USING A RECOMMENDER TO INFLUENCE CONSUMER ENERGY USAGE

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Foreword
As a master student in computer science at the University of Skövde, I have been orienting towards deeper knowledge in Information Fusion and interaction design. When I encountered the Smart Grid I was able to look upon it with both areas in interest. Information fusion technologies had been heavily researched within Smart Grids while interaction design was hardly presented at all. For that reason, curiosity struck me and I felt forced onto the road of which this dissertation have brought me.
I would like to thank my supervisor Gunnar Mathiason for all good feedback, easy access and fast responses. I would also like to thank Tarja Susi for helping me understand how to perform qualitative research, your mentorship have been invaluable. I am very grateful for the support from my girlfriend and my friends who have shown so much understanding during this process. I would like to send a special thanks to my friend and colleague, Johan Bjurén, for making my working days a pleasure and for being the sounding board I have needed.
Abstract
In this dissertation, the issues of the increased awareness of energy use are considered. Energy technologies are continuously improved by energy retailers and academic researchers. The Smart Grid are soon customary as part of the energy domain. But in order to improve energy efficiency the change must come from the consumers. Consumers should be active decision makers in the Smart Grid domain and therefore a Recommender system suits the Smart Grid and enables customers. Customers will not use energy in the way energy retailers, and politicians advocates instead they will do what fits them. By investigating how a Recommender can be built in the Smart Grid we focus on parameters and information that supports the costumers and enables positive change. An investigation of what customers perceive as relevant is pursued as well as how relevancy can adjust the system. A conceptual model of how to build a Recommender is rendered through a literature review, a group interview and a questionnaire.
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1 Introduction

On October the first 2012 a change (2012:510) of the law, 1997:857 (Sveriges riksdag 2012) was legislated in Sweden. This law entails that electricity retailers are required to transmit the hourly electricity consumption of the customers back to the customers, if they so request (Odell, 2012). This enables the customers to be aware of their energy consumption, from trends over longer periods down to single hours. By understanding the energy consumption, customers are able to adjust their behavior in order to save money, be environmentally friendly, or any other motivation customers might have.

This gives rise to two areas, which are in need of research in the future. Customers need support in knowing how high the consumption is at the moment and indications of how high the energy consumption might be in the future. According to Constanzo et al. (2011) this is important because the price of electricity changes and in order to save money customers should reduce their consumption when the price is high. Also, it is probable that in the future the electricity retailers will offer rate schedules, which make the customers committed to an off-peak plan. This is a type of load management which generally focuses on shifting demand away from high cost, peak demand periods according to York et al. (2007). This means that customers will have to lower their peak demand in order to save money. If exceeding a set peak of kWh a penalty will be introduced and the cost will rise significantly. Malinowski and Kaderly (2004) introduce a case study, which in a successful manor displays this kind of setup.

Electricity retailers can benefit of this law if customers peak shave (load managing) the electricity consumption so that they do not have to purchase external power and instead are able to provide a more constant amount of energy and therefore provide energy more efficiently. Constanzo et al. (2011) describe peak shaving as managing the energy load, which allows adaptation of the consumption according to the load of the grid and in that sense limit the request of electricity during peak demands. These opportunities provide a greater need for a nationwide Smart Grid infrastructure in Sweden. Smart Grids refers to the merging of electrical engineering with network communications (Fadlullah et al. (2011)).

In the future, one can imagine automated applications that predict consumers behavior through a variety of aspects: location of the inhabitants of a house or workers of a factory, daily and weekly routines of people influencing the consumption, but also external information; weather effects, sun hours, and so forth. At first however, there is a need for a system that consumers can interact with and where previously stored behaviors and external influences are predicted to provide estimations of how much will be consumed in the future. From these reasons this study investigates if it is possible to create a Recommender (recommender system) for the Smart Grid, i.e. based on probabilities for providing future consumption estimations by including risk handling and emphasizing possible alternatives.

By transforming the electrical grid to a Smart Grid, better planning of production and energy usage can be enabled. Storage techniques are widely researched but yet there is no practical way to store energy on a real large scale for supporting a population during a longer period. According Dörstel and Sieger (2010) the largest system can produce 26 MW for 15 minutes. In the Smart Grid there
is a need to combine more effective storage with high capacity for better energy management in order to meet peak demands successfully. This allows less production overcapacity. With smart meters and more measurements of energy usage, even at the consumer level, more informed decisions are possible for production planning as well as energy usage. Through the change (2012:510) of the law (1997:857), it is now possible to give consumers access to information that can be used for supporting energy usage behavior. This means that customers are a becoming a vital part of a smart energy storage system where environmentally friendly power production plants delivers energy to a large-scale battery system for power storage. The power storage interacts with information about customers’ energy consumption and customers peak shave in order to not strain the system.

A major challenge in the Smart Grid is to make use of new information and let consumers take part of that information in order to change their energy usage behavior. This is driven by the incentive of lowering the energy cost, and the efforts to make all energy usage consume energy produced by renewable energy sources.

For effective change of energy usage behavior, there is a need to understand what type of information influences the consumers’ energy behavior. Is it value for the money? Is it the consumers’ environmental footprint? Can the motivation to change be built on challenges from a contest? What will make the consumer behave differently, and what new knowledge will make the consumer adapt, so that the effect of the incentives will occur.

This dissertation handles these issues by,

1. Making a literature review in order to find logical ways of understanding the possible actions of handling information in the Smart Grid. Because Recommender systems are a certain type of DSS (decision support systems) with the primary function to deal with Information Overload. DSS (decision support systems) and Information Overload are investigated in order to represent information.

2. Investigating factors that influence behavior through action research where we are supported by SP (Technical Research Institute of Sweden)1

3. Using the agricultural high school Sötåsen2 as a platform for investigating the possibilities of the Smart Grid Recommender. Students of Sötåsen represent future consumers of energy and are therefore a suitable test group. Ideas, based on literature and an interview, are tested through a questionnaire based on the environments of Sötåsen. Through these sources, access have been granted to online data, which is updated approximately every twelfth seconds. The sensors that communicate the data are electricity meters that are deployed in the buildings of the school. The buildings power, frequency, voltage, current, power failure and total consumption are presented through these sensors3. This database acts as a source of developing scenarios for the questionnaire in order to relate to real events and the consequences of certain actions within the domain.

1 http://www.sp.se/sv/
2 http://www.naturbruk.nu/sotasen
3 http://el.sotasen.se/
The data of the action research was varied but through analysis of the questionnaire as well as the literature it was possible to establish a conceptual model that generally could describe how to develop a Recommender.

1.1 Thesis Outline

This dissertation is organized as follows: In chapter one the introduction is described with some background information to the problem area. In chapter two the problem and the problem area are discussed and presented. In chapter three we investigate the research domains of the Smart Grid, information overload, Recommenders, decision making and information fusion in a literature review. Chapter four presents the data collection methods. In chapter five we present the data from the questionnaire. Chapter six presents the analysis is conducted. In chapter seven the results of the analysis is described. In chapter eight the conclusions are presented through a conceptual model. In chapter nine a discussion is held about the study and in chapter ten thoughts of future work is presented.
2 Problem Definition

In this chapter, the problem of the dissertation is presented. It deals with how DSS can be used, in the Smart Grid domain, to change the energy usage behavior.

2.1 Problem Introduction

The Smart Grid makes use of large volumes of data, which can be difficult to interpret for the users. This makes the Smart Grid limited. Decision support should be provided to the users. By decision support we refer to decisions about energy consumption. Consumers are in need of understanding how much electricity they consume during different time periods and events and what it may result in. The customer should also be able to understand their typical consumption in order to adjust the behavior towards a more desirable outcome.

In the Smart Grid system the consumers should be able to adjust their consumption behavior in a way that fits them. Based on information provided from the Smart Grid system they should be able to make decisions concerning usage of electric devices in the home environment, such as when to use the home appliances.

The Smart Grid should propose estimations about how much energy the consumers will use during a given time period. A Smart Grid system that enables customers’ deeper understanding of their consumption, and therefore support the end customers’ decision process, must regard what information is relevant. A single and direct suggestion provided by the system is insufficient for creating a DSS that in an effective way is able to support the HCI (human-computer interaction). In such a case, the system replaces the decision maker instead of supporting the human decision making. This dissertation focuses on users who do not want to be told what to do. To make use of more detailed energy data, the consumers’ need to be able to become decision makers; provided with alternative solutions and information sources that can be evaluated. The system should not attempt to control the consumers into performing certain actions, which would be the case if only a single estimation is presented. The system should merely support consumers in a non-biased manner. Estimations cannot always be correct. There are circumstances that only the consumer can be aware of and thus such circumstantial influences need to be represented as well. For example, there is no way to know whether or not the consumer will go to the cinema on Tuesday evening for certain, only the consumer knows this. But historical data might show examples of how similar events like this have affected the consumption and therfore it can be important that the consumer is provided with data from those similar events.

2.2 Problem Statement

In this study, an investigation is conducted to determine whether a Recommender can help the consumers to plan their consumption more easily, through relevant information. There is a need to investigate ways to evaluate what information is relevant and useful for making decisions about energy usage. There is also a need to investigate what information lead to an effective Smart Grid recommendation, concerning decision support, in order to see if there are domain specific aspects to consider, like external influences and risk management, for answering this study’s research question:

*What information is relevant for an energy consumer’s decision making process in order to improve energy usage, in a way that suits the user’s motivation and needs?*
2.3 Problem Decomposition

In a Smart Grid there are several aspects that influence the energy consumption and in different types of decisions there are different aspects of influence that are of interest. Several types of scenarios have to be analyzed and several types of data are interesting for different scenarios. What type of information, and how much, is of interest in order to create a selective order of relevant information in a Recommender for decision support.

2.3.1 Aim

This dissertation aims at finding why some information influences consumers’ energy consumption behavior more than others. It also aims at creating a conceptual model of how to build a Recommender able to represent present and future energy consumption as well as cost influences in a way that increases consumers understanding and motivate change.

2.3.2 Objectives

In the purpose to succeed in reaching the aim of this dissertation we need to:

1) Design a suitable approach for developing Recommenders in the energy advice area. There is a need to understand current approaches used in the energy area, and also understand how potential approaches from other areas may be useful and effective for this problem.
2) Design and perform a user interview study and a survey for finding domain specific knowledge about the target group’s opinions and conditions.
3) Design and perform a questionnaire survey through the suitable approach derived from the literature review as well as information derived from the user interview study we are able to pose scenarios in a survey that may represent future decision situations of a user group that may represent a future user. The purpose is to find out what information may change consumers’ energy behavior in a way that fits their motivations and needs.
4) Development of a conceptual model with the findings in the survey we are able to evaluate the approach of the literature review as well as expand it to a conceptual model. The conceptual model needs to be built on the findings in objective 1) and the findings in objective 2). The idea is to produce a useful and effective list of requirements when implementing Recommenders in the Smart Grid domain.

2.4 Assumptions & General Constraints

The four assumptions and constraints described determines the path in which this dissertation takes. The assumptions gives an idea of what path is in most need of research. The constraints clarifies the choices of what is not investigated in this dissertation.

1) According to Keim et al. (2008) data handling success often depends on that the right information is being presented at the right time. The acquisition of data is no longer the biggest problem in the research field but rather to create and identify methods for making data understandable and manageable.
2) This study has no interest in creating user profiles concerning users’ preferences, only historical data of user consumption and the features that affected the consumption.
3) This study analyses aspects of fields in Human Computer Interaction and Information visualization but does not apply probability methods or visualizations. It is limited in the area
of selecting and ordering relevant information in the field of Human Computer Interaction and does not apply theories about collecting data.

4) The resulting Recommender is designed for domestic consumers in home environments.

2.5 Method
In this dissertation we apply three methods, a literature review, a survey and a development of a conceptual model.

1. Literature review: In order to find suitable means for creating a Recommender we apply a set of steps:
   a. Obtain the architecture of how the Smart Grid is composed by compiling ideas and requirements of academic papers. This is necessary in order to build a Recommender around it.
   b. Gain knowledge of how to build DSS and identify appropriate procedures for decision making through compiling ideas and requirements of academic papers. This is necessary in order to structure a Recommender around the user.
   c. Obtain a suitable frame for a conceptual Recommender, which is suitable in the Smart Grid and able to be evaluated and extended through an interview study. This is done by comparing Recommender techniques with set requirements of the Smart Grid system.

2. Interview study: This method is applied in order to reach understanding about the domain and be able to set the further investigations in a practical environment by:
   a. Creating scenarios that can demonstrate relevant situations where the respondents are situated in the role of a decision maker of their consumption in the Smart Grid system.

3. Questionnaire survey: In this dissertation we apply this in order to answer how energy users’ behavior can be changed. This questionnaire survey needs to:
   a. Answer what motivations and needs the respondents have concerning their energy consumption, and how they wish to change their consumption.
   b. Be able to function as an evaluation method, through reviews of respondents, for a Recommender frame constructed from the literature review in order to develop the frame into a complete conceptual model.

4. Development of a conceptual model: in this dissertation we need to find a way of using the findings in method 1 and 3 in order to set a list of requirements. This can be viewed as a conceptual model for implementing Recommenders in the Smart Grid domain. This set list should be implemented by the findings in method 1 and thereafter checked, modified and extended by the findings in method 3. The analysis and data of method 3 in this case must be the dominating force, which are able to train the proposed model from method 1.
3 Literature Review

In the literature review an exploration of information has been performed in order to build the best possible Recommender for the Smart Grid system. In order to do so we have explored the Smart Grid area and how the Smart Grid will affect and be implemented in a future society.

The literature review is used to examine the architecture of the Smart Grid as well as a DSS. From the Smart Grid domain research we are able to see what main parameters affect the energy concerning price and environment.

In the research field of risk management it has been possible to gain knowledge about how risk can be implemented as an influence factor in Recommenders.

3.1 Smart Grid

Today’s electricity grid generally converts only one-third of fuel energy into electricity and of the remaining two thirds produced, no energy is recovered since most electricity retailers are not able to store energy. About 8% of the electricity in the transmission lines is lost and about 20% is only produced to meet the peak demands that occurs about 5% of the time (Farhangi, 2010). This is a massive waste of energy production. The Smart Grid uses information and communicative technologies in electrical grids. The Smart Grid is addressing these issues and makes the production a lot more effective because it provides the electricity retailers with continuous measures about the on-going consumption (Farhangi, 2010). To give consumers information for decision making, increase understanding and create a more effective, economic and environmental electrical usage through an infrastructure perspective. The Smart Grid applies a full spectrum of communication, sensors, controls, and information technologies to modernize the distribution of electricity (U.S. Department of Homeland Security, 2011). As the name indicates, Smart Grids should be intelligent in a way; able of sensing if a system is about to be overloaded and provide information in order to change the power production and thereby preventing outages. In this way Smart Grids are able to not overproduce power as compensation (Litos Strategic Communication, 2008).

There are several different parameters that could influence the energy usage. In the literature review those are examined in order to understand which those are.

Ehrhardt-Martinez et al. (2009) suggest that in the household customers’ behavior is an important factor. The cost of energy is an important parameter, which is usually considered the most important factor customers regard concerning how much energy they wish to spend. A parameter that directly corresponds to the cost is the environmental footprint, which is also important as many are concerned about their effect on the environment.

Jeeninga and Huenges Wajer (2007) states that through consumption life-style, future energy use can be estimated. The amount of activeness of users is something that can show the user how much a recommendation predicts that the customer will be active given a certain period. Depending on if the user agree or disagree a change of energy usage can be done.

These parameters are considered as inner motivations for customers. Other parameters as described in International Energy Agency (2010), efficiency of electrical appliances in the household can possibly effect the consumption due to informative value of how recommendations are built. By displaying the energy spent and how much the recommendation predicts that the
customer will spend the customer could be able either settle for that or take an alternative course. According to Farhangi (2010) the Smart Grid incorporates smart meters and sensors to measure consumption parameters: the active power, reactive power, voltage, current, demand etc. These measurements must have acceptable precision and accuracy, and be resistant to manipulation.

According to Crawley and Huang (1997) the external influences of weather and sun hours are also parameters that can effect a possible change of energy usage. Depending on knowledge about how they affect future energy cost or that more or less energy are needed, for heat, air condition etc., they can be viable in understanding how to use the energy more cost efficiently.

3.2 Managing Information Overload

According to Litos Strategic Communication (2008) consumers’ main request are that human-computer interfaces should be simple and accessible i.e. they should not interfere with everyday life. The time spent on electric management applications should be as little as possible. The Smart Grid on the residential level should apply a “set-it-and-forget-it” technology; focused simply on adjusting their energy use. For this purpose, the information must be rich and useful in order for the consumers to save money and energy. Davoli et al. (2012) describe this as a problem since grid management i.a. concerns handling collections and analysis of large amounts of information in real time like: demand schemes, distributed resources, storage systems etc. The information must be filtered and aggregated by using analysis models for handling critical situations, i.e. enabling fewer but better decisions, and support regular operations, where the user are able to make more in depth planning.

In these days information overload is an occurring problem due to the amount of information processed every day. Raw data has no value in itself, value only occurs when information from data has been processed and been understood by a user. In the HCI field the usage are derived from the information extraction from data. Information overload refers to the danger of having too much data to handle. Data may be irrelevant in the current task handling. The data may also be processed or presented in an inappropriate way (Keim, o.a., 2008).

Information Overload is very time consuming and results in frustrated users and increased costs for organizations. Humans lack the ability to deal with enormous data volumes the information overload will result in inferior advances misguided results. Data handling should be simple and the working progress should be effective and easy. Hidden opportunities and knowledge should be made visible (Keim, o.a., 2008). Data handling should be simple and the working progress should be effective and easy. Hidden opportunities and knowledge should be made visible (Keim, o.a., 2008).

