Investigating the Relationship between Householders' Engagement with Feedback and Electricity Consumption: An Ontario, Canada Case-Study

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Julia Shulist

Abstract

In this study, 22 homes in Milton, Ontario had their electricity consumption monitored for between seven and 15 months, and they were provided access to their data via an online webportal. The webportal provided appliance-level and house-level data, allowed them to set consumption goals, and schedule when their appliances would be used. The households were chosen to participate because they had previously expressed interest in advanced smart meter grid technologies, and when contacted again by Milton Hydro, they agreed to participate in the study.

The main question being asked in this research is: what effect, if any, does having access to one's consumption data have on consumption? To investigate this question, consumption data from the monitoring period, and the previous year (the base year) were obtained from Milton Hydro and were used to determine how consumption changed between these two periods. The consumption data for the cooling months were weather normalized to account for increases in consumption that result from cooling the dwelling. Data regarding users' engagement with the webportal, including how often they would login, for how long and what pages they were visiting, were collected from the webportal. An engagement index was adapted and refined from Peterson & Carrabis (2008), and along with the engagement data from the webportal, was used to calculate the engagement index. Data from two surveys were used to profile the households and to investigate their attitudes and behaviours towards electricity consumption.

There were several key findings. First, engagement with the webportal was quite low; the engagement index (a value between zero and one) for the first three months the hub was open averaged 0.285 and ranged from 0 to 0.523. These numbers dropped by the end of the seventh month to an average engagement index of 0.163, and ranged from 0 to 0.341. The second key finding was that the hubs were not consistently conserving electricity; for the first three months, 10 of the 22 households had conserved electricity between the base year and monitoring period; at the end of the seventh month, this dropped to nine households. At the end of the third month, the change in consumption was an increase of 8.22%, and at the end of month seven it was an increase of 7.71%. The third finding was that there did not appear to be a connection between energy conserving attitudes and energy conserving behaviours. In the surveys, 12 households stated that their goal was to conserve electricity, however, of these 12, only four actually

conserved electricity at the end of month seven. Finally, when comparing the engagement index with the change in consumption, there appeared to be only a weak, negative correlation between the variables. This weak correlation may be a result of two things: (1) a lack of engagement, which limits the ability to find correlation between engagement and change in consumption; (2) there is actually a weak relation between the two variables.

Based on these findings, some recommendations are put forth, specifically about how to engage householders with the webportal. Suggestions include getting applications for mobile devices, and delivering electricity saving tips to households via e-mail, text message, and/or on the homepage of the portal. These tips could be given based on the season, or based on the goals that were set, and would encourage and explain to householders how to decrease consumption.

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Chapter 1: Introduction

According to the U.S. Energy Information Administration (EIA, 2013), the global net electricity generation is forecasted to increase by 93% by 2040 (EIA, 2013). Renewable electricity generation is projected to increase 2.8% every year until 2040 and coal-fired generation is projected to increase 1.8% every year until 2040, and is also projected to remain the largest source of generation in the next 30 years (EIA, 2013). The increase in consumption coupled with the increasing recognition of the unsustainable consequences of electricity generation from fossil fuels, has brought attention to the importance of, and need for, electricity conservation and demand management.

While conservation, using less electricity overall, is the main focus of this research, demand management, changing patterns of electricity consumption in an effort to change the shape of the load curve, is part of the framework of the thesis (Gellings, 1985). The homes in this study are under a time of use pricing scheme, which is a type of demand management. In addition to this pricing scheme, the homes in this study also receive feedback via a webportal. Feedback is designed to give householders detailed information about their consumption allowing them to better understand how they consume electricity (Gronhoj & Thogersen, 2011; Wallenborn, Orsini & Vanhaverbeke, 2011).

There is an abundance of literature on feedback, discussing types of feedback and the effects of feedback on household electricity consumption, but there is limited literature on how the user engages with the feedback, including how often and for how long they access their feedback, what types of feedback they are accessing and how that affects their consumption. This study aims to fill that gap by investigating how having access to one's feedback affects consumption. This will be done by monitoring consumption of 22 households in Milton, Ontario, giving them access to their consumption data and other feedback by way of a webportal, and monitoring their engagement with this feedback.

1.1 Electricity Demand in Canada and Ontario

In Canada, the demand for electricity has been rising since 1990, with industrial and residential sectors consuming the most and second most electricity, respectively (NRCan, 2009a). According to NRCan (2009a), the increased use of electrical appliances, along with increased population growth and economic growth are the main reasons for this increase in electricity demand in Canada. In Ontario, electricity demand is also increasing, and is expected to grow by 15% between 2010, and 2030 (OME, 2011).

Ontario's electricity system is currently being transformed to make it "cleaner, greener and smarter" (OPA, 2013). This goal is being achieved through three initiatives. The first is having a more efficient grid, which started with the installation of smart meters. The second is having a cleaner supply mix, which has been achieved with the elimination of coal-fired generation by 2014 and the addition of more renewable sources of electricity. The third is conservation, for which programs are being developed and geared towards the end user to help them to make better choices when it comes to electricity conservation, thus helping them better manage their electricity and save money (OME, 2012a; OPA, 2013)

This thesis will focus mainly on conservation efforts; conservation not only reduces the amount of electricity consumed, but it is also a more cost effective option, as it will lessen the need for new generating, transmission and distribution infrastructure, which can be costly in terms of time and money (Nadel, 1992; OME, 2012a). Conservation has been effective so far; since 2005, 1700 MW of electricity have been conserved in Ontario, saving consumers money on their electricity bills (OME, 2012a).

In 2011, residential electricity consumption was 49 TWh, 34% of the total electricity consumption in Ontario, the second highest consuming sector, second only to the commercial sector (OPA, 2012). This is predicted to increase to 53 TWh in 2031 (OPA, 2012). Since residential electricity use accounts for a large portion of electricity consumption and significantly contributes to the amount of carbon dioxide emitted, attention should be brought to the need for electricity demand management in the residential sector. Residential conservation can be facilitated by three different approaches: policy, economic and social/educational. Ontario has several policies that have already been implemented to help conservation, including updating the Ontario building code to increase standards for energy efficiency and reducing greenhouse gasses (MAH, 2013).

Ontario has also implemented time-of-use (TOU) pricing, a type of demand management that creates economic incentives to shift consumption from on-peak and mid-peak to off-peak times, giving consumers the opportunity to lower their electricity bills (OME, 2012b). In Ontario, the base load power is drawn from nuclear and hydro stations; variable and intermittent power is drawn from solar and wind power; and intermediate and peak power is drawn from hydro with storage capacity, natural gas and coal (until phased out) (OME, 2012a). While TOU pricing may only shift consumption to off-peak times, and may not decrease overall consumption, it helps reduce the demand for gas and coal-fired electricity generation, thus helping to decrease carbon dioxide emissions.

Currently, over 4.4 million electricity consumers in Ontario have smart meters installed (OME, 2013). Smart meters are a technology that records hourly electricity consumption, and provide a basis for demand management (OME, 2012b). Smart meters make it possible for households to get valuable feedback about their consumption, specifically about their on-peak, mid-peak and off-peak consumption, thus facilitating the social and educational approach to conservation.

In this research, both economic and social/educational approaches to conservation were used. The 22 dwellings in this research are located in Milton, Ontario where TOU pricing has been implemented, and as a result also all have smart meters. In this pricing scheme, on-peak is priced the highest, mid-peak is priced between on-peak and off-peak, and off-peak is priced the lowest (Milton Hydro, n.d.). Figure 1.1 shows the TOU pricing, where the summer is May 1 to October 31, and the winter is November 1 to April 30.

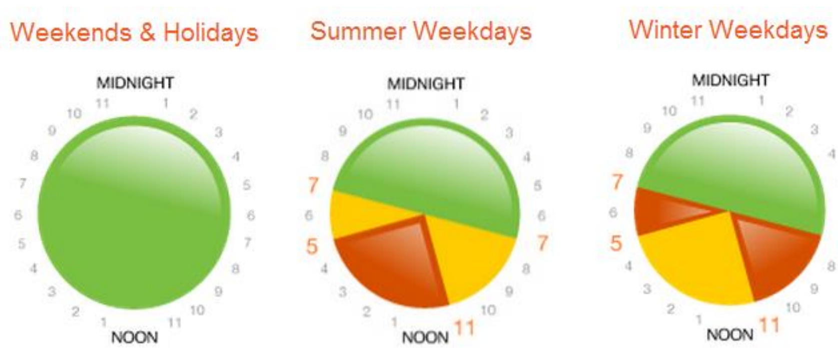

Figure 1.1 – Time-of-Use Pricing (Image from Milton Hydro, N.D.)

This economic approach is combined with a social and educational aspect which is provided by way of a webportal that displays real time consumption data, along with other types of feedback, such as goal setting and historical comparisons. Combining these two approaches gives the householder monetary incentive to save money by shifting consumption to off peak, while also giving them valuable information about their consumption, by way of the webportal.

1.2 The Energy Hub Management System

The research that was conducted in this thesis is part of a larger body of work conducted by the Energy Hub Management System (EHMS). The purpose of the EHMS is to "develop and to implement an Energy Hub Management System that will allow static energy users to manage effectively their energy requirements. More specifically, this project will empower energy hubs – that is, individual locations that require energy (e.g., manufacturing facilities, farms, retail stores, detached houses) – so that they can contribute to the development of a sustainable society through the real-time management of their energy demand, production, storage and resulting import or export of energy" (UW, n.d.). While the EHMS deals with commercial, industrial and residential hubs, this research will focus solely on residential hubs.

As a part of this project, a webportal was developed, and it has two functions. The first is to provide the householders in each hub with their consumption data, and the second is to give the researchers access to data collected from each hub, including consumption and engagement data. The webportal, and its functions will be discussed in more detail in chapter three.

1.3 Thesis Outline

After this chapter, there are five chapters that will discuss feedback, engagement with feedback and electricity consumption. Chapter two will present the literature reviewed for this thesis. Topics include the types of feedback, the connection between feedback and attitude, feedback and behaviour, and attitude and behaviour. There is also a discussion about users' engagement with their feedback. Key papers will also be discussed, and the thesis question and objectives will be presented. Chapter three is the methods section. This section will discuss and explain the tools used in this research, including the surveys and the webportal. It will also discuss the qualitative and quantitative data used, such as survey data, weather data, consumption data and engagement data. The methods used to analyse the data, such as weather normalization and the engagement index will also be discussed. Chapter four is the results section, and will contain detailed results from the survey, consumption data from the base year and the monitoring period, change in consumption from the base year to the monitoring period, and engagement data, including the engagement indices for each hub. Chapter five will contain the analysis and discussion of the data from chapter four. Chapter six will present the conclusions of the thesis, along with recommendations and directions for future research.

Chapter 2: Literature Review

2.1 Introduction

In this chapter, findings from the reviewed literature are presented. The articles reviewed were from both peer-reviewed literature and grey-literature, and were mostly obtained through searches on Web of Knowledge and Google Scholar. Textbooks, government websites and private reports were also consulted. Reviewed articles discussed topics such as effectiveness of goal setting and feedback, electricity consumption at the household and appliance level, and household engagement with feedback, including how householders like to receive feedback and how they like their data presented. The purposes of this literature review are as follows:

a) To identify the current state of research for the provision of electricity consumption data;
b) To understand what makes electricity consumption feedback easy for the householder to understand, and what gives them the information that can best help them to conserve electricity;
c) To understand what keeps householders engaged with their data, and the effects of long term engagement.

In this section, I will begin by discussing electricity consumption feedback, specifically, the different types of feedback, their benefits, and the barriers that keep behavioural change from occurring. From there, householder engagement with their consumption data and the challenges of keeping householders engaged will be discussed. This will be followed by a heuristic model of environmental decision making, which will help clarify why consumption data and feedback can be effective methods for facilitating conservation. Finally, I will discuss where the gaps are in the literature and how this research will help to fill them, concluding with the research objectives that will be examined in this thesis.

2.2 Feedback

Electricity consumption feedback involves giving a household information about their electricity consumption. It can be given anywhere from annually to real-time, and can be given in a variety of ways, including electricity bills, online webportals, or monitors that can be placed around the home (Fischer, 2008). Van Raaij & Verhallen (1983) describe feedback as having three main functions: learning, habit formation and internalization of behaviour. In terms of learning, feedback allows the householders to see and understand the connection between the electricity they use and the behaviours associated with that use. Specifically, it can bring attention to less desirable consumption practices (Becker, 1978). For example, feedback can bring the householders' attention to phantom power, which is electricity that is consumed even when an appliance is turned off, or is on standby (NRCan, 2009b).

Habit formation involves householders taking the information they have learned and applying it to their behaviours. For example, after seeing a lower electricity bill resulting from unplugging unused appliances, householders will continue this behaviour until it becomes second nature to them. Finally, internalisation of behaviour consists of attitudes changing to suit new behaviour changes. For example, a household could become more environmentally conscious as the propensity to save electricity in the home extends to other parts of their life, such as saving electricity at work or becoming more mindful of gas and water consumption.

2.2.1 The Need for Feedback

Electricity is a part of everyday life; we consume it without thinking, and we consume it indirectly, as part of a daily routine to facilitate different activities and behaviours such as cooking, watching television or making a phone call (Fischer, 2008). Residential electricity consumption at the household level is also highly unpredictable because it is very individualized, depending on personal appliances, schedules and routines, making it hard for householders to know when electricity is consumed, and in what quantity (Wallenborn et al., 2011; Wood & Newborough, 2003). The sporadic and unpredictable nature of individual electricity consumption makes it challenging to predict how much electricity is going to be used at specific times at the household level. This unpredictability makes it even more necessary to be able to link behaviours with electricity use, so that householders can understand how much electricity is used when they carry out their daily activities.

It is not the amount of electricity a person thinks about when they turn on the television or cook a meal, they are thinking about the show they are about to watch or the food they are about to eat (Van Houwelingen & Van Raaij, 1989). This invisibility of electricity acts as a barrier to electricity conservation because people are unaware of how much electricity they consume, and do not have the proper knowledge to change their daily consumption to achieve their conservation goals (Darby, 2006; Gronhoj, & Thogersen, 2011; Riche, Dodge & Metoyer, 2010; Wallenborn, et al., 2011).

In order to make electricity consumption visible, householders need to associate it with their actions and daily routines. Providing detailed, household specific feedback, by way of a monitor or webportal can help householders to monitor their consumption, thus increasing visibility (Gronhoj & Thogersen, 2011; McCalley & Midden, 2002; Wallenborn et al., 2011).

2.2.2 Types of Feedback

Indirect and Direct Feedback

Feedback can be direct or indirect. Direct feedback provides households with their consumption information in real time (or near real-time) via an electricity meter, in-home energy display or website (Darby, 2006; Ehrhardt-Martinez, Donnelly, & Laitner, 2010; Gronhoj & Thogerson, 2011). Providing feedback in real time allows householders to understand the link between their actions and their consumption, and allows them to react to their consumption immediately (Fischer, 2008).

Indirect feedback is consumption data that are provided after consumption, and has been processed in a way that gives the household more personally and socially relevant information about their consumption (Darby, 2006; Ehrhardt-Martinez, Donnelly & Laitner, 2010). Indirect feedback includes monthly, or bi-monthly utility billing, estimated disaggregated electricity information (based on whole household consumption and household and appliance information), daily and weekly feedback presented online, via-email or mailed reports (Darby, 2006; Ehrhardt-Martinez et al., 2010). Due to the nature and timing of indirect feedback, it is difficult for householders to make connections between their actions and their consumption, as the feedback can be given as much as two months after the behaviour.

Normative and Historical Comparisons

Feedback can be given by way of comparisons, which allows householders to understand their consumption data in relation to other consumption data. Fischer (2008) suggests that comparisons are part of effective feedback, but that while households do like these types of feedback, their effects are not entirely clear. Normative comparisons compare a household's electricity usage to other households that are similar in terms of size, type, or demographics, or to a national or regional average (Fischer, 2008; Wilhite et al, 1999). Historical comparisons compare a household's current consumption with their historical consumption, which can be the previous day, week, month or the same time period from a previous year (Fischer, 2008; Wilhite et al, 1999). Comparisons inspire a sense of competition, either between households, or with one's historical data (Fischer, 2008). Studies by Wilhite, Hoivik & Olsen (1999), Karjalainen (2011) and Bonino (2012) found that householders were interested in having comparisons as part of the way they receive their feedback.

Goal Setting

Goal setting is another type of comparison; it compares current electricity consumption with a more desirable future consumption (Van Houwelingen, & Van Raaij, 1989). It is an interactive way to keep householders engaged with their data, as it brings attention to the activity for which the goal was set, which is electricity conservation in our case (Locke & Latham, 2002). Several studies (e.g. Abrahamse, Steg, Vlek & Rothengatter, 2007; Becker, 1978; Bonino, Corno & De Russis, 2012; McCalley & Midden, 2002) have suggested that in order for feedback to be most effective, it needs to be accompanied by an electricity conservation goal. The goal gives the householder something to work towards, while feedback helps householders evaluate if they are on track to achieve their goal (McCalley, de Vries and Midden, 2011).

Becker (1978) designed a study with one hundred participants, whose electricity consumption was monitored for 25 days. There were five groups in the study that were used to understand the effects of feedback and goal setting: the control group (no goal, no feedback), 20% goal with feedback group, 2% goal with feedback group, 20% goal with no feedback group and 2% goal with no-feedback group. The study found that the only group to consume significantly less than the control group was the 20% goal with feedback group, indicating that the combination of a high goal and feedback produced the best results.

Appliance Specific Breakdown

When householders get their bills at the end of their billing period, it can be really difficult to understand where the electricity is used. Kempton and Layne (1994) compare this kind of feedback to receiving a grocery bill at the end of the month with a total, and no breakdown of what was bought. This is not an effective way to charge someone for groceries, nor is it an effective way to charge for electricity. This lack of knowledge about how electricity is being consumed can contribute to wasteful behaviour and impedes householders' ability to conserve (McCalley & Midden, 2002). This barrier can be overcome by providing households with appliance-specific (or disaggregated) electricity consumption data. Wilhite et al. (1999), Nye, Smith, Hargreaves & Burgess (2010) and Bonino (2012) found that householders liked having their electricity data disaggregated by appliance, as it gave them a better idea of how they were consuming electricity, where reductions could be made, and where reductions were being made. Disaggregated electricity consumption data can also allow householders to identify energy hungry appliances, help them understand what impact their actions have on electricity consumption, and help them to make more informed choices about their electricity consumption (Fischer, 2008; Hargreaves, Nye & Burgess, 2013; Karjalainen, 2011; Wood & Newborough, 2003).

Ueno, Sano, Saeki &Tsuji (2006) found that providing disaggregated electricity consumption information helped households conserve more electricity, and that conservation was higher for appliances for which consumption data were displayed. The Energy Consumption Information System (ECOIS) was installed in nine dwellings. This technology monitored the household for electricity use, and provided the consumption data to the users via a website that they could access through an information terminal (laptop) they were given. They were given an appliance specific breakdown of their consumption and energy saving tips. On average, households reduced their consumption by 9%; households had reduced electricity consumption by 12% for those appliances for which consumption data were displayed, and 5% for those appliances not displayed.

2.2.3 Effective Feedback

Fischer (2008) evaluated 26 papers (21 original studies and five review studies) that were designed specifically to give feedback resulting in a decrease in electricity consumption (studies designed to facilitate load shifting were excluded). Based on her evaluation of these studies, she came up with criteria for effective feedback, based on the best cases, that is, “projects or experimental conditions which produced highest savings” (Fischer, 2008:87). These criteria are:

1. Appliance specific breakdown
2. Historical or normative comparisons
3. Interactive element that engages householders and gives them multiple options for viewing their data
4. Frequent feedback
5. Long-term feedback
6. Based on actual consumption
7. Information is presented in an understandable and appealing way

The first two criteria were discussed in the previous section, so this section will discuss criteria three to seven.

Interactive, engaging feedback

Providing feedback that is interactive and that has choices for how the data are viewed can keep the householder interested and engaged with their data. This type of feedback described by Fischer includes the ability to view consumption data in a variety of different ways, including different time frames, load curves, in different units, or by appliance (Fischer, 2008). For instance, the units in which the data are viewed, kilowatt hours, dollars or grams of carbon dioxide, appeals to different motivations for conserving such as environmental and financial concern (Fischer, 2008; Riche et al., 2010). For example, people may not be able to understand or relate to data that are in grams of carbon dioxide, because it is not a unit that most people deal with on a daily basis, so being able to view their consumption data in different, more relatable units such as kilowatt hours or dollars, allows people to get the most out of their feedback. Goal setting, as described in the previous section, is another way to make the feedback interactive, and engaging.

Frequent Feedback

Fischer (2008) discussed frequent feedback as being an effective form of feedback, especially if given at minimum, daily, also indicating that immediate feedback would be most beneficial. Frequent feedback helps the householder to understand the connection between their actions and electricity consumption (Fischer, 2008). Van Houwelingen & Van Raaij (1989) found that two-thirds of householders prefer daily feedback, and 22% prefer immediate feedback. Frequent feedback can also be effective in reducing consumption. Gronhoj & Thogersen (2011) and Dobson & Griffen (1992) provided real-time, continuous consumption data to their participants, who saved between 8% and 13%. In the study described in Ueno et al. (2006) the electricity data were updated every thirty minutes (not quite real-time) and the savings were an average of 9%.

Long-term Feedback

Fischer (2008) suggests that long-term feedback would allow for habit formation, resulting in electricity savings. This is supported by Darby (2006) who said that "a new type of behaviour formed over a three-month period or longer seems likely to persist – but continued feedback is needed to help maintain the change and, in time, encourage other changes" (p. 4). In other words, feedback is needed in order to change a behaviour, and make this new behaviour into a habit, it is required for a long period of time in order for this new habit to persist.

Based on Actual Consumption

Fischer (2008) also recommends that the feedback provided is based in actual consumption rather than estimating consumption or allowing prepayments for billing. Wilhite et al. (1999) identify invoice billing as a type of billing where people are billed for a theoretical amount of electricity use based on the previous year's consumption, and at the end of the year, the customers pay the difference (Wilhite et al., 1999). This type of billing provides feedback once a year, and the authors suggest that it does not create interest in the consumption and makes it even more difficult for people to relate their actions to their consumption. Understanding consumption is a key step to conservation (Gronhoj, & Thogersen, 2011), which is why feedback needs to be based on actual consumption, rather than estimates**.**

Understandable and Appealing Presentation

How feedback is presented to householders is just as important as the information being given to them. If the information is not presented in an understandable and appealing way, householders may not be able to properly use the information, and they will stop trying to understand their feedback. Smith and Mosier (1986) make some recommendations for the design of energy consumption feedback. Wording and labels should be used consistently; the visuals need to be clearly presented and distinguishable from one another; when displaying data related to trends, graphical representations should be used instead of text; data should be immediately understandable, and should not require the householder to think very much about the information that is displayed.

2.2.4 Providing Feedback to the Household

Electricity consumption data can be presented to households via a monitor or website. With both methods, engagement starts off high and then drops off over time (see Gronhoj & Thogerson (2011) and Hargreaves et al. (2013) for examples of data given via monitors; see Abrahamse et al. (2007), Jain, Taylor & Peschiera (2012) and Ueno et al. (2006), for examples of data given via the internet). Gronhoj & Thogerson (2011) found that on average, households reduced their consumption by 8.1% compared with the previous year, while Ueno et al. (2006) found that on average, households reduced their consumption by 9%, demonstrating that data presented via monitors and internet can have comparable results.

If the monitor is placed in an area where it is easily accessible, the data presented by the monitor don't require much extra effort to view, whereas having the data on a webportal entails taking the extra step to turn on the computer and login (Darby, 2006). However, having a webportal means that the data can be accessed from anywhere with internet access. People already spend a lot of time online for work, school and personal use, so accessing consumption data while already online takes minimal effort. The internet is also a great way to reach a large number of people with their consumption data, and can allow people to get an estimation of their disaggregated electricity consumption just by filling out some information (as seen in Abrahamse et al., 2007), however providing estimated consumption data does not fall into Fischer's criteria for effective feedback.

2.2.5 Feedback and Knowledge

Feedback provides information to householders about their electricity consumption, and can give them insight into their habits and behaviours and how they affect consumption. Nye et al. (2010) found that when participants became familiar with their daily energy use and were able to identify what "normal daily consumption" for their household was, they became better equipped to notice when there were differences in their daily use. After the installation of the monitors, the consumption decreased, and after this decrease, the monitors were used to help maintain this new 'normal' level of consumption. However, feedback was not able to encourage conservation past this new level of normal consumption that householders defined for themselves, as they insisted that this new level of consumption was made up of necessary consumption (Hargreaves et al., 2013).

Having more detailed knowledge of their electricity consumption allowed householders to be more confident in discussing electricity consumption and its impact, both economic and environmental, with other interested people (Hargreaves et al., 2013). While in most cases, it appears that feedback provided people with a sense of empowerment over their electricity use, there are other instances, as described by Hargreaves, Nye & Burgess (2010)**,** where householders felt a sense of defeatism. Some felt that the environmental and financial problems were too large for them to tackle, and the monitor was a reminder of this. The monitor also elicited feelings of guilt and anxiety.

2.2.6 Feedback and Behaviour

When providing feedback, creating awareness about a household's consumption is important, because the expectation is that this awareness will lead to a change in behaviour. Behaviour change does happen, but the degree to which it happens varies. Hargreaves et al. (2010) monitored participants' homes at the house level and at the appliance level, and reported consumption to participants via a monitor or laptop computer. They reported that there was some behaviour change in all participants, with the most common changes in behaviour being to switch appliances off that weren't being used and to use the monitors to identify greedy appliances, and planning to use them more efficiently. In a report on the same study, Nye et al., (2010) reported that 70 to 90% of all users found the feedback given to them via the monitors encouraged them to turn off appliances and lights. By the end of the trial, these numbers dropped, but more than 60% of participants reported that they were still taking part in these electricity saving activities.

Abrahamse et al. (2007) provided participants with tailored information, tailored feedback and the ability to set goals in an attempt to see how energy use and behaviours changed. They found that those households that were given the tailored information, tailored feedback and goal setting abilities were more likely to embrace energy saving behaviours than those who had not been given the interventions. These behaviour changes were those that are easy to make, of low monetary cost, low time commitment, and were not inconvenient for the householders. These behaviours included programing the thermostat, not using the washing machine and clothes dryer when they were not full, and replacing traditional light bulbs with energy efficient light bulbs.

2.2.7 Barriers to Behavioural Change

In the literature, a variety of barriers to behavioural change have been discussed. This section will discuss those most relevant to electricity consumption, which are informational, social, and economic barriers. Informational barriers stop people from changing their behaviours because they do not have the information, or a good understanding of the information. At the most basic level, informational barriers include not wanting to seek out knowledge, and not knowing where to find information about how to act in an environmentally responsible way (Lorenzoni, Nicholson-Cole & Whitmarch, 2007). When information can be found, it can be confusing because it can be contradictory, and there are also questions about the validity of the information and whether or not the sources are trustworthy (Lorenzoni et al., 2007).

Hargreaves et al. (2013) reported that participants found that information regarding newer, energy efficient appliances was not as readily available as they would like, making the decision about purchasing new, energy efficient appliances more difficult than they would have anticipated. Other homeowners feel that it is the appliance, not the behaviour that led to high consumption, so no effort is made to change the behaviour (Wallenborn et al., 2011).

Social norms act as barriers to pro-environment behaviours because people don't want to stray too far from the norm, and are conscious about how others may perceive their actions (Lorenzoni et al., 2007; Steg & Vlek, 2009). This social pressure can be from society as a whole or from within the home. Many people want to maintain a level of comfort, which can include a desired level of lighting and temperature, so there may be pressure from members of the household who value comfort more than saving energy and/or money (Wilhite & Ling, 1995). This social pressure can be further compounded by the fact that Hargreaves et al. (2013) and Wallenborn et al. (2011) found that some householders didn't want to create conflict within the household about electricity consumption, and so in some situations it was just easier to accept a higher level of consumption than try to convince members of the household to change their behaviour.

There are also social pressures to maintain a certain lifestyle and have a certain level of comfort in the home. Comfort in the home is what Ueno et al. (2006) hypothesized led to the decrease in energy saving activities in their study. Hargreaves et al. (2013) found that some householders felt that certain activities and the use of certain appliances were integral to daily routines, justifiable and part of their personal comfort, and therefore did not deem it necessary to change consumption surrounding these uses.

Finally, people may be economically restrained by the cost of purchasing goods that are more environmentally friendly (Kaiser, Wolfing & Fuhrer, 1999). Lorenzoni et al. (2007) found that people did not want to pay more to be environmentally friendly because they felt that prices were high enough already.

2.2.8 Feedback, Decision Making and Energy Consumption

Matthies (2005) (as interpreted by Fischer (2008)) developed a "heuristic model of environmentally friendly behaviour" (Fischer, 2008:81) that can help explain why and how electricity consumption feedback can help conservation efforts. This model can be seen in Figure 2.1. It follows from the model that there are two types of behaviours that a person can have, routine/habitual behaviour and conscious behaviour. When behaviour is habitual, we don't think about our actions, we just perform them the same way we always have. Since we never have to think about these actions, we don't know if they provide us with optimal results. In order for a person to change their habits and act in a more conscious way, they need to become aware of what options are available to them, and how to evaluate these options.   This is called norm activation, and is the process by which conscious decisions are made. Norm activation has three building blocks: (1) realizing there is a problem, (2) realizing their behaviour is part of the problem, and (3) realizing they can change their behaviour to have a positive affect; this gives them a sense of control over the problem. In this process, a person realizes that there is a problem with the current way they are acting; the person must then realize that their behaviour is related to the problem, and that there are ways to change their behaviour to help solve the problem. For example, if a person sees that their electricity bill is high, they would have to realize that their consumption practices, and not the price of electricity or their appliances, are the reason for their high bills. For the change to happen, the person would have to understand how and when they consume electricity, and providing feedback is one way to do this, and can help them change their behaviour.

Next, they need motivation, and they need to evaluate the different motivations involved with changing their behaviours, and these can take the form of personal, social and other norms. Personal norms are the ways a person believes they should act; social norms relate to what norms a person feels others hold, and a person may act in a way they believe others want them to so they can be seen as socially desirable. In the case of electricity consumption, other norms include comfort and efficiency in the home; having a warm, well-lit home is important, and being able to perform household tasks without worrying about on and off-peak times is also valued. Finally, in order to decide how to change one's behaviour, a cost-benefit analysis of moral, environmental, personal, and social norms and values is needed. During this process, norms and values can be redefined, and the decisions to change one's actions can be made.

What Matthies does not include in this model, but what Fischer discusses is how information is necessary in this decision making process. Information is necessary for people to know that there is a problem, how their actions affect it and what options are available to make change. In the case of electricity consumption, this information comes in the form of feedback. Feedback brings attention to electricity consumption, and the more detailed the feedback, the more closely consumers can link their behaviour to their consumption. Appliance specific feedback, as discussed in section 2.2.2, gives the detailed information consumers need. This feedback can also help people increase their sense of control because they can see where changes need to be made and make those changes accordingly. Feedback can also help consumers think about their consumption in different ways, for example in terms of finances or the environment. They can even have their feedback reflect their values; it can be displayed in dollars, grams of carbon dioxide or kilowatt hours.

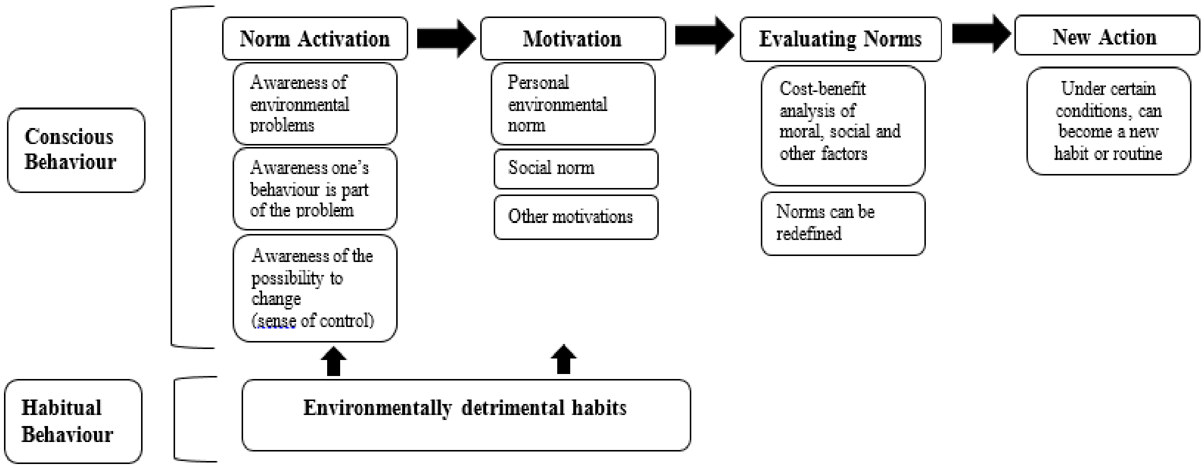

Figure 2.1 – Heuristic Model of Environmentally Friendly Behaviour (Fischer, 2008:81). Fischer translated the image from (Matthies, 2005).

2.3 Engagement with Consumption Data

In order for a household to take full advantage of their feedback, they need to understand how their routines affect consumption, and in order to do this, they need to regularly engage with the data. Jain et al. (2012) installed equipment that monitored the electricity consumption of 43 participants in experimental groups and 72 participants in a control group in a residence of Columbia University. The purpose of their research was to investigate how certain design components affect the participants' energy conservation efforts. The students were also given access to their consumption data. The researchers monitored how often the students logged in, what data they looked at and what application in the interface they used. The authors found that users who decreased their electricity consumption logged in to view their consumption data almost twice as many times as users who increased their consumption.

One of the main issues that arises in the dissemination of feedback is how to keep people engaged with their feedback. In the survey that Hargreaves et al. (2013) conducted, they found that three of the eleven people surveyed had completely stopped using their monitor; one person moved, one person needed to change the batteries, and one person made the decision to stop using it. The remaining eight interviewees said they continued to use the monitor, but they were using it a lot less than when they first received it. Gronhoj & Thogerson (2011) describe how behaviours or the participants in their study changed from users looking at their consumption data in detail, to them quickly scanning the data to ensure that nothing unusual was happening. Ueno et al. (2006) also found that engagement dropped off after the initial engagement period, and the initial effort made to conserve energy was not maintained over time. They found that the number of "button pressings," i.e. the number of interactions the users have with the website, decreased gradually over time.

Hargreaves et al. (2013) conducted interviews and found a variety of explanations for the decreased use of the monitor, including that the novelty wore off, old habits resurfaced, laziness, and the monitors became a nuisance, but the most common reason was that the device had stopped offering new information. This decrease in use of the monitors can be a result of the fallback, or drawback, effect which is ‘‘the phenomenon in which newness of a change causes people to react, but then that reaction diminishes as the newness wears off’’ (Wilhite & Ling, 1995:145).

They also found that once participants learned their consumption patterns, they didn't have to consult the monitor as often. Other participants said that the devices became part of the fabric of the home, and became incorporated into daily routines (Nye et al., 2010). Some householders began to find the monitor annoying, so it was moved out of communal areas to a more private part of the house where only those who were interested in the information could access it (Nye et al., 2010).

2.4 Research Need

This chapter discussed the interactions of householders with their feedback and electricity consumption. A key study was Hargreaves et al. (2013). In this study, self-reported data are used to discuss how often the data are being engaged with. While self-reported data can provide a wealth of valuable information, sometimes people can provide information that is not entirely true so that they will not be perceived in a negative light (Bryman, & Teevan, 2005). It is important to be able to see how a household interacts with their consumption data: how often, for how long, and what data are being accessed. This will help understand what types of feedback are useful and how the user is engaging with their data. Unfortunately, this type of in-depth information cannot be obtained through self-reporting, it has to be collected via the medium providing the feedback information, which is what is done in the research discussed in this thesis. Engagement data were collected from a webportal that provided a minute-by-minute, page-by-page description of the users' engagement with the webportal. These data will be compared with consumption data to see how increased engagement affects consumption.

Jain et al. (2012) also monitored their users' (university students) engagement with their webportal, collecting in-depth information about the pages they were visiting, the actions they were taking and how long they were spending on the webportal. While this research provided great insight to the correlation between engagement and consumption data at the room level, it is important to understand this at the household level, as households contain many more appliances, lighting fixtures and electronic equipment than a dorm room, and there are more people and individualized routines that need to be accounted for. The research presented in this thesis will take the research from Jain et al. (2012) one step further, and investigate at the household level.

The research conducted by Jain et al. (2012) provided six weeks of feedback; Ueno et al. (2006) conducted similar research, however, they only provided feedback for 40 workdays. In her discussion of successful feedback, Fischer (2008) suggests that feedback given over longer period of time (at least nine months) is an element of successful feedback. This research provided feedback to households for up to fourteen months. Investigating the households for a longer period of time will help to better understand how households engage with their feedback and the impact this engagement has on their electricity consumption. It will capture these behaviours after the novelty of the technology wears off, and will give insight into the longevity of conservation behaviours.

Many studies discussed in this chapter have made important contributions to the area of electricity consumption feedback, and several of these studies are similar to the research being discussed in this thesis. However, throughout this literature review, no article was found that discussed research that examined the correlation between engagement with electricity consumption data and electricity consumption that included all three of the following elements: (1) engagement data that was not self-reported; (2) data for a household; and (3) data over a long period of time. The research presented in this thesis contains all three of these elements in one study, allowing for a thorough analysis of engagement with consumption data and electricity consumption.

2.5 Research Objectives

This research will explore the interactions the participants have with the webportal and how their engagement affected their consumption. Specifically, the main question this thesis will seek to answer is "What impact does engagement with the webportal have on electricity consumption?" The following four objectives have been developed to help explore that question.

Objective 1: Adapt and refine an engagement index to investigate household engagement with the webportal.

Objective 2: Determine the levels of household engagement with the webportal.

Objective 3: Determine change in consumption from the base year to the monitoring period.

Objective 4: Investigate the relationship between householder attitudes and behaviours regarding electricity conservation.

2.6 Conclusion

This chapter presented key articles that discussed residential electricity consumption and feedback. It not only introduced the type of feedback, methods of disseminating feedback and the results of providing feedback to households, but it also introduced the connection between feedback, attitudes and behaviours. The hope is that when feedback is provided those who receive it will change their behaviours and reduce consumption. This thesis will investigate the connection between engagement with the webportal and electricity consumption, to see if the relationship between behaviours and feedback really depends on how engaged a household is with their feedback.

Chapter 3: Methods

3.1 Introduction

The purpose of this study is to determine what effect, if any, having access to one's household electricity consumption data has on how one consumes electricity in the home. The research discussed by Hargreaves et al. (2010), Hargreaves et al. (2013) and Nye et al. (2010) set out to investigate the effect of feedback on consumption, but they experienced technical difficulties and were unable to collect accurate consumption data. Jain et al. (2012) compared engagement with feedback with change in consumption, however it was done in college dormitories. While the study provided great information about the connection between engagement and consumption, it left something to be desired in that it only investigated the interaction at the room level. This study fills that gap in the literature by investigating whether or not increased engagement with feedback helps to increase electricity conservation. This study will investigate this over a longer period of time, one year for the base period and up to fourteen months for the monitoring period.

This chapter will detail the recruitment process, sample size, and length of participation. It will also give a detailed description of the tools used to investigate the research question, specifically the webportal and the surveys. From there, the chapter will go on to explain the different methods of analysis, including the engagement index, weather normalization and change in consumption calculations, and will conclude with a discussion of the limitations of this study.

3.2 Recruitment and Participant Selection

The data used for this research were collected from 22 homes in Milton, Ontario. Milton is located about 50 kilometres southwest of Toronto, and has a population of 84,000 (Statistics Canada, 2013). The homes that were considered for this study had previously expressed an interest in advanced smart grid technologies to Milton Hydro. Milton Hydro sent e-mails to customers who had expressed this interest, directing them to the project information and a consent letter. E-mails were sent out to ten interested households every two weeks until enough participants fit the eligibility criteria and had committed to the project.

If a household decided they wanted to participate in the study, they would fill out the consent form, and were directed to the Home Profile and Appliances Selection Survey (Appendix A). After they filled this form out, their survey was evaluated to see if they were eligible to participate. Eligibility criteria included having the internet, owning the house they lived in, living in that house for at least one year and not planning to move. If they were eligible to participate in the project, the EHMS project manager contacted them and arrangements were made to start installing the equipment to monitor their appliance-level and hub-level consumption.

3.3 Sample Size and Study Length

This study started out with 25 hubs, however two were excluded due to technical issues leading to low quality data, and a third was excluded because it did not have the data available for a full twelve month base year. Additionally, this household's webportal was used to troubleshoot errors and to show at conferences and events as an example of the work being done with the EHMS project, so it was hard to determine when the household logged in and when someone from the project logged in under their username. In total, 22 hubs were investigated and discussed in this thesis.

A sample size of 22 hubs may seem relatively small compared to sample sizes in some other feedback studies; for example, Dobson & Griffin (1992) had a sample size of 100, and Karbo & Larsen (2005) had a sample size of 3000 homes. However, there have been many other studies whose sample size is similar to this one, including Ueno et al. (2006) which had nine homes, Wood & Newborough (2003) which had 36 homes, Gronhoj & Thogerson (2011) which had 20 homes, and Wallenborn et al. (2011) which had 21 homes. While this sample is not large enough to be statistically significant, it will provide a lot of rich, descriptive data regarding the impact of feedback on electricity consumption. The sample is also not representative of the population, but the Home Profile and Appliances Selection Survey will give us a profile of each of the dwellings and demographics about the households.

These hubs were monitored anywhere from seven to 14 months, depending on when the equipment was installed and the webportals were activated, and in the cases of EHMS-20 and EHMS-25, when they withdrew from the study. The data from the hubs that withdrew are still included in the analysis because the data were good (i.e. there were no technical difficulties), and because the monitoring period varies for each hub, so including two hubs with slightly shorter monitoring periods is not considered to be a problem. Table 3.1 contains the details of when hubs were activated, when they withdrew and how long their monitoring period was. If there was no decommission date, then the last day data were collected was January 31, 2013.

Hub	Portal Activated	Portal Decommissioned	Length of Monitoring Period
01	29-Nov-11	n/a	14 months, 3 days
02	29-Nov-11	n/a	14 months, 3 days
04	29-Nov-11	n/a	14 months, 3 days
05	23-Dec-11	n/a	13 months, 9 days
07	03-Jan-12	n/a	11 months, 29 days
09	23-Dec-11	n/a	13 months, 9 days
10	23-Dec-11	n/a	13 months, 9 days
11	03-Jan-12	n/a	11 months, 29 days
12	23-Dec-11	n/a	13 months, 9 days
13	23-Dec-11	n/a	13 months, 9 days
14	23-Dec-11	n/a	13 months, 9 days
15	13-Jan-12	n/a	11 months, 19 days
16	13-Jan-12	n/a	11 months, 19 days
17	27-Apr-12	n/a	9 months, 5 days
18	27-Apr-12	n/a	9 months, 5 days
19	13-Jan-12	n/a	11 months, 19 days
20	27-Apr-12	09-Jan-13	8 months, 14 days
21	27-Apr-12	n/a	9 months, 5 days
22	27-Apr-12	n/a	9 months, 5 days
23	27-Apr-12	n/a	9 months, 5 days
24	27-Apr-12	n/a	9 months, 5 days
25	27-Apr-12	09-Nov-12	6 months, 14 days

Table 3.1 – Portal activation dates, decommission dates, and length of monitoring period.

Receiving long-term feedback can help shift behaviours towards consuming less electricity, and as a result can lead to more sustainable habits that will help reduce consumption (Fischer, 2008). While Fischer does not explicitly define what she means by ‘long-term,’ she found a distinct division of projects with respect to length for which feedback was given. Nine projects provided feedback for less than three months (usually four to six weeks), and eight projects provided feedback for at least nine months. So judging by this divide, it can be presumed that long-term refers to projects that received feedback for more than nine months.

While there is a need for data to be collected over a longer period of time, there are studies that are shorter in length, and have produced noteworthy and useful results. For example, Gronhoj & Thogerson (2011), and Ueno et al. (2006) collected data for five months, and 40 workdays, respectively.

The sample size and study length of this research were limited by resources available to the project, and were decided on by the EHMS management team before the topic was chosen for this thesis. As this thesis is being written, the project is still running, but the monitoring period for this thesis ended on January 31, 2013. The original intention for choosing this date was so that the last eight hubs that were activated on April 27, 2012, would have a monitoring period of over nine months, which, by this author's interpretation of Fischer's (2008) discussion on study length, would make this study "long-term" and part of effective feedback. However, since two hubs dropped out before this date, their monitoring periods were less than nine months, putting them close, but just under the long-term feedback threshold.

3.4 The Webportal

The webportal has two main functions: (1) to allow the households to have access to their consumption data, and (2) to allow the researchers to have access to data regarding the households' consumption and visits to the webportal.

3.4.1 Households and the Webportal

The webportal was designed to give households access to their consumption data, at the appliance and hub-level. In order to monitor and transmit consumption to the webportal, the homes involved in the study were outfitted with energy consumption monitors which relayed the consumption data to the webportal where it could be accessed by the householders. Once the equipment was installed, the households were sent an e-mail containing their username, password and a link to the webportal; the day this e-mail was sent is their activation date. After the webportal was activated, each household received e-mails on the 10th and 24th of every month. The e-mail on the 10th was to remind them to login, and the e-mail on the 24th was to remind them to login and set their consumption goals for the next month.

The webportal contains both real-time and historic data that can be viewed in kilowatt hours, dollars or carbon dioxide emissions, depending on the preferences of the user. It also shows the amount of hub-level electricity consumption for that current day, how much of it was on-peak, mid-peak and off-peak, and how much it cost. The homepage, shown in Figure 3.1, gives the users the most important information. On the top, the left side presents the current day's electricity usage, broken down by off-peak, mid-peak and on-peak, and the right shows whether or not the house is tracking to achieve their monthly goals (i.e. will their monthly consumption stay below the goals that were set for that month). On the bottom, the left shows the current price of electricity and if it is off-peak, mid-peak or on-peak, and the right shows the household's carbon footprint, equating their electricity consumption in carbon dioxide emissions to the number of kilometers driven in a car.

Figure 3.1 – The homepage of the webportal.

Real-time and Historical Data

Once the user leaves the home page and goes deeper into the webportal the data become more detailed. The hub-level consumption can be viewed by the hour, day or month, and can be viewed for the current day, the previous day, the current month, the previous month, the current year, the previous year or for any custom series of days the user wants. Figure 3.2 shows the hub-level data over a four day period, between March 27 and March 30. Each bar represents the amount of electricity (in kWh) consumed in each hour. The green bars represent off-peak, the yellow bars represent mid-peak and the red bars represent on-peak; the consumption break down for these three periods is in the box on the right. Along the bottom there are multiple options for changing the units and the timeframe for which the data are viewed.

Figure 3.2 – Hourly electricity consumption data

Appliance Specific Data

Data can also be broken down by appliance. When the Home Profile and Appliances Selection Survey was completed, each household had the opportunity to choose up to twelve appliances to monitor in the webportal. The researchers thought it was also important to monitor the larger appliances, such as the refrigerator, stove, washing machine, clothes dryer, dishwasher, furnace, and air conditioner. The final decision about which appliances were to be monitored was based on whether or not it was possible to install the required equipment. The appliances that were chosen to be monitored could be viewed in the webportal as a function of the total household consumption (Figure 3.3) or on their own (Figure 3.4).

In Figure 3.3, each bar represents one day, and each colour represents a different appliance; the list of appliances and their corresponding colours on the left side of the screen. The total consumption for the time period is listed with the appliance on the left. When the appliance name is clicked, it brings the user to the appliance specific detail, similar to what is shown in Figure 3.4, which shows the consumption for the clothes washer. Each bar represents the consumption in kWh for one day, and the box on the left shows the breakdown of consumption by off-peak, mid-peak and on-peak.

Figure 3.3 – Electricity consumption as a function of the individual appliances

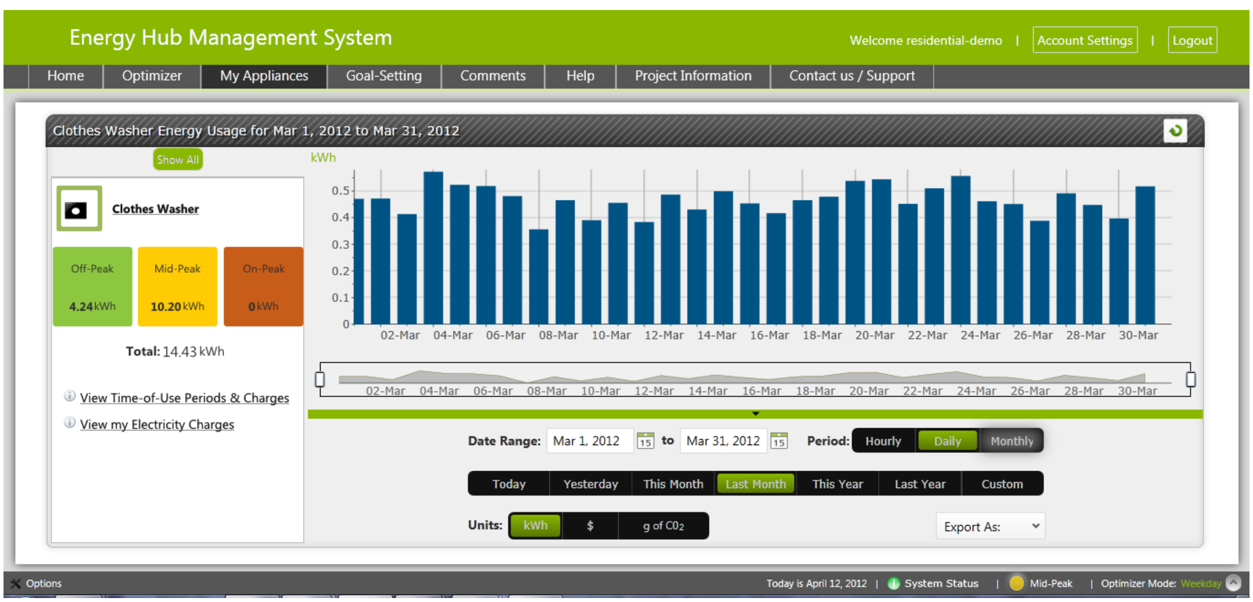

Figure 3.4 – Electricity consumption for the clothes washer

The Goal Setting Tool

The goal setting tool is an important part of the webportal. It allows the household to set a monthly electricity goal in dollars, kilowatt-hours or carbon dioxide emissions for each appliance and the dwelling as a whole. This goal is how monthly progress is tracked for the webportal. This progress tracking is shown on the homepage, Figure 3.1, and on the goal setting page, Figure 3.5. The goal setting page shows the goal for each appliance, and the actual usage, in whatever units the user chooses. It also shows the household's consumption as a percent of their goal, and whether or not they are on track to achieve their goal by using the following symbols: green check mark means they are using less than expected; yellow exclamation mark means they are using more than expected, and red x means they are over using. The box on the right shows the hub-level goal and how much can be consumed before going over their goal. Rowlands, Mallia, Shulist & Parker (2013) and Mallia (2011) provide more information about the goal setting function in the webportal.

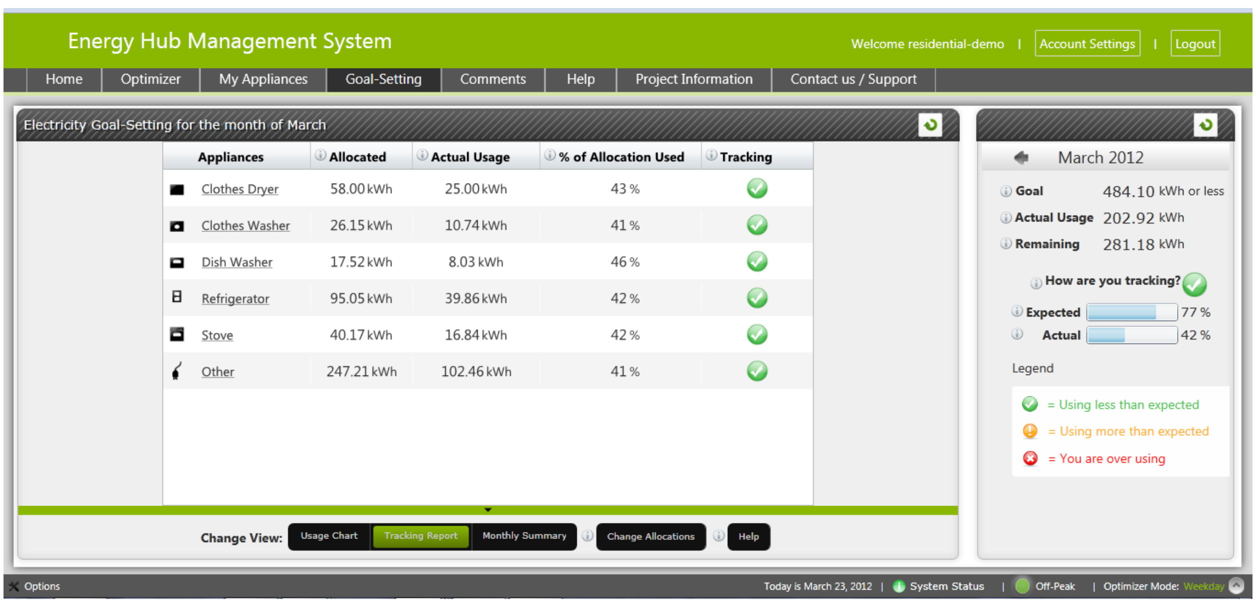

Figure 3.5 – Goal setting page

The Optimizer Function

The optimizer function was introduced late in the monitoring period at the beginning of November 2012. This function is designed with the purpose of allowing households to manage their electricity use according to their personal goals. Householders can schedule when their appliances can be used throughout the day according to their personal schedule, while also allowing them to conserve electricity. Users can choose three periods a day for which they can set a schedule for their appliances. For each period, they choose the length of time the appliance can be used. They can set this schedule for weekdays, weekends and holidays, and vacations. Figure 3.6 shows the optimizer for a clothes washer during the week. The three green boxes represent the three periods for which a schedule can be set. On the far left is the list of all the appliances for which a schedule can be set.

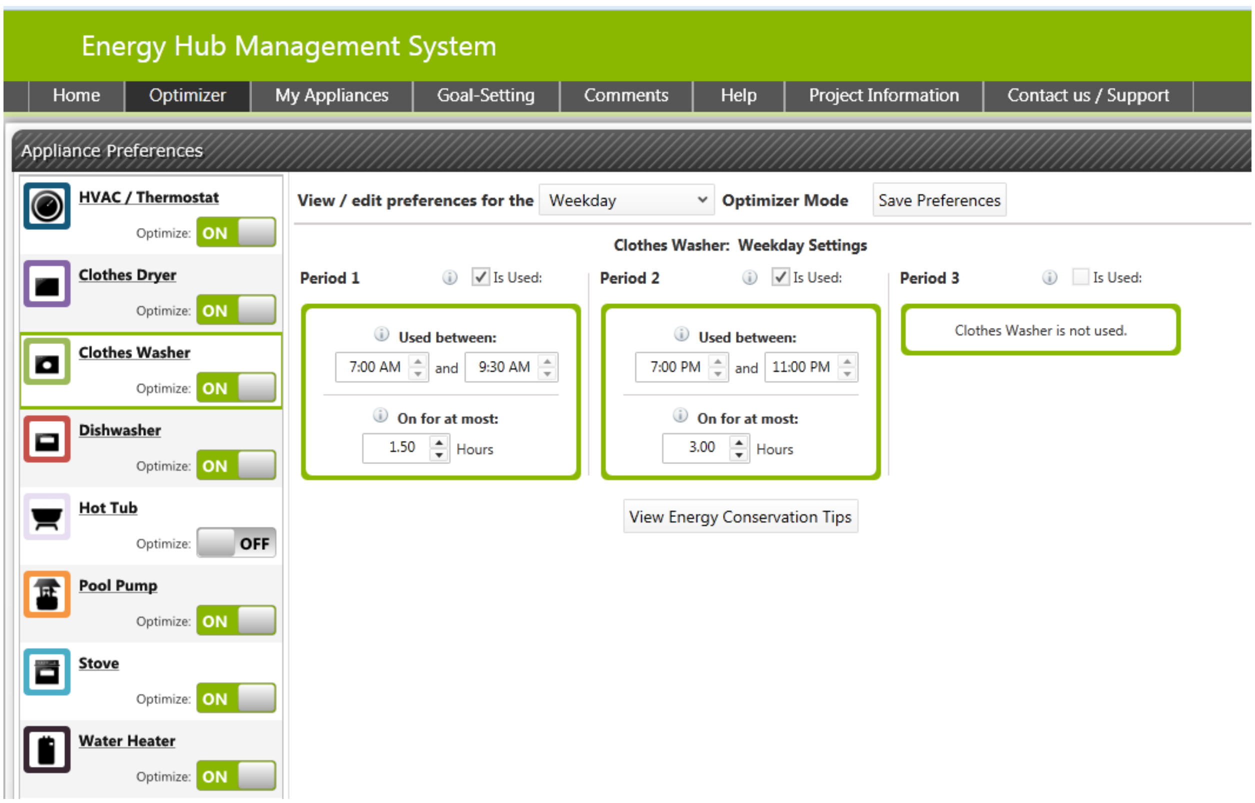

Figure 3.6 – Optimizer function

Help and Contact Pages

The webportal also contains several help and information sections where the householder can access information about the project, frequently asked questions regarding the project, the equipment and the functions of the webportal, video tutorials about how to use the different functions in the webportal and information about time of use periods. The webportal also contains several ways for the householder to contact the researchers. There is a section where comments can be left, and there is a contact page containing phone numbers and a section where messages can be sent to the researchers.

3.4.2 Researchers and the Webportal

There is a second section of the webportal that is exclusively for the researchers. From this section the researchers can download reports that contain data from each household. There are 16 reports available: event log report, comments report, monthly budget report, monthly budget appliances report, weather forecast report (hourly), hub-level consumption (5 min), hub-level consumption (hourly), appliance-level consumption (5 min), appliance-level consumption (hourly), appliance level status (5 min), temperature cooling set point, temperature cooling actual (5 min), temperature heating set point (5 min), temperature heating actual (5 min), (pivoted) thermostat data (5 min) and objective function report. For this research, only the event log report, comments report and monthly budget report were used.

The event log report shows how the householders are using the webportal. Specifically, it provides the following information:

- Date and time of the visit;
- Length of visit, and length of time spent on each page;
- The pages in the webportal they viewed;
- The units they view their consumption data in ($/kWh/$CO_2$);
- When their goals were automatically set; and
- If the monthly goals were changed.

The comments report shows the comments that the users have submitted, and the date and time they were submitted. The monthly budget report shows the automatic goals that were set, and if the household changed their goals, and what they changed their goals to (if applicable).

Event Log Data Cleaning

The event log report logs the IP addresses of the computers that login to the webportal. The researchers were able to login under the username of the participants in order to detect and/or troubleshoot problems. The IP addresses of the computer the researchers used were recorded, and when the data analysis was done, any data linked to their IP addresses were excluded. There was also a demonstration account that was used for the researchers to become acquainted with the webportal and understand the research from the point of view of the householder. Any entries in the event log report from the hubs that contain an IP address that was also used in the demonstration account was excluded, as only a researcher could have access to both the demonstration account and the account of a participant.

3.5 Surveys

In the literature, two methods were used to obtain information from the participants: interviews and surveys. Gronhoj & Thogerson (2011), Karjalainen (2011), and Riche et al. (2011) all used interviews to obtain information from the participants, while Abrahamse et al. (2007), Bonino et al. (2012), and Ueno et al. (2006) all administered online surveys. While interviews and surveys are equally popular methods in the literature, for this research, surveys were chosen. The surveys were completed online via Fluid Surveys; an e-mail was sent to each household containing a link to the Fluid Surveys website, and a follow up e-mail was sent to encourage completion of the survey. The surveys can be found in Appendices A and B.

While interviews and focus groups would have provided rich, detailed data, they were too expensive in terms of both time and money. Since the householders' participation for this study was primarily through the online webportal, it was in line with the rest of the study to ask them to fill out an online survey. Another reason surveys were chosen over interviews is social desirability; people may not tell the truth in situations where their answers can be perceived as undesirable (Bryman, Bell, Mills, & Yue, 2011). While the surveys were not anonymous, they were filled out online, so there were no researchers around to make the respondents feel as though they were being judged for their responses.

3.5.1 Home Profile and Appliances Selection Survey

This survey was administered to all households that were interested in participating in the EHMS project. It was used to help determine if households fit the criteria to participate in the study. It was designed to gather data about the dwelling (age, size, etc.), the major appliances in the dwelling, which appliances they want to monitor and control, type of electricity, demographics of the household (number of people, income, education, etc.) and information about their current electrical systems and internet. This survey can be found in Appendix A.

3.5.2 Welcome Survey

This survey was administered to all households who were chosen to participate in the study, and was e-mailed to them when their webportal was activated. The survey was designed to improve understanding of attitudes and motivations the householders had towards energy management in their home, and to help assess certain aspects of information delivery, communications and automation of the EHMS project. This survey can be found in Appendix B.

3.5.3 Post-Monitoring Survey

This survey was administered to all households who were chosen to participate in the study and was e-mailed to them at the beginning of December 2012. It was designed to get a sense of the respondents' attitudes, and motivations towards energy management in their home and help evaluate the respondents' experience with the Energy Hub Management System.

