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# The potential of nudging and gamification for reducing energy demand in the residential sector

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| AALTO-UNIVERSITY<br>SCHOOL OF ENGINEERING<br>PB 11000, 00076 AALTO<br>http://www.aalto.fi | ABSTRACT OF THE MASTER'S THESIS |
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The threat of human induced climate change is imminent. The reason is an ever increasing demand for energy and products, producing more and more greenhouse gas emissions. Everybody needs to take responsibility now. The estimations are that with 2% annual energy savings from residential households 12TWh and 3.3 billion metric tonnes of CO2 can be saved per year. Greenely, a startup from KIC InnoEnergy, wants to engage residential households to change their energy behaviour at home. They combine a smartphone application with the smart meter infrastructure to reduce households energy demand. Changing behaviour is complicated and research prior to this thesis revealed that information and economic incentives alone are not sufficient.

A simple and proven technique to change behaviour is Nudging A gentle push in the right direction while leaving the freedom of choice. A popular example is a printed fly in the men's urinal. It nudges them to aim at the fly. The cleaning costs were reduced by 80% at the Schiphol Airport Amsterdam.

Without application usage change is impossible for Greenely. Their main contact tool to households is a smartphone application. The smartphone market is vast and competition between applications is strong. Therefore the system outline needs to precede Nudging for ongoing engagement and long term change. To achieve that Gamification practices are implemented. It is the incorporation of game design into non-gaming contexts to achieve engagement through motivation and fun.

This master thesis is done in cooperation with Greenely and focuses on residential demand reduction schemas, Nudging and Gamification. The aim is to improve their actual application and create an outline for an improved version that promotes long term behaviour change. The result incorporates the most suitable features from the relevant topics and enables long term change.

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# Contents

# 1 Introduction

The advancements in technology with an ever increasing demand for energy, products and natural resources possess severe problems for our society today. The problem of deforestation and an unsustainable use of natural resources with an increasing production of CO2 needs to be tackled. With the interconnected world we live in global and local solutions need to be found and pursued. In Europe the European Union (EU) adopted the 20-20-20 targets. By 2020 the share of renewable energy should be increased by 20%, a 20% reduction of greenhouse gas (GHG) emissions compared to 1990 and 20% lower primary energy consumption than the projected consumption for 2020 should be achieved (Smit et al., 2014). To accomplish these goals the focus of today is efficient energy management, energy efficient technologies and energy saving supply methods. Possible technology independent changes through modifications in people's lifestyle and behaviour are nearly untapped. In studies the savings range from 2-13% or go up to 30% during peak demands (Carroll et al., 2014). Accordingly to Opower (2014) 2% annual energy savings from residential households in Europe result in 12TWh and 3.3 billion metric tonnes of $CO_2$ saved per year, indicating a high potential.

Energy is used in nearly everything we do nowadays with and without thinking. How it is used and for what is invisible. The actual energy bill only shows the aggregated total consumption. According to Carroll et al. (2014) this lack of information is a market failure. To change behaviour more insights in their consumption are needed. A study by Gram-Hanssen (2010) states also that information is crucial as one's behaviour is otherwise invisible. This conclusion was made by doing research on how daily energy consumption routines in households can be changed. The research involved studying standby consumption practices as they are examples for invisible and underlying behavioural patterns for turning appliances on and off. Therefore with more information it would be possible to analyse the patterns and create awareness about behaviours at home.

With smart meters it is now possible to supply that information. They are advanced electricity metering technology that measures the consumption of the inhabitant. Compared to a manual energy meter they enable the measurement of shorter time frames while also communicating the data digitally to the utility company. Depending on the ability of the smart meter the data can be delivered in real time (Depuru et al., 2011). In Sweden the coverage with smart meters is nearly 100% (Catalin et al., 2014). According to EU directives the coverage is supposed to reach 80% in the whole EU by 2020 (Hierzinger et al., 2013). That would be around 200 million installed meters enabling insights into consumption patterns of households.

But information can only be the first step. In a study by Carroll et al. (2014) no proof was found that more information was connected to reduced or necessary for demand reduction. In a pre- and post-trial questionnaire connected with actual consumption data they studied if there is a connection between improved information through feedback from smart meters and demand reduction as displayed in Figure 1. The study was done with 2722 households over the time frame of one year (January to December 2010). Therefore more is needed.

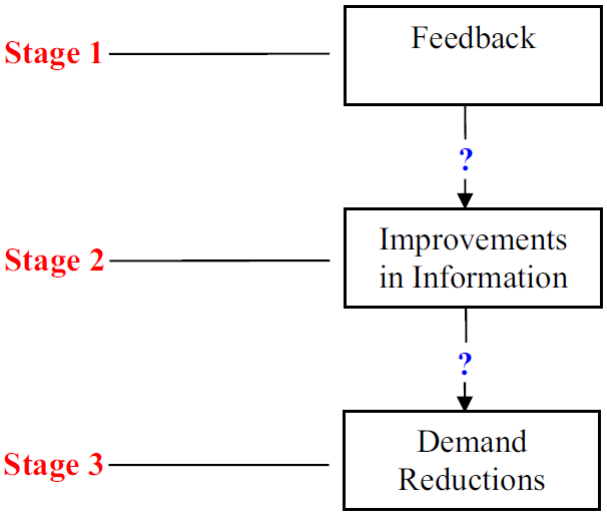


**Figure 1:** Research questions from Carroll et al. (2014)

Through the development of smartphones and available internet connections everywhere (Statista, 2013c; Czajka, 2011) this problem can be addressed in new ways. It is possible to engage households and address their lifestyles and behaviours where they are and guide them to a more sustainable living.

This thesis is done in cooperation with Greenely. It is a startup from the Royal Institute of Technology (KTH) Stockholm, Sweden and is incubated under KIC InnoEnnergy an European accelerator for sustainable energy. Through a smartphone application they connect the advanced metering infrastructure with residential households and visualize their consumption. The visualization is supported with incentives that nudge households to lower their demand. This enables them to become responsible and contribute to stop the global problem of human induced climate change.

## 1.1 Aim

The aim of this thesis is to develop an outline for an improved version of Greenely's application that engages households and creates long term behaviour change. To accomplish that the focus will lie on previous studies who tried to change energy behaviour, behaviour change techniques and customer engagement with an application. Based on this and an analysis of their actual application an outline for an improved version with the most suitable features is created.

## 1.2 Problem statement

Up to date governments mainly use policy instruments like laws or large-scale information based campaigns to educate people to change their behaviour (McKenzie-Mohr, 2006; John et al., 2011; Thaler and Sunstein, 2009). The campaigns involve on one hand to increasing the stock of knowledge and raise awareness and on the other hand focus on economic self-interest. The idea is that when attitudes change the behaviour follows or people will evaluate their choices and choose the one they profit the most (McKenzie-Mohr, 2006; Thaler and Sunstein, 2009). Research indicates that this is not

the case. The ability to force people to change behaviour and the affect of information based campaigns is limited and can be costly (McKenzie-Mohr, 2006). New strategies are needed.

Greenely's solution is a smartphone application with data analysis and an incentive system to raise the awareness of their customers. Finally they want persuade them to be more thoughtful with their energy usage behaviour at home. To achieve that on one hand affective techniques to change behaviour and on the other hand an engaging application is needed. Without its usage all behaviour change techniques are useless.

To change behaviour with an application it must be possible to integrate the techniques. Nudging is such a relatively new technique that is quite untried as a tool to reduce energy demand. It is a simple technique often referred to as slight push in the right direction while leaving the freedom of choice.

To achieve long term customer engagement the application has to be designed to do that. In 2013 more than 100 billion applications were downloaded all around the world from 1.31 billion smartphone users (Statista, 2013d,c, 2015). This is an increase by more than 65% from 2012 in downloads while the smartphone users increased only by less than 30% in the same period. In the US 75% of their usage time with applications is on their four favourite ones (ComScore, 2014). Even so the amount of download applications increased greatly compared to the increase in users only few are used on a regular bases. Therefore it is important to find, next to behaviour change techniques, also ways to engage customers with the application. Gamification is such a tool which is becoming more and more popular nowadays. It tries to engage and motivate the users by implementing game design practices into non gaming contexts. It is estimated that by 2018 the gamification industry will be worth $5.5 billion (Dale, 2014).

## 1.3 Research questions

To accomplish the aim of an engaging system outline for changing residential energy behaviour the main research questions for my master thesis are:

- In which way smart meters have been utilised to change energy consumption?
- How can Nudging help to change behaviour?
- What is important to create a long term engaging and motivating application with gamification?

## 1.4 Reading guidelines

The chapters are organized according to the research questions. In Chapter 2 all the relevant theory is presented. It is split up into three parts. In the first part Chapter 2.1 previous studies on demand reduction are analysed. From this valuable informations are gathered concerning features which have worked and can be implemented in the system outline. In the next part Chapter 2.2 I will go into detail what nudging is and explain the relevant techniques. The third part (Chapter 2.3) explains the basics of gamification to understand how applications can be engaging and motivating. Chapter 3 explains who Greenely is and what their actual status is. Furthermore it includes a SWOT-Analysis of Greenely's current application. In Chapter 4 the system outline

for Greenely is presented and explained in detail. It incorporates the relevant features from previous studies (Chapter 2.1), nudging (Chapter 2.2) and gamification (Chapter 2.3). In the last chapter (Chapter 5) the outline is discussed.

## 1.5 Methodology

This thesis is split up into two parts. The first part is analytical and the second part exploratory. The analytical part consists of literature research and analysis of Greenely's actual status. In the literature research I will analyse previous studies on demand reduction, nudging and gamification. This extensive literature research is than used to analyse Greenely's actual status. This is done with a SWOT-Analysis. The second part combines the knowledge from part one to create a system outline for an engaging and motivating smartphone application that creates long term behaviour change. A feedback system with different types of incentives will be able to engage residential households and achieve long term behaviour changes. This will lead to energy demand reduction engaging households in a more sustainable living. The research is qualitative and applied. The outcome will be a system outline for an improved application that can be designed and implemented.

## 1.6 Delimitations

The field of behavioural science is vast and spans from psychology to economic theory alike. Therefore I had to focus on what I think is most valuable for this work. I choose Nudging. It is a relatively new theory but is applicable in everyday situations and can be incorporated in an application. I also describe only shortly why Nudging works. Human behaviour and consciousness is complicated and several different theories try to explain how it works. Going more into detail would be out of scope and lead in the wrong direction. The outcome should be applicable and nudging works without knowing how human behaviour works in complete detail.

# 2 Literature review

In this chapter a literature review on the relevant topics and concepts will be carried out. They are previous studies done on energy behaviour, nudging and gamification.

## 2.1 Previous studies

The amount of scientific literature on energy demand reduction in residential households is limited. In the next chapters an analysis of all relevant found article will be presented. Each section represents one study. Through this structure it is possible to go into detail and highlight their useful features. They will be used later on for the development of the system outline.

### 2.1.1 A persuasive feedback support system for energy conservation and carbon emission reduction in campus residential buildings

In this study by Emeakaroha et al. (2014) the effectiveness of an energy delegate in combination with a persuasive feedback support system (PFSS) is tested. The subjects are students who live on the university campus of the University of Kent. In an initial survey they discovered that 80 % of the students were not motivated to conserve energy and imply that this is because of "lack of real time feedback on their energy consumption" (Emeakaroha et al., 2014). Students in campus residential buildings pay a fixed price every month for their rent. The electricity is included in this fixed price. Therefore their consumption is not displayed in their monthly bill. The study was done over a time period of 6 weeks with 16 student halls with 7 students in each one. The 16 halls were split up into an experimental and a control group. The control group only received the PFSS and an email alert compared to the experimental group with the PFSS and an energy delegate.

#### System architecture

The system architecture was designed with three main pillars which interact with each other. One part are the students who are supposed to reduce their consumption, The second part is PFSS which gathers the consumption data, analyses it and presents it to the students and the third part is an energy delegate. They form a triangle sketched in Figure 2.

The PFSS is a software platform that gives the students access to their consumption data. The data which is monitored is overall and not as detailed as the device level. The front page is shown in Figure 3. The consumption is displayed in kWh together with the costs and an arrow indicating if it is high or low. The CO2 emissions are also visible. They are included because through a questioner it was discovered that the main concern of the students was the environment (Emeakaroha et al., 2014). To see their consumption the student had to manually log in.