Keim et al. suggest that information overload can be overcome by

- Defining what information is relevant in a database.
- Identifying appropriate procedures for decision making.
- Presenting derived information for decision- or task-orientation.
- Facilitating interaction for problem solving (in this case providing relevant recommendations to deal with information overload) and decision making.
3.3 Recommender Systems

The user has to be the authority in specifying what task to perform and therefore chose the direction of the analysis. The system should provide the means of interaction and act as support in order to avoid information overflow (Keim, o.a., 2008).

DSS are interactive, computer-based systems, which are able to help users in judging, understanding and making choices. They are effective means for helping users concerning making fast decisions with high potential consequences (Druzdzel & Flynn, 2010). Velmurugan and Narayanasamy (2005) define a DSS as “An interactive information system that provides information, models and data manipulation tools to help make decisions in semi-structured and unstructured situations” (Velmurugan & Narayanasamy, 2005, s. 156). DSS are computer-based interactive human-computer decision-making systems and they have the ability to support decision makers rather than replacing them while they utilize data and models, solve problems and focus on effectiveness efficiency in the decision processes.

An example of a DSS is Recommenders, which help users to choose between suitable options through limited information. According to Fritz and Murphy (2011), a decision is based on relevant input and relevance depends on the users’ experiences and preferences. They also describe that attempts have been done previously in order to determine relevancy automatically by using recommendation based approaches. Chen et al. (2010) state that recommendation engines have been researched for finding a solution to filtering and discovery problems. By diminishing those problems it is easier to find and deal with information overload. Sun et al. (2012) describe that Recommenders can be essential components in interactive systems where the user has to select among large sets of options. A web page or software for computers or mobiles can rarely fit all available information but Recommenders can help users to approach the data or tasks supported by the data (Pazzani & Billsus, 2007). A Recommender shares recommendations to a decision maker or as a match to the decision makers’ queries (Burke, Hybrid Web Recommender Systems, 2007). According to Pazzini and Billsus (2007), the recommendations are usually presented as a summary list of items, provided through a database, and the users select specific items to gain further knowledge or make decisions. These items are usually records of previous actions or actions made by other users or customers. The system is able to provide information about previous actions and the user can make decisions based on those actions. van Setten et al. (2004) describe Recommenders as intelligent systems that in an efficient way are able to help users making decisions and quickly understand of what information is interesting in large amounts of data.

Google Reader e.g. has a feature that recommends RSS feeds. Other web-based services as Facebook, Twitter, Spotify, Netflix and Amazon also use Recommenders as decision support for users. These recommendation systems are affected by how recent the feed is: the newer the most interesting. It also integrates explicit interaction with the users i.e. the users interact not only with the system but also with other users in this way.

Chen et al. (2010) argue that users are not passive consumers in the information stream domain (the Internet and other information sharing applications). Users in the information stream domain are often active producers as well, which can result in more interest in the domain. In the information stream domain the user can act producers in micro blogging software such as Twitter and Facebook. But in a Recommender the judges, i.e. the force that determine what is relevant in
the Recommender, can be either human beings or computer programs (Sun, Lebanon, & Kidwell, 2012).

### 3.3.1 Techniques

According to Burke (2007) there are a variety of techniques that can be implemented in Recommenders. Different types of Recommenders are described below.

**Collaborative:** Collaborative Recommenders originate from human behavior. Information is gained from a historical database of several users’ ratings and the recommendations are gained by rating products. Collaborative Recommenders can use both explicit and implicit ratings. They can also make recommendations on users’ data either in a memory based approach or model based approach. In memory based approaches the recommendations are derived from choices made from other users with similar behavior while model based approaches compresses data into predictive models (Shani, Heckerman, & Brafman, 2005). Collaborative Recommenders assume that people with similar taste and behavior will make similar decisions (Shafer, Frankowski, Herlocker, & Sen, 2007).

**Content-based:** According to (Pazzani & Billsus, 2007) content-based recommendations are set from features or item descriptions and a single user’s ratings or user’s profile. Information is gained from a database of products and the recommendations are gained by rating products. Content-based recommendations can be used in a variety of domains and they describe items that are applied in the recommendation and create profiles of users in order to personalize the recommendations by comparing the items to the profiles. Normally profiles are automatically updated and bettered over time. Pazzani and Billsus (2007) state that unrestricted text cannot be implemented in Recommenders as profiles uses probability measures due to previous behaviors. The most common way is that users rank items and that they thereafter are included in order to refine the probabilities.

**Demographic:** recommendations are set by using demographic profiles. The recommendations are based on historical data and characteristics of a population in a demographical area.

**Knowledge-based:** recommendations are set from interpretations about users’ needs and preferences. Information is gained from domain knowledge and recommendations are gained through knowledge of a user’s needs or by a user’s provided queries. According to Shani et al. (2005) knowledge-based Recommenders go one step farther than content-based Recommenders as they uses deeper knowledge about the domain. According to Burke (2007) collaborative, content-based and demographic Recommenders applies learning techniques and therefor suffer from the cold-start problem; the system cannot recommend items if they have not been rated or put into context. Knowledge-based Recommenders do not need that and are therefore able to respond to casual users that have only recently started using the system or only uses it sparsely. Knowledge-based techniques are usually able to immediately respond to the user’s need since it doesn’t need item evaluation. The advantage of collaborative and demographic techniques is that they have the capacity of identifying cross solutions in order to recommend new solutions, which knowledge-based techniques only can do if the cross solutions are accounted for in advance.
3.3.2 Hybrids
The Recommender techniques can be combined in hybrids, using two or more of the different techniques (Burke, Hybrid Web Recommender Systems, 2007). An example of a hybrid Recommender is presented by Ghazanfar and Prügel-Bennet (2010): Naïve Bayes which is combined with collaborative filtering in order to create accurate recommendations and at the same time avoid the cold start problem. According to Burke (2007), hybrid Recommenders can apply the different techniques on the same data, in order to get more accurate probability measures on data that are difficult to interpret. Hybrid Recommenders can also apply different techniques on different sources, in order to effectively involve influencing aspects of different type. According to van Setten et al. (2004) Hybrid recommenders are equipped to provide better recommendations than single technique variants.

Burke (2002) suggested seven different varieties of hybrid Recommender combinations:

- **Weighted:** recommendations of different techniques are first determined separately and then combined into one recommendation
- **Switching:** in this variant the recommendation are switching between different techniques dependently on what the situation is
- **Mixed:** recommendations of the different techniques are presented separately but at the same time to show different alternatives
- **Feature combination:** features of different data are put together into a single recommendation algorithm.
- **Cascade:** one technique adjusts and refines the recommendations from another technique
- **Feature Augmentation:** the output of one Recommender are used as an input in another Recommender
- **Meta-level:** the model learned by one Recommender is used into another Recommender

These varieties of hybrid Recommender combinations can also be mixed, and combined between each other.

3.3.3 User Profiles
According to Pazzani and Billsus (2007) and Luis M. de Campos et al. (2006) the most Recommenders apply user profiles. They can be developed by storing the users’ preferences concerning items or the history of the users’ interactions or behaviors. Historical data of user interactions can be used e.g. by storing how the user have chosen or behaved in different occasions or by excluding items that are no longer of interest. Creating user profiles is a form of classification where items are sorted according to different standards of probability or categories. In an e-commerce e.g. if the user makes a purchase it is a high probability that the user likes items that are related to the purchased item.

van Setten et al. (2004) state that CBR (case-based reasoning), which can involve user profiles, is the best way of providing predictions to hybrid Recommenders and that CBR outperforms any individual prediction technique.

3.3.4 Risk Handling
By presenting alternatives for a user there will always be a probability that the user will choose an alternative that in the end did not fit the user’s needs. Risk is defined by Jones (2005) as “The
probable frequency and probable magnitude of future loss” (Jones, 2005, s. 8). Risk is a probability issue, which should make it possible to combine with other probability measures as in a Recommender. According to Jones (2005) most users do not expect precise estimations on how risky the alternatives are other than general descriptions e.g. “severe” to “very low” risk. Therefore the developer or, possibly the user him-/herself, can estimate general probabilities and provide description on how relevant they are to consider.

3.4 Results

3.4.1 Smart Grid Approach

In the Smart Grid domain there are large amounts of information enabled that are available in real time. This information could be revealed to the consumer but it would be very hard to make any use of the full spectrum of sensors, controls and information technologies available. In order to aid consumers in understanding their current consumption many parameters could be presented, such as active power, reactive power, voltage, current, demand, and even more if the consumers should be able to understand future consumption, which depends on behavior patterns and external factors.

According to Litos Strategic Communication (2008) Smart Grid management should not interfere in consumers’ everyday life and that it should be as simple as possible. Users should be able to make fast decisions about how they want to spend their energy and at the same time more in depth operations should be possible if required. The Smart Grid should enable consumers to understand how they could alter their behavior in a way that fits them, according to what motivates them i.e. comfort, saving money and environmental issues.

The conceptual model of the Smart Grid system has a customer focus. Therefore a DSS, like a Recommender, should be built and this is done by trying to manage the information overload problem, which has a high risk to occur in the Smart Grid domain. There are simply too much data available in the Smart Grid in order to handle it without sorting or filtering out information. The revealed information should fit the current task handling and it should also be presented in an appropriate way.

Some parameters are also users personal motivations e.g. consumption behavior, cost and environmental footprint. Some other motivations also influence these motivations as efficiency, energy price and weather. Previously mentioned parameters can be influenced by other parameters such as the condition of household equipment, numbers of lamps in the household etc. The third party parameters are not investigated as much as the other parameters in this dissertation.

3.4.2 Recommender System Approach

The field of Recommenders has been examined in order to understand the best suitable way in which a Recommender should function in the Smart Grid area. Thus the established Recommender techniques has been examined and also hybrid Recommenders in order to see the inner structure of the intended Recommender. Techniques and algorithms within the field of Recommenders are examined in order to establish what kind of information it is possible to present and how the information can be presented and related.
In this dissertation we find a suitable way of constructing a Recommender in the Smart Grid domain which is able of displaying personal patterns to end customers, therefor we need to establish; which kind of Recommender technique is best fitted to present the historical data of households’ energy usage, without utilizing the privacy issues of other households.

A Recommender is able to bring forth relevant information because relevancy depends on personal preferences and Recomme nders use historical data of customers to supply recommendations (Fritz & Murphy, 2011). Previous behaviors are able to show what is considered important for certain customers. As described by Chen et al. (2010) Recomme nders are also able to focus the customers attention to what is considered relevant as they rank information based on user behavior and filter out information that may be irrelevant for current task handling. A Recommender provides a summary list of items in a database where users can select items to gain further knowledge and make decisions. van Setten et al. (2004) suggest that a Recommender can provide relevant recommendations, which deals with information overload and supports the area of decision making and problem solving.

3.4.3 Risk Approach

This study proposes that risk is a factor, which affects what should be represented in a Smart Grid Recommender. If the user chooses one solution, the effect could be more risky than choosing another, since the solutions suggest different levels of energy purchase and the user can get penalties if the consumption exceeds what has been purchased. It is important to consider presenting the exception templates as well, in order for the user to understand certain circumstances in relation to the proposed solutions of other templates. At some points it can even be a good choice to represent a less likely solution for the user as the main solution if the risk is significantly decreased. To represent this risk factor a simplistic model is applied similar to that proposed by Jones (2005). The risk factor is implemented in the questionnaire by sorting the clusters of recommendations in a scale of risk; very high, high, moderate, low and very low. The clusters that have the highest estimated consumption are considered very low and the cluster that have the second highest estimated consumption are considered low etc. Every part of the scale is provided with a number between 0-1 where “very low” is provided the highest number, “low” the next highest numbers etc. In this fashion risk is considered as a part of the recommendations. The provided values are added to cluster probabilities in order to give possible effects on, which order a Recommender should provide the recommendations.

3.4.4 Frame of a Recommender System

The data is continuously changing concerning consumption. At least every day new data has to be accounted, and as users’ in home environments do not wish to update purchases of electricity each day a Smart Grid Recommender needs to be at least partially automatic in order to function practically. At the same time the consumers need to be active decision makers in the Smart Grid, and therefore a Recommender is suitable. A Recommender will not know whether or not a consumer will behave out of the ordinary, but are only able to represent historical behavior of data from the Smart Grid.

A Smart Grid Recommender needs to have a content-based approach due to the ability to draw conclusions and probability measures concerning historical data such as the users’ consumption behavior, everyday activities and external influences such as weather and sun hours. This means
that all information in a Recommender should be derived from databases. This technique does not account user rankings in order to propose recommendations since historical consumption and possibly choices of historical purchases in a better way displays varieties of how they consume energy and how willing they are to take risk.

It is possible to implement a knowledge-based approach to a Recommender in order to use knowledge of how, above all, external influences in general affect the consumption of electricity. By using a knowledge-based approach, the cold-start problem could be avoided.

If a knowledge-based approach can be implemented, then a weighted, mixed, switching, cascade or feature augmentative hybrid could be implemented. A cascaded hybrid are a good choice due to the fact that the knowledge-based approach are more general than the content-based and should merely influence the content-based information and not be equally important. By using a hybrid Recommender it is possible to give different external influences different pre-chosen probabilities on how they could affect the future consumption.

A Recommender in the Smart Grid domain should assume a hybrid Recommender, in order to combine content-based techniques and knowledge-based techniques. Due to privacy issues it might be inappropriate to apply collaborative Recommenders. Collaborative and demographic Recommenders are also not able to see personal pattern behavior, which could be vital in a Smart Grid Recommender e.g. other people, even with the same living conditions, cannot display occasional habits as Sunday dinner once a month with your stepmother in a good way. Likewise, it would be misguided to display a possible Sunday dinner for a person that never leaves the home environment on Sundays. This makes collaborative and demographic techniques inappropriate, at least as the main technique of a Smart Grid Recommender. But if it would be possible to implement those techniques they can provide valuable information. Content-based techniques are set from the consumers’ personal behavior; in this case their energy usage. It could also be other personal parameters as ratings on previous recommendations. With content-based techniques it is possible to teach the system personal behavior patterns. With content-based techniques though, research has shown that there is start up problem where the system are not able to provide any recommendations without a period of learning the consumers behavior patterns. Knowledge-based techniques are able partially solve this issue as they are set from inference about users’ needs and preferences. Content-based techniques are distinguished as they are the best technique for providing the best recommendations when there is enough information to distinguish different patterns in the data of personal behavior.

There are seven different variants of hybrid Recommender combinations and those that can apply content-based methods with knowledge-based methods are weighted, switching and mixed. Which of those methods that is more adequate in the Smart Grid context is not clear, therefor this dissertation do not apply any restriction concerning it function one particular way.

In this dissertation we expand the traditional Recommender with external influences in order to display that energy impact are not only influenced by energy usage. Smart Grid research has showed that other factors like the market, the weather etc. can influence what kind of impact the energy usage can result in. The internal consumption should be combined with external influences and clustered in groups dependent on the consumption distribution.
Through the literature review we explore the areas of interest in order to find a basis of different types of information in a Recommender, which we can evaluate through an interview study. These factors cover the amounts of influences we can possibly present and how each information type should be presented and, which information is more relevant.
4 Data Collection
The data collection is portioned into two parts; a pre study and a main study. In the pre study we establish where recommendations of energy usage can be useful and applied in the residents of the boarding school Sötåsen in particular.

In the main study a quantitative structured interview will be held based on the scenarios built from the pre study.

4.1 Interview study
In this dissertation a pre-study is applied for a survey questionnaire which provides: in-depth domain knowledge, general attitude towards energy usage. This is done in order to get a basis for creating appropriate scenarios, which are relevant both for the students and customers of the residential area. The pre study is executed by using unstructured interviews with final year students of the boarding school where discussions are held about support of energy usage and appliance areas. Respondents participating in the interview are able to contribute by conveying knowledge from views of factual background and experience. The respondents are representative as they possess knowledge from multiple views: domain knowledge of having been previously residential accommodation, domain knowledge of being a student in high school, domain knowledge of animal husbandry, machine management and agriculture. Through the interviews, respondents may develop school ways to consume electricity. Give students bigger responsibility and influence. Give respondents and other people more influence and understanding in electricity and influencing factors in the role of individuals and business owners. With the information received through the interview, a questionnaire is designed for the second year students of the high school. From the interview scenarios can be created that can be implemented in the survey questionnaire.

The interview was performed April the 8th 2013 at the high school of Sötåsen. 31 students participated in a semi structured group interview with a teacher present as well as one main interviewer and one second interviewer monitoring the event. To partake in the interviews was optional; the students could themselves choose to volunteer or not. The interview is evaluated by examining validation, reliability, bias, and content continuously through a simple transcription process.

Laundry room: Students sign up for using the laundry room. There are three washing machines and three tumblers used by the students. Students sign up for using each machine separately. It is not hard to get a time which is not booked so students can use the laundry room somewhat freely. Apparently more students use the laundry room at the evening, so the easiest period to use the laundry room is during the day. The laundry room cannot be used after 10 PM, sense personnel of the school locks the school buildings at that time.

Students have access to another laundry room as well. In this, however, only working clothes are washed. The periods where the students can use the utility is the same as in the other laundry room. Students do not book this one and they overlap with each other and helps out to manage the laundry.

Apartments: Each student has his/her own room at the school. Paired up with a few other students (four or five students in each apartment) they share a kitchenette, a hall and a bathroom.
In the apartment the students use the sockets for personal equipment’s as computers, TV, TV games, lamps, hair straighteners, hair dryer, music players and speakers.

In some kitchenettes the students have set up a micro oven and a kettle. Otherwise, the kitchenette is set up with a hotplate and a fridge. The kitchenettes did not include any ordinary ovens or freezers. The students mentioned though, that they are able to adjust the temperature in the fridge and in that way they can make it function as a freezer.

The students are also able to adjust the heat in the apartments by using thermostats on the elements. A problem with this though is that the water in the elements cannot be adjusted which means that they do not have the influence that they would want. In the summer time, the elements are shut off and in the winter time the heat is too high. The students state that they would rather adjust the temperature on the elements than open windows. They also state that it would be more environmentally friendly to do so. The school could also save money by doing this according to the students.

Just as with extra laundry room for work clothes there are showers available for students that have been working with the animals. So the showers in the apartments do not have to be the only ones used. But the students stated that they very rarely use those.

