SMUD's IHD Checkout Pilot – Load Impact Evaluation

Promoting energy and peak savings for residential customers through real-time energy information displays

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Herter Energy
RESEARCH SOLUTIONS

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CONTENTS

FIGURES

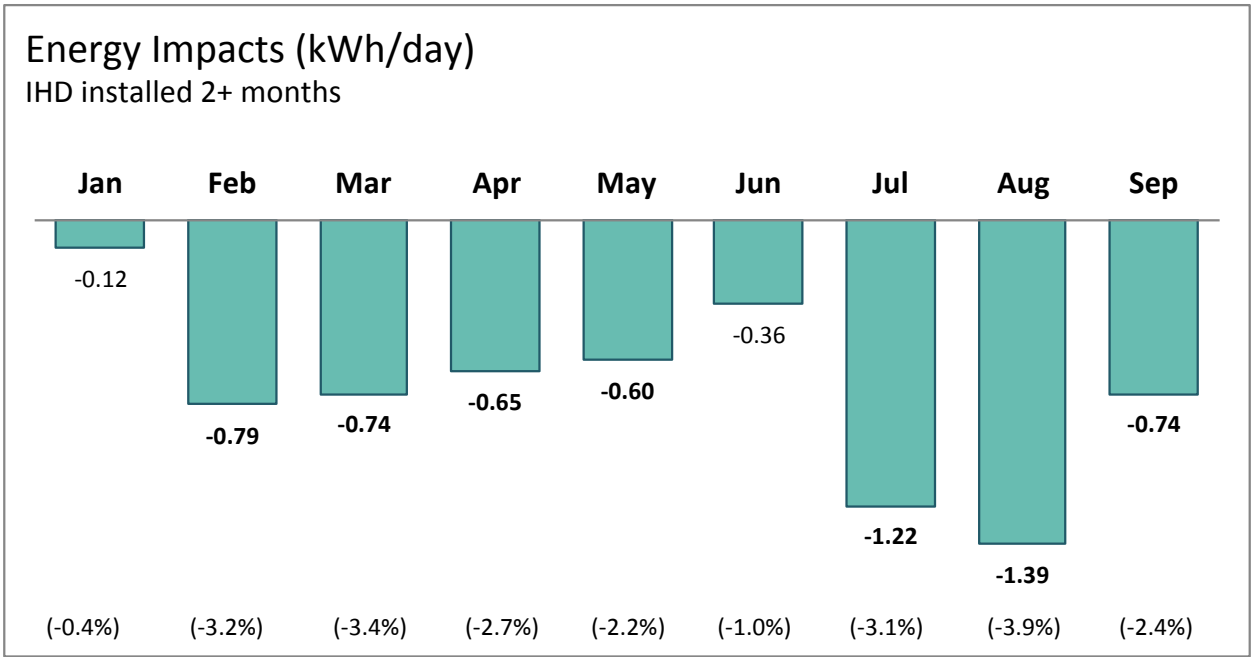
TABLES

EXECUTIVE SUMMARY

SMUD's 2012-2013 In-Home Display (IHD) Check-Out Pilot offered residential customers the opportunity to borrow an IHD from SMUD for a period of two months. The IHD communicated with SMUD's electricity meter at each site to display the near real-time electricity use and cost of the home. The objective of this report is to estimate the load impacts associated with this program, with a focus on the impacts on customer bills, energy use, and summer peak demand.

Monthly energy impacts were calculated for all customers for whom at least 2 months had passed since installing the IHD, whether or not they had returned the IHD to SMUD.[1] Average participant energy savings were highest in July and August, at between 1.2 and 1.4 kWh per day, comprising 3% to 4% of energy use in those months (Figure 1). The relative savings were similar in February and March at around 3%, though the absolute savings in kWh were lower.

FIGURE 1. AVERAGE DAILY ENERGY IMPACTS >2 MONTHS AFTER IHD INSTALLATION



Note: Values in bold are statistically significant (α = 0.05).

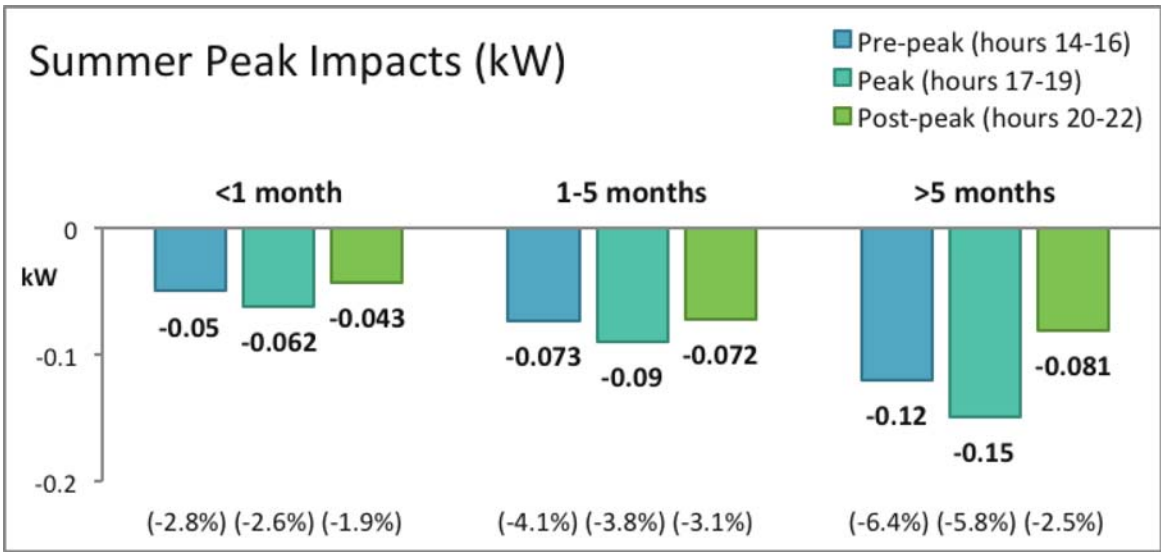
Using a weighted average of the summer and winter energy savings, the per-participant average annual energy savings beyond the first two months of IHD use was 260 kWh (2.6%), resulting in an average annual bill savings of just under $40 per year.[2]

[1] October through December data was unavailable or insufficient to estimate load impacts (see Table 4).

[2] Average winter savings are estimated as the average of January through May savings.

Average summer peak load impacts for summer weekdays from 4 to 7 pm were calculated for three subgroups of customers according to the amount of time that had passed between installation of IHD and the first day of summer: June 1, 2013. Figure 2 shows that savings were statistically significantly in all three-hour periods for all three subgroups. Those who installed the IHD more than 5 months prior to June reduced pre-peak and peak loads significantly more than did those who installed the IHD less than one month prior to June.

FIGURE 2. AVERAGE SUMMER PEAK ENERGY IMPACTS



Note: Values in bold are statistically significant (α = 0.05).

Prior to considering implementation of a similar program, we recommend the following:

- Conduct a cost effectiveness analysis of this pilot.
- Reevaluate the savings of this pilot one or two years out from the timing of this analysis to determine the extent of the persistence of savings over time.
- Conduct usability testing of multiple IHD models prior to device procurement and choose one or two units with high usability and preference scores for implementation.
- Conduct evaluations of effectiveness and cost effectiveness of the program annually.

1. Introduction

SMUD's new smart meters allow customers to access near real-time electricity use data through connected devices. This new capability has fostered several pilots designed to evaluate the impact of such devices on customers' energy consumption and summer peak loads.

SMUD's 2012-2013 In-Home Display (IHD) Check-Out Pilot offered residential customers the opportunity to borrow an IHD from SMUD. The IHD communicated with SMUD's electricity meter at each site to display the near real-time electricity use and cost of the home. The objective of this report is to estimate the load impacts associated with such a program, with a focus on the impacts on monthly electricity use (kWh), summer peak demand (kWh/h), and customer bills.

Study Overview

The main goal of the IHD checkout study is to provide SMUD with empirical data to support decisions about future residential customer programs that promote energy efficiency in the residential sector. The objective of this evaluation is to estimate the energy, peak demand, and bill impacts associated with a program that allows residential customers to borrow an in-home energy display (IHD) to monitor the near real-time energy use of their home.

This report describes the evaluation of electric load impacts resulting from the distribution of in-home displays to residential customers in the SMUD service territory. The evaluation makes use of hourly interval meter data to determine energy and summer peak impacts as well as customer monthly bill impacts. Additional information can be found in the market research reports completed by True North Research for this pilot (2013, 2014).

Study Design

The IHD Checkout Pilot involved a single study group comprised of customers who requested, received and installed an in-home energy display (IHD) that communicated with their smart meter to provide energy use information. During recruitment for the study, SMUD posted an invitation banner on the "My Account" web page, visible to customers who had signed up for an online account through SMUD's website and accessed it during the pilot marketing period. SMUD also distributed flyers describing the IHD and participation details to thirty Sacramento public libraries. Interested customers could request an IHD through the My Account web page, by phone, or by borrowing one from a participating library. Note that those who borrowed the IHDs from the library are not included in this analysis.

In-Home Display (IHD) Unit

IHD participants received an EnergyAware PowerTab IHD capable of displaying near real-time electricity use data received wirelessly from the electricity meter. The IHD collected and updated the instantaneous meter reading every 15 to 30 seconds, with longer periods required in challenging radio frequency environments. The unit could be powered with either batteries or a power cord (Figure 3).

Figure 3. The PowerTab In-Home Display

Available screens included: Current Use in units of instantaneous demand (kW) and dollars per hour ($/hr); daily Running Total in cumulative energy use (kWh) and dollars ($); and price per kWh ($/kWh) of electricity. The unit displayed the Base rate at all times, regardless of whether the customer was paying this lower rate or the higher Base Plus rate.

After about two months, customers were notified via email that their checkout period was expiring and that an envelope would be mailed to them for the return of the device to SMUD. More information on the EnergyAware PowerTab can be found in Appendix F.

Pilot Timeline

Table 1 outlines the major phases of project activity and corresponding research tasks.

Table 1. IHD checkout program pilot schedule

Task	Dates	Activities
Recruitment & Field Study	Oct 2012 – Oct 2013	• Invitation posted on the My Account web page • IHDs mailed to customers & provisioned o Customers asked to return IHDs after two months of use
Data Collection & Evaluation	Jan 2014 – May 2014	• Retrieve load database • Data analysis and reporting

2. Data

Evaluation Period

The treatment period, used for the purpose of evaluating the energy and demand impacts of the IHD Checkout Pilot, was November 2012 to September 2013. The pretreatment period, used to determine the baseline energy characteristics of participants and controls, starts in November 2011 and ends in September 2012 (Table 2).

Table 2. Evaluation period start and end dates

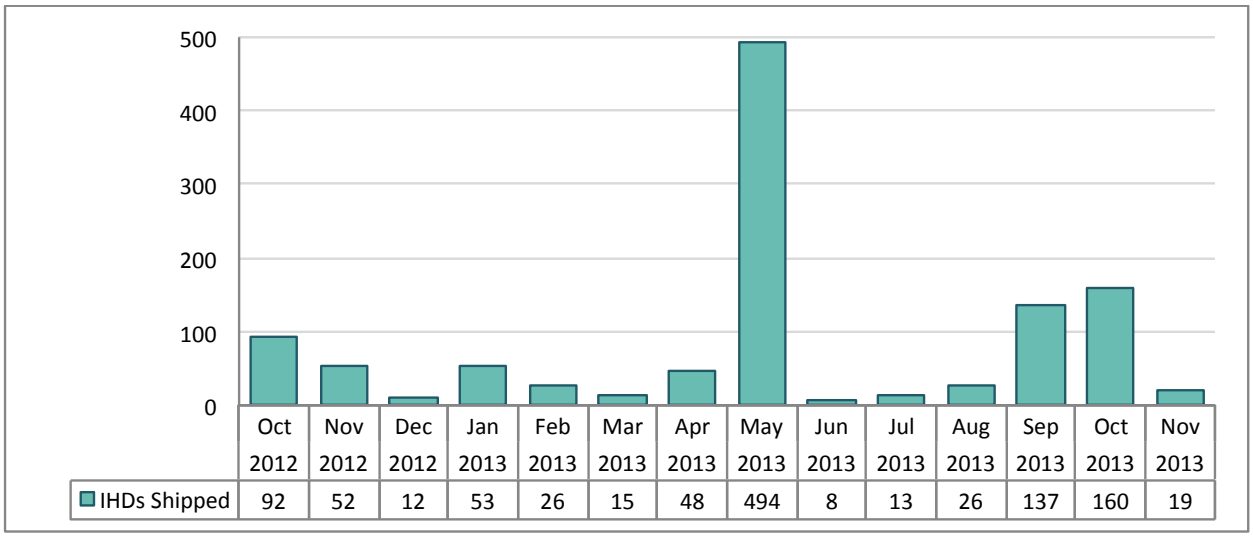
Evaluation period	Start date	End date
Pretreatment	11/1/11	9/30/12
Treatment	11/1/12	9/30/13

Participant Population

Between October 2012 and November 2013, SMUD mailed 1,155 IHDs to customers who requested them according to the schedule provided in Figure 4. Those receiving the IHDs in October and November comprised the control group.

Note the considerable month-to-month inconsistencies, with nearly 500 units shipped in May 2013 and just 8 units shipped in June 2013. This inconsistent distribution of IHDs ultimately compromised the sample sizes for the monthly energy analysis, as described in a later section.

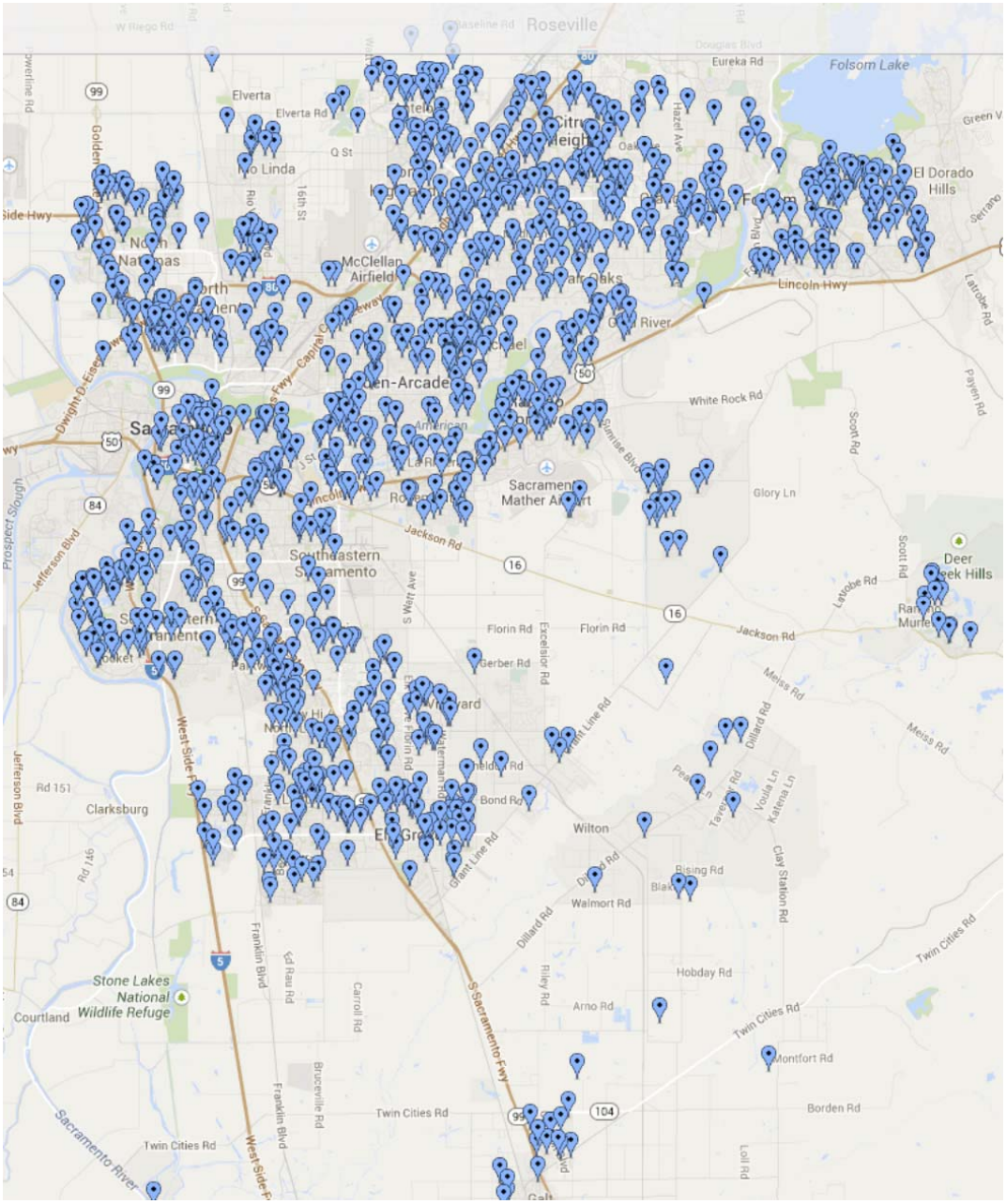
Figure 4. IHD Shipment Schedule



Geographic Locations of Installed IHDs

Of the 1155 IHDs mailed to customers, 1120 were installed[3] for more than 20 days. The locations of the 1120 installed IHDs are mapped in Figure 5. The reasonably even distribution provides evidence that a strong geographic bias is not present.

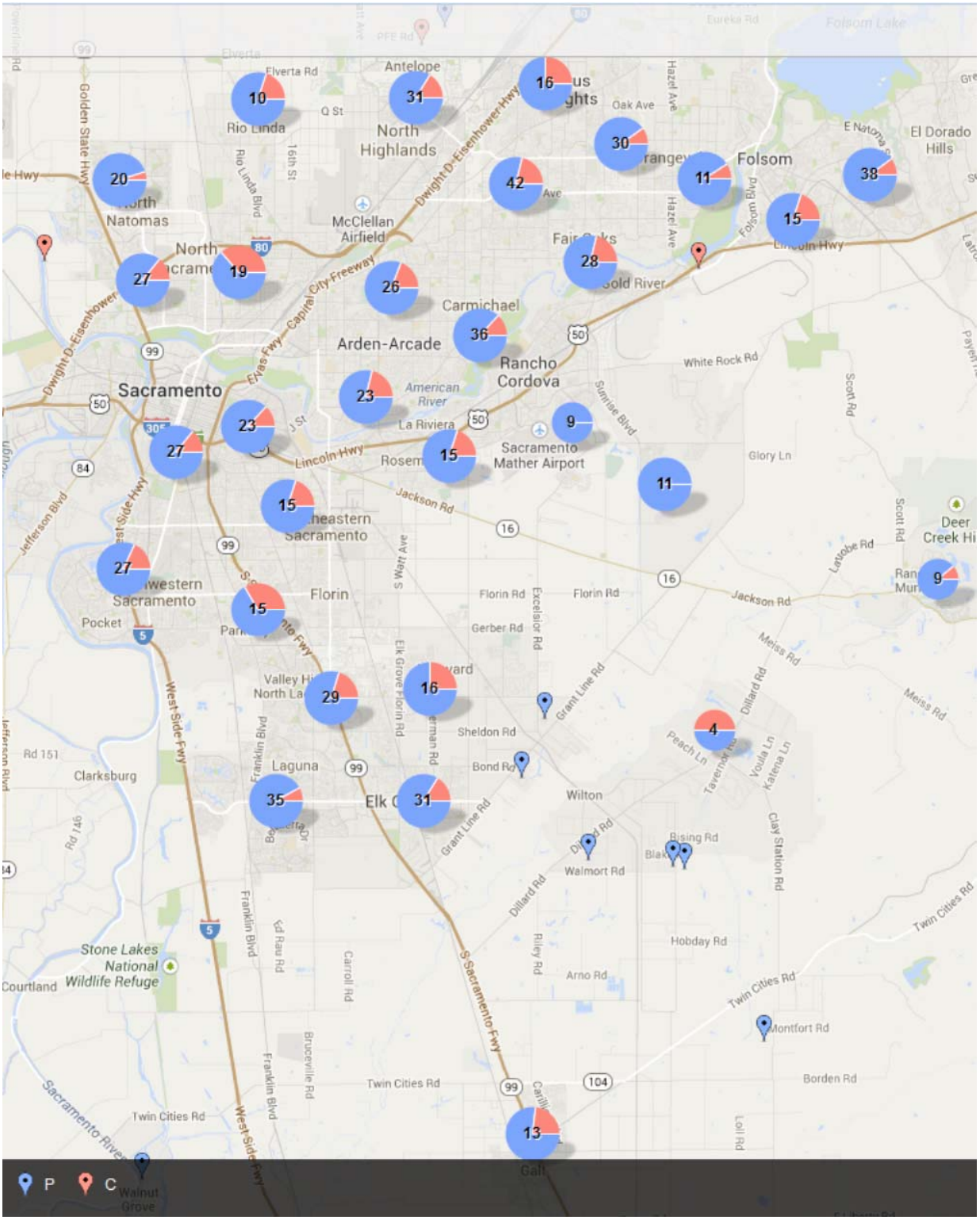
Figure 5. Map of all 1120 participant homes



[3] Throughout this report, the term "installed" means that an IHD has been mailed to the customer and not yet decommissioned by or returned to SMUD.

The locations of the participant and control homes used for the summer peak load analysis are mapped in Figure 6. The value in each circle represents the number of participants in that area.

FIGURE 6. MAP OF PARTICIPANT (BLUE) AND CONTROL (RED) HOMES FOR SUMMER PEAK ANALYSIS



TEMPERATURE DATA

The load impact evaluation makes use of temperature data from November 2012 to September 2013 as the treatment period data, with pretreatment load data spanning November 2011 to September 2012 (Table 2).

Figure 7 maps the ten weather stations in the SMUD service territory – charted using unique identifiers in the green boxes – for which hourly temperature data were downloaded. To ensure as-accurate-as-possible outdoor temperatures, participants were each assigned to the data recorded at the station closest to their home.

FIGURE 7. WEATHER STATIONS USED FOR LOAD IMPACT EVALUATION

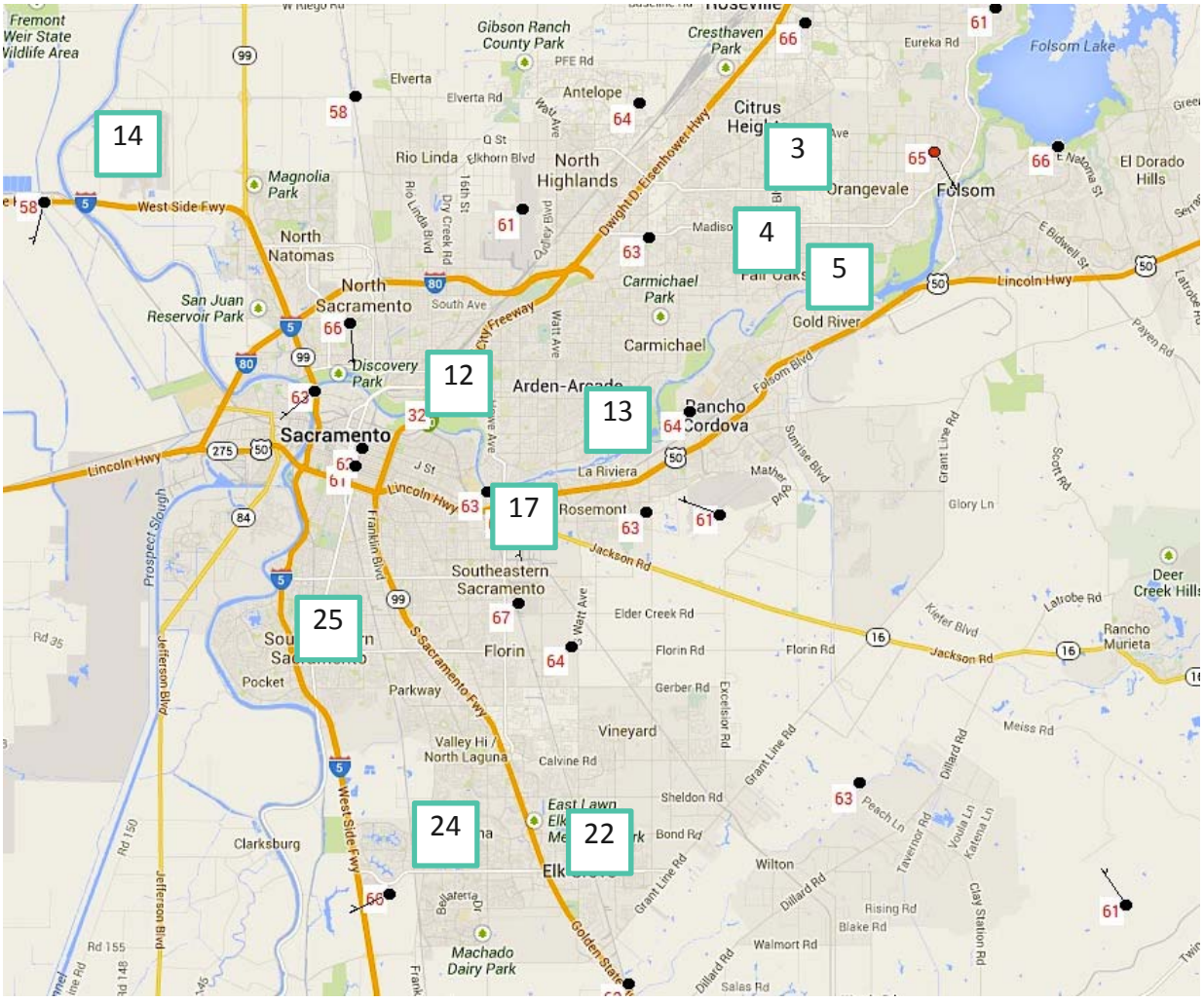


Figure 8 plots the average hourly summer temperatures at each of the 10 weather stations used in this analysis. Note that there are visible differences in temperatures across stations due to local microclimates, thus justifying the multiple-station approach.

FIGURE 8. AVERAGE HOURLY TEMPERATURE READINGS, SUMMER 2013

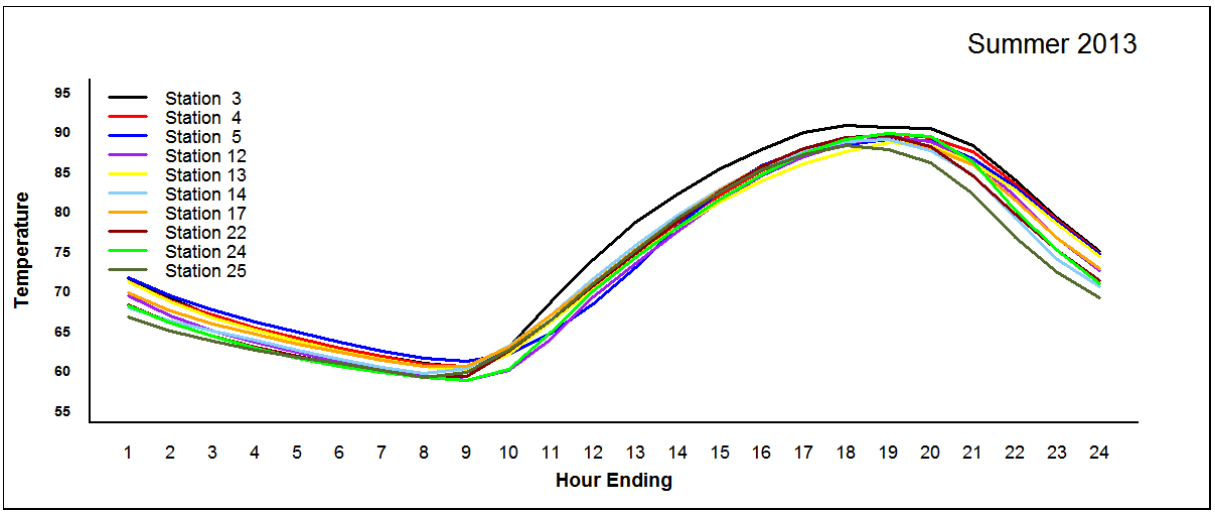
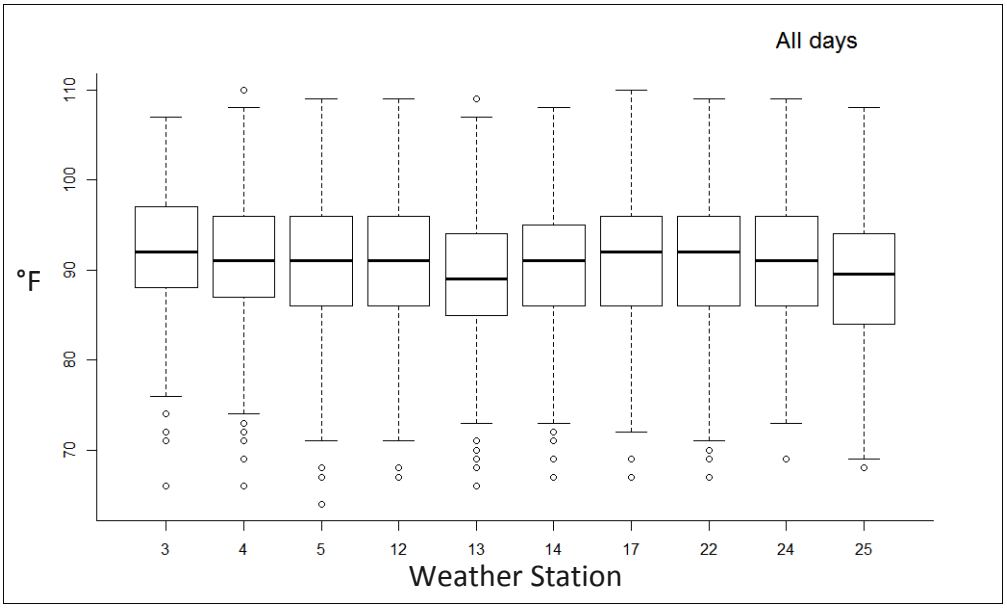


Figure 9 provides the distribution of maximum daily temperature measurements at each weather station for the summer of 2013, with the centerline of each box indicating the median, and the bottom and top edges of the boxes the first and third quartiles, respectively. Whiskers extend to the most extreme data point that is no more than 1.5 times the interquartile range. All points beyond the whiskers are outliers. At all stations, maximum daily temperatures range from roughly 70°F to 110°F, with median values of just over 90°F.

FIGURE 9. BOXPLOTS OF MAXIMUM DAILY TEMPERATURE READINGS, SUMMER 2013



Load Data

The hourly load database used to estimate impacts was collected by SMUD's existing metering infrastructure throughout the pretreatment and treatment periods (see Table 2) and provided by SMUD at the completion of the study. Outliers were determined using a two-sided outlier test for standardized (normalized) residuals. Observations with absolute standardized residuals greater than the $(1 - \alpha)/2 = 0.975$ quantile of the standard normal distribution were identified as outliers and excluded from the database.

Average load shapes for the final participant and control groups are provided in Appendix B.

Potential Sources of Bias

This section discusses some of the most likely sources of bias for this study.

Selection bias

Selection bias occurs as a result of limitations or errors in sampling. Evidence of selection bias can be detected by comparing load data for the group of *invited* customers to load data for a group that represents the program target market – in this case, SMUD's entire residential population. Such a comparison was not possible for this pilot because the "invited" customer population is not well defined. The presence of selection bias is possible in this study because the invited population consists of those customers who accessed My Account online during the recruitment period. In a full rollout, flyers distributed in monthly bills would potentially attract a different subset of customers.

