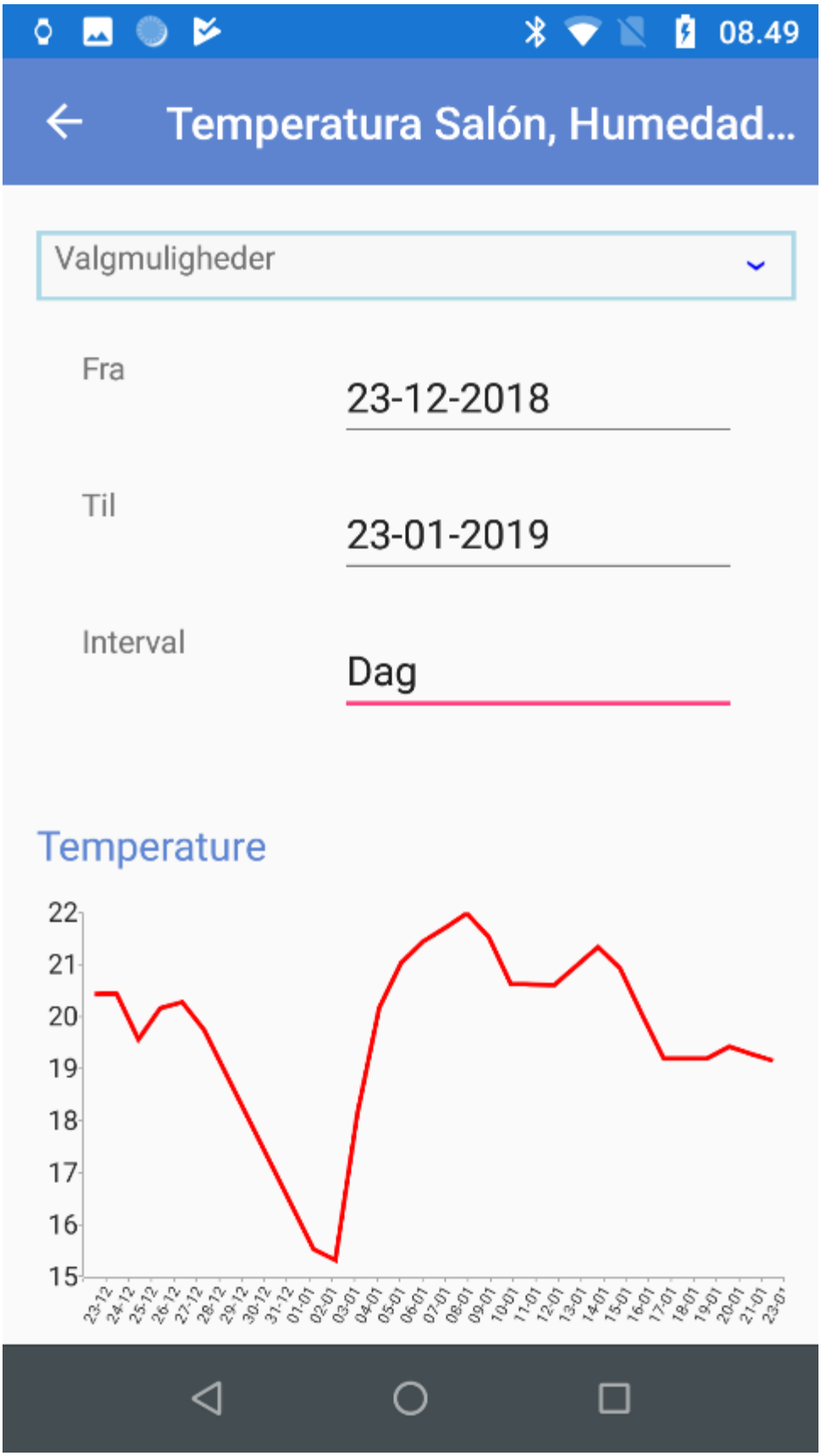
Start page



Temperature and relative humidity in the dwelling

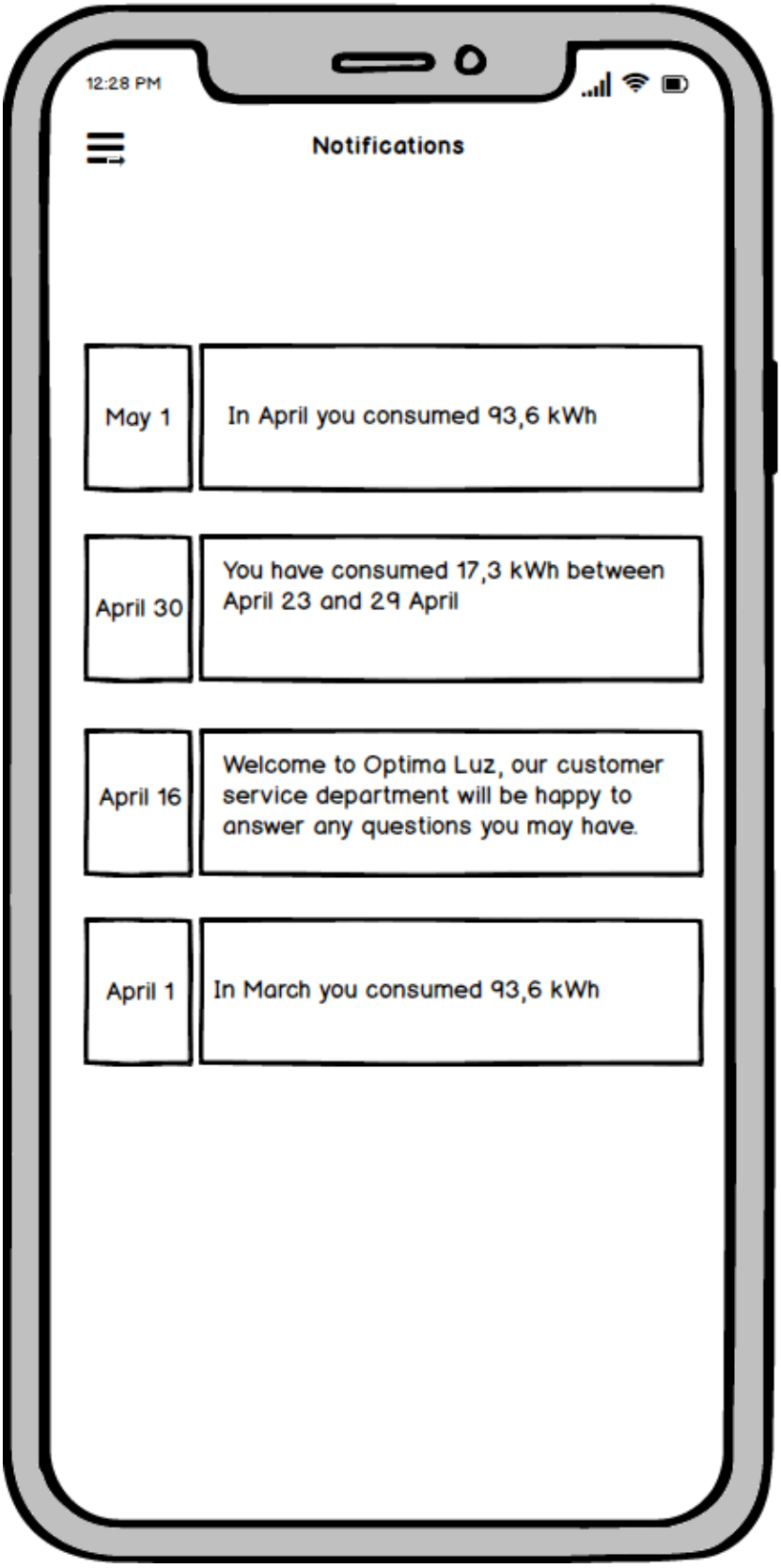


Temperature in different rooms in the dwelling



Local weather report

Notifications and recommendations



Possible app-functions for ”controlling” the heating

**Which features are wanted?**

***For example:***

- **Setting the preferred maximum and minimum temperatures?**
- **Permission each time the heat is switched off?**
- **Automatic control, with the option to cancel the next day's lowering of temperature the night before?**
- **Other things?**

# APPENDIX 4: SUMMARY AND ANALYSIS OF FOCUS GROUP ON ELECTRICITY IN AARHUS

## Focus group at ALBOA: DR in relation to electricity consumption

This focus group related to the RESPOND measures targeted demand response actions in relation to electricity consumption for other purposes than heating (i.e. mainly appliance use). As the pilot households are expected to take part in some amount of "active (manual) DR actions", this was the topic of this focus group. Focus was on how the participants perceive (understand) this, what they think about it and how it will fit into their daily habits and practices? The discussed topics moved from a general discussion of demand response and time shift of own energy consumption over discussing alternative variable pricing schemes to discussing the specific RESPOND solution and app.

*This summary of the focus group is based on a more detailed summary of the focus group prepared by the AAU team. In this summary, we have condensed the discussions combined with analytical observations on basis of the discussions and how this information can be used for the design of the RESPOND app and solutions. In this summary, the participants have been anonymized using pseudonyms instead of real names and excluding personal data that can be used to identify the individual participants.*

## 1. Time, place and participant recruiting

The focus group took place on Wednesday 30 January 2019 from 6.30 pm to 8.10 pm at the "common room" called "Ny & Næ" situated inside the ALBOA settlement. The participants were tenants of the ALBOA housing association who are RESPOND pilot families. They were recruited through a written invitation sent by email to the pilot households about a month in advance of the planned focus group. Before sending the invitation, the 20 pilot households were divided into two groups of equal size (one group were invited for this focus group, and the other for the focus group on heating).

The group division was done strategically in order to obtain a diverse composition of each focus group regarding age, family type, household size, educational background and ethnicity. Sandwiches, chocolate, coffee and soft drinks were offered at the focus groups to help motivate tenants to participate, because the time of the meeting coincided with the typical dinner time for Danish families.

## 2. Participants

All participants were from the same settlement. There were 6 men and 2 women representing 6 households since two couples participated (F1 & M3 & M5 & F2). Two of the represented households had children living at home, while three households included retired people. The last household included a couple in their working age, but with no children living at home.

List of participants (anonymized; M = Male and F = Female) and a few biographical details from the informal presentation round:

- F1 (lives together with M3): Has a child living at home. F1 og M3 both works during daylight hours.
- M1: Two adults in their household. They have two children living at home. Says that they consume a lot of power. Both works during daylight hours
- M2: Is retired. Lives alone.
- M3 (living together with F1): Works during daylight hours.

- M4: Two persons in the household. Employed.
- F2 (lives together with M5): Two persons in the household. M5 works and F2 is retired.
- M5 (lives together with F2): Works still.
- M6: Lives together with his wife. Both are retired.

Focus group moderators:
- Lisbet Stryhn Rasmussen (local contact and co-moderator)
- Toke Haunstrup Christensen (lead moderator)

## 3. Group process and dynamics

All participants arrived on time. During the focus group there were no problems with unexpected interruptions or noise from outside. Overall, the physical surroundings for the focus group were very suitable for the purpose and well known by the participants.

Lisbet, the local contact person, welcomed the participants and introduced the evening's program, the focus group lead moderator Toke, and gave a brief status of the RESPOND activities in the settlement including the installation of the new hardware. They were informed that thermostats and VOC sensors would be installed during March 2019. In the beginning, the tenants talked freely mainly with Lisbet about the installed devices and their concern/questions were handled. It all happened in a good mood and generated some laughs. During this introduction the participants were served sandwiches and drinks. After the general introduction, Lisbet gave the word to Toke, who introduced the procedure of the focus group (what is a focus group, what to expect, an overall introduction of the three topics, etc.). After this, the focus group discussions began (see later summaries of these).

During the focus group discussion, the participants alternated between directing their talk towards each other or to the moderators, respectively. However, they were in general good at commenting on each other's statements. In this way, the focus group succeeded in creating several instances of shared discussion and elaborations among the participants. However, since many participated actively in the discussions, the participants turned to the main moderator (Toke) for taking on more actively the role as a "chairman". Thus, many made small signs to Toke in order to be added to the list of persons who wanted to have a word. Toke took on this responsibility. Yet, a few participants did not follow the list and interrupted the order of speakers, but Toke tried to ensure the order of speakers and it did not turn out to be a problem.

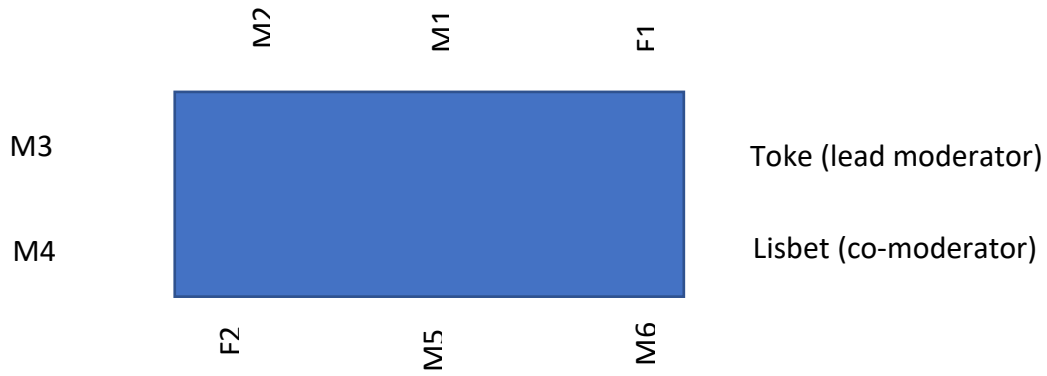
We had one deviation from the original planned procedure (cf. the focus group guide) as the main moderator (Toke) at the beginning of the focus group forgot to let the participants introduce themselves. Thus, the presentation round was carried out between topic 1 and topic 2 instead. This was not ideal, but it did not seem to have a serious impact on the discussions.

Overall, the focus group discussions happened in a good mood and often with laughs and friendly teasing. However, mid-way through the focus group (about minute 49:00), one participant (M2) asked about the focus of the project: Is it just about optimising energy consumption at the local neighbourhood? Or is it about the national energy system and how to improve this? This question indicated some uncertainties among the participants about what the RESPOND project is about. Another participant (M5) followed up on M2's question and concluded that the project is only about the neighbourhood and the housing association – describing it as a "self-centred project". This remark appeared as a critique and were also delivered in a confrontational way, which created some discomfort (including also the moderators). A few minutes were then spent on the moderators explaining the take of the project in more detail as well as other participants commenting and asking questions. In the end, the discomfort was "disarmed" and the topic discussions

continued. Even though some of the discomfort of the incidence might be due to how the critical question was delivered by some participants, the incidence is interesting as it shows that many of the participants are highly engaged in the pilot activities and actually have a wider focus than just on their own housing association. In this way, the incidence tells us that we should take care with the understanding that the pilot participants are in general only interested in and motivated by aspects related to their local neighbourhood and closest relations, but might in some cases find it relevant and meaningful (and motivating) to contribute to more overall transitions of the energy system.

In total, including the moderators' introduction, the focus group lasted 1 hour and 32 minutes.

The participants ended up sitting mixed men and women around the table as shown here:




# 4. Summary of focus group discussions

## 4.1 Topic 1: General attitude towards demand response

*Discussion starter and follow-up questions:*

a. Discussion starter: We are getting more and more renewable energy into the energy system. Much of the renewable energy – for instance wind and sun – is difficult to control and the production of energy is intermittent. This creates a new challenge: Sometimes we produce more energy than is needed – and at other times the energy consumption exceeds the energy we get from renewable energy sources. Therefore, there is a need to make consumption follow production. One way is to make households shift their consumption in time, so they move some of their consumption from hours with little renewable energy to hours with much renewable energy. For example moving consumption to night hours when the wind blows or to midday hours when the sun shines. *Discuss what you think about the idea of moving your own electricity consumption in time?*
b. Follow-up questions (comments to moderator on how to moderate in brackets []):

I. Discuss what types of electricity consumption you *would be able to* shift in time in your own household? [If people are finding it difficult to come up with ideas, introduce a few examples – e.g. laundering or dishwashing?]
II. What challenges do you think could be related to time shift your consumption?
III. Discuss what types of electricity consumption you *would be willing to* time-shift in your own everyday life?
IV. What would motivate you to time shift your consumption? [Should be open – try not to "steer" the discussion from the outset by giving examples like money saving or the environment. Save these examples to later, if needed to activate the discussion.]
V. What types of electricity consumption would you not be able to time shift? Why not?

*Summary:*

Toke introduced the theme and discussion-starter of Topic 1.

F1 and M2 think that laundering and dishwashing are the two types of electricity consumption that can be shifted in time. During the discussion of Topic 1, several other participants confirm that they also think this. Other everyday activities are more difficult to time shift – or as F1 says: "You are not watching the television while you are at work [during daytime]".

This is followed up by M2 who states that the vital thing is price differentiation. He refers to the local PV installation at ALBOA and makes a longer introduction to the economic model behind this. Today, every tenant pays the same fixed price for their electricity (2,20 DKK/kWh) – regardless of time of day and whether the PV generates power. In this way, the housing association generates a profit that are used to pay off the loans made for the PV investment. However, M2 suggest that one could make it economically affordable to consume electricity during daylight hours (with PV power production) by, e.g., by halving the electricity price in these hours. It is the price that motivates people to change habits, M2 states.

This is followed up by M6 that has heard [in the media?] that it has been suggested to make electricity cheap during the night instead because of a surplus of (renewable) energy during night hours: "And that's the exact opposite of what we should do out here [at ALBOA]. Here we should use the power during the day, right (…) But that's not like it always should be out in society…"

In this way, alternative perspectives on how to optimise (renewable) energy generation and consumption is developed by the participants at the very beginning of the focus group.

F2 returns to the discussion of time shifting one's own consumption. She points to the importance of whether one is having a (daytime) job or not. F2 is retired, and "to us [i.e. to people without a daytime job, e.g. retired people] who are staying at home during the day it is easier [to consume electricity during daylight hours]".

M3 questions whether it makes any difference to time shift consumption; if everyone starts consuming electricity during night, then we create a new problem. M4 agrees with M3: We should export the excess renewable electricity to other countries instead. M6 thinks that it would be the best if the housing association sell their excess electricity to other consumers (who needs the power).

M4 thinks that if he and his family should move dishwashing etc. to hours when nobody is at home, it would be nice if the project could look into issues of fire risk and water leaks (related to the use of washing machine and dishwasher). He would also like some kind of monitoring service, which could detect water on the floor or smoke from a fire. This in order to handle risks of fire and water leakage, and it could be part of the RESPOND app and service. From the later discussions, however, it appears as M4 is the only participant who

fears the risks of fire and leakage related to having machines running while not at home (several participants – about three – do already run their dishwasher or washing machine while at sleep or not at home).

M1 remarks that in his household a lot of electricity is consumed in relation to his teenager boys' use of PlayStation and computer – but it is difficult to see how to shift this in time.

Toke invites other examples of things to time shift, but people find it hard to come up with other ideas than dishwashing and laundering. However, M4 suggests that one could use Tesla batteries to save electricity when it is cheap for later usage. M6 mentions the option that "us who are retired" could make (hot) dinner at midday (instead of in the evening), but F2 disagrees strongly: "No! Then you would not get time to do all the other things you also need to do [several participants laugh]".

Price [variable prices] has been mentioned as a possible incentive for people to time shift consumption. Toke asks whether there could be other types of motivations than price. F1 mentions the concern for the environment. F2 adds that it can be a motivation to her to "consume less of our resources". Personally, she would be happy with doing the laundering doing the night hours and put up the wet clothes for drying (on a clothes line) in the morning if this is a good idea (in order to save resources): "But then we need to know when we should do things. But then I would go far in order to move consumption, because I can see that our resources are scarce." The statement by F2 is not followed up by other participants.

Common for many participants is that they don't believe that they can make much of a change (in the "larger picture") by their individual actions, such as time shifting of consumption of electricity. "It is not much we can move" is a common statement among several participants. However, M4 notes that it might not be much for the individual consumer, but if many consumers do the same, it might make a larger difference at the overall level.

M4 questions whether it isn't better for the environment to do other things than time shifting consumption (e.g. collecting waste in nature) – and if electricity is produced in a $CO_2$-neutral way, it wouldn't be a problem. M3 thinks that when we get electric vehicles, there will be a need for time shifting as the distribution network can't cope with too many EVs (charging at the same time).

M4 suggests an app that can start the dishwasher and washing machine automatically then there is excess of renewable power (F1 jokes that one then must hope that there's something in the dishwasher).

Toke asks if there are problems with noise when washing clothes during the night. Most participants don't think it would be a problem. Only one participant (M4) can hear his neighbours washing machine.

F2 asks how big a share of the housing association's electricity consumption that is covered by their PVs. M5 answers that this is about 60%. He further elaborates: Of the original investment of 9 mio. DKK, about 3 mio. DKK has already been paid. They pay off about 8-900.000 DKK a year. Thus, they will already have paid out the loan within few years. This raises a new problem: Should they continue with a flat price of 2,20 DKK/kWh, which makes it possible to pay off the loan soon. This will result in rather low electricity prices when the loan is payed off – which will be good for later residents, but to some extent on the expense of the current residents who pays the full price. Alternatively, one could already now reduce the price somewhat, which would make the full pay off time longer, but on the other hand be a benefit to the present residents also.

After this Toke closed Topic 1 and then followed the (delayed) presentation round where participants introduced themselves (at time 22:40).

*Analytical observations:*

The participants tend to think of laundering and dishwashing as the two types of electricity consumption that it is possible to shift in time. This might reflect that these examples have been mentioned earlier (e.g. in relation to the introduction meeting in January 2018). However, it might also reflect that this is in general the two types of consumption that is less time critical compared to other types of consumption (e.g. preparing dinner) – and that can partly be automated (using timers). Later in the discussion, M6 proposes that retired people, who often stay at home during daytime, could prepare dinner during the day. However, this is promptly rejected by F2: "No! In that case you would not be able to make all the other things one need to do".

M5 is obviously much into the details of the rooftop PV installation of ALBOA. He is also the first to suggest that reduced electricity price could be a way to motivate residents to time shift consumption to daylight hours. He believes that price is the thing that would motivate people to time shift their consumption. However, later in the focus group, he observes that a too high price reduction would also prolong the payback of the loans made to invest in the solar PVs. In this way, there are conflicting considerations to be balanced in a possible variable price scheme for the housing association.

Many of the participants appear to be well-acquainted with existing discussions in relation to the energy system transition. For instance, M6 observes early in the discussion that there is a difference between making electricity cheap during daylight hours at ALBOA versus the general debate which focuses on making electricity cheap during night hours (due to low consumption and high wind power generation in Denmark). This – and statements made by other participants throughout the focus group – indicates that the pilot households are not "average people" in relation to their knowledge on energy and energy systems. Similarly, M3 brings up the question whether it is worth time-shifting consumption compared to exporting excess electricity to other countries.

Regarding time-shifting energy, F2 notes that how easy this can be done depends on whether people are working or not during daylight hours: "To us staying at home during the day, it is easier." This is an observation that is repeated several times throughout the focus group (see also later). M1 observes that having children living at home complicates time-shifting even further.

