NAVIGANT

Regulated Price Plan Roadmap Pilot Program Final Impact Evaluation

Appendix J: Extended Analysis – Impact of Customer Engagement
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Prepared for:

ONTARIO ENERGY BOARD

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1. INTRODUCTION AND KEY FINDINGS

One of the recommendations made by Navigant's interim evaluation report of London Hydro's RPP pilot was that the OEB:

> *Undertake a secondary impact analysis, tying participant engagement data back to the consumption data. That is, test the hypothesis that the non-price motivated energy impacts and the CPP event response is improved by London Hydro's customer engagement strategy.*

In mid-2019, the Ontario Energy Board (OEB) engaged Navigant to undertake this analysis. This appendix describes the context, approach, and findings of this analysis. Quantitative outputs summarized here in Appendix J may also be found in Appendix K, a spreadsheet appendix that accompanies the main report.

In consultation with London Hydro staff, Navigant determined that the most suitable proxy that could be used to tie participant consumption data to the customer engagement strategy was the measure of participant attendance at London Hydro sponsored events, a key component of the overall engagement strategy. Attendance was kept (and could therefore be used in the quantitative analysis) for four types of events: Kick-Off Breakfasts, Focus Groups, Open Houses, and the Picnic in the Park event.

This Appendix is divided into four sections:

- **Introduction and Key Findings.** This section introduces the analysis, provides a few summary statistics regarding event attendance, and highlights Navigant's key findings from this analysis.

- **Approach.** This section provides a high-level description of the approach used for the analysis.

- **Results.** This section provides a summary of the key quantitative outputs.

- **Conclusions.** This section summarizes Navigant's conclusion as a result of the analysis.

The remainder of this section is divided into two sub-sections. The first provides the set of goals for this analysis, and the second provides the key findings of Navigant's extended analysis.

1.1 Analysis Goals and Structure

The OEB contracted with Navigant to analyze and estimate the following:

1. **Energy Impacts of Event Attendance**. Estimate the incremental impact on energy consumption (by TOU period) of event attendance by pilot participants. Specifically, answer these questions:

    a. Does attendance of any of the four types of events where London Hydro tracked individual attendance affect energy impacts in a statistically significant way?

    b. Where event attendance is estimated to deliver a statistically significant impact on energy consumption, to what degree (based on the observed distribution of event attendance)

may this impact be attributed to selection bias, and to what degree may it be attributed to the success of utility messaging.[1]

2. **Correlation of Disconnections and Event Attendance.** This is an important pre-analysis for evaluating how much event attendance affects the behavioural response to CPP. The focus of this analysis is understanding whether event attendance appears to be correlated with (or appear to affect) CPP event device disconnections. The results of this analysis dictate the most appropriate approach for quantifying how much event attendance affects CPP response.

3. **Estimate the incremental impact of event attendance on behavioural CPP response.** Conditional on the findings of the analysis described immediately above, does event attendance lead to any incremental impact on CPP event response from participants?

1.2 Key Findings of the Extended Analysis

Navigant's key findings can be divided into three categories:

- **Energy Impacts.** Findings related to the incremental impact on energy consumption of event attendance.

- **Disconnection Impacts.** Findings related to the comparative analysis of open house event attendance and device disconnections.

- **CPP Demand Response Impacts.** Findings related to the incremental impact on critical peak pricing event demand response of open house attendance.

Navigant's key findings related to the incremental impact of event attendance on energy consumption are:

1. **It is likely that any estimated impacts as a result of focus group or kick-off breakfast attendance are spurious, and the result of selection bias.** Most participants that attended these events did so in the period prior to the evaluation period, rendering attendance at these events effectively a cross-sectional indicator. Absent any variation in these groups during the event period, it seems likely (though is impossible to identify quantitatively) that any estimated incremental effects from attendance simply reflect the fact that the most enthusiastic participants are likely to both save more energy and attend these kinds of events.

2. **Attending open houses yielded substantial and consistent incremental impacts across all treatments and TOU periods.** Nearly all the estimated incremental impacts associated with open house attendance are statistically significant at the 90% confidence level.[2] In addition, open house attendance was staggered over time (particularly during the summer). This means that

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[1] As noted explicitly in Navigant's proposal:

> "*some selection bias is likely to be present in the results: attendees to London Hydro events may achieve higher energy conservation or CPP response savings than other participants due to information provided by London Hydro at these events, or they may achieve higher savings simply because the types of customers likely to attend such events are also the types of customers that are likely to be more invested in pilot participation.*
>
> *The reality is that any estimated incremental impact correlated with event attendance is likely to be a blend of these two effects and extrapolating the findings of this analysis out to a wider population should be done carefully, acknowledging this ambiguity.*"

[2] Unless explicitly noted otherwise, all inference testing conducted at the 90% confidence level.

estimated impacts are implicitly derived both from a comparison of attending participants against controls and non-attending participants, but *also* against participants *prior* to their attendance. While it is impossible to rule out that some portion of the incremental impacts are due to selection bias, it also seems likely that a portion of the incremental impacts are due to the in-person assistance provided by London Hydro staff to attendees.