Self-selection Bias

This study was designed to offer participants the same self-selection criteria as might ultimately be offered to program participants. In the absence of *selection* bias (described above), the high usage customers who agreed to participate in this pilot (see Appendix A) should be similar to those who would participate in a full rollout of the program.

Control Group Bias

Control group bias as defined here is bias that results in the control group not being an accurate representation of the participant groups in the absence of the treatment. The control group for this pilot is comprised of the customers who received their IHDs after the treatment period. Since the control and treatment groups both responded to the same offer, there is no expectation of self-selection bias in the control group. There is some potential for temporal bias, given that those in the control group requested the IHD at a later date than did those in the treatment group, but there is little reason to believe that this bias is significant.

3. Approach

Three approaches were used to characterize the impacts of SMUD's 2013 IHD Checkout pilot: an analysis of monthly energy impacts, an analysis of summer peak demand impacts, and an analysis of customer bill impacts. The energy and demand impacts are estimated using three-level mixed effects regression models. This approach allowed for the modeling of hourly loads while controlling for the observed and unobserved differences between customers and days without running into issues of model over-specification and multicollinearity.

Monthly Energy Analysis

The first analysis estimates the energy impacts that occurred in the first two months after installation of the IHD separately from energy impacts that occurred after two months, when SMUD requested that the IHD be returned. This involved the creation of two separate databases. The first database contained participant loads from the date of installation through 62 days past the installation date. The second contained participant loads starting 63 days past the installation date through the end of the analytical treatment period on September 30, 2013. Note that these two databases are not mutually exclusive in terms of participants, only in terms of the timing of the participant data included.

Table 3 and Table 4 show the sample sizes for each month in these two analyses before and after screening, delineating those excluded for: being in other pilots; being set aside for the control group (having installed their IHDs after September 30, 2013); having the IHD installed less than 20 days in the analysis month, having less than 20 days of pretreatment data for the analysis month; having missing hourly load data; or being an outlier, as defined previously. For the ≤2 months analysis, those having the IHD installed more than 62 days are excluded. For the >2 months analysis, those having the IHD installed less than 63 days are excluded.

Table 3. Sample sizes for the analysis of energy data ≤2 months after IHD installation

Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Original sample	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**
In other pilots	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*
Control Group	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*
<20 days IHD	*715*	*715*	*703*	*654*	*618*	*616*	*570*	*107*	*103*	*87*	*28*
<20 days baseline	*35*	*26*	*3*	*12*	*9*	*7*	*12*	*112*	*104*	*3*	*22*
Missing data, outliers	*5*	*6*	*0*	*2*	*6*	*0*	*2*	*15*	*26*	*0*	*1*
>62 days IHD	*0*	*27*	*133*	*134*	*175*	*200*	*232*	*280*	*280*	*753*	*764*
Total excluded	**1027**	**1046**	**1111**	**1074**	**1080**	**1095**	**1088**	**786**	**785**	**1115**	**1087**
Final sample	**93**	**74**	**9**	**46**	**40**	**25**	**32**	**334**	**335**	**5**	**33**

TABLE 4. SAMPLE SIZES FOR THE ANALYSIS OF ENERGY DATA >2 MONTHS AFTER IHD INSTALLATION

Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Original sample	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**	**1120**
In other pilots	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*
Control Group	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*	*222*
<63 days IHD	*848*	*830*	*716*	*716*	*711*	*668*	*639*	*641*	*598*	*166*	*168*
<20 days baseline	*0*	*5*	*31*	*28*	*25*	*31*	*33*	*28*	*35*	*116*	*96*
Missing data, outliers	*0*	*0*	*7*	*8*	*8*	*6*	*9*	*12*	*13*	*23*	*21*
Total excluded	***1120***	***1107***	***1026***	***1024***	***1016***	***977***	***953***	***953***	***918***	***577***	***557***
Final sample	**0**	**13**	**94**	**96**	**104**	**143**	**167**	**167**	**202**	**543**	**563**

From the 222 customers who requested but had not received an IHD by September 20, 2013, we removed those with insufficient pretreatment data (117 customers) and those with missing data (6 customers), leaving a total of 99 customers in the control group.

A separate model was created for each month. The general form of the monthly energy model is provided in Equation 1. All monthly models are random slope and intercept models corrected for heteroscedasticity and autocorrelation. Model diagnostics are given in Appendix C.

$$kwh_{ij} = \beta 0 + \beta 1(Year) + \beta 2(HDD_{ij}) + \beta 3(CDD_{ij}) + \beta 4(Treatment) + \beta 5(Year * Treatment) + r_i + \varepsilon_{ij} \quad (1)$$

Where, for customer i on day j:

kwh_{ij}: daily kWh as measured at the electric meter

CDD_{ij}: cooling degree day = sum of 24 cooling degree hour values, base 75

HDD_{ij}: heating degree day = sum of 24 heating degree hour values, base 65

$Treatment$: indicator variables for treatment: participant or control (reference)

$Year$: indicator variable for year: treatment or pretreatment (reference)

r_i: random effects for customer $\sim N(0, \varphi)$, assumed to be independent for different i

ε_{ij}: error terms $\sim N(0, \delta^2 I)$, assumed to be independent for different i, j, random effects

Note that CDD and HDD variables were included in models only where they improved the fit of the model. Table 5 shows the temperature variables used in each monthly model.

TABLE 5. TEMPERATURE VARIABLES BY MONTH

Months	Variable(s) Used
November - March	HDD
April – May	CDD, HDD
June - September	CDD

SUMMER WEEKDAY PEAK DEMAND ANALYSIS

The second analysis estimates the summer peak demand impacts in aggregate for participants who received an IHD prior to summer 2013, and also for three mutually exclusive subgroups characterized by length of time that had elapsed between installation of the IHD and June 1 – less than one month, between 1 and 5 months, and greater than 5 months.

The control group for the summer peak demand analysis consists of 107 customers who had been in their homes since the beginning of the pretreatment period (June 1, 2012) and received their IHDs after September 30, 2013, so they were not exposed to the IHD during the summer.

The general form of the summer peak demand model is provided in Equation 2. All peak demand models are random intercept models corrected for autocorrelation.

$$kw_{ijk} = \beta 1_k hour_{ijk} + \beta 2 CDH_{ijk} + \beta 3 CDD_{ij} + \beta 4_{m-1} Install\_month_m + \beta 7_{(k-1):(m-1)} \left(hour_{ijk} * Install\_month_m\right) + r_i + \varepsilon_{ijk} \quad (2)$$

Where, for customer i on day j at time k:

kw_{ijk}: hourly kWh as measured at the electric meter
$hour_{ijk}$: indicator for time of day: hour 1-24, or peak time periods 14-16, 17-19, 20-22
CDH_{ijk}: cooling degree hour base 75, lagged by 2 hours
CDD_{ij}: cooling degree = sum of 24 cooling degree hour values
$Install\_month_m$: indicator for IHD installation month
r_i: random effects for customer $\sim N(0, \varphi_1)$, assumed to be independent for different i
ε_{ijk}: error terms $\sim N(0, \delta^2 I)$, assumed independent for different i, j, random effects

Diagnostics for the summer peak demand model are given in Appendix D.

CALCULATION OF ENERGY AND DEMAND IMPACTS

The model coefficients obtained as described above allow the estimation of average daily energy and hourly demand values. Impact values are then calculated as the difference-in-differences (DID) of the four sets of values (Eq. 3). This approach compares the measure of interest at two points in time – before and after treatment – in both the treatment and control groups, where the pretreatment loads are normalized to treatment period temperatures.

EQUATION 1. CALCULATION OF LOAD IMPACTS

$$Load\_Impact_{ijk} = (Part.treat_{ijk} - Part.pretreat_{ijk}) - (Control.treat_{ijk} - Control.pretreat_{ijk}) \quad (3)$$

Where, for customer *i* on day *j* at hour *k*:

Load_Impact: estimate of hourly load change resulting from the treatment
Part.treat: modeled average participant loads during the treatment period
Part.pretreat: modeled average participant loads during the pretreatment period
Control.treat: modeled average control loads during the treatment period
Control.pretreat: modeled average control loads during the pretreatment period

Billing Analysis

Bills are estimated for each month beyond the first two months of IHD installation by applying the standard 2013 residential electricity rates shown in Table 6 to participants' actual treatment and modeled baseline loads.

Table 6. SMUD's standard residential rate (gas heat)

Season	Base	Base+
Summer	<= 700 kWh $0.0989	>700 kWh $0.1803
Winter	<= 620 kWh $0.0911	>620 kWh $0.1738

Baseline loads are estimated as the 2011-12 loads corrected for weather effects. Bill impacts are estimated as the difference-in-differences between the actual and baseline bills for the participant and control groups as follows.

1. Calculate actual 2012-13 bills for each participant (treatment)
    a. Aggregate kWh by month
    b. If kWh <= tier1.allowance then Actual.Bill = Actual.kWh*tier1.price
    Else Actual.Bill = (tier1.allowance*tier1.price) +
    (Actual.kWh - tier1.allowance)*(tier2.price)
2. Estimate what the 2013 bills would have been without the program (baseline)
    a. Estimate the baseline average Monthly.kWh for each month in 2013 based on 2011-12 load values and 2012-13 month-specific temperatures
        i. Hourly.kW = CDH + CDD + hour*year
        ii. Baseline.kWh = Sum24(Hourly.kW)*(number of days in the month)
    b. If Baseline.kWh <= tier1.allowance then monthly.bill = (kWh* tier1.price)
    Else Baseline.Bill = (tier1.allowance*tier1.price)
    + ((Baseline.kWh - tier1.allowance)*tier2.price)
3. Participant_Bill_impact = (Participant_Baseline.Bill – Participant_Actual.Bill)
– (Control_Baseline.Bill – Control_Actual.Bill)

Null Hypotheses

The purpose of the load impact evaluation is to estimate the energy, peak demand, and bill impacts of the IHD checkout program. These analytical goals imply the following null hypotheses:

Null Hypotheses for Summer Weekday Analysis

1. *Participant treatment loads are not different from their pretreatment loads adjusted for weather and exogenous effects*

$$H_0: \left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right) = 0$$

$$H_a: \left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right) \neq 0$$

$\mu_{part.treat_i}$ = average participant loads during the treatment period for $(Time\_since\_Install\_dummy)_i$

$\mu_{part.pretreat_i}$ = average participant loads during the pretreatment period for $(Time\_since\_Install\_dummy)_i$

$\mu_{control.treat}$ = average control group loads during the treatment period

$\mu_{control.pretreat}$ = average control group loads during the pretreatment period

2. *Amount of time passed since IHD installation has no effect on impacts (between-treatment comparison)*

$$H_0: \left[\left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right)\right] - \left[\left(\mu_{part.treat_{i'}} - \mu_{part.pretreat_{i'}}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right)\right] = 0$$

$$H_a: \left[\left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right)\right] - \left[\left(\mu_{part.treat_{i'}} - \mu_{part.pretreat_{i'}}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right)\right] \neq 0$$

Where, for *i*, *i'* representing different time durations since installation:

$\mu_{part.treat_i}$ = average participant loads during the treatment period for $(Time\_since\_Install\_dummy)_i$

$\mu_{part.treat_{i'}}$ = average participant loads during the treatment period for $(Time\_since\_Install\_dummy)_{i'}$

$\mu_{part.pretreat_i}$ = average participant loads during the pretreatment period for $(Time\_since\_Install\_dummy)_i$

$\mu_{part.pretreat_{i'}}$ = average participant loads during the pretreatment period for $(Install\_month)_{i'}$

$\mu_{control.treat}$ = average control group loads during the treatment period

$\mu_{control.pretreat}$ = average control group loads during the pretreatment period

Null Hypotheses for Monthly Energy Analysis

1. *Treatment loads are not different from pretreatment loads adjusted for weather and exogenous effects*

$$H_0: \left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right) = 0$$

$$H_a: \left(\mu_{part.treat_i} - \mu_{part.pretreat_i}\right) - \left(\mu_{control.treat} - \mu_{control.pretreat}\right) \neq 0$$

$\mu_{part.treat_i}$ = average participant loads during treatment period

$\mu_{part.pretreat_i}$ = average participant loads during the pretreatment period

$\mu_{control.treat}$ = average control group loads during the treatment period

$\mu_{control.pretreat}$ = average control group loads during the pretreatment period

4. RESULTS

The following sections provide the modeled loads and load impacts derived using the approach described above. For consistency and ease of comparison, all loads and impacts are presented in units of average kilowatt-hours per hour (kWh/h), abbreviated in most cases to kW, where positive impact values indicate an increase in energy use relative to the baseline, and negative impact values indicate savings. Note that these hourly kW values are easily converted to kWh through multiplication by the number of hours across the time period of interest.

ENERGY AND BILL IMPACTS

As discussed in the previous section, the monthly energy analysis was divided into two parts: (1) energy used in the first 2 months (≤62 days) after installation of the IHD, and (2) energy used beyond the first 2 months (≥63 days) after installation. The 2-month cutoff point is intended to provide a rough demarcation between the period during which the IHD was installed, and the time after the IHD was returned to SMUD, thus allowing for consideration of the effects of IHD presence in the home, as well as the effect of the passage of time on IHD energy impacts.

Table 7 shows the results of the monthly energy impact analysis. Because of the inconsistent IHD shipment schedule (see Figure 4), there were too few participants (<50) having the IHD installed less than two months in January through May, August, and September of 2013. Sufficient sample sizes existed for the analysis of energy use beyond the first 2 months of IHD installation in all months from January through September of 2013.

In Table 7, the "≤2 months…" results represent the monthly energy impacts of participants with at least 20 days in June for whom up to 62 days had passed since their IHD installation. Thus, the June 2013 analysis includes all participants in the evaluation database who received the IHD between April 10 and June 10. The ">2 months…" results represent the monthly energy impacts of participants for whom more than 62 days had passed since installing their IHD – after which customers were asked to return their IHD – so the June analysis includes all participants in the evaluation database who received the IHD before April 10.

TABLE 7. AVERAGE MONTHLY ENERGY IMPACTS

Month	Year	≤2 months after IHD installation N	kWh/h	%	>2 months after IHD installation N	kWh/h	%
November	2012	93	**+0.044***	**(+4.6%)**			
December	2012	74	+0.023	(+2.1%)			
January	2013				94	-0.005	(-0.4%)
February	2013				96	**-0.033***	**(-3.2%)**
March	2013				104	**-0.031***	**(-3.4%)**
April	2013				143	**-0.027***	**(-2.7%)**
May	2013				167	**-0.025***	**(-2.2%)**
June	2013	334	-0.026	(-1.8%)	167	-0.015	(-1.0%)
July	2013	335	-0.023	(-1.4%)	202	**-0.051***	**(-3.1%)**
August	2013				543	**-0.058***	**(-3.9%)**
September	2013				563	**-0.031***	**(-2.4%)**

* Statistically significant ($\alpha = 0.05$)

The results provided in Table 7 indicate that participants in the first two months after installation of the IHD did not save energy. Only November shows a statistically significant impact – an increase of 4.6% -- implying that energy conserving behavior and efficient equipment were either not implemented or ineffective in the first two months after IHD installation.

Beyond the first two months, energy savings are statistically significant in every month from February through September except June, suggesting that it may take a few months after IHD installation for savings to appear. This delay could be the result of a learning curve with the IHD. It could also reflect time needed for customers to purchase and install more efficient appliances or envelope enhancements.

Table 8 shows the average summer, winter, and annual energy and bill impacts calculated from 2013 standard rates (Table 6) and participant energy use beyond the first two months of IHD installation (Table 7). Across all participants, the average annual energy savings was 260 kWh, resulting in an average annual bill savings of just under $40.

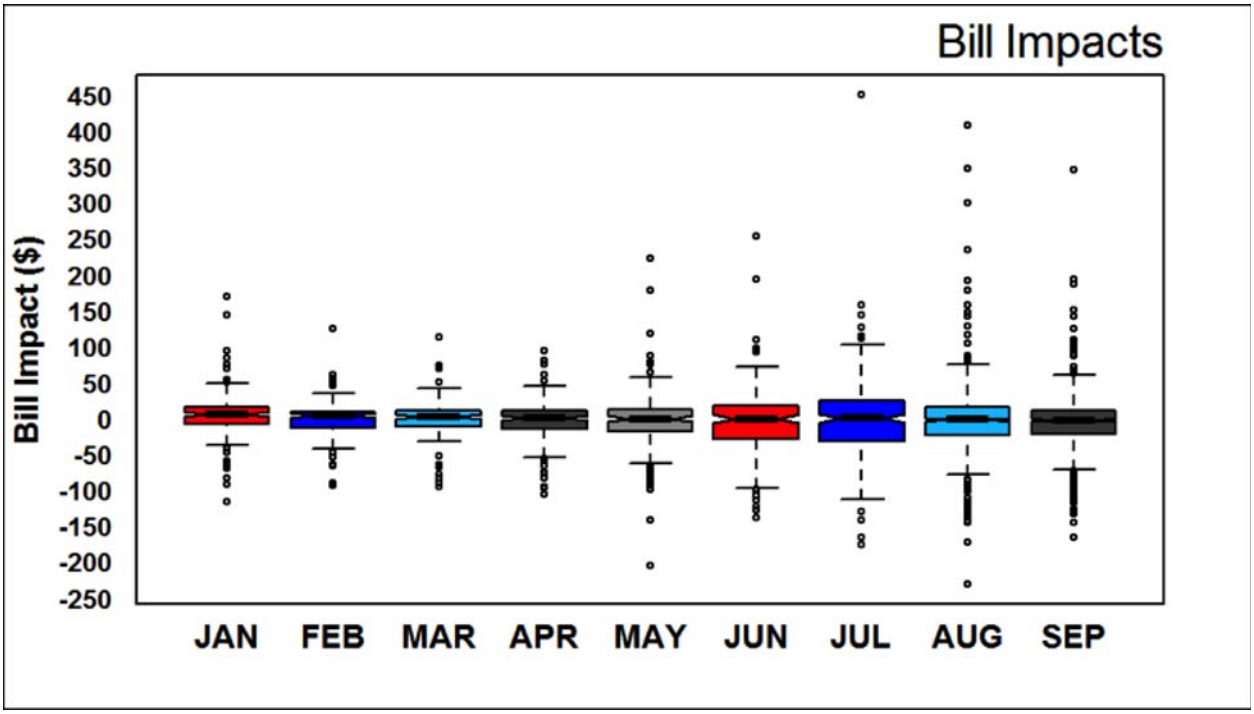
TABLE 8. SEASONAL AND ANNUAL ENERGY AND BILL IMPACTS

Season	Hourly Energy Impact (kWh/h)	Total Energy Impact (kWh)	% Energy Impact	Monthly Bill Impact ($/month)	Total Bill Impact ($)	% Bill Impact
Winter	-0.025	-140	-2.4%	-$2.46*	-$19.68	-2.8%
Summer	-0.042	-120	-2.9%	-$4.94*	-$19.76	-3.6%
Annual	-0.030	-260	-2.6%	-$4.22*	-$39.44	-3.4%

* Statistically significant (α = 0.05)

Bill impacts ranged from a maximum bill savings of nearly $250 to a maximum bill increase of nearly $450. Figure 10 shows that the distribution of monthly bill impacts clustered around $0 in all months. While there are several extreme outliers, it is important to keep in mind that the individual impacts are not necessarily the result of the treatment - only changes in the average of the full sample can be attributed to the IHD.

FIGURE 10. DISTRIBUTION OF CUSTOMER-SPECIFIC BILL IMPACTS



Summer Weekday Peak Impacts

Estimates of summer load impacts are obtained from a pooled mixed effects model using data for both the participant and control groups, as described previously. Figure 11 shows the modeled baseline and summer weekday loads for the control group, indicating very little change in energy use from 2012 to 2013.

Figure 11. Average summer weekday loads for the control group, adjusted for weather

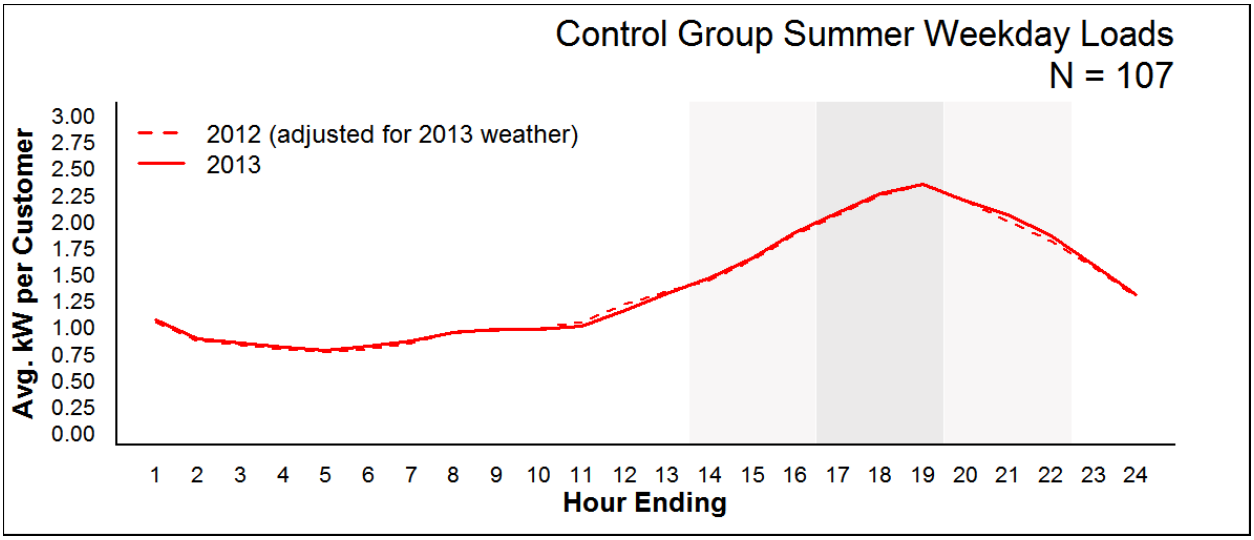


Figure 12 shows the modeled baseline and summer weekday loads of the 513 customers who received their IHDs prior to June 1, 2013, indicating modest but visible peak load reductions from 2012 to 2013.

Figure 12. Average summer weekday loads for participants, adjusted for weather

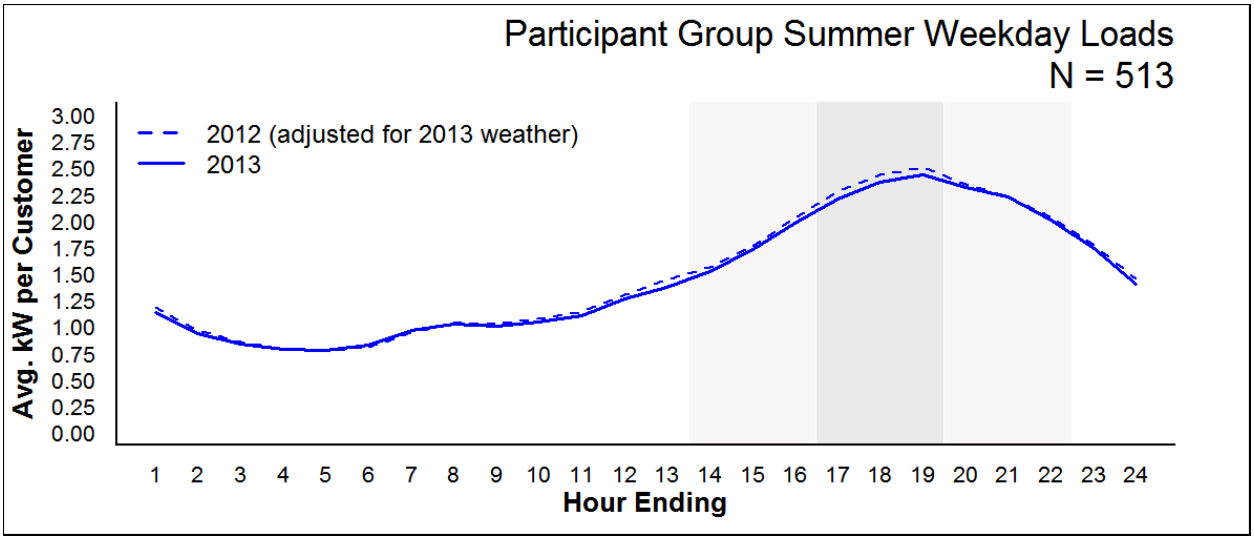


Figure 13 shows the summer weekday load impacts of the treatment group calculated as the difference in differences between the four hourly load shapes represented in Figure 11 and Figure 12. Average load impacts are statistically significant in each 3-hour period between 1 and 10 pm, with average pre-peak impacts of -0.067 kW (-3.7%), peak impacts of -0.083 kW (-3.4%), and post-peak impacts of -0.056 kW (-2.5%).

FIGURE 13. AVERAGE SUMMER WEEKDAY IMPACTS FOR PARTICIPANTS (DID)

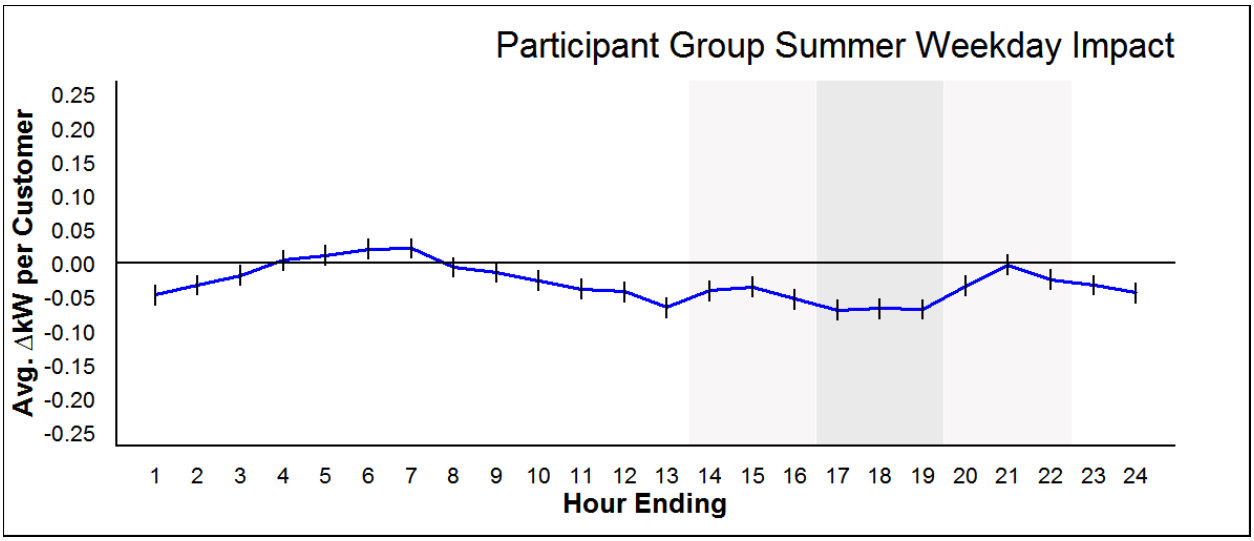


Figure 14 shows the same summer weekday impacts divided into three different subgroups of participants based on the amount of time that had passed since IHD installation:

<1 month: Participants who received the IHD in May 2013. Less than 1 month had passed between installation and the June 1 analysis period start date.

1-5 months: Participants who received the IHD between January and April 2013. Between 1 and 5 months had passed between installation and the June 1 analysis period start date.

>5 months: Participants who received the IHD in November or December of 2012. More than 5 months had passed between IHD installation and the June 1 analysis period start date.

Note that for each subgroup, the number of months that had passed after IHD installation increased as the summer progressed, such that by the end of September, more than 9 months had passed for the ">5 months" subgroup, 5-9 months had passed for the "1-5 months" subgroup, etc.

Average load impact estimates given in Table 9 indicate savings for all three subgroups in the 3-hour periods before, during and after the 4-7 pm peak.

FIGURE 14. AVERAGE HOURLY IMPACTS, SUMMER WEEKDAYS, BY DURATION AFTER IHD RECEIPT

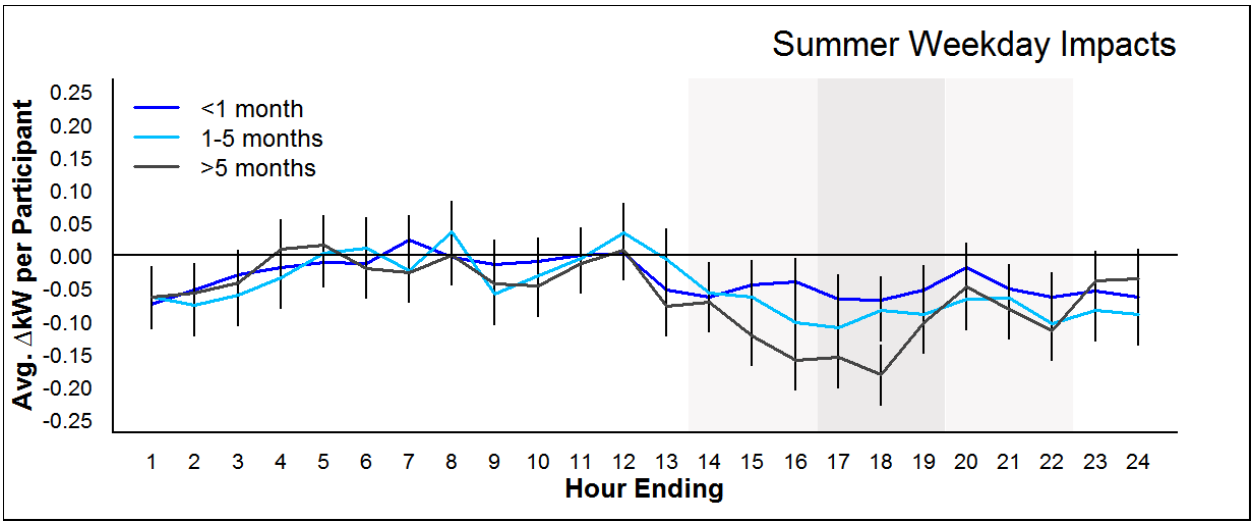


TABLE 9. SUMMER WEEKDAY PEAK IMPACTS, BY DURATION AFTER IHD INSTALLATION

IHD exposure (after 6/1/2013)	N	Pre-peak (hours 14-16)		Peak (hours 17-19)		Post-peak (hours 20-22)	
		kW	*%*	*kW*	*%*	*kW*	*%*
<1 month	319	-0.050*	(-2.8%)	-0.062*	(-2.6%)	-0.043*	(-1.9%)
1-5 months	94	-0.073*	(-4.1%)	-0.09*	(-3.8%)	-0.072*	(-3.1%)
>5 months	100	-0.12*	(-6.4%)	-0.15*	(-5.8%)	-0.081*	(-3.6%)
Average	513	-0.067*	(-3.7%)	-0.083*	(-3.4%)	-0.056*	(-2.5%)

* Statistically significant (α = 0.05)

Contrast analysis (Table 10) indicates that those with less than one month of exposure to the IHD had significantly lower savings during the peak period than did those who had received the IHD more than 5 months prior to the summer analysis period, which started on June 1. Reasons for these increased savings over time might include a learning curve for using the device, or time needed to implement appliance or envelope efficiency upgrades.

