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September 3, 2015

VIA RESS, EMAIL and COURIER

Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street
Suite 2700
Toronto, ON M4P 1E4

Dear Ms. Walli,

Re: Enbridge Gas Distribution Inc. (the "Company" or "Enbridge")
Ontario Energy Board (the "Board") File: EB-2015-0049
Multi-Year Demand Side Management Plan (2015 to 2020)
Undertaking Responses

Enclosed please find the following undertaking responses:

- Exhibit J5.6;
- Exhibits J6.2, 6.5, and 6.11;
- Exhibits J7.3 to 7.6;
- Exhibits J8.3, 8.4, 8.11, 8.12, 8.14, 8.16, and 8.17; and
- Exhibits J9.1 to 9.4, 9.6, 9.7 and 9.10.

The submission has been filed through the Board's Regulatory Electronic Submission System ("RESS") and will be available on the Company's website under the "Other Regulatory Proceedings" tab at www.enbridgegas.com/ratecase.

If you require further information, please contact the undersigned.

Yours truly,

(Original Signed)

Bonnie Jean Adams
Regulatory Coordinator

Encl.

cc: Mr. Dennis O'Leary, Aird &Berlis
EB-2015-0049 Intervenors

UNDERTAKING J5.6

UNDERTAKING

TR, page 116

Enbridge to illustrate how the DSMCEIDA account would operate in 2015/2016, using EP scenarios.

RESPONSE

This undertaking refers to the following request by Energy Probe Research Foundation, provided in writing to the Company:

> "We would like to understand better how the DSMEIDA works for EGDI RA programs in 2015 and 2016. Let's look at the 2015 and 2016 RA targets for convenience. We can look at JT 1.36. Attachment Update 2016 Tab 2 (pg 4 of compendium). The 2015 RA 100% target is 1011.9 CCM and the budget is $16.64M.
>
> Question A) Now as to 2015 budget, confirm the DSMVA is available and tell us how that would affect achievement of the 2015 target.
>
> Question B) Let's postulate that there are three possible scenarios regarding achieving the 2015 RA target. The RA target is achieved and the budget to do this was the $16.6M plus 15% from the DSMVA or approximately $4.5M for a total $19.1M. The RA target is achieved and the budget to do this was the $16.6M including $3.5M from the DSMVA or approximately $18.1M in total. If the 2015 RA target was not achieved therefore there is no opening amount to go into the 2016."

Question A

Enbridge confirms that the DSMVA would be accessible provided that the Company reached 100% of its Resource Acquisition weighted scorecard target. The purpose of the DSMVA is to enable the Company to continue its pursuit of results in successful programs.

Witnesses: M. Lister
F. Oliver-Glasford
B. Ott

Question B

Scenario 1: The RA target is achieved and the budget to do this was the $16.6M plus 15% from the DSMVA or approximately $4.5M for a total $19.1M.

> In this scenario, given that the budget was used in its entirety, no funds would be deferred to the next year via the DSMCEIDA from the Resource Acquisition budget.

Scenario 2: The RA target is achieved and the budget to do this was the $16.6M including $3.5M from the DSMVA or approximately $18.1M in total.

> Similarly to Scenario 1, given that the budget was used in its entirety, no funds would be deferred to the next year via the DSMCEIDA from the Resource Acquisition budget.

Scenario 3: The 2015 RA target was not achieved therefore there is no opening amount to go into the 2016.

> Since the Resource Acquisition weighted scorecard target was not achieved, the Company would not be permitted to carry forward funds from the Resource Acquisition budget to the following year via the DSMCEIDA.

Witnesses: M. Lister
F. Oliver-Glasford
B. Ott

UNDERTAKING J6.2

UNDERTAKING

TR, page 52

Enbridge to advise if there is anything that isn't within scope of the midterm review that should be approved now for the six-year period.

RESPONSE

In Enbridge's view, it would be appropriate for the following areas to be approved to 2020, and not subject to the mid-term review:

- The spectrum of customers that DSM should serve: The mid-term review should not be required to re-address which customers or rate classes should or should not receive DSM programming and its associated costs.

- The details of approved offers: Offers approved in this proceeding will be subject to process evaluations and ongoing improvement as part of regular DSM business processes and should not be re-scrutinized in detail as part of the mid-term review.

- Key framework elements such as payback screening criteria or the use of target adjustment factors: Barring unforeseen developments prior to the mid-term review these matters appear to have generated ample debate in this proceeding.

- The scorecard design and metrics: the mid-term review should not re-open a debate on whether or how to establish a balanced scorecard. The Board has already asked for a balanced scorecard as part of its Framework direction.

Witnesses: F. Oliver-Glasford
B. Ott

UNDERTAKING J6.5

UNDERTAKING

TR, page 69

Enbridge to respond to Mr. Neme's recommendations.

RESPONSE

Please see below Enbridge's responses to Chris Neme's recommendations.

Enbridge's Responses to Chris Neme Recommendations

Recommendations	Commentary
1. Given the information now available on the scale of the rate reducing impacts of T&D avoided costs, commodity price suppression, reduced purchases of relatively expensive gas and emission reduction cost avoidance, the Board should eliminate the budget caps included in its earlier guidelines and thereby enable greater savings without undue rate impacts for DSM non-participants. This would accord with Government policy, including recent greenhouse gas policy announcements, and lead to an improved economic outcome.	Enbridge does not agree that there is adequate evidence of any material issue that would require the elimination of budget caps within the Framework, or planning process at this time. Upcoming milestones, such as the IRP Study and more detail on the Province's carbon pricing regulations, should adequately inform budget guidance for the mid-term review.
2. Require future utility filings to include analysis of the combined effects of DSM spending and the rate reducing effects discussed above.	Enbridge agrees that at the time when there are certain and quantified rate reducing effects of DSM, it will be appropriate to include analysis of combined effects of DSM spending and rate reducing effects in future filings.

Witness: M. Lister
F. Oliver-Glasford
B. Ott
R. Sigurdson

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
3. Require future DSM Plan filings to include analyses of the size of eligible markets for all proposed measures and programs. This will facilitate evaluation of the proposals and facilitate subsequent evaluation of performance as well. This could be required as added information in the Technical Resource Manual (TRM) for each measure.	Enbridge is of the view that the TRM should be a standalone compilation of viable measures. Information such as 'size of eligible markets' is useful and to the degree that it can be captured with relative confidence, should be done as a separate activity, or perhaps within a potential study for example, to inform program design and future DSM filings. Direction to determine these values would require the utilities to propose budgets to commission specific research toward this end.
4. Given the timing of this proceeding, approve the utilities' budgets and targets for 2015 unless information put before the Board by other parties suggests significant problems in the way they were developed. However Union should report its 2015 results using the Board's Framework cost-effectiveness policy – that is including the 15% non-energy benefits adder in the TRC test and a 4% discount rate.	Enbridge is in agreement that 2015 budgets, inclusive of the Incremental Budget, and targets should be approved, as they are directly responsive to the Board's direction in Section 15.1 of the DSM Framework.
5. Given the timing of this proceeding and the fact that that the utilities are planning to significantly ramp up their DSM efforts, approve the utilities' proposed 2016 budgets and targets except as follows:	

Witness: M. Lister
F. Oliver-Glasford
B. Ott
R. Sigurdson

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
a. Require that Union continue to deliver its Large Volume program for the T2/R100 customers. i. The program budget for 2015 can be carried forward with a similar approach to setting the target as in previous years. This budget would be in addition to the budget Union has proposed for other customer classes for 2016. ii. The available shareholder incentive will need to be reallocated among the scorecards as a result of the addition of the budget for Large Volume T2/R100 program. iii. Consider allowing the self-direct funds to be spent over a multi-year period. This provides customers greater flexibility to plan large projects and should enable larger savings. iv. Preclude O&M projects with a payback of less than 1.5 or 2 years to reduce free ridership. v. Consider adopting the innovation that if customers can demonstrate funds for a 3 year period.	Enbridge takes no position on Mr. Neme's recommendations specific to Union Gas.
b. Adjust the utilities' proposed 2016 performance metrics as follows: i. Place a limit on the amount that any performance metric can contribute to the score computed for a scorecard. The limit should be equal to 150% of the weight of the metric. ii. Consider increasing Enbridge's small volume customer CCM target if the Company cannot adequately explain why its small business direct install program is forecast to cost more than other gas utilities' programs. iii. Increase Enbridge's low income single family target by 10%. iv. Remove all metrics associated with Enbridge's Home Health Reports, School Energy Competition, Run it Right, Comprehensive Energy Management and New Construction Commissioning programs from the Company's Market Transformation scorecard. The weight of the other metrics can be increased proportionally to account for those removals. v. Increase Enbridge's home ratings metric to 1000 homes.	i. Enbridge supports the current weighted scorecard methodology, and how multiple metrics included in individual scorecards interact within that scorecard. This approach provides benefits for participants in that it ensures successful programs continue to be aggressively pursued. Conversely, this approach ensures that all metrics are pursued, lest one poor performing metric negatively affect the overall scorecard weight. Lastly, weighted scorecards also allow Enbridge the ability to optimize spending thereby achieving the best value for ratepayers. ii. Enbridge supports its currently filed Resource Acquisition targets and the budgets that support them. However, the

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
vi. Consider whether to increase Union's Resource Acquisition CCM metric based on additional information provided in the hearing. vii. Increase Union's 2015 low income performance metrics by 50% unless additional evidence supporting lower values is presented in the hearing. viii. Eliminate Union's performance-based scorecard. The programs proposed for that scorecard can still be funded and run.	Company recognizes that it may have been conservative in estimating targets for its small business direct install offer, given that this is a new and untested offer within its portfolio, without the historical context upon which to build challenging yet achievable targets with a great degree of certainty. iii. Enbridge finds the approach it has taken in determining targets and budgets for Low income is appropriate, and lacking any compelling evidence to the contrary, believes they should remain unchanged. Enbridge also notes an additional $500,000 in the current budget for furnace replacement that was not included in previous budgets. This may account for Mr. Neme's perceived discrepancy. iv. Enbridge disagrees with Mr. Neme's recommendation to remove the noted MTEM metrics. The offers identified and their associated metrics are important to drive utility focus in pursuit of the Board's guiding principles and key priorities. v. Enbridge feels that its targets are adequately set based on the reduction in budget for this offer from 2015 to 2016. vi. to viii. N/A

Witness: M. Lister
F. Oliver-Glasford
B. Ott
R. Sigurdson

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
6. For 2017 the Board should establish an increased expected budget level for both utilities and require the LDCs to consult and file supplemental DSM plans during 2016, as was done a few years ago to accommodate additional low income spending. With the budget level established, the most contentious issue would be resolved and the utilities may well be able to present Plans that would enjoy a high level of support. I would recommend 2017 budgets be 30-40% higher than those in 2016 as a manageable ramp up.	Enbridge feels that the Board has already identified a logical time at which to address Mr. Neme's recommendation; the mid-term review. Enbridge further notes that the mid-term review must be completed by June 1st, 2018, which does not preclude the Board from initiating said review in time to inform the 2018 DSM year. The Minister's Directive presumably among other things sought to create some certainty and stability in conservation activities for utilities and the market. Asking for separate and different treatment in 2017 appears to work against that direction, and is further unnecessary given the flexibility of the mid-term review.
7. For the mid-term review (to address plans for 2018 to 2020) the Board should make clear that growing budgets and targets in pursuit of cost-effective savings are expected and require 3 year Plans to be filed in early 2017 to allow for an adequate review period before the year begins. The Board should articulate that its default expectation is that the utilities proposed savings levels will be at least as high as the top several gas DSM jurisdictions in North America. Deviations from that expectation will need to be justified through demonstration that the savings levels are not cost-effective, cannot be achieved, and/or produce undue rate impacts (after consideration of the rate mitigating factors discussed above). The Board may also want to consider whether the maximum shareholder incentive level should be increased if budgets, savings and levels of effort increase considerably in the 2018-2020 period.	Enbridge is supportive of filing plans early in 2017 to ensure decisions are received by the Board on an approved 2018 Plan in advance of the start of the 2018 year for optimization in operations. Enbridge does not support arbitrarily accepting targets set in other jurisdictions with related budget implications, given the individual jurisdictional idiosyncrasies at play (building codes, technology baselines, regulatory frameworks, avoided costs, market characteristics). Enbridge proposes targets based on its understanding of conditions in Ontario, and specifically its service territory, and continues to support the appropriateness of the plan targets.

Witness: M. Lister
F. Oliver-Glasford
B. Ott
R. Sigurdson

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
	Enbridge does agree with Mr. Neme, that meaningful increases in the level of effort required to deliver DSM (i.e. significantly larger budgets) should warrant additional incentives.
8. Regarding EM&V and oversight, continue the operation of the TEC and Audit Committees with the involvement of Board Staff. The committees should function as in the past but with two refinements (in addition to regular involvement of Board Staff): a. turn over the hiring of CPSV evaluators of the custom projects to the Auditor rather than the utilities, and b. reform the TEC decision-making process so that decisions can be made and work can proceed if consensus is not possible.	This recommendation is now addressed by the Board's recent issuance of the updated Evaluation process. Enbridge agrees however, that the Evaluation and Audit Committee will need to have decision-making processes that allow work to proceed should a consensus not be possible.

Enbridge's Responses to Chris Neme Recommendations	
Recommendations	**Commentary**
9. Regarding the integration of DSM into infrastructure planning: a. Accept Enbridge's proposed study scope of work and transition plan with the following modifications: i. make the development of hourly peak day load shapes for each major efficiency measure the first task and deliverable of the study ii. case studies for the study should be selected through a structured process as I outline in my evidence iii. ensure that at least one case study is launched as a pilot project in the field before the end of 2016 to enhance its transition plan. b. Reject Union's efforts in this area and instruct it to work with Enbridge on its study. c. Require Union to adopt the same transition plan as Enbridge, including the launch of a pilot infrastructure deferral project within before the end of 2016. d. Instruct both utilities to work with interested stakeholders on their studies and the development of pilot projects. e. Establish penalties that utilities will face if they do not abide by the Board's previous order to consider DSM as an alternative to infrastructure investments in all future leave to construct projects.	Enbridge has been proactive and responsive to the Board's direction around Integrated Resource Planning. On this basis, Enbridge submits that the Board should support and encourage its proactivity with positive signals, rather than impose unnecessary penalties.

Witness: M. Lister
F. Oliver-Glasford
B. Ott
R. Sigurdson

UNDERTAKING J6.11

UNDERTAKING

TR, page 172

Enbridge to provide a response to member Frank's series of questions on on-bill financing.

RESPONSE

At page 171 of Volume 6 of the transcript Member Frank asked eight questions of the panel concerning on-bill financing that are referenced in the preamble to this undertaking.

These questions were as follows:

1. What was the purpose of the on-bill financing that Enbridge did originally?

Prior to 2000 Enbridge, formerly operating as the Consumers Gas Company, ran a large scale water heater rental program and a retail business that sold and serviced natural gas heating equipment and appliances and complementary non-gas equipment, for example refrigerators and dishwashers to complement gas ranges or central air conditioning to complement natural gas furnaces. The main intent of these services was to foster load growth. In the years leading up to 2000 this business was expanded to include some home renovations, primarily replacement doors, windows, insulation and weather stripping, which were DSM related. The Company offered on-bill financing at that time as a convenient means by which customers could pay for any of these products and services. These businesses were operated within Enbridge as either ancillary lines of business within the utility or, in the case of the on-bill financing "Merchandise Finance Plan", as a non-utility function.

2. Why did Enbridge do it?

The Company offered on-bill financing at that time as a convenient means by which customers could pay for any of the above noted products and services. The Merchandise Finance Plan also contributed to the Company's earnings. Enbridge Services Inc. acquired the Enbridge water heater rental, appliance sales, HVAC sales, HVAC and appliance services businesses and Merchandise Finance Plan from Enbridge Gas Distribution Inc. in 2000. This business was subsequently acquired by Direct Energy in 2002. From 2000 until 2006 the Company shared its bill first with

Enbridge Services Inc. and later in 2002 with Direct Energy. The exclusive billing arrangement with Direct Energy was called into question in EB-2005-0001 / EB-2005-0437. The Board ultimately ruled that as part of the Company's 2007 rate case Enbridge must either come forward with a complete proposal regarding third party access to the Enbridge Bill or set out how it intends to ensure that its billing was separate from that of Direct Energy (EB-2005-0001/EB-2005-0437 Decision with Reasons dated February 9, 2006, p. 67). The Company responded to this directive in its 2007 rates application EB-2006-0034 with a comprehensive Open Bill Access ("OBA") proposal. This proposal was negotiated, settled, and accepted by the Board in this proceeding. OBA has since been the subject of four consultative processes (2009, 2012, 2013 and 2014). The Company continues to offer this service for three main reasons:

(i) customer convenience associated with being able to make monthly payments for energy related products and services;
(ii) an annual ratepayer benefit on the order of $5.4 million per year, and;
(iii) the opportunity to enhance earnings based on the OBA earnings sharing mechanism approved by the Board.

3. Was on-bill financing DSM-related?

From the mid-1980s until the Company divested itself of these businesses in 2000, customers could acquire home renovations. These renovations were primarily, though not necessarily, conservation related. Some examples include; HVAC equipment, replacement doors and windows, insulation and weather stripping. Customers were provided with the option of paying for these products under conditional sales contracts. The recurring monthly charges associated with these contracts where conveyed to the customers by way of their monthly Enbridge gas bill.

4. What kind of participation did on-bill financing change?

The Company has been unable to locate customer participation data prior to 2000 and does not keep statistics on the types of charges billed to customers by third parties through its current OBA program. The vast majority of charges billed are paid by customers to third parties in respect of rental hot water heating equipment. The Company is however aware, that approximately six of its OBA clients are currently using the OBA service to bill and recover finance charges related to the sale or leasing of replacement HVAC equipment.

Witnesses: S. McGill
J. Paris

5. Did Enbridge have a lot of customers participating in the on-bill financing program?

Based on the best information the Company has been able to find at this time it appears that there were approximately 38,000 customers that were receiving Merchandise Finance Plan charges on their bill in 1999, the last year the Company operated the program.

6. What was the cost to deliver on-bill financing?

The allocated and direct unit costs and forecasted unit revenues associated with the Company's current OBA Program are subject of the EB-2013-0099 Open Bill Access Settlement Agreement and are set-out in the table below. While these figures help to articulate some of the costs of administering charges on Enbridge's bills to customers, they do not offer insight into the cost to design or operate an on-bill financing program specific to DSM. Further, where the costs of the OBA program are essentially borne by third party billers as part of their business operations, it is not clear that an on-bill financing arrangement for DSM would encompass a similar cost recovery arrangement.

Open Bill Unit Costs & Fees

	2011/ 2012[2]	EB-2011-0354 2013	Proposed 2014	Proposed 2015	Proposed 2016	Proposed 2017	Proposed 2018
Cost per Shared Bill	$0.5112	$0.6052	$0.6043	$0.6133	$0.6334	$0.6563	$0.7195
Cost per Standalone Bill	$1.3454	$1.5052	$1.5410	$1.5891	$1.6484	$1.7113	$1.8186
Fee per Shared Bill[1]	$0.9000	$0.9410	$0.9590	$0.9755	$0.9924	$1.0095	$1.0268
Fee per Standalone Bill[1]	$2.0980	$2.1570	$2.1980	$2.2357	$2.2743	$2.3135	$2.3533

Notes:

-1) OBA Fees for 2012 are governed by the terms of the OBA Service Agreement (EB-2009-0043 Settlement Agreement)
-2) OBA Fees for 2013 are governed by the terms of the OBA Service Agreement (EB-2011-0354 Settlement Agreement)

7. Were there any challenges?

There have been numerous challenges faced and addressed by the Company in its transition from a bundled utility prior to 2000 to a gas distribution utility as it is today. The Company has been successful in meeting the technical, financial, consumer protection, competitive, and regulatory challenges it has faced since the first Open Bill regulatory settlement agreement in 2007. The program is now governed under the terms of the EB-2013-0099 Settlement Agreement that was approved by the Board on September 23, 2013. To be clear, there may be other challenges, either conceived of

or not at present by the Company, related to an on-bill and/or financing program specifically related to DSM activity.

8. Were there any lessons that we could learn from doing on-bill financing?

There are many lessons that can be taken from Enbridge's experience in the development the Company's current OBA program that would likely be applicable to the offering of an on-bill financing program in conjunction with utility DSM activities. Certainly one important lesson is that the interests of the competitive market must be respected. The reason Enbridge's current third party billing service is named "Open Bill Access" is because it is open to essentially all vendors offering energy related services operating within the Company's service area. There are no restrictions on the number of bills to be issued by the Company on behalf of a billing client, all billing clients are subject to the same contractual terms and conditions, and all billing clients pay the same unit rates for the use of the service regardless of their size. This openness was critical to reaching the settlement agreements with interested parties that were all subsequently approved by the Board. From a financial and technical standpoint the Company has worked its way through numerous challenges and this experience is available to inform any DSM related on-bill financing program that may be developed. Lastly, to the degree that any DSM related on-bill financing arrangement resembled or incorporated the Company's current OBA service, the time and associated cost to implement such an arrangement may be reduced relative to a different approach or design.

UNDERTAKING J7.3

UNDERTAKING

TR, page 145

Enbridge to provide its comments on the avoided carbon cost analysis provided in L.GEC.1, Table 3 of Mr. Neme's evidence, and in doing so put that into context of the synapse report in the forecast, and into the context of Enbridge's calculation in its exhibit k5.1

RESPONSE

The Company notes that Mr. Neme's analysis assumes a cost of carbon starting at $20USD/ton of C02, which equates to just under $29CAD/tonne. Enbridge believes a more appropriate analysis would consider the actual average price currently paid for emission allowances in 2018 in the Western Climate Initiative cap and trade system. GEC provided this price in Exhibit K1.2, page 20 as $15.22CAD/tonne, though Enbridge understands that these prices can fluctuate regularly.

As a general comment, Enbridge notes that the details, timing, and pricing of Ontario's pending cap and trade system remain unknown. ,It is the Company's view that these matters must become clearer before their bill impacts can be known and fully incorporated into decision-making processes. Enbridge expects that this will be possible during the mid-term review.

Witnesses: F. Oliver-Glasford
B. Ott

UNDERTAKING J7.4

UNDERTAKING

TR, page 149

Enbridge to comment on the order of magnitude re: the differential between the avoided cost and average commodity cost for the three load shapes that are listed.

RESPONSE

Enbridge would like to clarify that for the purposes of avoided gas costs used in screening DSM activities, SENDOUT does incorporate the concept of marginal and average cost of gas for each of the load shapes as part of the optimization process.

Although this is a concept that Enbridge has not typically analyzed in isolation, and does not necessarily endorse at this time, the following analysis has been undertaken to illustratively respond to what has been requested of Enbridge in this undertaking. Specifically, the Company has sought to show the order of magnitude difference between the average and marginal costs of gas. Toward this end, Enbridge has examined the difference between the average cost per m^3 of the Base Case with each of the average cost per m^3 for the four decrements using the SENDOUT analysis results from EB-2012-0394 Exhibit B, Tab 2, Schedule 2, page 7, Table 1. This examination estimated the average cost for the four decrements being approximately $0.01 per m^3 less than the average cost for the Base Case on a present value basis assuming a discount rate of 4% and a term of 16 years commencing in 2012 which is 10 times less than what is reported by GEC in Table 3 of Exhibit L.GEC.1. As Enbridge understands it, the present value is calculated in a manner that is consistent with the calculation provided by GEC in Exhibit M.GEC.EP.12, Attachment D.

Enbridge is unable to confirm the assumptions and calculations located in Row 3 of Table 3 on page 18 of Exhibit I.GEC.1 and as a result cannot comment on GEC's figures.

Witnesses: F. Oliver-Glasford
A. Welburn

UNDERTAKING J7.5

UNDERTAKING

TR, page 176

Enbridge to provide a bibliography related to the program

RESPONSE

For clarity, the undertaking that was given was to provide an index or bibliography of independent evaluations that have tested, measured, verified, and approved results for offerings like Enbridge's proposed My Home Health Record ("Opower").

Attached is an index of independent evaluations of Opower's Home Energy Report programs across North America. The index provides summary information such as jurisdiction, result, and contact information for each of the independent evaluation. All of the reports are available on Opower's website.

Witnesses: S. Bertuzzi
M. Lister

Opower Home Energy Report Program Independent Evaluations

1. Klos, Mary, September 2009. "Impact Evaluation of OPOWER SMUD Pilot Study." *Summit Blue Consulting, LLC*.

   - *Utility, State, Fuel:* Sacramento Municipal Utility Department, CA, Electric
   - *Results:* Summit Blue (d/b/a Navigant) verified an average of 2.2% savings in the first year, as well as a bump to 2.8% average savings in the first four months of year two
   - *Contact:* Mary Klos, 608-807-0083, mklos@summitblue.com

2. Ayres, Ian, et al., September 2009. "Evidence From Two Large Field Experiments That Peer Comparison Feedback Can Reduce Residential Energy Usage." *NBER Working Paper*.

   - *Utility, State, Fuel:* Sacramento Municipal Utility Department & Puget Sound Energy, CA & WA, Electric & Gas
   - *Results:* There is evidence of a reduction in the early years of the program of 1.2% (natural gas) and 2.1% (electric) participants
   - *Contact:* 203-415-5587, ian.ayres@yale.edu

3. Allcott, Hunt, February 2010. "Social Norms and Energy Conservation." *Working Paper, Massachusetts Institute of Technology*'s *Center for Energy and Environmental Policy Research*.

   - *Utility, State, Fuel:* Connexus, MN, Electric
   - *Results*: Using data from a randomized natural field experiment at 80,000 treatment and control households in Minnesota, it is estimated that the monthly program reduces energy consumption by 2.3 – 2.4% relative to baseline
   - *Contact:* Hunt Allcott, allcott@mit.edu

4. Allcott, Hunt and Sendhil Mullainathan, March 2010. "Behavior and Energy Policy." *Science*, Vol. 327

   - *Utility, State, Fuel:* This article is a literature review
   - *Results:* Using randomized, controlled trials with hundreds of thousands of utility customers across the United States, these [OPOWER] reports have been shown to reduce electricity consumption in the average household by over 2%.
   - *Contact:* Hunt Allcott, allcott@mit.edu

5. Macke, Rich, June 2010. "Measurement and Verification Report of Lake Country's OPOWER Energy Efficiency Pilot Program." *Power System Engineering*.

   - *Utility, State, Fuel:* Lake Country Power, MN, Electric
   - *Results:* Average of 2.77% first-year savings with 99% statistical confidence
   - *Contact:* Rich Macke, 763-783-5349, macker@powersystem.org

6. Ivanov, Chris, July 2010. "Measurement and Verification Report of OPOWER Energy Efficiency Pilot Program." *Power System Engineering*.

   - *Utility, State, Fuel:* Connexus, MN, Electric
   - *Results:* With 99% confidence, the program demonstrated an average of 2.07% savings across three distinct approaches to measuring and verifying the results
   - *Contact:* Chris Ivanov, 608-268-3516, ivanovc@powersystem.org

7. October 2010. "Puget Sound Energy's Home Energy Reports Program." *KEMA*.

   - *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
   - *Results:* The savings rate of the most recent 12 months was significantly greater than for the first 12 months – improving from 1.87% to 2.28% average electric savings
   - *Contact: Bobbi Wilhelm, 425-462-3432, bobette.wilhelm@pse.com*

8. Gunn, Randy, December 2010. "Energy Efficiency / Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010), Evaluation Report: OPOWER Pilot." *Navigant Consulting.*

   - *Utility, State, Fuel:* Commonwealth Edison Company (ComEd), IL, Electric
   - *Results:* "Average annual savings was 1.54% for high energy users, and was 1.27% for low energy users."
   - *Contact:* Randy Gunn, 312-938-4242, randy.gunn@navigantconsulting.com

9. Cooney, Kevin, February 2011. "Evaluation Report: OPOWER SMUD Pilot Year 2." *Navigant Consulting*.

   - *Utility, State, Fuel:* Sacramento Municipal Utility Department, CA, Electric
   - *Results:* (i) 2.89% savings in the second year, 22% increase over first year; (ii) Highest savings—3.56% savings in July/August of 2009—occurred during peak season; and (iii) only signs of impact stability over the first 30 months of the program
   - *Contact:* Kevin Cooney, 312-583-5700

10. Davis, Matt, May 2011. "Behavior and Energy Savings: Evidence from a Series of Experimental Interventions." *Environmental Defense Fund.*

    - *Utility, State, Fuel:* Report verifies results from 11 different gas and electric utilities covering urban and suburban communities in 6 states in the Northeast, Midwest, and West. Specific utility names are not released for confidentiality purposes. Electric only.
    - *Results:* Reports have driven electricity savings ranging from 1.1-2.9% across the 11 deployments, and, if fully deployed in the US, OPOWER programs would lead to $3 billion in annual savings
    - *Contact:* Matt Davis, mdavis@edf.org

11. Dougherty, Anne, June 2011. "Massachusetts Cross-Cutting Behavioral Program Evaluation." *Navigant Consulting and Opinion Dynamics*.

    - *Utility, State, Fuel:* National Grid, MA, Electric
    - *Results:* 1.61% average savings, of which the majority came from actions that were taken outside other National Grid programs.
    - *Contact:* Anne Dougherty, 617-492-1400

12. Todd, Annika, Steven Schiller, and Charles Goldman, October 2011. "Analysis of PSE's Pilot Energy Conservation Project: "Home Energy Reports." *Lawrence Berkeley National Laboratory*.

    - *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
    - *Results:* "The evaluation study design for the HER pilot program utilized a randomized controlled experiment with an opt-out design, which is the best feasible method of inferring that a program caused energy savings." Averaged 2.03% savings in the last 12 months for electricity, 1.40% for gas.
    - *Contact:* Annika Todd, 510-486-6544, atodd@lbl.gov

13. Allcott, Hunt, October 2011. "Social Norms and Energy Conservation." *Journal of Public Economics*, Vol 95 (9-10), pp. 1082 - 1095.

    - *Utility, State, Fuel:* Report verifies savings achieved by 600,000 households across 17 Opower deployments in various geographic areas, Electric only.
    - *Results*: Opower's program is the most effective non-price efficiency intervention available at scale to date. Average savings range from 1.4 – 3.3% with an unweighted mean of 2.0%, equivalent to a short-term price increase of 11 – 20% (or long-term increase of 5%), at a cost-effectiveness of $0.013 - $0.054 per kWh with an unweighted mean of $0.033 per kWh.
    - *Contact:* Hunt Allcott, allcott@mit.edu

14. April 2012. "Puget Sound Energy's Home Energy Reports Program: Three Year Impact, Behavioral, and Process Evaluation." *KEMA Energy & Sustainability*.

    - *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
    - *Results*: In its third year, this program generated savings of 2.6% for electric customers and 1.3% for gas. Electric impact leapt from 169.7 kWh per household per year in Year 1 to 274.2 kWh in Year 3, an increase of 62%. Gas impact increased from 10.7 to 11.9 therms, a change of 11%. In the third year, reports were suspended for a sub-set of the treatment group. In this group, the electric savings rate dropped to 1.6% compared to a savings rate of 2.6% for the group that continued to receive the reports.
    - *Contact:* N/A

15. Gunn, Randy, May 2012."AEP Ohio EE/DR Plan Year 3. Program Year 2011 Evaluation Report - HER Program". Navigant Consulting

- *Utility, State, Fuel:* AEP Ohio, Ohio, Electricity
- *Results:* In 2011 calendar year, the program generated a total of 53.9 GWh (1.69%). Average savings per participate range from 96 kWh for AMI particpants, to 384 kWh for higher use households (0.85 – 1.93%). Low-income households saved 197 kWh per participant.
- *Contact:* Randy Gunn, 312-583-5700

16. Gunn, Randy, May 2012. "Evaluation Report: Home Energy Reports." *Navigant Consulting*.

- *Utility, State, Fuel:* Commonwealth Edison, IL, Electric
- *Results*: In the second program year, savings range from 1.55 – 2.02% and 185.54 – 444.56 kWh per customer per year, depending on the treatment group. These results led the independent evaluator to conclude that, "average weather-normalized annual savings increased from 230 to 317 kWh per customer [from the first to second program year], and increase of 38%. This increase is statistically significant."
- *Contact:* Randy Gunn, 312-583-5700

17. Dougherty, Anne, July 2012. "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report." *Opinion Dynamics Corporation with Navigant Consulting*.

- *Utility, State, Fuel:* NSTAR & National Grid, MA, Electric & Gas
- *Results*: Electric savings range from 1.25 – 2.06% and gas savings range from 0.81 – 1.50%, depending on the number of years the program has been running. From the first to the second program year, electric savings increased from 1.61 – 2.06% in one program and 1.25 – 1.63% in another – increases of 28 and 30%, respectively. Gas savings increased from 0.81 to 1.25%, an increase of over 54%.
- *Contact:* Anne Dougherty, 617-492-1400

18. Sutter, Mary, October 2012. "Impact and Process Evaluation of 2011 (PY4) Ameren Illinois Company Behavioral Modification Program." *Opinion Dynamics Corporation with The Cadmus Group, Navigant, and Michaels Engineering.*

- *Utility, State, Fuel:* Ameren Illinois Company (AIC), IL, Electric & Gas
- *Results*: Overall, the program achieved electric net savings of 1.14% per household and gas net savings at 0.70% per household.
- *Contact:* Mary Sutter, 510-444-5050

19. Wu, May, November 2012. "Impact & Persistence Evaluation Report: Sacramento Municipal Utility District Home Energy Report Program." *Integral Analytics, Inc with BuildingMetrics Incorporated and Sageview.*

- *Utility, State, Fuel:* Sacramento Municipal Utility District (SMUD), CA, Electric
- *Results*: HERs had a net impact of 2.2% electricity savings per month per household (250 kWh) in the Wave 1 group (monthly report recipients, quarterly report recipients as well as

a third group that stopped receiving reports). The Wave 2 group, which included UCLA Selection, SMUD Segmentation, High Use, E-reports and Seasonal Burst sub-groups, experienced a net impact of 1.6% electricity savings per month per household (216 kWh). The Seasonal Burst notifications yielded 1.2% mean annual savings (178 kWh), along with 0.06 kW reductions on summer peak days. Additionally, "the team found that homes that make a structural change with SMUD efficiency rebate dollars that also receive the HER go on to save more than homes that merely participate in a rebate program."