Another issue regarding time-shifting consumption is risks of fire and leakage of water, which might happen if the dishwasher or washing machine is running while the residents are sleeping or not at home. This is mentioned by M4, although it does not seem to worry the other participants much (some even run their machines during night hours or while not at home already). M4 suggests that a solution to this problem could be including fire and leakage monitoring in the system.

Many believe that price (saving money) would be the most important incentive for time-shifting electricity. However, the electricity costs are already quite low, which makes some participants doubt if saving a few monies would be enough as incentive. F2 and F1 seems to be the only participants who think that there could be other reasons like consuming less resources or doing something good to the environment. In that case, it would be good with information on when it is best to consume electricity.

Noise does not seem to be a problem in relation to do clothes washing during night hours (in the terraced houses).

**4.2 Topic 2: Discussion of alternative ToU pricing schemes [28:00]**

*Discussion starter and follow-up questions:*

a. Discussion starter: Three different forms of Time-of-Use (ToU) pricing are presented to the participants for discussion. Each form of ToU pricing is illustrated on a sheet of paper (see Appendix), which are spread out on the table to support the discussion among the participants. The Topic begins with a general introduction by the moderator: "Today, most households have a fixed price, which means that they pay the same price for electricity regardless of when they consume it. However, it is suggested to introduce variable electricity prices to regular customers in the future. I.e. prices that in one way or the other varies according the patterns of renewable electricity production. The assumption is that this will help to motivate people to start time-shifting their own electricity consumption to save money by consuming at hours with low prices in order to better match the intermittent production from renewable energy sources. In this topic, we are going to discuss what you think about this on basis of three different suggestions to variable price models…"

   Following this general introduction, the moderator introduces the three different ToU schemes, which are:

   i. Scheme 1 – **Real-time pricing** (RTP): The price of electricity reflects the present (real-time) balance between production and consumption of the overall energy system. I.e. prices **change on an hourly basis** and can only **be predicted about 24 hours** ahead. Prices reflect the status of the national electricity system.
   ii. Scheme 2 – **Static ToU pricing**: The 24h day is divided into a few time intervals with different prices. E.g. low during night hours and extra high during peak hours in the morning and evening. The **prices and time intervals are the same every day**. Prices reflects the status of the national electricity system.
   iii. Scheme 3 – **Peak Production Rebates** (PPR): In this scheme, the price is in general flat, but during situations with a particularly high *local* renewable energy production (from solar or wind power), the residents are offered considerably lower prices for consumption in these hours. Residents are informed up to maximum 12 hours before the PPR. Prices reflect local renewable power production.

   Following this introduction, the moderator asks this discussion starter question: *What do you think about these three alternative pricing schemes? What would be pros and cons for each of them?*

b. Follow-up questions:
   i. Is there one of the schemes you would favour personally? And why?
   ii. Could you be interested in opting into one of these schemes, if it was offered to you?
   iii. If thinking of your daily life and if trying to follow one of these schemes, which one do you believe will fit best to you and your way of living? Why and how?
   iv. Do you have any ideas on how these schemes could be improved in order to make them (more) attractive to you?
   v. Do you have suggestions for other types of schemes that would be more attractive?

*Summary:*

Toke introduced the topic – and the handouts with the three different ToU pricing schemes were handed out to the participants. They were introduced and discussed one by one.

*Toke: Introduces Real-time pricing. What would you think about this type of pricing scheme?*

F2 immediately answers: "Never! I simply wouldn't bother [to do] that!". Prices that changes from hour to hour and day to day represent an "information overload" to F2. Other participants agree, and there appears to be a consensus in the focus group that real-time pricing is too complicated to follow. F2 adds that she would prefer a price scheme which gives information about when it is – on average – cheapest to consume electricity (this is similar to the static ToU pricing scheme, which had not been presented yet at this time of the focus group).

M4 suggests that real-time pricing might be feasible if the mobile app could help with recommendations on when it is smartest to wash clothes etc. M1 agrees. F2 is sympathetic to this idea (solution), although she seems to keep some reservation towards the idea of real-time pricing. M3 thinks that it should be automatized so that one doesn't need to (actively) follow and adapt to the variable prices.

Toke asks whether it is possible to automatize laundering (in a practical perspective)? M4 thinks that automation could be practical if just the app tells you when it is smartest to do the clothes washing. Then, he can make the machine ready (i.e. load it with dirty clothes) – and then the mobile app should tell him when the machine is ready (i.e. when it has finished its washing cycle). The same should be done with the dishwasher.

Lisbet asks how much the price difference should be if the participants would be willing to actively time shift their consumption according to the real-time pricing scheme. M5 suggests the double of what is shown on the hand-out (i.e. about 1 DKK in difference between lowest and highest price). F2 does not agree that this is enough, while M4 questions how many who would bother to do it at all. If it is not automatized, he should be able to save more than 1,000 DKK (about 140 euro) a year before he would be interested at all.

Following these statements on economic incentives for changing habits, F1 offers a different perspective: One should think of this in the same way as why people do waste sorting: "That's not the big money to us neither [means that they don't save much money by sorting their waste], right, that's [about] an attitude. Maybe one should think about it in this way – that it is not only about money, but that it is also a good thing [i.e. the right thing] to do." M1 acknowledges that this might be right, but a difference might be that it takes much more effort to time shift consumption (compared with waste sorting) – for instance if you have children who need to go to school at a specific time and who consumes much of the electricity. M4 follows up on the comparison with sorting waste, as he thinks that the waste sorting did not become a success before it was made easy to sort your waste by getting different waste bins in your home (for different waste fractions). In the same way, it needs to be easy for people to time shift consumption before they will do so. F1 kind of agrees with M4, but at the same time she holds on to the idea that people might still do some efforts in order to make their habits follow their attitudes (even if this is not about saving money).[3] F1: "If this app could tell me that today at 2 pm it is a good idea to do the [clothes] washing, then I could set [the timer of] my washing machine to start at 2 pm. I don't need to have it to do it automatically [for me to do it]."

[3] Analytical comment: In a way, this discussion represents a classical discussion of whether people (should) do the right thing – such as saving energy or the environment – for their *personal benefit* (which represents a so-called utilitarian ethics) or because it is the "right" or (morally) "*good thing*" to do (i.e. following the "ethics of duty", often called duty-based ethics or deontological ethics). These are two different ways of thinking about morals and why people do (or should do) as they do – and they are both valid in the sense that they co-exist and play a role in the life of most people (although in different ways and different balances from person to person).

M4 suggests that the app should tell him how much he can save (money-wise), preferably calculated as annual savings if he continues to do certain actions.

*Toke: Introduces static ToU pricing. What would you think about this type of pricing scheme?*

M6 thinks that this scheme would be much easier to follow than real-time pricing, because you don't need to check the prices regularly… "Why should you go to a [phone] app to control your [electricity consumption]… There's bloody enough of that sort of things already." M1 agrees and adds that this type of scheme would also be easier to make one's children to learn and follow. There is a consensus in the focus group that the static ToU pricing scheme is easier to follow than real-time pricing.

*Toke: Introduces the local peak production rebate scheme. What would you think about this type of pricing scheme? (~time 49:00)*

This is where M2 asks about the overall focus of the project: Is it only local or does it have a more general/national perspective? This causes some discussion and (critical) questions among the participants, as described previously in Section 3. Besides a general disorientation among the participants about what the RESPOND project is about, this discussion also reflects that different and not always compatible perspectives can be applied to the same issue of demand response. On one hand, it can be seen from a local (neighbourhood) perspective and be about balancing local power generation with local power consumption – and this can make sense seen from a local perspective. But at the same time, it can also be viewed in a national/regional electricity system perspective, where local (neighbourhood) optimization might be a "sub-optimization" on the macro scale. The participants' discussion very much reflected this ambivalence between conflicting perspectives.

This said, there was some sympathy towards the idea of local peak production rebates among several participants. As M6 suggests, since they (the housing association) have paid for their own solar PVs, it "makes good sense" that they "harvest" the benefits from producing electric power themselves.

*Toke: Which of the three price models would you favour?*

M2 says that he would favour the last one (local peak production rebates) – several of the other participants agrees. However, M5 notes that if they reduce the price of electricity during hours with excess PV power production, this will prolong the pay off period of the loans taken to invest in the PV panels.

The question of whether it makes any difference to them that the electricity is locally produced results in mixed reactions. To some it doesn't make any difference, but to others (seems to be the majority) it is something to be proud of (producing one's own power).

*Analytical observations:*
It is apparent from the focus group that real-time pricing (RTP) is perceived as too complicated to use and follow. It involves an "information overload". For example, M6 notes that "even retired people" (as himself) are planning activities several days into the future, and therefore it would be difficult to adapt to a RTP scheme.

However, an alternative perspective is offered by M4 (and supported by M1 and partially by F2), who suggests that if the mobile app could help with concrete recommendations on when it is smart to do the washing, RTP might make sense. M3 adds that it would be ideal, then, if the time-shifting could be automatized. In conclusion, the consensus of the focus group seems to be that RTP is too difficult to follow – especially if not combined with specific recommendations through an app.

The group discussed how big the financial incentive should be to make it attractive for them to shift their consumption. There seems to be some consensus that this should be substantial, although F1 suggested an alternative perspective on this: One needs to look at this in the same way as then one is sorting waste. Sorting waste is not about saving money, but they do it nevertheless because it is a question about attitude (like in "principles"). Part of the discussion seems to shift between the two alternative perspectives: Price incentives should be the means to make people shift consumption (but is this enough?) versus one should shift consumption because it's the "right" thing to do. The latter indicates a moral judgement, which some participants partly agreed in, but which was also questioned by some due to practical issues (is it feasible to do in normal everyday life) or by questioning if people would do this type of (moral) actions in practice.

There seems to be consensus that Static ToU pricing is more attractive and realistic than RTP. It is easier to understand and adapt to.

As mentioned earlier (Section 3), there is some discussion of whether focus should be on local optimization versus a national/regional system perspective (optimization). There seems not to be a strong consensus on this, although the discussion seems to end up with the conclusion that it is okay with the local perspective. In continuation of this, the participants seem to fairly agree that they would favor the last price model (Peak Production Rebates). However, M5 repeats the problem that offering too low prices during PV excess power production involves a risk for the pay-back time of the loans.

### 4.3 Topic 3: Discussion of RESPOND solution and mobile app (1:08:20)

*Discussion starter and follow-up questions:*

a. Discussion starter: The participants get a few hands-out (to be spread out on the table) showing a selected number (4-6) of functionalities (i.e. "pages") in the mobile app. The moderator briefly explains the overall DR approach to be utilized within the pilot site and the functionalities of each of the selected mock-up mobile app pages. This should not take longer than 4-5 minutes. After this presentation, ask the following discussion-starter question: *Please, consider how you could personally make use of this and discuss your immediate reactions to it. What do you think about it? How would this fit with your everyday life at home and in your family?*
b. Follow-up questions:
    i. What do you think about the design of the mobile app? Does it make sense to you? Something that's difficult to understand? Any suggestions for improvement?

*Summary:*

*Toke introduces the topic – including the handouts with "screen dumps" of selected "pages" of the mobile app. After presenting the screen dumps briefly, Toke asks what the participants think about the mobile app?*

M5 comments on the page with recommendations (in relation to which Toke gave as an example that one type of recommendation (or alert) could be if the household consumes more electricity than normal). M5 says that this type of recommendation already exists – he and his wife (F2) uses it already for their second home ("summer house"). This seems to be a service offered by the energy provider or the Distributed System Operator (DSO).

M6 is more interested in an app that can tell him about what the electricity is used for – i.e. a breakdown on appliance use. Several participants agree.

M4 (like several others) would also be interested in information about what the electricity is used for (appliance breakdown). In addition, he would be interested in humidity and temperature data (M1 agrees).

Lisbet and Toke explains that one of the ideas is to give the households a smart plug that can be used to measure different appliances' electricity consumption. Toke asks if this is something that they would be interested in? There seems to be a strong consensus that this would be attractive.

*Toke: Other comments?*

M6 would like a feature that would make it possible for him to compare his consumption with the previous year at the same time (e.g. January 2019 with January 2018). M4 would like to have fire alarm alerts via the app. Also, he would like the option of turning on/off appliances via the app – and in general be able to draw data from app/monitors for his own use.

*Toke asks whether the participants would be interested in comparing their own consumption with their neighbours?*

Several participants do not seem to be very interested in this. M5 notes that if this should be relevant/interesting, it should be a comparison with other households similar to one's own household. M4 agrees. If comparisons should be relevant to him, the comparison should be with households of similar household size and maybe similar age composition.

*Lisbet asks whether it would be interesting for them to know how much of their own electricity consumption (e.g. in a given week) that has been covered with their own, local PV power?*

M1 thinks this could be interesting – and there seems to be a consensus that this would be interesting. It might also be a motivational factor to increase the share of PV power of the energy consumption of one's household. Toke asks why this could be worth striving for, and M5 thinks this would make one feel better about oneself and M1 adds that it would give one a "good conscience". M5 suggests that prizes could be awarded (gold, silver and bronze) to those who are best at consuming the local PV power. F1 compares the motivational factor of the PV share information with people who do self-monitoring, e.g. in relation to health and how many steps they make. M6 adds that "we are proud of our solar cells – and if you could get information about how much [PV] power you consume yourself, this would be great".

*Toke asks whether they would use the page with the weather report?*

In general, no one expects to use this page – on the other hand, it might not be a problem to include it (~ it does not do any harm as such).

Regarding the navigation (the menus) of the app, people seem to find this rather straightforward and easy to understand.

*Analytical observations:*
One of the things that the participants are particularly interested in is a feature in the app that can **show them the energy consumption of different appliances**. This also relates to a point mentioned in the other Danish focus group (the one on heating) that there should be plugs that can be moved by the residents between different appliances. In other word: It is important for the participants to be able to make appliance-specific measurements – and, as part of this, have the option to choose freely what to measure.

Apparently, there is not much interest in comparing one's own consumption with others. And if so, it should be compared with **similar households** (regarding household size etc.). However, some would be interested in the possibility of **comparing one's own consumption with the historical consumption** of the same time period in the previous year.

There's some interest in monitoring of **air humidity and temperature**. Furthermore, M4 would be interested in access to the fire alarm via the app – and the possibility of turning on/off appliances via the app (however, this interest does not seem to be shared by most participants).

Interestingly, the idea that created the most enthusiastic reactions from the participants was the suggestion that the households should be provided with information about **the share of PV power in their own electricity consumption** through the app. Some even think that this could be a motivation to time shift energy in order to increase the PV share. M5 and M1 think that increasing the PV share could give one a good conscience. M5 even suggests making a competition among participants with gold, silver and bronze prices (to those with highest PV shares). F1 compares it with people with "pedometers", which seems to motivate them to walk more (this also relates to the discussion of the "quantified self" within digital media studies). M6 states that they are proud of their PVs, and therefore info about the share of PV power would be great. ***The fact that PV share and PV share competition seems to engage people indicates that this should be considered for the mobile app – see also a previous suggestion of this in deliverable D3.2 RESPOND User Engagement Strategy (see section 6.5 and figure 7 – se also below).***

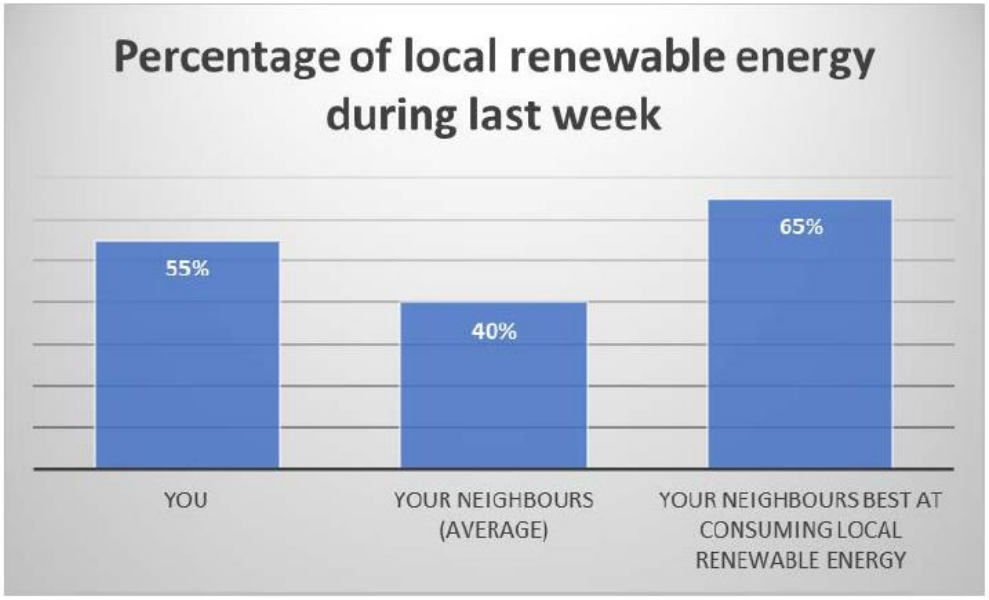
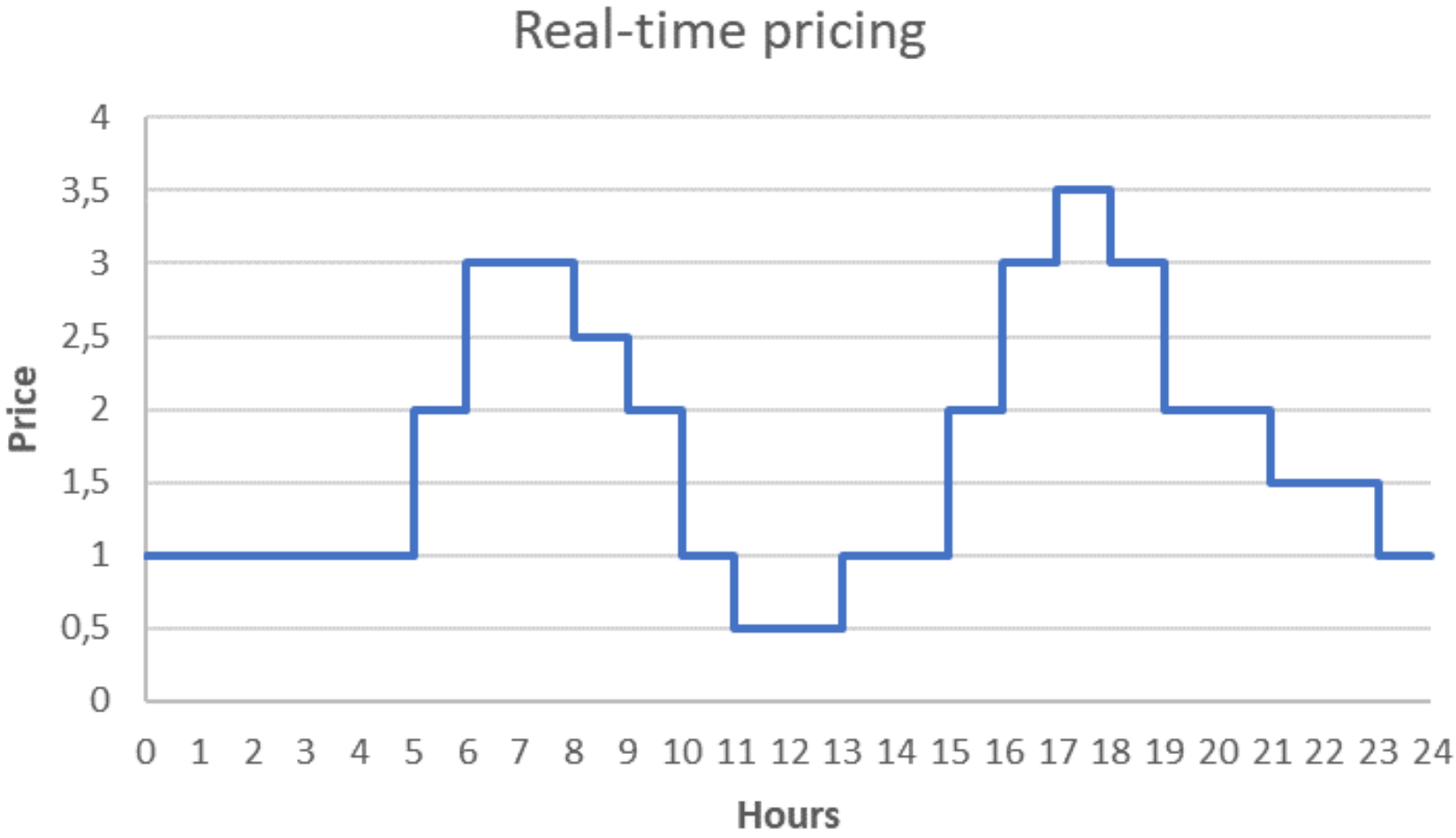



FIGURE 7: EXAMPLE OF HOW THE NEIGHBOUR COMPARISON OF THE INDIVIDUAL HOUSEHOLD COULD LOOK LIKE.

No enthusiasm related to the weather report page – although they at the same time seem to state that it does not make it worse, and that some of them might use it sometimes.