3. **There appears to be no statistically significant impact on winter energy consumption of event attendance.** Winter event attendance was generally much lower than summer attendance, and winter average impacts were not statistically significant (an unsurprising result given that a high proportion of summer response appears to have been delivered via space-cooling management).

Navigant's key findings related to the comparative analysis of open house attendance and device disconnections include:

1. **Participants that attended the open houses were half as likely to be disconnected for any given event.** CPP and CPP/RT participants were, on average, disconnected for 3.5 CPP events during the summer of 2018. Participants that attended the open houses were only on average disconnected for 1.8 CPP events during the summer of 2018.

2. **Nearly half of the open house attendees needed help with connection issues.** The factor driving the finding above is clear when the details of the open house visits are examined. Nearly half of the participants that attended these events did so to resolve an issue related to their connectivity and enabling technologies.

3. **More than a quarter of open house attendees required assistance with very basic software issues, issues that – had they not been resolved – would have prevented these participants from effectively engaging with the pilot treatments.** This group of participants required in-person assistance installing the Trickl app, logging in to the app or the London Hydro portal, retrieving passwords, etc. It seems possible that absent the availability of in-person assistance in resolving these issues these participants may have become frustrated and either exited the pilot or ceased trying to engage with it to reduce their demand and consumption.

Navigant's key findings related to the incremental impact on critical peak pricing event demand response of open house attendance include:

1. **Participants that attended open houses do deliver more summer demand response per event than average.** This is simply an extension of the finding above that participants that have attended open house events have much lower disconnection rates than those that have not. Lower disconnection rates inevitably mean higher per participant demand response impacts.

2. **Once disconnections are controlled for, open house attendance does not affect summer demand response in a statistically significant way.** Open house attendance does not deliver any statistically significant incremental summer CPP demand response beyond that provided due to the reduced number of disconnections. Winter CPP demand response is wholly unaffected by open house attendance.

2. APPROACH

This section of Appendix J provides a description of the data and approaches used to build the analysis required to achieve the goals for this extended analysis outlined above.

This section is divided into four sub-sections:

- Summary of Data

- Energy Impacts of Event Attendance

- Open House Attendance, Disconnections, and Reasons for Attending

- Open House Attendance Impact on CPP Demand Response

2.1 Summary of Data

The only incremental data required for this extended analysis not included in the core analysis (and described in the body of the report or in Appendix A) is the use of participant-specific event attendance data. At the inception of this work, Navigant requested, and London Hydro provided, a list of CPP, CPP/RT, and RT participants and the events they attended.

Altogether, London Hydro tracked participant attendance at four types of events:

     a. *Open Houses.*

     b. *Focus Groups*

     c. *Picnic at the Park*

     d. *Kick-Off Breakfasts*

These types of event are all described in Appendix I.

Figure 2-1, below, illustrates cumulative attendance over time by type of event. For example, the fact that the green area is flat after early April 2018, indicates that there were no further events after that time. A few things are evident from this:

- All kick-off breakfasts took place before the pilot began.

- No focus groups were conducted during the summer of 2018 – after the first set of focus groups (ending in March of 2018), there was only one more focus group, occurring December 12, 2018.

- Open-house attendance was gradual, and grew over time, with most open house attendance taking place in the summer of 2018.