**Leisure time:** There is a place, Gulan, where students can relax; play pool, rent and watch movies, play x-box or Wii. As every other place it closes at 10 PM. In this room the students can turn on and off the sound. Computers can also be used Gulan. They go to the bathroom and use hot water in this building as well as the heat on the elements even though they function in the same manner as in the apartments.

The auditorium called Aulan, is a gym with a scene. There the students have access to sound systems. The blinds are electrical as well. And students can turn the light on and off. Students can also open windows in order to adjust the temperature. In the auditorium it is possible to use a projector in order turn the room into a cinema. Movie nights are sometimes arranged by personnel but students can also arrange them on their own. In the basement of the auditorium there is a music room with sound equipment and electrical instruments as, electric guitars, synth, base’s, a drum set, a mixer table, recording equipment and microphones.

Next to the auditorium there is a gym, where there is a stereo. Temperature is adjusted by opening windows and the students are able to turn on and off the lights in the room. There are no showers available in the gym.

Ljungen is an old kitchen classroom that now is available for students. In this house the students can cook, bake and socialize. There are three to five stoves in the kitchen and some electronic equipment. There is also a room with a TV, for watching movies and playing video games. There is a crafts room, but there is no electronic equipment available there besides lights and elements which are adjustable in the whole house.

The school also has a sauna available for students to use during leisure time. Students can book time to use the sauna and personnel at the school start it. Thereafter it is shut off by a timer. Moreover the sauna is on two times in a week without any bookings.
The school buildings are not available to use in the weekends. So premises as Gulan, Aulan and Ljungen are not open then. The students need to have dispensations in order to use the apartments. And it is allowed for students to arrive a Sunday evenings.

There are computer rooms available for the students to use. They are supposed to be available the whole day until 22:00. The students do not have any routines concerning shutting the computers off or logging off when they have used them.

Vovvis is a building for dogs where the students are responsible for lights inside the building as well as spotlights at the agility ground outside.

Working hours: School hour’s ends, usually, at 16:20 but some students finishes at 17:30-18:00 if they have duties in the barns. During that kind of duties the students milk cows as well as handle all farm animals feeding. Cows, sheep, goats and pigs are the kind of animals that have to be taken care of. At 21:00

4.2 Survey Questionnaire

By using a frame of a suitable Recommender derived from the literature review we perform a semi structured questionnaire. In the chapter “The frame of a Recommender” a platform of what future Recommenders can introduce and recommend are established.

The questionnaire begins with posting of social problems which is suitable for the domain and engaging for the respondents. It is inspired by the approach in described by Wang et al. (2008). Through the findings of the interview study it is possible to build scenarios which are appropriate and engaging in the test domain. A scenario-based survey is able set the respondents in situations that concern them (Wang, Watson, & Brush, 2008). In the survey the respondents describe which of a pair of selected options that are perceived most relevant to a decision they see as beneficial.

Through the literature review it is possible to derive a frame of a Recommender suitable for the Smart Grid. In order to fully conceptualize a model of how to build a Smart Grid Recommender, the target group is subjects that have to represent the future society. The questionnaire can supply users’ personal opinions of what is considered relevant and what motivates change. Through these interviews answers can be given about the relevance; the measure of the ability of the data, risk management, information, and knowledge to support the process for making decisions. When considering how to determine if data is relevant or not it is important to know why and what kind of decision it is that has to be fulfilled. This means that any kind of information can be viable depending not only in different domains but also in different modes and different time periods. By a questionnaire we can understand the relevance of the represented data.

By applying a questionnaire we are able to concretize how parameters provided through the literature review are able to affect the energy usage and how relevant customers perceive these. The questionnaire are constructed by the general considerations about what customers would want to ask a Smart Grid Recommender as well as recommendations derived from a test group.

In the questionnaire we apply the frame of how a Recommender should function from the literature review considering what kind of techniques are most suitable for the Smart Grid domain. We have established the use of content-based techniques, which apply user profiles in order to find
behavior patterns. User profiles are contained by stored data of user behavior. By performing questionnaire survey guided by scenarios we are able to track how users’ preferences and behavior in different occasions can show what information is relevant.

The scenarios are able to show how a Recommender could function in the Smart Grid context. The scenarios are also adapted to represent common practices where Recommenders is useful as well as representing interests of the survey’s target group.

Each scenario contains a set of questions concerning how the students experience the relevancy of the parameters concerning the task handling process. This will concern understanding the energy usage. It also concerns factors that influence opinions about what is represented i.e. agreement and disagreement are viewed as relevant information and misunderstanding and lack of understanding sometimes suggest irrelevant information. The last factor tested is if some parameters influence a will to change previous behavior; if that happens those parameters are considered the most relevant.

In this dissertation the target group contains of students living in a boarding school. The boarding school, Sötäsen, is part of a Smart Grid interest group: Kraftsamling Smarta Nät where efforts are taken towards a Smart Grid society. Therefore the students are good representatives of a future society where the Smart Grid is a part of everyday life.

\footnote{http://www.kraftsamlingsmartanat.se/}
5 Data

5.1 Motivations

The first part of the questionnaire concerned the respondents’ motivations. The respondents were given the following text: “This motivates me when it comes to my energy behavior. Please check the boxes that best describes you. It is allowed to check several boxes” The following motivations were given: “Saving money”, “Being environmentally friendly”, “Making good decisions”, “Not to make bad decisions”, “Not having to worry about it”, “Being better than my friends” and “Gaining recognition”. The respondents were also given the options to add more motivations. Saving money was states as a motivation by 27 of the 30 respondents that participated in the survey questionnaire. Being environmentally friendly was stated by 15 respondents. Making good decisions stated by ten respondents. Not making bad decisions was stated by two respondents. Not having to bother with it was stated by ten respondents. Being better than my friends was stated by two respondents. Gaining recognition was stated by one respondent.

Diagram 1. In this diagram the distribution of motivations described by the respondents are shown.

Saving money was the most common motivation mentioned. Of those that did not regard money as a motivation did instead regard “Being environmentally friendly” (two of three) or “Not having to bother with it” (also two of three) as motivations instead.

5.2 Gambling & Competing

In the second part of the questionnaire games and contests was investigated. In 2.1 games and contests were investigated as a motivation. The reason for not including games as a motivation in part 1 was because it can be confusing for the respondents as games are not normally considered a part of energy behavior. Contests and games needed a bit more context and therefore a scenario was created where an energy game was described.
Part 2.1: The respondents were first asked “Are contests and games something that normally motivates you?” without the energy game considered. 23 of the 30 respondents stated that they were motivated by competing and participating in games. Six respondents stated that they were not motivated by contests or games and 1 respondent did not answer the question.

![Diagram 2. In this pie chart the distribution is displayed of how motivating games and contests were for the respondents](image)

Being motivated by games and contests appeared to be very common, but one thing to be considered was that nine respondents of the 23 that stated that this was motivating also showed some degree of uncertainty. These respondents stated that it depends on circumstances or that it was only motivating to some degree.

Part 2.2: In this part the question “What reward do you think would be appropriate and motivating?” was asked. This question was regarding the scenario described first in part 2 which depicted an energy game taking place in their School. Many different answers were given, everything from coffee, gadgets, and trips to mere recognition. But was investigated with this question was if any respondents would give unreasonable suggestions and therefore give an indication to how much it would take for them to be motivated by an actual energy game. The result was that everyone that answered the question did give reasonable suggestions. 23 of the 30 respondents gave answered the question and seven of the respondents did not.

Part 2.3: In this part the respondents was asked “Do you think that an energy game would work in real life?” 22 of the 30 respondents answered that an energy game would work. Seven answered that it would not work in real life and one respondent did not answer the question. The result suggested that an energy game would be appreciated by most people. The most common statement as to why it would function was that it would be motivating for people to save energy, be more aware and to learn more about how energy works. Saving money and being more environmentally friendly was two motivations mentioned that would be supported by introducing an energy game.
Of those that stated that an energy game would not work the most common statement as to why, was that they thought that people would not be fully committed or that they would grow tired of such a competition. An interesting fact is that no respondent directly stated that they themselves would get tired of it or not be fully committed.

5.3 Scenario: Ljungen
In the third part of the questionnaire a second scenario was depicted where weather and risk aspects were considered concerning information about energy estimations. The parameters that were considered was “probability for a certain day to have the cheapest energy price”, sun hours, wind strength, temperature, precipitation and risk.

Part 3.1: in the first question of part 3 the respondents were asked “Which day (or days) seems most probable to be the cheapest?”

Monday was the day with the highest “probability of cheaper energy prices”. It had also no sun hours, high wind rate, below zero degrees Celsius at the evening and a high risk factor. Three of 30 respondents thought that the cheapest day could be Monday. Tuesday the day that most respondents stated would be the cheapest was not the day that had the highest probability for being the cheapest. Instead it had the next highest probability. What other traits it had comparing to Monday (the one with the highest probability) was a low risk factor, a bit less snow and a bit more sun hours. 18 respondents thought that the cheapest day could be Tuesday. Wednesday had the third most probability for having the cheapest price. It had no sun hours, the warmest temperature mentioned during the day and the lowest during the evening. This day also had a very high risk factor. One respondent stated that Wednesday could be the cheapest day. Thursday was the day with the second least probability for having the cheapest energy price. It had the lowest interval of temperature, the lowest rate of wind and no precipitation. This day also had very low risk factor. Eight respondents thought that Thursday could be the cheapest day. Friday was the day with the least probability for having the cheapest energy price. It had no sun hours and an average risk factor. Three respondents thought that Friday could be the cheapest day.

Four respondents did not state any specific day. One of them stated that the warmer days could be the cheapest and one respondent stated that the sunny days could be the cheapest. Two of the respondents did not answer the question.
Diagram 3. In this column chart the amount of answers for every day is displayed in blue. Red color shows alternative answers that were not expected but still approved.

**Part 3.2:** For the question 3.1 there was a follow up question in 3.2 were the respondents were asked as to why they gave the answers that they did in 3.1. The respondents could state more than one reason. 6 of respondents stated “Probability of cheaper energy price” as a reason. Seven respondents stated risk as a reason. Nine respondents stated weather influences as a reason. Six respondents stated that it was a general overview of all parameters that made them decide day or days. Six respondents gave no reason at all.

As the majority of the respondents thought that Tuesday was the cheapest it is interesting to see as to why they thought that. Three of the respondents stated that it was because of the parameter “Probability for cheaper energy price”. Four stated that it was due to the risk factor. Four stated that it was because of the weather influences where the sun hours and the amount of precipitation were mentioned. Five respondents gave a general reason, indicating that it was all parameters combined that made them choosing Tuesday. Two of the respondents did not give any explanation.

By looking at the most agreed upon day no common parameter can be found. There is no obvious pattern and we cannot say that one parameter have been better than any other. Partly we can say that those that have regarded “The probability of cheaper energy price” as important have also included the risk factor.
Part 3.3: In this part the respondents were asked, which day (or days) has the highest risk? In the scenario description a risk factor was included that simply stated high, average or low for each day. In that sense it seems like an easy question but it was necessary in order to see if some respondents had another idea of how to interpret the risk, maybe by including other parameters as the weather or “The probability of cheaper energy price”. Monday and Wednesday were said to have a high risk factor. Tuesday and Thursday were said to have a low risk factor. Friday were said to have an average risk factor. 13 respondents stated that Monday had the highest risk factor. No one stated that Tuesday would have the highest risk factor. Eleven respondents stated that Wednesday had a high risk factor. Two stated that Thursday would have the highest risk factor and one stated that Friday would have the highest risk factor. Twelve respondents did give a suggestion. By looking at the answers it can be said that three of the respondents had a different way of considering how to interpret the risk and some of those that did not give a suggestion of a day stated that they simply did not know.

Part 3.4: In this part the respondents were asked “Which of the parameters do you perceive as relevant?” where the parameters were those mentioned in the scenario. Even if the question were stated so that they should not give more than one suggestion, some stated both “The probability of cheaper energy price and risk and some stated that they were all important.
Eight respondents believed that “The probability of cheaper energy price” was the most important parameter. Six respondents stated that risk was the most important parameter. Seven respondents stated that weather was the most important parameter. Two stated that all parameters were equally important. One did not perceive any parameter as important. Eleven respondents did either not comment on the question or stated that they do not know.

**Diagram 5.** In this column chart the answers of which parameters are considered important is displayed. But those that did not answer the question are not included

**Part 3.5:** In this part the respondents were asked “Why do you perceive the parameters as relevant?” in this way they were given the chance to elaborate the answer given in 3.4. About half of the respondent chose to elaborate and the most common answer was that they wanted cheap energy and chose the parameters that they thought would help with that. Some respondents argued for how weather influences the amount of energy available and some were seeking for the safest option.

**Part 3.6:** In this part the respondents were asked “Which day would you book Ljungen?” which were the objective in the scenario description. They also were asked to explain why they made that decision. One respondent picked Monday for booking Ljungen. Ten respondents picked Tuesday. No one picked Wednesday. Five respondents picked Thursday and no one picked Friday. Two respondents stated that they did not want to pick any day and twelve respondents either stated that they did not know or did not answer the question at all. One of the twelve stated that the scenario did not fit him or her in real life. The respondents were in the scenario not forced into doing a reservation. They were given the option to do so as a fun activity and therefore many chose not to do it. Even if many answers were discarded as no real decision were made, some of the discarded as well as the included answers had interesting information as to why they would pick or not pick a day.
Eight gave energy price as a reason for deciding. Three stated that they wanted to avoid days with high risk factors. Four gave weather conditions as the reason for choosing the day. Two stated that the chosen day simply seemed good. Five gave a motivation that was not supported by the scenario description. One of them said that he or she would book Ljungen the day before Wednesday as he or she wanted to party that day. One of them was positive that a mutual agreement would be the best solution. Another stated that he did not want to make plans like that. Twelve respondents did not provide a valid answer for that either.
Diagram 7. In this column chart the amount of answers given for why they choose a certain day are displayed but discarded answers or no answers given are not included.

5.4 Scenario: The Laundry

In this part of the questionnaire a scenario was presented were the respondents were encouraged to choose a week day were they would do their laundry. They had from Monday to Wednesday until all clothes would be dirty. They also need two hours in the laundry room in order to be done. They had six different parameters for helping them decide which day to do the laundry:

- National energy consumption (high to low)
- Most likely personal energy consumption (high to low)
- The next most likely personal energy consumption (high to low)
- Probable efficiency (high to low)
- Probable energy price seen over one day (öre per kWh)
- Probable cost for two hours of Laundry room usage seen over one day (Swedish kronor)

Part 4.1: In the first question of part 4 the respondents were asked which day they would pick in order to do the laundry. In order to answer the scenario question correctly they would have to pick a day within the boundaries of the scenario. But the answers that were incorrect would still not be disregarded since they could share valid insight about how students handle a Recommender. Ten respondents of 30 stated that they would do the laundry on Monday. Eight stated that they would do it on Tuesday. Two stated that they would do it on Wednesday and three stated that they would wait until the laundry was all dirty which would also suggest Wednesday. One stated that he or she would not do the laundry regardless it being dirty and wait until the weekend anyway and one stated that it would be done when he or she felt like it. Five respondents did not answer this question.
Part 4.2: the follow up question for 4.1 examined the reasons for the respondents’ decisions. The respondents did either answer the question from the Recommender view or from a motivational view. In the first case they would state which parameters that affected their decision the most. In the second case they would mention previously examined motivations that could be supported by the parameters in the scenario or motivations that are not supported by the parameters in the scenario and therefore mostly connected to the previously examined motivation “not having to bother with it”.

Three respondents stated that they tried to find the most environmentally friendly option. In the scenario these respondents did probably look mostly at the parameters national consumption, efficiency and the two handling personal energy consumption. Four respondents stated that they were trying to find the cheapest solution. That suggests that they used the parameter handling energy price and the parameter handling cost. One respondent stated that he or she looked mostly on the two parameters handling personal energy consumption. One respondent stated that the efficiency were the foremost parameter for deciding. Three respondents stated that the cost were the foremost parameter for deciding. Three respondents stated that they made their decision by overviewing all the scenario parameters. Eleven respondents gave non-supported motivations for deciding which day to pick, the most common being when they have to or when they feel like it. Seven respondents did not elaborate their choice or stated that they did not know which day to choose.

![Diagram 8](image.png)

Diagram 8. The amounts of answers are represented for each parameter in this column chart. Non-supported motivations are also included.

Part 4.3: In this part the respondents were asked more directly which information most contributing to their decision. They were able to give more than one type of information. Two
respondents stated that national consumption was contributing. Two respondents stated that personal energy consumption was contributing. Five respondents stated that efficiency was contributing. Two respondents stated that the price was contributing. Six respondents stated that the cost was contributing. Five respondents stated that all information provided by the scenario contributed to their decision. The most commonly explanation was that it was an overview of the values provided that were the most important factor. Five respondents gave non-supported types of information for their reason for deciding, most commonly the fact that they had to make a decision. Any detailed explanations were not given in any of those cases. Ten respondents did either not answer this question or stated that they did not know.

![Diagram 9. The amount of answers for each parameter that were considered as contributing are displayed in this column chart](image)

**Part 4.4:** In this part the respondents were asked whether or not they thought that the amount of information that they had been provided were enough, in order to give support in making a decision that they were satisfied with. 19 of 30 respondents stated that they thought that the amount of information were enough. Two respondents stated that were not enough information. Two respondents said that there might have been enough information. Seven respondents did either not give an answer or stated that they did not know.

**Part 4.5:** The continued issue of information in the scenario was in case the respondents lacked any specific information and if so, what that would be. Ten respondents stated that they did not miss any information and 15 respondents chose not to answer the question or state that they did not know. One respondent said that he or she missed a “best choice” option that he or she wanted provided from a Recommender. Two respondents said that he or she sought more in-depth information during shorter periods of time. One respondent stated that schedule for the available laundry hours would be helpful. One respondent sought more information about how the power plants function and how much they produce.
Part 4.6: In this part we asked the respondents more specifically about whether they believed that the price parameter is relevant or not. Eight of the respondents answered that price is relevant. Three respondents stated that as long as they live at school it is not relevant, but that it is relevant when they have their own apartment. Five respondents stated that it is not relevant. Three respondents stated that they did not know. One respondent said maybe, indicating that he or she did not know either. Ten respondents chose not to answer or they misread the question.