Originally the responses of the Welcome Survey were going to be compared with those of the Post-Monitoring Survey to see if there was a change in attitudes and/or behaviours over the course of the study. However the Post-Monitoring Survey only received two responses, and as a result, it was not used. It was then decided to use the Welcome Survey to develop a profile about the households and their attitudes and behaviours involving electricity consumption.

3.6 Consumption Data from Milton Hydro

Hourly consumption data for the 22 hubs were obtained from Milton Hydro for the base year and the monitoring period, shown in Table 3.2.

Hub	Base year		Monitoring Period	
	Start	**End**	**Start**	**End**
01	29-Nov-10	28-Nov-11	29-Nov-11	31-Jan-13
02	29-Nov-10	28-Nov-11	29-Nov-11	31-Jan-13
04	29-Nov-10	28-Nov-11	29-Nov-11	31-Jan-13
05	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
07	03-Jan-11	02-Jan-12	03-Jan-12	31-Jan-13
09	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
10	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
11	03-Jan-11	02-Jan-12	03-Jan-12	31-Jan-13
12	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
13	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
14	23-Dec-10	22-Dec-11	23-Dec-11	31-Jan-13
15	13-Jan-11	12-Jan-12	13-Jan-12	31-Jan-13
16	13-Jan-11	12-Jan-12	13-Jan-12	31-Jan-13
17	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
18	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
19	13-Jan-11	12-Jan-12	13-Jan-12	31-Jan-13
20	27-Apr-11	26-Apr-12	27-Apr-12	31-Dec-1
21	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
22	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
23	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
24	27-Apr-11	26-Apr-12	27-Apr-12	31-Jan-13
25	27-Apr-11	26-Apr-12	27-Apr-12	31-Oct-12

Table 3.2 – The base year and monitoring periods for the 22 EHMS hubs

Initially, consumption data were going to be collected from the webportal through the hub-level consumption (hourly) report, however, due to technical difficulties, the data did not always transmit properly from the equipment in the house to the webportal. These problems created gaps in the data, where hours or even days' worth of data would be missing from the reports. As a result, the hourly consumption data were obtained from Milton Hydro. These technical difficulties did not affect the consumption data on the homepage of the webportal because those data were taken directly from the smart meter that Milton Hydro collects their data from, rather than from the equipment installed for this research. So when the householders logged into the webportal and saw the homepage, the data were accurate. However, the further into the webportal the users went, the more inaccurate the data were for some of them, due to these technical problems.

3.7 Weather Data

In order to determine the change in consumption, a process called weather normalization was used. This process, which is described in-depth in section 4.4.1, helps compare electricity consumption between two years, independent of temperature, as temperature, especially extreme temperature can affect electricity consumption via use of air conditioning, electrical heating and furnace fan for gas heating. In order to use this process, weather data for the city of Guelph were obtained from the Government of Canada website (Government of Canada, 2013). Guelph was used because there was no weather data for Milton, Ontario. The Weather Network uses data from Georgetown to present the current weather on their website for Milton (The Weather Network, 2013). However, the Government of Canada website had an incomplete data set for Georgetown, meaning that there were some days that did not have an average temperature. There were a few alternative cities that could have been used, such as Oakville and Mississauga, however, Guelph, which is approximately 40 kilometers from Milton was chosen. Guelph was chosen because Oakville and Mississauga are on Lake Ontario, and being on a lake has a moderating effect, causing the winters to be warmer, and the summers to be cooler.

3.8 Engagement Index

The engagement index measures how engaged householders are with the webportal. Equation 3.1 calculates the engagement index for individual months, and Equation 3.2 calculates the engagement index over multiple months. The event log report and the comments report were used to calculate the engagement index. The engagement index used in this thesis has been adapted from Peterson & Carrabis (2008). This engagement index was chosen because it incorporated multiple different metrics of engagement into one index, rather than only using popular metrics such as number of pages visited and the amount of time spent on the site, which provide only a limited description of the user experience (Peterson & Carrabis, 2008). A description of the original engagement index and the changes that were made to it can be found in Appendix C.

$$Monthly\ engagament\ index = \frac{(Ci + Di + Ri + Si + Fi + Ii)}{6}$$

Where:

- Ci is the Click Depth Index
- Di is the Duration Index
- Ri is the Recency Index
- Si is the Session Index
- Fi is the Feedback Index
- Ii is the Interaction Index

Equation 3.1 – Monthly engagement index

$$Total\ engagament\ index = \frac{EI_1 + EI_2 + \cdots + EI_m}{m}$$

Where:

- EI is the monthly engagement index (Equation 3.1)
- m is the number of months

Equation 3.2 – Total engagement index

To calculate the engagement index, something called a session was used. This is the period of time that a user is logged into the webportal. A session starts when the user logs in (as indicated in the event log report), and can end in one of two ways: (1) when the user logs out, or (2) when the user has been inactive for 30 or more minutes. Inactivity can mean a variety of things, including the browser being closed without the user logging out, the user forgetting the page was open and opening another page; etc. Unless the user clicked the logout button, there was no exact way of knowing when the session ended, so after 30 minutes of inactivity the session was considered ended, and the end time was the last time stamped activity, as indicated by the event log report. The idea of using 30 minutes of inactivity was adapted from Khoo et al. (2008), who also used 30 minutes of inactivity to consider a session terminated, stating that after 30 minutes of inactivity, the user "is assumed to have closed the browser window, or otherwise ceased interacting with the website" (p. 376).

There were also instances of several logins by a user in a short period of time. Jain et al. (2012) decided that all logins within 30 minutes of each other should be treated as one login to "[guard] against data being skewed as a result of repeated short user logins" (p. 16). This idea from Jain et al. (2012) was adapted with a slight change: all logins within 30 minutes of each other were considered the same session *except* when there was a logout in the event log report. If there was no logout, the user could have accidentally closed the browser, the browser could have crashed, the computer could have shut off, or a variety of other things could have happened causing the window to close. But if there was a logout, and then another login during the thirty minute period, one householder could have logged off, and another could have logged on, making it two unique sessions.

3.8.1 Click Depth Index, C_i

The click depth index (equation 3.3) represents the ratio of sessions where the householder visited pages beyond the homepage to all sessions.

$$Ci = \frac{\#\ sessions\ with\ pages\ beyond\ the\ homepage\ visited}{total\ \#\ sessions}$$

Equation 3.3 – Click depth index

Khoo et al. (2008), Lehmann, Lalmas, Yom-Tov & Dupret (2012), and Hughes (2001) discuss how knowing how many pages on a website the user visits is an important metric for analyzing website traffic. These authors used the number of pages visited as one of many metrics to analyze website data, while also acknowledging that the number of pages visited does not tell the whole story. High numbers of page views may not necessarily mean high engagement, nor do low numbers mean low engagement. A poorly designed webpage can result in a high number of page visits, as the user could have gotten lost trying to find what they were looking for. A well designed site could result in few page visits because the user found what they were looking for immediately (Khoo et al., 2008, Hughes, 2001, Peterson & Carrabis, 2008). Alternatively high numbers of page views could mean high engagement and low numbers could mean low engagement. This illustrates the importance of using several metrics together when discussing engagement.

While this metric does not specifically discuss the number of pages visited, it does speak to how much information the user obtains: just viewing the homepage and then logging off gives the user the basic information, such as current day's consumption broken down by TOU, current TOU period, and price of electricity, if the household is tracking to meet their goal and their carbon footprint (see Figure 3.1 for screenshot of the homepage). However, going further into the website provides the user with more in-depth and detailed information, so instead of using number of pages visited to measure engagement, detail of information is used.

3.8.2 Duration Index, D_i

The duration index (equation 3.4) represents the ratio of sessions longer than y minutes to the total number of sessions, where y=5.

$$Di = \frac{\#sessions\ more\ than\ y\ minutes}{total\ number\ of\ sessions}$$

Equation 3.4 – Duration index

Peterson & Carrabis (2008) suggest using the mean number of minutes spent on the webportal for the y value, however, for this thesis, the median was used. When calculating the mean, unusually small and large values can create a skewed value, and in these data, there were several sessions that lasted for upwards of an hour, which created a high mean, so the median was used instead.

The webportal contains a lot of information and may take time for the user to understand and process, so knowing how much time is spent on the webportal is important. Khoo et al. (2008) and Yom-Tov et al. (2012) used time spent on a website as one of the metrics for evaluating user engagement with a website, and Lehmann et al. (2012) and Hughes (2001) both discuss how the length of a session is an important metric for evaluating user engagement. But similar to the number of page views, it needs to be used in conjunction with other metrics, because alone, it cannot tell the whole story about the session. For example, if a person goes on to the website, opens a page and then the phone rings and they leave the computer for five minutes, it may appear that the person was more engaged than they actually were. Also, if a person logs on and finds what they are looking for within the first minute and logs off, it may appear that they were not very engaged, when in fact the website was well designed and information was found immediately (Khoo et al., 2008; Peterson & Carrabis, 2008).

3.8.3 Recency Index, R_i

The Recency Index evaluates the user's "'visit velocity'—the rate at which they return to the site" (Peterson & Carrabis, 2008:24). This requires two simple calculations, equations 3.5 and 3.6. The first evaluates the number of days since the most recent session for each session. For the first session, the date of hub activation will be used for the most recent session, as this was the first day there could have been a session. The second calculation is a summation of all these calculations divided by the number of sessions in a given period.

$$Ri_{session} = \frac{1}{1 + \#days\ since\ most\ recent\ session}$$

Equation 3.5 – Recency index (Session)

$$Ri = \frac{\sum Ri_{session}}{\#sessions}$$

Equation 3.6 – Recency index

Yom-Tov et al. (2012) used the number of revisits as a metric to evaluate user engagement in their research, and Lehmann et al. (2012) discuss how it is a popular metric used in evaluating engagement. In many cases, revisits to a website indicate loyalty, but in terms of the webportal, these revisits indicate that the users are finding the information useful enough to login again. However, some of the respondents in Nye et al. (2010) and Hargreaves et al. (2013) discussed how after a period of time the feedback stopped offering new information and that once they had learned what their baseline consumption was, they stopped needing to refer back to the feedback as often. So over time, a decrease in the recency index may be a result of not needing the information any more, but can also indicate falling back into old habits.

3.8.4 Session Index, S_i

The session index (equation 3.7) is a representation of the number of sessions that a user has in a time frame. In this research, the time frame will be each calendar month, which was chosen because the goals are set and tracked during each calendar month. Lehmann et al. (2012) discusses the number of visits as an important metric to use when evaluating user engagement. For the purposes of this research, it is important to get an understanding of how often users are logging into the webportal, as it gives an indication of how interested they are in their electricity data.

$$Si = 1 - \left(\frac{1}{1 + \#sessions\ during\ timeframe}\right)$$

Equation 3.7 – Session index

3.8.5 Communication Index, Fi

This index, seen in equation 3.8, helps to evaluate how often users are contacting the EHMS project with questions or comments. This is a ratio of the number of sessions where the user contacts EHMS to all sessions.

$$Fi = \frac{\#\ sessions\ that\ EHMS\ was\ contacted}{all\ sessions}$$

Equation 3.8 – Communication index

There are three different ways of measuring communication with the EHMS project: a comment could have been submitted (see Appendix E for comments submitted), the *contact us* page could have been visited, or an e-mail could have been sent (See Appendix F for e-mail subjects). The contact us page contains a message box that sends an e-mail to the project manager and it also has contact phone numbers. While going to the *contact us* page does not necessarily mean they contacted the researchers, there is no way of verifying this because contact could be made via e-mail or phone and logs were not always kept for these interactions. As a result, every visit to the contact us page was treated as a communication between a householder and the researchers. Since e-mails are sent outside of the webportal, there would be no associated webportal session recorded in the event log. As a result, on several occasions, there was no session on the day (or even in the month) of an e-mail sent outside of the webportal. In order to include these e-mails in the engagement index calculations, an e-mail sent from a householder to the EHMS researchers was considered a session. A duration of zero minutes was allotted to these sessions, because while it took time to login to their e-mail account to send the e-mail, they did not login to the webportal and get the full webportal experience and associated information.

3.8.6 Interaction Index, Ii

This is a measure of actions that users take while they are engaged with the webportal. The index has two calculations, equations 3.9 and 3.10. The first is the ratio of the number of actions taken in a session to the total number of possible actions.

$$Ii_{session} = \frac{\#\ types\ of\ actions\ taken}{total\ \#\ types\ of\ actions}$$

Equation 3.9 – Interaction index (session)

Before November 2012, the total number of possible actions was three: (1) Changing the units that data are viewed in; (2) changing the time frame for which the data are viewed; (3) changing goal/change distribution. Starting in November 2012, when the optimizer function was activated, there were four possible actions: (1), (2) and (3) listed above, and (4) the optimizer function, which includes setting objectives for electricity consumption, and setting and changing consumption schedules. These actions were chosen because they are key applications of the website and enhance the user experience in the webportal by increasing the users' comprehension of the data and their consumption.

The second calculation is a summation of all the $Ii_{session}$ over the total number of sessions in the month:

$$Ii = \frac{\sum Ii_{sessions}}{\#sessions}$$

Equation 3.10 – Interaction Index

Jain et al. (2012) tracked how their users interacted with their webportal, including how they were viewing data (normative and historical comparisons, disaggregated by appliance), the different functions they were using (energy audits, incentives), and how often they were logging on. This index is important because it reveals how users interact with the webportal on a level that is more than just looking at, or reading information and data; it tracks how users customize their experience with the webportal.

3.9 Change in Consumption

For this research, the change in consumption will be a monthly value, with units of kilowatt-hours per day (see sections 3.9.1 and 3.9.2 for calculation details). The reason for using a monthly value, rather than a daily or hourly value is because the change in consumption will be compared to the engagement index, and the engagement index is a value that is calculated for each calendar month. The engagement index is calculated over the calendar month because consumption goals are set for each month, and these goals start on the first day of the month and end on the last day of the month. Since the webportal is experienced by the householders from the first of the month to the last of the month, it makes sense to keep our analysis of engagement, and therefore the change in consumption within the same timeframe.

Electricity consumption can be dependent on the outside temperature; to be able to more accurately compare consumption between the base year and the monitoring period, the consumption data from the monitoring period needed to be weather normalized. The weather normalization process estimates what the monitoring period's electricity consumption would have been if it had the same consumption patterns as the base year, but with the monitoring period's weather. The cooling months were weather normalized because air conditioning requires a considerable amount of electricity to run, and changes in outdoor temperature can cause large fluctuations in electricity used for air conditioning.

The heating months, however, were not weather normalized because the 22 hubs in this study used natural gas to heat their homes. There are appliances such as space heaters and furnace fans that can cause an increase in weather dependant electricity consumption in the heating months. The Home Profile and Appliance Selection Survey asked if there was a space heater, or other sources of electrical heating in the dwelling, and EHMS-09, 19, 20 and 25 indicated that their dwelling did contain a secondary source of electrical heating. The temperature versus consumption plots for these hubs were examined (Appendix G), and there did not appear to be any noteworthy increase in consumption over the heating months. In fact, when these plots were examined for all hubs, only three hubs showed a significant increase in consumption in the heating months. These increases could be explained by an electrical source of heating that was not mentioned, a change in behaviour resulting from a change in season, such as increased use of lighting, holiday entertaining, or any number of unknown factors.

A cooling month is defined as a month where the cooling degree days (CDD) were greater than zero. To calculate the cooling degree day, Equation 3.11 is used.

$$CDD = (Average\ Daily\ Temperature) - (Balance\ Point)$$

Equation 3.11 – Cooling degree days

The balance point is the temperature at which the household starts to cool their homes. A detailed explanation of how to determine this temperature can be found in section 4.4.1. To calculate the number of CDD for a month, the CDD for each day are added together, and if this sum is greater than zero for a month, then that month is a cooling month.

The weather normalization process will produce an *expected consumption* value, in kWh/day for each cooling month in the monitoring period, and will be used in place of *base year consumption* (kwh/day) to calculate the change in consumption. A detailed discussion of weather normalization can be found in section 4.4.1.

3.9.1 Monthly Change in Consumption

The monthly change in consumption is a value that is calculated for each individual month in the monitoring period. It is calculated differently for cooling months and non-cooling months. Equations 3.12 and 3.13 were used to calculate change in electricity consumption for cooling months, and required the following two values:

(1) Expected consumption (kWh/day)

(2) Monitoring period consumption (kWh/day)

$$\text{Monthly consumption change for cooling months (kWh/day)} = \text{(monitoring period consumption)-(expected consumption)}$$

Equation 3.12 – Consumption change for cooling months (kWh/day)

$$\text{Percent monthly consumption change for cooling months} = \frac{(\text{monitoring period consumption}) - (\text{expected consumption})}{(\text{expected consumption})}$$

Equation 3.13 – Consumption change for cooling months (%)

To calculate the change in consumption for non-cooling months, Equations 3.14 and 3.15 were used, which required the following two values:

(1) Base year consumption (kWh/day)

(2) Monitoring period consumption (kWh/day)

$$\text{Monthly consumption change for non-cooling months (kWh/day)} = \text{(monitoring period consumption)-(base year consumption)}$$

Equation 3.14 – Consumption change for non-cooling months (kWh/day)

$$\text{Percent monthly consumption change for non} - \text{cooling months} = \frac{(\text{monitoring period consumption}) - (\text{base year consumption})}{(\text{base year consumption})}$$

Equation 3.15 – Consumption change for non-cooling months

The base year consumption is used to calculate the change in consumption for non-cooling months. We determined there would be minimal change in consumption resulting from changes in the outside temperature, so a straight comparison between consumption in the base year and consumption in the monitoring period was done. However, for the cooling months, the expected consumption was used in place of the base year consumption. This was done because air conditioners, and other electric methods of cooling are high consumers of electricity, and the change in consumption resulting from change in outdoor temperature needed to be accounted for, which is what the expected consumption value does.

In the above equations, the base year consumption corresponds to the same month in the monitoring period, and the expected consumption also corresponds to the same month in the monitoring period. For example, if the change in consumption was being calculated for February 2012, a non-cooling month, it would be calculated by subtracting the consumption from February 2011 (base year consumption) from February 2012 (monitoring period consumption). If the change in consumption was being calculated for July 2012, a cooling month, it would be calculated by subtracting the expected consumption for July 2012 from the actual consumption July 2012 (monitoring period consumption).

3.9.2 Change in Consumption

The change in consumption calculates the change in consumption for the entire monitoring period or for a group of months within the monitoring period, rather than month by month, as described in the previous section. This will give a better understanding of the overall changes in consumption throughout the monitoring period. Equation 3.16 calculates the baseline consumption in kWh/day, and Equation 3.17 calculates the consumption for the entire monitoring period in kWh/day. These two values are then used to calculate the change in consumption, Equations 3.18 and 3.19.

It should be noted that the number of days in the baseline period (l in equation 3.16) will be the same as the number of days in the monitoring period (q in equation 3.17).

$$Baseline\ consumption = \frac{(by_1 + by_2 + \cdots + by_n) + (e_1 + e_2 + \cdots + e_k)}{l}$$

Where:

by is the total monthly consumption for the non-cooling months in the base year

e is the expected consumption for the cooling months in the monitoring period

n is the non-cooling months in the monitoring period

k is the number of cooling months in the monitoring period

l is the number of days in the baseline period

Equation 3.16 – Baseline consumption in kWh/day

$$\mathit{Monitoring\ period\ consumption} = \frac{(mp_1 + mp_2 + \cdots + mp_{n+k})}{q}$$

Where:

mp is the total monthly consumption for each month in the monitoring period

n+k is the number of months in the monitoring period

q is the number of days in the monitoring period

Equation 3.17 – Monitoring period consumption in kWh/day

$$\mathit{Consumption\ change\ (kWh)} = (\mathit{total\ monitoring\ period\ consumption})\text{-}(\mathit{baseline\ consumption})$$

Equation 3.18 – Consumption change (kWh/day)

$$\mathit{Consumption\ change}\ (\%) = \frac{(\mathit{monitoring\ period\ consumption}) - (\mathit{baseline\ consumption})}{(\mathit{baseline\ consumption})}$$

Equation 3.19 – Consumption change (%)

3.10 Limitations

3.10.1 Errors in Data Collection

Research that uses new technology often runs into technical problems, especially if it is a newer technology. One of the problems that we ran into, which is quite common when investigating electricity consumption, is accuracy in recording consumption data (see Nye et al., 2010). In this research, it was discovered that the problems were related to both the hardware and software, and after some troubleshooting, the problems were corrected.

These errors affected the appliance level data, which is why we chose not to continue with our investigation of electricity consumption at the appliance level in this study. Luckily, the hub-level data that were found on the homepage were accurate, as they were taken directly from the smart meters, which Milton Hydro uses for billing, allowing us to continue investigating consumption at the hub-level. However, these errors did affect what the users saw in their webportal beyond the homepage, specifically the appliance level consumption data. Because the data were being recorded erroneously, the users saw the erroneous data in their webportal, which could have affected how they set their consumption goals.

3.10.2 Start Dates and Withdrawals

In chapters four and five, the data from each hub will be compared with each other to investigate how consumption and engagement change over time. However, the monitoring periods for each hub vary due to activation dates and two early withdrawals. To account for the different activation dates, the month in which the hub was activated, regardless of how many days during that month the hub was active for, will be called month one, the second month the hub was active will be called month two, and so on until the final month the hub was active.

The reason for using calendar months (November 1 to November 30), rather than full months (i.e. if a hub was activated on November 29, making month one November 29 to December 28) is because goals are set for a calendar month, i.e. the household worked towards achieving their goals starting on the first day of every month until the last day of the month, and we wanted to keep the data analysis in line with how the householders viewed their data. It is important to mention this because in the following chapters when we mention months one, month two, etc., the reader needs to know two things: (1) not all month ones, twos, threes etc. are the same calendar month for each hub, and (2) not all month ones have the same number of days. Appendix D shows which calendar months are associated with each month number for each hub.

The lack of consistency with activation dates is a limitation because it may affect the consistency of the data. For example, the householders of the hubs that were activated in December, may not be as concerned about conserving electricity by the time the hot weather arrived because they had the system for so long, the newness has worn off. However, householders of the hubs that were activated in April may have still been keen to conserve when the hot months arrived.

Two households withdrew from the study early The first, EHMS-25, was decommissioned on November 9, 2012, making the last day of their monitoring period October 31, 2012 because November was not a complete month; their monitoring period was seven calendar months. The second, EHMS-20, was decommissioned on January 9, 2013, so their last day in the monitoring period was December 31, 2012; their monitoring period was nine calendar months. The reason the partial, final months of the EHMS-20 and 25 were not included in the data is the same reason why the consumption data and engagement data are collected from the first to the last of every month: so that we can capture the household's entire monthly experience, including the final day, when they either meet or exceed their goal.

3.10.3 Household Dynamics

For this study, the data were collected from several different sources, including surveys and the event log report. While they collect a lot of interesting data about each household, what we don't know is who in the household is providing us with the data. Specifically, we don't know if the person who filled out the survey, is the person who makes the energy-related decisions in the household, decisions like whether or not to get energy efficient appliances, type of insulation, programming the thermostat, etc. We also don't know who is logging into the webportal, if it is just one person or several people in the household. Not knowing this information could make some of the data seem disjointed. For example, if the person who filled out the survey is environmentally conscious and their responses to the questions reflect that, but the rest of the household is not so environmentally keen, this may be reflected in the consumption data.

3.10.4 Hawthorne effect

The Hawthorne effect is the idea that people will behave differently when they know they are being studied (Wallenborn et al., 2011). This can affect two parts of this study. The first is the household consumption; households are aware that their consumption is being monitored, so they may try to increase their conservation, beyond their usual conservation efforts in an effort to have more "desirable consumption." The second area is the surveys; the surveys were completed online which helped to reduce the need to have socially desirable responses, the responses are not anonymous, so people may still try and provide answers that make them appear more environmentally conscious.

3.10.5 Confounds

In this research, the weather in the cooling months was controlled for, but there are a variety of other factors that were not controlled for, that could affect the household consumption, which include a change in number of occupants, change in daily routine, and change in number and type of appliances. In some cases, as discussed below, the Home Profile and Appliances Selection Survey attempted to gain information about some of the confounds. However the timing of the survey and the fact that life can be unpredictable (i.e. plans can change and unexpected events can occur) means that no matter how much information the survey collected about confounds in an attempt to try and control for them, they still remain confounds.

A change in the number of householders could affect the consumption in the dwelling, and could account for major increases or decreases in consumption. The Home Profile and Appliances Selection Survey asked for the number of people in the home, at the time of the survey, in March 2010, and March 2011. Since webportals did not begin to be activated until November 2011, the difference in number of householders between March 2010 and March 2011 doesn't tell us if there was a change in number of householders between or during the base year and monitoring period.

A change in employment, whether it is switching jobs, going from being unemployed to employed, or losing one's job results in a change in daily routines and as a result, a change in electricity consumption patterns. This is not information we had, so a change in consumption could have been a result of change in employment.

Going on vacation can also have an effect on the electricity consumption in the home. If some, or all of the members of a household go on vacation, whether for a short period of time, or a long period of time, the consumption in the dwelling can be lower. If the householders vacationed in the base year, but not in the monitoring period, it can appear for that period of time that the household had increased their consumption. Not knowing when householders are on vacation makes it difficult to know if a change in consumption is due to a vacation or if consumption patterns changed. The Home Profile and Appliances Selection Survey asked if the householders would be away from their home for more than a month between the time they took the survey and March 2012; one respondent indicated that they did not know, while the remaining 21 responded no. Since the monitoring period ended in January 2013, this question did not encompass the whole monitoring period, nor did it ask about the base year, so there could have been a change in consumption that was a result of a vacation that we did not know about. The householders could have also made plans to go on vacation after the survey was filled out. This question only asks about vacations longer than a month, but shorter vacations can still have a noticeable effect on consumption.

Nineteen of the 22 households had school-aged children (17 and under); these households may have changes in consumption that reflect the school year. For example, there may be increases during March break and the summer, as the children would be home. The same goes for university-aged children; there may be changes in consumption during reading week and their summer. While these school-dependant changes would occur at approximately the same time each year, there may be differences with how the children spend their time. For example, children may go to camps, day or over-night, one year and not another, which can change consumption patterns between the base year and monitoring period.

Purchasing a new appliance can also affect electricity consumption. If a new energy efficient appliance is being purchased to replace an old appliance, this could decrease household consumption, and purchasing a new appliance that is not replacing another, could also increase overall consumption. The Home Profile and Appliances Selection Survey asked householders whether or not they would be replacing and/or adding appliances within the next year. However, there was no follow up with households about this, which means we don't know if and when any of the purchases occurred, so we are unable to link changes in consumption with a change in household appliances.

Chapter 4: Results

4.1 Introduction

The purpose of this chapter is threefold. First, it will provide a brief profile of each hub in the study, based on the responses provided in the Home Profile and Appliances Selection Survey, and the Welcome Survey (surveys can be found in Appendices A and B, respectively), as well as the consumption for the base year and monitoring period. Second, this section will provide the changes in electricity consumption, and third, it will provide the results of the engagement index calculations.

4.2 Hub Profiles

The hub profiles are based on the self-reported data taken from the surveys, and the consumption for the base year and monitoring period. There will be four sections to the profiles: (1) dwelling characteristics, (2) socio-demographic characteristics of the occupants; (3) base year and monitoring period consumption, and (4) attitudes and behaviours about electricity consumption.

4.2.1 Dwelling Characteristics

Tables 4.1 and 4.2 detail the size, year built and style of each of the dwellings. This information was taken from the participants' responses to the Home Profile and Appliances Selection Survey.

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Dwelling Size (square feet)	2000 - 2499	1500 - 1999	2000 - 2499	1500 - 1999	3000 - 3499	1500 - 1999	1500 - 1999	1500 - 1999	2000 - 2499	2500 - 2999	1500 - 1999
Year Built	1970 - 1979	1970 – 1979	2000 - 2006	1970 - 1979	2000 - 2006	2000 - 2006	2000 - 2006	2007 - 2010	2000 - 2006	2000 - 2006	1970 - 1979
Style of Dwelling	Detached two or more storey	Detached two or more storey	Semi-detached two or more storey	Detached two or more storey	Detached two or more storey	Detached one storey	Detached two or more storey	Condominium town house or semi detached	Detached two or more storey	Detached two or more storey	Detached two or more storey

Table 4.1 – Dwelling Characteristics for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Dwelling Size (square feet)	2000 - 2499	1000 - 1499	1500 - 1999	3000 - 3499	2000 - 2499	2000 - 2499	2500 - 2999	2500 - 2999	2500 - 2999	2500 - 2999	2000 - 2499
Year Built	2000 - 2006	2000 – 2006	2000 - 2006	2000 - 2006	2000 - 2006	2000 - 2006	2000 - 2006	2007 - 2010	2007 - 2010	2007 - 2010	2007 - 2010
Style of Dwelling	Detached two or more storey	Row housing (attached on both sides)	Semi-detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey	Detached two or more storey

Table 4.2 – Dwelling Characteristics for EHMS-15-25

4.2.2 Socio-demographic Characteristics

Tables 4.3 and 4.4 detail the socio-demographic characteristics of the householders in the 22 hubs. This includes the number of people in the household, and their ages, the household income before taxes, and the highest level of education in the household. This information was taken from the participants' responses to the Home Profile and Appliances Selection Survey.

EHMS-19 stated that they had two occupants in their dwelling, however, both residents were under the age of 13. This is more than likely not the case, so in analysis dealing with number of occupants, EHMS-19 will be omitted.

		EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Age	**0 - 5 years**	0	0	2	2	1	0	0	0	1	0	2
	6 - 13 years	0	0	2	0	0	2	1	0	1	0	0
	14 - 17 years	0	0	0	0	0	1	1	0	0	1	0
	18 - 64 years	2	3	2	2	2	2	3	2	2	3	2
	65+ years	0	0	0	0	0	0	0	0	0	0	0
Total # occupants		2	3	6	4	3	5	5	2	4	4	4
Income (before taxes)		$150,000 and over	$150,000 and over	$80,000 - $89,999	$125,000 - $149,999	$150,000 and over	$90,000 - $99,999	$60,000 - $69,999	$100,000 - $124,999	$150,000 and over	$100,000 - $124,999	$125,000 - $149,999
Highest certificate, diploma or degree in the household		Bachelor's degree	Bachelor's degree	Bachelor's degree	Bachelor's degree	University certificate or diploma below bachelor level	University certificate or diploma below bachelor level	Bachelor's degree	Bachelor's degree	Degree in medicine, dentistry, veterinary medicine or optometry	Apprenticeship or trades certificate or diploma	Bachelor's degree

Table 4.3 –Socio-demographic characteristics for EHMS-01, 02, 04, 05, 07, 09-14

		EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Age	**0 - 5 years**	0	1	1	0	1	0	2	1	2	1	1
	6 - 13 years	2	1	1	2	1	2	0	0	0	2	0
	14 - 17 years	0	0	0	0	0	0	0	0	0	0	0
	18 - 64 years	2	2	2	2	0	2	2	2	2	5	3
	65+ years	0	0	0	0	0	0	0	0	0	0	1
Total # occupants		4	4	4	4	2*	4	4	3	4	8	5
Income (before taxes)		$150,000 and over	$90,000 - $99,999	$90,000 - $99,999	$100,000 - $124,999	$125,000 - $149,999	$125,000 - $149,999	$125,000 - $149,999	$90,000 - $99,999	$150,000 and over	$150,000 and over	$90,000 - $99,999
Highest certificate, diploma or degree in the household		Bachelor's degree	College, CEGEP or other non-university certificate or diploma	Bachelor's degree	Bachelor's degree	Master's degree	University certificate or diploma below bachelor level	University certificate or diploma below bachelor level	Bachelor's degree	Master's degree	Bachelor's degree	Bachelor's degree

Table 4.4 – Socio-demographic characteristics for EHMS-15-25

4.2.3 Base Year and Monitoring Period Electricity Consumption

Tables 4.5 and 4.6 give the monthly electricity consumption for the base year in kWh/day (monthly electricity consumption/number of days in the month) and Tables 4.7 and 4.8 give the total monthly electricity consumption for the base year and the total annual consumption for the base year in kWh. Tables 4.9 and 4.10 give the monthly electricity consumption for the base year in kWh/day (total monthly electricity consumption/number of days in the month) and Tables 4.11 and 4.12 give the total monthly electricity consumption for the base year and the total annual consumption for the base year in kWh. The dates listed on the left side of the charts are not all complete months, some of them are partial months. These correspond to months where hubs were activated, and as a result are not applicable to all hubs.

As discussed earlier, activation dates varied for each hub, and month one varied in length from two days to 28 days. Where month one was shorter than seven days, the data may not accurately describe the whole month. There were also three occurrences (EHMS-09, 10 and 19) where consumption in kWh/day for the base year was considerably less for month one than for the rest of the months (Tables 4.5 and 4.6). In these three cases, the month one data did not accurately describe the data for the entire month, and be marked with an asterisk (*) in Tables 4.5 to 4.12. These data are included in calculations for change in consumption in section 4.4.2, but will be marked with an asterisk, to note to the reader that the changes in consumption may not accurately represent the changes between the base year and consumption period. These data are also excluded from analysis done for individual months in chapter five, but are included in analysis done for groups of months.

Milton Hydro provided hourly consumption data; the data were summed up for each month and divided by the number of days in the month to obtain the monthly consumption in kWh/day. The data received from Milton Hydro were in Eastern Standard Time, which does not account for daylight savings. Since the data in the webportal reflect the ‘real-clock’ time of residents of Milton, Ontario (i.e. did account for daylight savings time), the data provided by Milton Hydro was adjusted to reflect real clock time.

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-30, 2010	15.0*	20.8*	29.5*								
Dec-10	18.2	27.6	30.5								
Dec 23-31, 2010				29.9		9.6*	8.1*		35.6	16.8	22.6
Jan-11	29.1	23.4	29.8	27.6		22.9	20.1		35.2	17.1	26.9
Jan 3-31, 2011					29.7			15.8			
Jan 13-31, 2011											
Feb-11	25.3	25.6	30.1	27.0	29.0	22.4	18.0	14.6	33.8	16.1	24.7
Mar-11	26.5	23.0	29.3	24.7	27.1	20.5	16.7	11.9	32.9	14.4	21.8
Apr-11	31.7	21.0	30.9	22.0	19.8	21.9	16.9	14.3	30.4	14.0	21.6
April 27-31, 2011											
May-11	36.0	21.3	35.0	20.0	26.7	24.6	20.2	14.3	33.9	13.9	19.9
Jun-11	53.1	15.6	46.0	28.1	30.3	25.9	35.5	16.2	41.2	18.1	44.4
Jul-11	69.9	28.1	52.1	46.7	54.8	41.1	52.4	27.0	60.8	42.7	50.2
Aug-11	49.3	27.5	48.0	38.0	43.1	20.1	34.6	19.1	56.1	37.2	48.6
Sep-11	56.1	16.9	43.2	27.4	31.7	24.2	23.4	13.0	56.9	14.8	37.6
Oct-11	30.5	16.7	39.8	31.1	29.4	21.9	18.9	14.0	48.9	12.6	18.6
Nov-11				32.8	32.6	22.7	18.4	14.4	50.4	12.6	21.4
Nov 1-28, 2011	27.4	18.1	36.6								
Dec-11					28.2			15.0			
Dec 1-22, 2011				40.1		20.0	21.0		53.8	15.8	25.2
Jan-12											
Jan 1-2, 2012					23.1			17.8			
Jan 1-12, 2012											
Feb-12											
Mar-12											
April 1-26, 2012											

Table 4.5 – Electricity consumption (kWh/day) for the base year for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-30, 2010											
Dec-10											
Dec 23-31, 2010											
Jan-11											
Jan 3-31, 2011											
Jan 13-31, 2011	27.2	20.0			8.5*						
Feb-11	33.5	18.5			25.1						
Mar-11	24.6	15.6			21.2						
Apr-11	21.8	15.3			21.9						
April 27-31, 2011			8.8*	30.5*		13.5*	35.5*	10.5*	16.9*	14.6*	13.1*
May-11	20.9	13.8	8.7	23.8	22.1	12.0	26.7	10.1	35.0	14.4	20.3
Jun-11	31.1	14.9	8.9	34.0	28.3	18.6	39.9	12.4	42.9	26.7	19.9
Jul-11	51.7	22.7	13.3	52.4	34.8	34.9	54.7	23.7	57.9	41.4	39.1
Aug-11	42.8	17.0	10.0	42.8	27.8	24.8	51.5	18.1	45.5	24.9	28.6
Sep-11	30.3	17.3	9.1	24.0	24.8	17.4	32.3	10.3	35.4	14.3	14.4
Oct-11	24.4	16.7	9.3	28.4	23.9	15.8	30.5	11.5	34.1	10.2	17.1
Nov-11	24.3	18.2	10.0	32.5	23.2	13.1	28.9	12.3	29.0	13.3	10.0
Nov 1-28, 2011											
Dec-11	25.9	19.2	11.4	28.8	25.4	14.1	27.0	15.3	25.7	21.3	19.6
Dec 1-23, 2011											
Jan-12			11.4	32.8		18.0	35.7	16.6	30.1	23.3	18.5
Jan 1-2, 2012											
Jan 1-12, 2012	28.4	17.8			28.0						
Feb-12			10.7	30.4		20.6	40.1	13.8	28.4	22.5	17.0
Mar-12			10.3	32.2		15.5	33.8	13.7	25.9	23.4	18.0
April 1-26, 2012			9.8	29.7		14.6	30.9	12.1	21.3	25.1	21.8

Table 4.6 – Electricity consumption (kWh/day) for the base year for EHMS-15-25

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-30, 2010	60.1*	83.1*	118.2*								
Dec-10	564.8	855.0	945.2								
Dec 23-31, 2010				268.8		86.4*	73.1*		320.3	150.9	203.1
Jan-11	901.7	725.6	923.6	854.1		708.5	622.7		1091.3	530.8	835.1
Jan 3-31, 2011					862.1			458.9			
Jan 13-31, 2011											
Feb-11	708.2	715.5	842.4	755.8	811.4	626.9	503.0	410.1	945.7	450.0	691.1
Mar-11	822.2	713.3	909.1	764.8	839.2	636.0	518.9	368.1	1019.7	447.6	677.2
Apr-11	950.6	629.0	927.6	659.3	594.0	657.2	506.7	429.5	910.9	419.9	646.6
April 27-31, 2011											
May-11	1116.9	661.0	1086.3	618.6	826.4	761.5	624.8	444.8	1050.9	432.0	615.6
Jun-11	1593.0	468.0	1381.4	841.9	908.0	777.0	1066.3	486.7	1237.0	544.4	1332.1
Jul-11	2165.8	870.6	1614.4	1449.1	1700.0	1273.8	1625.9	836.0	1884.5	1322.6	1556.6
Aug-11	1528.5	852.0	1487.2	1176.9	1337.5	624.6	1071.4	593.0	1738.9	1152.1	1505.1
Sep-11	1684.9	506.7	1296.9	822.8	950.1	725.8	703.1	391.4	1705.6	444.1	1127.8
Oct-11	945.3	516.1	1234.6	963.7	909.9	678.0	585.8	434.6	1515.5	389.8	575.6
Nov-11				985.4	976.7	679.9	552.9	430.8	1512.4	377.7	642.8
Nov 1-28, 2011	766.2	554.2	1024.8								
Dec-11					873.2			464.3			
Dec 1-22, 2011				881.6		439.0	462.2		1184.6	348.5	553.8
Jan-12											
Jan 1-2, 2012					46.1			35.5			
Jan 1-12, 2012											
Feb-12											
Mar-12											
April 1-26, 2012											
Total	13808.2	8150.1	13791.5	11042.9	11634.7	8674.7	8916.5	5783.7	16117.3	7010.2	10962.5

Table 4.7 – Total monthly electricity consumption (kWh) for the base year for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-30, 2010											
Dec-10											
Dec 23-31, 2010											
Jan-11											
Jan 3-31, 2011											
Jan 13-31, 2011	516.6	380.0			161.7*						
Feb-11	939.0	517.0			701.5						
Mar-11	762.6	482.9			657.7						
Apr-11	653.8	458.9			655.9						
April 27-31, 2011			35.0*	122.0*		54.0*	142.0*	42.0*	67.6*	58.5*	52.5*
May-11	646.5	427.9	268.2	736.8	684.8	371.5	826.7	312.7	1085.3	447.6	628.8
Jun-11	934.3	448.4	265.8	1020.9	850.2	558.3	1197.4	372.3	1286.3	800.3	597.4
Jul-11	1601.4	703.6	410.9	1624.5	1077.5	1082.3	1694.7	734.8	1794.9	1283.9	1211.9
Aug-11	1326.1	525.8	310.6	1327.2	862.9	767.4	1597.0	560.1	1410.2	772.6	885.7
Sep-11	910.0	520.5	272.8	719.7	743.5	520.7	968.2	309.9	1061.7	428.3	431.7
Oct-11	756.1	518.7	287.0	879.4	741.2	490.8	944.2	355.9	1056.8	316.1	529.6
Nov-11	728.2	544.9	300.0	974.0	694.9	394.2	867.8	368.6	869.8	399.7	300.7
Nov 1-28, 2011											
Dec-11	804.2	594.4	353.6	891.4	786.5	436.6	837.2	474.3	796.8	660.1	607.8
Dec 1-23, 2011											
Jan-12			353.9	1017.9		557.3	1106.2	512.7	932.7	721.8	572.9
Jan 1-2, 2012											
Jan 1-12, 2012	340.9	213.0			336.3						
Feb-12			310.7	882.1		596.3	1162.4	399.8	822.4	651.1	492.6
Mar-12			319.3	999.2		479.0	1048.5	423.9	802.3	725.1	558.3
April 1-26, 2012			255.8	772.8		380.8	802.8	315.2	553.3	653.0	567.9
Total	10919.6	6336.0	3743.5	11967.9	8954.6	6689.2	13195.0	5182.3	12540.2	7918.1	7437.7

Table 4.8 – Total monthly electricity consumption (kWh) for the base year for EHMS-15-25

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-30, 2011	25.8*	23.0*	38.1*								
Dec-11	33.1	23.9	40.6								
Dec 23-31, 2011				45.1		15.4*	24.0*		59.3	17.3	29.3
Jan-12	29.4	26.1	34.9	35.4		19.2	19.8		61.5	14.3	24.3
Jan 3-31, 2013					22.9			16.6			
Jan 13-31, 2012											
Feb-12	31.0	25.0	32.9	34.3	22.3	19.0	18.7	16.4	60.3	14.7	22.9
Mar-12	29.2	19.5	35.0	32.4	20.6	18.1	16.9	14.6	58.6	12.6	20.0
Apr-12	36.4	19.9	34.7	30.1	17.9	19.2	17.2	16.9	55.7	12.7	19.7
April 27-31, 2012											
May-12	41.6	18.6	39.0	31.9	24.4	19.8	21.5	16.6	55.1	21.7	37.5
Jun-12	53.5	26.8	47.4	38.3	44.4	25.8	33.3	20.3	69.3	28.0	51.6
Jul-12	65.9	35.5	53.0	46.9	66.4	33.4	46.2	28.0	79.5	35.4	56.5
Aug-12	52.6	24.1	44.7	36.3	66.0	27.4	38.6	21.3	65.3	27.1	41.3
Sep-12	42.9	15.6	39.4	30.7	37.4	20.6	25.4	16.0	61.8	14.2	38.9
Oct-12	31.1	16.5	34.4	28.3	32.0	24.3	17.2	13.6	58.4	13.7	21.2
Nov-12	35.6	20.2	35.1	34.5	28.0	26.3	17.9	16.4	56.7	15.2	24.8
Dec-12	40.9	24.6	39.0	41.9	32.1	26.9	19.8	16.6	59.7	14.1	26.6
Jan-13	40.3	22.5	33.4	39.6	30.8	20.8	19.0	19.7	72.9	16.2	24.9

Table 4.9 – Monthly electricity consumption (kWh/day) for the monitoring period for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-30, 2011											
Dec-11											
Dec 23-31, 2011											
Jan-12											
Jan 3-31, 2013											
Jan 13-31, 2012	27.3	20.4			17.6*						
Feb-12	26.4	18.8			19.7						
Mar-12	19.3	17.3			16.7						
Apr-12	22.4	17.0			16.9						
April 27-31, 2012			8.9*	31.1*		18.0*	18.4*	10.2*	22.8*	25.7*	25.6*
May-12	29.7	15.8	9.1	36.6	19.9	14.6	34.6	13.0	29.8	23.0	22.7
Jun-12	42.2	20.0	9.8	34.8	26.9	28.3	43.9	17.3	35.8	45.3	30.9
Jul-12	52.2	26.2	10.7	60.2	14.9	39.8	58.1	24.1	39.9	54.6	40.5
Aug-12	45.6	20.6	5.3	40.5	30.6	30.2	51.7	16.6	44.0	47.9	31.8
Sep-12	31.5	18.8	9.0	23.6	22.6	24.3	36.6	12.4	31.6	32.3	26.7
Oct-12	23.9	18.2	9.8	17.8	14.7	22.5	34.7	12.5	24.7	22.7	24.3
Nov-12	26.0	18.4	10.7	21.1	17.0	24.4	35.0	14.0	24.4	24.9	
Dec-12	33.4	20.8	11.6	21.6	14.6	22.9	36.6	17.8	28.7	25.4	
Jan-13	27.9	19.9	11.8	23.4	18.8		38.6	17.6	29.3	23.7	

Table 4.10 – Monthly electricity consumption (kWh/day) for the monitoring period for EHMS-15-25

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-30, 2011	51.6*	46.1*	76.2*								
Dec-11	1025.5	741.4	1257.6								
Dec 23-31, 2011				406.1		138.7*	216.7*		534.0	155.5	264.0
Jan-12	912.4	809.8	1081.6	1096.4		595.0	613.2		1907.6	443.5	752.5
Jan 3-31, 2013					664.3			482.4			
Jan 13-31, 2012											
Feb-12	898.0	724.8	953.8	995.3	647.8	549.8	543.4	474.8	1748.1	426.5	662.9
Mar-12	905.9	604.7	1084.1	1003.0	637.5	560.7	524.3	452.4	1816.1	389.1	621.2
Apr-12	1092.7	597.0	1040.3	902.7	538.3	575.0	516.6	507.7	1670.8	381.1	590.3
April 27-31, 2012											
May-12	1289.1	577.0	1207.8	989.3	756.4	614.7	665.1	513.6	1707.0	671.5	1163.1
Jun-12	1606.0	803.4	1421.4	1150.1	1330.7	773.7	998.8	609.2	2077.4	841.1	1547.9
Jul-12	2043.7	1100.6	1644.1	1452.4	2057.2	1035.8	1432.3	868.5	2463.1	1096.9	1750.4
Aug-12	1629.8	745.9	1384.5	1125.6	2044.9	847.9	1196.6	660.4	2022.8	841.3	1280.0
Sep-12	1286.6	468.9	1183.3	919.6	1121.0	616.8	762.6	480.2	1853.2	426.2	1167.1
Oct-12	963.2	510.2	1064.7	878.5	991.6	753.2	532.4	421.1	1809.4	425.0	657.4
Nov-12	1067.4	605.0	1053.7	1035.5	838.5	790.2	535.7	491.3	1701.8	455.5	743.6
Dec-12	1266.2	763.4	1207.6	1298.8	994.9	834.2	614.9	514.2	1851.5	435.8	825.6
Jan-13	1248.4	698.3	1034.8	1227.0	955.5	644.1	589.7	609.2	2260.1	501.0	771.3
Total	17286.2	9796.6	16695.4	14480.3	13578.6	9329.6	9742.2	7084.9	25422.8	7490.0	12797.4

Table 4.11 – Total monthly electricity consumption (kWh) for the monitoring period for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-30, 2011											
Dec-11											
Dec 23-31, 2011											
Jan-12											
Jan 3-31, 2013											
Jan 13-31, 2012	518.9	387.0			333.5*						
Feb-12	765.6	545.7			571.4						
Mar-12	599.2	537.5			518.6						
Apr-12	671.5	511.1			505.7						
April 27-31, 2012			35.7*	124.4*		71.9*	73.5*	40.6*	89.9*	102.9*	102.3*
May-12	919.6	488.7	280.6	1134.9	616.1	451.9	1071.8	403.3	923.2	713.8	705.1
Jun-12	1266.6	599.7	294.9	1045.2	806.2	848.5	1318.3	517.5	1074.6	1358.8	926.5
Jul-12	1617.6	812.8	331.1	1866.4	461.8	1232.1	1801.6	748.4	1237.2	1691.5	1254.9
Aug-12	1412.3	637.8	164.1	1254.5	948.4	936.2	1603.1	514.5	1363.3	1485.1	985.3
Sep-12	943.8	563.5	268.8	707.1	677.9	727.6	1096.6	373.3	946.9	967.7	801.0
Oct-12	741.2	564.7	304.1	551.0	454.7	698.0	1076.9	387.8	764.4	705.1	753.5
Nov-12	780.3	552.2	319.5	632.1	510.7	731.3	1051.1	419.2	731.3	745.9	
Dec-12	1035.5	643.8	361.0	670.1	453.1	711.2	1135.5	551.4	889.8	788.4	
Jan-13	865.9	616.0	364.2	725.4	582.2		1195.7	543.9	909.0	734.1	
Total	12138.0	7460.5	2724.0	8711.3	7440.3	6408.7	11424.1	4499.9	8929.6	9293.2	5528.6

Table 4.12 –Total monthly electricity consumption (kWh) for the monitoring period for EHMS-15-25

4.2.4 Attitudes and Behaviours about Electricity Consumption

This section provides information about householders' attitudes and behaviours regarding electricity consumption. This information is presented in table form, and was taken from the responses of the Welcome Survey. Only 18 of the 22 households provided responses for the Welcome Survey. EHMS- 02, 19, 22 and 24 did not provide responses. There are four different categories of information presented in this section: awareness, attitudes, actions, and goals. Tables 4.13 and 4.14 present the responses regarding household awareness of electricity consumption, specifically about how much they are consuming, the cost, and carbon footprint. Tables 4.15 and 4.16 present the respondents' attitudes towards electricity consumption, specifically about reducing overall consumption and on-peak consumption. Tables 4.17 and 4.18 present the responses from households about their electricity management in their home (i.e. their conservation efforts). Tables 4.19 and 4.20 present the types of actions householders take to conserve electricity in the home, and the frequency of these actions. Tables 4.21 and 4.22 present the goals the households would like to achieve while participating in this study.

Please indicate how you perceive your level of awareness with regards to the following:									
	EHMS-01	**EHMS-04**	**EHMS-05**	**EHMS-07**	**EHMS-09**	**EHMS-10**	**EHMS-11**	**EHMS-12**	**EHMS-13**
Currently, I am aware of how much electricity is used by each of my electric appliances.	Somewhat agree	Disagree	Disagree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Disagree	Agree
Currently, I am aware of how much money it costs to use each of my electric appliances.	Somewhat agree	Disagree	Somewhat disagree	Somewhat disagree	Somewhat disagree	Somewhat disagree	Disagree	Neither agree nor disagree	Somewhat agree
Currently, I am aware of the carbon footprint associated with using each of my electric appliances.	Neither agree nor disagree	Disagree	Disagree	Somewhat disagree	Disagree	Somewhat disagree	Disagree	Strongly disagree	Agree

Table 4.13 – Awareness about electricity consumption for EHMS-01, 04, 05, 07, 09-13

Please indicate how you perceive your level of awareness with regards to the following:									
	EHMS-14	**EHMS-15**	**EHMS-16**	**EHMS-17**	**EHMS-18**	**EHMS-20**	**EHMS-21**	**EHMS-23**	**EHMS-25**
Currently, I am aware of how much electricity is used by each of my electric appliances.	Somewhat disagree	Disagree	Disagree	Neither agree nor disagree	Somewhat disagree	Somewhat agree	Disagree	Neither agree nor disagree	Strongly disagree
Currently, I am aware of how much money it costs to use each of my electric appliances.	Somewhat disagree	Disagree	Disagree	Neither agree nor disagree	Disagree	Somewhat agree	Disagree	Somewhat disagree	Strongly disagree
Currently, I am aware of the carbon footprint associated with using each of my electric appliances.	Somewhat disagree	Disagree	Disagree	Neither agree nor disagree	Strongly disagree	Somewhat agree	Disagree	Disagree	Strongly disagree

Table 4.14 – Awareness about electricity consumption for EHMS-14-18, 20, 21, 23, 25

To what extent do the following statements describe your attitudes towards energy management in your home?									
	EHMS-01	**EHMS-04**	**EHMS-05**	**EHMS-07**	**EHMS-09**	**EHMS-10**	**EHMS-11**	**EHMS-12**	**EHMS-13**
I believe that it is important to conserve as much energy in my home as possible.	Strongly agree	Agree	Strongly agree	Somewhat agree	Strongly agree	Agree	Somewhat agree	Strongly agree	Strongly agree
I believe that it is important to reduce my electricity usage during on-peak times as much as possible.	Strongly agree	Somewhat agree	Strongly agree	Somewhat agree	Strongly agree	Somewhat agree	Agree	Strongly agree	Strongly agree

Table 4.15 – Attitudes about electricity consumption for EHMS-01, 04, 05, 07, 09-13

To what extent do the following statements describe your attitudes towards energy management in your home?									
	EHMS-14	**EHMS-15**	**EHMS-16**	**EHMS-17**	**EHMS-18**	**EHMS-20**	**EHMS-21**	**EHMS-23**	**EHMS-25**
I believe that it is important to conserve as much energy in my home as possible.	Strongly agree	Strongly agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
I believe that it is important to reduce my electricity usage during on-peak times as much as possible.	Somewhat agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree

Table 4.16 – Attitudes about electricity consumption for EHMS-14-18, 20, 21, 23, 25

To what extent do the following statements describe your actions towards energy management in your home?									
	EHMS-01	**EHMS-04**	**EHMS-05**	**EHMS-07**	**EHMS-09**	**EHMS-10**	**EHMS-11**	**EHMS-12**	**EHMS-13**
I try to conserve as much energy in my home as possible.	Strongly agree	Neither agree nor disagree	Somewhat agree	Neither agree nor disagree	Agree	Somewhat agree	Somewhat agree	Somewhat agree	Agree
I try to reduce my electricity usage during on-peak times as much as possible.	Strongly agree	Neither agree nor disagree	Agree	Somewhat agree	Agree	Somewhat agree	Somewhat agree	Somewhat agree	Strongly agree

Table 4.17 – Conservation in the home for EHMS-01, 04, 05, 07, 09-13

To what extent do the following statements describe your actions towards energy management in your home?									
	EHMS-14	**EHMS-15**	**EHMS-16**	**EHMS-17**	**EHMS-18**	**EHMS-20**	**EHMS-21**	**EHMS-23**	**EHMS-25**
I try to conserve as much energy in my home as possible.	Strongly agree	Agree	Agree	Agree	Somewhat agree	Strongly agree	Somewhat agree	Agree	Agree
I try to reduce my electricity usage during on-peak times as much as possible.	Somewhat agree	Somewhat agree	Agree	Agree	Somewhat agree	Strongly agree	Agree	Neither agree nor disagree	Agree

Table 4.18 – Conservation in the home for EHMS-14-18, 20, 21, 23, 25

In the past year, how often have the following actions been performed in your home to conserve energy?	EHMS-01	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13
YEAR- ROUND									
Use less hot water	Once per week	n/a	Once per week	Once per year	Every 2 or 3 days	At least daily	Once per season	Every 2 or 3 days	At least daily
Turn off lights when no one is in the room	At least daily	At least daily	At least daily	Every 2 or 3 days	At least daily	At least daily	At least daily	At least daily	At least daily
Turn off T.V., stereo, computer, printer when not in use	Every 2 or 3 days	Every 2 or 3 days	Never	Every 2 or 3 days	At least daily	Every 2 or 3 days	Every 2 or 3 days	At least daily	At least daily
Hang clothes to dry	Never	Once per year	Never	Never	Once per week	Once per week	Once per season	Once per season	Once per week
Adjust heating/cooling vents in rooms not in use	Never	Never	Once per week	Never	Once per week	Once per week	Once per year	Once per season	Never
Run electric appliances at off-peak times	Every 2 or 3 days	Not applicable	At least daily	Once per week	Every 2 or 3 days	Every 2 or 3 days	Every 2 or 3 days	Every 2 or 3 days	Once per week
COLDER SEASONS									
Adjust thermostat to lower heat when no one is home	At least daily	Never	At least daily	Never	At least daily	Once per week	Once per season	Once per season	At least daily
Adjust thermostat to lower heat when my family is asleep	At least daily	Never	At least daily	Never	At least daily	At least daily	Once per season	Once per season	At least daily
Wear warmer clothes, so the thermostat can be kept lower	Never	Never	Every 2 or 3 weeks	Never	Every 2 or 3 days	At least daily	Every 2 or 3 weeks	Once per season	Never
WARMER SEASONS									
Use fans/open windows instead of air conditioning	Never	Every 2 or 3 weeks	Never	Once per season	At least daily	At least daily	Every 2 or 3 weeks	Every 2 or 3 days	At least daily
Raise the indoor temperature by adjusting the air-conditioner	At least daily	Every 2 or 3 days	Every 2 or 3 weeks	Never	At least daily	At least daily	Every 2 or 3 weeks	Once per season	Once per week
Close drapes during hot summer days	At least daily	At least daily	At least daily	Every 2 or 3 days	At least daily	At least daily	Every 2 or 3 weeks	At least daily	At least daily

Table 4.19 – Electricity conserving actions and their frequency for EHMS-01, 04, 05, 07, 09-13

In the past year, how often have the following actions been performed in your home to conserve energy?									
	EHMS-14	**EHMS-15**	**EHMS-16**	**EHMS-17**	**EHMS-18**	**EHMS-20**	**EHMS-21**	**EHMS-23**	**EHMS-25**
YEAR- ROUND									
Use less hot water	Every 2 or 3 days	Never	At least daily	Once per week	Never	At least daily	Never	Never	Every 2 or 3 days
Turn off lights when no one is in the room	At least daily	Never	At least daily	At least daily	At least daily	At least daily	At least daily	At least daily	At least daily
Turn off T.V., stereo, computer, printer when not in use	Never	Never	At least daily	At least daily	Every 2 or 3 weeks	At least daily	Once per week	At least daily	At least daily
Hang clothes to dry	Never	Every 2 or 3 weeks	Never	Once per week	Once per year	Once per season	At least daily	Never	Never
Adjust heating/cooling vents in rooms not in use	Once per season	Never	Never	Never	Never	Every 2 or 3 days	Every 2 or 3 weeks	At least daily	Once per week
Run electric appliances at off-peak times	At least daily	Every 2 or 3 days	At least daily	Every 2 or 3 days	Every 2 or 3 days	Every 2 or 3 days	Every 2 or 3 days	Never	Once per week
COLDER SEASONS									
Adjust thermostat to lower heat when no one is home	At least daily	At least daily	At least daily	At least daily	Once per season	At least daily	At least daily	At least daily	Once per week
Adjust thermostat to lower heat when my family is asleep	Never	At least daily	At least daily	At least daily	Never	At least daily	At least daily	At least daily	Once per year
Wear warmer clothes, so the thermostat can be kept lower	At least daily	Never	At least daily	At least daily	Never	At least daily	At least daily	Once per season	Once per year
WARMER SEASONS									
Use fans/open windows instead of air conditioning	Once per week	Every 2 or 3 weeks	At least daily	At least daily	Never	At least daily	At least daily	Every 2 or 3 weeks	At least daily
Raise the indoor temperature by adjusting the air-conditioner	Once per week	Every 2 or 3 days	At least daily	Every 2 or 3 days	Never	At least daily	At least daily	Once per year	Every 2 or 3 days
Close drapes during hot summer days	At least daily	At least daily	At least daily	At least daily	Never	At least daily	At least daily	Every 2 or 3 days	Every 2 or 3 days

Table 4.20 – Electricity conserving actions and their frequency for EHMS-14-18, 20, 21, 23, 25

With the Energy Hub Management System, you will have an opportunity to set and manage monthly goals relating to your home's electricity consumption. Please select the goal that best describes you. **“I would like to set goals that help…”**								
EHMS-01	**EHMS-04**	**EHMS-05**	**EHMS-07**	**EHMS-09**	**EHMS-10**	**EHMS-11**	**EHMS-12**	**EHMS-13**
I do not know.	I do not know.	DECREASE my home's electricity consumption.	I do not know.	I do not know.	I do not know.	MINIMIZE AN INCREASE of my home's electricity consumption.	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption

Table 4.21 – Household consumption goals for EHMS-01, 04, 05, 07, 09-13

With the Energy Hub Management System, you will have an opportunity to set and manage monthly goals relating to your home's electricity consumption. Please select the goal that best describes you. **“I would like to set goals that help…”**								
EHMS-14	**EHMS-15**	**EHMS-16**	**EHMS-17**	**EHMS-18**	**EHMS-20**	**EHMS-21**	**EHMS-23**	**EHMS-25**
DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption	DECREASE my home's electricity consumption

Table 4.22 – Household consumption goals for EHMS-14-18, 20, 21, 23, 25

4.3 Weather data

The weather data are used in the weather normalization process, specifically to find the balance point and to determine the cooling degree days. Table 4.23 shows the average daily temperature for each month in the base year and the monitoring period. Tables 4.24 to 4.31 show the daily averages for each of the cooling months, March to October, 2011 and 2012. These are the data used to calculate the cooling degree days, described in section 4.4.1. The data in Tables 4.23 to 4.31 were retrieved from Government of Canada (2013).