Figure 2-1: Cumulative Event Attendance
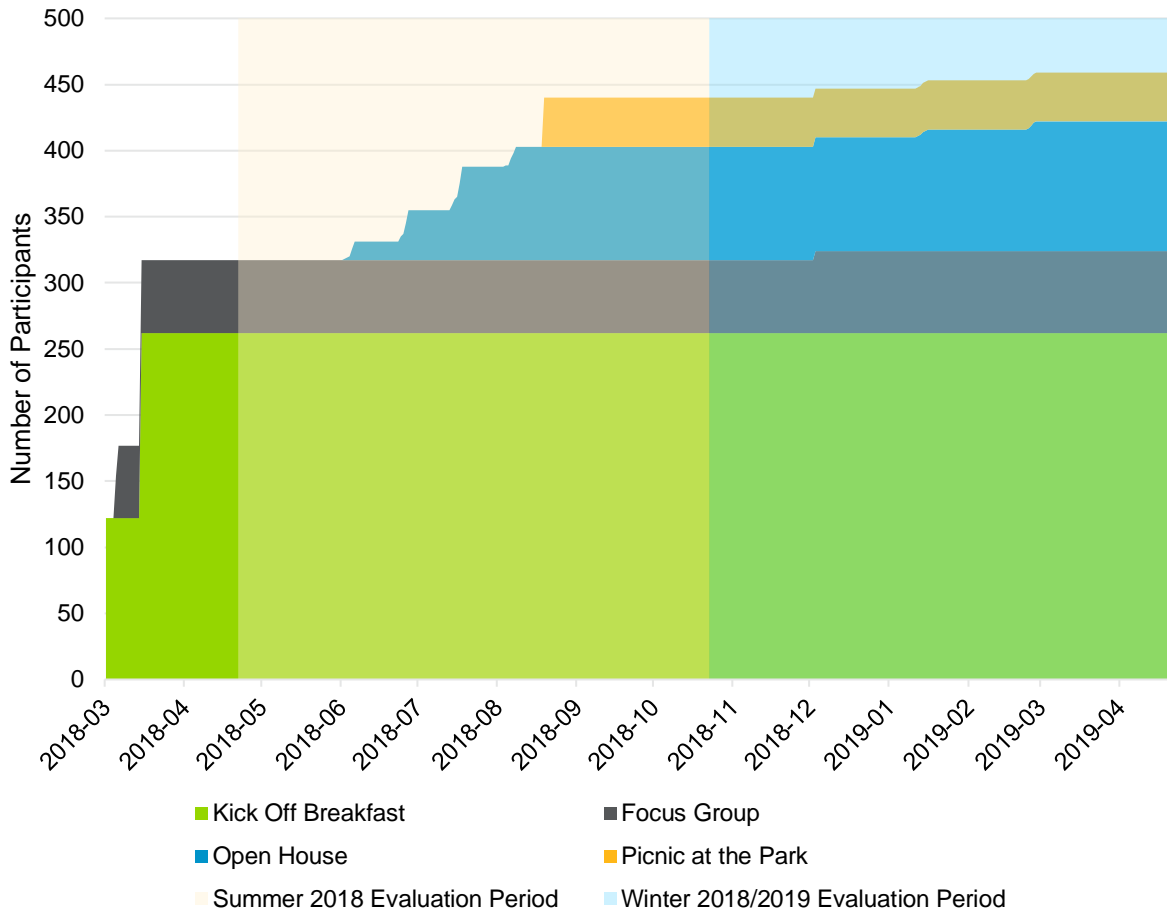
This analysis of the timing of event attendance is very important for interpreting the results from regression analysis that attempt to estimate the incremental effect of event attendance. Figure 2-1, below, presents the same data, in a slightly different format. This table provides the breakdown of total attendees by season, and by treatment group. For context, the average number of participants included in the analysis on any given day are also included in the first line of each seasonal table section.

Figure 2-2: Event Attendance by Season and Treatment Group[3]

Season	Type of Event	RT-Only	CPP-Only	CPP/RT
Summer (Absolute Number)	*Avg. Number Participants in Analysis*	*1,133*	*310*	*331*
	Focus Group Attendees	30	12	11
	Kick-Off Breakfast Attendees	117	59	74
	Open House Attendees	43	15	25
	Pizza Picnic in the Park Attendees	30	0	3
Summer (Percent of Treatment Group)	Focus Group Attendees	2.6%	3.9%	3.3%
	Kick-Off Breakfast Attendees	10.3%	19.0%	22.4%
	Open House Attendees	3.8%	4.8%	7.6%
	Pizza Picnic in the Park Attendees	2.6%	0.0%	0.9%
Winter	*Avg. Number Participants in Analysis*	*1,121*	*299*	*312*
	Focus Group Attendees	34	13	12
	Kick-Off Breakfast Attendees	117	56	71
	Open House Attendees	46	20	27
	Pizza Picnic in the Park Attendees	30	0	3
Winter (Percent of Treatment Group)	Focus Group Attendees	3.0%	4.3%	3.8%
	Kick-Off Breakfast Attendees	10.4%	18.7%	22.8%
	Open House Attendees	4.1%	6.7%	8.7%
	Pizza Picnic in the Park Attendees	2.7%	0.0%	1.0%

Between the cumulative attendance values illustrated in Figure 2-1 and the treatment group-specific total seasonal attendance shown in Figure 2-2, a few key points emerge:

- **Kick-off breakfast attendance is a purely cross-sectional differentiation.** All kick-off breakfast attendance occurred prior to the start of the pilot. Differences between impacts as a result of kick-off breakfast attendance will capture the difference between two static groups.

- **Focus group attendance in the summer months is a purely cross-sectional differentiation.** No focus groups took place during the summer. A focus group took place approximately 1 month into the winter period, attended by:
  - Four RT-only participants (~0.3% of participants in that group);
  - One CPP-only participants; and,
  - One CPP/RT participants[4].

- **"Picnic in the Park" attendance in the winter months is a purely cross-sectional differentiation**. For obvious reasons, no picnics were held in the winter. Note that only three CPP participants attended this event – approximately 1% of the CPP/RT group and less than half a percent of all participants subject to CPP rates.

- **Open house attendance was gradual and occurred mostly during the summer months**. More than 6% of participants subject to CPP rates attended open houses over the course of the summer. In contrast less than 4% of RT-only participants attended summer open houses.

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[3] Event attendance values only for participants included in the analysis.

[4] Note that that these include only the participants included in the regression analysis. A small number of participants that attended events are not included here because they could not be included in the analysis, principally due to issues related to the cross-sectional data provided by London Hydro.

The above is important when evaluating the impacts reported below.

When a difference (attendance vs. non-attendance) is purely cross-sectional, the estimated impact on consumption of that attendance is more likely to reflect some innate characteristic of participants (a form of selection bias).