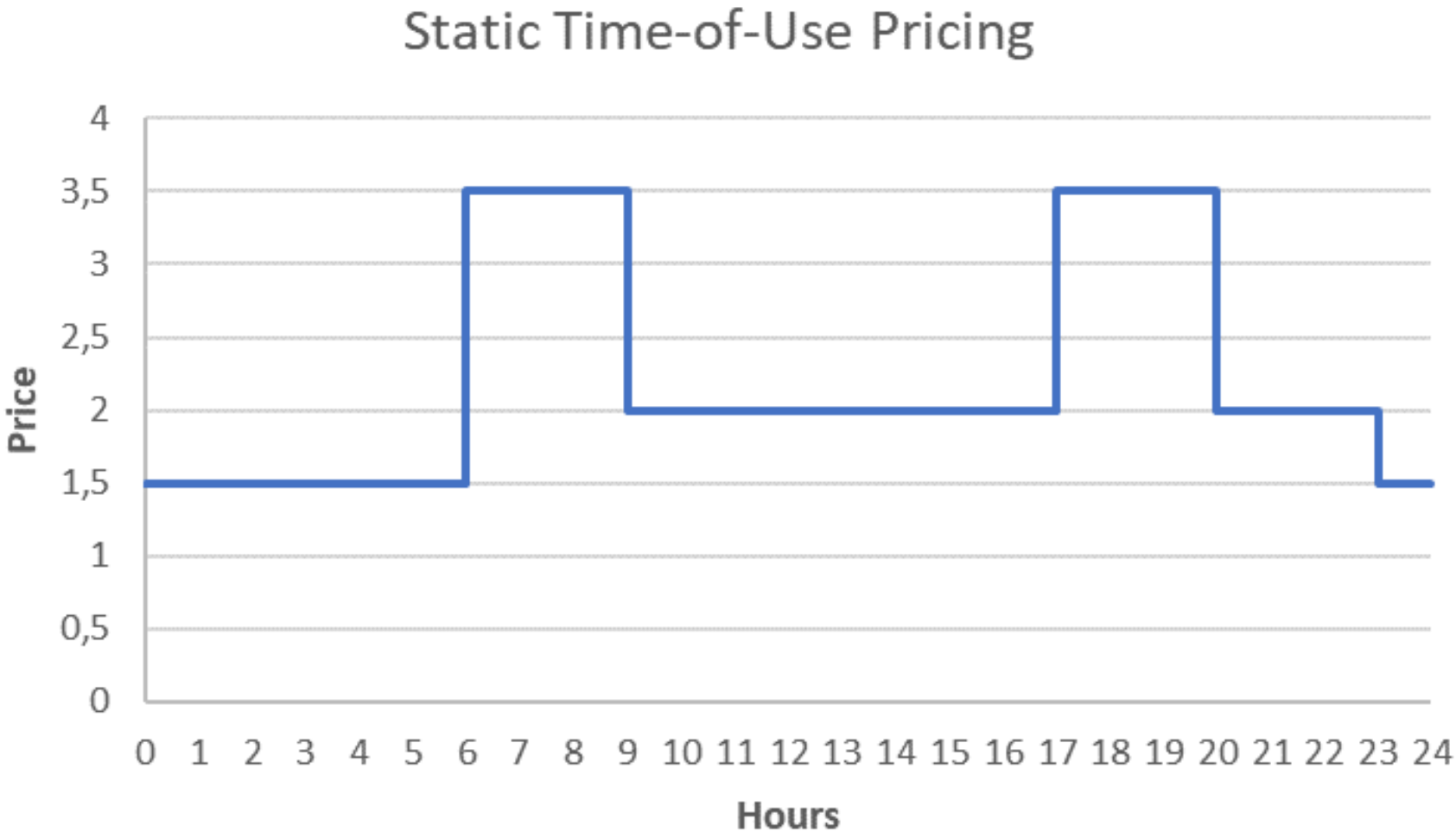
# Appendix: Hands-out in support of discussion of Topic 2 and Topic 3

*First three handouts relate to Topic 2, the remaining handouts relates to Topic 3. The first three handouts (Topic 2) where originally presented in a Danish version, but are here shown in English.*



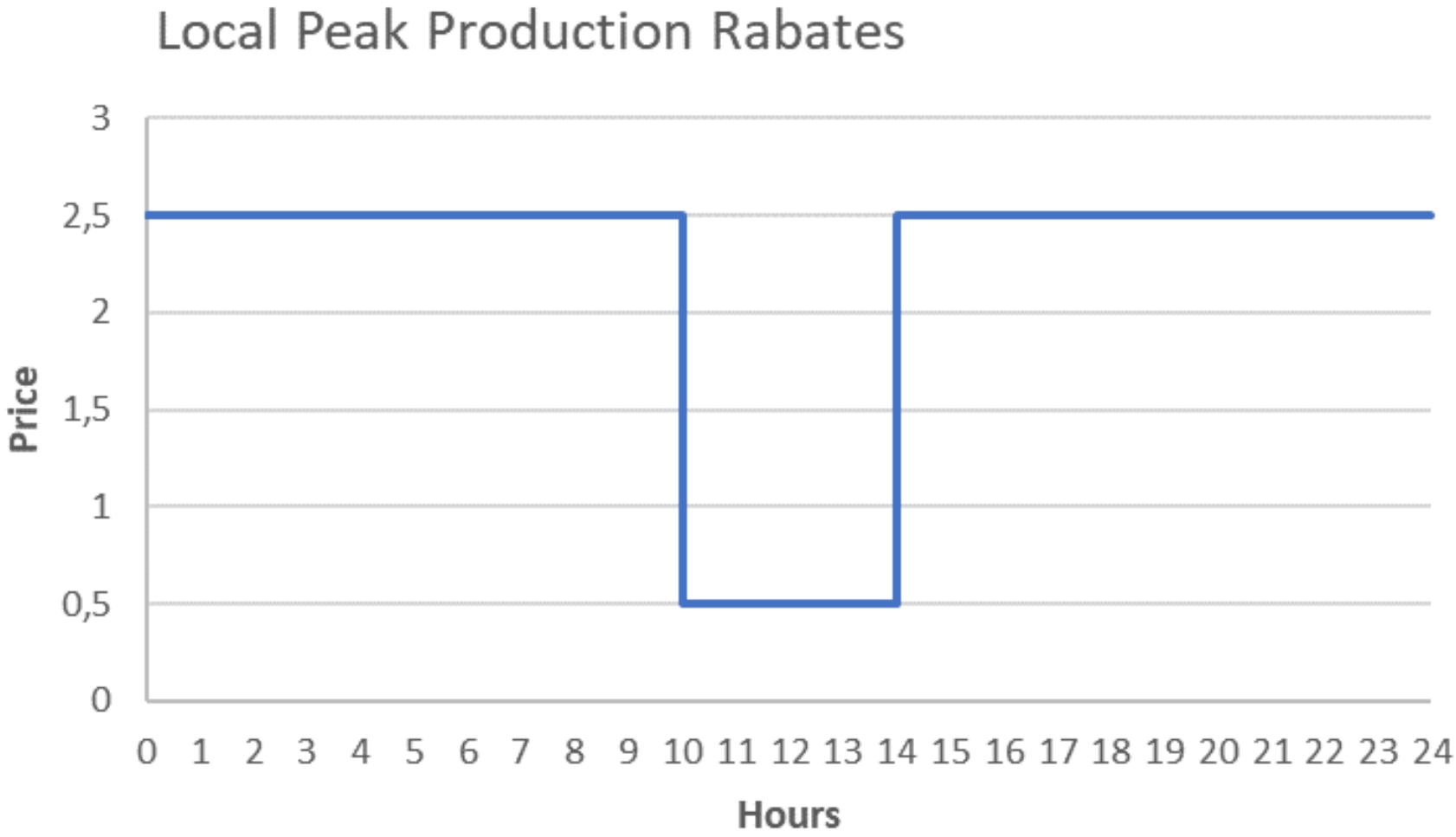

Electricity price varies from hour to hour – and in different ways from day to day,

The electricity prices of the next day is announced the day before.




The electricity price varies a few times a day and follows a static scheme.

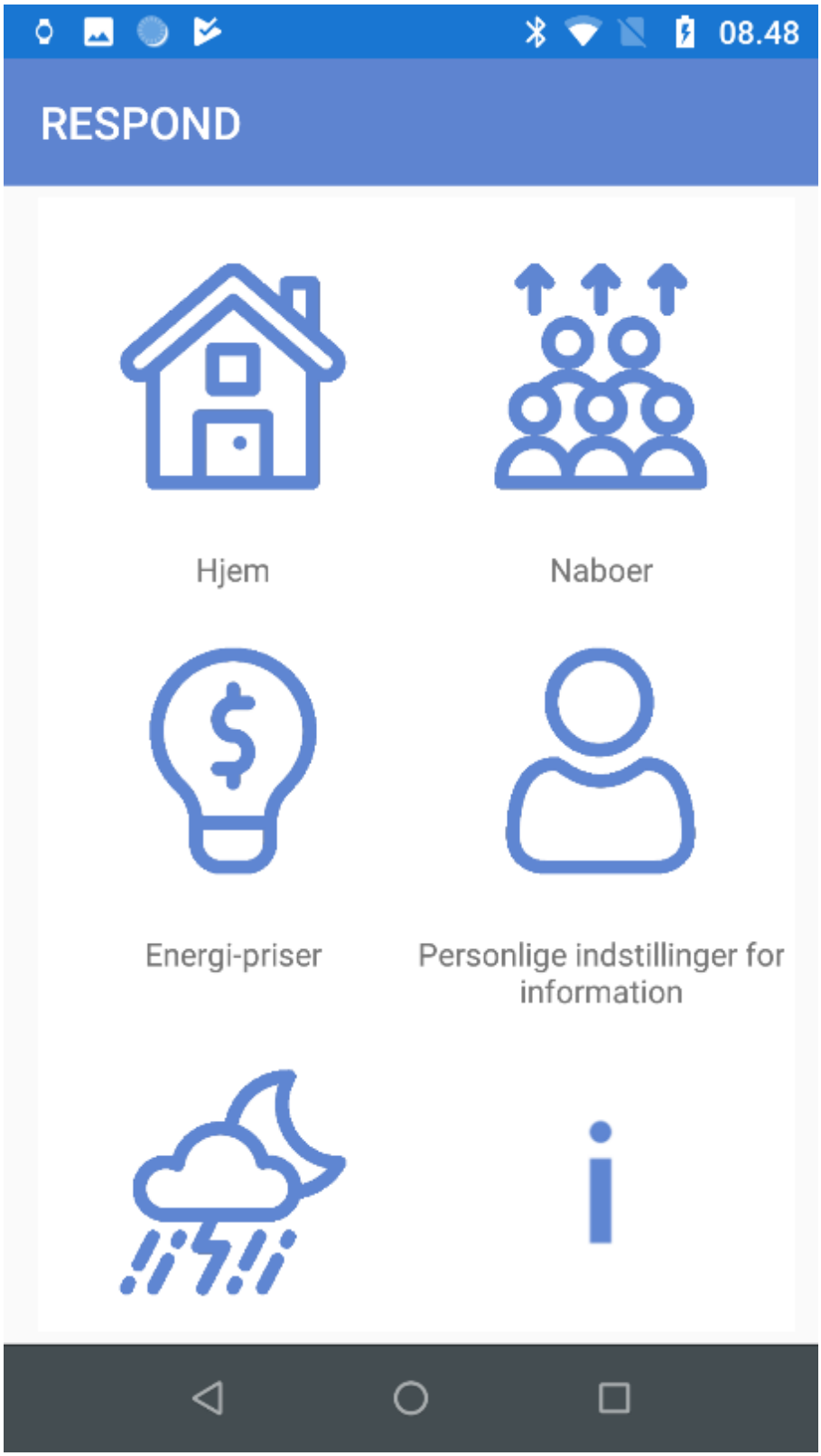
Same scheme every day.



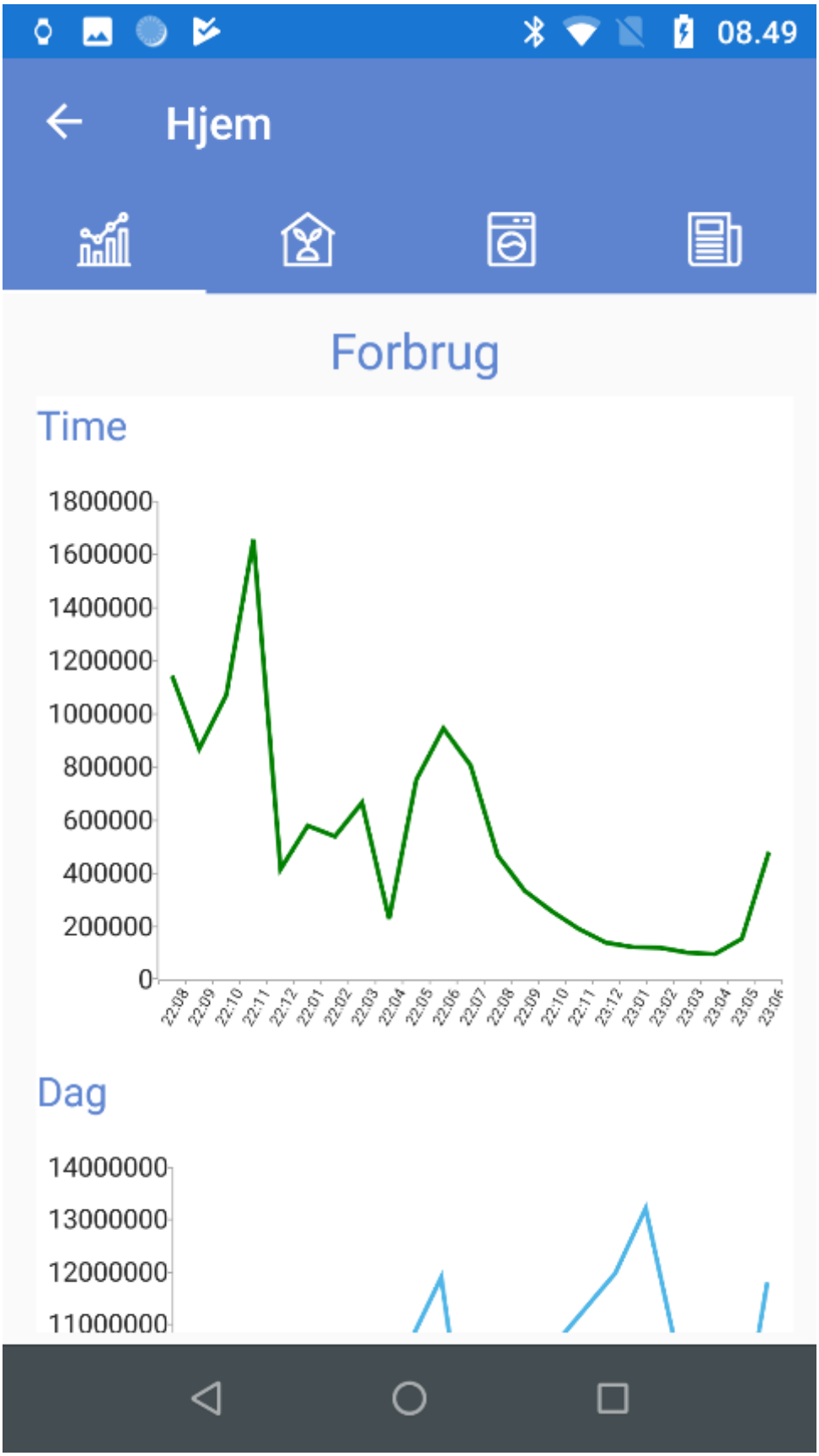

Fixed (flat) electricity price – except rebate in cases of local surplus of wind or solar power.

The hours of rebate (lower price) is announced the evening before

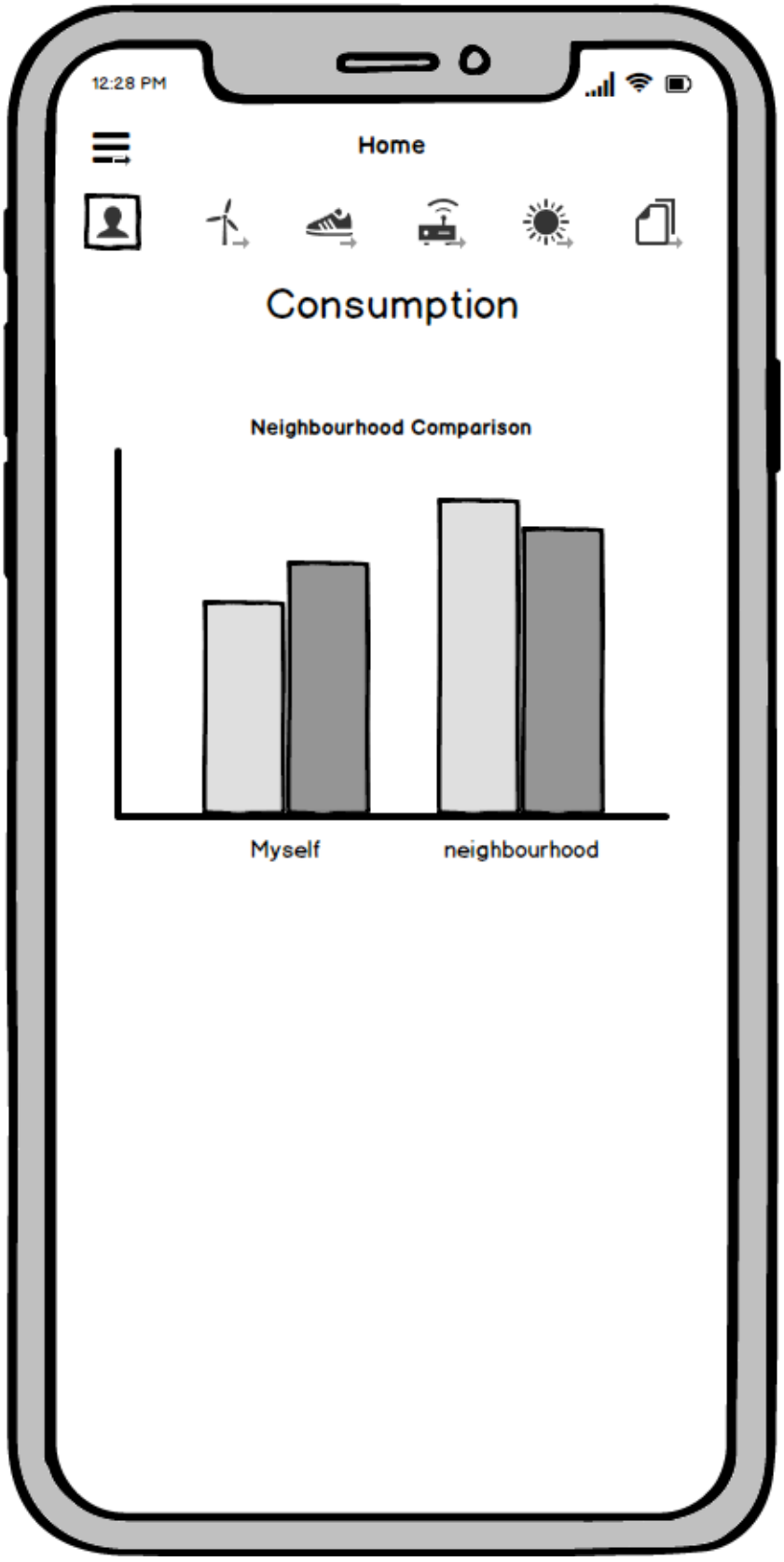
Start page


08.48
RESPOND
Hjem
Naboer
Energi-priser
Personlige indstillinger for information

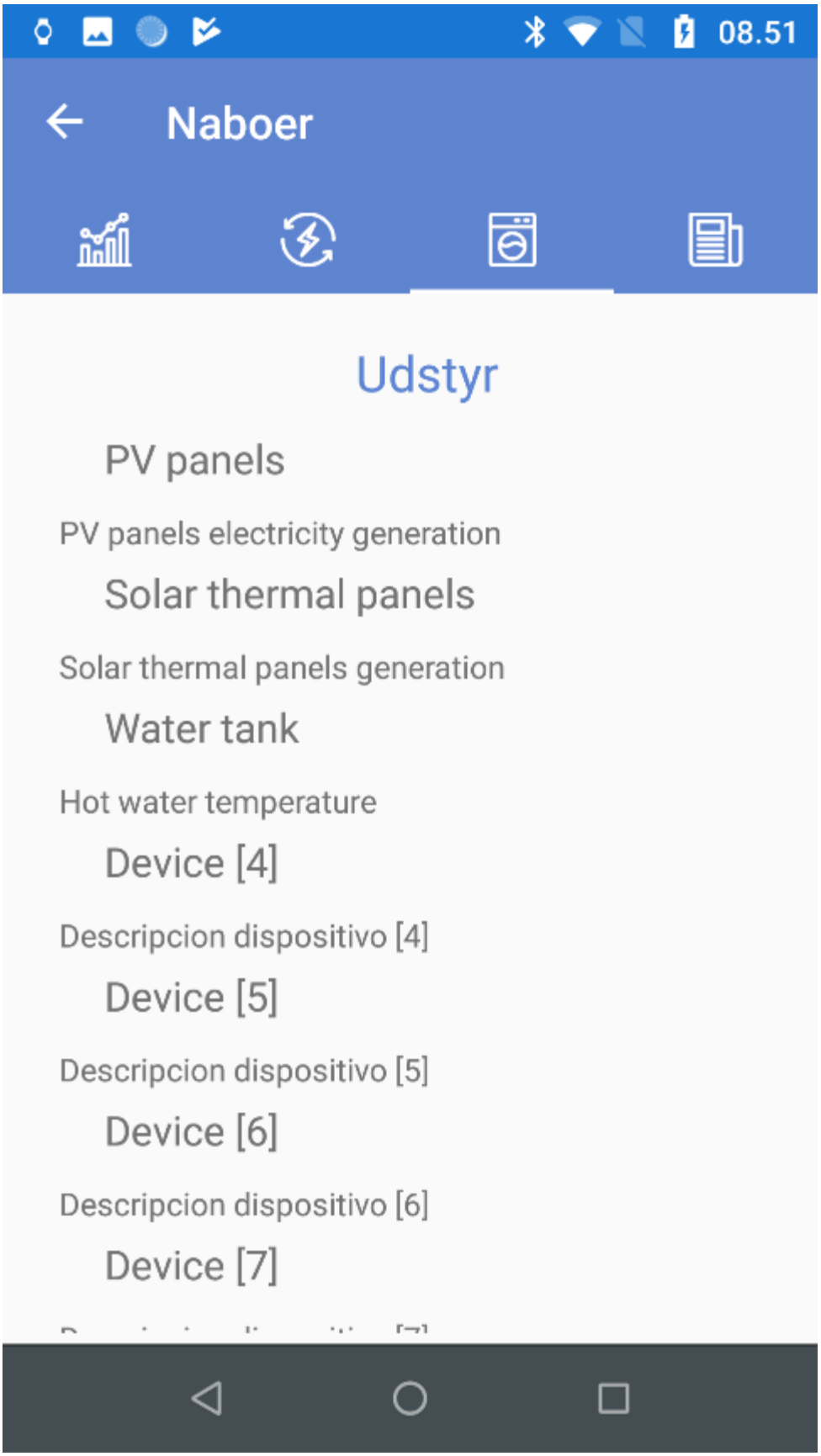
Consumption at home



Comparison with neighbours

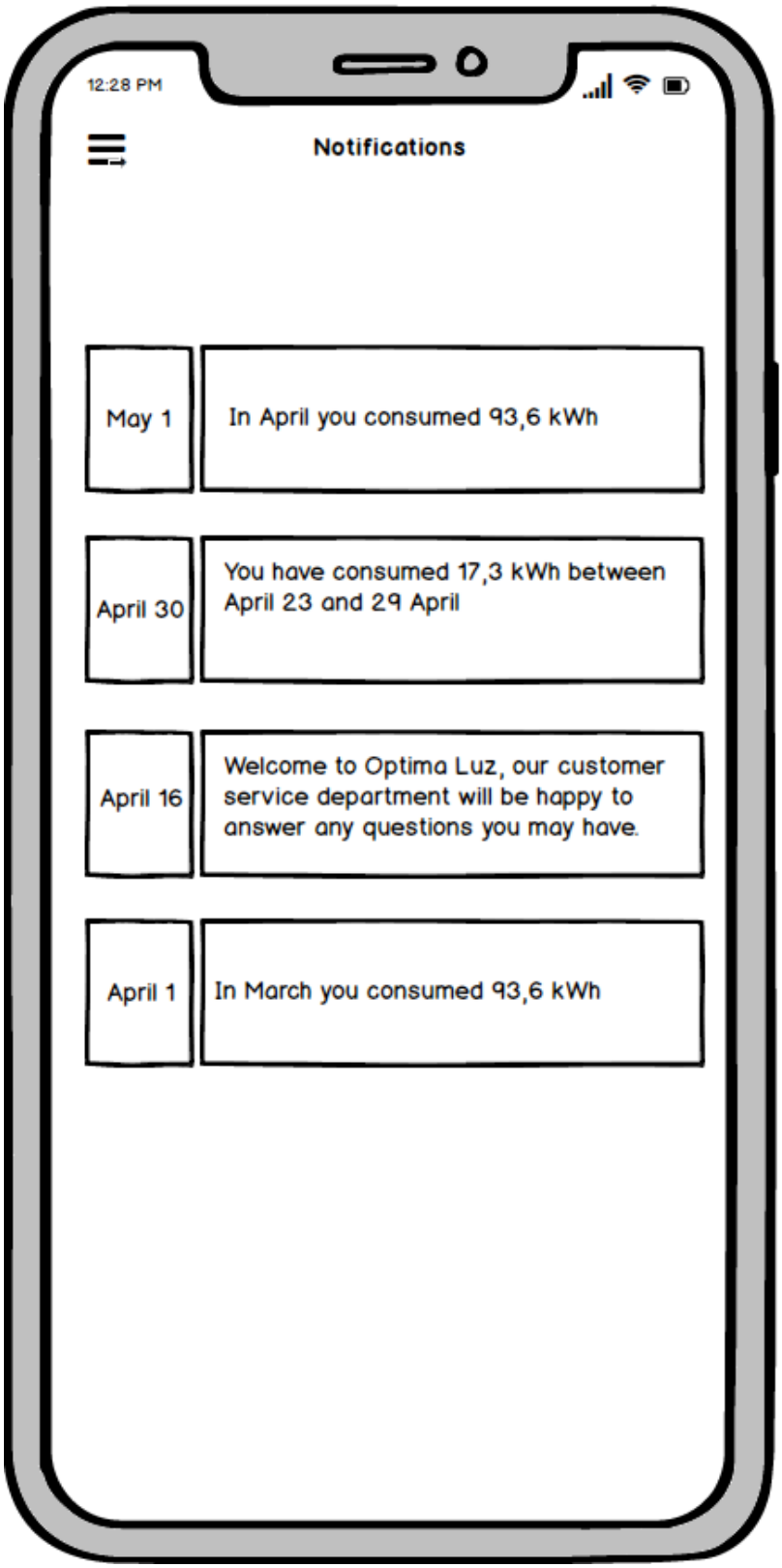


Equipment and their consumption/production



Local weather report

## Notifications and recommendations



# APPENDIX 5: SUMMARY AND ANALYSIS OF FOCUS GROUP ON COOLING/DHW IN MADRID

## Focus group at Madrid pilot site: on cooling/DHW

This focus group related to cooling and Domestic Hot Water (DHW).