	2010	2011	2012	2013
January		-9.4	-3.7	-4.1
February		-7.1	-2.2	
March		-2.9	5.5	
April		5.3	5.1	
May		12.7	14.5	
June		16.7	17.9	
July		21.4	21.4	
August		19.3	18.8	
September		15.2	13.8	
October		8.6	8.6	
November	2.9	5.0	1.6	
December	-5.5	-0.9	-0.6	

Table 4.23 – Average Daily Temperature (°C) for base year and monitoring period

Day	Mar-11	Mar-12
1	-5.2	0.7
2	-6.9	3.9
3	-9.7	2.0
4	-1.3	-7.8
5	1.3	-9.9
6	-6.0	-3.7
7	-8.3	8.7
8	-5.0	5.6
9	0.3	-5.0
10	3.0	-5.5
11	0.4	8.5
12	-0.2	5.6
13	-1.9	7.0
14	-3.0	6.7
15	-2.5	10.9
16	2.0	13.8

Day	Mar-11	Mar-12
17	5.0	12.6
18	6.6	13.5
19	-2.1	15.8
20	-2.5	15.2
21	3.4	16.4
22	1.4	16.4
23	-3.7	14.2
24	-9.3	8.3
25	-10.7	9.6
26	-11.8	-0.7
27	-10.6	-1.3
28	-8.3	9.7
29	-2.5	-1.6
30	-1.7	-1.8
31	1.1	3.5

Table 4.24 – Daily Average Temp (°C) for March 2011 and March 2012

Day	Apr-11	Apr-12
1	3.1	3.2
2	1.8	4.0
3	3.3	3.9
4	8.2	4.5
5	1.2	2.7
6	0.6	3.1
7	2.8	4.6
8	3.9	4.0
9	5.5	6.0
10	13.2	3.6
11	12.4	4.3
12	7.5	3.4
13	7.9	4.8
14	6.2	6.3
15	1.5	14.9

Day	Apr-11	Apr-12
16	4.6	14.7
17	0.9	2.2
18	0.6	2.6
19	0.7	10.6
20	3.5	12.7
21	0.4	3.8
22	2.3	5.7
23	11.5	2.7
24	7.3	2.3
25	6.9	6.2
26	9.4	4.1
27	13.6	2.8
28	9.6	1.8
29	3.2	3.9
30	6.1	2.1

Table 4.25 –Daily Average Temp (°C) for April 2011 and April 2012

Day	May-11	May-12
1	10.3	7.6
2	9.2	9.2
3	5.1	16.8
4	6.4	17.0
5	9.0	9.8
6	7.9	10.6
7	9.3	12.6
8	9.2	12.2
9	9.2	11.9
10	9.9	10.5
11	14.0	11.7
12	13.5	14.0
13	17.0	13.6
14	13.7	12.9
15	8.8	13.7
16	6.8	9.4

Day	May-11	May-12
17	9.4	8.3
18	13.2	11.4
19	13.7	16.7
20	16.7	18.9
21	17.3	19.7
22	19.2	17.2
23	18.9	18.1
24	12.0	18.7
25	10.0	20.7
26	15.9	17.8
27	11.6	18.0
28	14.7	22.6
29	19.0	20.8
30	20.9	14.7
31	22.8	12.0

Table 4.26 – Daily Average Temp (°C) for May 2011 and May 2012

Day	Jun-11	Jun-12
1	17.4	11.8
2	11.0	12.8
3	13.0	12.0
4	15.3	10.5
5	17.3	12.7
6	18.0	14.8
7	20.5	16.3
8	24.2	17.0
9	17.8	18.7
10	13.1	20.9
11	16.2	20.8
12	12.4	16.9
13	11.9	13.8
14	14.2	13.9
15	16.1	18.3

Day	Jun-11	Jun-12
16	17.7	18.7
17	17.4	20.9
18	20.0	22.8
19	16.3	26.7
20	16.4	25.7
21	18.8	25.2
22	19.7	18.2
23	20.0	17.6
24	17.7	16.9
25	16.4	14.8
26	16.3	14.8
27	16.7	19.5
28	18.9	21.9
29	14.7	21.4
30	15.6	21.8

Table 4.27 – Daily Average Temp (°C) for June 2011 and June 2012

Day	Jul-11	Jul-12	Day	Jul-11	Jul-12
1	16.2	20.4	**17**	23.5	28.1
2	21.0	20.1	**18**	25.2	22.1
3	19.2	22.0	**19**	24.2	17.3
4	18.0	24.9	**20**	24.4	17.6
5	19.1	23.2	**21**	27.3	17.9
6	20.3	24.9	**22**	22.6	23.9
7	18.4	22.4	**23**	24.6	25.0
8	19.9	20.6	**24**	23.9	19.7
9	19.6	17.8	**25**	21.7	18.4
10	22.6	18.9	**26**	18.8	22.4
11	23.8	19.3	**27**	19.5	21.5
12	22.7	20.1	**28**	22.5	20.0
13	17.4	22.5	**29**	23.8	19.2
14	17.7	22.6	**30**	21.7	19.7
15	17.9	23.7	**31**	23.0	22.1
16	21.3	23.8			

Table 4.28 – Daily Average Temp (°C) for July 2011 and July 2012

Day	Aug-11	Aug-12	Day	Aug-11	Aug-12
1	22.4	20.9	**17**	19.4	15.2
2	20.8	20.1	**18**	20.0	14.0
3	19.7	24.3	**19**	19.4	15.4
4	20.1	25.3	**20**	20.3	14.4
5	18.8	20.9	**21**	18.1	14.9
6	22.2	18.6	**22**	15.7	16.7
7	23.5	19.0	**23**	16.7	18.4
8	22.4	22.5	**24**	21.8	19.4
9	21.0	18.0	**25**	19.3	21.3
10	17.4	18.9	**26**	18.0	20.6
11	17.4	17.6	**27**	18.4	20.3
12	18.8	19.0	**28**	14.9	16.5
13	19.3	20.6	**29**	15.8	14.8
14	19.4	16.9	**30**	16.6	17.7
15	20.7	18.4	**31**	18.8	22.9
16	19.5	18.5			

Table 4.29 – Daily Average Temp (°C) for August 2011 and August 2012

Day	Sep-11	Sep-12
1	20.1	18.9
2	22.5	19.1
3	24.5	19.8
4	19.4	18.3
5	12.8	19.5
6	12.9	20.1
7	14.5	19.2
8	17.5	15.3
9	18.6	12.0
10	16.8	12.1
11	16.8	13.9
12	19.2	18.0
13	15.0	18.5
14	11.7	13.7
15	8.3	10.9

Day	Sep-11	Sep-12
16	8.3	13.4
17	10.3	14.8
18	11.3	11.9
19	12.2	9.3
20	14.5	13.1
21	14.8	12.5
22	14.9	10.7
23	13.6	7.8
24	15.1	7.0
25	16.7	15.2
26	19.7	9.8
27	15.6	8.3
28	15.0	9.0
29	13.4	10.3
30	11.3	11.8

Table 4.30 – Daily Average Temp (°C) for September 2011 and September 2012

Day	Oct-11	Oct-12
1	6.7	11.2
2	5.6	13.2
3	10.5	17.1
4	12.1	17.7
5	10.4	11.9
6	10.0	6.9
7	13.5	3.3
8	14.8	4.5
9	16.0	7.0
10	15.7	6.7
11	14.6	5.8
12	14.6	1.7
13	15.1	3.7
14	11.8	16.5
15	7.9	10.8
16	6.6	5.7

Day	Oct-11	Oct-12
17	8.0	9.5
18	9.3	11.5
19	8.7	8.9
20	8.4	7.7
21	6.9	7.3
22	3.3	9.2
23	6.0	9.6
24	9.0	9.3
25	5.8	16.6
26	4.3	10.1
27	-0.4	4.0
28	1.4	2.6
29	1.8	3.5
30	2.4	7.1
31	4.8	5.6

Table 4.31 – Daily Average Temp (°C) for October 2011 and October 2012

4.4 Changes in Electricity Consumption

This section will present the changes in electricity consumption for each hub and the results for the weather normalization process. A detailed, step-by-step example of the weather normalization process for EHMS-13 is shown in the next section, and Appendix G will provide the detailed results for all 22 hubs. Section 4.4.2 will provide a summary of the results for all 22 hubs.

4.4.1 Weather Normalization, EHMS-13

As discussed in section 3.9, weather normalization is an important part of comparing electricity consumption between two years, especially if the weather has differed significantly between the years. Here, the weather normalization produces an *expected consumption* (kWh/day) value for each of the cooling months, which is used in place of the base year consumption (kWh/day) to calculate the change in electricity consumption.

Balance Point and Cooling Degree Days

The first step in weather normalization is to find the balance point for the hub so that the CDD can be calculated. CDD can be calculated using a standard balance point, usually 18°C (BizEE, 2013). While this can be an easier way to weather normalize, it doesn't provide the most accurate results. Households start cooling their homes at different outdoor temperatures, resulting in different balance points. Table 4.36 shows the balance points for the 22 hubs; they vary from 13.4 to 21.3 °C. To improve accuracy in the weather normalization process, the balance point and CDD were calculated for each hub individually.

To find the cooling balance point, the point at which homeowners start to cool their homes in warmer months, the daily average temperature in degrees Celsius is plotted against the daily consumption in kilowatt hours for the base year. Two lines are drawn, the first is horizontal and represents consumption that is not temperature sensitive, and the second is a diagonal line, and represents consumption that is temperature sensitive, i.e. consumption that is related to the cooling of the home (Avina, 2012). The lines were inserted on the graph using the *Shapes* tool in Microsoft Excel, and their location was chosen after a visual inspection of the graph. To ensure an accurate and appropriate placement of the lines, the process was repeated several times. The point where the two lines intersect is the balance point (Avina, 2012). For EHMS-13, the balance point is 15.6 ^{0}C (see Figure 4.1).

It is important to note that the non-weather dependant consumption line is not always horizontal, and can be slightly diagonal. The slight increase on the left side of the plot could represent an increased use of lights due to shorter days, increased use of television and/or video games because the colder weather might discourage people from going outside, etc. If electrical heating were a factor, the increase in consumption during the warming months would be similar to that in the cooling months.

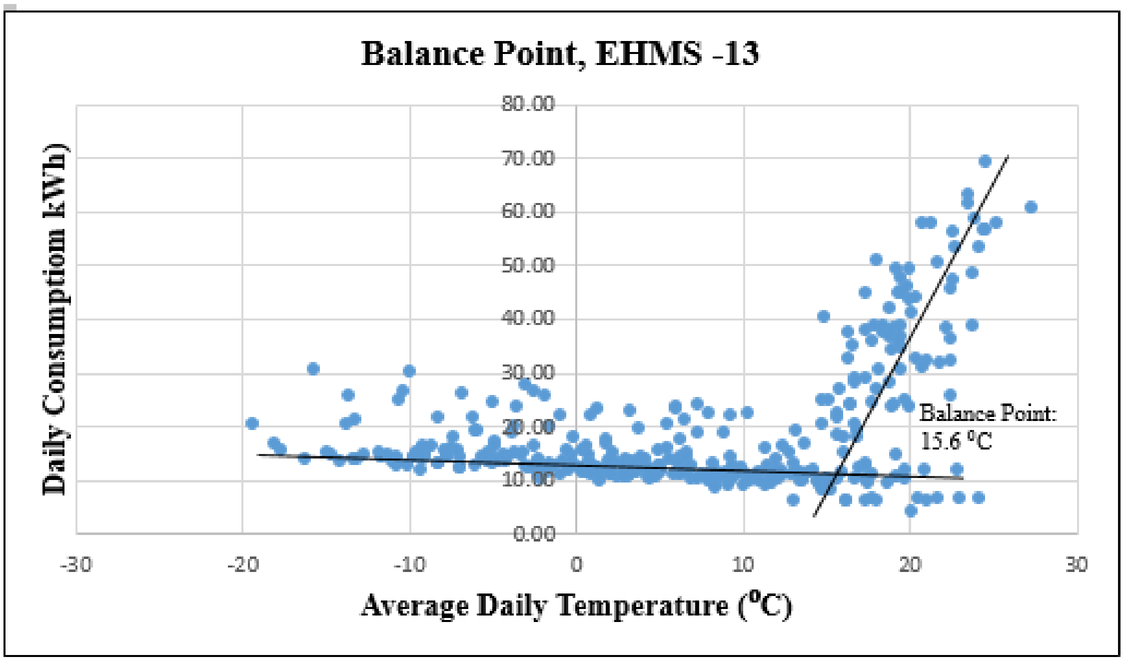

Figure 4.1 – Daily average temperature versus daily consumption for the base year, for EHMS-13

The balance point is then used to calculate the cooling degree days for each day in the monitoring period using Equation 3.11, originally introduced in section 3.9, but presented again here:

$$CDD = (Average\ Daily\ Temperature) - (Balance\ Point)$$

Equation 3.11 – Cooling Degree Days

Since CDD are never negative, if the difference between average daily temperature and balance point is negative, then CDD is equal to zero (Avina, 2012). CDD are proportional to household consumption, meaning that the more CDD there are, the higher the outdoor temperature is, resulting in more electricity needing to be consumed in order to keep the house at the desired temperature (Avina, 2012). Table 4.32 shows the CDD for the base year for EHMS-13, where monthly CDD is the sum of all the CDD in the month.

	# days in the month	Monthly CDD	Monthly Consumption
Dec 23-31, 2010	9	0.0	150.9
Jan-11	31	0.0	530.8
Feb-11	28	0.0	450.0
Mar-11	31	0.0	447.6
Apr-11	30	0.0	419.9
May-11	31	27.3	432.0
Jun-11	30	52.2	544.4
Jul-11	31	178.2	1322.6
Aug-11	31	113.7	1152.1
Sep-11	30	40.2	444.1
Oct-11	31	0.5	389.8
Nov-11	30	0.0	377.7
Dec 1-22, 2011	22	0.0	348.5

Table 4.32 –Cooling Degree days for the base year for EHMS-13

Calculating the Expected Consumption for the Monitoring Period

In order to determine the expected consumption for the monitoring period, average daily CDD (monthly CDD/number of days in the month) were plotted against monthly consumption for the cooling months in the base year in kWh/day (monthly consumption/number of days in the month, kWh/day). The data for this are shown in Table 4.33 and the graph is shown in Figure 4.2.

	Monthly CDD/ #days in month (⁰C)	Monthly Consumption/ #days in month (kWh/day)
May-11	0.881	13.934
Jun-11	1.740	18.147
Jul-11	5.748	42.664
Aug-11	3.668	37.164
Sep-11	1.340	14.803
Oct-11	0.016	12.573

Table 4.33 –Average daily CDD (^{0}C) versus consumption (kWh/day) for the cooling months in the base year for EHMS-13.

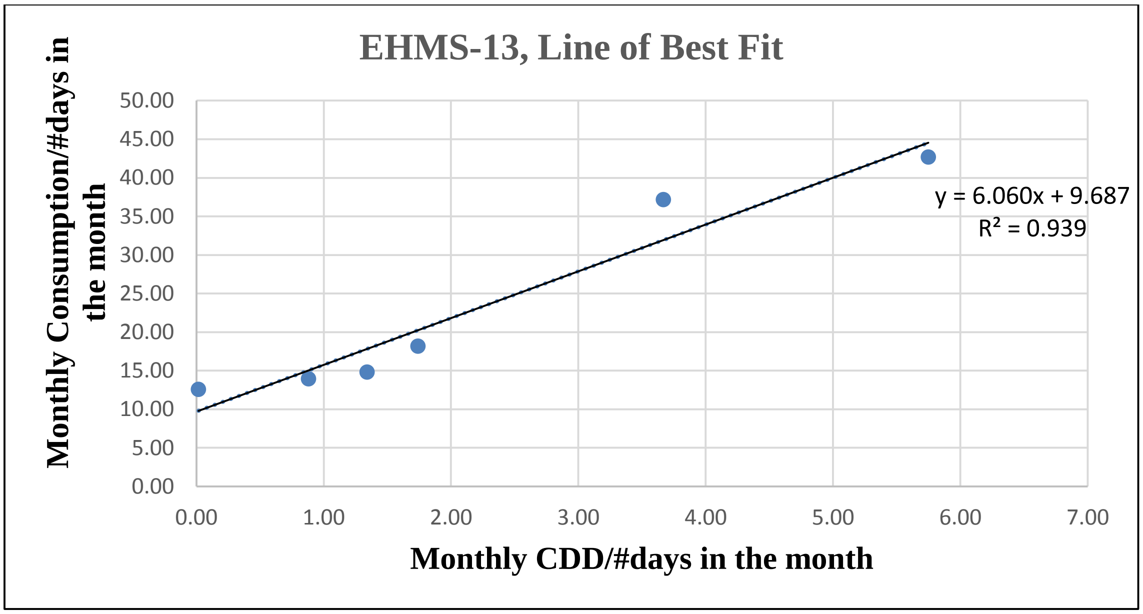

Figure 4.2 – Average daily CDD vs. monthly consumption (kWh/day) for the base year.

Figure 4.2 shows the line of best fit that was calculated by Microsoft Excel. It is y = 6.060x + 9.687, and has an R^2 value of 0.939. The R squared value represents how well the line of best fit fits the data points (Avina, 2012). R squared is a positive value between zero and one, where values close to zero represent a bad fit, and values close to one represent a good fit. Avina (2012) states that in most energy engineering circles, $R^2 > 0.75$ is considered a good fit.

After the line of best fit is determined, it is used to calculate the expected consumption for the cooling months in the monitoring period. These values are calculated using the CDD from the cooling months in the monitoring period (Table 4.34), which are subbed in for x in the line of best fit equation. Monthly CDD values for the monitoring period and the expected consumption values can be found in Table 4.35. The expected consumption values are only calculated for the cooling months, because the line of best fit was determined using only cooling months.

There was a heat wave in March 2012, which is why it is a cooling month. April was slightly cooler, and not a cooling month, which is why it is absent from Table 4.34. The expected consumption values for the monitoring period are the result of the weather normalization process, and are used to calculate the change in consumption for the cooling months.

	# days in the month	**Monthly CDD**	**Monthly CDD/ # days in month**
Dec 23-31, 2011	9	0.0	0.0
Jan-12	31	0.0	0.0
Feb-12	29	0.0	0.0
Mar-12	31	1.8	0.1
Apr-12	30	0.0	0.0
May-12	31	40.2	1.3
Jun-12	30	94.2	3.1
Jul-12	31	178.5	5.8
Aug-12	31	103.3	3.3
Sep-12	30	31.0	1.0
Oct-12	31	3.5	0.1
Nov-12	30	0.0	0.0
Dec-12	31	0.0	0.0
Jan-13	31	0.0	0.0

Table 4.34 – Cooling Degree Days for the monitoring period for EHMS-13

EHMS-13 Monitoring Period	**Average Daily CDD (x)**	**Expected Consumption for Monitoring Period (y = 6.0601x + 9.6872)**
Mar-12	0.1	10.0
May-12	1.3	17.6
Jun-12	3.1	28.7
Jul-12	5.8	44.6
Aug-12	3.3	29.9
Sep-12	1.0	15.9
Oct-12	0.2	10.8

Table 4.35 –Expected Consumption for cooling months in the monitoring period for EHMS-13

4.4.2 Weather Normalizing Results

This section will summarize the results of the weather normalization process for all 22 hubs. Table 4.36 contains the balance point, equation of line of best fit and R^2 value, and Tables 4.37 and 4.38 present the expected consumption for the cooling months in the monitoring period in kWh/day. Tables 4.39 and 4.40, show the change in consumption, values that were calculated using Equations 3.13 and 3.15. In these tables, as discussed in section 4.2.3, hubs that have fewer than seven days in month one, and hubs with unexpectedly low consumption for month one are marked with an asterisk, and the reader is cautioned from making any conclusions from these data. An increase in consumption is a positive number, and is indicated by a red cell, and a decrease in consumption is a negative number and is indicated by a green cell.

Hub	Balance Point (^oC)	Equation of Line of Best Fit	R^2 Value
EHMS-01	13.4	y = 4.3995x + 32.969	0.772
EHMS-02	18.0	y = 3.5869x + 17.184	0.636
EHMS-04	13.5	y = 2.3191x + 35.08	0.808
EHMS-05	18.0	y = 7.6796x + 21.986	0.903
EHMS-07	16.9	y = 7.0224x + 24.185	0.988
EHMS-09	17.7	y = 4.5361x + 20.609	0.605
EHMS-10	16.2	y = 6.2961x + 18.843	0.840
EHMS-11	17.5	y= 3.7301x + 12.172	0.951
EHMS-12	17.3	y = 5.4886x + 40.715	0.514
EHMS-13	15.6	y = 6.0601x + 9.6872	0.939
EHMS-14	14.0	y = 4.6835x + 21.434	0.765
EHMS-15	16.7	y = 6.7611x + 21.954	0.921
EHMS-16	21.0	y = 5.9514x + 14.872	0.896
EHMS-17	21.3	y = 3.9152x + 8.6738	0.967
EHMS-18	15.5	y = 4.353x + 25.358	0.785
EHMS-19	16.7	y = 2.5331x + 22.541	0.824
EHMS-20	16.4	y = 4.8131x + 11.122	0.967
EHMS-21	16.5	y = 6.2197x + 27.939	0.826
EHMS-22	17.0	y = 3.6114x + 8.3669	0.978
EHMS-23	15.2	y = 3.9445x + 32.078	0.934
EHMS-24	17.0	y = 6.2406x + 13.022	0.810
EHMS-25	18.7	y = 8.2665x + 16.124	0.880

Table 4.36 – The balance point, equation of line of best fit and R^2 value

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Mar-12	34.6		35.9				18.9			10.0	22.6
Apr-12	33.4		35.3								21.7
May-12	43.1	18.7	40.3	25.3	29.5	23.0	25.4	14.3	44.2	17.5	30.8
Jun-12	54.0	23.3	46.0	35.2	40.3	29.1	36.1	19.5	52.1	28.7	41.5
Jul-12	68.0	29.4	53.3	48.1	55.5	37.3	51.3	26.6	63.0	44.6	55.9
Aug-12	56.6	22.7	47.3	33.9	40.4	28.5	36.8	19.2	51.8	29.9	43.8
Sep-12	41.3	18.3	39.4	24.4	28.7	22.4	24.2	13.9	43.6	15.9	29.0
Oct-12	35.0		36.1		24.4		19.5	12.2	40.8	10.8	23.2

Table 4.37 – Expected consumption (kWh/day) for cooling months in the monitoring year for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Mar-12											
Apr-12											
May-12	27.6	15.2	8.8	31.2	24.7	15.7	33.7	11.0	37.9	17.6	18.6
Jun-12	38.3	18.5	10.8	39.3	28.7	23.7	43.8	16.4	45.5	27.0	27.7
Jul-12	53.4	22.4	13.0	50.9	34.3	35.0	58.2	24.1	56.4	40.2	39.3
Aug-12	38.5	17.0	9.9	40.2	28.8	24.1	44.2	16.4	46.5	27.0	25.6
Sep-12	26.7	14.9	8.7	30.0	24.3	14.9	32.7	10.6	36.6	16.9	17.3
Oct-12	22.3			26.2	22.7	11.5	28.3	8.5	33.0	13.2	

Table 4.38 –Expected consumption (kWh/day) for cooling months in the monitoring year for EHMS-15-25

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-31, 2011	71.4%*	10.9%*	28.9%*								
Dec-11	81.6%	-13.3%	33.1%								
Dec 23-31, 2011				51.1%		60.7%*	196.3%*		66.7%	3.1%	30.0%
Jan-12	1.2%	11.6%	17.1%	28.4%		-16.0%	-1.5%		74.8%	-16.5%	-9.9%
Jan 3-31, 2013					-22.9%			5.1%			
Jan 13-31, 2012											
Feb-12	22.4%	-2.2%	9.3%	27.1%	-22.9%	-15.3%	4.3%	11.8%	78.5%	-8.5%	-7.4%
Mar-12	-15.6%	-15.2%	-2.6%	31.2%	-24.1%	-11.8%	-10.6%	22.9%	78.1%	25.0%	-11.5%
Apr-12	9.1%	-5.1%	-1.7%	36.9%	-9.4%	-12.5%	2.0%	18.2%	83.4%	-9.3%	-9.2%
April 27-31, 2012											
May-12	-3.5%	-0.7%	-3.3%	26.0%	-17.4%	-13.6%	-15.6%	15.8%	24.6%	23.4%	22.0%
Jun-12	-0.8%	14.7%	3.1%	9.0%	10.1%	-11.3%	-7.8%	4.0%	32.9%	-2.4%	24.3%
Jul-12	-3.0%	20.8%	-0.5%	-2.6%	19.6%	-10.4%	-10.0%	5.4%	26.1%	-20.6%	1.0%
Aug-12	-7.1%	5.9%	-5.6%	7.3%	63.4%	-4.0%	5.0%	11.1%	26.0%	-9.2%	-5.7%
Sep-12	3.9%	-14.6%	0.2%	25.7%	30.2%	-8.4%	5.0%	15.2%	41.7%	-10.9%	34.0%
Oct-12	-11.2%	-1.1%	-4.9%	-8.8%	31.0%	11.1%	-11.8%	11.3%	43.1%	27.4%	-8.7%
Nov-12	30.5%	-6.3%	6.2%	5.1%	-14.1%	16.2%	-3.1%	14.1%	12.5%	20.6%	15.7%
Nov 1-8, 2012											
Dec-12	124.2%	-10.7%	27.7%	48.8%	13.9%	60.0%	9.3%	10.8%	62.4%	-16.5%	9.6%
Jan-13	38.4%	-3.7%	12.0%	43.7%	2.9%	-9.1%	-5.3%	24.3%	107.1%	-5.6%	-7.6%
Jan 1-8, 2013											

Table 4.39 – Monthly change in consumption (%) for EHMS-01, 02, 04, 05, 07, 09, 10-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-31, 2011											
Dec-11											
Dec 23-31, 2011											
Jan-12											
Jan 3-31, 2013											
Jan 13-31, 2012	0.4%	2.8%			106.3%*						
Feb-12	-21.3%	1.9%			-21.4%						
Mar-12	-21.4%	11.3%			-21.2%						
Apr-12	2.7%	11.4%			-22.9%						
April 27-31, 2012			2.0%*	2.0%*		33.2%*	-48.3%*	-3.2%*	33.0%*	75.9%*	95.0%*
May-12	7.5%	3.9%	2.4%	17.4%	-19.4%	-7.4%	2.7%	18.4%	-21.3%	31.2%	22.4%
Jun-12	10.2%	7.8%	-9.1%	-11.4%	-6.3%	19.4%	0.4%	4.9%	-21.3%	67.9%	11.6%
Jul-12	-2.4%	17.2%	-17.9%	18.4%	-56.6%	13.6%	-0.1%	0.1%	-29.2%	35.7%	3.0%
Aug-12	18.2%	20.7%	-46.6%	0.6%	6.4%	25.5%	17.1%	1.0%	-5.5%	77.8%	24.2%
Sep-12	17.8%	26.3%	3.3%	-21.4%	-7.1%	62.3%	11.8%	17.6%	-13.9%	91.5%	54.0%
Oct-12	7.4%	8.8%	6.0%	-32.1%	-35.2%	96.2%	22.7%	47.9%	-25.2%	72.5%	42.3%
Nov-12	7.2%	1.4%	6.5%	-35.1%	-26.5%	85.5%	21.1%	13.7%	-15.9%	86.6%	
Dec-12	28.8%	8.3%	2.0%	-24.8%	-42.4%	62.9%	35.6%	16.3%	11.7%	19.4%	
Jan-13	3.0%	0.2%	2.9%	-28.7%	61.6%		8.1%	5.5%	-2.6%	1.7%	

Table 4.40 –Monthly change in consumption (%) for EHMS-15-25

4.4.3 Change in Consumption

Tables 4.41, 4.42 and 4.43 present the baseline consumption (kWh/day) and monitoring period consumption (kWh/day) for months one to three, months one to seven and the entire monitoring period. These values were calculated using Equations 3.16 and 3.17. These tables also present the change in consumption (kWh/day and percent) between the baseline and monitoring period; these values were calculated using Equations 3.18 and 3.19. A positive change in consumption value represents an increase in consumption (red cell), while a negative value represents a decrease in consumption (green cell).

Hub	Baseline consumption (kWh/day) (months 1-3)	Monitoring period consumption (kWh/day) (months 1-3)	Change in Consumption (kWh/day) (months 1-3)	Change in Consumption (%) (months 1-3)
EHMS-01	23.9	31.1	7.2	30.3%
EHMS-02	26.0	25.0	-1.0	-4.0%
EHMS-04	31.0	37.7	6.7	21.6%
EHMS-05	27.6	36.2	8.6	31.0%
EHMS-07	28.6	21.9	-6.6	-23.3%
EHMS-09	20.9	18.6	-2.3	-11.0%
EHMS-10	17.6	19.9	2.3	12.9%
EHMS-11	14.1	15.8	1.8	12.7%
EHMS-12	34.7	60.7	26.1	75.2%
EHMS-13	16.6	14.9	-1.8	-10.7%
EHMS-14	25.4	24.3	-1.1	-4.3%
EHMS-15	28.4	23.8	-4.6	-16.2%
EHMS-16	17.7	18.6	0.9	5.2%
EHMS-17	9.7	9.4	-0.3	-3.5%
EHMS-18	34.9	35.5	0.6	1.6%
EHMS-19	19.5	18.0	-1.5	-7.6%
EHMS-20	19.3	21.1	1.8	9.6%
EHMS-21	38.4	37.9	-0.5	-1.4%
EHMS-22	13.5	14.8	1.3	9.8%
EHMS-23	40.1	32.1	-8.0	-19.9%
EHMS-24	21.7	33.5	11.7	54.1%
EHMS-25	22.4	26.7	4.2	18.9%
Average	24.2	26.3	2.1	8.2%

Table 4.41 – Change in consumption for months one to three

Hub	Baseline consumption (kWh/day) (months 1-7)	Monitoring period consumption (kWh/day) (months 1-7)	Change in Consumption (kWh/day) (months 1-7)	Change in Consumption (%) (months 1-7)
EHMS-01	30.7	33.4	2.7	8.8%
EHMS-02	23.4	22.2	-1.2	-5.2%
EHMS-04	34.0	36.2	2.3	6.7%
EHMS-05	27.1	34.3	7.2	26.6%
EHMS-07	33.1	31.4	-1.7	-5.0%
EHMS-09	22.6	19.9	-2.7	-5.0%
EHMS-10	21.9	21.4	-0.6	-11.9%
EHMS-11	16.8	18.5	1.8	10.5%
EHMS-12	38.0	60.0	22.0	57.9%
EHMS-13	17.2	17.3	0.1	0.7%
EHMS-14	27.8	29.3	1.5	5.5%
EHMS-15	32.7	31.6	-1.0	-3.2%
EHMS-16	17.8	19.3	1.5	8.5%
EHMS-17	10.1	8.9	-1.1	-11.2%
EHMS-18	36.2	35.6	-0.6	-1.8%
EHMS-19	24.3	19.0	-5.4	-22.0%
EHMS-20	20.7	26.4	5.7	27.8%
EHMS-21	40.1	42.8	2.7	6.8%
EHMS-22	14.4	15.9	1.5	10.1%
EHMS-23	42.1	34.0	-8.1	-19.2%
EHMS-24	23.5	37.4	13.9	59.4%
EHMS-25	24.0	29.4	5.4	22.3%
Average	26.3	28.4	2.1	7.6%

Table 4.42 – Change in consumption for months one to seven

Hub	Baseline consumption (kWh/day)	Monitoring period consumption (kWh/day)	Change in Consumption (kWh/day)	Change in Consumption (%)
EHMS-01	36.7	40.2	3.5	9.6%
EHMS-02	23.1	22.8	-0.3	-1.3%
EHMS-04	37.4	38.8	1.4	3.7%
EHMS-05	30.5	35.7	5.1	16.8%
EHMS-07	31.9	34.3	2.5	7.7%
EHMS-09	23.7	23.0	-0.7	-3.1%
EHMS-10	24.5	24.0	-0.5	-2.2%
EHMS-11	16.0	17.9	2.0	12.2%
EHMS-12	43.1	62.6	19.5	45.3%
EHMS-13	19.3	18.5	-0.8	-4.2%
EHMS-14	30.1	31.5	1.4	4.7%
EHMS-15	30.2	31.5	1.3	4.3%
EHMS-16	17.7	19.4	1.7	9.7%
EHMS-17	10.4	9.7	-0.6	-6.0%
EHMS-18	34.6	31.1	-3.5	-10.1%
EHMS-19	23.9	19.3	-4.6	-19.1%
EHMS-20	19.0	25.7	6.8	35.8%
EHMS-21	36.9	40.8	3.9	10.5%
EHMS-22	14.5	16.1	1.5	10.6%
EHMS-23	37.6	31.9	-5.7	-15.1%
EHMS-24	22.1	33.2	11.1	50.1%
EHMS-25	24.0	29.4	5.4	22.3%

Table 4.43 –Change in consumption for the entire monitoring period

4.5 Engagement Index

The engagement index, as described in section 3.8, is an index that describes the level of engagement each household has with the webportal. Tables 4.44 and 4.45 show detailed engagement data, including total number of sessions, average number of pages visited and actions taken per session, average number of minutes per session, average number of days between sessions, average number of sessions per month, number of sessions with communications, and average number of interactions per session. Tables 4.46 and 4.47 are the monthly engagement indices and were calculated using Equation 3.1. The total engagement indices for months one to three, months one to seven and the entire monitoring period are presented in Table 4.48, and these values were calculated using Equation 3.2. The engagement index was calculated for months one to three to see how households were engaging early on in the monitoring period. The engagement index was calculated for months one to seven to see how households were engaging after a longer period of time, and because this is the longest period of time where all 22 hubs were active, as the shortest monitoring period ended at the end of month seven. Appendix H contains the raw data used to calculate the engagement index and the calculations for each hub.

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
# months with an activated webportal	15	15	15	14	13	14	14	13	14	14	14
Total # of sessions	4	2	7	7	5	2	7	6	2	23	6
Average # pages visited and actions taken per session	20.8	0.0	7.4	25.7	15.2	27.0	15.4	24.0	9.5	8.4	24.7
Average # minutes per session	19.5	0.0	6.1	14.3	3.6	13.5	11.3	10.5	5.5	6.2	15.2
Average # days between sessions	105.3	180.5	51.9	38.9	66.4	55.5	15.4	59.8	194.5	17.7	60.2
Average # of sessions per month	0.3	0.1	0.5	0.5	0.4	0.1	0.5	0.5	0.1	1.6	0.4
# sessions with communications with EHMS	1	2	1	1	1	2	4	1	0	0	4
Average # interactions per session	0.8	0.0	0.7	1.4	1.0	1.0	0.7	1.3	1.0	0.5	1.7

Table 4.44 – Detailed engagement data for EHMS-01, 02, 04, 05, 07, 09, 10-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
# months with an activated webportal	13	13	10	10	13	10	10	10	10	10	8
Total # of sessions	19	8	2	6	3	1	2	3	15	1	2
Average # pages visited/actions taken per session	11.6	18.3	3.5	12.7	11.0	21.0	0.4	23.0	8.7	12.0	15.5
Average # minutes per session	8.7	10.8	2.5	4.0	2.7	17.0	6.6	13.3	2.9	1.0	4.5
Average # days between sessions	20.0	20.6	2.0	38.0	57.3	0.0	11.3	4.7	18.4	10.0	86.5
Average # of sessions per month	1.5	0.6	0.2	0.6	0.2	0.1	0.2	0.3	1.5	0.1	0.3
# sessions with communications with EHMS	2	1	0	1	1	0	0	1	5	0	0
Average # interactions per session	1.1	1.4	0.0	1.2	0.0	2.0	1.0	2.0	1.3	1.0	1.0

Table 4.45 – Detailed engagement data for EHMS-15-25

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Nov 29-31, 2011	0.000	0.000	0.000								
Dec-11	0.604	0.000	0.639								
Dec 23-31, 2011				0.479		0.806	0.253		0.000	0.514	0.617
Jan-12	0.000	0.000	0.419	0.601		0.000	0.776		0.532	0.398	0.645
Jan 3-31, 2013					0.321			0.503			
Jan 13-31, 2012											
Feb-12	0.000	0.000	0.256	0.489	0.256	0.000	0.312	0.312	0.000	0.317	0.000
Mar-12	0.000	0.000	0.254	0.000	0.313	0.000	0.000	0.000	0.000	0.256	0.000
Apr-12	0.421	0.000	0.000	0.000	0.000	0.640	0.700	0.000	0.000	0.000	0.000
April 27-31, 2012											
May-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.505	0.000
Jun-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.398	0.000
Jul-12	0.000	0.000	0.474	0.000	0.640	0.000	0.000	0.000	0.000	0.438	0.651
Aug-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.399	0.000
Sep-12	0.000	0.251	0.000	0.362	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oct-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nov-12	0.000	0.253	0.501	0.000	0.335	0.000	0.000	0.751	0.000	0.000	0.668
Dec-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.393	0.000	0.501	0.258
Jan-13	0.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.465	0.000

Table 4.46 – Monthly Engagement Index for EHMS 01, 02, 04, 05, 07, 09, 10-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Nov 29-31, 2011											
Dec-11											
Dec 23-31, 2011											
Jan-12											
Jan 3-31, 2013											
Jan 13-31, 2012	0.000	0.479			0.000						
Feb-12	0.562	0.511			0.000						
Mar-12	0.458	0.505			0.420						
Apr-12	0.000	0.000			0.000						
April 27-31, 2012			0.000	0.000		0.694	0.583	0.736	0.515	0.000	0.000
May-12	0.000	0.000	0.294	0.520	0.000	0.000	0.000	0.486	0.540	0.321	0.000
Jun-12	0.000	0.640	0.000	0.349	0.000	0.000	0.253	0.000	0.000	0.000	0.000
Jul-12	0.307	0.000	0.000	0.000	0.445	0.000	0.000	0.000	0.460	0.000	0.000
Aug-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sep-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oct-12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.363	0.000	0.459
Nov-12	0.000	0.000	0.000	0.251	0.000	0.000	0.000	0.000	0.000	0.000	
Dec-12	0.000	0.000	0.000	0.514	0.000	0.000	0.000	0.000	0.436	0.000	
Jan-13	0.352	0.000	0.000	0.000	0.000		0.000	0.000	0.253	0.000	

Table 4.47 – Monthly Engagement Index for EHMS 15-25

	Engagement Index for months 1 to 3	Engagement Index for months 1 to 7	Engagement Index for entire monitoring period
EHMS-01	0.201	0.146	0.099
EHMS-02	0.000	0.000	0.034
EHMS-04	0.352	0.224	0.169
EHMS-05	0.523	0.224	0.138
EHMS-07	0.296	0.218	0.143
EHMS-09	0.269	0.207	0.103
EHMS-10	0.447	0.292	0.146
EHMS-11	0.272	0.116	0.151
EHMS-12	0.177	0.076	0.056
EHMS-13	0.410	0.341	0.299
EHMS-14	0.421	0.180	0.203
EHMS-15	0.340	0.190	0.129
EHMS-16	0.498	0.305	0.164
EHMS-17	0.098	0.042	0.029
EHMS-18	0.290	0.124	0.163
EHMS-19	0.140	0.124	0.067
EHMS-20	0.231	0.099	0.077
EHMS-21	0.279	0.120	0.084
EHMS-22	0.407	0.175	0.122
EHMS-23	0.352	0.268	0.257
EHMS-24	0.107	0.046	0.032
EHMS-25	0.000	0.057	

Table 4.48 – Engagement Indices for months one to three, months one to seven and the entire monitoring period

EHMS-25 had a monitoring period of seven months, which is why the value for the engagement index for months one to seven and the entire monitoring period share the same cell in Table 4.48.

Chapter four presented the results of the surveys, the consumption data, the change in consumption data, the engagement data, and the engagement indices for each hub. In the next chapter, these results will be discussed, and comparisons will be made between different variables in order to achieve the objectives, and answer the question posed in chapter two.

Chapter 5: Discussion

5.1 Introduction

Chapter four presented the results of the surveys, household consumption, change in consumption, and engagement with the webportal. In this chapter, these results will be compared with each other to better understand the connection between engagement and consumption. The survey responses will be compared to whether or not households conserved electricity and their level of engagement to see if behaviours follow from attitudes and knowledge. Both consumption and engagement over time will be investigated by comparing values from months one to three, months one to seven, and the entire monitoring period with each other. Finally, the engagement index will be plotted against change in consumption to answer the main question posed in this thesis: “What impact does engagement with the webportal have on electricity consumption?”

5.2 Electricity Consumption and Attitudes, Behaviours and Goals

At the beginning of the research, the households were asked to fill out the Welcome Survey; many of these questions referred to electricity consumption in the home, the importance of conserving electricity and the methods the household is employing to reduce electricity consumption. This section will compare these with changes in consumption for months one to seven. Figure 5.1 compares whether or not the household believes it is important to conserve electricity with whether or not they conserved. The graph shows that all 18 of the respondents believed that conserving electricity is important. However, only six of the households actually conserved electricity.

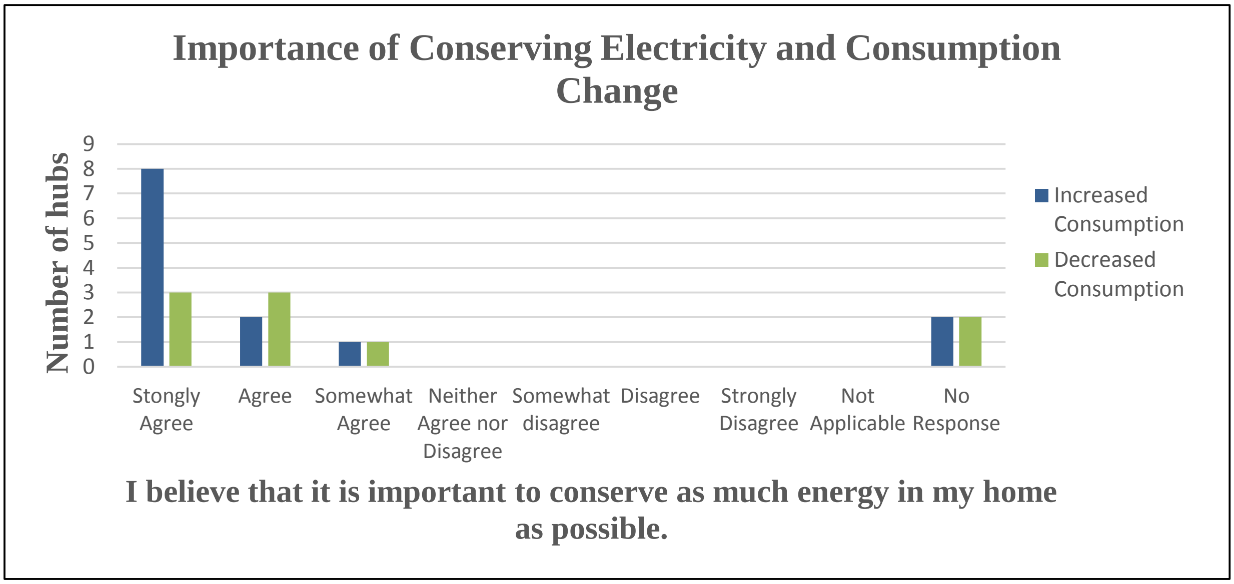

Figure 5.1 – Importance of conserving electricity compared with change in electricity consumption

Figure 5.2 presents householders' responses to whether or not they try to conserve electricity in the home and compare it with whether or not they actually conserved. Of the 18 households that responded, 16 responded positively to trying to conserve electricity; of these 16 households, only seven conserved electricity. Two of the households responded neutrally (i.e. neither agree nor disagree), and of these, one decreased their consumption, and one increased their consumption.

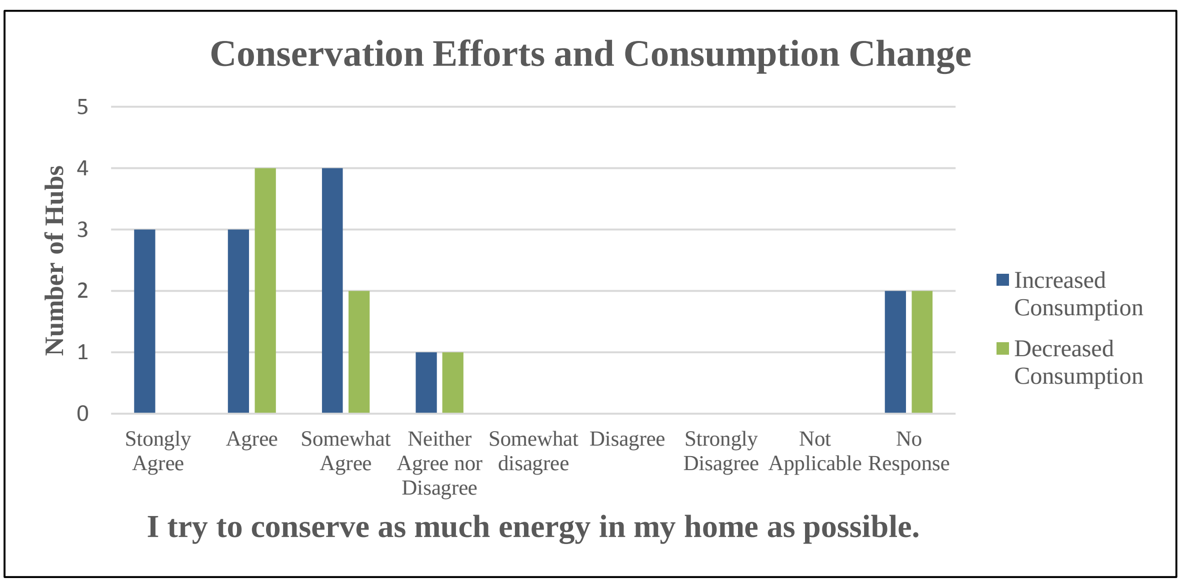

Figure 5.2 – Electricity conservation efforts and change in consumption

For the households that responded “strongly agree” and increased their consumption, it could be argued that perhaps their base year consumption was low, and there was not much room left to conserve. EHMS-01, 14 and 20 responded that they strongly agreed that they tried to conserve as much as possible; their base year consumptions were 37.8 kWh/day, 30.0 kWh/day, and 18.3 kWh/day, respectively. Below is a brief discussion about whether or not their increase in consumption was due to an already low base year consumption.

Table 5.1 presents the base year consumption (kWh/day), dwelling size (square feet), and number of residents in each hub, sorted by dwelling size. Tables 5.2 and 5.3 provide the average, median, minimum and maximum consumption for hubs with the same number of residents, and same size. These tables will help determine the relative level of base year consumption (i.e. was it high or low) for their size and number of occupants. EHMS-01 had a base year consumption of 37.8 kWh/day, two people in the household and a house size of 2000-2499 square feet. There was one other house that had two people in it, and their base year consumption was 15.9 kWh/day, less than half of EHMS-01. There were six other hubs with the same sized dwelling; the base year consumption for these hubs was 30.4 kWh/day, and the median was 29.9 kwh/day. These comparisons indicate that EHMS-01 had a high base year consumption, that increased by 8.8% from month one to month seven.

EHMS-14 had a base year consumption of 30.0 kWh/day, a dwelling size of 1500-1999 square feet, and four inhabitants. There were 10 other hubs with four inhabitants; the mean base year consumption for these hubs was 27.5 kWh/day and the median was 30.0 kWh/day, indicating that for dwelling size, EHMS-14 was the median, and just above average. There are six other hubs with the same dwelling size; the mean base year consumption for those hubs is 22.4 kWh/day, and the median is 23.8 kWh/day. This indicates that for dwelling size, EHMS-14 is considerably greater than both the mean and median. These comparisons indicate that EHMS-14 did not have a low base year consumption, and the consumption for this hub increased by 5.53% over the first seven months of the monitoring period.

The third household that strongly agreed that they try to conserve electricity in the home as much as possible was EHMS-20, which had four residents, a dwelling size of 2000-2499 square feet and a base year consumption of 18.3 kWh/day. Their base year consumption was less than the average and median for both their dwelling size and number of residents, and they had the lowest base year consumption for dwelling size. This indicates that they had a relatively low base year consumption, and perhaps it would have been hard for them to decrease anymore. However, they ended up increasing their consumption by 27.8% by the end of month seven and by 35.8% by the end of their monitoring period.

When EHMS-01 and EHMS-14 were compared with hubs of the same size and same number of residents; both had average to above average base year consumption. In the absence of any knowledge of household details (change in appliances, change in number of inhabitants, etc.), it appears there was room for conservation. EHMS-20 did have a low base year consumption compared to other hubs of the same size and number of residents, and they employed eleven of the twelve electricity saving techniques (as seen in Table 4.20). While some increase could be expected because of their already present conservation efforts, EHMS-20 increased their consumption by 27.8% after seven months and 35.8% after nine months. These increases are too high to be the result of normal fluctuations in household electricity consumption, and might indicate a change in household dynamics or appliances.

	Dwelling Size (Square feet)	Total # Occupants	Base Year Consumption (kWh/day)
EHMS-16	1000 - 1499	4	17.4
EHMS-02	1500 - 1999	3	22.2
EHMS-05	1500 - 1999	4	30.3
EHMS-09	1500 - 1999	5	23.8
EHMS-10	1500 - 1999	5	24.5
EHMS-11	1500 - 1999	2	15.9
EHMS-14	1500 - 1999	4	30.0
EHMS-17	1500 - 1999	4	10.2
EHMS-01	2000 - 2499	2	37.8
EHMS-04	2000 - 2499	6	37.6
EHMS-12	2000 - 2499	4	44.2
EHMS-15	2000 - 2499	4	29.9
EHMS-19	2000 - 2499	2*	24.5
EHMS-20	2000 - 2499	4	18.3
EHMS-25	2000 - 2499	5	20.3
EHMS-13	2500 - 2999	4	19.2
EHMS-21	2500 - 2999	4	36.1
EHMS-22	2500 - 2999	3	14.2
EHMS-23	2500 - 2999	4	34.3
EHMS-24	2500 - 2999	8	21.6
EHMS-07	3000 - 3499	3	31.9
EHMS-18	3000 - 3499	4	32.7

Table 5.1 – The total number of residents, dwelling size, and base year consumption for each hub

In the Home Profile and Appliances Selection Survey, EHMS-19 stated that they had two residents, and that those two residents were under the age of 13. For this reason, EHMS-19 was omitted from the calculation in Table 5.2.

# residents	# hubs	Average base year consumption (kWh/day)	Median base year consumption (kWh/day)	Minimum base year consumption (kWh/day)	Maximum base year consumption (kWh/day)
2	2	26.8	26.8	15.9	37.8
3	3	22.8	22.2	14.2	31.9
4	11	27.5	30.0	10.2	44.2
5	3	22.8	23.8	20.3	24.4
6	1	37.6	37.6	37.6	37.6
8	1	21.6	21.6	21.6	21.6
Total	21	26.3	24.4	10.2	44.2

Table 5.2 – Average, median, minimum and maximum base year consumption for household size

Dwelling size (Square feet)	# hubs	Average base year consumption (kWh/day)	Median base year consumption (kWh/day)	Minimum base year consumption (kWh/day)	Maximum base year consumption (kWh/day)
1000 - 1499	1	17.4	17.4	17.4	17.4
1500 - 1999	7	22.4	23.8	10.2	30.3
2000 - 2499	7	30.4	29.9	18.3	44.2
2500 - 2999	5	25.1	21.6	14.2	36.1
3000 - 3499	2	32.3	32.3	31.9	32.7
Total	22	26.2	24.5	10.2	44.2

Table 5.3 – Average, median, minimum and maximum base year consumption for dwelling size

Figures 5.1 and 5.2 show that people seem to be interested in conserving and believe it to be important, however, behaviors don't always follow from attitudes, and just because a person believes that they should conserve, doesn't necessarily mean that they will. As discussed by Lorenzoni et al. (2007) there are barriers that stop people from acting in an environmentally conscious way. One of those barriers is knowledge. While the webportal provided the households with the data they needed to understand their conservation, it did not provide information about *how* to conserve, which may have helped in householders' conservation efforts. Wood and Newborough (2003) and Ueno et al. (2006) are studies that provided their participants with information about how to save electricity; Ueno et al. (2006) provided information through their website, and Wood and Newborough provided information by way of an informational pamphlet. The Hawthorne effect (section 3.10.4) can also account for the discrepancies between responses and actions; people may state they think it is important to conserve electricity because they think it is the desirable answer, and not because they intend to conserve.

Figure 5.3 compares the number of electricity saving actions taken at least once a week (Tables 4.19 and 4.20) with change in consumption. Eleven of the 18 respondents indicated that they employed seven or more of the 12 actions at least once a week. Of this 11, eight had increased their consumption, and three decreased their consumption. The three households that that decreased their consumption had the highest number of electricity saving actions; one respondent indicated they employed eleven, and two respondents indicated they employed twelve. Of the seven that employed less than half of the actions, three had increased their consumption, while four had decreased their consumption.

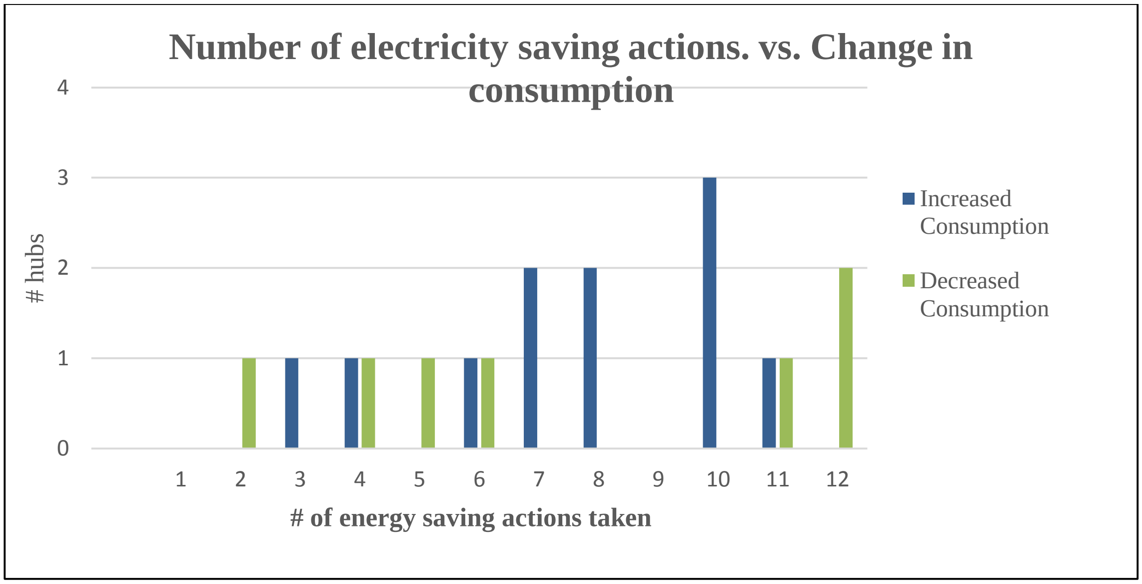

Figure 5.3 – Number of electricity saving action versus change in consumption

Figure 5.3 shows that the distribution for households that decreased their consumption was bimodal. Of the seven households that conserved, four employed half or less than half of the energy saving actions, and three employed the highest number of actions (11 and 12). It is interesting to note the households that employed fewer actions, and then proceeded to conserve, had average to high base year consumption, and the households that employed a high number of actions had low to average base year consumption. This bimodal distribution of households that conserved is not unexpected; it indicates that there were households that, prior to this research, were not conservers, and began to employ more electricity saving actions once the research began. It also indicates that there were households that were conservers before the research began, and after the research began continued to conserve by using the energy saving actions from the Welcome Survey more often and more effectively, or by using additional actions not listed on the Welcome Survey.

Eight of the 11 households that increased their consumption employed over half the energy saving actions. This is interesting because it suggests that at the beginning of the monitoring period, those households that employed more electricity saving actions ended up increasing their consumption by the end of month seven. It can be hypothesized that those households that increased their consumption and that had high numbers of actions taken, could have started out with a low base year consumption, and they did not have much room for decrease, resulting in an increase, or fluctuation in consumption.

EHMS-13, 16, 20 and 21 employed 10 or more electricity saving actions and had increased their consumption at the end of month seven. As Tables 5.1, 5.2 and 5.3 show, EHMS-13 had a below average base year consumption compared with hubs with the same size and number of residents. At the end of month seven, their increase in consumption was 0.7%, which as Table 5.4 shows, is only one of three months with a total increase in consumption. Tables 5.2 and 5.3 also show that EHMS-16 and EHMS-20 had low base year consumptions; Table 5.5 shows that their total consumption increased steadily throughout the monitoring period, where they reached an increase of 8.5% for EHMS-16 and 27.8% for EHMS-20. Finally, Tables 5.2 and 5.3 show that EHMS-21 had an above average base year consumption. For the first four months EHMS-21 decreased their total consumption, but after month four, it steadily increased.

Of the four households that employed 10 or more electricity saving actions, three of them had below average base year consumptions; two of them steadily increased their consumption, while one fluctuated. This suggests that households with low base year consumption and high use of electricity saving actions struggled to keep their consumption down.

Figure 5.4 compares the goals of each households (Figure 4.21 and 4.22) with their change in consumption. EHMS-11 responded that they wanted to minimize an increase in consumption. Their base year consumption was low compared to hubs of the same size and number of residents. They increased their consumption by 10.5%, which was an average increase of 1.8 kWh per day, from an average of 16.7 kWh per day to 18.5 kWh per day for the entire monitoring period. Of the 14 households that increased their consumption, EHMS-14 had the seventh highest increase, just above the median of 10.4% and well below the average of 16.2%. They also increased their consumption for all thirteen months of their monitoring period. Whether or not this was a minimization of their consumption can only be determined by the households, so it remains unclear whether or not their goals were met. As for the 12 households that set a goal to decrease their consumption, only four of them achieved their goal. This reiterates what Figures 5.1 and 5.2 demonstrated, which was that their actions may not follow from their attitudes.

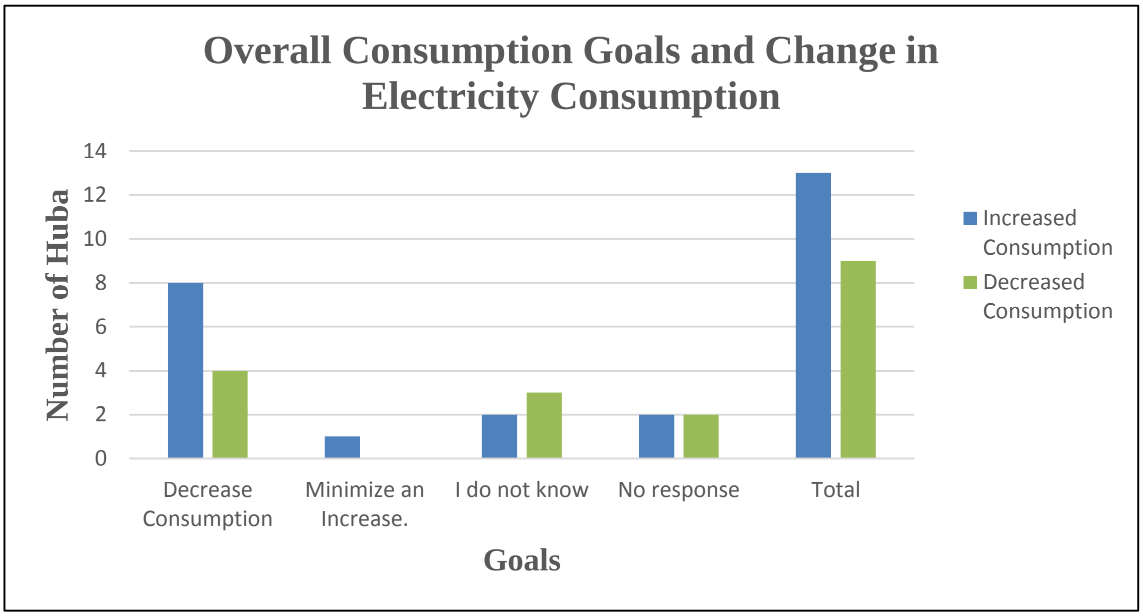

Figure 5.4 – Consumption goals compared with change in consumption

5.3 Consumption in the Long Term

In this section, change in consumption is calculated throughout the monitoring period to investigate how consumption changes over time. Ueno et al. (2006) and Hargreaves et al. (2013) found that with time, householders can slip back into their old consumption habits, as they want the comforts that increased electricity use can provide, and become comfortable with a new level of "normal" consumption. We wanted to see if this same observation was true in this research: if conservation efforts waned with time. Tables 5.4 and 5.5 show the change in consumption between the base year and the monitoring period over time; negative values indicate a decrease in consumption between the base year and the monitoring periods and positive values indicate an increase. Equation 3.19 was used to calculate these values. As discussed in section 4.2.3, some month one values are marked with an asterisk to caution the reader about making conclusions from these values, and these values are excluded from the discussion below.

There were three main patterns of consumption change: (1) Increase in consumption; (2) conservation for half the monitoring period; (3) conservation. Ten households fall into the first category by having an overall increase in their consumption between base year and monitoring period throughout their monitoring period. Nine households, EHMS-01, 04, 05, 11, 12, 16, 22, 24 and 25, had increased their consumption for their entire monitoring period, while EHMS-20 had a change in electricity that was negative at the end of month two indicating conservation, but the remaining changes in consumption were positive, indicating an increase in consumption between the base year and the monitoring period.