- *Contact: May Wu, May.Wu@IntegralAnalytics.com*

20. Gunn, Randy, November 2012. "Energy Efficiency / Demand Response Plan: Plan Year 4 (6/1/2011-5/31/2012), Evaluation Report: Home Energy Reports." *Navigant Consulting.*

- *Utility, State, Fuel:* Commonwealth Edison Company (ComEd), IL, Electric
- *Results:* Over the past two years, energy savings by Wave 1 customers do not show sign of diminishing and this evaluation calculated 2.20% savings for these participants. Participants who began receiving HERs later achieved lower savings rates (1.66% and 1.16%), although Navigant noted that "their savings are likely in a ramp-up phase" and that "Navigant expects that savings from Wave 4 participants will increase by at least 50% over the next year."
- *Contact:* Randy Gunn, 312-938-4242, randy.gunn@navigant.com

21. December 2012. "Verification of Hawaii Energy 2011 Programs." *Evergreen Economics.*

- *Utility, State, Fuel:* Hawaii Energy, HI, Electric
- *Results*: "The savings claimed by Hawaii Energy for this measure is a total of 1,704,648 kWh based on savings estimated by Opower."
- *Contact:* Evergreen Economics, 503-894-8676

22. December 2012. "Program Year 1 (2011-2012) EM&V Report for the Residential Energy Efficiency Benchmarking Program." *Navigant.*

- *Utility, State, Fuel:* Progress Energy Carolinas, NC, Electric
- *Results*: "Average savings were 224 kWh or 1.23% of energy consumption during the first twelve months of the program. Total program savings were 10.6 GWh during the twelve month period of August 2011 to July 2012."
- *Contact:* Stuart Schare, 303-728-2501

23. March 2013. "Puget Sound Energy's Home Energy Reports: 2012 Impact Evaluation." *KEMA*

- *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
- *Results:* "The overall credited savings for electric and gas were 300 kWh and 11 therms per household, respectively. These savings constitute 2.8% and 1.3% of the household's average electric and gas consumption, respectively…. Those current households that

continued to receive reports through the fourth year generated savings at or above levels established in the first two years of the program"

- *Contact:* Bobbi Wilhelm, bobette.wilhelm@pse.com

24. March 2013. "Evaluation of the Year 1 CL&P Pilot Customer Behavior Program." *NMR*

- *Utility, State, Fuel:* Connecticut Light and Power, CT, Electric
- *Results:* "Overall, the treatment group used an average of 1.7% less energy than did the control group, translating to 388 kWh less energy used by a treatment household, compared to a control group household, during the first year of the program… Monthly report recipients (2.2% savings) saved more electricity than did the quarterly report recipients (1.2% savings)."
- *Contact:* Lisa Wilson-Wright, NMR

25. April 2013. "Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010-2012 Program." *Freeman, Sullivan & Company*

- *Utility, State, Fuel:* Pacific Gas and Electric Company, CA, Electric & Gas
- *Results:* Program waves have been running between 11 to 17 months. Total electric and gas savings for the program were 49.9 GWh and 1,469 thousand Therms respectively through December 2012. Percent impact ranges from 0.9% to 1.5% for electric and 0.4% to 0.9% for gas depending on number of program months.
- *Contact:* Michael Perry

26. May 2013. "Home Energy Reports Program: Program Year 2012 Evaluation Report." *Navigant Consulting*

- *Utility, State, Fuel:* American Electric Power Ohio, OH, Electric
- *Results:* The Home Energy Report Program reported 53,174 MWh of energy savings with an average savings rate of 2.0%.
- *Contact:* Randy Gunn, 312-583-5714, randy.gunn@navigant.com

27. June 2013. "Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report." *Opinion Dynamics Corporation*

- *Utility, State, Fuel:* National Grid Massachusetts, NSTAR, Electric & Gas
- *Results:* Programs achieved 63 GWh and 344,681 MMBTu in 2012 for Massachusetts. Electric savings rate ranges from 0.89 - 2.47% and gas savings range from 0.50 - 1.80% depending on the number of years the program has been running. All electric programs running for at least two years show increased savings from PY1 to PY2 and PY2 to PY3 where applicable. Gas savings rates are steady or increasing.
- *Contact:* Anne Dougherty, 617-492-1400

28. July 2013. "Evaluation of Residential Incentive Program Portfolio: May 2012 through December 2012." *ADM Associates, Inc.*

- *Utility, State, Fuel:* Indiana Michigan Power, IN, Electric
- *Results:* The program achieved an annualized saving rate of 200 kWh per participant for a total savings from the program over the evaluation period of 4,051 MWh.
- *Contact:* ADM Associates, 916.363.8383

29. August 2013. "Review of PG&E Home Energy Reports Initiative Evaluation." *DNV KEMA*

- *Utility, State, Fuel:* Pacific Gas and Electric, CA, Electric & Gas
- *Results:* Independent evaluation of FSC estimates of savings from PG&E Home Energy Report initiative. DNV KEMA confirms FSC evaluation and "recommends accepting the findings regarding energy savings for HERs presented in the FSC report."
- *Contact:* Ken Agnew, DNV KEMA

30. August 2013. "2012 IPL Residential Peer Comparison EM&V Report." *TecMarket Works*

- *Utility, State, Fuel:* Indianapolis Power & Light Company, Electric
- *Results:* " Overall, the program achieved a net adjusted savings of 7,143 MWh during a full year 12-month program period." In this first year of the program, savings per households were 266 kWh and comprise a percent savings of 1.0%. "This program passes all key cost-effectiveness tests."
- *Contact:* Nick Hall, TecMarket Works

31. August 2013. "SDG&E Home Energy Reports Program." *DNV KEMA*

- *Utility, State, Fuel:* San Diego Gas & Electric Company, CA, Electric & Gas
- *Results:* Over the first 16 months, the program achieved 5,429 MWh of savings, although 117 MWh and 198 MWh of that were joint savings also attributable to downstream and upstream measures, respectively. On average, households in the program achieved energy savings of 292.8 kWh or about 1.9% of their usage during that period, and about 11.9 therms of gas, or 1.5% of usage.
- *Contact:* Ken Agnew, DNV KEMA

32. Stewart, James and Cleff, Jim, "Are You Leaving Peak Demand Savings on the Table? Estimates of Peak-Coincident Demand Savings from PPL Electric's Residential Behavior-Based Program" Working Paper, Behavior, Energy & Climate Change Conference.

- *Utility, State, Fuel:* PPL Electric, PA, Electric
- *Results:* "The program reduced PPL Electric's system peak by about 6.5 MW." "Demand savings were about 50-60% higher on average during system peak hours [compared to non-

peak hours]" "The program also resulted in energy savings of 36 million kWh per year at an average cost of $0.07/kWh"

33. Allcott, Hunt and Todd Rogers, 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review,* 104(10): 3003-37.

- *Utility, State, Fuel:* West Coast Utility (unidentified), Electric
- *Results:* At the beginning of a Home Energy Reports program, households display a pattern of high-frequency "action and backsliding" between reports, but these cycles diminish over time and savings become more durable as treatment continues. Even after two years of treatment, "continued treatment still has substantial incremental effects." "If the intervention stops after two years, the effects decay at only 10 to 20 percent per year"
- *Contact:* Hunt Allcott, allcott@mit.edu

34. January 2014. "Impact and Process Evaluation of Ameren Illinois Company's Behavioral Modification Program (PY5)" Opinion Dynamics.

- *Utility, State, Fuel:* Ameren Illinois, Illinois, Electric & Gas
- *Results:* "Approximately 198,000 dual fuel customers participated in the Behavioral Modification Program in PY5. The program saved 31,618 MWh and 1,576,341 therms."

35. January 2014. "National Grid Residential Building Practices and Demonstration Program Evaluation: Final Results." DNV KEMA

- *Utility, State, Fuel:* National Grid New York, NY, Electric & Gas
- *Results:* Over the first 19 months, the program achieved 45,050 MWh in electric savings and 1,049,976 Therms in gas savings. Of the electric savings, 152 MWh and 53 MWh were joint savings also attributable to downstream and upstream measures, respectively. On average, electric-only households in the program achieved savings of about 2.3% of their usage, and dual-fuel customers saved 1.52% of their electricity usage and 0.77% of their gas usage.
- *Contact:* Ken Agnew, DNV KEMA

36. January 2014. "First Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013, Program Year 4" The Cadmus Group, Inc.

- *Utility, State, Fuel:* PPL Electric, PA, Electric
- *Results:* "In the first year of the program, the percent savings (the percent reduction in average daily consumption) trend upward and reach a steady state of approximately 1.7% to 1.8% by the beginning of PY3….In PY4, the percent savings increase slightly to just above 2%." In the fourth year of the program, the average household saved 360 kWh (legacy group) and 495 kWh (expansion group). In the fourth year, "The average peak demand reduction for the whole program was 6.5 MW, enough electricity to meet the demand of approximately 1,800 control group customers during peak hours."

37. January 2014. “Program Year 2 (2012-2013) EM&V Report for the Residential Energy Efficiency Benchmarking Program.” Navigant Consulting, Inc.

- *Utility, State, Fuel:* Duke Energy Progress, NC, Electric
- *Results:* “Average savings for participants in the Initial Wave were 1.63% of energy consumption during PY2 (August 2012 to July 2013), an increase from 1.23% in PY1” This is equivalent to a reduction of “312 kWh if their account was active the entire program year.” Total program verified savings were 15.9 GWh, net of savings from other EE programs.

38. January 28, 2014. “Home Energy Reports Program: PY5 Evaluation Report.” Navigant Consulting, Inc.

- *Utility, State, Fuel:* Commonwealth Edison Company, IL, Electric
- *Results*: The evaluation finds total program verified savings to be 97,442 MWh, corresponding to a 2.04% reduction in usage for program participants. “Over the past three years energy savings by Wave 1 customers have been remarkably stable: 2.05% in EPY3, 2.20% in EPY4, and 2.16% in EPY5. This is a significant finding and indicates that going forward the program is likely to continue to generate savings of approximately 2% for this group”

39. March 2014. "Evaluation of 2013 DSM Portfolio: Submitted to CenterPoint Energy Arkansas." ADM Associates, Inc.

- *Utility, State, Fuel:* CenterPoint Energy Arkansas, AR, Gas
- *Results:* In program year 2013, the program produced 1,112,462 annual Therms savings; and 16,797.3 peak Therms. “Per customer, this averages to a 1.96% reduction in annual gas consumption for Wave 1 [in its second year] and 1.00% for Wave 2 [in it’s first year]”

40. March 2014. "Evaluation of 2013 DSM Portfolio: Submitted to SourceGas Arkansas." ADM Associates, Inc.

- *Utility, State, Fuel:* SourceGas Arkansas, AR, Gas
- *Results:* In program year 2013, the program produced 438,534 annual Therms savings; and 9,291.18 peak Therms. "The Home Energy Reports Program observed much higher savings in 2013, due largely to the heavier winter"

41. Todd, A., M. Perry, B. Smith, M. Sullivan, P. Cappers, and C. Goldman. 2014. "Insights from Sma rt Meters: The Potential for Peak Hour Savings from Behavior-Based Programs." Lawrence Berkeley National Laboratory.

- *Utility, State, Fuel:* Pacific Gas & Electric, CA, Electric
- *Results:* The evaluation finds "statistically significant electricity savings every hour; higher kWh savings during peak hours; and a higher percentage of savings during peak hours relative to the energy usage in each hour." In other words, "savings disproportionately

increase during the peak hours". During the ten highest system peak days included in the dataset, the evaluation finds even "higher peak savings" and "slightly higher proportional peak savings"

- *Contact:* Annika Todd, 510-486-6544, atodd@lbl.gov

42. March 2014. "Verification of Savings from Xcel Energy Minnesota's Print Energy Feedback Pilot Project – Final Report." Center for Energy and the Environment.

- *Utility, State, Fuel:* Xcel Energy, MN, Electric & Gas
- *Results:* "Over three years, the pilot project produced cumulative measured savings of 26,769 MWh of electricity and 643,667 therms of natural gas. Savings in each year were highly significant for each energy type ($p<0.001$)" "For the customers that remained in the program all three years, electricity savings increased significantly each year."

43. April 2014. "Home Energy Report Program. 2013 Impact Evaluation. Puget Sounds Energy". DNV-GL

- *Utility, State, Fuel:* Puget Sound Energy, Washington, Electric & Gas
- *Results: "*The current treatment group produced credited savings at 3.0% and 1.5% for electric and gas, respectively. The suspended treatment group incurred 49% less electric savings when compared to current treatment group….Households in the current group that continued to receive reports through the fifth year generated savings at or above levels established in the first two years of the program. Households in the suspended group that were in their third year of not receiving reports still generated at least half of the savings of the current treatment group."

44. May 2014. "Home Performance Program: Evaluation, Measurement, and Verification Report 2013" ADM Associates, Inc.

- *Utility, State, Fuel:* FirstEnergy Ohio Companies (Ohio Edison, The Cleveland Electric Illuminating Company, The Toledo Edison Company), Ohio, Electric
- Results: "The ex post verified annual electricity savings for all participants combined in 2013 were 12,792,850 kWh," equivalent to 175.24 annual savings per household. "Program-level critical peak demand impacts…were determined to be about 1,460 kW"

45. July 2014. "Home Electricity Report Program, January 2012 through December 2013 Study Period: 2013 Impact Evaluation" DNV-GL

- *Utility, State, Fuel:* Seattle City Light, WA, Electric
- *Results*: "The SCL HER program saved over 15 million kWh each year for 2012 and 2013, for a total of over 32 million kWh for the two years combined" Household-level impacts "range from over 400 kWh [greater than 3%] for the third and fourth years of the Legacy wave to 250 to 300 kWh [2-2.5%] for the first and second years of the Expansion and Expansion CPW waves. The small Legacy CPW wave has the highest per household savings, at greater than 500 kWh [5%] per household, perhaps reflecting the increased emphasis on conservation accompanying the CPW program"

46. July 2014. "Central Hudson Gas & Electric Corporation: Home Energy Comparison Report Program" Applied Energy Group.
- *Utility, State, Fuel:* Central Hudson Gas & Electric, New York, Electric and Natural Gas
- *Results:* "The average daily energy savings observed in the participant sample is…2.11 percent. The program achieved an average yearly savings of approximately 210 kWh per participant." "Overall, AEG determined that the HECR program resulted in net energy savings of 18,650 MWh and 286,226 Therms" "AEG determined that the overall TRC benefit-cost ration for the HECR program is 1.19, and is therefore cost-effective"

47. August 29, 2014. "Evaluation of Southern California Gas Company's 2013-2014 Conservation Campaign: Submitted to Southern California Gas Company." Nexant.

- *Utility, State, Fuel:* Southern California Gas Company, CA, Natural Gas
- *Results:* Customers enrolled in the HER program had total verified net savings of 159,708 therms. Customers who received email HERs only saved approximately 1.4% per household, while customers who received paper reports or a combination of paper and email reports had savings of approximately 1.5%-1.6% per household.

48. October 3, 2014. "Home Energy Reports Program: GPY3 Evaluation Report" Navigant Consulting, Inc.

- *Utility, State, Fuel:* People's Gas and North Shore Gas, IL, Natural Gas
- *Results:* "Total program verified net savings are 2,054,727 therms for People's Gas and 652,718 for North Shore Gas." "HER savings correspond to a 0.85% and 0.63% reduction in usage for program participants from People's Gas and North Shore Gas respectively. These savings are typical for first year savings for residential gas Home Energy Report Programs, as HER program typically exhibit a one to two year ramping period"

49. October 24, 2014. "SCE's Home Energy Report Program Savings Assessment: Ex-Post Evaluation Results, Program Year 2013." Applied Energy Group.
- *Utility, State, Fuel:* SoCal Edison (SCE), California, Electricity.
- Results: "We estimate ex-post energy savings of 8,541 MWh during the 12-month treatment period... We also estimate peak demand savings of 2,809 kW"

50. December 2014. "2013 SCE Home Energy Reports Program: Review and Validation of Impact Evaluation." DNV GL – Energy.

- *Utility, State, Fuel:* SoCal Edison (SCE), California, Electricity.
- Results: "DNV GL recommends the following savings estimates for 2013 SCE HER program: … 8,795,195 kWh [and peak demand reduction of]… 2,694 kW"

51. October 2014. "SDG&E Home Energy Reports Program: 2013 Impact Evaluation". DNV GL – Energy.
    - *Utility, State, Fuel:* San Diego Gas & Electric (SDG&E), California, Gas and Electricity.
    - *Results:* "In 2013, the HER program achieved a reduction of 4,540 MWh across the treatment households…. The program also generated 184,400 therms of gas savings"

52. January 16, 2015. "2013 PG&E Home Energy Reports Program: Review and Validation of Impact Evaluation ED Res 3.1" DNV GL – Energy.
    - *Utility, State, Fuel:* Pacific Gas & Electric (PG&E), California, Gas and Electricity
    - *Results:* DNV measured total electricity savings of 92,832,411 kWh, total gas savings of 2996,866 Therms, and a peak demand reduction of 15.4 MW

53. March 14, 2015. "Smart Energy Manager Program: 2013 Evaluation Report (01/01/2013 – 12/31/2013)" Navigant
    - *Utility, State, Fuel:* Baltimore Gas and Electric, Maryland, Electric
    - *Results:* Navigant measured total electricity savings of 37,980 MWh, total gas savings of 37,980 Therms, and a peak demand reduction of 15.4 MW

54. May 29, 2015. "Home Energy Reporting Program Evaluation Report (1/1/2014 – 12/31/14). Navigant
    - *Utility, State, Fuel:* Potomac Edison, Maryland, Gas and Electric.
    - *Results:* Navigant measured total electricity savings of 22,084 MWh and an average savings rate of 1.63%.

UNDERTAKING J7.6

UNDERTAKING

TR, page 181

Enbridge to provide the presentation to shareholders *[stakeholders]*

RESPONSE

For clarity, the exchange during FRPO's cross examination of Enbridge included an offer by Enbridge to provide the presentation that was made to stakeholders; not shareholders.

Three presentations were made to stakeholders. The first provided introductory thoughts and comments by Enbridge. The second included a detailed review of the program, including technical aspects, as well as Opower's experience in other jurisdictions. For the final presentation, Enbridge invited National Grid to share some of their own experience with their program in Massachusetts, New York, and Rhode Island.

Finally, Enbridge took notes during the day and provided these notes to the stakeholders who attended. It should be noted that in addition to the attendees, Enbridge extended the invitation to a broad list of stakeholder representatives to explore the benefits of engaging Opower's experience to deliver exceptional results in the Enbridge franchise for its residential customers.

Enbridge has provided the following attachments:

1. Enbridge presentation entitled, "Demand Side Management, Planning 2015-2020: Behavioural Programming Discovery Session"

2. Opower presentation entitled, "Enbridge Stakeholder Meeting"

3. National Grid presentation entitled, "Behavioral Energy Efficiency"

4. Enbridge meeting notes entitled, "Consultative meeting on Behavioural program, Sept. 16, 2014: notes of discussion"

Witnesses: S. Bertuzzi
M. Lister
S. Mills
F. Oliver-Glasford

Demand Side Management

Planning 2015-2020

Behavioural Programming Discovery Session

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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ENBRIDGE

Agenda

- Consumers and Energy Efficiency
- Behavioural Definition
- Where we have come from
  - Residential
  - Commercial
- Opower Introduction

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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ENBRIDGE

Consumers and Energy Efficiency

- On average the average consumer thinks about energy efficiency 6 to 9 minutes per year

  Accenture 2012

- It is becoming clearer that reaching the next level in energy savings will require an improved understanding of consumers' behaviour and better ways of engaging them

  McKinsey 2013

A need to better understand and communicate with consumers clearly exists

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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ENBRIDGE

Behavioural Definition

Awaiting Draft Guidelines

Behavioural based energy efficiency programs can be defined as those which modify, and/or influence end energy consumer behaviour, by implementing behaviour targeted strategies, tailored by sector, to ultimately reduce energy consumption.

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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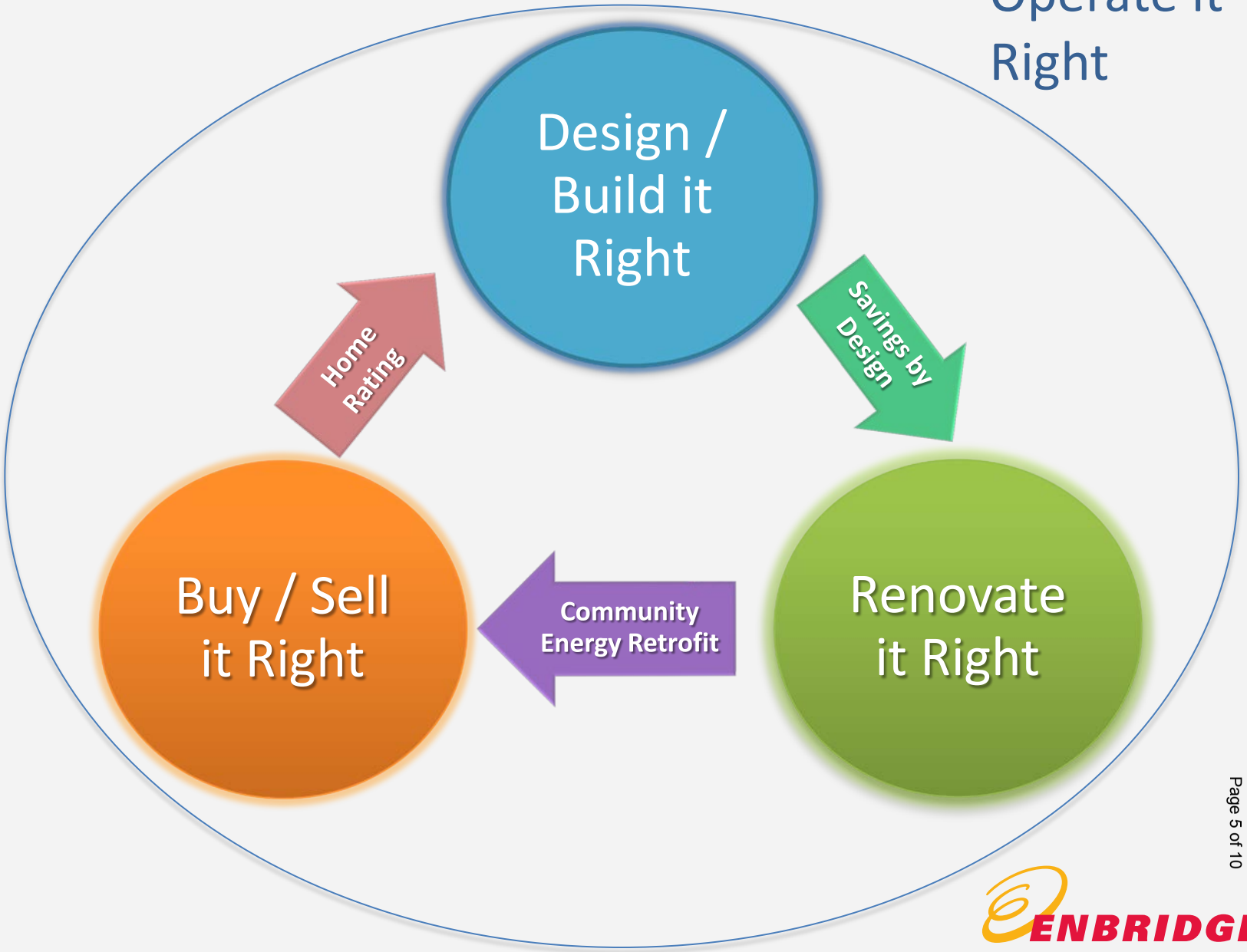
ENBRIDGE

Operate it Right



Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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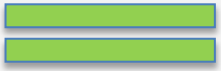
ENBRIDGE

Opportunity

Building, Renovating homes / buildings and installing energy efficient equipment is only part of the equation

Opower is a missing link to operating the “right way”



This approach prompts consumers to understand and lower their energy use and costs, and significantly reduce carbon emissions

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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ENBRIDGE

Who is Opower

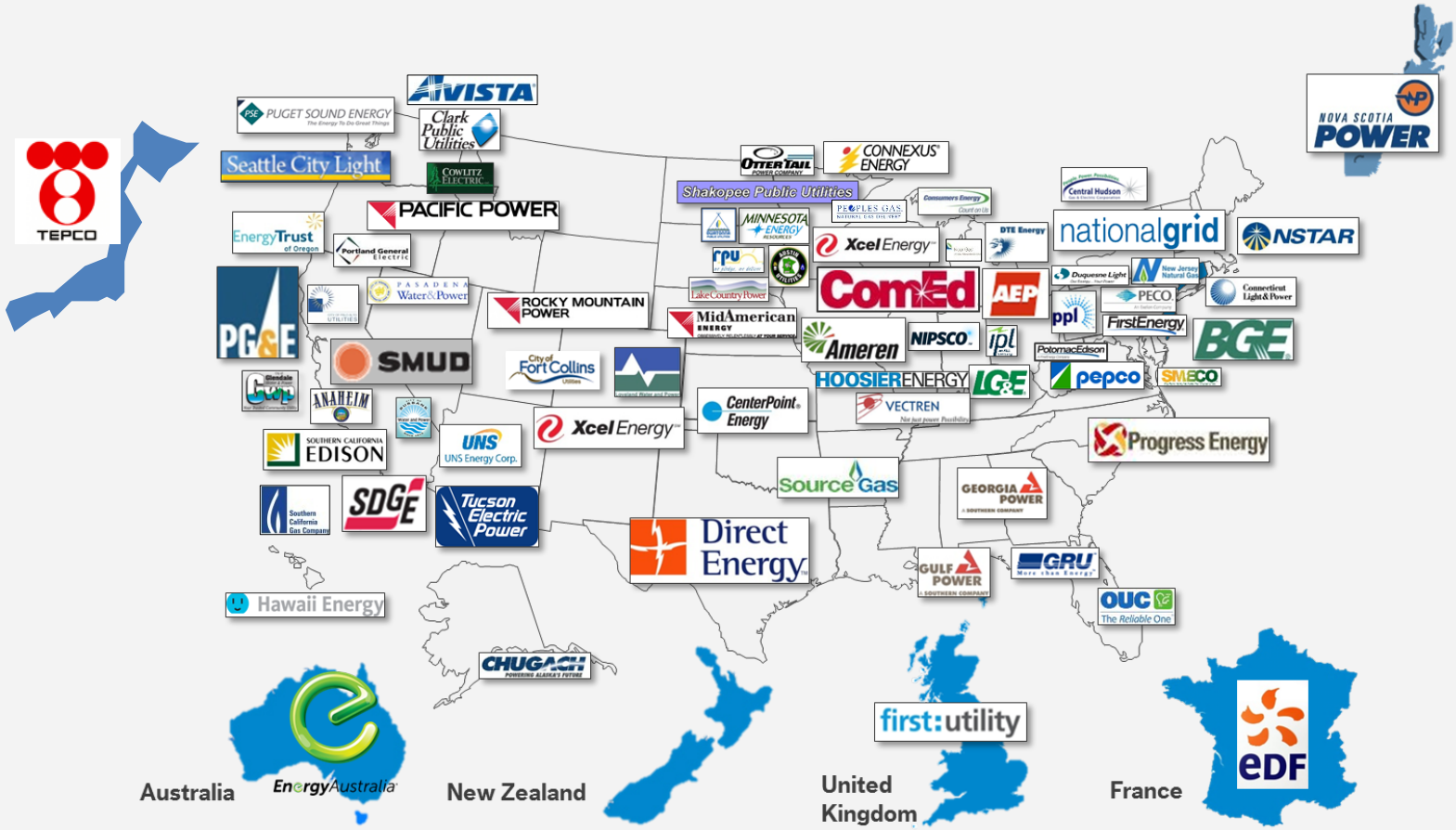
A Software as a Service Customer Engagement Platform

- The Company
  - Serving 90+ utilities in 8 countries
  - Over 5TWh saved to date
  - 40%+ of US household data under management totaling over 300 billion reads
  - 500+ staff in Washington, San Francisco, London, Singapore, Tokyo
- What they are all about
  - Behavioral science software
  - Data analytics
  - Consumer marketing
  - User-centric design

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
Page 7 of 10

ENBRIDGE

90 Utilities in 8 Countries Trust Opower



Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
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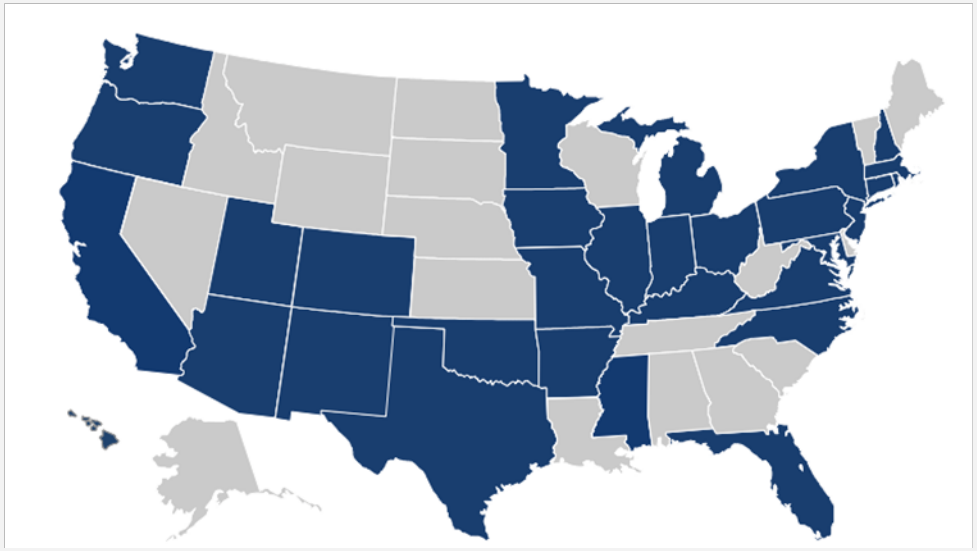
ENBRIDGE

Opower works with 32 gas clients across US and EU

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
Page 9 of 10

ENBRIDGE

Widespread Regulatory Approval: Setting a Global Standard



Opower approved as an EE Resource

Filed: 2015-09-03
EB-2015-0049
Exhibit J7.6
Attachment 1
Page 10 of 10

ENBRIDGE

Enbridge Stakeholder Meeting

September, 2014

Filed: 2015-09-03, EB-2015-0049, Exhibit J7.6
Attachment 2, Page 1 of 45

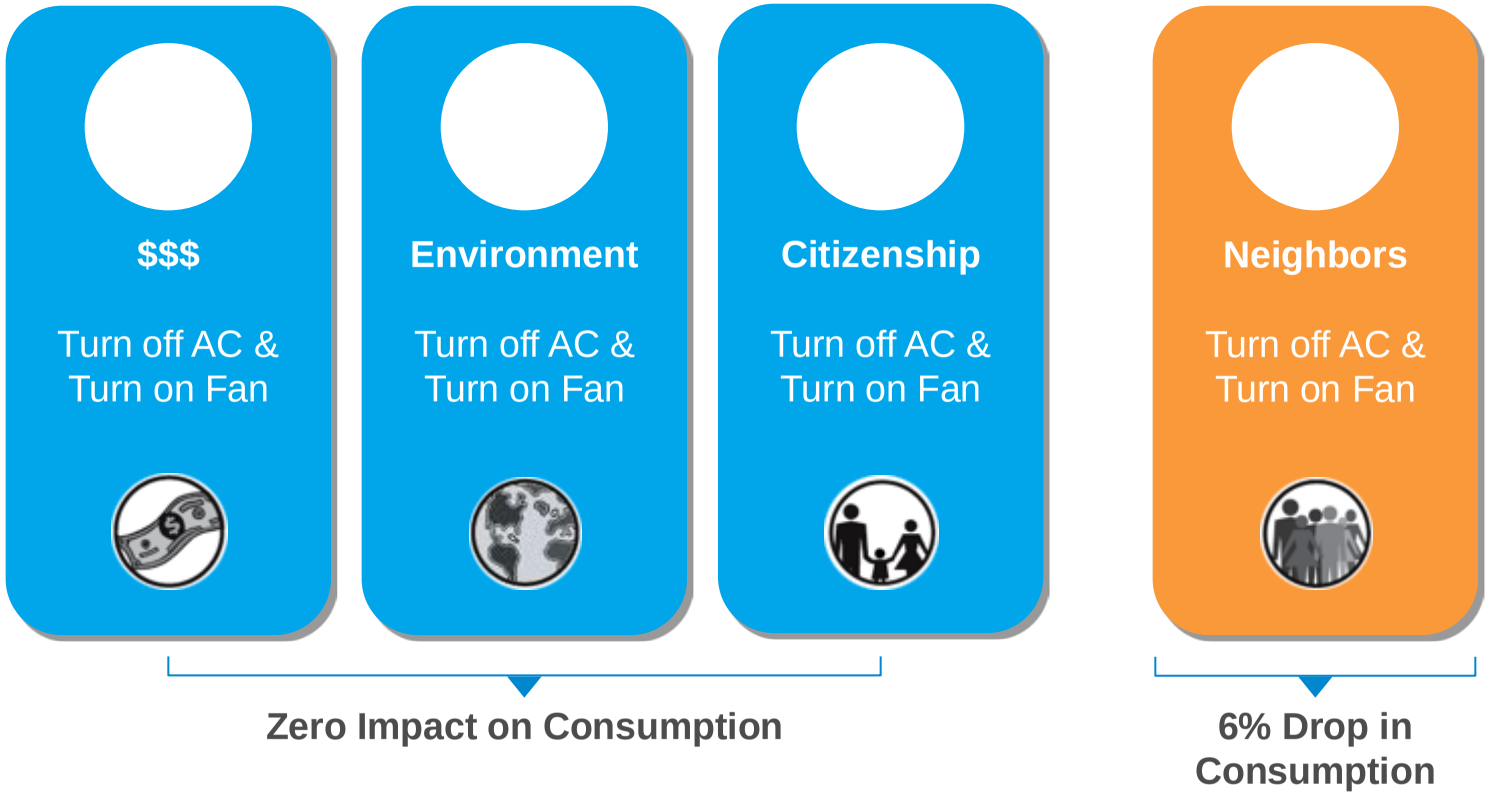
Prepared for Enbridge Gas

Agenda

1. **Behavourial EE Overview**
2. Program Results and M&V

Filed: 2015-09-03, EB-2015-0049, Exhibit J7.6
Attachment 2, Page 2 of 45

Applied Behavioral Science: the core of a behavioral EE program



Schultz & Cialdini (OPOWER Scientists)
Hewlett Foundation San Marcos Study

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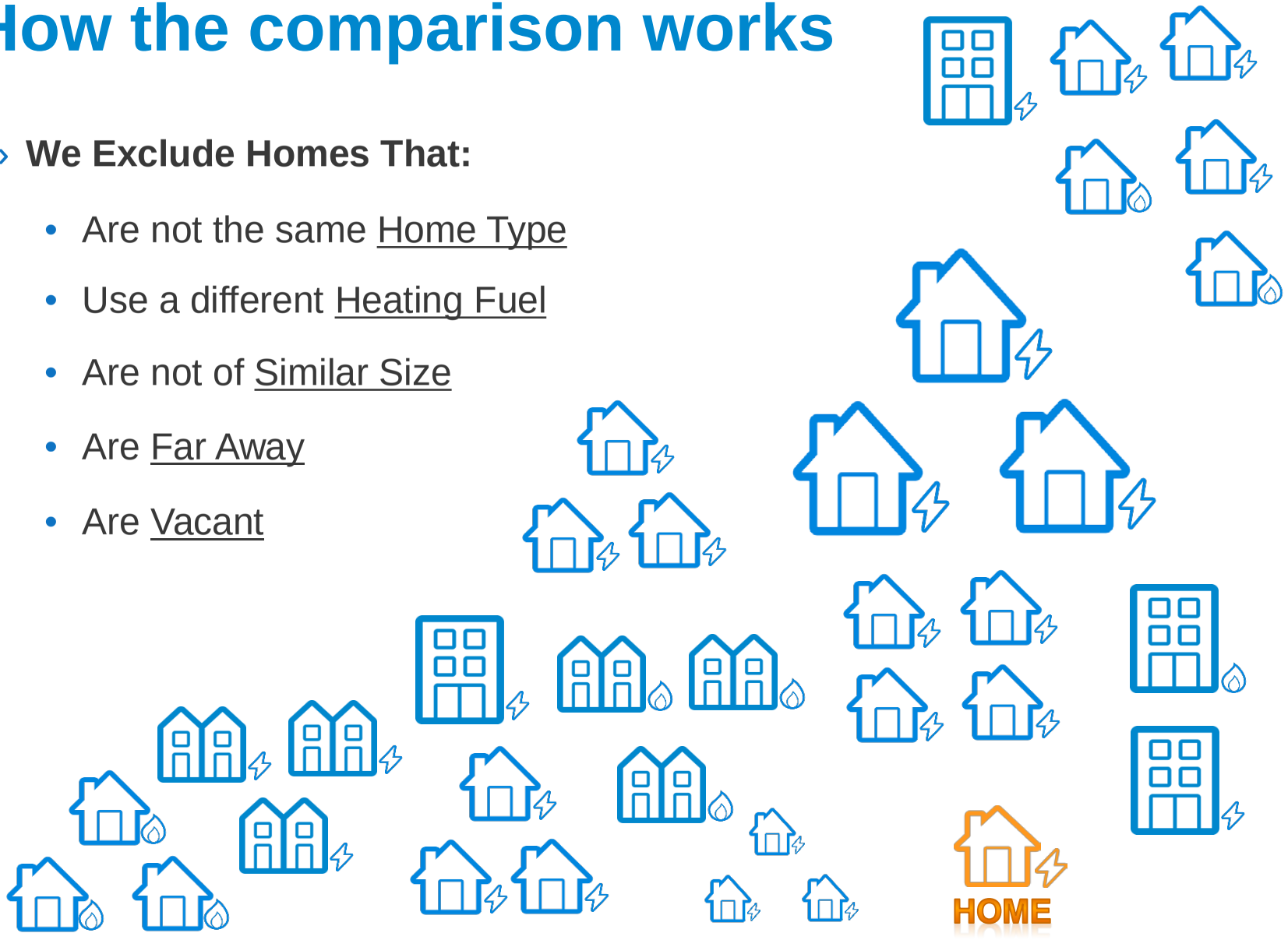
How the comparison works

