CHALMERS

# Development of an Energy Visualisation Tool

*Master of Science Thesis in the Master Degree Programme,*

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# PREFACE

This master thesis has been executed in cooperation with Exibea AB where we would like to send a big thank you to Joakim Ottander. We would like to thank you for inspirational input and support throughout the project and also for introducing us to the interesting and new dawning area of energy in relation to human behavior change.

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# ABSTRACT

This report presents a master thesis project that has been executed at the department of Product and Production Development at Chalmers University of Technology by Anna Berglund and Olof Hartelius. The project is a part of the master program Industrial Design Engineering and has been carried out in cooperation with Exibea AB. The project constitutes of 30 hp (ECTS) and has been ongoing from February 2010 to August 2010.

The world faces an enormous challenge when it comes to decreasing its carbon dioxide emissions in the next twenty years, in order to keep the global warming to a minimum. Today 80% of the world's energy production emits carbon dioxide and a substantial part of the energy produced is consumed in consumer households. Today there is an expenditure of energy in these households. By providing feedback of the energy consumption, a change in behavior and attitudes can be achieved that leads to less energy waste.

Exibea AB is a small Gothenburg company that has developed an energy display called Eliq. Eliq provides the users with real time feedback and historic information concerning their electricity usage. The idea is to help the users to decrease their electricity consumption and by so contribute to a more sustainable society. The goal of this project is to, develop a product concept that motivates and facilitates consumers to reduce their energy consumption in the household through the use of feedback for Exibea AB.

The project group carried out atheoretical and an empirical pre-study. In the theoretical pre-study the global and local energy situations were investigated together with a literature review of household energy usage and behaviour change.

A market analysis was performed and the target group was defined. In the empirical pre-study two interview sets and a questioner were performed that concluded that the consumers lackan understanding of energy, lack a relation towards their energy consumption and do not feel in control of their energy usage. Furthermore cost was identified as the most motivating factor for decreased energy consumption closely followed by minimising one's contribution to global warming.

In the development phase a product vision was created and further delimitations and goals of the project were defined. A number of concepts were developed and evaluated in an iterative process using for example focus groups, a pros and cons list and a usability test.

The final result is an attractive energy display called Eniq that will be launch on the market in three year time. Eniq fits well into a contemporary Swedish home. The display presents the current energy output, which creates an understanding for and awareness of energy usage for the consumer. According to theory presenting energy consumption feedback has the potential to decrease the energy usage with up to 20 percent. The display further provides the user with key values including for example cost in order to give the user a quick understanding of the current energy situation. Historical energy information is presented in an interactive diagram, which allows the user to monitor changes in the energy consumption. The user is also given the possibility to control specific devices in the household, which allows the user to keep the energy consumption at a minimum.

Keywords: Energy display, Behaviour change, Energy consumption, Exibea AB

## Word definitions

Smart point – A smart point is a small device that is connected between a device and the wall socket. The smart point measures the electricity consumption and can turn on or off the device connected to it. The smart point can both transmit and receive information.

Smart grid – A smart grid uses a two way digital communication between the electricity company and the user to enable control of appliances in the user's home on order to save energy, reduce cost and increase reliability and transparency within the electricity system.

Fluctuating price – Fluctuation price has in this project been defined as a price that can change over a short period of time due to market movements.

Energy usage area – Energy usage area is in this project defined as a specific area where energy is used. In this project mainly used for heating, hot water and household electricity.

Current consumption – Current consumption has in this project been defined as the real time energy output.

# TABEL OF CONTENT

# 1 INTRODUCTION

## 1.1 Background

The energy usage in the world has since 1971 almost doubled and is still growing according to IEA, international energy agency. The constantly increasing need for energy in the world is becoming a more and more severe environmental problem that needs to be addressed.

In 2008 an agreement between the EU countries was reached that states that by the year 2020 20% of the energy in EU shall be from renewable energy sources. In Sweden the parliament set the goal to 50% renewable energy by the year 2020. To be able to reach this goal the use of energy needs to be more efficient. An important part of this improvement work needs to be done by the consumer. This can be achieved by developing more energy efficient products and reduce waste of energy in the households, according to Energimyndigheten (2009).

Unnecessary use of energy in the household is not only an environmental issue, it also affects the economy negatively for the consumer. This provides a market opportunity for development of a product that can help the consumer to decrease his or her energy consumption. The product that will be developed in this project will be developed in cooperation with Exibea AB.

## 1.2 Purpose/aim

The purpose of this master thesis is to investigate how consumers can reduce their energy consumption with maintained living standard. To do so the existing market of energy saving products will be investigated together with the consumers' motivation and reasoning concerning energy usage.

## 1.3 Goal

The goal is to develop a product concept that motivates and facilitates consumers to reduce their energy consumption in the household through the use of feedback for Exibea AB.

## 1.4 Delimitation

Delimitations within this project have been set together with Exibea AB and are the following points.

- Focus will be on the Swedish consumer market
- Consideration will be taken for Exibeas prerequisites as a small company
- No detailed construction drawings or calculations will be made
- No detailed investigations of the product manufaturability will be made.

## 1.5 Report ouhtline

The report outline of this project has been divided into five major phases. These phases are pre-study, pre development, development, final result and finally the discussion. An illustration of the report outline can be seen in figure 1.


*Fig. 1. Report outline*

# 2 METHODS

In this chapter the methods used during this project are accounted for, a brief explanation of each method is given together with the implementation of each method.

## 2.1 Interview

### 2.1.1 Theory

Interview is the most fundamental method for gathering information regarding what people think according to Bohgard et al. (2009). Interviews collect peoples' opinions, dreams and reasoning so the results provided are of subjective nature. Interviews can be done as structured, semi-structure and unstructured. Structured interviews use predetermined questions where the interviewee can answer freely or by a set of fixed answers and are suitable to be used when quantitative data is required. In an unstructured interview the interviewer asks open questions and the interviewee can freely express his or her opinion. Unstructured interview technique is appropriate to use when the interviewer has an idea of what information that is important but lack domain knowledge. Unstructured interviews provide qualitative data. Semi-structured interviews are somewhere in-between unstructured and structured interviews and use predetermined question areas but leave the interviewer with the opportunity to freely choose to explore certain questions further and ask follow-up questions. (Bohgard et al., 2009)

### 2.1.2 Implementation

*First set of interviews*

Five telephone interviews were conducted using a semi-structured interview guide, see appendix 1. The five interviews were performed on household owners within the target group, see section 5.2.2 for target group definition. Questions regarding the users' perceived knowledge of their energy consumption, their perceived control of their energy consumption and what motivates them to keep their energy consumption down were asked.

*Second set of interviews*

In the second set of interviews one interview was carried out face-to-face and four interviews were conducted over the telephone. All the interviews were semi-structured. The interviewees for the second interview set were from Exibea's test households that had been testing the energy display Eliq for a few weeks. Questions regarding the test households' experience with Eliq and their perceived understanding of their electricity usage were asked, for the questions see appendix 2.

## 2.2 Questionnaire

### 2.2.1 Theory

Questionnaire can be said to be a form of structured interview but without the interviewer and interviewee having to meet. The primary fields to use a questionnaire are when a large amount of data is being collected from a large number of people over a short period of time. It is also useful when gathering data from people who are difficult or resource intensive to reach and when validation of preceding results from interviews are required. When questionnaires are constructed the wording is important to obtain valid results and also to perform pilot studies are recommended i.e. test the questioner on a number of people within the target group to see if the questions are interpreted correctly. The questions in a questionnaire should be simple, clear and unambiguous. Fixed alternatives or scales are to recommend if possible. Open questions can be used if the investigator is uncertain what aspects that are of interest but it should be kept in mind that it can be perceived as difficult and requires more from the responder to write freely. (Bohgard et al., 2009)

### 2.2.2 Implementation

A questionnaire was constructed around the three areas that were found during the first sets of interviews, energy consumption, motivation and felling of control. The questionnaire was first pilot tested on twelve test persons that had the possibility to comment on each question in the questionnaire if there were any vagueness.

The comments from the test persons were evaluated and a final questionnaire was compiled, see appendix 3. The final questionnaire were put on selected Internet forums and distributed via email contacts. As the questionnaire was not distributed to pre defined respondents a set of categorising questions were included to insure the sample validity, for example age, gender and education.

## 2.3 Persona

### 2.3.1 Theory

A persona is a fictional individual representation of the user of a system or product (Bohgard et al., 2009). Personas are constructed from the basis of interviews and observations of the user or intended user. A well-defined persona includes information about goals, attitudes, work, entertainment, skill, skill level and frustrations (Cooper, Reimann, 2003).

### 2.3.2 Implementation

Three personas were constructed based on the information gathered during the interviews and the questionnaire. The main parameters that the personas were built around were education, financial situation, environmental commitment and technical interest. Pictures of the personas and their home environment were included.

## 2.4 Scenario

### 2.4.1 Theory

Scenarios serve as an interactive mean of defining the behaviour of a product from the standpoint of a specific user according to Cooper and Reimann (2003). A scenario consists of a small story of a possible situation that could occur with the product. In the scenario the context surrounding the product should also be included. Context scenarios also called day-in-the-life scenario has the focus on the persona, her mental models, goals and activities (Cooper, Reimann, 2003).

### 2.4.2 Implementation

A scenario was constructed using information gathered during the second set of interviews and through brainstorming possible user situations involving the product. The context of the scenario was a normal day in the users life. The information from the interviewees concerning the interaction/use with Eliq was piled up in order to create the scenario. The scenario was constructed around the thoughts and needs concerning energy that the user in some way might experience in and nearby the home. The results of the scenario were complied into a mind map of the user.

## 2.5 Benchmarking

### 2.5.1 Theory

Benchmarking is a method where the competitors on the market are being mapped. A study is performed where products with similar function or that solves the same problem are being analyzed. The idea is to find competitors weaknesses and strengths. This information can be used in the development phase as an inspiration to new ideas or as an evaluation tool where new ideas are being compared to competitors. (Ulrich, Eppinger, 2003)

### 2.5.2 Implementation

The market analysis was conducted using the Internet. Products that in some way provide feedback on the usage of electricity, hot water, heating or a combination of the above mentioned were of interest. Parameters that were saved for the products found were name, function, price, picture and intended market. The market analysis was conducted searching for products in all the major Swedish retail stores that provide consumer electronics and searching broadly on the Internet to be able to identify possible competitors on other markets. Search words that were used were for example energy meter, hot water monitor and electricity monitor. All products found on different Web sites were backtracked to the manufacturing company of the product for validation of the information about the device. On the Swedish market a lot of the products were standard manufactured private label products, in these cases the information about the devices were taken from the retailer.

## 2.6 Vision in Product Design

### 2.6.1 Theory

Vision in Product Design (ViP) is a context driven method that explores the interaction between products and users (Lloyd, Hekkert, van Dijk, 2006).

The ViP method consists of two phases, the deconstruction phase and the design phase both divided into three stages, product, interaction and context stage. In the deconstruction phase an existing product in the area of interest is studied to find out why it is designed in a particular way and to find out what categorise the product and the interaction between the product and the user. In the design phase the designer builds up a context that the product is going to be used in and define what should characterise the wanted interaction between the product and the user. With this as a starting point the user designs the product. (Lloyd, Hekkert, van Dijk, 2006) For an illustration of the different stages and phases in the ViP method see figure 2.

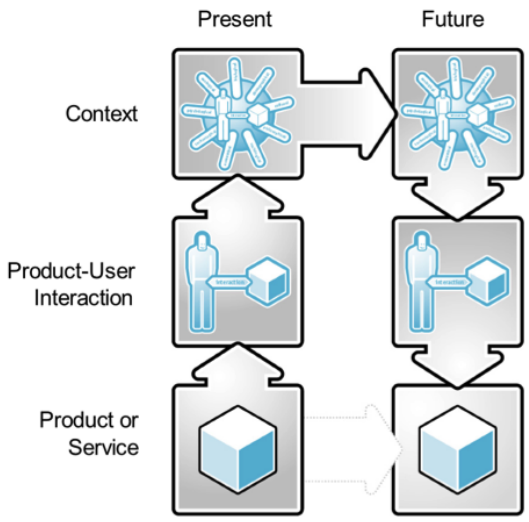


*Fig. 2. ViP, Vision in Product Design*

### 2.6.2 Implementation

In this project, stage four, designing the context and stage five, interaction vision, in the design phase of the ViP method was used. This was done in order for the project team to create an united vision of the future context and what is going to characterise the interaction with the future product.

Stage four was performed by generating a lot of different context factors and then selecting and organising the factors that were perceived as the most important and prominent ones. Stage five was executed by first making up a number of metaphors that the project team felt were descriptive of the interaction aimed at. The best metaphor was then chosen and five characteristic words describing the interaction were selected.

## 2.7 Image board

### 2.7.1 Theory

Image boards are used for communicating a feeling, expression or direction within a project group or to an external stakeholder. An image board is created by collecting a number of objects, for example pictures or photos, that in some way visualise the desired expression. (Michalko, 2006)

### 2.7.2 Implementation

Three image boards, named context board, expression board and consensus board were created using the Internet and interior design magazines. The image boards were created using an iterative process were the team members collected a lot of pictures and then through discussion selected the most descriptive pictures for each image board.

## 2.8 Brainstorming

### 2.8.1 Theory

Brainstorming is about taking advantage of a group's collective competence, imagination and experience in order to find suitable solutions. The idea with the method is to create a large amount of ideas in order to explore possible solutions. A brainstorming session should not be more than one hour in order to not lose enthusiasm. Before the brainstorming session starts the participants should be notified about the background of the project and the projects core values. Rules and the structure of the brainstorming sessions should also be presented. Rules are typically that no negative comments are allowed and that focus should be quantity rather than quality. (Landqvist, 1994)

### 2.8.2 Implementation

Brainstorming sessions were carried out on different occasions along the project where the number of participants varied between six and four. The topics of the brainstorming sessions corresponded to where in the development phase the project group were at the time. These brainstorming sessions did not use a specific method but implemented some general rules for idée-generation methods like no criticism of each other ideas.

## 2.9 3-plus method

### 2.9.1 Theory

This method is a variant of brainstorming. The participants are asked to write or sketch down ideas silently on a paper during three to five minutes. When the time is up the participants are asked to give the paper to the person to the right. Then the time starts again and the participants can either continue on the last person's ideas or create new ones. When the papers have travelled around the table the session is over and the ideas are presented. (Michalko, 2006)

### 2.9.2 Implementation

The project team first performed a brainstorming session around the question "How can we make energy consumption visible within the household?" and then invited four fellow students to further explore the area. The fellow students were before the brainstorming session briefly informed about the topic of the master thesis but no demands or limitation were given. During the brainstorming session with the four students the 3-plus method was used.

## 2.10 Sketching

### 2.10.1 Theory

Sketching is a tool that designers use to communicate and visualize ideas. It is also a useful tool for documentation. There are a larger number of different types of sketches that are used to communicate different kinds of information. For example idea sketches, technical drawings or photo realistic sketches. (Österlin, 2003)

Sketch models are a variant of sketching where all the three room dimensions are used. Sketch models is a good tool to communicate size and form of an object, it can also be used to perform basic ergonomic studies. (Österlin, 2003)

### 2.10.2 Implementation

Sketching was continuously used throughout the project. Most of the results from the brainstorming secessions were communicated via basic idea sketches.

Foam and clay was used in the first model making sessions to quickly get an idea of the shape and dimensions, while at the same time test out the perceived feeling in the hand of the different product shapes. The model making process was an iterative process with evaluations along the way as the models progressed.

For the second model making session only foam was used as it was perceived to produce a more realistic feeling to the models compared to clay.

## 2.12 KJ-analysis

### 2.12.1 Theory

The KJ-analysis is a fast and efficient method to structure collected data into different categories. The method is carried out by sorting data into different groups. If a piece of data fits with an already sorted data it is placed in the same group and if it does not fit it will start a new group of data. This way of working is based on intuition and creativity rather than logic. When all the data has been sorted the different groups are name according to the group's characteristics and the result is that the data has been structured into categories. (Karlsson, 2005)

### 2.12.2 Implementation

The interview answers from the second interview set were organised in a number of categories by the use of a KJ analysis. The categories were named after the main common denominator.

## 2.13 Usability test

### 2.13.1 Theory

Usability testing is an efficient method for testing a product during the development to identify possible usability problems or as an evaluation method for an existing product. The test persons included in the test should be as representative of the user group as possible. A usability test can be performed in either a lab representation of the user environment or in the actual product environment. When performing a usability test a fully working prototype should be developed according to Jordan (1998). The test is carried out by giving the test person a number of tasks to perform while recording performance measurements such as completion, number of steps on task and errors. Qualities measures such as satisfaction level can also be recorded. (Jordan, 1998)

### 2.13.2 Implementation

A usability test with five test persons evaluating the interface concept was implemented. The important characteristics for the test persons were identified as the test persons gender, age and perceived technical knowledge. Five test personas, three males and two females, between the age of 30-65 years were used for the test. The product was represented by an interactive computer animation. The animation was built in the program Adobe Flash and the user interacts with the animation through a touch screen. The computer animation reflects the intended interface to a high degree. The touch screen that the interface was tested on was although a 17" screen and in order to make the screen as representative as possible the project team made a mask using Capa board that concealed the screen area that were not used during the test. The touch screen hardware used during the test red off the finger less accurate than the project group's intended hardware, also the resolution of the screen was less than the intended screen. To compensate for this the project group made the interface somewhat larger than the intended interface.

The test was performed in a usability lab without external influence. The test persons were filmed and audio recorded during the test. The users were given seven scenario based tasks during the test that were thought to reflect situations that the users might encounter during normal usage, see appendix 4. Two objective measurements were used, effectiveness and efficiency. Effectiveness was measured as success or failure i.e. the user succeeds to complete a task and derive the right information or not. For the evaluation of efficiency the number of steps to complete the task was recorded. The subjective measurement of the test was measured by a 5-step scale that evaluated the satisfaction level, comprehensibility of the interface, task difficulty and performance. The subjective measurements were done after the test and are therefore a reflection on the entire interface interaction. The test persons were also encouraged to motivate their validations and to give further comments after the test.

## 2.14 Focus groups

### 2.14.1 Theory

A focus group is a group of people that meet and discuss a selected topic. A moderator leads the discussion and is responsible for keeping a pleasant atmosphere. The focus group can meet several times during the product development phase in order to give feedback. The group should consist of 6-10 test persons. (Bohgard et al., 2009)

### 2.14.2 Implementation

Focus groups have been used throughout the entire process for evaluation and idea generation. The focus groups consisted of students from the Industrial Design Engineering department but the composition of students within the group has changed from time to time. The focus group meetings have been performed in an informal and relaxed manner and mainly served as a way for the project group to get a quick second opinion for further work.

## 2.15 Pros and cons list

### 2.15.1 Theory

The pros and cons list method is used in order to structure the selection process of a concept. The method is carried out by discussing and writing down a list with strengths and weaknesses for each concept. The list forms the basis for making a decision within the group. (Ulrich, Eppinger 2003)

### 2.15.2 Implementation

The pros and cons list method was used several times during the project. The project group wrote down strengths and weaknesses for different concepts and the list formed a basis for decision making within the group.

## 2.16 Pugh's concept selection matrix

### 2.16.1 Theory

Pugh's concept selection matrix is used to evaluate and select a concept for further development. The evaluation is done in a matrix where the concepts are evaluated against pre-defined requirements. One concept is selected as a reference concept, which all the other concepts are compared to. A concept can either score better than, same as or worse than the reference concept. The concept or concepts that score the best result are selected for further development. (Ulrich, Eppinger 2003)

### 2.16.2 Implementation

*Form evaluation*

For the form evaluation the Pugh's concept selection method was used in a somewhat altered form. The evaluation was executed by presenting five mock-up models for the test person and this person was then asked to rate the models in relation to each other. The model that was perceived to be most descriptive of the word was placed closest to the word and then the next most descriptive model and so on. The words used to rate the concepts were derived from the image boards. The test person was given one word at the time and then rated the models. To minimise sources of error the words given to the test person were given in a random order. Five test persons were included in this test. A picture of one of the test persons performing the test can be seen in figure 3.

*Concept evaluation*

When evaluating different interface concepts to each other a slightly modified variant of the Pugh's matrix were used. The concepts were rated against each other by the project group on the defined requirements for that interface part. The concepts were ranked from most descriptive to least descriptive. If two concepts were perceived identical on a requirement they scored the same result. The result formed a basis for selecting the best concept. If the project group members had different opinions, input from a focus group were used rather than just looking at what concepts that had scored the best result.

*Fig. 3. Evaluation of the product form*

# 3 THEORY

In this chapter theories that support decisions within this project and theories that are used as guidelines within the development process are summarised.

## 3.1 Touch screen

### 3.1.1 Hub and Spoke

According to Tidwell (2006) Hub and Spoke menu handling is especially well suited for small screen mobile devices. A Hub and Spoke menu organises the different sub applications in the interface so that they have one way in and one way out from the main menu.

### 3.1.2 Buttons

Buttons in interfaces should be big, readable, obvious and extremely easy to use even for people that are unused to technical devices according to Tidwell (2006).

### 3.1.3 Legibility

For a display to be legible it requires high contrast, good luminance and the right viewing angle in respect to the beholder (Bohgard et al., 2009). Right viewing angle is an environmental factor that cannot be satisfied by the design of the interface. Good luminance or luminance contrast is best achieved with black on white or vice versa, but can also be sufficient with yellow on black or dark blue on white according to Ware (2008). According to Cooper and Reimann (2003) sans-serifs are to recommend for good readability in interfaces. Tidwell further stat that appropriate size, proper separation between unrelated text items and alignment of related items is the essence for a good readability.

### 3.1.4 Redundant information

It is much more likely that the information that is being perceived is correctly interpreted if the message is visualised in more than one way on the screen.
(Bohgard et al., 2009)

### 3.1.5 Consistent presentation

It is important that the interface is design in a consistent way. That is, similar tasks are carried out in a similar manner. If there is a common rule for solving tasks, the user only need to learn that one rule and the mental workload will decrease. The user will easier figure out how to solve new tasks and remember previous solutions (Jordan, 1998). A consistent colour coding is also very important within the system in order to not confuse of the user (Bohgard et al., 2009).

### 3.1.6 Colour as an index

Colour can be used as an index to convey the meaning of something else according to Klarén (2007). To be able to interpret an index the context needs to be understood, as an index in one situation can mean something and something else in another context (Klarén, 2007).

### 3.1.7 Dynamic colour

Dynamic colour is defined as colour that changes with time and/or interaction with the interface according to Li (2008). Dynamic colour or motions in the interface is one of the strongest attention catchers. Humans have a well developed motion sensitivity in the periphery of the visual field and if something is detected it will unavoidably direct the attention towards that stimuli (Ware 2008).

### 3.1.8 Compability

Compability means that the experience the user has from relating products should be able to be used to solve tasks in a new product (Jordan 1998). When designing a new system it is important to keep in mind that the user may have old habits that make them instinctively carry out certain actions. It is therefore suitable to design the system so that these actions correspond as closely to the old interface as possible. (Bohgard et al., 2009)

### 3.1.9 Memory functions

The human short term memory has a limited capacity of actively retaining and processing information at the same time. Data is usually only available and active around 30 seconds if it is not repeated. Humans have the ability to keep around seven plus minus two chunks of information in the short term memory at the same time. It is also difficult to quickly find information in the long term memory when there is a lack of cues. When this happens the user will use things that he or she knows well, that are supported by memory functions. (Bohgard et al., 2009)

### 3.1.10 Mental models

A mental model is a conceptual representation of a system, it includes the key elements and their connections, within a person's mind and it helps the person to understand and interact with the system. A mental model helps shape the user's behaviour and define an approach to solving problems and carrying out tasks. A persons mental model is highly individual and context dependent. (Bohgard et al., 2009)

### 3.1.11 Feedback

Feedback is extremely important for making the user understand that an action has been performed. If the user does not get sufficient feedback there is a risk that the user will try to repeat the action, which can lead to problems. It is also important that the feedback given is relevant and the user can understand the information otherwise it will only be confusing and counteract its purpose. (Jordan, 1998)

### 3.1.12 Error prevention and recovery

It is unavoidable that the user will make mistakes. This means that the designer of an interface needs to facilitate a possible way of recovery and make mistakes feels small and painless. (Jordan, 1998)

### 3.1.13 User control

The user should be in control and be able to choose when to perform actions or receive information. It is for example preferable that the user can decide when to exit a menu instead of a menu that disappears after a preset time. (Jordan, 1998)

### 3.1.14 Prioritising of functions

According to Jordan (1998) it is important to prioritise certain functions and information in the interface. When selecting what functions to prioritise the frequency of use and the perceived importance of the information presented are significant factors. (Jordan, 1998)

### 3.1.15 Hints

A designer should through the design of a product provide the user with hints off how it is supposed to be used. (Jordan, 1998)

## 3.2 Behaviour change

To only make every day appliances more efficient is not enough to reduce our energy consumption according to Sylwan and Stål (2008). There is also a need for behaviour change to make a larger impact. This is partly due to that when our appliances become more energy efficient there is a possibility to use more products for the same amount of money, which many times has been the case during the last century. (Sykwan, Stål, 2008)

It is generally easy to make people realise and understand that there is a need for a change i.e. affect people's attitudes, it is although much harder to make them change their behaviour. The more rooted and habit bound a behaviour is, the harder it is to change. According to Linden (2008) a combination of means are most effective for changing an unwanted behaviour. For example informative measures in order to create consensus in the society about a new norm and then use design measures to ease for the new behaviour pattern. (Lindén 2008)

Lindén (2008) presents four different means of control that can be used to produce a behaviour change informative, economic, administrative and design. Informative means are voluntary and work slowly. Economic means for example taxes and fees influence the consumer to look for alternatives and can be catalytic. Administrative measures are forcing and have an immediate effect, example of administrative measures are laws. Design measures work as a guide that either promote or prohibits a certain behaviour. (Lindén 2008)

Energy consumption is very much dependent on habits and routines. The user is simply not aware of if they're using energy or not according to Cames and Brohmann (2003). This is confirmed by Carlsson-Kanyama and Lindén (2002) that states that energy saving behaviour is done unconsciously and not related to environmental attitude or economic awareness. This is further confirmed by Brost, Lindstedt and Mårdsjö Blume (2010) that states that a lot of people does not know how much 1 kWh is and cannot calculate how much energy a product consumes i.e. cannot see if it is profitable to buy a more expensive product that consumes less energy.

Our decision-making process concerning energy consists of two types of decisions according to Hansson (2003). The first type is energy specific decisions for example choosing an energy efficient refrigerator or new heating system. The other type is energy relevant decisions that are controlled by other aspects like way of life. Only a handful of people make there every day life decisions rationally and well thought through, most follow the law of least resistance (Hansson, 2003).

Hansson (2003) states three controlling factors that influence our energy decisions, the physical surrounding that society creates, the social organisation and social environment and the individuals mental model. To create a change in behaviour is not a question of one measure or intervention but a sequence of mental processes that needs to happen in the right order. Roughly speaking Hansson (2003) states that it first comes down to creating an awakening, that is make the user see that there is a need for change. Then make the user in a rational manner chose an optional strategy and at last make the new habit a consistent behaviour (Hansson, 2003).

Palmborg (1986) concludes that how much energy different households consumes varies a lot. He concluded that households with a high consumption consume up to twice as much energy as an identically low consuming household. He states that one third of the energy consumption is based on behaviours and estimates the saving potential by behaviour changes to ten percent. Carlsson-Kanyama and Lindén (2002) conclude that a low consuming household regarding family and the type of household in a simplified version consists of many family members, has no teenagers or housewife, has a high income and education level and has positive attitudes towards environmental issues.

Under the research project ELAN Bartusch (2009) and Hallinet al., (2007) established that for the consumer of electricity to understand a visualisation of the energy consumption the user needs to be provided with some kind of absolute value. For the user to compare their own consumption with previous consumption in the same time period was found to be most efficient.

## 3.3 Energy usage in homes

The energy usage has become more and more invisible to the user. For only a hundred years ago the heating energy was clearly visible and concrete to most Swedish people. The energy that was going to be used was normally just brought into the home as wood sticks. Today heating a house is something many people takes for granted and do not reflect around. Sylwan and Stål (2008) summarizes that there is a lack of feedback, information and understanding of the process behind energy production.

Money was in comparison with environmental care found by Gram-Hansen (2003) to still be the most motivational factor for energy savings. This was also concluded in the studies made by Linden (1996).

Social pressure can also be a motivational factor. If the individual can see benefits with being perceived in a certain way they will act according to that norm, for example act environmental friendly. This type of behaviour does although not necessarily mean that the individual will act in line with the norm when the individual is alone. (Von Borgstede, C et. Al., 2002)

One method to motivate change, is to show something in comparison with the average for the same area. This method is an efficient method if the user that is supposed to be influenced is above the average, but if the user is below the average there is a risk that the user will feel content and stop being motivated to improve further. To reduce the risk of this happening injunctive messages, messages that are stating approval or disapproval of the user's actions can be used.
(Locton, Harrison & Stanton, 2008)

Kanheman and Tversky (1979) present a hypothesis that states that economic feedback will be most effective for individuals that prioritise egocentric values and attitudes. Most effective is negative economic feedback, as it has been shown that people are lost aversive in many cases, which means that the value of avoiding a lost is greater than the value of creating a profit.
(Kahneman & Tversky 1979)

## 3.4 Case studies

Sonderegger (1978) performed a study in the USA during the seventies with around 200 participating households. He concluded that 18% of the variation of the heating energy was due to behaviour. Another study performed in the Netherlands in the mid seventies with 145 one- and two dwelling houses, concluded that 26% of the variation of the heating energy was due to behaviour (Ver-hallen och van Raaij, 1981).

An empirical study has been made where the household members had the possibility to read of the electricity meters themselves. The conclusion is that this type of information has shown great energy saving potential. However the survey indicated that the most receptive test persons were the ones that actively wanted to participate in the study and that the users needed backing rather than help. (Darby, 1999)

According to Wågerman, Rydén and Sköldberg (2005) two conclusions can be made from previous research in the area of energy behaviour. First, previous research has clearly shown that feedback concerning energy consumption can be an efficient mean of decreasing people's energy consumption by behaviour change with up to 20 percent. Second, if the feedback is removed the households often fall back to their earlier consumption habits. The studies that has shown long term behaviour changes has in common that they have used interventions that has activated a new norm of behaviour. One example of successful feedback, is feedback that compares the household's consumption to other households.

# 4 PRE-STUDY

This chapter presents a theoretical pre-study and an empirical pre-study. In the theoretical pre-study the area of energy usage is explained both in terms of the global situation and down to how the users use energy in everyday life. Also included in the theoretical pre-study is a summation of the electricity and district heating market together with a brief description of Exibea AB and their product Eliq. In the empirical pre-study the defined market and the user is investigated and the results are accounted for.

## 4.1 Theoretical pre-study

### 4.1.1 A global problem

The united nations climate panel IPCC presented in 2007 a report that concluded that the world needs to decrease the carbon dioxide emission by 80% percent until 2050 in order to not exceed a global warming of two degrees until 2100. So far the global temperature has increased with 0.6 degrees Celsius. The WWF (2010) states that if the emissions are kept on the same level as today the world will exceed the two degrees target in less than twenty years. According to Naturvårdsverket (2010) the global carbon dioxide emissions are still increasing rapidly and they conclude that the next twenty years will be critical for the future of the world.