Six households fall into the second category, by having an overall change in consumption that was negative for half of their monitoring period. Four of these households, EHMS-07, 14, 15 and 21 conserved consistently until about halfway through their monitoring periods, when their change in consumption became positive. EHMS-10 and 18 had a change in consumption that was positive until months five and six, respectively. After that, the change in consumption became negative, indicating a decrease in consumption from the base year to the monitoring period, and stayed that way until the end of their monitoring period.

The remaining six households, EHMS-02, 09, 13, 17, 19 and 23 all conserved consistently throughout their monitoring period, with the exception of a few months at the beginning and in the middle of their monitoring periods. Interestingly, these hubs all had low to average base year consumption, except EHMS-23, which had high base year consumption. This indicates that low base year consumption does not necessarily mean that consumption will increase, and that there can be areas where consumption can be decreased.

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Month 1	-14.3%*	-44.6%*	-35.5%*	51.1%	-23.0%	60.7%*	196.2%*	5.1%	66.7%	3.1%	30.0%
Month 1-2	72.4%	-16.1%	25.4%	33.8%	-23.0%	-7.7%	19.3%	8.2%	73.0%	-12.1%	-2.1%
Month 1-3	30.3%	-4.0%	21.6%	31.0%	-23.3%	-11.0%	12.9%	12.7%	75.2%	-10.7%	-4.3%
Month 1-4	27.8%	-3.5%	17.8%	31.1%	-20.6%	-11.3%	5.2%	14.1%	76.1%	-3.0%	-6.3%
Month 1-5	13.8%	-6.1%	12.1%	32.3%	-19.9%	-11.6%	4.5%	14.4%	77.7%	-4.4%	-6.9%
Month 1-6	12.7%	-5.9%	9.2%	31.1%	-13.0%	-12.0%	-0.7%	12.1%	64.8%	1.9%	-0.2%
Month 1-7	8.8%	-5.2%	6.7%	26.6%	-5.0%	-11.9%	-2.6%	10.5%	57.9%	0.7%	5.5%
Month 1-8	6.6%	-2.4%	6.0%	20.0%	5.4%	-11.6%	-4.7%	10.6%	51.1%	-5.7%	4.4%
Month 1-9	4.4%	1.1%	4.8%	18.2%	7.7%	-10.6%	-3.1%	11.0%	47.4%	-6.3%	2.7%
Month 1-10	2.6%	1.6%	3.4%	18.9%	9.5%	-10.3%	-2.3%	11.1%	46.8%	-6.7%	5.7%
Month 1-11	2.7%	0.4%	3.1%	16.0%	7.4%	-8.5%	-3.0%	11.3%	46.4%	-4.9%	4.6%
Month 1-12	1.6%	0.3%	2.4%	15.0%	7.9%	-6.5%	-3.0%	11.3%	43.0%	-3.4%	5.3%
Month 1-13	3.2%	-0.1%	1.6%	14.8%	7.7%	-2.6%	-2.0%	12.2%	41.1%	-4.1%	5.6%
Month 1-14	7.8%	-1.1%	3.2%	16.8%		-3.1%	-2.2%		45.3%	-4.2%	4.7%
Month 1-15	9.6%	-1.3%	3.7%								

Table 5.4 – Change in consumption over time for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Month 1	0.5%	1.8%	1.96%*	2.0%*	106.3%*	33.2%*	-48.3%*	-3.2%*	33.1%*	75.9%*	95.0%*
Month 1-2	-13.6%	1.8%	2.4%	15.7%	2.7%	-3.4%	-3.4%	16.0%	-18.4%	35.5%	28.5%
Month 1-3	-16.2%	5.2%	-3.5%	1.6%	-7.6%	9.6%	-1.4%	9.8%	-19.9%	54.1%	18.9%
Month 1-4	-11.9%	6.8%	-9.1%	8.5%	-12.2%	11.4%	-0.9%	5.3%	-23.6%	45.4%	11.7%
Month 1-5	-7.5%	6.2%	-17.7%	6.6%	-14.1%	14.8%	3.5%	4.3%	-19.1%	53.2%	14.5%
Month 1-6	-3.4%	6.5%	-14.3%	2.4%	-12.4%	20.9%	4.7%	6.0%	-18.3%	58.0%	19.7%
Months 1-7	-3.2%	8.5%	-11.2%	-1.8%	-22.0%	27.8%	6.8%	10.1%	-19.2%	59.4%	22.3%
Month 1-8	0.1%	10.1%	-8.8%	-5.9%	-17.6%	16.0%	8.3%	10.5%	-18.9%	61.6%	
Month 1-9	1.8%	11.7%	-7.3%	-7.9%	-16.5%	35.8%	10.8%	11.3%	-16.3%	56.5%	
Month 1-10	2.2%	11.4%	-6.0%	-10.1%	-18.3%		10.5%	10.6%	-15.1%	50.1%	
Month 1-11	2.6%	10.4%			-19.0%						
Month 1-12	4.5%	10.2%			-21.1%						
Month 1-13	4.3%	9.7%			-19.1%						
Month 1-14											
Month 1-15											

Table 5.5 – Change in consumption over time for EHMS-15-25

Table 5.6 shows the change in consumption between the base year and the monitoring period in kWh/day for months one to three, one to seven, and the entire monitoring period. Here, a negative value indicates a decrease in consumption and a positive value indicates an increase in consumption. Of the hubs that had a monitoring period of 15 months, only one, EHMS-02, had a decrease in electricity consumption between the base year and monitoring period, and maintained that decrease for, most of the monitoring period. It is interesting to note that no one from the EHMS-02 household logged into the webportal during their monitoring period; the only reason they had an engagement index above zero was because they had sent e-mails to the researchers in two separate months. EHMS-01 and 04 started out with large increases in consumption, and managed to minimize their increased over time. While they may not be consuming less in the monitoring period than they were in the base year, they did manage to decrease their change in consumption within the monitoring period.

There were six hubs with a 14 month monitoring period. At the end of month three, three of the six had decreased their consumption between the base year and monitoring period, EHMS-09, 13 and 14; at the end of the seventh month, this number dropped to two, EHMS-09 and 10. At the end of the monitoring period EHMS-09, 10 and 13 had decreased their consumption, EHMS-05 and 12 had not decreased their consumption between the base year and monitoring period, but managed to reduce their increase during the monitoring period.

There were five hubs with a 13 month monitoring period. Of these hubs, EHMS-07, 15 and 19 had decreased their consumption for months one to three and months one to seven, but by the end of the monitoring period only EHMS-19 still managed to have a decreased consumption. Finally, there were six hubs with a 10 month monitoring period. EHMS-17, 21 and 23 had decreased their consumption between the base year and monitoring period for months one to three. EHMS-17, 18 and 23 decreased their consumption for months one to seven and the entire monitoring period. This is interesting because the shortest monitoring period (besides the two hubs that dropped out early) had the most consistency with change in consumption, in both number of hubs that conserved over time, and the changes in consumption for all the hubs.

Hub	Change in consumption for months 1 to 3	Change in consumption for months 1 to 7	Change in consumption for the entire monitoring period
15 Month Monitoring Period			
EHMS-01	30.3%	8.8%	9.6%
EHMS-02	-4.0%	-5.2%	-1.3%
EHMS-04	21.6%	6.7%	3.7%
14 Month Monitoring Period			
EHMS-05	31.0%	26.6%	16.8%
EHMS-09	-11.0%	-11.9%	-3.1%
EHMS-10	12.9%	-2.6%	-2.2%
EHMS-12	75.2%	57.9%	45.3%
EHMS-13	-10.7%	0.7%	-4.2%
EHMS-14	-4.3%	5.5%	4.7%
13 Month Monitoring Period			
EHMS-07	-23.3%	-5.0%	7.7%
EHMS-11	12.7%	10.5%	12.2%
EHMS-15	-16.2%	-3.2%	4.3%
EHMS-16	5.2%	8.5%	9.7%
EHMS-19	-7.6%	-22.0%	-19.1%
10 Month Monitoring Period			
EHMS-17	-3.5%	-11.2%	-6.0%
EHMS-18	1.6%	-1.8%	-10.1%
EHMS-21	-1.4%	6.8%	10.5%
EHMS-22	9.8%	10.1%	10.6%
EHMS-23	-19.9%	-19.2%	-15.1%
EHMS-24	54.1%	59.4%	50.1%
9 Month Monitoring Period			
EHMS-20	9.6%	27.8%	35.8%
7 Month Monitoring Period			
EHMS-25	18.9%	22.3%	

Table 5.6 – Change in consumption for months one to three, months one to seven, and the entire monitoring period

Table 5.7 presents the average changes in consumption for the different lengths of monitoring periods. As discussed with respect to Table 5.6, the hubs with the monitoring period of 10 months have minimal average change in consumption over time. Aside from that, the results do not seem to indicate that after longer periods of time, householders slip back into their old ways, as the literature might suggest. In fact, there does not seem to be much of a correlation between length of time and change in consumption.

Length of monitoring period	# hubs	Average change in consumption (months 1 to3)	Average change in consumption (months 1 to 7)	Average change in consumption (entire monitoring period)
10 months	6	6.8%	7.4%	6.7%
13 months	5	-5.8%	-2.2%	3.0%
14 months	6	15.5%	12.7%	9.5%
15 months	3	16.0%	3.4%	4.0%

Table 5.7 – Average change in consumption for different monitoring period lengths

5.4 Engagement

This section will investigate how engagement changes over time. One issue that was discussed in the literature was that over time people become less engaged with feedback (Nye et al., 2010; Ueno et al, 2006). Table 5.8 shows monthly engagement with the webportal. The second column indicates the number of hubs that were active for each month, because not all hubs were active for fifteen months, some were only active for eight. From these data, it is obvious that engagement decreases over time; the average number of sessions per hub in each month declines rapidly between months three and four, and with the exception of the increase between months six and nine, it remained low. To investigate the engagement over time, some key measures from Table 5.8 will be plotted against time. These plots can be seen in Figures 5.5, 5.6, 5.7, 5.8, 5.9 and 5.10.

The scatter plots give a visual representation of the patterns of engagement over the months of the monitoring period. To determine the relationship between length of access to webportal (month) and the engagement variables, Pearson's r was calculated. This measure of correlation was chosen because it measures the linear relationship between interval and/or ratio variables, which are the types of variables being investigated in this thesis (Cramer, 2004). This calculation produces a value between -1 and 1, where a value closer to -1 or 1 means that there is a strong relationship between the variables, and a value closer to zero means that there is little to no relationship between the variables. A negative value means that as one variable increases, the other decreases, and a positive value means that both variables are increasing together (Bryman, & Teevan, 2005).

month	#hubs active	# sessions	Average # of sessions per hub	Average # days between sessions	Average # pages visited and actions taken per session	Average # minutes per session	# sessions with communications with EHMS	Average # interactions per session
1	22	20	0.9	4.1	19.1	10.4	4	1.4
2	22	49	2.2	9.8	15.5	9.7	10	1.0
3	22	16	0.7	19.3	13.3	8.1	3	0.9
4	22	4	0.2	25	6.5	3	1	0.5
5	22	3	0.1	25.7	28.0	22.7	2	1.0
6	22	7	0.3	47.4	13.6	9.4	0	1.0
7	22	11	0.5	62.1	9.3	3.2	2	0.7
8	22	7	0.3	55.1	14.0	8.6	1	0.7
9	21	9	0.4	21.4	13.2	4.6	0	0.9
10	20	2	0.1	135.0	4.5	0.5	1	1.0
11	14	3	0.2	232.7	18.3	8.0	1	1.0
12	14	3	0.2	50.3	21.3	13.0	2	1.0
13	14	7	0.5	80.4	8.1	6.4	2	0.7
14	9	2	0.2	188	4.5	3.0	0	0.5
15	3	1	0.3	268.0	13.0	29.0	0	1.0

Table 5.8 – Engagement data by month

Figure 5.5 shows the average number of sessions per hub for each month. The first two months had the highest averages, of 0.9 and 2.2, respectively. The third month dropped to 0.7, and the remaining months ranged from 0.1 to 0.5 sessions per hub. These values indicate that for most months, there were some hubs that did not have any sessions. Tables 4.46 and 4.47 clearly show that there was no hub that logged in every month it was active.

The second month had the highest number of sessions, and the first month had the second highest number of sessions. One possibility for this is that many of the hubs were activated near the end of the month, so they did not have many days to login, and did a lot of their exploring of the webportal during month two. The Pearson's r value for these variables is -0.527, which is a moderate negative correlation between time and the number of sessions. This indicates that as time passed, there were fewer sessions per hub each month.

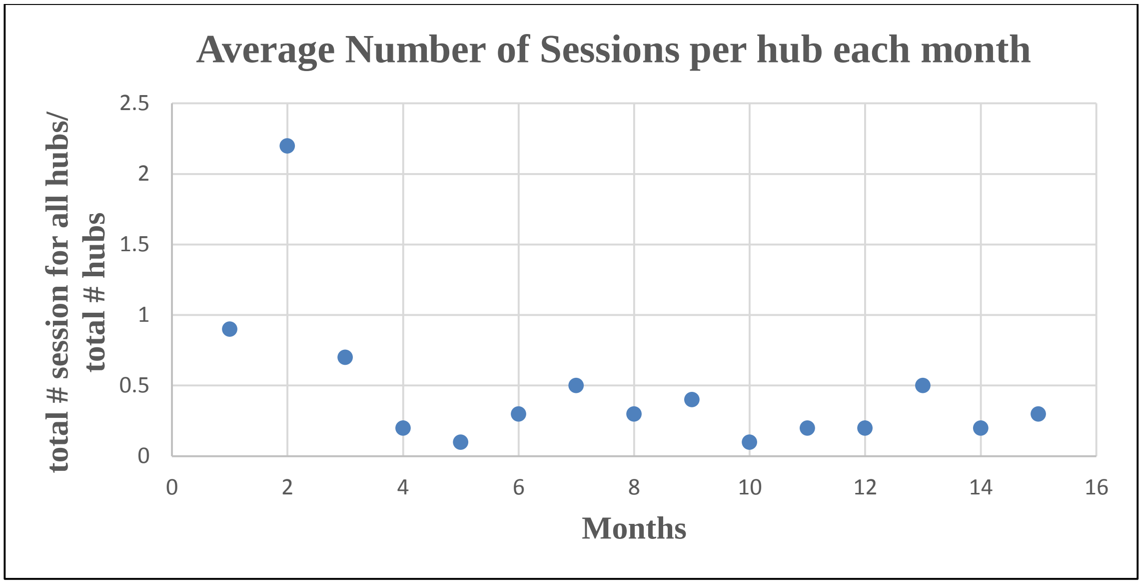

Figure 5.5 –The average number of sessions per hub for each month

Figure 5.6 shows the average number of days between sessions for all hubs, plotted against the number of months activated. There is a general upward pattern, and the Pearson's r value for these variables is 0.771, signifying a strong positive correlation, indicating that the longer the webportal is active, the more time there is between sessions, and the less engagement there is with the webportal.

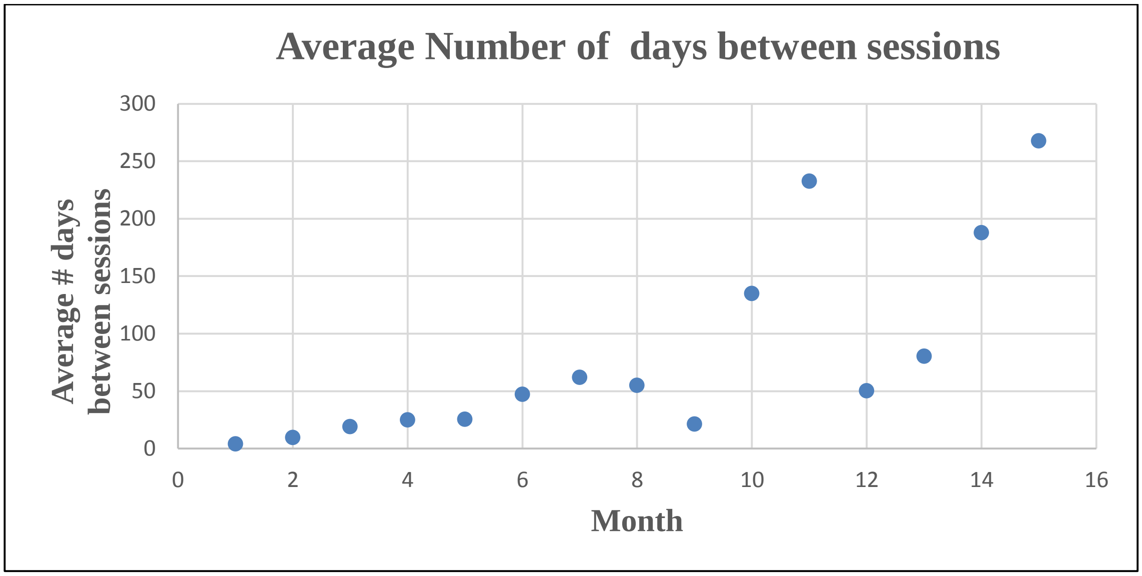

Figure 5.6 –The average number of days between sessions for all months

Figure 5.7 presents the average number of pages visited and actions taken for each month. The first four months show a decrease in the average number of actions taken per session, and month five has the highest value. Month five only has three sessions, one with seven pages and actions, another with 28, and a third with 49. The low number of sessions coupled with one session having a very high number of page visits and actions led to this high average. With the exception of months eleven and twelve, the remaining months had averages between four and 14 page visits and actions per session. Pearson's r was -0.293, indicating that there was a weak negative correlation between time and the average number of page visits and actions per session, as indicated by the vague downward pattern of the scatter plot in Figure 5.7.

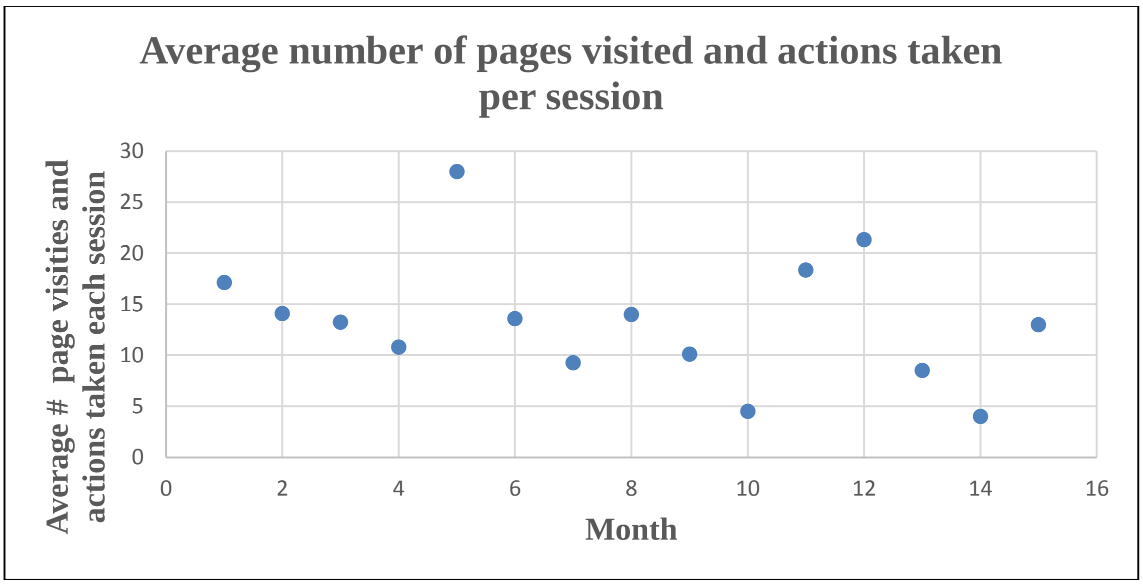

Figure 5.7 – Average number of pages visited and actions taken per session for each month

Figure 5.8 shows the plot of time (in months) versus the average number of minutes per session. Months one through four show a slight decline in the average for each month, and then after that, it fluctuates. With the exception of months five, and 15, all months had an average number of minutes per session between 0.5 and 13 minutes. Pearson's r for these two variables is 0.128, which is a weak, positive correlation, indicating that a weak, possibly non-existent, relationship between the number of months with an active portal and the length of time spent on the portal.

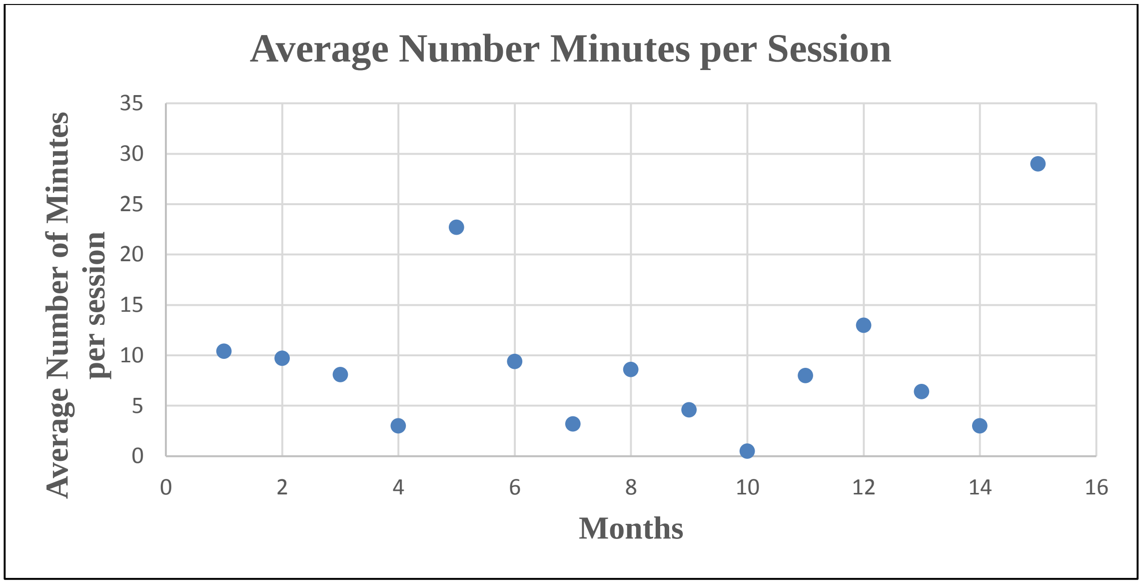

Figure 5.8 – Average number of minutes per session for all months

Figure 5.9 shows the time in months plotted against the number of sessions where a household contacted the EHMS project to provide feedback or to ask a question. The r value for these two variables is -0.583, indicating a moderate, negative correlation between time and the number of communications. The data show that in months one, two and three, there were four, ten, and three communications, respectively, from the users. For the remaining thirteen months, there were zero, one or two communications, indicating that the first three months yielded more questions and/or comments from the users, as the system was new, and after getting acquainted with the system, the communications decreased. It should be noted that months eight to 15 had fewer active hubs than months one to seven, and while the number of communications with the researchers were about the same for each month (with the exception of months one and two), had there been the same number of hubs active for months eight to fifteen, there could have been more communications.

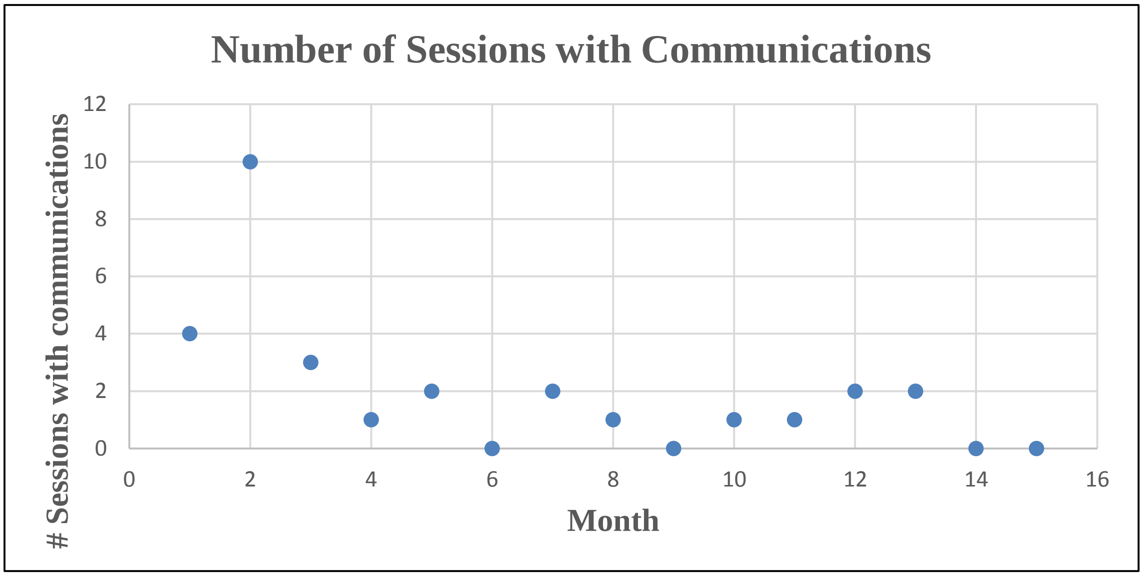

Figure 5.9 – Number of sessions with communications each month

Figure 5.10 shows the average number of interactions for all hubs for each month. Pearson's r value for these two variables is -0.316, a weak to moderate, negative correlation. The average number of interactions per session fluctuates between 0.5 and 1.4, with 12 of the 15 months having values between 0.7 and 1.0.

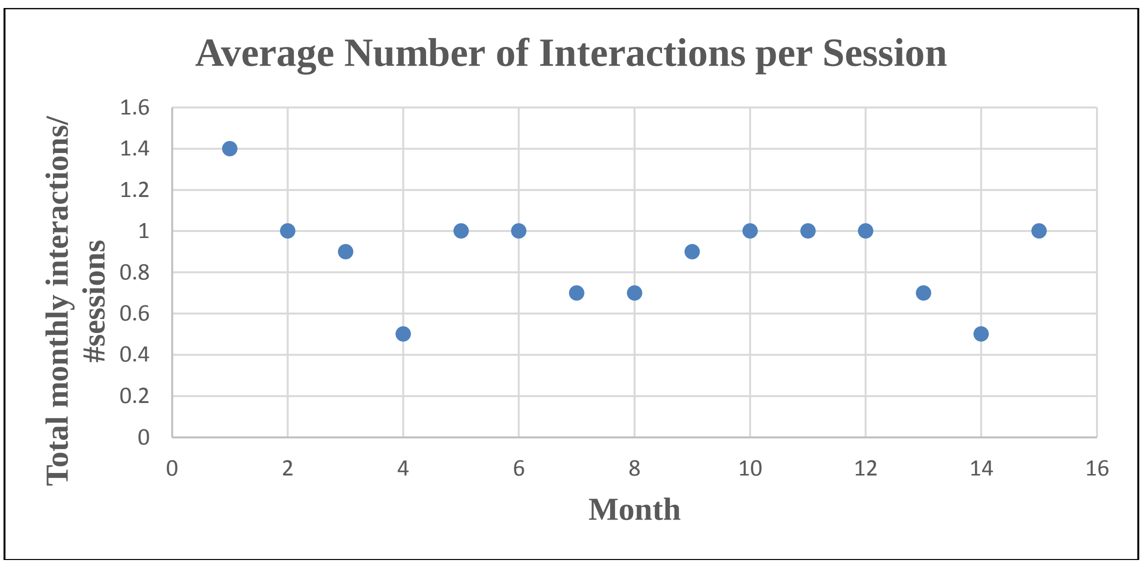

Figure 5.10 – Average number of interactions per session for each month in the monitoring period

Figure 5.11 compares the households' awareness of their electricity consumption with their level of engagement for months one to seven. Their level of engagement is divided up into low, medium and high engagement. These levels were determined by taking the lowest engagement index, 0, and the highest engagement index, 0.341, for months one to seven, and dividing it equally into three parts. Low engagement was from 0 to 0.113, medium engagement was from 0.114 to 0.227, and high engagement was from 0.228 to 0.341. There were six hubs with low engagement, 12 with medium engagement, and four with high engagement. Table 5.9 shows each hub, their engagement, and engagement level from months one to seven.

Hub	Engagement Index for months one to seven	Level of Engagement
EHMS-01	0.146	Medium
EHMS-02	0	Low
EHMS-04	0.224	Medium
EHMS-05	0.224	Medium
EHMS-07	0.218	Medium
EHMS-09	0.207	Medium
EHMS-10	0.292	High
EHMS-11	0.116	Medium
EHMS-12	0.076	Low
EHMS-13	0.341	High
EHMS-14	0.180	Medium
EHMS-15	0.190	Medium
EHMS-16	0.305	High
EHMS-17	0.042	Low
EHMS-18	0.124	Medium
EHMS-19	0.124	Medium
EHMS-20	0.099	Low
EHMS-21	0.120	Medium
EHMS-22	0.175	Medium
EHMS-23	0.268	High
EHMS-24	0.046	Low
EHMS-25	0.066	Low

Table 5.9 – Levels of engagement for months one to seven

Figure 5.11 is meant to investigate whether or not users who claim to have lower levels of knowledge about their electricity consumption (i.e. to the statement "Currently, I am aware of how much electricity is used by each of my electric appliances," they responded neither agree nor disagree, somewhat disagree, disagree or strongly disagree) are taking advantage of the opportunity to learn more about their consumption by logging into the webportal. In total, there were fourteen hubs that had lower levels of knowledge about their consumption, three were high engagers, eight were medium engagers and three were low engagers. In total, eleven of the fourteen households that claimed to have low levels of knowledge about their consumption, were medium to high engagers, indicating that they may have used the webportal to become more familiar with their consumption.

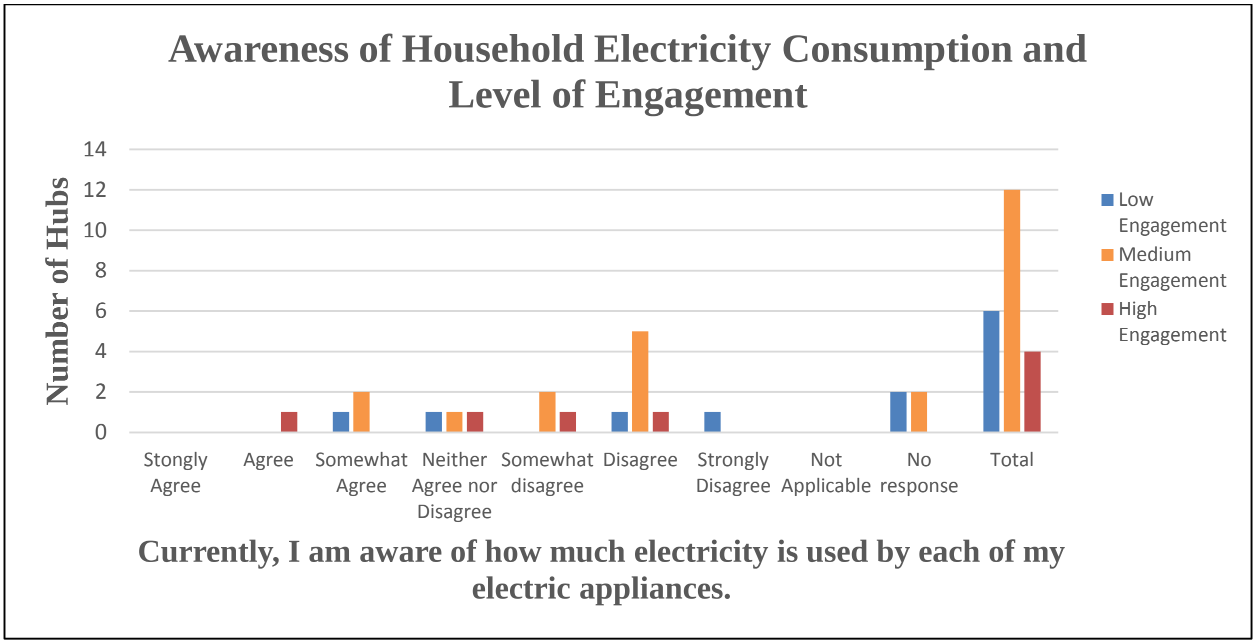

Figure 5.11 – Awareness of electricity consumption compared with level of engagement.

It should be noted that in this research, the households that were high engagers, did not login every month, and in some cases did not login for months. So the terms medium and high engagers are designations given relative to the other participants in this study, and it is uncertain whether they could be absolutely considered medium or high engagers, considering their low number of sessions.

5.4.1 Example of Regular Engagement

As discussed in the previous section, the participants did not log into the webportal regularly; on average, it was less than once a month. So the conclusions made about engagement, are done relative to the hubs in this research. To see how the households compared to regular engagers, two example hubs were created. Since e-mails were sent out twice a month, both example hubs had logins twice a month, on the days those e-mails were sent. The first example household, EHMS-A, had a variety of different activities each month, and stayed relatively engaged throughout the monitoring period. The second example household, EHMS-B, was heavily engaged for months one to three, and then dropped off, until November 2012, when the optimizer function was introduced. At this point, engagement increased for that month, and then dropped off again. The data and calculations for the example engagement indices can be found in Appendix H. EHMS-A had an engagement index of 0.499, an index just over 0.150 higher than the highest engagement index at month seven, and EHMS-B had an engagement index of 0.331, just 0.010 lower than the highest engagement index at month seven (Table 5.9).

5.5 Engagement in the Long-term

The total engagement index was calculated after every month in the monitoring period for each hub. These numbers are shown in Tables 5.10 and 5.11, and equation 3.2 was used to calculate the values. Twelve of the 22 households had total engagement indices that decreased steadily throughout the monitoring period. EHMS-02 increased their engagement index over time. However, they only had two months where they engaged with the webportal, month 11 and month 13. EHMS-25 only engaged with the webportal during the last month in their monitoring period, so the engagement index increases between months six and seven. Six of the households had an initial decrease in engagement index and it then fluctuated for the last months. Two households decreased steadily and then increased near the end of their monitoring period. These data show that no household maintained a constant level of engagement throughout their monitoring period, and with the exception of EHMS-02 and 25, all households had a general decreasing pattern of engagement throughout their monitoring period.

	EHMS-01	EHMS-02	EHMS-04	EHMS-05	EHMS-07	EHMS-09	EHMS-10	EHMS-11	EHMS-12	EHMS-13	EHMS-14
Month 1	0.000	0.000	0.000	0.479	0.321	0.806	0.253	0.503	0.000	0.514	0.617
Month 1-2	0.302	0.000	0.319	0.540	0.288	0.403	0.514	0.407	0.266	0.456	0.631
Month 1-3	0.201	0.000	0.352	0.523	0.296	0.269	0.447	0.272	0.177	0.410	0.421
Month 1-4	0.151	0.000	0.328	0.392	0.222	0.201	0.335	0.204	0.133	0.371	0.315
Month 1-5	0.121	0.000	0.313	0.314	0.178	0.289	0.408	0.163	0.106	0.297	0.252
Month 1-6	0.171	0.000	0.261	0.261	0.148	0.241	0.340	0.136	0.089	0.332	0.210
Months 1-7	0.146	0.000	0.224	0.224	0.218	0.207	0.292	0.116	0.076	0.341	0.180
Month 1-8	0.128	0.000	0.196	0.196	0.191	0.181	0.255	0.102	0.067	0.353	0.239
Month 1-9	0.114	0.000	0.227	0.174	0.170	0.161	0.227	0.091	0.059	0.358	0.213
Month 1-10	0.103	0.000	0.204	0.193	0.153	0.145	0.204	0.081	0.053	0.323	0.191
Month 1-11	0.093	0.023	0.186	0.176	0.169	0.131	0.186	0.142	0.048	0.293	0.174
Month 1-12	0.085	0.021	0.170	0.161	0.155	0.120	0.170	0.163	0.044	0.269	0.215
Month 1-13	0.079	0.039	0.196	0.149	0.143	0.111	0.157	0.151	0.041	0.287	0.218
Month 1-14	0.073	0.036	0.182	0.138		0.103	0.146		0.056	0.299	0.203
Month 1-15	0.099	0.034	0.169								

Table 5.10 – Total engagement index for EHMS-01, 02, 04, 05, 07, 09-14

	EHMS-15	EHMS-16	EHMS-17	EHMS-18	EHMS-19	EHMS-20	EHMS-21	EHMS-22	EHMS-23	EHMS-24	EHMS-25
Month 1	0.000	0.479	0.000	0.000	0.000	0.694	0.583	0.736	0.515	0.000	0.000
Month 1-2	0.281	0.495	0.147	0.260	0.000	0.347	0.292	0.611	0.528	0.160	0.000
Month 1-3	0.340	0.498	0.098	0.290	0.140	0.231	0.279	0.407	0.352	0.107	0.000
Month 1-4	0.255	0.374	0.074	0.217	0.105	0.174	0.209	0.306	0.379	0.080	0.000
Month 1-5	0.204	0.299	0.059	0.174	0.084	0.139	0.167	0.244	0.303	0.064	0.000
Month 1-6	0.170	0.356	0.049	0.145	0.070	0.116	0.139	0.204	0.253	0.053	0.000
Months 1-7	0.190	0.305	0.042	0.124	0.124	0.099	0.120	0.175	0.268	0.046	0.066
Month 1-8	0.166	0.267	0.037	0.140	0.108	0.087	0.105	0.153	0.235	0.040	
Month 1-9	0.147	0.237	0.033	0.182	0.096	0.077	0.093	0.136	0.257	0.036	
Month 1-10	0.133	0.213	0.029	0.163	0.086		0.084	0.122	0.257	0.032	
Month 1-11	0.121	0.194			0.079						
Month 1-12	0.111	0.178			0.072						
Month 1-13	0.129	0.164			0.067						
Month 1-14											
Month 1-15											

Table 5.11 – Total engagement index for EHMS-15-25

The total engagement index for months one to three, one to seven and the entire monitoring period are investigated more closely in Table 5.12. These data are divided up by when the hub was activated, and the engagement indices for each period of time are compared with each other. A negative difference (red cell) between engagement indices for different periods indicates a decrease in engagement between the two periods, and a positive difference (green cell) indicates an increase in engagement. Table 5.13 presents the average engagement indices for the different lengths of monitoring periods for months one to three, one to seven, and the entire monitoring period.

Twenty one of the 22 households had decreased their engagement between the end of month three and the end of month seven. The only household that increased their engagement was EHMS-25 because month seven was the only month they logged in. Between the end of month seven and the end of the monitoring period, four households increased their engagement. An interesting observation is that the average engagement index between the end of month three and the end of the monitoring period decreased the least for the households that were active for 15 months, and average engagement index dropped by more than half for the rest of monitoring periods. These findings could indicate that as time passes, householders lose interest with the consumption data, which is similar to what Ueno et al. (2006) found.

	Engagement Index			Difference	
	Months 1-3	**Months 1-7**	**Entire monitoring period**	**(Months 1-7)-(Months 1-3)**	**(Entire Monitoring Period)-(Months 1-7)**
15 Month Monitoring Period					
EHMS-01	0.201	0.146	0.099	-0.055	-0.047
EHMS-02	0	0	0.034	0	0.034
EHMS-04	0.352	0.224	0.169	-0.128	-0.055
14 Month Monitoring Period					
EHMS-05	0.523	0.224	0.138	-0.299	-0.086
EHMS-09	0.269	0.207	0.103	-0.062	-0.104
EHMS-10	0.447	0.292	0.146	-0.155	-0.146
EHMS-12	0.177	0.076	0.056	-0.101	-0.02
EHMS-13	0.41	0.341	0.299	-0.069	-0.042
EHMS-14	0.421	0.18	0.203	-0.241	0.023
13 Month Monitoring Period					
EHMS-07	0.296	0.218	0.143	-0.078	-0.075
EHMS-11	0.272	0.116	0.151	-0.156	0.035
EHMS-15	0.34	0.19	0.129	-0.15	-0.061
EHMS-16	0.498	0.305	0.164	-0.193	-0.141
EHMS-19	0.14	0.124	0.067	-0.016	-0.057
10 Month Monitoring Period					
EHMS-17	0.098	0.042	0.029	-0.056	-0.013
EHMS-18	0.29	0.124	0.163	-0.166	0.039
EHMS-21	0.279	0.12	0.084	-0.159	-0.036
EHMS-22	0.407	0.175	0.122	-0.232	-0.053
EHMS-23	0.352	0.268	0.257	-0.084	-0.011
EHMS-24	0.107	0.046	0.032	-0.061	-0.014
9 Month Monitoring Period					
EHMS-20	0.231	0.099	0.077	-0.132	-0.022
7 Month Monitoring Period					
EHMS-25	0	0.066		0.066	n/a

Table 5.12 – Engagement Indices for months one to three, one to seven and the entire monitoring period

Length of monitoring period	# hubs	Average Engagement Index		
		Months 1-3	Months 1-7	Entire Monitoring Period
7 months	1	0.000	0.057	
9 months	1	0.231	0.099	0.077
10 months	6	0.256	0.129	0.115
13 months	5	0.309	0.191	0.131
14 months	6	0.375	0.220	0.158
15 months	3	0.184	0.123	0.101

Table 5.13 – Average engagement indices for each length of monitoring period

5.6 Engagement Index vs. Change in Consumption

For each hub, the engagement index was plotted against the change in consumption for each month for months one to seven and the entire monitoring period. Table 5.14 shows the Pearson's r for each correlation, for each hub, and also provides the number of months that the hubs were engaged. A value close to minus one would indicate that as the engagement index increases, the household has decreased their consumption; i.e. the more often a person logs in, the more electricity they conserve. A positive value close to one indicates that as the engagement index increases, so does the household's consumption; i.e. the more often a household logs in, the more electricity they consume. As discussed in section 4.2.3, month one values for certain hubs are excluded from this analysis; in Table 5.14, these hubs are marked with an asterisk.

Table 5.15 shows the Pearson's r value for the correlation between the engagement index for month n, and the consumption for month n+1. This is an important correlation to investigate because the impact of looking at consumption data may not occur immediately. If changes in consumption result from looking at consumption data, they could be delayed, so comparing engagement in month n with change in consumption in month n+1 helps investigate this.

	Months 1-7		Entire Monitoring Period	
Hub	**# months with engagement**	**Pearson’s r**	**# months with engagement**	**Pearson's r**
15 Month Monitoring Period				
EHMS-01*	2	0.786	3	0.383
EHMS-02*	0	n/a	2	-0.343
EHMS-04*	4	0.924	6	0.441
14 Month Monitoring Period				
EHMS-05	3	0.364	4	0.330
EHMS-09*	1	0.239	1	-0.151
EHMS-10*	3	0.732	3	0.270
EHMS-12	1	0.224	2	0.433
EHMS-13	6	0.263	10	-0.304
EHMS-14	2	0.149	5	0.159
13 Month Monitoring Period				
EHMS-07	4	0.255	5	-0.324
EHMS-11	2	-0.379	4	-0.238
EHMS-15	3	-0.932	4	-0.811
EHMS-16	4	-0.426	4	-0.283
EHMS-19*	2	-0.681	2	-0.370
10 Month Monitoring Period				
EHMS-17*	1	0.312	1	0.173
EHMS-18*	2	0.386	4	0.126
EHMS-21*	1	-0.448	1	-0.404
EHMS-22*	1	0.093	1	0.115
EHMS-23*	3	-0.706	5	-0.067
EHMS-24*	1	-0.642	1	-0.263
9 Month Monitoring Period				
EHMS-20*	0	n/a	0	n/a
7 Month Monitoring Period				
EHMS-25*	1	0.414	1	0.414

Table 5.14 – The Pearson’s r values for the correlation between the engagement index and change in consumption

	Months 1-7 (Engagement Index for months 1-6 and change in consumption for months 2-7)		Entire Monitoring Period (Engagement Index for month n, and change in consumption for month n+1)	
Hub	**# months with engagement**	**Pearson’s r**	**# months with engagement**	**Pearson's r**
15 Month Monitoring Period				
EHMS-01	2	-0.363	2	-0.211
EHMS-02	0	n/a	2	-0.172
EHMS-04	4	0.009	6	0.230
14 Month Monitoring Period				
EHMS-05	3	0.270	4	0.014
EHMS-09	2	-0.611	2	-0.273
EHMS-10	4	-0.102	4	-0.190
EHMS-12	1	0.309	1	0.261
EHMS-13	5	-0.669	9	-0.583
EHMS-14	2	-0.457	5	-0.355
13 Month Monitoring Period				
EHMS-07	3	-0.665	5	0.256
EHMS-11	2	0.304	4	0.217
EHMS-15	2	-0.355	4	-0.344
EHMS-16	4	0.562	4	0.095
EHMS-19	1	0.051	2	0.128
10 Month Monitoring Period				
EHMS-17	1	0.030	1	-0.076
EHMS-18	2	0.194	4	0.020
EHMS-21	2	-0.527	2	-0.492
EHMS-22	2	-0.082	2	-0.034
EHMS-23	3	0.371	5	-0.008
EHMS-24	1	0.104	1	0.163
9 Month Monitoring Period				
EHMS-20	1	-0.552	1	-0.568
7 Month Monitoring Period				
EHMS-25	1	n/a	1	n/a

Table 5.15 – The Pearson’s r values for the correlation between the engagement index in month n and change in consumption for month n+1

Comparing the Pearson r values from Tables 5.14 and 5.15 gives some interesting results. There were seven hubs for which the correlation between engagement in month n and change in consumption in month n had a different direction (i.e. the Pearson's r value went from positive to negative, or vice versa) than the correlation between engagement in month n and change in consumption in month n+1. In both Tables, there were also quite a few hubs with positive Pearson r values; for months one to seven, there were 12 hubs in Table 5.5 and seven in Table 5.6 with positive r values, and for the entire monitoring period there were 10 hubs in Table 5.5 and six hubs in Table 5.6. This positive value indicates that as engagement increases, so does consumption. One such reason could be that perhaps users were logging in to monitor their consumption data for increases after they had purchased a new appliance, or had an event such as a holiday party, that required an increase in electricity consumption. In this case, that would mean that an increase in consumption caused users to login more.

The number of months with engagement was also included in these two tables because low amounts of engagement can produce high r values that do not accurately represent the experience of the hub throughout the monitoring period. For example, EHMS-15 had an r value of -0.932 for months one to seven and -0.811 for the entire monitoring period in Table 5.14. However, this household only engaged during three months, so these values may not accurately describe the experience of this household. The next section will discuss the results of specific hubs in order to get a better understanding of their individual results.

5.7 Examples of Individual Hubs

In this section, the results of several different hubs will be discussed. This will be done to get a closer look at different and interesting results found in this study. We will be looking at a hub with a positive correlation between engagement and change in consumption, hubs with a negative correlation between engagement and change in consumption, hubs with low engagement, and hubs with high engagement. Looking at different hubs will help the reader get a more detailed understanding of some of the experiences of households, and better understand the information the data are giving them.

5.7.1 EHMS-04

Figure 5.12 shows the engagement index plotted against the change in consumption. These two variables have an r value of 0.441 for the entire monitoring period, indicating a positive, moderate correlation. Figure 5.13 shows the engagement for month n and the change in consumption for month n+1. The Pearson's r value for this correlation is 0.230, again indicating a weak, positive correlation.

EHMS-04 was a medium engager, with an engagement index of 0.224 for the first seven months, and an engagement index of 0.169 for their entire monitoring period. Overall, their consumption increased, 3.7%, an average of 2.3 kWh per day over the entire monitoring period, and increased by 6.7%, an average of 3.4 kWh per day during the first seven months. Interestingly, after the seventh month, engagement decreased, but so did their consumption. This is what Figure 5.12 and 5.13 indicate: engagement index and change in consumption increase and decrease together.

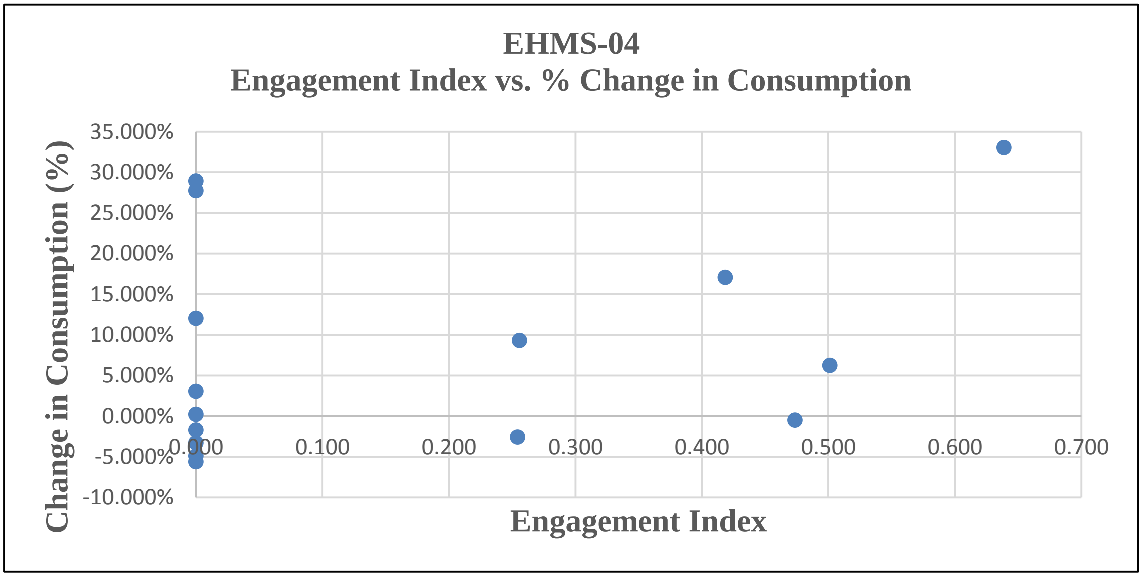

Figure 5.12 – Engagement index vs. percent change in consumption for EHMS-04

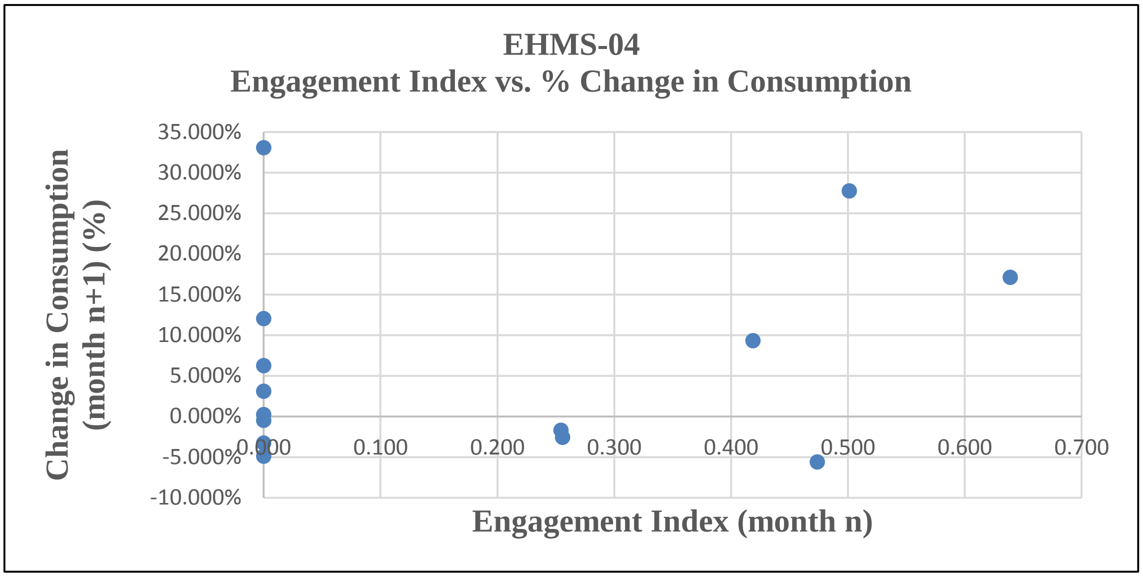

Figure 5.13 – Engagement index (month n) vs. percent change in consumption (month n+1) for EHMS-04

5.7.2 EHMS-15

EHMS-15 was a medium engager, with an engagement index of 0.190 for the first seven months, and 0.130 for the entire monitoring period. This hub also had an overall decrease in consumption between the base year and the monitoring period for the first seven months of 3.2%, and an overall increase for the entire monitoring period 4.3%. Figure 5.14 shows the plot of the monthly engagement index for month n against the monthly change in consumption for month n for EHMS-15. This relationship has a Pearson's r value of -0.811. Figure 5.15 shows the monthly engagement index for month n plotted against change in consumption for month n+1. This correlation produced a Pearson's r value of -0.344 for the entire monitoring period.

The Pearson's r values indicate that there is a strong negative correlation between the engagement index for month n and the change in consumption for month n, and a weak to moderate correlation for the engagement index for month n and the change in consumption (month n+1). This is interesting because it indicates that for this particular hub, engagement with the webportal in month n has more of an effect on change in consumption in month n than month n+1. However, looking closely at the data, only four of the 13 points in Figure 5.14 are off the y-axis, indicating there were only four months that the household engaged with the webportal, and of these four months, three of them were the only three months that this household conserved electricity, providing only a small glimpse of the overall experience of this household. Figure 5.15 has only three points that have an engagement index above zero, also providing a limited view of the experiences of this particular household.

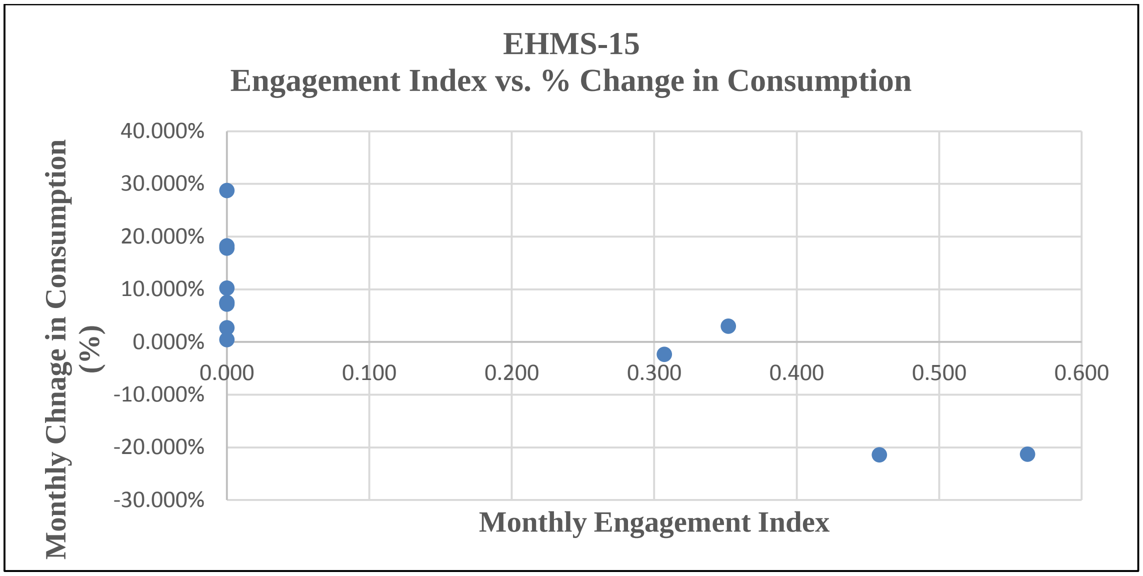

Figure 5.14 – Engagement Index plotted against the change in consumption for EHMS-15 for the entire monitoring period.

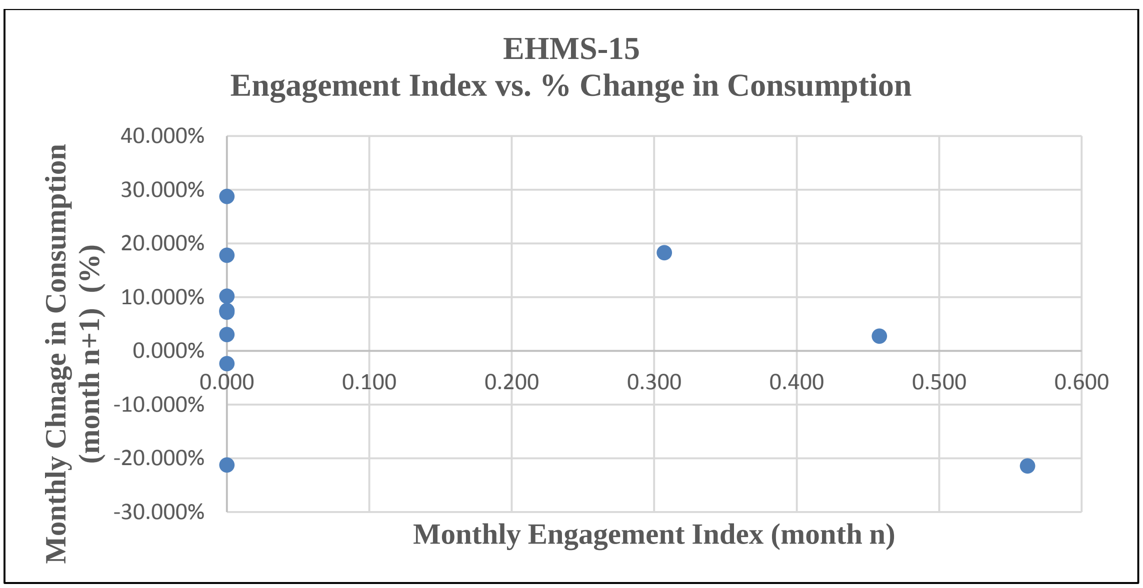

Figure 5.15 – Engagement index (month n) plotted against the change in consumption (month n+1) for EHMS-15 for the entire monitoring period.

This example shows how a small number of months where the household engaged with the webportal can create a correlation between engagement and change in consumption that may be mathematically strong, but contains too little data to provide an accurate description of the experience of that particular hub. Unfortunately, as Table 5.16 shows, 20 of the 22 households logged in fewer than half of the months their webportal was open. In fact, 11 of the households engaged with the webportal less than one-fifth of the months they were active. Having such sparse data makes it challenging to see patterns in individual hubs, as their correlations can be artificially high.

	Number of Months with Engagement	**# Months with an Active Webportal**	**% Months with Engagement**
EHMS-01	3	15	20%
EHMS-02	2	15	13%
EHMS-04	6	15	40%
EHMS-05	4	14	29%
EHMS-07	5	13	39%
EHMS-09	2	14	14%
EHMS-10	4	14	29%
EHMS-11	4	13	31%
EHMS-12	2	14	14%
EHMS-13	10	14	71%
EHMS-14	5	14	36%
EHMS-15	4	13	31%
EHMS-16	4	13	31%
EHMS-17	1	10	10%
EHMS-18	4	10	40%
EHMS-19	2	13	15%
EHMS-20	1	9	11%
EHMS-21	2	10	20%
EHMS-22	2	10	20%
EHMS-23	6	10	60%
EHMS-24	1	10	10%
EHMS-25	1	7	14%

Table 5.16 – Months that hubs engaged with the webportal

5.7.3 EHMS-13

EHMS-13 had the highest engagement index at seven months and for their entire monitoring period, 0.341 and 0.299 respectively, and the highest percentage of months with engagement, 71% of the months it was active, or 10 of the 14 months. In terms of consumption, at seven months, their consumption had increased by 0.8%, but at the end of their monitoring period, their consumption had decreased by 4.9%. Of the fourteen months the webportal was active they reduced their electricity consumption during nine of the months. However, four of the five months they increased their consumption, they increased it by over 20%. Figure 5.16 shows the engagement index plotted against the change in consumption, and Figure 5.17 shows the engagement index for month n plotted against the consumption for month n+1.

The correlation for engagement and change in consumption at month n yields a Pearson's r value of -0.304 for the entire monitoring period, and the correlation for engagement at month n and change in consumption at month n+1 was -0.583 for the entire monitoring period. These r values indicate that engagement with the webportal in month n seemed to affect the consumption in month n+1 more than in month n. This means that their intake of information and adaptation of electricity conserving behaviours may have been slightly delayed, rather than immediate.

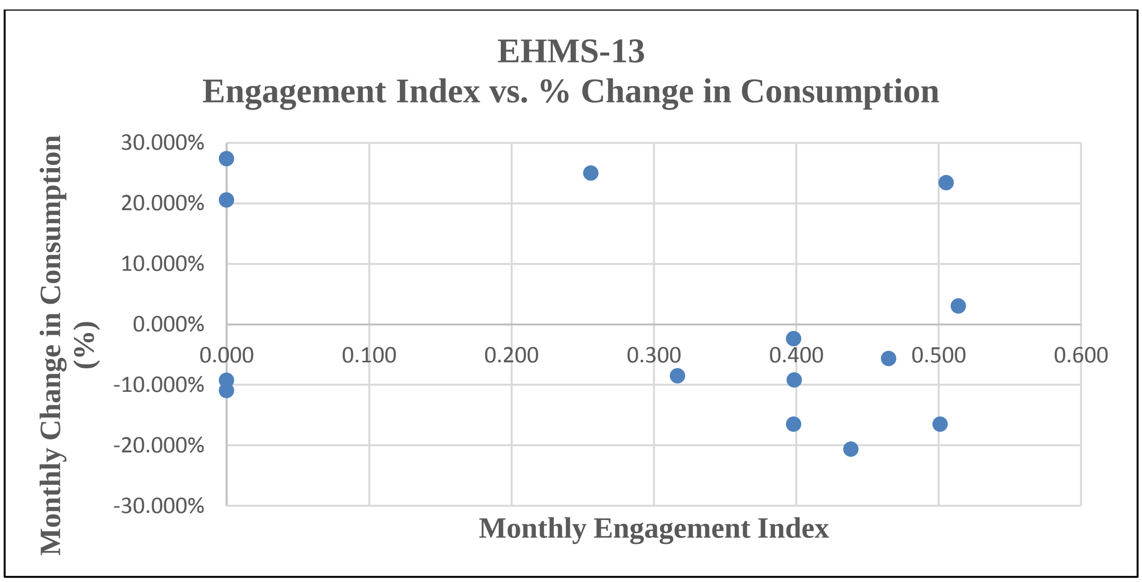

Figure 5.16 – Engagement Index plotted against the change in consumption for EHMS-13 for the entire monitoring period.