» **We Exclude Homes That:**

- Are not the same Home Type
- Use a different Heating Fuel
- Are not of Similar Size
- Are Far Away
- Are Vacant



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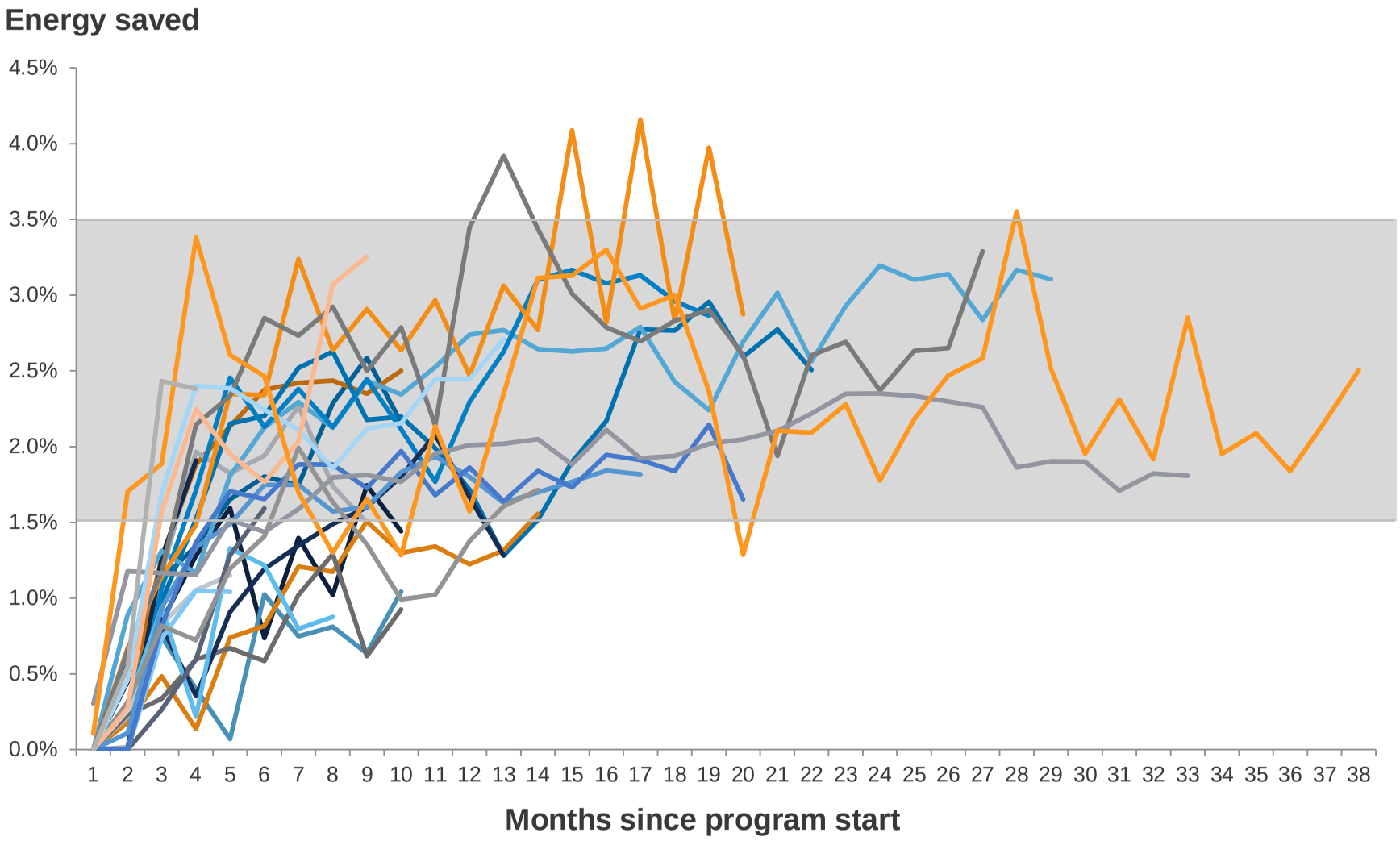
Results predictable, consistent & sustained across all geographies & fuels



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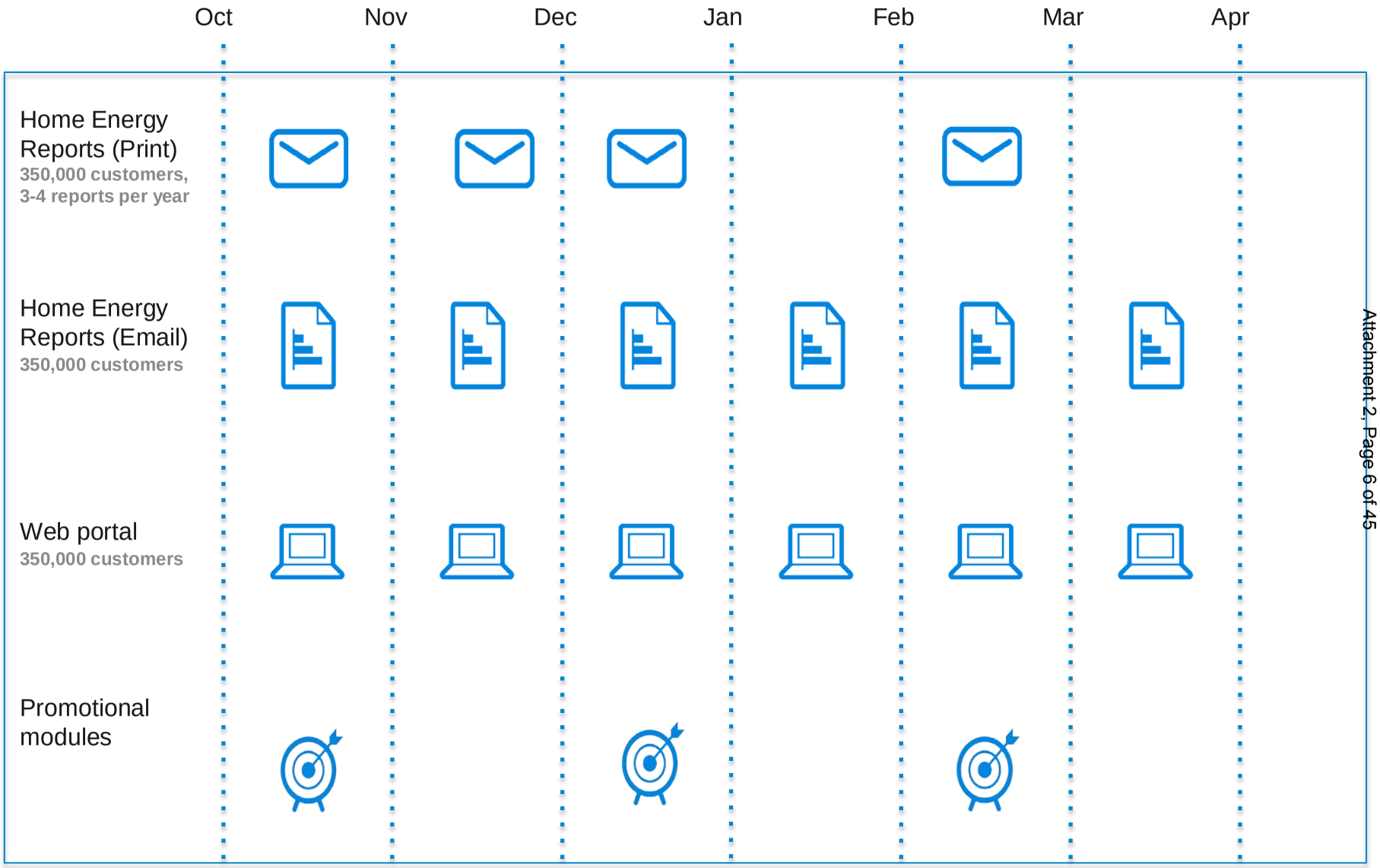
Proposed Program Design 2015-16



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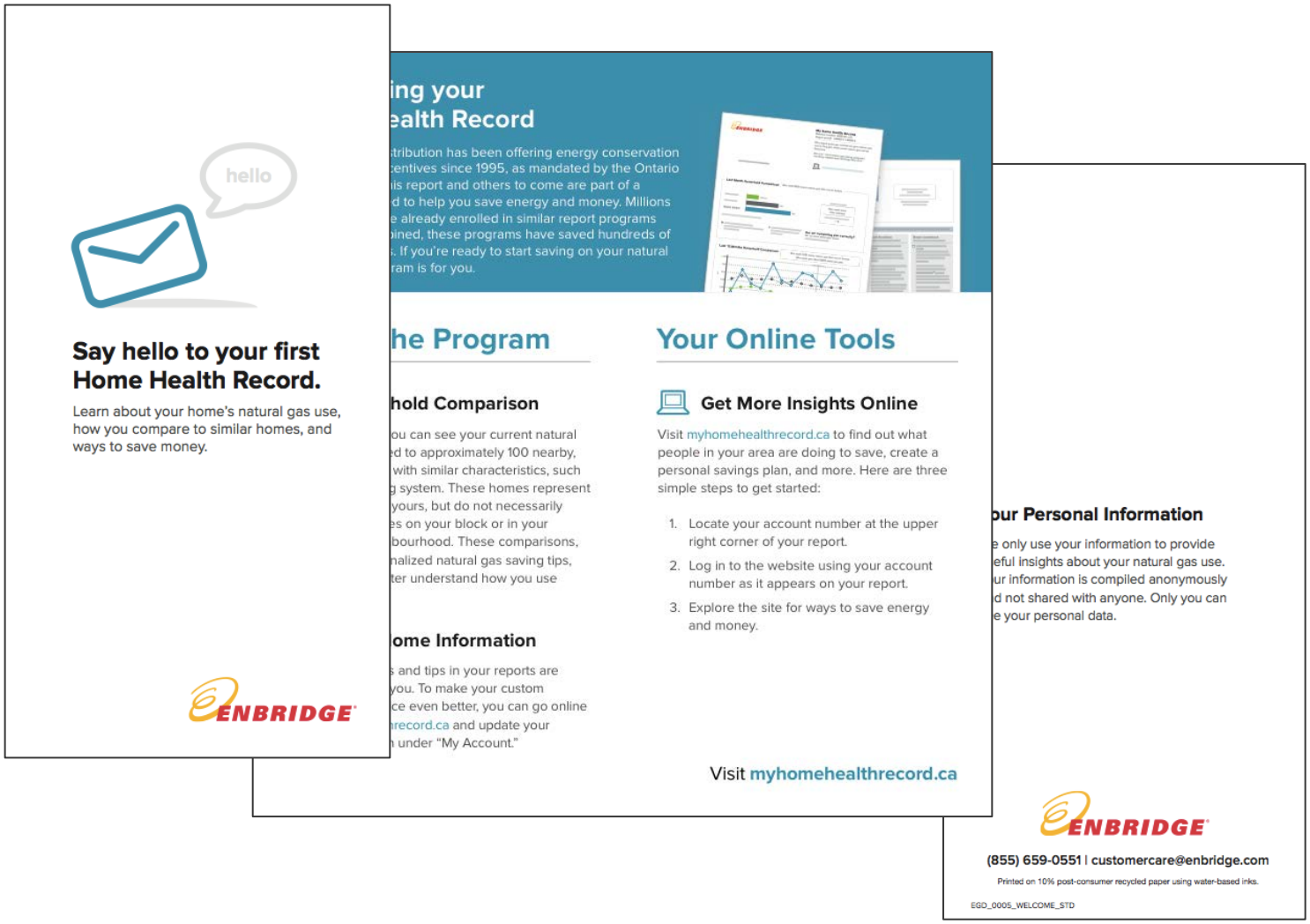
Welcome experience



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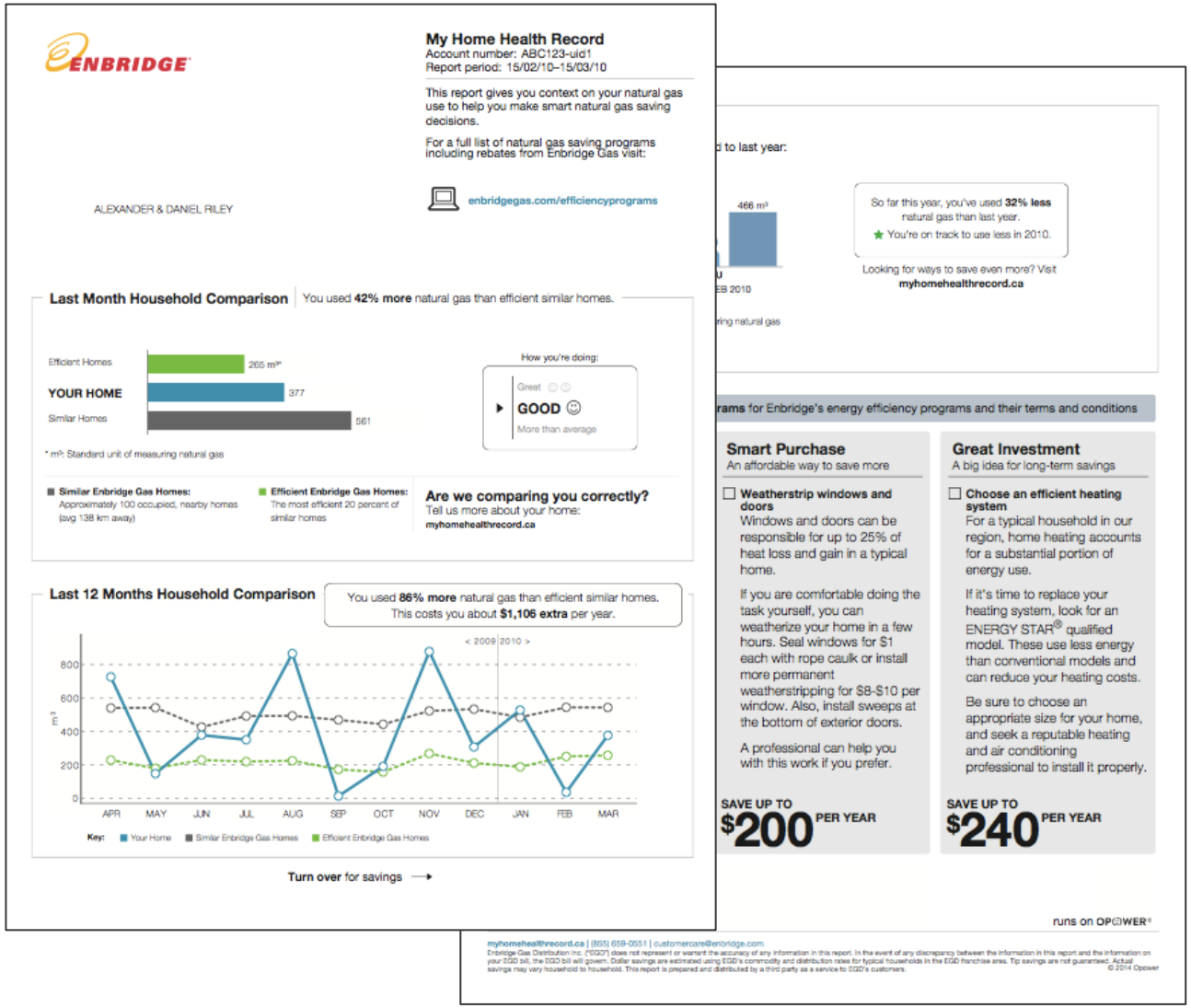
Sample Report



ENBRIDGE

My Home Health Record
Account number: ABC123-uid1
Report period: 15/02/10–15/03/10

This report gives you context on your natural gas use to help you make smart natural gas saving decisions.

For a full list of natural gas saving programs including rebates from Enbridge Gas visit:

enbridgegas.com/efficiencyprograms

ALEXANDER & DANIEL RILEY

Last Month Household Comparison | You used **42% more** natural gas than efficient similar homes.

Efficient Homes 265 m³
YOUR HOME 377
Similar Homes 561

* m³: Standard unit of measuring natural gas

How you're doing:
Great
GOOD
More than average

Similar Enbridge Gas Homes: Approximately 100 occupied, nearby homes (avg 138 km away)

Efficient Enbridge Gas Homes: The most efficient 20 percent of similar homes

Are we comparing you correctly?
Tell us more about your home:
myhomehealthrecord.ca

Last 12 Months Household Comparison

You used **86% more** natural gas than efficient similar homes.
This costs you about **$1,106 extra** per year.

< 2009 | 2010 >

800
600
400
200
0
E³

APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR

Key: Your Home | Similar Enbridge Gas Homes | Efficient Enbridge Gas Homes

Turn over for savings →

d to last year:

466 m³

EB 2010

ring natural gas

So far this year, you've used **32% less** natural gas than last year.
You're on track to use less in 2010.

Looking for ways to save even more? Visit
myhomehealthrecord.ca

rams for Enbridge's energy efficiency programs and their terms and conditions

Smart Purchase
An affordable way to save more

☐ **Weatherstrip windows and doors**
Windows and doors can be responsible for up to 25% of heat loss and gain in a typical home.

If you are comfortable doing the task yourself, you can weatherize your home in a few hours. Seal windows for $1 each with rope caulk or install more permanent weatherstripping for $8-$10 per window. Also, install sweeps at the bottom of exterior doors.

A professional can help you with this work if you prefer.

SAVE UP TO **$200** PER YEAR

Great Investment
A big idea for long-term savings

☐ **Choose an efficient heating system**
For a typical household in our region, home heating accounts for a substantial portion of energy use.

If it's time to replace your heating system, look for an ENERGY STAR® qualified model. These use less energy than conventional models and can reduce your heating costs.

Be sure to choose an appropriate size for your home, and seek a reputable heating and air conditioning professional to install it properly.

SAVE UP TO **$240** PER YEAR

runs on OPOWER®

myhomehealthrecord.ca | (855) 658-0551 | customercare@enbridge.com

Enbridge Gas Distribution Inc. ("EGD") does not represent or warrant the accuracy of any information in this report. In the event of any discrepancy between the information in this report and the information on your EGD bill, the EGD bill will govern. Dollar savings are estimated using EGD's commodity and distribution rates for typical households in the EGD franchise area. Tip savings are not guaranteed. Actual savings may vary household to household. This report is prepared and distributed by a third party as a service to EGD's customers.

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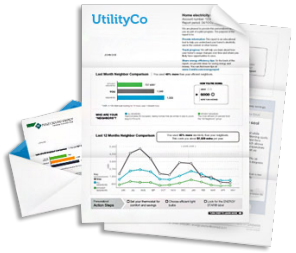
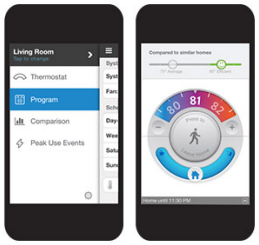
Proactive customer platform – today



Energy efficiency

Customer engagement

Demand response



Thermostat management

Concurrent Outbound Messaging

Web & Mobile Framework

Thermostat Management

Personalization Engine

Big Data Analytics

Data Integration System

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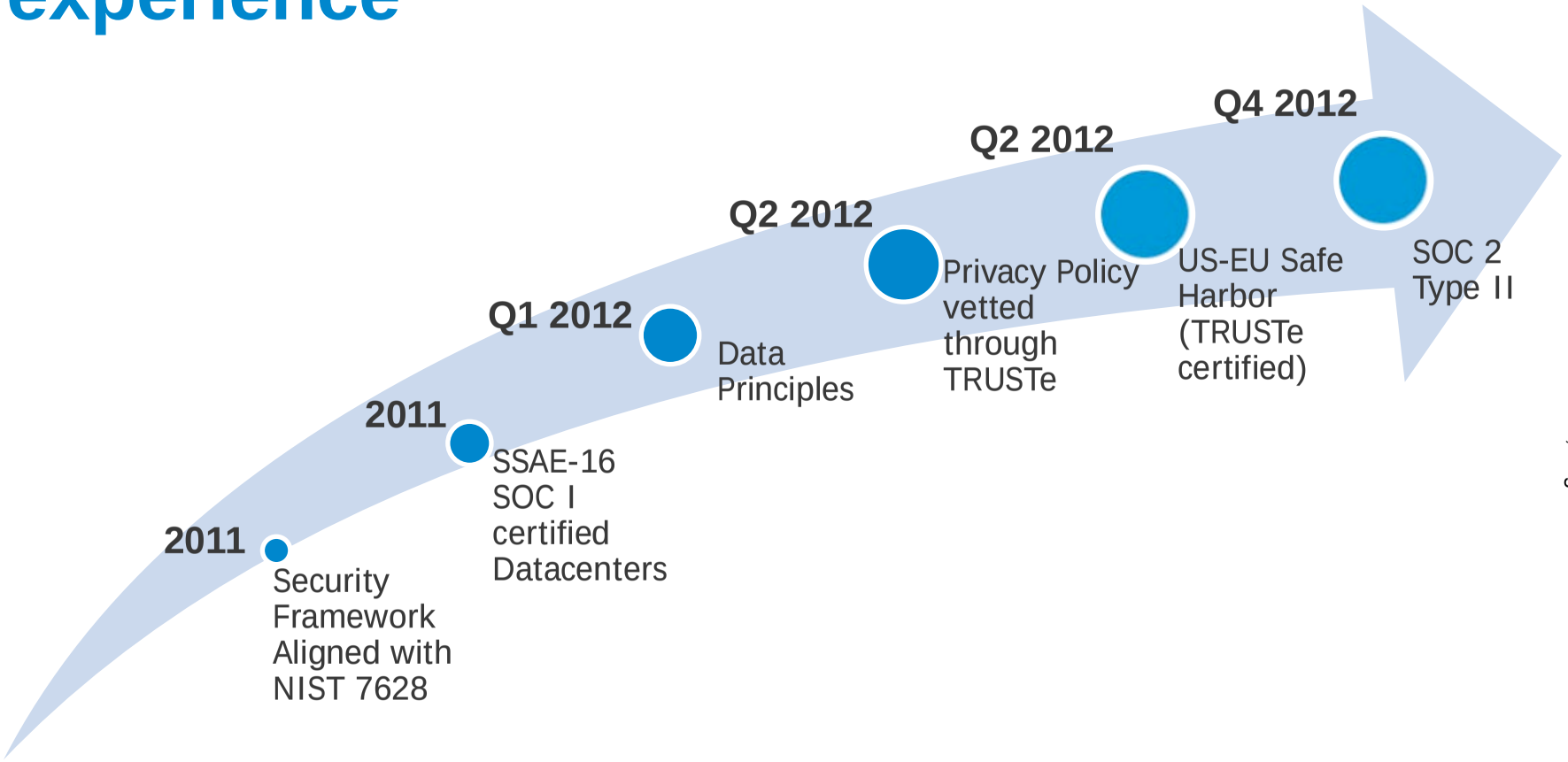
Opower ensures the most secure experience



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TRUSTe CERTIFIED PRIVACY

AICPA SERVICE ORGANIZATIONS SOC aicpa.org/soc Formerly SAS 70 Reports

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Agenda

1. Behavourial EE Overview

2. Program Results and M&V

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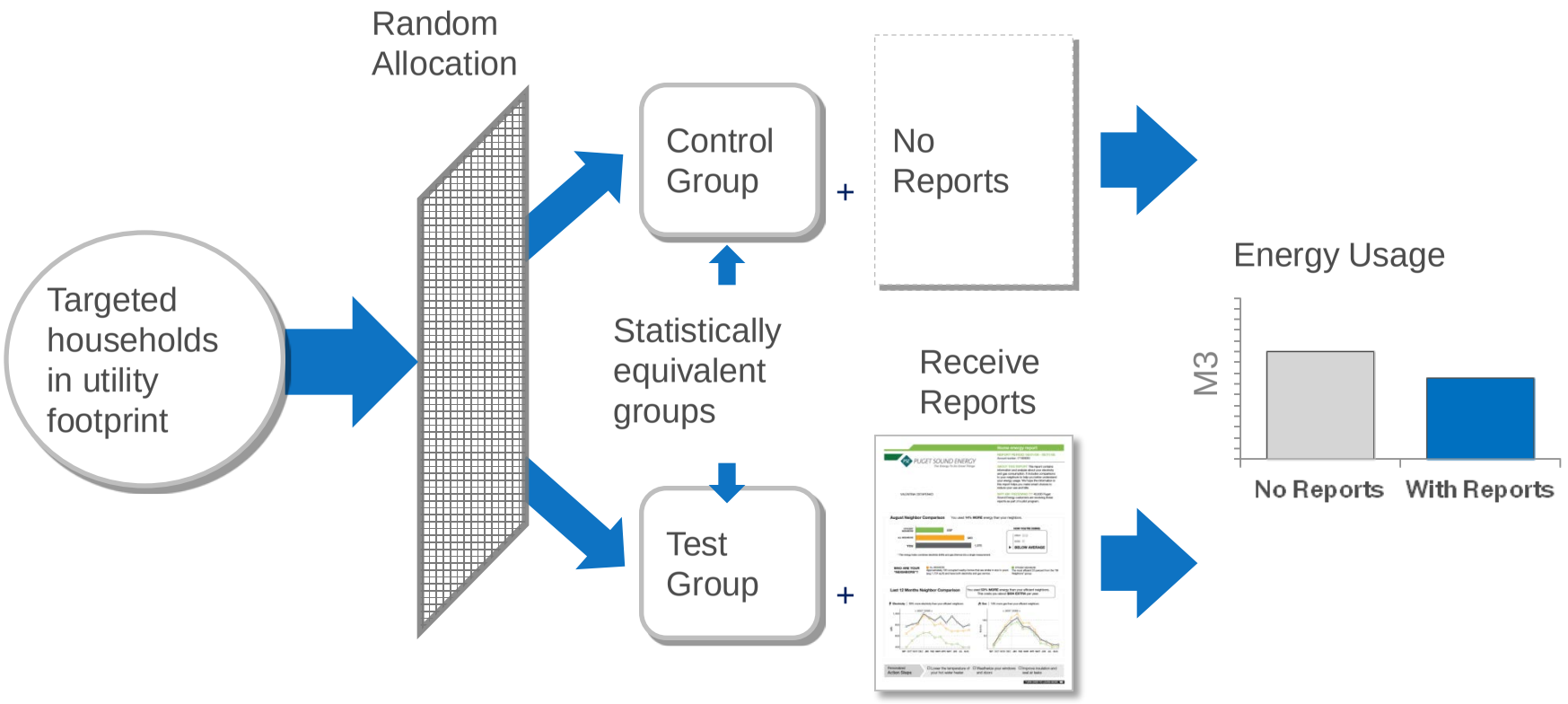
Attachment 2, Page 11 of 45

Our EM&V methodology allows us to measure actual results



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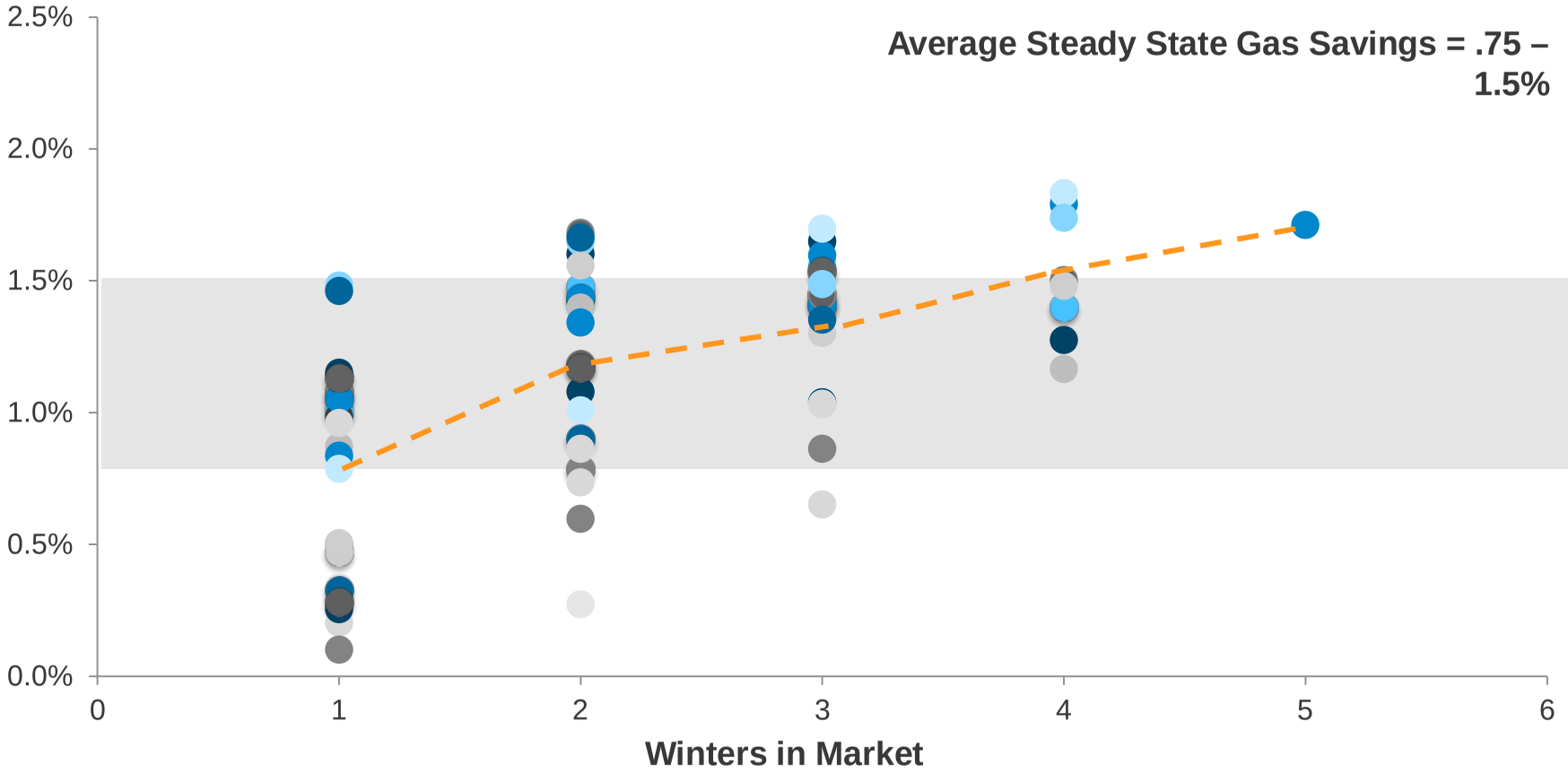
Predictable and Verified Gas savings



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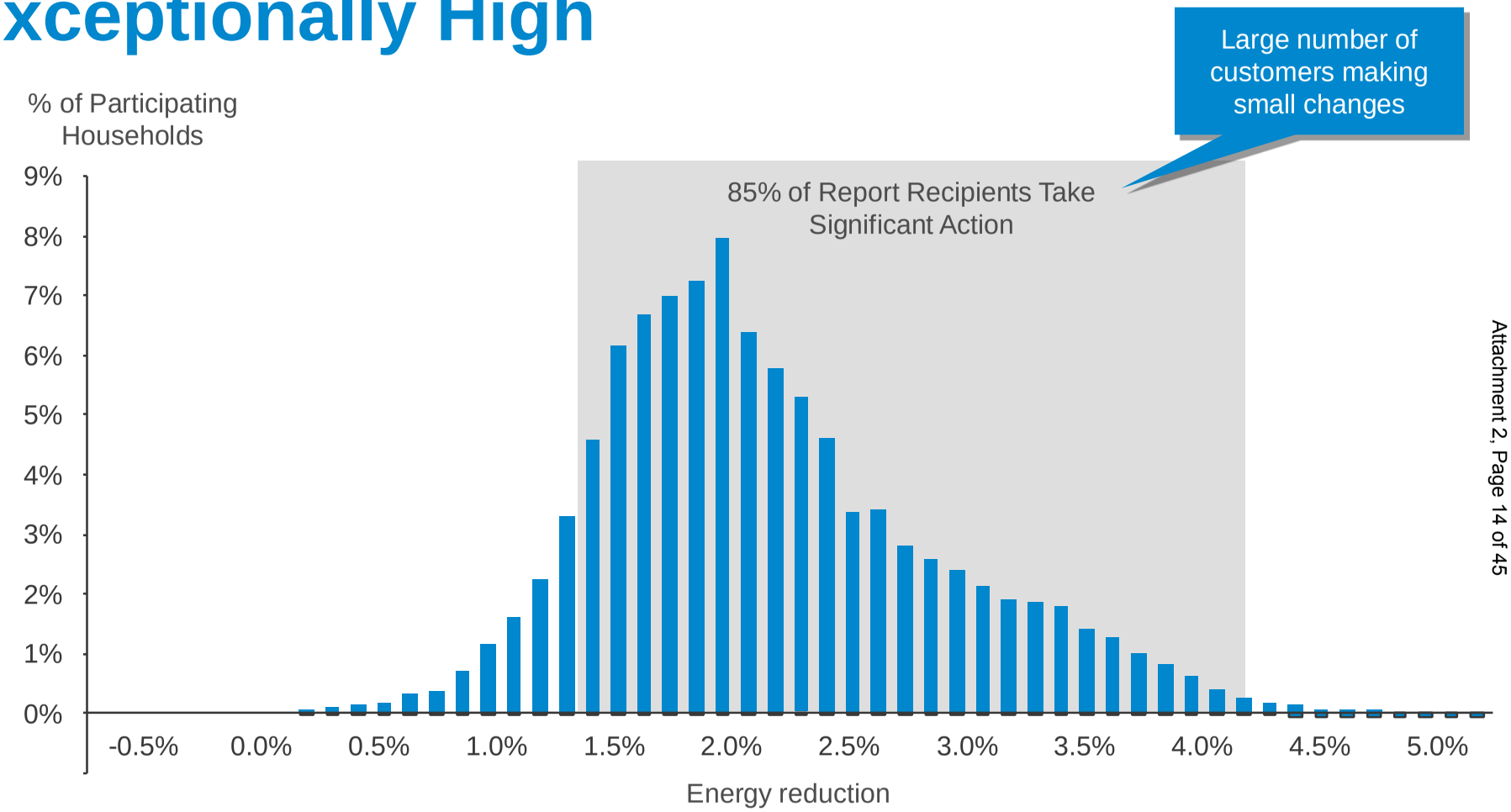
CADMUS ODC OPINION DYNAMICS CORPORATION NAVIGANT KEMA DNV

Our Customer Participation Rate is Exceptionally High



Independent Verification by Summit Blue Demonstrates High Customer Participation

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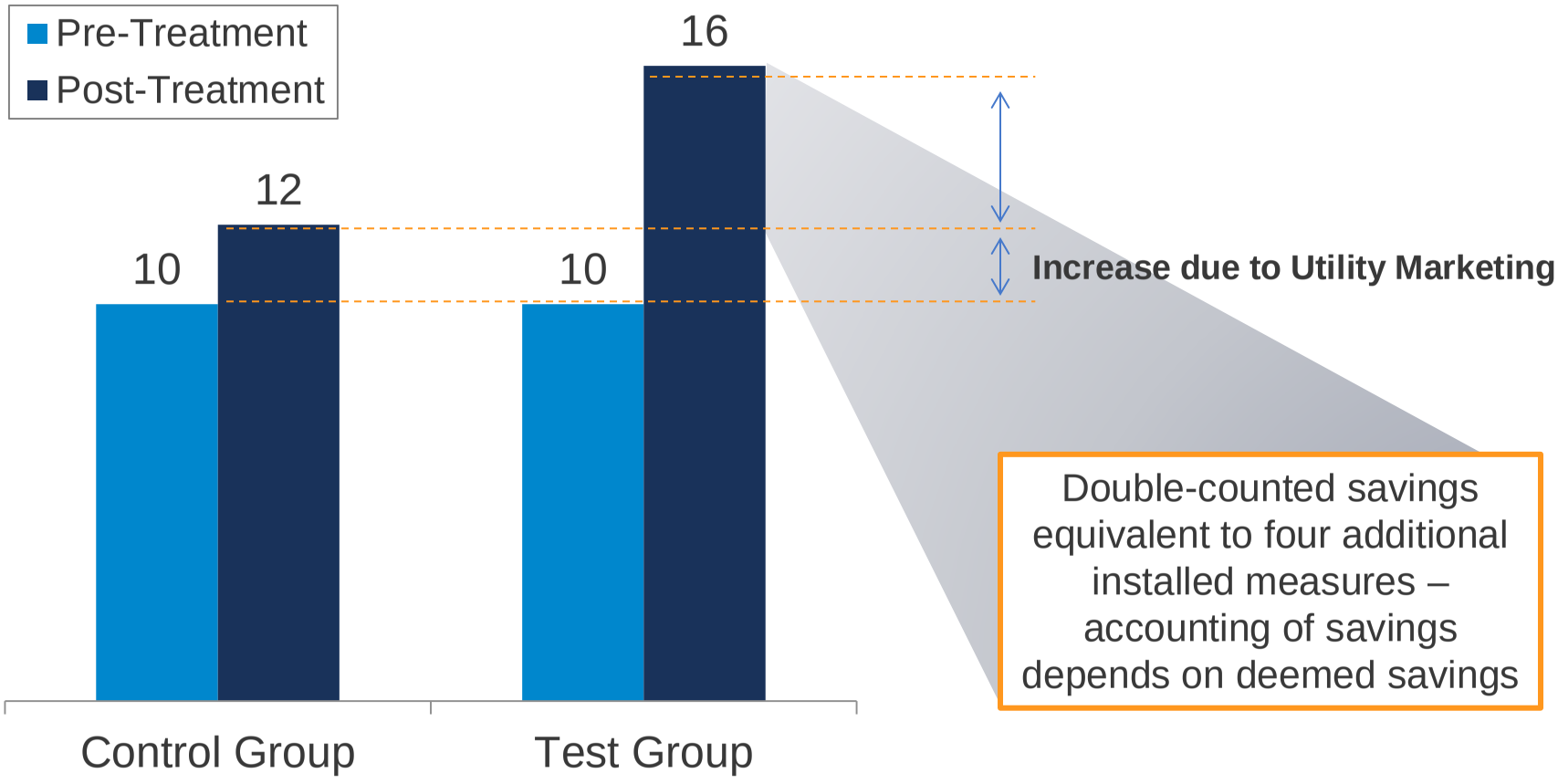
RCTs enable easy accounting for double-counted savings