TABLE 10. SUMMER WEEKDAY PEAK IMPACTS, COMPARISONS BETWEEN GROUPS

Impact of…	Relative to…	Pre-peak kW (hours 14-16)	Peak kW (hours 17-19)	Post-peak kW (hours 20-22)
<1 month	1-5 months	-0.036	-0.029	-0.029
1-5 months	>5 months	-0.045	-0.055	-0.009
<1 month	>5 months	-0.068*	-0.084*	-0.038

* Statistically significant (α = 0.05)

5. Discussion and Conclusions

This evaluation indicates that the IHD Checkout Pilot program prompted modest but statistically significant annual energy (2.6%) and bill (3.4%) savings in the first year after IHD installation. Summer peak demands were also significantly reduced – by about 3.4% – after introduction of the IHD. This higher rate of summer peak reduction relative to overall energy savings is likely the result of greater attention to the efficiency of air-conditioning, which is typically the largest electric appliance in Sacramento area homes.

Participants in the first two months after installation of the IHD did not save energy, implying that energy conserving behavior and efficient equipment were either not implemented or ineffective in the first two months after IHD installation. Beyond the first two months, energy savings were statistically significant in nearly every month from February through September. Similarly, the group of participants who installed the IHD more than five months prior to the summer reduced their peak demand significantly more than did the group of participants who received the IHD in the month immediately preceding the summer. In both the energy and demand analyses, the delayed savings imply that it may take a few months after IHD installation for savings to appear. The delay could be the result of a learning curve with the IHD, or it might reflect time needed for customers to purchase and install more efficient appliances or envelope enhancements.

Limitations of this Analysis

Following are some of the limitations of this analysis.

Short Time Period

The hourly load data available for this impact analysis spanned just 11 months. Thus, persistence of the effects cannot be determined beyond the first 11-months after IHD installation. In addition, average winter energy and bill impacts were based on energy use during just the five months (January - May) for which sufficient winter data was available. If impacts in the missing three winter months (October - December) differed substantially from the five available winter months, average annual energy and bill impacts could be overestimated or underestimated.

Hawthorne Effects

This study did not control for Hawthorne effects, a phenomenon in which study participants act according to the expectations of the study simply because they know they are being monitored and want to be good subjects. It is possible that the savings found in this study were enhanced by the Hawthorne effect.

A recent study of Hawthorne effects showed a 2.7% energy savings in homes that received no intervention other than weekly postcards informing them that they were in a study, suggesting that energy savings at that level might come through a heightened awareness of electricity use rather than through a better understanding of it (Schwartz et al. 2013). It is conceivable, then, that the mere *presence* of the IHD – not the information it provided – motivated customers to reduce their energy use by a similar 2.6%.

Worthy of further consideration, however, is that the 2.7% energy savings identified in the aforementioned Hawthorne effects study disappeared after the postcards ceased to be delivered. The energy savings found in the IHD checkout study, in contrast, *increased* after the two-month IHD return date had passed. This implies that the savings may have had less to do with the presence of the IHD than the education it provided. This might also suggest that the savings were a result of long-term energy saving actions, such as home and appliance upgrades, rather than of short-term energy-saving behaviors, such as turning off lights.

Lack of Comparison

This study considered only a single technology. The study would have benefited from comparisons to other information types, IHD models, or data delivery methods such as websites or smartphone applications.

Recommendations

The findings of this evaluation indicate that the IHD checkout program elicited a 2.6% energy savings in participant homes; however, we recommend that SMUD conduct a cost effectiveness analysis prior to considering implementation of a similar program. Future research efforts might also reevaluate the savings of this pilot one or two years out from the timing of this analysis to determine the extent of the persistence of savings over time.

For future IHD studies or programs, we recommend that SMUD conduct usability testing of multiple IHD models prior to device procurement and choose one or two units with high usability and preference scores for implementation. Evaluations should be conducted annually to ensure continued effectiveness and cost effectiveness of the program.

REFERENCES

Herter, K. and J. Okuneva. 2014. *SMUD's Low Income Weatherization & Energy Management Pilot – Load Impact Evaluation*. Prepared by Herter Energy Research Solutions for the Sacramento Municipal Utility District.

True North Research. 2014. EnergyAware Electricity Use Display Checkout Program - Survey Report. Prepared for the Sacramento Municipal Utility District.

True North Research. 2013. *IHD - PowerTab Display In-home Ethnographies*. Prepared for the Sacramento Municipal Utility District.

Schwartz, D., B. Fischhoff, T. Krishnamurti, and F. Sowell. 2013. "The Hawthorne Effect and Energy Awareness," *PNAS* vol. 110 no. 38.

APPENDICES

APPENDIX A. SUMMER ENERGY AND PEAK DEMAND COMPARISONS

FIGURE 15. SUMMER ENERGY (KWH) – PARTICIPANTS V. GENERAL POPULATION

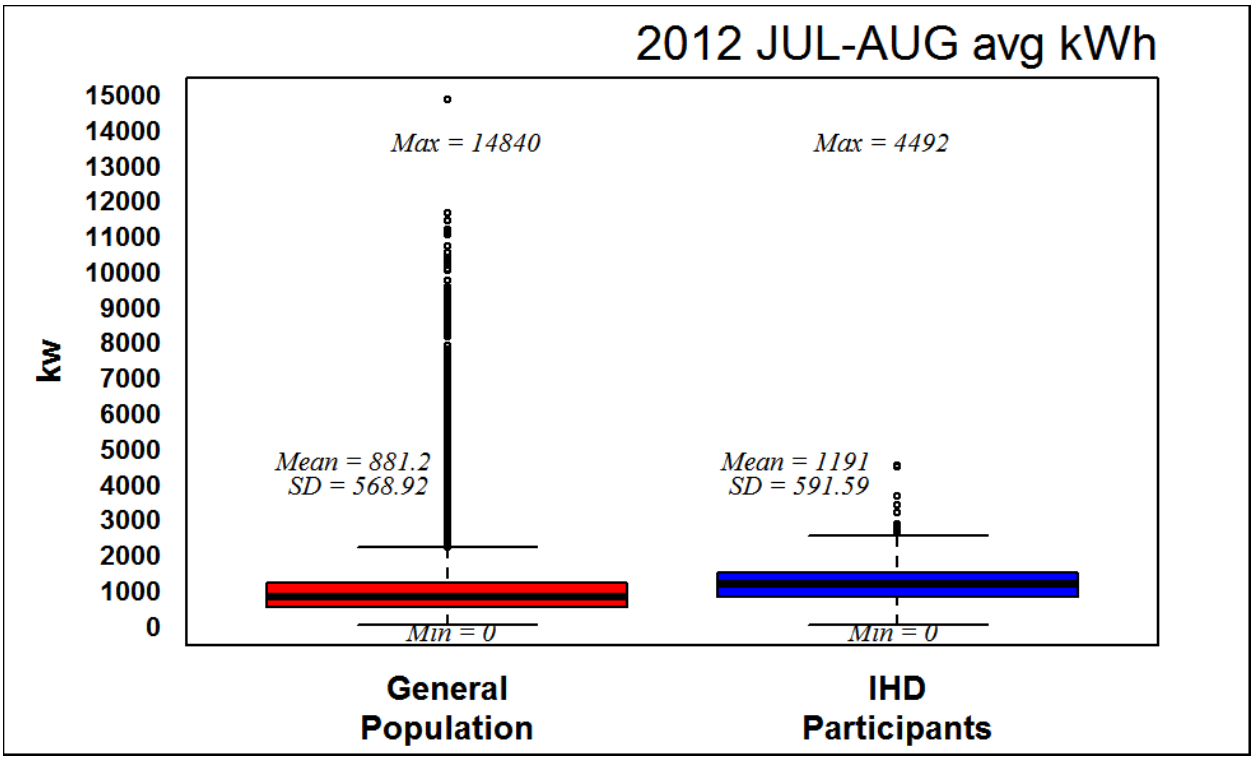


TABLE 11.SUMMER ENERGY (KWH) COMPARISONS, PARTICIPANTS VS. GENERAL POPULATION

Linear Hypotheses	Estimate	Std. Error	T-value	P-value
Participants – General Population = 0	309.32	25.21	12.27	< 0.0001

IHD participants had a higher summer energy use and this difference was statistically significant.

FIGURE 16. SUMMER PEAK DEMAND (KW) – PARTICIPANTS V. GENERAL POPULATION

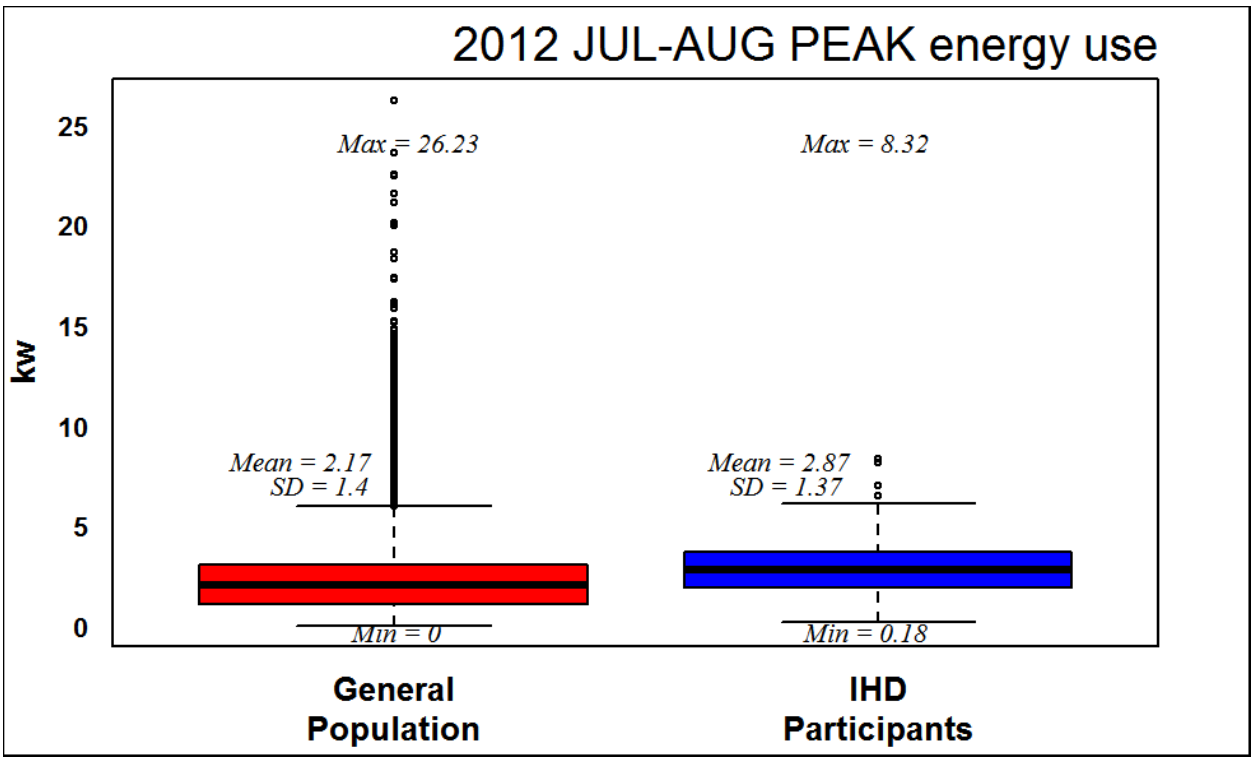


TABLE 12.SUMMER PEAK DEMAND (KW) COMPARISONS, PARTICIPANTS VS. GENERAL POPULATION

Linear Hypotheses	Estimate	Std. Error	T-value	P-value
IHD Parts – General Population	0.70334	0.06181	11.38	< 0.0001

IHD participants had a higher summer peak demand and this difference was statistically significant.

Appendix B. Actual Load Shapes, by Month

The following sections present averages of the actual measured loads collected by SMUD's electricity meters. The load shapes shown here have not been corrected for weather or exogenous effects.

Loads in the first 2 months after IHD installation

Figure 16 through Figure 24 show, for each month, the average daily loads for participant homes in the first 2 months (62 days) after installation of their IHD.

Figure 17. Average loads for February, IHD installed ≤2 months

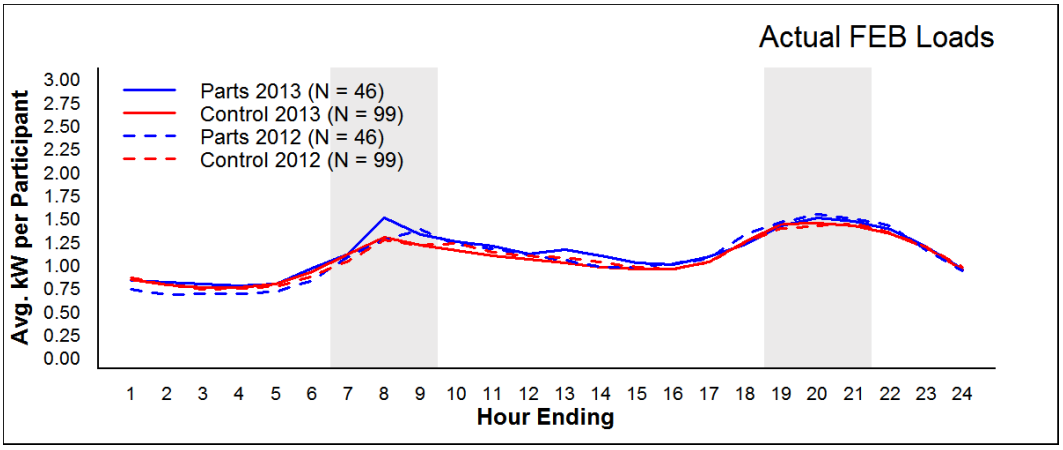


Figure 18. Average loads for March, IHD installed ≤2 months

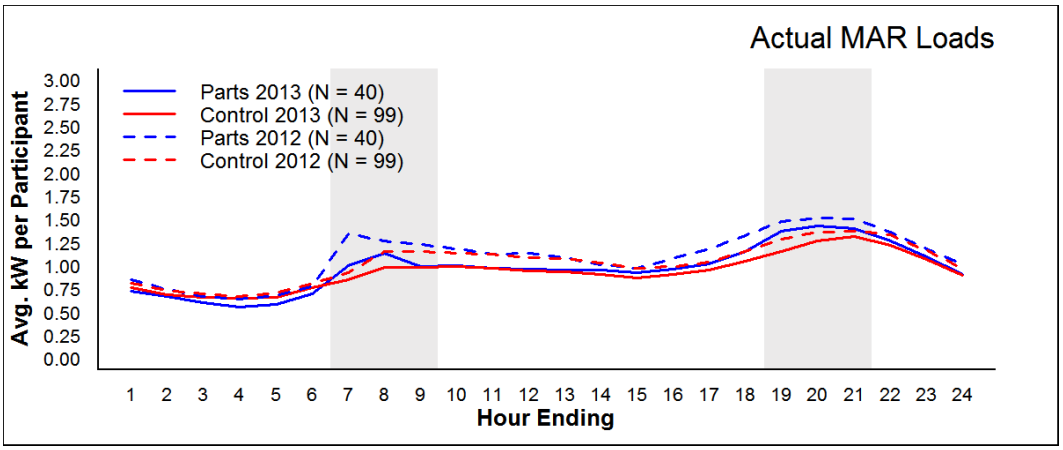


FIGURE 19. AVERAGE LOADS FOR MAY, IHD INSTALLED ≤2 MONTHS

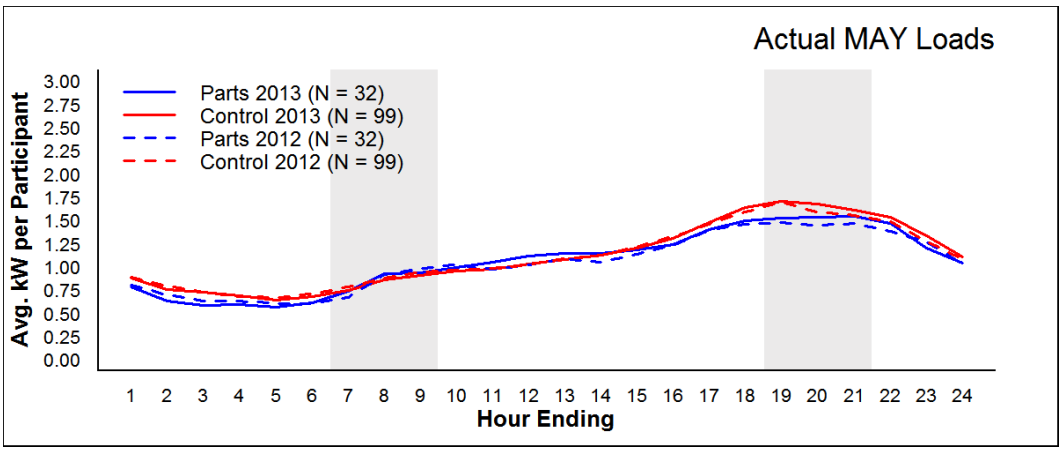


FIGURE 20. AVERAGE LOADS FOR JUNE, IHD INSTALLED ≤2 MONTHS

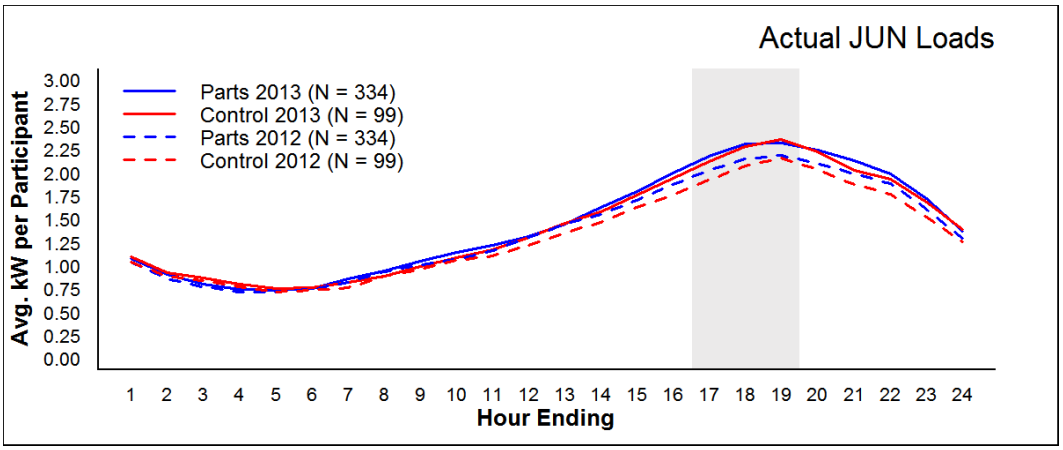


FIGURE 21. AVERAGE LOADS FOR JULY, IHD INSTALLED ≤2 MONTHS

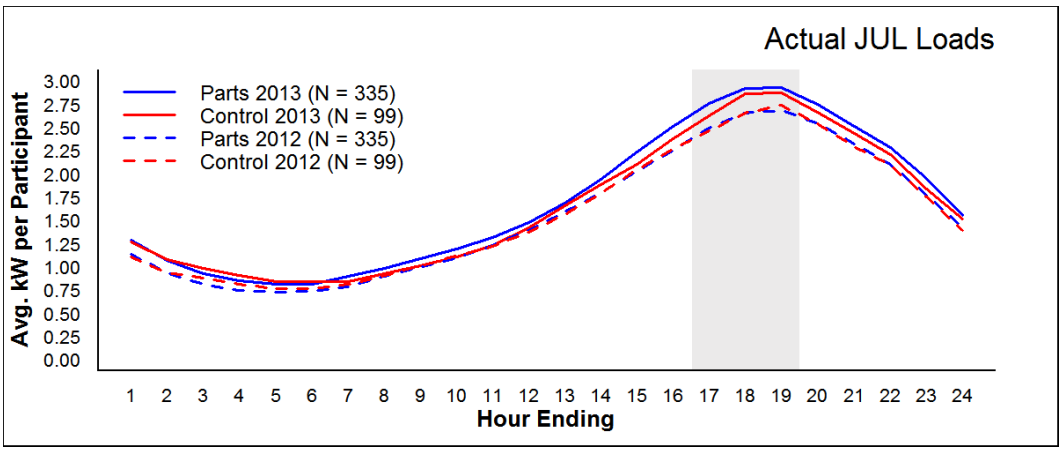


FIGURE 22. AVERAGE LOADS FOR SEPTEMBER, IHD INSTALLED ≤2 MONTHS

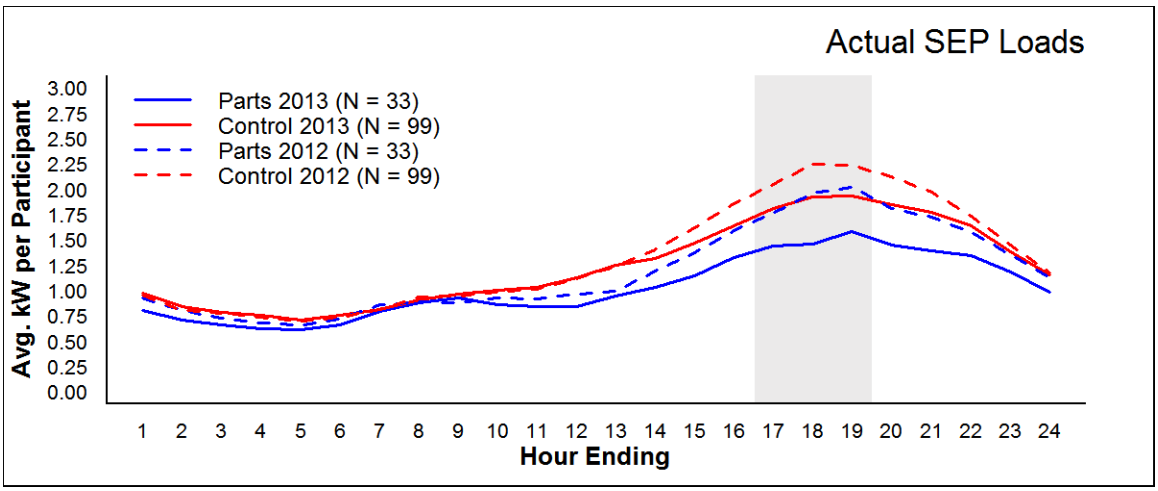


FIGURE 23. AVERAGE LOADS FOR NOVEMBER, IHD INSTALLED ≤2 MONTHS

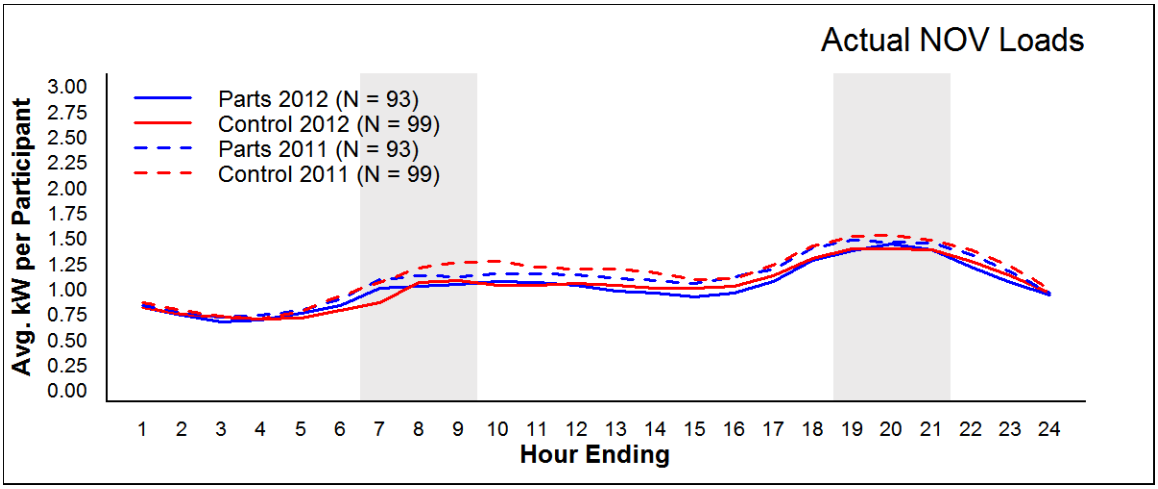
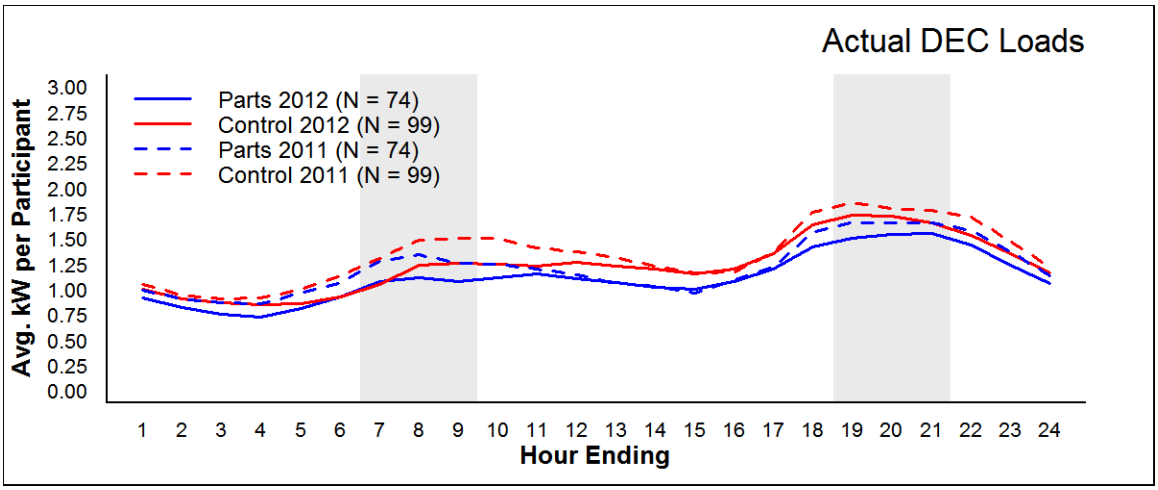


FIGURE 24. AVERAGE LOADS FOR DECEMBER, IHD INSTALLED ≤2 MONTHS



LOADS MORE THAN 2 MONTHS AFTER IHD INSTALLATION

Figure 25 through Figure 36 show the average daily loads for participant homes based on data collected from month 3 to month 12 (day 63 to day 365) after installation of their IHD. Note that most participants were no longer in possession of the IHD during this time.