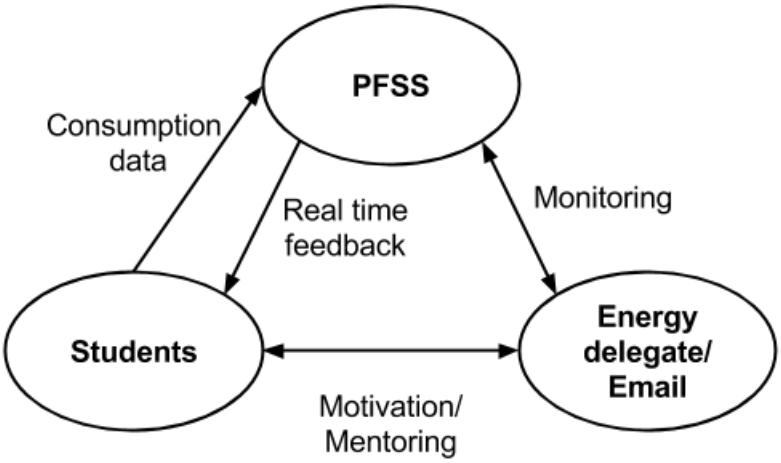


**Figure 2:** PFSS schema

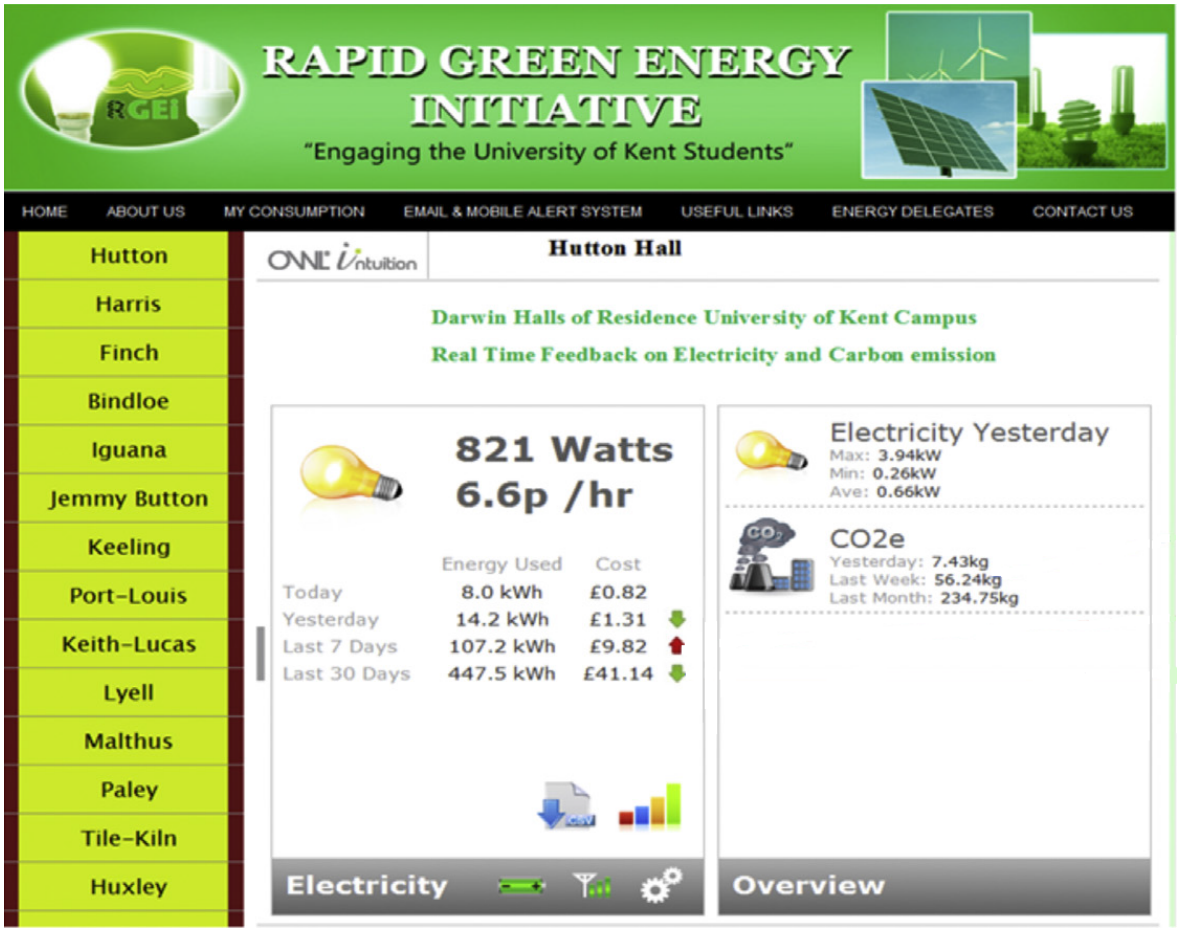


**Figure 3:** Visual display of the PFSS (Emeakaroha et al., 2014)

The main feature difference between the experimental and control group were the energy delegates. Their task was to monitor the students activities, mentor them towards a more concerned electricity consumption and be a simple reminder. Every week there was an appointed time in which they meet with the students and talked

about their consumption and behaviour. The energy delegate was a student from each hall itself. This formed a personal bond between students and delegate who was living as a visual example in the hall itself. They were appointed at the beginning of each year and received a reward certificate at the end (Emeakaroha et al., 2014).

### Results

There was no third group which had no access to the PFSS. Therefore no conclusion can be made if the PFSS in general is effective or not. The only difference between the two groups is the energy delegate or the email alert. It is visible that shortly before and after the appointed weekly meeting with the energy delegate there is drop in consumption. The average consumption for the experimental group was 91.45 kWh per week and 139.15 kWh for the control group. The difference is also visible in the amount of log-ins during the study period. The experimental group logged in 223 times compared to 96 from the control group (Emeakaroha et al., 2014). The results from the study are displayed in Figure 4 and 5. A meeting with a person instead of only a visual display seems to be effective.

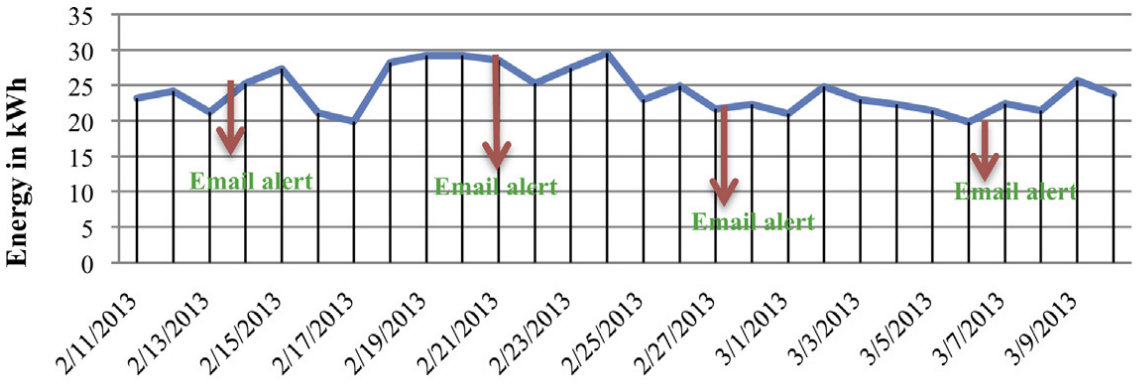


**Figure 4:** Consumption data with email alert (Emeakaroha et al., 2014)

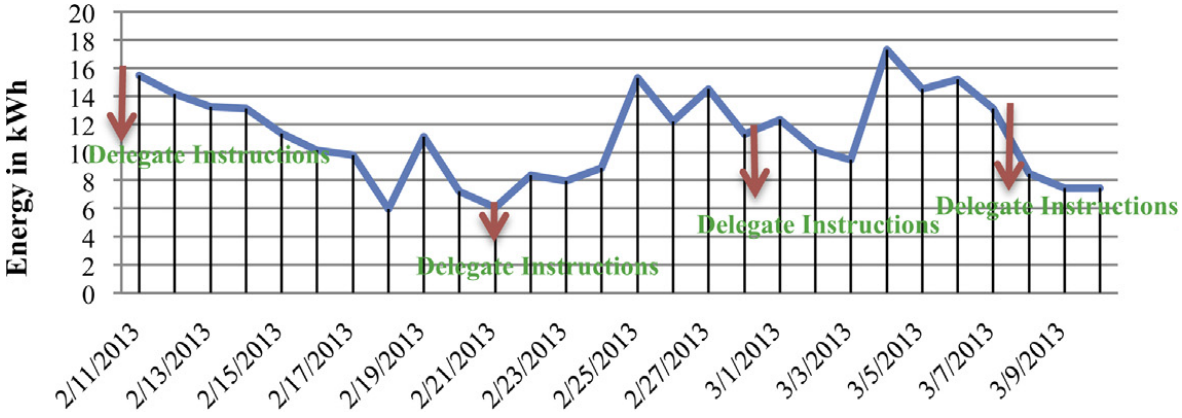


**Figure 5:** Consumption data with energy delegate (Emeakaroha et al., 2014)

### 2.1.2 Smart meter devices and the effect of feedback on residential electricity consumption: Evidence from a natural experiment in Northern Ireland

In this study by Gans et al. (2013) the effectiveness of advanced metering infrastructure (AMI) with real time feedback compared to no AMI is tested. The study is done with data from 1990 until 2009 and around 55,000 households (Gans et al., 2013). The household data is from the Continuous Household Survey of Northern Ireland. The survey is an annual survey done by the Northern Ireland Research and Statistics Agency. During this time the utility company had a monopoly. When customers wanted to reduce their electricity bill they had to change their behaviour. The utility company offered various payments plans. They range from direct debit to prepayment accounts. In the year 2002 all prepayment accounts received a keypad. It is an In-House-Display (IHD) with a visual display of the consumption in real time. By 2010 the keypad customers accounted for 34% of all customers.

#### System architecture

The prepayment customers were the experimental group while all the other counted as the control group. Before 2002 the prepayment customers had to go to a store and load money onto a plastic card. The plastic card was than inserted into the electricity meter at home. With the new keypad system customer bought a code online, at kiosks or via telephone and entered it into the IHD (Gans et al., 2013). Accordingly to Gans et al. (2013) The IHD allowed customers to check four important things:

1. *Amount of credit still left*
2. *Time credit will last, based on previous consumption*
3. *cost summary available for previous day, week or month*
4. *real time electricity usage*

#### Results

The study reveals savings over the whole time period of about 10 to 18%. If focused only on a short time period around the introduction of the keypad the savings range from 10 to 13%. According to the authors the improved information accounts for the savings. Psychological factors concerning the prepayment methods are not taken into account. In Figure 6 the electricity consumption between the experimental and control group is displayed.

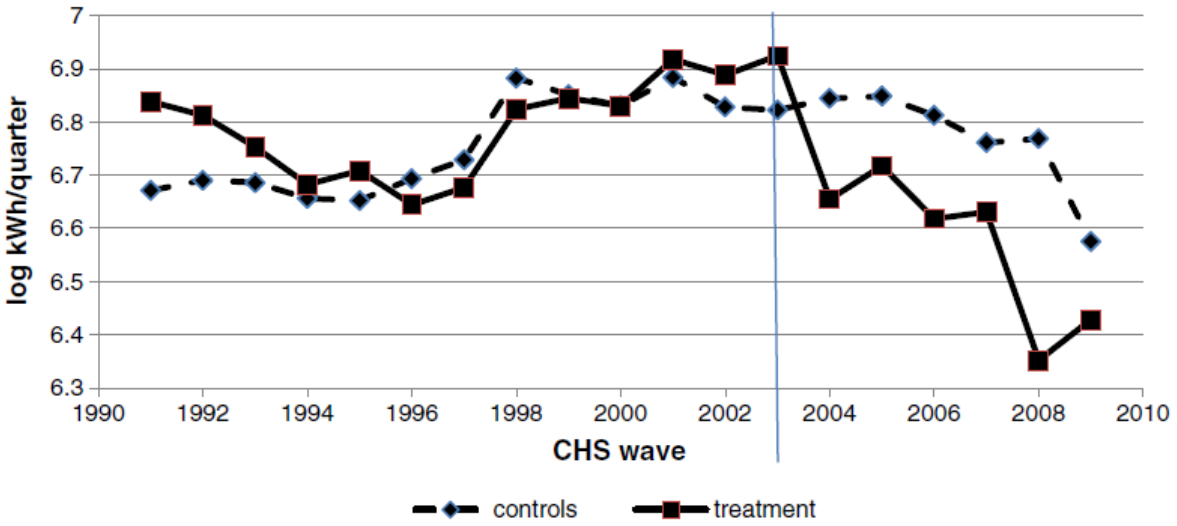


**Figure 6:** Log electricity consumption for experimental and control group (Gans et al., 2013)

### 2.1.3 Smart metering for residential energy efficiency: The use of community based social marketing for behavioural change and smart grid introduction

According to (Anda and Temmen, 2014) community based social marketing (CBSM) is effective at inducing behavioural change. The authors on one hand analysed programs which use CBSM to lower water demand and on the other hand smart meter trials in combination with CBSM to reduce electricity demand. The studies were done in Western Australia. In the water demand reduction programs from 2011 to 2013 participating households ranged from 4,000 to 11,0000 in each study and the water savings were as high as 6 to 7%. The smart meter trails were part of the Perth Solar City program with 16,000 participating households and over 9000 installed smart meters and around 2,500 IHDs. The program was for three years from 2009 to 2012.