Part 4.7: In this part we asked the respondents if they find information about cost to be relevant. Five respondents stated that they did find it relevant and six stated that it was not. Five respondents stated that it might be relevant or that they did not know and 14 respondents did not answer this question.

Part 4.8: This question regarded national consumption where the respondents were asked whether they found that parameter to be important. Three respondents stated that it was. Seven respondents stated that it was not. Five respondents did not know, was not sure or misread what it referred to.

Part 4.9: The last question for part 4 was whether the respondents found personal energy behavior to be relevant. Six respondents said that it was. Five respondents said that it was not. Four respondents did not know or was not sure and 15 were discarded or did not answer the question.

5.5 General Experience
The last section regarded how the respondents experienced the questionnaire.

Part 5.1: The first question of part 5 regarded the quantity of information in the questionnaire. The respondents were asked if the quantity was manageable and contributed to their decisions and understanding. Seven respondents stated that the quantity was manageable and contributing. Eleven respondents stated that it was not. Four respondents were not sure in some way. Eight respondents did not answer the question.

Part 5.2: The follow up question of 5.1 regarded why they thought that the information was or was not manageable or contributing. Of those who said yes the common answer was that they did not miss any information. Of those who said no the most common answers was either that it was too much information or that the language was too technical.

Part 5.3: In this part the respondents were asked “How much information do you think would be appropriate and why?” This is a very open question which more or less encourages simplistic answers like “More”, “Less” or “Enough” but those are also considered useful in this case. Such answers indicate a vague direction for which a Recommender should take. Seven respondents stated that a moderate amount of information is needed “enough information”. Four respondents state that it is enough to know only price per kWh or the cost of performing actions during periods of time. Four respondents state that there should be less information than was provided in the questionnaire. Three respondents answered that rather than the looking at the amount of information, it is more important to have more understandable information. Twelve respondents did not answer the question.

Part 5.4: In the last part of the questionnaire the respondents were asked if there is any information that they lacked during the questionnaire and that they wanted to introduce. Two respondents
stated that more information in general would be good. One respondent stated that he or she would like to know the origin of the energy. One respondent answered that the total cost for every outlet would be interesting, another said that the average consumption would be interesting to know. Three respondents stated that they wanted less intricate information which is more self-explanatory. Eight respondents stated that they did not want any more information and 14 did either not know or did not answer the question.
6 Analysis of the Questionnaire

6.1 Is an Energy Game Suitable?

The first part of the analysis is to examine whether or not an energy game is suitable for the respondents needs in a Recommender environment. This examination answer if games and competition are something that the respondents feel is motivating in order to understand, learn and ease energy issues. This examination is based on several answers that the respondents have had to answer during the questionnaire. The answer of part 2.1 is considered to be the most important factor, were the respondents’ state whether or not they are motivated by games and contests normally. 2.2, which regard appropriate and motivating rewards are also influential. 2.3, whether or not the respondents think an energy game would work in real life is probably the second most important factor. Question 3.4 and 3.7 are also included in order to see how the respondents react to risk factors.

An energy game would be suitable for the respondents need in 24 out of 30 cases. Most of these respondents answered yes, both on question 2.1 and question 2.3. Three of these respondents answered that they are normally not motivated by games but that they think that an energy game would work and help the competitors understanding, learning and motivation process concerning energy issues. Two of these respondents answered that they are motivated by games but that they did not think that an energy game would work. They are included anyway because the reason for not believing in the idea was that a good enough price would have to be included.

An energy game would not be suitable for four of the respondents. Three of these answered that they were not motivated by games nor did they believe that an energy game would work. One of the respondents stated that he or she is motivated by games but that an energy game would not work in the long run.
Two of the respondents did not give enough information in order to confirm whether or not an energy game would be suitable.

1 Is an energy game suitable for the respondents needs?

![Pie chart showing 80% Yes, 13% No, and 7% Not enough information.]

Diagram 10. The distribution in the pie chart shows how many that would benefit from an energy game

6.2 Reasoning & Understand Weather Influences

In the second part of the analysis an examination is performed in order to understand if respondents are able to recognize how weather influences the price and consumption of energy. The examination also investigate if respondents can reason about how weather influences.

This examination is based on three questions of the questionnaire: 3.2 why the respondents consider a certain day to be the cheapest, 3.4 which parameters the respondents perceive as relevant and 3.7 why the respondents would pick Ljungen a certain day. In none of these questions the respondents have to discuss weather influences, but they are allowed to do so. If a respondent do not discuss any weather influences that does not mean that the respondent do not understand how weather can influence energy price and consumption, only that other things might have been seen as more important.

13 respondents do some reasoning about weather in the scenario which indicates some understanding about that it influences energy consumption. This conclusion is based on that weather aspects are mentioned in the questions, 3.2 or 3.4 or a combination or 3.2, 3.4 and 3.7.

One respondent do reason about weather but do not show understanding about how weather influences energy aspects. This does not prove that the respondent do not understand it, only that it is not shown. This conclusion is based on that the respondent only mentions weather aspects in question 3.7 and not in 3.2 or 3.4.

Twelve respondents do not argue about weather aspects in their answers, instead they use other kinds of parameters in order to reach a decision. This does not prove that the respondents do not
understand it, only that it is not shown. This conclusion is based on that the respondents do not mention weather aspects in the questions 3.2, 3.4 or 3.7.

Four respondents do not answer enough questions, in order to suggest what type of reasoning or understanding, they might or might not have had. These respondents have stated that they do not know or not answered the questions 3.2, 3.4 or 3.7.

6.3 The Respondents’ Motivations (Ljungen)

In this part of the analysis an examination is performed in order to find out if the respondents were consistent regarding their mentioned motivations in part 1 of the questionnaire with part 3 of the questionnaire. With this examination an answer can also be given about what the respondents’ actual motivations would be no when it is tested.

In this examination we use the answers of the following questions: 1.1 what the respondents consider that their motivations are, 3.2 why the respondents consider a certain day to be the cheapest, 3.4 which parameters the respondents consider to be relevant and 3.7 why they would book Ljungen a certain day.

This analysis can be a bit intricate and therefore the reasoning of the analysis is included for every respondent. In the list below the numbering show the analysis for each respondent: 1 suggests the first respondent etc.

1) The answers in part 3 supports mentioned motivations, saving money and environment, but also adds one motivation in 3.7: not having to bother with it.
2) The answers in part 3 supports mentioned motivation saving money. The respondents lack interest throughout the questionnaire which strengthens the other mentioned motivations not
having to bother with it. He or she wants to avoid risk in 3.2, which adds a motivation not making bad decisions.

3) Answers from part 3 support mentioned motivation saving money throughout. It is not possible to verify motivation, being better than my friends, and motivation, not having to bother with it, other than lack of interest throughout the questionnaire.

4) Answers from part 3 support mentioned motivation saving money through answer in 3.4 but also give support for motivation, not having to bother with it, with the answer in 3.7.

5) Mentioned motivation was the saving money aspect but this is not supported in the answers since there was none. That does not have to contradict the saving money motivation, but indicated lack of understanding or lack of interest. However, since the respondent does not even want to try to provide answers that would suggest support for the motivation of not having to bother with it.

6) Mentioned motivation was saving money. This was not supported in the answers but is not fully contradicted either. The answer of 3.7 shows that joy of everyday life is most important. That supports the motivation of not having to bother with it, since the suggestions of the Recommender, which supports other motivations, was not considered at all.

7) The respondents believe that in order for energy to be cheap, there should be many sun hours. The respondent also decide after which day has the most sun hours which indicate that the respondent search for a day which is cheap to consume energy. This supports the mentioned motivation of saving money. No other motivations are clearly supported.

8) Mentioned motivations are saving money and being environmentally friendly. The respondent have a hard time interpreting the information but the correlation between answers in question 3.2 and 3.7 indicates that the respondent searches for the cheapest option. Helping environment is not supported but it is also not contradicted.

9) The respondent stated that he or she was motivated by saving money or environment. These motivations are not supported in the answers but not really contradicted either. The respondent states that he or she wants a group decision to be decisive; thereby the decision is transferred from energy issues to something non-supported which therefor is supported by the motivation of not having to bother with it.

10) The respondent state money, making good decisions and avoiding bad decisions to be the most important motivations. In question 3.7 the respondent states that he or she is not affected by the energy issues when deciding to consume or not. Therefore, making good decisions and making bad decisions are contradicted by that statement. Instead what is most fitting for the respondent is to not having to bother with it. The motivation saving money cannot is not fully contradicted and should therefor remain.

11) The respondent stated that saving money, environment and making good decisions were the most motivating aspects. All of them are supported by the answer in 3.4 and 3.7. In 3.2 the respondent states that low risk is a part of receiving the cheapest price as well which suggests that not making bad decisions is also a valid motivation for the respondent.

12) Not enough information to suggest anything else than the motivations that the respondent first suggested: saving money and environment.

13) The respondent stated that he or she was mostly motivated by saving money and the environment. In 3.4 the respondent states that all parameters were relevant which of course support the stated motivations, even though in a vague manner. No other motivation can be obviously suggested by the answers.
14) In part 1 the respondent answered saving money and environment. These are supported in 3.4. The answer of 3.7 supports both, not having to bother with it, and not making bad decisions.

15) The respondents state that saving money and not having to bother with it are the most motivating aspects. Money is supported through answers in 3.4 and 3.7. Not making bad decisions is also supported in 3.4. Not having to bother with it is somewhat supported by lack of interest in many of the questions overall.

16) In part 1 the respondent answered, being environmentally friendly. The respondents answers part three supports the Environment aspect but is also supporting the saving money aspect in 3.4 and 3.7.

17) The respondent states a lot of motivations in part 1: saving money, environment, making good decisions and not having to bother with it. The first three are motivated by 3.2, 3.4 and 3.7. Not making bad decisions is also supported through these answers. That the respondent does not wish to bother with energy is not supported, but it is also not contradicted.

18) The respondent answered saving money and not making bad decisions are supported. Environment remains as a motivation as it is not contradicted.

19) In part 1 the respondent answered environment and not having to bother with it. Environment is supported through 3.7. Not making bad decisions are supported in 3.4. Saving money is supported through correlation between 3.2 and 3.4, and also in 3.7. That the respondent does not wish to bother with energy is not supported but also not contradicted.

20) The respondent stated saving money, environment and making good decisions in part 1. There is not enough information in the answers to support or reject these answers.

21) In part 1 the respondent answered saving money and not having to bother with it. The first is supported in 3.4. The lack of answer in 3.7 supports the second in one sense. 3.4 also support the motivation of not making bad decisions.

22) The respondent answered saving money, making good decisions and not having to bother with it as motivations in part 1. There is not enough information in the answers to support or reject these answers.

23) Saving money, environment and making good decisions were stated in part 1. These are all supported through 3.2, 3.4 and 3.7.

24) Saving money, environment and making good decisions were stated in part 1. They are somewhat supported through the answer in 3.7. The lack of answers, support the motivation of not having to bother with it in a sense.

25) The respondent answered saving money and not having to bother with it in part 1. The answers in part 3 support saving money. Not having to bother with it is not contradicted.

26) The respondent stated, not having to bother with it as a motivation in part 1. This is supported by the answers in 3. No other motivation is fully supported.

27) Saving money, making good decisions and being better than my friends are suggested in part 1. These motivations are not fully contradicted but they do not seem to be supported either. Not having to bother with it seems supported by the answers though.

28) In part 1 the motivation of saving money is given as the motivation. The answers in part 3 do not contradict this, as the respondent have answered that he or she does not know. Caution is a trait that seems to fit the respondent's personality and could suggest that not making bad decisions would be a motivation but it should be more supported through the answers in order to include this more.
29) In part 1 the motivation of saving money, environment, making good decisions, not making bad decisions, not having to bother with it, being better than my friends and earn recognition are all given as the motivations. The answers in part 3 do not contradict this, as the respondent have answered that he or she does not know.

30) The respondent answered saving money and making good decisions in part 1. These are neither supported nor contradicted in part 3 and should therefore remain.

From the examination of the motivations supported in part 3 a reevaluation is done regarding how common the motivations are. 29 of 30 respondents have saving money as a motivation. 14 respondents have been environmentally friendly as a motivation. 20 respondents wish not to have to bother with energy issues. Eight respondents wish to make good decisions. Nine respondents do not want to make bad decisions. Three respondents wish to be better than their friends. One respondent wishes to earn recognition.

Diagram 12. In this column chart the respondents' motivations, adjusted by answers in part 3, are displayed

### 6.4 Reasoning & Understand Risk Influences

In this part of the analysis we focus on the aspect risk and examine whether or not the respondents understand how risk can influence the energy in different ways and if the respondents consider it important enough to reason about issues of risk.
In this analysis, question 3.2, 3.4 and 3.7 is considered. With question 3.2 it is possible to see if the respondents consider risk to be an influential factor on price. Question 3.4 answers whether or not risk is considered to be relevant. 3.7 give answer to if the respondents are affected by risk when deciding common action. The question 3.3 regard which day or days have the highest risk, which could be viewed as very basic as the days Monday and Wednesday have the trait high risk written to it. If the respondents answer any differently; they have probably not read the chart properly or made the reasoning complex. It is possible that they have viewed the risk as a probability factor and therefor tried to combine the probability for a certain day to have the cheapest price with the risk factor and therefor reached a different suggestion. This is not really possible to do though as the risk factor in this case does not have a probability value.

Just by giving a suggestion of a day in 3.3 gives a suggestion that a respondent have made some kind of reasoning concerning risk. 19 respondents gave a suggestion. One of the respondents that did not answer this question did reason about risk question 3.4 which means that 20 respondents of 30 reasoned about risk.

Eight respondents suggest that risk influences which day is the cheapest. Respondent 21 is included here since even though 3.2 was vague; he or she regarded risk in 3.4 as most relevant and also stated the expected choice for 3.1, if risk or sun hours was regarded to influence the price. Five of these respondents also indicated that they perceived risk as one of the most relevant factors in the chart. Four of these respondents did also indicate that risk affected them when they made the decision to choose a day. These respondents indicated that they understood risk in some way. Of those that did not give a risk suggestion on 3.2 there were three respondents that still described risk as the most relevant parameter. Two of these also indicated that they were affected by risk for their decision on choosing a day. These respondents also indicated that they understood risk in some way. Of the eleven respondents that showed that they were influenced by risk, all but one stated Monday or Monday and Wednesday as the days with the highest risk factor.

Two of the 30 respondents participating did not give enough answers in order to tell whether or not they were mostly influenced by risk or any other parameters. 17 respondents gave indication that they were more influenced by other parameters than risk, mostly weather influences and non-supported parameters were mentioned instead. Six of these respondents stated either Monday or Wednesday as the days with the highest risk, this indicates that they recognized the risk factors but chose not to regard it as one of the most important parameters. A total of four respondents gave a suggestion of a day that was not Monday or Wednesday. Thursday and Friday were suggested instead in these cases. The respondents that answered Friday did probably assume that the lower probability a day had to be the cheapest the higher the risk factor would became in the end. The respondents that answered Thursday did probably just guess or misread the question since the previous mentioned reasoning did not apply on Thursday.
Diagram 13. The distribution of the ability to understand and reason about risk is displayed in this pie chart. Those that did not provide enough information to be estimated are not included.

6.5 Helping Parameters

In this analysis we consider what parameters there were that actually helped the respondent during the part 3 of the questionnaire.

In order to do that an examination of question 3.4, 3.6 and 3.7 is performed. With question 3.4 we can see what the respondents themself consider to be important and with 3.6 and 3.7 we can see what motivated a decision. In cases where there is not enough information in mentioned question we can also look at 3.1 and 3.2 if the motivation saving money in 1.1 has been given as an answer. This analysis can be a bit intricate and therefor the reasoning of the analysis is included for every respondent. In the list below the numbering show the analysis for each respondent: 1 suggests the first respondent etc.

1) “Probability for a certain day to have the cheapest energy price” was considered the most important parameter, but the interpretation was inaccurate. No other supported parameter was as important though, except the will and availability of the respondent, which supports non-supported parameters.

2) ”Probability for a certain day to have the cheapest energy price” is used in 3.2 as well as risk factor. The respondent did not understand how to interpret probability though.

3) ”Probability for a certain day to have the cheapest energy price” was considered as the most important parameter. It was also used as a motivation for a decision.

4) Not enough information to say. All parameters were considered equally important but none of them were used to make a decision, nor any other kind of parameter.

5) Not enough information to say

6) Non-supported parameters. In this case, organization around everyday life convenience.
7) Weather influences in order to save money. Sun hours, temperature and precipitation was most influential.

8) Weather influences in order to save money. The lack of precipitation seems to be considered as helpful in order to have a cheaper price. Not to have so much wind seems also considered to be a good thing. These views might not have been that helpful but they are considered valid by the respondent and no other parameter has been as influential.

9) Non-supported parameters that support the motivation not having to bother with it. Not in the sense that the respondent dislikes energy issues but in the sense that the respondent do not like to be take charge or have responsibilities over other people.

10) Weather influences are considered the most relevant. Non-supported parameters are the ones that determined the decision. Convenience is the quality that the respondent seeks the most.

11) ”Probability for a certain day to have the cheapest energy price” is the parameter which is considered most relevant. It is also that parameter which is most influential.

12) Weather influences are used in 3.2 in order seek the most money saving option. Precipitation is the type of weather feature that were used.

13) Weather influences are used in 3.2 in order seek the most money saving option. Mild temperature and less wind are thought of as helpful.