The aim of the focus group was to collect participants' feedback, comments, relevant routines and habits in order to consider this valuable information for the development of RESPOND solution design. The purpose is, in other words, to review, adjust and validate the previous ideas that RESPOND consortium had for the DR actions and the functionalities of the mobile app. For this finality, the moderator raised questions to discuss about cooling patterns (DR), the use of DHW (DR) and RESPOND solution/mobile app.

### 1. Time, place and participant recruitment

The focus groups took place on Thursday 9 May 2019 from 6.00 pm to 7.00 pm at a "common area" situated inside the pilot site. The room is usually used for neighbourhood meetings and it was considered as an adequate place because of its proximity to the participants home location and also because of the familiarity that the participants have with the space chosen (we felt they could feel comfortable there in a well-known place and this would help to propitiate a relax atmosphere). Also, we tried to make it easy and practical for all participants to attend. The participants were RESPOND pilot families that live in the dwellings. The meeting was held in Spanish as it is the language of all pilot households and members of Feníe Energía involved in the project that participated in the meeting.

The recruiting was done during a neighborhood's meeting hold about one and a half month in advance of the planned focus group. In addition, about a week in advance of the meeting date, an invitation letter was sent to the participants and a poster was hung in a visible place of the interior of the pilot building with the purpose of informing them about the time and division of groups.

The households have similar characteristics regarding social, economic status and ethnicity, and they are either retired people or families composed by couples (male+female) and in some cases children/s. So we strategically divided the groups in order to balance retired individuals and working individuals, splitting them into the two groups.

The 10 pilot households were divided into two groups of equal size (one group was invited to the electricity for electric appliances focus group at 5.00 pm and the other group was invited to the cooling/DHW focus group at 6.00pm).

The time of the meeting was the afternoon, which usually is time of busy activities for the participants, as some of them have children in the families, are at work/coming back from work, practice activities or have responsibilities to do. But anyhow, the vast majority of the invited families attended to the meeting and all participants arrived on time. It should be noted that some participants invited to the second focus group at 6.00pm arrived at 5.00pm, so there were some spectators during the first focus group held at 5.00pm. This

could indicated that the event generated some curiosity and expectations, or at least the invited participants were willing to spend a good time among neighbours having afernoon snacks.

## 2. Participants

All participants were from the same settlement. There were 4 men and 2 women representing 4 households since two couples participated (M1 & F1 and M2 & F2). One family finally didn't attend.

Two of the represented households had children living at home, while two households included retired people with no children at home.

List of participants (anonymized; M = Male and F = Female) and a few biographical details from the informal presentation round:

- M1 + F1: They are a retired couple living together. A housekeeper is at home taking care of the house duties twice per week.
- M2 + F2: They are a retired couple. No children at home. A housekeeper is at home during day hours taking care of the house duties once per week.
- M3: A male representing a family composed by two adults and one child live in the dwelling. Both adults work. A housekeeper helps a few hours per week with the house duties.
- M4: A male representing two adults and two children living in the dwelling. Both works. A housekeeper is at home daily.

Focus group moderators:

- David García (lead moderator): Feníe Energía employee, not involved in RESPOND project, he has knowledge and experinece in energy field.
- Antonio Colino (local contact and co-moderator): involved in RESPOND project as coordinator role.

Minute taker (as we didn't audio recorded the meetings, notes were taken during the focus groups in order to create the present summaries):

- Rodrigo López: involved in RESPOND project as coordinator role.

## 3. Group process and dynamics

Antonio Colino welcomed the participants in a cheerful and relax atmosphere. Some participants were already in the room as spectators of the first focus group on electricity appliances held one hour before. The participants were talking among them and with the organizers. Then, all sat down. There was a table with material for the focus groups. The participants sat down at the front rows, the moderator and co-moderator were situated behind the table, the minute taker was situated at the last row, behind all participants (to be able to take pictures and take notes during the meeting).

A brief informal round of presentations was done. The co-moderator, Antonio Colino, presented the moderator, David García (who was the only person that is not familiar for the participants). Rodrigo López, briefly commented about the actual status of RESPOND project and afterwards all invited participants were invited to present themselves (name and if possible, informing about number of habitants at home,

employ/retired situation, housekeeper (yes/no). All participants collaborated and presentations proceed smoothly.

Afterwards, the moderator introduced the focus group (what it was, what to expect), he explained the dynamic (that consisted in three topics with a starter question and follow-up questions. After this, the focus group discussions began (see later summaries of these).

The participants seemed to be comfortable. The dynamic scheduled was followed: the moderator presented the topic to be discussed, then he raised the starter question and the participants answered, moreover the follow-up questions were raised followed by the participants answers.

# 4. Summary of focus group discussion

## 4.1 Topic 1: Preferences and habits about cooling

*Discussion starter and follow-up questions:*
In Madrid city we have warm/hot weather conditions during several months every year, the temperatures are even increasing with the global climatic changes, during this period of time, people consume a high volume of energy used to cool their houses. The idea is to consume energy in a more efficient way in order to contribute to the preservation of the planet resources and to take care of the environment. Besides, an efficient management of the energy conductes to economic savings. *Do you think you could change some habits related to cooling ambients in your houses?*

Follow-up questions:

I. Cooling schedules.
II. Could these schedules be time-shifted? How and when? Disadvantages?
III. All the house at the same temperature?
IV. Temperature settings reasons and people in charge.
V. Suggestions

*Summary*
David García introduced the theme and discussion-starter of Topic 1.

There were different opinions in regards to this theme, on the one hand, there are families that believe that they already really take care of the energy consumption for cooling their homes, on the other hand, other families stated that they are aware that energy in too many occasions is incorrectly managed at homes or could be controlled in a more efficient way and they believe they could improve the energy efficiency by changing habits. In general, all agreed on that there is much to learn about energy efficiency. So, in general, they all are willing to make efforts and they believe they could change some habits and routines with the purpose of saving energy consumption.

i. The moderator asked the participants when do they use air conditioner, ventilators or other appliances for cooling their homes? The answers were during summer period, specially during the hottest months (July and August).

The moderator asked about more precise cooling schedules (days per week, time bands (hourly)? The participants said that in spring months they use energy for cooling the houses only in peak hot hours, in summer months the consumption has longer periods: different routines commented were the followings:
-use of air conditioner during hot hours with constant temperature for long periods (mainly afternoons).
-use of air conditioner during hot hours with changes in the temperature (mainly when necessary).

The moderator suggested different routines and asked the participants if they practice them:
-sometimes we suddenly lower the temperatures of the thermostats and this action involves a huge energy consumption: YES.
-the use low-power cooling appliance (as ventilators) in order to reduce the consumption of air conditioner that has a higher consumption of energy: two families YES, two families NO.
-keep the houses well ventilated in the coolest hours of the day (in the morning and at night): YES.
-turn off the air conditioning a while before leaving home: YES.

ii. The participants answered that the schedules could be relatively time-shifted. They said they could make actions to improve the consumption of energy for cooling purposes, mainly regulating the temperatures, switching off/on the air conditioner when people is not at home or when it is not really necessary, shifting to an appliance with a higher efficient consumption of energy (ventilators instead of air conditioner). All these actions could be done at any time really.

The moderator asked about disadvantages of these actions and the participants answered that people look for their comfort. One participant said that sometimes a little less comfort could bring more benefits as money savings, environment care. In families with children or with elderly persons comfort is a very important aspect, they stated, but efforts could be done in order to improve.

iii. They said the houses of the pilot have different orientations and sizes.
The moderator asked if different messages, notifications should be sent to the different houses (which each have its own characteristics)? The answers were: the same messages related to temperature settings should be sent to all users to be fare.

The moderator asked the participants about their opinion in regards to the idea of a competition among the neighbors and if they think they would take part of it and find it interesting. The answers were positives. In general, they found the idea interesting.

iv. The answers were basically related to comfort of inhabitants. All participants think about money savings when manipulating temperature at homes. People in charge are the adults living in the dwellings, also the housekeepers in some cases, and childrens could also manipulate the thermostats.

*Analytical observations:*
Within Madrid pilot this topic could generate different DR actions.

## 4.2 Topic 2: DHW time-shifting indexes to thermosolar production

*Discussion starter and follow-up questions:*
David García introduced the topic explaining that it would be interesting to encourage the consumption of DHW when the thermosolar installation is producing energy. He explained that an energy grid with an increasing percentage of renewable energy requires time-shifting schedules to adapt the consumption curve to the generation curve in order to balance the energy system. *He asked if they would be able to adapt their DHW consumption habits to new routines on the thermosolar basis.*

Follow-up questions:

i. DHW consumption patterns. When do they use DHW (and for which purposes)?
ii. DHW time-shifting. Could some of this DHW be shifted in time? What consumption and how? And if not, why not?
iii. Thermosolar generation satisfaction. Are you happy with the available temperature? And the "reaction time" since they open the tap and the hot water achieves the desired temperature.
iv. Suggestions

*Summary:*
David García introduces the theme and discussion-starter of Topic 2.

All participants answered that they are willing to benefit from the thermosolar installation. They think is a benefitial resource they have gained with lots of advantages for the environment and for gas savings. In general, they think they would be able to time-shift consumption to different hours during the day.

i. The answers were they consume DHW for the followings:

-for showers. For working individuals: usually during nights from Monday to Friday and during mornings on the weekends. For retired people it depends, some during night always, others during mornings. For children: during evenings, there is a high consumption for baths.
-for doing the dishes: when necessary.
-to cook. Even if they said that they use gas and electricity to actual cook, but some DHW is consumed also in this activity. For working individuals: during mornings if housekeepers cook, during afternoons/evenings if male or female adults of the family cook. For retired individuals: usually mornings.
-for cleaning purposes: usually during mornings.

ii. The answers were that these consumption could be time-shifted sometimes in some cases:

-showers could be time-shifted for some participants, for others it would be difficult, they could relatively change habits within time bands. For children it is difficult at least from Monday to Friday, it would be easier on the weekends.
-the consumption of DHW for doing the dishes could be easily time-shifted.
-the consumption of DHW for cooking purposes is minor but could be time-shifted.
-the consumption of DHW for cleaning purposes could be time-shifted.

iii. The participants are satisfied with the DHW available temperature , also with the ”reaction time” of the DHW.

iv. One participant suggested that it would be interesting to have information available in the mobile app about savings (energy and money) generated because of the thermosolar vs other technologies (gas).

*Analytical observations:*
This topic could generate several DR actions, participants are aware about the benefits of having a renewable resource, so RESPOND solution should take advantage to create interactions with the users. Most of participants seemed to be flexible in regards the consumption of DHW and willing to try to change habits in general.

## 4.3 Topic 3: Discussion of RESPOND solution and mobile app

*Discussion starter and follow-up questions:*
Discussion starter: The participants got some mock-ups from the RESPOND mobile app functionalities and we asked for their feedback.

Follow-up questions:

i. What would you like to see in the mobile app? [The start page mock-up was shown to the participants.]
ii. [Other mock-up pages were shown to the participants] and a discussion about user interface/design was opened.
iii. Feedback messages. Which kind of notifications would you like to see?
iv. Control actions related to cooling/DHW. Which kind of automated control actions do you believe you could allow/follow? Which kind of recommendations do you think you could follow?

*Summary:*

i. They would like to have simple icons in the start page, for easy navigation within the app. They found the mock-up start page shown intuitive. Someone suggested to have notifications and alerts in the start page, as this will be the main interaction with the app. Another participant asked about how detailed is going to be showed the *Neighborhood*.

*ii.* About *Weather Forecast* page, they found it interesting. Someone asked about the period that will be shown.

About *Generation* pages, they wanted to know if the information is related to the energy that the thermosolar installation generates.

About *Devices* pages, they said they would like to see simple recognizable icons linked to the devices.

About *Energy prices* page, they commented it's difficult to understand the table shown as the information provided (3 days hourly prices) doesn't mean much for them, they don't have notions about a low/high price.

About *Comfort indicators* pages, they found the indicators useful and clear. VOC indicator is missing.

*iii.* They would like to see notifications about high values of comfort indicators, prices information (changes alerts), production values of thermosolar when there are extreme conditions (low/high production).

iv. Cooling automated actions: They would allow to regulate the temperature of the air conditioner with previous notification.

DHW automated actions: No automated actions related to DHW were found.

Cooling recommendations: All kind of recommendations are welcomed and and they would try to follow as much as possible.

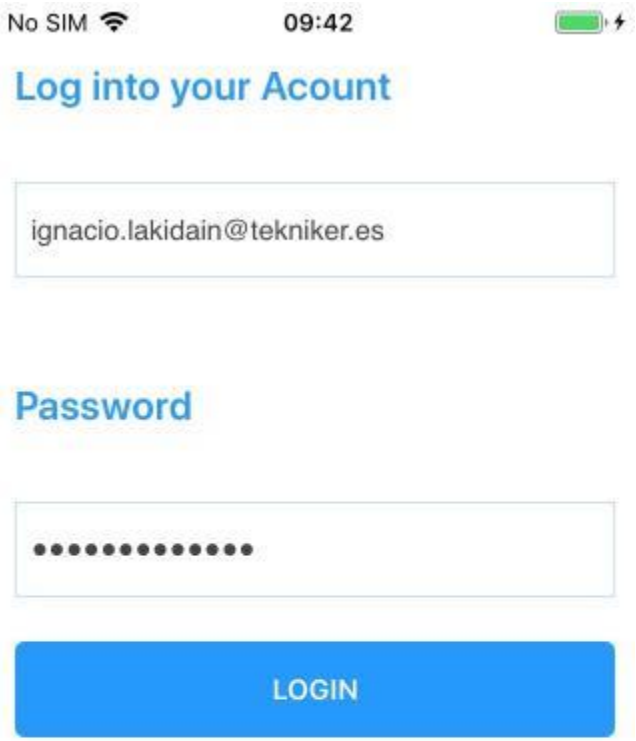
DHW recommendations: All kind of recommendations are welcomed and they would try to follow as much as possible.

*Analytical observations:*

From the answers that were given by the participants, they seemed willing to experiment and play with the RESPOND app, they showed curiosity and the feeling that it is something that could help them to change habits.

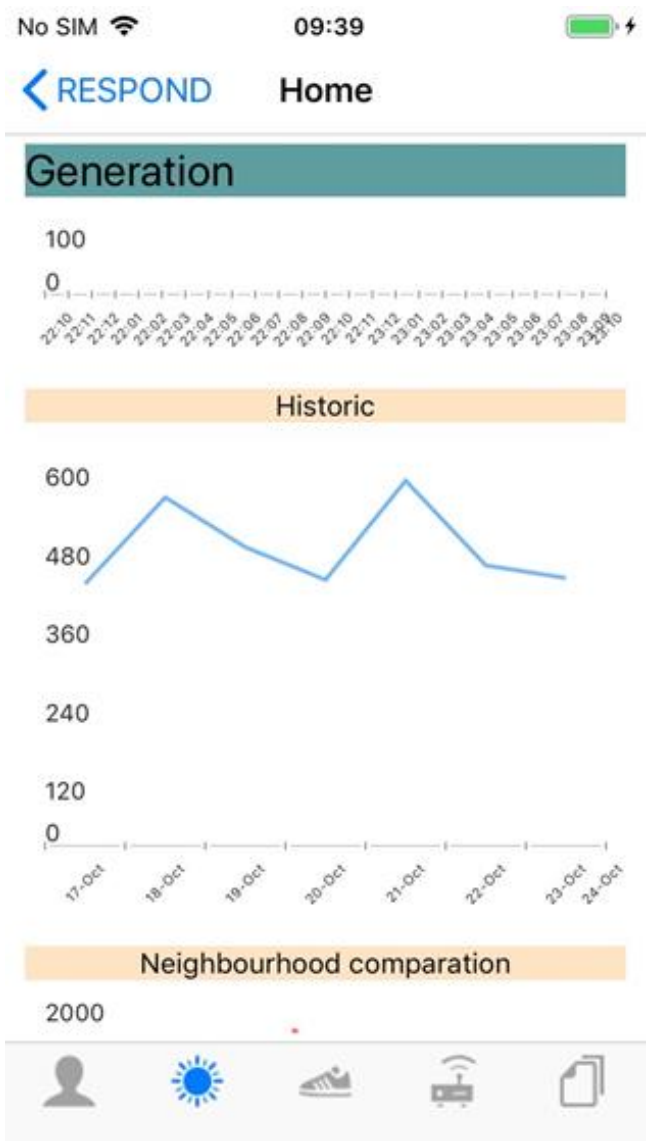
# Appendix: Handsout mock-ups in support of discussion of Topic 3

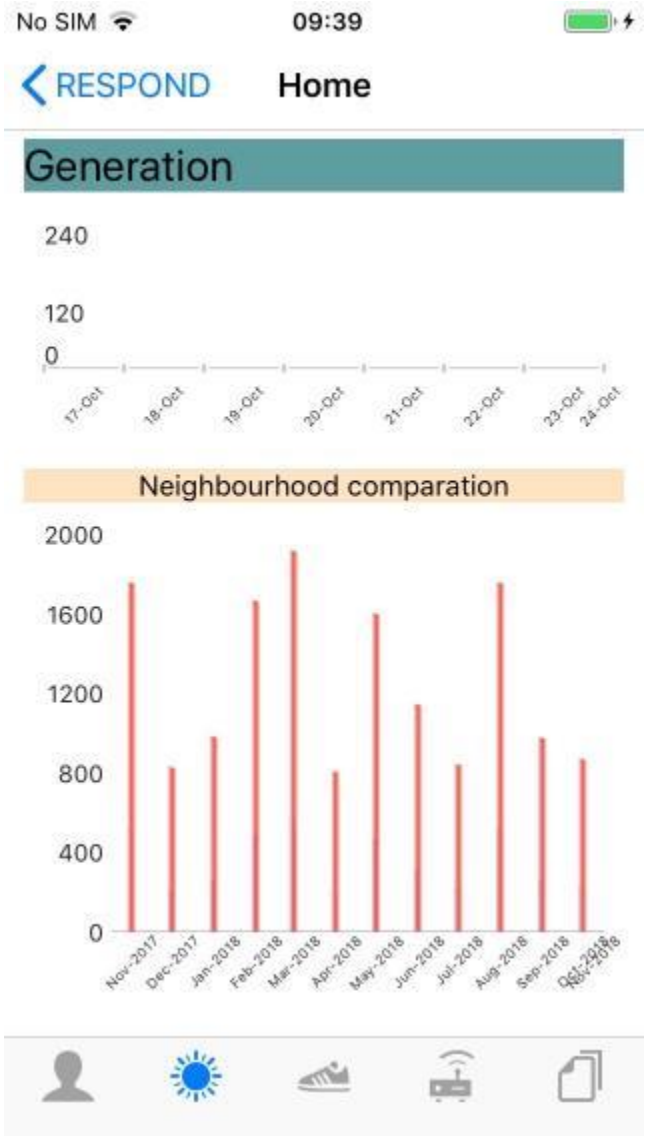
*The handouts relate to Topic 3 and some were shown in English version, others in Spanish version.*

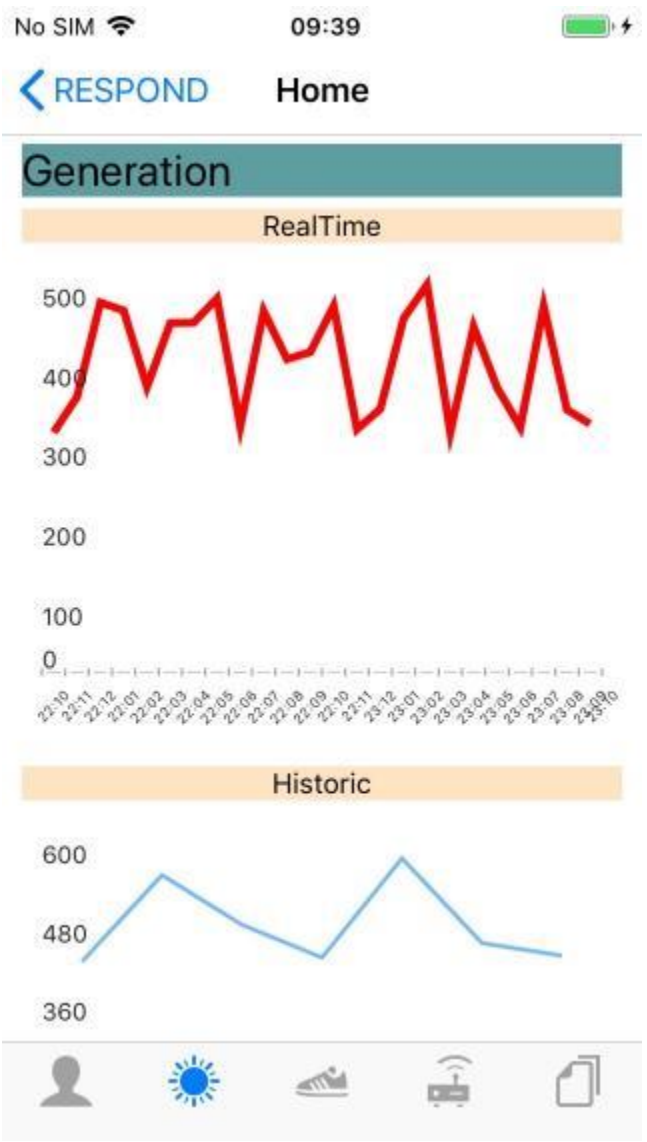

No SIM
09:42
Log into your Acount
ignacio.lakidain@tekniker.es
Password
LOGIN


9:36
RESPOND
Casa
Vecindario
Precio Energía
Información Personal
Pronóstico Tiempo