A differences-in-differences approach accurately measures these savings

Program Participation Accounting



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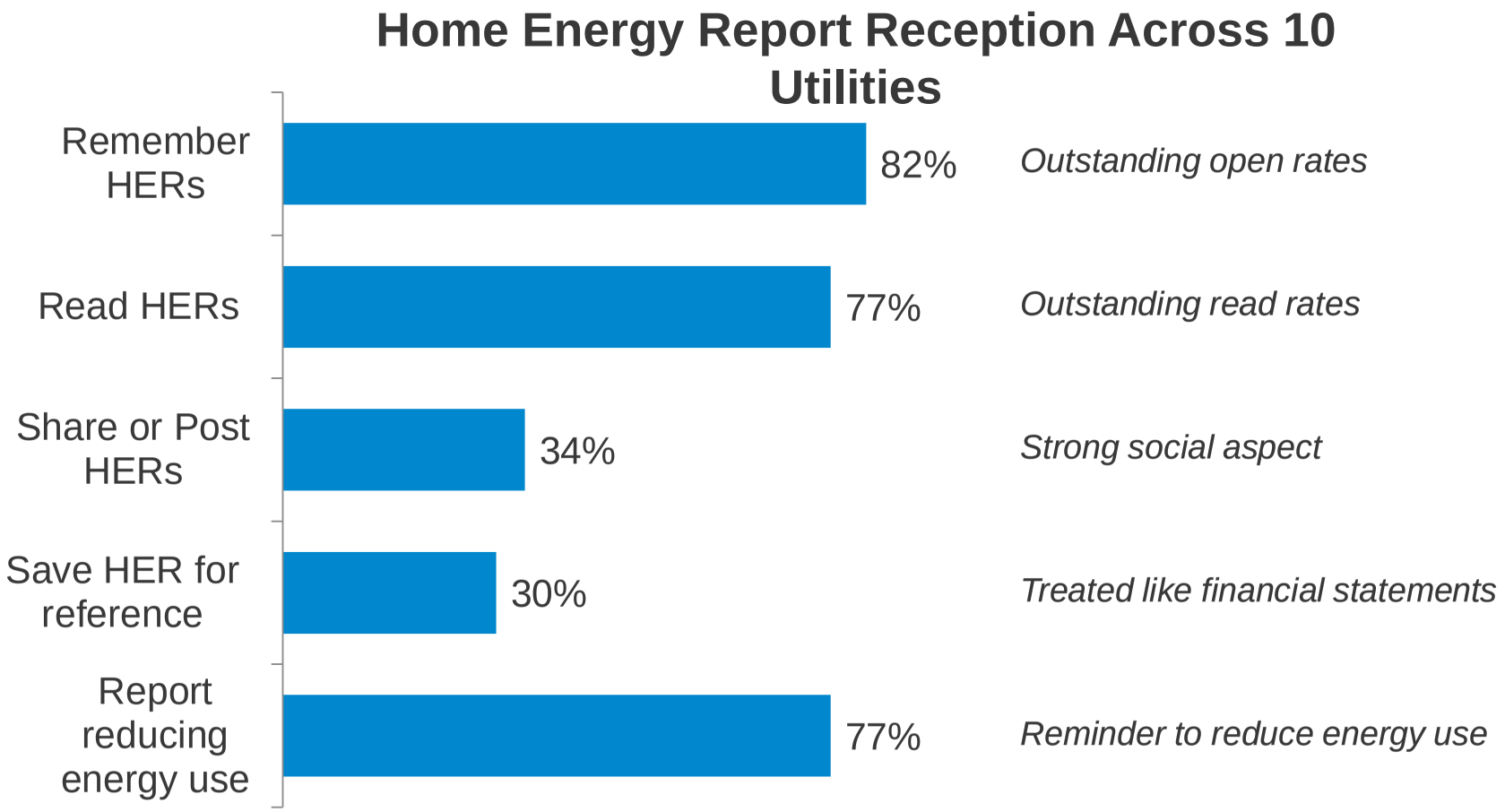
Quantitative research supplements billing analysis to deliver a holistic evaluation



Based on surveys across 10 utilities with 5079 treatment group interviews. Respondents could select more than one answer.

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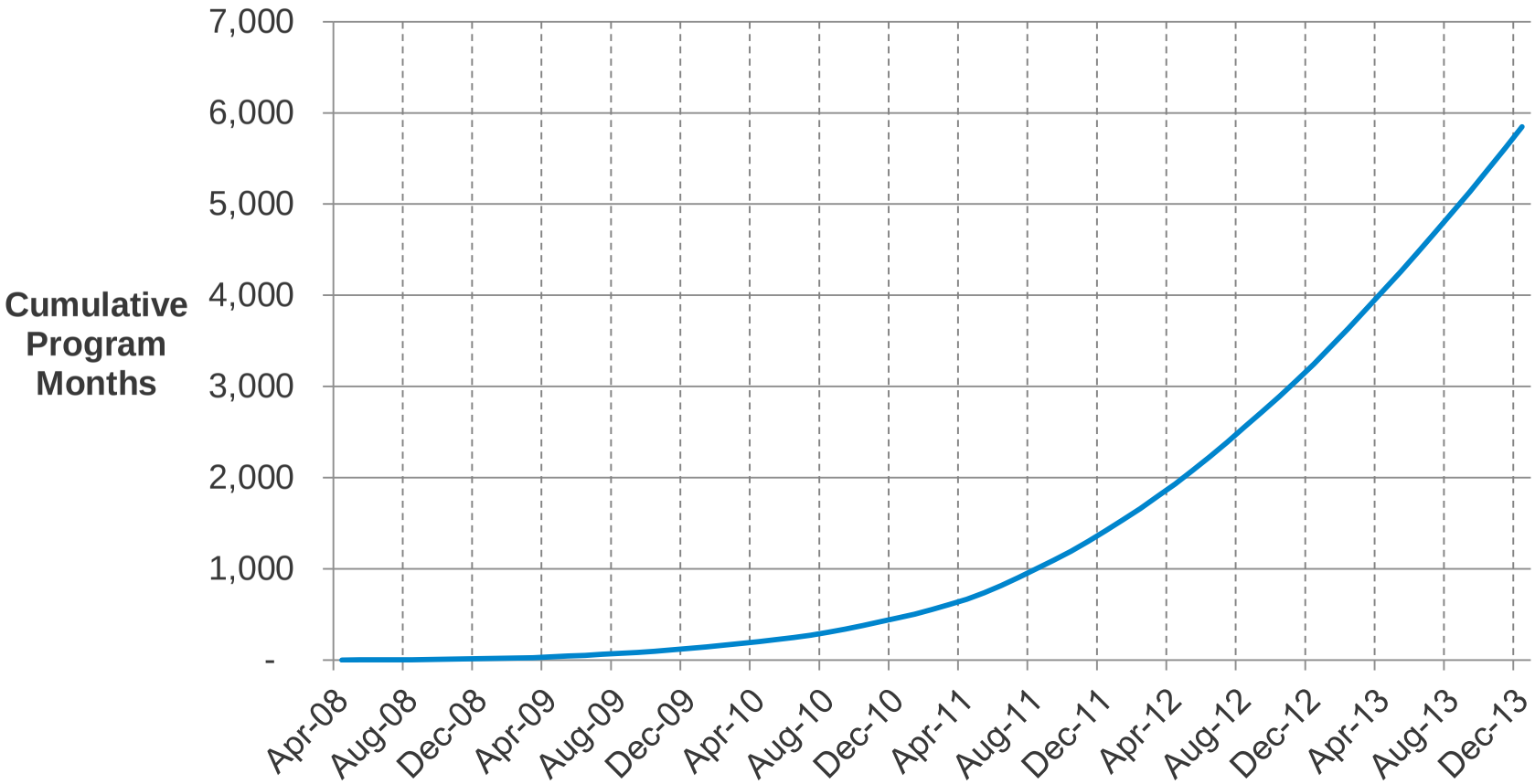
World's largest residential EE dataset

Opower bases forecasts off of nearly 500 program years of results

Cumulative Observations

Program Months



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Accounting for Opower Savings

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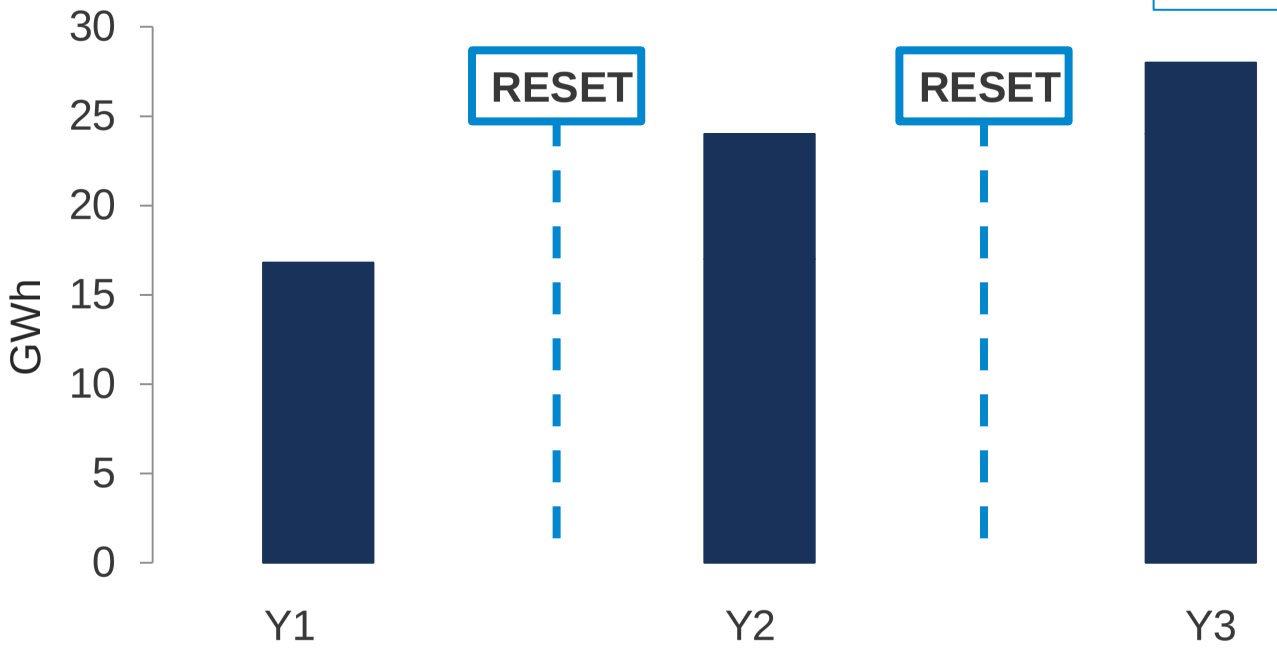
Attachment 2, Page 18 of 45

Original behavioral EE accounting: utilities counted full savings each year

ILLUSTRATIVE



Total savings from behavioral programs counted each year – which can overvalue behavioral EE savings in an incremental EERS framework.

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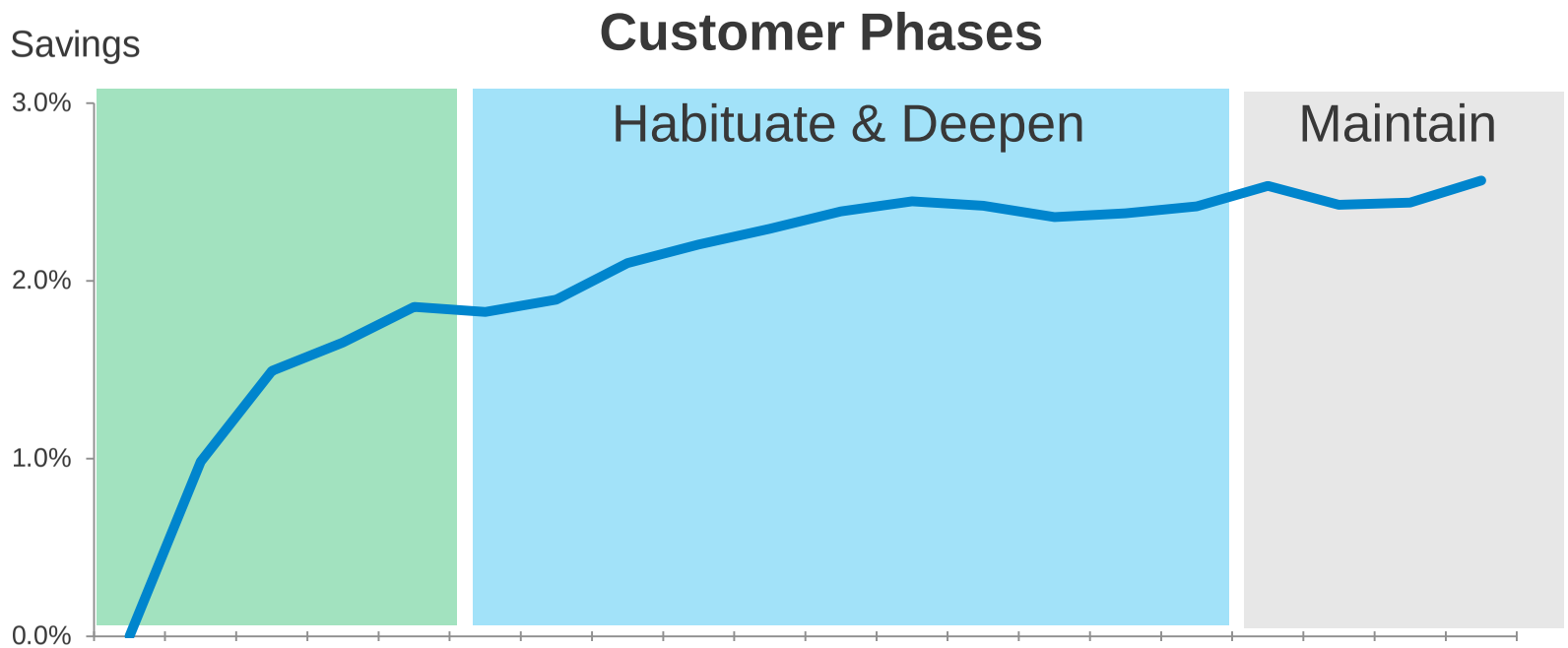
Now we know: Opower savings curve over time



- Savings rapidly increase
- Reports are novel; customer have high recall and sharing rates

- Savings continue to grow gradually
- Savings are smooth between reports; customers have developed daily efficiency habits
- Customers exhibit “tracking” behavior with reports

- Savings grow at reduced rate
- Customers continue to exhibit tracking behavior

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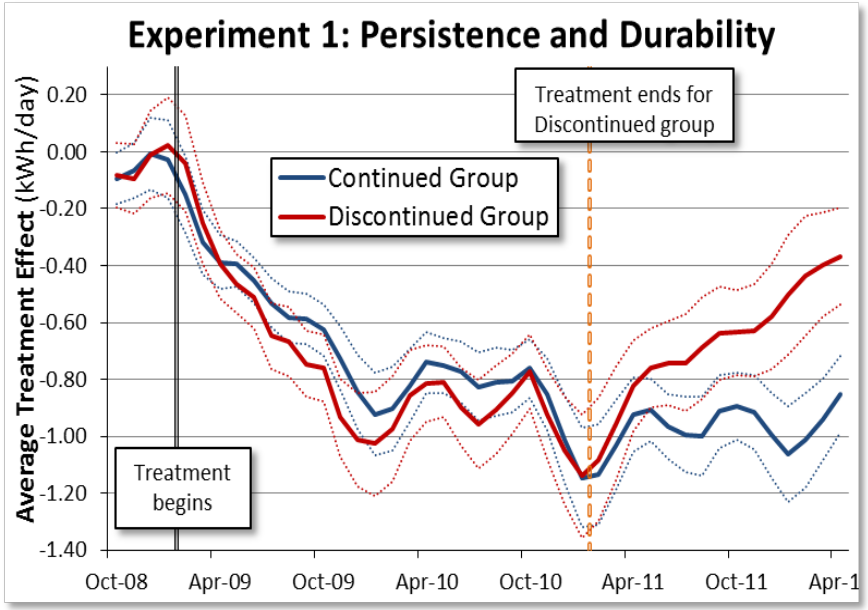
Multiple Evaluations Demonstrate that Savings Persist

Allcott and Rogers (2012)

- Savings erode once reports stop, but gradually
- Two thirds of the treatment effect remains after two years
- Equivalent to a savings decay rate of ~19% per year



Discontinued group still saves after treatment ends

Other independent evaluations also find that savings persist:

- KEMA Energy and Sustainability (2012)
- Faruqui, Ahmad, and Sanem Sergici (2012), The Brattle Group
- Wu, May (2012), Integral Analytics, Inc with Building Metrics Incorporated and Sageview
- NMR Group, Tetra Tech, and Hunt Allcott (2013)

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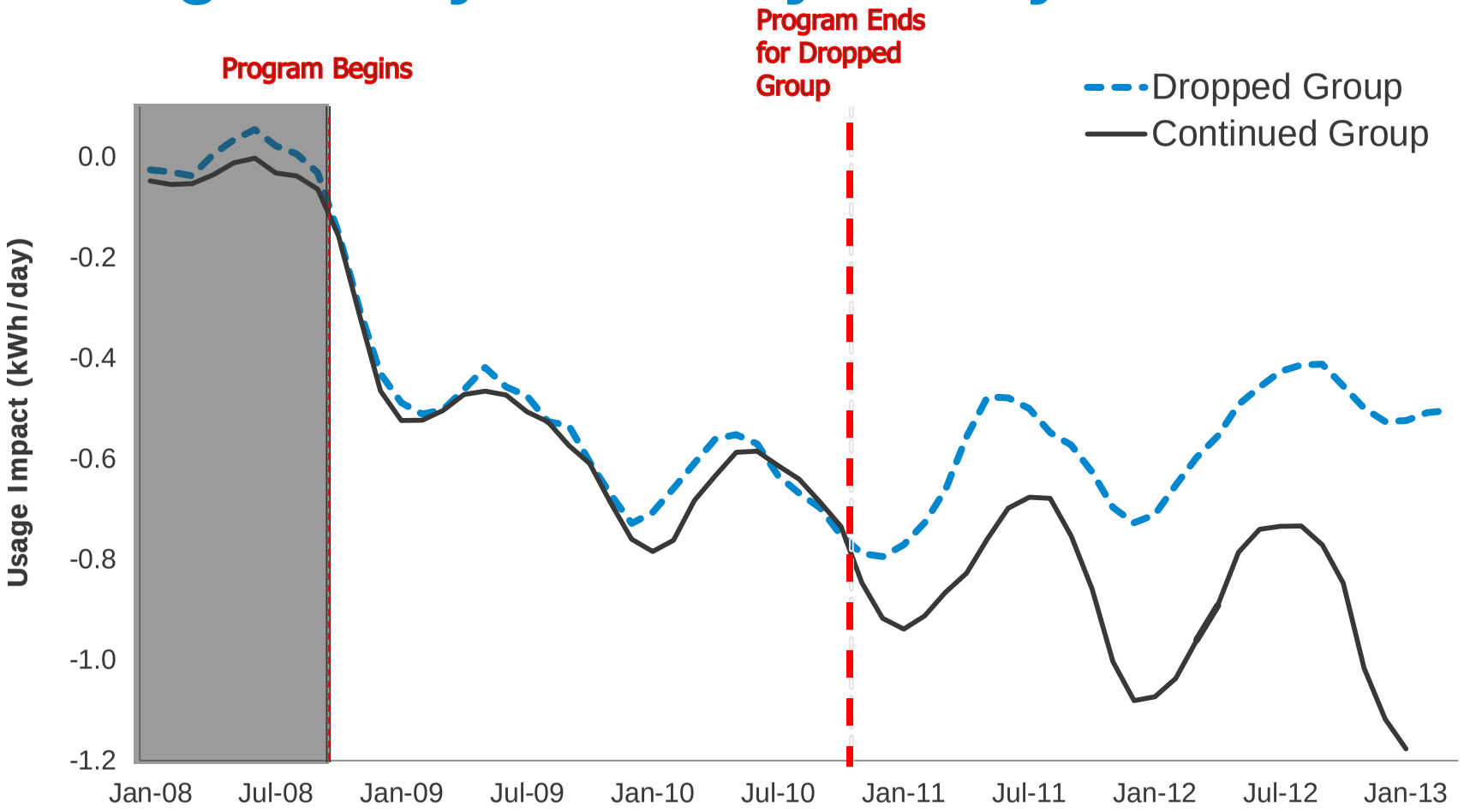
Research shows after two-year treatment savings decay relatively slowly



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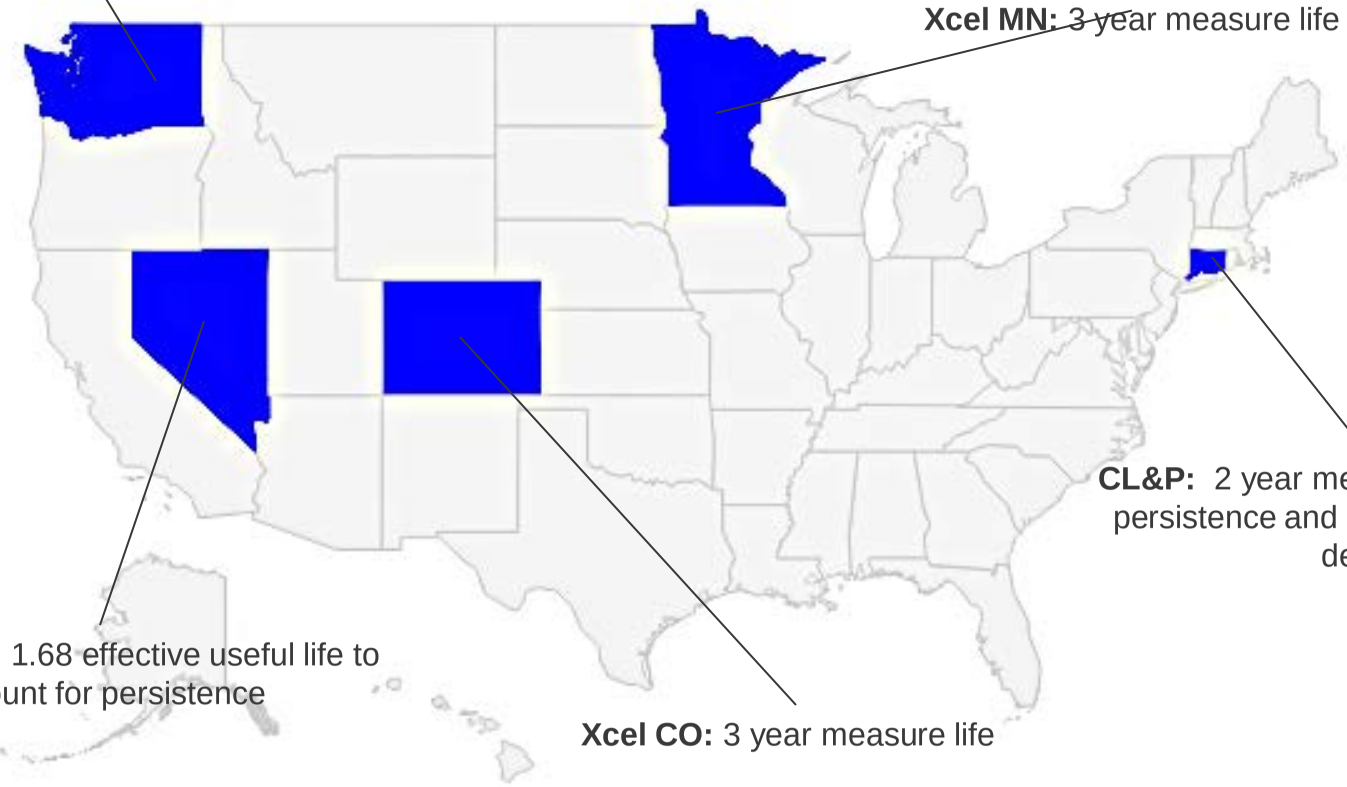
Because of persistence, some utilities & regulators now use longer measure life

Avista: 3 year measure life, including concept of persistence
PSE: 2 year measure life

Minnesota's Division of Energy Resources: Recommended that behavioral projects have a minimum lifetime of five years, so long as treatment continued for three years, so as to account for persistence.

Xcel MN: 3 year measure life



CL&P: 2 year measure life, including persistence and concept of avoided decay

NV Energy: 1.68 effective useful life to account for persistence

Xcel CO: 3 year measure life

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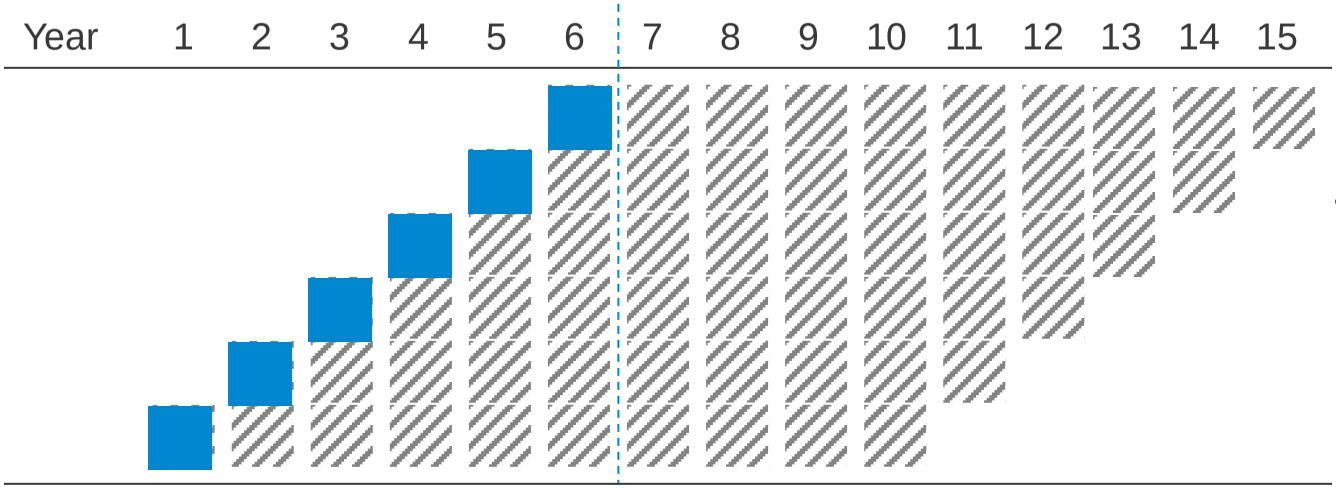
A typical EE program:

Running a refrigerator rebate program for 6 years:



Program Assumptions:

- 10,000 rebates distributed per year @ $55 each
- 100 M3 savings per measure per year
- 10 year measure life for installed measure

= 1 M3

There are two main ways to assess the savings benefits:

1. **What new, annual savings are being delivered?** We count the savings added each year.

2. **How cost-effective is the program?** To determine this we look to **all the costs** and **all the benefits** of the program.

Home Energy Reports fit in this framework as well.

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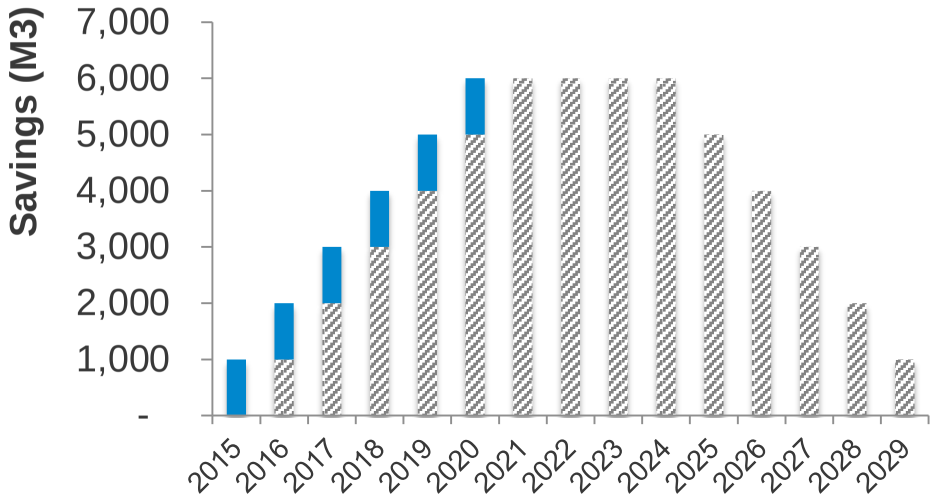
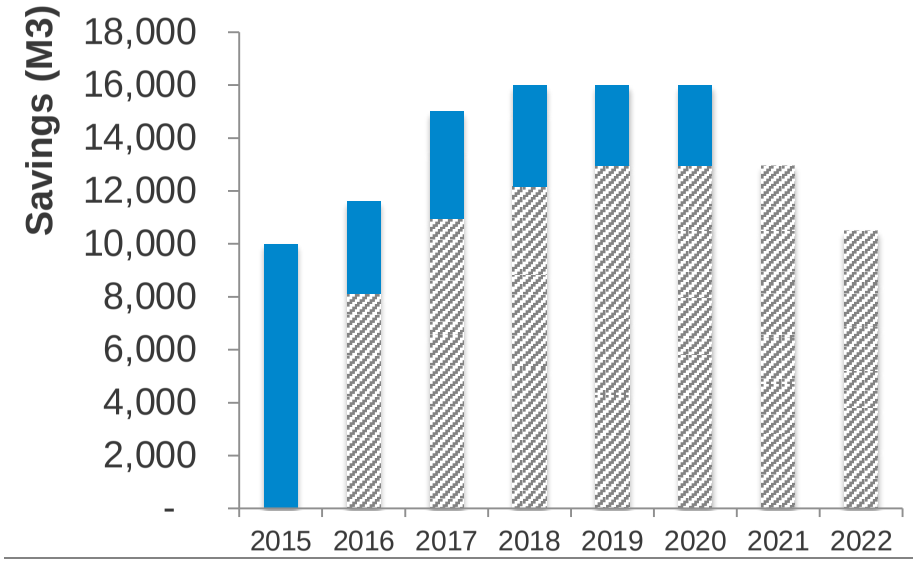
Accounting for savings



Program Name	Refrigerator Rebate
Participants	60,000
Program Years	6
Program Budget	$3,300,000
Expected Savings	6,000 M3 (incremental) 60,000 M3 (lifetime)
TRC	1.1
LUEC	$0.055



Program Name	Home Energy Reports
Participants	100,000
Program Years	6
Program Budget	$6,000,000
Expected Savings	16,000 M3 (incremental) 110,000 M3 (lifetime)
TRC	1.1
LUEC	$0.055

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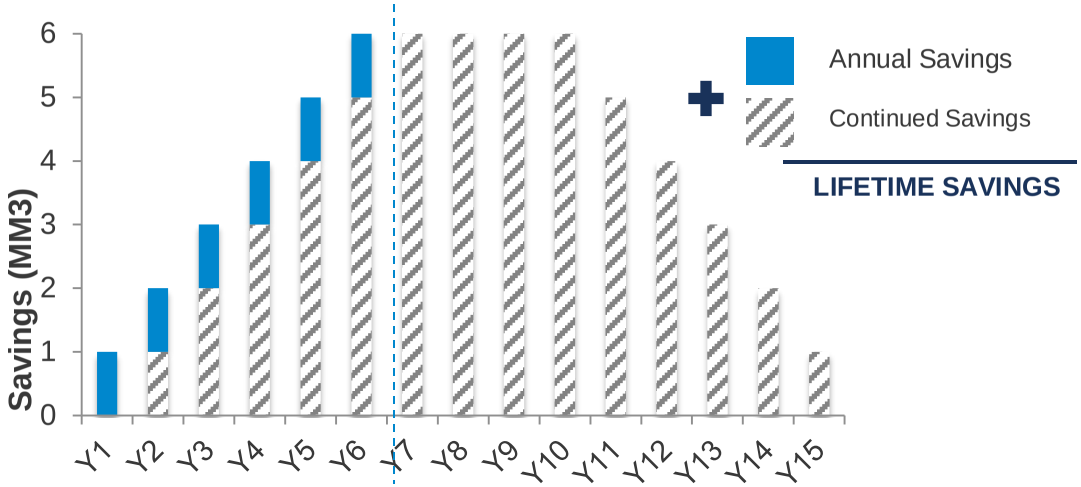
A typical EE program:

Running an installed measure program for 6 years:



Program Year	Annual Savings (MM3)	Lifetime Savings (MM3)
PY1	1	10
PY2	1	10
PY3	1	10
PY4	1	10
PY5	1	10
PY6	1	10
TOTAL	**6**	**60**

There are two main ways to assess the savings benefits:

1. **What new, annual savings are being delivered?** We count the savings added each year.
2. **How cost-effective is the program?** To determine this we look to **all the costs** and **all the benefits** of the program.

Behavioral programs fit in this framework as well.

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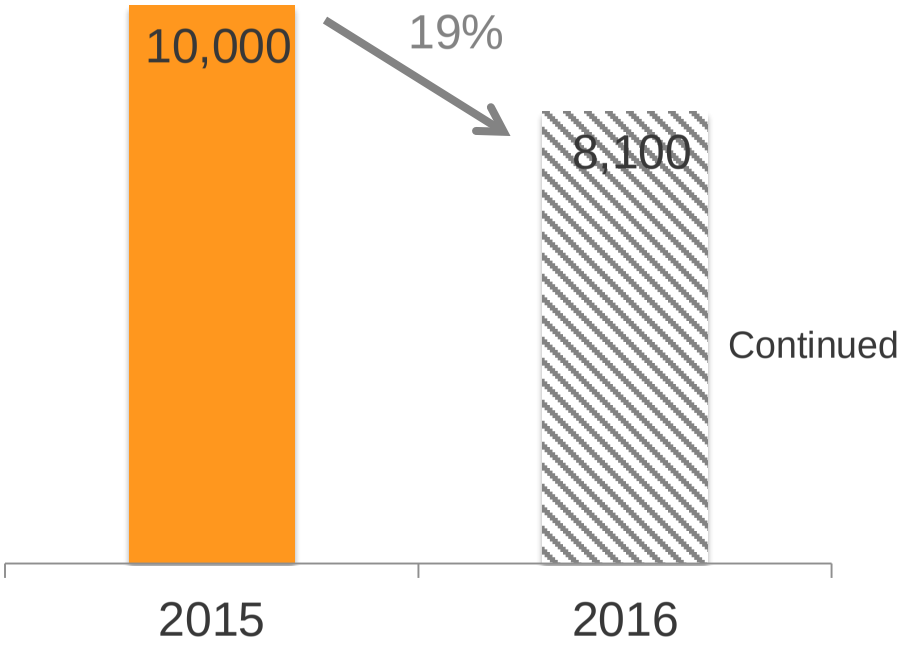
Example: Continued savings account for what happens if a program halted



» Continued: The savings that would occur after a program was suspended. In this example, savings would decline from 10,000 M3 to 8,100 M3 (19% decay) if the program stopped after 2015.