#### Community based social marketing

CBSM draws the basics from social psychology and wants to implement behaviour change programs on community level and engage people with direct personal contact. According to McKenzie-Mohr (2006) personal contact should be "emphasized because social science research indicates that we are most likely to change our behaviour in response to direct appeals from others.". The steps for CBSM are as follows according to McKenzie-Mohr (2006):

1. *Identifying barriers:* In everyday life there are barriers that hinder the adoption of new behaviours. If people get educated in sorting their waste but their household waste gets collected in one bin, their sorting effort at home is in vain. Barriers can be internal or external. Internal ones are lack of knowledge. External ones consists of structural problems like only one bin instead of several for the different wastes. The barriers are activity specific and need to be identified for each desired behaviour change. Identifying barriers is a three step process. The first step is to do a literature review. In the next step focus groups will be organized. They are done with residents from that area to gain deeper knowledge on attitudes and

habits the residents have. The last step is randomised phone survey with the residents. The combinations of focus groups and phone surveys greatly enhances the knowledge about possible barriers to desired behaviour changes (McKenzie-Mohr, 2006).

2. *Design strategic approach:* After identifying barriers the how to change behaviour is important. There are several tools that engage the target audience and identified barriers in an effective manner. These tools are implemented on community level and regularly involve direct personal contact
3. *Pilot approach:* As the implementation can be expensive testing it on a fraction of the target community can safe money. The program can be further developed and several different strategies can be tested next to each other.
4. *Evaluate impact of approach:* An ongoing evaluation is an essential part of the progress. It gives insights in the effectiveness, allows further development of the strategy and it's possible with the gained data to acquire more funding.

When implementing these four steps it is important to integrate these motivators for change as they are regarded as crucial (Anda and Temmen, 2014):

- *Community feeling*
- *Personal goal-setting*
- *Inspire concern for environment*

**System architecture**

The CBSM approach used in the electricity demand reduction smart meter trials was as follows (Anda and Temmen, 2014):

1. Identify barriers
2. Design how customers are approached
3. First contact through announcement letter and phone call
4. Distribution of desired educational material
5. Meter reads/ data analyses
6. Evaluation letter connected with a coaching phone call from specialised energy delegate
7. Final thank you letter and scorecard

According to Anda and Temmen (2014) the energy delegates were the main drivers for changes in behaviour. They engaged the customers and integrated them into the community, set personal goals with them and inspired a concern for the environment.

**Results**

The results for the three year Perth Solar city program are displayed in Table 1. The time-of-use (TOU) tariff in combination with the IHD seems to be good at lowering peak demand in comparison to an energy delegate who is more effective in lowering the average consumption. Most effective was the CBSM in combination with an energy delegate and an IHD. The energy delegate discussed more than only changes in behaviour to save energy. Changes in appliances or installation of renewable energies for own electricity production (Anda and Temmen, 2014) were included. How many people changed appliances or bought renewable energies is no stated.

**Table 1:** Summary of energy saving results (Anda and Temmen, 2014)

| Intervention | Average electricity reduction | Peak electricity reduction (14:00-20:00 weekdays) |
|---|---|---|
| Time-Of-Use tariff (TOU) + IHD | 6.3% | 13.1% |
| Energy delegate | 12.3% | 7.7% |
| CBSM | 7.5% | 7.1% |
| CBSM + energy delegate + IHD | 21.4% | 16.6% |

### 2.1.4 Opower

Opower is a company from the US focusing on reducing residential energy demand. They work together with 93 utility companies and processes data from up to 52 million households (Opower, 2014).

#### System architecture

Opower uses an enhanced version of the regular invoice. An excerpt is displayed in Figure 7. It gives the households a structured overview of their consumption. According to (Opower, 2014) educating the households enables them to make more intelligent resource decisions for long-term demand reductions. They also put the households consumption in relation to more efficient neighbours or the average of similar sized households with the same heating system. A smiley states how good your consumption is. An overview of your development over a longer time period is visible as well.

#### Results

Opower achieves on average a 2% energy demand reduction (Opower, 2014). This is accompanied by an increase in customer satisfaction of more than 5% and an increased program participation of up to 60% when actively promoted, leading to more customer for the utility (Opower, 2015).

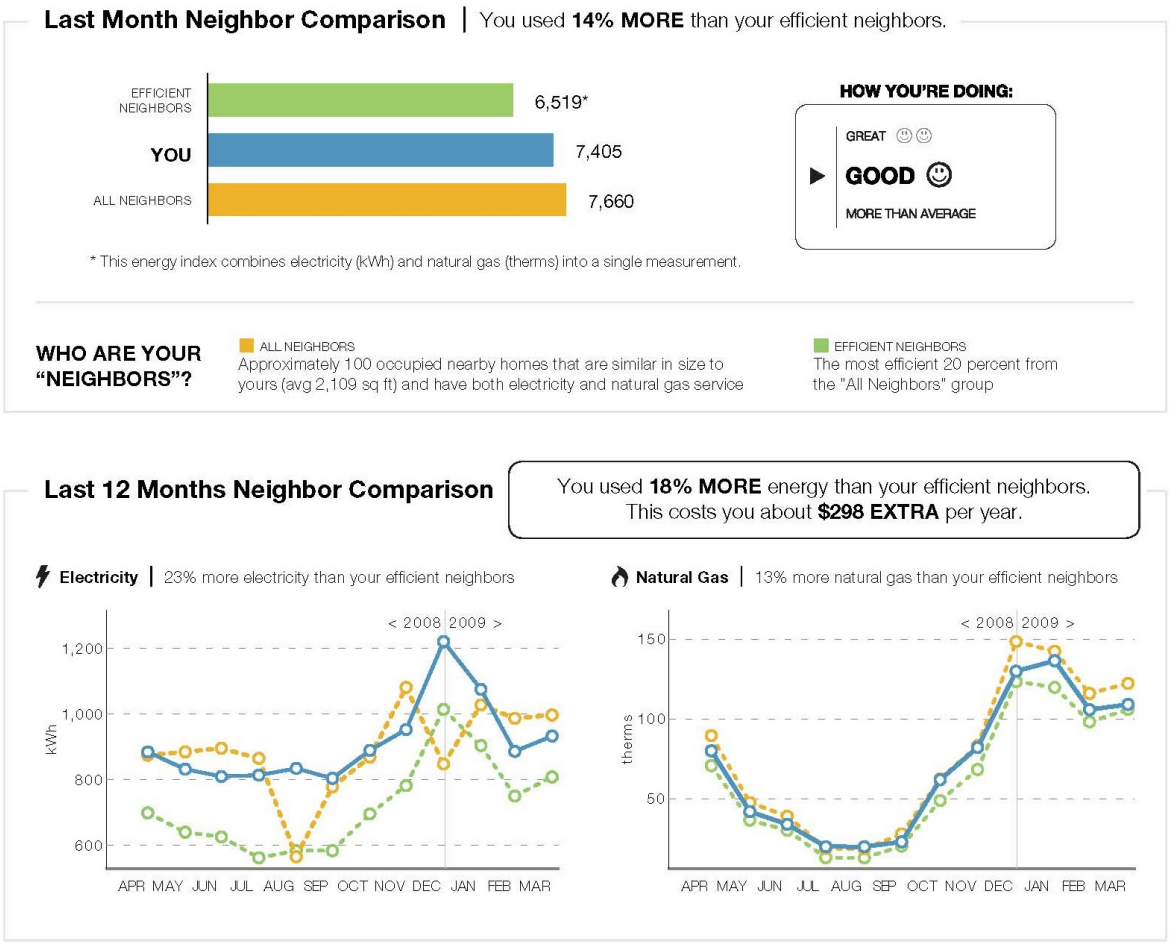


**Figure 7:** Invoice example from Opower (XcelEnergy, 2011)

### 2.1.5 The impact of informational feedback on energy consumption - A survey of the experimental evidence

In this research paper Faruqui et al. (2010) tries to identify the effectiveness of In-Home Displays (IHDs) which provide the customer with visual real time feedback. Their main idea is that direct feedback is a driver for behaviour change and motivates demand reduction. Therefore they analysed several studies which test IHDs alone and in combination with different payment plans.

#### System architecture

The amount of participants, duration of study, utility company and country are displayed in Table 2. Hydro One TOU was part of a larger study. Besides a combination of TOU and IHD customers with only a TOU tariff or as a control group with non of these two were tested.

**Table 2:** Summary of programs studying the effect of IHDs on consumer behaviour

| Program | Country | Participants | Duration |
|---|---|---|---|
| Hydro One TOU | Canada | 153 | 5 month |
| Woodstuck Hydro | Canada | 2,500 | 2004 ongoing |
| SRP | USA | 2,600 | 12 month |
| Country Energy | Australia | 200 | 18 month |

### Results

In Figure 8 the results of the study are displayed separated by payment plan. The savings range from 12.8 to 15% with a prepayment plan and from 7.6 to 8% with a TOU plan. Every study claimed only to use the IHD in cooperation with one of the payment plans. If other mechanism were unintentionally used it was not stated or visible in the research paper. The 8% savings from the Country energy study were accompanied by on average 16% savings on the bill and 30% demand reduction during critical price events. It indicates that most of the savings were during peak price moments shifting the load to cheaper times. The results from Hydro One (7.6%) TOU were accompanied by a load shift of 5.5% from peak price moments to mid-peak and off-peak hours and 8.5% during very hot days with more than 30 degrees Celsius (Faruqui et al., 2010). The control group which only had a TOU tariff without a IHD saved only 3.3%. Therefore it seems that a visual display of the own consumption in combination with a TOU tariff seems to be more effective than only a TOU in shifting load. The households see their own consumption in connection with varying prices and can act on it. A IHD in combination with a prepayment plan seems to be better at reducing the average load.

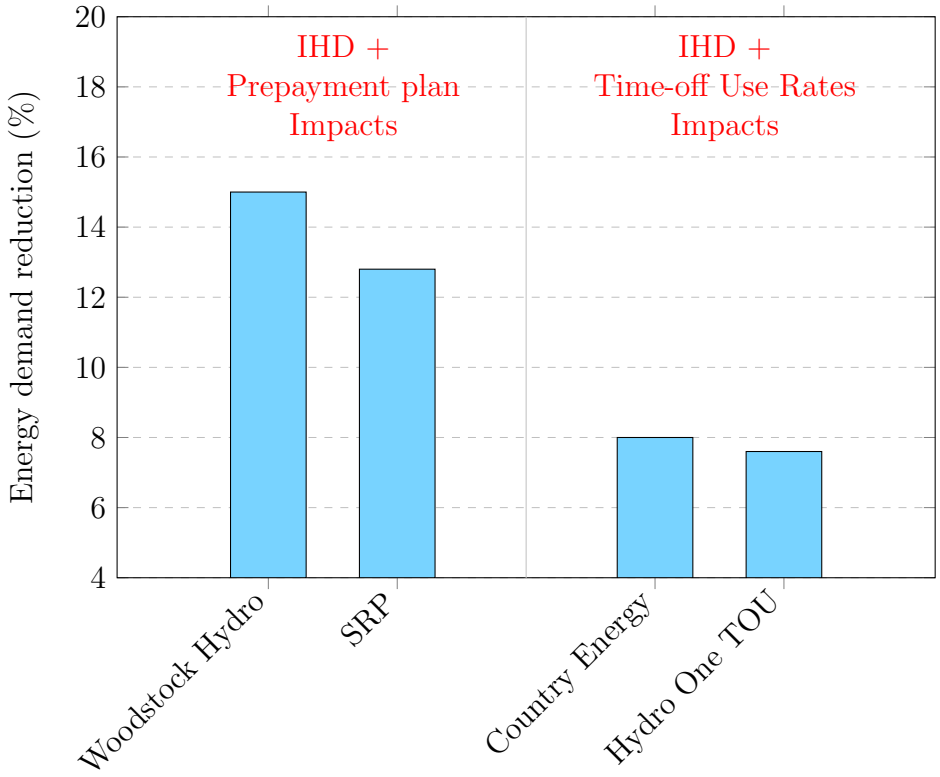


**Figure 8:** Comparison of results from different studies (Faruqui et al., 2010)

### 2.1.6 Summary of results

The list below displays the extracted features from previous studies which contributed to the energy reductions. They will be further used in Chapter 4 to create the application outline.

- IHD + prepayment billing plan
- IHD + TOU billing plan
- Enerty delegate
- Goal setting/ Commitment
- Concern for the environment
- identifying barriers target households have
- Sense of Community
- Comparison

The combination of IHD and prepayment plan achieved results from 10 to 18% in the study conducted in Northern Ireland (Gans et al., 2013) and 12.8% in the USA by SRP and 15% in Canada by Woodstock Hydro (Faruqui et al., 2010).