In order to reach these goals the world both need to replace carbon dioxide emitting activates and make these activities more efficient, i.e. both increasing the production of renewable energy and decreasing the energy usage by making the usage more efficient.

The European Union including Sweden has a target of reducing the carbon dioxide emission with 85% until 2050 (Naturvårdsverket, 2010). In Sweden the energy sector including transportations stands for about 90% of the total carbon dioxide emissions (Naturvårdsverket, 2010). The interrelation of energy sources for the total energy production in Sweden can be seen in figure 4. Sweden has the highest rate of renewable energy usage in Europe which was 44% in 2007.

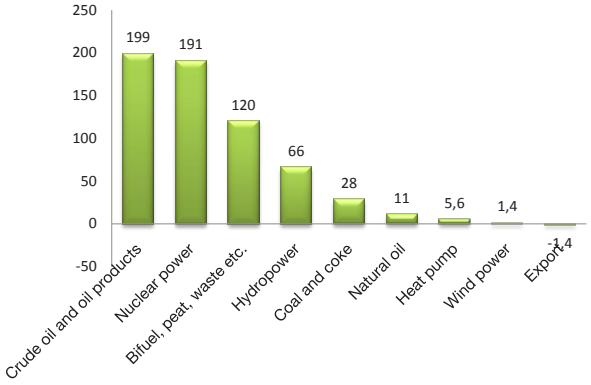


*Fig. 4. Energy production in Sweden 2007*

However Sweden's total energy infusion is built up by only 30% renewable energy, see figure 4. Sweden has agreed to reduce the carbon dioxide emission with 17 percent and have 49 percent renewable energy usage until 2020. (Energimyndigheten, 2009)

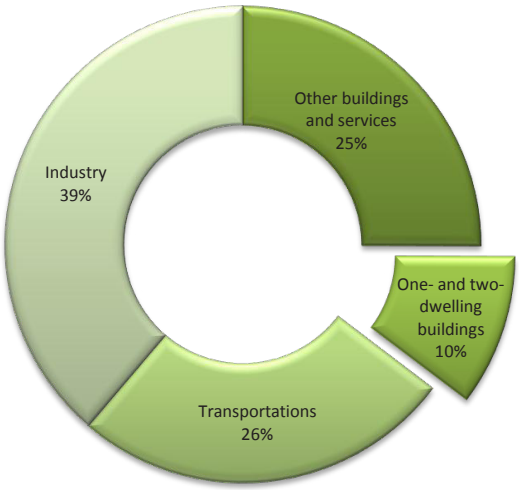


*Fig. 5. Swedens energy usage 2007*

The one- and two-dwelling building owners that are defined as the target group of this project, see section 4.2.2 stands for ten percent of Sweden's total energy consumption, see figure 5. The Swedish parliament decided in 2006 that the energy consumption in these houses should decrease with a fifth until 2020 and until 2050 the consumption should be halved. Until 2020 the dependents with mineral fuels should be broken. (Energimyndigheten, 2009)

As a part of the Swedish government's work to meet these goals the government legislated that by the 1st of July 2009 all households should have installed a new electricity meter that can be remotely red off every month (Ny Teknik, 2009). The legislation was taken to stimulate the users to lower their electricity consumption as the meter provides accurate readings every month instead of as before, when the consumers bill was an estimation based on last year's electricity consumption.

### 4.1.2 Energy production and usage in Sweden

An average Swedish one- or two-dwelling house that is heated by electricity consumes about 25 000 kWh/year according to Eon (2010). This is equivalent to around 30 000 SEK with the current electricity price, deducted in May 2010.

The energy usage in a household can be divided into three areas heating, hot water and household electricity. The interrelation between these areas in an average household can be seen in figure 6. Lighting and cold appliances stand for the larges consumption of household electricity, the distribution between different standard appliances in the household can be seen in figure 7.

The main types of energy sources that are used for heating the household and the hot water can be seen in figure 8. Electricity heating stands for about 58%, which includes all types of electricity powered radiators, heat pumps and heat-exchangers. The type of heating systems used in Swedish households are distributed according to figure 9.

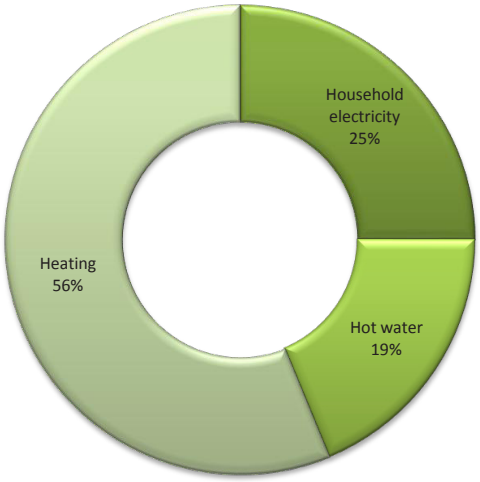


*Fig. 6. Energy distribution*

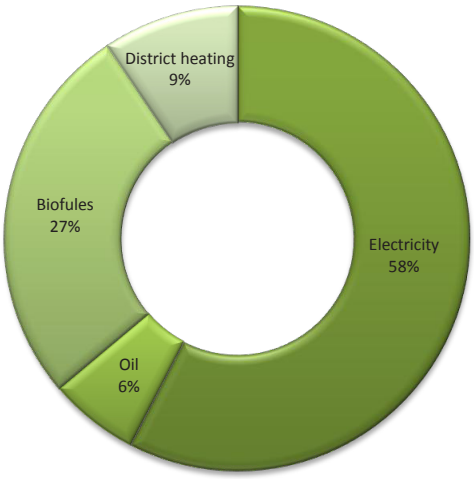


*Fig. 8. Energy source*

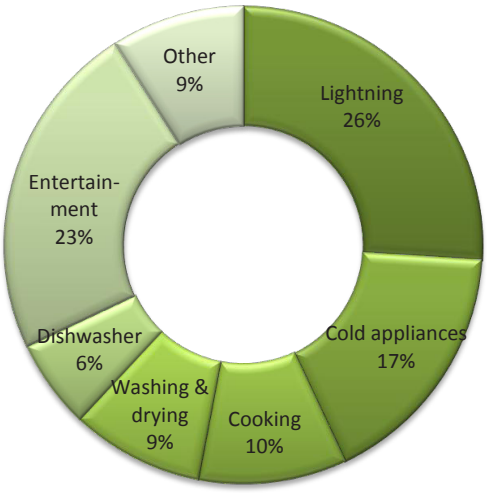


*Fig. 7. Energy usage distribution between standard appliances*

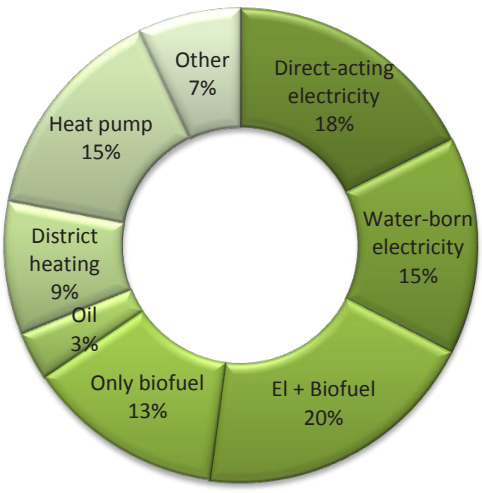


*Fig. 9. Heating system*

### 4.1.3 Environmental aspects of electricity

Electricity does not create any pollution locally where it is used, but carbon dioxide emission and other environmentally negative substances may be admitted at the production site depending on how it is produced. Wind power and hydropower plants produce almost no emissions at all but can create other negative environmental effects like disrupted water flows. In Sweden electricity is mostly produced by hydropower and nuclear power. The electricity produced in Sweden is to 97% produced without any carbon dioxide emission. In an international perspective mineral fuels are although completely dominating and the emissions levels from mineral fuels are extensive. Since the power distribution grid in Scandinavia and Europe are connected, power are imported and exported across the borders. (Energirådgivningen, 2010)

Today there is no comprehensive environmental marking of energy according Gustav Ebenå branch head at Energimyndigheten, this is due to the complexity of weighing different energy sources, their production manner and the long term environmental impact against each other. Carbon dioxide emission is possible to calculate, but according to Gustav Ebenå one should be aware that carbon dioxide emission is not an absolute measurement but rather an indication of the total impact.

Energirådgivningen (2010) recommends two ways of calculating the carbon dioxide emission of electricity, the "Nordic mix " and the "margin way". The "Nordic mix" approach is to divide the total carbon dioxide emissions of the energy production in the Nordic countries with the number of kilowatts produced. Since the Nordic countries electricity production is almost carbon dioxide free, due to that most of the energy is produced by water power plants and nuclear power plants this figure will be small, around 100 gram per kilowatt produced in carbon dioxide equivalence. The margin approach is to calculate how much carbon emissions that will be saved by reducing the energy usage. Sweden import a few percent of coal power plant produced electricity from Denmark and Germany and this import is what first will be decreased when reducing the energy consumption. This means that the energy saved by the users will correspond to a much higher figure of carbon dioxide, around one kilo carbon dioxide per saved kilowatt hour. (Energiradgivningen, 2010)

There are different opinions on which approach to use. However Energimyndigheten (2010) recommends that when calculation ones households total emissions it could be preferable to use the "Nordic mix" approach and when calculation what impact changes will have the "margin way" is better, for example when changing heating system.

### 4.1.4 Environmental aspects of District heating

District heating is according to Energimyndigheten (2010) a good heating selection from an environmental perspective. The Swedish district heating system is described as the most important factor for the decrease of Sweden's carbon dioxide emissions since the ninety's according to Svenska Fjärrvärme (2010). The district heating system has made it easier to use bio-fuels, has increased the efficiency and use spill heating from for example waste disposals. However because not all district heating power plants use bio fuels or spill heating there are still some emissions.

The Swedish district heating system emits according to ERA (2010) an average of 94 g carbon dioxide per kilowatt hour. However according to Naturskyddsföreningen (2010) the emission varies a lot depending on different power plants. The average district heating power plant is powered by 13% mineral fuels, but for example Värtaverket in Stockholm is powered by more than 25% mineral fuels. The district heating system has the potential to be run on entirely renewable bio energy and a lot of investments has been made and are currently being made in order to decrease the usage of mineral fuels.

According to Energimyndigheten (2010) it is impossible to estimate a general figure for how much district heating emits. Different plants use different types of raw materials and different system has different energy losses. Energimyndigheten (2010) recommend the user to check with the local power plant in order to estimate a figure.

### 4.1.5 The electricity price

Sweden, Norway, Finland, Denmark and the north of Germany have a common electricity market, Nordpool where the electricity price is set. The price at Nordpool determines how much the utility companies have to pay when they buy electricity for their customers. There are a number of factors that affects the energy price, among others the amount of energy that is currently being produced. If for example the hydropower basins are low on water or nuclear power plants are closed for maintenance the price will likely increase. The energy price is also affected by international factors such as fuel prices and exchange rates. If the price on oil or coal changes it will also affect the price since a part of the electricity production especially outside the Scandinavian countries are coal and oil based. The electricity is both imported and exported between the Scandinavian countries and the rest of Europe and therefore the energy prices are linked to each other. (Energirådgivingsbyrån, 2010b)

In Sweden there are basically two different types of electricity price models for consumers. Floating price and fixed price. The floating electricity price is set based on the current price at Nordpool and is updated every month. The fixed price is set to a specific price under a predefined time period. The price consist of, taxes, the energy company's supplement charge and the fee for the electric certificate. The government introduced the electricity certificate as a fee that will be used to increase the renewable energy production. On top of this, all inhabitants in Sweden have to pay a separate invoice for the transfer of electricity. This charge corresponds to the amount of energy transferred.
(Energimyndigheten, 2010)

### 4.1.6 District heating energy price

When installing district heating there is an initial cost for installation and connection to the grid. Depending on what the user pay as initial cost the price per kWh will differ. What municipality and the amount of users in that area also affect the energy cost. There are large differences between different areas in Sweden according to Energimyndigheten (2010a). The price per kWh of energy also depends on the time of year and is set separately for winter, summer and spring/autumn. There are also price models with a fixed price set over the entire year (Göteborg Energi, 2010a).

### 4.1.7 Exibea AB

André Mellin and Joakim Ottander founded Exibea AB in 2008 as a result of their master thesis work Electricity Consumption Visualization performed at Chalmers and Lunds University. Exibea AB vision is:

> *"Our vision is a society without a waste of energy and to achieve this we are driven by the conviction that it should be fun to save energy and at the same time provide the individuals effort with a lowered cost"*

Exibea AB has developed a product called Eliq that provides the user with real time feedback information about their electricity usage in the household. Eliq will be launched on the Swedish market during the autumn of 2010. Eliq provides the user with feedback concerning their current electricity consumption, see figure 10, as well as saves historic information. This means that the user can see his or her electricity consumption on a weekly, monthly and yearly basis, see figure 11-13. Eliq provides information concerning the electricity consumption in Watts, carbon dioxide emission and cost. The product communicates wirelessly with a transmitter that is mounted on the electricity meter. The transmitter counts the light impulses and the distance between the impulses that the electricity meter sends out. By doing so the product can calculate the total energy output of the electricity in the household. Today the product has an update speed of 10 seconds. Eliq is currently being tested in a number of households in the Gothenburg area. The World Wildlife Fond WWF elected Exibea AB as one of seven Climate Solver-companies in 2009.

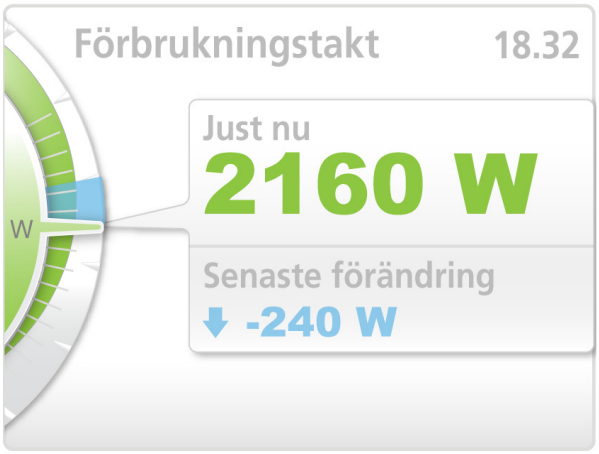


*Fig. 10. Current comsumption*

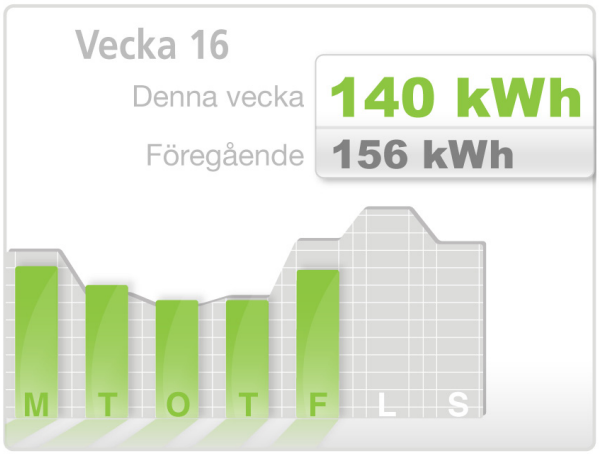


*Fig. 12. Weekly view*

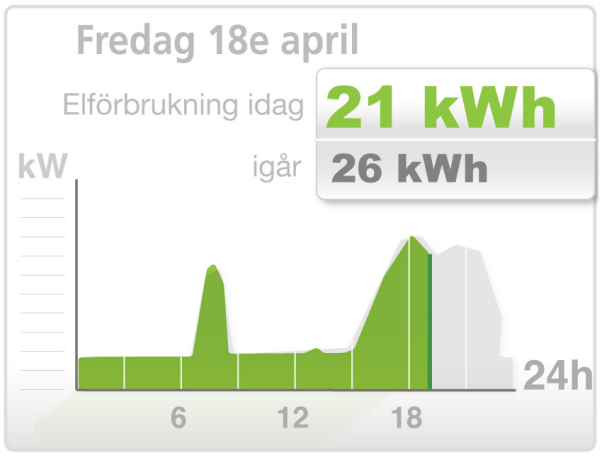


*Fig. 11. Day view*

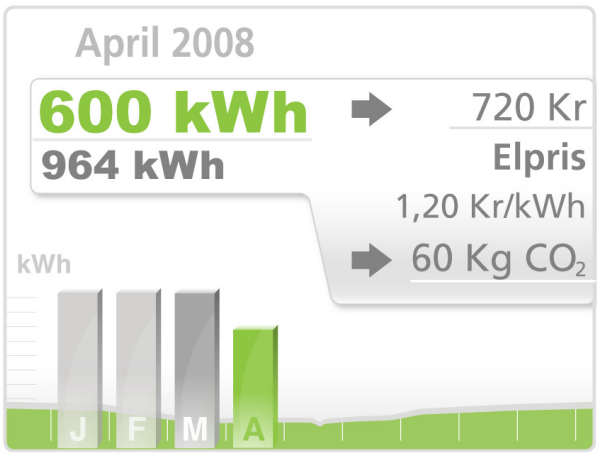


*Fig. 13. Monthly view*

## 4.2 Empirical pre-study

### 4.2.1 Benchmarking

What can be concluded from the market analysis is that there is a vast number of products on the market that offers feedback on electricity usage and control over specific devices in the household, an example of such a device can be seen in figure 14 (picture 1, 5 and 11). There are also a number of products that can measure and provide feedback on the electricity usage in the entire household. Within both of these product segments a lot of the products have a technical approach, i.e. they give the appearance of that there is a certain technical knowledge that is needed to understand the products. During the market analysis a number of products were also found that could provide feedback and in some cases manage the entire households energy usage, these products although were either sold only to utility companies, larger property owners or needs to be connected to a smart grid in order to function. Some of the products had also not yet been launched on the market, which may make them more visionary, see figure 14 (picture 2). In figure 14, a number of products identified during the market analysis can be seen. See appendix 5 for the entire market analysis. The conclusion made after the market analysis was that there is a lack of a product that can give feedback on the entire household's energy usage independent of energy source. There is also a lack of products that have a strong user perspective and a more "designed" look.

Picture 1, 5 and 11 show a device that measures the electricity consumption of a specific appliance.

Picture 3, 6, 7 and 8 show a device that measures the entire household electricity consumption.

Picture 4 shows a device that measures the water usage in the shower.

Picture 2 shows a device that measures and control the entire energy usage in the hosuehold.


*Fig. 14. Market analysis*

### 4.2.2 Target group

Before the project started the target market was set to Swedish consumers in collaboration with Exibea. To further diminish the target market the use of energy in Swedish households have been investigated to identify the target group that would have the largest potential gain of a product that decrease the energy usage. According to Eon (2010) the total energy consumption of an average one- and two-dwelling household is 25 000 kWh/year and an average apartment 12 000 kWh/year. The three energy usage areas in a household is heating, hot water and household electricity. Generally in Sweden all energy consumption except household electricity is included in the rent of an apartment (Linden, 2005). Because of the overall lower energy consumption in apartments and the fact that a large part of the energy consumption is included in the rent, which in turn delimits the economic incentive of actively reducing the energy consumption, the target market was set to one- and two-dwelling house owners.

The more people a household contain the larger energy consumption according to Lindén (2005). The energy consumption for heating is independent of the amount of people in the household but household electricity and hot water is not. The target group is therefore further defined to households with two or more inhabitants.

### 4.2.3 Result from first interview set

From the five telephone interviews conducted the project team could identify three areas that would be interesting to further investigate in a more comprehensive questionnaire. These three areas were named energy consumption, motivation and feeling of control. Down below the most interesting result from the telephone interviews are presented in the three categories identified. For the entire non-translated transcribed interviews, see appendix 6.

*The energy consumption*

Aspects that came up during the interviews in the area of energy consumption were that there is a lack of knowledge about where the energy in the household is being consumed, which makes it hard to know how much a certain change, effects the total consumption.

All the interviewees also estimated that they consume less energy than average, which is a possibility but could also be a misconception.

> *"Less, the lights are not on everywhere, we have a low indoor temperature"*

*Motivation*

In the motivation area money were perceived as the most motivational factor, which is inline with theory, see section 3.3. Environmental aspects were also perceived important for reduced energy usage.

> *"Environmental care but money is of course also a factor"*

*Feeling of control*

A lack of feeling of control was also identified which can also be seen as a result of the lack of knowledge on where the energy in the household is being consumed and the difficulty in knowing how to make a change that produce the wanted result of a lower energy usage. When one interviewee was asked if he or she had been surprised by the electricity bill, the interviewee answered,

> *"I always get surprised so nowadays I don't get surprised anymore"*

The result from the telephone interviews founded the basis to further investigate the three areas in a questionnaire in order to be able to valid that the information found were not only the five interviewees' thoughts and to further explore if there are additional needs.

### 4.2.4 Result from the online questionnaire

The results from the online questionnaire were compiled into the three areas that were identified during the first set of telephone interviews, see section 4.2.3. When the online questionnaire closed 148 respondents had answered. The gender and age distribution within the sample was evenly distributed for the entire sample as well as for the one- and two-dwelling house owner solely.

The sample although contained more people with a higher level of education around 80 % which needs to be kept in mind as it may affect the result. Down below the one and two dwelling house respondents result is accorded for.

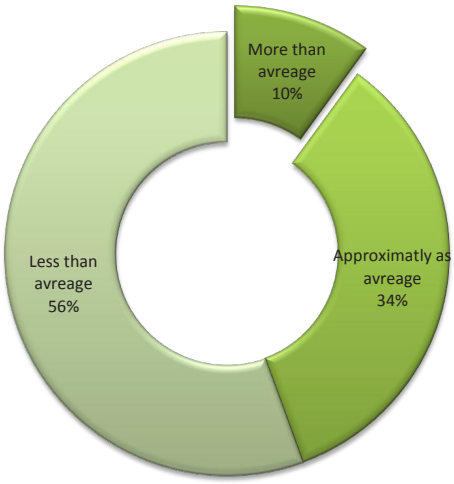


*Fig. 15.* *"How much energy do you think you consume in relation to similar households?"*

### *The energy consumption*

The conclusion is that people lack knowledge of their energy consumption. Around 60 percent are uncertain about how much their energy bill will add up to each month and more than two thirds are uncertain about how the consumption is divided between heating, household electricity and hot water. Another interesting finding is that only 10 percent believed that they consume more energy than an equivalent household, but 56 percent believe that they consume less than an equivalent household. 34 percent believes that they consume about the same as an equivalent household, see figure 15.

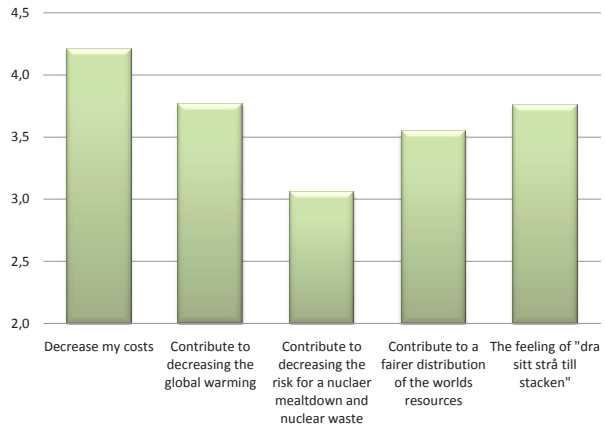


*Fig. 16.* *"What motivates you to decrease your energy consumption"*

### *Motivation*

Reducing cost was identified as the most motivating factor in order to reduce the energy consumption, see figure 16. The second most motivating factor was reducing the global warming follow by the perceived feeling of contributing to the society. A fairer distributing of the world's recourses and reducing the risk of a nuclear power plant meltdown was not as motivating. That cost was identified as the most motivational factor concur with the theory is section 3.2.

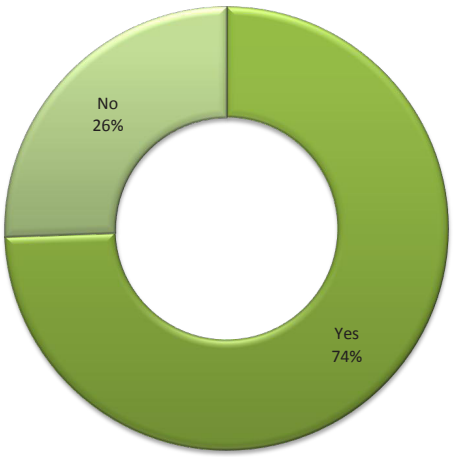


*Fig. 17.* *"Have you ever felt uncertain or worried about what your energy bill will add up to?"*

### *Feeling of control*

Lack of control was identified as a possible problem and the questionnaire confirmed this. More than two-thirds states that they have been worried or uncertain about how much their energy bill will add up to, and two thirds stated that they did not trust their utility company to charge them the correct amount, see figure 17.

### 4.2.5 Second interview set

Eight areas were identified in the KJ analysis that derived from the interviews with the households that had tested Eliq for a few weeks. These eight areas were named awakening, change, when and how, who, positive things, improvement and finally placing. The results from all areas except product malfunction, as this area was not interesting for the development work, are presented below. For the interviews and the original non-translated quotations from the interviews, see appendix 7.

*Awakening*

All respondents in the interview mentioned that they had in some way been surprised by at least something in the household's electricity consumption, for example the washing machine, the water kettle, the sauna or storage radiator. Almost all also stated that they had gained a better knowledge of their electricity usage and some were surprised that they had not been more on top of the subject before. Some quotes from the interview are presented below.

> *"I obviously did not have sufficient knowledge before…"*

> *"It shows when you are at home. I think I have gained better control"*

*Change*

Almost all respondents had in some way changed their behaviour after receiving feedback. Changes that were made were filling up the washing machine, pulling out the electric plug and installing energy save programs on the computer. Some quotes from the interviews are presented below.

> *"I pull out the plug more often now... Although I thought I had turned things off before, I obviously had not…"*

> *"The computer consumed more than we thought, so we installed a program that makes it turn off on its own"*

> *"The water kettle consumed more than the induction stow so we have thrown that one out"*

*When and how*

The product was used most days in the week and what time of day depended on when the test participants were at home. When specific activities were performed the view showing the current consumption was frequently used while to get an overview and compare data between days the statistics part was used. Depending on who was home and who performed the activities the use of the product shifted. Either the focus was to learn specifically what different activities consumed or to learn how different changes affected the total consumption.

> *"Every day, usually when we come home, check how were doing in comparison to yesterday for example"*

> *"My husband checks the statistics more while I check current consumption more. He checks how the day has been as he works during the day"*

*Who*

In the area of who the results were consistent between the households that the product was used by the adults. In the interview group there was although only one family that hade kids living at home that were not infants.

*Positive things*

In the area of positive things, it can be seen that both the real time feedback and comparative feedback was appreciated among the test households. The real time feedback was appreciated for identifying specific appliances and their electricity consumption. The comparative feedback on the other hand was appreciated for getting a holistic understanding of the consumption and see how changed behaviour affects the energy consumption.

*Improvement*

In the area of improvement one need came up and that was the need for being able to in some way differentiate the different appliances from each other.

> *"I miss information about what the different appliances use"*

> *"Do you have a list over what standard appliances in the household use that you could email me?"*

*Placing*

Unfortunately as the product did not cope with cold weather that well and the transmission from the transmitter had not been optimised, the results from the area of placing is non-representative as all household stated that they placed the product where it had the best transmission, in all case the living room.

## 4.3 Conclusion pre-study

The conclusion of the pre-study is that the energy consumption in the world and Sweden is an environmental and sustainability problem. To turn this trend around there is not just a need for sustainably produced energy but also a need to reduce the energy use in total. Energy consumption in households in Sweden has been discussed frequently in media and politics and there are measures being taken, for example monthly readings of the electricity meter, see section 4.1.1. As was found in the pre-study this is although not enough, the users still lack knowledge, consciousness and motivation to change their behaviour. That there is a need for changing behaviour is concluded in section 3.2. Today the user lacks a relation to energy and therefore has difficulties to know where there are savings potential. The user also is in some ways unaware of the energy usage today as it just exists like an endless source in the wall. This problem exists within the entire energy usage in the household including heating, hot water and household electricity.

# 5 PRE-DEVELOPMENT

In the pre-development chapter the user is defined and goals concerning the wanted expression and interaction of the product are set. A wide initial brainstorming and related evaluation is further included. In addition to this a technical investigation is concluded to define the possibilities and limitations that exists within the area. Finally a specification list is made for the further work of this project.

## 5.1 Defining the user

### 5.1.1 Personas

Three personas were created in the pre-development phase in order to cover the broad target group and these are presented below.

*Lars*

Lars is a 32 years old engineer that at the moment is on paternity leave with his 1,5 month old daughter Lisa. Lars is married to Ann and they all live in a spacious house outside Stockholm. Lars spends most of his days doing household work and looking after their daughter. When he gets a moment to himself he likes to surf the Internet for funny videos or listen to music on his new Bang o Olufsen stereo. Lars likes new technical gadgets and is always on the lookout for new toys as Ann sees it. Lars and Ann have their finances in good order but are still a bit concerned about their energy cost. Since they moved from an apartment in the city only six months ago they are not used to live in a house and have no idea what consumes what or if it is normal. Since their daughter was born both Lars and Ann is trying to be more environmental friendly and buy ecological products if possible. They feel it is important to try to preserve the beauty in nature for the future generations. See figure 18 for a picture of Lars and figure 19 for Lars's kitchen.

*Lena*

Lena is a middle-aged women living with her husband Hans and their three teenage kids, Alexander, Erik and Sofia. Lena is working in a paint shop which she loves, as one of her biggest interests is handicrafts. Lately Lena has been working a few extra hours each week in order to earn some more money, it is not inexpensive to provide for three teenage kids. The whole family is into sports, Hans is even the coach for Erik's soccer team. During the weekends both Lena and Hans like to take long walks in the nature just outside their home in one of Gothenburg's nicer suburbs. See figure 20 for a picture of Lena and figure 21 for Lena's kitchen.

*Gustav*

Gustav is a retired professor at Gothenburg University. He is married to Monica who works as a manager in the local pharmacy. They have two children that have both moved out a few years ago, and their newfound spare time has been filled with social activities. Gustav has started to play golf with some colleges from the University and has now a handicap of 26, which he is very proud of. During the summer time they both put down a lot of effort to keep their garden in an almost perfect condition, especially the snapdragons that are Gustav's babies. When Gustav don't play golf he is almost always involved in some kind of technical project. Last year he connected an electric engine to Monica's bicycle. Both Monica and Gustav care for the environment, which is reflected in their new small diesel car, which has just enough space for the golf clubs. See figure 22 for a picture of Gustav and figure 23 for Gustav's kitchen.

*Fig. 18. Lars*

*Fig. 19. Lars's kitchen*

*Fig. 20. Lena*

*Fig. 21. Lena's kitchen*

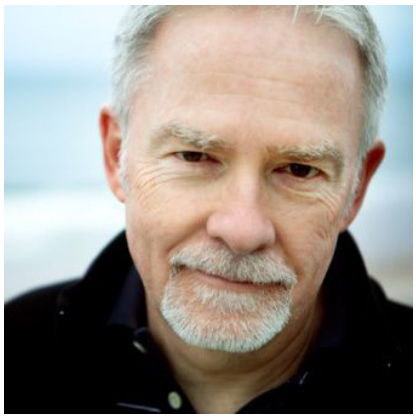

*Fig. 22. Gustav*

*Fig. 23. Gustav's kitchen*

### 5.1.2 Scenario

A scenario was created based on a normal day in a potential users life, compiled into a mind map, see figure 24.