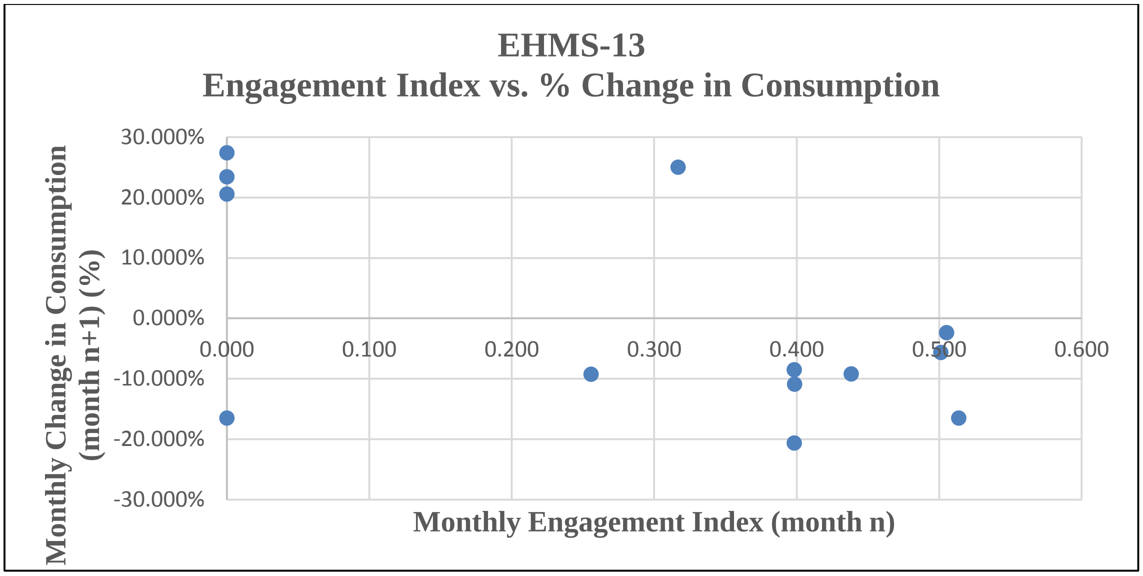

Figure 5.17 – Engagement Index plotted against the change in consumption for EHMS-13 for the entire monitoring period.

5.7.4 EHMS-14

EHMS-14 is an interesting hub because when the engagement index for month n was compared with the change in consumption for month n (Figure 5.18), the Pearson's r value was 0.159 for the entire monitoring period. However, when the engagement index for month n was compared to the change in consumption for month n+1 (Figure 5.19), the r value for the entire monitoring period was -0.355. The correlations went from being weak and positive to moderate and negative, indicating that engagement with their webportal may be related to a decrease in the change in consumption in the next month. This pattern was also seen in EHMS-01, 09 and 10. Again, as discussed with other hubs, there aren't a lot of months with non-zero engagement indices, so it is hard to make any conclusions.

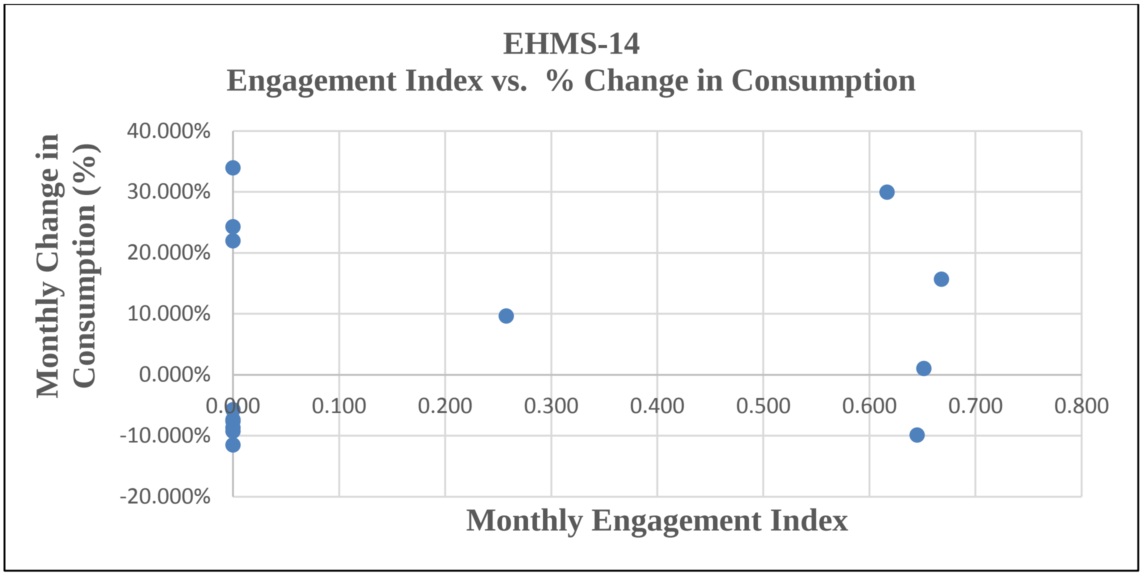

Figure 5.18 – Engagement index plotted against the change in consumption for EHMS-14 for the entire monitoring period.

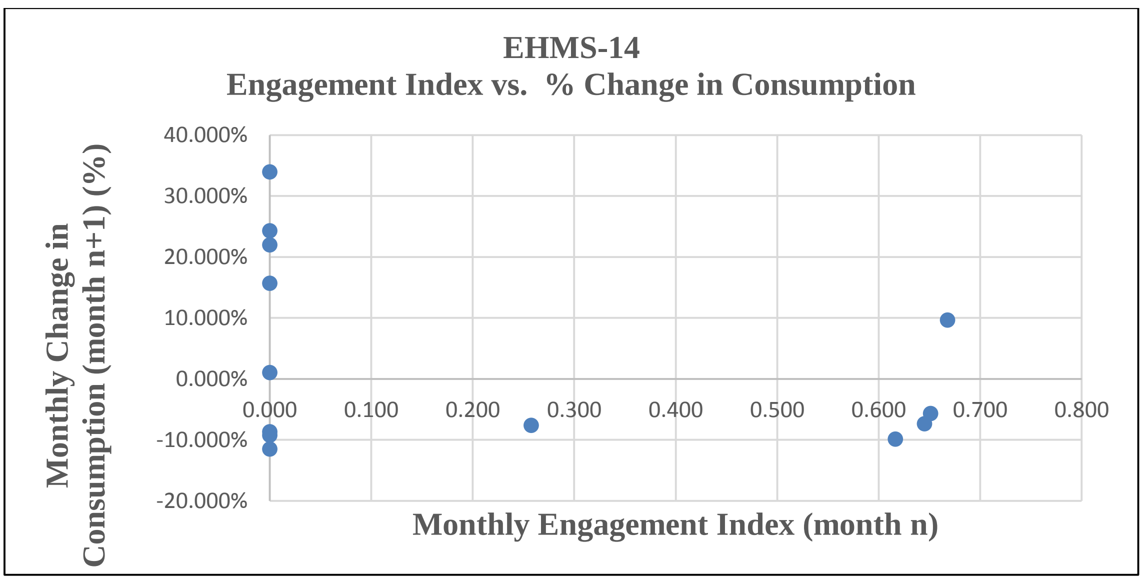

Figure 5.19 – Engagement index (month n) plotted against the change in consumption (month n+1) for EHMS-14 for the entire monitoring period.

5.8 Total Engagement Index versus Change in Consumption for all Hubs

In this section the total engagement index will be compared with the change in consumption for each hub. This will be done in two ways; (1) the total engagement index for months one to seven will be compared with the change in consumption for months one to seven (Figure 5.20): (2) the total engagement index for months one to six will be compared with the change in consumption for months one to seven (Figure 5.21). The first will help investigate how engagement affects consumption during the same period of time, while the second will help investigate how engagement affects consumption in the next month, i.e. if engagement has a delayed effect on consumption.

The Pearson's r value for Figure 5.20 is -0.331, indicating a weak to moderate, negative correlation between engagement and change in consumption. The Pearson's r value for Figure 5.21 is -0.228, indicating a weak, negative correlation. The direction of the correlations indicate that as engagement increases, change in consumption decreases (i.e. the household is conserving electricity compared with baseline consumption). However, both correlations are weak; this could be because there is simply a weak correlation between the two variables, and perhaps engagement with the webportal has very little impact on electricity consumption behaviours. However, there is also a second possibility. As discussed earlier in this chapter, throughout this study there was low engagement with the webportal, which led to low engagement indices for each hub. Low engagement makes it difficult to understand the correlation between the two variables. Perhaps if there had been more engagement we would have seen different results; maybe there would have been a strong correlation between engagement and consumption. Conversely, a weaker, or even positive correlation could have been the result of having more engagement data. Either way, more engagement would help in making more conclusive results.

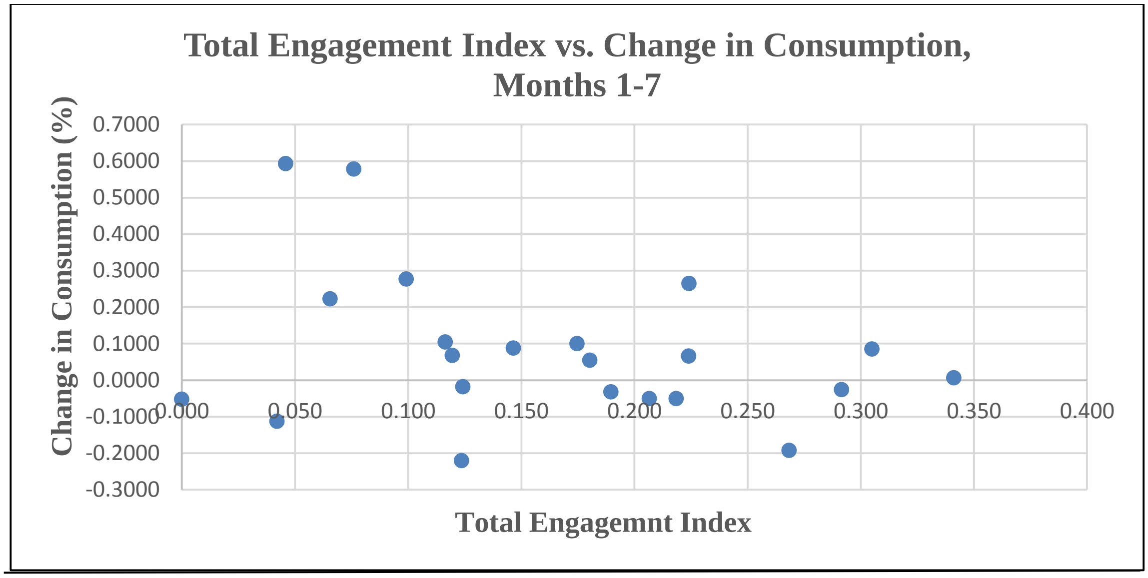

Figure 5.20 – Total engagement index versus change in consumption for the first seven months

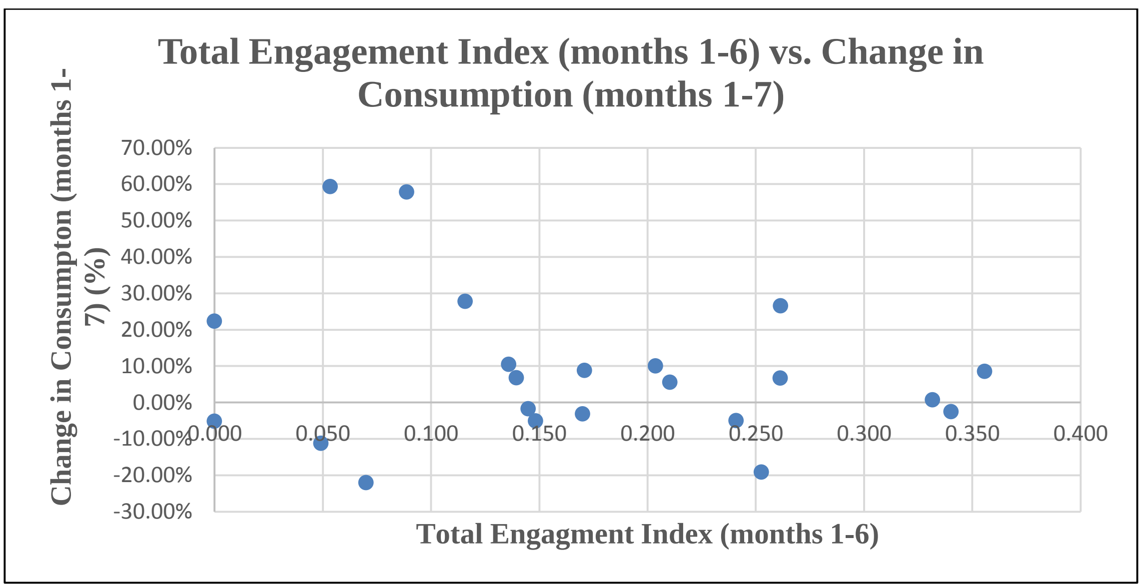

Figure 5.21 – Total engagement index for month s one to six versus change in consumption for months one to seven

5.9 Monthly Engagement Index versus Monthly Change in Consumption for all Hubs

In this section the monthly engagement index was plotted against the monthly change in consumption for every month in the monitoring period for each hub. Similar to the previous section, this will be done in two ways: (1) the monthly engagement index for month n will be compared with the change in consumption for month n (Figure 5.22); (2) the monthly engagement index for month n will be compared with the change in consumption for month n+1 (Figure 5.23).

Figure 5.22, the total engagement index for month n plotted against change in consumption for month n, has a Pearson's r value of -0.082, indicating that there is no relation between the two variables. As the figure shows, there are quite a few months with no engagement, in fact, of the 256 months plotted, 187 had an engagement index of zero. Table 5.17 highlights the differences between months with engagement and months without engagement**.** Both months with zero engagement and months with engagement indices greater than zero had average changes in consumption that were greater than zero, indicating an increase in consumption. However, the months with engagement indices greater than zero had average consumption that was lower than those months with zero engagement by 7%. Months with an engagement index greater than zero also had a higher percentage of hubs that decreased their consumption. The data seem to suggest that months with engagement have lower levels of consumption.

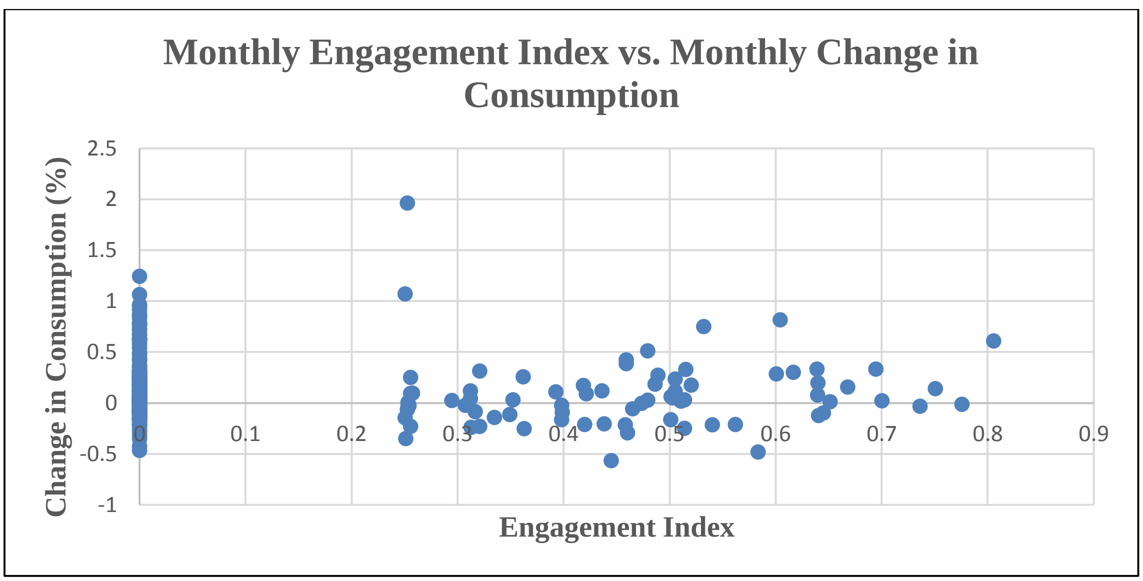

Figure 5.22 – Monthly engagement index plotted against the monthly change in consumption

	Months with Engagement Index of 0	**Months with Engagement Index greater than 0**
Average change in consumption	12.1%	5.1%
Median change in consumption	6.0%	2.4%
Months with decreased consumption	35.3% (66/187)	43.5 % (30/69)
Months with increased consumption	64.7% (121/187)	56.5% (39/69)
Total number of months	187	69

Table 5.17 – Comparison of months with 0 engagement index and months with engagement index greater than 0

Below is Figure 5.23, which plots the engagement index for month n against the change in consumption for month n+1. The Pearson's r value for this is -0.155. While this correlation is stronger than when engagement for month n was plotted against change in consumption for month n, it is still a weak correlation, and conclusions cannot be made. Like Figure 5.22, there are many months with an engagement index of zero, 179 out of a total of 248 months. Table 5.18 compares the consumption of months with no engagement and months with some engagement. Both the mean and median change in consumption were over 9% higher for months with an engagement index of zero, indicating that these months had consumed more electricity compared with the base year than months with an engagement index greater than zero. It is also worth noting that 58% of the months with engagement had a decrease in consumption in the following month, compared with 30.7% for months with no engagement.

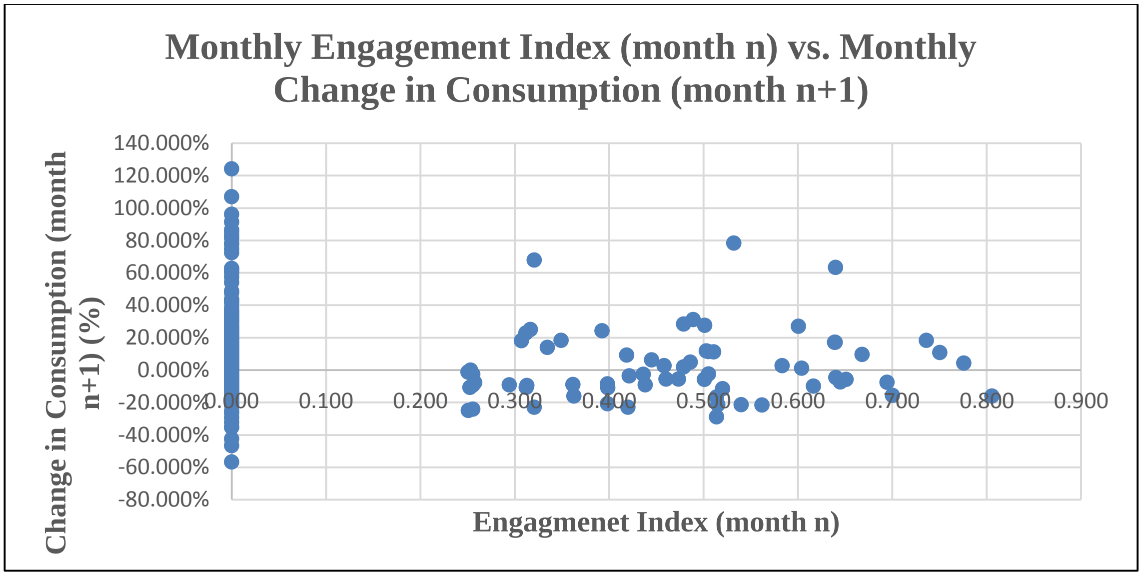

Figure 5.23 – Monthly engagement index for month n plotted against the monthly change in consumption for month n+1

	Months with Engagement Index of 0	Months with Engagement Index greater than 0
Average change in consumption for month n+1	13.1%	2.0%
Median change in consumption for month n+1	7.8%	-2.5%
Months with decreased consumption for month n+1	30.7% (55/179)	58.0% (40/69)
Months with increased consumption for month n+1	69.3% (124/179)	42.0% (29/69)
Total number of months	179	69

Table 5.18 Comparison of months with 0 engagement index and months with engagement index greater than 0, for engagement index for month n vs. change in consumption month n+1

The data in Tables 5.17 and 5.18, specifically the number of months with increased and decreased consumption, indicate that engagement with the webportal has more of an effect on the consumption of the following month. This is indicated by the percent of months that had engagement in month n and had decreased their consumption; 43.5% of months with engagement decreased their engagement in month n, while 58% had decreased their consumption in month n+1.

Chapter 6: Conclusions

The main focus of this research was to investigate how engagement effects change in consumption, and part of this process was developing a way to measure engagement (objective 1). This research started where Ueno et al. (2006), Hargreaves et al. (2013), and Jain et al. (2012) left off, and filled the gap left in the research, by taking the analysis of how people engage with their consumption data to the next step. Change in consumption is a calculation that was done in many of the articles that were reviewed in chapter two, and those articles that analysed engagement data, did so using number of button pressings (e.g. Ueno et al., 2006), and number of visits to the webportal (e.g. Jain et al, 2012). Using just one measure of engagement during analysis can skew the data, as section 3.8 discussed, but incorporating several measures into one index helps to give more complete insight into the engagement of the household.

This research has refined an engagement index that was initially meant for websites, and made it suitable to analyze the engagement data for webportals. Hopefully in the future it can be used, and perhaps further refined to gain a better understanding of householders' engagement with their consumption data, and how this engagement affects consumption.

In the first section of this chapter, the objectives and research question that were presented at the end of chapter two will be revisited, and the results will be discussed in terms of these objectives and the research question. The second section will discuss the recommendations that came from this research and the direction of future research on this topic.

6.1 Objectives and Research Question Revisited

Objective 1: Adapt and refine an engagement index to investigate household engagement with the webportal

Objective 2: Determine the levels of household engagement with the webportal

Objectives one and two dealt with the adaptation and use of the engagement index, which was adapted from Peterson & Carrabis (2008). The original index was intended to be used for websites, but since this thesis discusses webportals, the index was altered to be webportal specific. Details of the engagement index used in this thesis can be found in section 3.8, and details of the original engagement index and the changes made to adapt it to webportals can be found in Appendix C.

The engagement index, a value ranging from zero to one, was calculated for every month of the monitoring period for each hub (equation 3.1). The total engagement index was also calculated for every month for each hub (equation 3.2). The total engagement indices for months one to three, one to seven were focused on. For months one to three, the engagement index ranged from zero to 0.523, and for months one to seven, the engagement indices ranged from zero to 0.341. Twenty-one of the households decreased their total engagement between the end of month three and the end of month seven. Between the end of month seven and the end of the monitoring period, four households increased their engagement.

For hubs with monitoring periods between ten and fourteen months, the average total engagement index for the entire monitoring period increased as length of monitoring period increased. This seems contradictory to what would be expected, which is that those hubs with a longer monitoring period would have a lower average total engagement index, because interest is lost over time. The hubs with a 15 month monitoring period do have the lowest average engagement index for their entire monitoring period. For all lengths of monitoring period, the average engagement index decreased over time, indicating that all hubs, regardless of length of monitoring period, engaged with the webportal less over time.

Engagement with the webportal was low for all households; no households engaged with the webportal every month.   Only two engaged more than 50% of the months they were active, and they only logged in 60% and 71% of the months they were active

In summary, the results for engagement showed that engagement with the webportal was low; even the relatively high engagers were not engaging on a regular basis, or as much as expected. These results also showed that over time, for most of the hubs, engagement decreases. This is consistent with findings from Gronhoj & Thogerson (2011), Ueno et al. (2006) and Hargreaves et al. (2013), all of whom found that engagement with feedback decreased with time.

Objective 3: Determine change in consumption at the hub level from the base year to the monitoring period

The change in consumption was calculated for every month of the monitoring period for each hub. The change in consumption was also calculated for each month, with a focus on months one to three, one to seven and the entire monitoring period for each hub. After month three, the average change in consumption was an increase in consumption by 8.2%; 10 households conserved electricity between the base year and the monitoring period, for an average conservation of 10.2%, and the remaining 12 households had increased their consumption by an average of 23.6%. After month seven, the average change in consumption was an increase of 7.6%, indicating that while consumption was still more than the base year, it had decreased slightly since month three. Nine households conserved electricity, with an average conservation of 9.4%, and the remaining 13 had increased their consumption by an average of 18.5%. These numbers show that households that are consuming less in the monitoring period than the base year, are conserving less between month three and month seven, but households that are consuming more in the monitoring period than the base year, decreased their consumption between month three and month seven. After their entire monitoring period, only six households had conserved electricity. Interestingly, 10 of the households had decreased their percent change in consumption between the end of month three and the end of their monitoring period. This shows that while these users may not be consuming less in the monitoring period than they were in the base year, they appear to be making an effort within the base year to consume less.

Objective 4: Investigate the connection between householder attitudes and behaviours regarding electricity consumption and conservation

In general, there did not appear to be any consistent connection between attitudes and behaviours. There was no obvious relationship between change in electricity, and efforts to conserve or electricity saving actions. Also, of the 12 households whose goal was to conserve electricity through participation in this research, at the end of month seven, only four managed to conserve. As discussed in chapter two, having the proper knowledge is necessary to be able to assess and change behaviours to be more environmentally friendly. However, in this study, the participants only received consumption data, which gave them an understanding of their consumption, and where decreases could be made, but did not give them the knowledge they needed to facilitate these decreases.

What impact does engagement with the webportal have on electricity consumption?

For months one to seven, the total engagement index for month n was plotted against change in consumption for month n and month n+1. The first correlation produced a weak to moderate, negative correlation, and the second produced a weak, negative correlation. These results indicate that the feedback was more helpful for changing consumption in the same month, rather than the next month.

When the monthly engagement index for month n was plotted against the monthly change in consumption for month n and month n+1, the Pearson's r values were too weak to make conclusions. However, for both those plots, a comparison between months with zero engagement and months with above zero engagement was done. For both plots, it was found that the average change in consumption was lower for months with engagement. It was also found that a higher percentage of participants decreased their consumption in months with engagement as compared with months with no engagement. These data also showed that, for both plots, there were more months without engagement than there were with engagement. This information highlights once again that the householders did not engage very much with the webportal.

6.2 Recommendations and Future Research

This thesis was investigating the relationship between webportal engagement and electricity consumption. A key finding was that households were not engaging very much with the webportal, and these low levels of engagement made it difficult to understand the relationship between engagement and consumption. After seeing these results, two questions became apparent: (1) was there not enough motivation to convince people to login? Bi-weekly e-mails were sent, but are easy to ignore; (2) is having access to feedback data irrelevant? In the long term, will people consume as they want regardless of feedback? In order to investigate these questions, several recommendations will be made. First, there needs to be more opportunity for users to login to the webportal. One user inquired about an application for a cell phone or a tablet. Giving users access to their consumption data via other media makes it more accessible to them; they don't have to turn on their computer, they can simply open an app on their mobile device. People have their phones with them most of the time, and can do everything from banking to scheduling appointments to browsing the internet, so creating an app would give them access to their data with the touch of a button, from virtually anywhere.

Second, there needs to be more motivation for people to login. This can be done by providing users with electricity saving tips, which can be given in two ways. First, generic electricity saving tips can be given on a regular basis. They can be general tips like: "make sure to turn off appliances when they are not in use." They can also be season specific, like: "during summer months, make sure to close your blinds during the day to keep sunlight out and air conditioning costs down." The second way would be to give electricity saving tips when appliances are tracking to exceed the goal that was set for them. For example, if a dishwasher was tracking to exceed the goal, the following tip could be given: "make sure to only run your dishwasher when it is full to conserve electricity."   These messages could appear on the homepage of the webportal, they can also be sent via e-mail, as a text message to their phone, or can alert the user through an application for a mobile device.

In the future, feedback should focus on creating more ways for people to engage with their feedback, and giving them more information, specifically about how to conserve electricity. Future research about feedback should focus on how to get people to engage and keep people engaged with their feedback. Further investigation into barriers to behaviour change should also be conducted, as this could help in designing future feedback.

Bibliography

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting and tailored feedback on household energy use, energy related behaviours, and behavioural antecedents. Journal of Environmental Psychology, 27 (4), 265-276.

Avina, J. (2012, July 12), *An Energy Manager's Intro to Weather Normalization of Utility Bills*. Retrieved April 27, 2013 from www.abraxasenergy.com/articles/intro-weather-normalization/

Becker, L.J. (1978). Joint effect of feedback and goal setting on performance: A field study of residential energy conservation. *Journal of Applied Psychology, 63* (4), 428-433.

BizEE (2013). *Degree Days.net –Custom Degree Day Data*. Retrieved July 25, 2013 from http://www.degreedays.net/

Bonino, D., Corno, F. & De Russis, L. (2012). Home energy consumption feedback: A user survey. *Energy Buildings, 47*, 383-393

Bryman, A., Bell, E., Mills, A. J. & Yue, A. R. (2011). *Business Research Methods*. *Canadian Edition*. Toronto: Oxford University Press.

Bryman, A & Teevan, J. J. (2005). *Social Research Methods*. *Canadian Edition.* Toronto: Oxford University Press.

Cramer, D. (2004). Fundamental statistics for social research: Step-by-step calculations and computer techniques using SPSS for Windows. Routledge

Darby, S. (2006). The effectiveness of feedback on energy consumption. A Review for DEFRA of the Literature on Metering, Billing and direct Displays.

Dobson, J. K. & Griffin, J. D. A. (1992). Conservation Effect of Immediate Electricity Cost Feedback on Residential Consumption Behavior. In *Proceedings of the ACEEE 1992 Summer Study on Energy Efficiency in Buildings*, 10: 33–35. Washington, D.C.: American Council for an Energy-Efficient Economy.

Ehrhardt-Martinez, K., Donnelly, K. A., & Laitner, S. (2010, June). Advanced metering initiatives and residential feedback programs: a meta-review for household electricity-saving opportunities. Washington, DC: American Council for an Energy-Efficient Economy.

Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency, 1* (1), 79-104.

Gellings, C. W. (1985). The concept of demand-side management for electric utilities. *Proceedings of the IEEE*, *73*(10), 1468-1470

Government of Canada (2013, September 20). *Climate: Daily Data* (Data File). Retrieved May 8, 2013 from http://climate.weather.gc.ca/, Guelph Station (Latitude 43°33'00.000° N, Longitude 80°13'00.000°W), From November 2010 to January 2013.

Gronhoj, A. & Thogersen, J. (2011). Feedback on household electricity consumption: learning, and social influence processes. *International Journal of Consumer Studies, 35*(2), 138-146.

Hargreaves, T., Nye, M. & Burgess, J. (2010). Making energy visible: a qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy*, 38 (10), 6111-6119

Hargreaves, T., Nye, M. & Burgess, J. (2013). Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy*, *Energy Policy*, *52*, 126-134.

Jain, R.K., Taylor, J.E. & Peschiera (2012). Assessing eco-feedback interface usage and design to drive energy efficiency in buildings. *Energy and Building*, 48, 8-17.

Hughes, R. (2001). A Process Evaluation of a Website for Family Life Educators*. *Family Relations*, *50*(2), 164-170.

Kaiser, F.G., Wolfing, S. & Fuhrer, U. Environmental attitude and ecological behaviour. *Journal of Environmental Psychology 19* (1), 1–19.

Karbo, P., & Larsen, T. F. (2005). Use of online measurement data for electricity savings in Denmark. *Proceedings of the 2005 summer study of the European Council for an energy efficient economy*, 161-164.

Karjalainen, S. (2011). Consumer preferences for feedback on household electricity consumption. *Energy and Building, 43*(2), 458-467.

Kempton, W., & Layne, L. L. (1994). The consumer's energy analysis environment. *Energy Policy*, *22*(10), 857-866.

Khoo, M., Pagano, J., Washington, A. L., Recker, M., Palmer, B., & Donahue, R. A. (2008, June). Using web metrics to analyze digital libraries. In *Proceedings of the 8th ACM/IEEE-CS joint conference on Digital libraries*, 375-384.

Lehmann, J., Lalmas, M., Yom-Tov, E., & Dupret, G. (2012). Models of user engagement. In *User Modeling, Adaptation, and Personalization,* pp. 164-175. Springer Berline Heidelberg.

Locke, E.A. & Latham, G.P. (2002). Building a practically useful theory of goal setting and task motivation. *American Psychologist*, *57* (9), 707-717.

Lorenzoni, I., Nicholson-Cole, S., & Whitmarch, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Climate Change, 17* (3), 445-459.

Mallia, E. (2011). *Exploring householders' interest in home energy goal*-setting. (Unpublished master's dissertation). University of Waterloo, Waterloo, Ontario.

Matthies, E. (2005). Wie können PsychologInnen ihr Wissen besser an die PraktikerIn bringen? Vorschlag eines neuen, integrativen Einflussschemas umweltgerechten Alltagshandelns. [How can psychologists improve their outreach towards practitioners? A suggestion for a new, integrative model of environmentally sound everyday practice]. *Umweltpsychologie*, 9(1), 62–81.

McCalley, L.T. & Midden, C.J.H (2002). Energy Conservation through product-integrated feedback: The roles of goal setting and social orientation. *Journal of Economic Psychology, 23 (5)*, 589-603.

McCalley, L.T., de Vries, P.W. & Midden, C. J. H. (2011). Consumer response to product-integrated energy feedback: behaviour, goal Level shifts and energy conservation. *Environment and Behaviour, 43*(4), 525-545.

Milton Hydro (n.d.). Time of Use Pricing. Accessed March 8, 2012 from http://www.miltonhydro.com/smart-meter/time-of-use-pricing/

Nadel, S. (1992). Utility demand-side management experience and potential-a critical review. *Annual Review of Energy and the Environment*, *17*(1), 507-535

Natural Resources Canada (NRCan). (2009a). About electricity. Retrieved April 7, 2012 from http://www.nrcan.gc.ca/energy/sources/electricity/1387#domestic.

Natural Resources Canada (NRCan). (2009b, June 26). Standby Power: When "off" means "on." Retrieved March 24, 2013 from http://oee.nrcan.gc.ca/equipment/manufacturers/17201

Nye, M., Smith, G.D., Hargreaves, T. &Burgess, J. (2010). Visible Energy Trial. Retrieved July 30, 2012 from http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Documents1/ VET%20 Summary%20Report.pdf

Ontario Ministry of Energy (OME). (2011, December 6). Annual reports: Results-based plan, 2010-2011. Retrieved March 2, 2012 from http://www.energy.gov.on.ca/en/archive/annual-report-results-based-plan-2010-2011

Ontario Ministry of Energy (OME). (2012a). Ontario's Long-Term Energy Plan. Retrieved October 2, 2013 from http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf

Ontario Ministry of Energy (OME). (2012b). Smart Meters and Time-of-Use Prices. Retrieved March 9, 2013 from http://www.energy.gov.on.ca/en/smart-meters-and-tou-prices/

Ontario Ministry of Energy (OME). (2013). Conservation First: A renewed vision for energy conservation in Ontario. Retrieved October 22, 2013 from http://www.energy.gov.on.ca/en/conservation-first/

Ontario Ministry of Municipal Affairs and Housing (MAH). (2013, August 28). 2012 Building Code Overview. Retrieved October 22, 2013, from http://www.mah.gov.on.ca/Asset10201.aspx?method=1

Ontario Power Authority (OPA). (2012). *Ontario Electricity Demand. 2012 Annual long term outlook.* Retrieved October 7, 2013 from http://www.powerauthority.on.ca/sites/default/files/news/Q2-2012LoadForecast.pdf

Ontario Power Authority (OPA) (2013). Transforming Ontario's electricity system. Retrieved November 24, 2013 from http://www.powerauthority.on.ca/about-us/electricity-pricing-ontario/transforming-ontario%E2%80%99s-electricity-system

Peterson, E. T., & Carrabis, J. (2008). Measuring the immeasurable: Visitor engagement. *Web Analytics Demystified*.

Riche, Y., Dodge, J., & Metoyer, R. A. (2010, April). Studying always-on electricity feedback in the home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1995-1998.

Rowlands, I. H., Mallia, E., Shulist, J., & Parker, P. (2013, Jan). Developing Smart Tools for Householders: Making the Smart Grid Work for Ontario. *Municipal World* 123 (1), p.5-8.

Smith, S.L. & Mosier, J.N. (1986). Guidelines for Designing User Interface Software, Natl Technical Information. Retrieved March 27, 2012 from http://hcibib.org/sam/.

Statistics Canada (2013). Focus on geography series, 2011 census. Census subdivision of Milton, T-Ontario. Retrieved October 27, 2013 from http://www12.statcan.ca/census-recensement/2011/as-sa/fogs-spg/Facts-csd-eng.cfm?LANG=Eng&GK=CSD&GC=3524009

Steg, L. & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal or Environmental Psychology, 29* (3), 309-317.

The Weather Network (2013). *Statistics: Milton, Ontario.* Retrieved July 27, 2013 from http://origin.weather.ca/statistics/CL6152695/caon0434/

Van Houwelingen, J.H. & Van Raaij, W.F. (1989). The effect of goal setting and daily electronic feedback on in-home energy use. *Journal of consumer research, 7,* 98-105.

Van Raaij, W. F., & Verhallen, T. M. (1983). A behavioral model of residential energy use. *Journal of Economic* Psychology, 3(1), 39-63.

Wallenborn, G., Orsini, M. & Vanhaverbeke, J. (2011). Household appropriation of electricity monitors. International Journal of Consumer Studies, 35(5), 146-152.

Wilhite H, Hoivik A and Olsen J-G (1999) Advances in the use of consumption feedback information in energy billing: the experiences of a Norwegian energy utility. Proceedings, European Council for an Energy-Efficient Economy, 1999. Panel III, 02.

Wilhite, H. & Ling, R. (1995). Measured Savings from a more informative energy bill. Energy and Buildings, 22(2), 145-155.

Wood, G. & Newborough, M. (2003). Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. Energy Buildings and Design, 35(8), 821-841.

U.S. Energy Information Administration (EIA). (2013). International Energy Outlook 2013. Retrieved August 27, 2013 from http://www.eia.gov/forecasts/ieo/more_highlights.cfm

Ueno, T., Sano, F., Saeki, O., & Tsuji, K. (2006). Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data. Applied energy, 83(2), 166-183.

University of Waterloo (UW) (n.d.). The Energy Hub Management System: Enabling and empowering energy managers through increased information and control. Retrieved April 8, 2012 from http://www.energyhub.uwaterloo.ca/.

Yom-Tov, E., Lalmas, M., Dupret, G., Baeza-Yates, R., Donmez, P., & Lehmann, J. (2012, A0pril). The effect of links on networked user engagement. In Proceedings of the 21st international conference companion on World Wide Web, 641-642. ACM.

Appendix A: Home Profile and Appliances Selection Survey

Welcome to the Energy Hub Management System Home Profile and Appliances Selection Survey. This survey has two purposes:

(1) To create a profile of your home in order to determine whether it meets the project's selection criteria; and

(2) To create an inventory of home energy systems (such as heating and air conditioning) and appliances, in your home. This will assist the project in determining which of your appliances can be used in the monitoring and the control phases of the project.

Please note that any personal information obtained during the course of this research project is confidential and is not shared or distributed to any third parties. Only the researchers from this project will have access to this information and for the sole purpose of contacting you during the course of the project. All of the data will be summarized and no individual will be identified from these summarized results. You will not be personally identified in any way in any written reports, presentations or publications arising from this research.

Please follow these instructions when completing the survey:

- In your responses, please only consider your residence where equipment will be installed.
- Please attempt to respond to all questions. Where applicable, please select 'I don't know' rather than omit an answer.
- If you would like to alter a response to a previous question you will have the option to click 'back' in the survey to correct your response.
- The survey is designed to be completed in one session. Once you have clicked the 'submit' button at the end of the survey you will no longer be able to alter your responses.

If you have any questions about this survey in particular or the study in general, please feel free to contact the project office by email at: ehms@uwaterloo.ca or (519) 888-4567 ext. 38543

Question 1. What is the approximate square footage of your home? If your basement is finished, please include your basement space in your answer. (Please select one of the responses below.)

- Less than 1000 sq. ft.
- 1000-1499 sq. ft.
- 1500-1999 sq. ft.
- 2000-2499 sq. ft.
- 2500-2999 sq. ft.
- 3000-3499 sq. ft.
- More than 3500 sq. ft.
- I don’t know

Question 2. When was your home built? (Please select one of the responses below.)

- Before 1950
- 1950-1959
- 1960-1969
- 1970-1979
- 1980-1989
- 1990-1999
- 2000-2006
- 2007-2010
- I don’t know

Question 3. What type of home do you have? (Please select one of the responses below.)

- Detached one storey
- Detached two or more storey
- Semi-detached one storey
- Semi-detached two or more storey
- Condominium apartment
- Condominium town house or semi detached
- Row housing (attached on both sides)

Question 4. What is the primary type of energy that you use for home heating? (Please select one of the responses below.)

- Gas
- Electric
- Oil
- Propane
- Wood
- Other (specify)

Question 5. If you have a secondary source of energy for home heating, please check all additional sources that apply below.

- Gas
- Electric
- Oil
- Propane
- Wood
- Other (specify)

Question 6. Are you planning on being absent from your home for more than one month between now and March 2012?

- No
- Yes (Please list dates you plan to be away)
- I don't know

Question 7. Have you done any of the following renovations in your home? If so, please specify the year of installation.

	Yes or No	If yes, year of installation
Installed a new furnace		
Installed a new hot water heater		
Added Insulation		
Installed new windows		
Installed new doors		
Other (if yes, please specify with the year)		

Question 8. Are you planning any of the following renovations between now and March 2012?

	Yes or No
Upgrade Heating System	
Install a new air conditioning	
Install a new hot water system	
Add insulation	
Install new windows	
Install new doors	
Other (specify)	

Question 9. Do you have any of the following energy production systems at your home?

	Yes or No	If yes, year of installation
Solar hot water system		
Solar photovoltaic (electric) system		
Ground source heat pump		
Air source heat pump		
Other (please list year)		

Question 10. In order to develop a detailed inventory of the appliances in your home, please identify which of the following are currently in your home, which were replaced during the last year, and which you intend to replace during the next year. Please check all that apply.

	Present in home? Yes or No	If yes, please estimate year of purchase/installation	Intent to replace (or add) this device during the next 12 months Yes or No
Heating (furnace)			
Air Conditioner (central)			
Air conditioner (window)			
Air Conditioner (other)			
Natural gas hot water heater			
Electric hot water heater			
Clothes Washer			
Clothes dryer (electric)			
Clothes dryer (gas)			
Dishwasher			
Stove/range (electric)			
Stove/range (gas)			
Microwave Oven			
Refrigerator in the kitchen			
Secondary refrigerator			
Freezer			
Television			
Personal Computer			
Hot tub/spa pump			
Hot tub/spa heater			
Swimming pool pump			
Swimming pool pump (gas)			
Swimming pool pump (electric)			
Swimming pool pump (solar)			
Heat recovery ventilator			
Space heater (electric)			
Dehumidifier			
Humidifier			

Question 11. Do you have any energy storage devices? If yes, please specify.
If you do not have any energy storage devices, please proceed to the next question.

	Type of energy storage Device (please specify)	Estimate of year of purchase/installation	Intend to replace (or add) this device during the next 12 months? Yes or No
Device 1			
Device 2			
Device 3			
Device 4			
Device 5			

Question 12. Please list any large energy consuming devices such as tools, shop equipment, etc. in your home or garage, and which were not mentioned previously in this questionnaire.

Question 13. Please indicate which of the following appliances you would like to be able to monitor and to control in this project.

- Monitor means you will receive real-time reports on the appliance's energy usage.
- Monitor and Control means you will receive real-time reports on the appliance's or energy system's energy usage and you can specify when some of your appliances and energy systems can be operated or not be operated according to individualised time schedules. These schedules are selected based on your preferences to reduce energy usage, cost, and/or carbon emissions. The settings recommended by the schedule can be changed or overridden by you at any time via the system's website.

	Monitor Only	Monitor and Control	Neither/Not applicable
Furnace			
Central Air Conditioner			
Air conditioner: window or floor model			
Natural gas hot water heater			
Electric hot water heater			
Clothes Washer			
Clothes dryer (electric)			
Clothes dryer (gas)			
Dishwasher			
Stove/range (electric)			
Stove/range (gas)			
Microwave Oven			
Secondary refrigerator (bar or garage)			
Hot tub/spa pump			
Hot tub/spa heater			
Swimming pool pump			
Swimming pool heater			
Heat recovery ventilator			
Space heater (electric)			
Dehumidifier			
Humidifier			
Solar hot water panels			
Solar electricity panels			
Energy storage devices			

Question 14. Please indicate if there are any other appliances that you would like to monitor and to control in your home.
If you do not have any other appliances that you would like to monitor and to control in your home, please proceed to the next question.

	Type of Appliance (please specify)	Monitor Only	Monitor and Control	Neither/not applicable
Appliance 1				
Appliance 2				
Appliance 3				
Appliance 4				
Appliance 5				

Question 15. Do you currently participate in any of the following conservation or renewable energy programs? (Select all that apply.)

- Standard Offer Program
- Net-Metering
- MicroFIT
- Other, please specify:

Question 16. To help us develop a profile of your home's typical energy patterns (e.g., how many people are at home during the day versus the evening, and what typical energy use patterns are per person), please answer the following. How many people currently live within your home?

- Preschool aged children (0-5 years) ____________
- Elementary school aged children (6-13 years) __________
- High school aged children (14-17 years) __________
- Adults (18-64 year) __________
- Seniors (65+)__________

Question 17. Have the number of people living within the home changed in the past year? If so, please indicate the changes by answering the questions below. If not, please leave blank and continue to Question 18.

	13 years old or less	14 years old or more
How many people were living in your house at the end of March 2010?		
How many people were living in your house at the end of March 2011?		

Question 18. On weekdays, is there usually at least one adult (18 years and older) at home during at least six hours of the standard working day of 8:00 a.m. to 5:00 p.m.?

- Yes
- No

Question 19. What is your total household income (before taxes) this year?

- Under $30,000
- $30,000-$39,999
- $40,000-$49,999
- $50,000-$59,999
- $60,000-$69,999
- $70,000-$79,999
- $80,000-$89,999
- $90,000-$99,999
- $100,000-$124,999
- $125,000-$149,999
- $150,000 and over

Question 20. What is highest certificate, diploma or degree of the individual in your household with the most advanced qualifications?

- No certificate. Diploma or degree
- High school certificate or equivalent
- Apprenticeship or trades certificate or diploma
- College, CEGEP or other non-university certificate or diploma
- University certificate or diploma below bachelor level
- Bachelor's Degree
- Degree in medicine, dentistry, veterinary medicine or optometry
- Master's degree
- Earned doctorate

<u>Existing Electrical & Internet Profile Questions</u>

In order to determine that your household electrical system is suitable, safe and can communicate with the Energy Hub, we need to have an understanding of your existing system setup.

Question 21. Replacing Your Existing Panel

Will the replacement panel be installed where your current panel is now located? Please note that the location for the new panel requires a space of 34" (length) x 22" (width) x 10"(depth).

- Yes, the ne panel will be installed in the same location as the existing panel
- No, the new panel will be installed in a different location than the existing panel

Question 22. Main Circuit Breaker

Is your main circuit breaker inside your existing panel?

- Yes
- No
- I don't know. Please provide a comment if you would like: _______

Question 23. Main Circuit Breaker Rating
Is the main breaker for your home rated for more than 250 amps?

- Yes
- No
- I don't know. Please provide a comment if you would like: ____________

Question 24. Number of Active Circuit Breakers
In the text box below, please indicate how many active circuit breakers you have in your current panel (these should be labeled on the panel).

Question 25. Internet Communication
It is important to confirm that you have internet communication in your premises. Below is a list of internet service providers and modem/router types. Please indicate which internet service provider and modem/router type that is currently in use in your home.

- Bell with a Speedstream modem/router (black and grey)
- Bell with and Alcatel modem/router (black)
- Bell with a 2Wire modem/router (grey with blue)
- Rogers with a SMC8014 modem/router (grey with blue)
- Rogers with a SMC8014WG modem/router (grey with blue – antenna)
- Rogers with a Webstar modem/router (black)
- Lynksys with any modem/router
- Dlink with a Dlink modem/router (black, white or grey)
- Netgear with a Netgear modem/router (white or blue)
- Other, please specify: _____________________

Question 26. In order to identify and/or contact you during the course of the study we will need the following information:

- Name of Primary Contact_________________________
- Phone Number_________________________
- Alternative Phone number_________________________
- Full Address of residence where equipment will be installed ___________________
- Postal Code_________________________
- E-mail address of primary contact _________________________

FINAL NOTE: To help with the selection process, we would kindly ask that you send two pictures of your electrical panel (one showing its 'general location' on the wall in your basement; the other showing a 'close up' view of the existing switches, etc.) to ehms@uwaterloo.ca along with your name and address. As noted in our Information Letter & Consent Form, this will help us understand your suitability for the project. Thank you.

Any personal information obtained during the course of this research project is confidential and is not shared or distributed to any third parties. Only the researchers have access to that information and only for the sole purpose of contacting you during the course of the project. All of the data are summarized and no individual can be identified from these summarized results. You will not be personally identified in any way in any written reports, presentations or publications arising from this research.

Appendix B: Welcome Survey

Congratulations! You have been selected for the Energy Hub Management System pilot project. Before you begin using the system, we ask you to fill out this survey to help us with our research objectives. There are two purposes for this survey:

(1) Your responses to questions in sections A, B, C, and D will help us to better understand your attitudes, and motivations towards energy management in your home.

(2) Your responses to questions in section E will help us to better assess some aspects of information delivery, communications and automation of the Energy Hub Management System.

All Energy Hub Management System account holders in your home will be asked to complete this survey. We anticipate that this survey will take 20-25 minutes to complete. All information that you provide will be used for research purposes only.

Please note that any personal information obtained during the course of this research project is confidential and is not shared or distributed to any third parties. Only the researchers from this project will have access to this information and for the sole purpose of contacting you during the course of the project. All of the data are summarized and no individual can be identified from these summarized results. You will not be personally identified in any way in any written reports, presentations or publications arising from this research.

Please follow these instructions when completing the survey:

- Please record all responses only with respect to your address of residence where equipment has been installed.
- Please attempt to respond to all questions. Where applicable, please select 'I don't know' rather than omit an answer.
- If you would like to alter a response to a previous question you will have the option to click 'back' in the survey to correct your response.
- The survey is designed to be completed in one session. Once you have clicked the 'submit' button at the end of the survey you will no longer be able to alter your responses.

If you have any questions about this survey in particular or the study in general, please feel free to contact the project office by email at: ehms@uwaterloo.ca or (519) 888-4567 ext. 38543

Section A.

Your responses to the following questions will help us to better understand attitudes towards, and motivations for, energy management.

Question A.1. What do you think are some important energy conservation measures that could be done in your home in order to save energy?

Question A.2. Please indicate how you perceive your level of awareness with regards to the following:

	Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
Currently, I am aware of how much electricity is used by each of my electric appliances.								
Currently, I am aware of how much money it costs to use each of my electric appliances.								
Currently, I am aware of the carbon footprint associated with using each of my electric appliances.								

Section B.

Your responses to the following questions will help us to better understand attitudes towards, and actions for, energy management in your home.

Question B.1. To what extent do the following statements describe your attitudes towards energy management in your home?

	Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
I believe that it is important to conserve as much energy in my home as possible.								
I believe that it is important to reduce my electricity usage during on-peak times as much as possible.								

Question B.2. To what extent do the following statements describe your <u>actions</u> towards energy management in your home?

	Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
I try to conserve as much energy in my home as possible.								
I try to reduce my electricity usage during on-peak times as much as possible.								

Question B.3.In the past year, how often have the following actions been performed in your home to conserve energy? <u>Select the most appropriate frequency of activity.</u>

<u>YEAR ROUND</u>

	At least once per day	Every two or three days	Once per week	Every two or three weeks	Once per season	Once per year	Never	Not applicable
Use less hot water (e.g., have shorter showers)								
Turn off lights when no one is in the room								
Turn off T.V., stereo, computer, printer when no one is using them								
Hang clothes to dry instead of using the clothes dryer								
Adjust heating/cooling vents in rooms that are not in use								
Run electric appliances at off-peak times								

<u>COLDER SEASONS</u>

	At least once per day	Every two or three days	Once per week	Every two or three weeks	Once per season	Once per year	Never	Not applicable
Adjust thermostat to lower heat when no one is home								
Adjust thermostat (manually or programmable) to lower heat when my family is asleep								
Wear warmer clothes, so the thermostat can be kept lower								

WARMER SEASONS

	At least once per day	Every two or three days	Once per week	Every two or three weeks	Once per season	Once per year	Never	Not applicable
Use fans/open windows instead of air conditioning								
Raise the indoor temperature by adjusting the air-conditioner								
Close drapes during hot summer days								

ADDITIONAL ACTIVITIES (optional)
If there are additional activities not included in the lists above, you can use this section to indicate them here.

		At least once per day	Every two or three days	Once per week	Every two or three weeks	Once per season	Once per year	Never	Not applicable
Other (please specify)									
Other (please specify)									
Other (please specify)									

<u>Section C.</u>

Your responses to the following question will help us to better understand your motivations to adopt the Energy Hub Management System.

Question C.1. Please indicate which of the following factors have motivated you to adopt the Energy Hub Management System.

	Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
I like saving money whenever I can								
I would like to respond better to time-of-use electricity prices								
I would like to reduce the amount of energy my household consumes.								
I would like to manage my energy costs								
I would like to reduce my carbon footprint associated with the energy usage in my home								
I want to do my part in reducing smog and improving outdoor air quality.								
I am interested in learning more about my behaviours to help me plan my home's energy usage								
I would like to increase my personal comfort in my home								
I would like to learn more about my household appliances' energy consumption.								
My household has purchased energy efficient appliances, and I want to lower my home's energy usage even more.								
My household has had home renovations to conserve energy, and I want to lower my home's energy usage even more								
My household purchases Green Power from a green electricity provider, and I want to do more to lower my home's energy consumption								
My home has on-site energy production (e.g., solar hot water, ground source heat, solar photovoltaic panels), and I would like to compare this energy production to my household's energy consumption.								
I would like to try a new web-based energy management technology								

ADDITIONAL FACTORS (optional)
If there are additional factors that have motivated you to adopt the Energy Hub Management System, and they are not included in the list above, you can use this section to indicate them here.

		Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
Other (please specify)									
Other (please specify)									
Other (please specify)									

Section D.

Your responses to the following question will help us to understand your interest in setting monthly goals relating to your home's electricity consumption.

Question D.1. With the Energy Hub Management System, you will have an opportunity to set and manage monthly goals relating to your home's electricity consumption. Please select the goal that best describes you.

- I would like to set goals that help DECREASE my home’s electricity consumption
- I would like to set goals that help MAINTAIN THE SAME LEVEL of electricity consumption
- I would like to set goals that help MINIMIZE AN INCREASE of my home’s electricity
- Other, please specify:
- I am not interested in setting goals relating to my home’s electricity consumption
- I do not know what my goals would be right now

E.1. Do you currently have the following device in your household?

Device, interface or application	Yes	No
Mobile (cell) phone		
Smart phone (e.g., contains internet and applications, such as Blackberry, iPhone, etc.)		
iPod or MP3 player		
Personal computer (or laptop computer)		
Digital camera		
Video camera		
Cable television subscription		
Satellite television subscription		
Video game console		
Programmable thermostat		
Timers for lights		
Timers on appliances (e.g., dishwasher or clothes washer, etc.)		
Robots (e.g., robot vacuum cleaner)		
Global positioning system (GPS)		
Medical devices which take biophysical measurements and give dosage or other health-related advice (e.g., glucose monitoring, etc.)		

Please answer the following questions with respect to household use.

Device, interface or application	**E.2. In which year did you first use this device, interface, or application?**	**E.3. In the past year, how often have you used this device, interface or application?**							
		At least once per day	Every two or three days	Once per week	Every two or three weeks	Once per season	Once per year	Never	Not applicable
Internet									
E-mail									
Mobile Phone									
Smart phone (e.g., contains internet and applications, such as Blackberry, iPhone, HTC Legend, etc.)									
Web-based or smart phone applications to track personal information and offer advice (e.g., grocery list generators, diet and exercise tracking and advice, etc.)									
Social networking websites (e.g., Twitter, Facebook, myspace, ning, etc.)									
Video games									
Voice over internet protocol (VOIP) telephone, or Skype									
Online internet banking									
Online internet purchases and transactions (e.g., paypal, Amazon, eBay, etc.)									
Web generated driving directions (e.g., Google maps, Map quest, etc.)									
Global positioning system (GPS)									
Programmable thermostat									
Timers for lights									
Timers on appliances (e.g., dishwasher or clothes washer, etc.)									
Medical devices which take biophysical measurements and give dosage or other health-related advice (e.g., glucose monitoring, etc.)									

E.4. To what extent do you agree with the following statements?

	Strongly Agree	Agree	Somewhat Agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly Disagree	Not applicable
I like that cell phones and other mobile devices allow me to be more available to others.								
I often feel like my electronic devices can do more than what I actually use them for.								
When I get a new electronic device, I usually need someone else to set it up or show me how to use it.								
It is stressful to own and manage all of the different electronic devices I have.								
I often feel annoyed by having to respond to intrusions from my electronic devices.								
I believe I am more productive because of all of my electronic devices								
I have found that using my electronic devices helps me to save money.								

E.5. How difficult would it be to give up the following things in your life?

	Very Easily	Easily	Somewhat Easily	Does not matter	Somewhat difficult	Difficult	Very Difficult	Not applicable
Mobile phone or smart phone								
Cable or sattelite television subscription								
Web-based or smart phone applications to track personal information and offer advice (e.g., grocery list generators, diet and exercise tracking and advice, etc.)								
Online financial transactions (banking, purchases, etc.)								
Social networking websites (e.g., Twitter, Facebook, myspace, ning, etc.)								
Programmable thermostat, timers for lights, or timers for appliances								
Robots (e.g., robot vacuum cleaner)								
Global positioning system (GPS) or web generated driving directions								

E.6. Thinking about ALL of the devices mentioned in this survey which you have used...

	Much Easier	Easier	Somewhat Easier	Neither easier nor more complicated	Somewhat more complicated	More complicated	Much more complicated	Not applicable
Overall, would you say these devices make your life easier or make your life more complicated?								

Before submitting this completed survey, could you please provide your USER ID number in the field below?

This will be the same USER ID number that you use to login to the web portal and should be in the following format:

UW-EHMS-##

Appendix C: The Engagement Index

The Engagement Index that was used in this thesis was adapted from "The Visitor Engagement Calculation" described by Peterson and Carrabis (2008). The engagement calculation discussed in the report was made for websites, but in the research being discussed in this thesis, used a webportal, which differs from a website in three key ways: (1) only people who have been invited have access to it; (2) a password is required to access it; and (3) the webportal is customized to the user. These differences made it necessary to revise the index in order to tailor it towards webportals. This appendix will discuss the original engagement calculation and the changes that were made to it to make it better suited towards webportals.

The original visitor engagement calculation was

$$\sum(Ci + Di + Ri + Li + Bi + Fi + Ii)$$

Where:

- Ci is the Click Depth Index
- Di is the Duration Index
- Ri is the Recency Index
- Li is the Loyalty Index
- Bi is the Brand Index
- Fi is the Feedback Index
- Ii is the Interaction Index

Equation C.1 – Original engagement index from Peterson and Carrabis (2008)

Click Depth Index, Ci

The click depth index represents the ratio of sessions where the householder visited more than x pages to all sessions. The click depth index "resolves noise caused by visitor bouncing off the site after viewing only a small number of pages" ***(Peterson and Carrabis, 2008:19)***. The original click index is shown in equation C.2, and the index used in thesis is shown in equation C.3.

$$Ci = \frac{\#sessions\ with\ more\ than\ x\ pages\ visited}{total\ \#\ sessions}$$

Equation C.2 – Original click depth index from Peterson and Carrabis (2008)

$$Ci = \frac{\#sessions\ with\ pages\ beyond\ the\ homepage\ visited}{total\ \#\ sessions}$$

Equation C.3 – Click depth index used for this thesis

The reason for the change in the click depth index is as follows: every page in the webportal contains valuable information which will help the user to understand and to better manage their electricity consumption. The homepage contains the basic information: current day's consumption broken down by TOU, current TOU period and price of electricity, if the household is tracking to meet their goal and the hubs carbon footprint (see Figure 3.1). If the user is interested in only the basic information, they need not go past the homepage, but if they are interested in more detailed information or interested in better managing their electricity consumption, they will go further into the webpage. Every page in the webportal, past the homepage, provides different, but equally beneficial information and each individual will seek to get something different out of their visits to the webportal. To set a threshold as suggested by Peterson and Carrabis (2008) would not help to identify people who are more engaged, but changing the index to identify those who seek out more than just the basic information would. Initially, the idea was to set the threshold to x=1, however, there were several instances where the user clicked the homepage multiple times, so there were multiple page views, but they were all the homepage, so we wanted to account for instances similar to that one, so we set the threshold at pages beyond the homepage.