The combination of IHD and TOU achieved in Western Australia where CBSM was used 6.3% on average and 13.1% during peak times and ones 8% in Australia in the study from Country Energy and 7.6% in the study from Hydro One TOU in Canada.

The energy delegates were accountable for reductions in the study at the university campus of the University of Kent (Emeakaroha et al., 2014). Also in the CSBM study they accounted for 12.3% savings on average and 7.7% during peak demands (Anda and Temmen, 2014). The energy delegate also seemed to be quite useful in combination with the CSBM and an IHD accounting for 21.4% savings on average and 16.6% during peak demands (Anda and Temmen, 2014).

What the exact improvements through Goal setting, Concern for the Environment, a sense for the community and identifying barriers are is hard to say. They are named as an integral part of the CBSM. The CBSM accounted for savings itself of on average 7.5% and during peak times of 7.1% (Anda and Temmen, 2014).

Comparing neighbours also connects the households to their surrounding community and therefore also creates a sense of community. Opower uses this for annual savings of about 2%.

## 2.2 Nudging

An experiment in England in a local council near Manchester displayed that people cannot be forced to change their behaviour (John et al., 2011). In the local council waste management was in some of the publicly owned housing estates a problem. People refused to sort their waste and put everything in one bag. To get all people to sort their garbage a variety of measures were taken. They consisted of leaflets delivered to the households, big colourful posters at the entrance of each building and finally after nothing seemed to work the garbage collection was stopped for several weeks. The idea was to force the people to change their behaviour through being ashamed of the pile of garbage bags outside the door. Even so they piled up no effort was made to sort the waste into the right bins. Finally the environment department capitulated for health reasons and picked the garbage bags up again. The people could not be forced to change their behaviour (John et al., 2011). In democratic countries people are accustomed to their individual freedom and the right to have their say. Therefore other tools are needed besides normal policy instruments, like laws, which are used by governments or educating the people to elicit pro-environmental friendly behaviour.

Nudging is such an alternative. It is a simple technique that tries to give a gentle push in the right direction.

### 2.2.1 Concept of nudging

At the Schiphol airport in Amsterdam the dirtiness of the man's toilets became a problem. Evidence showed that man in general do not think about where they aim when peeing. At the airport with a frequent use of toilets the dirtiness became a problem. Therefore a fly was printed in the urinal to increase the aim of the user. According to Aad Kieboom, the economist who had the idea with the fly, man cannot resist aiming at it. The spillage was reduced by 80% through using this inexpensive technique while leaving the freedom to pee in any direction (Thaler and Sunstein, 2009). The user was "nudged" towards a cleaner toilet use without telling him to aim better.

Nudging is to find inexpensive ways to direct people in a desired direction without eliminating their freedom of choice (Thaler and Sunstein, 2009). Every person is influenced in his decision process through the environment in which the decision is made. The environment can be created intentionally or unintentionally. Through designing the environment decision makers can be influenced. The person who designs the environment is a choice architect. When it is done intentionally the person manipulates the environment with subtle changes to lead the decision maker in a desired direction. In Science there are widespread discussions about the ethics of nudging as the choice architect manipulates the decision maker to take the favoured option over the other ones. This discussion is beyond the scope of the Master Thesis and therefore will be left out.

### 2.2.2 How nudging works

In cognitive and social psychology alike a general separation of the human mind in a capacity-limited and -unlimited system is done. One accounts for unconscious, automatic, low effort and high capacity processes and the other one for conscious, controlled, high effort and low capacity processes. These two processes are named differently from different authors (Evans, 2008). Therefore neutral terms for both of them are chosen for this thesis. System 1 is unconscious and system 2 is conscious. By using policy instruments and education only system 2 is addressed. As addressing system 2 does not seem to work in all cases somehow system 1 needs to be addressed as well.

People have problems making the right choices to reach their long term goals or follow their intentions, as research shows (Hansen and Jespersen, 2013; Momsen and Stoerk, 2014). In Western countries only 3% of the ones who had the intention to buy electricity from renewable energy sources actually bought it (Momsen and Stoerk, 2014). "Due to their limitations in cognitive processes and attention, individuals have difficulties understanding the situation they are in and suffer from an imperfect ability to process new information. Consequently, they often fail to act upon their long-term intentions" (Momsen and Stoerk, 2014). As the brain has limits in the amount of information it can process it needs to select which ones it gives attention to (Marois and Ivanoff, 2005). How the brain chooses to divide it is connected to the emotions towards the object, experience in the choice environment and information about it available (Vermeulen, 2010; Schwabe et al., 2011; John et al., 2011). Besides that the brain has according to Marois and Ivanoff (2005) a maximum capacity, which is four to five items at a time. In another research paper from Miller (1994) the maximum capacity is seven plus minus two. Combining both articles the limits in capacity are between four to nine objects changing with complexity and available conscious time. This goes along with the theory of bounded rationality (BR). According to Bendor (2015) BR is founded on the following premises.

1. Humans cognitive capacity is limited
2. These constrains impact decision making
3. The harder the problem the more likely it is that a decision-maker's information processing limitations will matter

This theory connects the mental ability of people with the complexity of the problem he or she faces (Bendor, 2015). A complete rational person facing a difficult decision would gather as much information needed to accurately determine the consequences of all possible outcomes. As information gathering costs time and resources real humans find a trade-off between the costs and acting on already available information. They try to satisfice instead of optimise. With the available information and capacity to compute the consequences the satisfactory solution is chosen (Foxon, 2006). The capacity limits can be trained but even then a highly trained human is apt to cognitive illusions and make mistakes. Tversky and Kahneman (1974) tested cognitive biases that derive from relying on judgemental heuristics. When faced with a complex task people use preformed heuristic principles to brake down the task to simpler judgemental operations. This is helpful but can lead to "*severe and systematic errors* (Tversky and Kahneman, 1974). Through framing questions in a certain way people relied on the wrong judgemental heuristics and came to wrong conclusions in even simple questions. An example question Tversky and Kahneman (1974) asked was: "*Steve is very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail.*" The subjects than had a list with possible occupations and were supposed to sort them highest to lowest chance. Ask yourself. Is Steve a librarian or a farmer? In most cases the answer is librarian as the description fits more the stereotype of a librarian. But the probability that Steve is a farmer or a librarian is not affected by stereotypes. That he is a farmer is more likely. Humans tend to make schematic mistakes (Tversky and Kahneman, 1974). Bendor (2015) states six important properties of information-processors according to BR.

- Selective perception of information: There is always more information available in the environment than one can attend to. That leads to a selection process done by the inner environment of the decision maker
- Information processing is serial, especially conscious thinking and attention
- The information processing capability of humans is slow for many kinds of informations
- people are weak at calculations compared to computers
- Memory is not photographic but re-constructive
- The capacity of the short-term memory is very small. as stated above it's between 4 to 9 informations. It is the bottleneck as there is no known limit to the long-term memory

All this leads to the same conclusion that (Thaler and Sunstein, 2009) have. They conclude that "everything matters". Every minor detail can affect people's behaviour, is able to focus the attention in a certain direction, can fill up the capacity needed to make the desired choice and arouse emotions. Therefore to help people reach a decision or their long term goals the process can be arranged by using the limitations of cognitive processes and attention.

The choice architect designs the environment and uses the limits of the brain and system 1. The choice architecture is altered to achieve that the desired choice is easy, automatic and/or chosen by default. The right stimuli are put into focus and/or made more attention demanding while leaving the freedom of choice.

### 2.2.3 Nudging techniques

The choice architect has several ways of how to manipulate the choice environment. The possible ways which are relevant for this thesis are listed below (John et al., 2011; Lindahl and Stikvoort, 2014; Momsen and Stoerk, 2014).

1. Social norms
2. Prompts
3. Commitment

#### Social norms

Social norms play a vital role in how all society works. They are the invisible rules of which behaviour is accepted and which is forbidden and unacceptable. They are understood by each member without the enforcement of laws. Therefore sanctions for braking these laws come from the social group and not a legal entity (Cialdini and Trost, 1998). These laws form the identity of a social group. Each participating individual forms these norms by being in group situations with other individuals from the social group. The individual derives through these situations a personal perception and judgement for situations outside of the group. They are the expectations of how oneself thinks one has to behave. These expectations and invisible laws differentiate it from other social groups (McDonald and Crandall, 2015). The main traits to go along with social norms are imitation and social learning. They are built into all primates including humans, which are especially aware of what others around them are doing. In a study by Goldstein et al. (2008) the effect of social norms on towel reuse in hotels was investigated. The hotel guest were presented with two different messages. The message half the hotel guest received was connected to the environment and said: "HELP SAVE THE ENVIRONMENT". The other half received a social norm message which said: JOIN YOUR FELLOW GUESTS IN HELPING TO SAVE THE ENVIRONMENT". The experiment lasted for 80 days and 35% of the hotel guest presented with the environmental message reused their towels and 44% of the guest with the social norm message. In a second experiment they tested if the social identity with the reference group has an effect on the reuse of towels and what people rated as important to their social identity. Five messages were used and the identities were being a hotel guest in general, a citizen, gender identity or guest which stayed in the same hotel room beforehand. The results are displayed in Figure 9. All social norm messages have a higher effect on towel reuse than the normal environmental message. The highest effect had the message with the closest relation, a guest from the same hotel room. Interesting is that there is discrepancy between what people rate important and what had an effect. They rated the identity with the person visiting the particular room as not important but responded to it the most (Goldstein et al., 2008).

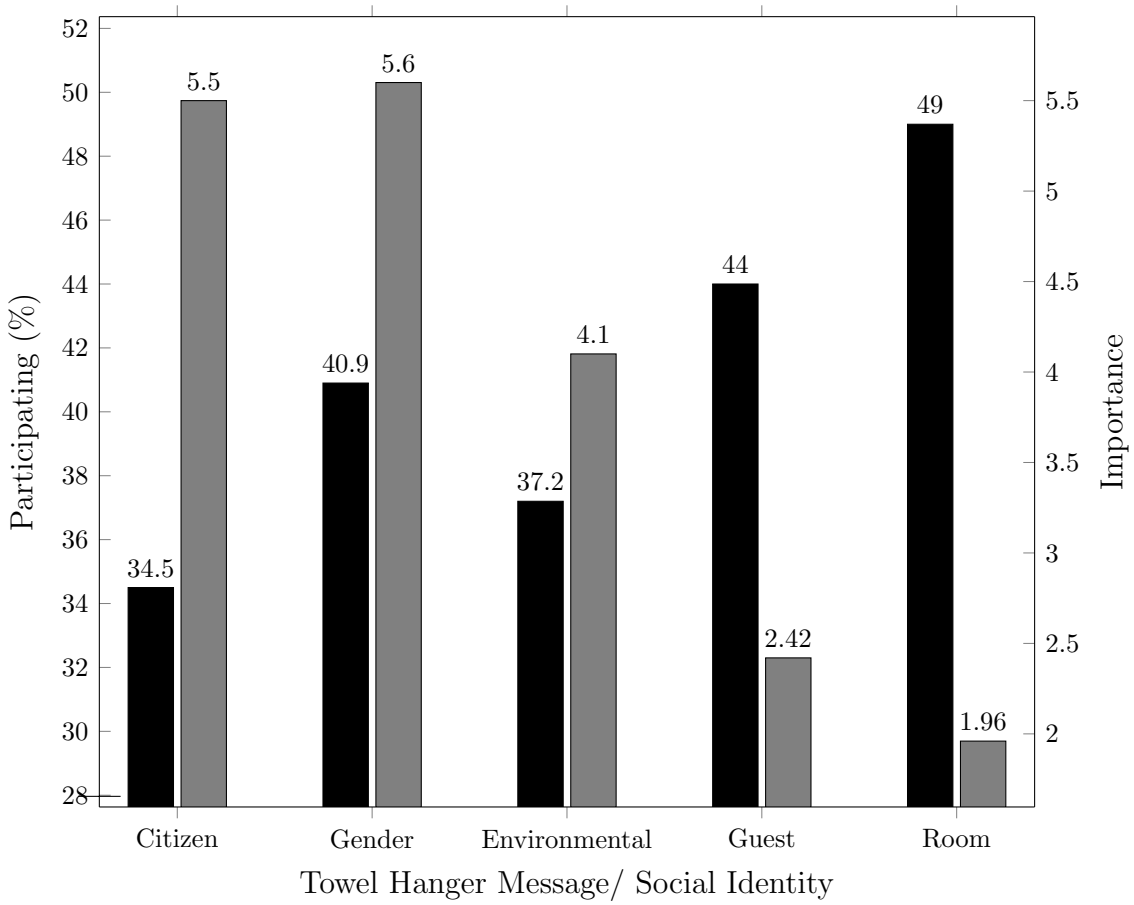


**Figure 9:** Towel Hanger Message results compared with people's importance rating of social Identity (Goldstein et al., 2008)

Norms in general work in two different ways. On one hand as so called "informational social influence" and on the other hand as so called "normative group pressure" (McDonald and Crandall, 2015). Informational social influence is descriptive and works through "providing an example of preferred behavior, and suggesting appropriate actions" (Melnyk et al., 2013). Normative group pressure is injunctive and works through a "focus on rules and beliefs, and people may adhere to these norms to avoid sanctions" (Melnyk et al., 2013). Social norms can therefore be also addressed in two different ways. A sentence with a descriptive norm condition would be: *inhabitants of Västerås are reducing their energy demand at home.* A sentence with a injunctive norm condition would be: *People from Västerås were saying that everybody should reduce their energy demand at home.* Research by Melnyk et al. (2013) shows that these two different ways of how social norms can be used can also lead to different results. This mainly depends on the context they are used in or the context in which the nudging person during the nudge is. When people where thinking about negative situations they want to prevent from happening in the future the disjunctive norm was not that effective any more. in a positive goal oriented state the disjunctive norm worked completely fine. The state had no effect on the injunctive norm.