## 5.2 Product vision

### 5.2.1 ViP Vision in product design

The results from the ViP method have been compiled into a list of characteristics for the product context together with a metaphor describing the wanted interaction between the user and the product. The interaction is further defined by five characteristic words together with the thoughts behind the metaphor.

*Step 4 designing the context*

**Trends**

- Eco awareness is progressing more and more
- Eco awareness is becoming a status symbol
- There is a reluctances towards the vast amount of choices that can be made in the society
- A lot of people feel a hopelessness concerning the environment
- There is a growing trend to enjoy life rather then just make money and buy things
- Do it by yourself, there is a desire to do things from scratch like growing your own plants and cooking food.

**Developments**

- There is still a strong technological development progressing
- Increased use of political measures to create a more environmentally friendly society
- The effects of global warming is becoming more and more apparent
- The information society is growing
- Energy prices are increasing
- Globalisation, the world is getting smaller and smaller
- More and more are recycled

**Principals**

- People are comfortable
- People are not willing to worsen their situation if there is not a clear winning
- Money is an important motivational factor

*Step 5 Interaction vision*

**Metaphor**

"Looking into the mirror after a day on the beach examining the difference between the newly tanned and the covered white skin on your body."

Characteristic words describing the interaction

- Objective
- True
- Self-reflecting
- Guiding
- Addictive

The main idea to portray with the metaphor is a product that communicates an objective reflection of the user's behaviour. A mirror is in regard to this a perfect metaphor as it only reflects what is without any judgement added. The mirror lets the user see what ones actions result in and track changes but does not in any way judge the behaviour. The mirror also guides the user in his or her choices as it lets the user see where there are changes needed and by so let the user decide if and when to make

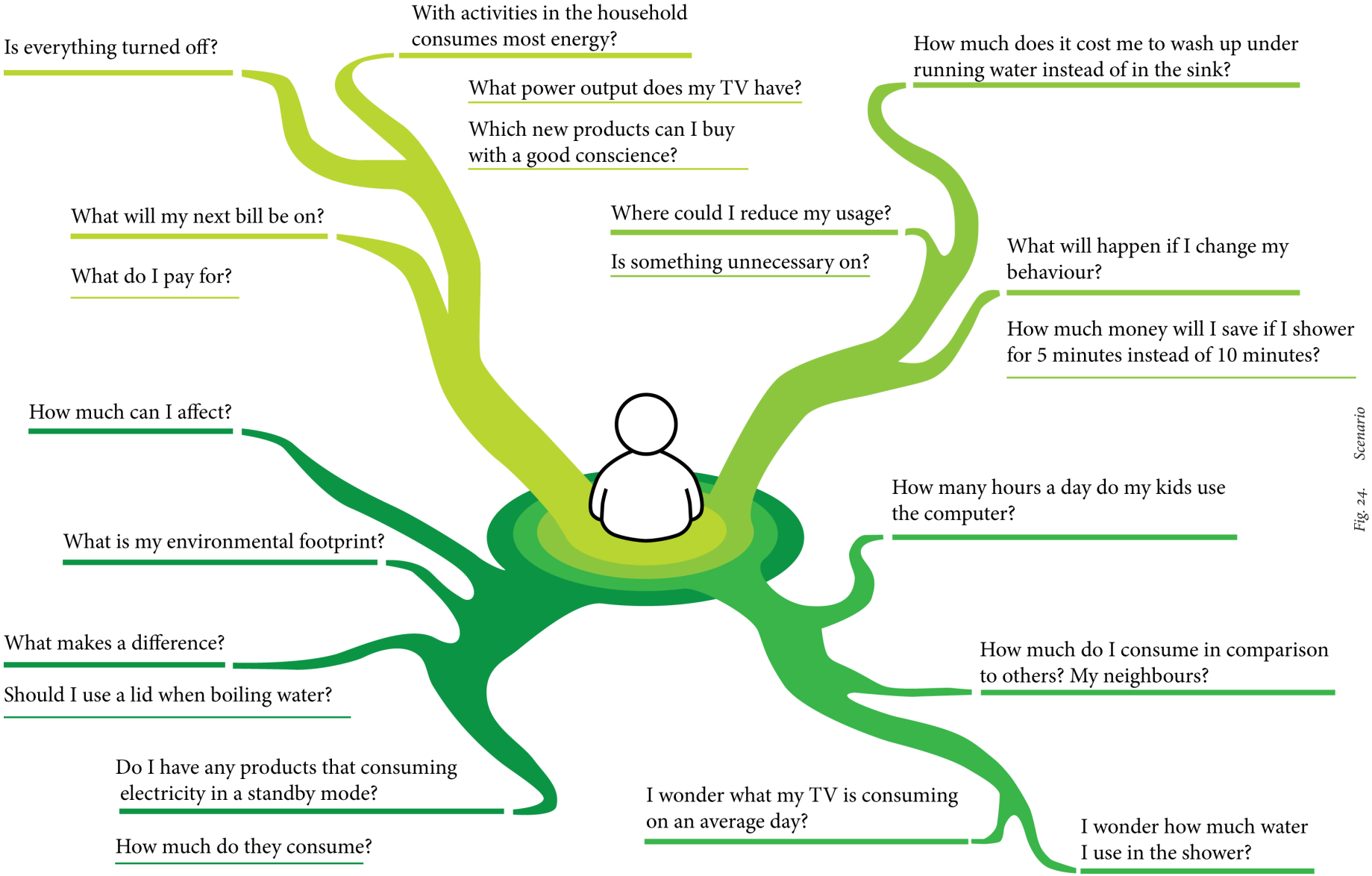


*Fig. 24. Scenario*

a change, in this case maybe a change of beachwear. The thought is also to create a need for this reflecting information so that the user will feel that it is a natural part of everyday life to check his or her status in the mirror.

### 5.2.2 Image boards

Three image boards named consensus board, expression board and context board were created to define the direction of the design work and create a common understanding within the project team. The consensus board, see figure 27, was build around the three words that were defined as core values within the product team. These were sustainable, simple and innovative. The expression board reflects the desired feeling of the product both in terms of graphics and the product shape's expression, see figure 26. The expression strived for was simple, friendly and light but still competent and trustworthy. In the context board, see figure 25 the project group collected pictures of what was perceived as a contemporary Swedish home environment in order to get a good feeling and understanding of the product environment.


*Fig. 25. Context board*

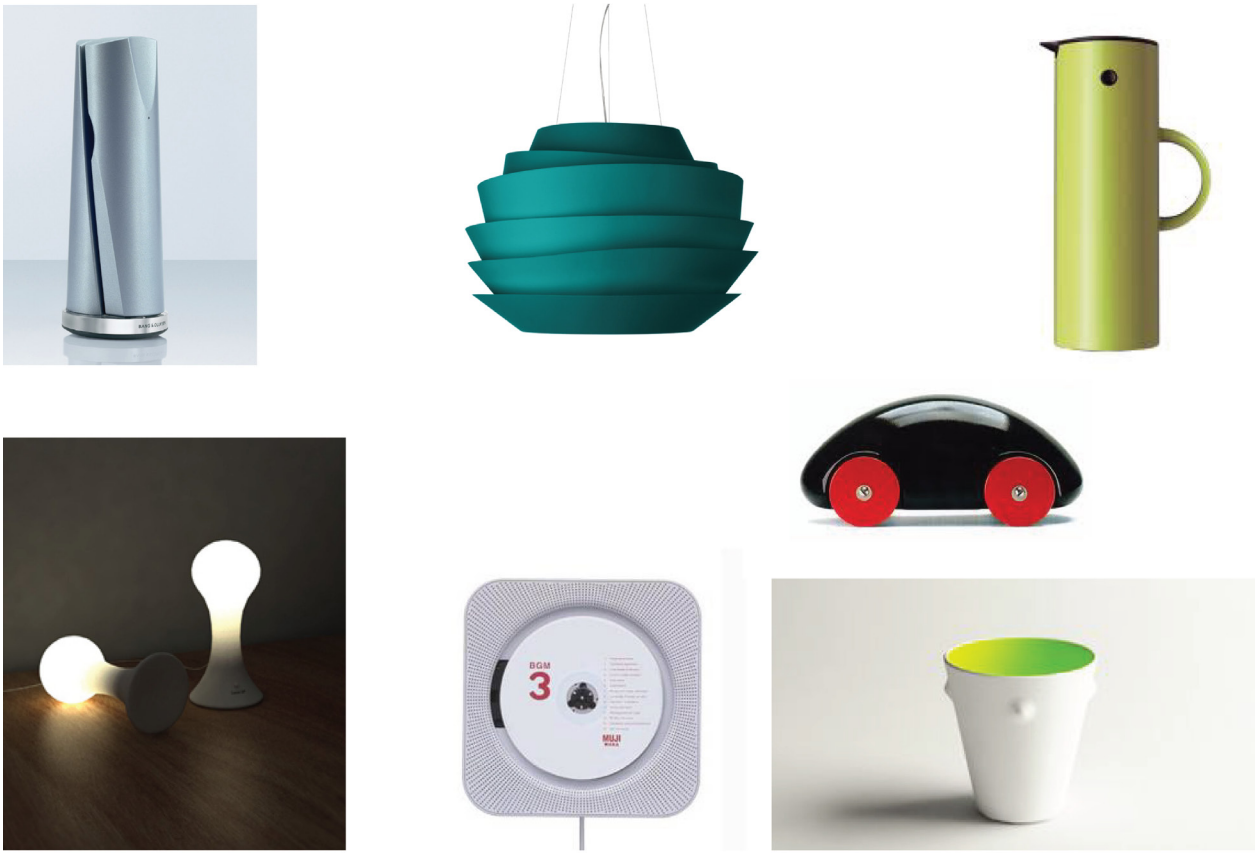


*Fig. 26. Expression board*

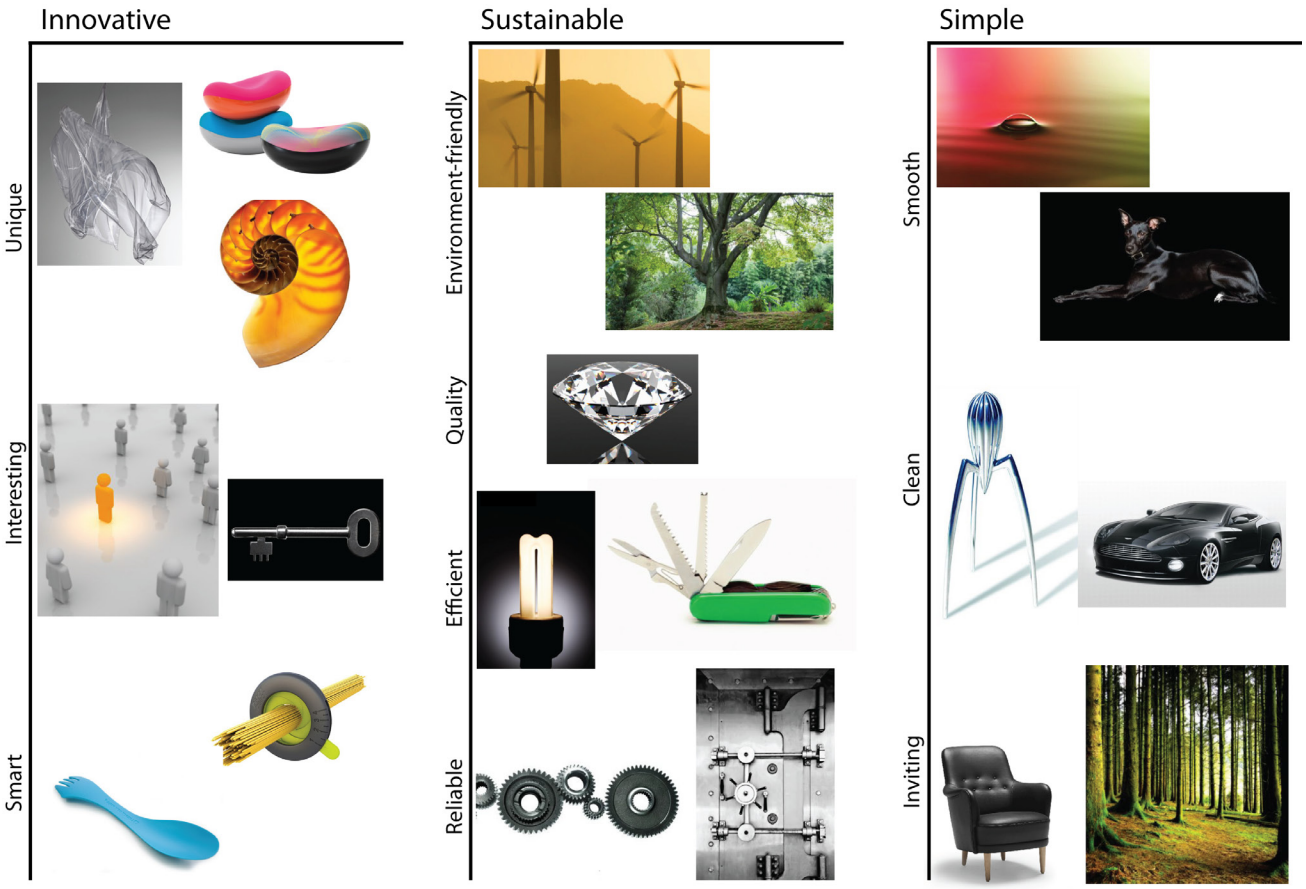


*Fig. 27. Consensus board*

## 5.3 Initial development

### 5.3.1 Wide brainstorming

The result from the wide brainstorming session that was made in a broad manor around the question, "How to make energy usage visible?" was compiled into list of different approaches how to visualise the energy consumption, see list 1. These approaches can be applied in different ways and three categories came up during the brainstorming session neutral, comparing and punishing/judging. Neutral ideas were ideas that in some way present facts objectively, for example letting the user know that a certain action will cost 10 SEK. The comparing approach was ideas that used the possibility to create awareness by comparing the user's actions to something else, for example the user's neighbours. The last category that came up was punishing/judging. These ideas could for example be clearly prohibiting and/or control the users energy usage. Some of the ideas that came up during the brainstorming session can be seen in figure 28.

*List 1*

- Real number
- Movement
- Vibrations
- Colour
- Light
- Position
- Amount
- Emotional triggers

### 5.3.2 Evaluation

The brainstorming session provided the project group with a wide range of ideas and formed the basis for the decision of what type of product that was going to be developed and the further focus of the project.

After the brainstorming session, the project group concluded that in order to provide the user with an efficient tool to save energy the device needs to be able to communicate somewhat complex information. The information needed was for example cost information and information regarding different energy types. Therefore the project group decided that some kind of display unit is needed.

The product could either consist of just a display unit or a display unit complemented with another unit, for example detailed information could be found on a computer and information regarding the real-time consumption could be displayed on a more decorative device. These two approaches were evaluated within the project group and it was decided to continue to work on just one display unit. The major advantage with this approach is that the user can without starting another device access all information and will therefore according to the project team probably use the information at hand more frequently than if an additional action was needed.

The product could be designed as a free standing product or be built as an application in for example a smart phone. The project group weighted the alternatives against each other and found that both ways had potential. The major benefit with creating a new device is that it will be able to provide momentary feedback to the user at all times and by so creating awareness which is in line with theory, see section 3.2. On the other hand the major benefit with creating an application to an already existing display unit is that it would probably be cheaper for the user and there would be no need to manufacturing a display unit. A disadvantage with integrating the product as an application is although that the user may be distracted with other applications available and that the market for the product would be limited to users that already own or are inclined to buy the additional display unit, in this case a smart phone.

The project group decided after consideration to focus on creating a new product with a display because it was believed to have a greater energy saving potential. However the project group also decided that the resolution and screen size of the display should be similar to smart phones of today in order to make it possible to create a complementary mobile application with just minor adjustments.


*Fig. 28. Early sketches*

### 5.3.3 Technical development

In order to present the information needed in the interface, different technical possibilities were evaluated to verify the possibility to acquire the information.

*Cost estimates*

A forecast of the monthly cost will be provided in the interface. The estimation will be calculated using the last 30 days average usage pattern and the assumption that the rest of the days in the upcoming month will be equal in usage. This will provide a rough value at the beginning of the month that will become more and more accurate as the month progress. As the price might fluctuate over time as well as the consumption if the user has a floating energy price, the price also needs to be estimated.

The electricity energy price is built up by a number of factors, see section 4.1.5. However there are only the electricity certificate price and spot market price that are floating and according to Gustav Ebenå the electricity certificate can be considered as constant as it at most changes once a year. By connecting the device to the Internet and the spot market the price fluctuations can be tracked and a cost estimate can be calculated. To be able to make the estimation as accurate as possible the user although have to add the utility company's specific fee.

*Energy usage areas*

It is beneficial to be able to divide the total energy consumption into different energy usage areas, in order to be able to track changes and better understands the consumption.

The energy in Swedish one- and two-dwelling households is mainly generated by three different sources of energy district heating, electricity and bio fuel, see section 4.1.2. Exibea AB has today a cooperation with a company that provides a system that gives feedback on the energy usage provided by bio fuel systems. Due to this bio fuel as an energy source will be excluded from the development work during this project. District heating and electricity will be of focus in this development project.

For households with district heating and electricity the differentiation between household electricity and district heating is suggestively done by attaching a transmitter on the district heating meter and one on the electricity meter. This is according to representatives for SVM Metering (2010) quite easy to achieve and there are products out on the market today with this ability. To differentiate between hot water and heating which are both produced by the district heating is a bit more difficult but can be done through the use of an algorithm that analyses the flow of the district heating. This type of algorithm has already been developed by another Swedish company called Kyab that could be a suitable partner for Exibea AB.

For households with electricity as the energy source for the hot water there are two options to calculate the electricity consumption of the water heater. One solution is to connect a smart point, see section 5.3.3, to the water heater. It is a simple and accurate solution, but since some water heaters does not use a regular wall socket it may not work in some situations. The second solution is to use a program with a smart algorithm. This program will notice if the total electricity consumption increases or decreases with the same energy output as the water heater.

*Table 1*

| Heating system | Number | Number (%) | Smallest (W) | Largest (W) | Variation (W) | Manufacturers |
|---|---|---|---|---|---|---|
| Air - Air heat pump | 300000 | 17% | 150W | 1,7kW | Large | IVT, KCC |
| Water - Air heat pump | 100000 | 6% | 1,43kW | 4,3 kW | ca 10-20% | Nibe, KCC, LVI |
| Exhauste air heat pump | 160000 | 9% | 0,7kW | 0.9kW | Small | IVT |
| Mount- soil -lake heat pump | 340000 | 19% | 1 kW | Stor | Small | IVT, KCC, Nibe |
| Electric pan | 500000 | 29% | 9 kW (3kW) | 17 kW | Small | Nibe, Relek |
| Eectric radiators | 500000 | 29% | 300W | 3kW | Small | LVI, PAX |
| Water heater | Många | | 1 kW | 3kW | Small | IVT, Nibe |

If the algorithm registers an increase it will start to count the energy consumption and if it registers a decrease it will stop the energy count. Thanks to that water heaters have a rather high electricity output, see table 1 the risk of other products having the exact same electricity output is low.

For households with electricity as sole energy source the differentiation between household electricity and heating will suggestively be done through an algorithm as well. During the night when only the heating and hot water heater is working except for low consuming products as the refrigerator, the energy output difference associated with heating and hot water can be registered.

By using the same principle as for the hot water heater, the energy consumption for the heating devices in the household can be counted and registered. However this idea requires that the heating devices have a constant power output, that is the power output does not vary over time. A number of heating systems has been mapped and are presented in table 1. The table shows that almost all systems have a constant power output except for air- air heat pumps.

The conclusion is that it is possible to differentiate the different energy usage areas independent of if the user have electricity or district heating as hot water or heating source.

*Devices*

The project group investigated possible solutions for collecting information from the different devices in the household. After brainstorming ideas and searching for information three concepts were compiled. The concepts represent different ways to collect information and are presented below.

**Concept intelligent**

The core of this concept is a program that automatically calculates energy consumption for devices at home. The program uses differences in the total electricity consumption in order to calculate which device that are on or off, in the same way as suggested above for the heating.

For example if a user turns on his or her TV the total electricity output will increase with the effect of that TV. This will be noticed by the program and the program will register the TV as on, until the power output is decreased with the same amount. In order for this to work perfectly two basic assumptions must be fulfilled:

- All devices must have an unique power output
- All devices must have a constant specific power output

These two assumptions are not fulfilled by all devices in a typical household, this means that the program will not work perfectly. Estimations made by the project group conclude that only about half of the devices in a household would probably be possible to monitor.

**Concept smart clip**

In this concept a clip is being used to measure the energy flow through the cord connected to a device. The clip is placed around the cord and measures the electricity by induction. It has a built in transmitter that sends the information to the main unit. This type of solution can be found on the market today.

*Table 2*

| | Importance | Intelligent | Smart clip | Smart point |
|---|---|---|---|---|
| Additional appliance needed | 4 | 5 | 0 | 0 |
| Measure with high accuracy | 5 | 0 | 3 | 5 |
| Need for extra energy source | 3 | 5 | 0 | 3 |
| Provides control of devices | 3 | 0 | 0 | 5 |
| Guarantee functionality | 5 | 0 | 5 | 5 |
| | | 35 | 40 | 72 |

**Concept smart point**

The electricity consumption of a device is measured by a smart point that is connected between the wall socket and a device. The smart point has a built in transmitter that sends the information to the main unit. This is a standard solution that is being used by other products on the market today.

**Evaluation**

The concepts were evaluated using a Pugh matrix, see table 2, and the concept that scored the highest points were the Smart point concept. This was mainly due to the good accuracy that can be achieved and that it adds value by letting the user control specific devices. Therefore the project group decided to continue with the power point concept.

## 5.4 Product specification

The project group defined the product specification and further delimitations for the project together with Exibea AB. The product specification consists of a descriptive part called the product vision where the product content is defined and also a specification list of the display unit, see list 2. Delimitations are also included in the specification list.

### 5.4.1 Product vision

The vision is to develop a product that make the users conscious of their energy usage and provides the users with a tool for reducing energy usage through the use of feedback. The product should fit into a contemporary Swedish home where it should serve as a reminder of the energy usage. The product should provide the user with feedback concerning the entire energy usage in the household including household electricity, hot water and heating in an easy to understand manner for the defined target group. The product should not be judging but rather help the users to reflect on their energy consumption in order to create long term behaviour change. Since it should be attractive for the consumer to buy the product, it is important that the product does not feel obtrusive but rather work as a guide and servant providing information that the user can choose to act on or not.

The product should although clearly visualise increases or decreases in the energy consumption. The product should include energy feedback both in real-time and store data to provide the user with the ability to see and understand how changes in behaviour effects the energy consumption. The product should also be able to provide the user with device specific energy consumption information. A base for competing with one self and/or others should also be included, but the main goal should be to let the user take control over his or her energy consumption and by so provide the user with a tool for making conscious energy decisions.

*Specification list 2*

- Screen size: 4” screen, resolution 400 x 300 pixels (Fit Smartphone standards)
- Screen response is estimated to be as good as the Apple Iphone is today
- The product should be able to stand on its own or be mounted on the wall
- The product is manoeuvred by a two hand grip
- The product will be launched in three years time
- The product should easily be able to connect and disconnected from the electrical cord
- The angle of the display should be adjustable
- Be able to put in standard components
- The product should express the desired expressions defined in the image boards.

*Delimitations*

- Cost will be kept in mind but no deeper cost estimations will be made
- All other energy sources except district heating and electricity will be excluded from this project.
- The smart point will not be developed during this project
- No further development of the technical differentiation of the energy usage areas will be made.
- No detailed material selection will be included in this project
- Exibea AB limitations as a small company should be kept in mind throughout the development process.

# 6 DEVELOPMENT

The development chapter consists of three subchapters. Structure and content includes the development of the interface structure together with a definition of what the different sub functions should include. The next subchapter named Sub functions and appearance and explores the different functions within the interface together with an evaluation of the developed concepts. The development of the product shape and an evaluation are also included in this chapter. The last subchapter within this chapter is named Further development accounts for the result of the further development of the interface and product shape.

## 6.1 Structure and content

The interface structure, see figure 29, is made using a Hub and spoke menu that is preferable in this kind of device, see section 3.4.1.

This type of structure lets the user selects one of six sub function and by so entering the sub function. When the user exits a part he or she returns to the main menu. This does not allow the user to access one sub function from another but in return makes the interface more lucid.

The division of sub functions were made in accordance to the perceived mental model of the intended user together with the use of the scenarios, see section 5.1.2. The sub functions defined in the structure are momentary consumption, today's consumption, statistics, report, devices and price. A specification list of the sub functions momentary, statistics, today and devices are included in appendix 8. The requirements for all sub functions can be read in section 6.1.1-6.1.6.

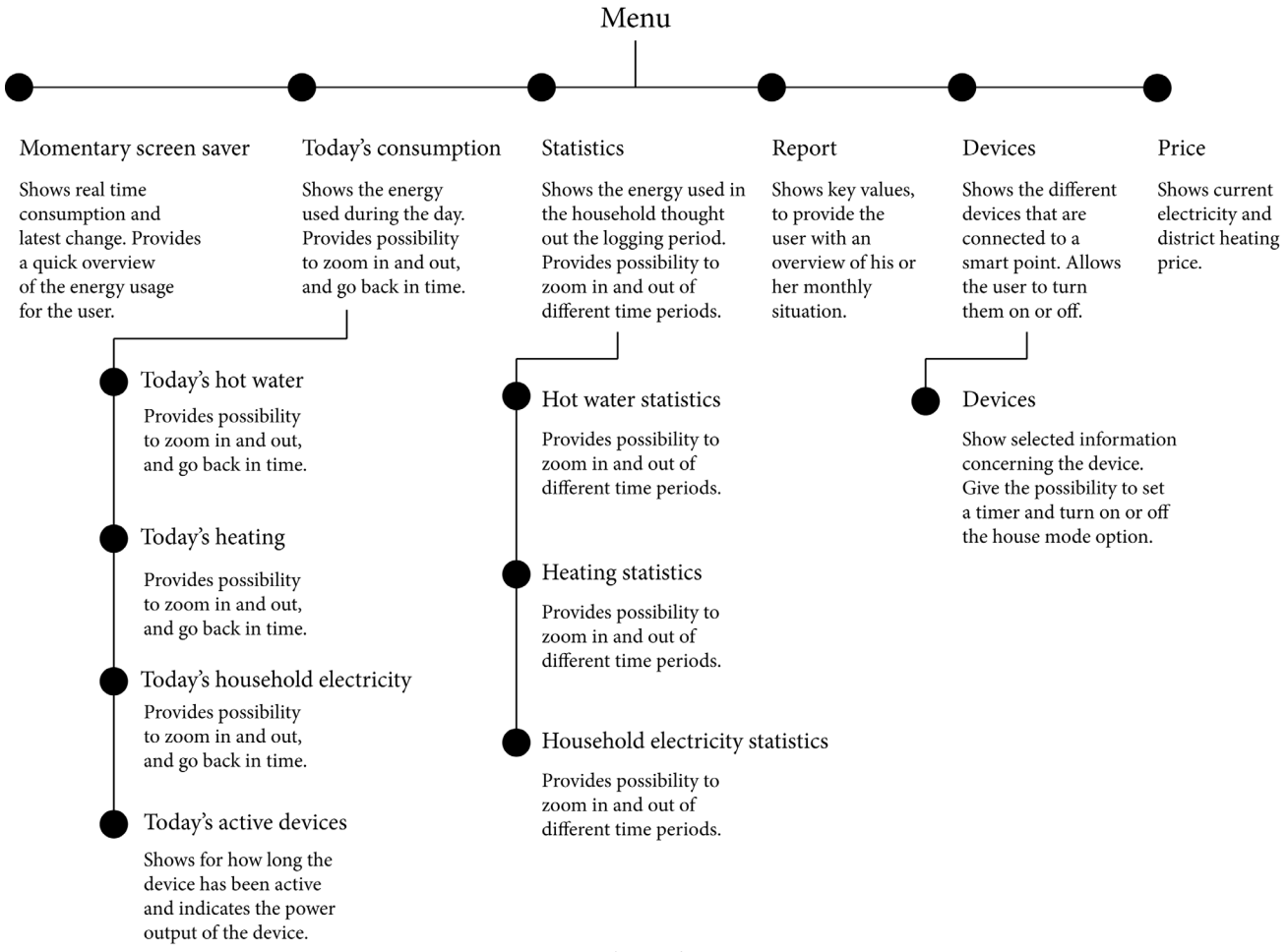


*Fig. 29. The interface structure*

### 6.1.1 Momentary consumption

In the momentary consumption sub function the user shall be provided with a quick overview of the energy consumption. Information about energy output and changes in energy consumption should also be provided. The purpose of this sub function is to attract the attention of the user so that he or she will consciously or unconsciously reflect over his or her energy consumption. The information should be able to be interpreted at a distance of 2 m. This sub function will serve as a screensaver activated by the user or automatically turned on after the product have been unused for a while. It is important that the design is informative but at the same time attractive and in no way viewed as obtrusive.

### 6.1.2 Today's consumption

The sub function of today's consumption should show the current day's energy consumption and energy output. The information should be able to be divide between the different energy usage areas of heating, hot water and household electricity. In addition to this the user should be able to see which deceives, that are connected to a smart point, that are active. The user shall be provided with both specific values and the ability to see increases or decreases in the consumption and energy output. The information provided should be readable at a distance of 40 cm. The purpose of this sub function is to provide the user with a way to closely monitor how the activities in the household effect the energy output and energy consumption.

### 6.1.3 Statistics

The sub function of statistics shall include energy consumption divided between the different energy usage areas of heating, hot water and electricity. The consumption should further be chunked into time periods that are consistent with the user's mental model of time. In addition to this the user shall be provided with both specific values and the ability to se increases or decreases in the consumption. The information provided should be readable at a distance of 40 cm. The purpose of this sub function is to allow the user to track the energy usage over a longer period of time to be able to see the long term changes made within the household.

### 6.1.4 Report

The report sub function shall increase the feeling of control for the user by providing relevant key values of the energy consumption in an easily and lucid but still comprehensive manner. The report function shall also include energy cost information.

### 6.1.5 Device

The device sub function shall include an intuitive way to control the devices connected to a smart point without risk of accidentally turning on a device. The sub function should further provide key values concerning the different devices and a relation to other connected devices. The function should also be scalable i.e. the number of devices connected to a smart point should not be limited. In the device sub function the user should also be able to see which devices that are active. A timer will also be included since this is perceived to be a desirable feature in this kind of product. The information provided should be readable at a distance of 40 cm.

### 6.1.6 Price

The sub function of price shall highlight the price situation and be easily accessible, as cost was found to be the most motivational factor, see section 4.2.4. The price sub function should be able to show fluctuating as well as fixed price. The information provided should be readable at a distance of 40 cm.