Duration Index, Di

The calculation of this index did not change from the original, which is shown in equation C.4.

$$Di = \frac{\#sessions\ more\ than\ y\ minutes}{total\ number\ of\ sessions}$$

Equation C.4 – Duration index

Recency Index, Ri

The recency index required two calculations; the first one changed for this thesis, while the second one remained the same. The original first equation is shown in equation C.5, and the version used in this thesis is shown in equation C.6.

$$Ri = \frac{1}{\#days\ since\ most\ recent\ session}$$

Equation C.5 – Original first equation for the recency index from Peterson and Carrabis (2008)

$$Ri_{session} = \frac{1}{1 + \#days\ since\ most\ recent\ session}$$

Equation C.6 –First equation for the recency index used for this thesis

In the original equation, if a user has two sessions in one day, for the second session, the number of days since the most recent session would be zero, making Ri=1/0. To correct this, one was added to the denominator, so if there were two logins on the same day, the second would have a Ri value of 1/1=1. The second equation, only had notation change, the original is shown in equation C.7, and the new equation is shown in equation C.8.

$$Ri_{cumm} = \frac{\sum Ri}{\#sessions}$$

Equation C.7 – Original second equation for the recency index from Peterson and Carrabis (2008)

$$Ri = \frac{\sum Ri_{session}}{\#sessions}$$

Equation C.8 – Second equation for the recency index used for this thesis

Loyalty Index, Li (Session Index, Si)

Originally this index was called the loyalty index, and recognized visitors who came to the site more than once. However, loyalty does not apply to the webportal because it is the only place where the users can get their consumption data, the name of the index was changed to ‘Session Index, Si” and has the purpose of measuring the number of sessions in a given timeframe. The original equation is shown in equation C.9.

$$Li = 1 - \left(\frac{1}{\#visitor\ sessions\ during\ timeframe}\right)$$

Equation C.9 – Original loyalty index from Peterson and Carrabis (2008)

However, when there was only one sessions a month, Li=0. While this value makes sense in terms loyalty, because the visitor never returned, but in terms of the webportal, every visit needs to be accounted for, not just return visits. So in order to account for all visits, equation C.10 was used. So if a household did not log in during the month (the timeframe chosen for this thesis), then using equation C.10, Si=1-(1/1) =0.

$$Si = 1 - \left(\frac{1}{1 + \#sessions\ during\ timeframe}\right)$$

Equation C.10 –Session index used for this thesis

Brand Index, Bi (Excluded)

This index was designed to represent the level of attention visitors pay the brand of the website before they actually arrive at the website. However, since this does not apply to the webportal, this index was omitted.

Feedback Index, Fi (Communication Index, Fi)

This index helps to evaluate how often users are providing feedback to the site about their visit. It can include clicks on e-mail links, feedback forms, click-to-call links and page feedback and rating tools. Since the webportal was set up differently from a standard webpage, none of these methods of submitting feedback exists. Feedback on the project and webportal was supposed to be collected by way of the Post-Monitoring Survey. As a result, this index was changed to the Communication Index, Fi, and instead of monitoring feedback, it monitored communication between the householders and the project, which, on several occasions, did include feedback. Equation C.11 is the original equation, and Equation C.12 shows the equation used in this thesis, where the only difference is the actions being counted in the numerator.

$$Fi = \frac{\#\ sessions\ where\ visitor\ submits\ feedback}{all\ sessions}$$

Equation C.11 – Original feedback index from Peterson and Carrabis (2008)

$$Fi = \frac{\#\ sessions\ that\ EHMS\ was\ contacted}{all\ sessions}$$

Equation C.12 –Communication index used for this thesis

Interaction Index, Ii

This index measures the actions that visitors take while they are on the website. Some of the examples provided include: submitting a comment, downloading a PDF, viewing a video or buying something. The original equation is shown in equation C.13.

$$Ii = \frac{\#\ sessions\ where\ visitor\ completes\ an\ action}{all\ sessions}$$

Equation C.13 – Original interaction index from Peterson and Carrabis (2008)

This equation was changed in order to indicate different levels of interactions the user engages in during their visit rather than a simple “interaction” or “no interaction.” The new calculation consists of two equations. The first is calculated for every session, and is equation C.14.   The second calculation is a summation of all the Ii over the total number of sessions in the months, and is equation C.15.

$$Ii_{session} = \frac{\#\ types\ of\ actions\ taken}{total\ \#\ types\ of\ actions}$$

Equation C.14 –First equation for the interaction index used for this thesis

$$Ii = \frac{\sum Ii_{session}}{\#sessions}$$

Equation C.15 –Second equation for the interaction index used for this thesis

Appendix D: Active Months

Hubs	EHMS-01, 02, 04	EHMS-05, 09, 10, 12, 13, 14	EHMS-07, 11	EHMS-15, 16, 19	EHMS-17, 18, 21, 22, 23, 24	EHMS-20	EHMS-25
Month 1	Nov 29-30, 2011	Dec 23-31, 2011	Jan 3-31, 2011	Jan 13-31. 2011	Apr 27-30, 2011	Apr 27-30, 2011	Apr 27-30, 2011
Month 2	Dec-11	Jan-12	Feb-12	Feb-12	May-12	May-12	May-12
Month 3	Jan-12	Feb-12	Mar-12	Mar-12	Jun-12	Jun-12	Jun-12
Month 4	Feb-12	Mar-12	Apr-12	Apr-12	Jul-12	Jul-12	Jul-12
Month 5	Mar-12	Apr-12	May-12	May-12	Aug-12	Aug-12	Aug-12
Month 6	Apr-12	May-12	Jun-12	Jun-12	Sep-12	Sep-12	Sep-12
Month 7	May-12	Jun-12	Jul-12	Jul-12	Oct-12	Oct-12	Oct-12
Month 8	Jun-12	Jul-12	Aug-12	Aug-12	Nov-12	Nov-12	Nov-12
Month 9	Jul-12	Aug-12	Sep-12	Sep-12	Dec-12	Dec-12	
Month 10	Aug-12	Sep-12	Oct-12	Oct-12	Jan-13		
Month 11	Sep-12	Oct-12	Nov-12	Nov-12			
Month 12	Oct-12	Nov-12	Dec-12	Dec-12			
Month 13	Nov-12	Dec-12	Jan-13	Jan-13			
Month 14	Dec-12	Jan-13					
Month 15	Jan -13						

Table D.1. – Active Months for each hub

Appendix E: Comments

Hub Name	Comment	Date Submitted
UW-EHMS-04	Media centre has been on all day so I'm not sure why it would be at Zero.	December 1 2011 08:32 PM
UW-EHMS-07	Air Conditioning is the most difficult! It's sucking up all the electricity but it's sooo hot it's hard to lower it	July 30 2012 10:33 AM
UW-EHMS-09	I'd like to see the gas usage feature implemented.	April 12 2012 11:28 PM
UW-EHMS-10	We are experiencing some issues with the furnace, our schedule say 21.5C all the day long, but after 8am the temperature doesn't go beyond 19C, the furnace start and stop very often and blow cold air, I make sure the furnace is on Heat mode. beyond that I believe the project is amazing and I am getting use to the system	January 17 2012 04:52 PM
UW-EHMS-14	Circuit #8 seems to brown out. Stereo Receiver started to cut out periodically since new panel installation. Occurs more frequent with extended use. Ran extension cord to different circuit, solved the problem. Other devices left on the circuit are not affected. Sat, DVD?	January 22 2012 12:36 PM

Table E.1 – Comments submitted through the webportal

Appendix F: E-mails

Hub	Date Sent	E-mail Subject
EHMS-02	24-Sept-12	User needed their login and password
EHMS-02	24-Nov-12	User needed their login and password
EHMS-14	12-Dec-12	Concerns about the control phase of the EHMS project and how that will affect day to day tasks
EHMS-15	01-Feb-12	Looking for help with their programmable thermostat
EHMS-15	12-Feb-12	Questions about the circuits and the functioning of a smart plug
EHMS-18	15-Jun-12	Inquiring about an iPad or Windows phone application
EHMS-23	28-Apr-12	Inquiring about a smart plug that may not be working; the webportal is showing huge, seemingly impossible consumption values for some appliances
EHMS-23	30-Apr-12	Follow-up about the same load; it is twice as expensive as other loads
EHMS-23	03-May-12	Inquiring about the webportal; it is not showing any data for May
EHMS-23	12-Jul-12	Having trouble logging in
EHMS-23	29-Jan-13	Addresses several issues: finds the optimization function confusing; Does not see value staying onboard, as they cannot see where they could be saving money or energy;

Table F.1 – E-mails from hub to EHMS regarding webportal issues

Appendix G: Detailed Results for Changes in Electricity Consumption

This appendix contains the detailed data used to calculate the change in electricity consumption, including weather normalization. A detailed description of the weather normalization process is found in section 4.4.1, and a detailed description of the change in consumption calculations can be found in section 3.9. In this appendix, the following will be presented for each hub:

- Plot of the daily average temperature versus the daily consumption for the base year; the horizontal line represents the non-weather dependant consumption, and the diagonal line represents the weather dependant consumption; the intersection of the two is the balance point
- Table presenting the CDD (total CDD/#days in the month) and consumption (total monthly consumption/#days in the month) for each month in the base year
- The plot of monthly CDD/#days in the month versus monthly consumption/#days in the month for the cooling months in the base year; this plot will yield the line of best fit used to calculate the expected consumption for the cooling months in the monitoring period
- Table presenting the CDD (total CDD/#days in the month) and consumption (total monthly consumption/#days in the month) for each month in the monitoring period
- Table presenting the equation of line of best fit, CDD (monthly CDD/#days in the month) which are used to calculate the expected consumption, and the values for expected consumption for the cooling months in the monitoring period
- Table presenting the change in consumption calculation

EHMS-01

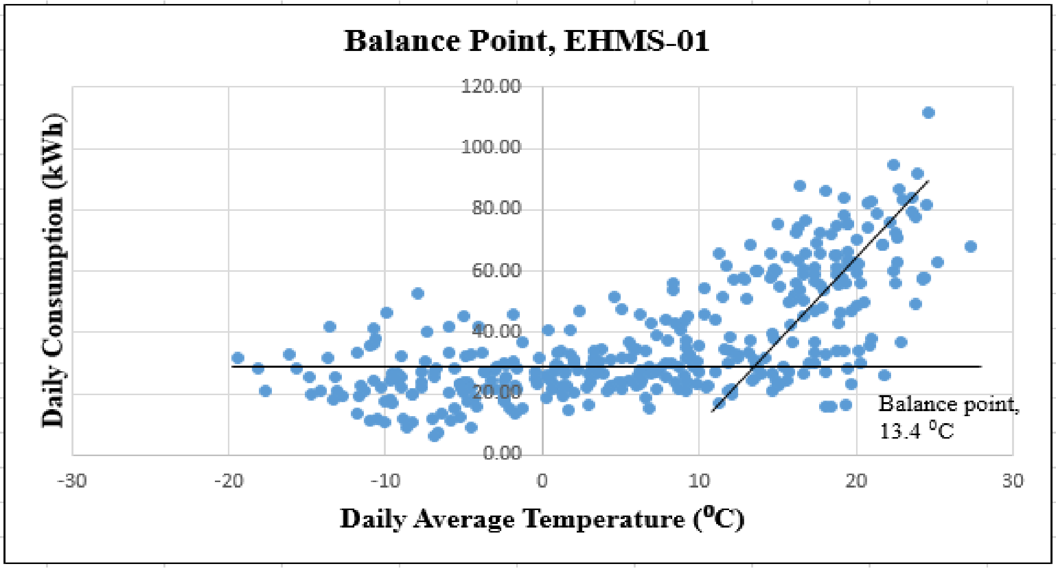

Figure G.1 – Daily average temperature versus daily consumption for the base year, for EHMS-01

EHMS-01 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Nov 29-30 2010	2	0.0	15.1
Dec-10	31	0.0	18.2
Jan-11	31	0.0	29.1
Feb-11	28	0.0	25.3
Mar-11	31	0.0	26.5
Apr-11	30	0.01	31.7
May-11	31	1.6	36.0
Jun-11	30	3.5	53.1
Jul-11	31	8.0	69.9
Aug-11	31	5.9	49.3
Sep-11	30	2.6	56.2
Oct-11	31	0.3	30.5
Nov 1-28 2011	28	0.00	27.4

Table G.1 – Cooling degree days and consumption for the base year for EHMS-01; the highlighted values were used to find the line of best fit in Figure G.2

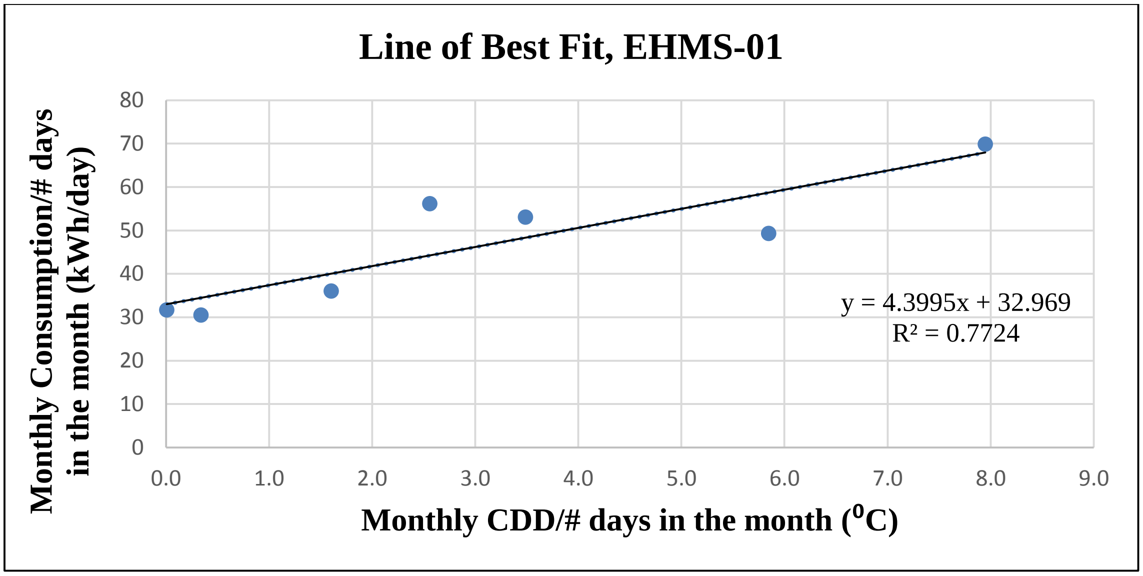

Figure G.2 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-01

EHMS-01 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
		y = 4.3995x + 32.969	
Nov 29-30, 2011	0.0		25.8
Dec-11	0.0		33.1
Jan-12	0.0		29.4
Feb-12	0.0		31.0
Mar-12	0.4	34.6	29.2
Apr-12	0.1	33.4	36.4
May-12	2.3	43.1	41.6
Jun-12	4.8	54.0	53.5
Jul-12	8.0	68.0	65.9
Aug-12	5.4	56.6	52.6
Sep-12	1.9	41.3	42.9
Oct-12	0.5	35.0	31.1
Nov-12	0.0		35.6
Dec-12	0.0		40.9
Jan-13	0.0		40.3

Table G.2 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-01

EHMS-01 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Nov 29-30, 2011	25.8	15.1		10.7		71.4%	
Dec-11	33.1	18.2		14.9		81.6%	
Jan-12	29.4	29.1		0.3		1.2%	
Feb-12	31.0	25.3		5.7		22.4%	
Mar-12	29.2		34.6		-5.4		-15.6%
Apr-12	36.4		33.4		3.0		9.1%
May-12	41.6		43.1		-1.5		-3.5%
Jun-12	53.5		54.0		-0.5		-0.8%
Jul-12	65.9		68.0		-2.1		-3.0%
Aug-12	52.6		56.6		-4.0		-7.1%
Sep-12	42.9		41.3		1.6		3.9%
Oct-12	31.1		35.0		-3.9		-11.2%
Nov-12	35.6	27.3		8.3		30.5%	
Dec-12	40.9	18.2		22.6		124.2%	
Jan-13	40.3	29.1		11.2		38.4%	

Table G.3 – Change in consumption calculations for EHMS-01

EHMS-02

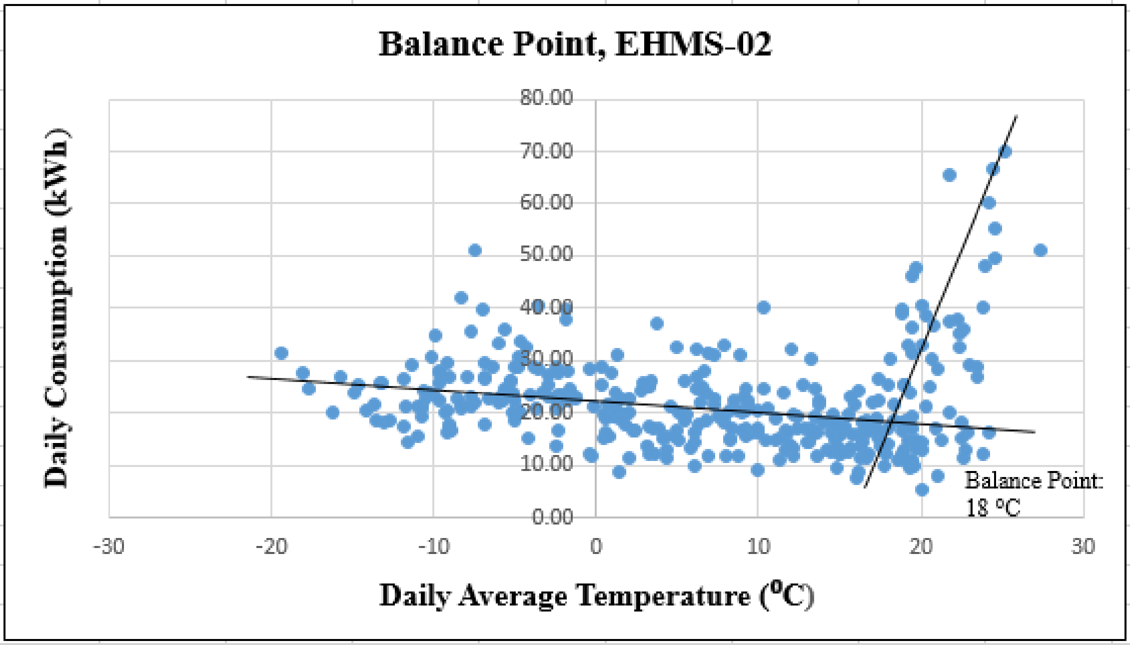

Figure G.3 – Daily average temperature versus daily consumption for the base year, for EHMS-02

EHMS-02 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Nov 29-20 2010	2	0.0	20.8
Dec-10	31	0.0	27.6
Jan-11	31	0.0	23.4
Feb-11	28	0.0	25.6
Mar-11	31	0.0	23.0
Apr-11	30	0.0	21.0
May-11	31	0.3	21.3
Jun-11	30	0.5	15.6
Jul-11	31	3.4	28.1
Aug-11	31	1.6	27.5
Sep-11	30	0.6	16.9
Oct-11	31	0.0	16.7
Nov 1-28 2011	28	0.0	18.1

Table G.4 – Cooling degree days and consumption for the base year for EHMS-02; the highlighted values were used to find the line of best fit in Figure G.4

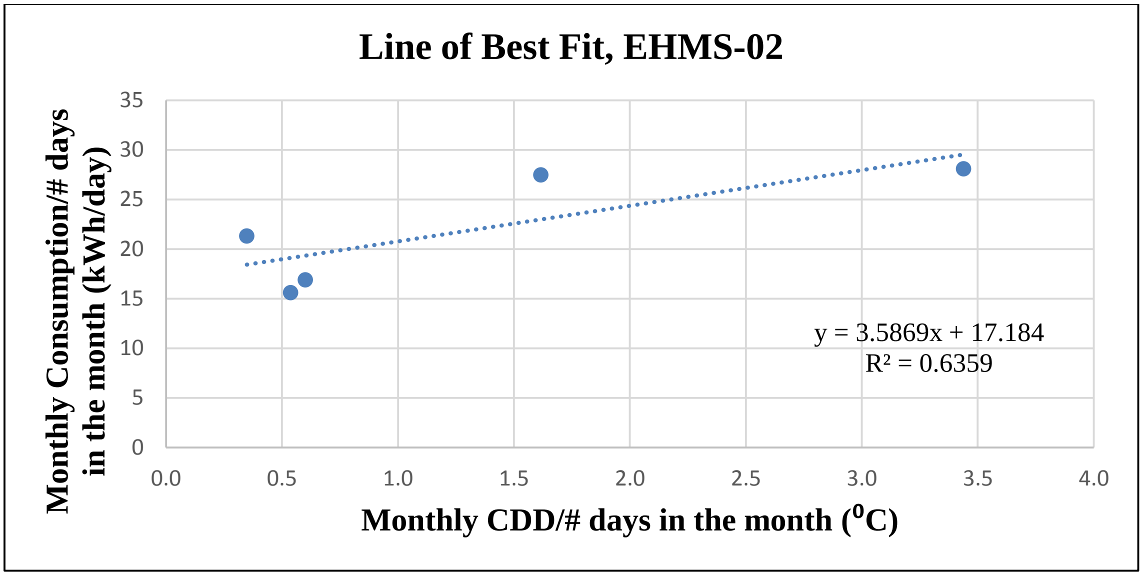

Figure G.4 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-02

EHMS-02 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 3.5869x + 17.184	
Nov 29-30, 2011	0.0		23.0
Dec-11	0.0		23.9
Jan-12	0.0		26.1
Feb-12	0.0		25.0
Mar-12	0.0		19.5
Apr-12	0.0		19.9
May-12	0.4	18.7	18.6
Jun-12	1.7	23.3	26.8
Jul-12	3.4	29.4	35.5
Aug-12	1.5	22.7	24.1
Sep-12	0.3	18.3	15.6
Oct-12	0.0		16.5
Nov-12	0.0		20.2
Dec-12	0.0		24.6
Jan-13	0.0		22.5

Table G.5 – Cooling degree days, expected consumption, and monitoring period consumption EHMS-02

EHMS 02-Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Nov 29-30, 2011	23.0	20.8		2.3		10.9%	
Dec-11	23.9	27.8		-3.7		-13.3%	
Jan-12	26.1	23.4		2.7		11.6%	
Feb-12	25.0	25.6		-0.6		-2.2%	
Mar-12	19.5	23.0		-3.5		-15.2%	
Apr-12	19.9	21.0		-1.1		-5.1%	
May-12	18.6		18.8		-0.1		-0.7%
Jun-12	26.8		23.3		3.4		14.7%
Jul-12	35.5		29.4		6.1		20.8%
Aug-12	24.1		22.7		1.3		5.8%
Sep-12	15.6		18.3	-2.7		-14.7%	
Oct-12	16.5	16.7		-0.2		-1.1%	
Nov-12	20.2	21.5		-1.4		-6.3%	
Dec-12	24.6	27.6		-3.0		-10.7%	
Jan-13	22.5	23.4		-0.9		-3.7%	

Table G.6 – Change in consumption calculations for EHMS-02

EHMS-04

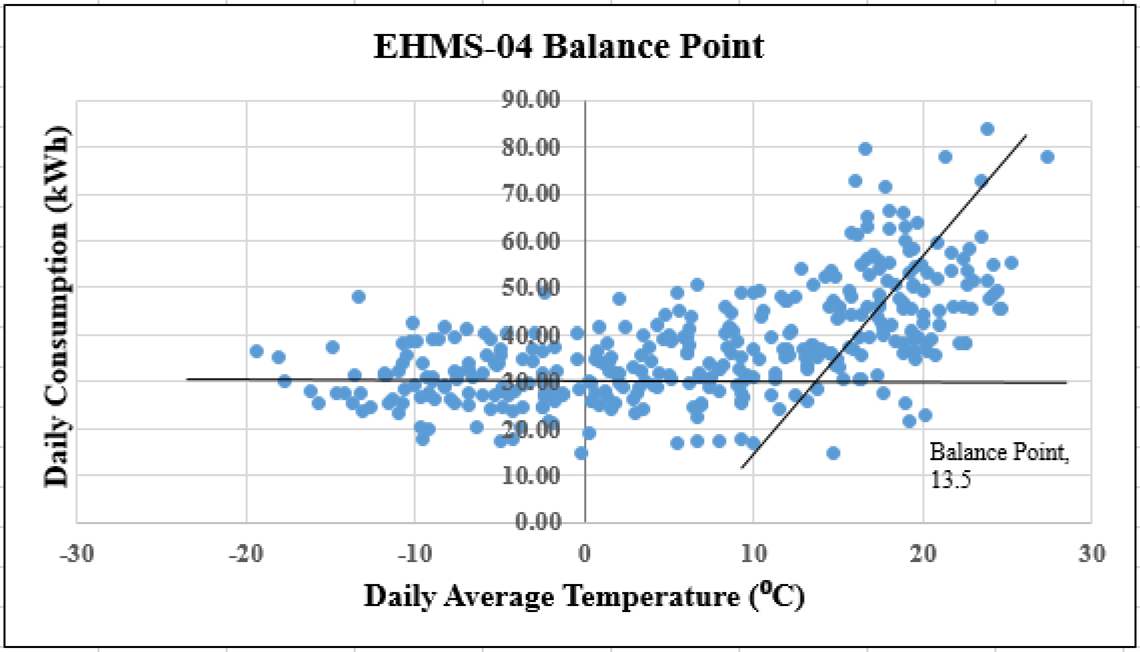

Figure G.5 – Daily average temperature versus daily consumption for the base year, for EHMS-04

EHMS-04 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Nov 29-20 2010	2	0.0	29.5
Dec-10	31	0.0	30.5
Jan-11	31	0.0	29.8
Feb-11	28	0.0	30.1
Mar-11	31	0.0	29.3
Apr-11	30	0.003	30.9
May-11	31	1.6	35.0
Jun-11	30	3.4	46.0
Jul-11	31	7.8	52.1
Aug-11	31	5.7	47.9
Sep-11	30	2.5	43.2
Oct-11	31	0.3	39.8
Nov 1-28 2011	28	0.0	36.6

Table G.7 – Cooling degree days and consumption for the base year for EHMS-04; the highlighted values were used to find the line of best fit in Figure G.6

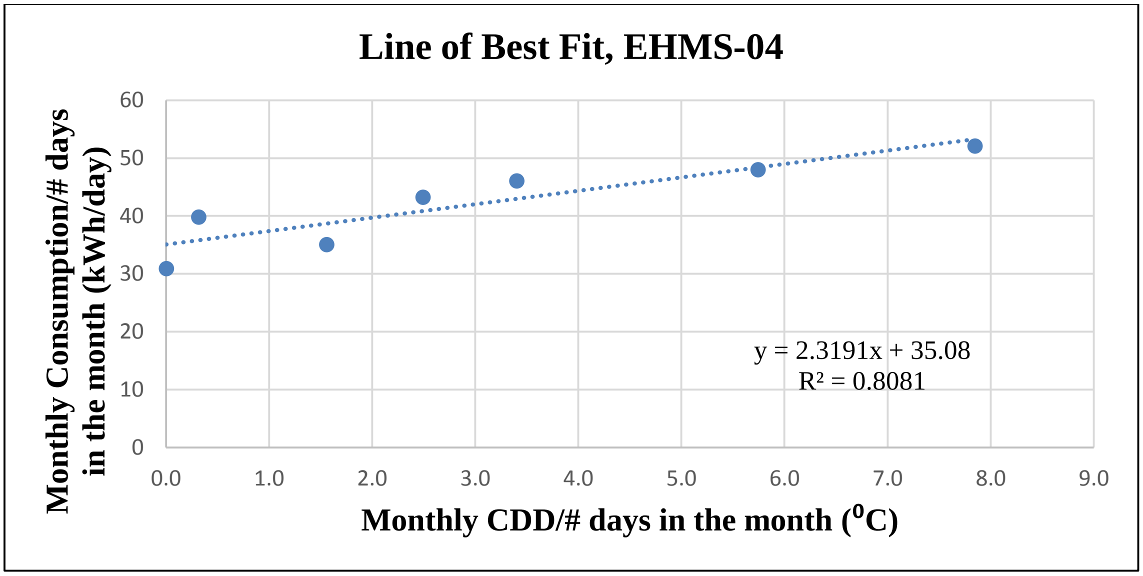

Figure G.6 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-04

EHMS -04 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 2.3191x + 35.08	
Nov 29-30, 2011	0.0		38.1
Dec-11	0.0		40.6
Jan-12	0.0		34.9
Feb-12	0.0		32.9
Mar-12	0.3	35.9	35.0
Apr-12	0.1	35.3	34.7
May-12	2.2	40.3	39.0
Jun-12	4.7	46.0	47.4
Jul-12	7.8	53.3	53.0
Aug-12	5.3	47.3	44.7
Sep-12	1.8	39.4	39.4
Oct-12	0.5	36.1	34.4
Nov-12	0.0		35.1
Dec-12	0.0		39.0
Jan-13	0.0		33.4

Table G.8 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-04

EHMS -04 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Nov 29-30, 2011	38.1	29.5		8.6		28.9%	
Dec-11	40.6	30.5		10.1		33.1%	
Jan-12	34.9	29.8		5.1		17.1%	
Feb-12	32.9	30.1		2.8		9.3%	
Mar-12	35.0		35.9		-0.9		-2.6%
Apr-12	34.7		35.3		-0.6		-1.7%
May-12	39.0		40.3		-1.3		-3.3%
Jun-12	47.4		46.0		1.4		3.1%
Jul-12	53.0		53.3		-0.3		-0.5%
Aug-12	44.7		47.3		-2.7		-5.6%
Sep-12	39.4		39.4		0.1		0.2%
Oct-12	34.4		36.1		-1.8		-4.9%
Nov-12	35.1	33.1		2.1		6.2%	
Dec-12	39.0	30.5		8.5		27.7%	
Jan-13	33.4	29.8		3.6		12.0%	

Table G.9 – Change in consumption calculations for EHMS-04

EHMS-05

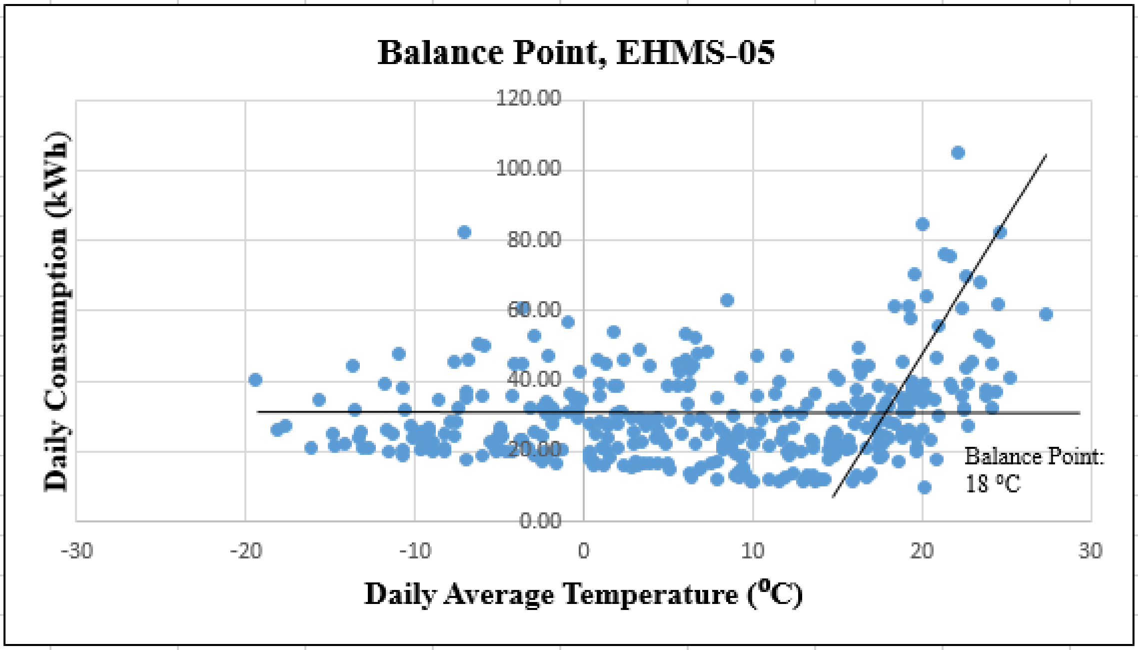

Figure G.7 – Daily average temperature versus daily consumption for the base year, for EHMS-05

EHMS-05 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2010	9	0.0	29.9
Jan-11	31	0.0	27.5
Feb-11	28	0.0	27.0
Mar-11	31	0.0	24.6
Apr-11	30	0.0	22.0
May-11	31	0.3	20.0
Jun-11	30	0.5	28.1
Jul-11	31	3.4	46.7
Aug-11	31	1.6	38.0
Sep-11	30	0.6	27.4
Oct-11	31	0.0	31.1
Nov-11	30	0.0	32.8
Dec 1-22, 2011	22	0.0	40.1

Table G.10 – Cooling degree days and consumption for the base year for EHMS-05; the highlighted values were used to find the line of best fit in Figure G.8

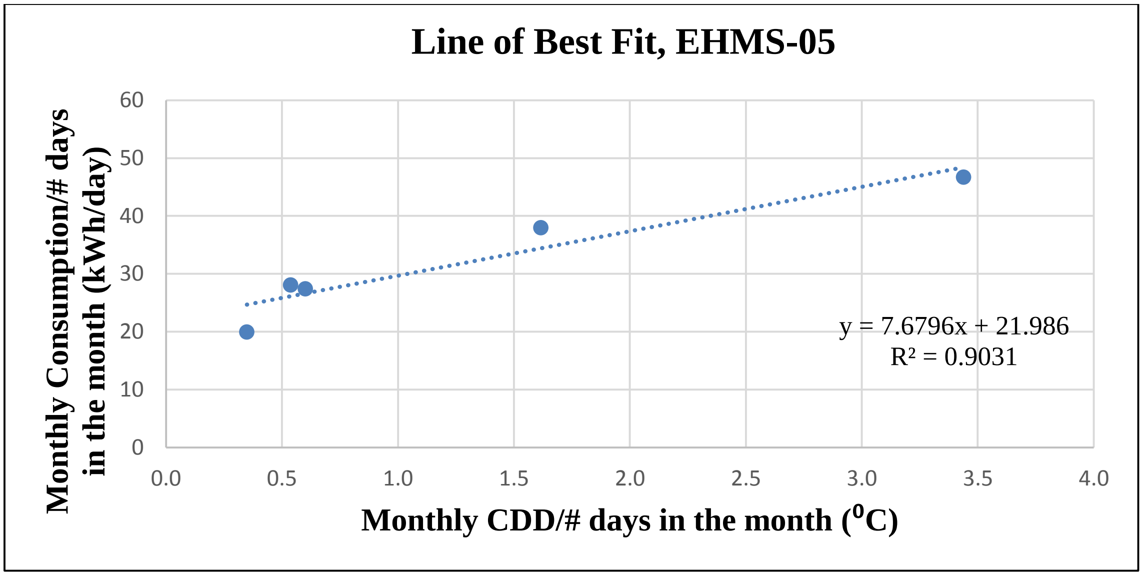

Figure G.8– Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-05

EHMS-05 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 7.6796x + 21.986	
Dec 23-31, 2011	0.0		45.1
Jan-12	0.0		35.4
Feb-12	0.0		34.3
Mar-12	0.0		32.4
Apr-12	0.0		30.1
May-12	0.4	25.3	31.9
Jun-12	1.7	35.2	38.3
Jul-12	3.4	48.1	46.9
Aug-12	1.5	33.9	36.3
Sep-12	0.3	24.4	30.7
Oct-12	0.0		28.3
Nov-12	0.0		34.5
Dec-12	0.0		41.9
Jan-13	0.0		39.6

Table G.11 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-05

EHMS-05 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{\text{MP} - \text{BY}}{\text{BY}}$	$\frac{\text{MP} - \text{ExMP}}{\text{ExMP}}$
Dec 23-31, 2011	45.1	29.9		15.3		51.1%	
Jan-12	35.4	27.6		7.8		28.4%	
Feb-12	34.3	27.0		7.3		27.1%	
Mar-12	32.4	24.7		7.7		31.2%	
Apr-12	30.1	22.0		8.1		36.9%	
May-12	31.9		25.3		6.6		26.0%
Jun-12	38.3		35.2		3.1		9.0%
Jul-12	46.9		48.1		-1.3		-2.6%
Aug-12	36.3		33.6		2.5		7.3%
Sep-12	30.7		24.4		6.3		25.7%
Oct-12	28.3	31.1		-2.7		-8.8%	
Nov-12	34.5	32.8		1.8		5.1%	
Dec-12	41.9	28.2		13.7		48.8%	
Jan-13	39.6	27.6		12.0		43.7%	

Table G.12 – Change in consumption calculations for EHMS-05

EHMS-07

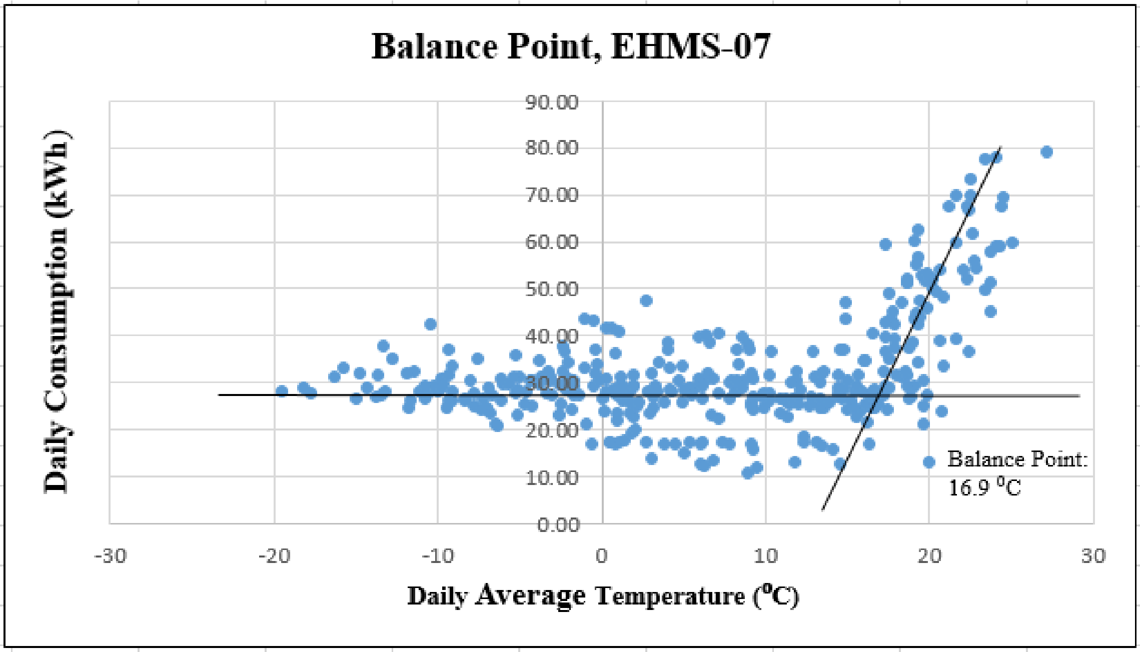

Figure G.9 – Daily average temperature versus daily consumption for the base year, for EHMS-07

EHMS-07 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Jan 3-31, 2011	29	0.0	29.7
Feb-11	28	0.0	29.0
Mar-11	31	0.0	27.1
Apr-11	30	0.0	19.8
May-11	31	0.5	26.7
Jun-11	30	1.0	30.3
Jul-11	31	4.5	54.8
Aug-11	31	2.5	43.1
Sep-11	30	0.9	31.7
Oct-11	31	0.0	29.4
Nov-11	30	0.0	32.6
Dec-11	31	0.0	28.2
Jan 1-2, 2012	2	0.0	23.1

Table G.13 – Cooling degree days and consumption for the base year for EHMS-07; the highlighted values were used to find the line of best fit in Figure G.10

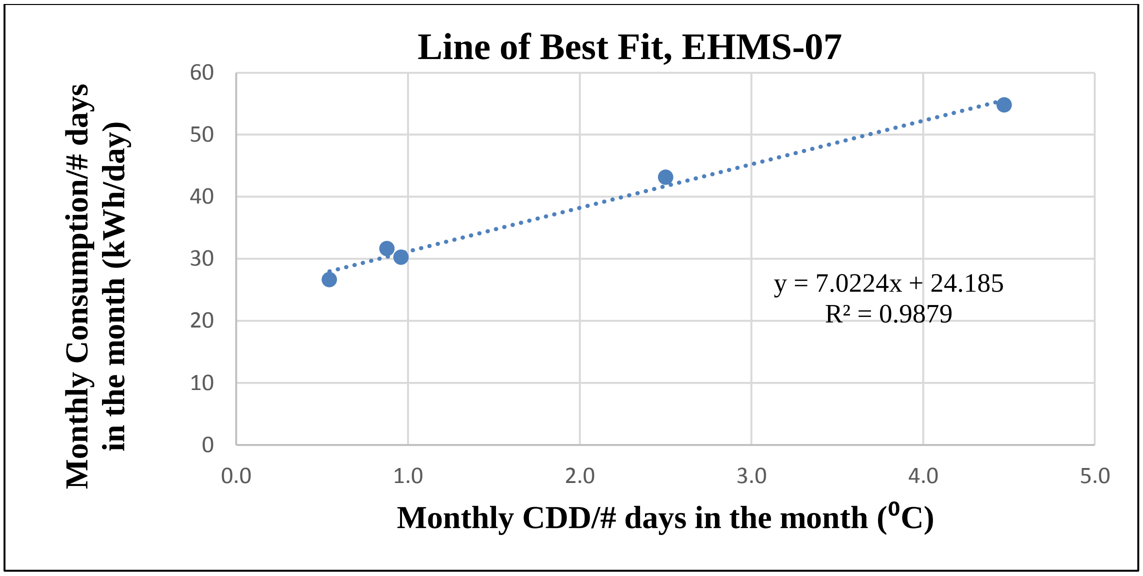

Figure G.10 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-07

EHMS -07 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 7.0224x + 24.185**	
Jan 3-31, 2012	0.0		22.9
Feb-12	0.0		22.3
Mar-12	0.0		20.6
Apr-12	0.0		17.9
May-12	0.8	29.5	24.4
Jun-12	2.3	40.23	44.4
Jul-12	4.5	55.5	66.4
Aug-12	2.3	40.4	66.0
Sep-12	0.6	28.7	37.4
Oct-12	0.03	24.4	32.0
Nov-12	0.0		28.0
Dec-12	0.0		32.1
Jan-13	0.0		30.8

Table G.14 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-07

EHMS -07 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Jan 3-31, 2012	22.9	29.7		-6.8		-22.9%	
Feb-12	22.3	29.0		-6.6		-22.9%	
Mar-12	20.6	27.1		-6.5		-24.1%	
Apr-12	17.9	19.8		-1.9		-9.4%	
May-12	24.4		29.5		-5.1		-17.4%
Jun-12	44.4		40.3		4.1		10.1%
Jul-12	66.4		55.5		10.9		19.6%
Aug-12	66.0		40.4		25.6		63.4%
Sep-12	37.4		28.7		8.7		30.2%
Oct-12	32.0		24.4		7.6		31.0%
Nov-12	28.0	32.6		-4.6		-14.1%	
Dec-12	32.1	28.2		3.9		13.9%	
Jan-13	30.8	30.0		0.9		2.9%	

Table G.15 – Change in consumption calculations for EHMS-07

EHMS-09

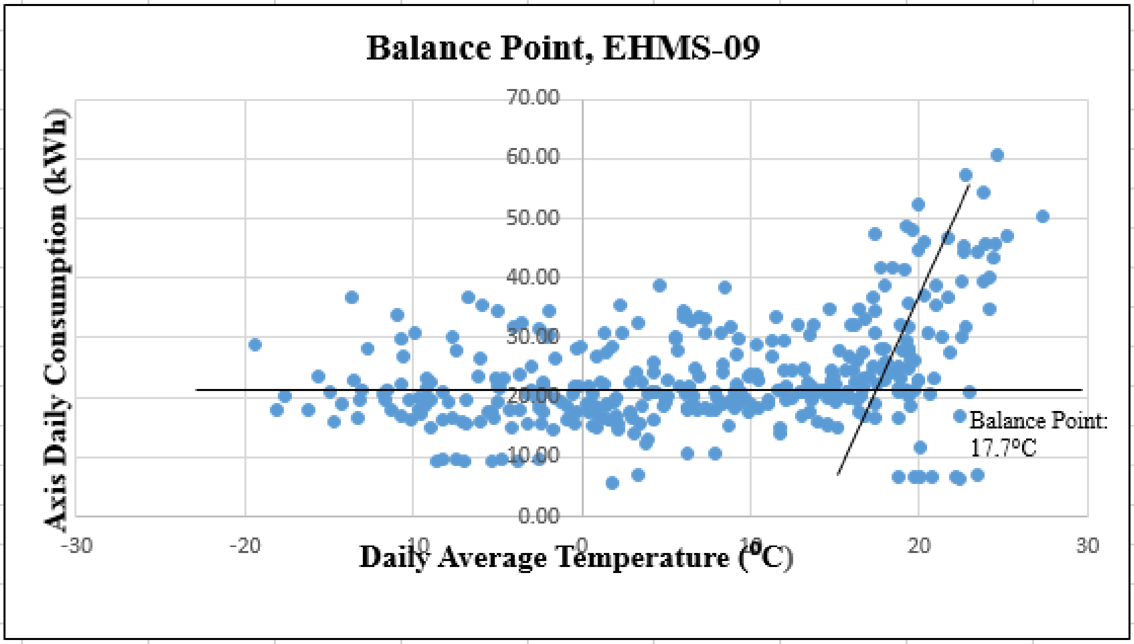

Figure G.11 – Daily average temperature versus daily consumption for the base year, for EHMS-09

EHMS-09 Base Year	# Days in the month	Monthly CDD/ #days in month (ºC)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2010	9	0.0	9.6
Jan-11	31	0.0	22.8
Feb-11	28	0.0	22.4
Mar-11	31	0.0	20.5
Apr-11	30	0.0	21.9
May-11	31	12.3	24.6
Jun-11	30	18.6	25.9
Jul-11	31	114.9	41.1
Aug-11	31	57.3	20.1
Sep-11	30	20.1	24.2
Oct-11	31	0.0	21.8
Nov-11	30	0.0	22.6
Dec 1-22, 2011	22	0.0	20.0

Table G.16 – Cooling degree days and consumption for the base year for EHMS-09; the highlighted values were used to find the line of best fit in Figure G.12

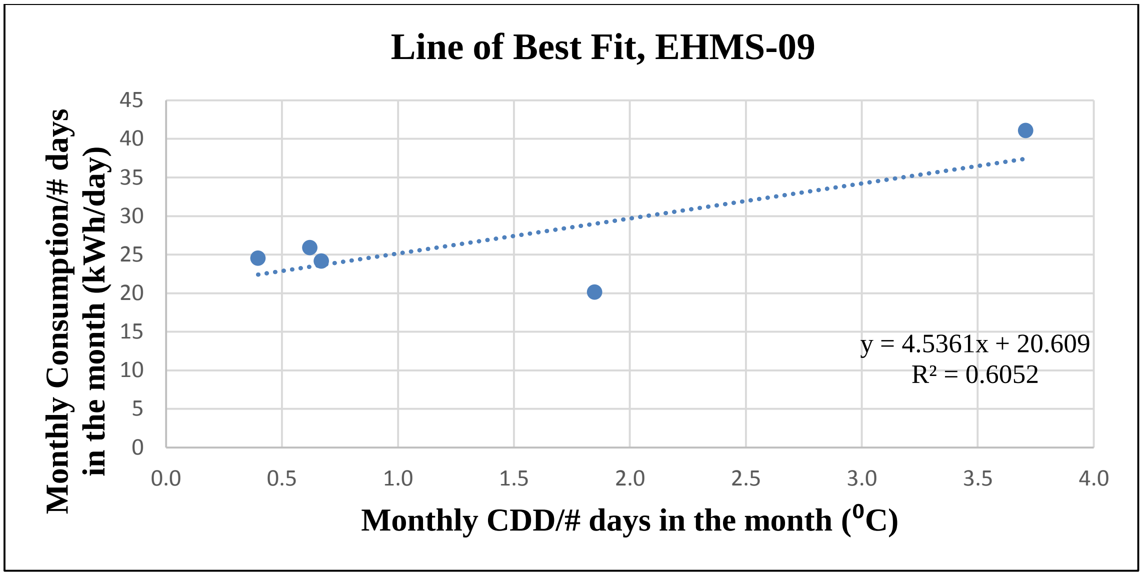

Figure G.12 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-09

EHMS-09 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y =4.5361x + 20.609	
Dec 23-31, 2011	0.0		15.4
Jan-12	0.0		19.1
Feb-12	0.0		19.0
Mar-12	0.0		18.1
Apr-12	0.0		19.2
May-12	0.5	23.0	19.8
Jun-12	1.9	29.1	25.8
Jul-12	3.7	37.3	33.4
Aug-12	1.7	28.5	27.4
Sep-12	0.4	22.4	20.6
Oct-12	0.0		24.3
Nov-12	0.0		26.3
Dec-12	0.0		26.9
Jan-13	0.0		20.8

Table G.17 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-09

EHMS-09 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Dec 23-31, 2011	15.4	9.6		5.9		60.7%	
Jan-12	19.2	22.9		-3.7		-16.1%	
Feb-12	19.0	22.4		-3.4		-15.3%	
Mar-12	18.1	20.5		-2.4		-11.8%	
Apr-12	19.2	21.9		-2.8		-12.5%	
May-12	19.8		23.0		-3.1		-13.6%
Jun-12	25.8		29.1		-3.3		-11.3%
Jul-12	33.4		37.3		-3.9		-10.4%
Aug-12	27.4		28.5		-1.1		-4.0%
Sep-12	20.6		22.4		-1.9		-8.4%
Oct-12	24.3	21.9		2.		11.1%	
Nov-12	26.3	22.7		3.8		16.2%	
Dec-12	26.9	16.9		10.1		60.0%	
Jan-13	20.8	22.9		-2.1		-9.1%	

Table G.18 – Change in consumption calculations for EHMS-09

EHMS-10

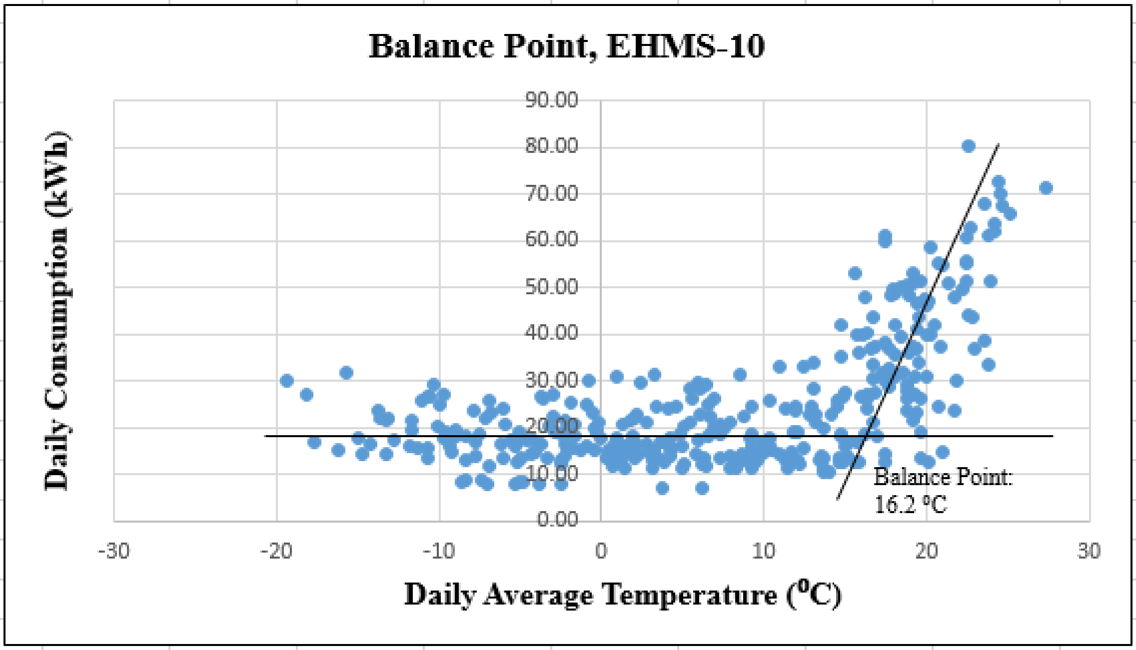

Figure G.13 – Daily average temperature versus daily consumption for the base year, for EHMS-10

EHMS-10 Base Year	# Days in the month	Monthly CDD/ #days in month (ºC)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2012	9	0.0	8.1
Jan-11	31	0.0	20.1
Feb-11	28	0.0	18.0
Mar-11	31	0.0	16.7
Apr-11	30	0.0	16.9
May-11	31	0.7	20.2
Jun-11	30	1.3	35.5
Jul-11	31	5.1	52.4
Aug-11	31	3.1	34.6
Sep-11	30	1.1	23.4
Oct-11	31	0.0	18.9
Nov-11	30	0.0	18.4
Dec 1-22, 2011	22	0.0	21.0

Table G.19 – Cooling degree days and consumption for the base year for EHMS-10; the highlighted values were used to find the line of best fit in Figure G.14

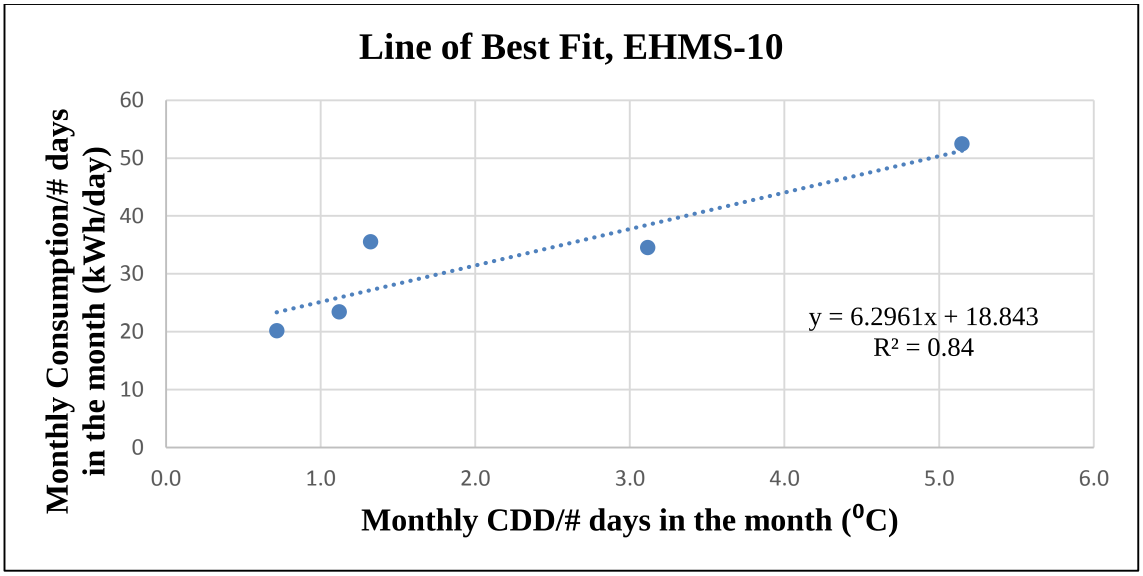

Figure G.14– Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-10

EHMS- 10 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 6.2961x + 18.843**	
Dec 23-31, 2011	0.0		24.1
Jan-12	0.0		19.8
Feb-12	0.0		18.7
Mar-12	0.01	18.9	16.9
Apr-12	0.0	25.4	17.2
May-12	1.1	36.1	21.5
Jun-12	2.7	51.3	33.3
Jul-12	5.2	36.8	46.2
Aug-12	2.8	24.2	38.6
Sep-12	0.9	19.5	25.4
Oct-12	0.1		17.2
Nov-12	0.0		17.9
Dec-12	0.0		19.8
Jan-13	0.0		19.0

Table G.20 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-10

EHMS- 10 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	**MP-ExMP**	$\frac{\mathbf{MP-BY}}{\mathbf{BY}}$	$\frac{\mathbf{MP-ExMP}}{\mathbf{ExMP}}$
Dec 23-31, 2011	24.1	8.1		16.0		196.3%	
Jan-12	19.8	20.1		-0.3		-1.5%	
Feb-12	18.7	18.0		0.8		4.3%	
Mar-12	16.9		18.9		-2.0		-10.6%
Apr-12	17.2	16.9		0.3		2.0%	
May-12	21.5		25.4		-4.0		-15.6%
Jun-12	33.3		36.1		-2.8		-7.8%
Jul-12	46.2		51.3		-5.1		-10.0%
Aug-12	38.6		36.8		1.8		5.0%
Sep-12	25.4		24.2		1.2		5.0%
Oct-12	17.2		19.5		-2.3		-11.8%
Nov-12	17.9	18.4		-0.6		-3.1%	
Dec-12	19.8	18.2		1.7		9.3%	
Jan-13	19.0	20.1		-1.1		-5.3%	

Table G.21 – Change in consumption calculations for EHMS-10

EHMS-11

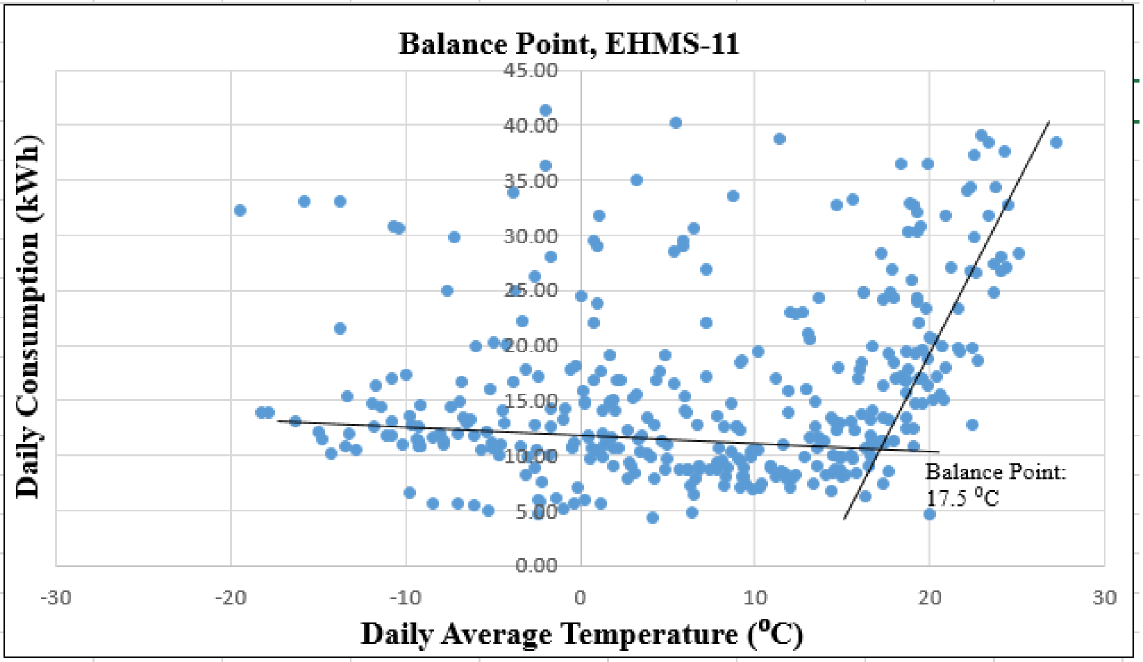

Figure G.15– Daily average temperature versus daily consumption for the base year, for EHMS-11

EHMS-11 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Jan 3-31, 2011	29	0.0	15.8
Feb-11	28	0.0	14.6
Mar-11	31	0.0	11.9
Apr-11	30	0.0	14.3
May-11	31	0.4	14.3
Jun-11	30	0.7	16.2
Jul-11	31	3.9	27.0
Aug-11	31	2.0	19.1
Sep-11	30	0.7	13.0
Oct-11	31	0.0	14.0
Nov-11	30	0.0	14.4
Dec-11	31	0.0	15.0
Jan 1-2, 2012	2	0.0	17.8

Table G.22 – Cooling degree days and consumption for the base year for EHMS-11; the highlighted values were used to find the line of best fit in Figure G.16