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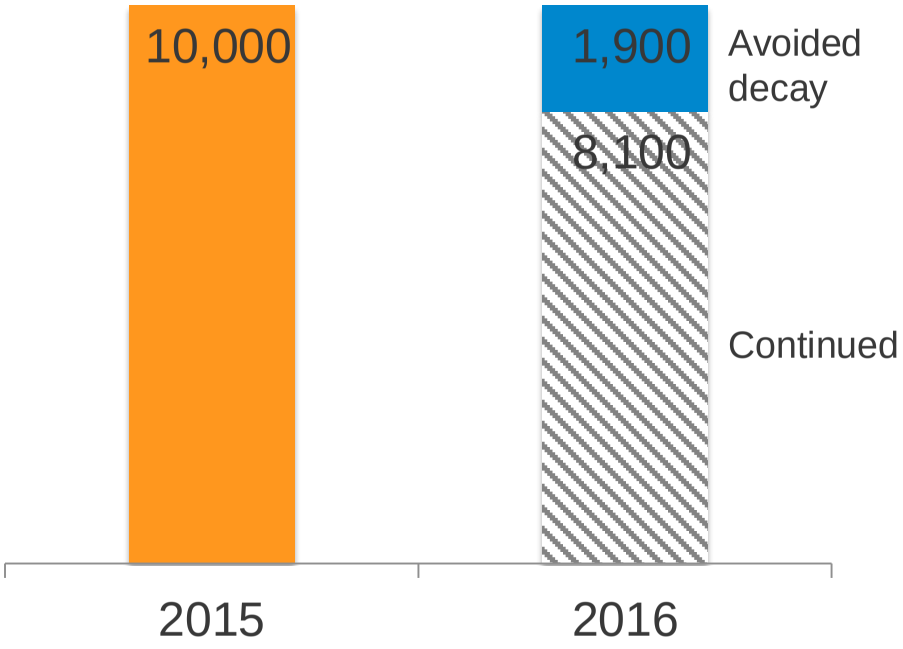
Example: Avoided decay reflects savings preserved by continuing the program



- Continued: The savings that would occur after a program was suspended. In this example, savings would decline from 10,000 M3 to 8,100 M3 (19% decay) if the program stopped after 2015.
- Avoided decay: Continuing the program into 2016 avoids the 19% decay.

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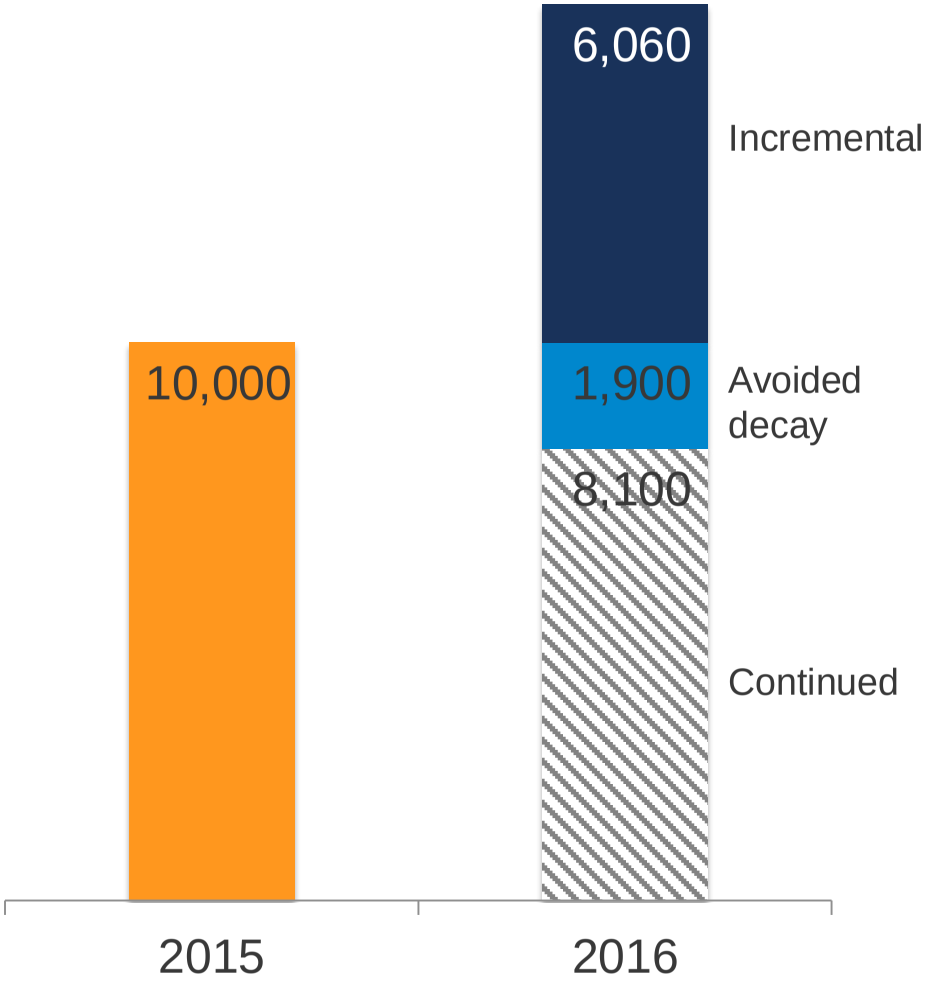
Example: Incremental savings capture the benefit from the ramp in savings rates



- Continued: The savings that would occur after a program was suspended. In this example, savings would decline from 10,000 M3 to 8,100 M3 (19% decay) if the program stopped after 2015.
- Avoided decay: Continuing the program into 2016 avoids the 19% decay.
- Incremental: Increase in savings over prior year.

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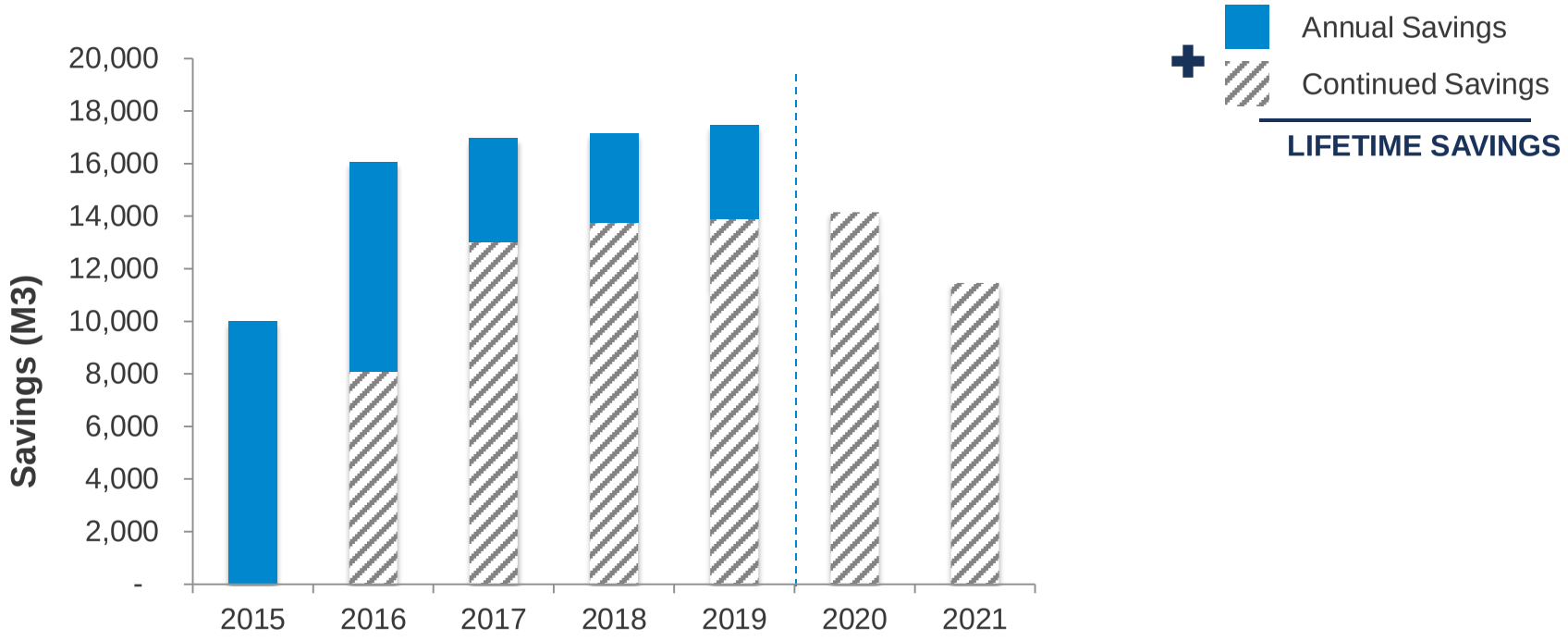
Revised behavioral EE accounting: how it works to incorporate persistence

This approach includes **new incremental savings and avoided decay** as annual savings.



Savings that continue from previous treatment are added to calculate **lifetime savings**, which are used to determine the cost-effectiveness of the program.

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Accounting vs. Measure Life

Our understanding of persistence suggests that our measure life is greater than one and will vary, increasing with the maturity of our program.

Behavioral Programs

Measure Life = Lifetime Savings ÷ Annual Savings

Installed Measures

Annual Savings × Measure Life = Lifetime Savings

- If calculating measure life as an output, behavioral programs have measure life that is based on the ratio of lifetime to annual savings, and thus varies each year.
  - This ratio should be calculated to include persistence using a given decay rate (ex. 19%) as an input.
- As behavioral programs mature, lifetime savings grow with respect to annual savings as a greater amount of overall savings continue in subsequent years, thereby increasing the calculated measure life.

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Approaches to measure life

Variable Measure Life

- **Pros:** Most accurate, based on latest studies of behavioral efficiency
- **Cons:** Complicated to fit into current accounting structure

	Annual savings (M3)	Lifetime savings (M3)	Measure Life
2015	10,000	24,661	2.5
2016	7,960	24,945	3.1
2017	3,964	18,312	4.6
TOTAL	21,924	67,917	3.1

Average Measure Life

- **Pros:** Relatively simple and accurate
- **Cons:** Undervalues lifetime savings in later years

	Annual savings (M3)	Lifetime savings (M3)	Measure Life
2015	10,000	30,000	3
2016	7,960	23,880	3
2017	3,964	11,892	3
TOTAL	21,924	65,772	3

Steady-state Measure Life

- **Pros:** Maximizes lifetime savings, best represents mature program
- **Cons:** Overstates lifetime savings in initial years

	Annual savings (M3)	Lifetime savings (M3)	Measure Life
2015	10,000	50,000	5
2016	7,960	39,800	5
2017	3,964	19,820	5
TOTAL	21,924	109,620	5

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Attachment 2, Page 32 of 45

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Small and Medium Commercial Engagement

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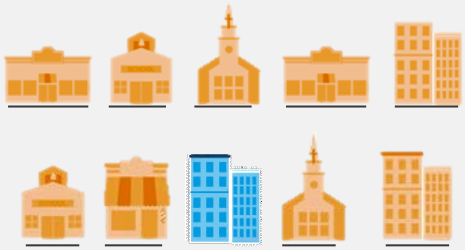
Attachment 2, Page 33 of 45

SMBs are important but underserved

- 5x more energy than homes
- Influential community members

Expect targeted solutions from their utility:



90%

Participation in utility SMB programs:

< 5%

Accenture, New Energy Consumers 2013
Opower market intelligence, participation rate from 51 SMB program filings

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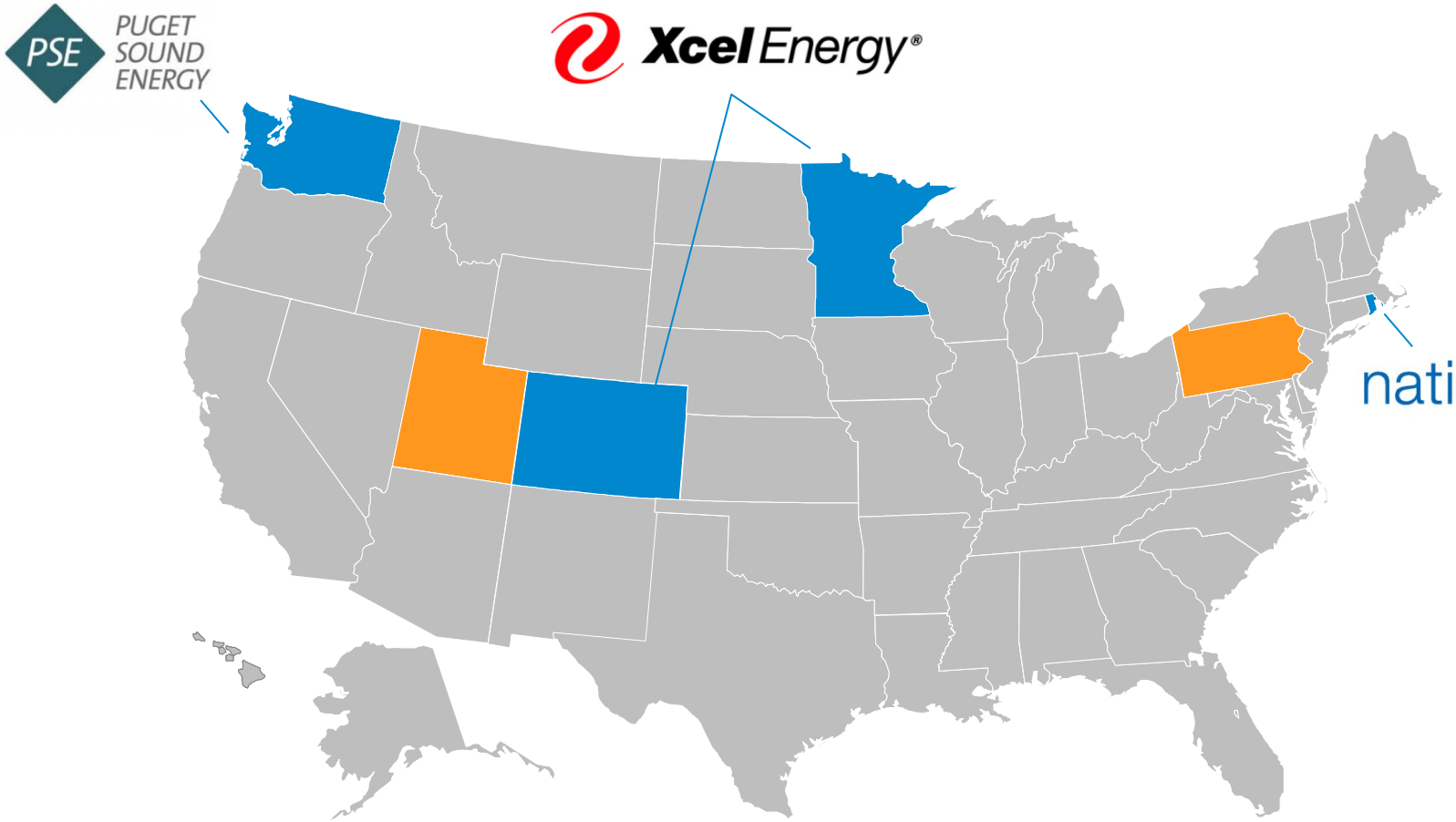
Attachment 2, Page 34 of 45

Four SMB programs live in 2014

Two additional programs contracted to deploy in 2015



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Attachment 2, Page 35 of 45

SMB segment presents unique challenges

Like residential customers, SMB owners are disengaged…

- Strapped for time
- Not knowledgeable about energy

Unlike residential, there are unique challenges…

- Heterogeneous market
- Data isn't good
- Can't reach champion
- Others impact use

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Attachment 2, Page 36 of 45

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Understanding SMBs

In-depth, onsite interviews:

East and west coast locations

Rural and urban settings

Hour long sessions

Research focused on three areas:

1. Understanding SMBs

- Decision making
- Agency
- Energy use

2. Validating product design

- Emotional reaction
- Perceived value
- Perception of utility

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Attachment 2, Page 37 of 45

Enhanced data acquisition & validation

	Data type	Example fields	Sources
	1. Personal identifiable information	Business name, address, phone number, usage	UtilityCo
	2. Core business data	Business type, square footage, and contact name	D&B
	3. Supplementary data	Mailing address, contact person, title, and phone number Cuisine type & open hours	infogroup + factual
	4. Manual research + extra personalization	Validate the information above Grab business logo (where available) or map	amazon mechanical turk + Google + Company website
	5. Customer input	Contact person, mailing address, business type, email address, square footage	Prompted to update info on program communications

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Proprietary segmentation goes beyond NAICS

	20% of SMBs	*65% of SMBs*	*15% of SMBs*
	No treatment for poor candidate industries	**Personalized experience** for most industries	**Tailored reporting** for priority industries
Examples	• Radio towers • Stop lights • Tunnels • Manufacturing • Mines • Construction • Agriculture	• Lodging • Education • Religious organizations • Healthcare • Offices • Warehouse storage	• Food service i.e. restaurants and bars • Retail stores & services
		Includes **220+** sub verticals	Includes **80+** sub verticals

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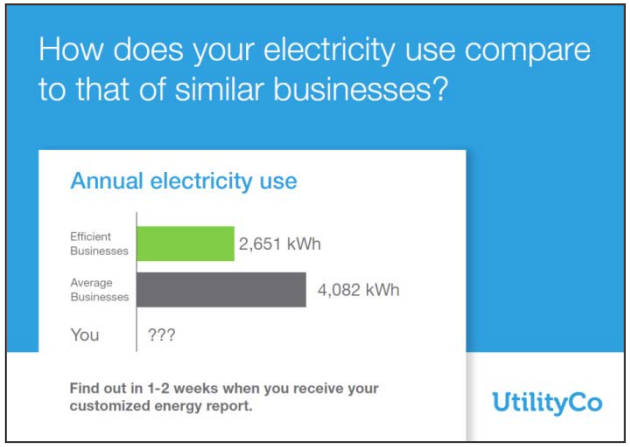
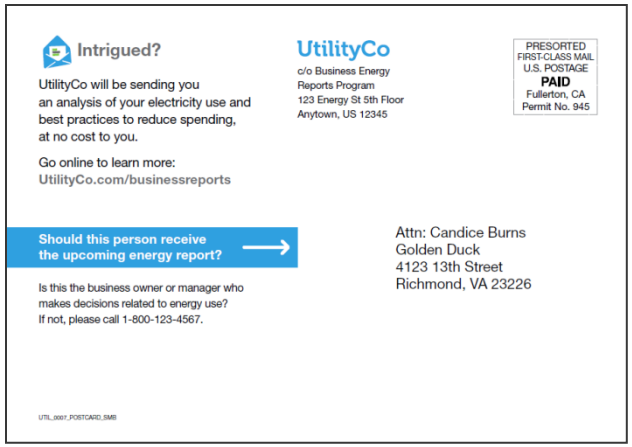
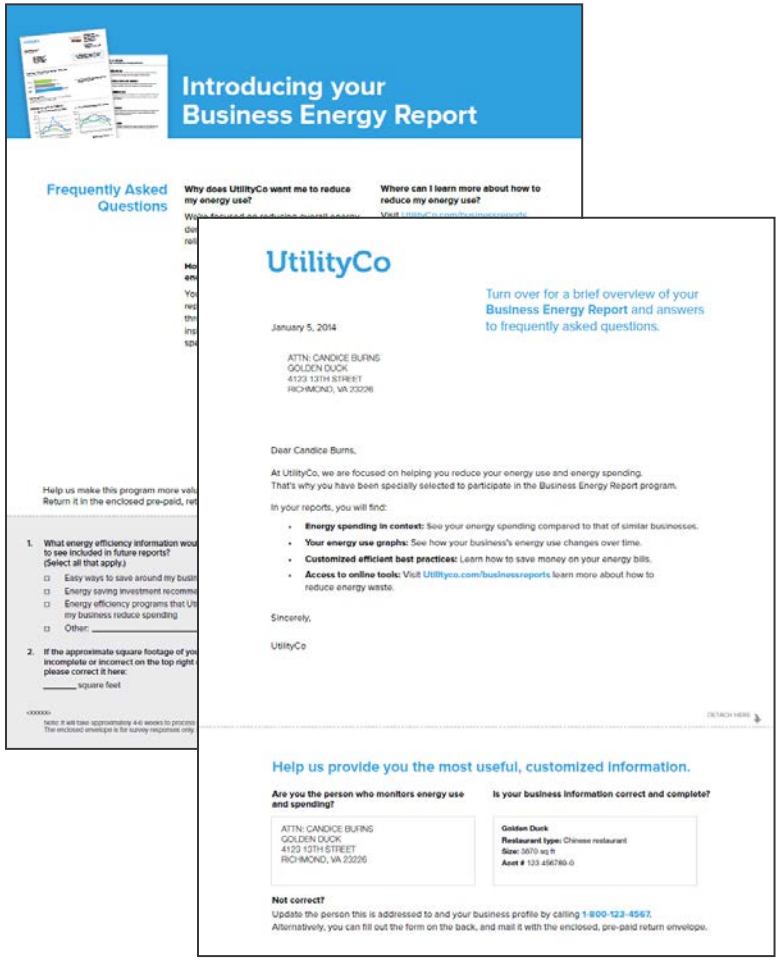
Attachment 2, Page 39 of 45

Pre-program communications

Reach the right person and confirm customer information







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Attachment 2, Page 40 of 45

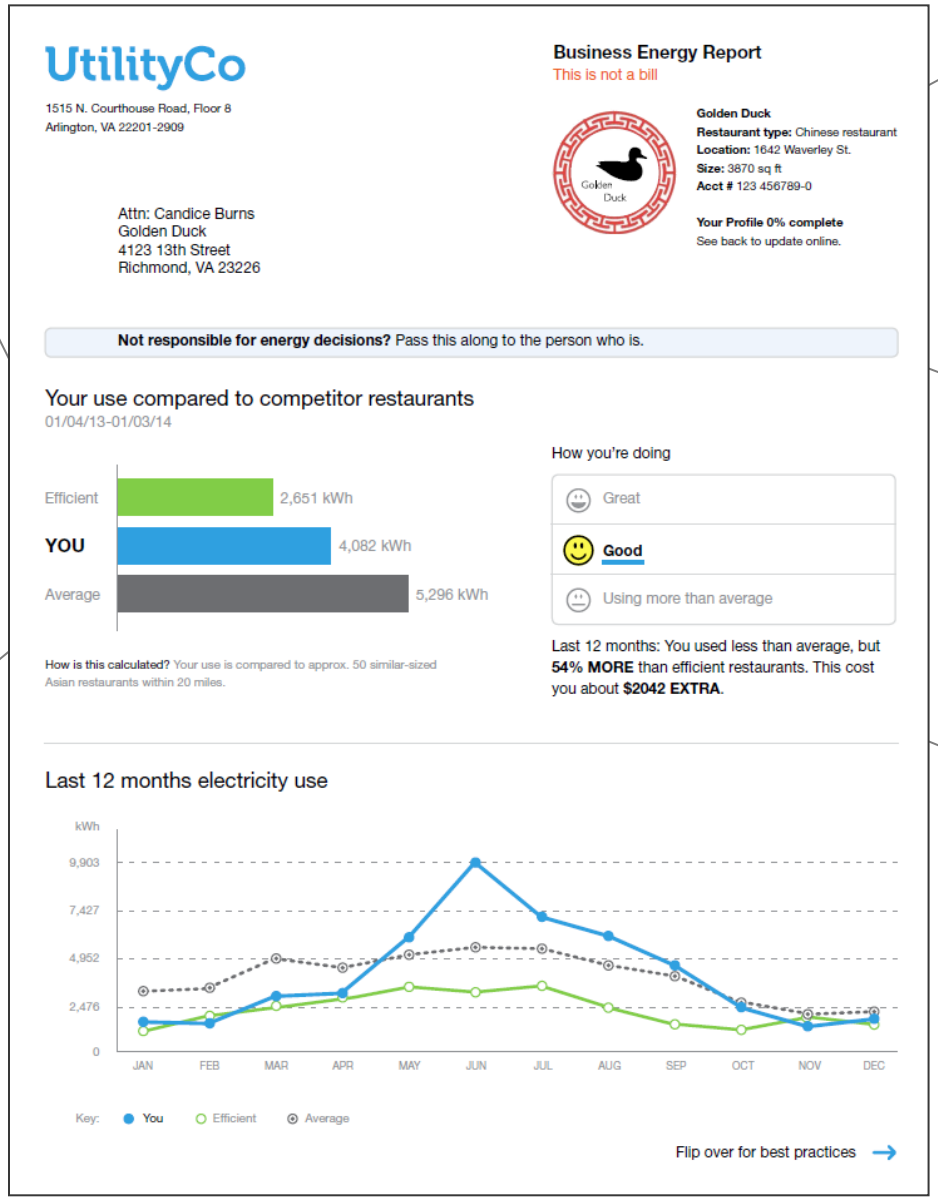
Proactive energy reporting

Assume people don't care

Highly specific normative comparison with competitor language makes energy strategic

Design for everyone

Personalized insights for 300+ verticals



Bombarded by junk mail

Logo and deep personalization front and center

Hard to reach the right person

Instructions to deliver to the decision maker

Design for how people actually behave

Highlight bottom line impact

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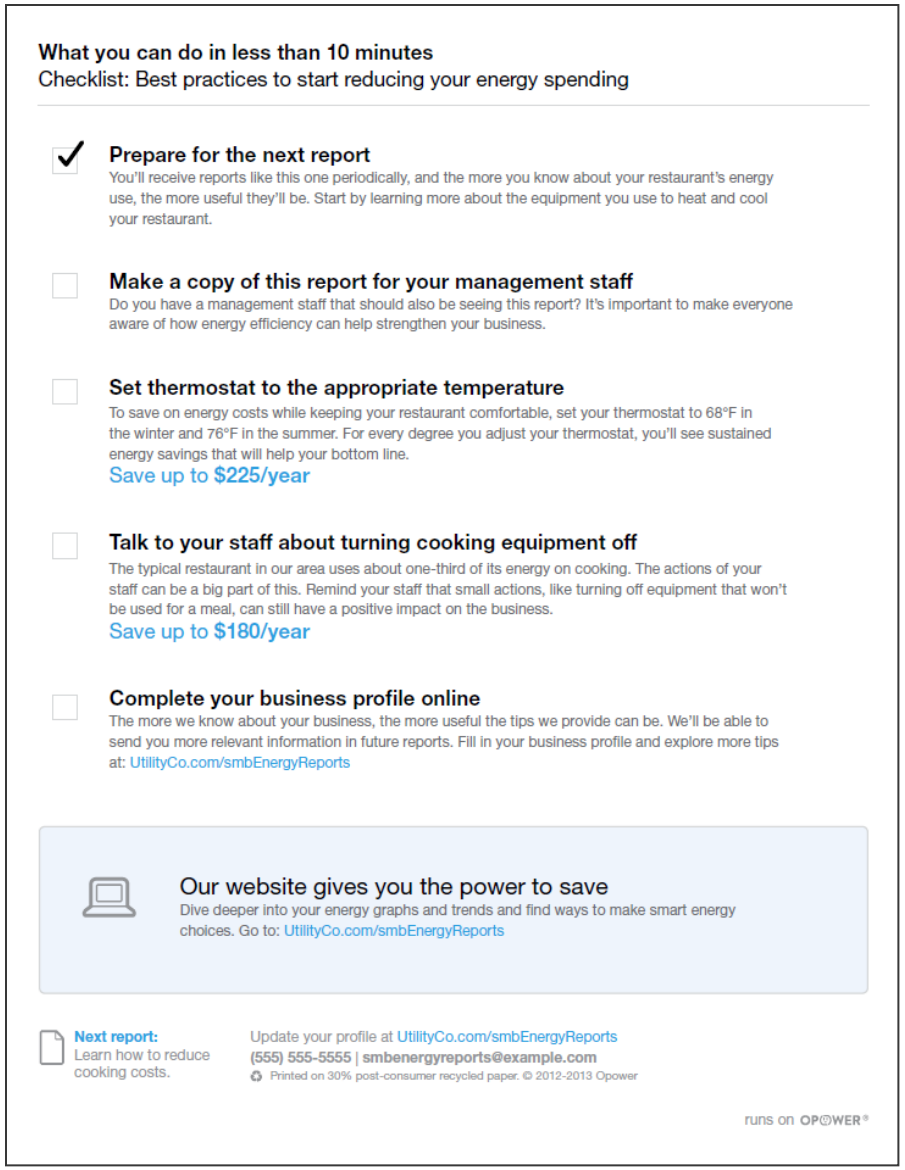
Attachment 2, Page 41 of 45

Proactive energy reporting

Not enough time or money to act

"What to do in less than 10 minutes" behavioral tips



What you can do in less than 10 minutes
Checklist: Best practices to start reducing your energy spending

- [x] **Prepare for the next report**
  You'll receive reports like this one periodically, and the more you know about your restaurant's energy use, the more useful they'll be. Start by learning more about the equipment you use to heat and cool your restaurant.
- [ ] **Make a copy of this report for your management staff**
  Do you have a management staff that should also be seeing this report? It's important to make everyone aware of how energy efficiency can help strengthen your business.
- [ ] **Set thermostat to the appropriate temperature**
  To save on energy costs while keeping your restaurant comfortable, set your thermostat to 68°F in the winter and 76°F in the summer. For every degree you adjust your thermostat, you'll see sustained energy savings that will help your bottom line.
  Save up to **$225/year**
- [ ] **Talk to your staff about turning cooking equipment off**
  The typical restaurant in our area uses about one-third of its energy on cooking. The actions of your staff can be a big part of this. Remind your staff that small actions, like turning off equipment that won't be used for a meal, can still have a positive impact on the business.
  Save up to **$180/year**
- [ ] **Complete your business profile online**
  The more we know about your business, the more useful the tips we provide can be. We'll be able to send you more relevant information in future reports. Fill in your business profile and explore more tips at: UtilityCo.com/smbEnergyReports

Our website gives you the power to save
Dive deeper into your energy graphs and trends and find ways to make smart energy choices. Go to: UtilityCo.com/smbEnergyReports

Next report: Learn how to reduce cooking costs.

Update your profile at UtilityCo.com/smbEnergyReports
(555) 555-5555 | smbenergyreports@example.com
Printed on 30% post-consumer recycled paper. © 2012-2013 Opower

runs on OPOWER

Aim for a lasting relationship

Paper report pushes to additional channels

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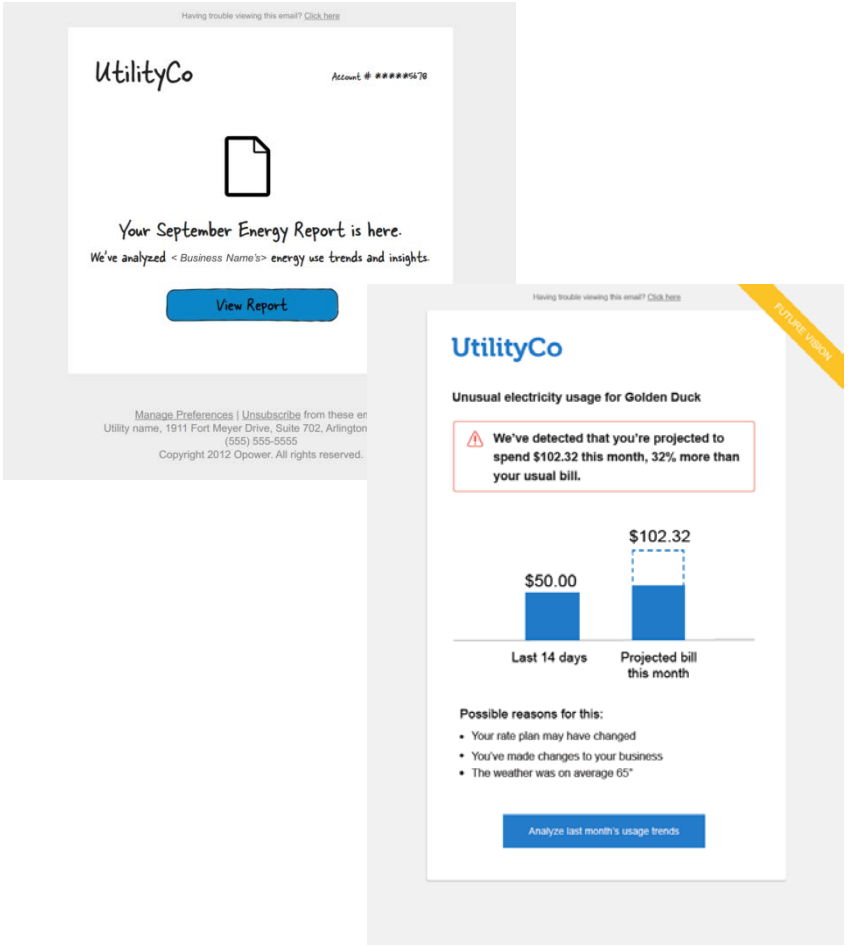
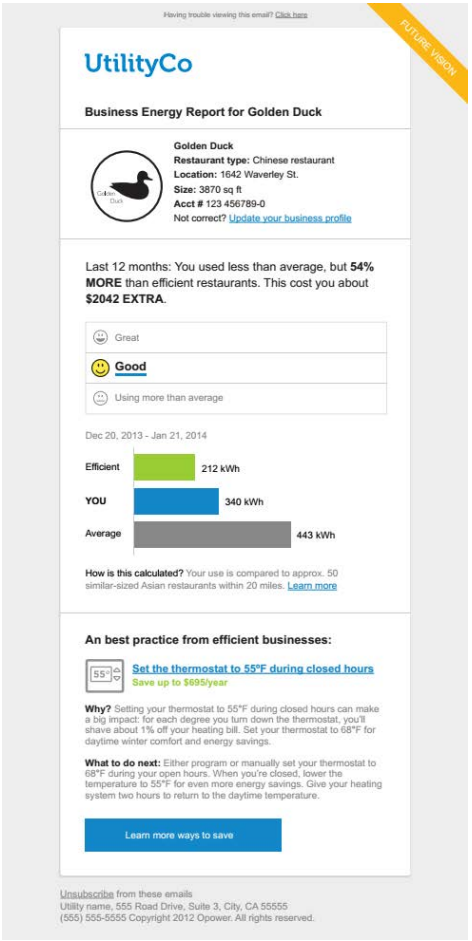
Attachment 2, Page 42 of 45

Proactive energy reporting

Email alerts and notifications



Electronic Business Energy Reports



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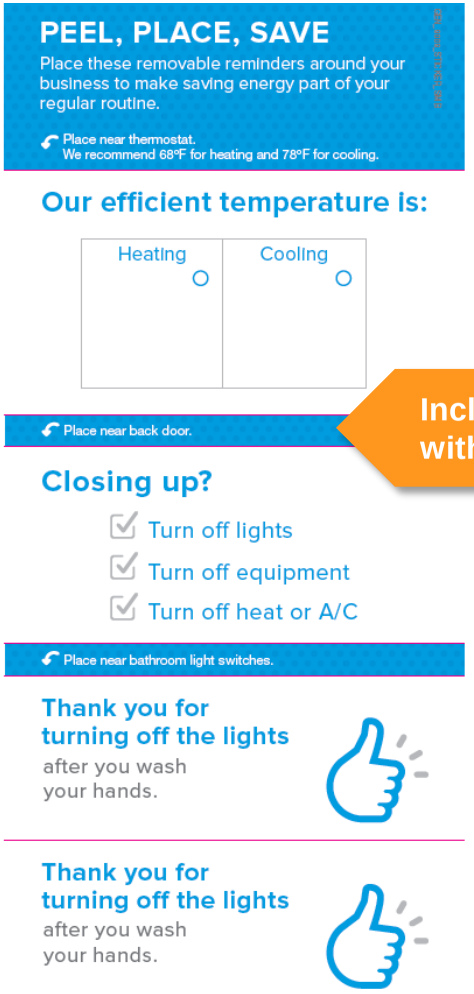
Attachment 2, Page 43 of 45