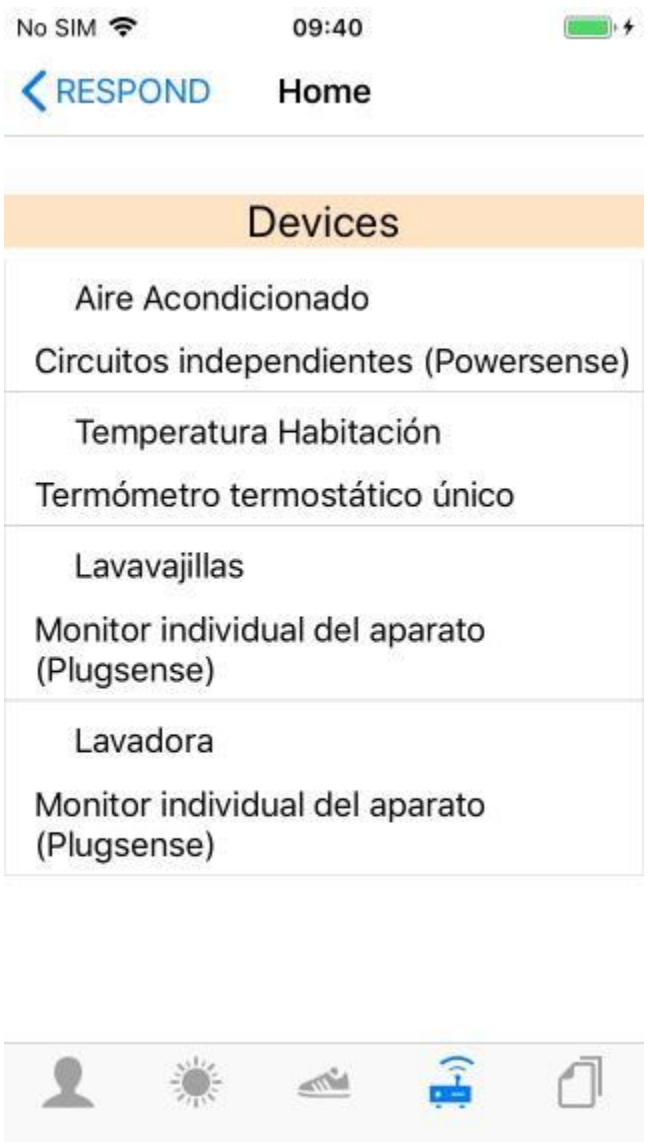

No SIM
09:42
Back
Weather Forecast
Today
23-Oct
Cloud intervals
Temperature 13 °C
Humidity 85 %
Rain 0 mm
Wind
Light southwesterly wind
Week
24 25 26 27
12 °C 12 °C 12 °C 5 °C
78 % 76 % 94 % 83 %
0 m 0 m 0 m 1 m

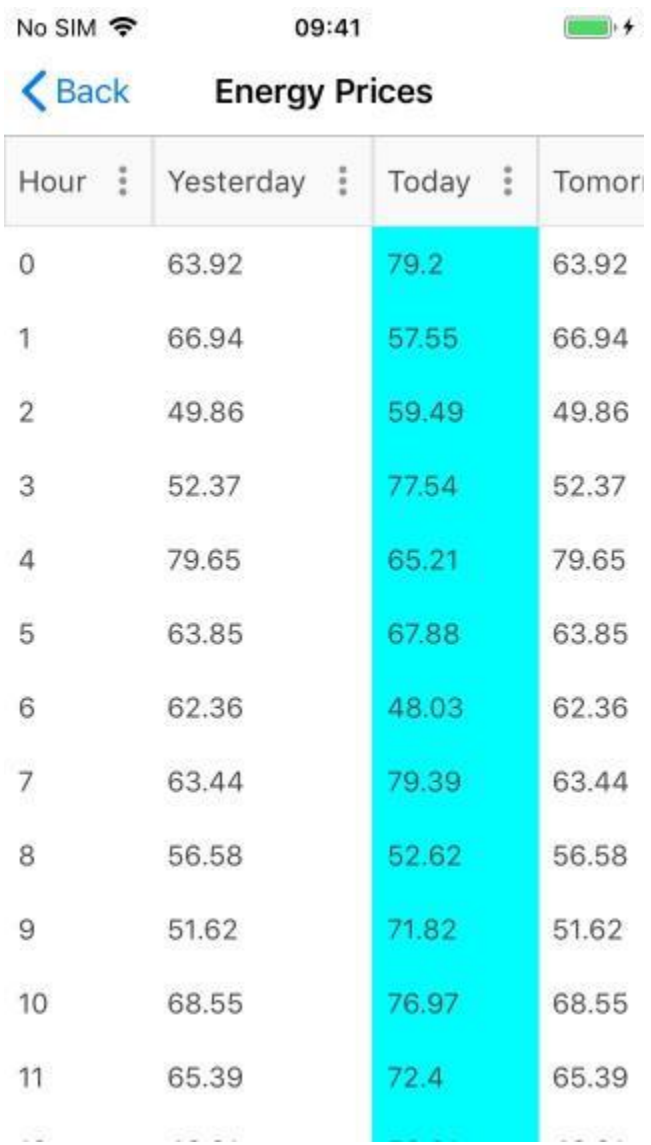

No SIM
09:39
RESPOND
Home
Generation
100
0
Historic
600
480
360
240
120
0
17-Oct
18-Oct
19-Oct
20-Oct
21-Oct
22-Oct
23-Oct
24-Oct
Neighbourhood comparation
2000


No SIM
09:39
RESPOND
Home
Generation
240
120
0
17-Oct
18-Oct
19-Oct
20-Oct
21-Oct
22-Oct
23-Oct
24-Oct
Neighbourhood comparation
2000
1600
1200
800
400
0
Nov-2017
Dec-2017
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018


No SIM
09:39
RESPOND
Home
Generation
RealTime
500
400
300
200
100
0
Historic
600
480
360


No SIM
09:40
RESPOND
Home
Devices
Grupo media
Media de Temperatura, Humedad y CO2 de los sensores
Temperatura Cocina, Humedad Cocina
Display (Portasight)
Temperatura Salón, Humedad Salón, CO2 Salón
Air Quality Sensor (Airsense) sensor
Aire Acondicionado


No SIM
09:40
RESPOND
Home
Devices
Aire Acondicionado
Circuitos independientes (Powersense)
Temperatura Habitación
Termómetro termostático único
Lavavajillas
Monitor individual del aparato (Plugsense)
Lavadora
Monitor individual del aparato (Plugsense)


No SIM
09:41
Back
Energy Prices
Hour
Yesterday
Today
Tomor
0 63.92 79.2 63.92
1 66.94 57.55 66.94
2 49.86 59.49 49.86
3 52.37 77.54 52.37
4 79.65 65.21 79.65
5 63.85 67.88 63.85
6 62.36 48.03 62.36
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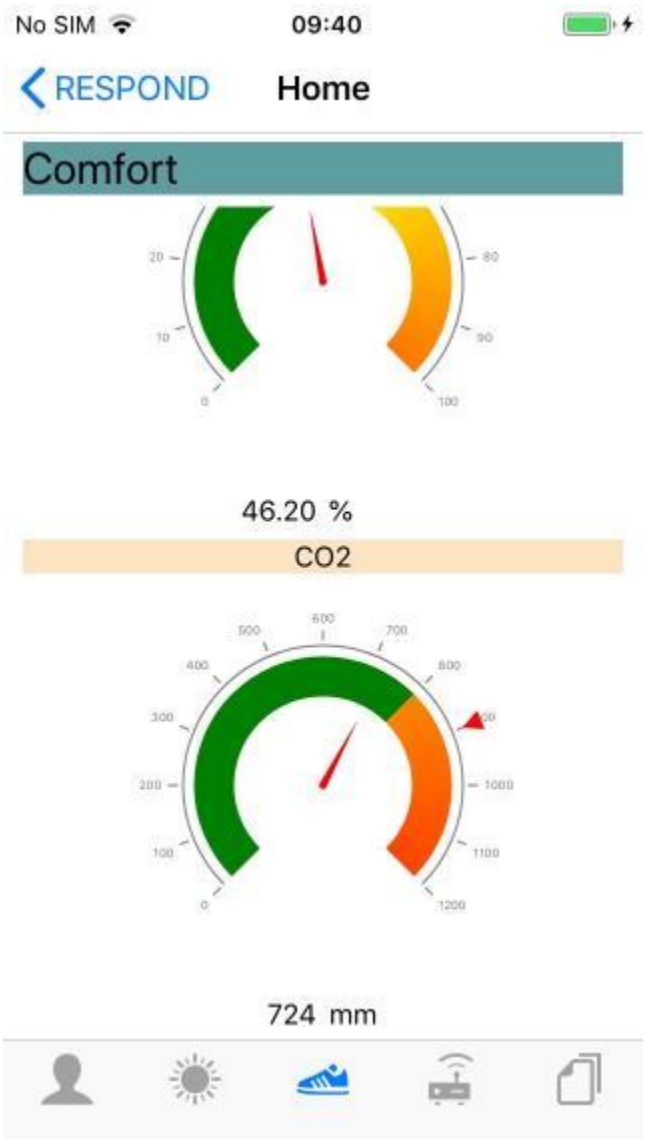
11 65.39 72.4 65.39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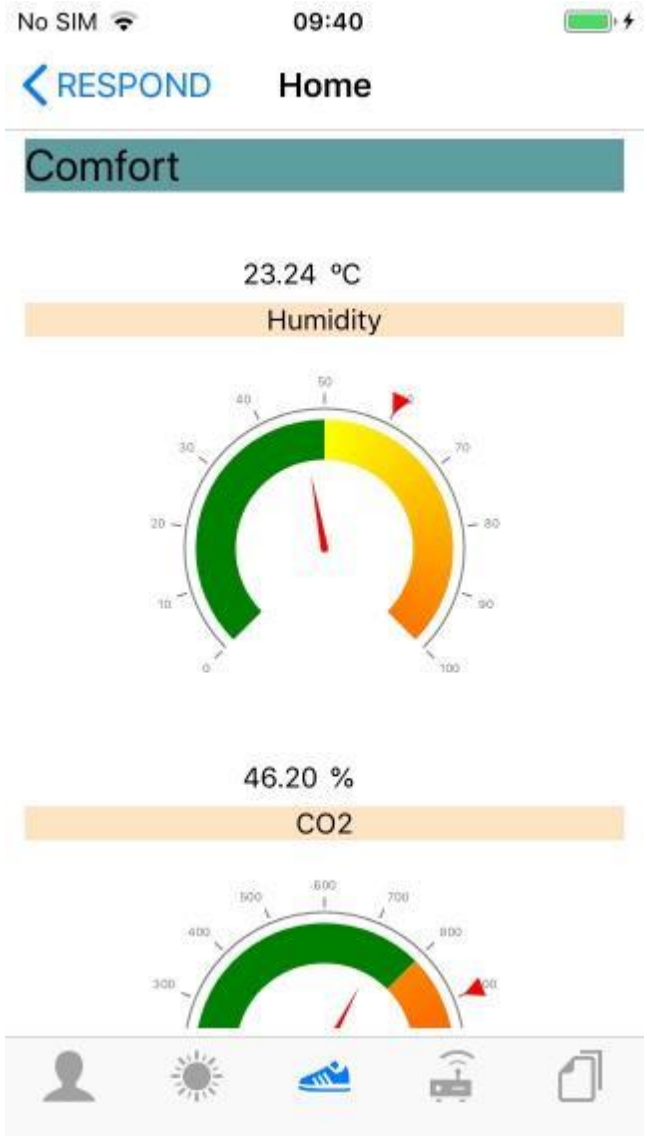
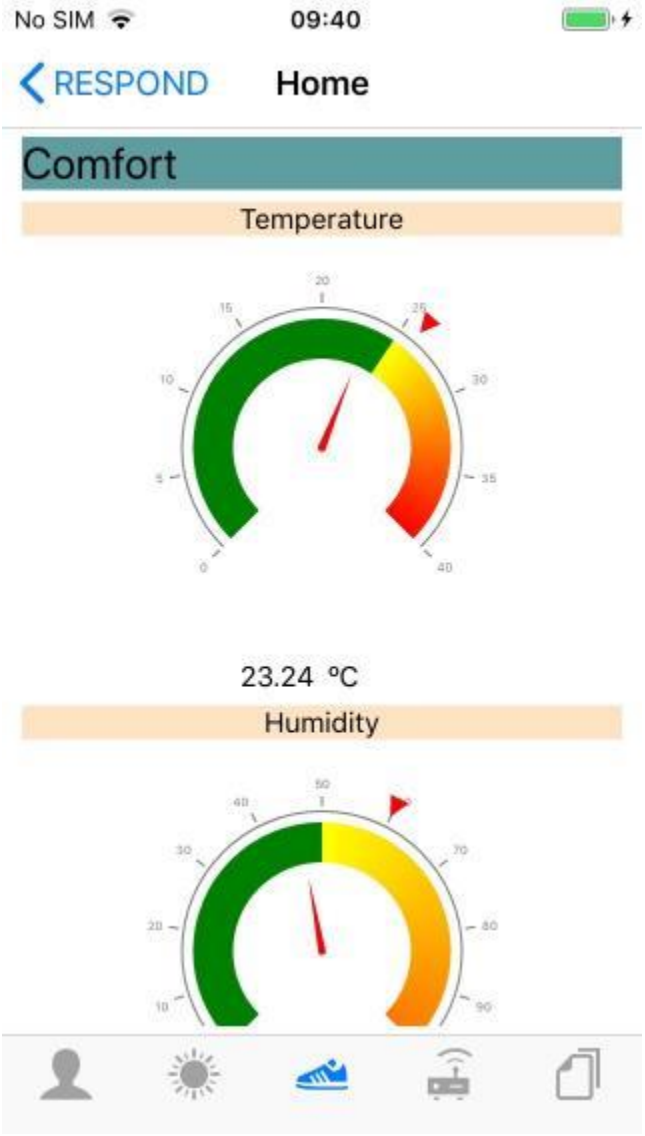
09:40
RESPOND
Home
Comfort
46.20 %
CO2
724 mm


No SIM
09:40
RESPOND
Home
Comfort
23.24 °C
Humidity
46.20 %
CO2


No SIM
09:40
RESPOND
Home
Comfort
Temperature
23.24 °C
Humidity

# APPENDIX 6: SUMMARY AND ANALYSIS OF FOCUS GROUP ON ELECTRICITY FOR ELECTRIC APPLIANCES IN MADRID

## Focus group at Madrid pilot site: on electricity for electric appliances

This focus group related to electricity for electric appliances.

The aim of the focus group was to collect participants' feedback, comments, relevant routines and habits in order to consider this valuable information for the development of RESPOND solution design. The purpose is, in other words, to review, adjust and validate the previous ideas that RESPOND consortium had for the DR actions and the functionalities of the mobile app. For this finality, the moderator raised questions to discuss about electricity consumption (DR), different alternative prices schemes and RESPOND solution/mobile app.

### 1. Time, place and participant recruitment

The focus groups took place on Thursday 9 May 2019 from 5.00 pm to 6.00 pm at a "common area" situated inside the pilot site. The room is usually used for neighbourhood meetings and it was considered as an adequate place because of its proximity to the participants home location and also because of the familiarity that the participants have with the space chosen (we felt they could feel comfortable there in a well-known place and this would help to propitiate a relax atmosphere). Also, we tried to make it easy and practical for all participants to attend. The participants were RESPOND pilot families that live in the dwellings. The meeting was held in Spanish as it is the language of all pilot households and members of Feníe Energía involved in the project that participated in the meeting.

The recruiting was done during a neighborhood's meeting hold about one and a half month in advance of the planned focus group. In addition, about a week in advance of the meeting date, an invitation letter was sent to the participants and a poster was hung in a visible place of the interior of the pilot building with the purpose of informing them about the time and division of groups.

The households have similar characteristics regarding social, economic status and ethnicity, and they are either retired people or families composed by couples (male+female) and in some cases children/s. So we strategically divided the groups in order to balance retired individuals and working individuals, splitting them into the two groups.

The 10 pilot households were divided into two groups of equal size (one group was invited to the electricity for electric appliances focus group at 5.00 pm and the other group was invited to the cooling/DHW focus group at 6.00pm).

The time of the meeting was the afternoon, which usually is time of busy activities for the participants, as some of them have children in the families, are at work/coming back from work, practice activities or have responsibilities to do. Anyhow, the vast majority of the invited families attended to the meeting and all participants arrived on time. It should be noted that some participants invited to the second focus group at 6.00pm arrived at 5.00pm, so there were some spectators during the first focus group hold at 5.00pm. This

could indicated that the event generated some curiosity and expectations, or at least the invited participants were willing to spend a good time among neighbors having afternoon snacks.

## 2. Participants

All participants were from the same building. There were 5 men and 2 women representing 5 households since two couples participated (M1&F1 & M2&F2).

Three of the represented households had children living at home, while two households included retired people with no children at home. So, we had a sample composed by a mix of retired people and adults with children living at home. To be noticed the high percentage of dwellings with housekeeper helping with the home duties at least some hours per day.

List of participants (anonymized; M = Male and F = Female) and a few biographical details from the informal presentation round:

- M1: Male representing a couple living together with children at home. Both adults work. A housekeeper is at home taking care of the house duties.
- M2 + F2: They are a retired couple. No children at home. A housekeeper is at home during a few day hours helping with the house duties.
- M3: Two adults and one child live in the dwelling. Male works, female is at leave at the moment. A housekeeper helps a few hours per week with the house duties.
- M4: Male representing a family composed by two adults and two children live in the dwelling. Both works. A housekeeper a few hours per week.
- M5 + F2: Retired couple. No children at home.

Focus group moderators:

- David García (lead moderator): Feníe Energía employee, not involved in RESPOND project, he has knowledge and experinece in energy field.
- Antonio Colino (local contact and co-moderator): involved in RESPOND project as coordinator role.

Minute taker (as we didn't audio recorded the meetings, notes were taken during the focus groups in order to create the present summaries):

- Rodrigo López: involved in RESPOND project as coordinator role.

## 3. Group process and dynamics

Antonio Colino welcomed the participants in a relaxed atmosphere. The participants at the beginning of the meeting and they were talking among them and with the organizers. Then, all sat down. There was a table with material for the focus groups. The participants sat down at the front rows, the moderator and co-moderator were situated behind the table, the minute taker was situated at the last row, behind all participants (to be able to take pictures and take notes during the meeting). As mentioned above, there were some spectators sitting as observers (all of them were neighbors, participants in RESPOND project as users and even some curious neighbor not participant of the project).

A brief informal round of presentations was done. The co-moderator, Antonio Colino, presented the moderator, David García (who was the only person that is not familiar for the participants). Rodrigo López, briefly commented about the actual status of RESPOND project, and afterwards, all invited participants were invited to present themselves (name and if possible, informing about number of habitants at home, employ/retired situation, housekeeper (yes/no). All participants collaborated and presentations proceed smoothly.

Afterwards, the moderator introduced the focus group (what it was, what to expect), he explained the dynamic (that consisted in three topics with a starter question and follow-up questions. After this, the focus group discussions began (see later summaries of these).

The focus group proceed in a cheerful, relaxed mood. Participants were in a collaborative mood, they seemed to be comfortable. The dynamic scheduled was followed: the moderator presented the topic to be discussed, then he raised the starter question and the participants answered, moreover the follow-up questions were raised followed by the participants answers.

# 4. Summary of focus group discussion

## 4.1 Topic 1: Demand Response introduction

*Discussion starter and follow-up questions:*
The energy grid is gradualy changing, going to a greener model direction, where consumers have a more participative role in the system and are becoming even producers, ”prosumers”. This new model implies to make some changes in the way pf comsuming energy as the production/consumption curves need to be balanced. *What do you think about the idea of changing the times of your own electricity consumption?*

Follow-up questions:

I. We asked for types of electricity consumption.
II. Time-shifting and other possibilities (suitable devices). Which appliances would you be able to really time-shifted?
III. Motivations. What are the motivations for time shifting?
IV. Availability.
V. Suggestions.

*Summary:*
David García introduced the theme and discussion-starter of Topic 1.

In general, all participants answered that they are willing to change their habits and time-shifted their own electricity consumption if the result is a benefit for their own economic savings, also if consuming more green energy implies a benefit for the environment. All agree on the necessity of making an effort in order to contribute to a more conscious way of consuming energy.

i. The answers were washing machine and tumble dryer, dishwasher, television, thermomix or other appliances for cooking, oven, fridge, hoover, coffee machine, lights, charging of mobiles and computers, use of computers tablets and game consoles, hair dryer, warmer baby bottles.

ii. Almost all of them agreed on that they could time-shifted the dishwasher (usually they do it at night hours around 9.00pm-10.30pm but they could do it in daily hours). The washing machine and tumble dryer could be time-shifted (usually the housekeepers do it during the mornings, families with children do it sometimes also on weekends. The majority think it has to be done during solar hours to get benefit of the external conditions). Thermomix, other appliances for cooking, oven and hoover could be relatively time-shifted. They found them more difficult to time-shifted others appliances like hair dryer, warmer baby bottles and coffee machine, as their use is on demand. The charging of mobiles and computers could be easily time-shifted (normally they charge mobiles during the night, while sleeping, The intensity of lights could be, a little bit, regulated when this option is available. Retired people found difficult to time-shifted television, as they have their routines watching programmes, while families with young adults seemed to be more flexible and have more dynamic habits regarding the use of television, tablets, computers, game consoles, also they are more focus on educating and making their children conscious regarding taking care of the environment and saving resources, so they could try to move some habits regarding the use of tv, tablets, game consoles, computers.

iii. The main motivation was the economic savings, also environmental care, improve management of resources. The educational motivation for making children more consciousness/raise awareness about taking care of the environment/resources was mentioned too. The moderator asked if a community competition would incentivate the participants to be more engaged? The answers were diverse, some were happy with the idea, as they found it motivational as a game for the families. Others were not very interested in the community competition.

iv. They are available to change some habits. They said there is a general motivation to do so, but they said they would need guidance to concretely make it as they find it a bit complicated at the beginning.

v. One participant suggested to organize a trial or demonstration once the mobile app will be ready to start operating. In general, all participants have expectations and they are curious and willing to experiment the interactions with RESPOND solution and the mobile app.

*Analytical observations:*

In general, all participants are in a collaborative mood and willing to interact with RESPOND solution. There is a difference between retired people and young adults still working, as technology is easier to understand and manage for the second group. Besides, young adults seemed to be more optimistic and flexible with the idea of changing patterns and routines. Anyhow, retired people seemed to have an opened approach as well towards the project, even if they state that they could have some limitations in regards to the use of technology.

## 4.1 Topic 2: Discussion of alternative pricing schemes

*Discussion starter and follow-up questions:*

David García introduced the theme explaining that we are used to have fixed prices for domestic use of electricity and there are other possibilities of variable prices that could help people start being more flexible and make them change their consumption patterns with the motivation of consuming greener energy, as well as, for cost savings. He showed to the participants three different alternatives models of Time-of-Use pricing schemes:

- Scheme 1 – Real-time pricing (RTP): Electricity price varies from hour to hour and in different ways from day to day. The electricity prices of the next day is announced the day before.