FIGURE 25. AVERAGE LOADS FOR JANUARY, IHD INSTALLED >2 MONTHS

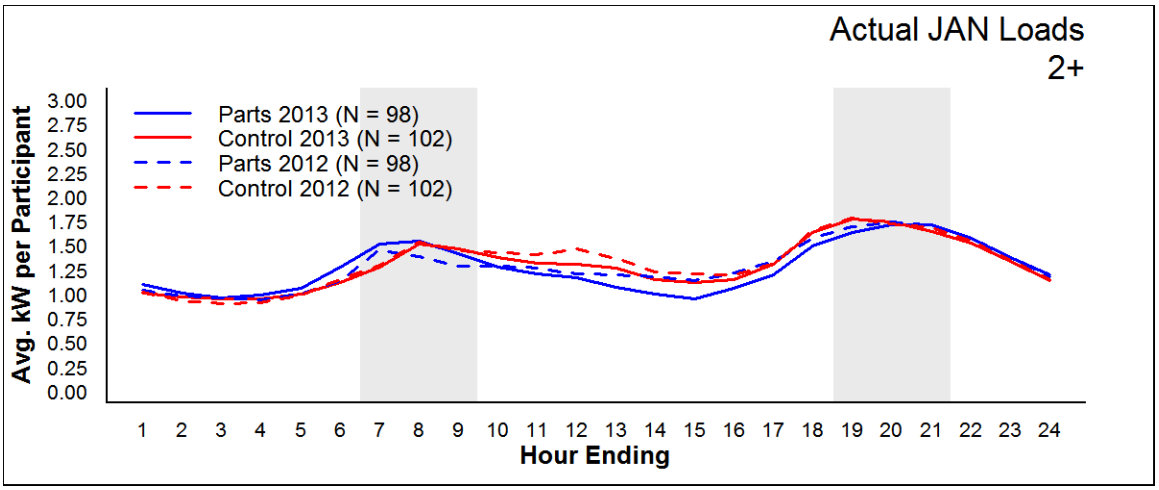


FIGURE 26. AVERAGE LOADS FOR FEBRUARY, IHD INSTALLED >2 MONTHS

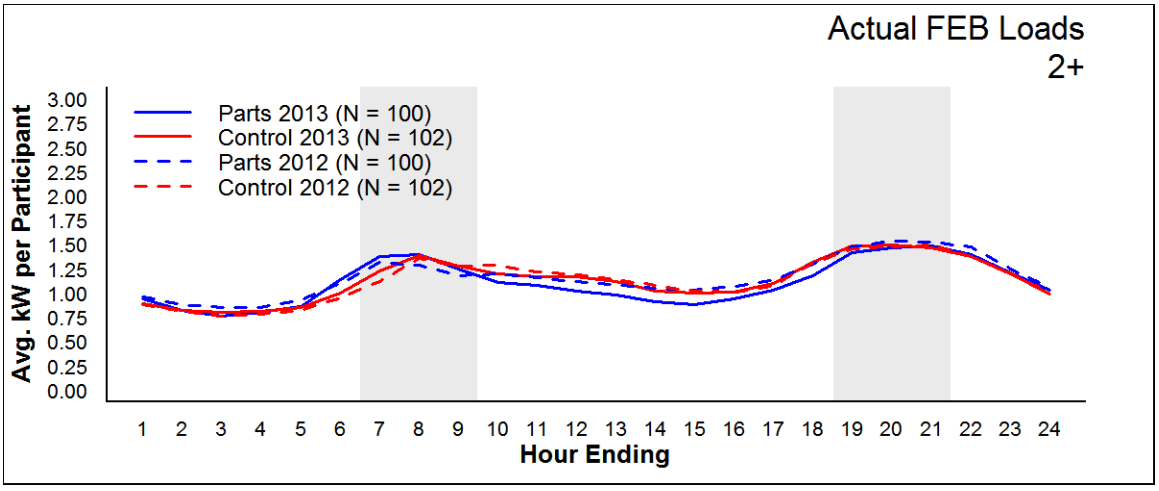


FIGURE 27. AVERAGE LOADS FOR MARCH, IHD INSTALLED >2 MONTHS

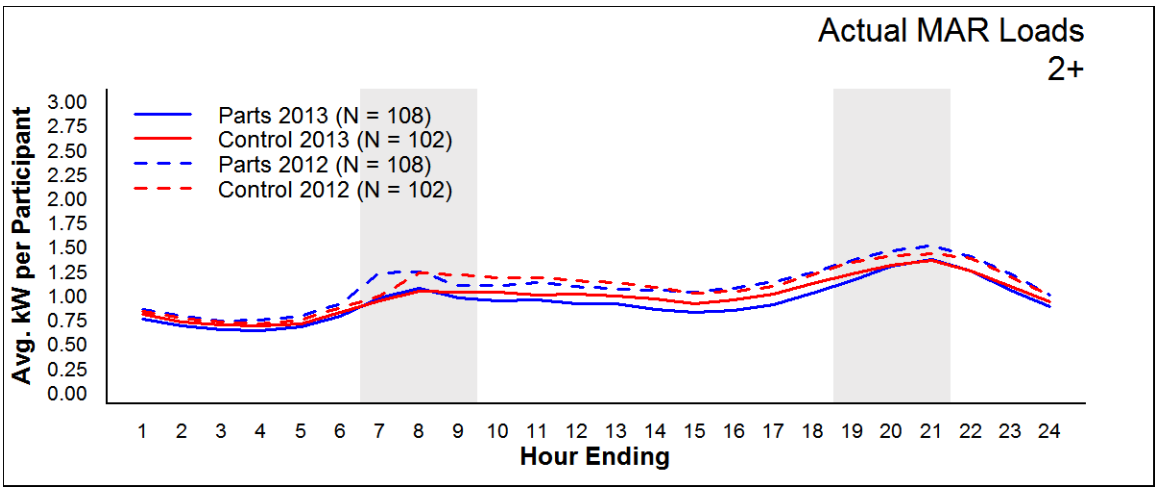


FIGURE 28. AVERAGE LOADS FOR APRIL, IHD INSTALLED >2 MONTHS

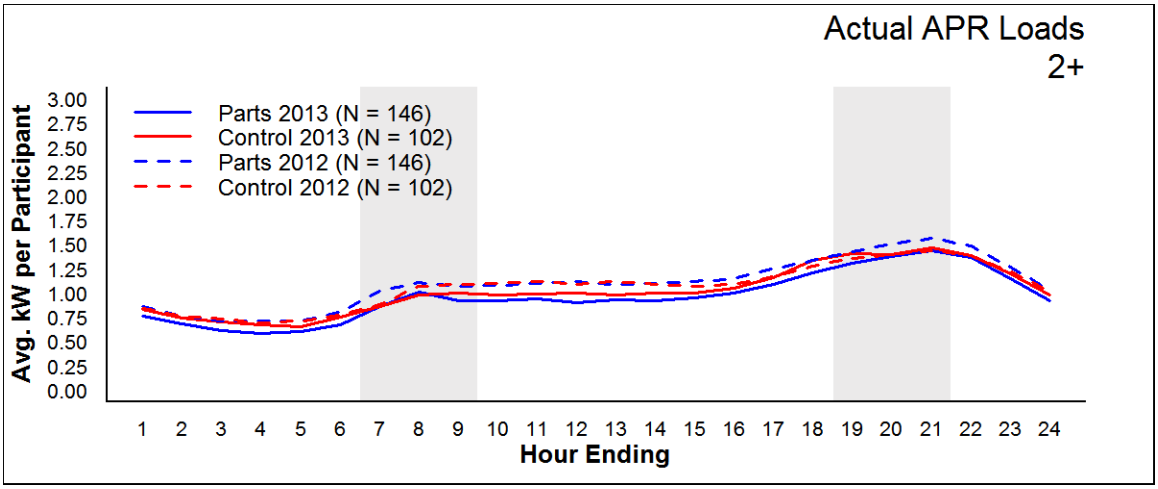


FIGURE 29. AVERAGE LOADS FOR MAY, IHD INSTALLED >2 MONTHS

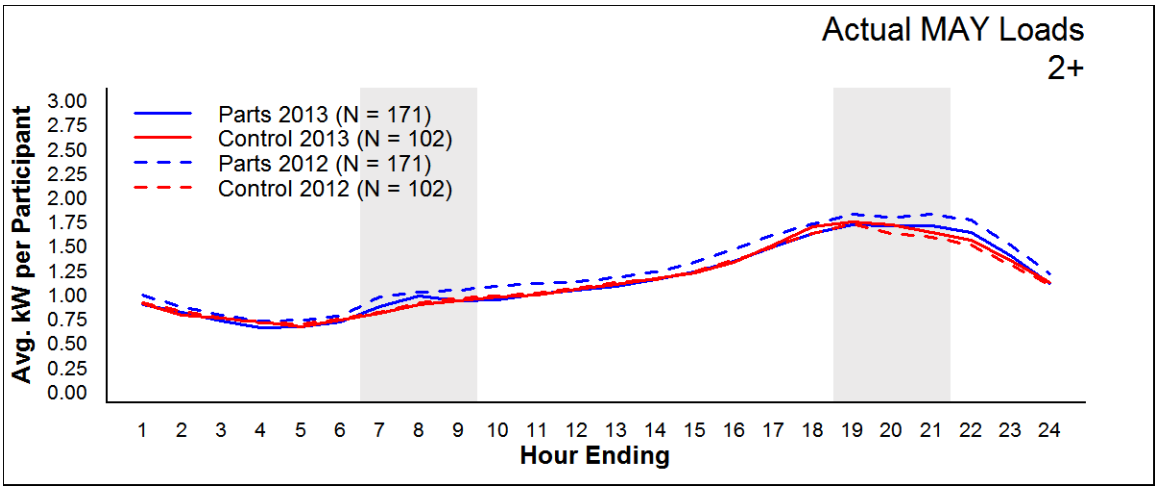


FIGURE 30. AVERAGE LOADS FOR JUNE, IHD INSTALLED >2 MONTHS

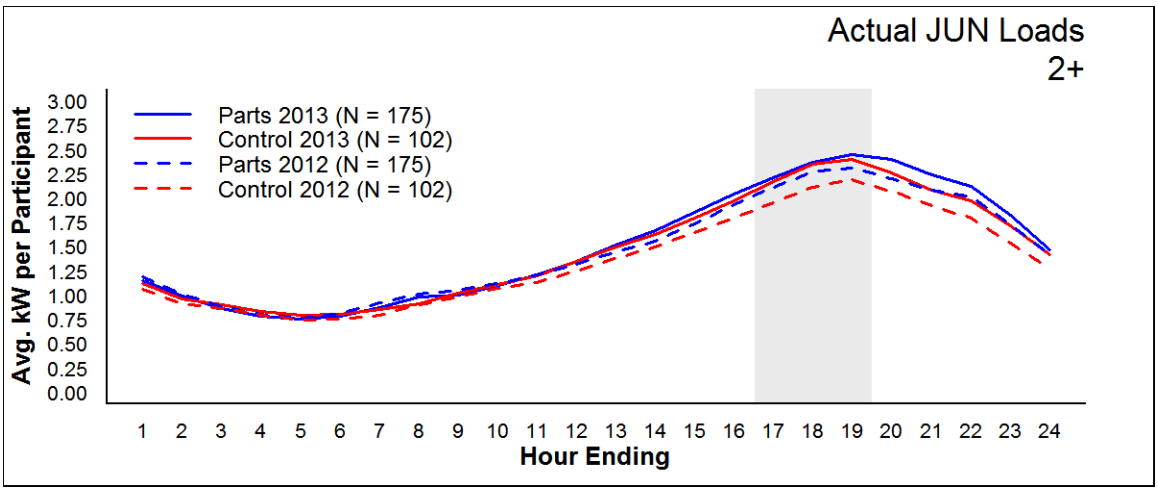


FIGURE 31. AVERAGE LOADS FOR JULY, IHD INSTALLED >2 MONTHS

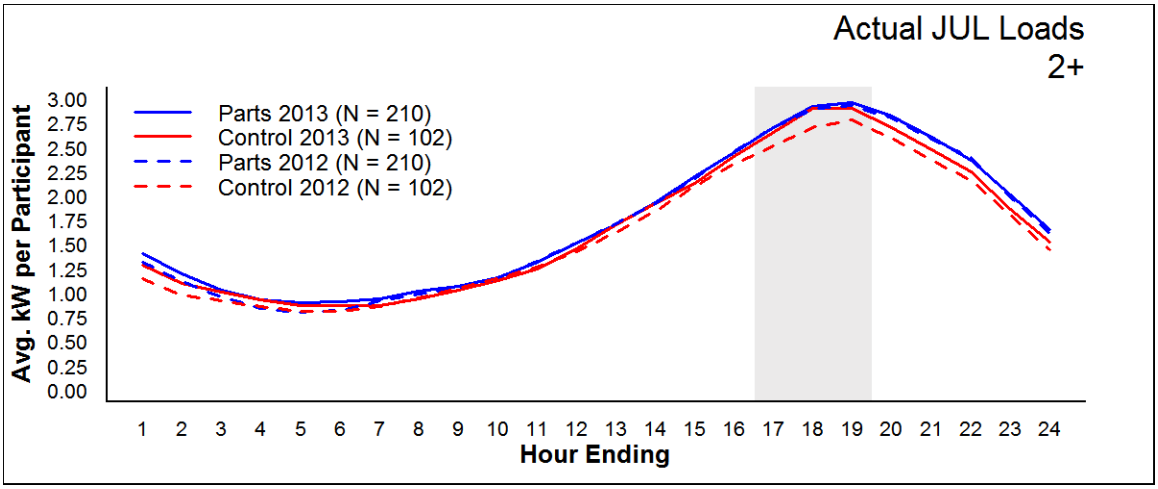


FIGURE 32. AVERAGE LOADS FOR AUGUST, IHD INSTALLED >2 MONTHS

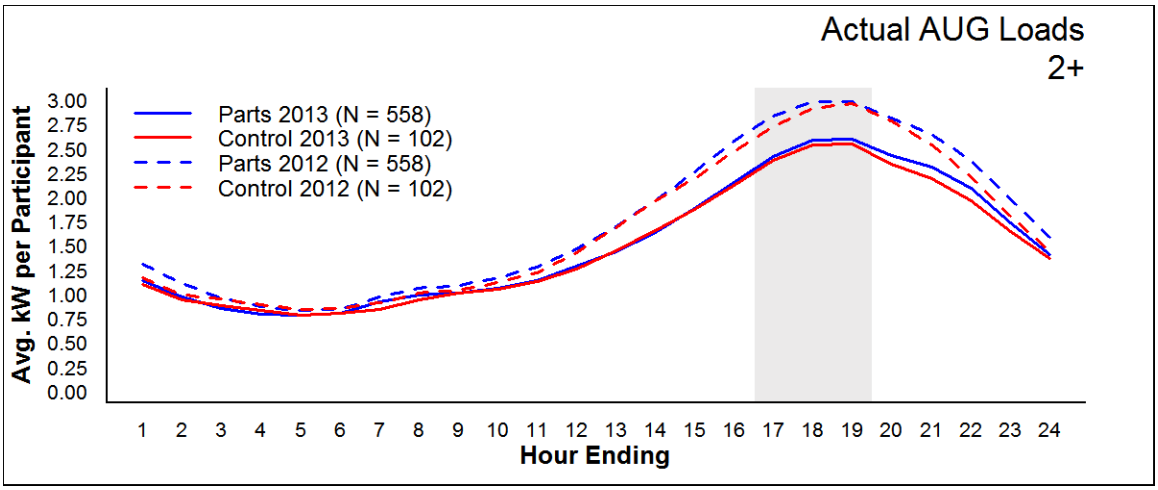


FIGURE 33. AVERAGE LOADS FOR SEPTEMBER, IHD INSTALLED >2 MONTHS

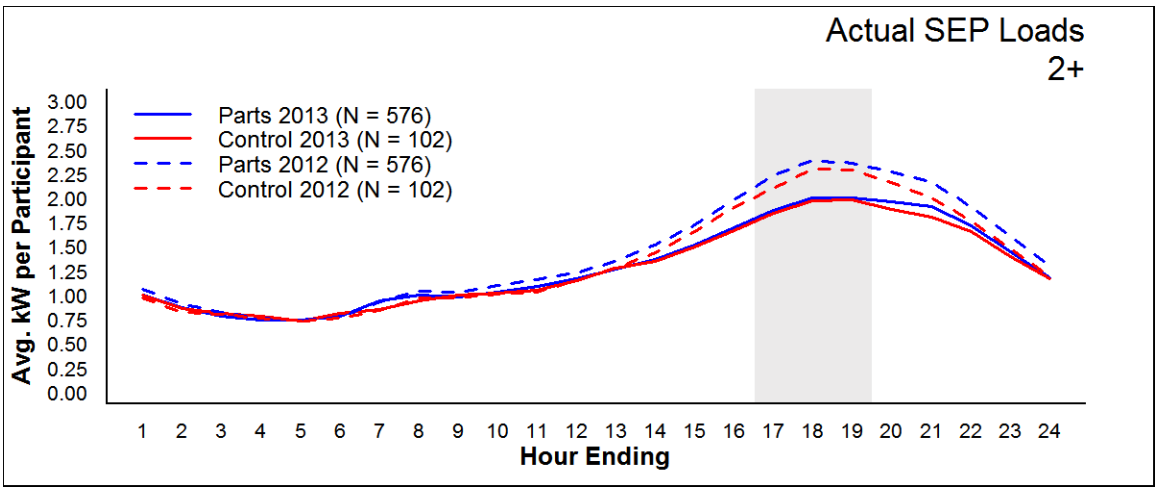


FIGURE 34. AVERAGE LOADS FOR NOVEMBER, IHD INSTALLED >2 MONTHS

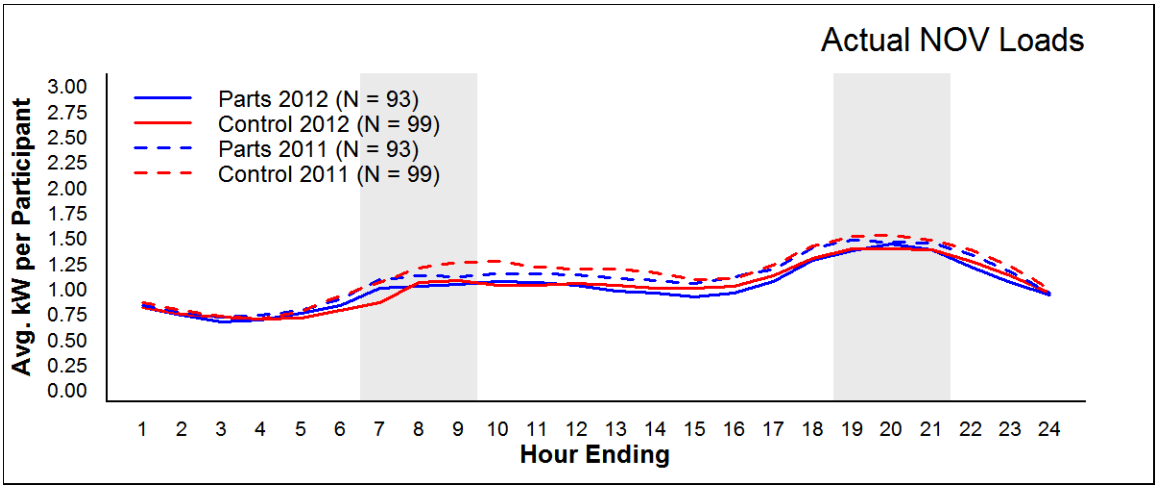
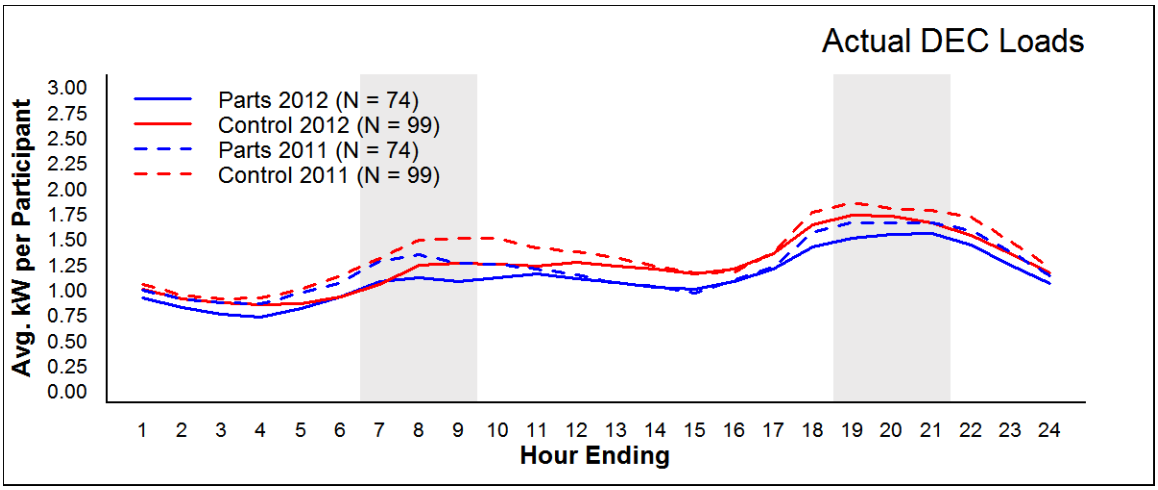


FIGURE 35. AVERAGE LOADS FOR DECEMBER, IHD INSTALLED >2 MONTHS



Appendix C. Monthly Models

Model Diagnostics

In this section we provide model diagnostics for IHD installed 1-2 months models. Please note we only present diagnostic plots for the months of December and July as diagnostic plots for all other months look similar.

IHD installed up to 2 months

Figure 36 shows that the modeled loads are nearly identical to the average of the actual loads.

Figure 36. Actual and modeled loads, IHD installed ≤2 months

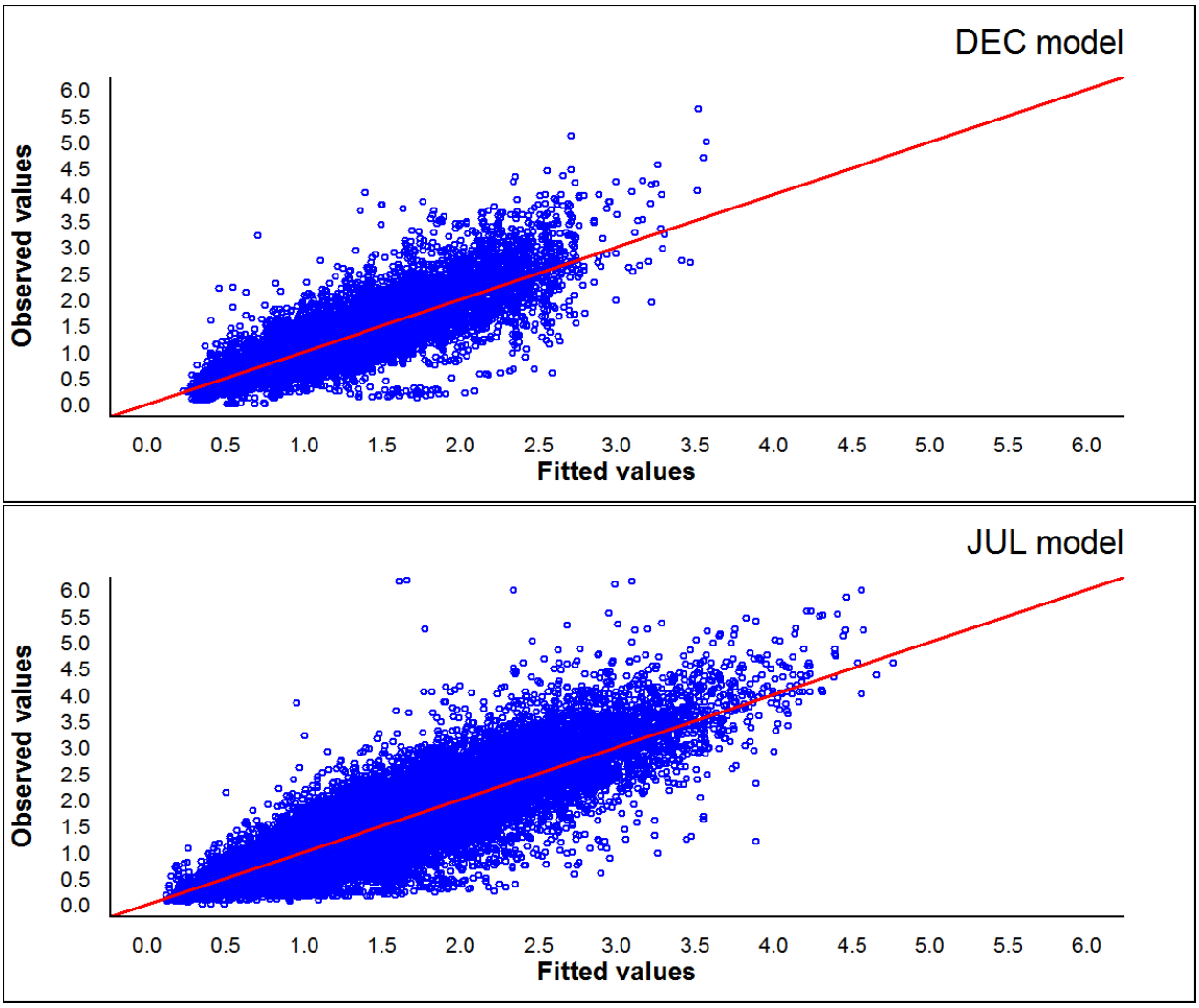


Figure 37 provides scatter plots of slope vs. intercept showing the outliers that were excluded from the analysis, marked“parts” for an excluded participant and “control” for an excluded control.

FIGURE 37. OUTLIERS, IHD INSTALLED ≤2 MONTHS

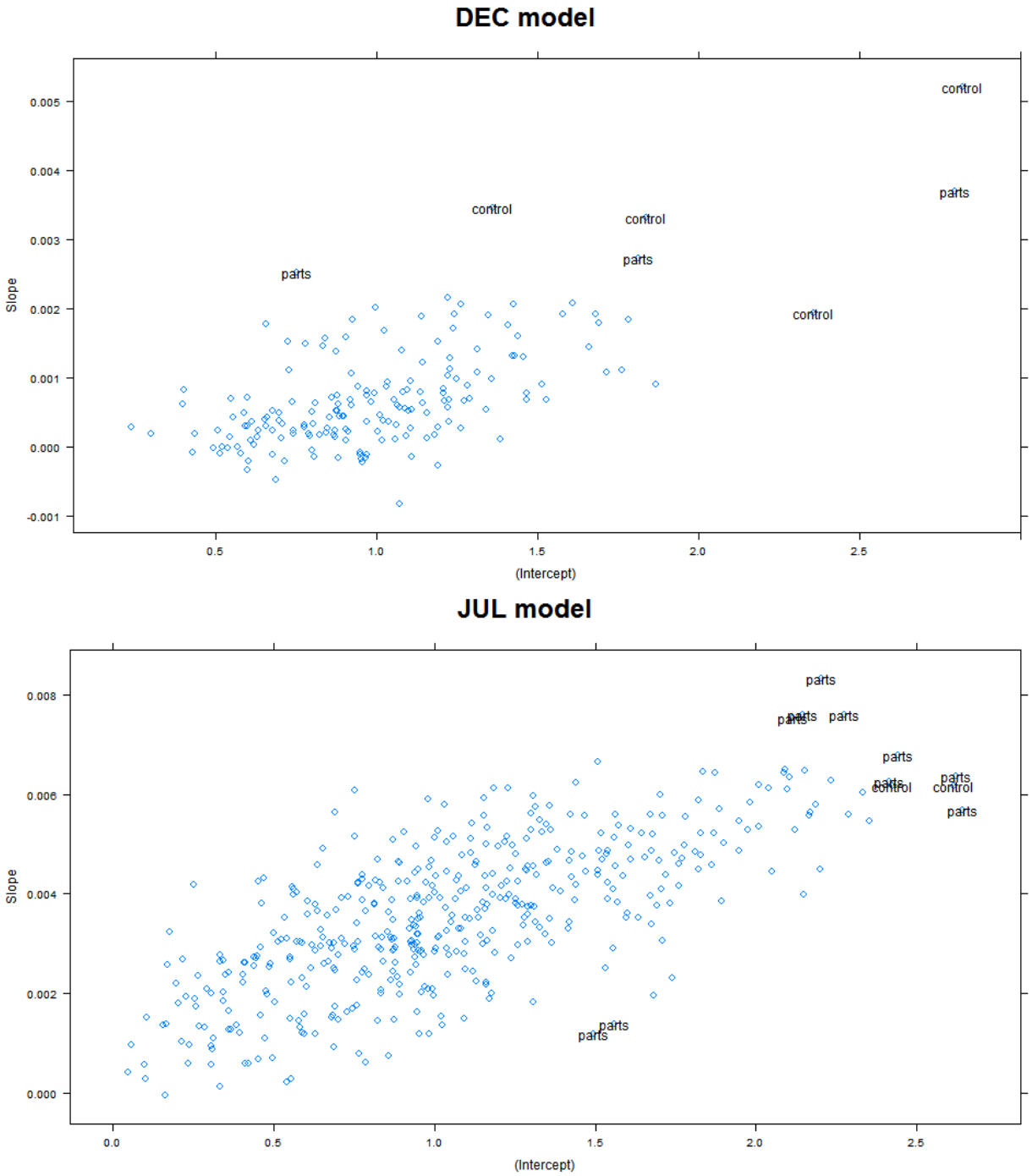


Figure 38 provides scatter plot of normalized residuals versus fitted values for December and July models.

FIGURE 38. NORMALIZED RESIDUALS VERSUS FITTED VALUES, IHD INSTALLED ≤2 MONTHS

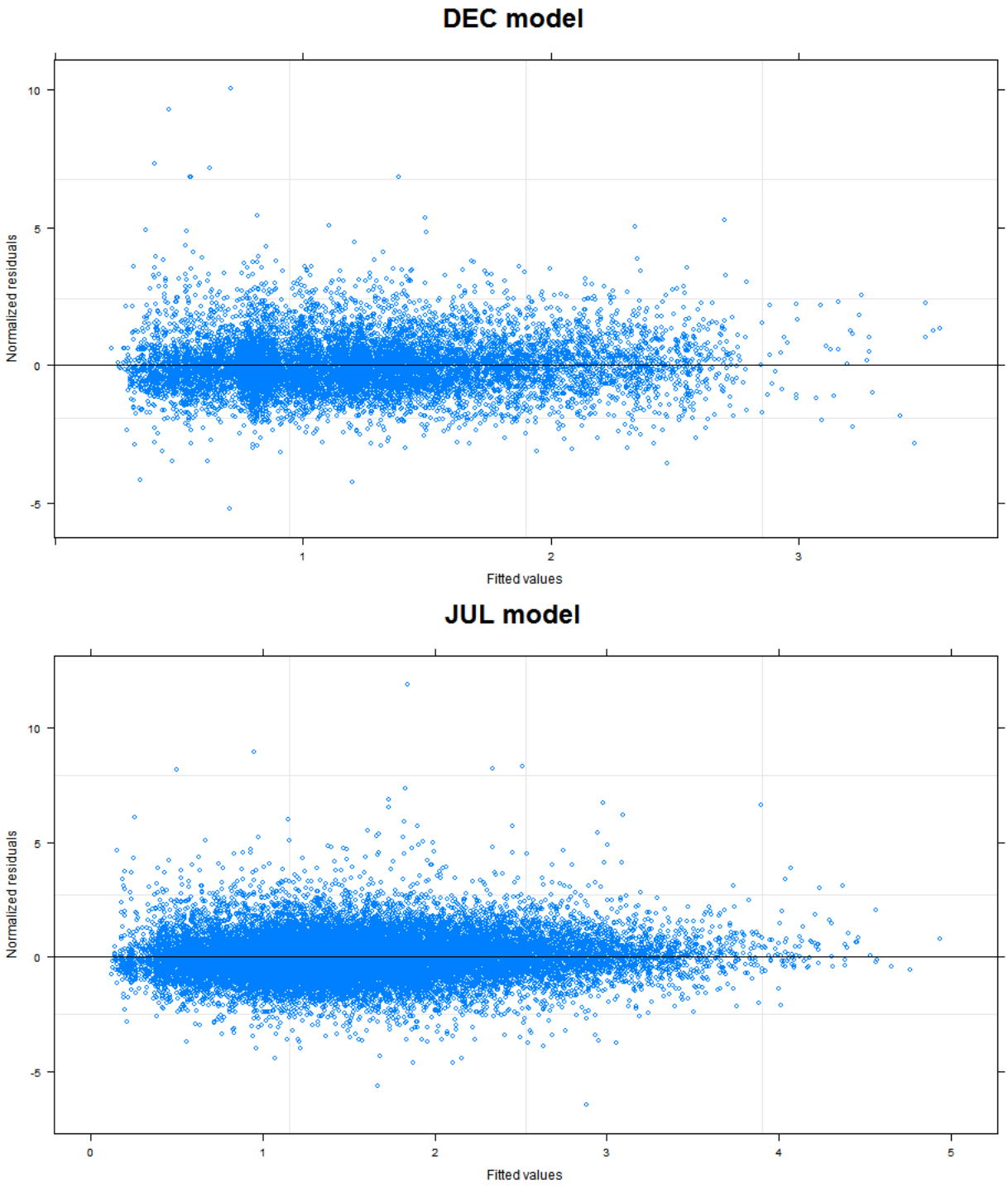


Figure 39 provides a plot of the empirical autocorrelation function.

FIGURE 39. EMPIRICAL AUTOCORRELATION FUNCTION CORRESPONDING TO NORMALIZED RESIDUALS, IHD INSTALLED ≤2 MONTHS

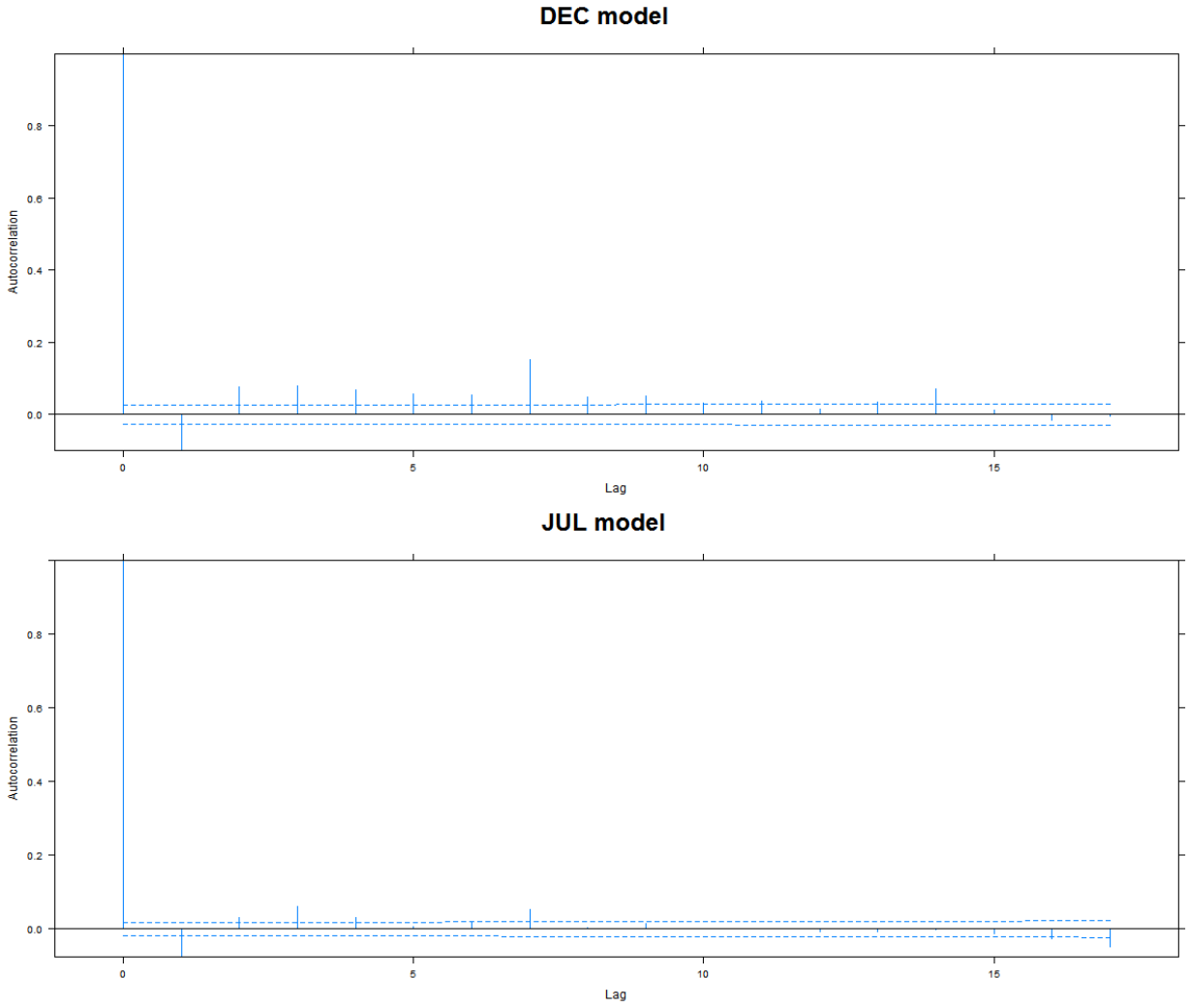


Figure 40 provides normal plot of residuals for December and July models.