Enlisting employees & customers

Badges

Stickers



Included with report

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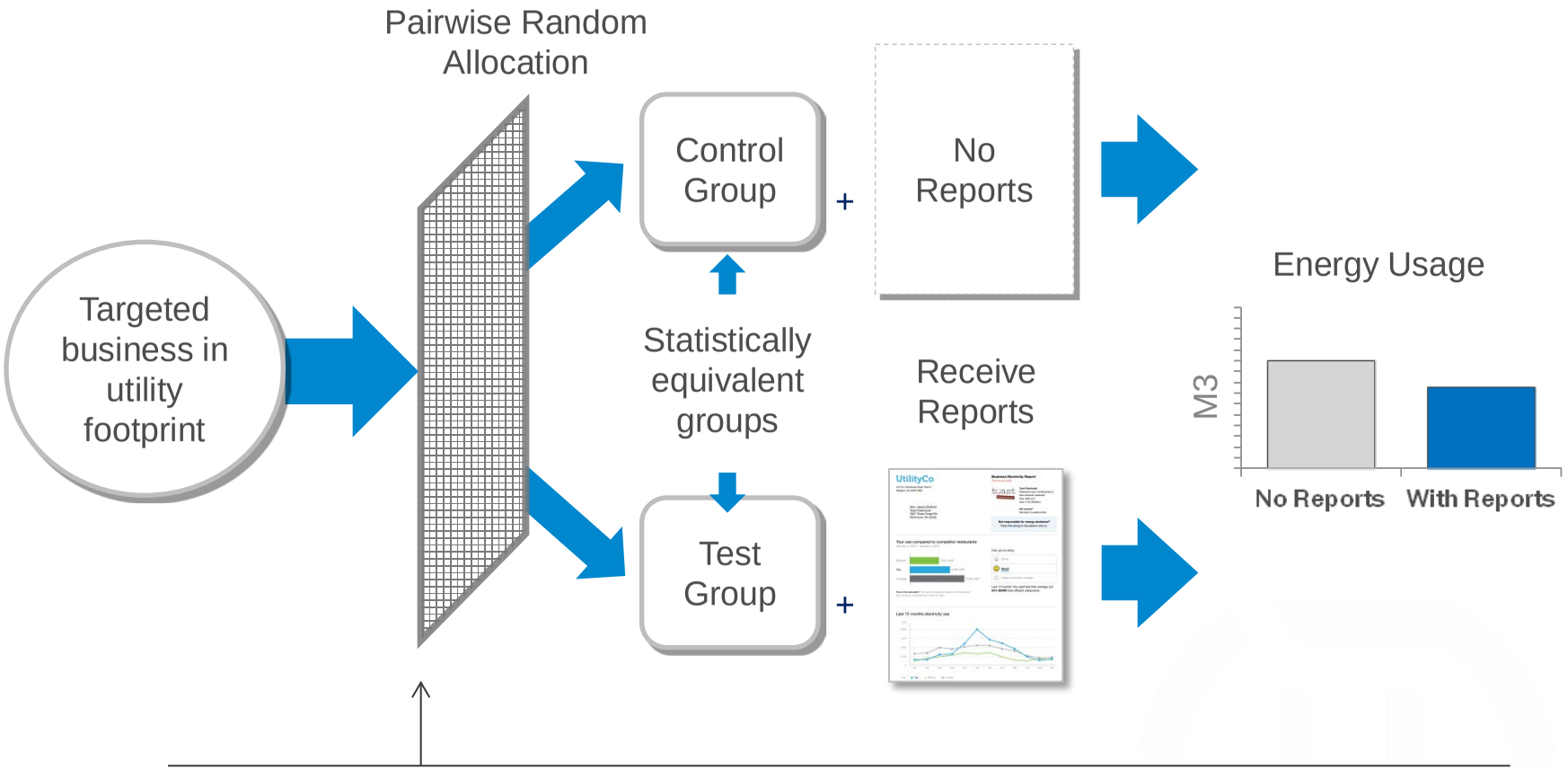
Attachment 2, Page 44 of 45

Measurement & verification



Pairwise randomization allows us to measure statistically significant savings at a more granular level

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Attachment 2, Page 45 of 45

nationalgrid

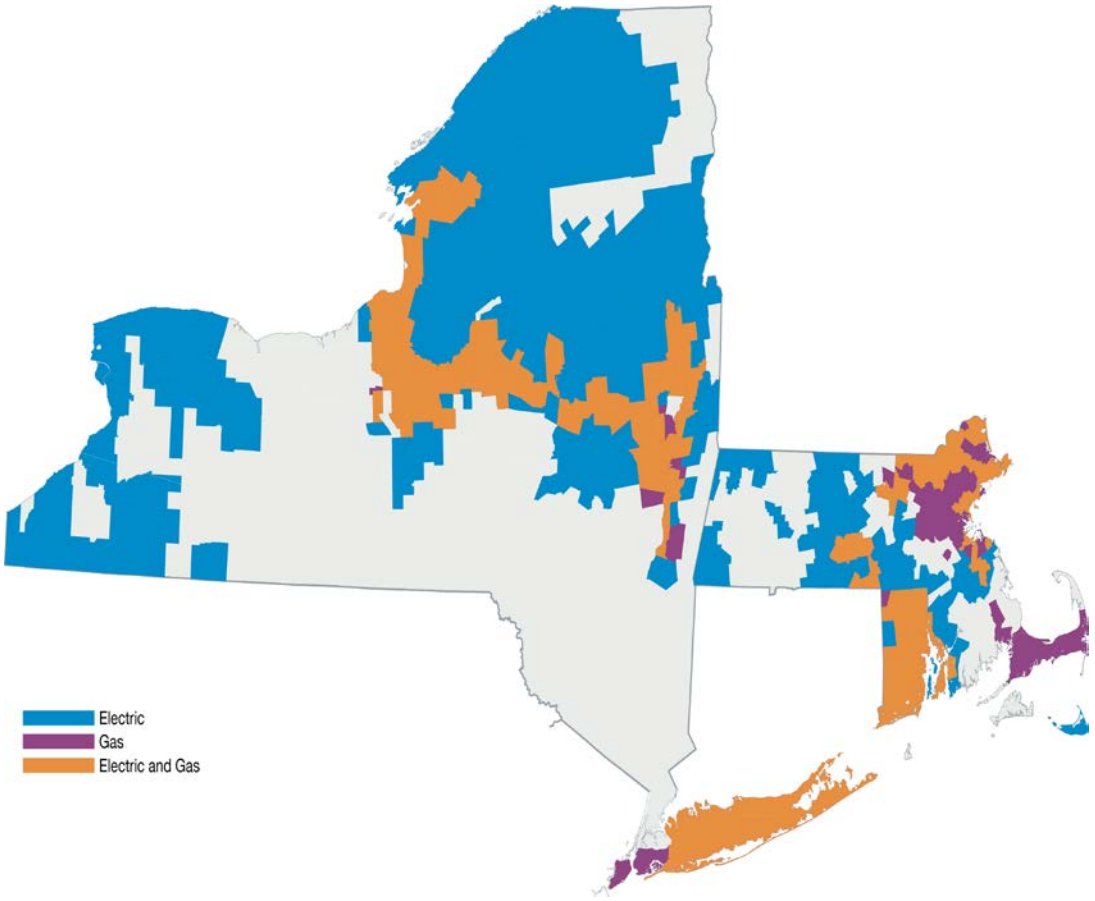
Behavioral Energy Efficiency

September 16, 2014
Tom Baron

Filed: 2015-09-03, EB-2015-0049, Exhibit J7.6
Attachment 2, Page 1 of 13

nationalgrid

Introduction To National Grid



- Based in the UK and the Northeast US
- One of the world's largest investor-owned utilities
- Product of Mergers & Acquisitions – legacy utilities
- Serving approx 3.5M electric & gas customers in MA, NY and RI

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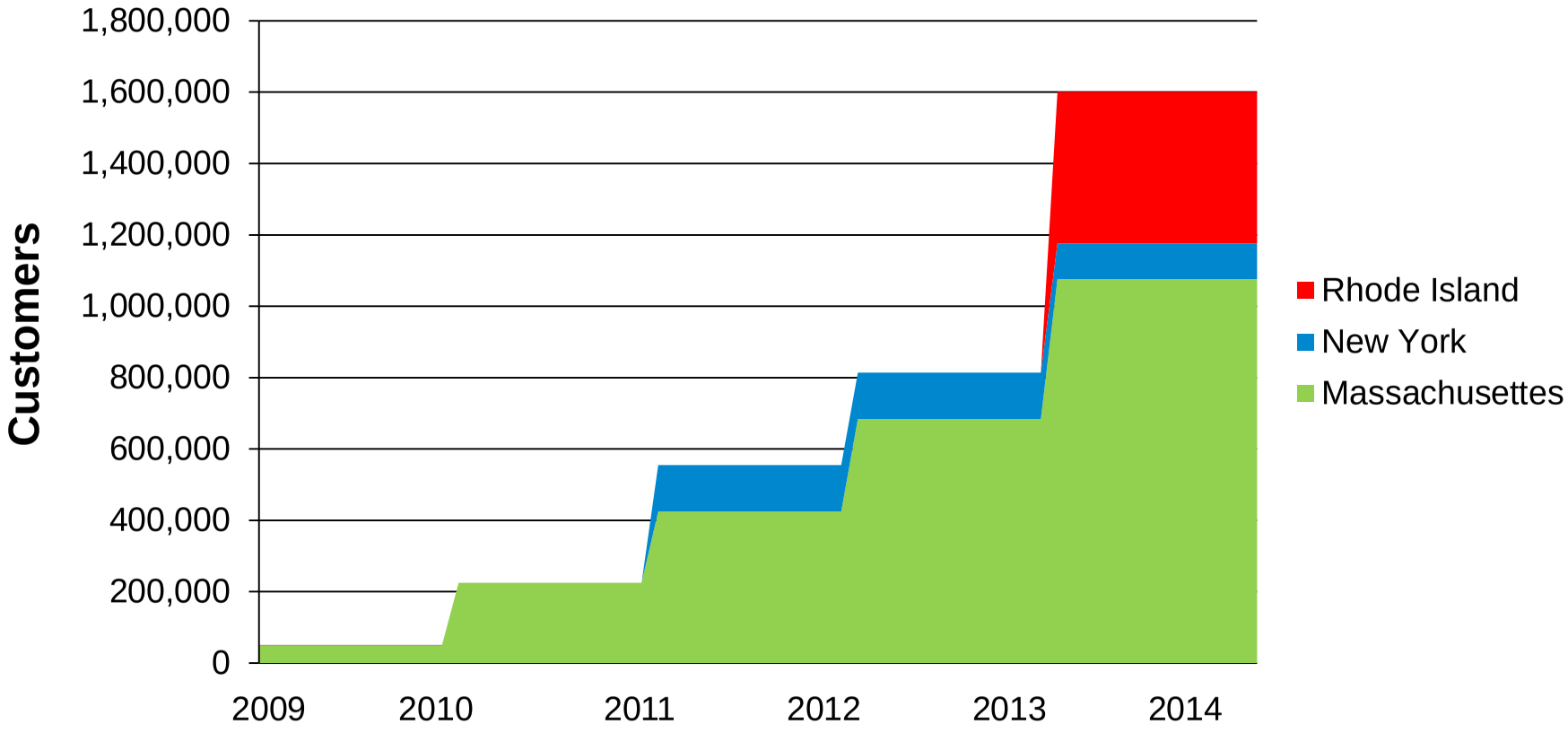
Attachment 2, Page 2 of 13

nationalgrid

Program Growth: 3 states, 5 years, 1.6M customers



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Attachment 2, Page 3 of 13

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Infrastructure: Cross Functional Team

Leverage Team Model

- Legal & Regulatory
- Procurement
- Evaluation (M&V)
- IT/Data Systems
- Marketing & Brand
- Media Relations
- Customer Service

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Attachment 2, Page 4 of 13

Identifying cost-effective households

» Program scaling led to:
  - Reaching more lower usage customers
  - Less cost effective

» Needed creative ways to reach additional households

Solution

- Email reports
- Less reports for more mature participants
- Community outreach

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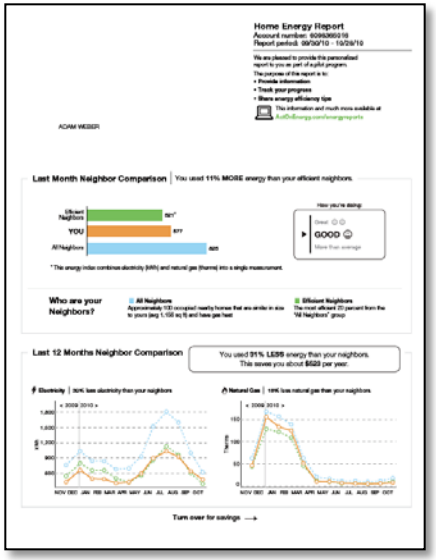
Attachment 2, Page 5 of 13

Beyond Paper Reports

Detailed Program Components

- E-mail across 40% of customer base to increase touch points
- Web for all customers
- Increasing program impact while keeping it fun:
  - Door Hangers
  - Wall Stick-Ons
  - Holiday e-Cards
- Customer Surveys: Phone, Paper, Online & In-Home



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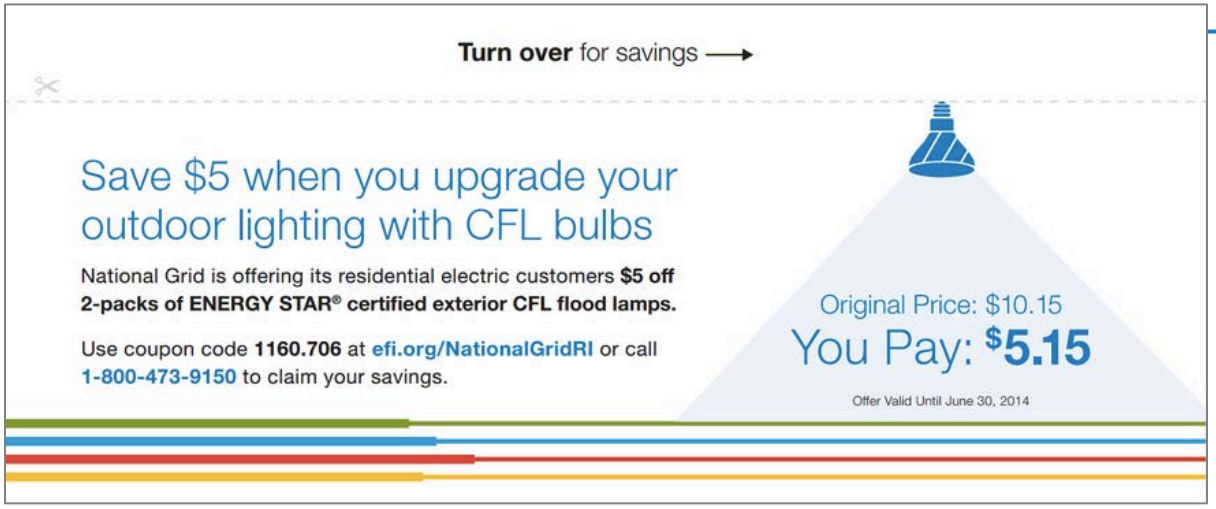
Supporting other objectives



Lift in EE program participation

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Attachment 2, Page 7 of 13

What makes Rhode Island different?

New experiences: New movers and opt-in

Rewards for saving

The RI Energy Challenge: Find Your Four!

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Attachment 2, Page 8 of 13

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Delivering Value

Results

- Savings: Meet and exceed aggressive annual savings targets
- Cost Effective: Pass Benefit/Cost Ratio (BCR) test

Savings

- 16,000,000 Therms
- 328,000,000 kWh
- $74,000,000 saved on utility bills

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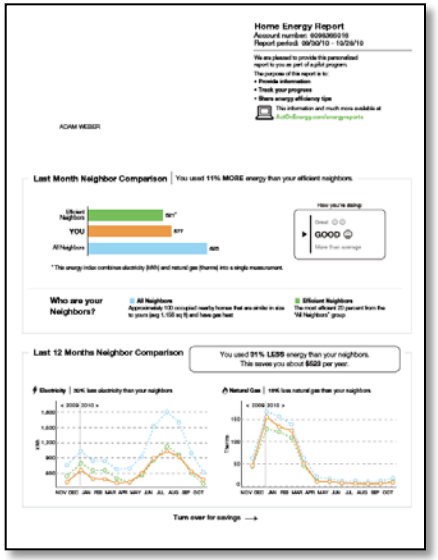
Attachment 2, Page 9 of 13

Lessons Learned

- Proven Savings – Behavioral energy efficiency is an important part of the National Grid portfolio
- Growth Potential – Successfully scaled from a small pilot to a large portion of our customer base
- Cross Promotion – Other efficiency programs and utility efforts
- Customer Sentiment – Positive toward reports and utility



National Grid High-Efficiency Heating, Water Heating and Controls Program

nationalgrid

What's Next? …Residential

- Enhanced Web Experience – SSO and Web Integration
- Campaigns: The Winter of 68 (degrees)
- Target New York High Users
- Use "Rewards" to Incent Paperless Billing
- Report module for Electric Vehicle TOU Rates

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Attachment 2, Page 11 of 13

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What's Next? …Commercial

Small Medium Business

- Pilot program to 9,000 Rhode Island businesses
  - Improve utility relationship with underserved market
- Relevant industry comparisons & recommendations
  - Utility Data + Industry Data
- Business Energy Reports
  - Personalization via company logo & location/map
  - Are we reaching the energy decision maker?
  - Sharing energy tips with your staff
  - Quick wins
- Lead generation for business energy audits

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Attachment 2, Page 12 of 13

nationalgrid

Thank You!

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Attachment 2, Page 13 of 13

CONSULTATIVE MEETING ON BEHAVIOURAL PROGRAM, SEPT. 16, 2014: NOTES OF DISCUSSION

This memo summarizes the feedback provided to Enbridge at a meeting on Sept. 16 whose purpose was:

- To build understanding of the OPower behavioural program which Enbridge will launch in the residential market and is considering for the commercial market
- To secure feedback on the program
- To identify additional potential collaborative ideas which Enbridge could consider for the future

In addition to members of the Enbridge team, external participants at the session included:

Name	Company
OPA/LDC's	
Evelyn Lundhild	Ontario Power Authority
Karen Sweet	Union Gas
Other	
Irene Scher	OPower
Drew Sloan	OPower
Tyler Curtis	OPower
Tom Baron	National Grid
Intervenors	
Chris Neme (by conference call)	Green Energy Coalition
Norm Rubin	Energy Probe
Jack Gibbons	Environmental Defense
Marion Fraser	BOMA
Josh Wasylyk	OEB
Takis Plagiannakos	OEB

1. Residential program

Q AND A

Meeting participants posed multiple questions to the OPower team to build understanding of the program. This summarizes the questions posed and answers provided by the OPower and Enbridge team members.

Question	Answer
1. *Definition of comparables. How geographically specific will a "neighbourhood" group be defined? In very dense neighbourhoods, 1 mile area may be too wide.*	The program uses multiple sorts including similar home type, same fuel, similar size, and vicinity to get an adequately sized comparable sample, within the closest possible radius, preferably within a mile. If comparable sample is too small, it uses concentric rings going out to reach minimum sample size. OPower uses MPAC data on house type and size. Customers can correct the data on the web portal. No data is collected on # occupants as the data is too difficult to source reliably and the occupancy changes frequently (guests, family members moving in/out)
2. *Can you break load data into space and water heating?*	No. The program will, however, provide tips tailored to householder based on whether or not they have a water heater. (customer can provide profile data on line)
3. *How do savings for gas customers compare to electric?*	Gas household savings are typically less than electric. Savings are higher in cold climes than warm.
4. *Does OPower have experience with dual fuel customers or with gas and electric utilities working together*	Approximately ½ of OPower's gas utility customers are dual fuel companies. In Oregon, a gas utility and an electric utility are collaborating on the program by combining customer account information. Union and Enbridge face challenges in collaboration due to electric utility fragmentation in the market --- 74 electric utilities facing 2 gas. There are no experiences thus far of collaboration with water, with possible exception of a Middle East program.
5. *What is OPower's relationship with the end customer?*	OPower has no relationship with the end customer and is not seeking to create one. All materials are branded by the utility
6. *Is the program compliant with Ontario privacy laws?*	Yes. The program has reached the highest level of certification in the US re security. It complies with Privacy by Design. Its operations are audited annually for security. Enbridge has secured approval from internal Legal. Union

	Gas and Hydro One are also pursuing the program. OPower cannot provide any household data to a third party and is bound by an "air tight" NDA. OPower operates like a billing service to Enbridge, not a third party. OPower has no intent to use the program as an advertising vehicle
7. *How quickly will Enbridge extend the program across its customer base?*	The intent in 2014 is to start small, build experience with the program and then to expand to a larger group in 2015 while maintaining the small (10,000) control group to enable measurement. Ultimately, all customers outside the control group may be brought into the program, with the exception of very low usage customers where there is unlikely to be a return. Expansion to lower usage customers will require a shift in communications approach to reduce costs (e.g. "e" not mail)
8. *Is the program cost effective?*	All programs are designed to meet cost hurdles in the jurisdiction. OPower works with the utility to ensure this.
9. *How transparent are the calculations in the "black box"?*	All OPower customers have had independent review and evaluation of their programs. The program is designed so that all results can be independently verified.
10. *Could OPower data be used to validate utilities' claims of savings from other programs ("widgets")*	OPower data brings nothing incremental to that analysis, which is done through actual billing data.
11. *Is the program designed to generate interest in other savings programs?*	The primary reason is to drive savings through behavioural shifts attributable to the OPower program. However, Enbridge recognizes the power of the program to build interest in other programs and will use the tool to build participation in other programs

FEEDBACK SESSION

Participants were asked to communicate what they liked about the program and any concerns and suggestions for improvement. The table below documents that feedback.

Likes

- The idea of having customers benchmarked with neighbours
- The program taps a large potential pool of savings which hasn't been addressed up to now
- Measurement and monitoring are strong

- Strong customer focus
- Ability to use program to cross promote other programs

Concerns and suggestions for improvement

- For very dense neighbourhoods, tighten comparables distance to less than a mile
- Don't wait "20 years" to achieve high customer coverage
- Use the OPower program to drive participation in other programs. It is an important tool for cross promotion. Savings from behavioural programs are relatively short lived; thus, we need continued investment in "hard" savings programs. Do not consider this as a replacement for other programs. Regulators, intervenors and utilities will need to take a holistic view of the whole set of programs, not just the OPower program. (*Note: Enbridge remarked that it is their intent to use the OPower program to promote other programs, not to replace them*)
- Pay special effort to getting clarity and alignment on the final definition of goals and measurement. Need to ensure that OEB and OPA agree on a common method for evaluation. Clarify the definition/measurement of persistence and be clear on how the longer term goals are set. Measurement must be aligned with goals.
- Ensure positive cost/benefit. Pursue the potential for cost advantage as a large player: greater ability to focus in early days on heavy users and to negotiate cost with OPower.
- Address the issue of declining impact over time. How can we justify continued implementation? (*OPower noted that program costs will diminish over time through changes in communications approach and frequency).*
- Pursue ways to integrate with electricity and, eventually, with water. While differences in scale and geographic scope of gas to electric utilities pose as challenge (2 gas/75 electrics), Enbridge and Union could focus on pilots with a few large electrics e.g. Hydro One. *Enbridge remarked that discussions are already underway.*
- Ensure that communications frequency and complexity don't overwhelm the consumer. Integrated communications among utilities could enable this. Pursue mobile applications to move with consumer trends.
- Consider using collateral material such as the stickers in the commercial program e.g. "I'm your most efficient neighbour".

2. Commercial program

FEEDBACK SESSION

Likes
• Focuses on an underserved segment
Concerns/suggestions for improvement
• Ensure pairwise randomization doesn't allow bias (*OPower says that software prohibits bias)* • Consider using energy intensity measures e.g. kwh/sq. ft. or per opening hour • Use business associations to help engage their members • Consider expansion to institutional market (e.g. schools, hospitals). Smaller players may already be included in SME • Figure out how to deal effectively with franchise organizations, especially those which are multi city/region. *(OPower mentioned that other utilities have managed on a case by case basis).* Union and Enbridge will need to collaborate. • Pursue Union/Enbridge integrated approach to the program. *(Enbridge mentioned that discussions are underway)*

3. Longer term collaboration opportunities (blue sky

What future opportunities might exist for Enbridge to enhance DSM effectiveness/impact through collaboration?

- Communicate the comparative usage information on the bill as well, to reinforce message delivered through "OPower" mailings
- Include water as well
- Enable simple one source energy management information system which could link consumer to other programs such as coupons for energy saving devices. Measure use of energy saving measures as well as results.
- Provide mobile solutions: e.g. to provide information and promotional offers when customer is in a store
- To secure more net zero homes, we'll need regulatory change, enabling, for example, gas utilities to use rate based pipes to move other energy around.
- Pursue peak time savings potential. Can we leverage OPower data to build some form of gas demand response? Create the business case for time of use metering (we know the cost, but not the benefits). Consider a selective program.

UNDERTAKING J8.3

UNDERTAKING

TR, page 20

Enbridge to provide technical documentation that describes what OPower does and how they do it, including information related to the establishment of test and control groups

RESPONSE

Enbridge has provided two attachments in response to this undertaking. The first document is labeled "Opower Home Energy Reports: Program Design and Measurement and Verification of Energy Savings". This document provides summary information for each of the following components:

- Description of program
- Benefits of program
- Adoption of similar programs throughout North America
- Program design
- Methodology for measurement and verification of results

The second document is labeled "Chapter 17: Residential Behaviour Protocol, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures", which was co-authored by The Cadmus Group and Lawrence Berkeley National Laboratory. This document provides a technical explanation of best practices (which Opower uses) for the following:

- Common designs of behavioural programs
- Design of samples
- Analysis of measurement methods

In response to the Board's specific inquiry into how the test and control groups are established, please see pages 7 to 9 of the second attachment provided. The document also covers best practices for determining program size, randomly assigning customers to treatment and control groups, administering the Home Energy Reports, collecting data, and verifying the savings.

Witnesses: S. Bertuzzi
S. Hicks
M. Lister

Opower Home Energy Reports: Program Design and Measurement and Verification of Energy Savings

Introduction

By providing customers with better information on their energy use and personalized energy saving advice, Opower motivates customers to measurably and verifiably use less energy and save money on their monthly bills. The Home Energy Report (HER) program also helps to increase participation in other utility-run efficiency programs.

Opower is the leading global provider of behavioral energy efficiency, behavioral demand response, and customer engagement solutions for the utility industry. Today, Opower works with more than 95 utilities, in 36 U.S. states and 9 countries to deliver personalized energy usage insights to over 50 million residential households and Opower's HER programs have saved over eight terawatt-hours of energy.[1] The savings from Opower HER programs have been confirmed by over 50 independent evaluations and accepted as energy efficiency resources by regulators in 33 U.S. states.[2,3]

Opower's HER program provides residential customers with better energy information through personalized mailed reports and an integrated web portal to empower them to make better energy usage decisions. There are multiple public benefits associated with this energy efficiency program, including but not limited to:

a. **Cost effective energy savings:** Opower HER programs create consistent and sustainable energy savings on the range of 1.5 - 2.5% savings for electric customers and 1.0% - 1.5% savings for gas customers. These energy savings results have been verified through over 50 independent evaluations of programs across millions of households.[4] This leads to reduced energy costs and lower bills for families who participate in the program.

b. **Widely distributed benefits:** Opower HER programs drive widespread energy savings over a large customer population. HER programs have the added benefit of delivering energy savings to residential customers regardless of demographics, including age and income. On average, seniors, renters, and low-income customers save just as much, if not more, than homeowners and customers in average- to high-income groups, respectively.[5]

c. **Heightened awareness of efficiency:** Opower delivers energy savings by providing better energy information. Through Opower's program, households become more aware of their energy usage and opportunities for conservation – through both

changes in behavior and the purchase of energy efficient products. For example, Opower has demonstrated an ability to lift participation in other utility efficiency programs.

HER Program Design

Opower HER programs are designed to maximize cost-effective energy savings for residential customers. HER programs are typically designed with the following characteristics:

1. **Delivery of reports:** Targeted households automatically receive one welcome insert to introduce them to the program followed by four home energy reports annually. These reports provide periodic updates on the energy usage behavior of a given household, and offer tips for saving energy.

2. **Delivery of web portal**: All program participants have access to a web portal designed by Opower that is integrated into the utility's website. This site enables participants to create a profile, perform an online audit, access energy savings tips, monitor usage over time, and compare usage to neighbors for benchmarking purposes.

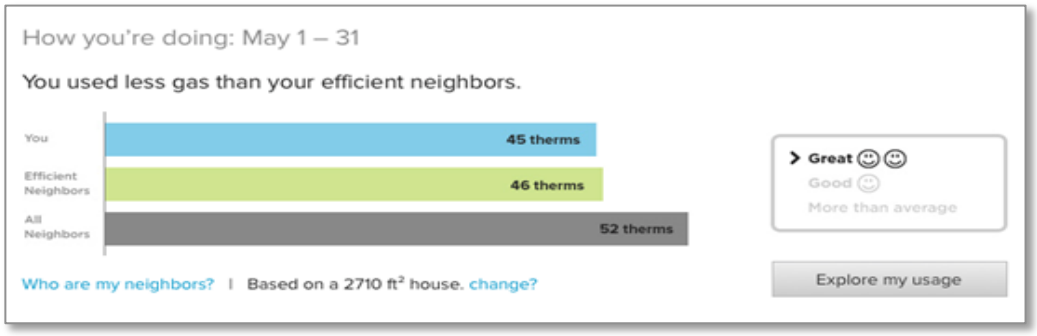
3. **Ability to opt-out**: All participants have a clear method for opting out of the program if they no longer want to receive the information. The opt-out rate for the HER program has generally been less than 1%.[6]

Applied Behavioral Science at the Core of Program Design

The HER program incorporates the breakthrough research of the well-known Behavioral Scientist, Dr. Robert Cialdini, and is organized around two concepts. First, motivate consumers to change their behavior by putting their usage in context. Second, provide them with salient, personalized advice to capitalize on this motivation to use less energy and save money. Figure 1 provides a sample neighbor comparison that puts a household's usage in context to motivate them to take action.

To see Opower's president, Alex Laskey describe Opower's application of Cialdini's research, please see his TED talk at http://www.ted.com/speakers/alex_laskey.

Figure 1: Sample Neighbor Comparison Module



Normative messaging (i.e. peer benchmarking) provides the foundation for the reports. The most recognizable application of this the "neighbor" comparisons (as illustrated in Figure 1), wherein participants are compared to 100 of their peers (e.g., customers with close proximity and weather patterns) as well as to their most efficient neighbors, defined as the lowest-using 20% of those 100 homes. Behavioral science research has demonstrated that peer-based comparisons are highly motivating ways to present information.[7]

Once motivated by this comparison, customers receive individually targeted savings tips based on their energy usage patterns, housing characteristics, and demographics. Opower's HER programs present customers with the most relevant suggestions that are likely to deliver the greatest savings.

Additionally, the HERs include "loss language" in the tips and recommendations, encouraging customers to pursue energy management actions in such a way that they feel they are missing an opportunity to save if they do not follow through on a suggestion.

Program Results

As highlighted in the introduction, savings from Opower's HER programs have been independently verified by more than fifty separate evaluations and reported an average of 1.5 - 2.5% savings for electric customers and 1.0% - 1.5% savings for gas customers.[8] In addition, multiple independent evaluations have verified the cost effectiveness of Opower's behavioral programs.[9] Dr. Hunt Allcott (2011), for example, verified average cost effectiveness of 3.3 cents/kWh across seventeen separate Opower deployments, with a range from 1.3 – 5.4 cents/kWh.[10]

Opower's ability to drive increased participation in installed measure programs delivers more energy and bill savings, and reduces the marketing costs associated with other programs. In this sense, Opower enhances the effectiveness of the entire efficiency portfolio.

Increased program participation occurs even without Opower directly promoting particular programs. Opower refers to this as the "halo" effect of the program. With direct promotion of programs, Opower can drive further increases in program participation. For example, Opower recently increased participation by 59% in a refrigerator-recycling program for an electric utility in the Midwest.[11]

Methodology for Measuring and Verifying Program Savings

The Opower HER program uses randomized controlled trials (RCTs) and *ex-post* measurement—rather than *ex ante* deemed savings—to measure savings with over 90% statistical confidence. Under this approach, Opower uses parameters to create an eligible group of recipients, randomly assigns households to control and treatment groups, tests these groups to ensure statistical equivalence, sends reports only to the treatment group, and measures the difference in energy usage between the two groups using statistical billing analysis. Both groups are exposed to the same local weather, energy prices, and economic environment. The only statistically meaningful difference between the groups is that the test group receives HERs while the control group does not. As such, any subsequent shifts in the usage pattern of the test population can be attributed to the treatment.

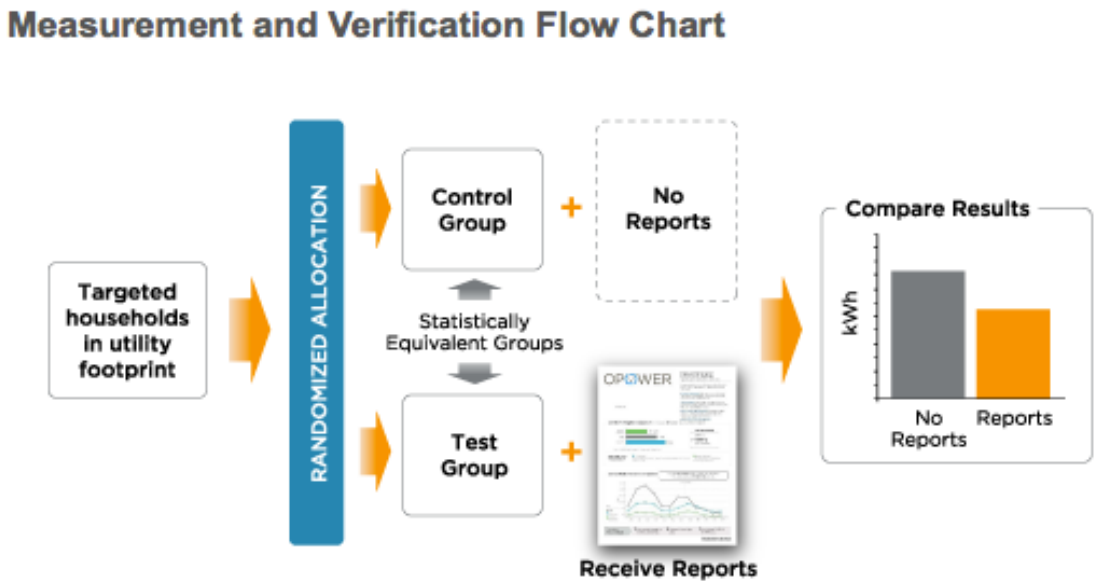
This approach measures savings without bias and with precision. Key components of this approach include:

(i) Statistically equivalent and randomly allocated control and treatment groups
(ii) Opt-out design
(iii) *Ex-post* measurement
(iv) Panel data methodology billing analysis for comparison of control and treatment groups

The following is the basic calculation of impact:

kWh saved (test group) = kWh used (control group) – kWh used (test group) – kWh saved by rebated equipment (product participation) for the same time period and same customers

Figure 2: Measurement and Verification Flow Chart



Randomized Control Trials with Panel Data Analysis are Best Practice

RCT methodology is consistent with the recommendations of the U.S. Department of Energy's *Uniform Methods Project for Determining Energy Savings for Specific Measures*.[12] The Uniform Methods Project report concludes:

> "This protocol recommends randomized control trials … because they yield unbiased and robust estimates of savings caused by the program."[13]

This is a low-risk approach because the results are proven and predictable, but also because they are measured *ex post*, so the credit is given for results actually achieved. This is different from many other efficiency programs, which have expected values but no means by which to measure after savings have occurred. It is an approach that has been recognized as the gold standard by the U.S. Department of Energy and used by over fifteen independent evaluations of program impact.[14]

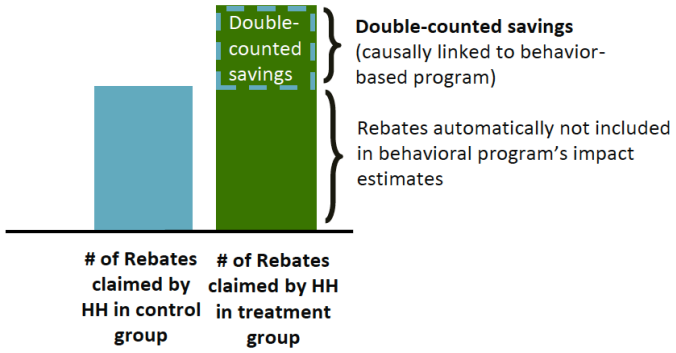
This approach is also consistent with best practices supported by the National Action Plan for Energy Efficiency guidelines,[15] the California Evaluators Manual,[16] and The Brattle Group's Principles of Behavior-Based Energy Efficiency.[17]

Addressing Double Counting

Opower recognizes that correct attribution of savings is critical to the fair accounting of portfolio efficiency standards. Accordingly, Opower follows the U.S. Department of Energy's recommendations for addressing double counting, as articulated in Figure 3 below.[18]

Figure 3: Addressing Double Counting

1. Calculate the savings that result from participation in a given program in the control (blue shading) and treatment groups (green shading)
2. Measure the difference between savings in treatment and control groups ("double-counted savings" in chart)
3. Assign double-counted savings and associated program cost to Opower, the other efficiency program, or both



For individually tracked utility-run efficiency programs, Opower can estimate these double-counted savings with statistical precision. From an accounting perspective, these savings can either be subtracted from Opower's reported overall savings or shared between the Opower program and the other programs.