### Prompt

People are prone to forgetting tasks or actions they intended to do. Leaving the cotton bag that was intended to replace the plastic bags at home or forgetting to turn off the light after leaving the room. in such cases a simple reminder would be of great help. A prompt is such a reminder of an intended action. It can be visual or auditory. It is not designed to change attitudes or increase motivation but just to help us accomplish our own goal McKenzie-Mohr (2006). In Copenhagen the litter around the bin was reduced by 46% by printing green footsteps that walk towards the bin on the ground Hansen (2012).

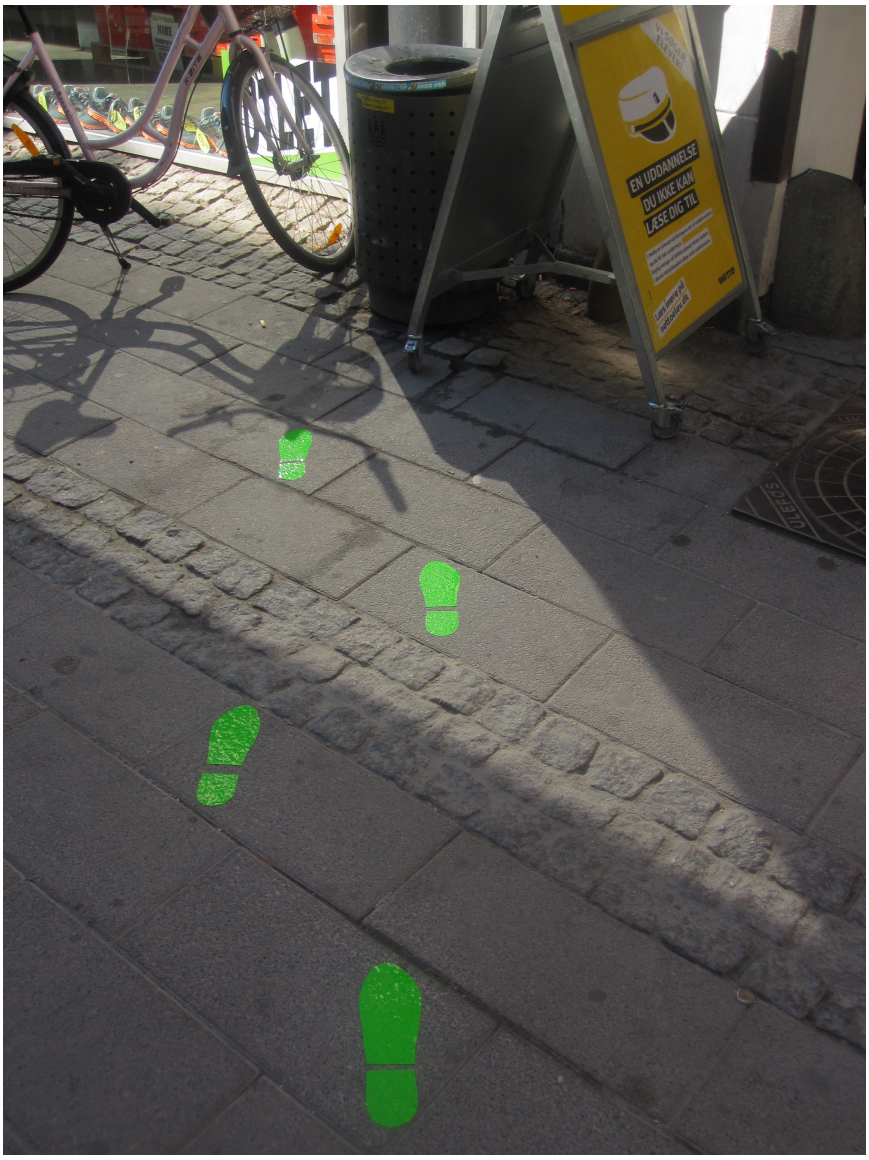


**Figure 10:** Green Footprints (Progressive Manager's Network, 2008)

Another way a prompt can work is to let the mind think in certain direction. In California People were asked if they would place a large, ugly and obtrusive "DRIVE CAREFULLY" billboard on their front lawn. The persons who were asked beforehand to put a small "BE A SAFE DRIVER" sign in their car agreed to it with 73% compared

to without prior confrontation with a similar topic (McKenzie-Mohr, 2006). The first question worked as an anchor the persons were measuring themselves against and related to later on.

#### Commitment

People try to be consistent with their believes and actions. They want that there actions are in line with their expressions of their believes. When they make a commitment they try to follow their commitment to not be out of line with their actions. According to McKenzie-Mohr (2006) making a commitment changes how people look on themselves. They come to the point that they themselves are supporters of what they have committed to. It creates a "strong internal pressure to behave consistently" (McKenzie-Mohr, 2006). According to a study by Moriarty (1975) people who committed to safe guard property from an unknown person did so in 95% of the case compared to only 20% if they were not asked prior to the theft. In light of the Self-Discrepancy theory from Higgins (1987) not obtaining what they have committed to leads to motivational/ emotional problems. On one hand it is the "absence of positive outcomes" (disappointment, dissatisfaction) and on the other hand the "presence of negative outcomes" (fear, thread). This motivational/ emotional problems arise from the self concept of how they see themselves and perception of how others view them. There is an actual, ideal and ought to be self which can be viewed from the standpoint of the person himself and people around him. Therefore there are six combinations which can lead to these motivational/ emotional problems. When there is problem between their actions and believes people feel uncomfortable and would rather change their believes than their actions John et al. (2011) to avoid these problems. This can be countered by making commitments openly. Than there is conflict between their view of themselves and the perceived view of the others around them. The motivation to change the actions instead of their believes becomes stronger. Social Norms are now present, which are discussed in Chapter 2.2.3 under Social Norms. Being inconsistent in matching your believes with your actions leads in society often to the image of being unreliable or untrustworthy (McKenzie-Mohr, 2006).

## 2.3 Gamification

In the recent years the term gamification has become more and more popular. It is an approach for organizations to implement gaming mechanisms into real world applications to understand and influence the behaviour of their employees or customers. The gamification practices are aimed at making the interaction of the people with the system fun and entertaining (Dale, 2014). A happier, more engaged and loyal bond can be formed. Gamification practices are already encountered in real life situations. airlines offer reward points for using their service grocery stores have loyalty cards for returning customers. The interest in gamification is rapidly growing and according to Dale (2014) Gartner projects that by 2015 Organizations will have allocated 2.8 billion USD in direct spendings on implementing Gamification practises into their business. As it is rooted in the gaming industry the basic gamification frameworks are drawn from there to create game like experiences.

### 2.3.1 Concepts of gamification

Every game has its own rules, tools, types of interactions, boundaries, players and rewards (Dale, 2014; Robson et al., 2015). There are various concepts on how to implement these practices. Choosing one which fits the cause best is crucial as Gartner (2012) predicts that 80% of the gamification applications will fail to meet their cause. They identified the reason for that as misunderstanding of the term gamification and therefore wrong assumptions of how to implement it.

The focus of the master thesis lies on the concept from Reiners and Wood (2015). It is called the "RECIPE for Meaningful Gamification". They choose the word meaningful as they base it on motivational differences in how gamification practices can be designed to elicit different motivations in the players. The motivational aspects of gamification are explained later in Chapter 2.3.2. They want to implement longer lasting change and address the problem Gartner (2012) blames for the 80% failures from the motivational aspect of the players.

Reiners and Wood (2015) principles are:

- ***Play:*** *facilitating the freedom to explore and fail within boundaries*
- ***Exposition:*** *creating stories for participants that are integrated with the real world setting and allowing them to create their own*
- ***Choice:*** *developing systems that put the power in the hands of the participants*
- ***Information:*** *using game design and game display concepts to allow participants to learn more about the real-world context*
- ***Engagement:*** *encouraging participants to discover and learn from others interested in the real-world setting*
- ***Reflection:*** *assisting participants in finding other interests and past experiences that can deepen engagement and learning*

#### Play

It is an element of every game. When players play together they agree on rules and boundaries everyone follows (Reiners and Wood, 2015). The game is defined through these common agreements. Playing should also be optional. This can be done by giving choices that the players can choose with which element they want to interact.

#### Exposition

It consists of two parts. The first is the development of a narrative element and the second is the presentation of it. The purpose it to give the player additional ways to connect the game with the real world. It also enables the visualisation of relationships between past, present and future. The player than can make more educated decisions if narrative is similar to real life. There are four kinds of narratives. The *evoked* narrative puts the game in a pre-existing world from a movie, book or previous game. The *enacted* narrative uses short clips, player limitations and fixed paths to present the backstory. *Embedded* narrative is putting elements in the game that tell a story happened in the past for the player to discover. *Emergent* narrative let's the player make meaningful choices to create the narrative himself (Reiners and Wood, 2015). The story of the game, the challenges the players had and the goals they achieved can

be shared with others.

#### Choice
It puts the player in control. For playful experiences it is important to have choices on how to interact with the game and also not to engage at all. This can be done by presenting a challenge or goal and a guide with several activities how the task can be tackled. The guide could also be editable by the players. Players can also share their guides with other players (Reiners and Wood, 2015).

#### Information
It is a crucial element to connect the "why" and "how" with the gamification system. It gives the gamification system its credibility and helps the players to understand why they should change their behaviour. To deepen the learning experience the information should be presented in various ways. A graphical display helps the users to connect their actions to the real world (Reiners and Wood, 2015). The players also have different backgrounds and knowledge. Therefore some information can be important for some and uninteresting for the others. Players who are more advanced need to be considered as well (Reiners and Wood, 2015).

#### Engagement
It is on one hand with the system itself and on the other hand social interaction. The interaction with the system itself should be motivating and fun. These topics are discussed in the next chapters. The social interaction can happen through the player itself or game mechanisms. The interaction by the players themselves can happen through Facebook or a forum. The interaction through game mechanisms can be competitions or cooperating (Reiners and Wood, 2015).

#### Reflection
It enables the players to connect their gamification experiences with their own life or the real world. Without it the players will not find meaning in their doings. When reflection happens in a social setting with others it is stronger and they can learn from each other. Reflection consists of three basic components. During description the players think about their interaction with the system and shares it. In the analysis part they analyse their interaction and connect it to the real world. The final one is the application when players act on their gained experience. Behaviours learned in the system are than taken beyond it into the live of the player (Reiners and Wood, 2015).

The concept represent guidelines to help implement gamification practices and reduce the rate of failure. Popular gaming mechanism include Achievements, Points, badges, levels, competitions, leadership boards and etc.

### 2.3.2 The players motivation

It is important to understand the users and how to influence human behaviour. Gamification draws from the fundamentals of psychology and behavioural science. Motivation, ability level and triggers found the three main pillars. When these three things are present behaviour change can happen (Dale, 2014). Motivation and ability level depend on each other. The higher the motivation the lower the ability which is needed and vice versa. When the designer creates the gamification experiences the player should

be in the state of flow which are complimented with three central motivators that are used in games (Zichermann and Cunningham, 2011): Pleasure, rewards and time.

### Flow

In the flow state the players are motivated to play and to continue to play. The flow state was intensively researched by Mihaly Csikszentmihalyi (Nakamura et al., 2005). It is displayed in Figure 11. While a player is in the flow channel they enjoy playing. In the areas outside of it they are likely to quite. If the game is too easy and the player to skilled he gets bored or vice versa the person can get anxious or finally panic. Both states are not desired. The players should be in the flow channel.