When a difference changes over time (for example in the case of the "picnic in the park", or even better, the open house attendees), then the estimated impact is derived not only from a comparison across different groups of participants (controls vs. participants that did not attend vs. participants that did attend) but is also a comparison over time *within* the attending participants. Put another way, the earlier behaviour of the participants (before they attended) acts as another control for evaluating the later behaviour of those participants *after* they attended.

2.2 Energy Impacts of Event Attendance

Fifteen different regressions were estimated for each season for the energy analysis. For each season, five different model specifications were estimated for three different data sets. The three different data sets included:

- RT-only participants and RCT control customers

- CPP and CPP/RT participants and RCT control customers (all days included)

- CPP and CPP/RT participants and RCT control customers (CPP event days excluded).

Unless otherwise noted, any estimated values presented in this Appendix for the CPP and CPP/RT participants should be assumed to be from the data set from which CPP events were excluded.

The "base" regression specification (as used in the summer months) is presented below. This is followed by a brief description of the way the four other model specifications differed, and how the winter model specifications differed from those used for the summer analysis.

Equation 1: Energy Analysis Model Specification

$$
y_{i,t,p} = \sum_{p=1}^{P=4}\sum_{d=1}^{D=15} \beta_{p,d,1} \cdot tou_{t,p} \cdot daytype_{t,d} \cdot prekWh_{i,p.d} + \sum_{p=1}^{P=4} \beta_{p,2} \cdot tou_{t,p} \cdot cdh_{t,p}
$$

$$
+ \sum_{p=1}^{P=4} \beta_{p,3} \cdot tou_{t,p} \cdot hdh_{t,p} + \sum_{p=1}^{P=4} \beta_{p,4} \cdot tou_{t,p} \cdot hbu_{t,p} + \sum_{p=1}^{P=4} \beta_{p,5} \cdot tou_{t,p} \cdot cbu_{t,p}
$$

$$
+ \sum_{p=1}^{P=4} \gamma_{p,1} \cdot tou_{t,p} \cdot treat_i + \sum_{p=1}^{P=4} \gamma_{p,2} \cdot tou_{t,p} \cdot treat_i \cdot focus_{i,t} + \sum_{p=1}^{P=4} \gamma_{p,3} \cdot tou_{t,p} \cdot treat_i \cdot brkfst_{i,t}
$$

$$
+ \sum_{p=1}^{P=4} \gamma_{p,4} \cdot tou_{t,p} \cdot treat_i \cdot openhouse_{i,t} + \sum_{p=1}^{P=4} \gamma_{p,5} \cdot tou_{t,p} \cdot treat_i \cdot picnic_{i,t} + \varepsilon_{i,t,d}
$$

Where all variables above are as defined in Appendix A (sections A.1 and A.2) of the report, and:

$focus_{i,t}$	=	A dummy variable equal to one if participant i had, on or before the day of sample t attended a focus group, and zero otherwise.
$brkfst_{i,t}$	=	A dummy variable equal to one if participant i had, on or before the day of sample t attended a kick-off breakfast, and zero otherwise.
$openhouse_{i,t}$	=	A dummy variable equal to one if participant i had, on or before the day of sample t attended an open house, and zero otherwise.
$picnic_{i,t}$	=	A dummy variable equal to one if participant i had, on or before the day of sample t attended the "picnic in the park", and zero otherwise.

For each season this specification was estimated in the manner outlined above (including dummies for all event types), and then again including only one of the four event-specific dummies. A model was estimated with all the dummies (shown above), then one that includes just the focus group dummy and excludes the breakfast, open house and picnic dummies, etc..

The key difference this makes to the interpretation of the parameters is this:

- In the "All" model specification (which contains all the dummies)
  - The base impact (the $\gamma_{p,1}$ set of parameters) is the average impact in the given period of a participant who attends *none* of the events.
  - The incremental impact of event attendance (e.g., $\gamma_{p,2}$) is the incremental impact of attending *only* the flagged event type.

- In contrast, under, for example, the focus group specific regression specification (which does not include $brkfst_{i,t}$, $openhouse_{i,t}$, or $picnic_{i,t}$)
  - The base impact is the average impact in the given period of a participant who does not attend the controlled for type of event (focus groups in this example) but who attends the others with same average frequency as the sample.
  - The incremental impact of event attendance is the incremental impact of attending the flagged event type, combined with the impact of attending all event types with the average frequency of the overall sample.

Unless otherwise noted, all estimated outputs presented below are drawn from the "all" model that includes all the dummy variables shown above.

2.3 Open House Attendance, Disconnections, and Reasons for Attending

This portion of the extended analysis has two components.

1. Comparison of Average Number of Disconnections.
2. Assessment of Reasons for Attending Open House

2.3.1 Comparison of Average Number of Disconnections

The first element of this analysis is a seasonal comparison of the average number of disconnections per participant. For this analysis Navigant used connectivity data, event attendance data (used above) and open-house specific attendance data (that included an indication of why participants attended the open house, and whether any action by London Hydro was required).