## 6.2 Sub functions and appearance

### 6.2.1 Product shape

The project group explored different shapes and ideas using sketches, clay models and models made in foam. The models were evaluated continuously during the exploration of shapes. The image boards, see section 5.2.2, were used to discuss the result and the expression of the models. The product specification list, see section 5.4, was also used for discussion and evaluation of the ideas. Some of the models created in this phase can be seen in figure 30.

*Fig. 30. Models*

### 6.2.2 Momentary

The overall goal with the momentary sub function is to create an aesthetically pleasing concept that provides informative feedback to the user of his or her current energy consumption. The brainstorming and idea generation sessions resulted in large number ideas on how to illustrate the momentary energy consumption. These ideas were summarized into five different concepts, which are presented below, see figure 31-35.

*Concept Line chart*

The energy consumption is visualized in a traditional line chart. The line chart provides feedback of for example the latest hours energy consumption. The arrow indicates the latest change. The concept provides the user with a quick overview of the energy consumption as well as the present consumption in a way that is easy to understand, see figure 31.

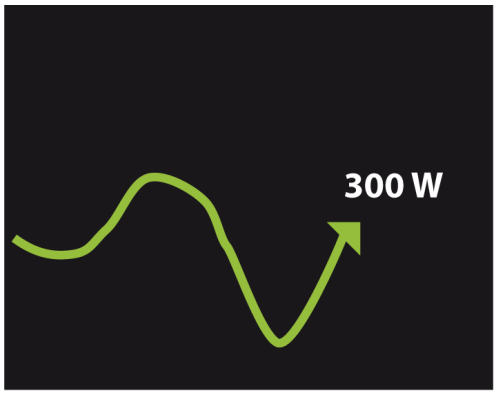


*Fig. 31. Line chart*

*Concept Watch*

The energy consumption is visualized as a bent line chart in a clock. The clock attracts attention and gives the line chart a clear time scale. The concept provides the user with a quick overview of the energy consumption as well as the present consumption in a way that is innovative and interesting, see figure 32.

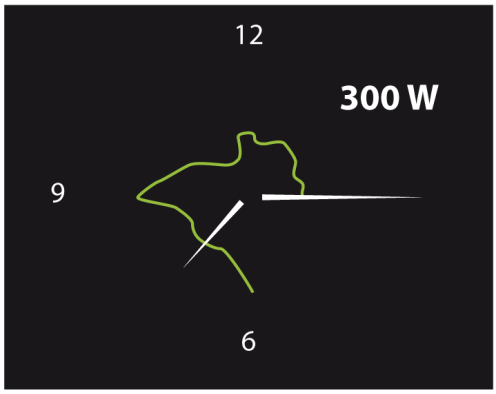


*Fig. 32. Watch*

*Concept House*

Small balls of energy are entering the screen. The speed and distance between the balls indicates the energy output. When the balls hit the house, the house is growing to show the accumulated energy consumption during that day. The concept provides the user with an understanding of energy output and energy consumption, see figure 33.

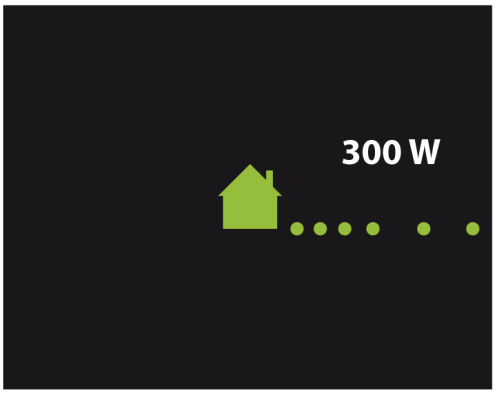


*Fig. 33. House*

*Concept Meter*

The energy consumption is visualized using a meter. It gives the user a clear indication of the energy output at the moment, see figure 34.


*Fig. 34. Meter*

*Concept Rain*

Small balls of energy are raining down and are creating a pool of energy. This is an analogy to a real pool with rain in order to increase the users understanding. The faster and more it rains the faster the pool gets filled. This could also be used to show the energy consumption relatively to a target, for example if the energy pool is filled it could flood, see figure 35.

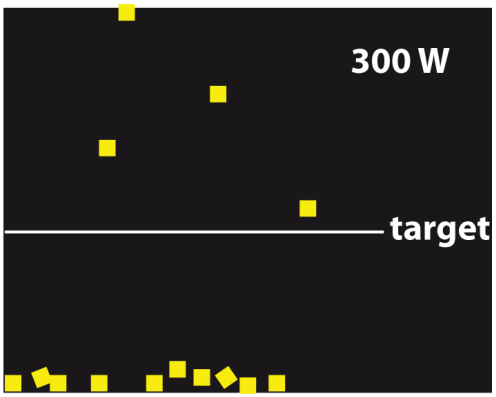


*Fig. 35. Rain*

*Evaluation*

A pugh matrix was used to evaluate the concepts to the requirement list defined in section 6.1, see appendix 9. Concept Watch was the concept that best fulfilled the requirements. Concept Watch was also the concept chosen to work further with as it combines a watch with an indication of the present and past energy consumption, this was seen by the project team to be beneficial as it gives a clear indication of the time span in terms of energy usage and when the energy was consumed. It also adds value to the display as it provides a clock for the user, which will provide the user with two motives to watch the display i.e. see the time and get a look of the energy situation in the household.

### 6.2.3 Statistics connected to today's consumption

The goal with presenting real time feedback together with energy statistic concerning the present day is to provide the user with feedback on how his or her behaviour affects the energy consumption in the present and also in a clear way visualize how behaviour changes effect the accumulated consumption, see section 3.4. To accomplish this the data needs to clearly visualize changes in energy output between different time spans and clearly communicate the present situation. It should be possible to see trends as well as specific values. Line charts were found to be most suitable for this purpose as the relationship between energy output, time and energy can easily be represented, as time and energy output give energy i.e. the area underneath the line. A number of different overall ways to structure the bar chart were developed and the five most promising ones can be seen in figure 36-40.

Concept A shows the three different energy usage areas through three different coloured continues lines and their energy output variations over time.

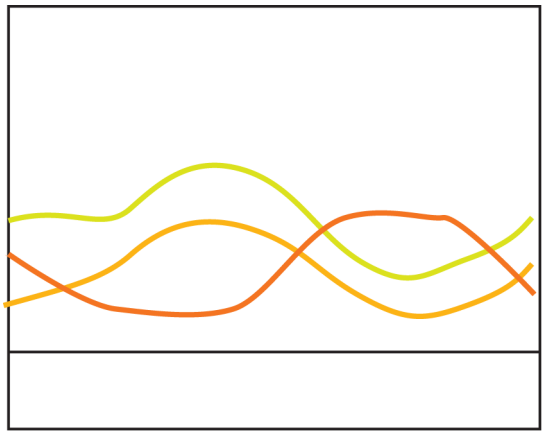

*Fig. 36. Concept A*

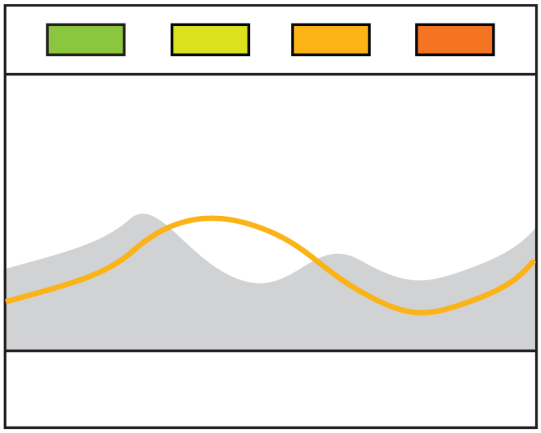

*Fig. 37. Concept B*

Concept B presents one energy usage area or the total energy usage through a continues line. The user selects the energy usage area by pressing on one of the coloured boxes seen in the figure 37. Behind the line a gray filled line chart is displayed that shows the average energy usage during the last week for the selected energy usage area.

In concept C the idea is the same as in concept B but the continues line has been changed to a filled line chart.

In concept D the different energy usage areas are presented together. The energy usage area energy output is presented as a line chart. The different energy output for each usage area is piled up on top of each other and shows the total energy usage.

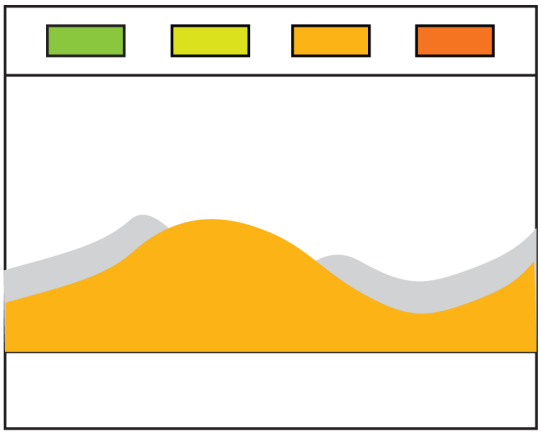

*Fig. 38. Concept C*

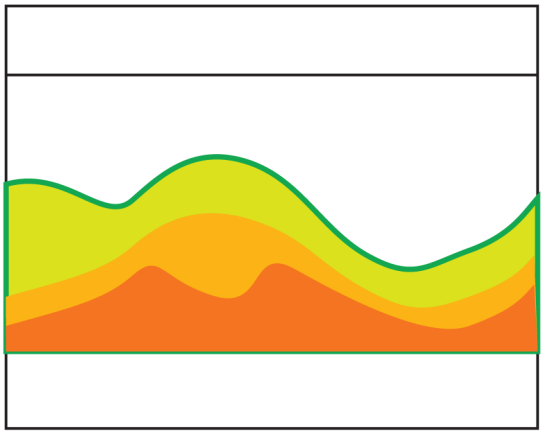

*Fig. 39. Concept D*

Concept E shows a double-sided line chart that expands on both sides of the time line when the energy output is increased. The different energy usage areas are separately displayed.

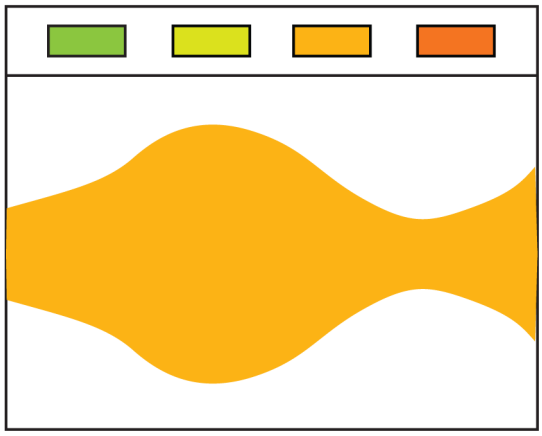

*Fig. 40. Concept E*

*Evaluation*

A pugh matrix, see appendix 9 was used to evaluate the concepts to the requirement list defined in section 6.1 and the result was that concept B fulfilled the requirements best. This was due to that concept B both provides the possibility to easily read of the energy output and also provides a comparison with the previous week.

### 6.2.4 Energy statistics

The goal with presenting stored energy statistic is to provide the user with feedback on how his or her behaviour effects the energy consumption over time. To accomplish this the data presented needs to clearly visualize changes between different time spans and clearly communicate time. It should be possible to see trends as well as specific values. A bar chart was found to be most suitable for this purpose as it clearly communicates the chunks of energy that is consumed by the household over a specific time for example a month's consumption. A number of different ways to structure the bar chart was developed, three of these can be seen in figure 41-43.

The idea with concept A, see figure 41, is to show all energy usage areas in one graph and their relationship to each other. In this way the total energy consumption is built up by the different parts and the user gets an understanding of for example how much of the total energy consumption the households electricity stands for.

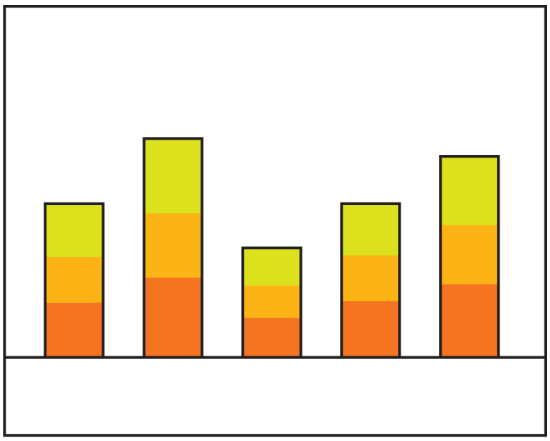

*Fig. 41. Concept A*

In concept B the different energy usage areas have been separated into different graphs. The user can access the desired energy usage area by pressing one of the colour coded buttons and clearly follow the consumption history within this specific area, see figure 42.

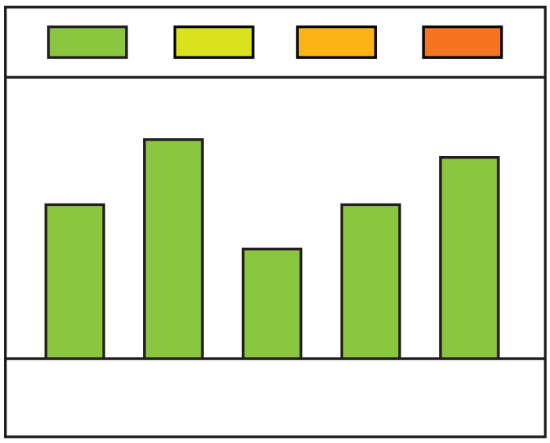

*Fig. 42. Concept B*

In concept C three bar charts representing each of the energy usage areas are plotted together. This gives the user a clear picture of the distribution between the energy usage areas and the user can also follow trends for the different areas, see figure 43.

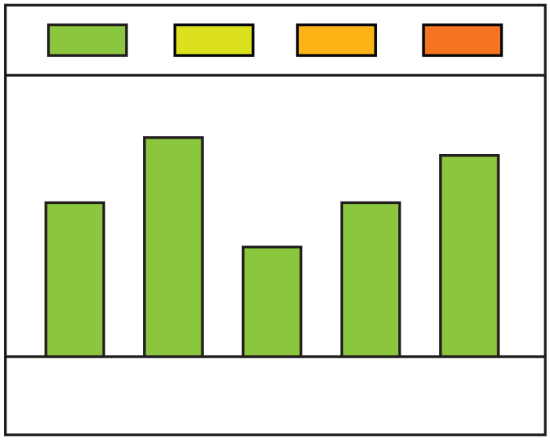

*Fig. 43. Concept C*

*Evaluation*

A pugh matrix, see appendix 9 was used to evaluate the concepts to the requirement list defined in section 6.1. Concept B was found to be the best choice. This was due to the fact that concept B clearly can show trends for each energy usage area including the total energy usage and also that concept B makes it easy for the user to read off specific values.

### 6.2.5 Monthly report

The idea with the monthly report is that the user should get a quick overview of the current energy consumption by presenting relevant key figures. The brainstorming and idea generation did not result in a large number of concepts but rather a discussion of different ways to communicate the household's current status. A short summary of the discussion is presented below.

After brainstorming and idea generation the project group identified four major areas of interest that could describe the household's current state; cost, trend, energy distribution and an environmental and comparison part. Also the appropriate time period associated with the key values is discussed.

*Period of time*

In order to present most of the information a fixed time span is required. There are according to the project group two possible time periods that could be used in order to give a quick overview of the current energy consumption, month and week. The week period has the advantage of representing a time period where everyday activities are repeated. Another advantage with the week period is that it gives the user a quicker feedback of the households consumption compared to the month period. This property leads however also to a disadvantage, it will be more sensitive to changes, for example it the user spend an evening away from the home this will have a bigger impact on the energy consumption. Another disadvantage with the week period is that the cost relatively to a week is not a very relevant figure, as the energy bill is paid once every month. Since the need for better control of the energy costs was identified to be important to the users, the project group selected a month to represent the current energy status.

*Cost*

As concluded in the pre-study of this project two thirds of the users have been worried or uncertain about how much their energy bill will add up to. A possible solution to this problem could be that the monthly report provides a figure that states how much money that has been spent so far this month and also a figure that estimates the total cost of the present month. The user will then know how much that has been spent and will see a forecast of his or her energy bill.

*Trends*

By for example providing the user with a figure or symbol that represents the trend compared to last month the users feeling of control will increase. The user will know what is happening; an increase or decrease from last month would be easy to see. Such a number or figure would also give the user a clear feedback of good or bad energy behaviour. The device could for example state disapproval or approval of the household's energy trend in an exhortative way. It would also be preferable to be able to divide the heating trend from the total trend since the heating trend is very much affected by the weather.

*Distribution*

As found in the questionnaire survey more than two thirds were uncertain about how the energy consumption is divided between heating, household electricity and hot water. By providing this type of information the users' feeling of control would probably also increase. By showing the distribution the user can also get a more detailed feedback, which would guide the user to make more relevant energy changing decisions. The user might for example be surprised by the amount of energy that is spent on the hot water and would therefore focus on decreasing the showering time instead of putting effort in other less relevant areas.

*Compare/environment*

A challenge when discussing energy seems to be that people lack a relation towards their consumption, see section 3.3. People might know how much they consume in kilowatts but find it difficult to relate their consumption both to other areas such as driving a car and to other people's consumption. In the questionnaire performed earlier in this project only ten percent of the respondents though that they consume more energy than an equivalent household. This indicates that people tend to believe that they are better than they really are.

A way to motivate people to consume less energy and question their present consumption could be to provide information of how the household are doing relative to an equivalent household. This can be an efficient way but it is also important to consider that the people that are consuming less energy than an equivalent household would feel less motivated to decrease their consumption, see section 3.3. This effect can however be decreased by providing information that states disapproval or approval of good or bad energy behaviour, which is actually what can be found in the trend part of the monthly report.

There are of course other interesting comparisons that can be made in order to provide information that puts the household's consumption into a context. The households consumption could for example be compared to energy consumption of the average household in the world, or for example compared to how much energy that could be spent if all people should only consume renewable energy.

However there are some difficulties with these kinds of comparisons. The figure of for example the average world household consumption needs to be estimated, which is very difficult due to the number of influencing factors. The world's inhabitants' energy consumption might also feel "too far away" for the users, so it might just be neglected. Other factors such as different climates' will also affect the credibility of the estimations.

A survey presented in SVT Rapport (2010) concludes that people in general perceive the transport sector as the worst climate threat, but according to Naturvårdsverket (2010) the households' consumption influence the climate just as much as the traffic. By providing relevant comparison figures the households motivation for decreasing their energy consumption might increase. Such relevant figures could for example be comparing how many miles a car could drive with the same energy amount as the last month's energy consumption. The idea is consequently to provide the user with a number of examples that the user can relate to in order to better understand his or her energy consumption without having to compare kilowatts.

Another more and more common way to communicate a person's environmental impact is by providing a figure that states how many kilograms carbon dioxide a set activity correspond to. The figurer itself is difficult to relate to, but it can be a good way to compare different activities with each other. This figure can for example be used to compare a hamburger with a flight to Thailand. A negative aspect the carbon dioxide emission measurement is that it is only related to global warming and does not include other important aspects of a sustainable society. But on the other hand, in the questionnaire performed earlier in this project, global warming was identified as the most motivating "environmental" factor by the respondents in order to lower their consumption.

Using carbon dioxide as a measurement in the product has a few implications. It is tricky to calculate how much carbon dioxide a kilowatt corresponds to. Energimyndigheten (2010) recommends two ways to calculate the carbon dioxide emissions produced by electricity, the "Nordic mix" approach and the margin way as describes in section 4.1.3.

The project group believes that the margin way of calculating the carbon dioxide emission is the most suitable way in this project. The more electricity that Sweden saves the more non carbon dioxide emitting electricity can be exported to other countries and replace coal powered produced electricity. However this way of reasoning around energy may not be shared with everyone. In Sweden a lot of utility companies offer "green" electricity to a slightly higher price. There is a risk that people feel that they don't need to decrease their consumption when they pay for "green" electricity. This leads to an interesting contrast. Either the user can see the energy spent as "It doesn't matter, I only use renewable energy" or the user can see it as "This spent renewable energy could have saved the same amount of coal power produced energy". When providing a figure that represents the carbon dioxide emission it must be clear what it stands for and communicate that also "green" energy in the end leads to carbon dioxide emissions.

The carbon dioxide emission for district heating will be calculated using the average emission for district heating in Sweden, see section 4.1.4. There is a high uncertainty in this number since the emission rate of district heating is very depending on the fuel used, type of facility and by periods of high energy demand when mineral fuels often are used, however this approach was perceived to be the best choice.

### 6.2.6 Devices

The goal with providing control and statistics concerning a number of specific devices in the household is to enable the user to track a specific device's energy usage, enable the user to control the product and to provide the user with a relation to what different devices consume. The user will by so gain a better understanding of his or her energy consumption. A number of concepts that combined both control and statistic functions were generated and four concepts can be seen in figure 44-47.

In concept A the devices are presented in a list. It is possible to select a device in order to control and to find more information and statistics about the device. The diagram in figure 44 presents when and for how long the device has been on during that day.

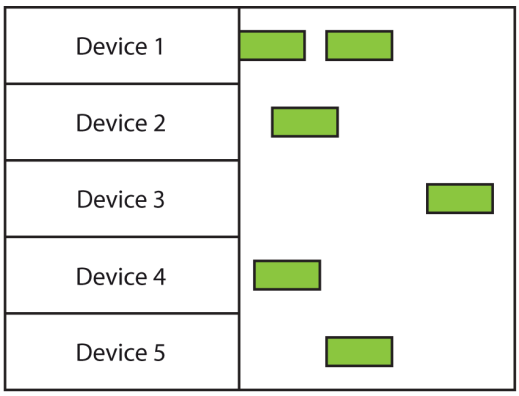


*Fig. 44. Device concept A*

In concept B the devices are illustrated in a pie chart and each pie slice represents a device. The size of the pie illustrates the energy output of the device. By clicking on one pie slice the user can control the corresponding device and get further information and statistics, see figure 45.

Concept C consists of a list where the devices monitored are displayed. It is possible to turn on or off the device by using the left button and the horizontal bar to the right represents the device energy consumption. By clicking in the middle on the device's name more information is presented about the device and further control settings can be reached, see figure 46.

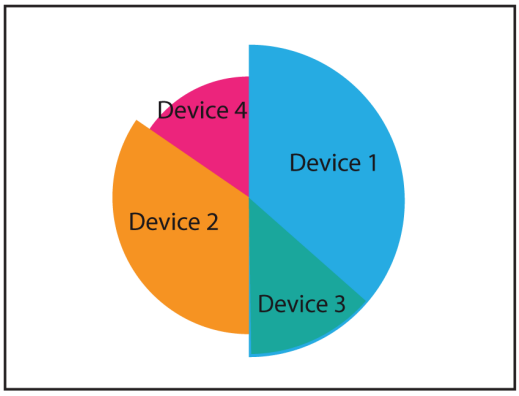


*Fig. 45. Device concept B*

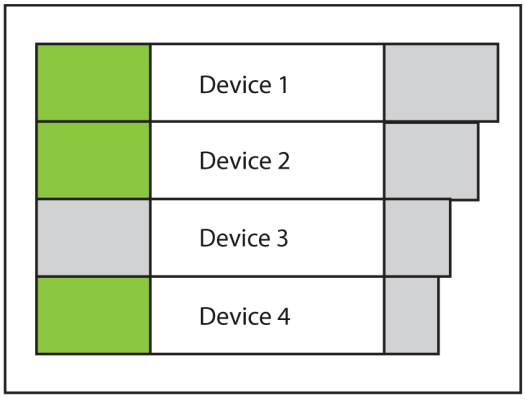


*Fig. 46. Device concept C*

In concept D the devices are presented in a folder list at the top in the figure. Statistics that varies over time are presented in the graph and more static general information is presented at the bottom of the graph. In this concept the devices cannot be controlled, see figure 47.

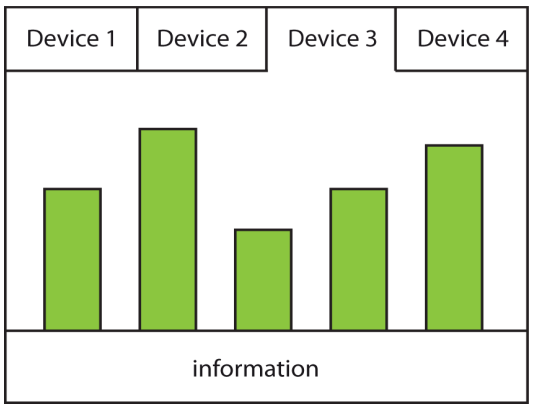


*Fig. 47. Device concept D*

*Evaluation*

A pugh matrix, see appendix 9 was used to evaluate the concepts to the requirement list defined in section 5.4. The result of the evaluation was that there was no concept that became an obvious winner but rather that there were good and less good things with all concepts. This made the project team further develop concept A and concept C. The visualization of the activity level of the different devices from concept A was combined with the layout and way of controlling the devices from concept C.

### 6.2.7 Price

The development of how to provide the user with feedback on the price of energy that is being used was mainly done through discussions within the project team. Three concepts with different complexity levels were constructed.

Concept 1 gives the user a comprehensive picture of the energy price and how the market fluctuates over time. In this concept the user also gets guidance in choice of utility company and type of agreement as it includes a price comparison between companies.

In concept 2 the user is provided with price and information about the different price components. The user can also track the fluctuations on the energy market and see how these fluctuations effects his or her price in the present and past times.

Concept 3 provides the user with only his or her current energy price. If the price is fluctuating an estimate of what the price will be at the end of the month is given.

*Evaluation*

In the evaluation of these concepts concept 1 was perceived as being too complex and most likely be very hard to make simple enough so that the user could benefit from it. To guide the user in the selection of utility company was also considered difficult due to the number of influencing factors and in the outskirt of the project scoop. Concept 3 was on the other hand perceived as being to uninformative for presenting the fluctuating energy price in an understandable manner. The conclusion was therefore that concept 2 should be further developed.

### 6.2.8 Icons

Before the icon development a search for iconic products and existing icons within the area was done to provide inspiration and examine if there were any existing icons suitable for use. Under the development process fourteen icons were developed for the interface. The icons were first developed in black and white in order to first find expressive shapes, and later add colour in order to emphasise the expression. For each icon a number of alternatives were developed and these were evaluated using a focus group consisting of four Industrial Design Engineering students. After the focus group evaluation session the icons were further developed and the end results can be seen in figure 48.

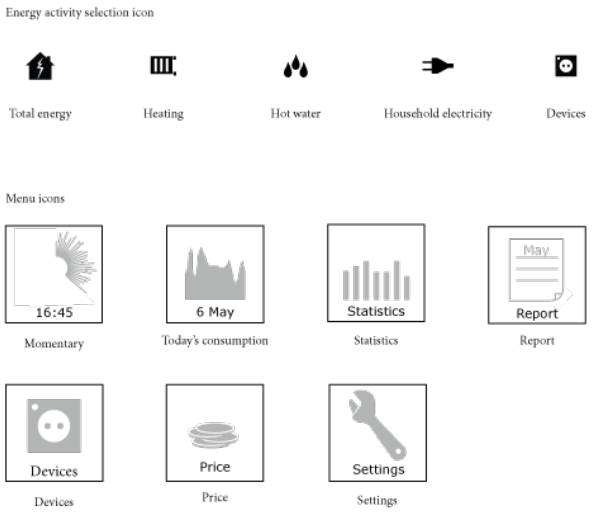


*Fig. 48. Icons*

## 6.3 Further development

### 6.3.1 Product shape

The product shape was further developed by the use of foam models in an iterative process. Five different models of the display unit emerged during this process, see figure 49.


*Fig. 49. Foam models of the product shape*

### 6.3.2 Momentary

The watch concept was further developed and is here presented more into detail. The concept consists of a watch, an energy pattern and figures representing the current energy output and the latest change, see figure 50.

*The watch*

The overall idea with integrating a watch in the concept is to encourage the user to look at the concept more often and also to provide the concept with an intuitive time span interpretation. The clock is analogue in order to not interfere with the digital information representing the current energy output and latest change. By dividing the information into analogue and digital the information is interpreted in two different ways and therefore the mental workload is less. The pointers are differentiated by width and length, which make them clearly distinguishable.

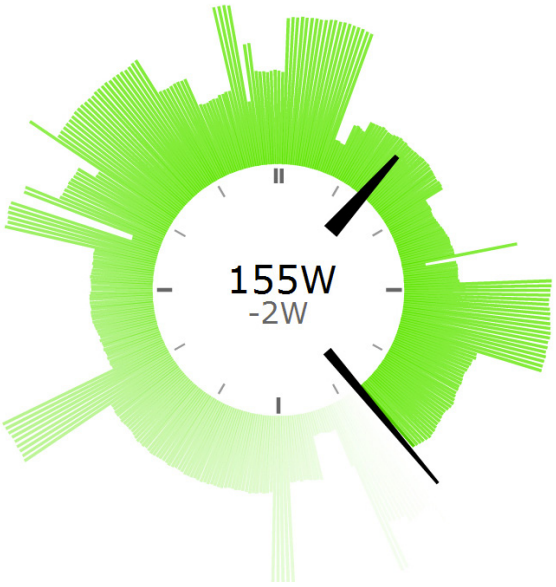


*Fig. 50. The momentary consumption*

*The pattern*

The idea with the energy pattern is to provide a tool for the user to quickly get an overview of the latest hour's energy consumption and to create an interesting and beautiful dynamic pattern. The time span was selected to be an hour since most energy consuming activates in the home is about an hour or less, for example coffee making and vacuum. It is not possible to read exact values from the pattern. The pattern is more for a rough overview, by a quick glance the user can see if there is a lot of colour and thereby understand if the consumption is high or low. The pattern starts behind the minute pointer and is starting to fade after about forty-five minutes. A new bar is created every ten seconds which indicates the update speed of the device, when a new bar is created the minute pointer change colour to green in order to emphasize that the pattern starts from the minute pointer. The idea is that the user will understand the time span since it starts behind the minute pointer and the user can see that the pattern is built up much quicker than if the time span would have been twelve hours.

*The figures*

The two figures in the middle represent the current consumption and the latest change. Providing an exact number of the current consumption might seem unnecessary and difficult to understand but according to the interviews, see section 4.2.5, the user quickly gets a relation to Watts.

And by so gets an understanding of if the consumption is high or low. When the user gets a better and more intuitive understanding of Watts the user will use his or her knowledge in other situations as well, for example when buying new devices. The user can for example understand that an infrared heater of two kilowatts consumes a lot of power since he or she can compare this to his or hers own household's energy consumption. The figure representing the latest change is useful when the user wants to know what a specific activity or device power output without needing to connect it to a smart point. When a device is turned on the total power output will increase with that device's power output and the latest change will represent that device's specific  power output.

### 6.3.3 Today statistics

The concept consists of a text box in the top, a graph illustrating the energy consumption, a timeline and a bottom part with buttons. How to interact with the diagram is first presented and then the different parts, see figure 51 and 52.

*Interaction*

**Move**

If the user drags his or her finger horizontally on the screen the diagram also moves horizontally. This allows the user to easily find a specific time frame.

**Zoom**

If the user drags his or her finger vertical on the display the user zooms in and out in the diagram. The max zoom is 24 hours and minimum zoom is 30 minutes. This allows the user both to get an overview of today's consumption but also see more detailed changes throughout the day.

*Top text box*

In the top text box the consumption so far during the day is presented together with a comparison figure of the last seven days average consumption during the same time period. This gives the user a relation to his or her consumption. There is a small text box next to the last plotted bar of the current consumption that presents the power output in this particular moment.