FIGURE 40. NORMAL PLOT OF RESIDUALS, IHD INSTALLED ≤2 MONTHS

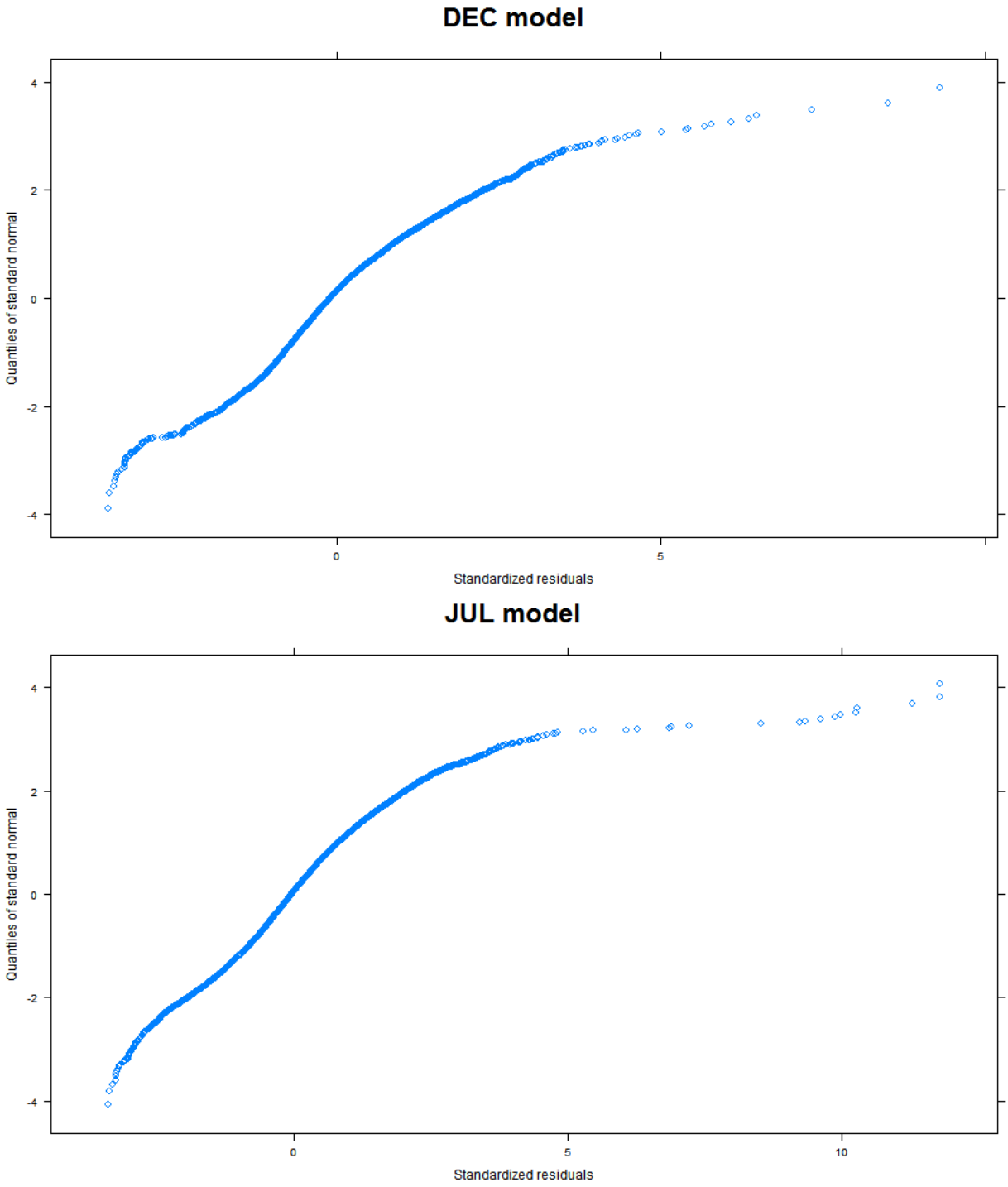
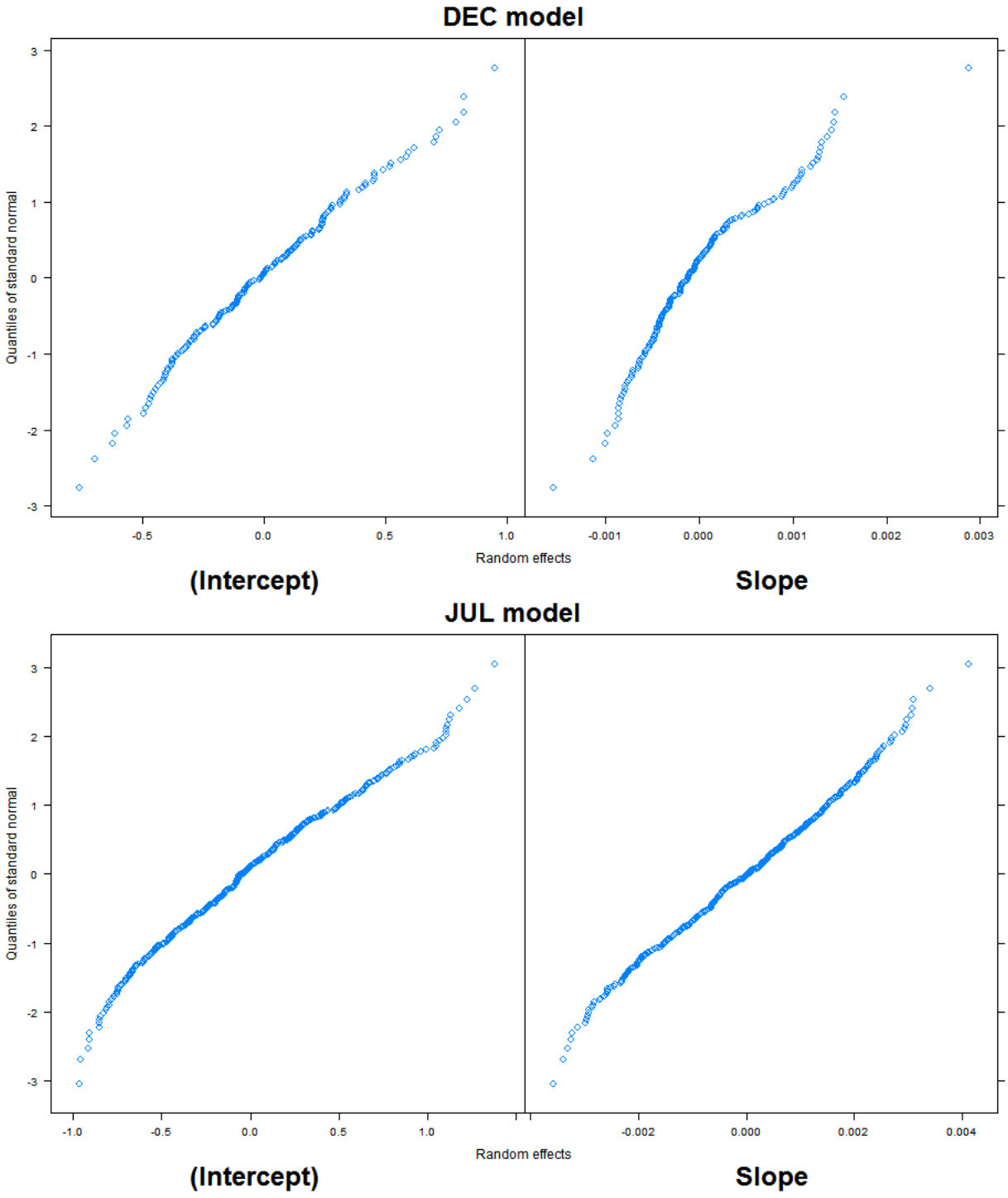


Figure 41 provides normal plots of estimated random effects for December and July models.

FIGURE 41. NORMAL PLOTS OF ESTIMATED RANDOM EFFECTS, IHD INSTALLED ≤2 MONTHS



>2 MONTHS AFTER IHD INSTALLATION

In this section we provide model diagnostics for IHD installed 1-2 months models. Please note we only present diagnostic plots for the months of January and July as diagnostic plots for all other months look similar.

Figure 42 shows that the modeled loads are nearly identical to the average of the actual loads.

FIGURE 42. ACTUAL AND MODELED LOADS, >2 MONTHS AFTER IHD INSTALLATION

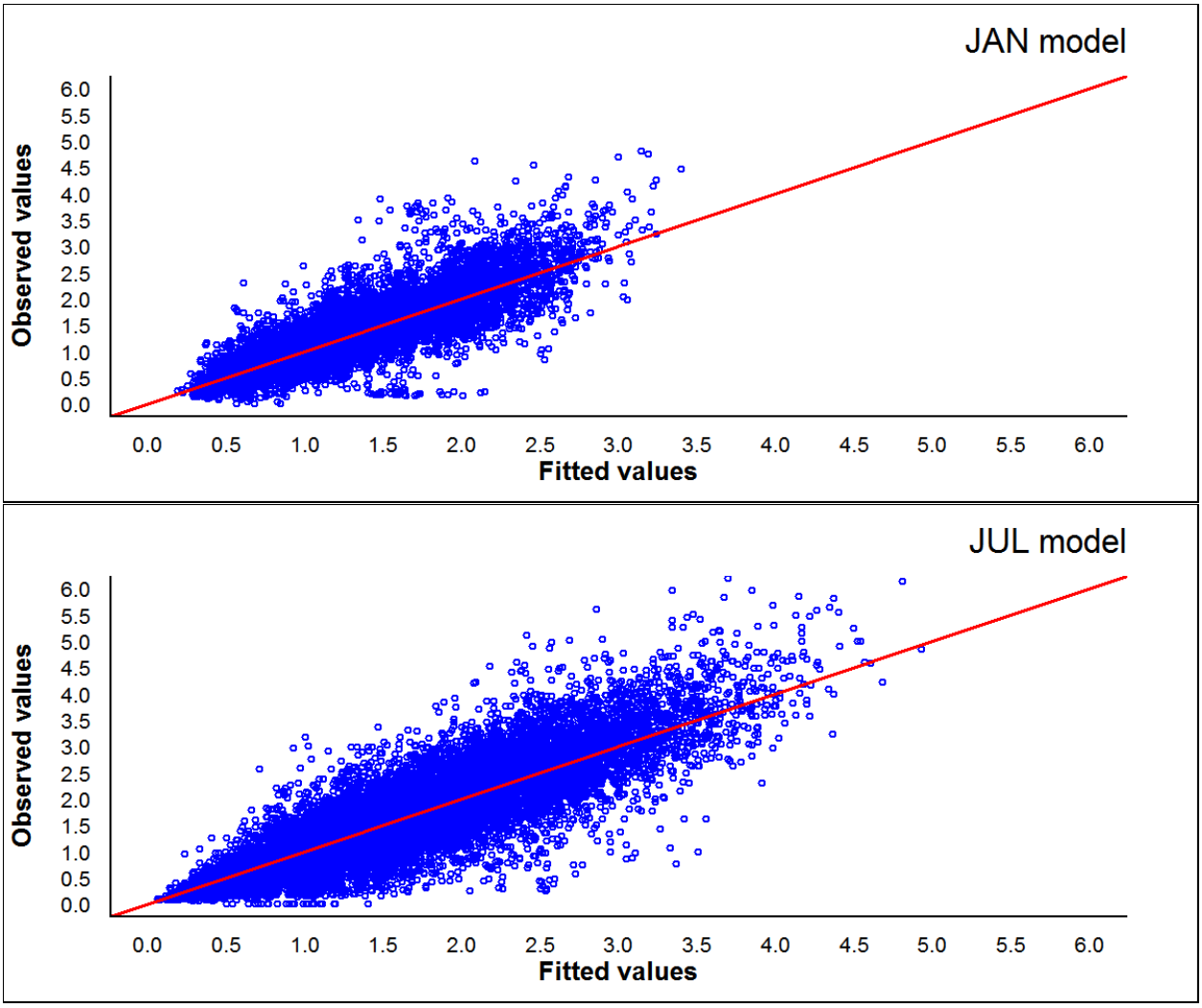


Figure 43 provides scatter plots of slope vs. intercept showing the outliers that were excluded from the analysis, marked“parts” for an excluded participant and “control” for an excluded control.

FIGURE 43. OUTLIERS, >2 MONTHS AFTER IHD INSTALLATION

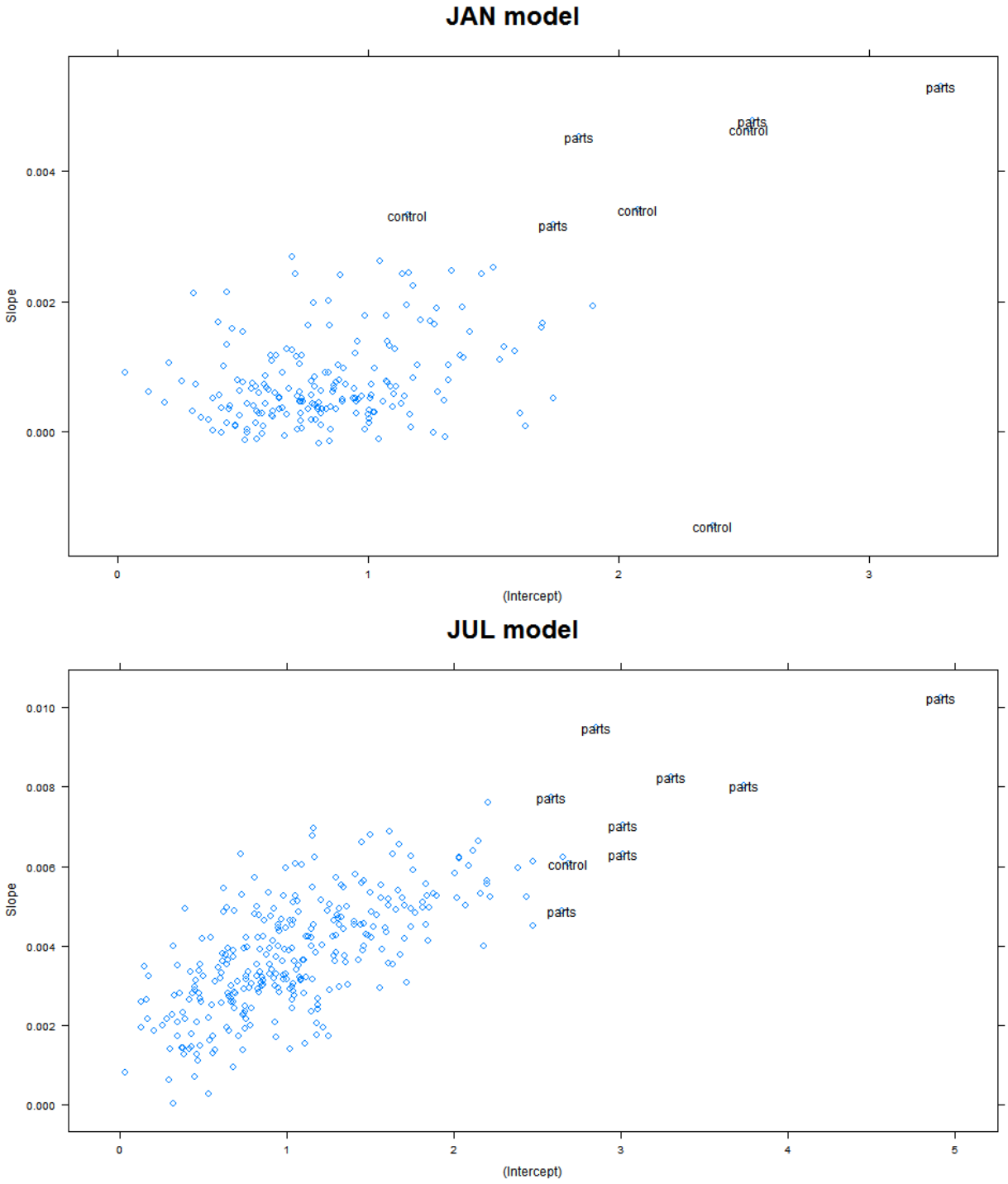


Figure 44 provides scatter plot of normalized residuals versus fitted values for January and July models.

FIGURE 44. NORMALIZED RESIDUALS VERSUS FITTED VALUES, >2 MONTHS AFTER IHD INSTALLATION

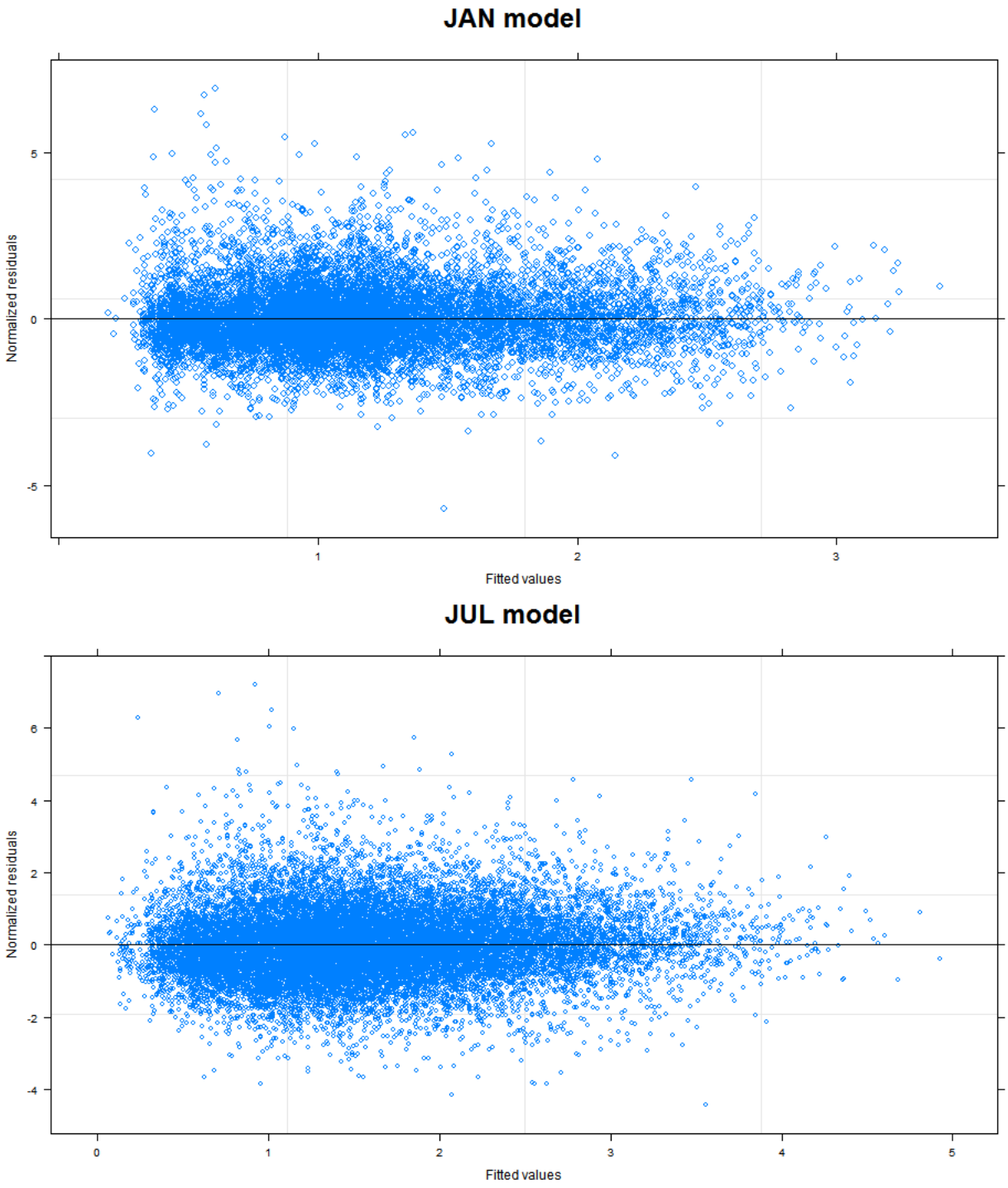


Figure 45 provides a plot of the empirical autocorrelation function.

FIGURE 45. EMPIRICAL AUTOCORRELATION FUNCTION FOR NORMALIZED RESIDUALS, >2 MONTHS AFTER IHD INSTALLATION

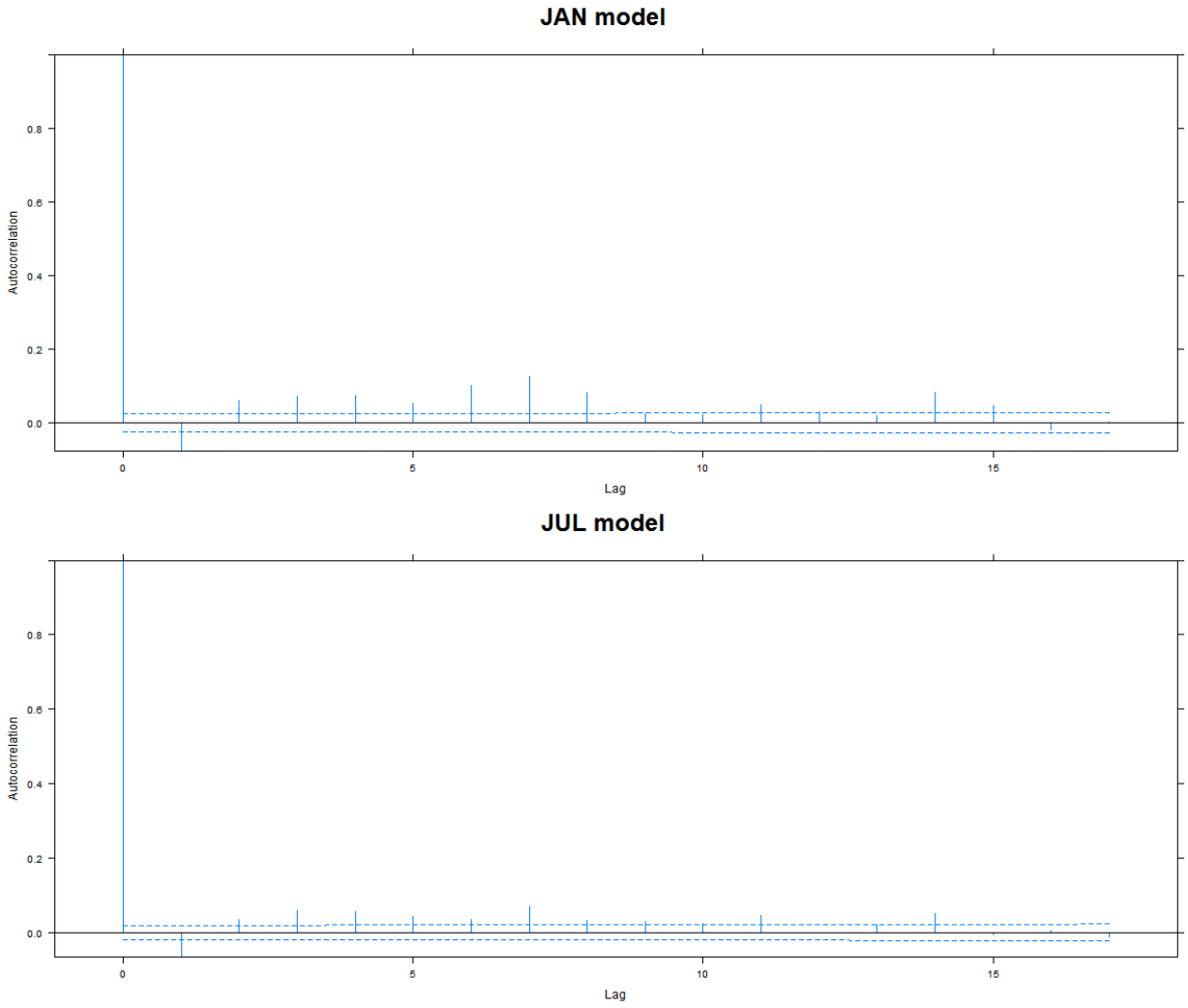


Figure 46 provides normal plot of residuals for January and July models.

FIGURE 46. NORMAL PLOT OF RESIDUALS, >2 MONTHS AFTER IHD INSTALLATION

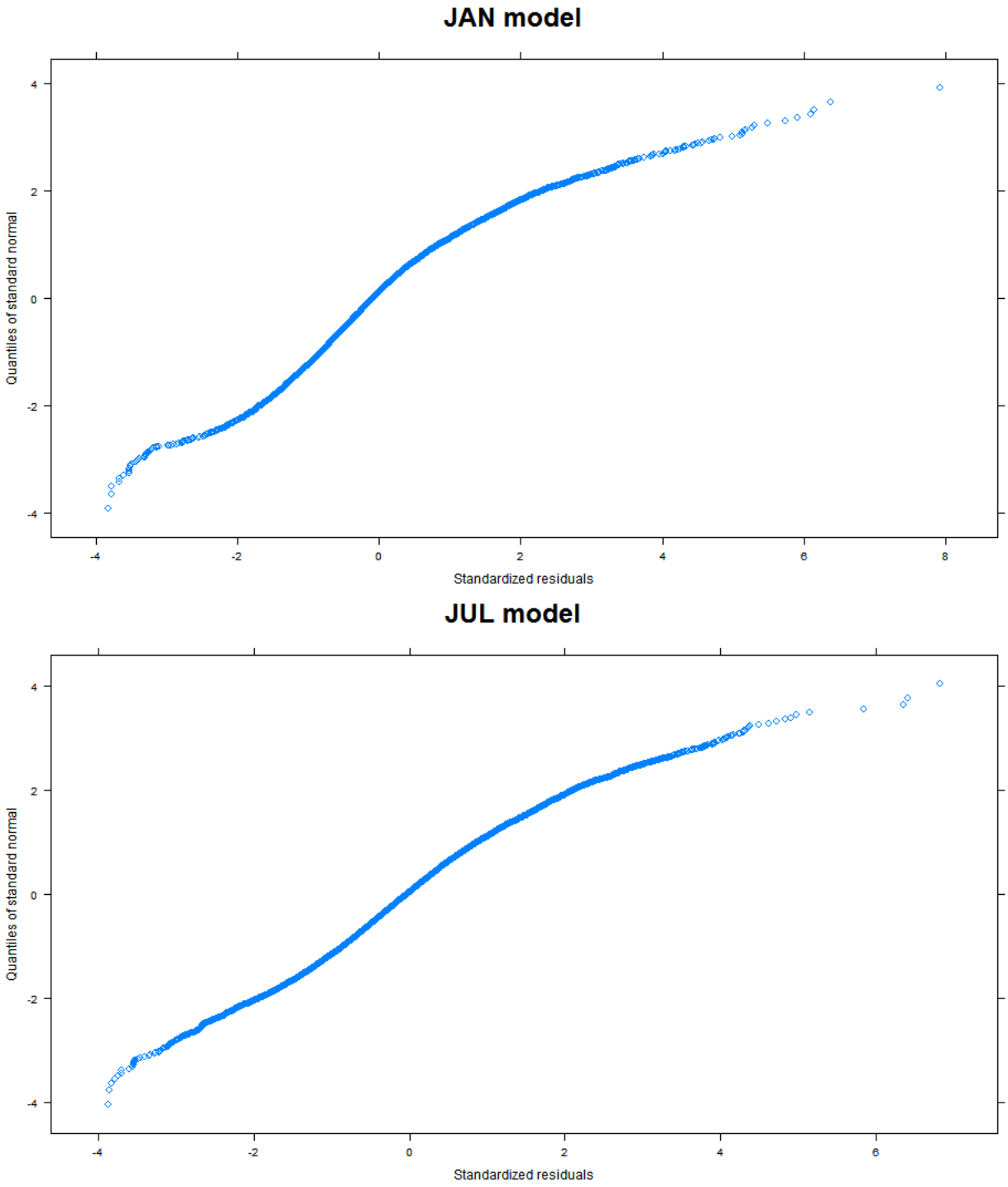
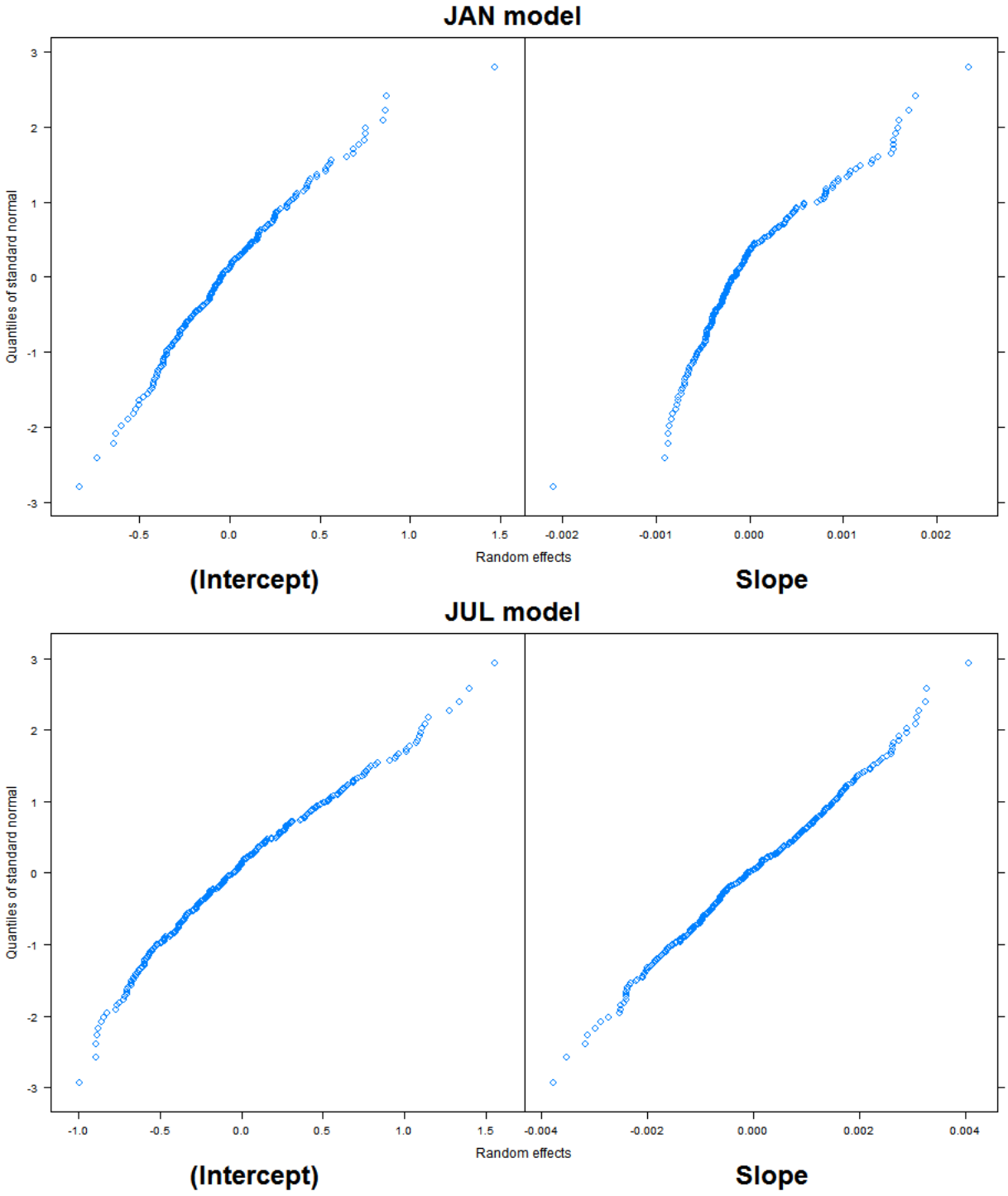


Figure 47 provides normal plots of estimated random effects for January and July models.