Conclusion

There is broad consensus among North American energy regulators as to the value and robustness of the energy savings of Opower's HER programs. These commissions agree that HER programs are prudent efficiency investments that deliver benefits to customers in the form of bill savings, as well as avoided energy and capacity costs. In fact, behavioral programs have been incorporated into long-term energy efficiency strategy and resource planning in several utilities in the U.S. For example, PacifiCorp treats behavioral programs as a planning resource in the Integrated Resources Plan for its multi-state utility operations.[19]

Finally, the potential of behavioral programs to generate lasting energy savings with concomitant emissions reductions has been recognized by the environmental regulatory community, as well. In May 2015, the U.S. National Association of Clean Air Agencies included behavioral programs among the menu technologies and policy options to reduce greenhouse gas emissions from the power sector in compliance with the U.S. Environmental Protection Agency's Clean Power Plan.[20]

Endnotes

[1] Eight terawatt-hours is equivalent to the amount of electricity needed to power all residential households in the state of New Mexico for one year.
[2] See Appendix 2 for an annotated bibliography of independent evaluations of Opower HER programs.
[3] See Appendix 1 for a comprehensive list of regulatory approvals of Opower HER programs by state.
[4] See, for example, the following select independent evaluations:

(i) Dougherty, Anne, July 2012. "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report." *Opinion Dynamics with Navigant Consulting*;
(ii) Gunn, Randy, May 2012. "Evaluation Report: Home Energy Reports." *Navigant Consulting*;
(iii) April 2012. "Puget Sound Energy's Home Energy Reports Program: Three Year Impact, Behavioral, and Process Evaluation." *KEMA Energy & Sustainability*;
(iv) Allcott, Hunt, October 2011. "Social Norms and Energy Conservation." *Journal of Public Economics* Vol 95 (9-10), pp. 1082 – 1095;
(v) Todd, Annika, Steven Schiller, and Charles Goldman, October 2011. "Analysis of PSE's Pilot Energy Conservation Project: Home Energy Reports." *Lawrence Berkeley National Laboratory*;
(vi) Dougherty, Anne, June 2011. "Massachusetts Cross-Cutting Behavioral Program Evaluation." *Navigant Consulting and Opinion Dynamics*;
(vii) Davis, Matt, May 2011. "Behavior and Energy Savings: Evidence from a Series of Experimental Interventions." *Environmental Defense Fund*;
(viii) Cooney, Kevin, February 2011. "Evaluation Report: OPOWER SMUD Pilot Year 2." *Navigant Consulting*;
(ix) Wilhelm, Bobbi, October 2010. "Puget Sound Energy's Home Energy Reports Program." *KEMA*;
(x) Ivanov, Chris, July 2010. "Measurement and Verification Report of OPOWER Energy Efficiency Pilot Program." *Power System Engineering*;
(xi) Macke, Rich, June 2010. "Measurement and Verification Report of Lake Country's OPOWER Energy Efficiency Pilot Program." *Power System Engineering*;
(xii) Allcott, Hunt and Sendhi Mullainathan, March 2010. "Behavior and Energy Policy." *Science*. Vol. 327;
(xiii) Allcott, Hunt, February 2010. "Social Norms and Energy Conservation." *Working Paper, Massachusetts Institute of Technology*'s *Center for Energy and Environmental Policy Research*;
(xiv) Ayres, Ian, et al., September 2009. "Evidence From Two Large Field Experiments That Peer Comparison Feedback Can Reduce Residential Energy Usage." *NBER Working Paper*;
(xv) Klos, Mary, September 2009. "Impact Evaluation of OPOWER SMUD Pilot Study." *Summit Blue Consulting, LLC*

[5] See, for example, the following select independent evaluations:

(i) Gunn, Randy, December 2010. "Energy Efficiency / Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010), Evaluation Report: OPOWER Pilot." Navigant Consulting.
(ii) Gunn, Randy, May 2012."AEP Ohio EE/DR Plan Year 3. Program Year 2011 Evaluation Report - HER Program". Navigant Consulting
(iii) Gunn, Randy, May 2012. "Evaluation Report: Home Energy Reports." Navigant Consulting
(iv) December 2012. "Program Year 1 (2011-2012) EM&V Report for the Residential Energy Efficiency Benchmarking Program." Navigant
(v) May 2013. "Home Energy Reports Program: Program Year 2012 Evaluation Report." Navigant Consulting
(vi) January 2014. "First Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013, Program Year 4" The Cadmus Group, Inc.

[6] Allcott, Hunt, October 2011. "Social Norms and Energy Conservation." *Journal of Public Economics* Vol 95 (9-10), pp. 1082 – 1095; See Table 2 for opt-out results.
[7] For a discussion of the power of normative comparisons relative to economic, civic, or environmental persuasive appeals, see: Cialdini, Robert, and Wesley Schultz, 2004, "Understanding and Motivating Energy Conservation via Social Norms," *Arizona State and California State Universities*, available here: http://opower.com/uploads/library/file/2/understanding_and_motivating_energy_conservation_via_social_norms.pdf

[8] See footnote 1.
[9] See footnote 1.
[10] Allcott, Hunt. "Social Norms and Energy Conservation." October 2011. Journal of Public Economics Vol. 95 (9-10), pp. 1082-1095.
[11] Ibid.
[12] Steward, James and Annika Todd. "Chapter 17: Residential Behavior Protocol." *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. January 2015. Prepared for the U.S. Department of Energy National Renewable Energy Laboratory. Available: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter17-residential-behavior.pdf.
[13] Ibid., p. 5.
[14] See footnote 1.
[15] National Action Plan for Energy Efficiency. "Model Energy Efficiency Program Impact Evaluation Guide." November 2007. Available online at: http://www1.eere.energy.gov/office_eere/pdfs/napee_evaluation_guide.pdf.
[16] California Public Utilities Commission. "California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals." April 2006. Available Online at: http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf.
[17] Sergici, Sanem and Ahmad Faruqui. "Measurement and Verification Principles for Behavior-Based Efficiency Programs." May 2011. Available online at: http://opower.com/uploads/library/file/10/brattle_mv_principles.pdf.
[18] Ibid., pp. 31 – 33.
[19] PacifiCorp. (March 2015). *2015 Integrated Resource Plan: Volume I.* Available: http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2015IRP/PacifiCorp_2015IRP-Vol1-MainDocument.pdf.
[20] U.S. National Association of Clean Air Agencies. (May 2015). *Implementing EPA's Clean Power Plan: A Menu of Options*.

Appendix 1: Regulatory Approvals of Opower Home Energy Report Programs

Below, find the names of utilities that have received approval from their respective regulatory commissions to implement Home Energy Report programs, the regulatory commission granting the respective approvals, and the case/docket numbers within which the approvals were granted.

	Regulatory Commission	Utility	Case/Docket Numbers
1	Arizona Corporation Commission	Arizona Public Service Tucson Electric Power	10-0219 07-0401; 11-0055
2	Arkansas Public Service Commission	Empire District Source Gas AR CenterPoint Entergy	07-076-TF 07-078-TF 07-081-TF 07-085-TF
3	California Public Utilities Commission	Pacific Gas & Electric San Diego Gas & Electric Southern California Gas	A. 12-07-001- A.12-07-004 D. 12-11-015 & (AL) 4449.
4	Colorado Public Utilities Commission	Xcel Black Hills Energy	10A-471EG 14A-0488G
5	State of Connecticut Public Utilities Regulatory Authority	United Illuminating; Connecticut Light & Power	Dockets 12-02-01; 11-10-03, 10-10-04
6	Florida Public Service Commission	Gulf Power Progress	100154-EG 100160-EG
7	Hawaii Public Utilities Commission	Hawaii Energy	No docket number; third party administrator

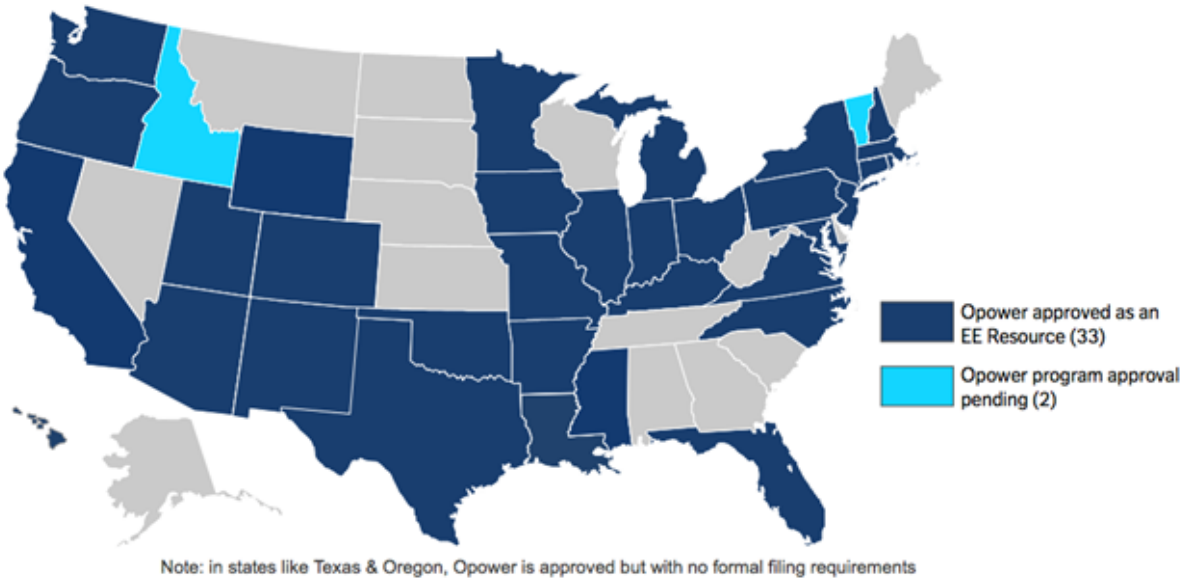
8	Illinois Corporation Commission	Ameren ComEd Nicor Gas North Shore Gas/People's	10-0568 13-0498 10-0570 13-0546 13-0549 13-0550
9	Iowa Utilities Board	MidAmerican Interstate Power & Light	N/A – pilot program run under docket EEP-2008-0002; EEP-2012-0002 N/A – pilot program run under docket EEP-2012-0001
10	Indiana Utility Regulatory Commission	Indiana Michigan NIPSCO Vectren	43959; 44486; 43912; 43938
11	Kentucky Public Service Commission	LGE/KU Kentucky Power	2011-00134 2014-00003 2014-00271
12	New Orleans City Council (Louisiana)	Entergy NO	R-15-140
13	Maryland Public Service Commission	Potomac Edison Baltimore Gas & Electric Potomac Electric Delmarva Power & Light SMECO	9153 9154 9155 9156 9157
14	Massachusetts Department of Public Utilities	National Grid NSTAR	09-121;12-103 09-126; 12-105
15	Michigan Public Service Commission	DTE	U-17049

16	Minnesota Public Utilities Commission	MERC CenterPoint Otter Tail Power Company Xcel	G011/CIP-09-800; G008/CIP-09-291; G008/CIP-12-564 E017/CIP-13-277 E017/CIP-10-356; G002/CIP-09-198; G002/CIP-12-447
17	Missouri Public Service Commission	Kansas City Power & Light	EO-2012-0008; EO-2012-0009 EO-2014-0095
18	Mississippi Public Service Commission	Mississippi Power Company	2014–UN–10
19	Nevada Public Utilities Commission	NV Energy	13-07002
20	New Hampshire Public Utilities Commission	National Grid – PSNH	DE 10-188
21	New Jersey Board of Public Utilities	New Jersey Natural Gas	GO10030225
22	New Mexico Public Regulation Commission	Xcel	09-00352-UT
23	New York State Public Service Commission	Central Hudson National Grid NYSEG RGE	07-M-0548 08-E-1133 08-E-1129 08-E-1130
24	North Carolina Utilities Commission	Progress	E-2, Sub 989
25	Public Utilities Commission of Ohio Public Utilities Commission of Ohio	AEP Ohio FirstEnergy – Cleveland Elect. FirstEnergy – Ohio Edison FirstEnergy – Toledo Edison	11-5028-GA-UNC: 09-1089-EL-POR 12-2190-EL-POR 12-2191-EL-POR 12-2192-EL-POR
26	Oklahoma Corporation Commission	CenterPoint	PUD 201-000148; PUD 201300085
27	Oregon Public Utility Commission	Energy Trust of Oregon	N/A - Third party program

28	Pennsylvania Public Utility Commission	PECO PPL West Penn Power Duquesne Light	M-2009-2093215 M-2009-2093216 M-2012-2234388 M-2009-2093218 M-2009-2093217 M-2012-2289411
28	Rhode Island Public Utilities Commission	National Grid	Docket 4284
29	Public Service Commission of South Carolina	South Carolina Electric & Gas Company	2013-50-E 2015-45-E
30	Public Service Commission of Utah	Rocky Mountain Power	08-999-05 12-035-77
31	Virginia State Corporation Commission	Washington Gas Light Co.	PUE-2012-00138
32	Washington Utilities and Transportation Commission	Puget Sound Energy Pacific Power	UE-100177 UE-132047
33	Wyoming Public Service Commission	Rocky Mountain Power	20000-461-EA-14

Note: Table does not include approval of Home Energy Reports program in Hawaii and Oregon, where a third party administrator structure is in place. These programs do not require PUC approval, but are in place in both states.

The map below illustrates the states with regulatory approval for Home Energy Reports programs:



Appendix 2: Annotated bibliography of independent evaluations of Opower HER programs

Copies of all evaluations are available for download at http://opower.com/company/library/verification-reportshttp://opower.com/company/library/verification-reports http://opower.com/company/library/verification-reports

1. Klos, Mary, September 2009. "Impact Evaluation of OPOWER SMUD Pilot Study." *Summit Blue Consulting, LLC*.

- *Utility, State, Fuel:* Sacramento Municipal Utility Department, CA, Electric
- *Results:* Summit Blue (d/b/a Navigant) verified an average of 2.2% savings in the first year, as well as a bump to 2.8% average savings in the first four months of year two
- *Contact:* Mary Klos, 608-807-0083, mklos@summitblue.com

2. Ayres, Ian, et al., September 2009. "Evidence From Two Large Field Experiments That Peer Comparison Feedback Can Reduce Residential Energy Usage." *NBER Working Paper*.

- *Utility, State, Fuel:* Sacramento Municipal Utility Department & Puget Sound Energy, CA & WA, Electric & Gas
- *Results:* There is evidence of a reduction in the early years of the program of 1.2% (natural gas) and 2.1% (electric) participants
- *Contact:* 203-415-5587, ian.ayres@yale.edu

3. Allcott, Hunt, February 2010. "Social Norms and Energy Conservation." *Working Paper, Massachusetts Institute of Technology*'s *Center for Energy and Environmental Policy Research*.

- *Utility, State, Fuel:* Connexus, MN, Electric
- *Results*: Using data from a randomized natural field experiment at 80,000 treatment and control households in Minnesota, it is estimated that the monthly program reduces energy consumption by 2.3 – 2.4% relative to baseline
- *Contact:* Hunt Allcott, allcott@mit.edu

4. Allcott, Hunt and Sendhil Mullainathan, March 2010. "Behavior and Energy Policy." *Science*, Vol. 327

- *Utility, State, Fuel:* This article is a literature review
- *Results:* Using randomized, controlled trials with hundreds of thousands of utility customers across the United States, these [OPOWER] reports have been shown to reduce electricity consumption in the average household by over 2%.
- *Contact:* Hunt Allcott, allcott@mit.edu

5. Macke, Rich, June 2010. "Measurement and Verification Report of Lake Country's OPOWER Energy Efficiency Pilot Program." *Power System Engineering*.

- *Utility, State, Fuel:* Lake Country Power, MN, Electric
- *Results:* Average of 2.77% first-year savings with 99% statistical confidence
- *Contact:* Rich Macke, 763-783-5349, macker@powersystem.org

6. Ivanov, Chris, July 2010. "Measurement and Verification Report of OPOWER Energy Efficiency Pilot Program." *Power System Engineering*.

- *Utility, State, Fuel:* Connexus, MN, Electric

- *Results:* With 99% confidence, the program demonstrated an average of 2.07% savings across three distinct approaches to measuring and verifying the results
- *Contact:* Chris Ivanov, 608-268-3516, ivanovc@powersystem.org

7. October 2010. "Puget Sound Energy's Home Energy Reports Program." *KEMA*.

- *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
- *Results:* The savings rate of the most recent 12 months was significantly greater than for the first 12 months – improving from 1.87% to 2.28% average electric savings
- *Contact: Bobbi Wilhelm, 425-462-3432, bobette.wilhelm@pse.com* mailto:bobette.wilhelm@pse.com

8. Gunn, Randy, December 2010. "Energy Efficiency / Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010), Evaluation Report: OPOWER Pilot." *Navigant Consulting.*

- *Utility, State, Fuel:* Commonwealth Edison Company (ComEd), IL, Electric
- *Results:* "Average annual savings was 1.54% for high energy users, and was 1.27% for low energy users."
- *Contact:* Randy Gunn, 312-938-4242, randy.gunn@navigantconsulting.com

9. Cooney, Kevin, February 2011. "Evaluation Report: OPOWER SMUD Pilot Year 2." *Navigant Consulting*.

- *Utility, State, Fuel:* Sacramento Municipal Utility Department, CA, Electric
- *Results:* (i) 2.89% savings in the second year, 22% increase over first year; (ii) Highest savings—3.56% savings in July/August of 2009—occurred during peak season; and (iii) only signs of impact stability over the first 30 months of the program
- *Contact:* Kevin Cooney, 312-583-5700

10. Davis, Matt, May 2011. "Behavior and Energy Savings: Evidence from a Series of Experimental Interventions." *Environmental Defense Fund.*

- *Utility, State, Fuel:* Report verifies results from 11 different gas and electric utilities covering urban and suburban communities in 6 states in the Northeast, Midwest,

and West. Specific utility names are not released for confidentiality purposes. Electric only.
- *Results:* Reports have driven electricity savings ranging from 1.1-2.9% across the 11 deployments, and, if fully deployed in the US, OPOWER programs would lead to $3 billion in annual savings
- *Contact:* Matt Davis, mdavis@edf.org

11. Dougherty, Anne, June 2011. "Massachusetts Cross-Cutting Behavioral Program Evaluation." *Navigant Consulting and Opinion Dynamics*.

- *Utility, State, Fuel:* National Grid, MA, Electric
- *Results:* 1.61% average savings, of which the majority came from actions that were taken outside other National Grid programs.
- *Contact:* Anne Dougherty, 617-492-1400

12. Todd, Annika, Steven Schiller, and Charles Goldman, October 2011. "Analysis of PSE's Pilot Energy Conservation Project: "Home Energy Reports." *Lawrence Berkeley National Laboratory*.

- *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
- *Results:* "The evaluation study design for the HER pilot program utilized a randomized controlled experiment with an opt-out design, which is the best feasible method of inferring that a program caused energy savings." Averaged 2.03% savings in the last 12 months for electricity, 1.40% for gas.
- *Contact:* Annika Todd, 510-486-6544, atodd@lbl.gov

13. Allcott, Hunt, October 2011. "Social Norms and Energy Conservation." *Journal of Public Economics*, Vol 95 (9-10), pp. 1082 - 1095.

- *Utility, State, Fuel:* Report verifies savings achieved by 600,000 households across 17 Opower deployments in various geographic areas, Electric only.
- *Results*: Opower's program is the most effective non-price efficiency intervention available at scale to date. Average savings range from 1.4 – 3.3% with an unweighted mean of 2.0%, equivalent to a short-term price increase of 11 – 20% (or long-term increase of 5%), at a cost-effectiveness of $0.013 - $0.054 per kWh with an unweighted mean of $0.033 per kWh.
- *Contact:* Hunt Allcott, allcott@mit.edu

14. April 2012. "Puget Sound Energy's Home Energy Reports Program: Three Year Impact, Behavioral, and Process Evaluation." *KEMA Energy & Sustainability*.

- *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
- *Results*: In its third year, this program generated savings of 2.6% for electric customers and 1.3% for gas. Electric impact leapt from 169.7 kWh per household per year in Year 1 to 274.2 kWh in Year 3, an increase of 62%. Gas impact increased from 10.7 to 11.9 therms, a change of 11%. In the third year, reports were suspended for a sub-set of the treatment group. In this group, the electric savings rate dropped to 1.6% compared to a savings rate of 2.6% for the group that continued to receive the reports.
- *Contact:* N/A

15. Gunn, Randy, May 2012."AEP Ohio EE/DR Plan Year 3. Program Year 2011 Evaluation Report - HER Program". Navigant Consulting

- *Utility, State, Fuel:* AEP Ohio, Ohio, Electricity
- *Results:* In 2011 calendar year, the program generated a total of 53.9 GWh (1.69%). Average savings per participate range from 96 kWh for AMI particpants, to 384 kWh for higher use households (0.85 – 1.93%). Low-income households saved 197 kWh per participant.
- *Contact:* Randy Gunn, 312-583-5700

16. Gunn, Randy, May 2012. "Evaluation Report: Home Energy Reports." *Navigant Consulting*.

- *Utility, State, Fuel:* Commonwealth Edison, IL, Electric
- *Results*: In the second program year, savings range from 1.55 – 2.02% and 185.54 – 444.56 kWh per customer per year, depending on the treatment group. These results led the independent evaluator to conclude that, "average weather-normalized annual savings increased from 230 to 317 kWh per customer [from the first to second program year], and increase of 38%. This increase is statistically significant."
- *Contact:* Randy Gunn, 312-583-5700

17. Dougherty, Anne, July 2012. "Massachusetts Three Year Cross-Cutting Behavioral Program Evaluation Integrated Report." *Opinion Dynamics Corporation with Navigant Consulting*.

- *Utility, State, Fuel:* NSTAR & National Grid, MA, Electric & Gas
- *Results*: Electric savings range from 1.25 – 2.06% and gas savings range from 0.81 – 1.50%, depending on the number of years the program has been running. From the first to the second program year, electric savings increased from 1.61 – 2.06% in one program and 1.25 – 1.63% in another – increases of 28 and 30%, respectively. Gas savings increased from 0.81 to 1.25%, an increase of over 54%.
- *Contact:* Anne Dougherty, 617-492-1400

18. Sutter, Mary, October 2012. "Impact and Process Evaluation of 2011 (PY4) Ameren Illinois Company Behavioral Modification Program." *Opinion Dynamics Corporation with The Cadmus Group, Navigant, and Michaels Engineering.*

- *Utility, State, Fuel:* Ameren Illinois Company (AIC), IL, Electric & Gas
- *Results*: Overall, the program achieved electric net savings of 1.14% per household and gas net savings at 0.70% per household.
- *Contact:* Mary Sutter, 510-444-5050

19. Wu, May, November 2012. "Impact & Persistence Evaluation Report: Sacramento Municipal Utility District Home Energy Report Program." *Integral Analytics, Inc. with BuildingMetrics Incorporated and Sageview.*

- *Utility, State, Fuel:* Sacramento Municipal Utility District (SMUD), CA, Electric
- *Results*: HERs had a net impact of 2.2% electricity savings per month per household (250 kWh) in the Wave 1 group (monthly report recipients, quarterly report recipients as well as a third group that stopped receiving reports). The Wave 2 group, which included UCLA Selection, SMUD Segmentation, High Use, E-reports and Seasonal Burst sub-groups, experienced a net impact of 1.6% electricity savings per month per household (216 kWh). The Seasonal Burst notifications yielded 1.2% mean annual savings (178 kWh), along with 0.06 kW reductions on summer peak days. Additionally, "the team found that homes that make a structural change with SMUD efficiency rebate dollars that also receive the HER go on to save more than homes that merely participate in a rebate program."
- *Contact: May Wu, May.Wu@IntegralAnalytics.com*

20. Gunn, Randy, November 2012. "Energy Efficiency / Demand Response Plan: Plan Year 4 (6/1/2011-5/31/2012), Evaluation Report: Home Energy Reports." *Navigant Consulting.*

- *Utility, State, Fuel:* Commonwealth Edison Company (ComEd), IL, Electric
- *Results:* Over the past two years, energy savings by Wave 1 customers do not show sign of diminishing and this evaluation calculated 2.20% savings for these participants. Participants who began receiving HERs later achieved lower savings rates (1.66% and 1.16%), although Navigant noted that "their savings are likely in a ramp-up phase" and that "Navigant expects that savings from Wave 4 participants will increase by at least 50% over the next year."
- *Contact:* Randy Gunn, 312-938-4242, randy.gunn@navigant.com

21. December 2012. "Verification of Hawaii Energy 2011 Programs." *Evergreen Economics.*

- *Utility, State, Fuel:* Hawaii Energy, HI, Electric
- *Results*: "The savings claimed by Hawaii Energy for this measure is a total of 1,704,648 kWh based on savings estimated by Opower."
- *Contact:* Evergreen Economics, 503-894-8676

22. December 2012. "Program Year 1 (2011-2012) EM&V Report for the Residential Energy Efficiency Benchmarking Program." *Navigant.*

- *Utility, State, Fuel:* Progress Energy Carolinas, NC, Electric
- *Results*: "Average savings were 224 kWh or 1.23% of energy consumption during the first twelve months of the program. Total program savings were 10.6 GWh during the twelve month period of August 2011 to July 2012."
- *Contact:* Stuart Schare, 303-728-2501

23. March 2013. "Puget Sound Energy's Home Energy Reports: 2012 Impact Evaluation." *KEMA*

- *Utility, State, Fuel:* Puget Sound Energy, WA, Electric & Gas
- *Results:* "The overall credited savings for electric and gas were 300 kWh and 11 therms per household, respectively. These savings constitute 2.8% and 1.3% of the household's average electric and gas consumption, respectively…. Those current

households that continued to receive reports through the fourth year generated savings at or above levels established in the first two years of the program"

- *Contact:* Bobbi Wilhelm, bobette.wilhelm@pse.com

24. March 2013. "Evaluation of the Year 1 CL&P Pilot Customer Behavior Program." *NMR*

- *Utility, State, Fuel:* Connecticut Light and Power, CT, Electric
- *Results:* "Overall, the treatment group used an average of 1.7% less energy than did the control group, translating to 388 kWh less energy used by a treatment household, compared to a control group household, during the first year of the program… Monthly report recipients (2.2% savings) saved more electricity than did the quarterly report recipients (1.2% savings)."
- *Contact:* Lisa Wilson-Wright, NMR

25. April 2013. "Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010-2012 Program." *Freeman, Sullivan & Company*

- *Utility, State, Fuel:* Pacific Gas and Electric Company, CA, Electric & Gas
- *Results:* Program waves have been running between 11 to 17 months. Total electric and gas savings for the program were 49.9 GWh and 1,469 thousand Therms respectively through December 2012. Percent impact ranges from 0.9% to 1.5% for electric and 0.4% to 0.9% for gas depending on number of program months.
- *Contact:* Michael Perry

26. May 2013. "Home Energy Reports Program: Program Year 2012 Evaluation Report." *Navigant Consulting*

- *Utility, State, Fuel:* American Electric Power Ohio, OH, Electric
- *Results:* The Home Energy Report Program reported 53,174 MWh of energy savings with an average savings rate of 2.0%.
- *Contact:* Randy Gunn, 312-583-5714, randy.gunn@navigant.com

27. June 2013. "Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report." *Opinion Dynamics Corporation*

- *Utility, State, Fuel:* National Grid Massachusetts, NSTAR, Electric & Gas

- *Results:* Programs achieved 63 GWh and 344,681 MMBTu in 2012 for Massachusetts. Electric savings rate ranges from 0.89 - 2.47% and gas savings range from 0.50 - 1.80% depending on the number of years the program has been running. All electric programs running for at least two years show increased savings from PY1 to PY2 and PY2 to PY3 where applicable. Gas savings rates are steady or increasing.
- *Contact:* Anne Dougherty, 617-492-1400

28. July 2013. "Evaluation of Residential Incentive Program Portfolio: May 2012 through December 2012." *ADM Associates, Inc.*

- *Utility, State, Fuel:* Indiana Michigan Power, IN, Electric
- *Results:* The program achieved an annualized saving rate of 200 kWh per participant for a total savings from the program over the evaluation period of 4,051 MWh.
- *Contact:* ADM Associates, 916.363.8383

29. August 2013. "Review of PG&E Home Energy Reports Initiative Evaluation." *DNV KEMA*

- *Utility, State, Fuel:* Pacific Gas and Electric, CA, Electric & Gas
- *Results:* Independent evaluation of FSC estimates of savings from PG&E Home Energy Report initiative. DNV KEMA confirms FSC evaluation and "recommends accepting the findings regarding energy savings for HERs presented in the FSC report."
- *Contact:* Ken Agnew, DNV KEMA

30. August 2013. "2012 IPL Residential Peer Comparison EM&V Report." *TecMarket Works*

- *Utility, State, Fuel:* Indianapolis Power & Light Company, Electric
- *Results:* " Overall, the program achieved a net adjusted savings of 7,143 MWh during a full year 12-month program period." In this first year of the program, savings per households were 266 kWh and comprise a percent savings of 1.0%. "This program passes all key cost-effectiveness tests."
- *Contact:* Nick Hall, TecMarket Works

31. August 2013. "SDG&E Home Energy Reports Program." *DNV KEMA*

- *Utility, State, Fuel:* San Diego Gas & Electric Company, CA, Electric & Gas
- *Results:* Over the first 16 months, the program achieved 5,429 MWh of savings, although 117 MWh and 198 MWh of that were joint savings also attributable to downstream and upstream measures, respectively. On average, households in the program achieved energy savings of 292.8 kWh or about 1.9% of their usage during that period, and about 11.9 therms of gas, or 1.5% of usage.
- *Contact:* Ken Agnew, DNV KEMA

32. Stewart, James and Cleff, Jim, "Are You Leaving Peak Demand Savings on the Table? Estimates of Peak-Coincident Demand Savings from PPL Electric's Residential Behavior-Based Program" Working Paper, Behavior, Energy & Climate Change Conference.

- *Utility, State, Fuel:* PPL Electric, PA, Electric
- *Results:* "The program reduced PPL Electric's system peak by about 6.5 MW." "Demand savings were about 50-60% higher on average during system peak hours [compared to non-peak hours]" "The program also resulted in energy savings of 36 million kWh per year at an average cost of $0.07/kWh"

33. Allcott, Hunt and Todd Rogers, 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review,* 104(10): 3003-37.

- *Utility, State, Fuel:* West Coast Utility (unidentified), Electric
- *Results:* At the beginning of a Home Energy Reports program, households display a pattern of high-frequency "action and backsliding" between reports, but these cycles diminish over time and savings become more durable as treatment continues. Even after two years of treatment, "continued treatment still has substantial incremental effects." "If the intervention stops after two years, the effects decay at only 10 to 20 percent per year"
- *Contact:* Hunt Allcott, allcott@mit.edu

34. January 2014. "Impact and Process Evaluation of Ameren Illinois Company's Behavioral Modification Program (PY5)" Opinion Dynamics.

- *Utility, State, Fuel:* Ameren Illinois, Illinois, Electric & Gas
- *Results:* "Approximately 198,000 dual fuel customers participated in the Behavioral Modification Program in PY5. The program saved 31,618 MWh and 1,576,341 therms."

35. January 2014. "National Grid Residential Building Practices and Demonstration Program Evaluation: Final Results." DNV KEMA

- *Utility, State, Fuel:* National Grid New York, NY, Electric & Gas
- *Results:* Over the first 19 months, the program achieved 45,050 MWh in electric savings and 1,049,976 Therms in gas savings. Of the electric savings, 152 MWh and 53 MWh were joint savings also attributable to downstream and upstream measures, respectively. On average, electric-only households in the program achieved savings of about 2.3% of their usage, and dual-fuel customers saved 1.52% of their electricity usage and 0.77% of their gas usage.
- *Contact:* Ken Agnew, DNV KEMA

36. January 2014. "First Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013, Program Year 4" The Cadmus Group, Inc.

- *Utility, State, Fuel:* PPL Electric, PA, Electric
- *Results:* "In the first year of the program, the percent savings (the percent reduction in average daily consumption) trend upward and reach a steady state of approximately 1.7% to 1.8% by the beginning of PY3….In PY4, the percent savings increase slightly to just above 2%." In the fourth year of the program, the average household saved 360 kWh (legacy group) and 495 kWh (expansion group). In the fourth year, "The average peak demand reduction for the whole program was 6.5 MW, enough electricity to meet the demand of approximately 1,800 control group customers during peak hours."

37. January 2014. "Program Year 2 (2012-2013) EM&V Report for the Residential Energy Efficiency Benchmarking Program." Navigant Consulting, Inc.

- *Utility, State, Fuel:* Duke Energy Progress, NC, Electric
- *Results:* "Average savings for participants in the Initial Wave were 1.63% of energy consumption during PY2 (August 2012 to July 2013), an increase from 1.23% in PY1" This is equivalent to a reduction of "312 kWh if their account was active the entire program year." Total program verified savings were 15.9 GWh, net of savings from other EE programs.

38. January 28, 2014. “Home Energy Reports Program: PY5 Evaluation Report.” Navigant Consulting, Inc.

- *Utility, State, Fuel:* Commonwealth Edison Company, IL, Electric
- *Results*: The evaluation finds total program verified savings to be 97,442 MWh, corresponding to a 2.04% reduction in usage for program participants. “Over the past three years energy savings by Wave 1 customers have been remarkably stable: 2.05% in EPY3, 2.20% in EPY4, and 2.16% in EPY5. This is a significant finding and indicates that going forward the program is likely to continue to generate savings of approximately 2% for this group”

39. March 2014. "Evaluation of 2013 DSM Portfolio: Submitted to CenterPoint Energy Arkansas." ADM Associates, Inc.

- *Utility, State, Fuel:* CenterPoint Energy Arkansas, AR, Gas
- *Results:* In program year 2013, the program produced 1,112,462 annual Therms savings; and 16,797.3 peak Therms. “Per customer, this averages to a 1.96% reduction in annual gas consumption for Wave 1 [in its second year] and 1.00% for Wave 2 [in it’s first year]”

40. March 2014. "Evaluation of 2013 DSM Portfolio: Submitted to SourceGas Arkansas." ADM Associates, Inc.

- *Utility, State, Fuel:* SourceGas Arkansas, AR, Gas
- *Results:* In program year 2013, the program produced 438,534 annual Therms savings; and 9,291.18 peak Therms. "The Home Energy Reports Program observed much higher savings in 2013, due largely to the heavier winter"

41.Todd, A., M. Perry, B. Smith, M. Sullivan, P. Cappers, and C. Goldman. 2014. "Insights fro m Smart Meters: The Potential for Peak Hour Savings from Behavior-Based Programs." Lawrence Berkeley National Laboratory.