For the first component of this analysis, Navigant calculated the average number of disconnections (and the associated standard deviation) experienced by season for the participants, and then for the open house attending participants. The calculation of the sample standard deviation of the disconnections observed in the two groups allows for a statistical comparison of the average rate of disconnection across the two groups, and an evaluation of whether the difference is (or is not) statistically significant.

2.3.2 Assessment of Reasons for Attending Open House

As Navigant proceeded with the analysis, London Hydro – in response to an enquiry by Navigant – was able to provide Navigant with a short verbal summary of each open house attendees reasons for attending. Although this extended analysis was not scoped as a process analysis, it was clear to Navigant that in attempting to understand the relationship between disconnections and open house attendance (if such a relationship exists) this data set could provide valuable insights.

In reviewing the verbal summaries describing the reason for each participant attending the open houses, Navigant noticed a few trends, and, in order to enhance the extended analysis created four binary coding categories for each attendee visit. These categories are not mutually exclusive (although in many cases only one category applies to each visit), so, for example, it is possible a participant attended an open house to resolve a connection issue *and* a comprehension issue. The underlying data used in this exercise may be found in Appendix K.These categories are:

- *"connection_issue":* this variable is assigned a value of 1 if the participant is experiencing an issue with device connectivity, is experiencing technical issues with their hardware, or needs help with one of the automated response technologies (the hub, the smart plug, or the panel-mounted load switch).

- "*comprehension_education_issue":* this variable is assigned a value of 1 if the participant has general questions about app functionality, the purpose or rules of the pilot, or has any other enquiry which can be responded to purely through the provision of information.

- *"download_login_basic_app_help":* as Navigant reviewed the attendance reasons in the provided data set it became clear that many participants attended the open house for aid in crossing initial technology hurdles. Many participants required help downloading or installing the app, logging into the London Hydro portal (or using their London Hydro credentials to log in to the Trickl app). In many cases participants using the open houses for help appear (based on the reported attendee details) to not be very experienced (or comfortable) with mobile devices, computers, or the conventions of online subscription-based services. This variable takes a 1 when the participant attended to receive this kind of help.

- "feedback": in a non-trivial number of cases participants attended the open houses simply to provide their feedback to pilot staff. In other cases, feedback was provided on aspects of the pilot as assistance was provided in another category.

Navigant has, below, examined the frequency of each of these variables and used this to inform our analysis and selection of the appropriate regression specification for identifying the incremental impact of event attendance on CPP event response.

In reviewing the attendance details data, Navigant did notice some issues with the data, which – while they don't invalidate conclusions drawn from the distribution of reasons for attending the open houses – mean that these data cannot be meaningfully linked to the quantitative data used for estimation. Put another way: attribution issues in the data mean that it the values above (e.g., "connection_issue") could not be included in a regression.

The key issue is this: when the cross-sectional data provided by London Hydro is applied to these data, the reasons for some participants attendance is at odds with the participant group in which they are enrolled. Specifically, there are fourteen instances when one of the reasons for the RT-only participant attending the open house event relates to a smart plug. Smart plugs were not distributed to RT-only participants.

2.4 Open House Attendance Impact on CPP Demand Response

Testing the impact of open house attendance on CPP demand response was conducted by re-estimating the regression models used to estimate CPP impacts for the overall participant sample, but with some additional interactions. More specifically:

- **Summer Impacts.** Estimated using Equation 3 (see section 3.4 of the main body of the report), but also including:
  - o An additional set of energy interaction terms intended to capture the incremental impact on daily energy savings of open house attendance
  - o An additional set of event-specific interaction terms intended to capture the incremental impact on disconnected customers of attending the open house.
  - o An additional set of event-specific interaction terms intended to capture the incremental impact on connected customers of attending the open house.
- **Winter Impacts.** Estimated using Equation 4 (see section 3.4 of the main body of the report), but also including:
  - o An additional set of event-specific interaction terms intended to capture the incremental impact on disconnected customers of attending the open house.
  - o An additional set of event-specific interaction terms intended to capture the incremental impact on connected customers of attending the open house.

In the new equation, every variable that included an interaction with the "treat" variable in the original equation is included as it was in the original equation, but also interacted with a dummy variable identifying whether by the given point in time the given participant had attended the open house event.

The joint statistical significance of the open-house attendance interaction parameters was tested with a standard F-test of equation restrictions (where the restricted model is simply the original Equation 3 – for summer – or Equation 4 – for winter).

3. RESULTS

This section of this appendix summarizes the estimated the results of the analysis described above in Section 2.

3.1 Energy Impacts of Event Attendance

Figure 3-1, below, provides the estimated impacts of event attendance in the six months of the summer.

- The "Base Impact" rows show the average impact achieved by those that do not attend any events;

- The "Combined Impact" rows show the average total impact achieved by those that attend only the event specified.

- The "Incremental Impact" rows show the incremental impact – over and above the "Base Impact" achieved by participants that attend the type of event specified.