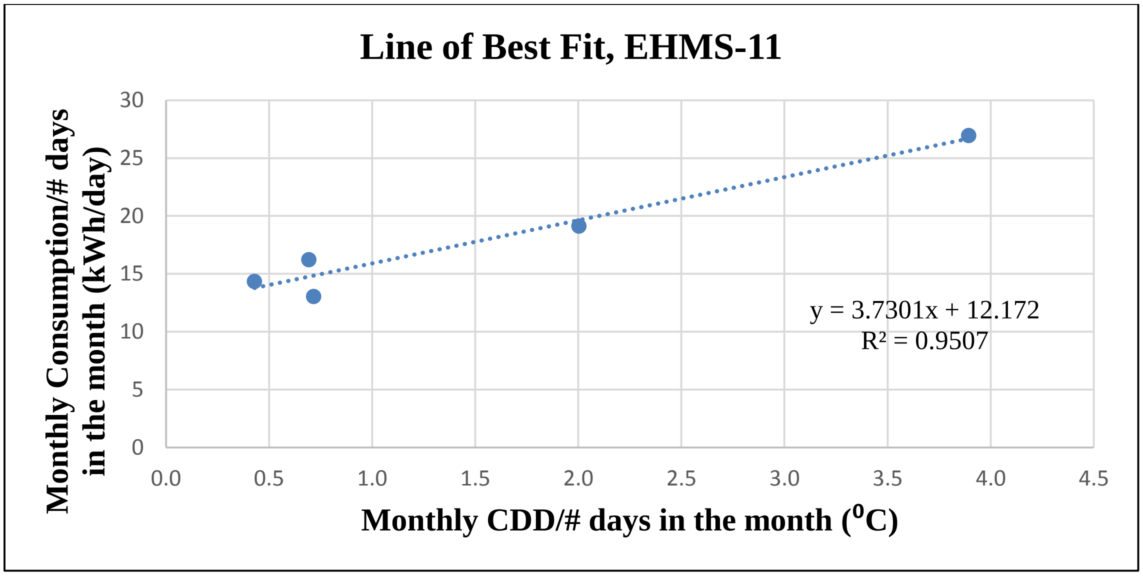

Figure G.16 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-11

EHMS-11 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 3.7301x + 12.172**	
Jan 3-31, 2012	0.0		16.6
Feb-12	0.0		16.4
Mar-12	0.0		14.6
Apr-12	0.0		16.9
May-12	0.6	14.3	16.6
Jun-12	2.0	19.5	20.31
Jul-12	3.9	26.6	28.0
Aug-12	1.9	19.2	21.3
Sep-12	0.5	13.9	16.0
Oct-12	0.01	12.2	13.6
Nov-12	0.0		16.4
Dec-12	0.0		16.6
Jan-13	0.0		19.7

Table G.23 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-11

EHMS-11 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Jan 3-31, 2012	16.6	15.8		0.8		5.1%	
Feb-12	16.4	14.6		1.7		11.8%	
Mar-12	14.6	11.9		2.7		22.9%	
Apr-12	16.9	14.3		2.6		18.2%	
May-12	16.6		14.3		2.3		15.8%
Jun-12	20.3		19.5		0.8		4.0%
Jul-12	28.0		26.6		1.4		5.4%
Aug-12	21.3		19.2		2.1		11.1%
Sep-12	16.0		13.9		2.1		15.2%
Oct-12	13.6		12.2		1.4		11.3%
Nov-12	16.4	14.4		2.0		14.1%	
Dec-12	16.6	15.0		1.6		10.8%	
Jan-13	19.7	15.8		3.8		24.4%	

Table G.24 – Change in consumption calculations for EHMS-11

EHMS-12

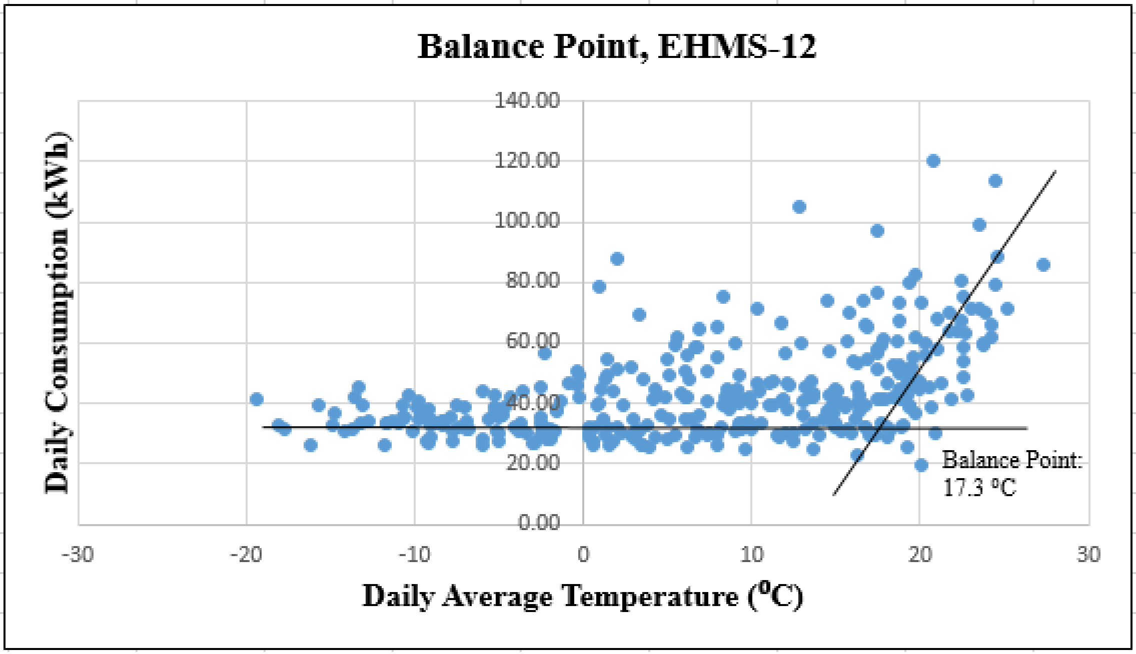

Figure G.17 – Daily average temperature versus daily consumption for the base year, for EHMS-12

EHMS-12 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2010	9	0.0	35.6
Jan-11	31	0.0	35.2
Feb-11	28	0.0	33.8
Mar-11	31	0.0	32.9
Apr-11	30	0.0	30.4
May-11	31	0.5	33.9
Jun-11	30	0.8	41.2
Jul-11	31	4.1	60.8
Aug-11	31	2.2	56.1
Sep-11	30	0.8	56.9
Oct-11	31	0.0	48.9
Nov-11	30	0.0	50.4
Dec 1-22, 2011	22	0.0	53.8

Table G.25 – Cooling degree days and consumption for the base year for EHMS-12; the highlighted values were used to find the line of best fit in Figure G.18

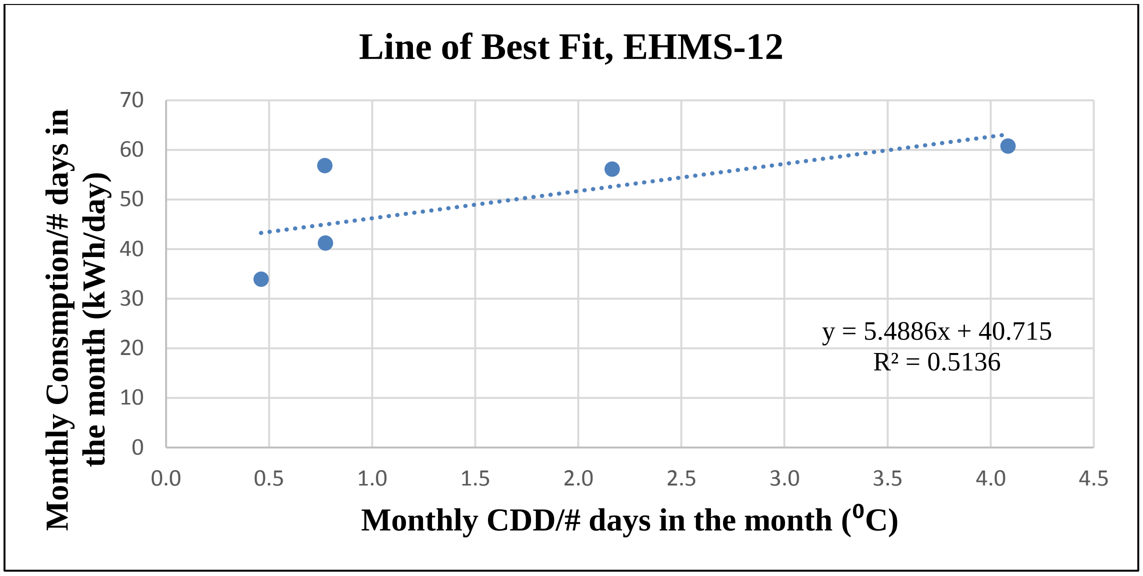

Figure G.18 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-12

EHMS-12 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 5.4886x + 40.715	
Dec 23-31, 2011	0.0		59.3
Jan-12	0.0		61.5
Feb-12	0.0		60.3
Mar-12	0.0		58.6
Apr-12	0.0		55.7
May-12	0.6	44.2	55.1
Jun-12	2.1	52.1	69.3
Jul-12	4.1	63.0	79.5
Aug-12	2.0	51.8	65.3
Sep-12	0.5	43.6	61.8
Oct-12	0.0	40.8	58.4
Nov-12	0.0		56.7
Dec-12	0.0		59.7
Jan-13	0.0		72.9

Table G.26 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-12

EHMS-12 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Dec 23-31, 2011	59.3	35.6		23.7		66.7%	
Jan-12	61.5	35.2		26.3		74.8%	
Feb-12	60.3	33.8		26.5		78.5%	
Mar-12	58.6	32.9		25.7		78.1%	
Apr-12	55.7	30.4		25.3		83.4%	
May-12	55.1		44.2		10.9		24.6%
Jun-12	69.3		52.1		17.1		32.9%
Jul-12	79.5		63.0		16.5		26.1%
Aug-12	65.3		51.8		13.5		26.0%
Sep-12	61.8		43.6		18.2		41.7%
Oct-12	58.4		40.8		17.6		43.1%
Nov-12	56.7	50.4		6.3		12.5%	
Dec-12	59.7	36.8		22.9		62.4%	
Jan-13	72.9	35.2		37.8		107.1%	

Table G.27 – Change in consumption calculations for EHMS-12

EHMS-13

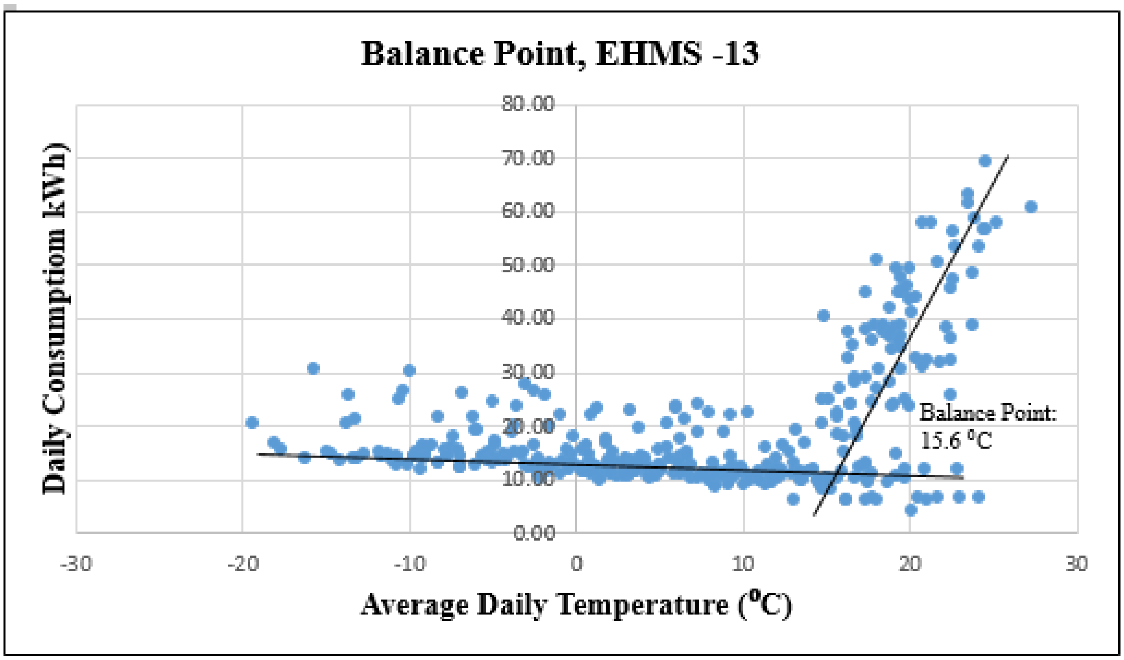

Figure G.19 – Daily average temperature versus daily consumption for the base year, for EHMS-13

EHMS-13 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2010	9	0.0	16.8
Jan-11	31	0.0	17.1
Feb-11	28	0.0	16.0
Mar-11	31	0.0	14.4
Apr-11	30	0.0	14.0
May-11	31	0.9	13.9
Jun-11	30	1.7	18.1
Jul-11	31	5.8	42.7
Aug-11	31	3.7	37.2
Sep-11	30	1.3	14.8
Oct-11	31	0.02	12.6
Nov-11	30	0.0	12.6
Dec 1-22, 2011	22	0.0	15.9

Table G.28 – Cooling degree days and consumption for the base year for EHMS-13; the highlighted values were used to find the line of best fit in Figure G.20

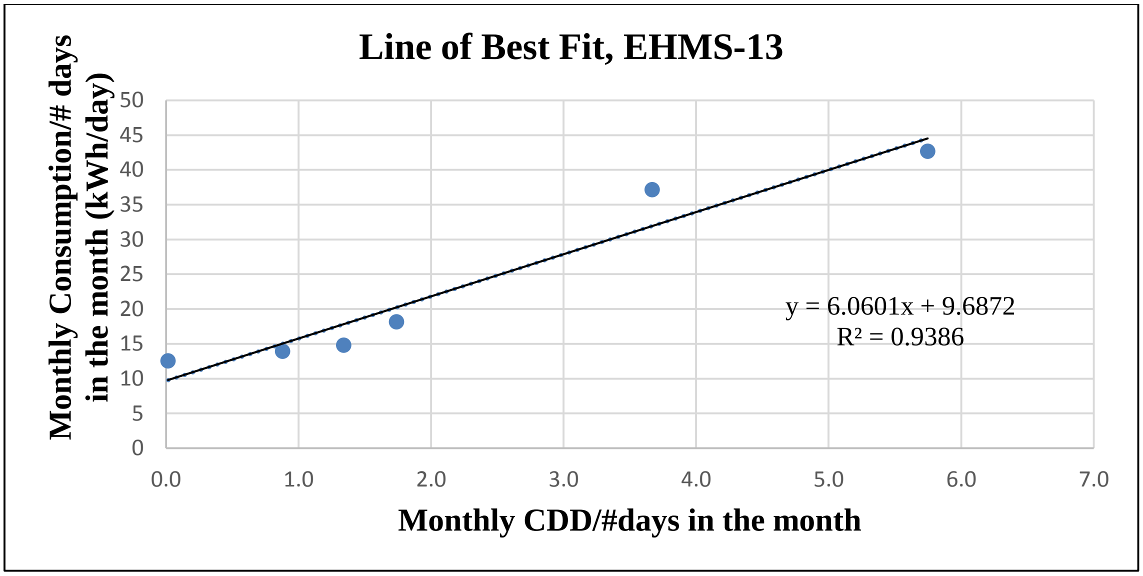

Figure G.20 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-13

EHMS-13 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 6.0601x + 9.6872	
Dec 23-31, 2011	0.0		17.3
Jan-12	0.0		14.3
Feb-12	0.0		14.7
Mar-12	0.1	10.0	12.6
Apr-12	0.0		12.7
May-12	1.3	17.5	21.7
Jun-12	3.1	28.7	28.0
Jul-12	5.8	44.6	35.4
Aug-12	3.3	29.9	27.1
Sep-12	1.0	16.0	14.2
Oct-12	0.2	10.8	13.7
Nov-12	0.0		15.2
Dec-12	0.0		14.1
Jan-13	0.0		16.2

Table G.29 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-13

EHMS-13 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Dec 23-31, 2011	17.3	16.8		0.5		3.1%	
Jan-12	14.3	17.1		-2.8		-16.5%	
Feb-12	14.7	16.1		-1.4		-8.5%	
Mar-12	12.6		10.0		2.5		25.0%
Apr-12	12.7	14.0		-1.3		-9.3%	
May-12	21.7		17.5		4.1		23.4%
Jun-12	28.0		28.7		-0.7		-2.4%
Jul-12	35.4		44.6		-9.2		-20.6%
Aug-12	27.1		29.9		-2.7		-9.2%
Sep-12	14.2		16.0		-1.7		-10.9%
Oct-12	13.7		10.8		2.9		27.4%
Nov-12	15.2	12.6		2.6		20.6%	
Dec-12	14.1	16.8		-2.8		-16.5%	
Jan-13	16.2	17.1		-1.0		-5.6%	

Table G.30 – Change in consumption calculations for EHMS-13

EHMS-14

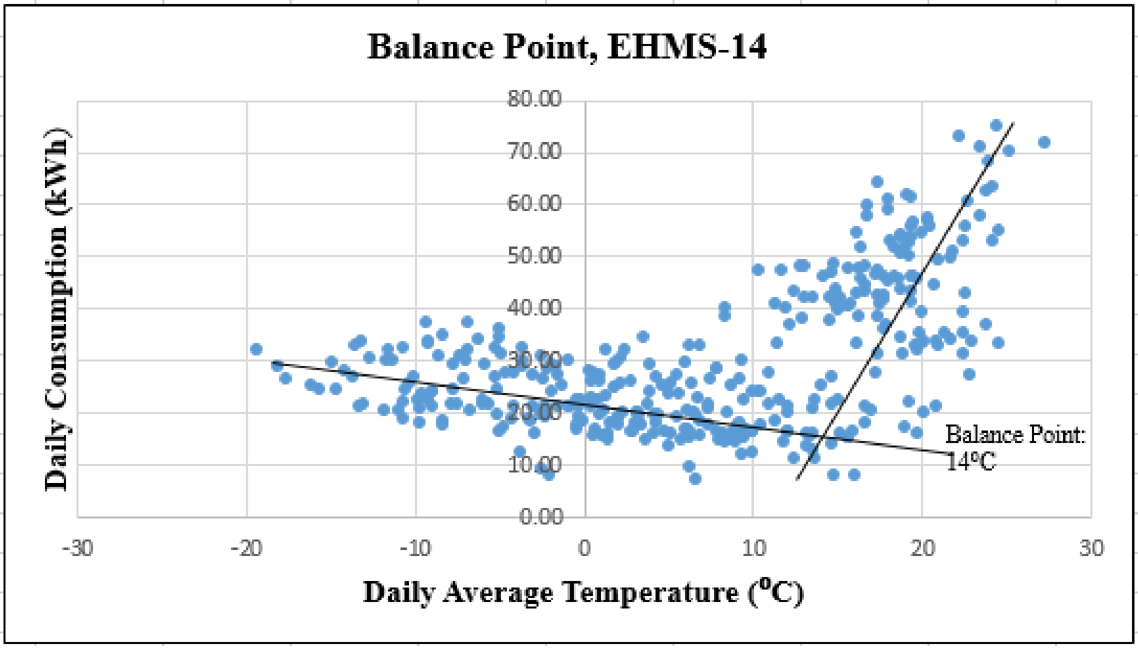

Figure G.21– Daily average temperature versus daily consumption for the base year, for EHMS-14

EHMS-14 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Dec 23-31, 2010	9	0.0	22.6
Jan-11	31	0.0	26.9
Feb-11	28	0.0	24.7
Mar-11	31	0.0	21.8
Apr-11	30	0.0	21.6
May-11	31	1.4	19.9
Jun-11	30	3.0	44.4
Jul-11	31	7.3	50.2
Aug-11	31	5.2	48.5
Sep-11	30	2.2	37.6
Oct-11	31	0.2	18.6
Nov-11	30	0.0	21.4
Dec 1-22, 2011	22	0.0	25.2

Table G.31 – Cooling degree days and consumption for the base year for EHMS-14; the highlighted values were used to find the line of best fit in Figure G.22

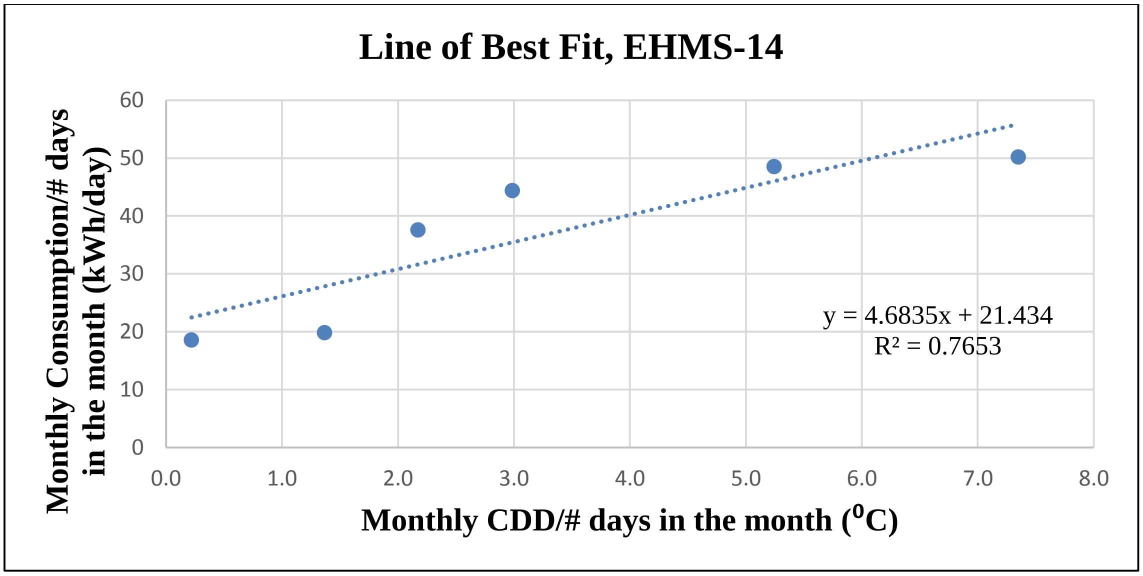

Figure G.22 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-14

EHMS-14 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 4.6835x + 21.434**	
Dec 23.-31, 2011	0.0		29.3
Jan-12	0.0		24.3
Feb-12	0.0		22.9
Mar-12	0.3	22.6	20.0
Apr-12	0.1	21.7	19.7
May-12	2.0	30.8	37.5
Jun-12	4.3	41.5	51.6
Jul-12	7.4	55.9	56.5
Aug-12	4.8	43.8	41.3
Sep-12	1.6	29.0	38.9
Oct-12	0.4	23.2	21.2
Nov-12	0.0		24.8
Dec-12	0.0		26.6
Jan-13	0.0		24.9

Table G.32– Cooling degree days, expected consumption, and monitoring period consumption for EHMS-14

EHMS-14 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Dec 23.-31, 2011	29.3	22.6		6.8		30.0%	
Jan-12	24.3	26.9		-2.7		-9.9%	
Feb-12	22.9	24.7		-1.8		-7.4%	
Mar-12	20.0		22.6		-2.6		-11.5%
Apr-12	19.7		21.7		-2.0		-9.2%
May-12	37.5		30.8		6.8		22.0%
Jun-12	51.6		41.5		10.1		24.3%
Jul-12	56.5		55.9		0.6		1.0%
Aug-12	41.3		43.8		-2.5		-5.7%
Sep-12	38.9		29.0		9.9		34.0%
Oct-12	21.2		23.2		-2.0		-8.7%
Nov-12	24.8	21.4		3.4		15.7%	
Dec-12	26.6	24.3		2.3		9.6%	
Jan-13	24.9	26.9		-2.0		-7.6%	

Table G.33– Change in consumption calculations for EHMS-14

EHMS-15

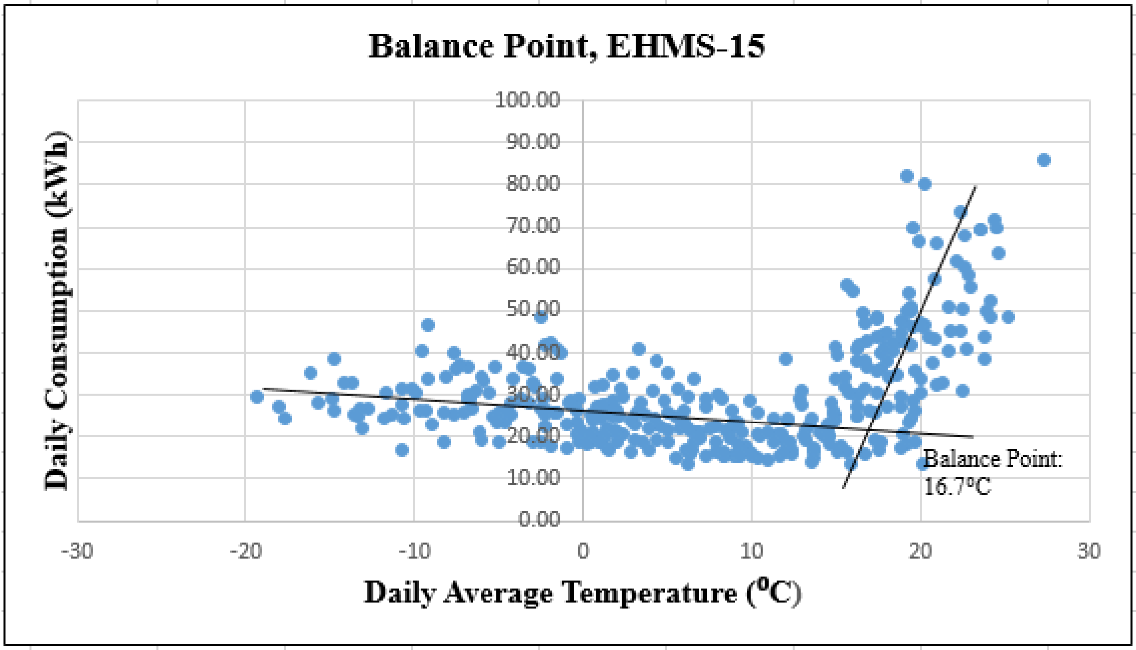

Figure G.23 – Daily average temperature versus daily consumption for the base year, for EHMS-15

EHMS-15 Base Year	# Days in the month	Monthly CDD/ #days in month (ºC)	Total monthly consumption/ # days in month (kWh/day)
Jan 13-31. 2011	19	0.0	27.2
Feb-11	28	0.0	33.6
Mar-11	31	0.0	24.6
Apr-11	30	0.0	21.8
May-11	31	0.6	20.8
Jun-11	30	1.1	31.1
Jul-11	31	4.7	51.7
Aug-11	31	2.7	42.8
Sep-11	30	0.9	30.3
Oct-11	31	0.0	24.4
Nov-11	30	0.0	24.3
Dec-11	31	0.0	25.9
Jan 1-12, 2012	12	0.0	28.4

Table G.34 – Cooling degree days and consumption for the base year for EHMS-15; the highlighted values were used to find the line of best fit in Figure G.24

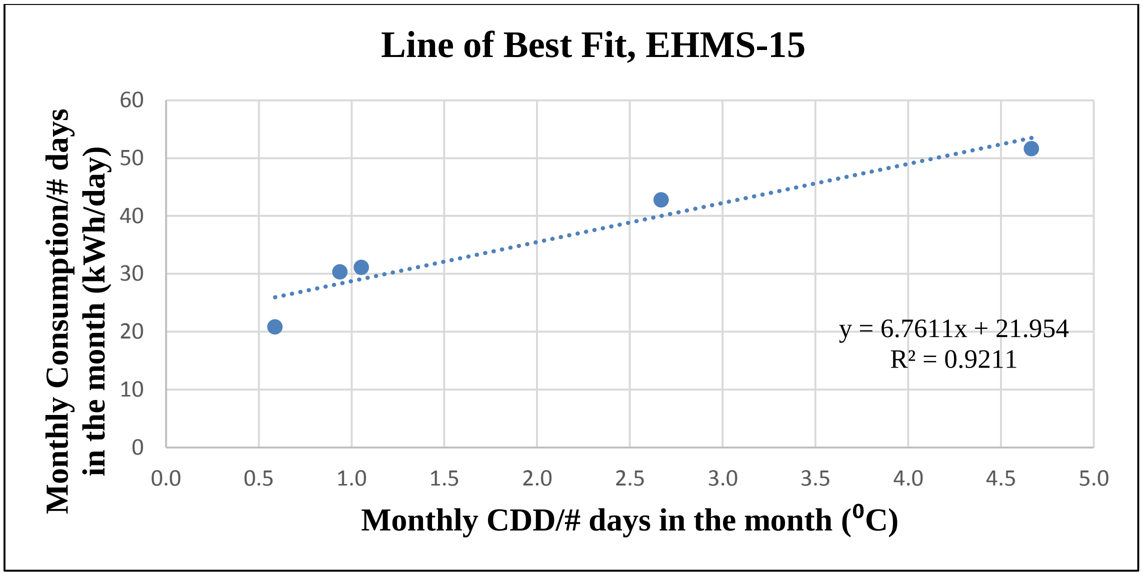

Figure G.24 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-15

EHMS-15 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 6.7611x + 21.954	
Jan 13-31 2012	0.0		27.3
Feb-12	0.0		26.4
Mar-12	0.0		19.3
Apr-12	0.0		22.4
May-12	0.8	27.6	29.7
Jun-12	2.4	38.3	42.2
Jul-12	4.7	53.5	52.2
Aug-12	2.5	38.5	45.6
Sep-12	0.7	26.7	31.5
Oct-12	0.1	22.3	23.9
Nov-12	0.0		26.0
Dec-12	0.0		33.4
Jan-13	0.0		27.9

Table G.35 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-15

EHMS-15 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Jan 13-31 2012	27.3	27.2		0.1		0.4%	
Feb-12	26.4	33.5		-7.1		-21.3%	
Mar-12	19.3	24.6		-5.3		-21.4%	
Apr-12	22.4	21.8		0.6		2.7%	
May-12	29.7		27.6		2.0		7.4%
Jun-12	42.2		38.3		3.9		10.2%
Jul-12	52.2		53.4		-1.3		-2.4%
Aug-12	45.6		38.5		7.0		18.2%
Sep-12	31.5		26.7		4.8		17.8%
Oct-12	23.9		22.3		1.7		7.4%
Nov-12	26.0	24.3		1.7		7.2%	
Dec-12	33.4	25.9		7.5		28.8%	
Jan-13	27.9	27.1		0.8		3.0%	

Table G.36 – Change in consumption calculations for EHMS-15

EHMS-16

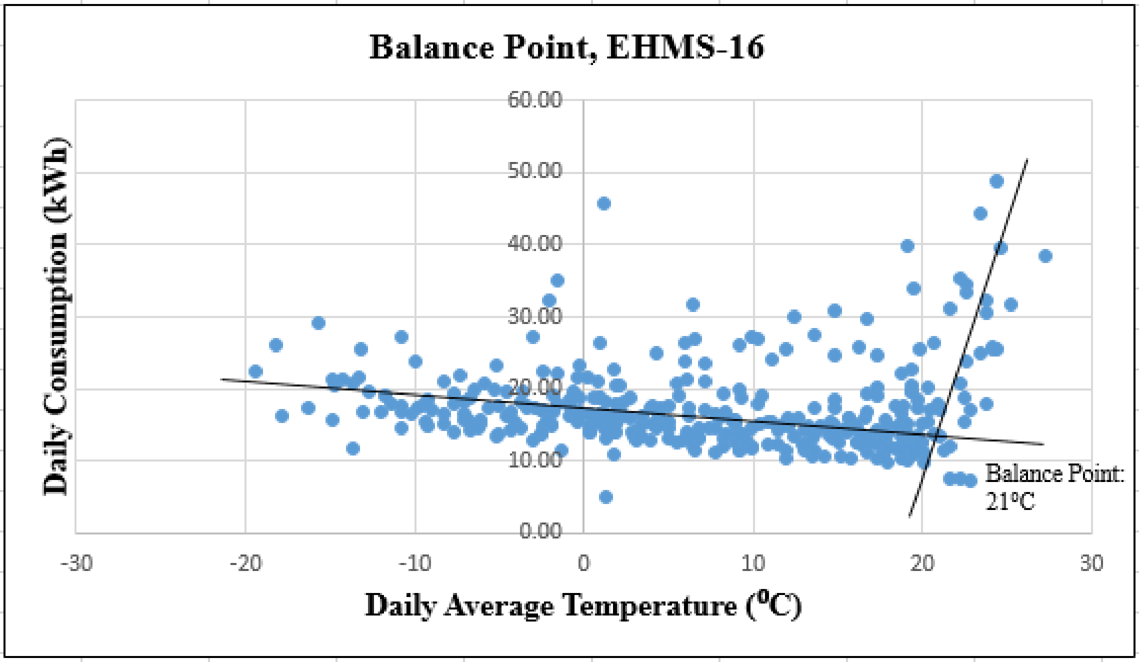

Figure G.25 – Daily average temperature versus daily consumption for the base year, for EHMS-16

EHMS-16 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Jan 13-31. 2013	19	0.0	20.0
Feb-11	28	0.0	18.4
Mar-11	31	0.0	15.6
Apr-11	30	0.0	15.3
May-11	31	0.1	13.8
Jun-11	30	0.1	14.9
Jul-11	31	1.3	22.7
Aug-11	31	0.2	17.0
Sep-11	30	0.17	17.3
Oct-11	31	0.0	16.7
Nov-11	30	0.0	18.2
Dec-11	31	0.0	19.2
Jan 1-12, 2012	12	0.0	17.8

Table G.37 – Cooling degree days and consumption for the base year for EHMS-16; the highlighted values were used to find the line of best fit in Figure G.26

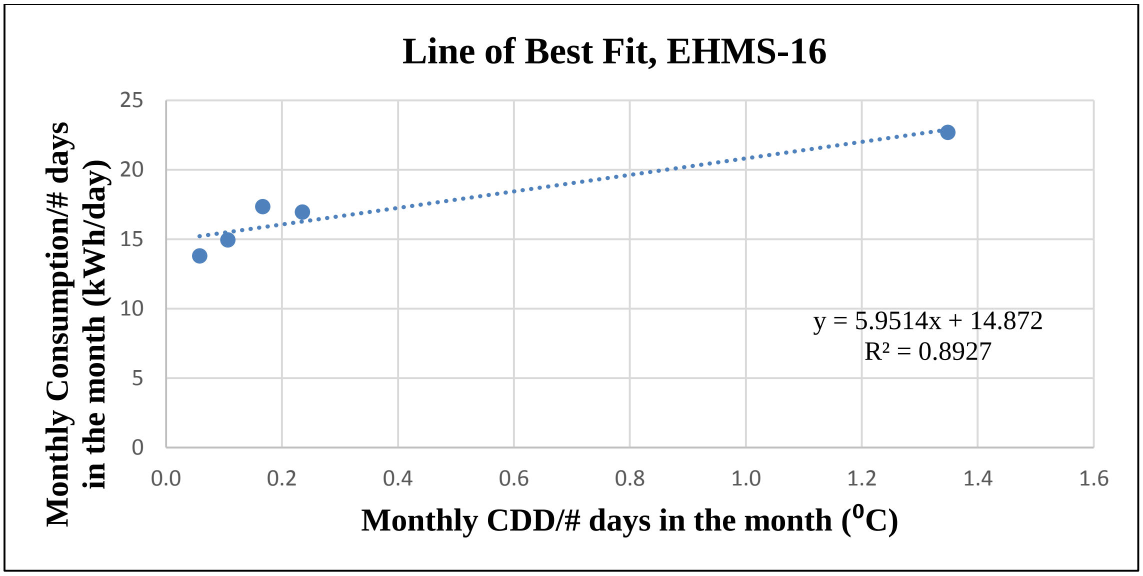

Figure G.26 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-16

EHMS-16 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 5.9514x + 14.872	
Jan 13-31, 2012	0.0		20.4
Feb-12	0.0		18.8
Mar-12	0.0		17.3
Apr-12	0.0		17.0
May-12	0.1	15.2	15.8
Jun-12	0.6	18.5	20.0
Jul-12	1.3	22.4	26.2
Aug-12	0.4	17.0	20.6
Sep-12	0.0	14.9	18.8
Oct-12	0.0		18.2
Nov-12	0.0		18.4
Dec-12	0.0		20.8
Jan-13	0.0		19.9

Table G.38 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-16

EHMS-16 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Jan 13-31, 2012	20.4	19.8		0.5		2.8%	
Feb-12	18.8	18.5		0.4		1.9%	
Mar-12	17.3	15.6		1.8		11.3%	
Apr-12	17.0	15.3		1.7		11.4%	
May-12	15.8		15.2		0.6		3.9%
Jun-12	20.0		18.5		1.4		7.8%
Jul-12	26.2		22.4		3.8		17.2%
Aug-12	20.6		17.0		3.5		20.7%
Sep-12	18.8		14.9		3.9		26.3%
Oct-12	18.2	16.7		1.5		8.8%	
Nov-12	18.4	18.2		0.2		1.4%	
Dec-12	20.8	19.2		1.6		8.3%	
Jan-13	19.9	19.8		0.1		0.2%	

Table G.39 – Change in consumption calculations for EHMS-16

EHMS-17

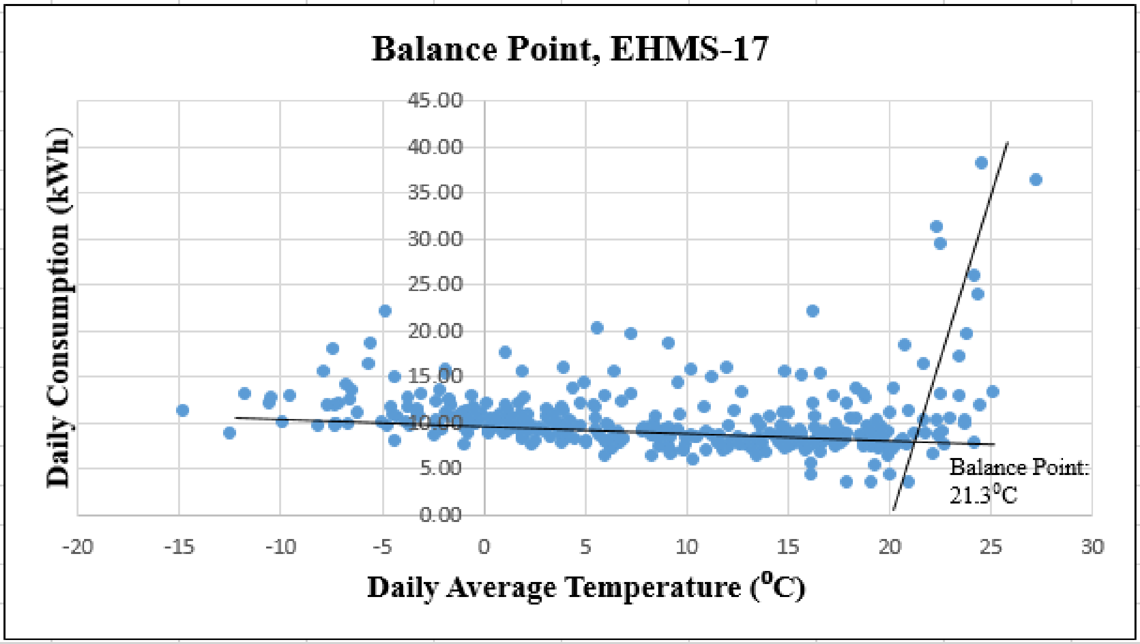

Figure G.27 – Daily average temperature versus daily consumption for the base year, for EHMS-17

EHMS-17 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	8.8
May-11	31	0.5	8.7
Jun-11	30	0.1	8.9
Jul-11	31	1.2	13.3
Aug-11	31	0.2	10.0
Sep-11	30	0.1	9.1
Oct-11	31	0.0	9.3
Nov-11	30	0.0	10.0
Dec-11	31	0.0	11.4
Jan-12	31	0.0	11.4
Feb-12	29	0.0	10.7
Mar-12	31	0.0	10.3
April 1-26, 2012	26	0.0	9.8

Table G.40 – Cooling degree days and consumption for the base year for EHMS-17; the highlighted values were used to find the line of best fit in Figure G.28

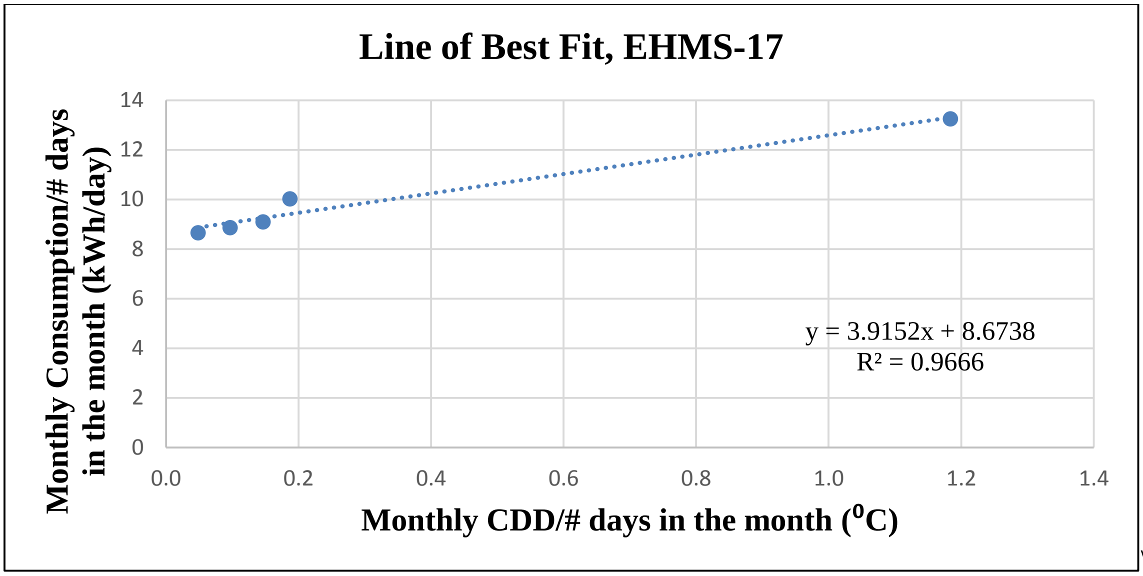

Figure G.28 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-17

EHMS- 17 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 3.9152x + 8.6738	
April 27-30, 2012	0.0		8.9
May-12	0.04	8.8	9.1
Jun-12	0.5	10.8	9.8
Jul-12	1.1	13.0	10.7
Aug-12	0.3	9.9	5.3
Sep-12	0.0	8.7	9.0
Oct-12	0.0		9.8
Nov-12	0.0		10.7
Dec-12	0.0		11.6
Jan-13	0.0		11.8

Table G.41 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-17

EHMS- 17 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{\text{MP} - \text{BY}}{\text{BY}}$	$\frac{\text{MP} - \text{ExMP}}{\text{ExMP}}$
April 27-30, 2012	8.9	8.8		0.2		2.0%	
May-12	9.1		8.8		0.2		2.4%
Jun-12	9.8		10.8		-1.0		-9.1%
Jul-12	10.7		13.0		-2.3		-17.9%
Aug-12	5.3		9.9		-4.6		-46.6%
Sep-12	9.0		8.7		0.3		3.3%
Oct-12	9.8	9.3		0.6		6.0%	
Nov-12	10.7	10.0		0.7		6.5%	
Dec-12	11.6	11.4		0.2		2.0%	
Jan-13	11.8	11.4		0.3		2.9%	

Table G.42 – Change in consumption calculations for EHMS-17

EHMS-18

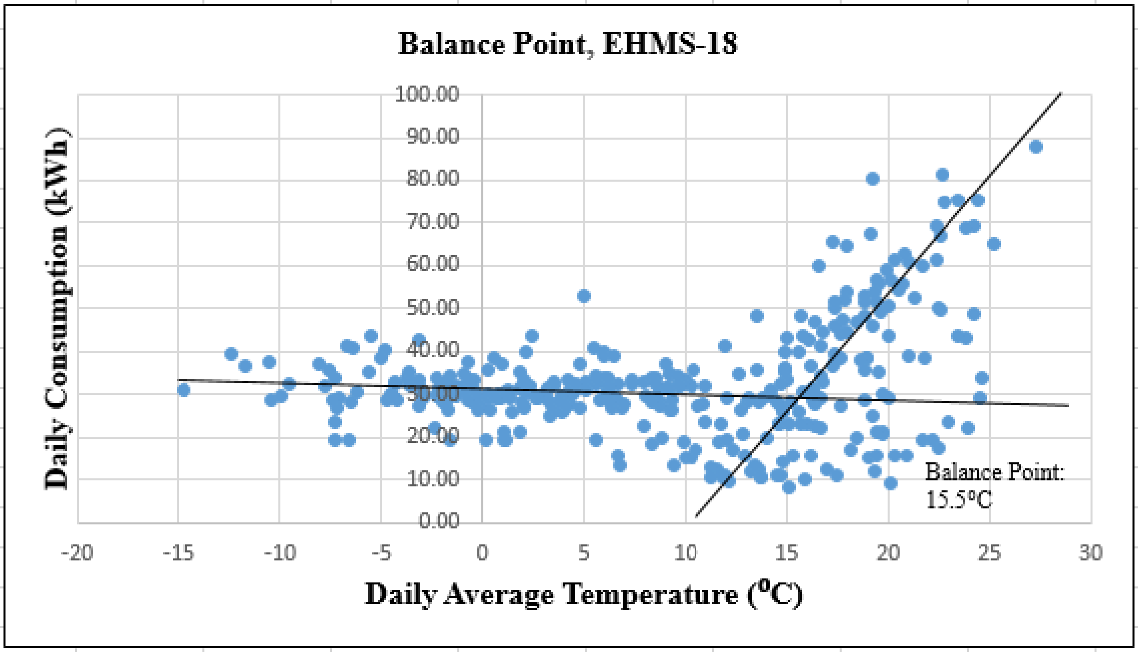

Figure G.29 – Daily average temperature versus daily consumption for the base year, for EHMS-18

EHMS-18 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	30.5
May-11	31	0.9	23.8
Jun-11	30	1.8	34.0
Jul-11	31	5.8	52.4
Aug-11	31	3.8	42.8
Sep-11	30	1.4	24.0
Oct-11	31	0.02	28.4
Nov-11	30	0.0	32.5
Dec-11	31	0.0	28.8
Jan-12	31	0.0	32.8
Feb-12	29	0.0	30.4
Mar-12	31	0.1	32.2
April 1-26, 2012	26	0.0	29.7

Table G.43 – Cooling degree days and consumption for the base year for EHMS-18; the highlighted values were used to find the line of best fit in Figure G.30

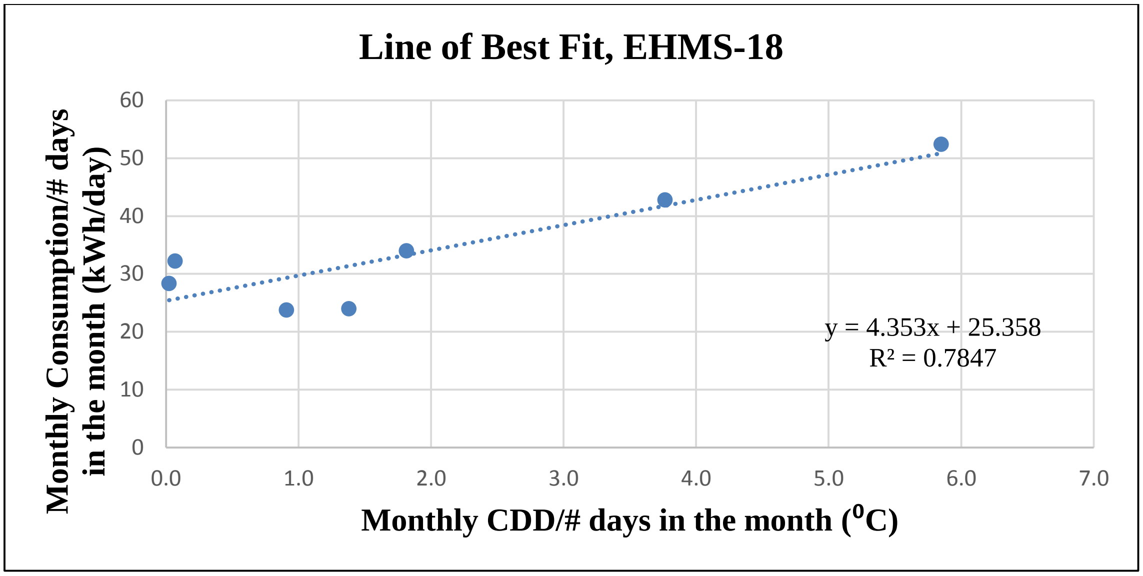

Figure G.30 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-18

EHMS-18 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 4.353x + 25.358**	
April 27-30, 2012	0.0		31.1
May-12	1.3	31.2	36.6
Jun-12	3.2	39.3	34.8
Jul-12	5.9	50.9	60.2
Aug-12	3.4	40.2	40.5
Sep-12	1.1	30.0	23.6
Oct-12	0.2	26.2	17.9
Nov-12	0.0		21.1
Dec-12	0.0		21.6
Jan-13	0.0		23.4

Table G.44 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-18

EHMS-18 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	31.1	30.5		0.6		2.0%	
May-12	36.6		31.2		5.4		17.4%
Jun-12	34.8		39.3		-4.5		-11.4%
Jul-12	60.2		50.9		9.3		18.4%
Aug-12	40.5		40.2		0.3		0.6%
Sep-12	23.6		30.0		-6.4		-21.4%
Oct-12	17.8		26.2		-8.4		-32.1%
Nov-12	21.1	32.5		-11.4		-35.1%	
Dec-12	21.6	28.8		-7.1		-24.8%	
Jan-13	23.4	32.8		-9.4		-28.7%	

Table G.45 – Change in consumption calculations for EHMS-18

EHMS-19

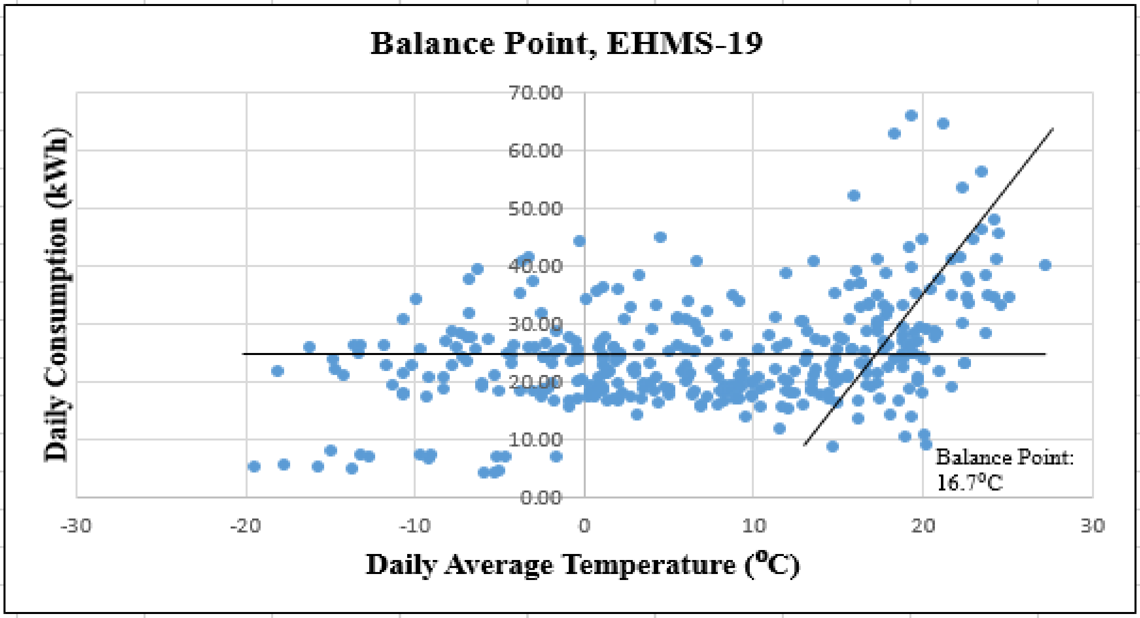

Figure G.31 – Daily average temperature versus daily consumption for the base year, for EHMS-19

EHMS-19 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
Jan 13-31. 2011	19	0.0	8.5
Feb-11	28	0.0	25.1
Mar-11	31	0.0	21.2
Apr-11	30	0.0	21.9
May-11	31	0.6	22.1
Jun-11	30	1.1	28.3
Jul-11	31	4.7	34.8
Aug-11	31	2.7	27.8
Sep-11	30	0.9	24.8
Oct-11	31	0.0	23.9
Nov-11	30	0.0	23.2
Dec-11	31	0.0	25.4
Jan 1-12, 2012	12	0.0	28.0

Table G.46 – Cooling degree days and consumption for the base year for EHMS-19; the highlighted values were used to find the line of best fit in Figure G.32

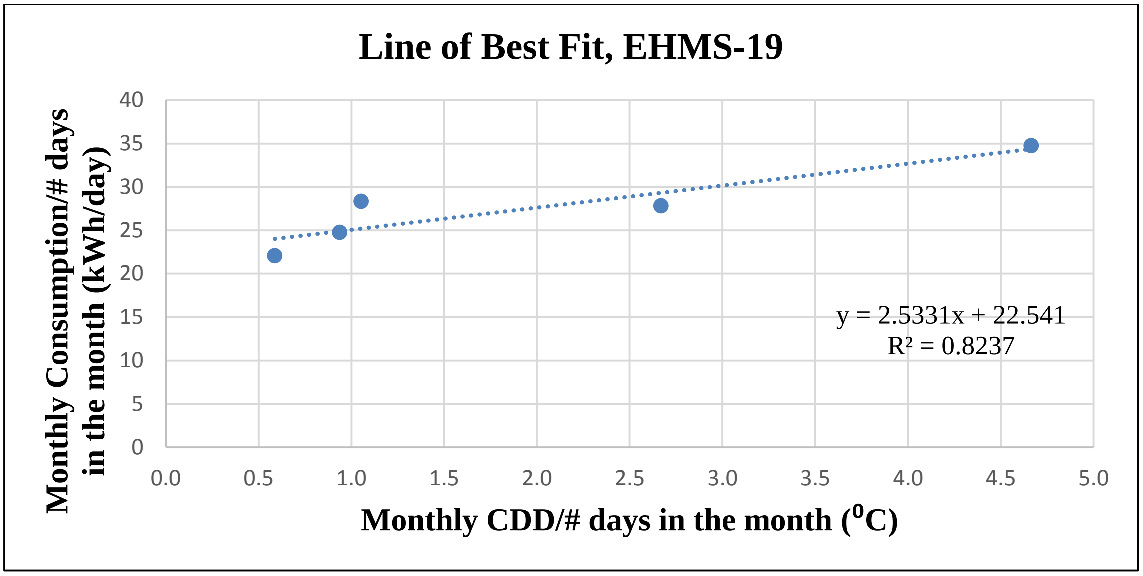

Figure G.32– Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-19

EHMS-19 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 2.5331x + 22.541	
Jan 13-31, 2012	0.0		17.6
Feb-12	0.0		19.7
Mar-12	0.0		16.7
Apr-12	0.0		16.9
May-12	0.8	24.7	19.9
Jun-12	2.4	28.7	26.9
Jul-12	4.7	34.3	14.9
Aug-12	2.5	28.8	30.6
Sep-12	0.7	24.3	22.6
Oct-12	0.05	22.7	14.7
Nov-12	0.0		17.0
Dec-12	0.0		14.6
Jan-13	0.0		18.8

Table G.47 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-19

EHMS-19 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
Jan 13-31, 2012	17.6	8.5		9.1		106.3%	
Feb-12	19.7	25.1		-5.4		-21.4%	
Mar-12	16.7	21.2		-4.5		-21.2%	
Apr-12	16.9	21.9		-5.0		-22.9%	
May-12	19.9		24.7		-4.8		-19.4%
Jun-12	26.9		28.7		-1.8		-6.3%
Jul-12	14.9		34.3		-19.4		-56.6%
Aug-12	30.6		28.8		1.8		6.4%
Sep-12	22.6		24.3		-1.7		-7.1%
Oct-12	14.7		22.7		-8.0		-35.3%
Nov-12	17.0	23.2		-6.1		-26.5%	
Dec-12	14.6	25.4		-10.8		-42.4%	
Jan-13	18.8	11.6		7.2		61.6%	

Table G.48 – Change in consumption calculations for EHMS-19

EHMS-20

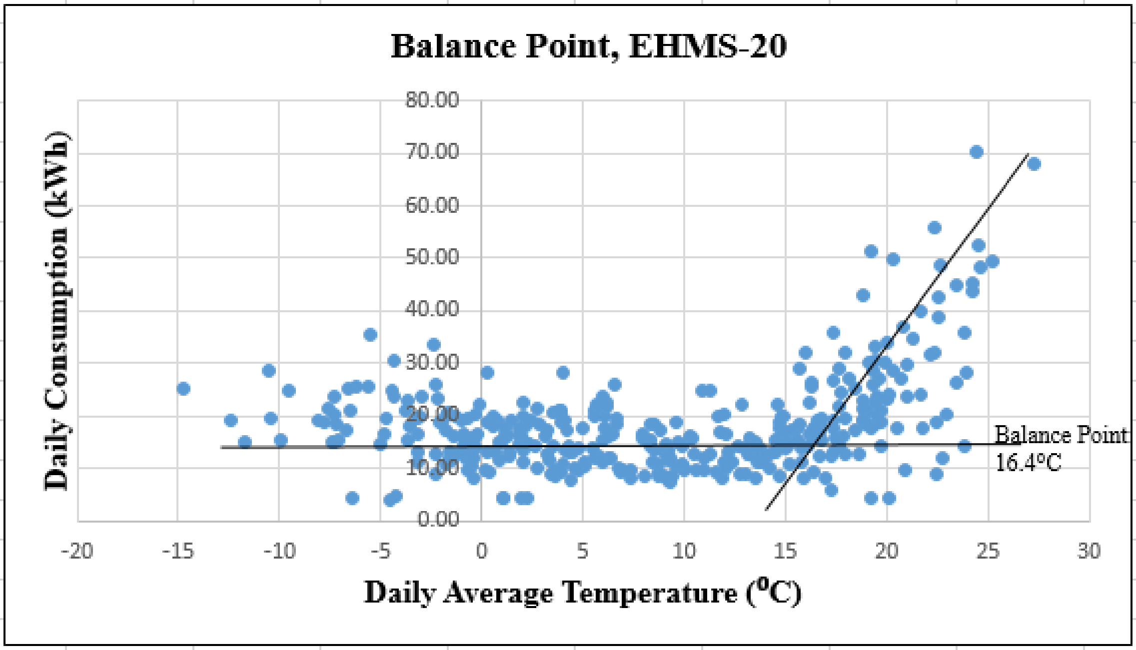

Figure G.33 – Daily average temperature versus daily consumption for the base year, for EHMS-20

EHMS-20 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	13.5
May-11	31	0.7	12.0
Jun-11	30	1.2	18.6
Jul-11	31	5.0	34.9
Aug-11	31	2.9	24.8
Sep-11	30	1.0	17.4
Oct-11	31	0.0	15.8
Nov-11	30	0.0	13.1
Dec-11	31	0.0	14.1
Jan-12	31	0.0	18.0
Feb-12	29	0.0	20.6
Mar-12	31	0.0	15.5
April 1-26, 2012	26	0.0	14.6

Table G. 49– Cooling degree days and consumption for the base year for EHMS-20; the highlighted values were used to find the line of best fit in Figure G.34

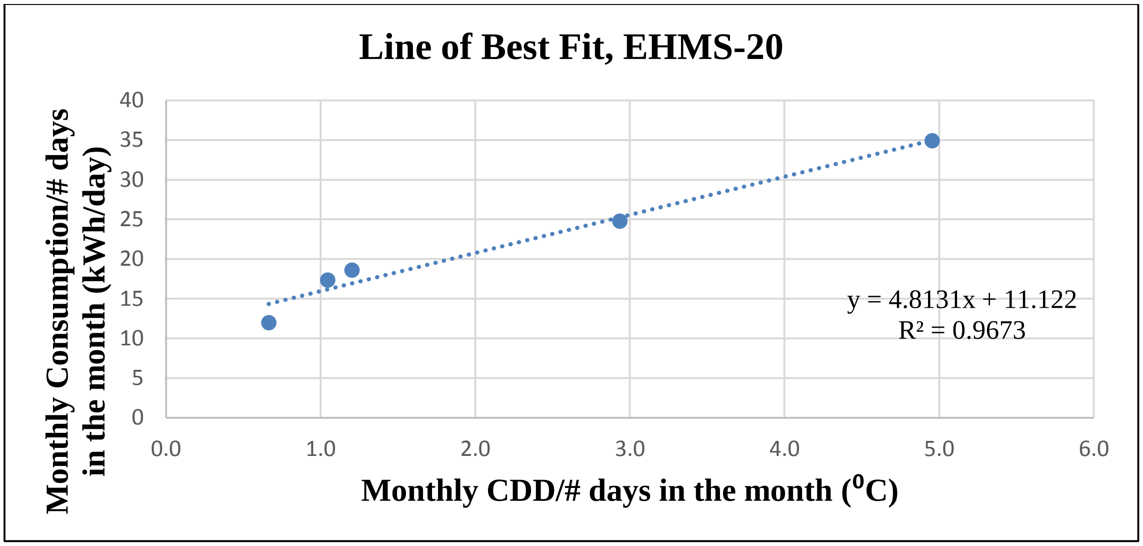

Figure G.34 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-20

EHMS- 20 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 4.8131x + 11.122**	
April 27-30, 2012	0.0		18.0
May-12	1.0	15.7	14.6
Jun-12	2.6	23.7	28.3
Jul-12	5.0	35.0	39.8
Aug-12	2.7	24.1	30.2
Sep-12	0.8	14.9	24.3
Oct-12	0.1	11.5	22.5
Nov-12	0.0		24.4
Dec-12	0.0		22.9

Table G.50 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-20

EHMS- 20 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	18.0	13.5		4.5		33.2%	
May-12	14.6		15.7		-1.2		-7.4%
Jun-12	28.3		23.7		4.6		19.4%
Jul-12	39.8		35.0		4.8		13.6%
Aug-12	30.2		24.1		6.1		25.5%
Sep-12	24.3		14.9		9.3		62.3%
Oct-12	22.5		11.5		11.0		96.2%
Nov-12	24.4	13.1		11.2		85.5%	
Dec-12	22.9	14.1		8.9		62.9%	