*The graph*

The graph is a filled line chart that has a quite detailed resolution, see figure 51. The project group has decided to use this high level of details in order to give a fair view of the day's consumption. The more the user zooms in the more details can be seen in the graph.

*Timeline*

The more zoomed in the user are the more detailed timeline information is presented in order to guide the user.

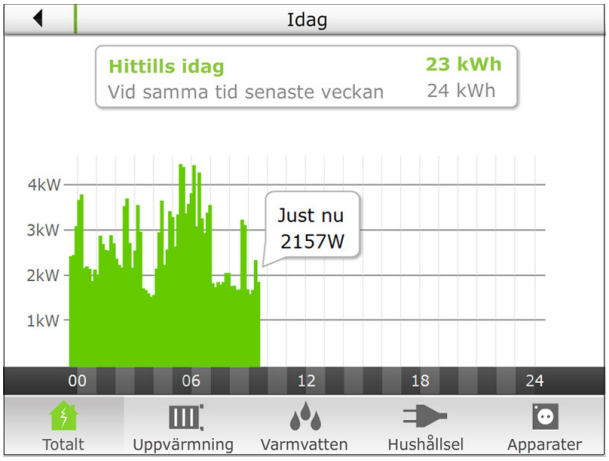


*Fig. 51. Today statistics*

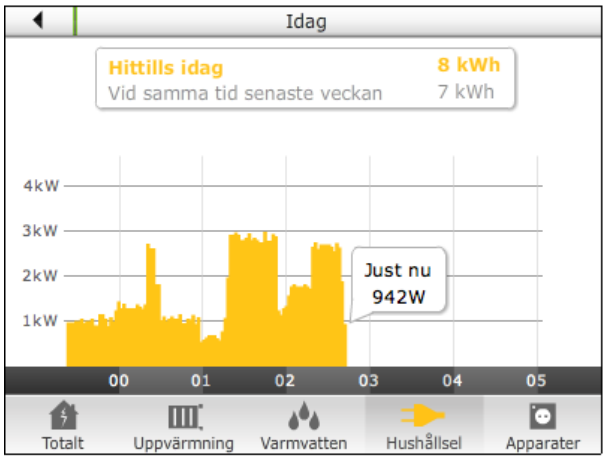


*Fig. 52. Different energy areas*

*Buttons*

The buttons at the bottom makes it possible for the user to view different energy usage areas and the devices connected to a smart point. The buttons are colour coded so when a selection is made the button pressed gets the same colour as the graph displayed. The buttons are placed in the bottom of the screen in order for the user to be able to press the buttons without covering the diagram with his or her fingers, see figure 52.

*Energy usage areas*

The user can chose to see the total energy consumption or divide it up between the energy usage areas of heating, hot water and household electricity. These energy usage areas are presented separately in order to emphasize the possibility to clearly see trends and specific values within these energy usage areas. The energy usage areas are colour coded to further enhance when a selection has been made and to clearly separate them.

### 6.3.4 Statistics

The concept consists of a top text box, bars, a timeline and buttons at the bottom, these parts are presented below together with a description of the interaction. Consistency between the today's statistic sub function and the statistics sub function is believed to be important which has been regarded to large extent. See section 3.1.5 for consistency.

*Interaction*

**Move**

The user has the possibility to interact with the diagram. When the user drags his or her finger horizontally on the screen the bars are also moved horizontally, which allows the user to move through time and find a specific day or see how the energy consumption has change over time.

**Zoom**

If the user drags his or her finger vertical on the display the user zooms in and out in the diagram. If the user zooms out, more and more bars are displayed on the screen, see figure 53-54 and if the user zooms in, less and less bars are visible in the diagram until the user has zoomed into one day. By being able to see a large amount of bars the user can easily see trends, and by being able to zoom in the user can easily see specific values.

**Transfers between time periods**

If the user zooms out more than a fixed number of bars, the bars are merged together and a new time period is defined. For example, if the user zooms out more than thirty days the days are merged together to a month, which means that the time period is shifted from days to months. Equally, if the user zooms in when only one yearly bar is visible the bar is broken up into smaller months bars. This way of manipulating time is thought to correspond to the user's mental model of time.

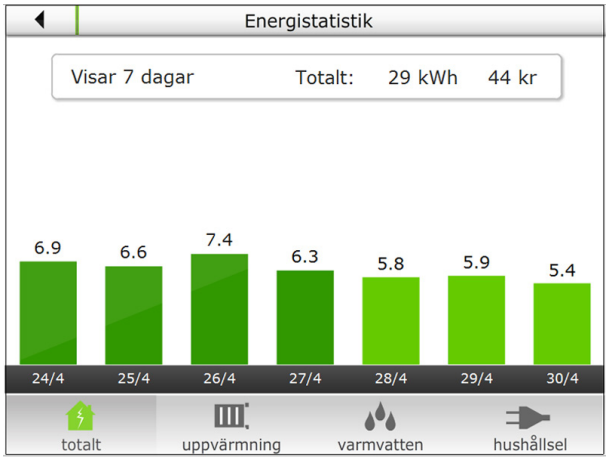


*Fig. 53. Statistics (1)*

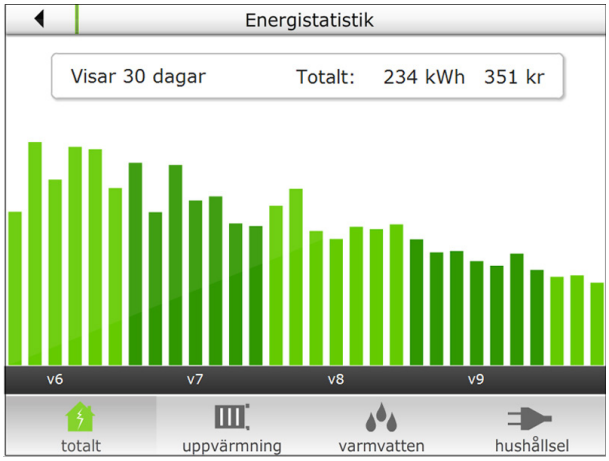


*Fig. 54. Statistics (2)*

*Selecting time periods*

The user can slide between three time periods, days, months and years. The project group discussed to also include weeks as a time period but it was dismissed. This was due to that the week and month period interfere with one another as all months does not consist of four weeks i.e. 28 days, which could make it confusing. Weeks was although chosen to be visualised by colour coding, see figure 54.

*Top text box*

In the top of the screen a text box is found, see figure 54. It displays how many bars that are showed right now in the diagram and what the total energy consumption and cost of the visible bars are. The idea of showing the sum of the visible bars in the diagram is to make it easy and intuitive for the user to find information. The user easily adjusts the number of bars visible and the specific dates visible according to his or her goal and can easily read off the total consumption during that time period in the top box.

*Bars*

When the bars are showing days they are colour coded in order to visualise weeks, see figure 54. When more than seven bars are visible no information is presented above the bars in order to emphasise the trend rather than specific values. The more zoomed in the user is the more he or she is thought to be interested in specific values and therefore more detailed information is presented above the bars. When less than eight bars are visible the bars energy consumption is presented, and when only one bar is visible the energy consumption plus the cost and the corresponding carbon dioxide emission is presented, see figure 55.

*Time line*

In the time line the period of time that represents each bar is presented. The timeline's purpose is to give the user an understanding of where in time he or she is. Therefore the timeline present information depending on what is thought to be relevant at the moment, for example weekday, date, week or name of the month.

*Buttons*

The buttons at the bottom makes it possible for the user to view the total energy consumption and the different energy usage areas. The buttons are placed in the bottom of the screen in order for the user to be able to press the buttons without covering the diagram with his or her fingers.

*Energy usage areas*

The user can chose to see the total energy consumption or divide it up between the energy usage areas of heating, hot water and household electricity. These different energy usage areas are presented separately in order to emphasize the possibility to differentiate them and by so see trends. The energy usage areas and the total energy consumption is colour coded to create a clear separation between the areas. The total energy consumption is also visible but faded in order to highlight the relation between the energy usage areas, see figure 56.

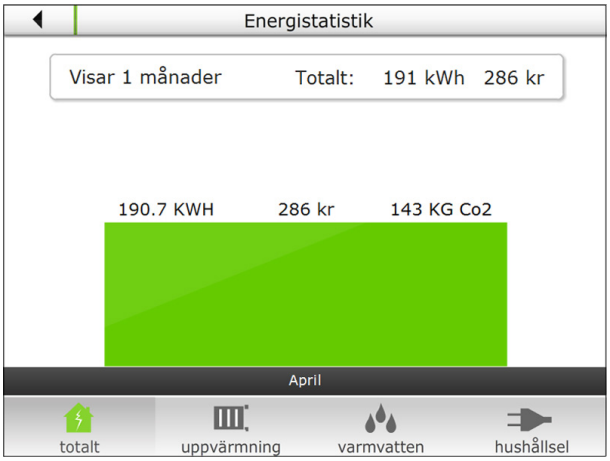


*Fig. 55. Statistics (3)*

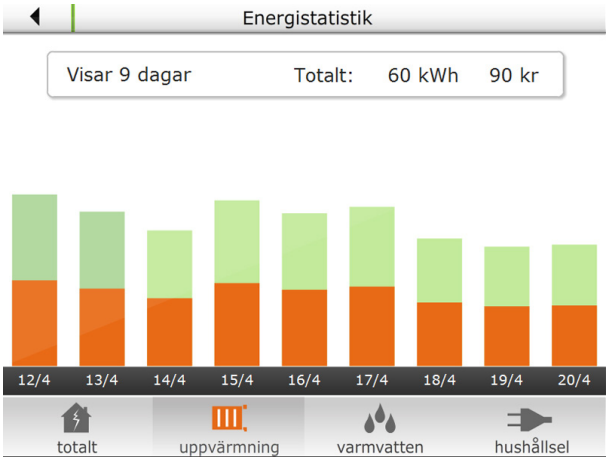


*Fig. 56. Statistics (4)*

### 6.3.5 Report

The discussions and ideas found in the ideation phase founded a basis for further development of the monthly report sub function. The monthly report consists of four parts, cost, comparative, trend and energy distribution, see figure 57.

*Cost*

The estimated monthly cost is presented together with a figure that represents the consumption so far this month. These two figurers will give the user a better control of the costs. A figure that represents the last month's cost is also presented in order to provide a value to compare the estimated monthly cost with.

*Comparative*

Comparing the user's household to other equivalent households was the figure that was thought to influence the households the most as a result of the questionnaire, see section 4.2.4. To provide an average comparison was also found as an effective mean for creating behaviour change according to theory, see section 3.3.

*Trends*

In the trend part the user can see if the current month's energy consumption is higher or lower compared to the same time last month. The user can see how much each energy usage area has increased or decreased and also the total trend. This makes it easier for the user to track changes in the energy consumption.

*Energy distribution*

The energy distribution sub function gives the user better understanding of how different energy types relates to each other. By understanding the distribution the user will get more detailed feedback, which guides the user to make more effective energy changing decisions.

### 6.3.6 Devices

The concept consist of a device menu where the user can control and select a specific device, an information and setting part where the user can find key values and edit settings and finally a diagram part that are located under the today's statistics sub function.

*The select and control part*

The select and control part consists of a list that are devided into two colums, see figure 58. In the left menu the user can turn on and off the devices and in the right menu the user can view the device's label and also press the button in order to find more information about the device. This allows the user to easily turn on and off the devices and find relevant information. At the bottom of the screen the user can find the house mode option. By turning on and off the house mode the user can turn on or turn off all devices that are linked with the house mode option. The house mode option works as a main switch, which is useful when the user for example leaves the house or goes to bed, and it makes sure that stand by electricity is kept to a minimum. If a device is linked to the house mode option a small house icon is visiable in the right column for that device, see figure 58

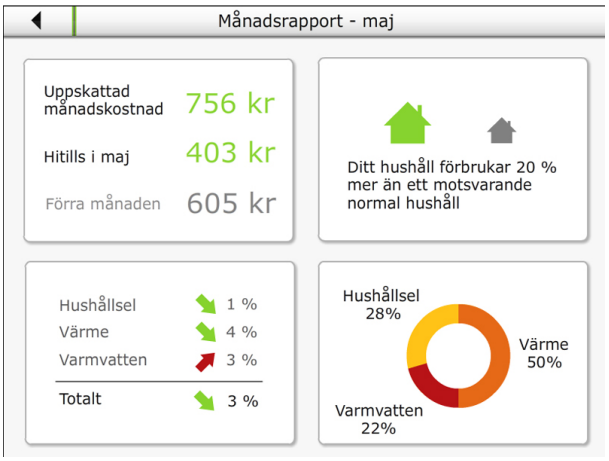


*Fig. 57. Montly report*

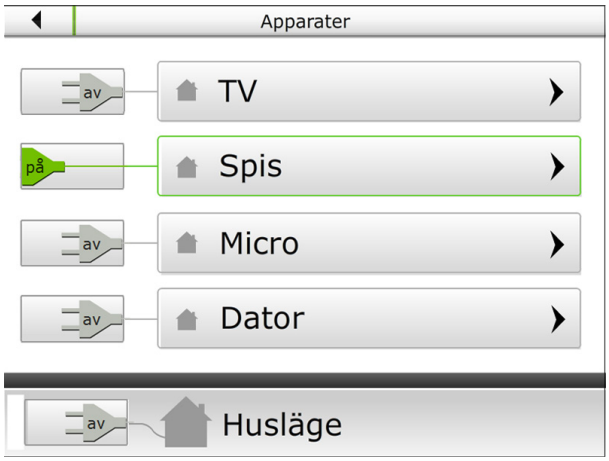


*Fig. 58. Select and control part*

*Information and setting part*

In the information and setting part the user can find key values for the selcted device and also set the built in timer or add or remove the device from the house mode. The selceted key values include cost and energy consumption per month and usage per day, see figure 59

*Diagram part*

In the digram part that is located under the todays statistics the user can find informaiton of what devices that has been on during the day, see figure 60. For example a mom or dad can see if their kids have been watching TV during the day. It has been located under the todays statistics since it is rather a statistical information than a specfit devcice part. Also it adds value to the todays statistict since the user can follow values in the electricity statistics part and then see what devices that has been on in order to understand the consumption pattern better.

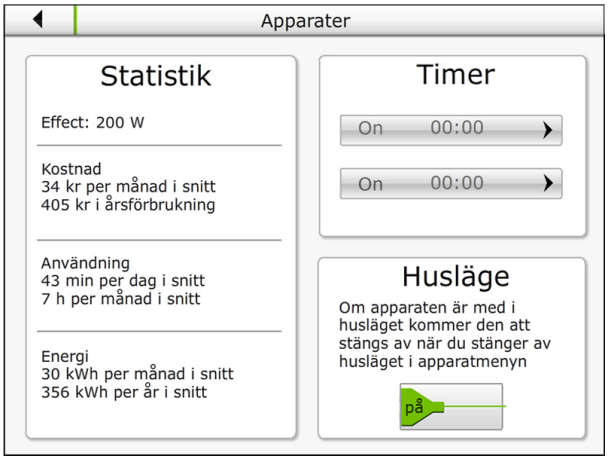


*Fig. 59. Information and setting part*

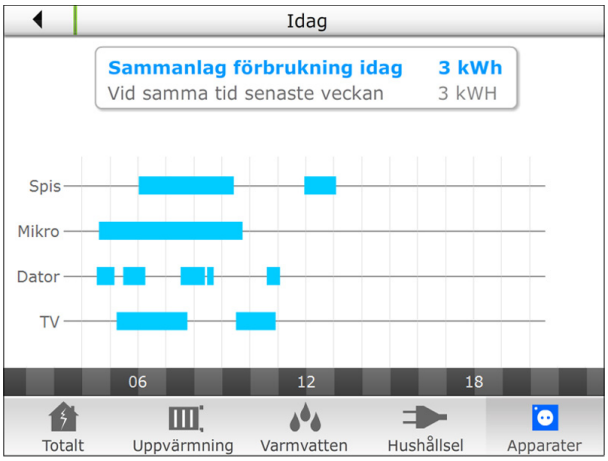


*Fig. 60. Diagram part*

### 7.3.7 Price

The price sub function consists of two parts, the electricity price and the district-heating price.

*The electricity price*

The estimated electricity price for the present month is presented in figures to the left and the last month's electricity price is presented below as a comparison. The small graph to the right is a representation of the fluctuations on the spot market, which will give the user a better understanding of how the estimated price is calculated, see figure 61.

*The district heating price*

Since the district heating price is rather constant, see section 4.1.6, the only figure that is presented is the current energy price.

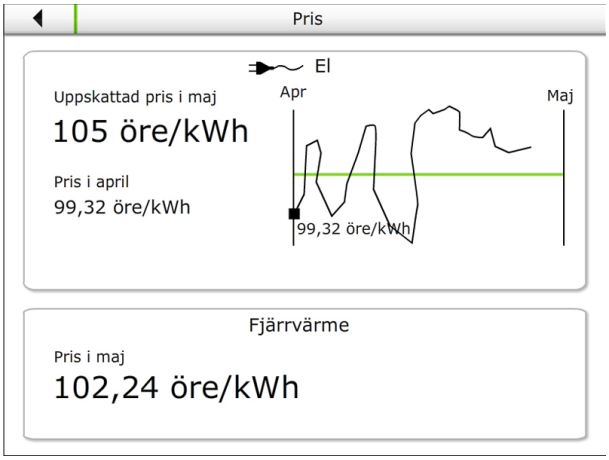


*Fig. 61. Price*

# 7 EVALUATION

In this chapter the result from the usability test and the product shape evaluation are summarised and a short conclusion of the results is defined.

## 7.1 Product shape evaluation

In the evaluation of the product shape a pugh matrix selection was used see appendix 10. The evaluated models can bee seen in figure 49. The highest score in the evaluation were given to concept square, see figure 62. This selection was made as the evaluators ranked the model highest by all models on the evaluation words, competent, unique and harmonic. This model was also four out of five evaluator's favourite shape.


*Fig. 62. Concept square*

## 7.2 Usability test

The results from the usability test were summarized in a problem matrix where the problem, the possible cause of the problem and ideas on how to adjust the problem is presented, see appendix 11. Below follows a summary of the most important findings.

A frequent problem for the test participants were that they didn't noticed the possibility to zoom in and out in the graph or move the graph horizontally.

This result was expected by the project group since the interface more or less lack clues to describe these functions. However once these functions were pointed out the participants hade no trouble using or remembering them.

One of the most frequent problems that were discovered was that the participants didn't understand the graph that illustrates the floating electricity price. The participants understood that it in some way illustrated the floating price and could do a read off of the estimated price but did not fully understand the illustration.

The problem that the users struggled with the most was to understand the week consumption. The total consumption of the bars displayed on the screen is added up and the total consumption figure is presented at the top of the chart. This was not understood by most of the participants. Lack of visual connection between the information box and the bars, and problem understanding that to be able to read off a week's accumulated consumption the bars corresponding to that week have to be displayed on the screen with no additional bars visible.

The momentary consumption represented by the watch also had some problems. Some of the participants did not understand that the energy pattern created by the clock represents the time span of one hour but instead interpret it as displaying twelve hours. Some of the participants also had trouble with understanding that the grey figure represented the latest change in energy output.

Observed during the usability test was also that the division of the statistics and the today's consumption were perceived to be somewhat awkward.

The quantitative attitude measurements collected during the test indicated that the participants were satisfied, perceived the interface as quite comprehensible and the tasks performed as rather simple, see appendix 11. Some quotes form the participants that were recorded were:

*"I would like one of those"*

*"I like that you can control devices"*

*"Interesting device, when I lived in a villa a made my own excel sheets"*

*"Nice responsive interface"*

*"A fun idea, I would definitely have bought one"*

## 7.3 Conclusion of the usability test

As a conclusion of the usability test the project team could decide that some parts of the interface needed to be improved and further developed. Structural changes that were agreed upon were to make statistic and today's consumption into one sub function. It was also decided to make the price sub function a part of the monthly report sub function. Further changes needed were to make the read off of a weeks energy consumption easier and more understandable. The momentary energy pattern that some of the participant hade a hard time understanding will be kept as the project team believes that the user will quickly learn the time span when using the product in everyday life. The project team further believes that to provide a nice looking energy pattern is more important then a display that could be correctly read off at first glance. The colour coding was also decided upon to be excluded as it was perceived to be somewhat confusing when the colours used for heating, hot water and household electricity was also used to state good or bad behaviour and the user could therefore read in more to the statistics information then intended. To further develop the graphical profile to create a more consistent look was also found to be important.

# 8 FINAL RESULT

The final result of this development project is presented in this chapter. The chapter is divided into two main parts, the product shape and the interface design.

## 8.1 Product shape

### 8.1.1 Expression

The product has a friendly and inviting expression at the same time as it expresses competence and quality. The product manages to balance the fine line between blending into a contemporary home and naturally taking its rightful place. The product has through its unique design the potential to be a new environmental friendly status symbol. The product has also the potential to be a conversational piece that provokes discussions regarding energy consumption, see figure 63-65.

The rounded back of the display creates the illusion that the display unit is thinner than it really is which makes the display be perceived as light and smooth. The organic form adds to the friendly feeling. When mounted on to a wall the rounded back of the product make it stand out from the wall which creates the perception that it is easy to detach the product from the wall.

The colour white was chosen for the product shell as it makes the product fit into a contemporary Swedish home. White is also perceived as a calm colour in this context, which makes the product less obtrusive. The display has a rectangular shape but the screen is oblong which creates an area underneath the screen that gives the product a direction and a lower centre of gravity. The rectangular shape of the product also adds to the uniqueness of the product. The chamfer on the front side of the display further adds to the friendly and tranquil feeling of the product shape.

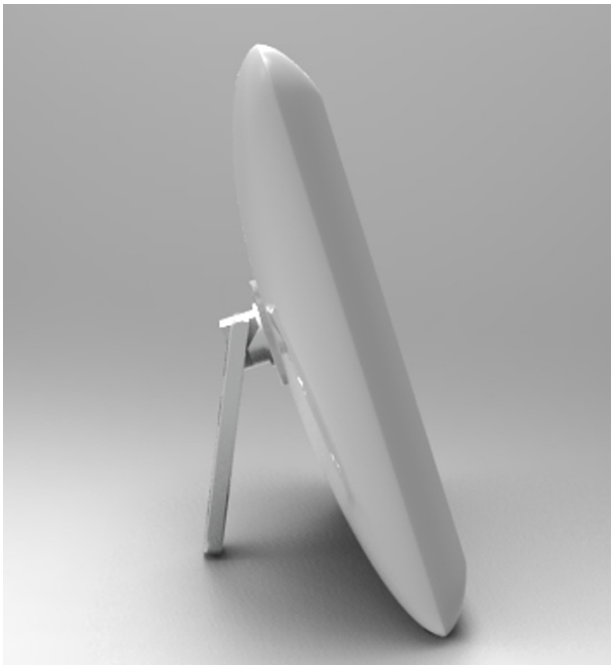

*Fig. 63. Side*

*Fig. 64. Back*


*Fig. 65. Front*

### 8.1.2 Handling

The rounded chamfer on the front side of the display creates a resting point for the thumb when holding the display and the rounded back creates a comfortable grip when the product is resting in the palm. The non-active front area below the screen serves as an area where the user can place his or her fingers when holding the product, see figure 69.

### 8.1.3 Placement and support

The product can either be placed on a flat horizontal surface or be mounted on to a wall, see figure 70 and figure 67. A support is attached to the backside of the product. The hole where the support is attached is in the middle of the rounded back area. The support is fixed to the product with help from a magnet. The electric cord is included in the support and is automatically connected when the support is connected. This was made in order to make the plug in and out process quick and further create a slicker look. The angle between the support and the display can be altered when the display is standing, but when the display is mounted on to the wall the angel locks into a 90 degree position, see figure 66. The support has two holes that allows it to be mounted on the wall.

### 8.1.4 Dimensions

In figure 68, the external dimensions of the product are presented.

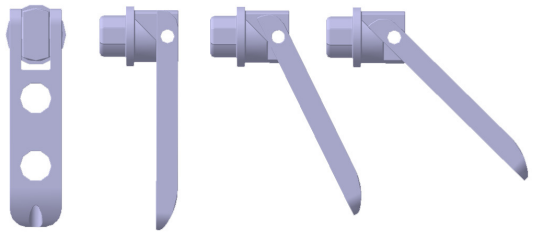

*Fig. 66. Product support*

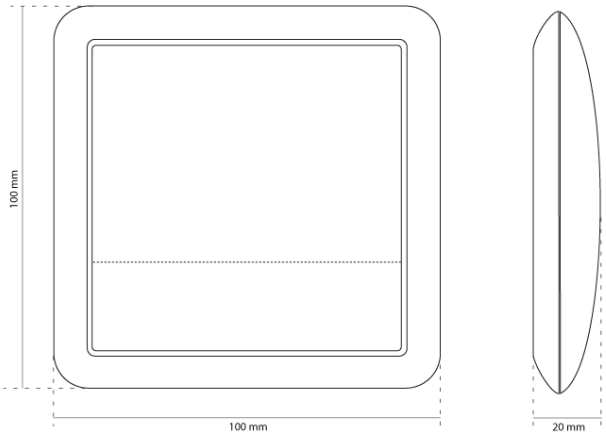


*Fig. 68. Product external dimensions*

*Fig. 67. Product mounted on a wall*

*Fig. 69. Product handeling*

*Fig. 70.* *Product in home environment*

## 8.2 Interface

### 8.2.1 Structure

The final interface structure consists of a Hub and Spoke menu, see section 3.1.1, where from the user can reach six sub functions. These sub functions are momentary, energy statistics, report, control, weather and settings. The structuring of the menu functions and sub function are made according to the user's mental model , see section 3.1.10, and the perceived work order within the interface. The structure is made this way to provide the user with an easterly overview but still comprehensive system. This is a common way to design small screen devices and therefore the structure selection is also supported by the compability theory in section 3.1.8. By using this type of easy and transparent structure the user can easily recover from a mistake which is important according to the theory in section 3.1.12. The user has to do an active choice when entering or exiting a sub function which is preferable according to the user control theory in section 3.1.13. A generalised model of the system structure is presented in figure 72.

The main menu of the product consists of six square shaped buttons, see figure 71, that has been design according to interface button guidelines, see section 3.1.2. The menu was designed to give a light and easily understandable impression where each button is clearly separated with a well-balanced white space surrounding.


*Fig. 71. Main menu*

For each button an icon has been developed. Consistently all icons have been kept simple, to only try to portray the essence of the sub function. For the momentary sub function a clock icon was chosen as this was seen to be the main visual characteristic of the sub function. The energy pattern surrounding the clock was excluded as it made the icon more complex at the expense of its clarity. At the bottom of the momentary sub function button the current energy output is displayed. When designing the report sub function icon and button the project group focused on communicating the time aspect of a month. Therefore a monthly calendar is used to symbolize the report sub function together with the name of the current month. The text at the base of the button clarifies that it is some kind of report. For the statistic sub function an icon displaying a bar chart was chosen, as it is an iconic sign for statistics. The device menu icon was made to reassemble a smart point that the user connects to the wall socket. As the design of the smart point was not included in this project, the icon would need to be updated when this design work has been done. In the weather button the current weather is displayed. This was done to guide the user in understanding the functionality of the sub function and provide an easy way to check the weather. At the base of the button the current outdoor temperature is displayed. A monkey wrench was used to illustrate the setting button, which is consistent with similar products.

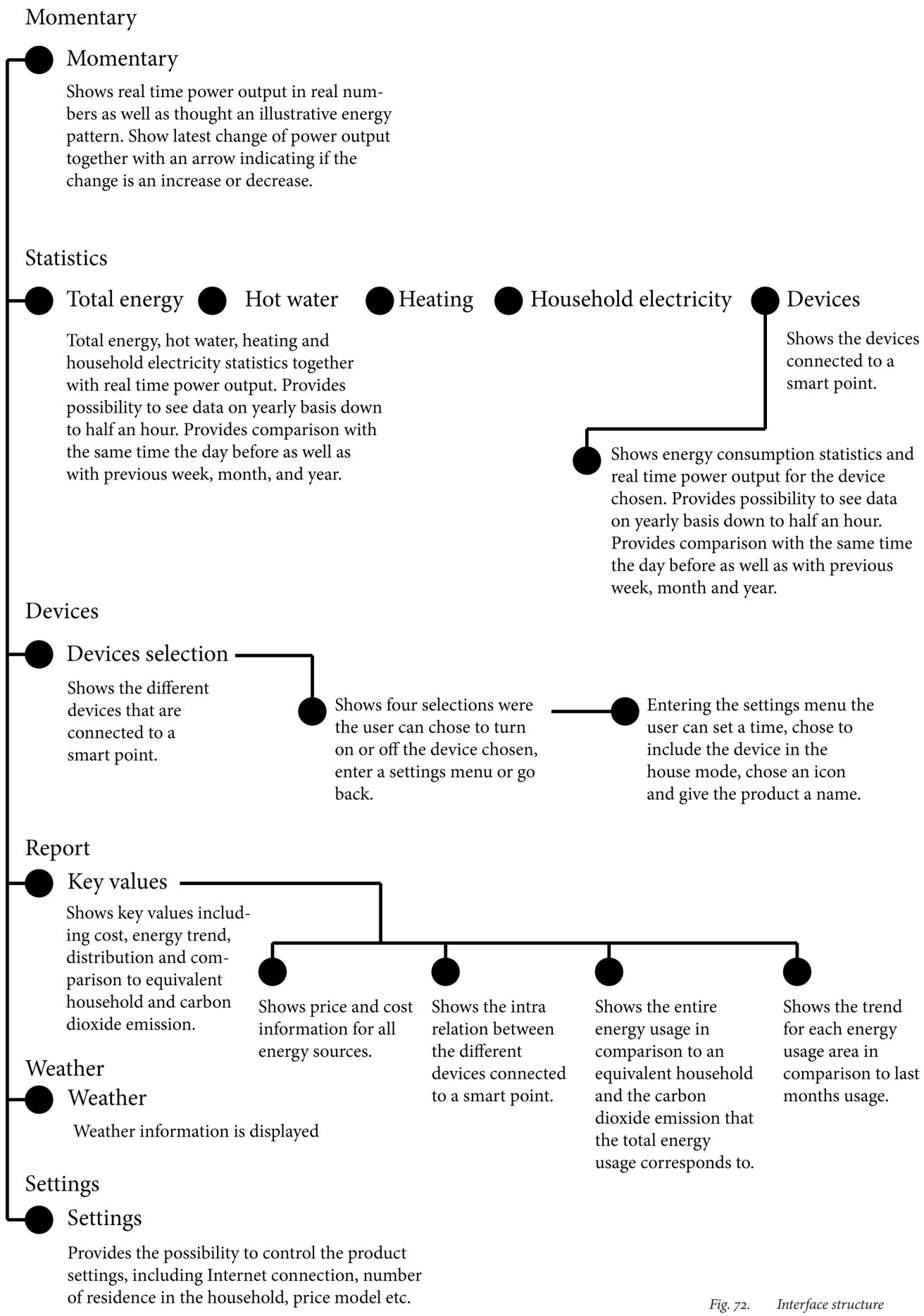


*Fig. 72. Interface structure*

### 8.2.2 Momentary

The momentary energy output is visualised by an analogue clock that plots an energy pattern with the minute hand. In the middle of the clock the energy output of the household is displayed together with the latest change of the energy output and an arrow indicating if the energy output is increasing or decreasing, see figure 73-75.