Figure 3-1: Energy Impacts, Summer

Impact Type	Event Type	TOU Period	RT-Only kWh Impact	CPP Groups kWh Impact
Base Impact	no_event	On-Peak	-0.14 (N/S)	-0.21
Base Impact	no_event	Mid-Peak	0 (N/S)	-0.09 (N/S)
Base Impact	no_event	Off-Peak	0.23 (N/S)	0.27 (N/S)
Base Impact	no_event	Weekend Off-Peak	0.22 (N/S)	0.11 (N/S)
Combined Impact	focus_grp	On-Peak	-0.8851	-0.62
Combined Impact	focus_grp	Mid-Peak	-0.3 (N/S)	-0.41 (N/S)
Combined Impact	focus_grp	Off-Peak	0.27 (N/S)	-0.01 (N/S)
Combined Impact	focus_grp	Weekend Off-Peak	-1.03 (N/S)	-0.13 (N/S)
Combined Impact	ko_breakfast	On-Peak	0.04 (N/S)	-0.47
Combined Impact	ko_breakfast	Mid-Peak	0.01 (N/S)	-0.33
Combined Impact	ko_breakfast	Off-Peak	0.16 (N/S)	0.24 (N/S)
Combined Impact	ko_breakfast	Weekend Off-Peak	0.39 (N/S)	-0.57 (N/S)
Combined Impact	open_house	On-Peak	-0.7313	-0.60
Combined Impact	open_house	Mid-Peak	-0.6146	-0.63
Combined Impact	open_house	Off-Peak	-1.0849	-0.67 (N/S)
Combined Impact	open_house	Weekend Off-Peak	-2.3105	-1.24 (N/S)
Combined Impact	picnic	On-Peak	-0.24 (N/S)	-0.08 (N/S)
Combined Impact	picnic	Mid-Peak	-0.31 (N/S)	-0.03 (N/S)
Combined Impact	picnic	Off-Peak	0.2 (N/S)	2.7 (N/S)
Combined Impact	picnic	Weekend Off-Peak	0.13 (N/S)	2.61 (N/S)
Incremental	focus_grp	On-Peak	-0.7450	-0.42 (N/S)
Incremental	focus_grp	Mid-Peak	-0.29 (N/S)	-0.33 (N/S)
Incremental	focus_grp	Off-Peak	0.03 (N/S)	-0.28 (N/S)
Incremental	focus_grp	Weekend Off-Peak	-1.25 (N/S)	-0.24 (N/S)
Incremental	ko_breakfast	On-Peak	0.18 (N/S)	-0.27
Incremental	ko_breakfast	Mid-Peak	0.01 (N/S)	-0.24
Incremental	ko_breakfast	Off-Peak	-0.08 (N/S)	-0.04 (N/S)

Impact Type	Event Type	TOU Period	RT-Only kWh Impact	CPP Groups kWh Impact
Incremental	ko_breakfast	Weekend Off-Peak	0.17 (N/S)	-0.69 (N/S)
Incremental	open_house	On-Peak	-0.5912	-0.4 (N/S)
Incremental	open_house	Mid-Peak	-0.6112	-0.54
Incremental	open_house	Off-Peak	-1.3192	-0.94
Incremental	open_house	Weekend Off-Peak	-2.5327	-1.35
Incremental	picnic	On-Peak	-0.1 (N/S)	0.13 (N/S)
Incremental	picnic	Mid-Peak	-0.3 (N/S)	0.06 (N/S)
Incremental	picnic	Off-Peak	-0.03 (N/S)	2.43 (N/S)
Incremental	picnic	Weekend Off-Peak	-0.09 (N/S)	2.5 (N/S)

Key observations from the summer analysis include:

1. **Event attendance effects in the CPP participant's Base Impact is statistically non-significant.** Specifically, the estimated Mid-Peak impact in the core analysis for CPP participants was a reduction of 0.17 kWh per day that was statistically significant.[5] After introducing these new variables for event attendance the "base impact" is not statistically significant.[6] This suggests that contributions to Mid-Peak reductions are coming principally from participants that attend one or more events.

2. **Estimated incremental impacts from event attendance are statistically significant with the expected sign.** In every case, the estimated impact of attending an event (when it is statistically significant) is that it results in *more* energy savings. This is encouraging, in that it suggests that even when the attribution of impacts is highly uncertain (due to questions of spurious correlation due to selection bias), there is unequivocally a correlation between participant engagement and estimated savings.

3. **Statistically significant impacts of kick-off breakfast and focus group attendance may reflect the effects of selection bias as much as motivational or educational impacts from those interventions.** As noted above, attendance to these two types of events in the summer period is a purely cross-sectional distinction: the two groups don't change over the course of the summer period of analysis. This makes it quite possible that the estimated impacts simply reveal that the most enthusiastic pilot participants both are more likely to save more energy *and* to want to attend the events.

4. **The type of event with the most consistent statistically significant impact on consumption was the open houses.** The estimated impacts in all TOU periods of event attendance are statistically significant in every case except for the On-Peak period for CPP participants. The CPP On-Peak incremental impact is only just barely statistically insignificant (relative precision of +/- 109%).

   Furthermore, given the gradual and on-going nature of these events (which effectively allows attendees pre-attendance consumption to act as another control), these impacts are more likely to be the result engagement interventions than is the case for the other event types. That is, although there is doubtless some component of these estimated impact that is spurious (as a result of selection bias – the most enthusiastic participants being more likely to seek out help), it is likely a smaller component of the impact than in cases where event attendance is purely cross-sectional.