Table G.51 – Change in consumption calculations for EHMS-20

EHMS-21

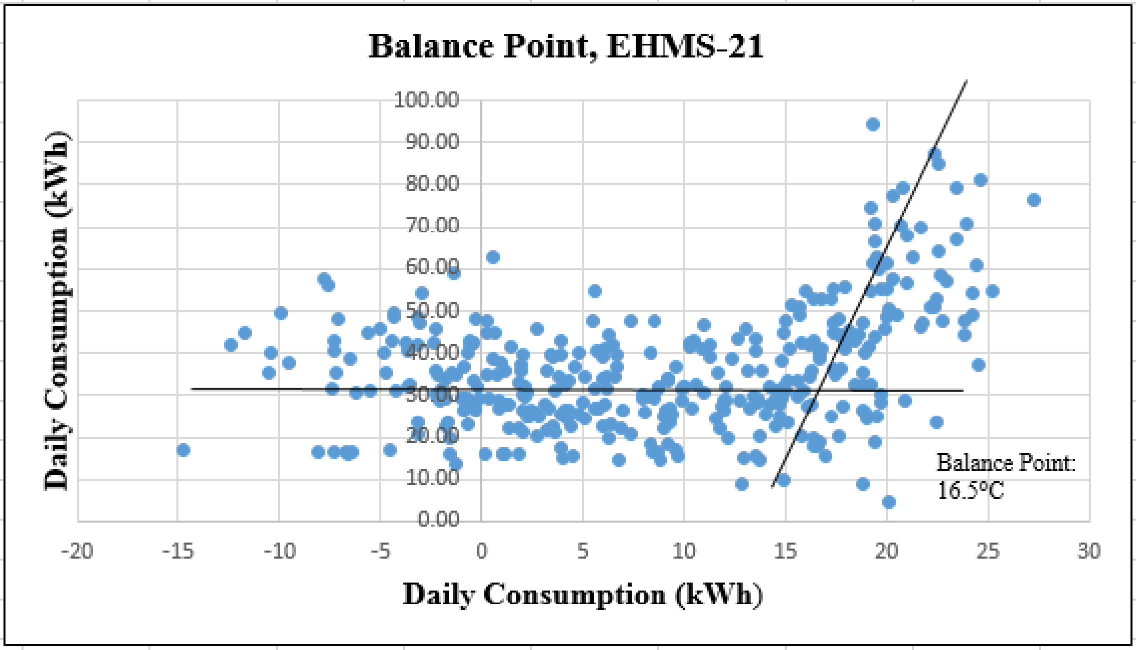

Figure G.35 – Daily average temperature versus daily consumption for the base year, for EHMS-21

EHMS-21 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	35.505
May-11	31	0.6	26.7
Jun-11	30	1.2	39.9
Jul-11	31	4.9	54.7
Aug-11	31	2.9	51.5
Sep-11	30	1.0	32.3
Oct-11	31	0.0	30.5
Nov-11	30	0.0	28.9
Dec-11	31	0.0	27.0
Jan-12	31	0.0	35.7
Feb-12	29	0.0	40.1
Mar-12	31	0.0	33.8
April 1-26, 2012	26	0.0	30.9

Table G.52 – Cooling degree days and consumption for the base year for EHMS-21; the highlighted values were used to find the line of best fit in Figure G.36

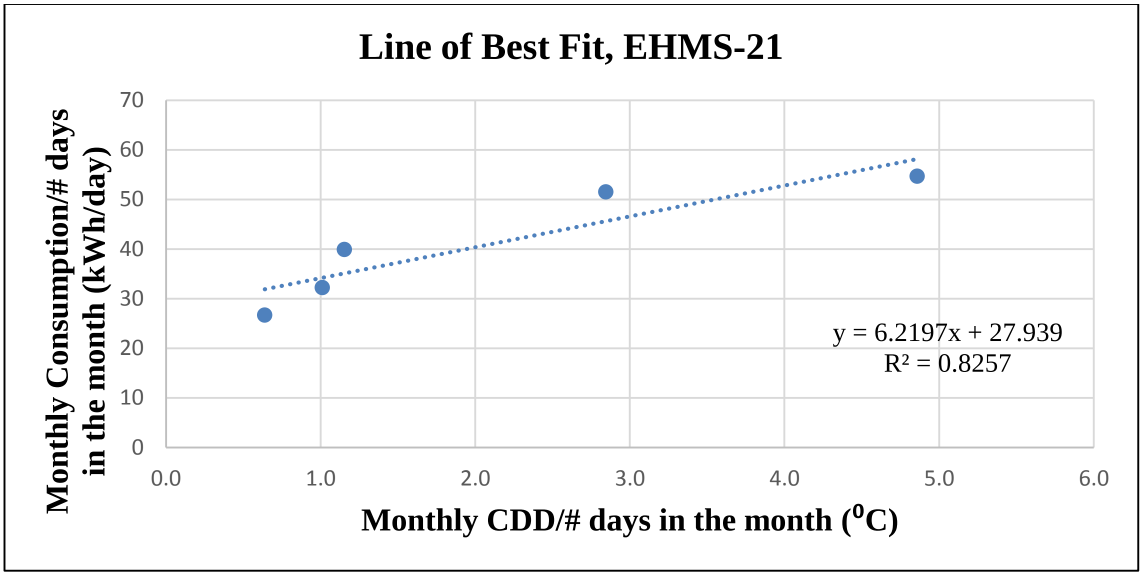

Figure G.36 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-21

EHMS-21 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 6.2197x + 27.939**	
April 27-30, 2012	0.0		18.4
May-12	0.9	33.7	34.6
Jun-12	2.6	43.8	43.9
Jul-12	4.9	58.2	58.1
Aug-12	2.6	44.2	51.7
Sep-12	0.8	32.7	36.6
Oct-12	0.1	28.3	34.7
Nov-12	0.0		35.0
Dec-12	0.0		36.6
Jan-13	0.0		38.6

Table G.53 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-21

EHMS-21 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	18.4	35.5		-17.1		-48.3%	
May-12	34.6		33.7		0.9		2.7%
Jun-12	43.9		43.8		0.1		0.4%
Jul-12	58.1		58.2		-0.04		-0.1%
Aug-12	51.7		44.2		7.6		17.1%
Sep-12	36.6		32.7		3.9		11.8%
Oct-12	34.7		28.3		6.4		22.7%
Nov-12	35.0	28.9		6.1		21.1%	
Dec-12	36.6	27.0		9.7		35.6%	
Jan-13	38.6	35.7		2.9		8.1%	

Table G.54 – Change in consumption calculations for EHMS-21

EHMS-22

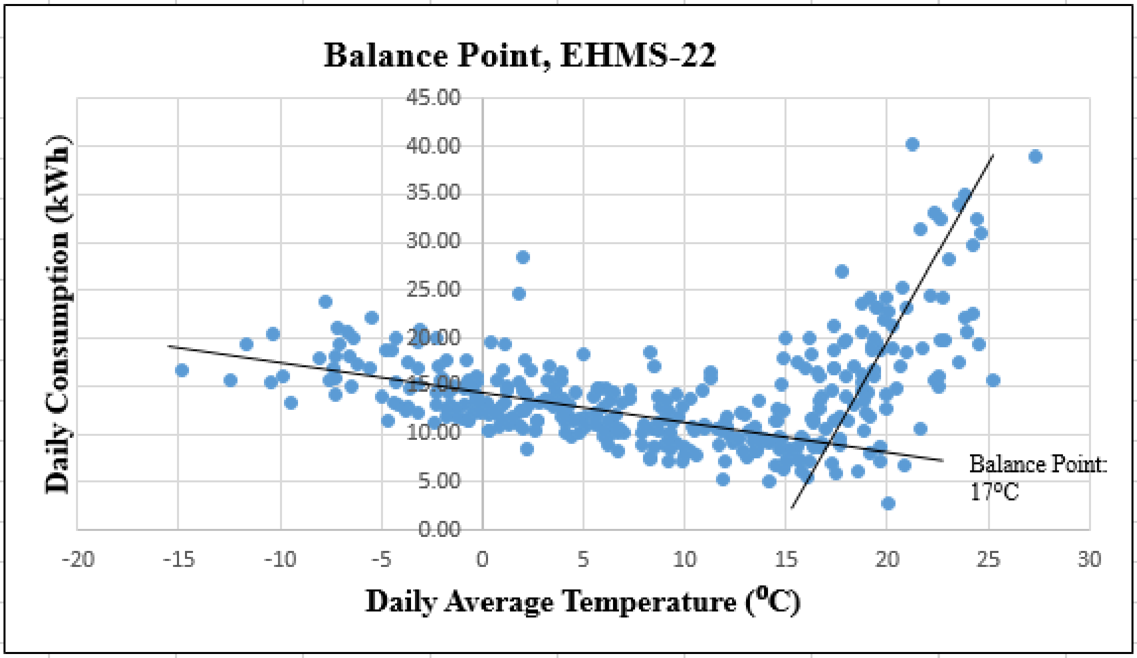

Figure G.37 – Daily average temperature versus daily consumption for the base year, for EHMS-22

EHMS-22 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	10.5
May-11	31	0.5	10.1
Jun-11	30	0.9	12.4
Jul-11	31	4.4	23.7
Aug-11	31	2.4	18.1
Sep-11	30	0.9	10.3
Oct-11	31	0.0	11.5
Nov-11	30	0.0	12.3
Dec-11	31	0.0	15.3
Jan-12	31	0.0	16.6
Feb-12	29	0.0	13.8
Mar-12	31	0.0	13.7
April 1-26, 2012	26	0.0	12.1

Table G.55 – Cooling degree days and consumption for the base year for EHMS-22; the highlighted values were used to find the line of best fit in Figure G.38

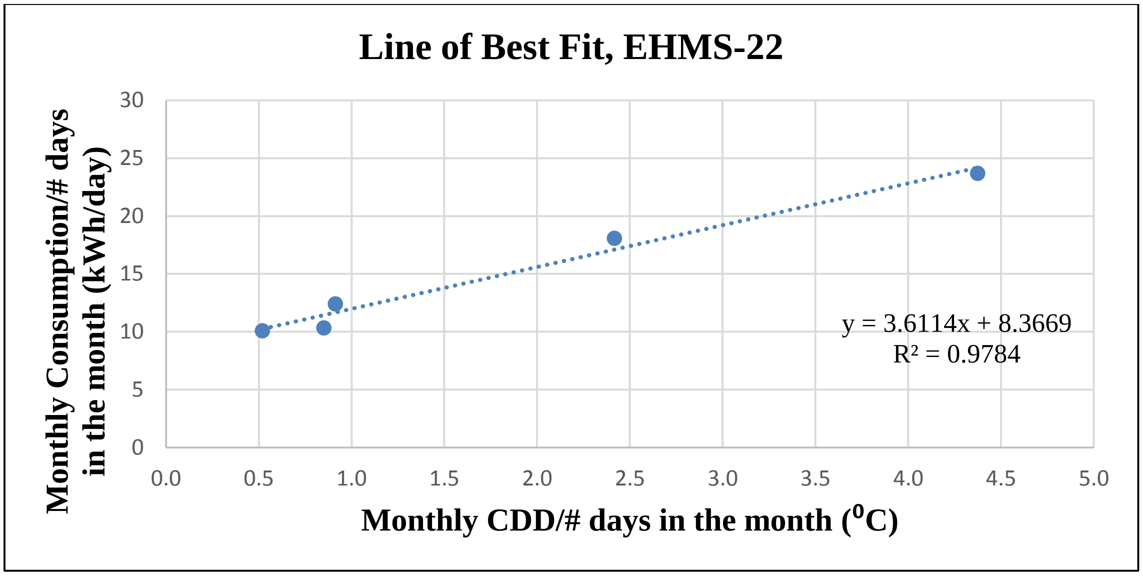

Figure G.38 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-22

EHMS-22 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 3.6114x + 8.3669	
April 27-30, 2012	0.0		10.2
May-12	0.7	11.0	13.0
Jun-12	2.2	16.4	17.3
Jul-12	4.4	24.1	24.1
Aug-12	2.2	16.4	16.6
Sep-12	0.6	10.6	12.4
Oct-12	0.03	8.5	12.5
Nov-12	0.0		14.0
Dec-12	0.0		17.8
Jan-13	0.0		17.6

Table G.56 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-22

EHMS-22 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	10.2	10.5		-0.3		-3.192%	
May-12	13.0		11.0		2.0		18.4%
Jun-12	17.3		16.4		0.8		4.9%
Jul-12	24.1		24.1		0.03		0.1%
Aug-12	16.6		16.4		0.2		1.0%
Sep-12	12.4		10.6		1.9		17.6%
Oct-12	12.5		8.5		4.1		47.9%
Nov-12	14.0	12.3		1.7		13.7%	
Dec-12	17.8	15.3		2.5		16.3%	
Jan-13	17.6	16.6		0.9		5.5%	

Table G.57 – Change in consumption calculations for EHMS-22

EHMS-23

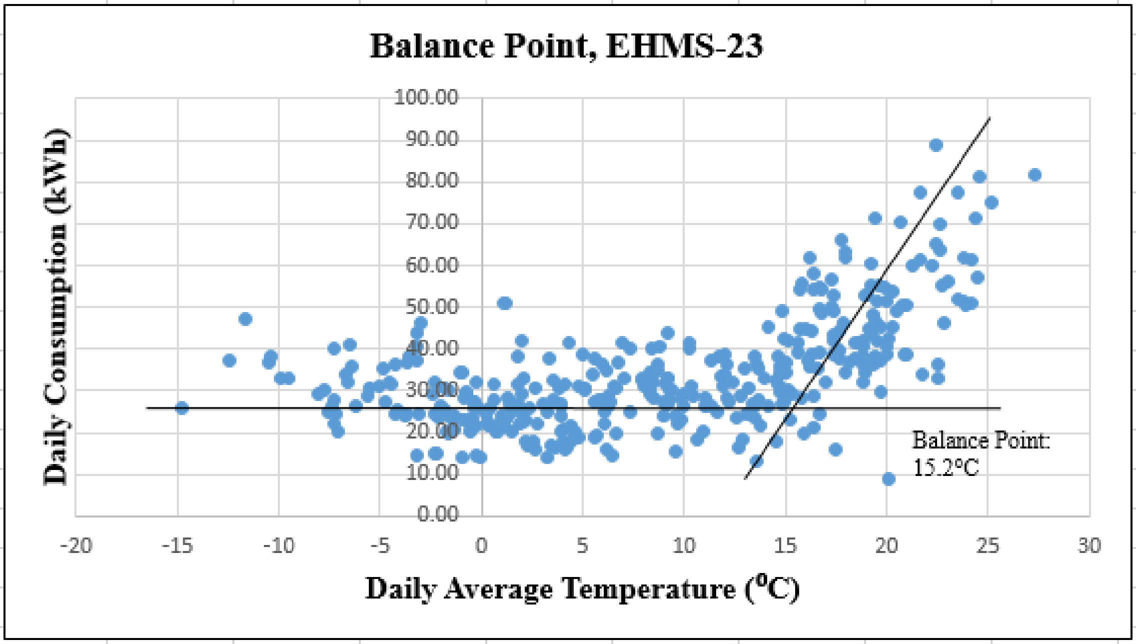

Figure G.39 – Daily average temperature versus daily consumption for the base year, for EHMS-23

EHMS-23 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	16.9
May-11	31	1.0	35.0
Jun-11	30	2.0	42.9
Jul-11	31	6.1	57.9
Aug-11	31	4.1	45.5
Sep-11	30	1.5	35.4
Oct-11	31	0.04	34.1
Nov-11	30	0.0	29.0
Dec-11	31	0.0	25.7
Jan-12	31	0.0	30.1
Feb-12	29	0.0	28.4
Mar-12	31	0.1	25.9
April 1-26, 2012	26	0.0	21.3

Table G.58 – Cooling degree days and consumption for the base year for EHMS-23; the highlighted values were used to find the line of best fit in Figure G.40

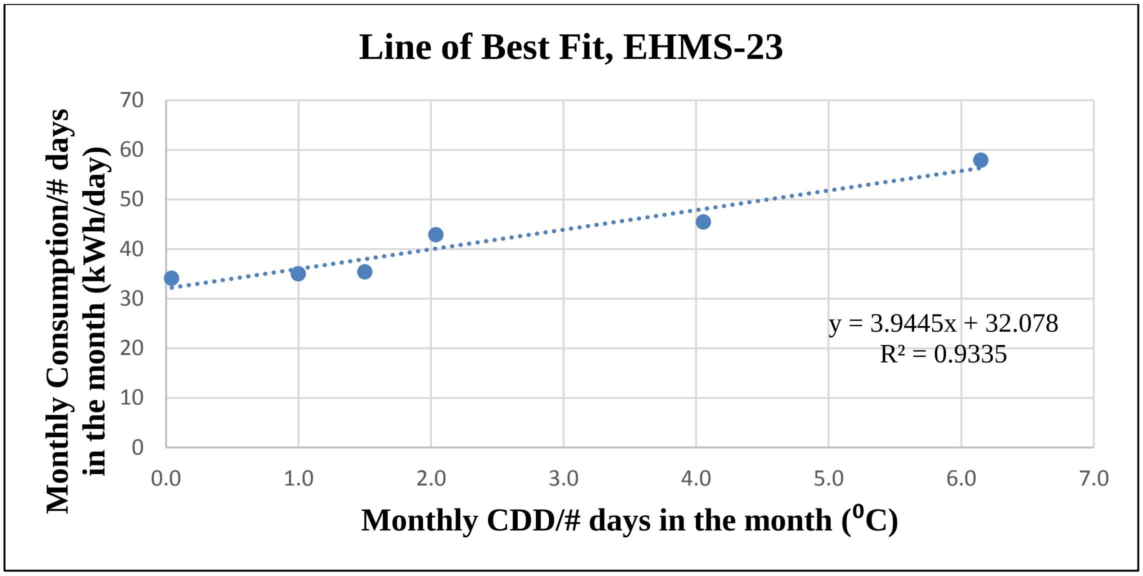

Figure G.40 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-23

EHMS-23 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	**y = 3.9445x + 32.078**	
April 27-30, 2012	0.0		22.5
May-12	1.5	37.9	29.8
Jun-12	3.4	45.5	35.8
Jul-12	6.2	56.4	39.9
Aug-12	3.7	46.5	44.0
Sep-12	1.2	36.6	31.6
Oct-12	0.2	33.0	24.6
Nov-12	0.0		24.4
Dec-12	0.0		28.7
Jan-13	0.0		29.3

Table G.59 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-23

EHMS-23 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	22.5	16.9		5.6		33.0%	
May-12	29.8		37.9		-8.1		-21.3%
Jun-12	35.8		45.5		-9.7		-21.3%
Jul-12	39.9		56.4		-16.5		-29.2%
Aug-12	44.0		46.5		-2.5		-5.5%
Sep-12	31.6		36.6		-5.1		-13.7%
Oct-12	24.7		33.0		-8.3		-25.2%
Nov-12	24.4	29.0		-4.6		-15.9%	
Dec-12	28.7	25.7		3.0		11.7%	
Jan-13	29.3	30.1		-0.8		-2.6%	

Table G.60 – Change in consumption calculations for EHMS-23

EHMS-24

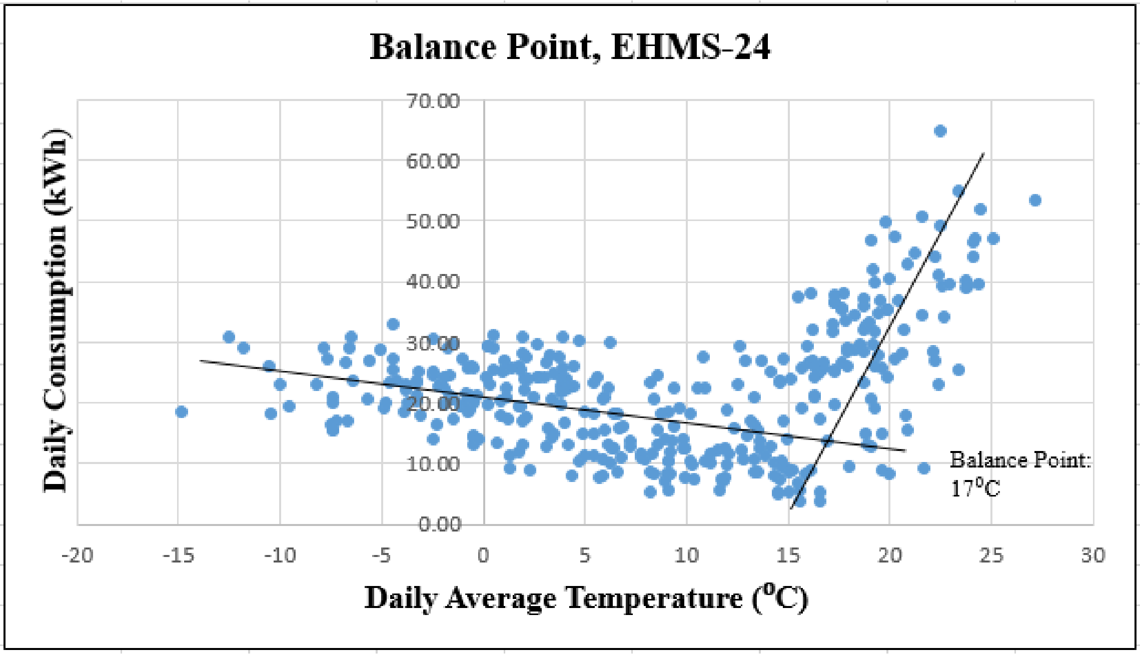

Figure G.41 – Daily average temperature versus daily consumption for the base year, for EHMS-24

EHMS-24 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	14.6
May-11	31	0.5	14.4
Jun-11	30	0.9	26.7
Jul-11	31	4.4	41.4
Aug-11	31	2.4	24.9
Sep-11	30	0.9	14.3
Oct-11	31	0.0	10.2
Nov-11	30	0.0	13.3
Dec-11	31	0.0	21.3
Jan-12	31	0.0	23.3
Feb-12	29	0.0	22.5
Mar-12	31	0.0	23.4
April 1-26, 2012	26	0.0	25.1

Table G.61 – Cooling degree days and consumption for the base year for EHMS-24; the highlighted values were used to find the line of best fit in Figure G.42

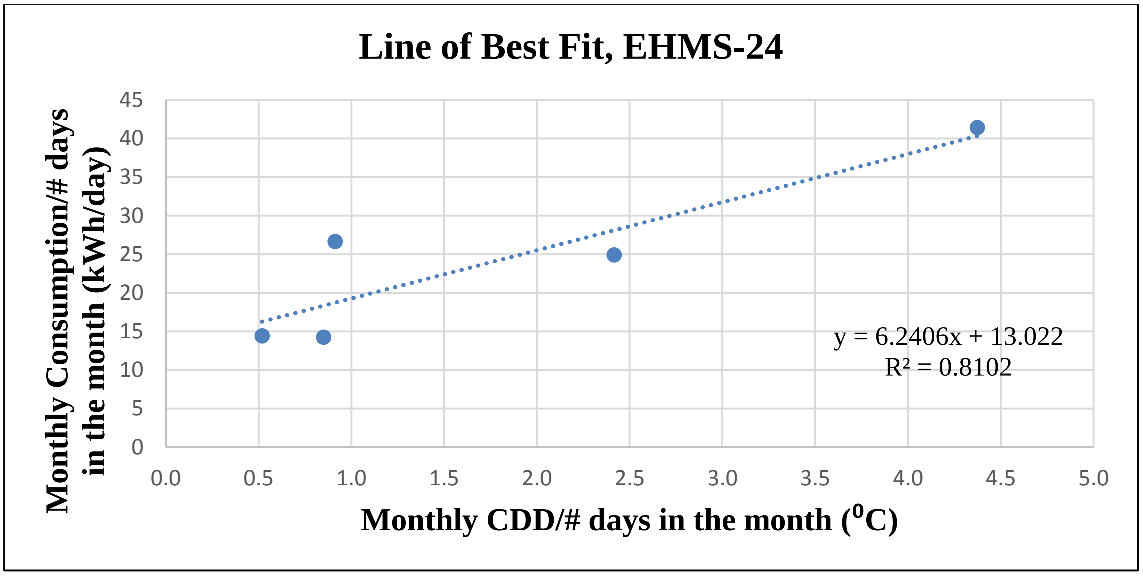

Figure G.42 – Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-24

EHMS-24 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 6.2406x + 13.022	
April 27-30, 2012	0.0		25.7
May-12	0.7	17.6	23.0
Jun-12	2.2	27.0	45.3
Jul-12	4.4	40.2	54.6
Aug-12	2.2	27.0	47.9
Sep-12	0.6	16.9	32.3
Oct-12	0.02	13.1	22.7
Nov-12	0.0		24.9
Dec-12	0.0		25.4
Jan-13	0.0		23.7

Table G.62 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-24

EHMS-24 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	MP-ExMP	$\frac{MP - BY}{BY}$	$\frac{MP - ExMP}{ExMP}$
April 27-30, 2012	25.7	14.6		11.1		75.9%	
May-12	23.0		17.6		5.5		31.2%
Jun-12	45.3		27.0		18.3		67.9%
Jul-12	54.6		40.2		14.3		35.7%
Aug-12	47.9		27.0		21.0		77.78%
Sep-12	32.3		16.9		15.4		91.5%
Oct-12	22.7		13.2		9.6		72.45%
Nov-12	24.9	13.3		11.6		86.6%	
Dec-12	25.4	21.3		4.1		19.4%	
Jan-13	23.7	23.3		0.4		1.7%	

Table G.63 – Change in consumption calculations for EHMS-24

EHMS-25

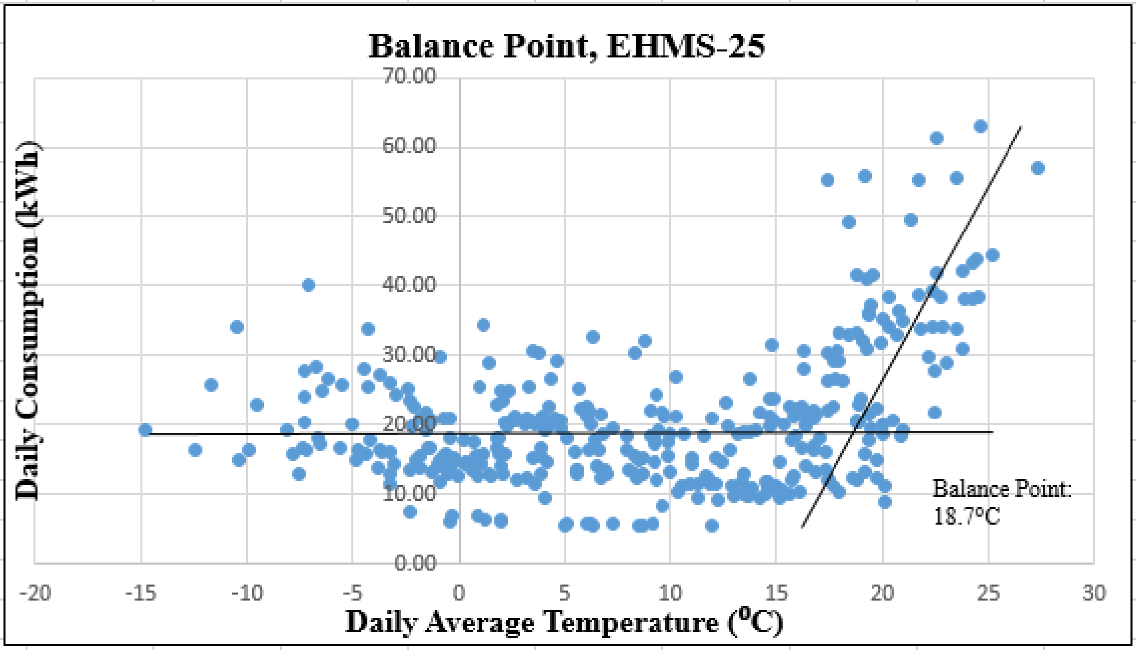

Figure G.43 – Daily average temperature versus daily consumption for the base year, for EHMS-25

EHMS-25 Base Year	# Days in the month	Monthly CDD/ #days in month (°C)	Total monthly consumption/ # days in month (kWh/day)
April 27-30, 2011	4	0.0	13.1
May-11	31	0.2	20.2
Jun-11	30	0.4	19.9
Jul-11	31	2.9	39.1
Aug-11	31	1.1	28.6
Sep-11	30	0.4	14.4
Oct-11	31	0.0	17.1
Nov-11	30	0.0	10.0
Dec-11	31	0.0	19.6
Jan-12	31	0.0	18.5
Feb-12	29	0.0	17.0
Mar-12	31	0.0	18.0
April 1-26, 2012	26	0.0	21.8

Table G.64 – Cooling degree days and consumption for the base year for EHMS-25; the highlighted values were used to find the line of best fit in Figure G.44

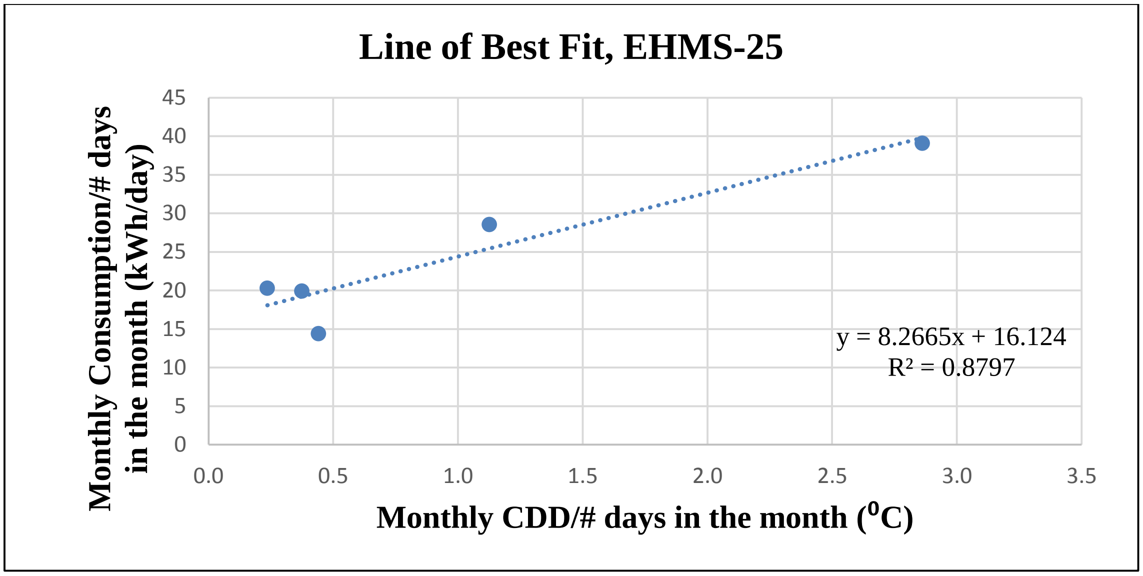

Figure G.44– Line of best fit, used to calculated the expected consumption for the cooling months of the monitoring period for EHMS-25

EHMS-25 Monitoring Period	Monthly CDD/ #days in the month (°C)	Expected Consumption (kWh/day)	Monitoring Period Consumption (kWh/day)
	x	y = 8.2665x + 16.124	
April 27-30, 2012	0.0		25.6
May-12	0.3	18.6	22.7
Jun-12	1.4	27.7	30.9
Jul-12	2.8	39.3	40.5
Aug-12	1.1	25.6	31.8
Sep-12	0.1	17.3	26.7
Oct-12	0.0		24.3

Table G.65 – Cooling degree days, expected consumption, and monitoring period consumption for EHMS-25

EHMS-25 Monitoring Period	Monitoring period consumption (kWh/day) (MP)	Base year consumption (kWh/day) (BY)	Expected consumption (kWh/day) (ExMP)	Change in consumption for non-cooling months (kWh/day)	Change in consumption for cooling months (kWh/day)	Change in consumption, non-cooling months (%)	Change in consumption, cooling months (%)
				MP-BY	**MP-ExMP**	$\frac{\mathbf{MP - BY}}{\mathbf{BY}}$	$\frac{\mathbf{MP - ExMP}}{\mathbf{ExMP}}$
April 27-30, 2012	25.6	13.1		12.5		95.0%	
May-12	22.7		18.6		4.2		22.4%
Jun-12	30.9		27.7		3.2		11.6%
Jul-12	40.5		39.3		1.2		3.0%
Aug-12	31.8		25.6		6.2		24.2%
Sep-12	26.7		17.3		9.4		54.0%
Oct-12	24.3	17.1		7.3		42.3%	

Table G.66 – Change in consumption calculations for EHMS-25

Appendix H: Detailed Results for the Engagement Index

This appendix contains two tables for each hub. The first contains the raw data used to calculate the engagement index, and the second contains the values for each index used to calculate the engagement index, and the engagement index. As a reminder, the equations used to calculate the engagement index are presented below in Table H.1. These equations were first introduced in section 3.8, which also contains a detailed explanation of each index used to calculate the engagement index.

<table>
<tr><td>Click Depth Index (Ci)
(Equation 3.3)</td><td>$$Ci = \frac{\#\ sessions\ with\ pages\ beyond\ the\ homepage\ visited}{total\ \#\ sessions}$$</td></tr>
<tr><td>Duration Index (Di)
(Equation 3.4)</td><td>$$Di = \frac{\#sessions\ more\ than\ y\ minutes}{total\ number\ of\ sessions}$$</td></tr>
<tr><td rowspan="2">Recency Index (Ri)
(Equations 3.5 and 3.6)</td><td>$$Ri_{session} = \frac{1}{1 + \#days\ since\ most\ recent\ session}$$</td></tr>
<tr><td>$$Ri = \frac{\sum Ri_{session}}{\#sessions}$$</td></tr>
<tr><td>Session Index (Si)
(Equation 3.7)</td><td>$$Si = 1 - (\frac{1}{1 + \#sessions\ during\ timeframe})$$</td></tr>
<tr><td>Communication Index (Fi)
(Equation 3.8)</td><td>$$Fi = \frac{\#\ sessions\ that\ EHMS\ was\ contacted}{all\ sessions}$$</td></tr>
<tr><td rowspan="2">Interaction Index (Ii)
(Equations 3.9 and 3.10)</td><td>$$Ii_{session} = \frac{\#\ types\ of\ actions\ taken}{total\ \#\ types\ of\ actions}$$</td></tr>
<tr><td>$$Ii = \frac{\sum Ii_{sessions}}{\#sessions}$$</td></tr>
<tr><td>Monthly Engagement Index
(Equation 3.1)</td><td>$$\frac{(Ci + Di + Ri + Si + Fi + Ii)}{6}$$</td></tr>
</table>

Table H.1 – Engagement index equations

EHMS-01

EHMS-01	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Nov 29-31, 2011							
Dec-11	1	1	1	1	7	1	0
Jan-12							
Feb-12							
Mar-12							
Apr-12	1	2	2	1	126	0	1
	2				20		1
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13	1	1	1	1	268	0	1

Table H.2 – Raw data used to calculate the engagement index for EHMS-01

EHMS-01	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Nov 29-31, 2011									
Dec-11	1.000	1.000	0.125	0.125	0.500	1.000	0.000	0.000	0.604
Jan-12									
Feb-12									
Mar-12									
Apr-12	1.000	0.500	0.008	0.028	0.667	0.000	0.333	0.333	0.421
			0.048				0.333		
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13	1.000	1.000	0.004	0.004	0.500	0.000	0.250	0.250	0.459

Table H.3. – Engagement Index calculations for EHMS-01

EHMS-02

EHMS-02	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Nov 29-31, 2011							
Dec-11							
Jan-12							
Feb-12							
Mar-12							
Apr-12							
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12	1	1	0	0	300	1	0
Oct-12							
Nov-12	1	1	0	0	61	1	0
Dec-12							
Jan-13							

Table H.4 – Raw data used to calculate the engagement index for EHMS-02

EHMS-02	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Nov 29-31, 2011									
Dec-11									
Jan-12									
Feb-12									
Mar-12									
Apr-12									
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12	0.000	0.000	0.003	0.003	0.500	1.000	0.000	0.000	0.251
Oct-12									
Nov-12	0.000	0.000	0.016	0.016	0.500	1.000	0.000	0.000	0.253
Dec-12									
Jan-13									

Table H.5 – Engagement Index calculations for EHMS-02

EHMS-04

EHMS-04	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Nov 29-31, 2011							
Dec-11	1	1	1	1	2	1	0
Jan-12	1	2	1	1	43	0	2
	2				0		0
Feb-12	1	1	1	0	28	0	0
Mar-12	1	1	1	0	38	0	0
Apr-12							
May-12							
Jun-12							
Jul-12	1	1	1	1	115	0	1
Aug-12							
Sep-12							
Oct-12							
Nov-12	1	1	1	1	137	0	2
Dec-12							
Jan-13							

Table H.6 – Raw data used to calculate the engagement index for EHMS-04

EHMS-04	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Nov 29-31, 2011									
Dec-11	1.000	1.000	0.333	0.333	0.500	1.000	0.000	0.000	0.639
Jan-12	0.500	0.500	0.023	0.511	0.667	0.000	0.667	0.333	0.419
			1.000				0		
Feb-12	1.000	0.000	0.034	0.034	0.500	0.000	0.000	0.000	0.256
Mar-12	1.000	0.000	0.026	0.026	0.500	0.000	0.000	0.000	0.254
Apr-12									
May-12									
Jun-12									
Jul-12	1.000	1.000	0.009	0.009	0.500	0.000	0.333	0.333	0.474
Aug-12									
Sep-12									
Oct-12									
Nov-12	1.000	1.000	0.007	0.007	0.500	0.000	0.500	0.500	0.501
Dec-12									
Jan-13									

Table H.7 – Engagement Index calculations for EHMS-04

EHMS-05

EHMS-05	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011	1	2	2	1	3	0	1
	2				5		2
Jan-12	1	2	2	2	1	1	0
	2				24		1
Feb-12	1	2	2	1	12	0	3
	2				7		1
Mar-12							
Apr-12							
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12	1	1	1	0	220	0	2
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.8. – Raw data used to calculate the engagement index for EHMS-05

EHMS-05	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011	1.000	0.500	0.250	0.208	0.667	0.000	0.333	0.500	0.479
			0.167				0.667		
Jan-12	1.000	1.000	0.500	0.270	0.667	0.500	0.000	0.167	0.601
			0.040				0.333		
Feb-12	1.000	0.500	0.077	0.101	0.667	0.000	1.000	0.667	0.489
			0.125				0.333		
Mar-12									
Apr-12									
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12	1.000	0.000	0.005	0.005	0.500	0.000	0.667	0.667	0.362
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.9 – Engagement Index calculations for EHMS-05

EHMS-07

EHMS-07	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Jan 3-31, 2013	1	1	1	0	10	0	1
Feb-12	1	1	1	0	28	0	0
Mar-12	1	1	1	0	22	0	1
Apr-12							
May-12							
Jun-12							
Jul-12	1	1	1	1	149	1	1
Aug-12							
Sep-12							
Oct-12							
Nov-12	1	1	1	0	123	0	2
Dec-12							
Jan-13							

Table H.10 – Raw data used to calculate the engagement index for EHMS-07

EHMS-07	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Jan 3-31, 2013	1.000	0.000	0.091	0.091	0.500	0.000	0.333	0.333	0.321
Feb-12	1.000	0.000	0.034	0.034	0.500	0.000	0.000	0.000	0.256
Mar-12	1.000	0.000	0.043	0.043	0.500	0.000	0.333	0.333	0.313
Apr-12									
May-12									
Jun-12									
Jul-12	1.000	1.000	0.007	0.007	0.500	1.000	0.333	0.333	0.640
Aug-12									
Sep-12									
Oct-12									
Nov-12	1.000	0.000	0.008	0.008	0.500	0.000	0.500	0.500	0.335
Dec-12									
Jan-13									

Table H.11 – Engagement Index calculations for EHMS-07

EHMS-09

EHMS-09	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011	1	1	1	1	0	1	1
Jan-12							
Feb-12							
Mar-12							
Apr-12	1	1	1	1	111	1	1
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.12 – Raw data used to calculate the engagement index for EHMS-09

EHMS-09	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011	1.000	1.000	1.000	1.000	0.500	1.000	0.333	0.333	0.806
Jan-12									
Feb-12									
Mar-12									
Apr-12	1.000	1.000	0.009	0.009	0.500	1.000	0.333	0.333	0.640
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.13 -- Engagement Index calculations for EHMS-09

EHMS-10

EHMS-10	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011	1	2	1	0	4	0	0
	2				1		0
Jan-12	1	3	3	3	20	3	0
	2				0		1
	3				0		1
Feb-12	1	1	1	0	24	0	1
Mar-12							
Apr-12	1	1	1	1	28	1	2
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.14 – Raw data used to calculate the engagement index for EHMS-10

EHMS-10	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011	0.500	0.000	0.200	0.350	0.667	0.000	0.000	0.000	0.253
			0.500				0.000		
Jan-12	1.000	1.000	0.048	0.683	0.750	1.000	0.000	0.222	0.776
			1.000				0.333		
			1.000				0.333		
Feb-12	1.000	0.000	0.040	0.040	0.500	0.000	0.333	0.333	0.312
Mar-12									
Apr-12	1.000	1.000	0.034	0.034	0.500	1.000	0.667	0.667	0.700
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.15 – Engagement Index calculations for EHMS-10

EHMS-11

EHMS-11	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Jan 3-31, 2013	1	2	2	1	0	0	1
	2				27		1
Feb-12	1	1	1	0	25	0	1
Mar-12							
Apr-12							
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12	1	1	1	1	275	1	4
Dec-12	1	2	2	1	11	0	1
	2				21		0
Jan-13							

Table H.16 – Raw data used to calculate the engagement index for EHMS-11

EHMS-11	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Jan 3-31, 2013	1.000	0.500	1.000	0.518	0.667	0.000	0.333	0.333	0.503
			0.036				0.333		
Feb-12	1.000	0.000	0.038	0.038	0.500	0.000	0.333	0.333	0.312
Mar-12									
Apr-12									
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12	1.000	1.000	0.004	0.004	0.500	1.000	1.000	1.000	0.751
Dec-12	1.000	0.500	0.083	0.064	0.667	0.000	0.250	0.125	0.393
			0.045				0.000		
Jan-13									

Table H.17 – Engagement Index calculations for EHMS- 11

EHMS-12

EHMS-12	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011							
Jan-12	1	1	1	1	37	0	2
Feb-12							
Mar-12							
Apr-12							
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13	1	1	1	0	352	0	0

Table H.18 – Raw data used to calculate the engagement index for EHMS-12

EHMS-12	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011									
Jan-12	1.000	1.000	0.026	0.026	0.500	0.000	0.667	0.667	0.532
Feb-12									
Mar-12									
Apr-12									
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13	1.000	0.000	0.003	0.003	0.500	0.000	0.000	0.000	0.250

Table H.19 – Engagement Index calculations for EHMS-12

EHMS-13

EHMS-13	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011	1	1	1	1	3	0	1
Jan-12	1	2	2	1	19	0	0
	2				15		1
Feb-12	1	1	1	0	14	0	1
Mar-12	1	1	1	0	28	0	0
Apr-12							
May-12	1	3	3	2	77	0	0
	2				1		1
	3				0		0
Jun-12	1	4	4	1	3	0	0
	2				3		0
	3				6		1
	4				20		1
Jul-12	1	4	4	2	1	0	0
	2				2		0
	3				9		1
	4				18		0
Aug-12	1	5	5	1	10	0	0
	2				3		0
	3				3		0
	4				2		0
	5				4		2
Sep-12							
Oct-12							
Nov-12							
Dec-12	1	1	1	1	142	0	2
Jan-13	1	1	1	1	24	0	1

Table H.20 – Raw data used to calculate the engagement index for EHMS-13

EHMS-13	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011	1.000	1.000	0.250	0.250	0.500	0.000	0.333	0.333	0.514
Jan-12	1.000	0.500	0.050	0.056	0.667	0.000	0.000	0.167	0.398
			0.063				0.333		
Feb-12	1.000	0.000	0.067	0.067	0.500	0.000	0.333	0.333	0.317
Mar-12	1.000	0.000	0.034	0.034	0.500	0.000	0.000	0.000	0.256
Apr-12									
May-12	1.000	0.667	0.013	0.504	0.750	0.000	0.000	0.111	0.505
			0.500				0.333		
			1.000				0.000		
Jun-12	1.000	0.250	0.250	0.173	0.800	0.000	0.000	0.167	0.398
			0.250				0.000		
			0.143				0.333		
			0.048				0.333		
Jul-12	1.000	0.500	0.500	0.246	0.800	0.000	0.000	0.083	0.438
			0.333				0.000		
			0.100				0.333		
			0.053				0.000		
Aug-12	1.000	0.200	0.091	0.225	0.833	0.000	0.000	0.133	0.399
			0.250				0.000		
			0.250				0.000		
			0.333				0.000		
			0.200				0.667		
Sep-12									
Oct-12									
Nov-12									
Dec-12	1.000	1.000	0.007	0.007	0.500	0.000	0.500	0.500	0.501
Jan-13	1.000	1.000	0.040	0.040	0.500	0.000	0.250	0.250	0.465

Table H.21 – Engagement Index calculations for EHMS-13

EHMS-14

EHMS-14	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Dec 23-31, 2011	1	1	1	1	4	0	3
Jan-12	1	1	1	1	26	1	1
Feb-12							
Mar-12							
Apr-12							
May-12							
Jun-12							
Jul-12	1	2	2	2	185	1	2
	2				6		2
Aug-12							
Sep-12							
Oct-12							
Nov-12	1	1	1	1	119	1	2
Dec-12	1	1	0	0	21	1	0
Jan-13							

Table H.22 – Raw data used to calculate the engagement index for EHMS-14

EHMS-14	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Dec 23-31, 2011	1.000	1.000	0.200	0.200	0.500	0.000	1.000	1.000	0.617
Jan-12	1.000	1.000	0.037	0.037	0.500	1.000	0.333	0.333	0.645
Feb-12									
Mar-12									
Apr-12									
May-12									
Jun-12									
Jul-12	1.000	1.000	0.005	0.074	0.667	0.500	0.667	0.667	0.651
			0.143				0.667		
Aug-12									
Sep-12									
Oct-12									
Nov-12	1.000	1.000	0.008	0.008	0.500	1.000	0.500	0.500	0.668
Dec-12	0.000	0.000	0.045	0.045	0.500	1.000	0.000	0.000	0.258
Jan-13									

Table H.23 – Engagement Index calculations for EHMS-14

EHMS-15

EHMS-15	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Jan 13-31, 2012							
Feb-12	1	12	9	7	18	2	0
	2				0		0
	3				10		0
	4				0		1
	5				1		2
	6				0		0
	7				1		0
	8				11		3
	9				0		3
	10				2		1
	11				1		2
	12				0		1
Mar-12	1	3	3	1	7	0	2
	2				6		2
	3				15		1
Apr-12							
May-12							
Jun-12							
Jul-12	1	1	1	0	105	0	1
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13	1	3	2	1	199	0	0
	2				1		0
	3				2		1

Table H.24 – Raw data used to calculate the engagement index for EHMS-15

EHMS-15	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Jan 13-31, 2012									
Feb-12	0.750	0.583	0.053	0.588	0.923	0.167	0.000	0.361	0.562
			1.000				0.000		
			0.091				0.000		
			1.000				0.333		
			0.500				0.667		
			1.000				0.000		
			0.500				0.000		
			0.083				1.000		
			1.000				1.000		
			0.333				0.333		
			0.500				0.667		
			1.000				0.333		
Mar-12	1.000	0.333	0.125	0.110	0.750	0.000	0.667	0.556	0.458
			0.143				0.667		
			0.063				0.333		
Apr-12									
May-12									
Jun-12									
Jul-12	1.000	0.000	0.009	0.009	0.500	0.000	0.333	0.333	0.307
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13	0.667	0.333	0.005	0.279	0.750	0.000	0.000	0.083	0.352
			0.500				0.000		
			0.333	5			0.250		

Table H.25 – Engagement Index calculations for EHMS-15

EHMS-16

EHMS-16	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Jan 13-31, 2012	1	2	2	1	2	0	1
	2				11		2
Feb-12	1	2	2	1	15	1	1
	2				14		1
Mar-12	1	2	2	1	15	0	0
	2				0		2
Apr-12							
May-12							
Jun-12	1	2	2	2	108	0	2
	2				0		2
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.26 – Raw data used to calculate the engagement index for EHMS-16

EHMS-16	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Jan 13-31, 2012	1.000	0.500	0.333	0.208	0.667	0.000	0.333	0.500	0.479
			0.083				0.667		
Feb-12	1.000	0.500	0.063	0.065	0.667	0.500	0.333	0.333	0.511
			0.067				0.333		
Mar-12	1.000	0.500	0.063	0.531	0.667	0.000	0.000	0.333	0.505
			1.000				0.667		
Apr-12									
May-12									
Jun-12	1.000	1.000	0.009	0.505	0.667	0.000	0.667	0.667	0.640
			1.000				0.667		
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.27 – Engagement Index calculations for EHMS-16

EHMS-17

EHMS-17	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012							
May-12	1	2	1	0	4	0	0
	2				0		0
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.28 – Raw data used to calculate the engagement index for EHMS-17

EHMS-17	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012									
May-12	0.500	0.000	0.200	0.600	0.667	0.000	0.000	0.000	0.294
			1.000				0		
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.29 – Engagement Index calculations for EHMS-17

EHMS-18

EHMS-18	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012							
May-12	1	2	2	1	12	0	2
	2				1		2
Jun-12	1	2	1	0	38	1	1
	2				1		0
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12	1	1	1	0	165	0	0
Dec-12	1	1	1	1	11	0	2
Jan-13							

Table H.30 – Raw data used to calculate the engagement index for EHMS-18

EHMS-18	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012									
May-12	1.000	0.500	0.077	0.288	0.667	0.000	0.667	0.667	0.520
			0.500				0.667		
Jun-12	0.500	0.000	0.026	0.263	0.667	0.500	0.333	0.167	0.349
			0.500				0.000		
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12	1.000	0.000	0.006	0.006	0.500	0.000	0.000	0.000	0.251
Dec-12	1.000	1.000	0.083	0.083	0.500	0.000	0.500	0.500	0.514
Jan-13									

Table H.31 – Engagement Index calculations for EHMS-18

EHMS-19

EHMS-19	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
Jan 13-31, 2012							
Feb-12							
Mar-12	1	1	1	1	53	0	0
Apr-12							
May-12							
Jun-12							
Jul-12	1	2	2	0	119	1	0
	2				0		0
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.32 – Raw data used to calculate the engagement index for EHMS-19

EHMS-19	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
Jan 13-31, 2012									
Feb-12									
Mar-12	1.000	1.000	0.019	0.019	0.500	0.000	0.000	0.000	0.420
Apr-12									
May-12									
Jun-12									
Jul-12	1.000	0.000	0.008	0.504	0.667	0.500	0.000	0.000	0.445
			1.000				0.000		
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.33 – Engagement Index calculations for EHMS-19

EHMS-20

EHMS-20	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012		1	1	1	0	0	2
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan 1-9, 2013							

Table H.34 – Raw data used to calculate the engagement index for EHMS-20

EHMS-20	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012	1.000	1.000	1.000	1.000	0.500	0.000	0.667	0.667	0.694
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan 1-9, 2013									

Table H.35 – Engagement Index calculations for EHMS-20

EHMS-21

EHMS-21	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012		1	1	1	2	0	2
May-12							
Jun-12		1	1	0	51	0	0
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.36 – Raw data used to calculate the engagement index for EHMS-21

EHMS-21	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012	1.000	1.000	0.333	0.333	0.500	0.000	0.667	0.667	0.583
May-12									
Jun-12	1.000	0.000	0.019	0.019	0.500	0.000	0.000	0.000	0.253
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.37 – Engagement Index calculations for EHMS-21

EHMS-22

EHMS-22	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012	1	2	2	2	2	1	2
	2				1		3
May-12	1	1	1	1	11	0	1
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.38 – Raw data used to calculate the engagement index for EHMS-22

EHMS-22	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012	1.000	1.000	0.333	0.417	0.667	0.500	0.667	0.833	0.736
			0.500				1.000		
May-12	1.000	1.000	0.083	0.083	0.500	0.000	0.333	0.333	0.486
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.39 – Engagement Index calculations for EHMS-22

EHMS-23

EHMS-23	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012	1	4	2	1	0	2	2
	2				1		0
	3				2		2
	4				0		0
May-12	1	5	4	2	1	1	2
	2				2		2
	3				0		0
	4				25		2
	5				1		2
Jun-12							
Jul-12	1	2	1	1	43	1	2
	2				1		0
Aug-12							
Sep-12							
Oct-12	1	1	1	0	105	0	2
Nov-12							
Dec-12	1	2	2	1	38	0	3
	2				7		0
Jan-13	1	1	0	0	50	1	0

Table H.40 – Raw data used to calculate the engagement index for EHMS-23

EHMS-23	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012	0.500	0.250	1.000	0.708	0.800	0.500	0.667	0.333	0.515
			0.500				0.000		
			0.333				0.667		
			1.000				0.000		
May-12	0.800	0.400	0.500	0.474	0.833	0.200	0.667	0.533	0.540
			0.333				0.667		
			1.000				0.000		
			0.038				0.667		
			0.500				0.667		
Jun-12									
Jul-12	0.500	0.500	0.023	0.261	0.667	0.500	0.667	0.333	0.460
			0.500				0.000		
Aug-12									
Sep-12									
Oct-12	1.000	0.000	0.009	0.009	0.500	0.000	0.667	0.667	0.363
Nov-12									
Dec-12	1.000	0.500	0.026	0.075	0.667	0.000	0.750	0.375	0.436
			0.125				0.000		
Jan-13	0.000	0.000	0.020	0.020	0.500	1.000	0.000	0.000	0.253

Table H.41 – Engagement Index calculations for EHMS-23

EHMS-24

EHMS-24	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012							
May-12		1	1	0	10	0	1
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12							
Nov-12							
Dec-12							
Jan-13							

Table H.42 – Raw data used to calculate the engagement index for EHMS-24

EHMS-24	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012									
May-12	1.000	0.000	0.091	0.091	0.500	0.000	0.333	0.333	0.321
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12									
Nov-12									
Dec-12									
Jan-13									

Table H.43 – Engagement Index calculations for EHMS-24

EHMS-25

EHMS-25	Session #	# Sessions	# Sessions with pages beyond homepage	# Sessions that are 5+ minutes	# Days since most recent session	# Sessions that EHMS was contacted	# Types of actions (per session)
April 27-31, 2012							
May-12							
Jun-12							
Jul-12							
Aug-12							
Sep-12							
Oct-12		2	2	1	172	0	1
					1		1
Nov 1-9, 2012							

Table H.44 – Raw data used to calculate the engagement index for EHMS-25

EHMS-25	Click Depth Index (Ci)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Session Index (Si)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii)	Engagement Index (Ei)
April 27-31, 2012									
May-12									
Jun-12									
Jul-12									
Aug-12									
Sep-12									
Oct-12	1.000	0.500	0.006	0.253	0.667	0.000	0.333	0.333	0.459
			0.500				0.333		
Nov 1-9, 2012									

Table H.45 – Engagement Index calculations for EHMS-25

EHMS-A

EHMS-A	Session #	#sessions	#sessions that are 5+ minutes	# days since most recent session	#sessions with pages beyond homepage	# sessions that EHMS was contacted	#types of actions (per session)
Nov 29-30, 2011	1	1	1	1	1	0	2
Dec-11	1	2	1	10	2	2	1
	2			14			3
Jan-12	1	2	2	17	2	1	1
	2			14			2
Feb-12	1	2	1	17	2	0	0
	2			14			1
Mar-12	1	2	2	14	2	0	0
	2			14			1
Apr-12	1	2	1	17	2	0	1
	2			14			1
May-12	1	2	2	16	1	1	0
	2			14			2
Jun-12	1	2	1	17	2	0	1
	2			14			2
Jul-12	1	2	2	16	2	0	2
	2			14			3
Aug-12	1	2	0	17	1	0	0
	2			14			0
Sep-12	1	2	2	17	2	1	1
	2			14			1
Oct-12	1	2	1	16	2	0	0
	2			14			1
Nov-12	1	2	2	17	2	0	2
	2			14			2
Dec-12	1	2	1	16	2	0	1
	2			14			2
Jan-13	1	2	2	17	2	0	1
	2			14			1

Table H.46 – Raw data used to calculate the engagement index for EHMS-A

EHMS-A	Session Index (Si)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Click Depth Index (Ci)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii))	Engagement Index (Ei)
Nov 29-30, 2011	0.500	1.000	0.500	0.591	1.000	0.000	0.667	0.667	0.626
Dec-11	0.667	0.500	0.091	0.079	1.000	1.000	0.333	0.667	0.652
			0.067				1.000		
Jan-12	0.667	1.000	0.056	0.061	1.000	0.500	0.333	0.500	0.621
			0.067				0.667		
Feb-12	0.667	0.500	0.056	0.061	1.000	0.000	0.000	0.167	0.399
			0.067				0.333		
Mar-12	0.667	1.000	0.067	0.067	1.000	0.000	0.000	0.167	0.483
			0.067				0.333		
Apr-12	0.667	0.500	0.056	0.061	1.000	0.000	0.333	0.333	0.427
			0.067				0.333		
May-12	0.667	1.000	0.059	0.063	0.500	0.500	0.000	0.333	0.510
			0.067				0.667		
Jun-12	0.667	0.500	0.056	0.061	1.000	0.000	0.333	0.500	0.455
			0.067				0.667		
Jul-12	0.667	1.000	0.059	0.063	1.000	0.000	0.667	0.833	0.594
			0.067				1.000		
Aug-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.000	0.205
			0.067				0.000		
Sep-12	0.667	1.000	0.056	0.061	1.000	0.500	0.333	0.333	0.594
			0.067				0.333		
Oct-12	0.667	0.500	0.059	0.063	1.000	0.000	0.000	0.167	0.399
			0.067				0.333		
Nov-12	0.667	1.000	0.056	0.061	1.000	0.000	0.667	0.667	0.566
			0.067				0.667		
Dec-12	0.667	0.500	0.059	0.063	1.000	0.000	0.250	0.458	0.448
			0.067				0.667		
Jan-13	0.667	1.000	0.056	0.061	1.000	0.000	0.250	0.292	0.503
			0.067				0.333		

Table H.47 – Engagement Index calculations for EHMS-A

EHMS-B

EHMS-B	Session #	#sessions	#sessions that are 5+ minutes	# days since most recent session	#sessions with pages beyond homepage	# sessions that EHMS was contacted	#types of actions (per session)
Nov 29-30, 2011	1	1	1	1	1	0	3
Dec-11	1	2	2	10	2	1	2
	2			14			3
Jan-12	1	2	2	17	2	0	2
	2			14			2
Feb-12	1	2	0	17	1	0	0
	2			14			1
Mar-12	1	2	0	14	1	0	0
	2			14			1
Apr-12	1	2	0	17	1	0	0
	2			14			1
May-12	1	2	0	16	1	0	0
	2			14			1
Jun-12	1	2	0	17	1	0	0
	2			14			1
Jul-12	1	2	0	16	1	0	0
	2			14			1
Aug-12	1	2	0	17	1	0	0
	2			14			1
Sep-12	1	2	0	17	1	0	0
	2			14			1
Oct-12	1	2	0	16	1	0	0
	2			14			1
Nov-12	1	2	1	17	1	0	3
	2			14			4
Dec-12	1	2	0	16	1	0	0
	2			14			1
Jan-13	1	2	0	17	1	0	0
	2			14			1

Table H.48 – Raw data used to calculate the engagement index for EHMS-B

EHMS-B	Session Index (Si)	Duration Index (Di)	Ri (session)	Recency Index (Ri)	Click Depth Index (Ci)	Communication Index (Fi)	Ii (session)	Interaction Index (Ii))	Engagement Index (Ei)
Nov 29-30, 2011	0.500	1.000	0.500	0.591	1.000	0.000	1.000	1.000	0.682
Dec-11	0.667	1.000	0.091	0.079	1.000	0.500	0.667	0.833	0.680
			0.067				1.000		
Jan-12	0.667	1.000	0.056	0.061	1.000	0.000	0.667	0.667	0.566
			0.067				0.667		
Feb-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		
Mar-12	0.667	0.000	0.067	0.067	0.500	0.000	0.000	0.167	0.233
			0.067				0.333		
Apr-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		
May-12	0.667	0.000	0.059	0.063	0.500	0.000	0.000	0.167	0.233
			0.067				0.333		
Jun-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		
Jul-12	0.667	0.000	0.059	0.063	0.500	0.000	0.000	0.167	0.233
			0.067				0.333		
Aug-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		
Sep-12	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		
Oct-12	0.667	0.000	0.059	0.063	0.500	0.000	0.000	0.167	0.233
			0.067				0.333		
Nov-12	0.667	0.500	0.056	0.061	0.500	0.000	1.000	1.167	0.482
			0.067				1.333		
Dec-12	0.667	0.000	0.059	0.063	0.500	0.000	0.000	0.167	0.233
			0.067				0.333		
Jan-13	0.667	0.000	0.056	0.061	0.500	0.000	0.000	0.167	0.232
			0.067				0.333		

Table H.49 – Engagement Index calculations for EHMS-B