- Scheme 2 – Static ToU pricing: The electricity varies a few times a day and follows a static scheme. Same scheme every day.

- Scheme 3 – Peak Production Rebates (PPR): Fixed flat electricity price except rebates in cases of local surplus of wind or solar power. The hours of rebates (lower price) is announced the day before.

Following this introduction, the moderator asked the following discussion-starter questions: *Do you think variable prices schemes could be an option instead of fixed prices? Do you find advantages?*

Follow-up questions:

i. Types of pricing. Is there one of these schemes you would favour personally? Why?
ii. Current situation. What tariff do you currently have?
iii. Do you think you could get used to a tariff with variable prices?
iv. Preferences.
v. Suggestions.

*Summary:*
David García introduces the theme and discussion-starter of Topic 2.

Answering to the discussion-starter questions: One participant said that variable prices require more engagement and follow-up of the information, that is constantly being updating and you need to keep checking. He also said that a practical tool would help the users to understand the energy prices as they don't have technical acknowledge about the topic. Another participant said that variable prices are too much complicated to be followed and he prefers fixed prices because is to what they are used to. A third participant commented that she is familiar to the existence of day-night time discriminating domestic tariff, but she thinks that, from her point of view, it doesn't have benefits for domestic consumers, as they make the majority use of electricity during daily hours and the tariff is cheaper at night hours. After this intervention, some found that variable prices during daily hours could bring benefits for the users, if there are lower prices during daily hours (when there is a high demand of electricity) this option would bring money savings for the domestic consumers. Then the moderator asked if "free energy" could be a motivation to time-shifted electricity consumption? All answered that it would definitly be a motivation to try to change habits.

Regarding the three different prices schemes that the moderator showed to the participants. The comments were the followings:

- On the first scheme, **Real-time pricing**, [participants were looking at the figure], they said that is difficult to follow as you have to check the prices the day before on a daily basis and it is high difficult to schedule different routines everyday. One participant commented that he observed that the price shown in the scheme 1 was much lower in certain times (11.00am-12.00pm-1.00pm in the figure shown) when usually there is a high demand of energy at homes, he pointed as an example that retired people and housekeepers are at home consuming electricity for washing machines, cooking, cleaning up the house, etc... during mornings, so he noted that this would be an advantage. Another participant asked if there is a pattern for real-time pricing scheme or it could be unpredictably variable? The moderator answered that different factors have impact in the prices variability: the period of the year (in spring prices are lower for example), the percentage of energy injected in the grid from renewable resources (some technologies like the wind farms and the hydraulic have a

decisive impact influence in the variability of prices), the demand also has an impact (more energy demand causes higher prices and less energy demand causes lower prices). Another participant stated that in any case, the scheme 1 doesn't compensate, as on the other hand, prices are very high in other peak hours (6am-7am-8am and 05pm-06pm in the figure shown) when there is a lot of activity at homes. Another participant reflected that, it is normal to have high prices in peak hours, because the purpose is to make people not to consume in those peak hours. The general opinion was that they would prefer a more balanced price that would be easy to follow. They said they find complicated to have to check prices too many times per day.

- On the second scheme, **Static Time-of-Use pricing,** [participants were looking at the figure], the participants point of view was that the scheme is easier to follow, clearer, and they could try to move consumption to some hours (9.00am to 5.00pm in the figure shown). They said that the advantage is that there is the same scheme everyday, so once they have learned the price ranges, it would be easier to try to time-shifted consumption. A participant said that they could try everyday to change some habits and it would be easier to obtain results sometimes. So, in general, this scheme was well valued because of its predictability.

- On the third scheme, **Peak Production Rebates,** [participants were looking at the figure], the participants found the scheme interesting, but one participant said that they have the solar thermal energy source for hot water only, so there would not be a direct impact in the electric appliances consumption. Another asked if the idea is to make a kind of an experiment, in which actually they don't know from where this renewable energy comes from, but the purpose is to test if people could change routines when the incentivation is a mayor presence of renewable energy. A debate was created at this point about the functioning of the energy grid.

i. In general, they prefer the same scheme everyday or at least every week or month, as they think they need time to be able to adapt their habits to the scheme.

ii. All of them currently have fixed prices.

iii. They said they could progressively get used to variable prices.

iv. They said they prefer simple schemes, same scheme for a medium-long period to get used to.

v. There were no suggestion on their own initiative. Therefore, the moderator asked if it would work for them to have information in the mobile app in regards to money savings and the answers were positive. Also, he asked if extreme prices would be effective in order to incentivate them to change habits and the answer was that they would do their best to follow instructions but sometimes it is difficult, anyhow it could be a motivation to time-shifted schedules.

*Analytical observations:*

From the answers given by the participants, we could say that in general simple schemes that are maintained for a period for the users would be more practical for them. Some extreme actions could be performed (as a game) to see the engagement level that the participants could reach.

## 4.1 Topic 3: Discussion of RESPOND solution and mobile app

*Discussion starter and follow-up questions:*
Discussion starter questions: The participants got some mock-ups from the RESPOND mobile app functionalities and the moderator asked them about their opinion and feedback.

Follow-up questions:

i. What would you like to see in the mobile app? [The start page mock-up was shown to the participants.]
ii. [Other mock-up pages were shown to the participants] and a discussion about user interface/design was opened.
iii. Feedback messages. Which kind of notifications would you like to see?
iv. Control actions related to electricity for electric appliances. Which kind of automated control actions do you believe you could allow/follow? We provided examples. Which kind of recommendation do you think you could follow? We provided examples.

*Summary:*

i. The participants commented that mainly they would like to see the consumption of their own devices, the recommendations/notifications and the energy prices. They commented that the start page looks simple and intuitive.

ii. About *Weather Forecast* page, on one hand, they commented that they find useful to have it integrated in the mobile app along with prices information. It would help if the purpose is to use more renewable energy. On the other hand, they said that they prefer not to see the information in weeks number (example: week 24, 25, 26). They are more interested in having the forecast of one week by days (example: April – Monday 01, Tuesday 02, Wednesday 03).

About *Home Consumption* pages, they were curious about how the electricity consumption will be showed (regarding what periods). They would like a simple graphic of the consumption by home (average of the consumption per hour, per day, per week, per month), also a graphic of the consumption by device, and a graphic of the neighborhood comparison. But they are wondering how detailed this information is going to be displayed. Some people commented they wouldn't like to share a much detailed information with the neighborhood.
They also said they would like the icons of the mobile app to be clear and simple to understand.

About the *Comfort* page, they found the parameter indicators very useful.

About *Devices* page, they would like to see displayed simple information in real time.

About the *Energy Prices* page, they don't find useful to show information per hour without indicators that explain to non-technical people if a value is a low-medium-high price. The moderator suggested to insert colors in the values, for example green-orange-red for good/low price-medium price-high price and they find it interesting. A participant said he would rather prefer to have only simple notifications like "the price is much lower now for three hours" or "the price is high for the next two hours". Another participant said she doesn't have the technical knowledge to understand energy prices table, so she would like to receive practical messages.

iii. They would like to see simple alerts about best time to consume at lower or free prices or the opposite message (”high prices, try not to consume”), they would like to see also notifications reminding the current price scheme in order to be able to try to reorganize routines based on the variability of the prices.

iv. About electric appliances automated control actions: They would allow the dishwasher to be blocked, the washing machine relatively. They would allowed the lights intensity and temperature of rooms to be slightly adjusted.

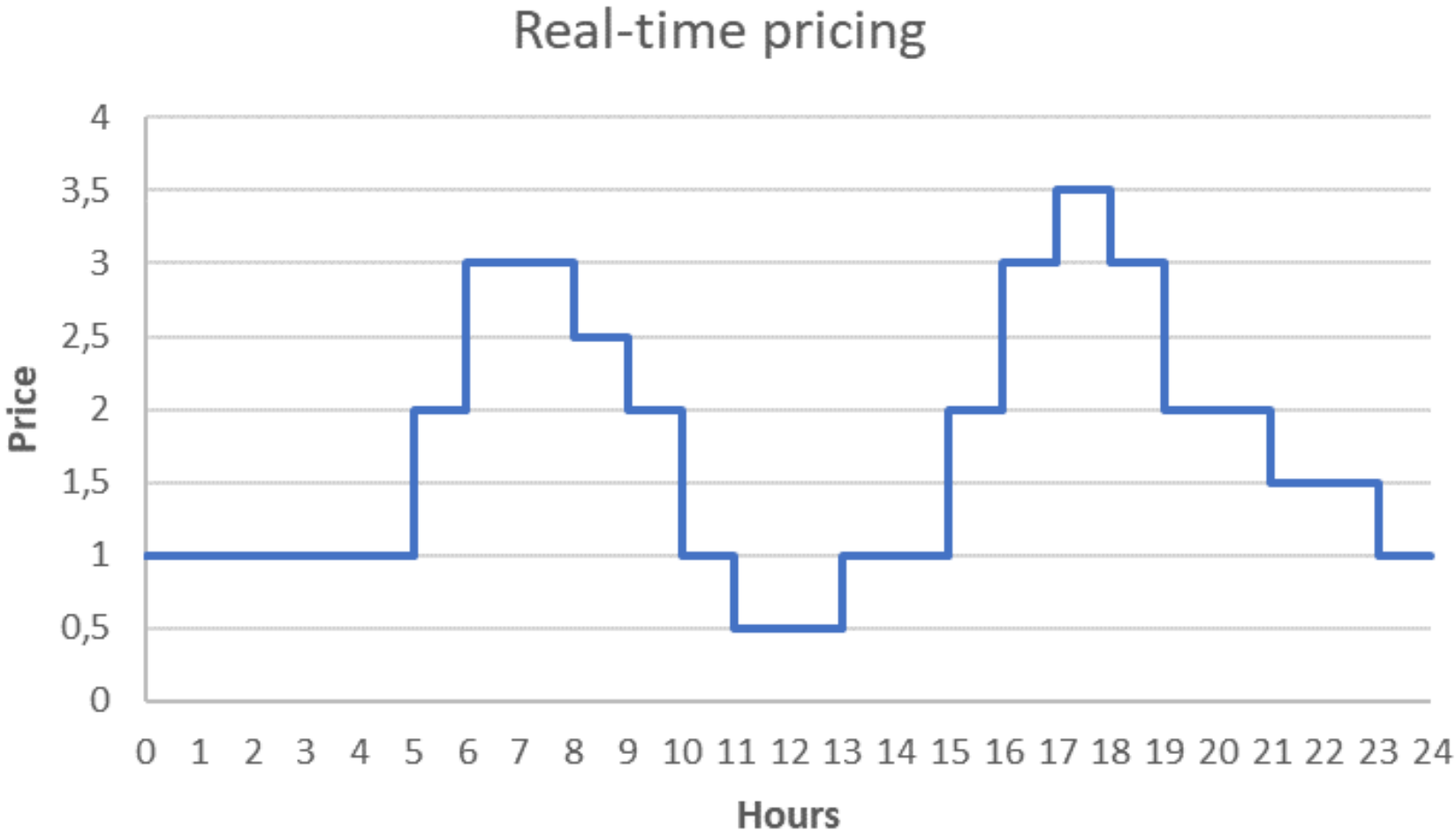
About electric appliances recommendation: they prefer recommendations rather than automated actions. They said they could follow prices recommendations to consume or not at certain hours, recommendations to switch on/off certain appliances, extreme prices notifications could be interesting to have sometimes as a motivation to really try to time-shifted consumption.

*Analytical observations:*

From the answers that were given by the participants, they seemed willing to experiment and play with the RESPOND app, they showed curiosity and the feeling that it is something that could help them to change habits.

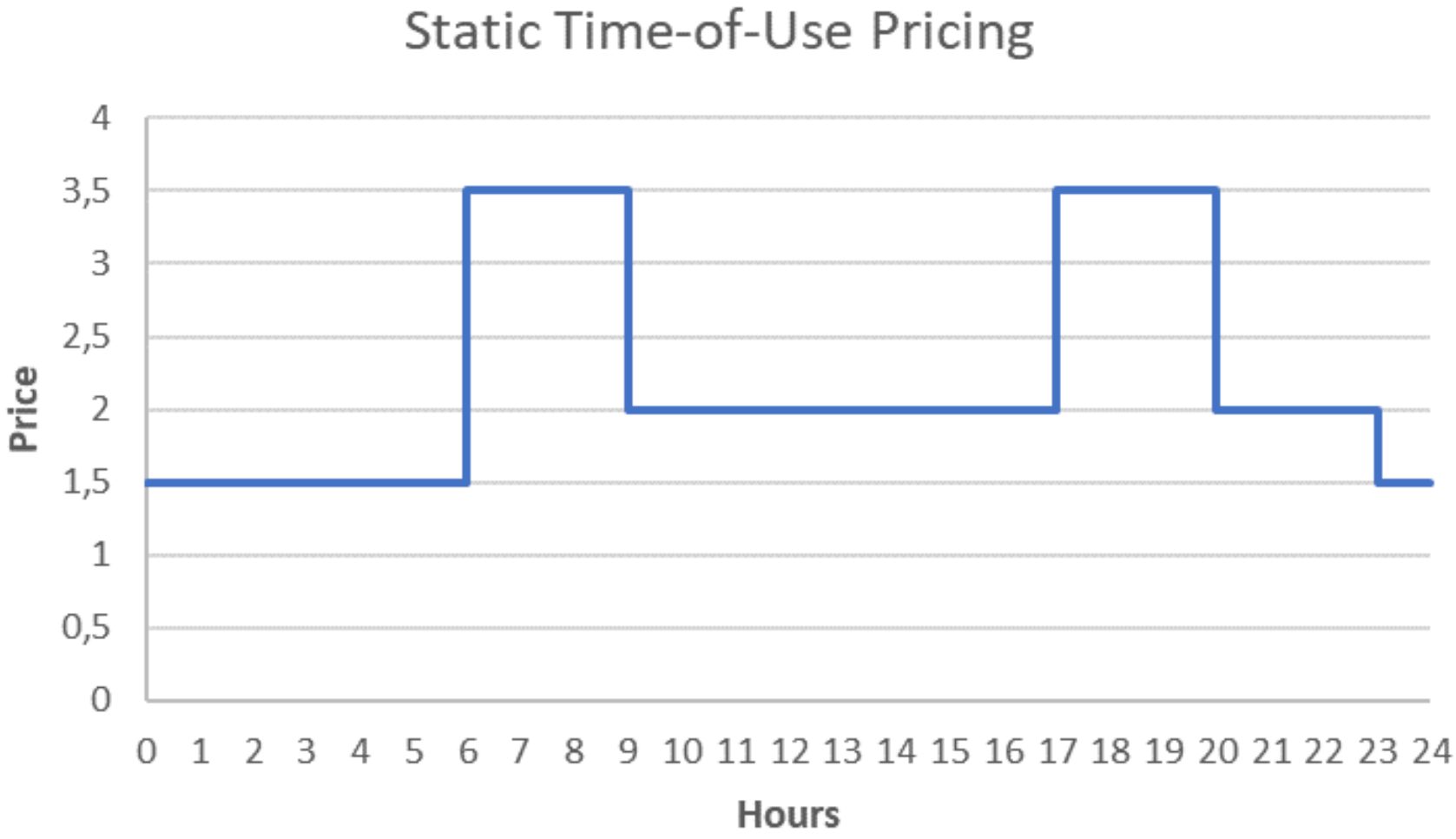
# Appendix: Hands-out mock-ups in support of discussion of Topic 2 and Topic 3

*First three handouts relate to Topic 2, the remaining handouts relate to Topic 3. The first three handouts (Topic 2) where originally presented in English version. The others handouts were presented in Spanish version some of them and others in English version.*



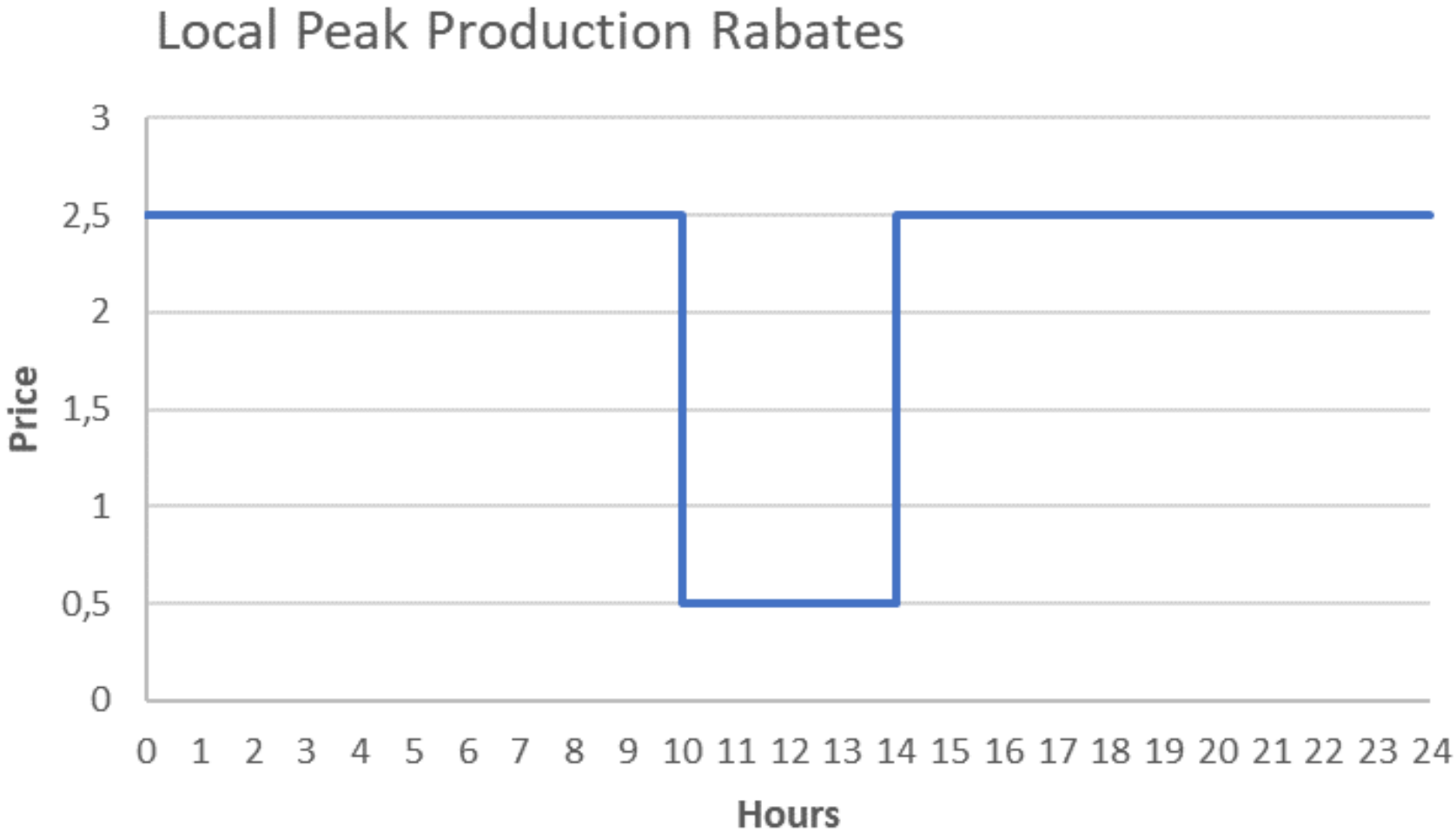

Electricity price varies from hour to hour – and in different ways from day to day,

The electricity prices of the next day is announced the day before.



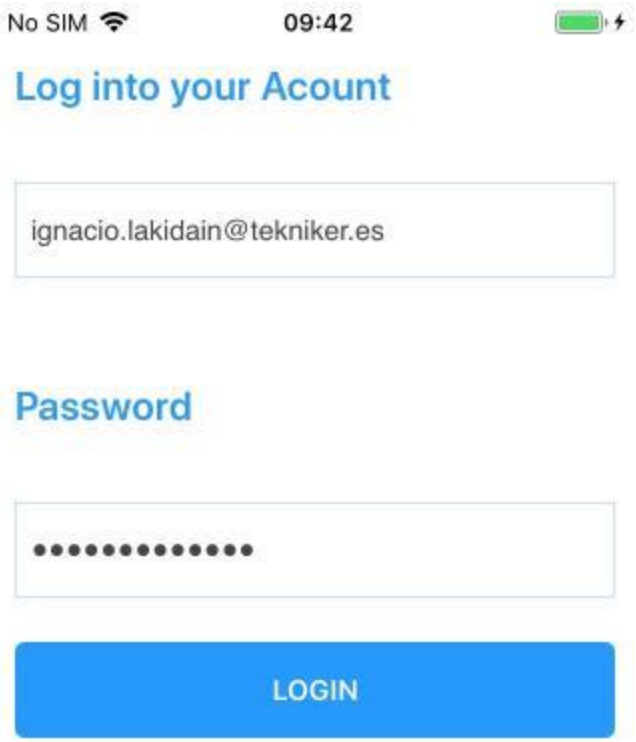

The electricity price varies a few times a day and follows a static scheme.

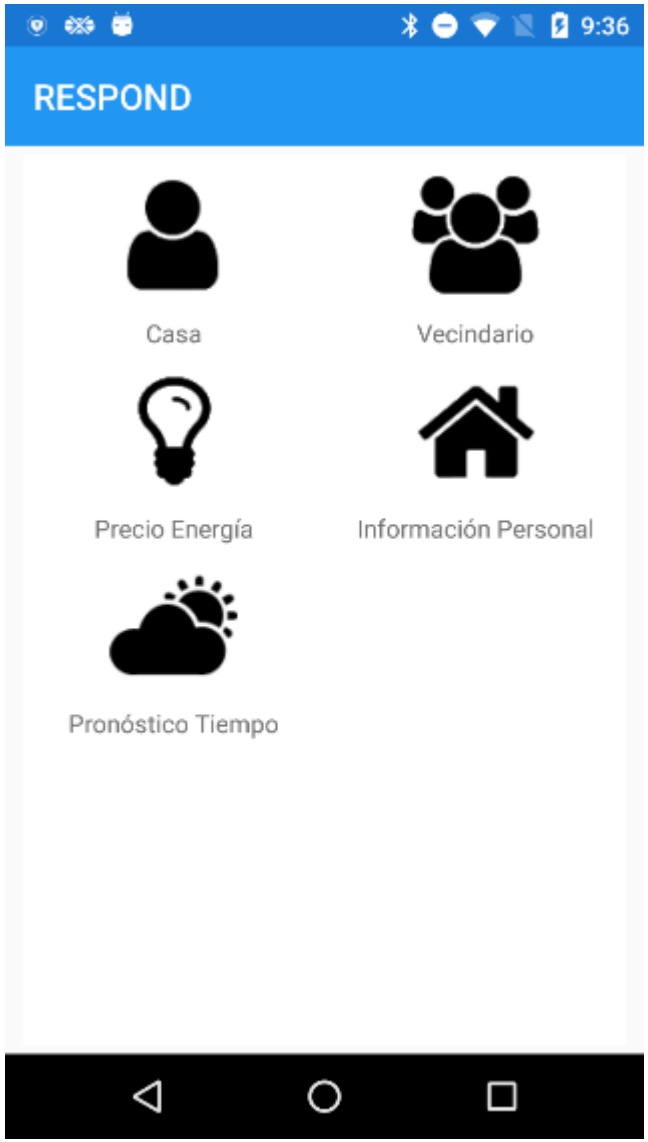
Same scheme every day.