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[5] Although highly uncertain, with a relative precision of +/- 90% at the 90% confidence level.
[6] With a relative precision of +/- 183% at the 90% confidence level.

Figure 3-2, below, provides the estimated impacts of event attendance in the six months of the winter.

Key observations from the summer analysis include:

1. **As in the core analysis, none of the base impacts are statistically significant.** There appears to be no statistically significant impact on energy consumption during the winter.

2. **Aside from incremental impacts associated with open house attendance, the only statistically significant incremental impacts of event attendance appear likely to be spurious effects due to selection bias.** For the RT-only participants only the incremental impact on On-Peak consumption related to attendance to the "Picnic in the Park" event is statistically significant. For CPP participants, the open house (Mid-Peak only), the focus group (Off-Peak weekdays only) and the "Picnic in the Park" (On-Peak and Mid-Peak) events appear to have any statistically significant impact.

   a. Only three CPP participants attended the (summer) picnic event. These estimated impacts are likely spurious, capturing the correlation between individual participant enthusiasm, attempts to reduce consumption, and attendance at London Hydro events.

   b. The incremental impact associated with attending open houses may be due to information or encouragement obtained at that event, although selection bias is likely to be a factor as well. An additional seven CPP participants (incremental to the summer) attended winter open houses, so there is not nearly as much intra-period variation in the summer. It is also peculiar that these participants realized their incremental reductions in energy use during the winter mid-day Mid-Peak, rather than the On-Peak period. Not only is the On-Peak period more expensive, but CPP events in the winter are more likely to occur during the On-Peak period.

Figure 3-2: Energy Impacts, Winter

Impact Type	Event Type	TOU Period	RT-Only kWh Impact	CPP Groups kWh Impact
Base Impact	no_event	On-Peak	-0.09 (N/S)	-0.08 (N/S)
Base Impact	no_event	Mid-Peak	-0.04 (N/S)	0.1 (N/S)
Base Impact	no_event	Off-Peak	-0.09 (N/S)	0.19 (N/S)
Base Impact	no_event	Weekend Off-Peak	0.12 (N/S)	0.53 (N/S)
Combined Impact	focus_grp	On-Peak	-0.09 (N/S)	-0.51
Combined Impact	focus_grp	Mid-Peak	-0.31 (N/S)	-0.32 (N/S)
Combined Impact	focus_grp	Off-Peak	0.28 (N/S)	-0.75 (N/S)
Combined Impact	focus_grp	Weekend Off-Peak	0.61 (N/S)	-1.25 (N/S)
Combined Impact	ko_breakfast	On-Peak	0.11 (N/S)	-0.05 (N/S)
Combined Impact	ko_breakfast	Mid-Peak	0.08 (N/S)	0.02 (N/S)
Combined Impact	ko_breakfast	Off-Peak	0.16 (N/S)	0.42 (N/S)
Combined Impact	ko_breakfast	Weekend Off-Peak	0.91 (N/S)	0.53 (N/S)
Combined Impact	open_house	On-Peak	-0.03 (N/S)	-0.19 (N/S)
Combined Impact	open_house	Mid-Peak	-0.08 (N/S)	-0.23 (N/S)
Combined Impact	open_house	Off-Peak	-0.09 (N/S)	-0.13 (N/S)
Combined Impact	open_house	Weekend Off-Peak	0.16 (N/S)	-0.22 (N/S)

Impact Type	Event Type	TOU Period	RT-Only kWh Impact	CPP Groups kWh Impact
Combined Impact	picnic	On-Peak	-0.5385	-0.78
Combined Impact	picnic	Mid-Peak	-0.24 (N/S)	-1.24
Combined Impact	picnic	Off-Peak	-0.28 (N/S)	0.96 (N/S)
Combined Impact	picnic	Weekend Off-Peak	-0.99 (N/S)	-0.5 (N/S)
Incremental	focus_grp	On-Peak	-0.01 (N/S)	-0.43 (N/S)
Incremental	focus_grp	Mid-Peak	-0.27 (N/S)	-0.42 (N/S)
Incremental	focus_grp	Off-Peak	0.37 (N/S)	-0.94
Incremental	focus_grp	Weekend Off-Peak	0.49 (N/S)	-1.78 (N/S)
Incremental	ko_breakfast	On-Peak	0.2 (N/S)	0.03 (N/S)
Incremental	ko_breakfast	Mid-Peak	0.12 (N/S)	-0.08 (N/S)
Incremental	ko_breakfast	Off-Peak	0.25 (N/S)	0.22 (N/S)
Incremental	ko_breakfast	Weekend Off-Peak	0.79 (N/S)	0 (N/S)
Incremental	open_house	On-Peak	0.05 (N/S)	-0.11 (N/S)
Incremental	open_house	Mid-Peak	-0.04 (N/S)	-0.32
Incremental	open_house	Off-Peak	0 (N/S)	-0.32 (N/S)
Incremental	open_house	Weekend Off-Peak	0.04 (N/S)	-0.75 (N/S)
Incremental	picnic	On-Peak	-0.4533	-0.70
Incremental	picnic	Mid-Peak	-0.2 (N/S)	-1.34
Incremental	picnic	Off-Peak	-0.19 (N/S)	0.77 (N/S)
Incremental	picnic	Weekend Off-Peak	-1.11 (N/S)	-1.02

3.2 Open House Attendance, Disconnections, and Reasons for Attending

This portion of the extended analysis has two components.