As the visualisation of the momentary consumption will automatically be turned on as a screen saver for the display, the main function is to draw attention to the product. By incorporating a clock together with the energy pattern the user will have two motives to look at the product, that is to see what time it is and to get a quick overview of the consumption. To incorporate the clock also provides the user with an intuitive time span interpretation. The energy pattern is plotted by the minute hand and will starting to fade after about forty-five minutes. A new bar is created every ten second, which indicates the update speed of the device. When a new bar is created the minute hand change colour to green in order to emphasize that the pattern starts from the minute hand. The colour green is used for the energy pattern as it is a colour that is not to bold, as the screen saver will be on at all times. The colour green also emphasises the environmental friendliness of the product.

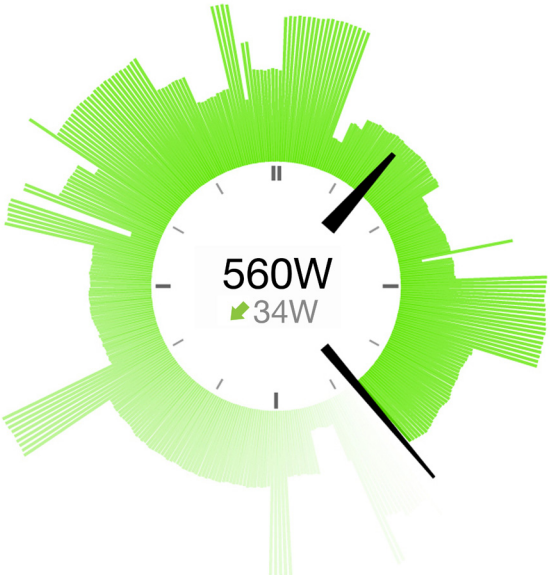


*Fig. 74. Current consumption (2)*

The current energy output and the latest change of the energy output was chosen to be given as numeric numbers, so it would be easy to exactly read off the figures. The arrow that indicates the direction of the latest change is provided to emphasise if the user is decreasing or increasing the energy consumption, which is in line with theory, see section 3.1.4.

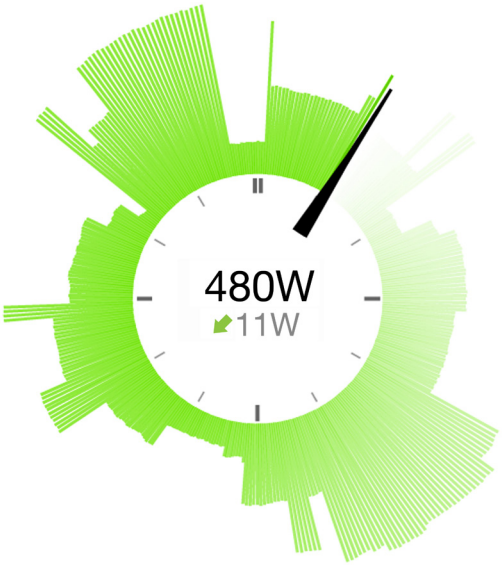


*Fig. 73. Current consumption (1)*

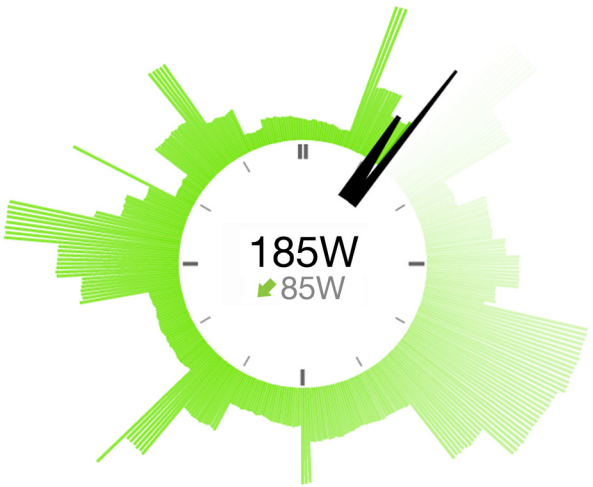


*Fig. 75. Current consumption (3)*

### 8.2.3 Statistics

When entering the statistics sub function the first thing the user sees is the fluctuations of the total energy usage in the household during the last six hours presented by a green line chart, see figure 76-78. Behind the green line chart, a gray line chart is displayed that shows the energy usage at the same time the day before. To show both today's and yesterday's energy consumption provides the user with a reference point for comparison without having to read off the exact values. To use yesterday as a reference also have the advantage that people still remember what they did, and can draw conclusions about how their behaviour effects their energy consumption. At the bottom of the screen the user can select what type of energy usage area or device that is of interest. If for example hot water usage is chosen, the fluctuations in the hot water consumption is displayed together with yesterday's consumption.

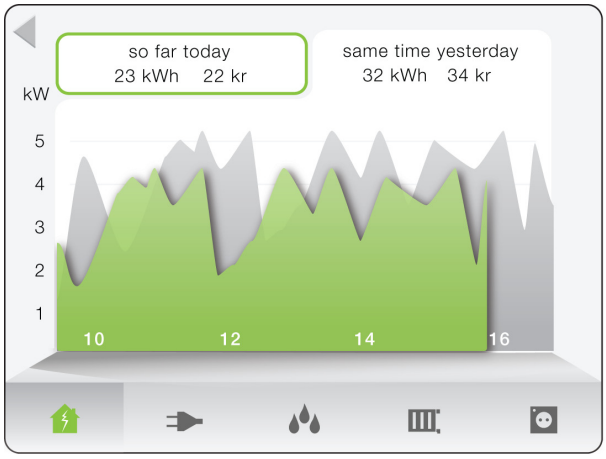


*Fig. 76. Six hours*

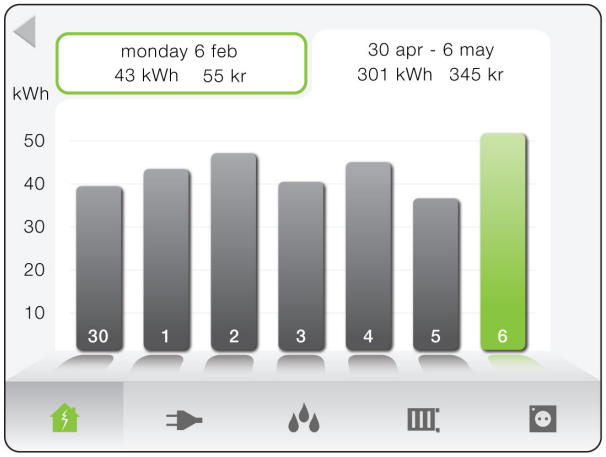


*Fig. 77. Seven days*

To highlight changes in the energy usage, that would be hard to see if only the total energy consumption was displayed, the opportunity to differentiate the different energy usage areas and devices are incorporated. This creates an understanding of how much different activities consume and by so creates an understanding about where there is savings potential for the particular user. When the user is going from showing for example the energy usage for heating to displaying the energy usage of a device a rescale of the scale is necessary since the energy output is significantly different. Trying not to confuse the user too much the scale will be fixed for the total energy usage and the energy usage areas, heating, hot water and household electricity.

The shape resembling a folder in the statistics sub function is shaped in order to provide a connection between the information displayed in the upper right corner and the bars in the bar chart, see figure 77. In the upper right corner the sum of the bars that are visible on the display is given. The user can also access specific key values by clicking on one bar within the graph. This action makes the key values concerning that bar appear in the upper left corner. Colour coding is used in this action to guide the user's attention towards the left corner that has the same colour as the bar clicked on. The key values chosen to display for the bar are cost and energy usage. This choice was made as the most motivational factor for reducing one's energy consumption was identified both by theory and the empirical research to be money, see section 3.3 and section 4.2.4. To also display energy usage in kWh was chosen in order to provide an objective measurement of the consumption as the price and by so the cost can vary for the same amount of energy used.

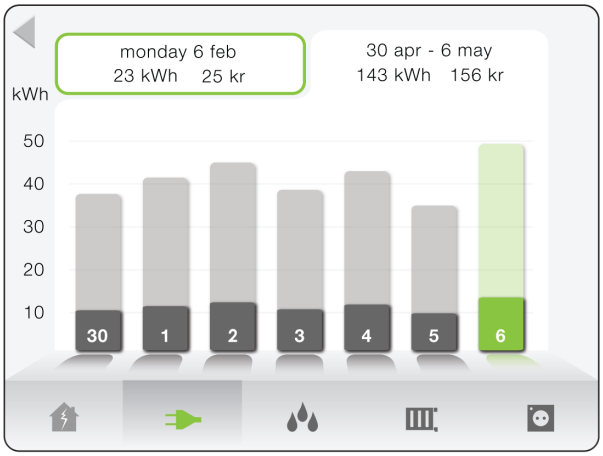


*Fig. 78. Energy usage area*

After using the product for a period of time the user will also have a reference to what is a "normal" and "high" usage and can understand the values displayed. This can be compared to if you have never driven a car it may be hard to estimate and understand the fuel consumption, this knowledge will although soon be acquired.

The area around the graph is designed to create the illusion of looking into a window with something behind, in order to give the user a cue that the display window may be manipulated. The shadows that the graph creates have been designed so that it looks like the graph is projected onto a somewhat rounded area, see figure 77. The bars and the line chart is also given a small drop shadow to make them stand out from the background and be perceived as clickable.

On the left side of the graph there is a scale that makes it easy for the user to read the value of a bar without having to click on it. Over the scale in the upper left corner the back arrow is displayed that is consistently used within all sub functions to go back to the main menu. The arrow was design in this way as it is a commonly used icon for return, used both on web pages and smart phones.

The user can reach information concerning the energy usage from yearly statistics down to hourly bases, see figure 76-80. The information selection is made by zooming in and out of time by moving one finger up and down vertically on the touch screen. The zoom function is designed so that the longer from the point of origin the user drags his or her finger on the screen the more rapidly it zooms in or out.

By designing the zoom function in this way the user can quickly zoom in or out of a specific time span and at the same have good control of the zoom function.

When the user zooms in and out of the different time spans the statistic information is chunked into days, weeks, months and years to ease the mental workload of the user and provide a framework for differentiation of different time spans. The time spans are chunked using spacing between the bars as an indication together with compiling for example the days of a month into one bar that represents the entire month. When zooming into one day, the statistics information provided changes from showing energy chunks to showing energy and energy output fluctuations throughout the day and vice versa in the other direction. To be able to show these energy output fluctuations a line chart is used. When zooming into one day this is visualised thought the extraction of that specific days bar into a line chart. When zooming in or out of a day the graphical presentation of energy is not the only change that occurs, the scale to the left side in the screen also change from showing energy to showing energy output.

In the statistics window the user can also move within the same time frame, that is, if one week is displayed the user can choose to display another week. This function is controlled by moving one finger horizontally across the touch screen in the direction that is of interest. This provides the user with an increased sense of control and lets that user track specific deviations that can be difficult to see in a larger or smaller time spans.

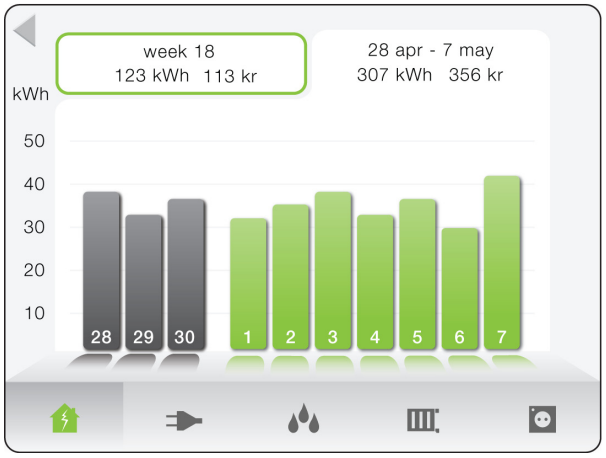


*Fig. 79. Weeks*

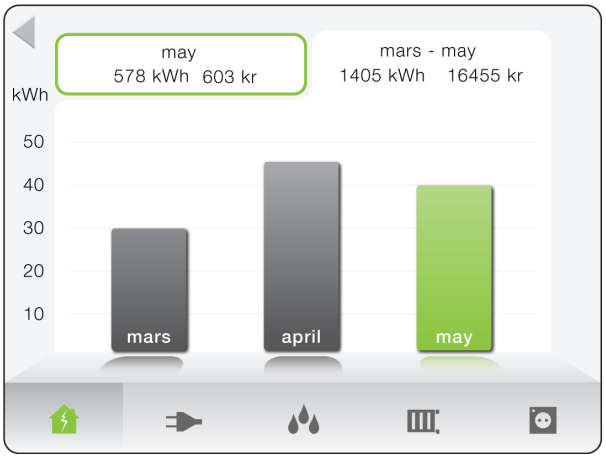


*Fig. 80. Months*

From the statistic part the user can also access statistics regarding the devices connected to the smart point. This is done by clicking on the device symbol to the right in the lower selection list, see figure 81. A popup list will appear which allows the user to select the desired device. Once a device is selected the popup list is closed and the statistics is displayed, see figure 82. The icon of the chosen device will replays the device icon as long as no further choice is made for another device or the sub function is closed.

The icons used in the selection list at the bottom of the statistics sub function represent the energy usage areas and the devices connected to a smart point, see figure 82. The icon for the total energy usage is a house with a flash going straight through.

The idea with using a house is that it symbolizes the entire household and the flash is a common sign for power. The household electricity icon portrays an electricity cord. Which was seen as the main characteristic for household electricity. The hot water icon was designed to resemble water drops in order to communicate hot water. The heating icon was designed to portray a radiator as this was seen as the main characteristic of heating a house. The device icon was made to reassemble a smart point that the user connects to the wall socket. As the design of the smart point was not included in this project the icon would need to be updated when the design work of the smart point has been done.

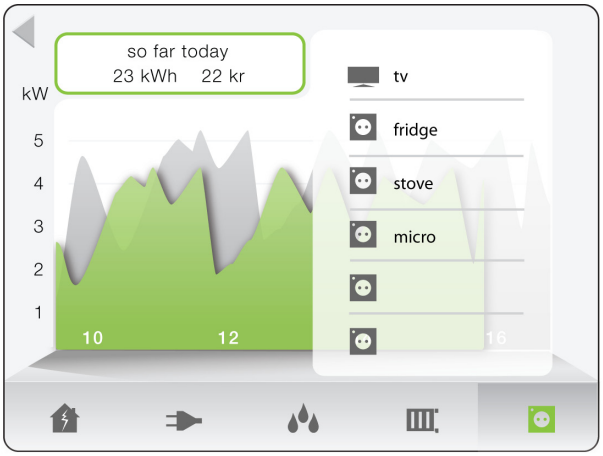


*Fig. 81. Device selection*

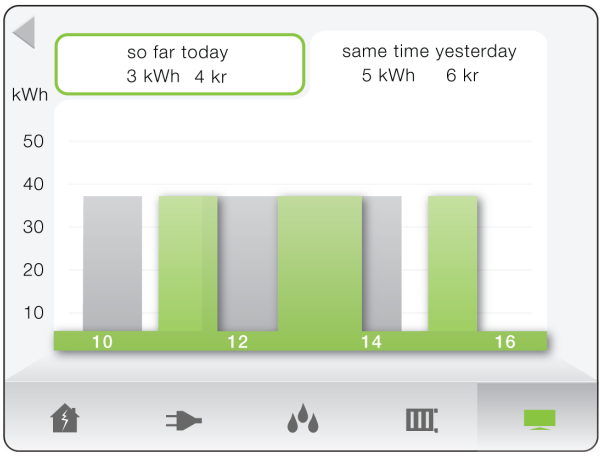


*Fig. 82. Device statistics*

### 8.2.4 Report

When entering the report sub function four information windows appear, see figure 83. All four windows in the report sub function can be extended for further information. When one of the sub functions are extended a quick animation that extends the window gives the user feedback that the action has been carried out, see section 3.1.11 and 3.1.14. To not present to much information and by so overload the memory function, the windows are extendable, see section 3.1.9.

*Cost*

In the upper left corner a green bar visualise the progression of the present month. The window also shows the accumulated cost so far this month, it is visualised in a green colour to creates coherence with the green bar. A black figure can also be seen, it shows the expected total cost for all energy at the end of the present month. The figures are connected to the bar with the use of colour. When the cost window is extended the cost and price information concerning the user's source of energy is displayed. In figure 84 the user has district heating for hot water and heating and by so has two energy sources. The cost information is shown in the same way as in the first screen with a bar that fills up with a green colour as the month progress and the current cost displayed in green numbers and the estimated cost at the end of the month in black. Underneath the cost information the current price per kWh is shown together with an arrow indicating if the price has gone up or down compared to last month. This is further enhanced by the colour coded arrow and the change in percent.

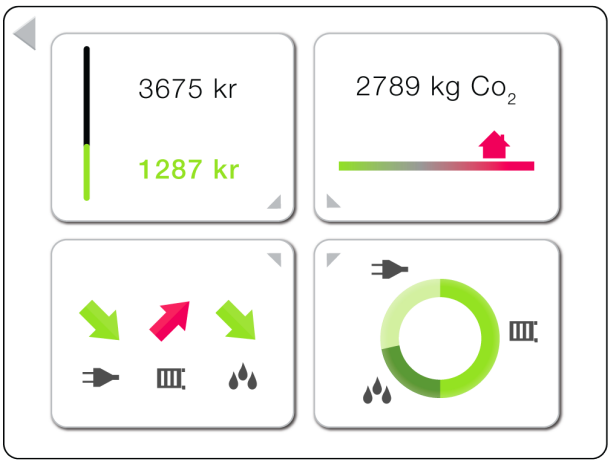


*Fig. 83. Report*

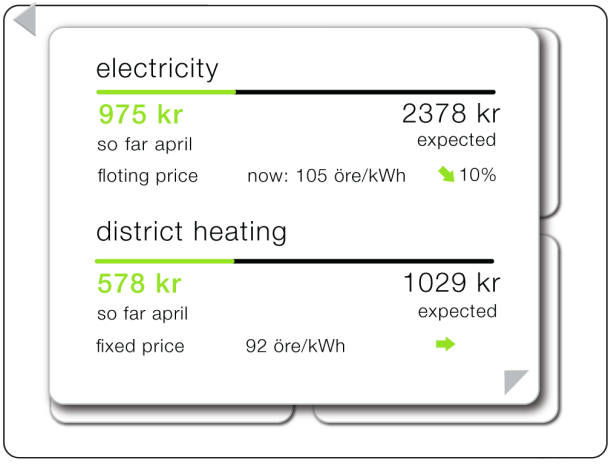


*Fig. 84. Report*

*Environmental/comparative*

In the upper right corner, see figure 83 the information window shows the expected carbon dioxide emission this month and a visualisation of how this particular household is consuming in comparison to an equivalent household. The carbon dioxide measurement is provided in order to make it possible for the user to compare the households energy consumption to other carbon dioxide labelled activities, for example an air travel. The comparison part is presented using a house on a scale that goes from green to red. In figure 83 the household is consuming more energy than an equivalent household and therefore the house is placed above the red part of the scale. The comparison part is presented since this type of feedback has show great energy saving potential according to theory, see section 3.2.

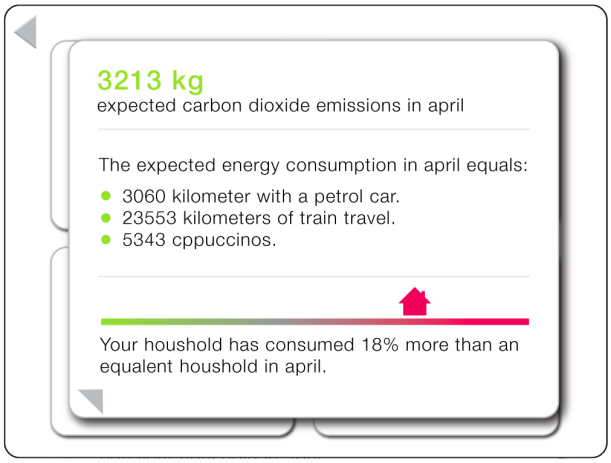


*Fig. 85. Comparative*

When the window is extended, see picture 85, more detailed information is shown. First the carbon dioxide emission is once more accounted for together with a short explanatory text.

After this, the household's energy consumption is compared to three interesting measurements. As concluded in the pre-study, see section 3.3, people lack knowledge on how to compare and relate their energy consumption to other energy consuming activities. By providing these comparison measures the idea is to increase the knowledge and by so encourage users to reflect on their energy behaviour.

Finally a visualisation of how the household is consuming in comparison to an equivalent household is displayed together with a short explanatory text.

*Trend*

In the down left corner, see figure 83 three arrows one for each energy usage area visualises if the energy usage areas consumption is increasing or decreasing. The trend of the energy usage area is shown by the colour and direction of the arrow, that is, a red arrow in an upwards direction indicate an increase of the energy consumption and green arrow in a downwards direction indicates a decrease. When the window is extended, see figure 86, the trend of each energy usage area is once more displayed together with the change in percent. The total increase or decrease of the energy consumption is also displayed at the bottom of the window.

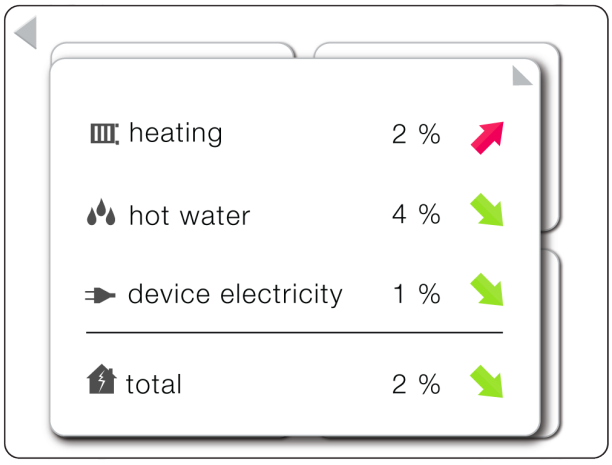


*Fig. 86. Trend*

*Distribution*

In the down right corner, see figure 83, a pie chart diagram shows the distribution between the three energy usage areas. The pie chart is coded in different shades of green to differentiate the energy usage areas but without adding any meaning to the colour. Extending the window, see figure 87 displays the pie chart with the energy usage areas together with information in percent about the distribution. The user can also click on a seconded pie chart in the down right corner, see figure 88. This will display a pie chart showing the interrelation between the energy consumption of the devices connected to a smart point. Differentiation of the devices is made in different shades of blue.

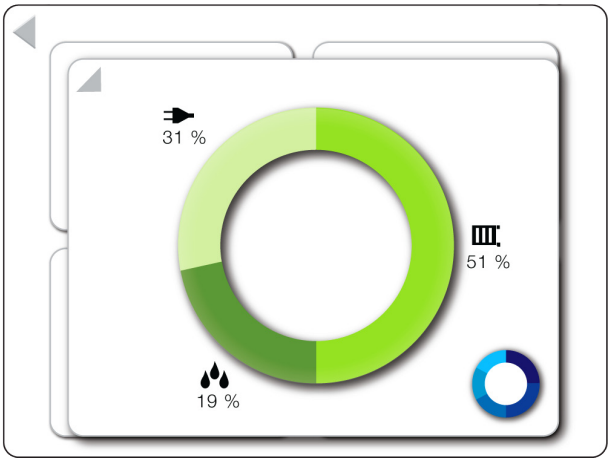


*Fig. 87. Distribution*

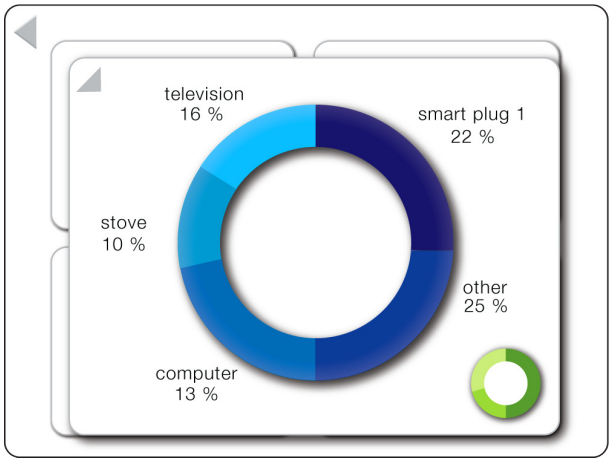


*Fig. 88. Distribution*

### 8.2.5 Devices

In the control sub function the user can control devices in the household that are connected to the smart points. The smart points communicate wireless with the energy display.

Entering the control sub function, see picture 89, the user will see what devices that are connected to the smart points. Each device connected to a smart point has a separate button showing an icon of the device and the name of the device. In addition to this the user will be able to see if a device is on or off, as the button will light up in a green when the device is on or have a gray colour when it is turned off. The buttons in the control sub function were designed to create consistency, see section 3.1.5, with the main menu and let the system be scalable, that is, allow a large amount of smart points to be connected.


*Fig. 89. Device menu*

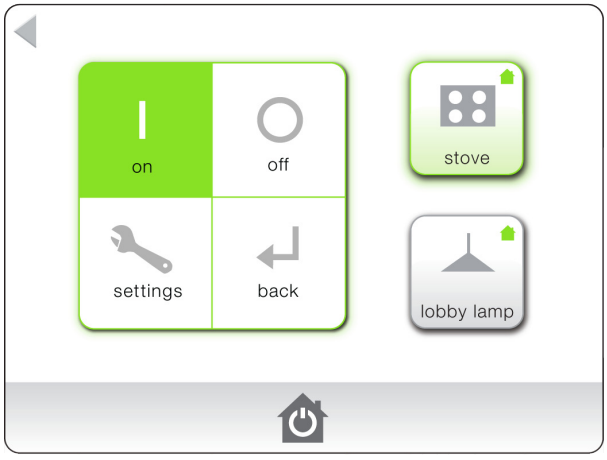


*Fig. 90. Select and control panel*

At the bottom of the screen a button is located that control the house mode function. The house mode function works as a master slave switch, that is, by turning the house mode off the devices connected to the house mode will all be turned off simultaneously and not be able to be turned on until the house mode is turned on again. This is useful when the user for example leaves the house or has products that consume energy in a standby mode. The house mode button was created by using the same graphics as in the statistics sub function to create consistency in the interface, see section 3.1.5. The house mode icon uses the same house icon as used in the total energy icon but with an on/off symbol in the middle. The on/off symbol is commonly used among other devices.

Pressing on one of the device buttons the select and control panel will appear that consists of four buttons, see figure 90. In the upper row the user can turn on or off the device and in the lower row the user can either return, or go into the settings menu. If the device is on, the on labelled button will have a green colour and if the device is off the off labelled button will become grey. To minimise the risk that the product is turned on or off by mistake the on and off buttons are marked with both a zero and a one icon that is a commonly used sign for on and off, as well as with writing on and off at the bottom of the buttons, see section 3.1.4. The use of green as the active colour further enhances the message. The icon used for return is an arrow in a loop, and this type of icon is commonly used in both smart phones and web pages. The settings icon used is the same icon as is used in the settings sub function, this was done to create consistency within the interface.

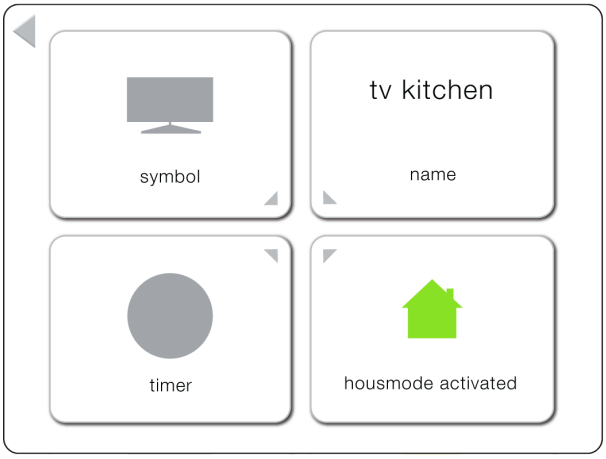


*Fig. 91. Device settings menu*

Pressing the settings button the user enters the settings menu that consists of four parts where the user can set the name of the device, select an appropriate icon, set a timer and activate or deactivate the house mode function for the specific device, see figure 91. The different sub parts of the settings function has not been developed graphically or interaction-wise, but the functionality will although be accounted for here. To let the user enter a name and select an appropriate icon for the devices connected was chosen to be included so that the user easily would be able to distinguish between the connected devices. To use both a symbol and a name was done as there may be more than one device of the same kind and to only mark the device buttons with a name would demand the user to read each button every time entering the sub function and by so increase the mental workload for the user. In the icon selection the user has a number of icons premade to chose from that portray the most common household appliances. Entering the name function the user will be able to enter a name of the device consisting of a fixed set of letters using a touch keyboard. A timer has also been included in the product to let the user control the product without being present. The timer function also let the user subsidise existing timers in the household and by so increases the customer value. In the settings mode the user can also connect the device to the house mode option. When the user has activated the house mode a small icon of a house will appear in the upper right corner on the device button, see figure 89.

### 8.2.6 Weather

Graphically designing the weather sub function has been delimited from this project, a description of the main idea is although accounted for here. The idea is that the user can find information about the current weather and a forecast of the coming days. By adding a weather function the user is more likely to use the product more often and thereby faster get a better understanding of his or her energy consumption. The weather function also adds customer value to the product.

The weather information is updated via an Internet site in the same way as many smart phones are today. However the local temperature is measured via an outside sensor that provides the exact local temperature, which is something that smart phones cannot provide.

### 8.2.7 Settings

Graphically designing the settings menu has been delimited from this project, a description of its content will although bee given here. In the settings menu the user will enter a number of key figures to ensure good values. These settings will be energy type and price model for each energy usage area, time and date, size of the household and number of people permanently living there and finally wireless network settings. The energy type for each energy usage area is included to be able to calculate the differentiation between the energy types, carbon dioxide emission and price per kilowatt. The price model for each energy type is also important as it dictates if there is a need for the device to update against the spot market or not. Size of the house and number of residence is important to provide in the settings menu as without this information the product could not provide a good estimate against an equivalent household. Wireless setting is needed both for the product to be able to communicate with the transmitter attached to the electricity meter and or the district heating meter and the Internet. The Internet connection is needed to provide information about spot market price and for updates, for example the weather forecasts.

### 8.2.8 Overall design elements

Some design elements have been used throughout the design of this product both in the interface design as well as in the product shape to create a consistent presentation and coherent feeling of the product.

*Overall*

The intended overall feeling of the interface is that it is spacious and airy. White areas together with simple graphics and a thoughtful use of colours create an inviting and friendly feeling. The well organized information adds to the competent feeling of the interface.

*Geometrical elements*

Rounded rectangles have been used in the interface. The radius of the roundness is consistent in many parts of the interface in order to create a feeling of belongingness, see figure 96-98 but has in some places been adjusted to better fit the size of the rectangle.

A fade from transparent to grey has been used on different parts of the interface, see figure 96-98. A drop shadow with the same depth and angle has been applied on several of the rectangles presenting information. The use of a drop shadow is useful according to the position theory, see section 3.1.14, in order to emphasize what the user should focus on, see figure 96-98. Small arrows has also been used throughout the interface in order to provide the user with hints of functions, according to the theory of hints in section 3.1.15.