14) ”Probability for a certain day to have the cheapest energy price” is the parameter which is considered most relevant. Non-supported parameters are used in the decision. Convenience is the quality that the respondent seeks the most. The respondent uses the first mention parameter when stating a secondary answer but does also include the risk factor.

15) ”Probability for a certain day to have the cheapest energy price” is the parameter which is considered most relevant. It is also used for the final decision.

16) ”Probability for a certain day to have the cheapest energy price” and risk factor are considered most relevant. They are both used for the final decision.

17) Weather influences are considered the most relevant as well as risk factor. Risk seems to be the one which is foremost used when deciding, even though the respondent gave an unexpected answer if that day were to be used as most valid parameter.

18) ”Probability for a certain day to have the cheapest energy price” is the parameter which is considered most relevant together with risk factor. Both are used for deciding a day.

19) Risk factor is considered as most relevant. It is used together with the probability for a certain day to have the cheapest energy price and weather influences in order to decide a day. For viewing risk as most important the respondent gave an unexpected answer.

20) In 3.2 the respondent are influenced by weather influences in order to reach the motivation, saving money.

21) Risk factor is considered as most relevant but it is not used for when deciding a day. There is not enough information to determine that, but if the respondent would wish to decide between equal options the risk factor could be what determines the result.

22) Not enough information to say

23) Weather influences and the probability for a certain day to have the cheapest energy price are mentioned as most relevant and both seem to be used for deciding a day.

24) The respondent mentions Tuesday as the cheapest day and decide for that day as well. The respondent do not state why but the parameters that was used must have been either
Probability for a certain day to have the cheapest, weather influences or risk factor. But it cannot really be verified if it is all, two or just one of them that the answer was based on. Therefor there is not enough information to say.

25) Weather influences were thought of as the most relevant.
26) Weather influences were thought of as the most relevant but it was non-supported parameters that were decisive in the final decision.
27) Weather influences were thought of as the most relevant but it was non-supported parameters that were decisive in the final decision.
28) Not enough information to say
29) Not enough information to say
30) Weather influences are used in 3.2 in order seek the most money saving option. Warm temperature is considered the most important factor.

6.6 Information That Will Help Respondents Further

By further examining the answers of question 3.6 and 3.7 it is possible to evaluate what information or parameters would help the respondents further; parameters that would help the respondents to be more sure about their answers and guide them into making decisions that they want. If in some cases the answers of 3.6 and 3.7 are not enough an examination of the other questions in part 3 is performed as well.

- In five cases the examination concluded that the respondents would benefit from receiving a basic “best” option based on saving money or being environmentally friendly.
- In three cases the respondents could benefit from having easier explanations of the values in the chart.
- Four respondents would also benefit by having the parameters more explained.
- Five respondents could probably benefit from having a schedule accessible that show available hours.
- Seven respondents showed indications that further explanations about weather influences would help them further.
- Seven respondents could benefit from easier or more explanatory tools to analyze probability of certain days to have a cheaper price and risk factors.
- Three respondents showed no real weakness in their analysis and therefor it was not possible to see how they could be additionally supported.
- Five respondents did not give enough information in order for the examination to determine how they could be helped further.
- One respondent showed some indications, that a more in depth explanation about how power plants function would support that respondent’s analysis process.
- One respondent could probably benefit from understanding what parameters the predictions in the chart was based on.
- Another respondent indicated that short time usage of a Recommender was not of that person’s interest and therefore a more long term management of the energy consumption would probably suit that person’s needs more.

Concerning weather influence respondents in general seem confident in knowing that during days with mild temperature, many sun hours and calm wind they do not consume that much energy. At
the same time they understand that precipitation and wind are used by power plants in order to produce energy even though sun panels are somewhat used by households. That knowledge complicates the understanding of which type of weather is best in order to estimate how environmentally friendly and cheap the days will be. In order to improve this understanding, the respondents could be provided with statistical knowledge about price during different kinds of weather.

6.7 The Respondents’ Motivations (The Laundry)

Were the respondents consistent, regarding motivations in the laundry room scenario and the survey part concerning motivations? What would the respondent's motivations be when considering both part 1 and 4 of the questionnaire?

In this examination we use the answers of the following questions: 1.1 what the respondents consider that their motivations are, 4.3 which information the respondents consider to be most contributing and 4.2 why they would do Laundry a certain day. Other answers from part 4 can in some cases be proven valuable.

This analysis can be a bit intricate and therefore the reasoning of the analysis is included for every respondent. In the list below the numbering show the analysis for each respondent: 1 suggests the first respondent etc.

1) The answers in part 4 supports mentioned motivations, saving money and environment.
2) The answers in part 4 supports mentioned motivation saving money.
3) Answers from part 4 support mentioned motivation saving money throughout. It is not possible to verify the motivation “being better than my friends” and motivation of not having to bother with it other than lack of interest throughout the questionnaire.
4) Answers from part 4 does not support mentioned motivation saving money but also give support for motivation of not having to bother with it.
5) Answers from part 4 does not support mentioned motivation saving money but also give support for motivation of not having to bother with it.
6) Answers from part 4 does not support mentioned motivation saving money but also give support for motivation of not having to bother with it.
7) The answers in part 4 supports mentioned motivation saving money.
8) The answers in part 4 supports mentioned motivation saving money and environment in one sense, as answer 4.1 Tuesday at 20-21 PM is considered to be the best option for being environmentally friendly and possibly money.
9) The answers in part 4 supports mentioned motivation saving money and environment in one sense, as answer 4.1 Tuesday is considered to be the best option for being environmentally friendly and possibly money.
10) Answers from part 4 does not support mentioned motivation saving money but also give support for motivation of not having to bother with it.
11) Not enough information to suggest anything else than the motivations that the respondent first suggested: saving money and environment.

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13) The respondent stated that he or she was mostly motivated by saving money and the environment. The motivation saving money is supported by the answers in part 4. The environment issue cannot be verified or contradicted.
14) The respondent stated that he or she was mostly motivated by saving money and the environment. The motivation saving money is supported by the answers in part 4. The environment issue cannot be verified or contradicted.
15) The respondents state that saving money and not having to bother with it are the most motivating aspects. Money is supported through answers in 4.3. Not having to bother with it is somewhat supported by lack of interest in many of the questions overall.
16) In part 1 the respondent answered environment. The respondents answers in part 4 supports the Environment aspect but is also supporting the saving money aspect in 4.2.
17) The respondent states a lot of motivations in part 1: saving money, environment, making good decisions and not having to bother with it. Making good decisions is supported in 4.3, Environment and Money is supported in 4.9. Not having to bother with it is somewhat supported with lack of interest in 4.5, 4.7, and 4.8.
18) The respondent answered saving money and environment in part 1. In part 4 saving money is supported. Environment remains as a motivation as it is not contradicted.
19) In part 1 the respondent answered environment and not having to bother with it. Saving money is supported through 4.2, 4.3 and 4.6. That the respondent does not wish to bother with energy or want to be environmentally friendly is not supported but also not contradicted.
20) The respondent stated saving money, environment and making good decisions in part 1. There is not enough information in the answers to support or reject these answers.
21) In part 1 the respondent answered saving money and not having to bother with it. The first is supported in 4.2 and 4.3. The lack of answer in 4.7, 4.8 and 4.9 supports the second in one sense.
22) The respondent answered saving money, making good decisions and not having to bother with it as motivations in part 1. There is not enough information in the answers to support or reject these answers.
23) Saving money, environment and making good decisions were stated in part 1. These are all supported through 4.2 and 4.6.
24) Saving money, environment and making good decisions were stated in part 1. They are somewhat supported through the answer in 3.7. The lack of answers supports the motivation of not having to bother with it, in a sense.
25) The respondent answered saving money and not having to bother with it in part 1. The answers in part 4.3 support saving money. Not having to bother with it is somewhat supported in 4.2.
26) The respondent stated not having to bother with it as a motivation in part 1. This is supported by the answers in 4. No other motivation is fully supported.
27) Saving money, making good decisions and being better than my friends are suggested in part 1. Money is supported through 4.6, 4.7 and 4.9. Making good decisions and being better than his or hers friends are not contradicted.
28) In part 1 the motivation of saving money is given as the motivation. The lack of answers does not contradict the motivation of saving money but it supports the motivation of not having to bother with it.
29) In part 1 the motivation of saving money, environment, making good decisions, not making bad decisions, not having to bother with it, “being better than my friends” and earn recognition
are all given as the motivations. The answers in part 4 do not contradict this, as the respondent have answered that he or she does not know.

30) The respondent answered saving money and making good decisions in part 1. These are neither supported nor contradicted in part 4 and should threfor remain.

From the examination of the motivations supported in part 4 a reevaluation is done regarding how common the motivations are. 29 of 30 respondents have saving money as a motivation. 15 respondents have being environmentally friendly as a motivation. 15 respondents wish not to have to bother with energy issues. Eight respondents wish to make good decisions. One respondent do not want to make bad decisions. Three respondents wish to be better than their friends. One respondent wishes to earn recognition.

6.8 Level of Understanding
In this part of the analysis we consider the respondents level of understanding with the focus on the parameters. This analysis accounts several questionnaire answers and therefor the reasoning of the analysis is included for every respondent as some answers prove more or less important in different cases. In the list below the numbering show the analysis for each respondent: 1 suggests the first respondent etc.

1) Basic to high. The respondent could somewhat in a decent way understand the parameters. Question 4.7 and 4.8 were not understood and question 4.6 was avoided, but otherwise the respondent had no real problems.

2) Low to basic. The expected day was selected and the respondent argued for low energy consumption to be the best option. It is hard to tell if it was lack of knowledge or lack of interest that resulted in so few answers.

3) Basic. The respondent’s answers indicate understanding, but the elaboration is not. That suggests that even though the respondent is not familiar to the terminology the respondent is able to make interpretations due to wit and logic.

4) Low. The respondent did probably not understand. The respondent chose not to argue or comment anything concerning the parameters.

5) Low. The respondent states that no information could help him yet all information was equally important and with the right amount. The reason could be that the respondent did not read the all instructions.

6) Low. The respondent made his decisions around non supported parameters and avoided to use the information of the scenario or the chart, the reason was probably due to lack of understanding or interest.

7) Basic. Question 4.3 can indicate that the respondent simplify the parameters. The respondent seems to understand some of the parameters but not enough to make an analysis that would make the respondent feeling sure and satisfied.

8) Basic. This is a peculiar example. The respondent picks the most probable solution and also asks for more in-depth facts about the information but at the same time is not able to argue or reason around the parameters. Even though there were so few answers the respondents understanding cannot be viewed as low.

9) Basic. The most probable solution is chosen once again when efficiency is accounted for. Answer 4.9 indicates some understanding and also some curiosity which normally comes
from some basic understanding. Otherwise the respondent avoids discussing the parameters and seeks non-supported information.

10) Low. The respondent did probably not read the background information and did probably not understand the parameters. The reason was due to lack of interest or lack of understanding.

11) Low. The respondent had a hard time to understand the parameters except cheapest cost and at the same time the respondent states that cost is not relevant. The respondent did probably not read the instructions fully because of lack of understanding or interest.

12) Low. This respondent answered gave very few answers during the questionnaire which indicates frustration over the amount of understanding it took to complete the task.

13) Basic. The respondent seeks out cost as the most important parameter for the respondent. That is considered acceptable. The respondent did not pick a day though which indicates that the respondent were discouraged by parameters that he or she could not interpret.

14) Low. The respondent were able to understand that some of them were important but had problems to understand how it all were connected. The parameters themselves were not the focus instead the valuation were.

15) Low to basic. The respondent avoided answering some valuable questions. But from the cost and price perspective the respondent chose a fitting day and time which indicates some indication of understanding.

16) High. Yes the respondent seems to be able to understand the information.

17) Basic. The respondent made a decision based on an overview of all parameters but was not able to reason about them.

18) Basic to high. The respondent answers from a money saving perspective and is able to argue for it. Other parameters than cost, price and personal energy behavior are neglected though.

19) Basic to high. Calculated cost was somewhat hard to interpret for the respondent and the relevancy of national consumption. The respondent argued mostly from saving money and utilized the price parameter the most in order to find the most fitting option.

20) Low. This respondent answered gave very few answers during the questionnaire which indicates frustration over the amount of understanding it took to complete the task.

21) Basic. The respondent was able to argue from a money saving perspective and use the cost parameter in order to do that. Other parameters were neglected though but the respondent had no problem before this scenario; this suggests lack of interest or some kind of disturbance was the most important reason for this, rather than lack of understanding.

22) Low. This respondent answered gave very few answers during the questionnaire which indicates frustration over the amount of understanding it took to complete the task.

23) High. The focus was mostly to get an overview of how energy production stands at the moment which is very good. The respondent seems to make most estimation him/herself by thinking “outside the box”. I think that the respondent was able to make a decision that he or she thought was good and, even though two questions were neglected, this suggests high understanding and interest.

24) Low. The respondent did not make a bad decision though, he or she probably used efficiency due to the environmental connection, but it is not enough information to say for sure. Overall this respondent answered gave very few answers during the questionnaire which indicates frustration over the amount of understanding it took to complete the task.
25) Low to basic. The respondent was able to argue from the money saving perspective by using the parameter energy price. The lingua was considered too hard in some cases; the respondent was not sure what relevant referred to.

26) Low. The respondent had a hard time interpreting the parameters. Maybe because of not understanding the scenario description or maybe because of the terminology.

27) Low to basic. Economical parameters and energy behavior seems to have been understood the other answers were avoiding reasoning and decision making.

28) Low. This respondent answered gave very few answers during the questionnaire which indicates frustration over the amount of understanding it took to complete the task.

29) Low. The respondent states that he or she do not know the answer of most questions but it is not possible to say for sure whether it is because of lack of understanding or lack of reading instructions.

30) Low. The respondent states that he or she do not know the answer of most questions but it is not possible to say for sure whether it is because of lack of understanding or lack of reading instructions.

Diagram 14. The respondents understanding of energy issues and the questionnaire is displayed in this pie chart

6.9 Most & Least Influential Parameters
In this part of the analysis we investigate which parameters were most and least influential for the respondents during the questionnaire. If any parameter affected the respondent in a negative way, it is considered, but in this case it is better to be influential in a negative way than not influential at all, sense such a parameter is still considered relevant in some way. This analysis is mostly based on the answers from question 4.3, 4.6 and 4.7, 4.8 and 4.9

One respondent’s most influential parameter was the personal energy behavior, both the most probable and the next most probable. Three respondents had the efficiency as the most influential parameter. Probable price had the most impact on two respondents. Five respondents were the most influenced by the probable cost. Five respondents were more influenced by the overall picture
or the values of the parameters than any single parameter. In 14 cases there was no way to estimate what parameter influenced them the most.

Two respondents were the least influenced by personal energy behavior during their decision making. Another two were the least influenced by the probable cost. Six respondents were not influenced by national consumption in any way. In the rest of the cases there were no ways to say what the least affecting parameter was.

6.10 Experience of Information Overload

In this part of the analysis we investigate whether the respondents experienced information overload during the questionnaire. In order to do so every answer of the questionnaire is investigated in order to find trends. We also seek indications in single answers where question 5.1 and 5.2 are the most important. As this analysis accounts several questionnaire answers and the reasoning and the analysis can also be included for the respondents as some answers prove more or less important in different cases. In the list below the numbering show the analysis for each respondent: 1 suggests the first respondent etc.

1) No information overload occurred. The respondent did well during the questionnaire. Some information overload could have occurred but probably not as the respondent seemed interested and motivated throughout the survey. The terminology and the lingua can have been frustrating in some cases but it was lack of understanding rather than amount of information that hampered the respondent’s decision making process.

2) Yes, information overload occurred. The respondent mentions that the terminology and language is too difficult for him or her so that can be the reason for the lack of answers. Lack of understanding, lack of interest or information overload or a combination of all of them have occurred; probably the latter alternative.

3) No information overload occurred. The respondent thought that the amount of information helped him make better estimations and did not complain about the amount.

4) Yes, information overload occurred. But the respondent stated that he was not interested in the survey which is shown from part 3 of the questionnaire, so the respondent did probably not read the scenario descriptions or the tables. The lack of interest occurred probably because of the amount of information, as the first estimation of part 3 was analyzed correctly.

5) Yes, information overload occurred. It could also mean that the respondent did not bother with the instruction of other reasons, but it is equally probable that the respondent felt that there was too much information. The amount of information was probably more disturbing than the lack of knowledge as the respondent started avoiding questions before any analysis was required.

6) Yes, information overload occurred. The respondent states that he or she did not thought that the amount of information were too much to handle, but it is hard to know for sure as the respondent did not use the information from the scenarios in order to make decisions. In part 4 the respondent did not follow the instructions which indicate that he or she did not read them fully.

7) No information overload occurred. The respondent believes that he or she were able to interpret all information. I do not believe that the respondent were affected by information overload since the respondents decisions was not obstructed by the information and the
respondent used the information that were viewed as relevant and were able to make some reasoning concerning those.

8) Yes, information overload occurred. But in this case it is possible that the respondent seeks out the information that stood out easily and used that and only that in order to make a decision. That would suggest that the respondent used the information in a way that was not frustrating even if some mistakes probably did happen.

9) No information overload occurred. The respondent avoided these questions therefore there is no way to say for sure. The respondent shows indications that the lingua was too difficult for him or her rather than the amount.

10) Yes, information overload occurred. The respondent answered well until part 4 of the scenario. After that the respondent had very many difficulties answering the questions and showed a lot of frustration. The reason was probably due to the amount of information.

11) Yes, information overload occurred. The respondent states that he or she was frustrated over the amount of information and wished for a lot less. The respondent did well though during the questionnaire but some indications of frustration are shown in part 4.

12) Yes, information overload occurred. Everything suggests that the respondent hit a barrier where the amount of information or the lingua was too hard for the respondent. It also happened during a question that was not considered to have a difficult analysis required. That indicates that the amount was the most probable reason for frustration.

13) Yes, information overload occurred. The most prominent difficulty was the level of understanding and the lingua though, but the amount of information was probably part of that as well.