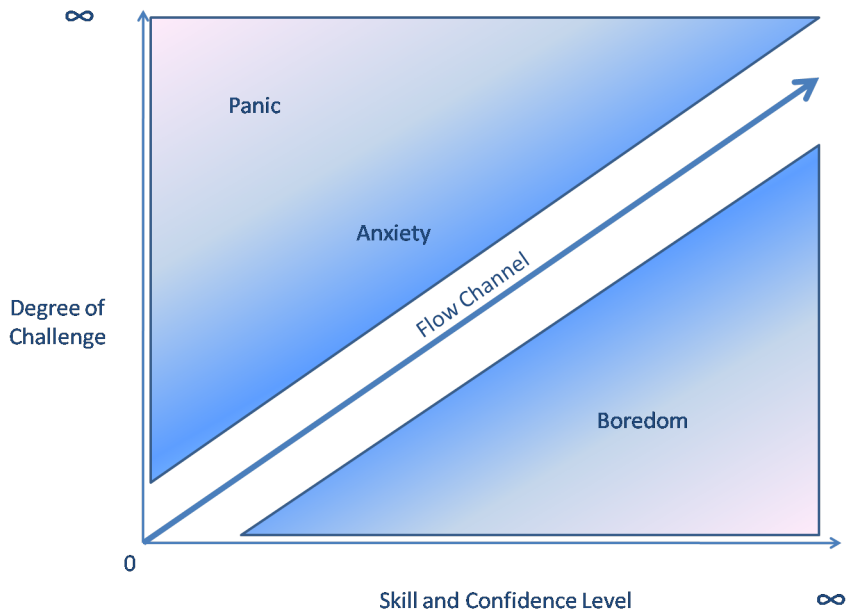


**Figure 11:** Flow channel (Progressive Manager's Network, 2008)

To understand how to get a player in the flow state there are several different angles on how to look at designing a gamification experience. Lazzaro (2004) the president of XeoDesign researched why people play, Bartle (1996, 2005) did research on the characteristics of players and another angle would be to identify where the motivation comes from.

Lazzaro (2004) main findings where that the games have to create experiences and fun. She identified the four key factors hard fun, easy fun, altered state and people factor for creating that. They are not mutually exclusive. The most popular games combine at least three but they also stand alone as pillars to engage with. Another discovery in her research was that players who play in "groups emote more frequently and with more intensity than those who play on their own" (Lazzaro, 2004). The social interactions enhances the experience.

**1. Hard fun**
It is based on challenging the player with obstacles and pursuing a goal. The emotions which are created in the process of reaching the goal are failure and victory. Players want to feel success by getting their abilities challenged. Hard fun can be experienced through cooperative and competitive gameplay.

**2. Easy fun**
It is directed towards maintaining attention rather than winning. The player should experience the world by exploring it and discovering new things. His feelings of curiosity are fulfilled by creating a sense of wonder, awe and mystery. It grabs the players attention with many details, incompleteness and ambiguity.

**3. Altered state**
It focuses on the internal emotions the players feels while playing. What effects create the external stimuli of the game on the internal emotions of the player. While playing players feel excitement and relief. They play to have a relaxed time, avoid boredom or clearing the mind.

**4. People Factor**
It focuses on letting players interact with each other. The focus is on teamwork and the pursuit of shared goals. The main factor for people to play is social interaction. The social interaction can happen through cooperation or competition

Bartle (1996) focus lies on the characteristics of the players. When you understand the player you can design the experience shaped towards them. He identified four player types. The types are Achievers, Killers, Socialisers and Explorers. Amy Jo Kim (2012) developed Bartle's 4 player types further and made it more applicable for gamification practices. She is a social Game Designer with a PhD in behavioural neuroscience and works as a Game Design professor at USC School of Cinematic Arts. Her player types are displayed in Figure 12 and are further explained afterwards.


**Figure 12:** Kim's player types (Kim, 2012)

### Express

People want to express their achievements and showcase what they have done and who they are. Their motivational drive derives from gaining new skills and increasing their possibilities. Social media and modern social gaming use self-expression to gain customer engagement and purchases/ monetization.

### Compete

People who like competition want to overcome obstacles and compete against others or themselves to improve their own metrics. It is the main driver of social gameplay and self-improvement.

### Exploring

People who like exploring are motivated through discoveries of new information or things. Possibilities to gain access to new things or knowledge instead of stand-alone points are important to them.

### Collaborate

People who like collaborating want to work together. Instead of winning against someone group work and the feeling of being part of something great is meaningful from them.

They are not mutually exclusive. Players can be a combination of various types and can develop into another over time Bartle (2005). In case that a player could only be one type the majority with around 75 % would be according to Zichermann and Cunningham (2011) collaborators.

### Intrinsic versus extrinsic motivation

In Psychology motivation is separated into two kinds. On one hand it can come from inside (intrinsic) and on the other hand from outside (extrinsic). Intrinsic motivation is self-motivating and works through valuing the activity while extrinsic is a strong external coercion or regulation to do the activity (Ryan and Deci, 2000).

***Intrinsically*** motivated people search for mastery, develop spontaneous interest and try to explore. The traits are important for personal and social development and are main sources for enjoyment and vitality throughout life (Ryan and Deci, 2000). In the flow channel when a player is challenged in combination with effectance-promoting feedback they become intrinsically motivated. According to the research from Ryan and Deci (2000) they found that competence, autonomy, relatedness and meaning are the basic elements of intrinsic motivation. An activity is done for the enjoyment itself. Reiners and Wood (2015) states that intrinsic motivation is important for long-term change. When performing an activity for ***extrinsic*** motivation it comes from outside as a regulation activity. The responses it can evoke range from amotivation, unwillingness over to passive obedience and active personal commitment (Ryan and Deci, 2000). The motivation itself can be really divers. It can range from a threat, follow government policies, advice from parents to social norms. The problem with extrinsic rewards are that they can undermine intrinsic motivation. According to Reiners and Wood (2015) giving rewards can end up in a reward loop with participants expecting an increase of rewards with an increase of ability. People also perform inferior with an extrinsic motivation than with an intrinsic one, often stop performing the action when the rewards stop and it can do long lasting harm. Alfie et al. (1995) comes to this conclusion by reviewing up to 100 research papers. According to Reiners and Wood (2015) Extrinsic motivation is in general good for immediate and short-term change. But there is also another side to extrinsic motivation. It can be internalized and continue as intrinsic (Ryan and Deci, 2000). When a new employee adopts the company culture extrinsic motivation is internalized and becomes intrinsic. In Table 3 examples of intrinsic and extrinsic gamification motivators are displayed.

**Table 3:** Extrinsic vs. Intrinsic Rewards (Dale, 2014)

| **Extrinsic** | **Intrinsic** |
|---|---|
| Money | Recognition |
| Points/Badges/Trophies | Personal Achievements |
| Prizes | Responsibility |
| Penalties | Power |
| Quests | Fun |
| Progress bars | Mastery |

The aim should be to create a gamification experience which finally leads to an intrinsic motivation. As extrinsic can become intrinsic but also damage the outcome a careful balance is needed. Ryan and Deci (2000) research suggests that for extrinsic to become intrinsic autonomy, relatedness, meaning and competence need to be facilitated. When a person feels competent and related to a reference group and feels autonomy the external regulations of the group are internalized and become intrinsic. another way is that people grasp the meaning of the external regulation and it fits their own goals and values.

### Stages of mastery

While playing the players gains experience, skill and confidence in performing the task. They develop as they proceed in the game. To keep the players motivated, in the flow channel, the challenge through the task needs to increase with their development. There will come the point the player mastered the game or internalized the desired behaviour. A player who mastered the game and is further engaged can help to improve the game itself Zichermann and Cunningham (2011). According to Dreyfuss and Dreyfus (1980) a players development has 5 stages. The stages are novice, competent, proficient, expert and master. In the expert stage the player mastered the game. The last stage mastery or according to Zichermann and Cunningham (2011) Visionary, the player engages with the designer and tries to help improve the overall experience. When designing a game the later stages are important as well. Not in the beginning as most players will be novices, but through playing they proceed. Not all players will proceed through all stages. Some will stop at some levels (Zichermann and Cunningham, 2011).

### Motivation through rewards

Rewards for motivation can come in different forms. They can be categorized in terms of their effect on the player. They are status, access, power and stuff Zichermann and Cunningham (2011). They are sorted from the most to the least desired and sticky and cheapest to most expensive one.

The ***status*** describes the individual position in affiliation to the other gamers or internally formed groups. With a different status players can display that they are ahead of others and show how good they are. The two core mechanics are badges and levels or leaderboards. Badges are a display of your accomplishments. They must be visible to the other players, otherwise they cannot be put in affiliation. Levels and leaderboards express you affiliation to the other players and indicate if you are ahead or behind. High usage customers can be given ***access*** to special areas or things which most of the players don't have. This creates a desire in people who don't have access. For doing good a player can be rewarded with ***power***. For example he or she can be made a moderator to educate other people about the game. An accomplishment can be rewarded with a real life ***stuff*** in form of a present. The problem is that when it's a one time present the length the players engage in the game is the time they need to achieve the accomplishment.

Players have problems evaluating the rewards. Therefore people judge most often stuff as more valuable than the other things even so they react differently to them. While being part of a game status, access and power are higher evaluated than stuff. It is mostly also cheaper to use them instead of giving away free presents.

### 2.3.3 Design of a gamification experience

When designing a gamification experience one of the first decision is suppose be if it is a direct or indirect application. Direct gamification is creating a game while indirect is the utilization of gamification practices. The game mechanics are next. They consist of elements such as points, levels or progress bars, leaderboard, badges, challenges, the rules and what happens if a player progresses and increases his performance (Zichermann and Cunningham, 2011).

***Points*** are one of the fundamental elements of gamification. Point systems can range from completely to barely and not visible at all. In any case they are the core to track the progress and interaction of the players with the application. Points can be given in various ways. Experience points are given by interacting with the game. They display the status of the player and make him comparable with the other players. They don't decrease and are not exchangeable. As a designer they give a clear image of the interaction with the game. Every task in the game needs to be assigned with a certain amount of points. Than there are exchangeable ones. They are gained through actions taken in the game. As they are interchangeable between players they can form a alternative currency system. Such a system needs a careful design. As soon as it is revealed players often look for the advantage they can get from them (Zichermann and Cunningham, 2011). Therefore the system needs exchangeable items for the points that suit them. Otherwise there is the risk to lose players. Than there can be points which sole purpose is to give them away. They can be used to let the players interact with each other. If a player thinks another player does a good job he or she can give that player points to acknowledge their behaviour. Or it can be used as voting points for the implementation of new features.

***Levels and progress bars*** are a visible display of the progress for the player itself and others. They depend on the design of the game. Is the whole game one progress or does the player proceeds from level to level. With levels the challenge of playing increases with each new achieved level.

***Leaderboards*** are intended for an easy comparison between players. By proceeding through the game the player gains points. More points mean the player is further ahead. When designing a leaderboard it is important how the players should be compared. Players can be compared locally, globally or socially (Zichermann and Cunningham, 2011). The designer also should think about how players are displayed. Will they see where they stand compared to the rest of the players or just the ones in front and behind of them.

***Badges*** are a good way to display the status and the achievements of the players. It is a good way for other players to see which task the player has accomplished. People desire them for several reasons. They symbol status, can appeal to peoples drive of collecting or can be a surprise rush of enjoyment when received unexpectedly (Zichermann and Cunningham, 2011). When implementing badges it is important that they have meaning. Otherwise what they symbolizes vanishes.

***Challenges*** are the task player encounter to interact with the game. By completing them they receive rewards. They are substantial as they present the task from which

the players learn the behaviour. Challenges can be done by one player or in cooperation. Creating cooperative challenges increases the experiences (Zichermann and Cunningham, 2011; Lazzaro, 2004).

# 3 Background

The master thesis is done in cooperation with Greenely. Their actual status is analysed in this chapter. This is important to find weakness and further improve their system.

## 3.1 Greenely

Greenely is a startup company from KTH Innovation from the Royal Institute of Technology (KTH) from Stockholm, Sweden. They are incubated under KIC InnoEnnergy an European accelerator for sustainable energy. They are supported for their innovative idea to engage residential households in helping to stop global warming by lowering their energy consumption. They created a new way to visualize it with a smartphone application using research-based algorithms. It connects the existing infrastructure, smartphones, with the fast growing emerging market of the advanced meter infrastructure (AMI) around the world. This enables customers to easily engage with and contribute to stop global warming. Utilities are supposed to have an enhanced customer satisfaction, reduced expenses through load shifting and should be able to market their products better through deeper customer understanding.

### 3.1.1 System architecture

Greenely builds a bridge between the utility and their customers. A sketched model is displayed in Figure 13. The utility company supplies the electricity to the households. The consumption data is gathered by the smart meter and send back to the utility. The utility than sends the data to Greenely for further analysis and processing. The analysed data is than on one hand send back to the utility and on the other hand processed for the household. The households are contacted via a smartphone application.