FIGURE 47. NORMAL PLOTS OF ESTIMATED RANDOM EFFECTS, >2 MONTHS AFTER IHD INSTALLATION



Model Details

Contrasts

Treatment loads are not different from baseline loads (adjusted for weather and exogenous effects)

$H_0: L = 0$

$H_a: L \neq 0$

$L = \sum_{i=1}^{4} c_i \mu_i \; where \; \sum_{i=1}^{4} c_i = 0, If \; |t^* = \frac{L}{\sigma^2\{L\}}| \leq t(n-p-q), then \; H_0; otherwise, H_a$

Where:

n=number of observations
p = number of model parameters associated with fixed effects
q = number of covariance parameters with random effects or correlations
For monthly models, c_1 through $c_4 = 1, -1, -1, 1$

Examples

Treatment loads are not different from baseline loads (adjusted for weather and exogenous effects)

$$\hat{L} = (\hat{\mu}_{participant.treatment} - \hat{\mu}_{participant.baseline}) - (\hat{\mu}_{Control.treatment} - \hat{\mu}_{Control.baseline})$$

Notes:

$\mu's$ are estimated using regression coefficients with the temperature profile of interest – average treatment period temperatures.

Model Comparisons

(A) 1-2 months

All Monthly models are random slope and intercept models corrected for heteroscedasticity and autocorrelation.

Table 13. Model comparison, IHD installed ≤2 months, DEC model

NOV models (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
NOV Model Random Customer (Intercept)	1	7	9926.97	9977.93	-4956.48			
NOV Model Random Customer (Slope & Intercept)	2	9	9131.98	9197.50	-4556.99	1 vs 2	798.99	<0.0001
NOV Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	9152.16	9210.41	-4568.08	2 vs 3	22.19	<0.0001
NOV Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	6225.84	6298.65	-3102.92	3 vs 4	2930.32	<0.0001
FINAL MODEL: NOV Model Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	3878.68	3958.77	-1928.34	4 vs 5	2349.16	<0.0001

Table 14.Model comparison, IHD installed ≤2 months, DEC model

DEC model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
DEC Model Random Customer (Intercept)	1	7	11254.70	11305.25	-5620.351			
DEC Model Random Customer (Slope & Intercept)	2	9	10537.13	10602.12	-5259.562	1 vs 2	721.58	<0.0001
DEC Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	10540.55	10598.33	-5262.277	2 vs 3	5.43	0.0198
DEC Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	8379.74	8451.96	-4179.870	3 vs 4	2164.82	<0.0001
FINAL MODEL: **DEC Model** Random Customer (Slope & Intercept)	5	11	6017.75	6097.19	-2997.874	4 vs 5	2363.99	<0.0001

Heteroscedastic AR(1)

TABLE 15. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, FEB MODEL

FEB model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
FEB Model Random Customer (Intercept)	1	7	7601.32	7650.38	-3793.66			
FEB Model Random Customer (Slope & Intercept)	2	9	7232.97	7296.06	-3607.49	1 vs 2	372.35	<0.0001
FEB Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	7289.28	7345.35	-3636.64	2 vs 3	58.30	<0.0001
FEB Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	3796.55	3866.64	-1888.27	3 vs 4	3496.73	<0.0001
FINAL MODEL: **FEB Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	2723.73	2800.83	-1350.86	4 vs 5	1074.82	<0.0001

TABLE 16. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, MAR MODEL

MAR model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
MAR Model Random Customer (Intercept)	1	7	5670.46	5719.54	-2828.23			
MAR Model Random Customer (Slope & Intercept)	2	9	5130.65	5193.75	-2556.32	1 vs 2	543.82	<0.0001
MAR Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	5141.62	5197.71	-2562.81	2 vs 3	12.97	0.0003
MAR Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	2605.67	2675.79	-1292.84	3 vs 4	2539.95	<0.0001
FINAL MODEL: **MAR Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	1565.11	1642.24	-771.56	4 vs 5	1042.56	<0.0001

TABLE 17. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, MAY MODEL

MAY model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
MAY Model Random Customer (Intercept)	1	8	5562.45	5618.46	-2773.22			
MAY Model Random Customer (Slope & Intercept)	2	13	4851.29	4942.31	-2412.64	1 vs 2	721.16	<0.0001
MAY Model Random Customer (Slope & Intercept Diagonal matrix)	3	10	4875.87	4945.89	-2427.94	2 vs 3	30.58	<0.0001
MAY Model Random Customer (Slope & Intercept Blocked-diagonal matrix)	4	11	4875.19	4952.20	-2426.59	3 vs 4	2.69	0.1012
MAY Model Random Customer (Slope & Intercept) Heteroscedastic	5	14	3222.12	3320.14	-1597.06	4 vs 5	1659.07	<0.0001
FINAL MODEL: **MAY Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	6	15	2219.56	2324.58	-1094.78	5 vs 6	1004.56	<0.0001

TABLE 18. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, JUN MODEL

JUN model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
JUN Model Random Customer (Intercept)	1	7	34073.89	34131.03	-17029.95			
JUN Model Random Customer (Slope & Intercept)	2	9	30189.30	30262.76	-15085.65	1 vs 2	3888.60	<0.0001
JUN Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	30248.08	30313.38	-15116.04	2 vs 3	60.79	<0.0001
JUN Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	24705.63	24787.26	-12342.82	3 vs 4	5546.45	<0.0001
FINAL MODEL: **JUN Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	19926.55	20016.34	-9952.28	4 vs 5	4781.08	<0.0001

TABLE 19. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, JUL MODEL

JUL model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
JUL Model Random Customer (Intercept)	1	7	31256.68	31312.30	-15621.34			
JUL Model Random Customer (Slope & Intercept)	2	9	29459.75	29531.25	-14720.87	1 vs 2	1800.93	<0.0001
JUL Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	29509.61	29573.17	-14746.80	2 vs 3	51.86	<0.0001
JUL Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	25776.16	25855.61	-12878.08	3 vs 4	3737.45	<0.0001
FINAL MODEL: **JUL Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	20161.01	20248.40	-10069.50	4 vs 5	5617.15	<0.0001

TABLE 20. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, SEP MODEL

SEP model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
SEP Model Random Customer (Intercept)	1	7	6064.84	6113.29	-3025.42			
SEP Model Random Customer (Slope & Intercept)	2	9	5512.40	5574.70	-2747.20	1 vs 2	556.44	<0.0001
SEP Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	5524.84	5580.22	-2754.42	2 vs 3	14.44	0.0001
SEP Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	4150.72	4219.94	-2065.36	3 vs 4	1378.12	<0.0001
FINAL MODEL: **SEP Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	3134.12	3210.26	-1556.06	4 vs 5	1018.60	<0.0001

TABLE 21. MODEL COMPARISON, IHD INSTALLED ≤2 MONTHS, OCT MODEL

OCT model (1 to 2 months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
OCT Model Random Customer (Intercept)	1	8	2327.26	2383.11	-1155.63			
OCT Model Random Customer (Slope & Intercept)	2	13	1462.69	1553.45	-718.34	1 vs 2	874.57	<0.0001
OCT Model Random Customer (Slope & Intercept Diagonal matrix)	3	10	1508.38	1578.19	-744.19	2 vs 3	51.69	<0.0001
OCT Model Random Customer (Slope & Intercept Blocked-diagonal matrix)	4	11	1506.78	1583.57	-742.39	3 vs 4	3.60	0.0578
OCT Model Random Customer (Slope & Intercept) Heteroscedastic	5	14	156.16	253.90	-64.08	4 vs 5	1356.62	<0.0001
FINAL MODEL: **OCT Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	6	15	-521.93	-417.21	275.97	5 vs 6	680.09	<0.0001

(B) 2-12 MONTHS

All Monthly models are random slope and intercept models corrected for heteroscedasticity and autocorrelation.

TABLE 22. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, JAN MODEL

JAN model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
JAN Model Random Customer (Intercept)	1	7	10508.05	10559.52	-5247.02			
JAN Model Random Customer (Slope & Intercept)	2	9	9417.69	9483.87	-4699.85	1 vs 2	1094.35	<0.0001
JAN Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	9470.89	9529.72	-4727.45	2 vs 3	55.20	<0.0001
JAN Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	6804.80	6878.33	-3392.40	3 vs 4	2670.09	<0.0001
FINAL MODEL: **JAN Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	4653.87	4734.76	-2315.94	4 vs 5	2152.93	<0.0001

TABLE 23. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, FEB MODEL

FEB model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
FEB Model Random Customer (Intercept)	1	7	8138.24	8189.38	-4062.12			
FEB Model Random Customer (Slope & Intercept)	2	9	7677.03	7742.78	-3829.51	1 vs 2	465.22	<0.0001
FEB Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	7744.49	7802.94	-3864.25	2 vs 3	69.47	<0.0001
FEB Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	4075.77	4148.84	-2027.89	3 vs 4	3672.72	<0.0001
FINAL MODEL: **FEB Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	2784.56	2864.93	-1381.28	4 vs 5	1293.21	<0.0001

TABLE 24. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, MAR MODEL

MAR model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
MAR Model Random Customer (Intercept)	1	7	7045.49	7097.33	-3515.74			
MAR Model Random Customer (Slope & Intercept)	2	9	6182.00	6248.65	-3082.00	1 vs 2	867.49	<0.0001
MAR Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	6202.70	6261.95	-3093.35	2 vs 3	22.70	<0.0001
MAR Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	3178.61	3252.67	-1579.30	3 vs 4	3028.09	<0.0001
FINAL MODEL: **MAR Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	1830.38	1911.85	-904.19	4 vs 5	1350.23	<0.0001

TABLE 25. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, APR MODEL

APR model (2+ months)	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
APR Model Random Customer (Intercept)	1	8	11217.79	11278.41	-5600.89			
APR Model Random Customer (Slope & Intercept)	2	13	9276.47	9374.99	-4625.23	1 vs 2	1951.32	<0.0001
APR Model Random Customer (Slope & Intercept Diagonal matrix)	3	10	9319.52	9395.30	-4649.76	2 vs 3	49.05	<0.0001
APR Model Random Customer (Slope & Intercept Blocked-diagonal matrix)	4	11	9318.11	9401.47	-4648.05	3 vs 4	3.41	0.0648
FINAL MODEL: **APR Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	15	4093.63	4207.31	-2031.81	4 vs 5	5232.48	<0.0001

TABLE 26. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, MAY MODEL

MAY model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
MAY Model Random Customer (Intercept)	1	8	14215.59	14277.24	-7099.80			
MAY Model Random Customer (Slope & Intercept)	2	13	13049.82	13150.00	-6511.91	1 vs 2	1175.77	<0.0001
MAY Model Random Customer (Slope & Intercept Diagonal matrix)	3	10	13119.38	13196.44	-6549.69	2 vs 3	75.56	<0.0001
MAY Model Random Customer (Slope & Intercept Blocked-diagonal matrix)	4	11	13120.56	13205.33	-6549.282	3 vs 4	0.81	0.3668
MAY Model Random Customer (Slope & Intercept) Heteroscedastic	5	14	8227.38	8335.26	-4099.69	4 vs 5	4899.18	<0.0001
FINAL MODEL: **MAY Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	6	15	5951.53	6067.11	-2960.76	5 vs 6	2277.85	<0.0001

TABLE 27. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, JUN MODEL

JUN model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
JUN Model Random Customer (Intercept)	1	7	20327.53	20381.27	-10156.76			
JUN Model Random Customer (Slope & Intercept)	2	9	18152.80	18221.90	-9067.40	1 vs 2	2178.73	<0.0001
JUN Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	18204.92	18266.33	-9094.46	2 vs 3	54.12	<0.0001
JUN Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	14445.38	14522.16	-7212.69	3 vs 4	3763.53	<0.0001
FINAL MODEL: **JUN Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	11599.28	11683.73	-5788.64	4 vs 5	2848.10	<0.0001

TABLE 28. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, JUL MODEL

JUL model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
JUL Model Random Customer (Intercept)	1	7	25742.23	25797.06	-12864.12			
JUL Model Random Customer (Slope & Intercept)	2	9	24150.17	24220.66	-12066.09	1 vs 2	1596.06	<0.0001
JUL Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	24180.05	24242.71	-12082.03	2 vs 3	31.88	<0.0001
JUL Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	21160.51	21238.83	-10570.25	3 vs 4	3023.54	<0.0001
FINAL MODEL: **JUL Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	17151.22	17237.38	-8564.61	4 vs 5	4011.28	<0.0001

TABLE 29. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, AUG MODEL

AUG model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
AUG Model Random Customer (Intercept)	1	7	50616.42	50676.55	-25301.21			
AUG Model Random Customer (Slope & Intercept)	2	9	47149.23	47226.54	-23565.61	1 vs 2	3471.19	<0.0001
AUG Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	47186.07	47254.79	-23585.04	2 vs 3	38.85	<0.0001
AUG Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	40115.33	40201.23	-20047.67	3 vs 4	7074.74	<0.0001
FINAL MODEL: **AUG Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	31035.44	31129.93	-15506.72	4 vs 5	9081.89	<0.0001

TABLE 30. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, SEP MODEL

SEP model (2+ months)	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
SEP Model Random Customer (Intercept)	1	7	40082.78	40142.87	-20034.39			
SEP Model Random Customer (Slope & Intercept)	2	9	37177.89	37255.15	-18579.95	1 vs 2	2908.89	<0.0001
SEP Model Random Customer (Slope & Intercept Diagonal matrix)	3	8	37238.44	37307.11	-18611.22	2 vs 3	62.54	<0.0001
SEP Model Random Customer (Slope & Intercept) Heteroscedastic	4	10	28978.20	29064.04	-14479.10	3 vs 4	8264.24	<0.0001
FINAL MODEL: **SEP Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	5	11	21780.33	21874.76	-10879.17	4 vs 5	7199.87	<0.0001

TABLE 31. MODEL COMPARISON, >2 MONTHS AFTER IHD INSTALLATION, OCT MODEL

OCT model	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
OCT Model Random Customer (Intercept)	1	8	25242.54	25310.78	-12613.27			
OCT Model Random Customer (Slope & Intercept)	2	13	21224.42	21335.30	-10599.21	1 vs 2	4028.13	<0.0001
OCT Model Random Customer (Slope & Intercept Diagonal matrix)	3	10	21374.94	21460.24	-10677.47	2 vs 3	156.53	<0.0001
OCT Model Random Customer (Slope & Intercept Blocked-diagonal matrix)	4	11	21364.83	21458.66	-10671.42	3 vs 4	12.11	0.0005
OCT Model Random Customer (Slope & Intercept) Heteroscedastic	5	14	12957.83	13077.24	-6464.91	4 vs 5	8413.01	<0.0001
FINAL MODEL: **OCT Model** Random Customer (Slope & Intercept) Heteroscedastic AR(1)	6	15	6812.05	6940.00	-3391.03	5 vs 6	6147.77	<0.0001

Tests for Fixed Effects

Table 32. Test for fixed effects, IHD installed 1-2 months models

Model	Variable	Numerator DF	Denominator DF	F-value	p-value
NOV model	(Intercept)	1	10538	884.76	<0.0001
NOV model	HDD	1	10538	92.14	<0.0001
NOV model	year	1	10538	6.15	0.0131
NOV model	treatment	1	192	0.23	0.6337
NOV model	year:treatment	1	10538	6.64	0.0100
DEC model	(Intercept)	1	9942	878.32	<0.0001
DEC model	HDD	1	9942	118.99	<0.0001
DEC model	year	1	9942	5.96	0.0146
DEC model	treatment	1	171	1.41	0.2363
DEC model	year:treatment	1	9942	1.12	0.2902
FEB model	(Intercept)	1	8037	613.15	<0.0001
FEB model	HDD	1	8037	137.79	<0.0001
FEB model	year	1	8037	1.68	0.1956
FEB model	treatment	1	143	0.15	0.6963
FEB model	year:treatment	1	8037	8.66	0.0033
MAR model	(Intercept)	1	8060	657.22	<0.0001
MAR model	HDD	1	8060	71.21	<0.0001
MAR model	year	1	8060	8.84	0.0029
MAR model	treatment	1	137	0	0.9839
MAR model	year:treatment	1	8060	1.58	0.2082
MAY model	(Intercept)	1	7987	526.37	<0.0001
MAY model	CDD	1	7987	164.33	<0.0001
MAY model	HDD	1	7987	55.33	<0.0001
MAY model	year	1	7987	2.47	0.1162
MAY model	treatment	1	129	0	0.9778
MAY model	year:treatment	1	7987	0.27	0.6021
JUN model	(Intercept)	1	25484	912.42	<0.0001
JUN model	CDD	1	25484	1444.45	<0.0001
JUN model	year	1	25484	1.52	0.2177
JUN model	treatment	1	431	1.15	0.2837
JUN model	year:treatment	1	25484	3.19	0.0742
JUL model	(Intercept)	1	20423	834.86	<0.0001
JUL model	CDD	1	20423	1670.7	<0.0001
JUL model	year	1	20423	0.11	0.7346

Model	Variable	Numerator DF	Denominator DF	F-value	p-value
JUL model	treatment	1	432	1.3	0.2555
JUL model	year:treatment	1	20423	1.33	0.2496
SEP model	(Intercept)	1	7365	404.66	<0.0001
SEP model	CDD	1	7365	285.71	<0.0001
SEP model	year	1	7365	4.07	0.0436
SEP model	treatment	1	130	2.58	0.1109
SEP model	year:treatment	1	7365	7.5	0.0062
OCT model	(Intercept)	1	7822	567.15	<0.0001
OCT model	CDD	1	7822	185.85	<0.0001
OCT model	HDD	1	7822	8.35	0.0039
OCT model	year	1	7822	40.14	<0.0001
OCT model	treatment	1	132	0.46	0.4974
OCT model	year:treatment	1	7822	2.34	0.1259

TABLE 33. TEST FOR FIXED EFFECTS, >2 MONTHS AFTER IHD INSTALLATION MONTHLY MODELS

Model	Variable	Numerator DF	Denominator DF	F-value	p-value
JAN model	(Intercept)	1	11347	881.58	<0.0001
JAN model	HDD	1	11347	124.25	<0.0001
JAN model	year	1	11347	22.1	<0.0001
JAN model	treatment	1	191	1.06	0.3049
JAN model	year:treatment	1	11347	0.08	0.7823
FEB model	(Intercept)	1	10813	902.41	<0.0001
FEB model	HDD	1	10813	168.37	<0.0001
FEB model	year	1	10813	16.79	<0.0001
FEB model	treatment	1	193	0.3	0.5814
FEB model	year:treatment	1	10813	6.59	0.0103
MAR model	(Intercept)	1	11958	1014.68	<0.0001
MAR model	HDD	1	11958	107.2	<0.0001
MAR model	year	1	11958	60.78	<0.0001
MAR model	treatment	1	201	0.43	0.5148
MAR model	year:treatment	1	11958	5.93	0.0149
APR model	(Intercept)	1	14213	960.86	<0.0001
APR model	CDD	1	14213	345	<0.0001
APR model	HDD	1	14213	23.28	<0.0001
APR model	year	1	14213	87.93	<0.0001

Model	Variable	Numerator DF	Denominator DF	F-value	p-value
APR model	treatment	1	240	0.12	0.7273
APR model	year:treatment	1	14213	4.61	0.0319
MAY model	(Intercept)	1	16146	783.5	<0.0001
MAY model	CDD	1	16146	374.76	<0.0001
MAY model	HDD	1	16146	93.76	<0.0001
MAY model	year	1	16146	21.89	<0.0001
MAY model	treatment	1	264	0.02	0.8845
MAY model	year:treatment	1	16146	4.62	0.0315
JUN model	(Intercept)	1	15688	454.64	<0.0001
JUN model	CDD	1	15688	995.48	<0.0001
JUN model	year	1	15688	0.17	0.6826
JUN model	treatment	1	264	0.06	0.8047
JUN model	year:treatment	1	15688	0.92	0.3374
JUL model	(Intercept)	1	18326	448.61	<0.0001
JUL model	CDD	1	18326	1380.35	<0.0001
JUL model	year	1	18326	7.91	0.0049
JUL model	treatment	1	299	0.02	0.8807
JUL model	year:treatment	1	18326	7.82	0.0052
AUG model	(Intercept)	1	39102	1371.68	<0.0001
AUG model	CDD	1	39102	2058.08	<0.0001
AUG model	year	1	39102	94.82	<0.0001
AUG model	treatment	1	641	0	0.9707
AUG model	year:treatment	1	39102	14.43	0.0001
SEP model	(Intercept)	1	38841	1721.44	<0.0001
SEP model	CDD	1	38841	1404.1	<0.0001
SEP model	year	1	38841	1.55	0.2138
SEP model	treatment	1	660	0.41	0.5212
SEP model	year:treatment	1	38841	5.48	0.0193
OCT model	(Intercept)	1	36797	1978.41	<0.0001
OCT model	CDD	1	36797	702.21	<0.0001
OCT model	HDD	1	36797	16.27	0.0001
OCT model	year	1	36797	234.56	<0.0001
OCT model	treatment	1	607	2.1	0.1474
OCT model	year:treatment	1	36797	0.04	0.8417

Model Coefficients

Table 34 provides conditional R^2 for all monthly models

Table 34. Conditional R^2 for monthly models

Model	IHD Installed 1-2 months	IHD Installed 2+ months
JAN	--	0.6376
FEB	0.6521	0.6372
MAR	0.6336	0.6207
APR	--	0.6067
MAY	0.7135	0.7515
JUN	0.7508	0.7476
JUL	0.7297	0.7560
AUG	--	0.7552
SEP	0.7285	0.7455
OCT	0.7137	0.7409
NOV	0.5999	--
DEC	0.5694	--

Table 35 and Table 36 provide monthly models coefficients. Baseline year is the reference level.

Table 35. Model Coefficients, IHD installed ≤2 months models

Model	Variable	Coefficient	Std.Error	DF	t-value	p-value
NOV model	(Intercept)	0.931523	0.044471	10538	20.95	<0.0001
NOV model	HDD	0.000561	0.000063	10538	8.94	<0.0001
NOV model	year2012	-0.043409	0.012156	10538	-3.57	0.0004
NOV model	participant	-0.069125	0.063804	192	-1.08	0.2800
NOV model	year2012:participant	0.045184	0.017532	10538	2.58	0.0100
DEC model	(Intercept)	0.976494	0.042408	9942	23.03	<0.0001
DEC model	HDD	0.000646	0.000062	9942	10.48	<0.0001
DEC model	year2012	-0.035253	0.013776	9942	-2.56	0.0105
DEC model	participant	-0.093881	0.064913	171	-1.45	0.1499
DEC model	year2012:participant	0.022793	0.021549	9942	1.06	0.2902
FEB model	(Intercept)	0.818724	0.043511	8037	18.82	<0.0001
FEB model	HDD	0.000648	0.000056	8037	11.52	<0.0001
FEB model	year2013	-0.008408	0.008956	8037	-0.94	0.3479
FEB model	participant	0.022377	0.076532	143	0.29	0.7704
FEB model	year2013:participant	0.040087	0.013621	8037	2.94	0.0033
MAR model	(Intercept)	0.857156	0.041874	8060	20.47	<0.0001
MAR model	HDD	0.000566	0.000075	8060	7.59	<0.0001

Model	Variable	Coefficient	Std.Error	DF	t-value	p-value
MAR model	year2013	-0.030318	0.009547	8060	-3.18	0.0015
MAR model	participant	-0.020100	0.076964	137	-0.26	0.7944
MAR model	year2013:participant	0.021179	0.016826	8060	1.26	0.2082
MAY model	(Intercept)	1.048810	0.044453	7987	23.59	<0.0001
MAY model	CDD	0.002107	0.000158	7987	13.34	<0.0001
MAY model	HDD	-0.000834	0.000110	7987	-7.60	<0.0001
MAY model	year2013	-0.010288	0.008862	7987	-1.16	0.2457
MAY model	participant	0.002344	0.077761	129	0.03	0.9760
MAY model	year2013:participant	-0.009625	0.018461	7987	-0.52	0.6021
JUN model	(Intercept)	0.974825	0.045248	25484	21.54	<0.0001
JUN model	CDD	0.003466	0.000091	25484	38.02	<0.0001
JUN model	year2013	0.012720	0.012842	25484	0.99	0.3219
JUN model	participant	0.063934	0.050188	431	1.27	0.2034
JUN model	year2013:participant	-0.026006	0.014567	25484	-1.79	0.0742
JUL model	(Intercept)	1.023781	0.047571	20423	21.52	<0.0001
JUL model	CDD	0.003540	0.000087	20423	40.82	<0.0001
JUL model	year2013	0.013119	0.016612	20423	0.79	0.4297
JUL model	participant	0.067828	0.052956	432	1.28	0.2009
JUL model	year2013:participant	-0.022716	0.019731	20423	-1.15	0.2496
SEP model	(Intercept)	0.996345	0.045739	7365	21.78	<0.0001
SEP model	CDD	0.002998	0.000177	7365	16.93	<0.0001
SEP model	year2013	0.034587	0.011113	7365	3.11	0.0019
SEP model	participant	-0.072005	0.088070	130	-0.82	0.4151
SEP model	year2013:participant	-0.062205	0.022721	7365	-2.74	0.0062
OCT model	(Intercept)	0.937454	0.062029	7822	15.11	<0.0001
OCT model	CDD	0.002361	0.000166	7822	14.19	<0.0001
OCT model	HDD	-0.000153	0.000089	7822	-1.72	0.0864
OCT model	year2013	-0.059398	0.013396	7822	-4.43	<0.0001
OCT model	participant	-0.059189	0.067782	132	-0.87	0.3841
OCT model	year2013:participant	0.023321	0.015235	7822	1.53	0.1259

TABLE 36. MODEL COEFFICIENTS, IHD INSTALLED >2 MONTHS MODELS

Model	Variable	Value	Std.Error	DF	t-value	p-value
JAN model	(Intercept)	0.861856	0.044996	11347	19.15	<0.0001
JAN model	HDD	0.000752	0.000064	11347	11.68	<0.0001
JAN model	year2013	-0.037247	0.011625	11347	-3.20	0.0014
JAN model	participant	-0.064010	0.062974	191	-1.02	0.3107
JAN model	year2013:participant	-0.004606	0.016665	11347	-0.28	0.7823
FEB model	(Intercept)	0.815368	0.041315	10813	19.74	<0.0001
FEB model	HDD	0.000664	0.000049	10813	13.45	<0.0001
FEB model	year2013	-0.010556	0.008941	10813	-1.18	0.2378
FEB model	participant	-0.023907	0.058222	193	-0.41	0.6818
FEB model	year2013:participant	-0.032874	0.012808	10813	-2.57	0.0103
MAR model	(Intercept)	0.865740	0.039878	11958	21.71	<0.0001
MAR model	HDD	0.000491	0.000059	11958	8.37	<0.0001
MAR model	year2013	-0.033586	0.009420	11958	-3.57	0.0004
MAR model	participant	-0.007558	0.054971	201	-0.14	0.8908
MAR model	year2013:participant	-0.030741	0.012622	11958	-2.44	0.0149
APR model	(Intercept)	0.914658	0.039090	14213	23.40	<0.0001
APR model	CDD	0.002673	0.000150	14213	17.86	<0.0001
APR model	HDD	0.000172	0.000054	14213	3.18	0.0015
APR model	year2013	-0.040907	0.009972	14213	-4.10	<0.0001
APR model	participant	0.001451	0.048736	240	0.03	0.9763
APR model	year2013:participant	-0.026890	0.012530	14213	-2.15	0.0319
MAY model	(Intercept)	1.071628	0.047058	16146	22.77	<0.0001
MAY model	CDD	0.002189	0.000111	16146	19.77	<0.0001
MAY model	HDD	-0.000932	0.000090	16146	-10.38	<0.0001
MAY model	year2013	-0.010210	0.009393	16146	-1.09	0.2771
MAY model	participant	0.017739	0.053662	264	0.33	0.7412
MAY model	year2013:participant	-0.024828	0.011545	16146	-2.15	0.0315
JUN model	(Intercept)	0.975960	0.043337	15688	22.52	<0.0001
JUN model	CDD	0.003494	0.000111	15688	31.53	<0.0001
JUN model	year2013	0.012698	0.012497	15688	1.02	0.3096
JUN model	participant	0.018453	0.051412	264	0.36	0.7199
JUN model	year2013:participant	-0.014830	0.015457	15688	-0.96	0.3374
JUL model	(Intercept)	1.049158	0.049734	18326	21.10	<0.0001
JUL model	CDD	0.003811	0.000102	18326	37.23	<0.0001
JUL model	year2013	0.010752	0.014995	18326	0.72	0.4733
JUL model	participant	0.009582	0.058727	299	0.16	0.8705

Model	Variable	Value	Std.Error	DF	t-value	p-value
JUL model	year2013:participant	-0.050821	0.018170	18326	-2.80	0.0052
AUG model	(Intercept)	1.102948	0.050038	39102	22.04	<0.0001
AUG model	CDD	0.003394	0.000075	39102	44.99	<0.0001
AUG model	year2013	-0.003413	0.014135	39102	-0.24	0.8092
AUG model	participant	0.034524	0.053662	641	0.64	0.5202
AUG model	year2013:participant	-0.058160	0.015312	39102	-3.80	0.0001
SEP model	(Intercept)	1.013731	0.049563	38841	20.45	<0.0001
SEP model	CDD	0.002958	0.000079	38841	37.29	<0.0001
SEP model	year2013	0.032837	0.012459	38841	2.64	0.0084
SEP model	participant	0.061114	0.053106	660	1.15	0.2502
SEP model	year2013:participant	-0.031410	0.013422	38841	-2.34	0.0193
OCT model	(Intercept)	0.913752	0.076073	36797	12.01	<0.0001
OCT model	CDD	0.002358	0.000087	36797	27.11	<0.0001
OCT model	HDD	-0.000064	0.000046	36797	-1.40	0.1630
OCT model	year2013	-0.055595	0.016318	36797	-3.41	0.0007
OCT model	participant	0.113844	0.077800	607	1.46	0.1439
OCT model	year2013:participant	-0.003347	0.016765	36797	-0.20	0.8417

Variance-covariance matrices

(a) IHD installed 1-2 months

Table 37. Variance-covariance matrix, IHD installed ≤2 months, NOV model

	Variance	StdDev	Corr
Customer (Intercept)	1.604434e-01	0.4005538619	(Intr)
HDD (Slope)	4.804976e-07	0.0006931794	0.086
Residual	1.020148e-02	0.3193975829	

Table 38. Variance-covariance matrix, IHD installed ≤2 months, DEC model

	Variance	StdDev	Corr
Customer (Intercept)	1.201011e-01	0.3465560741	(Intr)
HDD (Slope)	4.593449e-07	0.0006777499	0.364
Residual	1.120177e-02	0.3346904668	