14) Yes, information overload occurred. The most prominent difficulty was the level of understanding and the lingua though, but the amount of information was probably part of that as well.

15) Yes, information overload occurred. The respondent states that the amount of information was difficult to handle and this is shown in part 2 were the respondent did not answer questions that had to do with the level of understanding or lingua.

16) No information overload occurred. Even though the respondent thought that the questionnaire was hard and that the information was difficult to interpret, the respondent did very well. The information overload did probably not occur, but the respondent would probably feel frustrated the longer the respondent used this Recommender.

17) No information overload occurred. The respondent was satisfied with the amount of information and was able to do some analysis during the questionnaire even though he or she had some difficulties with more intricate analysis.

18) No information overload occurred. The even though the respondent whished for more basic information he or she had no real problems during the questionnaire and was more satisfied with the amount than less.

19) Yes, information overload occurred. The respondent states that he or she had a hard time but the respondent did still do well during the questionnaire. There was probably some information overload even due to that the respondent was smart and had some previous understanding.

20) Yes, information overload occurred. The respondent more or less gave up after half of the questionnaire during a question that did not require that much analysis. That suggests that it was the amount of information that mostly disturbed the respondent.
21) Yes, information overload occurred. The respondent did very well until the last questions of part 4 were he or she just stopped. The most prominent reason was the lingua level but the amount of information did probably affect the respondent as well.

22) Yes, information overload occurred. The respondent answered very few questions and states that he or she could not manage the quantity of information.

23) No information overload. The respondent was able to do some analysis and answer most questions. The respondent did also state that he or she could manage the amount of information.

24) Yes, information overload occurred. The respondent was most affected by the lack of understanding but the amount of information was probably a big influence to the lack of answers as well.

25) Yes, information overload occurred. The respondent was most affected by the lingua but the amount of information was probably a big influence to the lack of answers as well.

26) No information overload. The respondent states that it did not and even though the respondent had a hard time to understand many questions he or she did not seem that frustrated during the questionnaire.

27) No information overload occurred. The respondent did not seem bothered with the amount of information. The respondent had more problems with the level of understanding and had a hard time interpreting the charts.

28) Yes, information overload occurred. The respondent did not answer many questions and therefor the amount of information was probably contributing to that.

29) Yes, information overload occurred. The respondent did not answer many questions and therefor the amount of information was probably contributing to that.

30) Yes, information overload occurred. The respondent did not answer many questions and therefor the amount of information was probably contributing to that.

In 20 cases there were indications enough to assume that information overload did occur, as they either stated that the quantity was disturbing or showed during the questionnaire that they were frustrated. Ten respondents did probably not experience the information overload.

6.11 Overall Energy Understanding

In this part of the scenario an investigation is done in order to estimate the respondents overall energy understanding. In this case every answer in part 3, part 4 and part 5 are considered as well as any indication of trends. If the respondents answer that they do not know, misinterpret the information or chooses not to answer questions that is considered to be indications of how well they understand energy parameters and terminology.

13 respondents are considered to have a low overall energy understanding and apprehension of the scenarios. Seven respondents were estimated to have low to basic understanding. Six respondents were estimated to have a basic understanding. Three respondents were estimated to have basic to high understanding and one respondent was estimated to high a high level of understanding.
11 What was the respondents overall understanding?

Diagram 15. The analysis of the respondents' overall understanding is displayed in the pie chart.
7 Results

With the findings in the literature review and the interview study it is possible to draw some understanding about how Smart Grid Recommenders should function in an end user perspective. In this dissertation a set a list of requirements are clinched from these understandings; a conceptual model for how Recommenders should be implemented in the domain.

In the result chapter the analyzed results are referred to as guidelines. The reason is that they should be distinguished separately from the data. Furthermore, they should not be interpreted as solid facts but more as rules of thumb, recommendations or advices.

7.1 Information Must Be Relevant

What is relevant is determined by all users’ personal motivations. The results presented in 5.1 indicate that saving money is the most important motivation for users concerning energy behavior. Those that are not primarily motivated by saving money are instead motivated by being environmentally friendly or motivated by not having to bother with it. The latter indicates either having enough money, that it is not a problem, or not using so much energy that it becomes a problem. Besides saving money, the two motivations being environmentally friendly, not having to bother with it or the general aspect making good decisions, are the most common mentioned motivations. With this information we can set a requirement when handling information:

- **Guideline 1**: Motivate all information presented in the Recommender from a money-saving perspective, an environmentally friendly perspective or a perspective where the user is supported into handling energy issues as little as possible without hurting the needs of the user.

The results in 5.2 indicate that most people are motivated by competing. The analysis in 6.1 suggests that an energy game is also suitable for the respondents needs. The interesting aspect of games and competitions are that they can make things that were not considered important by a person suddenly very important; the competition feature enhances the status of other features. A competition is therefore a useful tool for improving the chance of different types of information to be seen as important from different user perspectives.

- **Guideline 2**: If an energy game is introduced, make sure it affects as much of the presented information as possible, in order to enhance relevancy.

From the analysis of 6.9 we can see that national consumption was the parameter that was not seen as relevant by most respondents. 6 respondents were not influenced by this parameter. But it does not say that national consumption should not be included. National consumption was not in any case the most influential parameter but the result in 5.4, part 4.3 two respondents considered it as a motive for making a decision. In 5.4, part 4.8, national consumption was stated as an important parameter by three respondents. This indicates that the least influential parameter in the questionnaire was still a relevant parameter. Information must be relevant but what is perceived as relevant can vary from person to person. This is shown in part 3.4 under 5.3 where the answer of which parameters is considered as relevant gave a very mixed result. There is no easy way to say what information is relevant or not. It varies depending on situation, motivation and background experience. Therefore designers should not discard information because it is experienced as irrelevant.
- **Guideline 3:** Developers should discard information that can obstruct users’ analysis process or available information that does not fit current task handling.

The analysis in 6.5 proposes the parameters that were most relevant during the questionnaire. This analysis was based on a scenario where users need to plan for an event. In that case, parameters describing price, risk and weather were considered most relevant. The circumstances of the scenario can affect what is considered relevant but it does suggest that those have relevancy and should therefore not be discarded. A simple straight recommendation is not a bad thing. Five respondents during the questionnaire specifically asks for that. The lack of alternatives, presented from different motivations, is the issue.

- **Guideline 4:** A simple straight recommendation is not enough. Each recommendation needs to be motivated so that the user can be able to decide what decision is best.

Information which is not directly part of a prediction can also have value. Several respondents regarded in analysis 6.5 propose non-supported information as help: schedules, energy origin etc.

- **Guideline 5:** Regard information that affects the users, not only the recommendation.

Furthermore in analysis 6.5 respondents indicate that they would benefit from more explanatory information. This is something that should not be presented in main display, but receiving more knowledge can increase how relevant information is perceived and therefore learning should be supported by a Recommender.

- **Guideline 6:** Permit in-depth analysis of information that affects recommendations. The more knowledge a user has the more relevant the information can be perceived.

### 7.2 The Knowledge of the User

The more knowledge the user has the better but the more information the user must handle the worse. In 6.8 it is possible to see that 13 respondents were considered to have a low understanding during analysis the scenarios. In 6.7 it is possible see that these respondents’ correlates with those that was considered to experience information overload. This supports the statement above. In 5.1 the answer “not having to bother with it” is common. With this motivation and lack of interest few will be able to have a good understanding of energy as they avoid the opportunities to learn. By looking at this the opposite way we can assume that in order increase the interest of energy the users need to be more knowledgeable.

- **Guideline 7:** Support the users learning process by providing information about domain specific knowledge in the Recommender that they might not fully understand. This domain specific knowledge can for example be about movie genres that needs to be described in Netflix.com or formats of books available to purchase at Amazon.com

In 5.5 many respondents stated that the amount of information was not manageable for them. Most of these respondents felt that there was too much information or that the language was too hard. Furthermore in 5.5 the respondents that wish for more information are few but existent and should therefore be supported in some way.
- **Guideline 8:** Use as little information as possible in a main display were decisions are made. Explanations should if possible be located in separate layers.

In 6.5 of the analysis it is possible to see that what was helping the users varied a lot between the main three possible influences: price, risk and weather. They were all helpful but for different respondents, even if the purpose is the same.

- **Guideline 9:** People have different kinds of knowledge and because of that it is important to show relations and impacts between different influences. In that way the Recommender supports further learning.

### 7.3 As Simple as Possible

There is no need for the information per se to be intricate or complicated just because many of the analysis required might be. In 5.1 the answer “not having to bother with it” must be supported as it was a quite common. The users should be able to spent a very short amount of time with the Recommender and still be able to make decisions that they are satisfied with. The amount of information that can be presented in a questionnaire is not nearly close to what you can present in an end system. Yet, seen to 5.5 many respondents experienced the amount of information as overwhelming.

- **Guideline 10:** The information should be as simple as possible; easy to overview and easy to interpret without stopping the respondents from making decisions based from other motivations as well.

In 5.5 there are few respondents that wish for more information than what was represented in the questionnaire. When there is little information there are fewer possibilities for explaining parameters or relations. In order to present less information it must be easier. It is possible to reach by presenting the information in a more self-explanatory manner. Only words and terms might not be enough and therefore presenting the information more visually should be considered. Another way is to make sure that the information is presented in a way the users are familiar with.

- **Guideline 11:** Apply visual aids and familiar terms in order to present less information and more simplified information.

In 6.5 it was possible to see that non-supported parameters were considered helpful even though they were not presented in the questionnaire. The respondents used their own knowledge in order to find suitable options and make decisions.

- **Guideline 12:** Information not related to recommendation parameters can still support decisions, especially concerning availability, like schedules, makes decisions easier.

In 6.8 it was possible to see that the level of understanding was generally low. At the same time in 5.5 many of these respondents did not wish for more information. A way to deal with both of these problems is to make information more self-explanatory.

- **Guideline 13:** Many of the respondents had low understanding. A way to help the users is to explain what the values of the parameters indicate. This dissertation has not investigated visual aids but those are a good example that could do such an explanation in a simple way.
Cost and the overall picture were the most influential parameters in 6.9, but it was not obviously the best parameters. The spread of answers indicate than an overview is more important than any single parameter.

- **Guideline 14:** Use the parameters to describe the full picture rather than viewing parameters separately.

In 5.4 respondent 25 stated that he or she wished to learn more about how power plants function and how their status is during times of decision. In analysis 6.6 several other types of information are considered that would help some respondents in understanding what recommendation fits them the best.

- **Guideline 15:** By providing information about the function of energy power plants, how and when power plants produce energy and how it affects price can in some cases help users that lack understanding but wish to change that. Other information about energy in general might also help; what kWh is, what good isolation can provide, why it is usually better to spend energy during night hours etc.

### 7.4 Fast Decisions

Many respondents stated that they wished not to bother with energy issues in question 5.1. In 6.8 the general level of understanding was low. Therefore the system should support decisions to be made fast if the respondents so wish without the result to affect them in a way they experience as negative.

- **Guideline 16:** “The best option” supports users that might struggle

### 7.5 Altering Behavior

The Smart Grid should enable consumers to understand how they could alter their behavior in a way that fits them, according to what motivates them. What the motivations reasons for decision vary in 5.1 and 5.4, part 4.2. The motivation concerning energy issues varies from person to person and sometimes from issue to issue.

- **Guideline 17:** Different things motivate different people. Regardless of what it is the Recommender should motivate a positive change.

In most cases of analysis 6.1 an energy game is suitable for respondents in order to motivate them in energy issues. The game function as a motivation that can, if presented correctly increase the level of incentive in other motivations as well. Some respondents state that a game would be good, not only to win but to be more environmentally friendly, help the school and making users more responsible.

- **Guideline 18:** If a game can provide more motivations it is good. But is it necessarily good that money is saved and that environment is saved? Not really. Is a Recommender better if the user wants to use it regularly? Not really. But an energy game can provide motivation where there previously were none, which is a good thing.

In 6.8 it was possible to see that the level of understanding was generally low. Those that had the lowest understanding also perceived less information helpful and generally answered less questions.
- **Guideline 19:** Parameters that are considered helpful are firstly understood in some sense, secondly considered relevant. Consider to make sure that all the parameters that are presented can easily be understood through different means.

In 5.3 and 5.4 respondents sometimes suggested parameters that was not included in the questionnaire as the main reason for decision. These parameters were often not supporting other motivations than not having to bother with it.

- **Guideline 20:** Non supported parameters are usually what “fits” the user. Those are therefore important to regard when presenting information.

### 7.6 Presented Appropriately

In 5.1 very few gave more than 1-3 motivations. If a respondent have a certain motivation concerning energy issues, then the alternatives that support that motivation should be presented in the Recommender. This can be a flaw in a Recommender that is only content-based. This type of system is able to learn which recommendation it is that most likely serve the respondent, but it takes time.

- **Guideline 21:** If the main motivation is environment issues, then the most environment-risky alternative should not be represented as the most recommended. Determine what a best recommendation is depending on the users’ preferences.

If an energy game is introduced, as recommended in 5.2, it is important that the information is not represented as a video game experience or a casino game, because the information could be seen as trivial, if a respondent is not motivated by games. In 5.4 some respondents state that energy issues do not apply to them and therefore some information is not considered relevant. If it was only due to saving money, it would in one sense be motivated, but if they have mentioned environmental issues as a motivation they affect it regardless if they are not paying for energy or not.

- **Guideline 22:** If users are motivated by something supported by the Recommender, they should be able to recognize and understand that their decisions have impact.

In 5.5: Part 5.1 many feel that the amount of information is overwhelming and therefore the recommendations should be user driven.

- **Guideline 23:** Display parameters that are decided to be part of the Recommender as equally important. Recommendations can have a “best option” determined through the respondents’ motivations but the final choice is made by the users and they should be the ones deciding which parameters are most important in different situations.

### 7.7 Parameters

The data of 5.3, part 3.2 indicate that the parameters used were widely spread. The most popular choice for determining price was mentioned 9 times and the least popular ones was mentioned 6 times. In this case it is important to notice that all parameters in the questionnaire had actual impact for what the respondents was set to seek. That does not support that the most popular parameter in the questionnaire are also the most popular parameter in general. It does however suggest that parameters in general are considered to have different relevance for different users. This is also
supported through 5.3 part 3.4 were the respondents were asked to state which parameter they though were relevant. The three main parameters were stated almost the same amount of times. Therefore, all of them were relevant. The same thing is shown through the in 6.5 when analysis which parameters were helpful.

- **Guideline 24:** All parameters that are variables in the recommendation should be presented in the system in some way.

Influences of the consumption can also influence the respondents’ decisions: obligations, schedules, weather can all be used to predict future consumption but they can also be used by the users in their decision making as well. Other influences of consumption like, amount of lamps, effect on the stove, wall isolation cannot be considered as relevant. They are not unimportant though as they can help the user in determining energy waste. These types of influences are more permanent until the user invests in them; buying energy lamps, install better isolation etc. Therefor it is not as important to present them as part a prediction but they can be presented in a secondary display it is considered a good thing.

Motivations can also be non-supported by energy, and therefore be supported by non-supported parameters. It might not be practical to have recommendations that use parameters from every part of a user’s future plans and obligations. But there might be parameters that are not included in the recommendations that can be part of what motivates the users in their decision process. Therefor it can be of interest to implement information about parameters that are not supported through the recommendations such as, schedules, obligations and events. To view this in another way, when asked in 5.4, part 4.4 and 4.5, the users’ sought very few other parameters than what was represented. A recommended option, more specific prices for shorter periods were asked for, which both will probably be represented in a real Recommender. 1 respondent only sought a schedule and one sought more information about energy origin. Two non-supported types of information were therefor desired. It cannot be a requirement to include these as parameters but if they can be supported through the recommendation system it should be considered an improvement.

- **Guideline 25:** In the way it is possible the implementation schedules, obligations etc. should be supported in the Recommender

### 7.8 Amount of Activeness

The respondents were shown have separate motivations in 5.1. These motivations were considered to be supported through different parameters by different respondents in 5.3 Part 3.4 and the analysis in 6.9. Therefore there is no way to choosing the parameters in the Recommender through a motivation perspective other than letting the user decide what parameters are not relevant to them. But if it is possible to tweak the number of parameters presented it is considered valuable

- **Guideline 26:** If the system is able to recognize parameters that are of no interest for the respondent in terms of supporting their motivations, then the system can remove such parameters from being presented.
7.9 Focus Attention
Focus the user’s attention to what is believed to be considered as relevant. In 5.1 the respondents had different motivations. If a respondent acts through a certain motivations those should be highlighted in the system. The most obvious way to do this is by let the motivations be weights for how strong the recommendations are. This is only practical if the motivations are measurable, therefore this cannot be done for the recommendation “not having to bother with it” only. But if one recommendation is more environmental and one is more money saving and the user clearly are more motivated by environmental issues, than the most environmental friendly recommendation should be the highest recommended. An option to this is to let the user set a mode which arranges the recommendations according to a motivation.

- **Guideline 27:** Analyze the user and let the user’s decisions act as weights in the recommendations if the decisions support a certain motivation.

In 5.3 Part 3.2 the respondents were not coherent in choosing which parameter was most important for choosing the cheapest day. This is something to regard when presenting a recommendation. If the parameters used are not presented then how can a user know whether or not the recommendation fits his or hers needs.

- **Guideline 28:** It is important to state which parameters support the recommendation and how they differ from an alternative recommendation.

7.10 Information Overload
If a user is motivated it is easier to handle information. Through the questionnaire 5.1 and 6.7 it is possible to see that users that states “not having to bother with it” as a motivation more easily experienced information overload. In order to support users whose motivations can be measured the users should be provided feedback. If the users are motivated by the environment then they should know if they make environmental friendly decisions.

- **Guideline 29:** Provide the users with feedback that supports their motivations

Respondents that are only motivated by “not having to bother with it” should be allowed to do that as much as possible. The only reason really having to bother with energy is that it can become too expensive.

- **Guideline 30:** If the system cannot find a measurable motivation for the user, then a simple best option should be recommended which is supported by saving money.