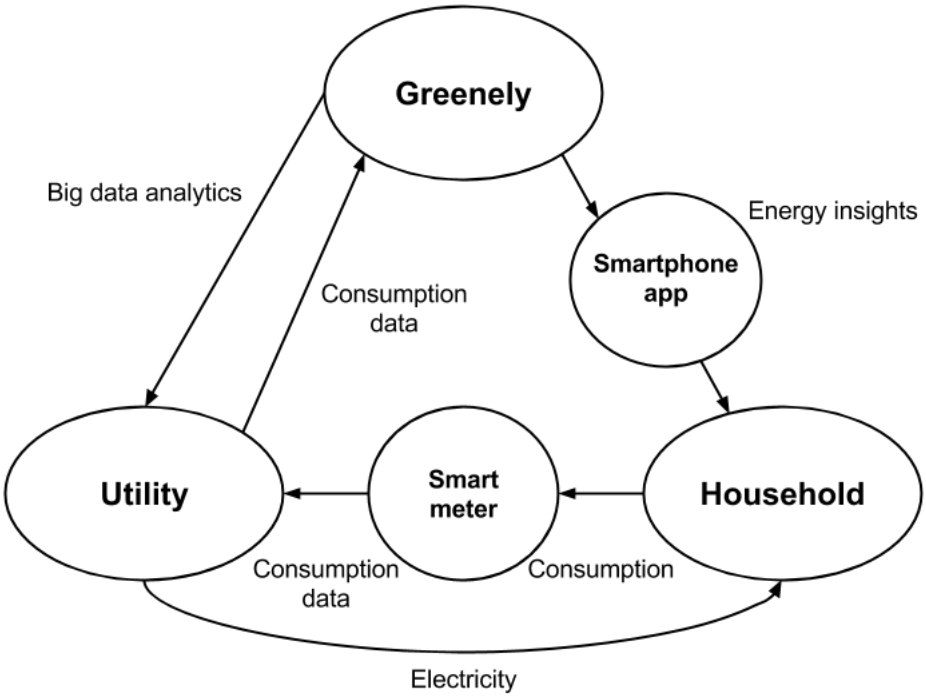


**Figure 13:** Greenely's schema

### 3.1.2 Smartphone application

Greenely's application consists of three screens (Figure 14). The "Energy Usage" screen is the main screen. It displays the consumed energy and the energy tree. The energy tree is designed as visual consumption display. It varies depending on the consumption and therefore includes a rating. There are five different possible trees. The trees are display in Figure 15. From highest consumption with one leave and red colour to lowest and full of leaves, green colour and butterflies. In the bottom of the application are three buttons. With them the user can switch between the screens. The other two screens are "Analysis" and "News".

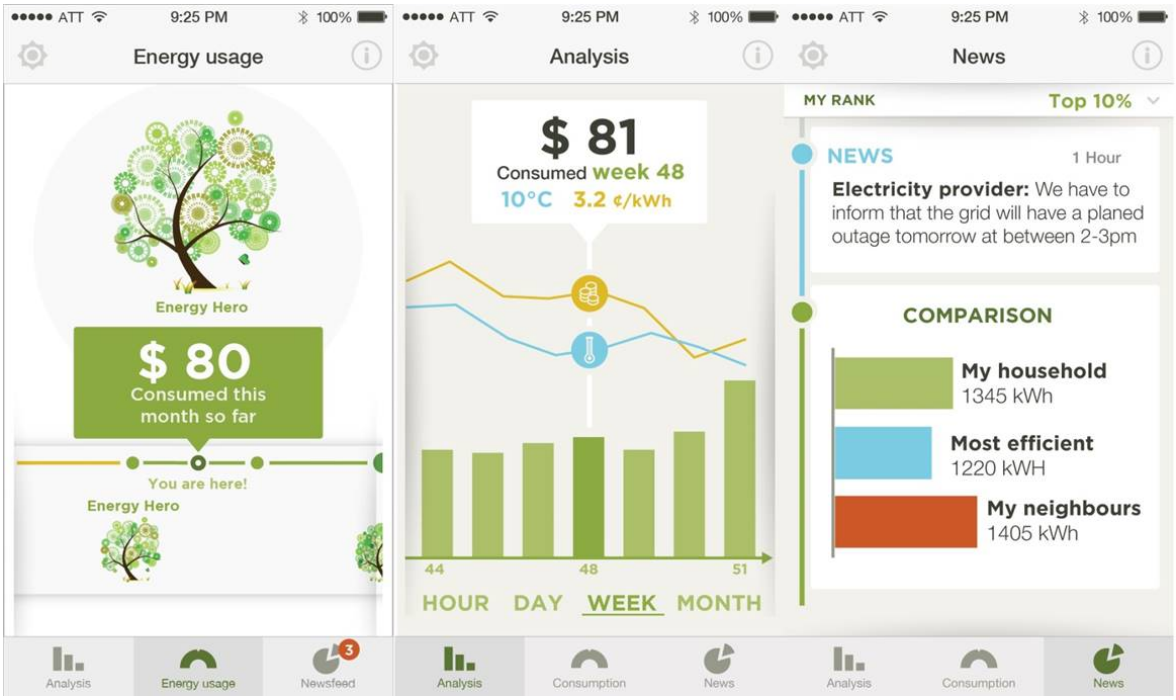


**Figure 14:** Smartphone application screens

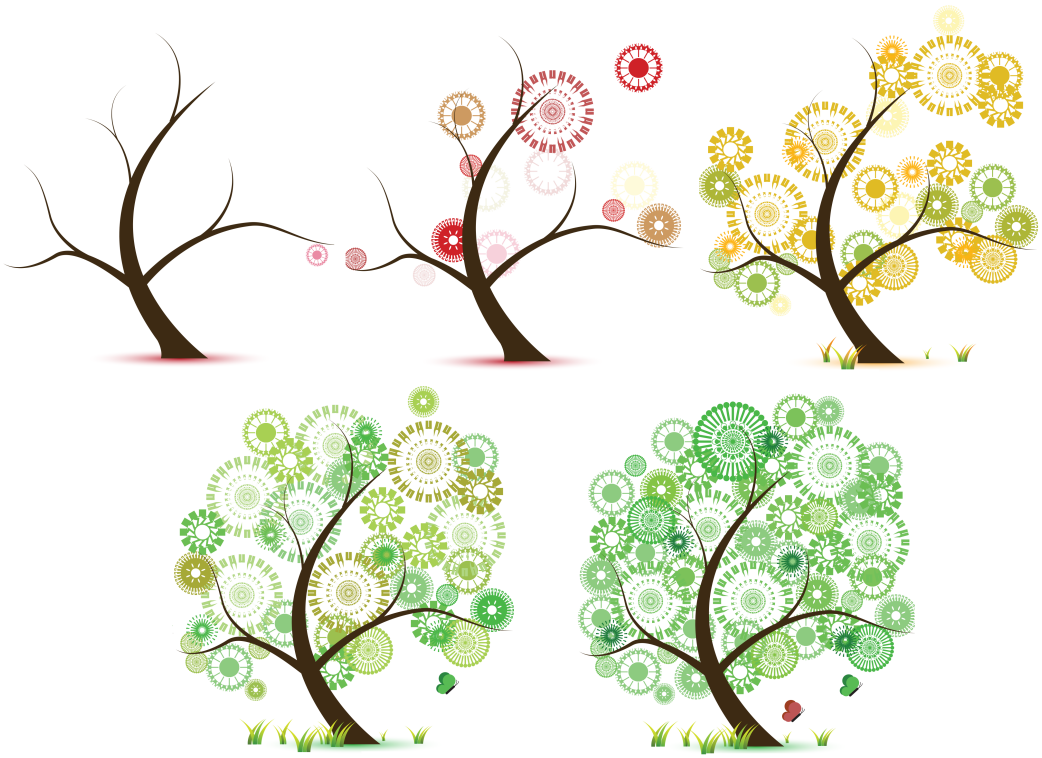

**Figure 15:** Energy tree

The Analysis screen gives an overview about the consumption, the actual electricity price per kWh, the week and the temperature. It can be displayed per hour, day, week and month. The News screen presents up to date informations. In case of this

example news from the utility provider telling that there will be a grid outage tomorrow for one hour are presented. At the top the ranking of the household is visible. The ranking compares households energy consumption with each other and puts the them into relation. Greenely's algorithm makes the different households comparable as there are various factors which influence the consumption of the households. They include number of occupants, floor size, type of housing, type of heating and weather conditions. The next part visible in the News screen is the comparison. The households own consumption is put into relation to more efficient neighbours or all their neighbours. In case of new available informations the News button is highlighted with a red dot and a number for the amount of new news. This is visible in the Energy usage screen in Figure 14.

### 3.1.3 Analysis of greenely

Greenely proposes to use existing hardware in combination with a smartphone application. The application is for free for the customers. No extra expensive or maybe complicated to install hardware can hinder adaptation from households as only a smartphone is needed. The market is growing rapidly an nearly every one has one nowadays. The penetration of smartphones in the USA is supposed to more than triple from 2011 with 92.8 million to 2017 with around 209.7 million (Statista, 2013a) and in the United Kingdom (UK) more than double from 2011 with 21.6 million to 2017 with 43.3 million (Statista, 2013b). The smartphone penetration in the world is supposed to be 2.38 billions by 2017. From all smartphone users in the US the most time spend on media consumption is on applications, Seven out of eight minutes (ComScore, 2014). Smartphones with internet also open the opportunity to reach your data from everywhere around the world. All this strengthen the idea to use a smartphone application with no extra hardware as the market is growing fast.

Even so everybody who has a smartphone will be able to use the application the participating households are limited to customers from cooperating utilities with a smart meter. The consumption data is passed on by the utility to Greenely (Figure 13). As no extra hardware is needed the commercially installed smart meters are used. They most often only provide hourly data or even larger time spans of up to a month. Another limiting factor are the utility companies. Depending on when the data is passed on it can be out of date. According to Greenely in most cases they will receive the data monthly. Therefore immediate feedback is complicated. They also do not engage households with an energy delegate which showed to be useful in Chapter 2.1.

With no energy delegate it is important how the application engages the households as most of the mobile usage time is already taken. 75% of all time spend with the mobile device are on the four favourite applications of the user (ComScore, 2014). Gamification is a way to engage users. From that perspective the application is not very engaging, motivating and fun. The concept only involves limited *play*. You compete with the other users with your real life consumption for a higher ranking. Ranking can be a status reward which is desired in gamification practices. For ranking to become a status you need be able to relate it to others and be able to share it. In the application you are only able to see you ranking without knowing to whom or more specifically to which neighbours you are compared to. It is only visible to you. From the player

types (Chapter 2.3.2) perspective the ranking only engages the competing one. Most of the players are collaborators. There is also no *exposition* through the absence of a narrative element. Considering *choice* households can choose to engage with the application as there is no obligation from the utility. When they choose to use the application they have no choice on how to participate. The play element ranking is obligatory. *information* is nearly completely absent. The application itself lacks an explanation why the users should change their behaviour. There is a visual feedback of the consumption in form of an energy tree and advice in the news screen on activities the households can do for demand reduction. From the *engagement* with the system only a limited version of hard fun and extrinsic motivation in form of a leaderboard is incorporated. The households want to lower their demand and their own behaviour is an obstacle to achieve that. From the social side there is no real interaction. The users are compared to each other but only as vague neighbours. They lack the opportunity to share their results or cooperate and compete with each other. Finally the *reflection* part is missing. The application supports none of the three components. Therefore from the gamification perspective the application only engages the users for short term.

From the behavioural aspect only social norm (Chapter 2.2.3) are used. Opower achieves consistently 2% annualy with that. The results from Chapter 2.1 suggest that more is possible with the incorporation of more up to date behavioural science.

As a summary Greenely's application is displayed in a SWOT analysis.

**Table 4:** SWOT Analysis

| Strength | Weaknesses |
|---|---|
| • Smartphone application<br>• Reach through application<br>• Free to join<br>• Easy to use from everywhere | • No real time data<br>• No energy delegate<br>• Not engaging or motivating |
| **Opportunities** | **Threats** |
| • Possibilities of engagement<br>• Advancements in behaviour science | • Household response<br>• Only short term engagement |

# 4 Results

After analysing Greenely's actual application it is clear that improvements are possible and maybe needed. A greater affect on households can turn the them into more conscious and sustainable thinking human beings and reduce demand faster. With less energy consumptions fewer emissions are produced; helping to tackle the imminent problem of global warming. When they are more conscious Greenely's idea can expand to other parts of their life creating an overall positive effect on their environment. Greenely reaches their goal and the application might spread faster through the word of mouth forcing more utilities to cooperate with Greenely; leading to an even greater reduction and contributing to stop global warming.

In the following I will present an idea on how an improved system outline that creates a greater affect on households can look like. Therefore I incorporate the gained knowledge from previous studies and nudging practices to combine them both with gamification. This system should support Greenely's vision more effectively than their previous version. It is designed to nudge the households and engage them to achieve high possible demand reductions. I try to incorporated the opportunities and tackle the weaknesses and eliminate the threats. It will be an outline for a future application and explains what kind of measures and why they should be included. The design and creation of the application is out of scope of this thesis and is left to Greenely.