Table 39. Variance-covariance matrix, IHD installed ≤2 months, FEB model

	Variance	StdDev	Corr
Customer (Intercept)	1.455158e-01	0.3814653588	(Intr)
HDD (Slope)	1.709989e-07	0.0004135201	0.40
Residual	9.236328e-02	0.3039132850	

Table 40. Variance-covariance matrix, IHD installed ≤2 months, MAR model

	Variance	StdDev	Corr
Customer (Intercept)	1.472423e-01	0.3837217009	(Intr)
HDD (Slope)	4.904036e-07	0.0007002882	0.017
Residual	8.757204e-02	0.2959257264	

TABLE 41. VARIANCE-COVARIANCE MATRIX, IHD INSTALLED ≤2 MONTHS, MAY MODEL

	Variance	StdDev	Corr	
Customer (Intercept)	1.863319e-01	0.4316618420	(Intr)	CDD
CDD (Slope)	2.950689e-07	0.0005432025	-0.549	
HDD (Slope)	2.209769e-06	0.0014865292	0.548	-0.979
Residual	8.225736e-02	0.2868054440		

TABLE 42. VARIANCE-COVARIANCE MATRIX, IHD INSTALLED ≤2 MONTHS, JUN MODEL

	Variance	StdDev	Corr
Customer (Intercept)	2.260647e-01	0.475462570	(Intr)
CDD (Slope)	3.106376e-06	0.001762491	0.522
Residual	1.084499e-02	0.329317320	

TABLE 43. VARIANCE-COVARIANCE MATRIX, IHD INSTALLED ≤2 MONTHS, JUL MODEL

	Variance	StdDev	Corr
Customer (Intercept)	2.416877e-01	0.491617476	(Intr)
CDD (Slope)	2.538453e-06	0.001593252	0.606
Residual	1.230047e-01	0.350720317	

TABLE 44. VARIANCE-COVARIANCE MATRIX, IHD INSTALLED ≤2 MONTHS, SEP MODEL

	Variance	StdDev	Corr
Customer (Intercept)	1.987394e-01	0.44580199	(Intr)
CDD (Slope)	3.025130e-06	0.00173929	0.528
Residual	8.304395e-02	0.28817347	

TABLE 45. VARIANCE-COVARIANCE MATRIX, IHD INSTALLED ≤2 MONTHS, OCT MODEL

	Variance	StdDev	Corr	
Customer (Intercept)	1.726043e-01	0.4154566867	(Intr)	CDD
CDD (Slope)	1.91473e-06	0.0013837390	0.582	
HDD (Slope)	6.078814e-07	0.0007796675	-0.537	-0.541
Residual	7.280958e-02	0.2868054440		

(B) IHD INSTALLED 2-12 MONTHS

TABLE 46. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, JAN MODEL

	Variance	StdDev	Corr
Customer (Intercept)	1.565902e-01	0.3957148496	(Intr)
HDD (Slope)	5.719520e-07	0.0007562751	-0.051
Residual	9.073177e-02	0.3012171466	

TABLE 47. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, FEB MODEL

	Variance	StdDev	Corr
Customer (Intercept)	1.297392e-01	0.3601933205	(Intr)
HDD (Slope)	1.897717e-07	0.0004356279	0.31
Residual	8.598855e-02	0.2932380501	

TABLE 48. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, MAR MODEL

	Variance	StdDev	Corr
Customer (Intercept)	1.336367e-01	0.3655634777	(Intr)
HDD (Slope)	4.388099e-07	0.0006624273	0.018
Residual	8.449587e-02	0.2906817302	

TABLE 49. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, APR MODEL

	Variance	StdDev	Corr	
Customer (Intercept)	1.459420e-01	0.3820236161	(Intr)	CDD
CDD (Slope)	3.375738e-06	0.0018373182	0.614	
HDD (Slope)	3.492723e-07	0.0005909926	-0.045	-0.447
Residual	9.999853-02	0.3162254361		

TABLE 50. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, MAY MODEL

	Variance	StdDev	Corr	
Customer (Intercept)	2.589498e-01	0.5088710591	(Intr)	CDD
CDD (Slope)	2.085593e-06	0.0014441581	0.548	
HDD (Slope)	6.933428e-07	0.0008326721	-0.626	-0.723
Residual	9.242258-02	0.3040108245		

TABLE 51. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, JUN MODEL

	Variance	StdDev	Corr
Customer (Intercept)	2.106692-01	0.458987182	(Intr)
CDD (Slope)	2.792289e-06	0.001671344	0.606
Residual	1.055006e-01	0.324808490	

TABLE 52. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, JUL MODEL

	Variance	StdDev	Corr
Customer (Intercept)	2.572771e-01	0.507224902	(Intr)
CDD (Slope)	2.530036e-06	0.001590609	0.564
Residual	1.130929e-01	0.336292869	

TABLE 53. VARIANCE-COVARIANCE MATRIX, >2 MONTHS AFTER IHD INSTALLATION, AUG MODEL

	Variance	StdDev	Corr
Customer (Intercept)	2.652860e-01	0.515059227	(Intr)
CDD (Slope)	2.821382e-06	0.001679697	0.592
Residual	1.048078e-01	0.323740342	

Table 54. Variance-covariance matrix, >2 months after IHD installation, SEP model

	Variance	StdDev	Corr
Customer (Intercept)	2.585329e-01	0.508461336	(Intr)
CDD (Slope)	2.980035e-06	0.001726278	0.562
Residual	9.582243e-02	0.309551980	

Table 55. Variance-covariance matrix, >2 months after IHD installation, OCT model

	Variance	StdDev	Corr	
Customer (Intercept)	2.426868e-01	0.4926324730	(Intr)	CDD
CDD (Slope)	2.362245e-06	0.0015369597	0.609	
HDD (Slope)	6.647232e-07	0.0008153056	-0.286	-0.505
Residual	8.808580e-02	0.2967925243		

Model Results

Table 56. Monthly energy impacts, IHD installed <2 months

Treatment Group	N	Time Period	Baseline Year	Savings (kWh/h)	Standard Error	95% Confidence Interval		Reference Load	% Savings
IHD (1 to 2 months)	93	NOV	2011	**+0.044***	0.0175	0.0108	0.0795	0.97	+4.6%
IHD (1 to 2 months)	74	DEC	2011	+0.023	0.0216	-0.0194	0.0650	1.13	+2.1%
IHD (1 to 2 months)	46	FEB	2012	**+0.040***	0.0136	0.0134	0.0668	1.09	+3.7%
IHD (1 to 2 months)	40	MAR	2012	+0.021	0.0168	-0.0118	0.0542	0.93	+2.3%
IHD (1 to 2 months)	32	MAY	2012	-0.010	0.0185	-0.0458	0.0266	1.09	-0.9%
IHD (1 to 2 months)	334	JUN	2012	-0.026	0.0146	-0.0546	0.0025	1.46	-1.8%
IHD (1 to 2 months)	335	JUL	2012	-0.023	0.0197	-0.0614	0.0160	1.63	-1.4%
IHD (1 to 2 months)	33	SEP	2012	**-0.062***	0.0227	-0.1067	-0.0177	1.14	-5.5%
IHD (1 to 2 months)	98	OCT	2012	+0.023	0.0152	-0.0065	0.0532	0.83	+2.8%

TABLE 57. MONTHLY ENERGY IMPACTS, IHD INSTALLED ≥2 MONTHS

Treatment Group	N	Time Period	Baseline Year	Savings (kWh/h)	Standard Error	95% Confidence Interval		Reference Load	% Savings
IHD (2+ months)	94	JAN	2012	-0.005	0.0167	-0.0373	0.0281	1.15	-0.4%
IHD (2+ months)	96	FEB	2012	**-0.033***	0.0128	-0.0580	-0.0078	1.04	-3.2%
IHD (2+ months)	104	MAR	2012	**-0.031***	0.0126	-0.0555	-0.0060	0.93	-3.4%
IHD (2+ months)	143	APR	2012	**-0.027***	0.0125	-0.0514	-0.0023	0.98	-2.7%
IHD (2+ months)	167	MAY	2012	**-0.025***	0.0116	-0.0475	-0.0022	1.12	-2.2%
IHD (2+ months)	167	JUN	2012	-0.015	0.0155	-0.0451	0.0155	1.42	-1.0%
IHD (2+ months)	202	JUL	2012	**-0.051***	0.0182	-0.0864	-0.0152	1.64	-3.1%
IHD (2+ months)	543	AUG	2012	**-0.058***	0.0153	-0.0882	-0.0282	1.50	-3.9%
IHD (2+ months)	563	SEP	2012	**-0.031***	0.0134	-0.0577	-0.0051	1.28	-2.4%
IHD (2+ months)	573	OCT	2012	-0.003	0.0168	-0.0362	0.0295	1.00	-0.3%

Appendix D. Summer Weekday Model

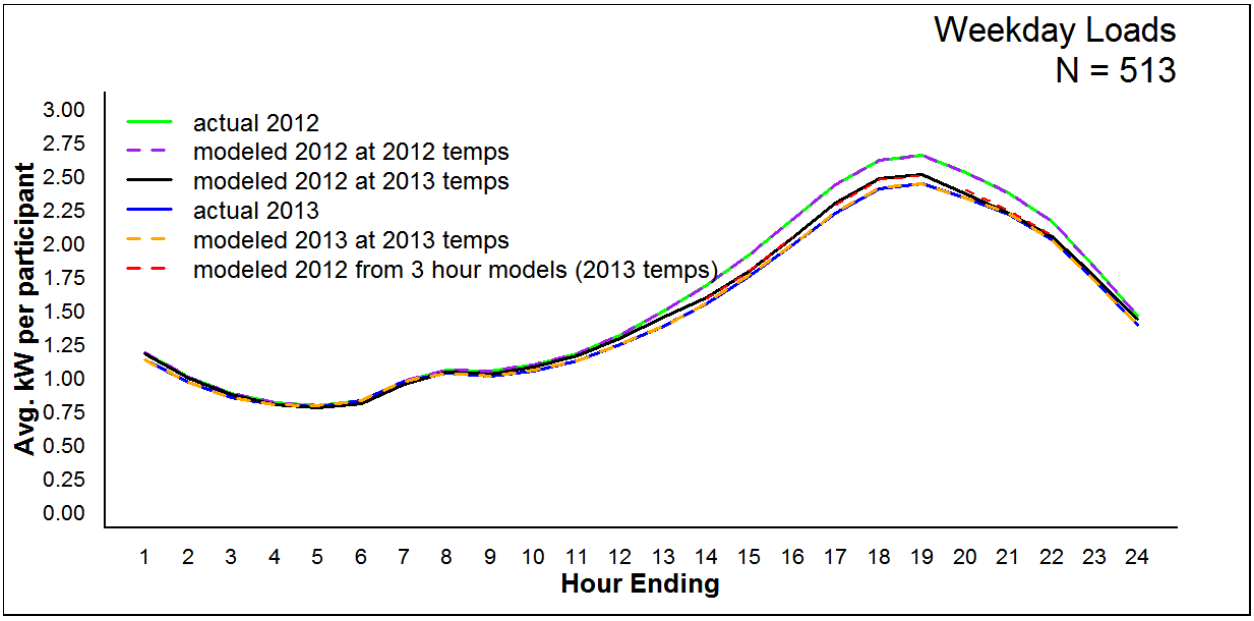
Weekends and holidays are excluded from the analysis.

- Pretreatment = June 1, 2012 – September, 30 2012
- Treatment = June 1, 2013 – September 30, 2013

Model Fit

Figure 48 shows that the modeled loads are nearly identical to the average of the actual loads.

Figure 48. Modeled and actual weekday loads for summer treatment group



Model Diagnostics

Pre-peak

Figure 49 provides diagnostic plots for PEAK model.

FIGURE 49. MODEL DIAGNOSTICS PLOTS, PRE PEAK MODEL

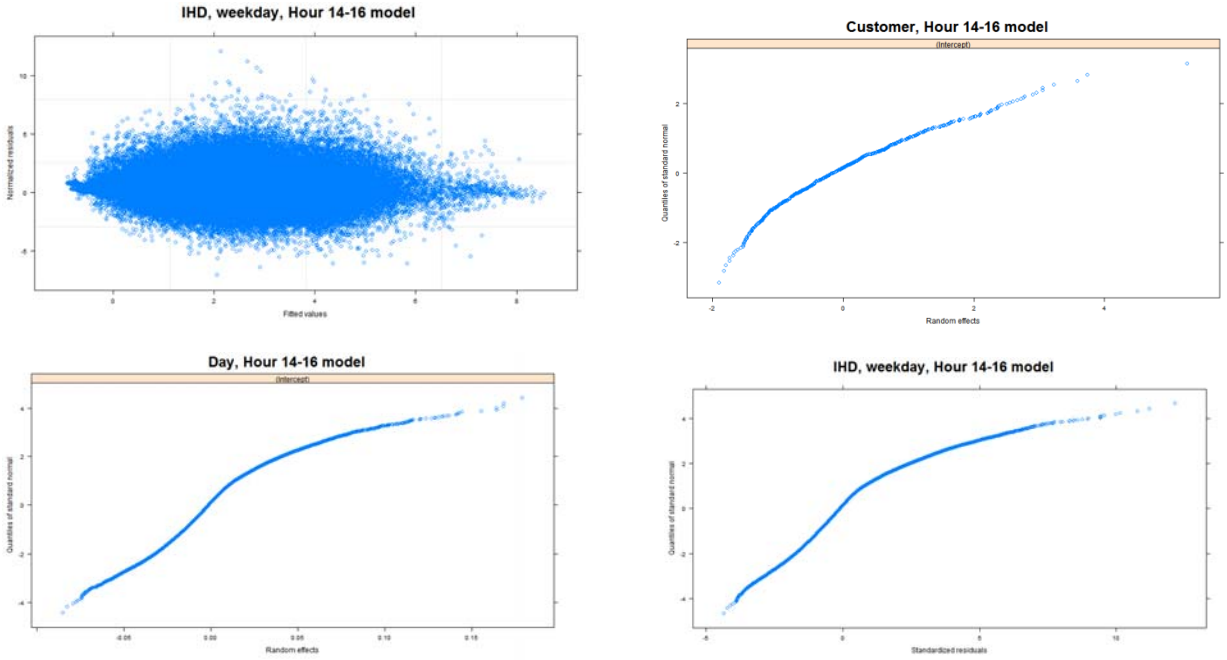


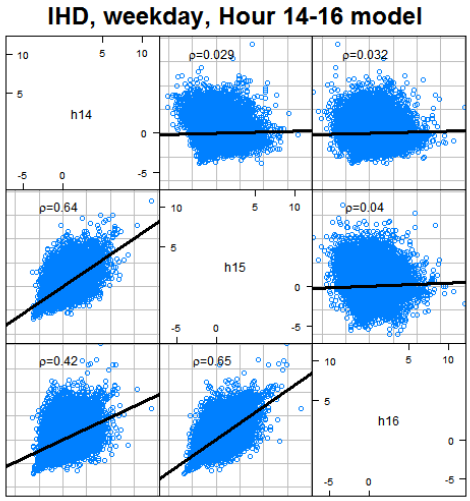
Table 58 provides summary of normalized residuals.

TABLE 58. SUMMARY OF NORMALIZED RESIDUALS, PRE PEAK MODEL

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-7.0850	-0.5360	-0.1392	0.0000	0.3687	12.0700

Figure 50 shows that the Pearson residuals for hours 14-16 are correlated (lower left), but normalized residuals (upper right) are approximately uncorrelated.

FIGURE 50. SCATTER PLOT MATRIX OF PEARSON AND NORMALIZED RESIDUALS, PRE PEAK MODEL



PEAK

FIGURE 51. MODEL DIAGNOSTICS PLOTS, PEAK MODEL

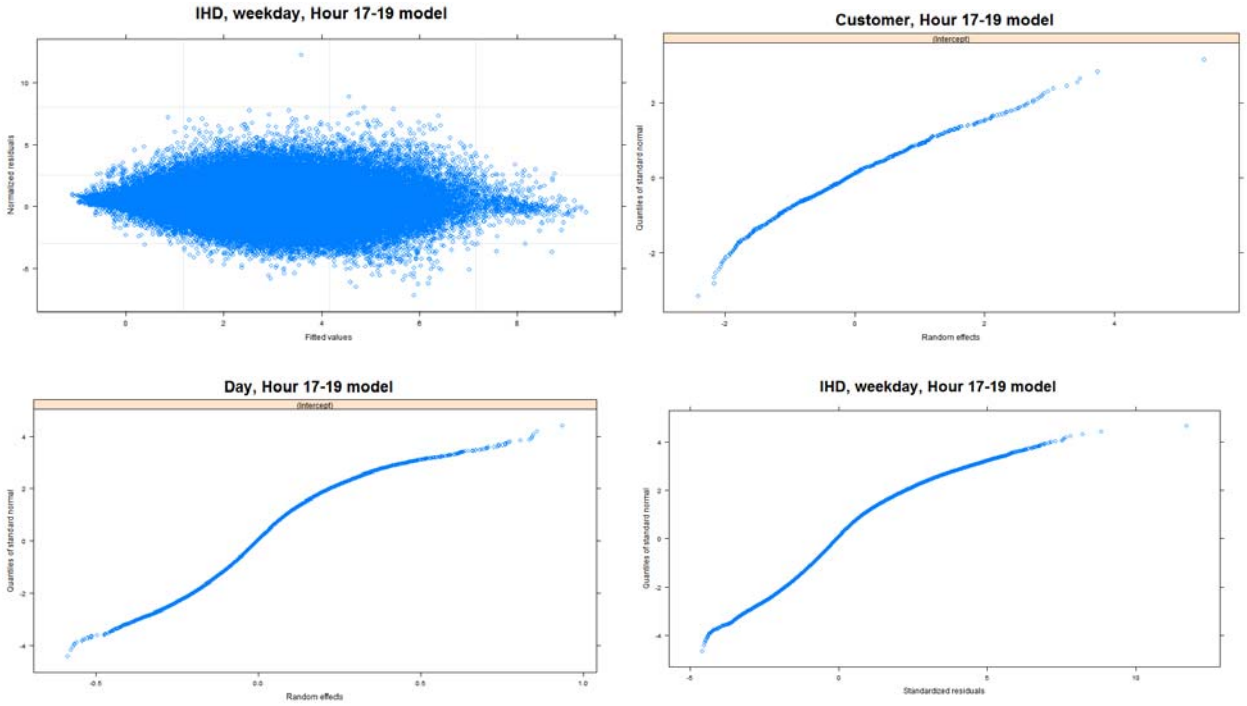
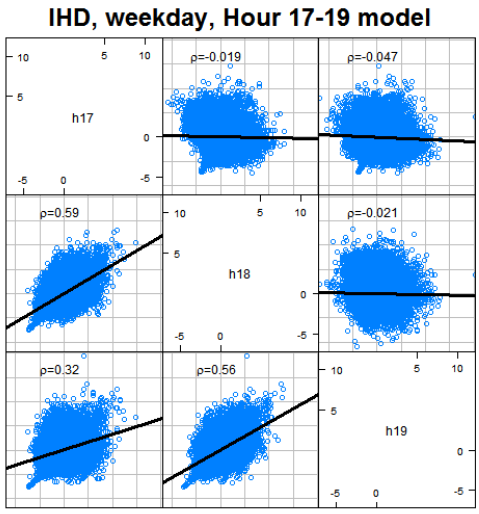


Table 59 provides summary of normalized residuals.

TABLE 59. SUMMARY OF NORMALIZED RESIDUALS, PEAK MODEL

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-7.1560	-0.5302	-0.09694	0.0000	0.4198	12.2000

FIGURE 52. SCATTER PLOT MATRIX OF PEARSON AND NORMALIZED RESIDUALS, PEAK MODEL



POST-PEAK

FIGURE 53 MODEL DIAGNOSTICS PLOTS, POST PEAK MODEL

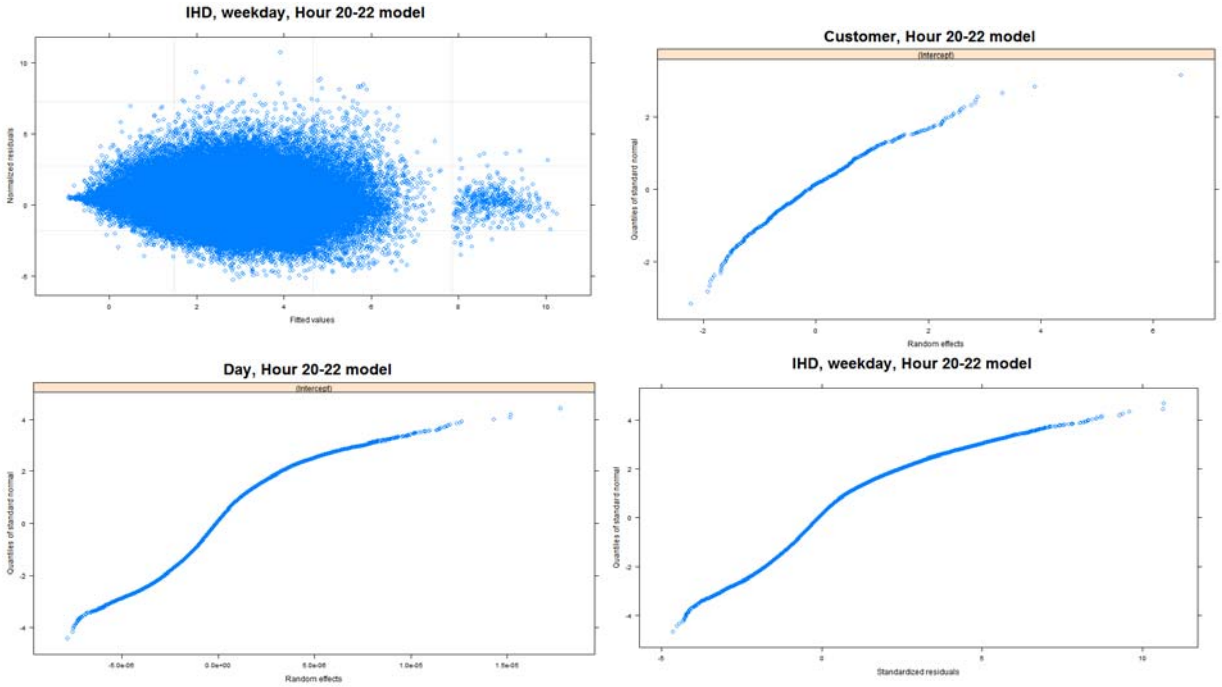
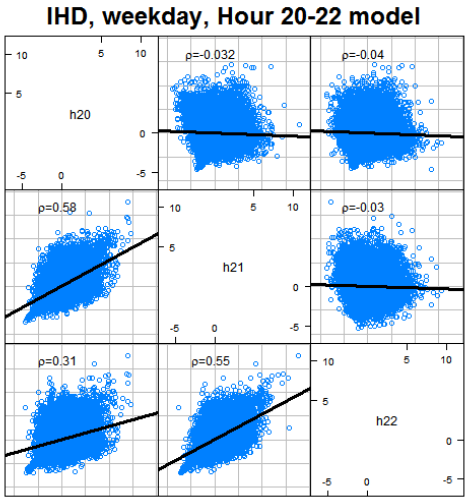


Table 60 provides summary of normalized residuals.

TABLE 60. SUMMARY OF NORMALIZED RESIDUALS, POST PEAK MODEL

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-5.2870	-0.5351	-0.07516	0.0000	0.4021	10.7200

FIGURE 54. SCATTER PLOT MATRIX OF PEARSON AND NORMALIZED RESIDUALS, POST PEAK MODEL



Model Details

Contrasts for 3-hour models

1. L*oads are not different from baseline loads (adjusted for weather and exogenous effects)*

$H_0: L = 0$

$H_a: L \neq 0$

$L = \sum_{i=1}^{12} c_i \mu_i \ where \ \sum_{i=1}^{12} c_i = 0, If \ |t^* = \frac{L}{\sigma^2\{L\}}| \leq t(n-p-q), then \ H_0; otherwise, H_a$

Where n=number of observations, p = number of model parameters associated with fixed effects, q = number of covariance parameters with random effects or correlations.

For peak model, $c_1 through \ c_{12} = {}^1/_3, -{}^1/_3, {}^1/_3, -{}^1/_3, {}^1/_3, -{}^1/_3, -{}^1/_3, {}^1/_3, -{}^1/_3, {}^1/_3, -{}^1/_3, {}^1/_3$

2. *Install month has no effect on impacts (adjusted for weather and exogenous effects)*

Same as in 1 above but different set of means.

CONTRASTS EXAMPLES

Peak impact relative to baseline for nov_dec_2012 (adjusted for weather and exogenous effects), and comparing nov_dec_2012 and jan_apr_2013 peak impacts (adjusted for weather and pretreatment differences)

1. *Treatment loads are not different from baseline loads (adjusted for weather and exogenous effects)*

$$\hat{L} = \left[\frac{(\hat{\mu}_{\text{nov\_dec\_2012 }.treat.at.hr17} - \hat{\mu}_{\text{nov\_dec\_2012 }.base.at.hr17}) + (\hat{\mu}_{\text{nov\_dec\_2012 }.treat.at.hr18} - \hat{\mu}_{\text{nov\_dec\_2012 }.base.at.hr18}) + (\hat{\mu}_{\text{nov\_dec\_2012 }.treat.at.hr19} - \hat{\mu}_{\text{nov\_dec\_2012 }.base.at.hr19})}{3}\right] - \left[\frac{(\hat{\mu}_{control.treat.hr17} - \hat{\mu}_{control.base.hr17}) + (\hat{\mu}_{control.treat.hr18} - \hat{\mu}_{control.base.hr18}) + (\hat{\mu}_{control.treat.hr19} - \hat{\mu}_{control.base.hr19})}{3}\right]$$

2. *Treatment type has no effect on impacts (adjusted for weather and exogenous effects)*

$$\hat{L} = \left[\frac{(\hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.treat.at.hr17} - \hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.base.at.hr17}) + (\hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.treat.at.hr18} - \hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.base.at.hr18}) + (\hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.treat.at.hr19} - \hat{\mu}_{\text{nov}_{\text{dec}_{2012}}.base.at.hr19})}{3}\right] - \left[\frac{(\hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.treat.at.hr17} - \hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.base.at.hr17}) + (\hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.treat.at.hr18} - \hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.base.at.hr18}) + (\hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.treat.at.hr19} - \hat{\mu}_{\text{jan}_{\text{apr}_{2013}}.base.at.hr19})}{3}\right]$$

Notes:

$\mu's$ are estimated using regression coefficients with the temperature profile of interest – average temp weekday summer 2013 days.

Models Comparison

All peak demand models are random slope and intercept models corrected for autocorrelation.

Table 61.Model comparison, PRE peak model

Model name	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
PRE peak **model Random Customer And Day**	1	29	894282	894591	-447112			
FINAL MODEL: PRE peak **model Random Customer And Day AR(1)**	2	30	878016	878336	-438978	1 vs 2	16267	<0.0001

Table 62.Model comparison, PEAK model

Model name	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
PEAK **model Random Customer And Day**	1	29	963349	963658.8	-481645			
FINAL MODEL: PEAK **model Random Customer And Day AR(1)**	2	30	948442	948762.5	-474191	1 vs 2	14908	<0.0001

Table 63.Model comparison, POST peak model

Model name	Model	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
POST peak **model Random Customer And Day**	1	29	941293	941602	-470617		NA	NA
FINAL MODEL: POST peak **model Random Customer And Day AR(1)**	2	30	926903	927223	-463421	1 vs 2	14391	<0.0001

Tests for Fixed Effects

Table 64.Test for fixed effects, PRE peak model

Variable	Numerator DF	Denominator DF	F-value	p-value
CDH	1	208183	43438	<0.0001

CDD	1	103473	1277	<0.0001
hour	3	208183	469	<0.0001
Intall_month	7	103473	8.148	<0.0001
hour:Intall_month	14	208183	7.687	<0.0001

TABLE 65.TEST FOR FIXED EFFECTS, PEAK MODEL

Variable	Numerator DF	Denominator DF	F-value	p-value
CDH	1	208183	43871	<0.0001
CDD	1	103473	456.9	<0.0001
hour	3	208183	613.6	<0.0001
Intall_month	7	103473	11.90	<0.0001
hour:Intall_month	14	208183	3.836	<0.0001

TABLE 66.TEST FOR FIXED EFFECTS, POST PEAK MODEL

Variable	Numerator DF	Denominator DF	F-value	p-value
CDH	1	208183	39237	<0.0001
CDD	1	103473	2999	<0.0001
hour	3	208183	552.8	<0.0001
Intall_month	7	103473	6.659	<0.0001
hour:Intall_month	14	208183	9.583	<0.0001

Model Coefficients

Table 67 provides conditional R^2 for PRE peak, Peak, and POST peak models.

Table 67.Conditional R^2 for PRE peak, Peak, and POST peak models

Model	R^2
PRE peak	0.5109
Peak	0.5624
POST peak	0.4870

Table 68 - 15 provide model coefficients for PRE peak, Peak, and POST peak models. Control.2012 is the reference level in all 3 models.