*Colour*

The project group has strived to give the interface good legibility according to section 3.1.3. Although the project group has strived for good contrast the extensive use of green colour in the interface must be seen as a trade of between contrast and user experience.

A bright green colour is used to describe that something is active in the interface and grey is used when something is inactive. Dynamic colour in the interface is one of the strongest attention catchers as humans have, see section 3.1.6 and section 3.1.7 The used of green colour has been used consistently in Exibeas graphic image and therefore it also is also used to communicate belonging to Exibeas current product on the market.

*Fig. 92. Design elements statistics*

Green is also a colour that adds to the feeling of an environmentally friendly product. Green and red arrows are used to describe when something is positive or when something is negative in accordance with theory, see section 3.1.6.

*Font*

The font family used in the interface is Helvetica and the font style is light. It is a sans serif, which is suitable for good readability on onscreen devices, see section 3.1.3. Two font sizes are used in order to be able to direct attention in the interface, but still not make the perceived expression of the interface too sprawling.

*Fig. 93. Report design elements*

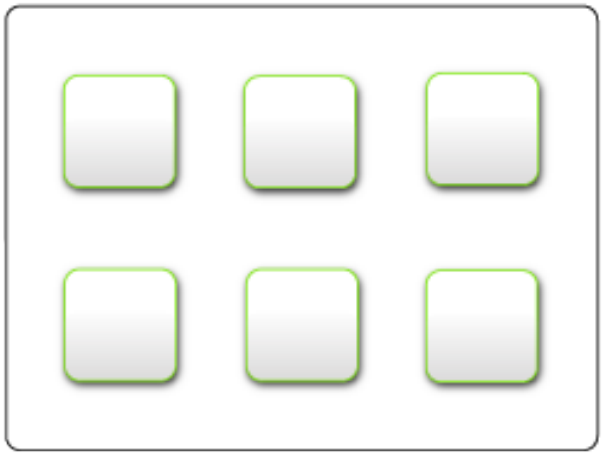

*Fig. 94. Menu design elements*

## 8.3 Conclusions

The project group has developed a product that has an attractive appearance. The product suits well in a contemporary Swedish home and has the potential to be a new environmentally friendly status symbol. By being attractive the product is more likely to be used among its intended target group and by that increase its energy saving potential. The product will also by its unique design attract attention and work as a conversational piece that will provoke discussion regarding energy consumption.

The product provides the user with feedback that will help the customer to reduce their energy consumption in their household. The feedback is given in several dimensions in order to maximize the efficiency.

Feedback is given to the user regarding the present energy consumption and past energy consumption. The user will learn what different activities consume in energy and will be able to monitor changes within their own energy consumption. The user will also be given normative feedback of their consumption and the users will learn how to relate their energy consumption to other energy consuming activities in the society. This feedback will influence the users in a both subconscious and conscious way to decrease their energy consumption.

The user will also be motivated to use the product since it provides feedback of energy costs and will decrease the users uncertainty regarding their energy bill. Other functions such as the weather forecast will also motivate the user to use the product.

# 9 DISCUSSION

## 9.1 Goal

We believed that our result fulfils the goal of this project. By defining a target group and in an organized manner defining that target groups requirements and demands, we have been able to develop a product that is both desirable for the consumer and provides the user with an efficient tool for reducing the energy consumption.

The product developed does although only provide the user with a tool for reducing the energy consumption and therefore the user needs to be active and deduct his or her own conclusions to be able to save energy. This can be argued to be a weak point with the product as it relies on the commitment and desire to experiment with alternative procedures in everyday life of the user. If the user chooses to neglect the information given by the product it becomes worthless and just another product that uses the resources of the world. We although believe that by providing this product the user will both consciously and unconsciously be affected as the information is constantly present and the user does not need to choose to look the information up in any way more that take a quick glance at the display and view the energy pattern presented. This constant presence of the information is also why we believe that a physical product can be justifiable, if the information were included in for example a smart phone application the user would have to choose to find the information instead of being reminded of it, as it can otherwise be seen as a contradiction to develop a physical product that use energy to save energy.

The choice to further include a smart point in the product for being able to measure specific devices can be discussed as it adds another physical product. If a software program algorithm would be possible to use for acquiring this information it would be much preferred as it would cost less to manufacture, not require any material, cost less for the consumer and be more environmentally friendly. As this solution was not possible with an adequate quality of the function, the product group although feel that a smart point is the second best alternative. To totally exclude information concerning specific devices could be argued to be another alternative.

We although believe that the possibility to control the devices that is made possible with the smart point solution add customer value and make the product appeal to a larger customer group. By attracting more users, more users will acquire the information and thereby start reflecting over their energy consumption.

The project group struggled during the development work with how to provide a satisfactory measurement of the environmental impact that energy usage has. The choice to provide carbon dioxide emission was perceived as a good measurement as it can easily be compared to other areas, for example flying. The project group although would have liked to offer an additional measurement, as carbon dioxide emission does not provide the entire picture. After discussions with Gustav Ebenå at Energymyndigheten the complexity of environmentally marking energy became apparent. To develop a more conclusive environmental measurement of energy could therefore be something to work further with, as it is very much needed not only for this product.

## 9.2 Methods

To use an Internet questionnaire was perceived to be very efficient in this project. It allowed us to quickly research a vast number of users. By using an online questionnaire we could persuade a lot of people to answer our questions. Since the participants could choose when to answer the questionnaire, the effort needed by the user was minimised which would not had been possible if the users were to be interviewed. The online questionnaire also provided a quick analysis process as the data could be easily exported.

In this project the area of the product and the product itself are relatively new. This created some problems in the development work as a lot of the methods learned during our education are created to analyse an existing product or area.

A problem encountered during the project was to try to define the interaction with the product that was felt to be very important for the success of the project. To only define the interaction as for example intuitive, was perceived to be too general and non descriptive. The ViP method was therefore seen as a good method for creating a common goal within the project group for the interaction. As none of the project group member's hade used the method before it was also perceived as interesting to learn.

Since the product area is relatively new we also struggled with trying to get a grip of what the user needed. When researching the area people had nothing to relate to. The interviews made with the test households were therefore very useful.

## 9.3 Work process

The project work during this project has involved a lot of discussions between the project members. During the project it has become obvious that the same problem, need or idea can be interpreted in many different ways. The many and thorough discussions made throughout the project have although resulted in a well thought through product. The project group has worked with consensuses throughout the project, which means that we have worked until both parties in the project team are satisfied rather then compromising along the way. If the project had been done by one of the group members it would probably have become more extreme in one direction.

During this project work we have struggled a lot with to what extent we should account for the development process including all the changes made throughout the process. In the design of the interface this has particularly been hard since the most parts of the interface are interrelated to some extent, which means that a change made in one part affects the other parts. It is also difficult to account for a process that has been highly iterative.

The development of the interface after the usability test is and can be seen as quite extensive. The development process of the different parts was although excluded from the report as the work was done very much in parallel and consist of so many small parts.

To include some does not give a comprehensive picture and does not clarify the interrelation between the different parts, and to give a complete picture would take up to much space. The choice to exclude a report of the further development between the final result and usability test was therefore made as we believe that the reader will hopefully get an understanding of the work behind and a understanding of the development work by reading the final result.

In the beginning of the project we tried to apply our normal product design process on the interface design development. We are used to follow a product design process that incorporates a part where a number of holistic concepts are developed and compared to each other. This was however difficult when designing this interface. Due to the time and effort that is needed to develop just one complex interface concept, the task to design several whole interface concepts with equal complexity level was found impossible. This resulted in the problem that the concepts that first were developed had both too low complexity level and also different complexity level, which made it hard to compare and evaluate them. Therefore we adopted a new product development process. Due to the fact that most of the parts in the interface were independent of each other once the main structure of the interface was set, the different parts could also be developed independently. A varying number of concepts were developed for the different sub parts, evaluated and further developed. This process was found to be appropriate in this project.

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# APPENDIX

## Appendix 1

**Intervjuvunderlag**

**Kategoriserande info**

- Hur gammal är du?
- I vilken typ av hus bor du? Storlek?
- Antal personer i hushållet och deras ålder?
- Vad har du för typ av uppvärmning (värme, varmvatten)
- Hur ofta får du räkning? Fast eller rörligt pris? fast
- Anser du att du är miljömedveten? Gradera från 1, inte bryr sig alls -5, gör flertal aktiva val och handlingar.

**Medvetenhet om energi**

- Vet du hur stor energi kostnad du har?
    - Värme har
    - Varmvatten
    - El
- Vet du hur stor del värme, varmvatten och hushållsel står för?
- Vet du om du förbrukar mer eller mindre energi än medelförbrukning?
- Diskuterar du energifrågor med dina bekanta?
- När du köper en ny produkt reflekterar du över dess energiförbrukning?
- Har du någon gång blivigt överraskad när energiräknigen/arnan kom?
- Skulle du vilja ha bättre kontroll över din energi förbrukning? Lägger du ner mycket energi på att ha koll?
- Reflekterar du över hur din energiförbrukning påverkar miljön? I vilka situationer visar sig detta?

**Motivation**

- Tycker du det är viktigt att minska energiförbrukningen hemma?
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning?
    - Kostnad
    - Global uppvärmning
    - Rättvis fördelning av resurser
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning?
- Om du var tvungen att minska energiförbrukningen med 30 % vad skulle du göra då?

## Appendix 2

**Ostrukturead intervju.**

*Hej! Hur funkar produkten idag? Har den hjälp dig att minska förbrukningen? Har du tänkt på problem/förbättringar?*

Interview

**Målet med att fråga om befintlig produkt?**

Undersöka om folk upplever att den fungerar? Folk har reflekterat på energiförbrukning och vi får bättre information. *Hur funkar produkten idag? Har du tänkt på problem/förbättringar*

*Momentan i watt. Månadsvis i kr, $CO_2$ och wattimmar*

**Kategorierande info**

- Antal personer i huhållet och deras ålder?
- Fast eller rörligt pris?
- Anser du att du är miljömedveten? Utveckla

Kommentarer:

**Användnig**

- När använder du produkten? I vilka olika situationer har du använt den?
- Vem/vilka använder produkten? Varför inte alla?
- Är det kul/intressant att använda den?

*Kommentarer:*

Ändrade vanor

- Är det något som du blivit förvånad över?
- Kan du ge exempel på några ändrade vanor?
- Varför tror du att dessa vanor har ändrats?
- Har du kunnat följa förändringar

*Kommentarer:*

**Förslag**

- Har du några tankar på fler /bättre funktioner?
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten?
- *(Värme. Vatten och el).*
- *(Har du tittat någonting på dusch och uppvärmningskostnader?)*

*Kommentarer:*

**Specifikt**

- Vet du hur sammbandet mellan effekt och energi ser ut?
- Hur ser du på watt, kilowatt och kilowattimme?
- Tycker du att det är bra att den visar…
- Skulle du vilja ha en annan enhet?
  - 
- Tycker du att det är bra att den visar $Co_2$ utsläppet?
- Kan du ge exempel på vad $Co_2$ informationen innebär?
- Finns det något annat mått som är bättre?

# Appendix 3

## Enkät om energianvändning i hushållet

Denna enkät kommer att användas som underlag för ett examensarbete inom energisektorn. Enkäten vänder sig till personer över 18 år med eget hushåll. Tryck på knappen "submit" när du är färdig! Tack för att du tar dig tid att fylla i denna enkät!

1. Kön?
   - ○ Man
   - ○ Kvinna

2. Hur gammal är du?
   - ○ 18-24
   - ○ 25-34
   - ○ 35-44
   - ○ 45-54
   - ○ 55-64
   - ○ 65+

3. Vad har du för utbildning?
   - ☐ Grundskoleutbildning
   - ☐ Gymnasieutbildning
   - ☐ Högskoleutbildning
   - ☐ Annan utbildning

4. I vilken typ av bostad bor du?
   - ○ Hyresrättslägenhet
   - ○ Bostadsrättslägenhet
   - ○ Kedjehus
   - ○ Radhus
   - ○ Villa

5. Vilken typ av uppvärmning har din bostad?
   - ☐ El
   - ☐ Biobränsle
   - ☐ Fjärrvärme
   - ☐ Värmepump
   - ☐ Olja
   - ☐ Annat

6. Hur många kvadratmeter uppvärmd yta har du? Inklusive eventuell uppvärmd biarea.
   - ○ <50
   - ○ 50-100
   - ○ 100-150
   - ○ 151-200
   - ○ 201-250
   - ○ >250

7. Antal personer som stadigvarande bor i hushållet?
   - ○ 1
   - ○ 2
   - ○ 3
   - ○ 4
   - ○ 5
   - ○ 6 eller fler

8. Hur väl stämmer detta påståendet? 1=Stämmer väl, 5=Stämmer inte alls

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Jag har ett stort miljöengagemang | ○ | ○ | ○ | ○ | ○ |
| Mitt miljöengagemang resulterar ofta i handling | ○ | ○ | ○ | ○ | ○ |

9. Vet du, utan att titta på räkningen/arna, hur stor total energikostnad du har per månad?
   - ○ Ja, jag vet nästan exakt hur stor kostnad jag har
   - ○ Nja, jag är osäker men jag kan göra en ungefärlig uppskattning
   - ○ Nja, jag är osäker och kan endast göra en grov uppskattning
   - ○ Nej, jag har ingen direkt uppfattning

10. Vet du hur energifördelningen mellan uppvärmning, varmvatten och hushållsel ser ut i din bostad?
    - ○ Ja, jag vet hur fördelningen ser ut
    - ○ Nja, jag är osäker men jag kan göra en ungefärlig uppskattning
    - ○ Nja, jag är osäker och kan endast göra en grov uppskattning
    - ○ Nej, jag har ingen direkt uppfattning

11. Hur tror du att din totala energikonsumtion förhåller sig jämfört med ett likvärdigt hushåll?
    - ○ Mindre än genomsnittet
    - ○ Lite mindre än genomsnittet
    - ○ Ungefär som genomsnittet
    - ○ Lite mer än genomsnittet
    - ○ Mer än genomsnittet

12. Vilken uppfattning har du om vad följande aktiviteter och produkter konsumerar i energi? 1=God uppfattning, 2=Ungefärlig uppfattning, 3=Liten uppfattning, 4=Ingen uppfattning

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Tv | ○ | ○ | ○ | ○ |
| Kyl & frys | ○ | ○ | ○ | ○ |
| Din totala belysning | ○ | ○ | ○ | ○ |
| Dusch | ○ | ○ | ○ | ○ |
| Din uppvärmning | ○ | ○ | ○ | ○ |

13. Känner du dig osäker eller oroar du dig över vad kostnaden av din totala energiförbrukning kommer att bli?
    - ○ Alltid
    - ○ Ofta
    - ○ Ibland
    - ○ Sällan
    - ○ Aldrig

14. Hur ofta känner du dig säker på att energibolaget/en debiterar dig rätt?
    - ○ Alltid
    - ○ Ofta
    - ○ Ibland
    - ○ Sällan
    - ○ Aldrig

15. Vad motiverar dig till att hålla nere din energikonsumtion? 1=Mycket motiverande, 5=Inte motiverande

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Minska mina konstnader | ○ | ○ | ○ | ○ | ○ |
| Bidra till att minska den globala uppvärmningen | ○ | ○ | ○ | ○ | ○ |
| Bidra till att minska risken för kärnkrafthaveri och att minska kärnkraftsavfall | ○ | ○ | ○ | ○ | ○ |
| Bidra till rättvisare fördelning av jordens resurser | ○ | ○ | ○ | ○ | ○ |
| Känslan av att dra mitt strå till stacken | ○ | ○ | ○ | ○ | ○ |

16. Är det något annat som motiverar dig?

17. Hur ofta brukar du reflektera över hur din egen energiförbrukning påverkar miljön?

- Alltid
- Ofta
- Ibland
- Sällan
- Aldrig

18. Hur viktigt tycker du det är det att minska energikonsumtionen om man i huvudsak använder förnyelsebar energi istället för icke-förnyelsebar energi?

- Mycket viktigare
- Något viktigare
- Lika viktigt
- Mindre viktigt
- Inte viktigt alls

19. På energiräkningen anges energin i kilowattimmar, men på lampor och andra produkter anges istället effekten watt. Vet du hur förhållandet mellan watt och kilowattimme ser ut?

- Ja
- Nej

20. Övriga kommentarer:

# Appendix 4

**Overall:**

Hjälp nivåer:

Niv 1: Lite st ttande typ: F rs k lite till..?
Nivå 2: Man ger explicit hjälp

**What we want to test:**

Hej och välkommen till vårt usabilitytest. Du kommer att få interagera med en touch skärm som ska motsvara en Iphone liknande display. Vi skulle vilja att du försöker prata högt under testet för att beskriva vad du tänker. Det är viktigt att komma ihåg att vi inte utvärderar dig utan gränssittet.

För-frågor:
Ålder:
Kön:
Utbildning:
Teknikvana (1-5) : 1 = Jag är betydligt smämre än vanligt
5 = Jag är betydligt bättre än geomsnittet

**Scenario:**
Din granne har köpte en ny apparat som visar energiförbrukning i hans hem. Det är en liten trådlös display som mäter den totala energiförbrukningen och den har också fyra tillhörande smarta kontakter, som man kan stoppa in i eluttag. Du har nu kommit hem till din granne och du blir såklart nyfiken och börjar studera den apparaten som sitter i hallen.

**Del 1 (klockan)**

Titta på bilden under en minut. Beskriv sen sedan vad det är du tror att du ser.

Kriterire:
- Om man förstår att det är en klocka.
- Om förstår att siffran i mitten motsvarar energiförbrukningen.
- Om man förstår att senaste förändringen är just senaste förändringen.
- Om man tolkar den gröna grafiken som ett energimönster.
- Om man förstår var nuläget är.
- Om man förstår att tidsramen är lite mindre än en timma.

**Del 2 (Idag)**

Du vill nu veta hur mycket energi som din granne förbrukade klockan 06 idag, hur gör du då?

Hur mycket stor del var väreförbrukningen för just då?

Villka apparater var på klockan 06?

Kriterier

- Om man kan läsa av vilket effekt som var på klockan ett
- Om man kan läsa av hur stor del värmen stod för
- Om man kan läsa av vilka apparater som var på klockan ett

**Del 3 (statistik)**

Nu är du nyfiken på att undersöka hur mycket energi som din granne förbrukade den 13 april. Hur gör du då?

Nu är du nyfiken på att se hur mycket uppvärmningsenergi som din granne förbrukade förra veckan?

Du undrar också över hur mycket energi grannen förbrukade i April

Kriterier

- Lyckades man förstå hur mycket energi som förbrukades den 13 april
- Lyckades man förstå hur mycket energi som förbrukades förra veckan
- Lyckades man förstå hur mycket energi som förbrukades i April

**Del 4 (pris)**

Du är nyfiken på att ta reda på vad din granne betalar för sin energi, undersök detta?

Berätta vad grafen till höger betyder?

Kriterier

- Man förstår vad energipriset är
- Man förstår hur priset är uträknat

**Del 5 (Apparater)**

Du undrar nu vad din grannes TV har för effekt, och hur mycket han tittar på TV. Hur gör du?

Din granne ber dig stänga av TV åt honom, hur gör du?

Vad är husläget för något? Undersök och beskriv vad det kan användas till

Kriterier

- Om man lyckas förstå vad TV har för effekt och hur ofta den är på
- Om man lyckas stänga av TV
- Om man lyckas beskriva vad husläget är för något

**Del 6 (Lägesrapport)**

Nu undrar du vad din granne kommer att ha i månadskostnad, hur gör du då?

Kriterier

- Om man lyckas navigera till menyn
- Om man lyckas öppna statusdelen
- Om man lyckas tolka informationen

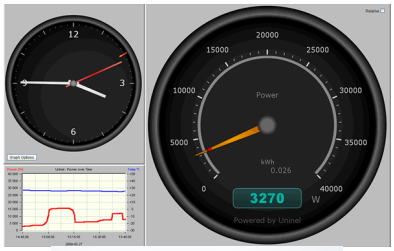
**Hur kände du dig när du testade displayen?**
*irriterad tillfreds*
*1-5*
**Vilken nivå av begriplighet tyckte du att displayn hade?**
*låg hög*
*1-5*
**Hur upplevde du uppgifterna som du utförde?**
*svåra lätta*
*1-5*
**Hur väl klarade du av uppgifterna enligt dig själv**
*dåligt bra*
*1-5*

Övriga kommentarer

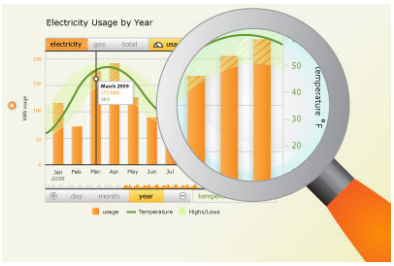
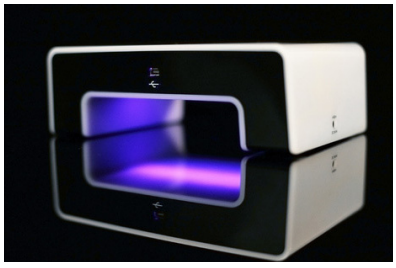
## Appendix 5

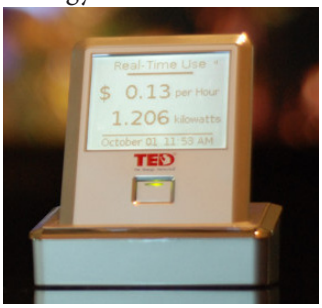
# Electricity monitor

| Look | Functionality | Price | Market |
|---|---|---|---|
| Electricity monitor  | The product connected to a device or equipment were the electivity usage is of interest. The electricity meter can be programmed with kW price. Show Volt, Watt, Ampere, kWh etc for the connected on the LCD-display. | 99 SEK | Swedish consumer market<br><br>Claes Ohlson |
| Wireless electricity monitor  | The product connected to a device or equipment were the electivity usage is of interest. The electricity meter can be programmed with kW price. Wireless display unit show voltage, load, effect, time and indoor temperature. Can handle up to four wireless transmitters. | Main unit 399 SEK, wireless unit 179 SEK. | Swedish consumer market<br><br>Claes Ohlson |
| Energy Check 3000 radio  | The electricity monitor is connected between a device or equipment and the wall socket were the electivity usage is of interest. Consist of a wall socket monitor and a base unit that communicates through radio, can handle up to nine wall socket units. Show kWh, effect, price, voltage and current. | 389 SEK | Swedish consumer market<br><br>www.conrad.se |
| Etech electricity monitor  | Is connected to a device or equipment were the electivity usage is of interest. The electricity meter can be programmed with kW price and can thereby show the accumulated cost of electricity for the device. | 149 SEK | Swedish consumer market<br><br>Siba |
| Energy Check 3000  | Electricity monitor that is connected to a device or equipment were the device or wall socket voltage is of interest. | 299 SEK | Swedish consumer market<br><br>www.conrad.se |

| Look | Functionality | Price | Market |
|---|---|---|---|
| Digital electricity monitor PM300<br>  | The electricity meter is connected to a device or equipment were the electivity usage is of interest. The electricity meter can be programmed with kW price and can thereby show the accumulated cost of electricity for the device on the product LCD display. Also measure the voltage and load. Additional functions are timer and overload warning. | 199 SEK | Swedish consumer market<br><br>Jula |
| Electricity monitor<br>  | The electricity meter is connected to a device or equipment were the electivity usage is of interest. Can measure voltage, effect, current and maximum current. | 149 SEK | Swedish consumer market<br><br>Jula |
| Electricity monitor<br>  | Electricity monitor that is connected to a device or equipment were the device or wall socket voltage is of interest. | 169 SEK | Swedish consumer market<br><br>Rusta |
| Uninel<br>  <br>  | Electricity monitor that measures the electricity usage in the entire household. The electricity monitor consist of one transmitter unit positioned in the electricity cabinet that is conected to a computer throught a network cord. The electricity consumption can be shown in realtime aswell as historic data. Show cost, usage in kWh, average consumption and outdoor temperature. | 695-1143SEK | Swedish consumer market |

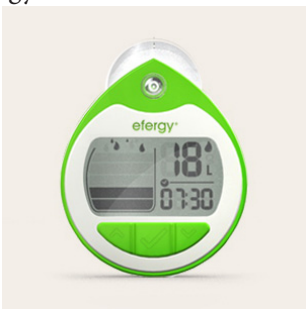
| Look | Functionality | Price | Market |
|---|---|---|---|
| Wireless electricity monitor  | Electricity monitor that measures the electricity usage in the entire household. The electricity monitor consist of two units a transmitter and a display unit. The transmitter is positioned in the electricity cabinet and transmits wireless to the display unit the electricity consumption. Show cost, usage in kWh, average consumption and electricity consumption history. | 599 SEK | Swedish consumer market<br><br>Claes Ohlson |
| Google PowerMeter  | Provides a real-time read-out of home electricity use and weekly trends from a Web browser that needs to be connected to a smart meter or an other electricity monitoring device in the household. | - | Not on the market yet |
| Cent-a-meter   | Electricity monitor that monitors the electricity us in the entire household and displays it on a wireless LCD display. A sensor is attached to the incoming main wire of the household which transmits wireless to the display. Can be programmed with electricity rate to show cost, also shows greenhouse gas emission and provides an alarm for extensive peak load use. Additional features are visualisation of temperature and humidity comfort level in the home. | 180 C$ | Consumer market USA and Canada |
| AlertMe Energy  | Monitors the household electricity usage by attaching the AlertMe meter on to the electricity meter and show the real-time energy usage. Alertme show the energy comsumption on either a alertme dashboard or has partered up with google power meter that show the information using a Web browser. | 69 £ | Primerlly Brittish consumer market |

| Look | Functionality | Price | Market |
|---|---|---|---|
| Hohm   | By signing up to the Hohm webpage and providing detailed information about the household energy use the program calcutates where the user can save energy and how. Provides the the opertunaty to compare energy usage with other Hohm users and build up project list based on how much you want to spend or save. | Free | USA consumer market<br><br>Microsoft |
| Envi   | Electricity monitor that tracks the entire household electricity usage can also be complemented with up to ten sensors that measure specific appliances. Can be programmed with the electricity rate and how it fluctuates over the day. A display on the main unit is used to show the information. The possibility to show gas, LPG gas, oil is under development. | 40 £ | British consumer market<br><br>Efergy |
| Elite electricity monitor  | Monitors and saves data concerning the electricity usage in the household. Visualises daily, weekly and monthly data and calculates average usage. Is attached to a conventional electricity meter and wirelessly sends real time updates to a wireless handheld remote main unit. | 40 £ | British consumer market<br><br>Efergy |
| Wattson  | Monitors the electricity usage in the entire household. Can show daily, weekly and monthly information about the electricity usage thought the attached software holmes. Lets the user see the electricity usage thought the use of colour change. Displays effect and cost on the device. | 100 £ | Consumer market in Australia, Europe and Asia |

| Look | Functionality | Price | Market |
|---|---|---|---|
| ConnectedLife energy management | Monitors electricity usage in real-time to track and compare daily, weekly, and monthly trends to pre-set energy and expenditure goals to be able to control peak energy usage. Can remotely manage and control devices from the Web or mobile phone. Needs to be connected to a smart meter. Show electricity usage in cost, usage and carbon footprint. | - | Launch during 2010<br>Consumer market USA. |
| EnergyHub<br>  | Monitors and controls all electricity use in the household thought a touch screen or web browser. Provides real-time feedback on electricity usage for all appliances. Provides the possibility to control and access data from a Web browser and share information and compare data with other users of the system. Require a smart meter | - | Not on the market yet |
| The energy detective TED<br>  | Monitor electricity usage in the household and presents the data in real-time. For more comprehensive information a software program is used that show graphs, charts, analysing trends, load-profiling etc. TED can be used with Google Power meter for visualisation or an optional display unit. | 240 US$ | Consumer market USA |
| Intel<br>  | Monitor the electricity consumption in the household and provide the opportunity to set monthly energy targets and learn how to reach them and discover where the electricity is used. Additional features are to provide family members with information to help them plan their daily activities, access personal messages and activate home security systems. Require a smart meter. | - | Not on the market yet |

| | | | |
|---|---|---|---|
| PowerCost Monitor  | Electricity monitor that measures the electricity usage in the entire household. The electricity monitor consist of two units a transmitter and a display unit. The transmitter is positioned in the electricity cabinet and transmits wireless to the display unit the electricity consumption. Show cost, usage in kWh, average consumption and electricity consumption history. | 109 US$ without tax | USA and Cananien consumer market<br><br>Blue Line Innovations |

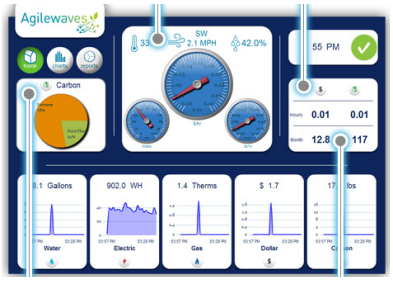
## Water monitor

| Look | Functionality | Price | Market |
|---|---|---|---|
| Efergy showertime  | Measures water flow in the shower and alerts when a certain amount has been used. The amount of water that can be used before the alarm goes of is possible to set individually. | 8 £ | British consumer market |

## Hot water and heating monitor

| | | | |
|---|---|---|---|
| Kyab  | Measures district heating usage and differansiates between hot water usage and heating usage through an algoritm. | - | Not on the market yet |

# Energy monitor

| Look | Functionality | Price | Market |
|---|---|---|---|
| Control4 Energy Systems  | The Controll4 Energy Management System is a bundle product that includes energy controller, programmable thermostat and energy management analytic software. Needs to be connected to a smart meter. The system has a touch screen that displays collects, analyzes and displays real time residential energy use data it also lets the user set the control of devices during peak times. Additional features are weather monitoring, display photos, check out podcasts, display the time etc. | - | Not on the market yet |
| Onzo  | Provides data capture, software modules and an in-home display that show the electricity and water usage in the household. The data can also be accessed thought a Web browser. Under development is also the functionality to optimise heating and cooling in the household. | - | Utility companies in the UK. |
| Agilewaves Resource Monitor  | Monitors electricity, gas and water use in the household and provides information in real-time using a Web browser. The system analyses the data and can send notifications about leaks or extensive energy use thought email or text messages. The system can also track other factors such as temperature/humidity, output from solar PV, performance of solar or geo-thermal water heating and indoor air quality. Current and historical information is automatically stored which enables trend analysis and comparative features to be displayed across any time period. | - | Utility companies in the USA |

| Look | Functionality | Price | Market |
|---|---|---|---|
| The duet, Green energy option  | Monitors electricity, heating and hot water usage in the household and provides real-time feedback. Can monitor and remote control up to six distinct appliances at the same time. Show current energy usage and tracks energy use over time for comparison between current and historical use. Displays the energy consumption information in CO2 emission, cost and over all energy load on a remote display. | - | Not on the market yet<br><br>Green energy option |
| Manodo  | Measure and display the energy e.g. hot water, heating and electricity usage in the household. The information can be displayed on optional media. | - | Property owners in Sweden |

# Appendix 6

## Intervju 1

### Kategoriserande info

- Hur gammal är du? 60 och 61
- I vilken typ av hus bor du? Villa, 180 kvm 100 kvm uppvärmd källare
- Antal personer i huhållet och deras ålder? 2st 60 och 61
- Vad har du för typ av uppvärmning (värme, varmvatten) Fjärvärme till varm vatten och värme
- Hur ofta får du räkning? Fast eller rörligt pris? Rörligt pris
- Anser du att du är miljömedveten? Utveckla  Ja har fjärvärme sorterar tidningar glas etc.