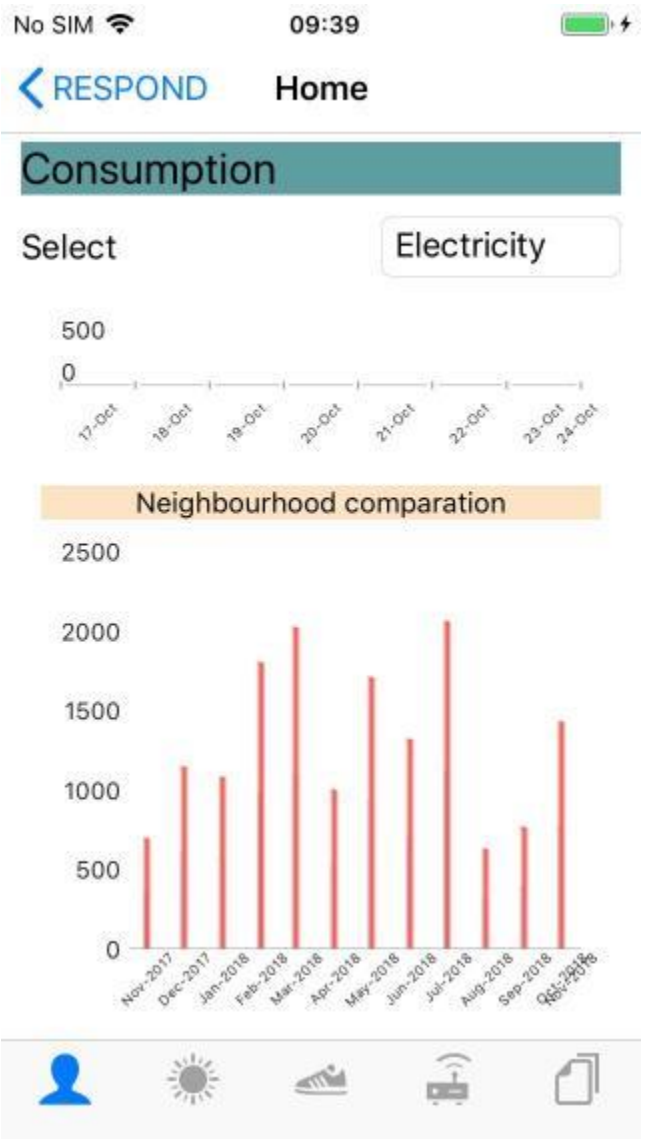

Fixed (flat) electricity price – except rebate in cases of local surplus of wind or solar power.

The hours of rebate (lower price) is announced the evening before.

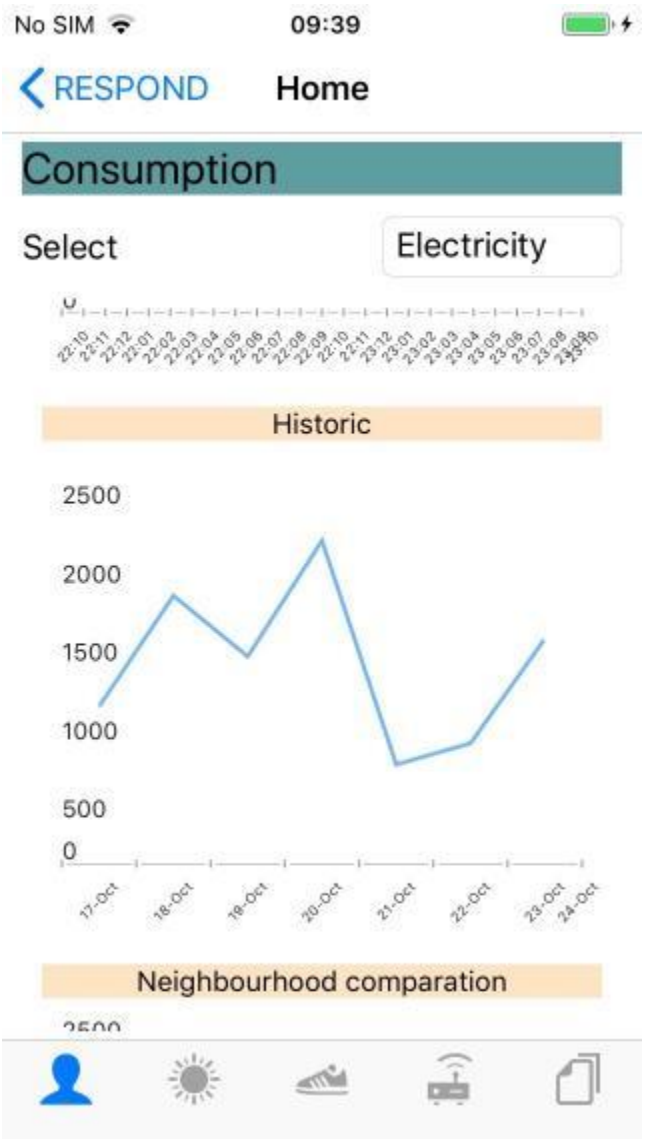

No SIM
09:42
Log into your Acount
ignacio.lakidain@tekniker.es
Password
LOGIN

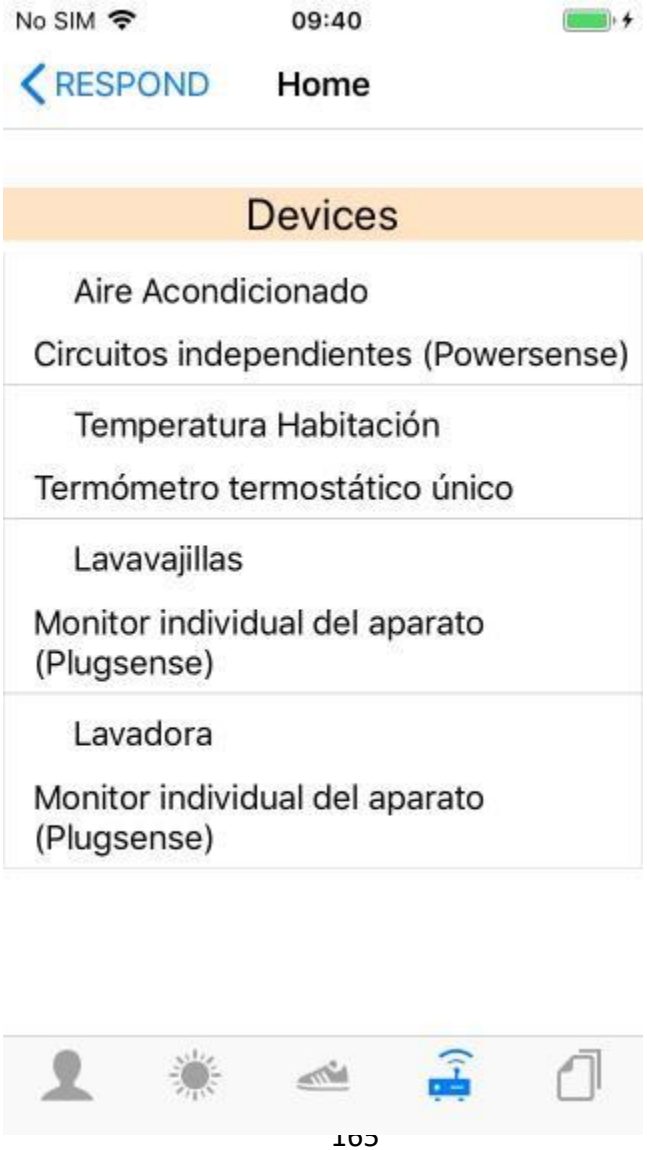

9:36
RESPOND
Casa
Vecindario
Precio Energía
Información Personal
Pronóstico Tiempo

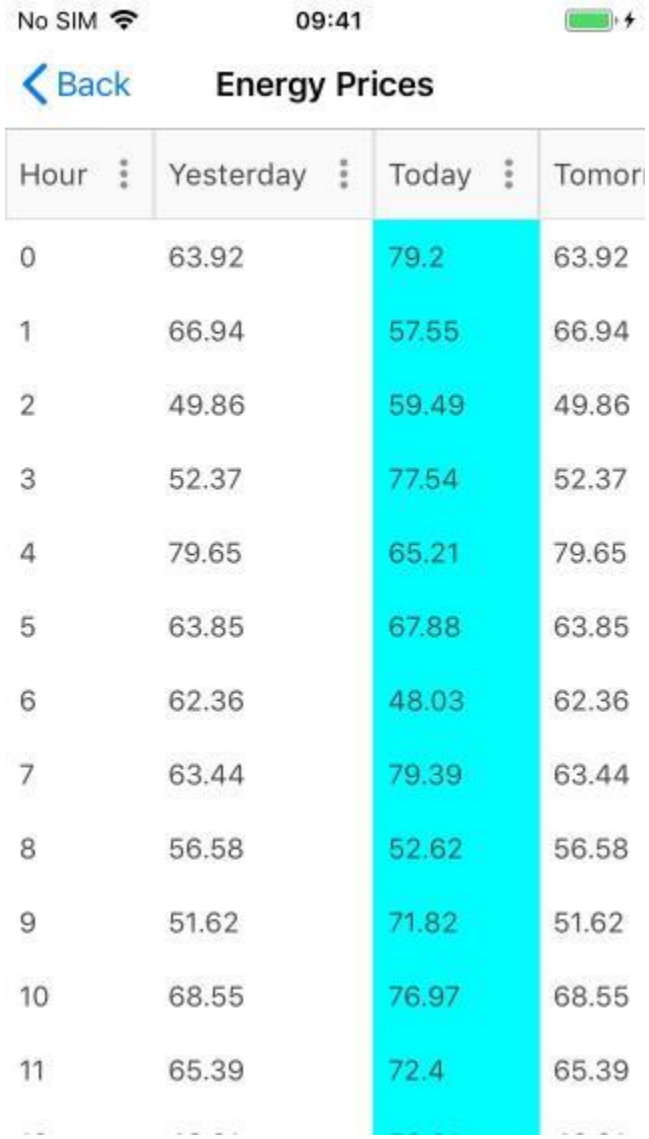

No SIM
09:42
Back
Weather Forecast
Today
23-Oct
Cloud intervals
Temperature 13 ºC
Humidity 85 %
Rain 0 mm
Wind
Light southwesterly wind
Week
24 25 26 27
12 ºC 12 ºC 12 ºC 5 ºC
78 % 76 % 94 % 83 %
0 m 0 m 0 m 1 m


No SIM
09:39
RESPOND
Home
Consumption
Select
Electricity
500
0
17-Oct
18-Oct
19-Oct
20-Oct
21-Oct
22-Oct
23-Oct
24-Oct
Neighbourhood comparation
2500
2000
1500
1000
500
0
Nov-2017
Dec-2017
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018

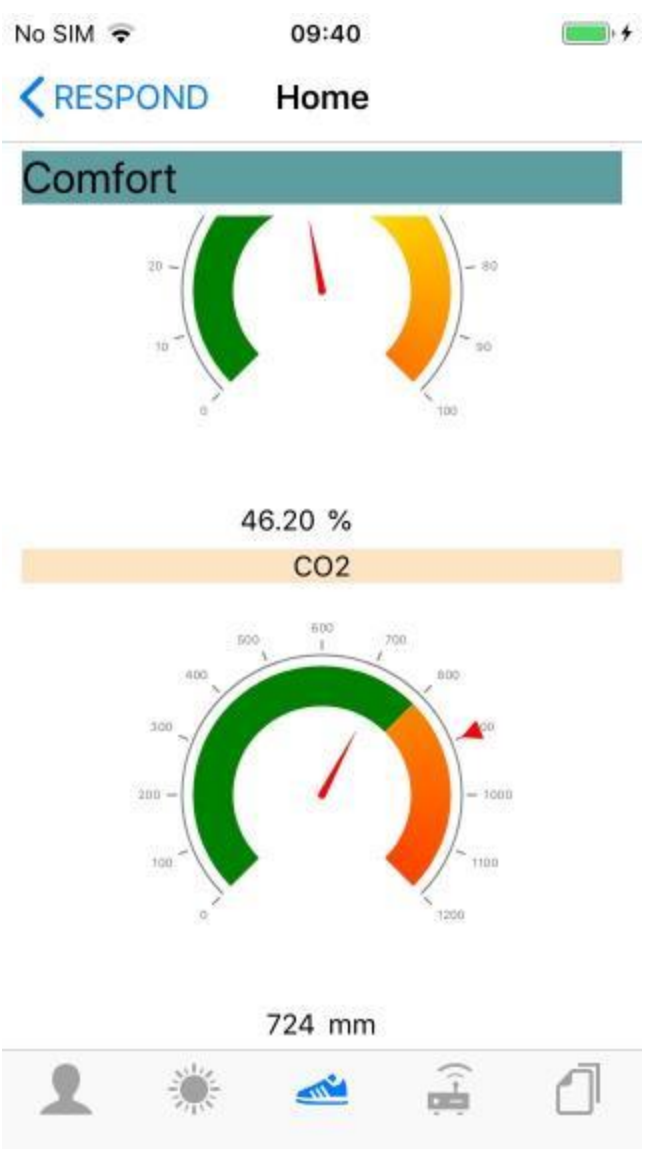

No SIM
09:39
RESPOND
Home
Consumption
Select
Electricity
RealTime
1500
1200
900
300
0
Historic
2500
2000

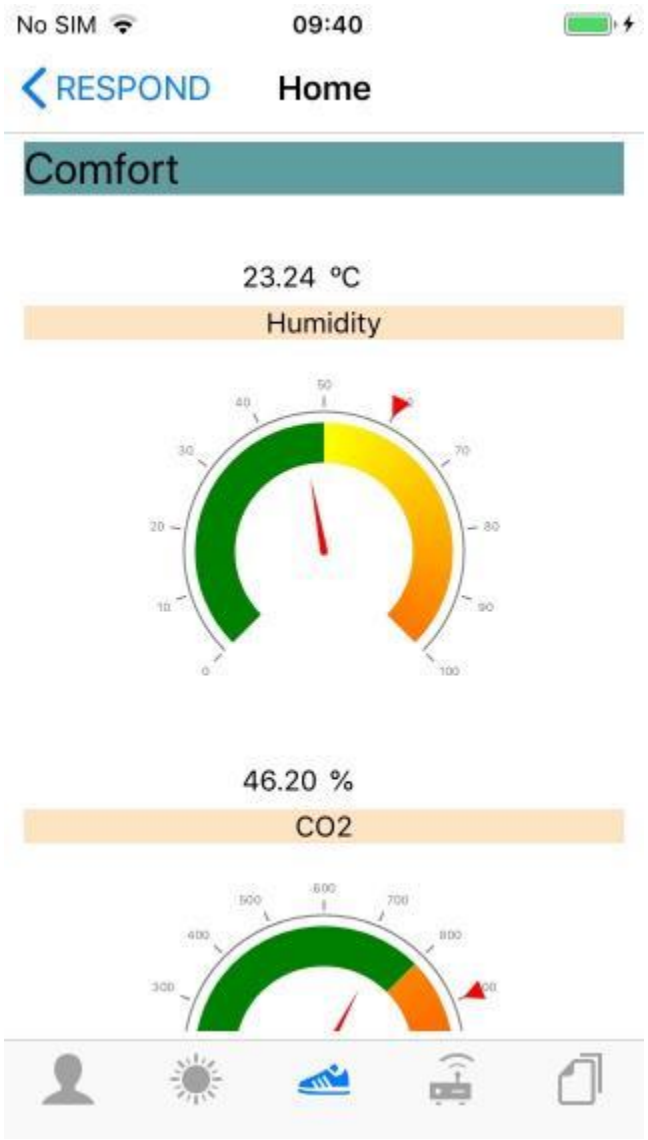

No SIM
09:39
RESPOND
Home
Consumption
Select
Electricity
Historic
2500
2000
1500
1000
500
0
17-Oct
18-Oct
19-Oct
20-Oct
21-Oct
22-Oct
23-Oct
24-Oct
Neighbourhood comparation

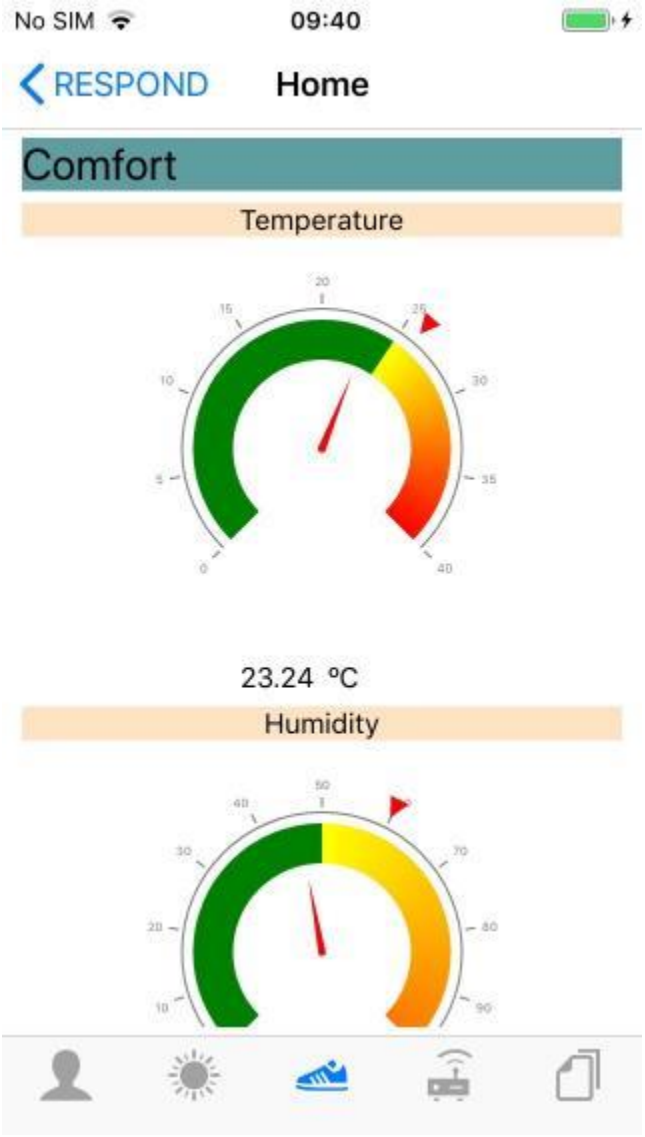




| Hour | Yesterday | Today | Tomor |
|---|---|---|---|
| 0 | 63.92 | 79.2 | 63.92 |
| 1 | 66.94 | 57.55 | 66.94 |
| 2 | 49.86 | 59.49 | 49.86 |
| 3 | 52.37 | 77.54 | 52.37 |
| 4 | 79.65 | 65.21 | 79.65 |
| 5 | 63.85 | 67.88 | 63.85 |
| 6 | 62.36 | 48.03 | 62.36 |
| 7 | 63.44 | 79.39 | 63.44 |
| 8 | 56.58 | 52.62 | 56.58 |
| 9 | 51.62 | 71.82 | 51.62 |
| 10 | 68.55 | 76.97 | 68.55 |
| 11 | 65.39 | 72.4 | 65.39 |


No SIM
09:40
RESPOND
Home
Comfort
46.20 %
CO2
724 mm


No SIM
09:40
RESPOND
Home
Comfort
23.24 °C
Humidity
46.20 %
CO2


No SIM
09:40
RESPOND
Home
Comfort
Temperature
23.24 °C
Humidity

# APPENDIX 7: SUMMARY AND ANALYSIS OF FOCUS GROUP ON ENERGY CONSUMPTION ON ARAN ISLAND

**Focus Group on Aran Island: DR in relation to Energy Consumption**

This focus group related to the demand response actions in relation to electricity/hot water consumption among the participants of the RESPOND project on the Aran Islands. There are several types of households participating in RESPOND on Aran. They can be broken down into homes with PV panels and homes with solar thermal/thermodynamic panels. DR functions and flexibility are mostly available to households who produce their own electricity as it has the most flexible usage (Available for many different applications – heating, appliances, EV charging and more) Householders with solar thermal panels are more restricted in terms of DR functions as time shifting the hot water produced is more difficult. This group discussed two topics. 1- Time shifting of the energy (electrical or thermal) produced by the renewable installations on each individuals home. 2-RESPOND Solution and App. (Functions and Capabilities)

1. **Time, Place and Participant recruiting**

   This focus group took place on Tuesday the 30th July at 8pm. All participants in the RESPOND project were invited to participate in this focus group. This was done to allow for the maximum possible attendance as the focus group was conducted during the busiest time of year, in the middle of the tourist season. Most of the participants are involved in one way or another with the tourist season, or act as hosts to teenagers during the summer months who come to the island to learn the Irish language. 8pm was selected as this is after the last ferry comes arrives to the island, to allow participants who were on the mainland to attend if they wish.

   All participants were invited personally by phone call where possible or else by text message by Avril Ní Shearcaigh, who outlined the reason for the focus group and explained its importance to the project. It was held in Halla Rónán, the local community hall on Aran. To try and ensure a good turnout, participants were told that we would aim to keep the focus group to one hour.

2. **Participants**

   There were seven participants at this focus group, representing six of the 12 households, one couple participated (M5 and F1). There were 5 males and 2 females in total. The participants covered a wide range of demographics, some were retired/working/self-employed ranging in age from late teens to early seventies. Some participants had adult children living at home.

   List of Participants

   M1 is retired and lives with his wife, both are in the household mostly all day – solar thermal panels.

   F1 is retired, living with M4. Both still operate their own business.

   M2 is employed and lives with his wife, they have three grown up children. One lives at home, the other two are away and return at weekends/during school holidays.

M4 is a final year high school student nominated by his parents to represent the household at

this focus group. He is the only child living at home. One parent is working and the other is retired.

M5 is self-employed, living with his wife. They have adult children who all come home at different times throughout the year. Mainly during university holidays.

F2 is living with her husband. They do not have children, both are unemployed but host teenagers studying the Irish Language during the summer months.

Moderators

This focus group was lead by Avril Ní Shearcaigh, and co-moderated by Brian Sharkey and Helena Concannon. Brian Sharkey was newly appointed by the Aran Pilot Site manager to complete the outstanding RESPOND installation at the Aran Pilot just the week before the focus group and attended the focus group to take notes and get to meet the participants, he is the RESPOND contact point for this pilot. Helena Concannon helped to facilitate the focus group and co-moderated also.