7.11 Active Decision Makers
Consumers of a Smart Grid should be active decision makers. The data of 5.1 suggest that respondents’ motivations differ and a simple suggestion would not be enough since the Recommender cannot always satisfy every motivation in every recommendation. If the users do not want to be analytic they can determine themselves how active they want to be by choosing the first recommendation.

- **Guideline 31:** Provide the user with a couple of recommendations. The user should make active decisions and therefor they should be provided with choices.
7.12 The Risk Factor

Risk is the effect of uncertainty on objectives. The objectives can be anything but the normal effect is usually a potential of loss. In risk management, risk is normally presented on a variable from low to high but can be presented from 0-1 or visually by using colors. In the questionnaire risk was one of the parameters that was most understood by the respondents. The simplistic presentation of risk was manageable in most cases.

The risk effect investigated in this dissertation handles the uncertainty for the parameter values to be good in a certain case. Risk can be a measurement on any kind of parameter. Many respondents in the questionnaire chose the less risky alternative than an alternative that had a higher probability to generate less cost. This is shown in the 4.7.4 analysis. The reason is probably that risk is a word that raises attention. Risk can therefore influence the users in a good or negative way and therefore it is important that the users receive information about what the risk are regarding and what does a high or low value indicate.

- **Guideline 32**: When presenting risk it needs to be explained what it proposes.
8 Conclusions
In the results 32 progenies were found by viewing some of the analysis. These progenies are able to display how a conceptual model of a Smart Grid Recommender should be.

![Diagram of user activities in a Smart Grid environment.](image)

Picture 1. The model above describes an overview of the user activities in a Smart Grid environment. The activities are distinguished using yellow circles and the arrows describe the activity sequence. A circle within a circle are used to describe activities within other activities.

The first part of the conceptual model describes the user activities which affects the system. The analyzing activities are considered to be any type of reflection of system content, decisions and motivations. Within the analysis activity there are the two more focused activities of prioritizing anything that has been analyzed. When the user knows what to prioritize, he or she determines the policies which affects any other type of action. From this point we distinguish three main types of activities; continuing as usual (living everyday life), seeking or receiving feedback (appraisal) or making active decisions (daily decision). From performing any of these actions the user start over with the analysis process.
In the next part of the conceptual model we can see how user impacts and user development affects different parts of the activity process. The guidelines presented in the result chapter are presented with numbers in order to see how they relate to the model. By increasing the users understanding and opinions about relevancy, activities such as prioritizing, determining of policies and daily decisions are supported. The feeling of positive change is also increased and the user will find it easier to determine what motivates him or her. Through participating in games, competing and socializing the user is encouraged to increase the understanding and may develop strategies which affects what is considered relevant. Participating in games also engage the user when seeking appraisal and provides strategic thinking when analyzing. When the users experience a positive change it increases appraisal and also encourages further analysis. The user motivations affects
what the user prioritizes and what policies the user wish to set. The users motivations focuses what type of appraisal they seek and it engages the user to seek further appraisal.

One of the fundamental findings in this work shows that the decisions of the users should affect what is presented to them. In this part of the model we suggest that at least the users determined policies should affect the build of options presented to them. In turn the options should support everyday living and daily decisions. Within the options there are parameters presented that support the users prioritizing and determining of policies. Each option should have a description which eases the analysis process. The options are part of recommendations in the Recommender system which ease user prioritizing and determining of policies.

More generalizes recommendations are viewed separately. These ease the user activity of prioritizing and determining of policies. These recommendations are also more focused on supporting the activity of everyday living. The recommendations provide information about energy issues. This information support decisions form a broader perspective and also support the understanding of energy in the analysis process. Information that not is directly focused on energy issues are provided in this part. This information can also support prioritizing and determining of policies. They support everyday living and daily decisions that are affected by obligations and other priorities.

Picture 3. The model above uses the activities from picture 1 but also incorporates system recommendations and the recommendation properties. Numbers within parenthesis describe which guidelines they are supported by and which guidelines provide further specifications.
The model above describes the process of creating a Recommender system in a Smart Grid environment through a user, motivation and system perspective. Numbers within parenthesis describe which guidelines they are supported by and which guidelines provide further specifications. In order to see the conceptual model in a larger scale, see appendix III.

The conceptual model displays an iterative process where the user are the decisive force who determines what is included and presented in the Recommender. The user’s comprehension affects what is considered relevant, as well as the user’s background and mentality. The system can support the understanding with in-depth analysis and general information. The user is influenced by different motivations. The users are also supported through information about energy and information which is not related to energy consumption other than in a latent manner. More than one recommendation is always presented in the main display. The recommendations have descriptions, risks and parameters respectively. Those are visualized equally and are self-explanatory and easy to understand.
9 Discussion

In this dissertation we have considered different means of validity. Through a positivist perspective the internal validity has been one of the focuses. Therefore the tests that have been performed has been controlled and confirmed several times under scrutiny.

Familiarity with the culture of the participants was developed early at the middle of the fall 2012. Guided tours, informative meetings and independent attendance occurred commonly.

For the respondents the sampling of individuals attending was as random as was possible. Random classes were chosen and there had been no encounter with the individuals previously for both the interviews and the questionnaire. The respondents did not have to participate, but most of them did anyway.

In order to ensure that the respondent answered as honestly as possible the interviews was primarily informative and the questionnaire was anonymous. In the questionnaire the respondents had no pressure on them. They were told that the questionnaire could be tricky but at the same time they did not have to answer all the questions but they were encouraged to say if they were not sure rather than not saying anything. In none of them there was any reason for not being honest.

What a respondent say and what the respondent do are two different things. Therefore the questionnaire included iterative questioning where answers given early were tested through other questions during active decision making. An example is a respondent that states that saving money is not a motivation and that environmentally issues are, but during the scenarios only argues from money saving perspectives. By this iterative process it was possible to understand more of the respondents’ answers than what they said separately.

Frequent debriefing has occurred between important forces of the domain. The supervisor, Gunnar Mathiason, have interest in both the dissertation and the focus domain. Collaboration and assistance have been provided both from SP (Technical Research Institute of Sweden)\(^5\) and the principals and teachers from Sötäsen\(^6\). They have all provided fresh perspectives and insights during the process. The supervisor Gunnar Mathiason, the examiner Ronnie Johansson and a personal mentor, the lector Tarja Susi have provided peer scrutiny and feedback during the research project. During the research process I have also had a colleague, Johan Bjurén, who has been working on a separate research on Sötäsen, and the Smart Grid but with a focus on using Case-based reasoning for predicting future consumption. The areas have been close enough during the main part of the master project that we have been able to offer each other feedback and reflective views. Those have occurred often as we have shared an office the project.

By doing a literature review it has been possible not only to examine previous research findings but also to integrate those in a final product.

The restrictions of the respondents in the interviews were that they had to be current boarding school students or previously lived at the school. 31 students participated in the interview, in order to have that many participants a group interview had to be performed. It would not have been

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\(^5\) [http://www.sp.se/sv/](http://www.sp.se/sv/)

\(^6\) [http://www.naturbruk.nu/sotasen](http://www.naturbruk.nu/sotasen)
feasible time-wise otherwise. 30 students participated in the questionnaire. Member checks could not be performed due to issues that delayed the process.

This dissertation has attained transferability in the region Västra Götaland in Sweden, by having three different organizations from that area influence the study. The focus of the research is the future users of a Smart Grid. The knowledge of the respondents is specific for the high school students in Sweden. But that does not mean that the results are not transferable to other domains like domestic areas or companies. The fact that the students are not used to handle energy issues makes them perfect to describe new users of the system. The learning process is considered in the dissertation and therefore the resulting conceptual model can be transferred to other areas as well.

Two researchers participated in the field work. I was assisted by Johan Bjurén at these occasions where he acted as a consultant as I managed the interview and the questionnaire. For collecting the data from the interview, a recorded was used. The questionnaire was carried out using pen and paper. The data collection at the occasion of the interview took about one hour of fieldwork. The data collection at the questionnaire took about three hours. The total period of data collection lasted from the March to June in 2013.

The observations of this research are tied to the situation of the study. That specific time and that ethnographic present can never occur again. But as the process of the study, the prototype model is described in detail and the work method is repeatable, even though the results may not be the same. Through the arguments in the literature review, proposed parameters were found. Through the open group interview, scenarios were introduced as well as events and objectives that the respondents could relate to. The questionnaire was a product of combining these. Several scenarios was originally created and those that were able to include as many parameters as possible were the one that was chosen.

The effectiveness of the inquiry was good but some things could have been improved. If more time would have been provided, member checks could have supported further comprehension of how the respondents experienced the questionnaire and fill in the gaps of the questions that never had an answer. In another survey that could have proven worse though since in this case those answers were used as measurable factors that indicated frustration, distraction and lack of interest.
10 Future work

In this dissertation I have been able to investigate many of the factors that have been of my interest. I have managed to identify how users should influence the Recommender and how a Recommender should be presented. But some aspects of DSS systems could not be proven through the research. I would like to investigate through an actual Recommender if less information is shown to the user, makes the decisions faster, with and without domain knowledge. I would also like to investigate, if the respondent has to deal with information less time in order to find a satisfactory decision, do they necessarily experience less information overload? With these two questions answered it would be possible to test actual Recommenders and see how many parameters the recommendations should present and how much information they can contain.

Furthermore it would be interesting to build an actual Recommender by using the conceptual model presented in the conclusions and the progenies from the results. It would be interesting to test the model both in a school environment and the domestic domain. Additionally work could also include how a model of classification algorithms can support the conceptual model of this dissertation.
References


Appendix I

Transcription of the Interview

Here the transcription of the interview, with students of the high school, Sötsåsen, in the fourth of April, 2013, is presented. A set of advanced notation examples are used in Gail Jefferson (1989), where notation symbols as: a dot in a parenthesis, underscoring, colons, arrows etc. are used to indicate in which way subjects talk. This interview does not include a conversation analysis, but rather a content analysis; therefor advanced notations are not included in this transcription. An exception in this case is the use of double parentheses which is used by the transcriber to comment on something. The interview was conducted in Swedish.

Part 1

Interviewer: … Det viktigaste jag behöver från er är domänkunskap om området här. Så, eh, först tänkte jag fråga om tvättstugan; hur den fungerar. Är det någon som känner att den kan prata om det?

Lady teacher: ((Girl name is uttered. Because of anonymity it is excluded from this transcription)) berätta om tvättstugan.

Boy student 1: Ja, (Same name uttered again).

Girl student 1: Ska jag berätta om det?

Boy student 1: Du kan la ta, vi kan…

Girl student 1: Man skriver upp på en lapp.

Interviewer: Mm.


Interviewer: Okej, eh, är det svårt att få tid? Är det mycket, många som bokar samtidigt så?

Girl student 1: Ne, det är ganska enkelt. I alla fall om man tar det på någon rast under dan och så här. Sen på kvällen är det väl lite mer än på dagen.

Interviewer: Okej. Eh, stängs tvättstugan någon gång? Eller är den öppet dygnet runt?

Girl student 1: Det är väl öppet dynet runt i princip.

Interviewer: Okej

Girl student 1: Eller inte på natten vid typ tio elva sådär när fritiden låser.

Interviewer: Okej, eh…
Girl student 1: Så sen får vi inte vara ute ändå

((Interviewer och några elever skrattar))

Interviewer: Okej

Lady teacher: Och så har ni den andra tvättmaskinen, använder ni den någonting? Den stora…

Boy student 2: Hygien?

Girl student 1: Ah eh där är det ju bara… där skriver vi inte upp oss, där är för att tvätta lagårdskläder.

Interviewer: Ah just…

Girl student 1: Där är det bara att slänga in när det är ledigt.

Interviewer: Ah

Girl student 1: Där är det ingen tid att skriva upp.

Interviewer: Men sköter ni det helt själva också eller är det någon som hämtar ut grejerna.

Girl student 1: Nä, om man ska tvätta och man ser att det är färdigt så lägger man ju i tumlaren åt den som har tvättat innan om den inte har varit där, om man själv ska tvätta där.

Interviewer: Okej

Girl student 1: Så det är ju… man hjälps åt lite

Part 2

Interviewer: Okej, eh. Vissa saker är kanske helt självklart för er men jag behöver få ner det på papper ändå så. För era lägenheter så har ni ju eluttag i väggen och där stoppar ni in sladdar för dator och mobil och. Någon som kommer på mer saker som ni använder dom här elutagen till?

Girl student 2: Lampor.


Girl student 3: Plattång.

Interviewer: Plattång

Girl student 3: Och Hårfön

Interviewer: Hårfön, aha. Har ni egen TV på…

Girl student 2: Ja
Interviewer: Inne i era egna rum
Boy student 3: Mm
Interviewer: Mm. Då kommer x-box och sådant där också till?
Boy student 3: Mm.
Boy student 4: Micro.
Interviewer: Micro har ni på rummet?
Boy student 4: Ja eller i pentryt
Interviewer: Okej. Pentryt, delas det av flera eller är det enskilt?
Girl student 4: Delas av flera.
Interviewer: Delas av flera, okej. Pentryt då, vad innehåller det? År det…
Girl student 4: Kylskåp.
Girl student 5: Ett litet kök.
Girl student 6: Vattenkokare.
Interviewer: Vattenkokare, eh men också micro, ugn, det finns kyl.
Girl student 7: En del har micro…
Interviewer: En del
Girl student 7: Inte alla.
Girl student 8: En del har bara en platta i sådant fall om dom inte har en micro.
Interviewer: En platta… aha, typ…
Girl student 8: En vanlig kokplatta alltså.
Interviewer: Aha okej. Eh, frys antar jag? Eller?
Girl student 7: Ne
Interviewer: Inte frys?
Boy student 5: Nepp.
Girl student 7: Bara kyl.
Interviewer: Okej, då är det svårt att köpa Billypizzor för hela veckan alltså.
Boy student 6: Kyler, kyla ner den kallt på fr… kylen så blir den som en frys.
Interviewer: Eh, ((Interviewer laughs shortly)) ja.

Boy student 5: Ja det gör den fan. Maten blir stelfrusen.

(((Interviewer and students laughs)))

Interviewer: Okej, ja men då sköter ni ju kylan på den också, det är ju bra. Ehm, värme för era lägenheter. Sköter ni det?

Boy student 6: Det finns termostater men temp… elementvattnet är alltid detsamma ändå så det händer ju inget med värmen ändå.

Boy student 5: Mm.

Girl student 8: Det är avstängt under så då får man ju… det blir kallt under sommar alltså. Sen så det är väl halvdant på vintern.

Interviewer: Okej ((Interviews laughs))

Girl student 1: Antingen går det inte att skruva upp eller så går det inte att skruva ner.

Boy student 1: Det blir aldrig…

Girl student 1: Så det är alltid samma temp på dem ändå.

Boy student 1: Ja.

Interviewer: Okej. Skulle ni vilja kunna sköta det själva ((Interviewer laughs)).

Girl student 8: Alltså det hade ju underlättat.

Boy student 1: Ja antingen ligger man och svettas ihjäl eller så fryser man ihjäl liksom det är ju.

Boy student 2: Ja det är det ju

Girl student 9: Känns ju ganska ovärt att öppna fönster för att man svettas jättemycket, då man lika gärna kunnat dra ner lite.

Boy student 1: Mm

Boy student 7: Ska du kyla ner hela rummet liksom så kostar det bara att värma upp det igen.

Boy student 5: Du behöver ju inte öppna fönstret, det är ju ganska effektivt…

(((students talking and hoots occur as well as laughs)))

Boy student 7: Precis.

Interviewer: Men ni skulle kunna sätta in egna eleelement också antar jag.

Boy student 5: Mjao.

Interviewer: Men det kanske ni inte får, det vet jag inte.
Boy student 8: Ne... ne
Boy student 9: Jag vet inte.
Boy student 10: Jag vet inte ens vad såna heter.
Girl student 1: Känns ju onödigt att släpa upp en sån på tåget kanske.
Interviewer: Ja. Eller så ger man order till föräldrarna.
Girl student 1: Eh

((Interviewer and students laughs))

Interviewer: Ehm okej. Har ni egen dusch i lägenheten eller är det nåt som delas.
Boy student 1: Ne
Interviewer: Egen dusch
Girl student 1: Gemensamt
Boy student 1 and Girl student 1: I pentryt
Interviewer: Gemensam dusch i pentryt, egen i lägenheten eller?
Girl student 1 and Boy student 1: Ne
Interviewer: Okej gemensamt:
Boy student 1: Gemensamt.
Girl student 1: För jag antar att du bara pratar om skolan nu?
Girl student 10: En del gör det.
Interviewer: Men ni vet ju hur det ser ut.
Lady teacher: Men det finns ju mer duschar också.
Boy student 12 and Girl student 11: Hygien
Lady teacher: Hygien också.
Interviewer: Hygien? När ni kommer ut från?
Girl student 11: Gemensamt.
Interviewer: Okej.
Boy student 8: Men det är la ingen som använder dom nästan.
Lady teacher: Det ska man göra.

((Hustle and laughs occur))

Boy student 9: Det har ni inte lyckats med på tre år än.
Boy student 10: Vi duschade när vi bada isvak. ((students burst into laughter)) Då var det kallt.

((Interviewer and students laugh))

Interviewer: Ehm. Okej, ehm. Får ser här. Finns... fanns det något i övrigt i erat boende som ni skulle kunna tänka er, ehm, som påverkar elförbrukningen i övrigt som ni inte har nämnt nu.
Lady teacher: Ingen som har något till nåt djur tänkte jag, har man akvariefiskar och sånt där skumt?
Girl student 11: Skumt?

((Students laugh))

Boy student 10: Och det släpar man hit?
Lady teacher: Jo jo men man behöver ha lite ström till det tänkte jag.
Boy student 10: Men va fasen…
Lady teacher: Nä det vet inte jag, ni har ju…
Girl student 12: Jag har ju bara hunden. Hunden behöver ingen el.
Girl student 1: Nå det är nog ingenting.
Interviewer: Ingenting ni kommer på.
Girl student 1: Det är väl det som är i köket ja.
Boy student 12: Det är la lite högtalare och sånt, är det ju.
Interviewer: Högtalare ja. Just det. Ehm. Men det finns korridorer som ni delar mellan köket och så... nej?