### Medvetenhet om energi

- Vet du hur stor energi kostnad du har? Nej / Nej, 6000 kwh per år på el hushållsel, 8-10 kubik i månaden kall vatten, varm vatten och värme vet ej
- Vet du hur stor del värme, varmvatten och hushållsel står för? Nej / Mer än hälften på värme och varm vatten ca 60% hushålls el resten
- Vet du om du förbrukar mer eller mindre energi än normalt? Kanske lite mindre än normalt litet hushåll stort hus. / Mindre, lyser inte hela huset, inte så varmt
- När du köper en ny produkt reflekterar du över dess energiförbrukning? Ja tänker efter, skulle definitivt kolla stand by läge vid köpa av ny tv / I viss utsträckning tvingats till på lampor. Väljer produkt först sen jämför i steg två energiförbrukning på möjliga val.
- Har du någon gång blivigt överrasskad när energiräknigen/arnan kom? Bara betalar, inte här. Mormor vatten men berodde på läckande toa / Nej
- Känner du att du har kontroll över din energiförbrukning?  Nej inte tagit det ansvars för det området. / Tycker jag har kontroll, har bytt leverantör och från till rörlig
- Reflekterar du över hur din energiförbrukning påverkar miljön?  Lite, gick över från olja till fjärrvärme, mindre utsläpp än med olja. / Nej har valt fjärrvärme vet att tekniska verket eldar miljövänligt mycket bättre än olja
- I vilka situationer visar sig detta?

### Motivation

- Tycker du det är viktigt att minska energiförbrukningen hemma? Ingen fanatiker, inte förbruka mer än nödvändigt släcker inte ned och släcker inte för varje krona. / Ja ska hushålla för den globala saken inget resultat annars
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning? Kostnaden i säj inte så liktig, miljö mer viktig. Hur mycket dyrare (minskad kostnad, mindre miljöpåverkan, spara energi för samhället) / Pengar i första hand, kronor och ören fattar alla 100 kr mindre tydligare än 1000kwh i månaden eller liknande
- Vad motiverar dig till att släcka lampan när du lämnar ett rum?
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning? Ser över sina maskiner kyl frys, apparater som drar el i stand by, inte 20 min i duschen, viste att det var för dyrt. Kolla upp vad de drar i standby.  / Inte speciellt mycket, sänk temp inte trevligt, har tilläggs isolering, testa med värme kamera vart värmen försvinner, vara noggrannare med att släcka i källaren

## Intervju 2

### Kategoriserande info

- Hur gammal är du? 58
- I vilken typ av hus bor du? Storlek? Kjedjehus
- Antal personer i hushållet och deras ålder? 2
- Vad har du för typ av uppvärmning (värme, varmvatten) Fjärvärme, (upp oovh värme)
- Hur ofta får du räkning? Fast eller rörligt pris? Fast el, fjärrvärme fast. El varje kvartal, färrvärme månadsvis fast belopp. En gång om året får jag se vad jag förbrukat, och medelvärdet.
- Anser du att du är miljömedveten? Gradera från 1, inte bryr sig alls -5, gör flertal aktiva val och handlingar. 4.

### Medvetenhet om energi

- Vet du hur stor energi kostnad du har? Inte el.
- Värme
- Varmvatten
- El
- Vet du hur stor del värme, varmvatten och hushållsel står för? Kan se hyfsat
- Vet du om du förbrukar mer eller mindre energi än normalt? Förbrukar lite mer värme, El osäker, nog lite mindre.
- Diskuterar du energifrågor med dina bekanta? Ja,
- När du köper en ny produkt reflekterar du över dess energiförbrukning? Nja, ingen faktor som påverar. Mest kvalitet. Kyl och frys, viktigt.
- Har du någon gång blivigt överraskad när energiräknigen/arnan kom? Inte direkt, går inte över värme och vatten.
- Skulle du vilja ha bättre kontroll över din energi förbrukning? Nja,
- Reflekterar du över hur din energiförbrukning påverkar miljön? I vilka situationer visar sig detta? Ja, det klart. Val av el, valt bort kärnkraft. Kolla

### Motivation

- Tycker du det är viktigt att minska energiförbrukningen i ditt hem? Ja, jag fundrear på det.
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning?
- Kostnad: Självklart.
- Global uppvärmning: Ja det är viktigt.
- Rättvis fördelning av resurser: Ja, mycket.
- Minskat deponerings avfall (Kärnkraft, avfall):
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning? Sänka värmen, olika tankar kring det. Dusch kortare, minska bad.
- Om du var tvungen att minska energiförbrukningen med 30 % vad skulle du göra då? Minska värmen, Kortare dushar, Släcka lampor, Isolera

## Intervju 3

### Kategoriserande info

- Hur gammal är du? 31
- I vilken typ av hus bor du? Storlek? Villa 125 + 140
- Antal personer i hushållet och deras ålder? 3, 31, 31, och 5 mån
- Vad har du för typ av uppvärmning (värme, varmvatten) pellets vinter halvåret, varm vatten genom el på sommaren.
- Hur ofta får du räkning? Fast eller rörligt pris? Leverans beroende av åtgång på pellet typ en gång om året, rörligt elavtal har nyligen byt
- Anser du att du är miljömedveten? Gradera från 1-5, inte bryr sig alls 5, gör flertal aktiva val och handlingar. 4

### Medvetenhet om energi

- Vet du hur stor energi kostnad du har?
- Värme och varm vatten 12 000 kr oktober till maj eldar i kaminen med ved där utöver
- El 10 000 kwh per år inklusive sommar varm vatten
- 
- Vet du hur stor del värme, varmvatten och hushållsel står för? Värm hälften el och vatten 25 % var
- Vet du om du förbrukar mer eller mindre energi än medelförbrukning? Medel
- När du köper en ny produkt reflekterar du över dess energiförbrukning? Lite inte speciellt mycket antar att de jag köper nytt är bättre än det gamla jag byter ut
- Har du någon gång blivigt överraskad när energiräknigen/arnan kom? Bra koll jämn året runt pga att det bara är hushålls elen
- Skulle du vilja ha bättre kontroll över din energi förbrukning? Har bra koll
- Reflekterar du över hur din energiförbrukning påverkar miljön? I vilka situationer visar sig detta? Mest är pengarna jag tänker på 50 pengar -50 miljö

### Motivation

- Tycker du det är viktigt att minska energiförbrukningen hemma? Ja det tycker jag
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning?
- Kostnad JA
- Global uppvärmning nja
- Rättvis fördelning av resurser Nej
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning?
- Skulle kunna tilläggs isolera, köpa ny disk maskin. Men tänker rätt så mycket på det redan nu, full tvätt maskin och diskar stor disk för hand för att inte fylla upp disk maskinen i onödan.
- Om du var tvungen att minska energiförbrukningen med 30 % vad skulle du göra då? Tilläggsisolera parallellt mindre lampor, lampor uppskattas till 5-10 % av hushållselen.

## Intervju 4

### Kategoriserande info

- Hur gammal är du? 57
- I vilken typ av hus bor du? Storlek? Radhus 117kvm
- Antal personer i hushållet och deras ålder? 2, 57, 52
- Vad har du för typ av uppvärmning (värme, varmvatten)fjärrvärme
- Hur ofta får du räkning? Fast eller rörligt pris? Månadsviss, rörligt för fjärrvärmen, månadsviss fast för hushållselen
- Anser du att du är miljömedveten? Gradera från 1, inte bryr sig alls -5, gör flertal aktiva val och handlingar. 4

### Medvetenhet om energi

- Vet du hur stor energi kostnad du har?
- Värme för statistik men kan inte svara utan att titta på den
- Varmvatten
- El vet ej
- Vet du hur stor del värme, varmvatten och hushållsel står för? 25% el resten fjärrvärme var av 20% varm vatten och 80 % värme
- Vet du om du förbrukar mer eller mindre energi än medelförbrukning? Inte mer, normalt till mindre har gemensamt el skåp med grannen och det förbrukar mer el än vi
- När du köper en ny produkt reflekterar du över dess energiförbrukning? Ja, köpte nyligen ny diskmaskin viktiga kriterier var tyst och energi snål
- Har du någon gång blivigt överraskad när energiräknigen/arnan kom? Nej
- Skulle du vilja ha bättre kontroll över din energi förbrukning? Ja följer inte upp gör inget aktivt val tex. av el leverantör byta
- Reflekterar du över hur din energiförbrukning påverkar miljön? I vilka situationer visar sig detta? Funderar på energi förbrukning vid till exempel insamling till återvinning tvätt av mjölk paket vs bränna upp dem vad som är bäst. Tvättmaskin ful och så vidare inte slösa

### Motivation

- Tycker du det är viktigt att minska energiförbrukningen hemma? Ja vi förbrukar mer och mer el genom mer grejer inte hållbart
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning?
- Kostnad
- Global uppvärmning
- Rättvis fördelning av resurser
- miljö aspekter viktigt dock komplext problem u-länder vill utvecklas kan förstå dem men funkar inte om alla ska slösa eller ha det som vi
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning? Använder inte så mycket energi, släcka lampor, timmer på motor värmare
- Om du var tvungen att minska energiförbrukningen med 30 % vad skulle du göra då? Släck mer lampor, bilen kortare på motor värmare, noga med att stäng av apparater när det inte används, stänga av standby läge men slösar inte så mycket

Intervju 5

## Kategoriserande info

- Hur gammal är du? 58
- I vilken typ av hus bor du? Radhus
- Antal personer i hushållet och deras ålder? 3st ålder 58,55,19
- Vad har du för typ av uppvärmning (värme, varmvatten) Direktverkande el (oljeelement), Varmvattenbredare.
- Hur ofta får du räkning? Fast eller rörligt pris? Fast (5 år) Varannan månad
- Anser du att du är miljömedveten? (1 till 5) Utveckla: Ja, ganska (4). Kunskap men inte förmågan.
- Betalar du energiräkningen. Delar.. men mest jag

## Medvetenhet om energi

- Vet du hur stor energi kostnad du har? Ja ungefär 1700/månad
- Vet du hur stor del värme, varmvatten och hushållsel står för? Nej, men jag skulle nog kunna gissa ganska bra
- Är det ett problem? Ja, det hade varit intressant att se vad de olika produkterna drar
- Vet du om du förbrukar mer eller mindre energi än normalt? Om man bortser ifrån den direktverkande elen så tror jag att jag ligger något under, jag försöker vara medveten
- När du köper en ny produkt reflekterar du över dess erngiförbrukning? Ja, väldigt mycket. Det påverkar mitt beslut till en stor del
- Har du någon gång blivigt överrasskad när energiräknigen/arnan kom? Jag blir alltid överraskad så nu för tiden blir jag inte överraskad längre..
- Kännder du att du har kontroll över din energiförbrukning? Jag kan ha kontroll om jag vill..
- Reflekterar du över hur din energiförbrukning påverkar miljön? Ja i mycket stor grad
- I vilka situationer visar sig detta? Korta duschar, energi lampor, Nya tekniker intressant. Ny spis. Stand by.

## Motivation

- Tycker du det är viktigt att minska energiförbrukningen hemma? Ja!
- Reflektera lite kring vad som motiverar dig till minskad energiförbrukning? (minskad kostnad, mindre miljöpåverkan, spara energi för samhället). Miljön men pengarna är såklart också en faktor.
- Vad tror du själv att du skulle kunna göra för att minska din energiförbrukning? Främst nya tekniker eller energisnålare produkter, jag tror det är svårt att minska förbrukningen i vardagen mer än vad vi redan gör.

# Appendix 7

## Intervju 1

### Kategorierande info

- Antal personer i huhållet och deras ålder? 3st 1,33,37
- Fast eller rörligt pris? Rörligt 3 mån

### Användnig

- När använder du produkten? I vilka olika situationer har du använt den? *Det har ju varit lite problem med produkten ett tag, vi har ju kunnat använda den väldigt begränsat. Svårt med temperaturen tror jag. Tittat emellanåt eftersom det inte går att gå runt med den. När den har funkat så har vi tittat på tvätt. Mer sporadiskt med tanke på funktionelitetet*
- Vem/vilka använder produkten? Varför inte alla?*Han kollar statestiken mer men jag kollar nuvarande åtgång mer. Han kollar mer hur det har varit under dagen eftersom han jobbar*
- Är det kul/intressant att använda den? *Man har blivit besviken på dålig sändgning*

### Ändrade vanor

- Är det något som du blivit förvånad över? *Förvånad, spisen drar mycket ojojoj. Inget göra åt men man har ju reagerat. Ingen speciell användnings förändring eftersom den inte fungerat*
- Kan du ge exempel på några ändrade vanor?
- Varför tror du att dessa vanor har ändrats?
- Har du kunnat se dina ev. förndringar med hjälp av Eliq?

### Förslag

- Har du några tankar på fler /bättre funktioner? *Saknas funktion: Eftersom jag kollar mest nuvarande förbrukning, det hade varit intressant att se nuvarande förbrukning i kostnad, typ hur mycket kostar det om denna förbrukningen är på i en timme.*
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten? *Bästa: Att man kan se statestiken lite under dan och så och se total kostnad och så.*
- *Sämsta: Att den funkat dåligt och så. Om det är vårt hus och så men det vet man ju inte vi har ju sånt suteränghus.*
- Värme. Vatten och el
- Har du tittat någonting på dusch och uppvärmningskostnader?

### Specifikt

- Vet du hur sammbandet mellan effekt och energi ser ut?
- Hur ser du på watt, kilowatt och kilowattimme?
- Tycker du att det är bra att den visar…
- Skulle du vilja ha en annan enhet?
- Tycker du att det är bra att den visar Co2 utsläppet?
- Kan du ge exempel på vad Co2 informationen innebär?
- Finns det något annat mått som är bättre?

Intervju 2

# Besökte

## Interview

### Kategorierande info

- Antal personer i huhållet och deras ålder? 3st 35, 38 1år
- Fast eller rörligt pris? rörligt, kanske inte så bra nu

### Användnig

- När använder du produkten? I vilka olika situationer har du använt den? Varje dag
- Vem/vilka använder produkten? Varför inte alla?
- Är det kul/intressant att använda den? Kul och intressant att använda den
- Tycker du att informationen presenterat klart och tydligt?

## Ändrade vanor

- Är det något som du blivit förvånad över?
- Kan du ge exempel på några ändrade vanor?
- Varför tror du att dessa vanor har ändrats?
- Har du kunnat se dina ev. förndringar med hjälp av Eliq?
- Kommentarer: Har aktivt kollat vad olika saker förbrukar. Kaffekokarn, vattenkokaren drar mer än induktionsspisen så den har vi slängt ut. Bastu, mm

### Förslag

- Har du några tankar på fler /bättre funktioner?
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten?
- *(Värme. Vatten och el).*
- (Har du tittat någonting på dusch och uppvärmningskostnader?)
- Kommentarer: Jag saknar information om vad de olika produkterna drar och vad de kostar..

### Specifikt

- Vet du hur sammbandet mellan effekt och energi ser ut?
- Hur ser du på watt, kilowatt och kilowattimme?
- Tycker du att det är bra att den visar…
- Skulle du vilja ha en annan enhet?
- Tycker du att det är bra att den visar Co2 utsläppet?
- Kan du ge exempel på vad Co2 informationen innebär?
- Finns det något annat mått som är bättre?

## Intervju 3

### Kategorierande info

- Antal personer i huhållet och deras ålder? 3st 24, 54, 54 år
- Fast eller rörligt pris? Jag tror att vi har fast.. Det var min man som hade beslutat om den här

### Användnig

- När använder du produkten? I vilka olika situationer har du använt den? Vi tittar ju litegranna varje dag
  Vi har den i vardagsrummet/allrummet
  Mest på kvällen, varje kväll?
- Vem/vilka använder produkten? Varför inte alla? Bara jag och min man?
- Är det kul/intressant att använda den? Ja det är kul intressant

#### Ändrade vanor

- Är det något som du blivit förvånad över? *Ja att de drar så väldigt mycket olika saker, Tvätt dra ju väldigt mycket alltså*
- Kan du ge exempel på några ändrade vanor? *Ja jag har ju dratt ner, framförallt tvätt*
- Varför tror du att dessa vanor har ändrats? *Tvätten rullade på, på mätaren*
- Har du kunnat se dina ev. förndringar med hjälp av Eliq?

### Förslag

- Har du några tankar på fler /bättre funktioner?
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten?
- *(Värme. Vatten och el).*
- *(Har du tittat någonting på dusch och uppvärmningskostnader?)*
- Kommentarer:
- Bästa: Att man ser energiförbrukningen får en tankeställare.
- Innan/Efter: Drar ut kontakter oftare nu.. Fast man trodde att man stängt av den så hade man ju inte det..
- Sämsta: Njaa det är väl ingenting så, lite dum placering.. men den gav ju bäst utslag där..

### Specifikt

- Vet du hur sammbandet mellan effekt och energi ser ut?
- Hur ser du på watt, kilowatt och kilowattimme?
- Tycker du att det är bra att den visar…
- Skulle du vilja ha en annan enhet?
- 
- Tycker du att det är bra att den visar Co2 utsläppet?
- Kan du ge exempel på vad Co2 informationen innebär?
- Finns det något annat mått som är bättre?

## Intervju 4

### Kategorierande info

- Antal personer i huhållet och deras ålder? 3st 35, 43, 1år
- Fast eller rörligt elpris? rörligt avtal

### Användnig

- När använder du produkten? I vilka olika situationer har du använt den? I princip daglingen, kul om man sätter på diskmaskin och så. Den står i vardagsrummet.
- Vem/vilka använder produkten? Varför inte alla? Både jag och min man
- Är det kul/intressant att använda den? Ja det är kul och intressant, vet lite mer vad det är för produkter som drar mest och vad man kan spara in på och aå
- Tycker du att informationen presenterat klart och tydligt? Ja det presenteras tydlingt

### Ändrade vanor

- Är det något som du blivit förvånad över? *Ja disk och tvätt blir man förvånad över framförallt eftersom det är eca program. Kul att jämföra eca program de vanligt program.*
- Kan du ge exempel på några ändrade vanor? *Jo, vi har ju testat med tvätt och så men det ör ju ett program som går fortare just för att spara på förbrukningen.*
- Varför tror du att dessa vanor har ändrats?
- Har du kunnat se dina ev. förndringar med hjälp av Eliq?

### Förslag

- Har du några tankar på fler /bättre funktioner?
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten?
- *(Värme. Vatten och el).*
- *(Har du tittat någonting på dusch och uppvärmningskostnader?)*
- Kommentarer:*Nja, jag tycker funktionerna är bra. Men man måste ju starta produkter i olika ordning, hade varit bra med difernttiering.*

*Det märks ju när man kommer hem och så. Tycker jag fått bättre kontroll.*

*Sämsta: Den funkar inte med minusgrader vilket är dåligt*

- Övrigt: *Nja, inget så speciellt som sagt jag tycker den är tydlig och lätt att följa men som du säger om det hade funnits i produkterna som man köper hade det ju varit bättre men det är ju bra att man bara behöver en produkt.*

### Specifikt

- Har du fått en bättre förståelse över watt?
- Tycker du att det är bra att den visar…
- Skulle du vilja ha en annan enhet?
- Tycker du att det är bra att den visar Co2 utsläppet?
- Kan du ge exempel på vad Co2 informationen innebär?
- Finns det något annat mått som är bättre?

## Intervju 5

### Kategorierande info

- Antal personer i huhållet och deras ålder? 4st 43, 35, 7, 4 år
- Fast eller rörligt elpris? Rörligt

### Användnig

- När använder du produkten? I vilka olika situationer har du använt den? *Varje dag, ofta när vi kommer hem, kollar hur viligger till jäför med igår tex.*
- Vem/vilka använder produkten? Varför inte alla? *Jag och min hustru*
- Är det kul/intressant att använda den? *Ja, dat är kul och intressant*
- Kommentarer: Det står bredvid TV bänken. Kanske inte där vi vill ha den eftersom den måste var nära givvarskået. Jag skulle helst vilja ha den lite mer undansku

### Ändrade vanor

- Är det något som du blivit förvånad över?
- Kan du ge exempel på några ändrade vanor?
- Varför tror du att dessa vanor har ändrats?
- Har du kunnat se dina ev. förndringar med hjälp av Eliq?
- Kommentarer: Ja, jag har blivit förvånad. Tex har vi ett varmförråd, där har vi stängt ner värmen för det drog så mycket. Datorer hemma som vi märkte draog mer än vad vi hade tänkt därför fixade vi program som stänger av sig själv.
  Ja, jag har tydligt märkt förrändringen gissar att vi fått ner snittförbrukningen med ca 50% från ca 20kwh/dar till ca 16kwh/dar.
  Jag hade tydligen dålig koll innan..

### Förslag

- Har du några tankar på fler /bättre funktioner?
- Saknar du någon information?
- Saknar du några funktioner? Skulle någon funktion gjorts annorlunda?
- Vad är det bästa / sämsta med produkten?
- *(Värme. Vatten och el).*
- *(Har du tittat någonting på dusch och uppvärmningskostnader?)*
- Kommentarer: Ja, det hade varit kul att kunna ändra elpriset. Fast egenligen är inte det de väsäntliga. Jobbigt att den lyser hela tiden, kunde kanske gå ner i sleepmode.
  Bästa: Dels att man ser den momentana förbrukningen. Den är inte riktigt så momentan, den pendlar ganske mycket ändå kanske pga kylskåp. Kul men kanske inte funkar så bra. Kul att kunna jämföra över dagar och veckor.
  Sämsta: Tappar signal fort och dåligt.

  Övrigt: Nä egentligen inte. Den välter lite lätt om man har den stående.

## Appendix 8

| Devices |
|---|
| **Usability** |
| Readable at a distance of 40 centimeters<br>Easily understandable information |
| **Interaction / Control** |
| Intuitive interaction<br>Be able to easily turn on and off devices<br>Be able to turn of all devices<br>Be able to set a timer |
| **Information** |
| Communicate key values<br>Communicate trends<br>Communicate energy consumption relative to other devices<br>Be able to see which devices that are on<br>Be able to have a lot of devices<br>Be able to see what devicess that has been on during the day |

| Energy statistics |
|---|
| **Usability** |
| Readable at a distance of 40 centimeters<br>Easily understandable information |
| **Interaction** |
| Intuitive interaction |
| **Information** |
| Communicate trends<br>Communicate specific values<br>Communicate total energy consumption of desired time span<br>Communicate energy consumption in desired time chunks, day, week, month and so forth<br>Be able to view different types of energy<br>Be able to understand relation between different energy types |
| **Aesthetic** |
| Innovative<br>Interesting |

| Momentary consumption |
|---|
| **Usability** |
| Readable at a distance of minimum 2 meters<br>Easily understandable information |
| **Information** |
| Communicate current energy consumption (effect)<br>Comunicate energy changes<br>Comunicate an overview of the energy consumption<br>Communivate consumption relative to a goal |
| **Aesthetic** |
| Encourage conversations<br>Innovative<br>Intresting |

| Today Statistics |
|---|
| **Usability** |
| Readable at a distance of 40 centimeters<br>Easy to read off information |
| **Interaction** |
| Intuitive interaction |
| **Information** |
| Give an overview of today´s energy consumption<br>Show current energy consumption<br>Show the energy distribution during the day<br>Be able to distinguse different energy sources<br>Be able to understand energy patterns |
| **Aesthetic** |
| Innovative<br>Intreresting |

## Appendix 9

| Devices | Concept A | Concept B | Concept C | Concept D |
|---|---|---|---|---|
| **Usability** | | | | |
| Readable at a distance of 40 centimeters | 1 | 1 | 1 | 1 |
| Easily understandable information | 1 | 1 | 1 | 1 |
| **Interaction / Control** | | | | |
| Intuitive interaction | 1 | 1 | 1 | 1 |
| Be able to easily turn on and off devices | 1 | 0 | 0 | 0 |
| Be able to turn of all devices | 0 | 0 | 0 | 0 |
| Be able to set a timer | 0 | 0 | 0 | 0 |
| **Information** | | | | |
| Communicate key values | 0 | 0 | 0 | 1 |
| Communicate trends | 0 | 0 | 0 | 1 |
| Communicate energy consumption relative to other devices | | | | |
| Be able to see which devices that are on | 1 | 1 | 1 | 0 |
| Be able to have a lot of devices | 1 | 0 | 1 | 1 |
| Be able to see what devicess that has been on during the day | 1 | 0 | 0 | 0 |
| **Sum** | 7 | 4 | 5 | 6 |

| Momentary consumption | Importance 1-5 | Line chart | Watch | House | Meter | Rain |
|---|---|---|---|---|---|---|
| **Usability** | | | | | | |
| Readable at a distance of minimum 2 meters | 5 | 1 | 1 | 1 | 1 | 1 |
| Easily understandable information | 5 | 2 | 3 | 4 | 1 | 5 |
| **Information** | | | | | | |
| Communicate current energy consumption (effect) | 5 | 2 | 3 | 5 | 1 | 4 |
| Comunicate energy changes | 4 | 1 | 2 | 4 | 3 | 5 |
| Comunicate an overview of the energy consumption | 3 | 2 | 1 | 4 | 5 | 3 |
| Communivate consumption relative to a goal | 3 | 3 | 3 | 2 | 5 | 1 |
| **Aesthetic** | | | | | | |
| Encourage conversations | 4 | 2 | 1 | 1 | 1 | 1 |
| Innovative | 4 | 5 | 1 | 3 | 4 | 2 |
| Intresting | 4 | 5 | 1 | 2 | 4 | 3 |
| **Sum** | | 23 | 16 | 26 | 25 | 25 |

| Energy statistics | Concept A | Concept B | Concept C |
|---|---|---|---|
| **Usability** | | | |
| Readable at a distance of 40 centimeters | 1 | 1 | 1 |
| Easily understandable information | 2 | 1 | 3 |
| **Interaction** | | | |
| Intuitive interaction | 1 | 1 | 1 |
| **Information** | | | |
| Communicate trends | 3 | 1 | 2 |
| Communicate specific values | 3 | 1 | 2 |
| Communicate total energy consumption of desired time span | 1 | 1 | 2 |
| Communicate energy consumption in desired time chunks, day, week, month and so forth | 1 | 1 | 1 |
| Be able to view different types of energy | 1 | 1 | 1 |
| Be able to understand relation between different energy types | 2 | 3 | 1 |
| **Aesthetic** | | | |
| Innovative | 1 | 1 | 1 |
| Interesting | 1 | 1 | 1 |
| **Sum** | 17 | 13 | 16 |

| Today Statistics | Concept A | Concept B | Concept C | Concept D | Concept E |
|---|---|---|---|---|---|
| **Usability** | | | | | |
| Readable at a distance of 40 centimeters | 1 | 1 | 1 | 1 | |
| Easy to read off information | 4 | 1 | 2 | 5 | 3 |
| **Interaction** | | | | | |
| Intuitive interaction | 1 | 1 | 1 | 1 | 1 |
| **Information** | | | | | |
| Give an overview of today´s energy consumption | 1 | 1 | 1 | 1 | 1 |
| Show current energy consumption | 1 | 1 | 1 | 1 | 1 |
| Show the energy distribution during the day | 2 | 3 | 3 | 1 | 3 |
| Be able to distinguse different energy sources | 1 | 1 | 1 | 1 | 1 |
| Be able to understand energy patterns | 3 | 1 | 2 | 4 | 5 |
| **Aesthetic** | | | | | |
| Innovative | 2 | 2 | 2 | 2 | 1 |
| Intreresting | 1 | 1 | 1 | 1 | 1 |
| **Sum** | 17 | 13 | 15 | 18 | 17 |

## Appendix 10

| | Stämmer bäst in | | | | Stämmer inte in |
|---|---|---|---|---|---|
| Kompetent | Fyrkantig (1,8) | Tajt (2,3) | Baksida (3,2) | Bullig (3,7) | Skål (4,0) |
| Vänlig | Bullig (1,7) | Skål (2,7) | Tajt (3,0) | Fyrkantig (3,7) | Baksida (4,0) |
| Trovärdig | Fyrkantig (1,7) | Tajt (2,7) | Baksida (3,3) | Bullig (3,7) | Skål (3,7) |
| Elegant | Fyrkantig (1,0) | Skål (2,7) | Tajt (3,3) | Baksida (3,8) | Bullig (4,0) |
| Harmonisk | Skål (2,2) | Fyrkantig (2,2) | Bullig (2,7) | Tajt (3,5) | Baksida (4,5) |
| Hård | Baksida (1,5) | Tajt (1,5) | Fyrkantig (3,3) | Bullig (4,3) | Skål (4,3) |
| Unik | Fyrkantig (1,5) | Baksida (2,3) | Skål (2,5) | Bullig (4,2) | Tajt (4,2) |
| High tech | Fyrkantig (1,7) | Baksida (2,0) | Skål (3,2) | Tajt (4,0) | Bullig (4,2) |
| Intressant | Fyrkantig (1,5) | Baksida (2,5) | Skål (3,0) | Tajt (3,5) | Bullig (4,7) |
| Anonym | Baksida (2,2) | Bullig (2,2) | Tajt (2,2) | Skål (4,0) | fyrkantig (4,5) |
| Tråkig | Tajt (1,7) | Bullig (2,0) | Skål (3,2) | Baksida (3,8) | Fyrkantig (4,3) |

## Appendix 11

| Noticed problems | Occurrence | Possible cause | Possible solution |
|---|---|---|---|
| Doesn't understand the green line in the price graph | 5 | # The graph lacks visual clarity<br># The user a unused to this kind of information<br># Presenting both the mean value and the exact value might be confusing | The graph needs to be redesign with high visual clarity and the price must be presented in a much clearer way |
| Doesn't notice the zoom funct | 4 | # There are no hints that explains the zoom function<br># The users mental model of interaction with a big fat touch screen is different from interacting with a small portable device | The zoom could be clarified by using an graph that illustrates the zoom function, or it could be clarified by for example zooming in or out on the graph when the user enters that graph part in order to visualise that the function exists. |
| Problems understanding the week consumption | 4 | # The perceived connection between the information box and the box chart diagram is weak<br># It is difficult to understand that the total value represents the value of the total viewed information..<br># This way of summarizing information is not widely used in other applications. | There needs to be a stronger visual connection between the graph and the information box. |
| Doesn't notice the move funct | 3 | # There are no hints that explains the move function<br># The users mental model of interaction with a big fat touch screen is different from interacting with a small portable device | The interface could provide some hints but this way of interaction with small portable devices such as Smartphone's is becoming more and more widely used. |
| Doesn't understand that the grey figures represent the latest change in energy consumption | 3 | # The user can see that there is some kind of change but has no time span to relate to.<br># This function is not expected by the user<br># The test person has nothing to relate to which you would have in a normal household | The time span between the updates could perhaps be showed more clearly in order for the user to notice the changes |
| Doesn't understand that the energy pattern represents a hour | 3 | # The user are unable to understands the time span indications<br># There is a lack of time span indications | |