1. Comparison of Average Number of Disconnections.
2. Assessment of Reasons for Attending Open House

3.2.1 Comparison of Average Number of Disconnections

On average, the participants that had attended an event at some point were much less likely to have been disconnected for any given event. As may be seen in Figure 3-3, below, while the average CPP participant in the summer and winter months experienced 3.5 disconnections, participants that attended an open house in the summer were subject to on average only 1.8 disconnections in that season, whereas participants that had attended an open house in either the winter or the summer were subject to an average of only 2.4 disconnections in the winter.

The differences between these averages is statistically significant at the 99% confidence level.

Figure 3-3: Average Number of Disconnections Per Season

Season	All Participants	Open House Attendees
Summer	3.5	1.8
Winter	3.5	2.4

What this indicates is that there is (as might be expected) a statistically significant correlation between attending an open house and a reduced number of disconnections.

3.2.2 Assessment of Reasons for Attending Open House

As noted above, the data with the specific details of each open house visit appears to suffer from some data entry problems, with numerous participants whose account number indicates that they are from the RT-only group visiting the open house to help resolve smart plug issues (smart plugs were not provided to RT-only participants).

While this somewhat reduces the usefulness of these data, it does not eliminate – an examination of the distribution for reasons for visiting the open house is very revealing, see Figure 3-4 below. Note that each individual could visit for multiple reasons, so the sum of the percentages in the table below will exceed 100%.

Figure 3-4: Distribution of Reasons for Visiting Open House

Issue Type	% of Attendees
Connection Issue	46%
Comprehension/Education Issue	38%
Download/Login/Basic IT Help	26%
Offering Feedback	15%

The most common reason for attending an open house was to resolve a connection issue, with nearly half of those that attended the open houses requiring help in resolving real or perceived issues with their smart plugs or other devices.

The next most important value in this list is not the 38% that had questions about the pilot ("Comprehension/Education Issue"), but rather the quarter of open house attendees that needed the assistance of London Hydro staff to complete the most basic of program actions: installing the Trickl app, logging in to that app or the My London Hydro portal, re-setting their password, etc. It seems highly likely that without this assistance, these participants – whose very need for that assistance indicates that they are very challenged by the use of these technologies – may very well have simply stopped trying to engage. If these participants required hands-on assistance for such basic tasks such as retrieving a password or installing an app, it is extremely unlikely that they would have been able to solve these issues themselves by consulting online FAQs, and might have become too frustrated with over-the-phone support to pursue the issue.

Given the quite substantial (compared to the base impact) incremental average impact delivered by open house attendees, it seems that very basic, in-person technical assistance to price-motivated participants may be very important for ensuring the success of price-response.

4. OPEN HOUSE ATTENDANCE IMPACT ON CPP DEMAND RESPONSE

In neither winter nor summer, after controlling for disconnections, did event attendance have a statistically significant impact on CPP demand response.

4.1 Summer Impacts

The parameters associated with all impact variables interacted with the open-house attendance dummy do test as jointly statistically significant. The F-statistic is 5.757 and the associated p-value is less than 0.00000001. This is expected when considering that:

- Open house attendance has a statistically significant impact on energy consumption in both the On-Peak and Mid-Peak periods (see Figure 3-1 above, in this appendix). These daily energy impacts are captured in Equation 3 by the ρ_1^h and ρ_2^h parameters, and the daily energy impact of the interaction with open house attendance (identified in Figure 3-1) is also captured in two new parameters.

- Open house attendance has a statistically significant impact on participant disconnection rates. This was demonstrated in section 3.2.

When the joint statistical significance is tested only of the parameters associated with demand response to the event itself (i.e., the analogues to γ_1 through γ_4 that reflect the new variables that interact event dummy variables and connectivity dummy variables with event attendance dummy variables), the joint effect ceases to be statistically significant. The F-statistic associated with these four restrictions is 0.2883 and delivers a p-value of 0.8858.

From this, Navigant feels it is reasonable to conclude that while open-house attendance appears to be correlated with daily energy response, it does not appear to contribute to event-period demand response impacts in the summer, except for inasmuch as it results in a reduced disconnection rate among participants.

4.2 Winter Impacts

In the case of the winter effects, all event attendance interactions are jointly non-significant, with an F-statistic value of 1.031 and a p-value of 0.4. This is consistent with the finding presented in 3.1, above, that open-house attendance had no incremental impact on winter energy savings and also matches the finding in the main body of the report that the absolute differential between connected and disconnected impacts is much smaller in the winter than in the summer.

From this Navigant has concluded that open-house event attendance does not appear to have any meaningful impact on event-period demand response impacts in the winter.