**3. Group Process and Dynamics**

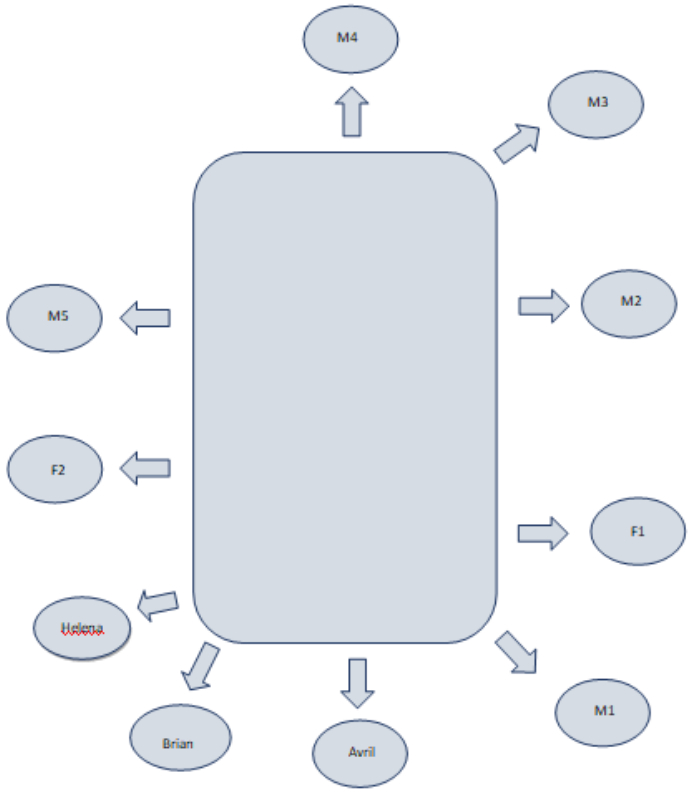
Most participants arrived on time, however two arrived only for the second discussion topic. Overall, the focus group was very informal with a pleasant, friendly atmosphere, and mostly led by the participants themselves. All participants provided valuable feedback and opinions on the topics.

Avril, who has been the RESPOND contact person until now welcomed the group and introduced the other two co-moderators, Brian and Helena. She also explained that Brian would be overseeing the remaining installations from now on, and would be in contact with all households individually from now on. As the Aran pilot is a very small community, all participants and moderators were known to each other before the RESPOND project. Avril also gave an outline of the status of the project relating to the Aran Pilot and the timeline expected for the installations to be completed. At first the participants talked freely about the project and also some topics not related to the project but to island life in general, this helped to keep the mood of the session very informal and relaxed.

Avril then introduced the agenda for the session, and gave a brief explanation of both topics of discussion that were planned, she explained that the session should stay very informal and that people were welcome to speak freely . Avril also explained that in order to summarise the session afterwards, Brian would be taking some notes during the session and that she would like to audio record the focus group. She reassured everyone that all participants would be anonymised and only she would be listening to the recording afterwards. All participants were happy to proceed on this basis, although it did take somewhat from the informal atmosphere in the beginning. After a few minutes the atmosphere returned to how it had been previously, and so this did not cause any issue.

The focus group went very smoothly for the most part, with all participants in a jovial mood and very open to the suggestions of others. Most participants were in agreement on almost everything throughout the session, however, M1 deviated substantially from the planned session towards the end when he mentioned that he believed hydrogen was the way forward and what we should all be focusing our efforts on. He felt that it was unnecessary to upgrade and retrofit homes with expensive insulation and electrical heating systems when it was possible to exchange fossil fuels for green

hydrogen. This discussion lasted about 2 minutes and then we returned to the planned topics. The entire focus group lasted about 1 hour and 10 minutes from beginning to end.




4. **Summary of Focus group discussions**

4.1 Topic 1 General attitude towards demand response

a. Discussion starter – The renewable energy systems installed in each of your homes comes from solar, which can be difficult to control and is very intermittent. Often there is a surplus of 'free' energy, and at other times (often when it is needed) there is a deficit. One way to combat this is to time shift some of the consumption within a household to make sure you are getting the benefit of the renewables you have invested in. For example, moving certain consumption to the middle of the day for PV, or using hot water in the evening rather than during the day (so that as much as possible of the energy used to heat it is from the sun, and not from a top up with the immersion heater/boiler/heat pump etc).

b. Follow up questions –

i. What types of consumption would you be able to/willing to time shift?

ii. What is the biggest consumers of electricity/hot water in your household? Could that be time shifted?

iii. What challenges would arise from this?

iv. What would be the biggest motivation for you to time shift some of your consumption?

**Summary** -

Avril introduced the first discussion topic and then, when required the follow up questions.

F2 said that at this time of year, the biggest consumer of electricity in her home (which has PV panels) is the showers. She has both electric showers and pumped showers, the hot water for the pumped shower is heated by an air to water heat pump so both use electricity either way. She mentioned that these cannot be time shifted, as the majority of this demand is from the students she hosts during the summer months. They mostly use the showers between 5pm and 7pm when they are back from classes before the evening events as they leave early in the morning and arrive back at 10pm. She did note, however, that since she invested in PV panels (2kw array) that her electricity bills for this time of year have almost halved and she doesn't feel there is any surplus to be used during those hours. M5 then added that he cannot time shift much, if any, of his consumption as everyone in his household is at work during the daylight hours. He suggests that having somewhere to store the energy would be more useful as then it would be there at anytime rather than having you think about when you consume it.

The participants then went on to discuss the possibility of a feed in tariff being established for Irish micro generators in Ireland early next year, M5 feels like this would also benefit those who cannot time shift their consumption as they would be getting some benefit from the power they are producing although everyone agreed that using it within the household directly would be the preferred option.

M3 three states that they have already being trying to time shift some consumption like laundry/dishwashing etc in order to use surplus energy during the day. This has been very successful, and they have seen a decrease in their bills over time. F2 says that she is also conscious of making the most of the PV energy during the day as she is typically home all day , she does this by time shifting some of the laundry and dishwashing. M1 has solar thermal panels, and says that both he and his wife, for medical reasons, take a bath each night. He feels it is not possible to time shift this, and that it would not have much of an effect anyway. M2 who also has solar thermal says that his hot water tank is very efficient and can retain a lot if heat, so he doesn't feel the need to time shift his hot water consumption. He also has electric showers, which heat water themselves and so there isn't much demand on the hot water in the tank. All participants agreed that saving money was probably the biggest motivator in time shifting their consumption, and also getting the return on their initial investment as well as they obvious environmental benefits.

**Analytical observations –**

It seems that all participants are knowledgeable in terms of understanding the need to adapt or change habits to get the most benefit from their renewable installations. All except M5 have already been making efforts in this, and that is only because they are the only household in this session where there is no one home all day. It seems that F2 and M3 are the most active in trying to ensure they are leaving as little a surplus of clean energy as possible and they are both having great success with this. All other participants, especially those with solar thermal seemed to feel that the PV panels offered great flexibility in terms of use, but those with solar thermal also appreciated the fact that they already had somewhere to store what they panels were producing and so did not need to adapt or change their habits much at all. Overall, laundry and dishwashing seemed to be the obvious things those with PV panels were willing and able to time shift. This seemed to be mainly due to the fact that they use quite a lot of power and were easily changed/controlled and did not need much notice to do.

The key motivator for people 'going the extra mile' and time shifting their consumption seems to be mostly financial. People with PV panels failing to receive a payment for their surplus power which they provide to

the grid seems to be a bone of contention for the householders and so all participants seemed keen to ensure they are consuming as much as possible within the household.

4.2 Topic 2 Discussion on RESPOND solution and mobile app.

a. Printed versions of the mock-up of the RESPOND app were distributed to the participants showing some of the proposed functionalities available in the mobile app. Avril explained each of these functionalities in turn. Participants were asked their immediate reaction to the mock up

b. Follow up questions-
What do you think of the design of the app? Is there anything you don't understand? Is there anything you think could be improved? Would you be willing to allow remote controlling of the appliances in your home? (either remotely operated by you or automatically set to turn on/off through the app itself)

**Summary-**

Firstly, M3 says that it would be very important for the graphs etc displayed in the app to be easily comprehensible. All of the participants agreed with this statement. M1 voices a concern that older people may have difficulty using the app, this brought about some laughter as he is one of the older people in the room. He was also concerned that slow internet speeds on the island may affect the apps functionality for some householders. This seemed to also be a concern for other participants.

None of the participants found anything they did not understand on the mock ups, once they had been explained to them. M3 also stated that he did not think a forecast of the potential production through the weather monitor within the app was explicitly necessary, as most of the DR functions were for actions that either did not require much notice, or would be done during the course of the day anyway and were not dependant only on power from PV panels. (If there was no power being produced they would carry out these tasks, but they could chose to do them at specific times if the power happened to be there) There are not any DR functions for households with solar thermal panels within the app, however, all participants would be very interested in having a breakdown of consumption per appliance.

When asked about the neighbourhood portion of the app, comparing a household against the average household in the group – seeing how efficient households were in terms of using the most of their renewable energy was of interest to participants although it did not seem like it would inspire them to increase their efforts.

M6 stated that he loves technology, but finds that sometimes people may lose interest once the novelty of a device/app wears off. He said he might use the app for the first few days, and possibly use the remote operating function too but that he was likely to forget about it after a while, and not use it to its full potential.

It was at this point the group discussed the possibility of automated DR functions within the app. i.e loading an appliance in the morning or evening before, and once there is sufficient power they automatically begin to run. This brought a huge reaction from the participants. F1 and M5 said they felt this would be really useful as it would allow them to time shift their consumption without having to always be conscious of it. M6 said that this would solve his issue of being gone all day, and allow the home to use the power it is producing without having to physically be there.

One thing that was important to all participants was that the householder would have the ability to override this function, i.e. if they were away, or did not have any laundry to do etc. They were assured that this would be the case, as they would have the responsibility of switching this function on/off when it best worked for them.

Having this flexibility, to not always have to be present in the household to carry our DR functions seemed to appeal greatly to the participants, even more so than the option to carry out the on/off functions remotely.

**Analytical observations –**

It was interesting to note that the first to mention the need for the app to be simple to navigate and understand was M3, the youngest in the room. However, all participants agreed that the less complicated the app was, the more likely they were to use it to its full potential in the long term.

Having a breakdown of current and historical consumption of appliances seemed to be very appealing to all participants, for various reasons. As did having live values of their power generation and total consumption.

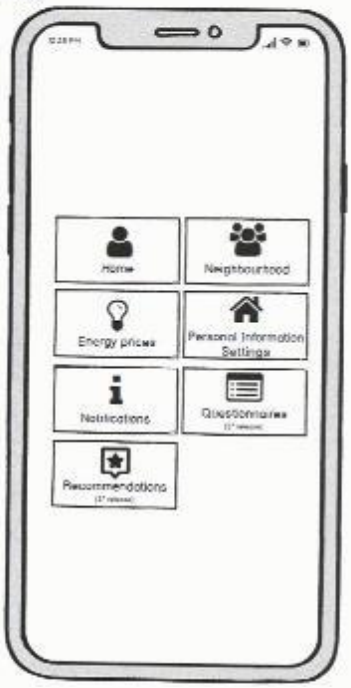
The point raised my M6 that he might lose interest in the app was very honest, and seemed to resonate around the table. The novelty of an app like this might quickly wear off, and the automatic function, where people do not have to think about the DR functions seemed to be the most appealing function of the entire app. The entire group unanimously agreed that the automatic function on the app would be of most benefit to them all.

Participants did not seem over interested in comparing their consumption to one another, but did not seem to be opposed to it either. This lead the moderators to believe that they were unlikely to pay much attention to this function. It seemed to interest participants the most that they might be able to see what percentage of their consumption came from their PV panels and how that compared to the average household here.

Again, the ability of the app to allow participants to lower their costs seemed to be what garnered the most interest, and the ability to set this function to run automatically, without much continued interference from the householders seemed to be the favourite function of the entire group overall.

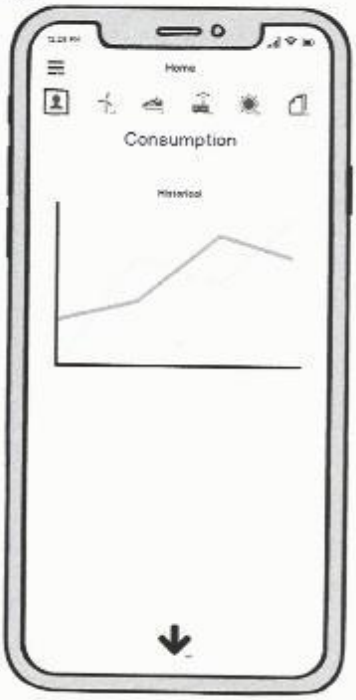
# Appendix: Hands-out mock-ups

Rwepond Main Page

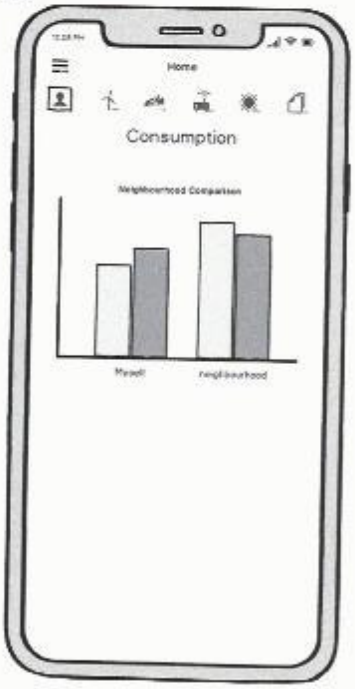



Home-Consume-1

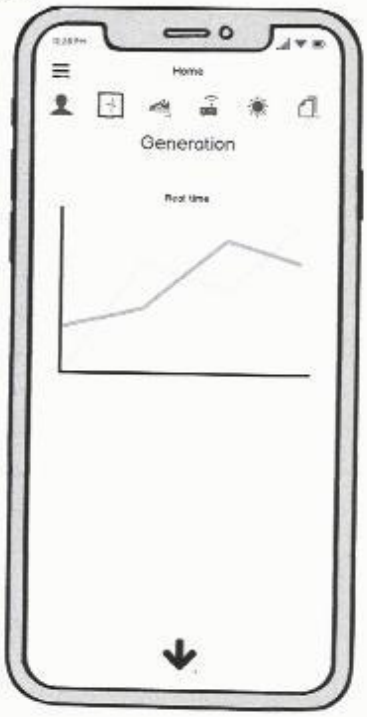

Home-Consume-2



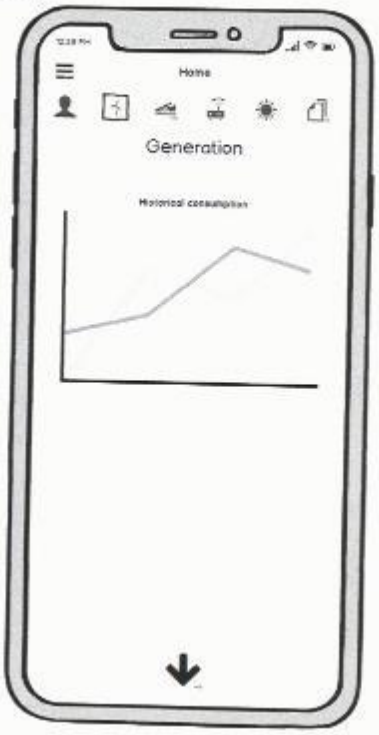

Home-Consume-3



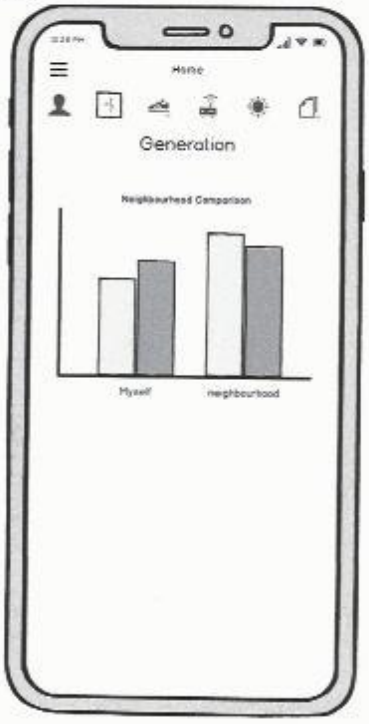
Home-Generation-1



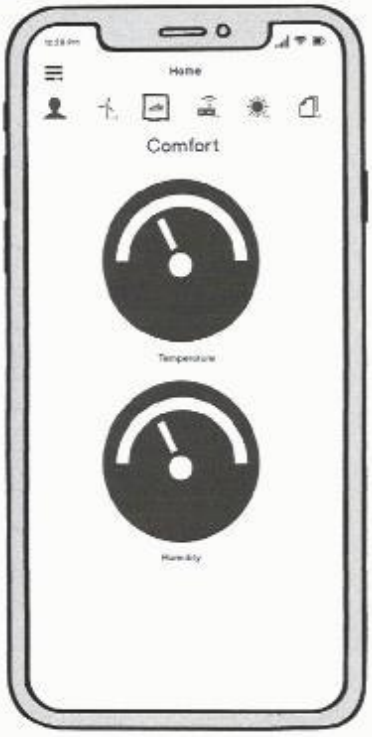

Home-Generation-2




Home-Generation-3




Home-Comfort-1




Home-Devices-1
10 / 38
Home
Devices
Home heating
Whole house heating consumption
Dishwasher
Dishwasher electricity consumption
Washing Machine
Washing machine electricity consumption
Living room thermomet..
Temperature and humidity at living room
Heat pump
Heat pump performance
Water tank
Water tank parameters

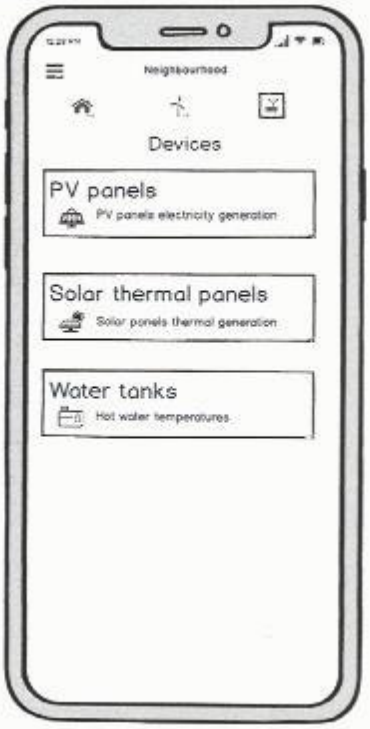

Home-Weather-1-1
11 / 38
Home
Weather forecast
Today
Partly Cloudy
High : 63° F
Low : 30° F
Rel.Hum: 60%
Precip: 30%
Barometer: 30.1
Wind: NE 5 km/h


Home-Weather-1-2
12 / 38
Home
Weather forecast
Next Week
Today
Tomorrow
Day 3
Day 4


Neighbourhood-Consume-2
15 / 35
Neighbourhood
Consumption
Historical

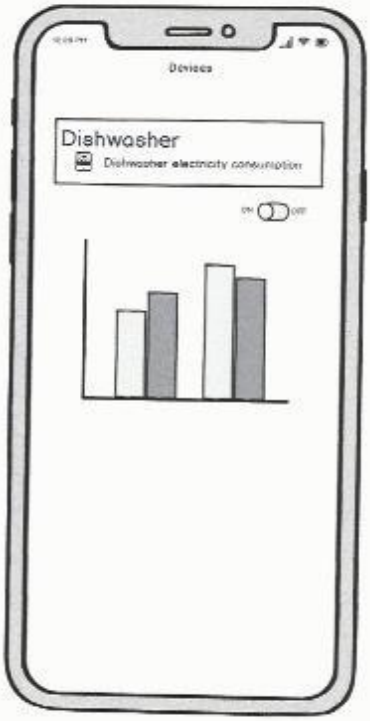
Neighbourhood-Generation-1


Neighbourhood-Devices-1



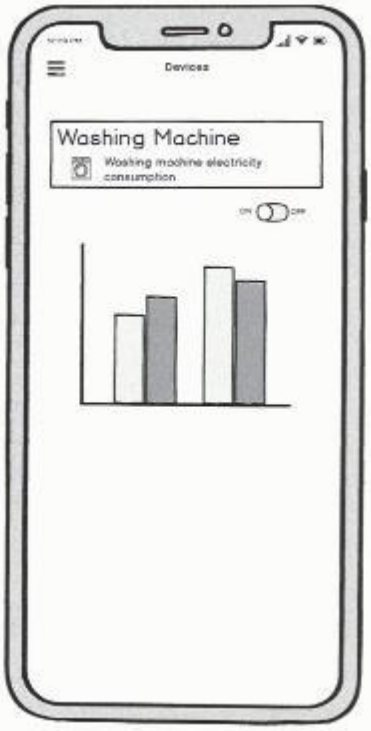

Device-1


Device 2



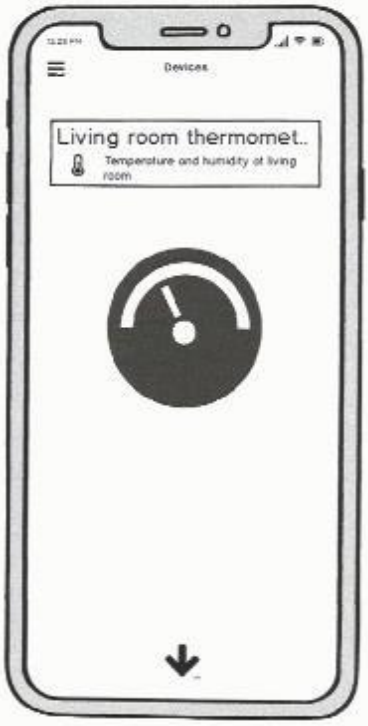
Device-3

27 / 38




Device-4

28 / 38




Device-5

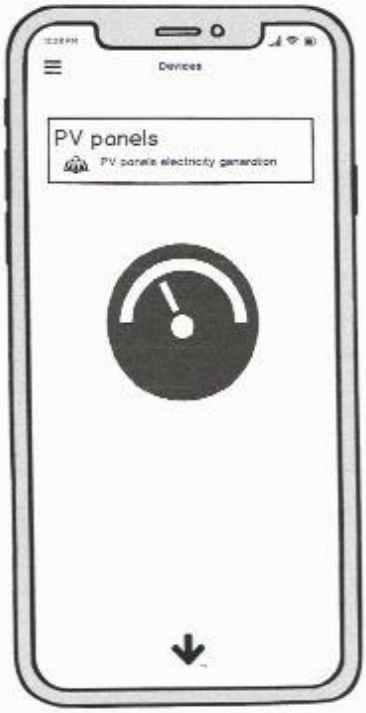
30 / 38


Device-6

31 / 38

Device NEIGH-1

33 / 38

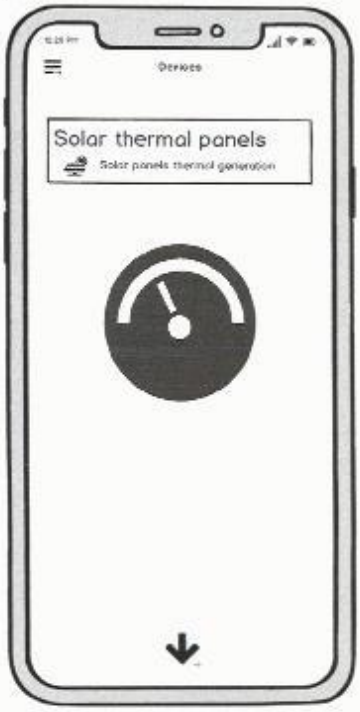



Device NEIGH-1-Hist

34 / 38


Device NEIGH-2

35 / 38




Device NEIGH-2-Hist

36 / 38