## 4.1 Application outline

In most cases Greenely will receive the consumption data monthly from the utility company. Through that it is complicated to engage the users constantly with the application when there are no data updates that present something new. Therefore the outline is focused on strong enough incentives that are a stimulant while the application is not used. Therefore it rests on three pillars that are embedded in a fourth. They form the foundation of the application and are displayed in Figure 16.

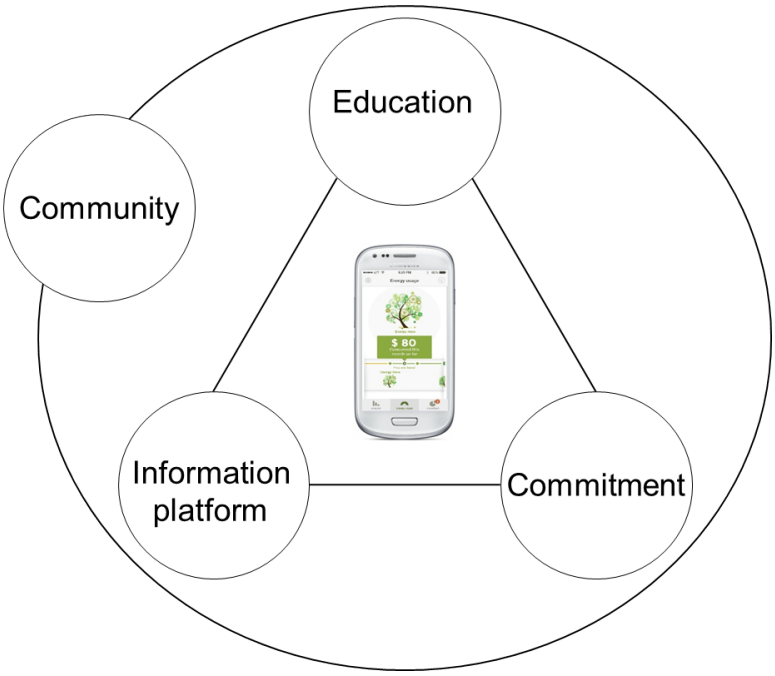


**Figure 16:** Proposed system architecture

The pillars education, commitment and information platform are designed as a three step process. In the first step a concern for the environment is created and the users are nudged with a prompt. This puts them into the right mindset for the next step. The second step uses that mindset for a commitment. They should follow close behind each other. Doing that is important to make sure most users agree to a commitment (Chapter 2.2.3). During the monthly period when no new consumption information is presented the third step helps them to accomplish their goal. This is supported by Social Norms through the Greenely or Neighbouring community and the comparison tool Greenely already uses in their application. The pillars are explained in detail in the following chapters.

### 4.1.1 Education

This part serves two purposes. On one hand it educates the users and gives reason and background informations for the desired behaviour change. On the other hand it is a nudge that puts the user in the right mindset for the next pillar commitment.

From the gamification perspective the education is done as an enacted narrative (Chapter 2.3.1). Pictures and maybe short-climbs explain the background story in a vivid and easy to understand way. For example a vivid and short sequence of pictures explaining as a story of how global warming began up to the problems now. It should happen with limited text. It also serves as part of the information part (chapter 2.3.1) and gives Greenely's idea credibility and supplies the users with why they should save energy. It is the reason behind the why and creates a concern for the environment and gives meaning.

The other purpose is that of a prompt. A prompt is a nudge (Chapter 2.2.3). It servers as an anchor point for the pillar commitment. With the enacted narrative the users are

reminded to do something. When the users start to think about a topic they are more likely to engage with it. Therefore the next pillar should follow shortly afterwards.

### 4.1.2 Commitment

This part is crucial. In the Community based social marketing (CBSM) study (Chapter 2.1.3) commitment is regarded as one of the important factors (Chapter 2.2.3). It is also a nudge (Chapter 2.2.3). When they commit they should have a choice between a personal or a group demand reduction target or compete for one. They can choose if they want to set themselves a goal of how much energy they want to save or form a group with friends or neighbours and set a bigger target for all together. The application could give here options the users can choose from. Concerning the player types most of the people are collaborators (Chapter 2.3.2) but some also want to compete. Therefore the option of challenging other users is included as well. It should be designed to make it is easy to engage with your neighbours. Being able to work or compete together builds a sense of community and is from the players motivation aspect (Chapter 2.3.2) people factor and hard fun. Achieving to overcome your target or winning challenges also build competence. Doing both together also let's the user relate to each other, strengthening the sense of community. Agreeing on a commitment together makes it also public. A public commitment is stronger because you community knows it. In any case making the commitment somehow public or easy to share with other users or people strengthens it. There also needs to be a message for the person or team that lost to keep them motivated. The message should be vivid and easy to grasp. Being able to choose what you do gives also the feeling of autonomy. People feel that they are in control.

### 4.1.3 Information platform

When the users have committed they need the best help they can get to achieve their goal. They need to be able to find solutions to overcome their everyday obstacles. Giving them that builds confidence that they can achieve their goal. The information platform should also be designed to be adjustable by the users. They need to be able to create content. Through that autonomy is build and engagement from . The users feel in control. Here they can share their advice or/ and interact with Greenely's community and their neighbours. This also helps with a varying knowledge bases through different backgrounds. Everybody can find the right information. Here they can also reflect on their doings and share their experience and can gain valuable feedback. This can be later brought into real life by adjusting behaviour. Another feature should also be that user are able to rate advice. Users with more valuable advice and high savings can be used as interactive guides or maybe as an energy delegates. This is useful also for players who gain experience, skill and confidence. They want to proceed further and need more motivators to engage with the application (Chapter 2.3.2). This information platform should also include advice on new and energy efficient appliances.

### 4.1.4 Community

Integrating a feeling that the users belong to a community is crucial. On one hand it should be emphasized that all users are part of the Greenely community and together help stop global warming. A vivid progress bar can displaying all the savings summed

up with an interesting correlation as an example. On the other hand the community of neighbours is important as well. The more the people relate to each other the more effective is the community feeling (Chapter 2.2.3). The community feeling enables the nudge social norms and also supports the pillar commitment. Creating this feeling can be done through the pillar education and through the right presentation of information. To have a community of peers enables you to reflect and get feedback.

### 4.1.5 Rewards

From the aspect of motivation I would incorporate Status, Access and Power (Chapter 2.3.2 - Motivation through rewards). To accomplish this I suggest points, badges, a progress bar and a leaderboard.

**Badges:**
They are a visible display of all achievements of the users and more importantly of their status. They should earn them by accomplishing their commitments or contribution to the information platform. They should be visible for the other users. This is important as otherwise most of the status affect is gone. Without them it is impossible to put yourself in relation to others (Chapter 2.3.2 - Motivation through rewards).

**Progress bar:**
It should show the users their savings in a unit easy to grasp. This could be savings in CO2, kWh or something completely different like a contribution to the countries CO2 reduction target. To make this more memorable it should be vivid. When they touch the progress bar it goes more into detail and gives a picture of what the savings did. To increase the community feeling a progress bar that sums up the savings from all Greenely users or the direct neighbour could be useful. It strengthens the community feeling and the feeling of being part of something bigger. Especially in the beginning when the savings are very small and the global contribution is marginal.

**Leaderboards:**
The integration of this part is limited and the design should be carefully considered. According to the player types (Chapter 2.3.2) most of the players are collaborators. In commitment I suggested competitions. To make competitions easier a leaderboard to easily find competitors is a good way. Than advanced savers play against users with the same knowledge. Beginners will not get demotivated by loosing against advanced savers.

**Points:**
Points are an integral part of any gamification experience. Either for the user or the designer of the experience. They are a way to measure how the user behaves or his progress in the system. with points the system can go into two directions. On one hand they can be visible for the user and on the other hand only visible for the designer. With visible points a complementary currency system could be created, rewarding the users with coins they could exchange into real things inside certain boundaries. Complementary currencies are out of the scope of this master thesis. The invisible ones are used to determine when users get badges or what their position on the leaderboard is.

**Extra features:**
Besides the system outline I would still incorporate the comparison tool Opower and Greenely already use. It uses social norms and is proven to work without implementation uncertainties (Chapter 2.1.4 & 2.2.3). It is also a good motivator during the time without new data. Especially if someone is not doing a commitment. Another tool which could be useful are mini games. They could also be a way to engage users during times without new data. Longer engagement might be hard otherwise when the users only receives monthly data. The application should also be adapted to social media. User should have the possibility to share everything with friends. This serves as status and can attract new customers as well.

## 4.2 Analysis of application outline

The four pillars include the following functions listed in Table from previous studies (Chapter 2.1), nudging (Chapter 2.2) and gamification (Chapter 2.3) stated below in Table 5 to achieve the desired goal.

**Table 5:** Included functions in the system

| Education | Commitment | Information platform | Community |
|---|---|---|---|
| • Prompt | • Commitment | • Information | • Social norms |
| • Play* | • Social norms | • Engagement | • Engagement |
| • Information | • Play | • Reflection | • Reflection |
| • Exposition | • Choice | • Autonomy | • People Factor |
| • Altered State* | • Engagement | • Competence | • Relatedness |
| • Meaning | • People Factor | • Relatedness | |
| | • Hard fun | | |
| | • Autonomy | | |
| | • Competence | | |
| | • Relatedness | | |

*Only included in case mini games are implemented in education (Chapter 4.1.1).

From analysing previous studies on demand reduction (Chapter 2.1.6) I could gain valuable information on functions that could possibly be integrated into the system outline. They are in line with Greenely's ideas and possibilities. The integrated functions are as follows:

- Goal setting/ Commitment
- Concern for the environment
- Sense of community
- Comparison

The IHD and the TOU are left out because the IHD would be extra hardware and the billing plan depends on the utility. Identifying barriers as in Chapter 2.1.3 is a complex, costly and time intensive process. Therefore it is out of scope from what Greenely intends. It could be integrated as an ongoing process that starts with a questionnaire in the target area before Greenely deploys the application and then expand through the interaction with it.

The explained nudges and from the concept of gamification the principles are included. To make the interaction fun and enjoying from the player's motivation hard fun, people factor and in case of implementation of mini games altered state are incorporated. To change the motivation from extrinsic to intrinsic all four important factors are present. Therefore the application should have the ability to achieve the desired outcome to engage the users and create long term behaviour change.

# 5 Discussion

What I presented was a proposal for an application outline that improves Greenely's current application. It includes features and elements which should be incorporated and reasons why. The features were selected after analysing previous studies done on demand reduction and an intensive research on nudging and gamification. Concerning the application outline all of the features are tested individually and work. The question which remains is how they will work together. In theory it should work and lead to the desired behaviour change. In practice how they correlate is to a certain degree unknown. The time needed to design and thoroughly test the application was out of scope. Concern for the environment and commitment are tested together in community based social marketing (CBSM). There they both are part of a larger overall system in which they function together. If they do in a different system needs testing. The commitment was also done together with the energy delegate.

What also can and will happen is that some users will not make a commitment. Making a commitment with an application or a person is something completely different. An application can be turned off while an energy delegate, who is at you house, is inescapable. To achieve demand reductions even than the comparison tool which is already used in their previous application is integrated. While they reduce their demand through the comparison tool I hope that social norms through the Greenely or neighbouring community sooner or later lead them to make a commitment. Here the right rewards can play an important role as well. They can serve as an incentive to make a commitment.

A limiting factor is also the utility data. The application outline is now designed for receiving the data monthly and expects no constant usage time. In case Greenly receives data more frequently the application needs to be upgraded. In my opinion the system outline works also with more frequent data updates. But how this will change the dynamics of the application and the users is complicated to predict.

Another interesting questions is if the energy delegate can be replaced by a virtual one. A virtual guide helping the users when they are using the application. In my opinion this could be possible in some ways. Having the guide explaining the narrative could make it more engaging as if the story is just presented. The users can form a bond to this guide and might relate more to the story and the application. If it is as effective as an energy delegate? I think the virtual one is limited for several reasons. The virtual one depends on the application usage. He is gone with turning the application off. In that sense he can be counted as the email alert compared to the energy delegate in study University of Kent (Chapter 2.1.1). The email could just be skipped. The real delegate comes to a certain time and is there even if the users don't use the tools provided. The delegate is to certain degree like a commitment which also serves as a prompt. He or she comes to a certain agreed time. The users know the time and date which puts pressure on them and reminds them that there is something to do. According to McKenzie-Mohr (2006) The reasons for that are found in social science which indicates the direct appeal of a delegate as an important factor. Therefore in my opinion a virtual delegate can only give limited support by maybe making the application more engaging.

The next step in the whole process of improving the application is the final design and afterwards the distributed to households for further testing and refining. Creating an outline was only the first step. How it is designed can have a major influence on the correlation of the functions or how the users accept it. This is left to Greenely.

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