Part 3

Interviewer: Okej okej. Ehm då tänkte jag gå ifrån själva internatboendet och fråga mer hur ni har det på fritiden här. År ni här på fritiden mycket nu? Eller var det mer så för när ni bodde här?
Girl student 5: När man bor här är man ju mer här.
Interviewer: Mm?

Girl student 5: Kommer ju inte ifrån lika lätt.

Interviewer: Ja.

Girl student 5: Men om man… Vi som bor i Töreboda nu vi kan ju åka hit och vara i gymmet och sånt på eftermiddagarna också, och basta eller va i Gulan och spela biljard eller så.

Interviewer: Okej, eh, okej. Då kommer jag till Gulan då. Eh, vart ligger den? (Laughs occur)

Boy student 13: Vid lärarna.

Interviewer: Där rektorn sitter va?

Elever: Ja

Interviewer: Ah Okej. Vad... vad finns där, eh, för er?

Girl student 14:Tvättstugan

Interviewer: Tvättstugan är där.

Boy student 14: Biljard

Interviewer: Biljard

Girl student 1: Hyra film

Interviewer: Hyra film. Titta på film där också?

Girl student 13: Ja

Girl student 5: Ja det går att spela x-box och sådant där.


((Several students agrees at the same time))

Interviewer: Ja. Eh, vet ni, när stänger den då?

Boy student 2 and Boy student 5: Tio.

Interviewer: Tio. Allt stänger tio kanske eller?

Girl student 1: Ja.

Boy student 5: Ja vi ska vara inne på rummet vid den tiden.

Interviewer: Hårda bud! ((Interviewer and students laugh)) okej. Vad skulle ni kunna sköta där som har med el att göra? Det var Wii, det var tv… släcka tända?
Boy student 13: Mm.
Boy student 5: Datorer.
Interviewer: Fast det kanske inte ni sköter så mycket?
Boy student 13: Datorer. Varmvatten finns det kanske i vanliga kranar eller? ((Several students agrees by saying yes)) Och värme på termostat, det var samma där som på rummen okej. ((Several students agrees by saying yes)) Eh, kanske vi var klara där. Aulan är det någon som kan förklara den för mig?
Boy student 8: Idrottshall med scen.
Interviewer: Idrottshall med scen.
Boy student 8: Ja, med lite ljudanläggningar och sånt.
Interviewer: Ljudanläggningar, som i ett musikrum då eller?
Boy student 8: Njao. Det är väl då i källaren där nere.
Girl student 15 samtidigt: Ne musikrummet är nere i källaren.
Interviewer: Okej men det kanske inte är riktigt tillhörande då?
Boy student 1: Du går in på samma ställe och går ner under scen bara så finns musikrummet där.
Girl student 8: Det finns en tavla på scen som man kan ha…
Boy student 4: Det finns mixerbord och lite annat.
Interviewer: Okej ehm.
Girl student 8: Då kan man dra ner en skärm så att det blir som en stor jävla tv.
Interviewer: Jaha okej. Typ som en liten bio då. ((Several students agrees by saying yes)).
Boy student 4: Med projektor och så där.
Girl student 1: Och sen så hade vi ju gymmet där också.
Interviewer: Gymmet precis bredvid ja.
Girl student 1: Ja
Girl student 5: Och där inne har vi ju stereo och sån också
Interviewer: stereo där. Mhm okej, och då eh då får ni öpp… det blir varmt där också då antar jag så då öppnar ni fönster och så eller ((Several students agrees by saying yes)). Okej. Ehm finns dusch där också då eller? ((Several students says no)) Okej
Girl student 1: Ne hygien. Men det…

Boy student 9: Rullgardinerna är eldrivna och.

Interviewer: Är det… jaha okej

Boy student 9: tror ja. (Several students agrees with the student)

Interviewer: Okej, men under Aulan så var det musikrum, det var nåt mer där eller?

Boy student 5: Förråd

Interviewer: Förråd

Girl student 1: Med idrottsgrejer.

Interviewer: Okej, inget sånt här umgängesrum eller så, nej?

Girl student 1: Nå

Interviewer: Vad är eldrivet i musikrummet? Syntar och sånt kanske?

Boy student 11: Trumsetet, syntarna eh…

Interviewer: trumsetet?

Girl student 1: elgitarrer och bas

Boy student 11: det är ett… ett…

Girl student 1: det är elektronsikt

Interviewer: Jaha okej. Eh, inspelningsaparater.

Girl student 1: det finns lite microfoner också.

Interviewer: Microfoner okej. Eh hur sköter ni… det är stängning där klockan tio också (Several students agrees by saying yes). Filmkvällar får ni ansvara för det själva, eller är det... arrangeras det eller. I aulan alltså?

Girl student 1: Ibland arrangeras det ju men man får säga till om man vill se på nånting så får man säga till fritiden.

Interviewer: Okej.

Girl student 1: Men man får inte göra det själv liksom.

Interviewer: Ah och det… då görs det efter skoltid då?

Girl student 1: Ja

Interviewer: När slutar ni oftast då?

Flera elever: Tjugo över fyra.
Interviewer: Alltid tjugo över fyra?

Girl student 1: Ja... eller om vi...

Boy student 1: Nej... inte nu... det sista...

Girl student 1: om vi går heldag.

Interviewer: heldag.

Flera elever: då slutar vi tjugo över fyra.

Lady teacher: Ladugården halv sex. (Several students agrees by saying yes))

((several students starts discussing, resulting in noise disturbance))

Interviewer: Okej... okej... om man har ladgårdstjänst då alltså, eller? (Several students agrees by saying yes)) Så den sista saken du gör om du har ladgårdstjänst alltså är halv sex?

Girl student 14: Ja eller sex. (Girl student 1 and Boy student 1 agrees)

Interviewer: Är det mjölkning då eller?

Girl student 14: Det är både mjölkning och utfodring.

Girl student 15: Då ska du vara färdig senast klockan nio.

Lady teacher: Då börjar man klockan fem. På morgonen

Interviewer: Ja. Eh, och då med ladugårdstjänst vad innebär det? Är det bara kor? Eller är det grisarna, hästarna…?

Girl student 8: Det är fåren också.

Interviewer: Får.

Boy student 5: Fast det är ju två som är på lagården och två som är på grisar och får.

Interviewer: Mhm

Girl student 1: Vi har ju haft udda på (The student talks too quietly for a short while in order for the microphone to pick up the sound) olika turer.

Interviewer: Har alla ansv... har alla ladugårdstjänsterna här eller alltså som är treo... som är gymnasieelever?

Flera elever: Ja

Girl student 1: Alla testar ju på det i ettan, men nu är det ju nytt för nya gymnasielever, dom har ju inte samma som oss dom har ju antingen bara ladugården eller bara djurhus.
Interviewer: Okej…
Lady teacher: Men alla provar fortfarande i ettan.
Girl student 1: Ah okej.
Interviewer: Jaha okej. Ehm, Ljungen är den någon som kan förklara den för mig?
Girl student 15: Det är ett stort kök där inne
Interviewer: Vart ligger den?
Girl student 8: Nedanför Gulan
Girl student 15: I ett litet rött hus.
Interviewer: Mhm okej
Girl student 15: Och det är ett stort kök...
Girl student 16: Det är la fyra fem kök.
Girl student 15: Först är det en korridor och sen är det ett kök där inne med fyra, tre, fyra spisar eller nånting.
Girl student 1: En gammal hemkunskapssal
Interviewer: Aha, så det är framförallt kök. Eller är det bara kök?
Girl student 17: Det finns pysselrum och på övervåningen finns det så man kan kolla på film och musik…
Girl student 16: Musik även där:
Interviewer: Musik, pyssel, kök.
Girl student 15: Det finns massagerum också…
Interviewer: Okej, och det är samma? Det stänger tio? Kan man boka det närsomhelst på dagen?
Girl student 8: Det är bara att säga till så öppnar dom.
Interviewer: Okej mhm. Hur sköts bastun då? Det finns någon nånstans?
Girl student 6: Ja, det är timer på den. (Interviewer says: tim..?) Om man vill… jag tror dom har två bastukvällar i veckan som dom har igång bastun. Då får man gå dit när man vill.
Interviewer: Okej.
Interviewer: För allt som vi pratat om. Är allt tillgängligt på helgen också eller?
Girl student 8: Nej
Interviewer: Det är sällan man är här på helgen? Men det går att vara det?
Girl student 1: Det finns ingen här på helgen.
Interviewer: Okej
Boy student 5: Om du har dispens får du komma hit.
Girl student 15: Man får komma hit på söndag kväll.
Interviewer: Okej.
Girl student 14: Om man jobbar extra kan man bo här på söndagar.
Interviewer: Okej, okej. Eh, finns det något övrigt fritidsrum ni kommer på så här?
Girl student 8: Det är la datasalarna
Interviewer: Datasalarna ja. Men ni sköter inte… de är alltid på stand-by va? Eller, ni stänger aldrig av dem?
Girl student 8: Det är la olika, en del stänger av dom när de bara vill logga ut. Så trycker man på stänga av och så går man.
Interviewer: Okej.
Girl student 8: Eller så loggar man bara ut.
Interviewer: Okej.
Girl student 1: Jag vet inte om Sven stänger av dom på nätterna. Helt.
Girl student 8: Ne dom…
Lady teacher: Det ska nog vara avstängt i alla fall. Det finns ju ström att spara där.
Interviewer: Finns det nåt i dom här rummen som vi har nämnt, som ni känner att, ni känner själva att, det här hade jag kunnat tagit ansvar för? Fast det är någon annan som gör det. Det är någon personal som gör det.
Lady teacher: Är det till musikrummet eller nåt sånt du tänker på eller?
Interviewer: Ja precis. Eller ansvara själva för att s… alltså nu är det kanske inte genomförbart men att läsa och släcka själva liksom
Girl student 8: De litar inte på oss

((Interviewer and students laughs))
Boy student 9: Nej

Girl student 8: Vi har ju numret till fritiden så det är ju bara att ringa till dom så öppnar ju dom allting så det är ju…


Boy student 5: Det är bara i gymnasalen som dom är elektriska, här vevar man.


Girl student 11: Kanske att man stänger av datorn efter. Andra loggar ju bara ut och så.


Elever: Ja


Girl student 11: Det är längre ner i ett annat hus.

Interviewer: Okej. Är det ni som sköter laddningen för dom?

Flera elever: Nej.

Girl student 1: Vi får inte köra dom. Det är bara fyraårs.


Lady teacher: Det beror på att dom har parkutbildning vilket inte ni har.

Girl student 8: Det spelar ingen roll, vi får inte låna dom ändå.

((Students discuss so that disturbance noise occurs))

Interviewer: ((Interviewers laughs)) Okej men ni får köra traktorer?

Flera elever: Ja.
Interviewer: Okej. Finns det i något övrigt rum eller lokal som vi inte har nämnt nu, inom skolverksamhet alltså, som ni känner att där är det någonting som ni skulle kunna påverka?

Girl student 16: Vovvis

Interviewer: Va?

Girl student 16: Vovvis

Interviewer: Vov…? Vad är det?


Girl student 1: Men det är automatsläckning där

Interviewer: Okej.


Interviewer: Okej. Så det var alla frågor jag hade. Eh

Interviewer2: Henric får jag bryta in lite?

Interviewer: Ja visst.

Interviewer2: Bara så att vi, så att vi är helt inne på detta. Micron den hade man i pentryn. Det fanns ingen som hade det hemma eller i rummen eller?

Flera elever: nej.


Lady teacher: Sitta i datasalen till tolv och så.

Girl student 1: Dom stänger ju av internet automatiskt vid tio, halv tio eller nåt sånt där så det går ju inte att sitta längre.

Interviewer: Okej.

Girl student 8: Det här är ett fängelse. ((students laugh))
Girl student 12: Sen så finns det ju internet i pentryt och på rummen ju. Så har man egen dator kan man sitta där.

Girl student 8: Internet där är ju på hela resten av natten.

Boy student 14: Förutom i vissa pentryn för där finns inget internet alls.

Interviewer2: Men dom här datasalarna. Har ni tillgång till dom också hela dan fram till tio också?

Girl student 5: Ja.

Girl student 6: Om det inte är en lektion i dom.

Lady teacher: Du sitter i en nu. Det här är en av dom salarna.

Girl student 8: Men det har varit lite slarv nu så nu är det väldigt eh det är

ElevT9: Det är hela tiden vetu som det har varit sabotage och såna här grejer.

Girl student 8: Inte så stor chans att man får sitta i datasalarna längre, så det är begränsat.

Interviewer: Okej. Mhm tack så mycket.
Appendix II

The Questionnaire (In Swedish)


Förhållning till elkonsumtion

Motivation

Detta motiverar mig när det kommer till mitt energibeteende. Kryssa i de rutor som bäst stämmer in på dig. Det är tillåtet att kryssa i flera rutor:

- Att spara pengar
- Att vara miljövänlig
- Att fatta bra beslut
- Att inte fatta dåliga beslut
- Att jag ska slippa bekymra mig om det
- Att vara bättre än mina vänner
- Att få erkännande

Annan/andra motivationer:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Energispel

Föreställ dig att skolan har satt upp ett energispel där alla internatelever är deltagande. Energispelet går ut på att elever kan få poäng genom att spara el. Internatelever i gemensam lägenhet tävlar emot de andra lägenhetsboende på skolan. För varje månad utdelas poäng till de som gjort bäst ifrån sig under den månaden. Det finns fem sätt att införskaffa poäng:

1. Den lägenhet som spenderat minst el.
2. Den mest lägenhet som minskat sin förbrukning mest.
3. Den lägenhet som spenderat el mest effektivt (det vill säga spendera mest respektive minst då producenterna tillverkar mest respektive minst).
4. Den lägenhet som generellt förbrukat minst el per lägenhet under lektionstimmar.
5. Lägenhetsboende får gissa hur mycket de kommer att spendera tillsammans. De som kommer närmast sin ursprungliga uppskattning tilldelas poäng.

Frågor

Är tävlingar och spel något som normalt sett motiverar dig?  
Vad tycker du de poäng man får skulle kunna ge för typ av belöning, som skulle vara passande och motiverande för dig?


Tror du att ett energispel skulle fungera i verkligheten?  
Ja ☐  Nej ☐

Om du svarade ja. Vad skulle energispelet bidra med som inte redan existerar på Sötåsen?


Om du svarade nej. Varför skulle inte ett energispel inte ett bra alternativ? Vad skulle det kunna resultera i?


Väderpåverkan


<table>
<thead>
<tr>
<th>Bakningsdag</th>
<th>Sannolikhet för billigast elpris</th>
<th>Baseras främst på följande parametrar</th>
<th>Risk (att andra parametrar infaller och förändrar utfallet av vilken dag som har billigast elpris)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onsdag</td>
<td>18 %</td>
<td>Soltimmar: Mulet och snöfall hela dagen</td>
<td>Hög risk: Osäker väderpåverkan: risk för att snöväder kan resultera i trasiga elledningar.</td>
</tr>
<tr>
<td>Torsdag</td>
<td>8 %</td>
<td>Temperaturintervall: Max 0°C Min -8°C</td>
<td>Låg risk: Osäker väderpåverkan: risk för att snöväder kan resultera i trasiga elledningar.</td>
</tr>
<tr>
<td>Fredag</td>
<td>4 %</td>
<td>Soltimmar: Mulet och snöfall hela dagen</td>
<td>Medel risk: Osäker väderpåverkan: risk för att starkt kyla påverkar vattenkraftverken negativt.</td>
</tr>
</tbody>
</table>

Frågor

Vilken dag (dagar) verkar det mest troligt att elen är billigast på?

Varför?

Vilken dag (dagar) är risken störst på?

De faktorer som beskrivs är:
- Sannolikhet för billigast elpris
- Risk
- Soltimmar
- Temperatur
- Vindstyrka
- Nederbörd

Vilka av faktorerna upplever du som relevanta för dig?

Varför upplever du faktorerna som relevanta?

Vilken dag skulle du välja att boka ljungen?

Varför?
Tvättrummet


<table>
<thead>
<tr>
<th>Nationell elförbrukning</th>
<th>Troligast personlig energiförbrukning</th>
<th>Näst troligast personlig energiförbrukning</th>
<th>Trolig effektivitet (Hög = miljövänligt och billigt, vice versa)</th>
<th>Troligt elpris utslaget över dagen (øre per kWh)</th>
<th>Trolig kostnad per två timmars tvättid utslaget över dagen (kronor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Måndag</td>
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<tr>
<td>17-18</td>
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<td>Låg</td>
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<td>Medel</td>
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</tr>
</tbody>
</table>

Frågor

Vilken dag beslutar du att tvätta på?
Vilket är ditt främsta motiv att välja tvättdag?
Vilken information bidrar främst till ditt beslut?
Finns det tillräckligt med information för att fatta ett beslut som du känner dig nöjd med? 

Finns det information du saknar? Vad i så fall är det för information och varför saknar du den? 

Upplever du att informationen om elpris är relevant för dig? Varför? 

Upplever du att den beräknade kostnaden är relevant för dig? Varför? 

Upplever du att en nationell översikt av elanvändning är relevant för dig? Varför? 

Upplever du att det är relevant att känna till ett uppskattat energibeteende för din lägenhet? Varför? 

Rekommendationssystem

Du har nu fått ett litet smakprov på den typ av information du kan få från ett rekommendationssystem som hanterar elförbrukning.

Upplevde du att mängden information var hanterbar och bidrog till din förståelse? 

Varför? 

Hur mycket information skulle du tycka vore lämpligt? Varför? 

V
Fanns det någon information du skulle vilja införa för att få en större förståelse för ditt energibeteende?


Tack så jättemycket för ditt bidrag!
Appendix III
The Conceptual Model