Table 68.Model Coefficients, PRE peak model

Variable	Coefficient	Std.Error	DF	t-value	p-value
CDH	0.0442695	0.00108	208183	40.945011	<0.0001
CDD	0.0037233	0.00009	103473	40.37958	<0.0001
hour14	0.8812187	0.10242	208183	8.6039255	<0.0001
hour15	0.9448445	0.10235	208183	9.2315177	<0.0001
hour16	1.05455	0.10240	208183	10.298795	<0.0001
control.2013	0.033759	0.01767	103473	1.9100112	0.0561
may_2013.baseline	0.131655	0.11814	103473	1.114437	0.2651
may_2013.treatment	0.1020328	0.11814	103473	0.8636802	0.3878
jan_apr_2013.baseline	0.1092815	0.14949	103473	0.7310404	0.4648
jan_apr_2013.treatment	0.0879383	0.14949	103473	0.5882524	0.5564
nov_dec_2012.baseline	0.1085959	0.14708	103473	0.7383411	0.4603
nov_dec_2012.treatment	0.0711066	0.14708	103473	0.4834475	0.6288
hour15:control.treatment	-0.006596	0.01466	208183	-0.449814	0.6528
hour16:control.treatment	-0.016742	0.01885	208183	-0.888322	0.3744
hour15:may_2013.baseline	0.0011361	0.01197	208183	0.0948904	0.9244
hour16:may_2013.baseline	0.0180506	0.01539	208183	1.1731309	0.2407
hour15:may_2013.treatment	0.0132925	0.01198	208183	1.1093475	0.2673
hour16:may_2013.treatment	0.0235835	0.01540	208183	1.5314486	0.1257
hour15:jan_apr_2013.baseline	-0.003841	0.01515	208183	-0.253547	0.7998
hour16:jan_apr_2013.baseline	0.0082006	0.01947	208183	0.4212402	0.6736
hour15:jan_apr_2013.treatment	-0.017892	0.01517	208183	-1.179715	0.2381
hour16:jan_apr_2013.treatment	-0.053518	0.01949	208183	-2.745826	0.006

hour15:nov_dec_2012.baseline	0.0714366	0.01490	208183	4.7928429	<0.0001
hour16:nov_dec_2012.baseline	0.1306578	0.01915	208183	6.8213785	<0.0001
hour15:nov_dec_2012.treatment	0.0140311	0.01491	208183	0.9408701	0.3468
hour16:nov_dec_2012.treatment	0.0259421	0.01917	208183	1.3535782	0.1759

TABLE 69. MODEL COEFFICIENTS, PEAK MODEL

Variable	Coefficient	Std.Error	DF	T-value	p-value
CDH	0.040819374	0.001395643	208183	29.25	<0.0001
CDD	0.005137205	0.000141024	103473	36.43	<0.0001
hour17	1.037822053	0.117553135	208183	8.83	<0.0001
hour18	1.182988951	0.117628164	208183	10.06	<0.0001
hour19	1.239293784	0.117661743	208183	10.53	<0.0001
control.treatment	0.032196711	0.019447672	103473	1.66	0.0978
may_2013.baseline	0.197974464	0.13562891	103473	1.46	0.1444
may_2013.treatment	0.163754548	0.135631181	103473	1.21	0.2273
jan_apr_2013.baseline	0.191572896	0.171623239	103473	1.12	0.2643
jan_apr_2013.treatment	0.117351295	0.171627	103473	0.68	0.4941
nov_dec_2012.baseline	0.296049507	0.168860182	103473	1.75	0.0796
nov_dec_2012.treatment	0.1731545	0.168862287	103473	1.03	0.3052
hour18:control.treatment	0.00150044	0.016664742	208183	0.09	0.9283
hour19:control.treatment	-0.025130017	0.021124078	208183	-1.19	0.2342
hour18:may_2013.baseline	-0.020203457	0.013614274	208183	-1.48	0.1378
hour19:may_2013.baseline	-0.064747997	0.017257089	208183	-3.75	2.00E-04
hour18:may_2013.treatment	-0.020173538	0.013612887	208183	-1.48	0.1384
hour19:may_2013.treatment	-0.074360957	0.017255198	208183	-4.31	<0.0001
hour18:jan_apr_2013.baseline	-0.016643697	0.017225248	208183	-0.97	0.3339
hour19:jan_apr_2013.baseline	-0.014958464	0.021834228	208183	-0.69	0.4933
hour18:jan_apr_2013.treatment	0.011738227	0.017237898	208183	0.68	0.4959
hour19:jan_apr_2013.treatment	-0.019063867	0.021850091	208183	-0.87	0.3829
hour18:nov_dec_2012.baseline	0.01133188	0.016947898	208183	0.67	0.5037
hour19:nov_dec_2012.baseline	-0.05547811	0.02148267	208183	-2.58	0.0098
hour18:nov_dec_2012.treatment	-0.012743913	0.01694816	208183	-0.75	0.4521
hour19:nov_dec_2012.treatment	-0.025597926	0.0214827	208183	-1.19	0.2334

TABLE 70. MODEL COEFFICIENTS, POST PEAK MODEL

Variable	Coefficient	Std.Error	DF	T-value	p-value
CDH	0.0250034	0.0009614	208183	26.006559	<0.0001
CDD	0.0051927	0.0000987	103473	52.607666	<0.0001
hour20	1.367331	0.0997329	208183	13.709936	<0.0001
hour21	1.2106313	0.0996628	208183	12.147271	<0.0001
hour22	1.1008226	0.0996820	208183	11.043343	<0.0001
control.treatment	-0.032224	0.0180653	103473	-1.783744	0.0745
may_2013.baseline	0.1367245	0.1150181	103473	1.1887219	0.2346
may_2013.treatment	0.0896175	0.1150210	103473	0.7791401	0.4359
jan_apr_2013.baseline	0.1892959	0.1455425	103473	1.3006227	0.1934
jan_apr_2013.treatment	0.0968427	0.1455469	103473	0.6653716	0.5058
nov_dec_2012.baseline	0.2144959	0.1431993	103473	1.4978835	0.1342
nov_dec_2012.treatment	0.1374731	0.1432017	103473	0.9599965	0.3371
hour21:control.treatment	0.0631639	0.0167512	208183	3.7707231	0.0002
hour22:control.treatment	0.0891071	0.0209946	208183	4.244278	<0.0001
hour21:may_2013.baseline	0.0663222	0.0136850	208183	4.8463446	<0.0001
hour22:may_2013.baseline	0.0654812	0.0171430	208183	3.8197111	0.0001
hour21:may_2013.treatment	0.0950946	0.0136841	208183	6.9492847	<0.0001
hour22:may_2013.treatment	0.1053759	0.0171586	208183	6.1412882	<0.0001
hour21:jan_apr_2013.baseline	0.0774505	0.0173144	208183	4.4731822	<0.0001
hour22:jan_apr_2013.baseline	0.134303	0.0216888	208183	6.1922674	<0.0001
hour21:jan_apr_2013.treatment	0.1425422	0.0173273	208183	8.2264626	<0.0001
hour22:jan_apr_2013.treatment	0.1868783	0.0217180	208183	8.6047505	<0.0001
hour21:nov_dec_2012.baseline	0.0533767	0.0170358	208183	3.1332185	0.0017
hour22:nov_dec_2012.baseline	0.0424609	0.0213402	208183	1.989713	0.0466
hour21:nov_dec_2012.treatment	0.0793219	0.0170361	208183	4.6561123	<0.0001
hour22:nov_dec_2012.treatment	0.0598948	0.0213539	208183	2.8048622	0.0050

Variance-covariance matrices

Table 71. Variance-covariance matrix, PRE peak model

	Variance	StdDev
Customer (Intercept)	1.10153758	1.0495416
Day	0.01727494	0.1314342
Residual	1.38382349	1.1763603

Table 72. Variance-covariance matrix, PEAK model

	Variance	StdDev
Customer (Intercept)	1.4537103	1.2056991
Day	0.1101602	0.3319038
Residual	1.5856953	1.259243

Table 73. Variance-covariance matrix, POST peak model

	Variance	StdDev
Customer (Intercept)	1.042567	1.021061458
Day	1.422360e-06	0.001192627
Residual	1.462232	1.209227864

Corrections

AR(1) error structure was the only correction applied.

Model Results

Table 74. Summer weekday impacts, by Install month

Treatment Group	N	Time Period (hour)	Savings (kWh/h)	Standard Error	95 % Confidence Intervals		Reference Load (2012)	% Savings
Nov-Dec 2012	100	14-16	**-0.12***	0.0216	-0.1688	-0.0662	1.85	-6.4%
Jan-Apr 2013	94	14-16	**-0.073***	0.0219	-0.1248	-0.0204	1.78	-4.1%
May 2013	319	14-16	**-0.050***	0.0173	-0.0909	-0.0085	1.81	-2.8%
Nov-Dec 2012	100	17-19	**-0.15***	0.0235	-0.2012	-0.0894	2.51	-5.8%
Jan-Apr 2013	94	17-19	**-0.09***	0.0239	-0.1472	-0.0337	2.41	-3.8%
May 2013	319	17-19	**-0.062***	0.0189	-0.1066	-0.0169	2.40	-2.6%
Nov-Dec 2012	100	20-21	**-0.081***	0.0211	-0.1312	-0.0310	2.27	-3.6%
Jan-Apr 2013	94	20-21	**-0.072***	0.0214	-0.1227	-0.0208	2.29	-3.1%
May 2013	319	20-21	**-0.043***	0.0169	-0.0830	-0.0025	2.21	-1.9%

Table 75. Summer weekday impacts, between install month comparisons

Treatment Group	Time Period (hour)	Savings (kWh/h)	Standard Error	95 % Confidence Intervals	
May 2013 vs Jan-Apr 2013	14-16	0.023	0.0182	-0.0203	0.0663
May vs Nov-Dec 2012	14-16	**0.068***	0.0178	0.0257	0.1103
Jan-Apr 2013 vs Nov-Dec 2012	14-16	0.045	0.0223	-0.0081	0.0981
May 2013 vs Jan-Apr 2013	17-19	0.029	0.0198	-0.0181	0.0761
May vs Nov-Dec 2012	17-19	**0.084***	0.0193	0.0381	0.1299
Jan-Apr 2013 vs Nov-Dec 2012	17-19	0.055	0.0243	-0.0028	0.1128
May 2013 vs Jan-Apr 2013	20-21	0.029	0.0178	-0.0133	0.0713
May vs Nov-Dec 2012	20-21	0.038	0.0174	-0.0034	0.0794
Jan-Apr 2013 vs Nov-Dec 2012	20-21	0.0093	0.0218	-0.0426	0.0612

APPENDIX E. DEMOGRAPHIC DATA SUMMARY

This section provides a summary of the demographic data collected through participant surveys.

Q15 - INCLUDING YOURSELF, HOW MANY PEOPLE LIVE IN YOUR HOUSEHOLD?

Table 76 shows the summary of responses for the number of household occupants. Majority of homes had less than 3 occupants with 61% of homes with two occupants and 20% of homes with only one occupant.

TABLE 76.SUMMARY OF RESPONSE, HOUSEHOLD OCCUPANTS (ALL)

Adult	count	Percent
1	63	20%
2	190	61%
3	30	10%
4	9	3%
5	3	1%
6	2	1%
NA's	16	5%
Total	313	101%

Table 77 shows the summary of responses for the number of household occupants between the ages of 13 and 17. Most households (80%) didn't have any teenage occupants.

TABLE 77.SUMMARY OF RESPONSES, HOUSEHOLD OCCUPANTS (13 TO 17 YEARS OF AGE)

Teenagers (13 to 17 years of age)	count	Percent
0	250	80%
1	36	12%
2	8	3%
3	2	1%
4	1	0%
NA's	16	5%
Total	313	101%

Table 78 shows the summary of responses for the number of household occupants under the age of 12. Over half of the households didn't have any children age 12 or younger (58%).

Table 78.Summary of responses, household occupants (12 years or younger)

Children (12 years or younger)	count	Percent
0	182	58%
1	65	21%
2	41	13%
3	6	2%
4	3	1%
NA's	16	5%
Total	313	100%

Q16 – Of the people in your household, how many used the EnergyAware Electricity Use Display at least occasionally to review or monitor electricity use in your home?

Table 79 shows the summary of responses for the number of household occupants who used the EnergyAware Electricity Use Display.

Table 79.Summary of responses, how many occupants used the EnergyAware Electricity Use Display (all)

Adults	Count	Percent
0	14	4%
1	158	50%
2	117	37%
3	6	2%
4	2	1%
NA's	16	5%
Total	313	99%

Table 80 shows the summary of responses for the number of household occupants between ages of 13 and 17 who used the EnergyAware Electricity Use Display.

Table 80. Summary of responses, how many occupants used the EnergyAware Electricity Use Display (13 to 17 years of age)

Teenagers (13 to 17 years of age)	Count	Percent
0	33	11%
1	12	4%
2	2	1%
NA's	266	85%
Total	313	101%

Table 81 shows the summary of responses for the number of household occupants under the age of 12 who used the EnergyAware Electricity Use Display.

Table 81. Summary of responses, how many occupants used the EnergyAware Electricity Use Display (12 years or younger)

Children (12 years or younger)	Count	Percent
0	90	29%
1	19	6%
2	6	2%
NA's	198	63%
Total	313	100%

Q17 - In the first week that you had the Display wirelessly connected to your smart meter, how many days did you actively review the electricity use information provided on the Display?

Table 82 shows the summary of responses for how many days participants consulted their energy display in the first week after the installation. More than half of the participants reviewed their energy use every day of the week in the first week after the installation.

Table 82.Summary of responses, In the first week that you had the Display wirelessly connected to your smart meter, how many days did you actively review the electricity use information provided on the Display

Q17	Count	Percent
0	16	5%
1	7	2%
2	11	4%
3	10	3%
4	7	2%
5	35	11%
6	9	3%
7	194	62%
NA's	24	8%
Total	313	100%

Q18- After the first week, on average how many days per week have you actively reviewed the electricity use information provided on the Display?

Table 83 shows the summary of responses for how many days participants consulted their energy display after the first week it was installed. After the first week, only 33% of participants reviewed their energy use provided on the installed display daily, while 85% reviewed it at least once per week.

Table 83.Summary of responses, After the first week, on average how many days per week have you actively reviewed the electricity use information provided on the Display

Q18	Count	Percent
0	19	6%
1	16	5%
2	23	7%
3	41	13%
4	30	10%
5	44	14%
6	10	3%
7	104	33%
NA's	26	8%
Total	313	99%

Q19- How long would you prefer to have the EnergyAware Electricity Use Display checked-out for?

Table 84 shows the summary of responses for how long participants would prefer to have the EnergyAware Electricity display checked-out for.

Table 84.Summary of responses, How long would you prefer to have the EnergyAware Electricity Use Display checked-out for

Q19	Count	Percent
Always need one	88	28%
Up to one month	25	8%
One to two months	56	18%
Three to six months	82	26%
Seven months to one year	27	9%
One to two years	19	6%
Prefer not to answer	16	5%
Total	313	100%

QD1 - In what year were you born?

Table 85 shows the summary of responses for participant age. Most participants were between the ages of 26 and 54.

Table 85.Summary of responses, participant age

Age	Count	Percent
19-25	15	5%
26-35	86	27%
36-54	113	36%
55-75	48	15%
76 or more	7	2%
Prefer not to answer	44	14%
Total	313	99%

QD2 - What is your gender?

Table 86 shows the summary of responses for participant gender.

Table 86.Summary of responses, participant gender

Gender	Count	Percent
Female	93	30%
Male	204	65%
Prefer not to answer	16	5%
Total	313	100%

QD3 - Do you own or rent your home?

Table 87 shows the number of owners and renters. 63% of participants in the program were the house owners.

Table 87.Summary of responses, own/rent

Rent/Own	Count	Percent
Own	196	63%
Prefer not to answer	12	4%
Rent	105	34%
Total	313	101%

QD4 - Which of the following best describes your home?

Table 88 shows the summary of responses for the dwelling type. Majority of customers were in single-family homes (76%).

Table 88.Summary of responses, dwelling type

Home	Count	Percent
Condominium or Apartment	50	16%
Mobile home	1	0%
Prefer not to answer	6	2%
Single-family detached home	238	76%
Townhome, duplex or tri-plex	18	6%
Total	313	100%

QD5 - Does your home have central air conditioning (AC)?

Table 89 shows the summary of responses for whether or not participants have central air conditioning (AC). Nearly all participants (92%) had central air conditioning.

Table 89.Summary of responses, Does your home have central air conditioning (AC)

AC	Count	Percent
No	20	6%
Prefer not to answer	4	1%
Yes	289	92%
Total	313	99%

QD6 - What is the last grade or level you completed in school?

Table 90 shows the summary of responses for participant education level. Most participants had some college education, graduated from college or had their graduate degree.

Table 90.Summary of responses, participant education level

Education	Count	Percent
Some high school (9 to 11 years)	1	0%
High school graduate (12 years)	22	7%
Technical / Vocational school	8	3%
Some college	64	20%
College graduate (2 year degree)	36	12%
College graduate (4 year degree)	78	25%
Some graduate school	16	5%
Graduate, professional, doctorate degree...	67	21%
Prefer not to answer	21	7%
Total	313	100%

QD7 - Which of the following categories best represents your household's total annual income before taxes?

Table 91 shows the summary of responses for participant income.

Table 91. Summary of responses, participant income

Income	Count	Percent
Less than $30,000	40	13%
$30,000 to $44,999	21	7%
$45,000 to $59,999	37	12%
$60,000 to $79,999	37	12%
$80,000 to $99,999	45	14%
$100,000 to $149,999	40	13%
$150,000 or more	27	9%
Not sure	2	1%
Prefer not to answer	64	20%
Total	313	101%

APPENDIX F. ENERGYAWARE POWERTAB

INSTALLATION PROCESS

TABLE 92. IHD INSTALLATION AND PROVISIONING PROCESS NARRATIVE

Responsibility	Step	Narrative
Residential Services Support	1	Receive request for IHD from customer.
	2	Decision: Is the address an apartment? If yes, go to Step 3. If no, go to Step 4.
	3	Pull wireless range extender from supply.
	4	Assign the asset(s) to the customer in the SQL database.
	5	Create customer .csv file to include device location (10 digits), rate category, program ID.
	6	Upload the .csv file to HCM.
	7	Create mailing labels from the SQL database.
	8	Create and ship participant package to include educational materials, IHD, wireless range extender (if necessary), and letter with due date.
Customer	9	Receive the IHD (and extender) from SMUD and install it in the home per instructions.
Residential Services Support	10	Provision the devices in HCM, assign IHD to customer, join the IHD to the meter, and add wireless range extender (if needed) by associating and joining it to the meter.
	11	Send a letter to the customer with the IHD (and extender) return due date.

energyaware

PowerTab™ User Guide

Table of Contents

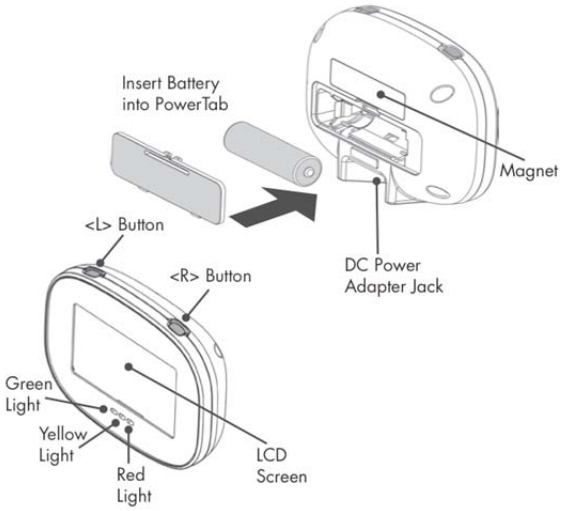
1 Introduction

The PowerTab is an In-Home Display (IHD) that provides real-time feedback on your electricity consumption. The display communicates wirelessly with the smart electricity meter outside your home.

Your PowerTab allows you to:

- View your current household electricity use
- Track your electricity consumption and associated costs over time
- Test consumption and costs of operating individual devices
- Receive and acknowledge messages from your utility or service provider

Your PowerTab package contains a display unit, a battery, and a power adapter.



2 PowerTab Basics

This section provides information on the primary functions of your PowerTab.

2.1 Your PowerTab's power modes

Your PowerTab has three power modes: On, Off, and Sleep.

To turn your PowerTab on, press either <L> or <R>. Turn your PowerTab off by pressing and holding <L> for three seconds. A confirmation screen will appear. Press <L> again ("Yes") to approve the shutdown.

Note: Your PowerTab is unable to receive text messages from your service provider when it is off.

When not connected to a network, the PowerTab will turn off automatically after 5 minutes of inactivity. When the PowerTab is connected to a network, it will enter sleep mode after 5 minutes of inactivity. In sleep mode, only primary information remains visible and the current time is shown in the top right corner of the screen. This is depicted in the following sample screen.

Wake the PowerTab from sleep by pressing <L> or <R>, or by plugging it in.

2.2 Charging your PowerTab

To charge your PowerTab, first ensure the battery is installed, then connect the power adapter to the DC power adapter jack and plug your PowerTab into a power outlet.

2.3 Joining a ZigBee Smart Energy network

When your PowerTab is not joined to a network, it will display the following screen:

To commission your PowerTab, follow the procedures supplied by your service provider. Typical procedures will require the use of the display's Extended Unique Identifier (EUI-64) and its install code, both displayed on the No Network screen.

When the commissioning process is complete, join the network by holding <L> and <R> for three seconds at the No Network screen.

Note: It is advisable to keep your PowerTab connected to external power while attempting to join a network to prevent any possible interruptions due to power failure.

Your PowerTab may take up to 5 minutes to complete the network joining process.

2.4 Leaving a ZigBee Smart Energy network

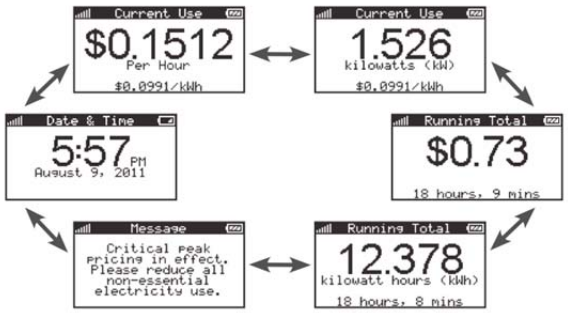
Warning: Involvement from your service provider will be required to recommission your PowerTab when you want to join a ZigBee Smart Energy network again. In general, you should only leave the network if you are moving, or if you were specifically asked to do so by your service provider.

To remove your PowerTab from your meter's network:

1. Turn the device off
2. Turn the device on
3. While the startup screen is shown, hold <L> and <R> buttons for 10 seconds
4. Press <L> ("Yes") at the network leave confirmation screen that appears

2.5 Navigating your PowerTab screens

The main screens of your PowerTab are arranged in a loop. Navigate through the screens by pressing <L> or <R>.



Note: The Message screen is only available when there is at least one active message. Additional message screens will be included in the loop when there are multiple active messages. The Date & Time screen is only available when the PowerTab has successfully synchronized local time information with the meter.

2.6 Signal strength and battery charge indicators

The battery icon in the top-right corner of your PowerTab screen shows an approximation of its remaining charge. When connected to external power, the battery icon will animate to show that your PowerTab is charging. When your PowerTab has finished charging but is still plugged in, a plug is displayed in the middle of the battery icon.

The vertical bars in the top-left corner of your PowerTab screen show the strength of its connection to the network. Six bars indicate the highest signal strength, while one bar indicates that your PowerTab is nearly outside the network's range.

3 Using Your PowerTab

Your PowerTab provides you with feedback that will enable you to better understand your electricity bills and manage your consumption. This section explains a few ways in which you might use your PowerTab.

3.1 Viewing your current electricity use

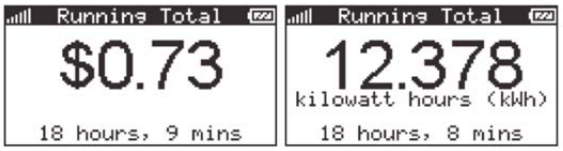
To view your home's current rate of electricity consumption, navigate to the Current Use screen on your PowerTab shown below using the <L> or <R> button.

In the screen on the left, the large number shows the cost of your current consumption rate in dollars per hour. The large number in the screen on the right shows your actual consumption rate in kilowatts. The smaller number at the bottom of the screens show the current price you are being charged for each kilowatt-hour of electricity consumed.

To determine the cost of operating a single appliance, compare the displayed electricity consumption rate when the appliance is both on and off. The difference between the two rates will be a close approximation of the power used by that appliance.

3.2 Tracking your electricity use over time

To view your home's total electricity consumption over a fixed period of time, navigate to either of the Running Total screens on your PowerTab shown below using the <L> or <R> button.



In the screen on the left, the large number shows the cost of your accumulated electricity consumption in dollars. The large number in the screen on the right shows your accumulated consumption in kilowatt-hours.

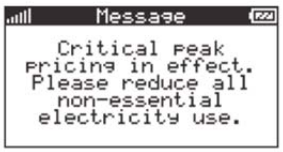
The Running Total can be reset by pressing the <L> and <R> buttons at the same time. The small numbers at the bottom of the screens show how much time has elapsed since the last reset. If you want to see how much you spend on electricity during a certain event or time period, reset the total and then check it once the event is done.

Note: Depending on how your service provider supplies pricing information to the PowerTab, it is possible for inaccuracies in the Running Total cost estimate to develop. Keeping your PowerTab turned on and within range of your meter at all times will minimize the size of these potential inaccuracies.

If the PowerTab is unable to obtain pricing information for any portion of the energy consumption in the Running Total period, it will not be included in the cost estimate. The total unaccounted kilowatt-hours will be displayed as shown in the screen below.

3.3 Receiving messages from your service provider

If your service provider has sent you a message, it will appear on its own screen. An example message is shown below.

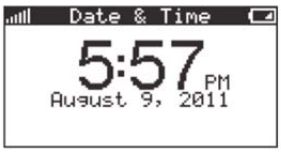


Messages will remain viewable on your PowerTab until they expire (configured by your service provider). Expired messages are not retrievable.

Some messages may require that you acknowledge them and will instruct you to do so. Press <L> and <R> at the same time at the relevant Message screen to acknowledge the message. If a message requiring acknowledgment expires before you've acknowledged it, it will no longer be possible to send an acknowledgement for that message.

3.4 Viewing the date and time

The PowerTab is also capable of displaying the current date and time on its dedicated date & time screen shown below. Time information is synchronized to your meter and does not need to be entered manually.



3.5 Understanding the lights on your PowerTab

Your PowerTab has three lights that are used to indicate the presence of new messages and the current relative cost of electricity."

Note: The lights will continue to function while your PowerTab is in sleep mode.

When a new or unacknowledged message is available on your PowerTab, the lights will show this by simultaneously blinking once every 7 seconds. The lights will continue to blink until you have acknowledged this message or changed to another display screen.

When no new messages are present, the lights will indicate the current relative cost of electricity. A pulsing light indicates the price period you are currently in, while a blinking light in conjunction with a pulsing light indicates an upcoming price period change. The special case of Critical Peak Pricing (CPP) is indicated when the red light is blinking on its own.

The exact behaviour of the lights is dependent on the number of active price tiers, however green will always indicate the cheapest tiers, and red the most expensive.

The following table shows examples of the lights' behaviour for a typical time-of-use pricing structure involving four price tiers: Off-Peak, Mid-Peak, On-Peak, and CPP.

Pulsing Light "_ _ _"	Blinking Light ".. .. .."	Description
Green ● ○ ○	None ○ ○ ○	Off-Peak price in effect
Yellow ○ ● ○	None ○ ○ ○	Mid-Peak price in effect
Red ○ ○ ●	None ○ ○ ○	On-Peak price in effect
None ○ ○ ○	Red ○ ○ ●	CPP in effect
Green ● ○ ○	Yellow ○ ● ○	Off-Peak price in effect Mid-Peak price upcoming within 5 minutes
Red ○ ○ ●	Green ● ○ ○	On-Peak price in effect Off-Peak price upcoming within 5 minutes

4 Troubleshooting/FAQ

Solutions to most of the problems you might encounter with your PowerTab are described in this section.

4.1 If your PowerTab fails to join a network

If your PowerTab displays "No networks found" after you attempt to join your meter's network, your PowerTab may not be in wireless range of your meter. Try moving closer to your meter and attempt joining again. If this does not solve the issue, it may be necessary to recommission the PowerTab. Contact your service provider and ask them to commission your PowerTab again.

4.2 If your PowerTab has lost the network

When your PowerTab loses connection to the network it will periodically attempt to reconnect. During a reconnection attempt you will see the following screen.

Between reconnection attempts, the following screen indicates how much time is remaining before the PowerTab's next automatic retry.

You may force an immediate reconnection attempt at any time by pressing <L> or <R>.

The connection interruption may have occurred because:

- Your PowerTab is not within wireless range of your meter.

Try moving your PowerTab closer to the meter or away from large obstacles.

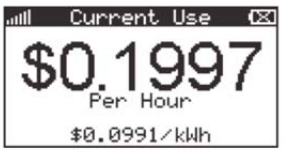
- Your meter's network has gone down due to a power outage or due to being serviced by a field technician.

4.3 If your PowerTab will not turn on

If your PowerTab will not turn on in response to a button-press, its battery may be dead. Try connecting the power adapter to the DC power adapter jack and plug your PowerTab into a power outlet.

4.4 If your PowerTab will not recharge

If your PowerTab will not charge and is displaying the battery icon shown in the following screen, it has detected a battery that it is unable to charge. Replace the battery with a rechargeable Nickel-Metal Hydride (NiMH) battery.



4.5 If you need to change the battery

Your PowerTab uses a rechargeable Nickel-Metal Hydride AA battery.

CAUTION: Only rechargeable, Nickel-Metal Hydride batteries may be used in the PowerTab. DO NOT USE ANY OTHER CELL CHEMISTRIES WITH YOUR POWERTAB.

To replace your PowerTab's battery, follow these steps:

- Disconnect your PowerTab from the power outlet
- Open the battery door and remove the battery
- Insert a new rechargeable Nickel-Metal Hydride (NiMH) battery according to the orientation shown in the battery compartment
- Replace the battery door and check that the PowerTab has turned on

Rechargeable Nickel-Metal Hydride (NiMH) batteries with a capacity from 2300mAH – 2600mAH and manufactured by the following companies, are the only suitable replacements for the battery that you received with your PowerTab.

You should not replace the battery with anything other than those listed here:

- Energizer rechargeable NiMH battery, 2300mAH – 2600mAH
- Duracell rechargeable NiMH battery, 2300mAH – 2600mAH
- PowerEx rechargeable NiMH battery, 2300mAH – 2600mAH
- Sanyo rechargeable NiMH battery, 2300mAH – 2600mAH
- Rayovac rechargeable NiMH battery, 2300mAH – 2600mAH

4.6 Your Running Total does not match your electricity bill

Your PowerTab is intended for feedback purposes only and is not a billing tool. Discrepancies may exist between your PowerTab's running total and your bill, even if you reset your running total at the beginning of your billing cycle.

4.7 How to figure out what an individual appliance is consuming

Your PowerTab displays the electricity used by your entire home. Electricity consumed by individual outlets or appliances can only be indirectly measured by comparing your home's consumption rate with those appliances on and off. (See section 3.1.)

4.8 Your current use value does not change when you turn on/off a light

Some electrical loads are too small to register a change in your meter's current electricity use value. For example, Compact Florescent Light bulbs (CFLs) draw very little electricity and may not cause a change on your PowerTab's Current Use screen.

4.9 Your service provider sent you a message, where did it go?

Your service provider sends messages with a pre-set expiration time. Once a message has expired it can no longer be viewed. Generally, messages will not be set to expire until they are no longer relevant.

5 Appendix

5.1 Safety Instructions

To ensure your PowerTab is used safely, please read these Safety Instructions and the rest of this User Manual thoroughly before using the product.

- The PowerTab contains a magnet. Do not place your PowerTab directly on credit cards, computers, or other pieces of electronic equipment, as this may cause damage.
- Do not attempt to repair your PowerTab or DC power adaptor yourself. If you are experiencing problems with the device, contact your service provider for assistance. Opening the product casing for any reason will void the product warranty.
- Do not touch any exposed electronic circuitry of the device if it becomes damaged.
- Do not immerse your PowerTab in water.
- Avoid using your PowerTab in high moisture areas such as a bathroom for extended periods of time.
- Keep your PowerTab away from heat sources such as stoves and heaters.
- Do not drop your PowerTab or cause any sudden impact to it.
- Take care when handling a damaged LCD display as the liquid crystals can be harmful to your health. If any fluid does leak from your PowerTab's LCD, immediately wash with soap and water.

5.2 Product Specifications

Communications
- Frequency Band: 2.4GHz
- Radio Output Power: 20dBm
- Protocol: IEEE 802.15.4

Size and Weight
- Length: 28 mm (1.10 inches)
- Width: 108 mm (4.25 inches)
- Height: 79 mm (3.11 inches)
- Weight: 134 grams (4.7 ounces)

Battery
- Approximate life between charges: 2 weeks
- Recharge time: 15 hours

5.3 FCC Compliance

FCC Class B Part 15

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by Energy Aware Technology Inc. may void the user's authority to operate the equipment.

IC RSS 210

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

FCC/IC RF Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna(s) used for this equipment must be installed to provide a separation distance of at least 8 inches (20cm) from all persons.

Cet équipement est conforme à l'exposition aux radiations de FCC et d'Industrie Canada établies pour un environnement non contrôlé. L'antenne (s) utilisé pour cet équipement doit être installé pour fournir une distance d'au moins 20cm à partir de toutes les personnes.

5.4 Manufacturing Information

Designed by Energy Aware Technology Inc.
134 Abbott Street, Suite 604
Vancouver, BC, Canada
V6B 2K4

Made in Canada in an ISO 9000-2008 certified facility.