- *Utility, State, Fuel:* Pacific Gas & Electric, CA, Electric
- *Results:* The evaluation finds "statistically significant electricity savings every hour; higher kWh savings during peak hours; and a higher percentage of savings during peak hours relative to the energy usage in each hour." In other words, "savings disproportionately increase during the peak hours". During the ten highest system peak days included in the dataset, the evaluation finds even "higher peak savings" and "slightly higher proportional peak savings"
- *Contact:* Annika Todd, 510-486-6544, atodd@lbl.gov mailto:atodd@lbl.gov

42. March 2014. "Verification of Savings from Xcel Energy Minnesota's Print Energy Feedback Pilot Project – Final Report." Center for Energy and the Environment.

- *Utility, State, Fuel:* Xcel Energy, MN, Electric & Gas
- *Results:* "Over three years, the pilot project produced cumulative measured savings of 26,769 MWh of electricity and 643,667 therms of natural gas. Savings in each year were highly significant for each energy type ($p<0.001$)" "For the customers that remained in the program all three years, electricity savings increased significantly each year."

43. April 2014. "Home Energy Report Program. 2013 Impact Evaluation. Puget Sounds Energy". DNV-GL

- *Utility, State, Fuel:* Puget Sound Energy, Washington, Electric & Gas
- *Results: "*The current treatment group produced credited savings at 3.0% and 1.5% for electric and gas, respectively. The suspended treatment group incurred 49% less electric savings when compared to current treatment group….Households in the current group that continued to receive reports through the fifth year generated savings at or above levels established in the first two years of the program. Households in the suspended group that were in their third year of not receiving reports still generated at least half of the savings of the current treatment group."

44. May 2014. "Home Performance Program: Evaluation, Measurement, and Verification Report 2013" ADM Associates, Inc.

- *Utility, State, Fuel:* FirstEnergy Ohio Companies (Ohio Edison, The Cleveland Electric Illuminating Company, The Toledo Edison Company), Ohio, Electric
- Results: "The ex post verified annual electricity savings for all participants combined in 2013 were 12,792,850 kWh," equivalent to 175.24 annual savings per household. "Program-level critical peak demand impacts…were determined to be about 1,460 kW"

45. July 2014. "Home Electricity Report Program, January 2012 through December 2013 Study Period: 2013 Impact Evaluation" DNV-GL

- *Utility, State, Fuel:* Seattle City Light, WA, Electric
- *Results*: "The SCL HER program saved over 15 million kWh each year for 2012 and 2013, for a total of over 32 million kWh for the two years combined" Household-level impacts "range from over 400 kWh [greater than 3%] for the third and fourth years of the Legacy wave to 250 to 300 kWh [2-2.5%] for the first and second years of the Expansion and Expansion CPW waves. The small Legacy CPW wave has the highest per household savings, at greater than 500 kWh [5%] per household,

perhaps reflecting the increased emphasis on conservation accompanying the CPW program"

46. July 2014. "Central Hudson Gas & Electric Corporation: Home Energy Comparison Report Program" Applied Energy Group.

- *Utility, State, Fuel:* Central Hudson Gas & Electric, New York, Electric and Natural Gas
- *Results:* "The average daily energy savings observed in the participant sample is…2.11 percent. The program achieved an average yearly savings of approximately 210 kWh per participant." "Overall, AEG determined that the HECR program resulted in net energy savings of 18,650 MWh and 286,226 Therms" "AEG determined that the overall TRC benefit-cost ration for the HECR program is 1.19, and is therefore cost-effective"

47. August 29, 2014. "Evaluation of Southern California Gas Company's 2013-2014 Conservation Campaign: Submitted to Southern California Gas Company." Nexant.

- *Utility, State, Fuel:* Southern California Gas Company, CA, Natural Gas
- *Results:* Customers enrolled in the HER program had total verified net savings of 159,708 therms. Customers who received email HERs only saved approximately 1.4% per household, while customers who received paper reports or a combination of paper and email reports had savings of approximately 1.5%-1.6% per household.

48. October 3, 2014. "Home Energy Reports Program: GPY3 Evaluation Report" Navigant Consulting, Inc.

- *Utility, State, Fuel:* People's Gas and North Shore Gas, IL, Natural Gas
- *Results:* "Total program verified net savings are 2,054,727 therms for People's Gas and 652,718 for North Shore Gas." "HER savings correspond to a 0.85% and 0.63% reduction in usage for program participants from People's Gas and North Shore Gas respectively. These savings are typical for first year savings for residential gas Home Energy Report Programs, as HER program typically exhibit a one to two year ramping period"

49. October 24, 2014. "SCE's Home Energy Report Program Savings Assessment: Ex-Post Evaluation Results, Program Year 2013." Applied Energy Group.

- *Utility, State, Fuel:* SoCal Edison (SCE), California, Electricity.
- Results: "We estimate ex-post energy savings of 8,541 MWh during the 12-month treatment period... We also estimate peak demand savings of 2,809 kW"

50. December 2014. "2013 SCE Home Energy Reports Program: Review and Validation of Impact Evaluation." DNV GL – Energy.

- *Utility, State, Fuel:* SoCal Edison (SCE), California, Electricity.
- Results: "DNV GL recommends the following savings estimates for 2013 SCE HER program: … 8,795,195 kWh [and peak demand reduction of]… 2,694 kW"

51. October 2014. "SDG&E Home Energy Reports Program: 2013 Impact Evaluation". DNV GL – Energy.

- *Utility, State, Fuel:* San Diego Gas & Electric (SDG&E), California, Gas and Electricity.
- *Results:* "In 2013, the HER program achieved a reduction of 4,540 MWh across the treatment households…. The program also generated 184,400 therms of gas savings"

52. January 16, 2015. "2013 PG&E Home Energy Reports Program: Review and Validation of Impact Evaluation ED Res 3.1" DNV GL – Energy.

- *Utility, State, Fuel:* Pacific Gas & Electric (PG&E), California, Gas and Electricity
- *Results:* DNV measured total electricity savings of 92,832,411 kWh, total gas savings of 2996,866 Therms, and a peak demand reduction of 15.4 MW

OPOWER

September 1, 2015

The following document provides a detailed explanation of the recommended best practices for Evaluation, Measurement and Verification of residential behavioral energy efficiency programs that Opower follows when designing its Home Energy Report programs. This includes best practices for determining program size, randomly assigning customers to treatment and control groups, administering the Home Energy Reports, collecting data, and verifying the savings:

- Prepared by J. Stewart, and A. Todd. *Chapter 17: Residential Behavioral Protocol.* The Uniform Methods Project. U.S. Department of Energy- National Renewable Energy Laboratory. 2015. Available online at: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter17-residential-behavior.pdf

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Chapter 17: Residential Behavior Protocol

The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures

Created as part of subcontract with period of performance
September 2011 – December 2014

James Stewart
The Cadmus Group
Waltham, Massachusetts

Annika Todd
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Berkeley, California

NREL Technical Monitor: Charles Kurnik

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January 2015

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Chapter 17: Residential Behavior Protocol

The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures

Created as part of subcontract with period of performance September 2011 – December 2014

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Prepared under Subcontract No. LGJ-1-11965-01

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Acronyms

BB	behavior-based
RCT	randomized control trial
RED	randomized encouragement design
ITT	intent-to-treat
D-in-D	difference-in-differences
TOT	treatment effect on the treated
OLS	Ordinary Least Squares
LATE	local average treatment

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1 Measure Description

Residential behavior-based (BB) programs use strategies grounded in the behavioral and social sciences to influence household energy use. These may include providing households with real-time or delayed feedback about their energy use; supplying energy efficiency education and tips; rewarding households for reducing their energy use; comparing households to their peers; and establishing games, tournaments, and competitions.[1] BB programs often target multiple energy end uses and encourage energy savings, demand savings, or both. Savings from BB programs are usually a small percentage of energy use, typically less than 5%.[2]

Utilities introduced the first large-scale residential BB programs in 2008. Since then, dozens of utilities have offered these programs to their customers.[3] Although program designs differ, many share these features:

- They are implemented using a randomized experimental design, where eligible homes are randomly assigned to treatment or control groups.
- They are large scale by energy efficiency program standards, targeting thousands of utility customers.
- They provide customers with analyses of their historical consumption, energy savings tips, and energy efficiency comparisons to neighboring homes, either in personalized home reports or through a Web portal, or offer incentives for savings energy.
- They are typically implemented by outside vendors.[4]

Utilities will continue to implement residential BB programs as large-scale, randomized control trials (RCTs); however, some are now experimenting with alternative program designs that are smaller scale; involve new communication channels such as the Web, social media, and text messaging; or that employ novel strategies for encouraging behavior change (e.g., Facebook competitions).[5] These programs will create new evaluation challenges and may require different evaluation methods than those currently employed to verify any savings they generate. Quasi-experimental methods, however, require stronger assumptions to yield valid savings estimates and may not measure savings with the same degree of validity and accuracy as experimental methods.

[1] See Ignelzi et al. (2013) for a classification and descriptions of different BB intervention strategies and Mazur-Stommen and Farley (2013) for a survey and classification of current BB programs.
[2] See Alcott (2011), Davis (2011), and Rosenberg et al. (2013) for savings estimates from residential BB programs.
[3] See the 2013 Consortium for Energy Efficiency (CEE) database for a list of utility behavior programs; it is available for download: http://library.cee1.org/content/2013-behavior-program-summary-public-version.
[4] Vendors that offer residential BB programs include Aclara, C3 Energy, Opower, and Simple Energy.
[5] The 2013 CEE database includes descriptions of many residential BB programs with alternative designs such community-focused programs, college dormitory programs, K-12 school programs, and programs relying on social media.

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2 Applicability Conditions of Protocol

This protocol recommends the use of RCTs or randomized encouragement designs (REDs) for estimating savings from BB programs that satisfy the following conditions:[6]

- Residential utility customers are the target.
- Energy or demand savings are the objective.
- An appropriately sized analysis sample can be constructed.
- Accurate energy use measurements for sampled units are available.

The next section of this protocol carefully defines and explains these evaluation methods. A significant body of evidence indicates that randomized experimental approaches work; that is, they result in unbiased and robust estimates of program energy and demand savings.

This protocol applies only to residential BB programs. In theory, evaluators can apply the experimental methods recommended in this protocol to nonresidential BB programs, and there are examples of evaluators applying such methods.[7] However, utilities have offered relatively few BB programs to nonresidential customers thus far. Thus, knowledge about the efficacy of evaluation methods in the nonresidential sector is lacking. As more evidence accumulates, the National Renewable Energy Laboratory could expand this protocol to include nonresidential programs.

This protocol also addresses best practices for estimating energy and demand savings. There are no significant conceptual differences between measuring energy savings and measuring demand savings; thus, evaluators can apply the algorithms in this protocol for calculating BB program savings to either. The protocol does not directly address the evaluation of other BB program objectives, such as increasing utility customer satisfaction, educating customers about their energy use, or increasing awareness of energy efficiency.[8]

This protocol also requires that the analysis sample be large enough to detect the expected savings with a high degree of confidence. Because most BB programs result in small percentage savings, a large number of sampled units are required to detect savings. This protocol does not address program evaluations conducted with insufficiently sized samples.

Finally, this protocol requires that the energy use of participants or households affected by the program (for the treatment and control groups) can be clearly identified and measured. Typically, the analysis unit is the household; in this case, treatment group households must be identifiable and individual household energy use must be measurable. However, depending on the BB

---

[6] As discussed in Considering Resource Constraints in the Introduction of this UMP report, small utilities (as defined under the U.S. Small Business Administration regulations) may face additional constraints in undertaking this protocol. Therefore, alternative methodologies should be considered for such utilities.

[7] For example, PG&E offers a Business Energy Reports Program, which it implemented as a field experiment. See http://beccconference.org/wp-content/uploads/2013/12/BECC_PGE_BER_11-19-13_seelig-.pdf

[8] Process evaluation objectives may be important, and omission of them from this protocol should not be interpreted as a statement that these objectives should not be considered by program administrators.

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program, the analysis units may not be households. For example, for a BB program that generates an energy competition between hundreds of housing floors at a university, the analysis unit may be floors; in this case, the energy use measurement of individual floors must be available.

The characteristics of BB programs that *do not* determine the applicability of the evaluation protocol include:

- Whether the program is opt in or opt out[9]
- The specific behavior-modification theory or strategy
- The channel(s) through which program information is communicated.

This protocol does not recommend quasi-experimental methods to evaluate BB programs covered by this protocol. Evaluators of BB programs have employed quasi-experimental methods,[10] but more knowledge about the efficacy of these methods is needed before they can be recommended.[11] As more evidence accumulates, the National Renewable Energy Laboratory may update this protocol as necessary.

Although this protocol strongly recommends RCTs or REDs for estimating savings from residential BB programs when the applicability criteria are met, it also recognizes that other considerations such as regulatory requirements or program objectives may take precedence, and evaluators may not always be able to apply these methods. In these cases, evaluators will have to employ quasi-experimental methods, which require stronger assumptions than do experimental methods to yield valid savings estimates. If these assumptions are violated, quasi-experimental methods may produce biased results. The extent of the biases in the estimates is not knowable *ex ante*, so results will be less reliable. Because there is currently not enough evidence of quasi-experimental methods that perform well, this protocol refrains from recommending non-RCT evaluation methods. A good reference for the application of quasi-experimental methods to behavior-based program evaluation is See Action (2012) or Cappers et al. (2013).

2.1 Examples of Protocol Applicability

Examples of residential BB programs for which the evaluation protocol applies follow:

- **Example 1:** A utility sends energy reports encouraging conservation steps to thousands of randomly selected residential customers.

[9] In opt-in programs, customers enroll or select to participate. In opt-out programs, the utility enrolls the customers, and the customers remain in the program until they opt out. An example opt-in program is having a utility Web portal with home energy use information and energy efficiency tips that residential customers can use if they choose. An example opt-out program is sending energy reports to utility selected customers.

[10] For example, see Harding and Hsiaw (2012), who use variation in timing of adoption of an online goal-setting tool to estimate savings from the tool.

[11] Allcott (2011) shows that a within-subject design using a pre-post comparison of monthly energy use of households receiving energy reports overestimates savings compared to difference-in-differences (D-in-D) estimation using treatment and control group subjects.

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- **Example 2:** Several hundred residential customers enroll in a Wi-Fi-enabled thermostat pilot program offered by the utility.
- **Example 3:** A utility invites thousands of residential customers to use its Web portal to track their energy use in real time, set goals for energy saving, find ideas about how to reduce their energy use, and receive points or rewards for saving energy.
- **Example 4**: A utility sends voice, text, and email messages to thousands of residential utility customers encouraging—and providing tips for— reducing energy use during an impending peak demand event.

Examples of programs for which the protocol does not apply follow:

- **Example 5:** A utility uses a mass-media advertising campaign that relies on radio and other broadcast media to encourage residential customers to conserve energy.
- **Example 6:** A utility initiates a social media campaign (e.g., using Facebook or Twitter) to encourage energy conservation.
- **Example 7:** A utility runs a pilot program to test the savings from in-home energy-use displays, and enrolls too few customers to detect the expected savings.
- **Example 8:** A utility runs a BB program in a large college dormitory to change student attitudes about energy use. The utility randomly assigns some rooms to the treatment group. The dorm is master-metered.

The protocol does not apply to Example 5 or Example 6 because the evaluator cannot identify who received the messages. The protocol does not apply to Example 7 because too few customers are in the pilot to accurately detect energy savings. The protocol does not apply to Example 8 because energy-use data are not available for the specific rooms in the treatment and control groups.

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3 Savings Concepts

This protocol applies to residential BB programs that satisfy the applicability conditions described in Section 2. RCTs or REDs and regression analysis of energy use for periods before and during the treatment for treatment and control group subjects are recommended for estimating energy or demand savings from BB programs. The protocol recommends RCTs and REDs because they yield unbiased and robust estimates of savings caused by the program; that is, net savings. Unless otherwise noted, all references in this protocol to savings are to net savings.

Section 3.1 defines some key concepts; Section 3.2 describes specific evaluation methods.

3.1 Definitions

Control group. In an experiment, the control group comprises subjects (e.g., utility customers) who do not receive the program intervention or treatment.

Experimental design.[12] Randomized experimental designs rely on observing the energy use of subjects who were randomly assigned to program treatments or interventions in a controlled process.

External validity. Savings estimates are externally valid if evaluators can apply them to different populations or different time periods from those studied.

Internal validity. Savings estimates are internally valid if the savings estimator is expected to equal the causal effect of the program on consumption.

Opt-in program. Utilities use opt-in BB programs if the customers must agree to participate, and the utility cannot administer treatment without consent.

Opt-out program. Utilities use opt-out BB programs if customers need not agree to participate. The utility can administer treatment without consent, and customers remain enrolled until they ask the utility to stop the treatment.

Quasi-experimental design. Quasi-experimental designs rely on a comparison group who is not obtained via random assignment. Such designs observe energy use and determine program treatments or interventions based on factors that may be partly random but not controlled.

Randomized Control Trial (RCT). An RCT yields an unbiased estimate of savings. Evaluators randomly assign subjects from a study population to a treatment group or a control group. Subjects in a treatment group receive one program treatment (there may be multiple treatments), while subjects in the control group receive no treatment. The RCT ensures that receiving the treatment is uncorrelated with the subjects' pre-treatment energy use, and that evaluators can attribute any difference in energy use between the groups to the treatment.

[12] When this protocol uses the term *experimental methods*, it refers to randomized experiments such as RCTs or REDs, not other experimental evaluation approaches such as natural experiments or quasi-experiments.

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Randomized Encouragement Design (RED). In an RED, evaluators randomly assign subjects to a treatment group that receives *encouragement* to participate in a program or to a control group who does not receive encouragement. The RED yields an unbiased estimate of the effect on energy use of encouraging energy-efficient behaviors and the effect on customers who participate because of the encouragement.

Treatment. A treatment is an intervention administered through the BB program to subjects in the treatment group. Depending on the research design, the treatment may be a program intervention or encouragement to accept an intervention.

Treatment effect. This is the effect of the BB program intervention(s) on energy use for a specific population and time period.

Treatment group. The treatment group includes subjects who receive the treatment.

3.2 Experimental Research Designs

This section outlines experimental methods for evaluating BB programs. The most important benefit of an RCT or RED is that, if carried out correctly, the experiment results in an unbiased estimate of the program's causal impact.[13] Unbiased savings estimates have internal validity. A result is internally valid if the evaluator can expect the value of the estimator to equal the savings caused by the program intervention. The principal threat to internal validity in BB program evaluation derives from potential selection bias about who receives a program intervention. RCTs and REDs yield unbiased savings estimates because they ensure that receiving the program intervention is uncorrelated with the subjects' energy use.

Experimental research designs may yield savings estimates that are applicable to other populations or time periods, making them externally valid. Whether savings have external validity will depend on the specific research design, the study population, and other program features.

A benefit of field experiments is their versatility: evaluators can apply them to a wide range of BB programs regardless of whether they are opt-in or opt-out programs. Evaluators can apply experimental methods to any program where the objective is to achieve energy or demand savings; evaluators can construct an appropriately sized analysis sample; and accurate measurements of the energy use of sampled units are available.

Experimental methods generally yield highly robust savings estimates that are not model dependent; that is, they do not depend on the specification of the model used for estimation.

The choice of whether to use an RCT or RED to evaluate program savings should depend on several factors, including whether it is an opt-in or opt-out program and the utility's tolerance for subjecting customers to the requirements of an experiment. For example, using an RCT for an opt-in program might require delaying or denying participation for some customers. A utility may prefer to use an RED to accommodate all the customers who want to participate.

[13] List (2011) describes many of the benefits of employing randomized field experiments.

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Implementing an RCT or RED design requires upfront planning. Program evaluation must be an integral part of the program planning process; this need will be evident in the experimental research design descriptions described in Section 3.3.

3.3 Basic Features

This section outlines several types of RCT research designs, which are simple but extremely powerful research tools. The core feature of RCT is the random assignment of study subjects (e.g., utility customers, floors of a college dormitory) to a treatment group that receives or experiences an intervention or to a control group that does not receive the intervention.

Section 3.3.1 outlines some common features of RCTs and discusses specific cases.

3.3.1 Common Features of Randomized Control Trial Designs

The key requirements of an RCT are incorporated into the following steps:

1. **Identify the study population:** The program administrator screens the utility population if the program intervention is offered to certain customer segments only, such as single-family homes. Programs designers can base eligibility on dwelling type (e.g., single family, multifamily), geographic location, completeness of recent billing history, heating fuel type, utility rate class, or other energy use characteristics.
2. **Determine sample sizes:** The numbers of subjects to assign to the treatment and control groups depend on the type of randomized experiment (e.g., REDs and opt-out RCTs generally require more customers) and hypothesized savings. The number of subjects assigned to the treatment versus control groups should be large enough to detect the hypothesized program effect with sufficient probability.[14]

   Evaluators can use a statistical power analysis to determine the number of subjects required. This results in minimum sample sizes for the treatment and control groups as a function of the hypothesized program effect, the coefficient of variation of energy use, the specific analysis approach that will be used (e.g., simple differences of means, a repeated measure analysis), and tolerances for Type I and Type II statistical errors.[15] Most statistical software (including SAS, STATA, and R) now include packages for performing statistical power analyses. It is not uncommon for BB programs with expected savings of less than 5% to require thousands of subjects in the treatment and control groups.[16]

   An important component of the random assignment process is to verify that the treatment and control groups are statistically equivalent or balanced in their observed covariates. At

[14] The number of subjects in the treatment group may also depend on the size of the program savings goal.
[15] A Type I error occurs when a researcher rejects a null hypothesis that is true. Statistical confidence equals 1 minus the probability of a Type I error. A Type II error occurs when a researcher accepts a null hypothesis that is false. Many researchers agree that the probability of a 5% Type I error and a 20% Type II error is acceptable. See List et al. (2010).
[16] EPRI (2010) illustrates that, all else equal, repeated measure designs, which exploit multiple observations of energy use per subject both before and after program intervention, require smaller analysis sample sizes than other types of designs.

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a minimum, evaluators should check before the intervention for statistically significant differences in average pre-treatment energy use and in the distribution of pre-treatment energy use between treatment and control homes.

3. **Randomly assign subjects to treatments and control:** Study subjects should be randomly assigned to treatment and control groups. To avoid the appearance of a conflict of interest and to ensure the integrity of the RCT, this protocol highly recommends that a qualified independent third party perform the random assignment. Also, to preserve the integrity of the experiment, customers must not choose their assignments. The procedure for randomly assigning subjects to treatment and control groups should be transparent and well documented.

4. **Administer the treatment:** The intervention must be administered to the treatment group and withheld from the control group. To avoid a Hawthorne effect, in which subjects change their energy use in response to observation, control group subjects should receive minimal information about the study. Depending on the research subject and intervention type, the utility may administer treatment once or repeatedly and for different durations. However, the treatment period should be long enough for evaluators to observe any effects of the intervention.

5. **Collecting data:** Data must be collected from all study subjects, not only from those who chose to participate or only from those who did not drop out of the study or experiment.

   Preferably, evaluators collect multiple pre- and post-treatment energy use measurements. Such data enable the evaluator to control for time-invariant differences in average energy use between the treatment and control groups to obtain more precise savings estimates. Step 6 discusses this in further detail.

6. **Estimate savings:**[17] Evaluators should calculate savings as the difference in energy use or difference-in-differences (D-in-D) of energy use between the subjects who were initially assigned to the treatment versus the control group. To be able to calculate an unbiased savings estimate, evaluators must compare the energy use from the entire group of subjects who were originally randomly assigned to the treatment group to the entire group of subjects who were originally randomly assigned to the control group. For example, the savings estimate would be biased if evaluators used only data from utility customers in the treatment group who chose to participate in the study.

   The difference in energy use between the treatment and control groups, usually called an intent-to-treat (ITT) effect, is an unbiased estimate of savings because subjects were randomly assigned to the treatment and control groups. The effect is an ITT because, in contrast to many randomized clinical medical trials, ensuring that treatment group subjects in most BB programs comply with the treatment is impossible. For example, some households may opt out of an energy reports program, or they may fail to notice or simply ignore the energy reports. Thus, the effect is ITT, and the evaluator should base

[17] This protocol focuses on estimating average treatment effects; however, treatment effects of behavior programs may be heterogeneous. Costa and Kahn (2010) discuss how treatment effects can depend on political ideology and Allcott (2011) discusses how treatment effects can depend on pretreatment energy use.

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the results on the initial assignment of subjects to the treatment group, whether or not subjects actually complied with the treatment.

The savings estimation approach should be well documented, transparent, and performed by an independent third party.

3.4 Common Designs

Section 3.1 describes some of the RCT designs commonly used in BB programs.

3.4.1 Randomized Control Trial With Opt-Out Program Design

One common type of RCT includes the option for treated subjects to opt out of receiving the program treatment. This design reflects the most realistic description of how most BB programs work. For example, in energy reports programs, some treated customers may ask the utility to stop sending them reports.

Figure 1 depicts the process flow of an RCT in which treated customers can opt out of the program. In this illustration, the utility initially screened utility customers to refine the study population.

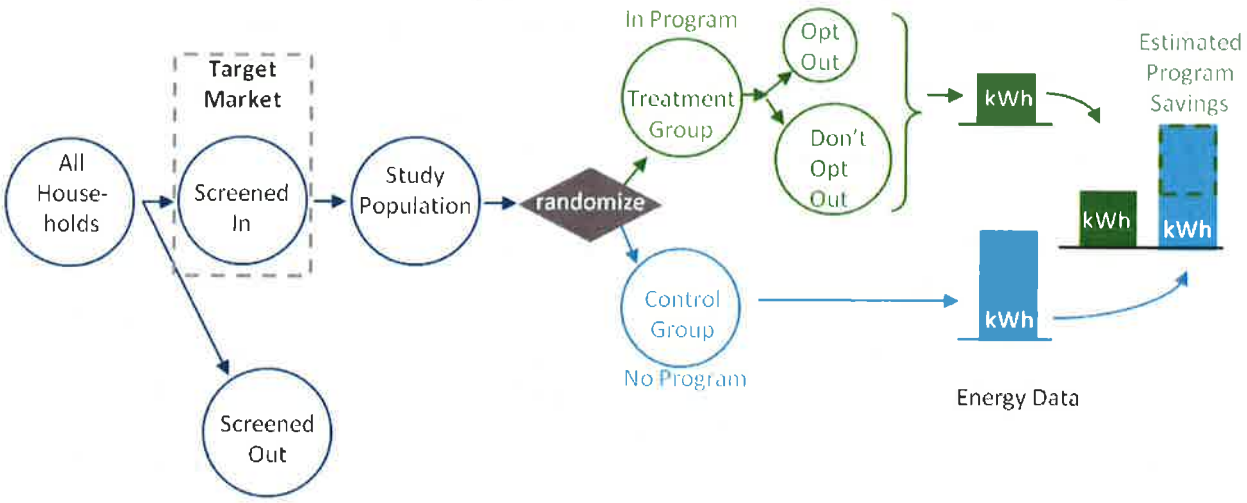

Figure 1. Illustration of RCT with opt-out program design[18]

Customers who pass the screening constitute the study population or sample frame. The savings estimate will apply to this population. Alternatively, the utility may want to study only a sample of the screened population, in which case a third party should sample randomly from the study population. The analysis sample must be large enough to meet the minimum size requirement for the treatment and control groups. The program savings goals and desired statistical power will determine the size of the treatment group.

[18] This graphic and the following ones are variations of those that appeared in SEE Action (2012). A coauthor of the SEE Action report and the creator of that reports' figures is one of the authors of this protocol.

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The next steps in an RCT with opt-out program design are to (1) randomly assign subjects in the study population to the program treatment and control groups; (2) administer the program treatments; and (3) collect energy use data.

The distinguishing feature of this experimental design is that customers can opt out of the program. As Figure 1 shows, evaluators should include opt-out subjects in the energy savings analysis to ensure unbiased savings estimates. Evaluators can then calculate savings as the difference in average energy use between treatment group customers, including opt-out subjects and control group customers. Removing opt-out subjects from the analysis would bias the savings estimate because identifying subjects in the control group who would have also opted out had they received the treatment is impossible. The resulting savings estimate is therefore an average of the savings of treated customers who remain in the program and of customers who opted out.

Depending on the type of BB program, the percentage of customers who opt out may be small, and may not affect the savings estimates significantly (e.g., few customers generally opt out of energy reports programs).

3.4.2 Randomized Control Trial With Opt-In Program Design

RCT with opt-out subjects assumes that the BB program treatments can be administered to subjects without their agreement. This is the case for programs in which, for example, a utility mails energy reports to customer homes or leaves door hangers with energy savings tips on customer homes. However, the utilities must have consent to administer some interventions. Examples include offering Web-based home audit or energy consumption tools; programmable, communicating thermostats with wireless capability; an online class about energy rates and efficiency; or in-home displays. All these interventions require that customers opt in to the program.

An opt-in RCT, (Figure 2) can accommodate the necessity for customers to opt in to some BB programs. This design results in an unbiased estimate of the ITT effect for customers who opt in to the program. The estimate of savings will have internal validity; however, it will not have external validity, because it will not apply to subjects who do not opt in.

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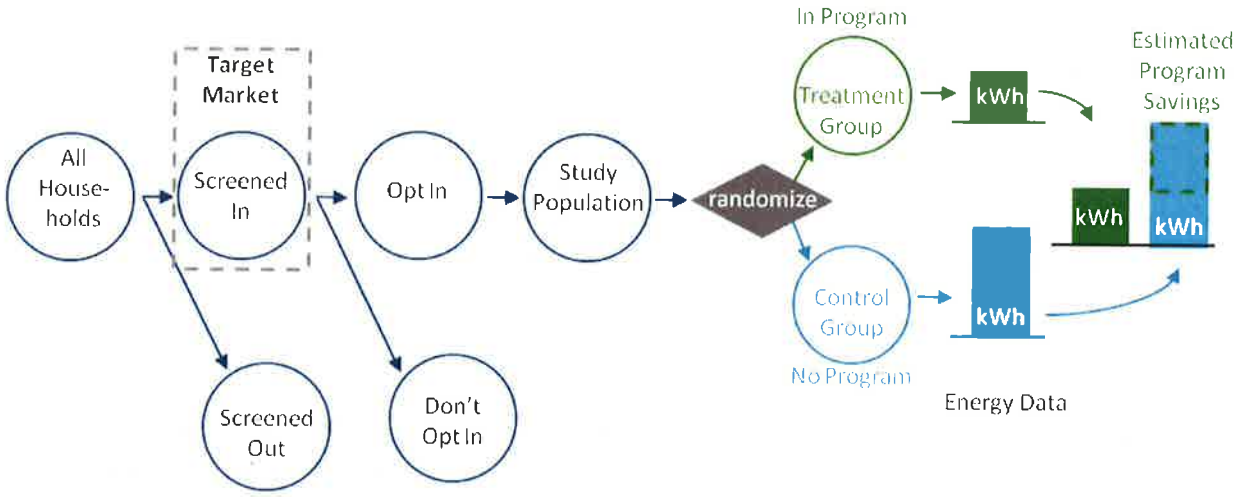

Figure 2. Illustration of RCT with opt-in program design

Implementing opt-in RCTs is very similar to implementing opt-out RCTs. The first step, screening utility customers for eligibility to determine the study population, is the same. The next step is to market the program to eligible customers. Some eligible customers may then agree to participate. Then, an independent third party randomly assigns these customers to either a treatment group that receives the intervention or a control group that does not. The utility delays or denies participation in the program to customers assigned to the control group. Thus, only customers who opted in and were assigned to the treatment group will receive the treatment.

Randomizing only opt-in customers ensures that the treatment and control groups are equivalent in their energy use characteristics. In contrast, other quasi-experimental approaches, such as matching participants to nonparticipants, cannot guarantee either this equivalence or the internal validity of the savings estimates.

After the random assignment, the opt-in RCT proceeds the same as an RCT with opt-out subjects: the utility administers the intervention to the treatment group. The evaluator collects energy use data from the treatment and control groups, then estimates energy savings as the difference in energy use between the groups. The evaluator does not collect energy use data for customers who do not opt in to the program.

An important difference between the opt-in RCTs and RCTs with opt-out subjects is how to interpret the savings estimates. In the RCT with opt-out subjects, the evaluator bases the savings estimate on a comparison of the energy use between treatment and control groups, which pertains to the entire study population. In contrast, in the opt-in RCT, the savings estimate pertains to the subset of customers who opted into the program, and the difference in energy use represents the treatment effect on customers who opted in to the program. Opt-in RCT savings

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estimates have internal validity; however, they do not apply to customers who did not opt in to the program.

3.4.3 Randomized Encouragement Design

For some opt-in BB programs, delaying or denying participation to some customers may be undesirable. In this case, neither the opt-out nor the opt-in RCT design would be appropriate, and this protocol recommends an RED. Instead of randomly assigning subjects to receive or not receive an intervention, a third party randomly assigns them to a treatment group that is *encouraged* to accept the intervention (i.e., to participate in a program or adopt a measure), or to a control group that does not receive encouragement. Customers who receive the encouragement can refuse the intervention, and, depending on the program design, control group customers who learn about the intervention may be able to participate.

The RED yields an unbiased estimate of the effect of encouragement on energy use and, depending on the program design, can also provide an unbiased estimate of either the effect of the intervention on customers who accept it because of the encouragement or the effect of the intervention on all customer who accept it.

Figure 3 illustrates the process flow for a program using an RED. As with the RCT with opt-out and opt-in RCT, the first two steps are to identify the sample frame and select a study population. Next, like the RCT with opt out, a third party randomly assigns subjects to a treatment group, which receives encouragement, or to a control group, which does not. For example, a utility might employ a direct mail campaign that encourages treatment group customers to use an online audit tool. The utility would administer the intervention to treatment group customers who opt-in. Although customers in the control group did not receive encouragement, some may learn about the program and decide to sign up. The program design shown in Figure 3 allows for control group customers to receive the behavioral intervention.

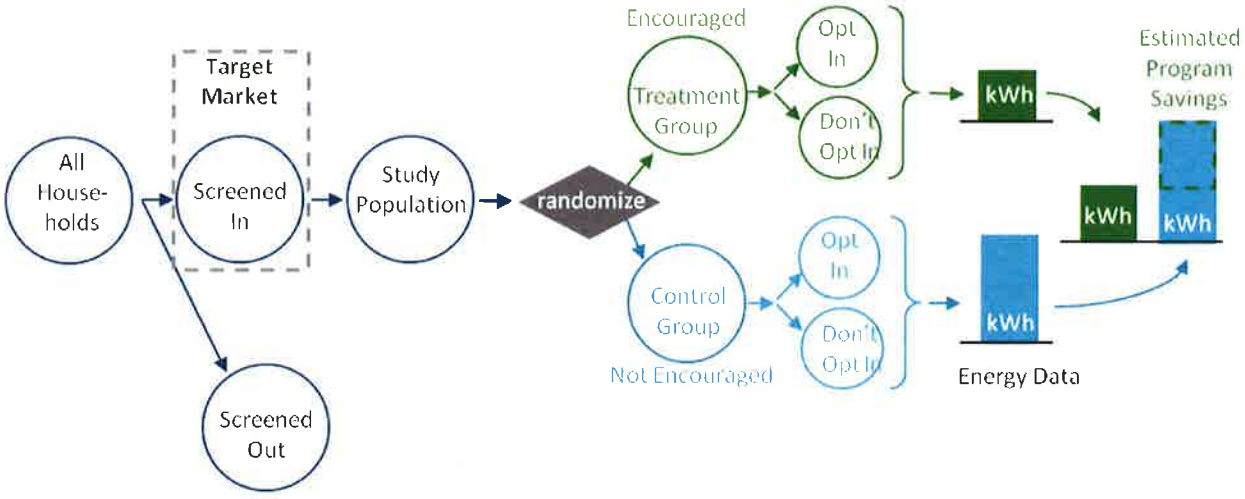

Figure 3. Illustration of RED program design

In Figure 3, the difference in energy use between homes in the treatment and control groups is an estimate of savings from the encouragement, not from the intervention. However, evaluators can

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also use the difference in energy use to estimate savings for customers who accept the intervention because of the encouragement. To see this, consider that the study population comprises three types of subjects: (1) always takers, or those who would accept the intervention whether encouraged or not; (2) never takers, or those who would never accept the intervention even if encouraged; and (3) compliers, or those who would accept the intervention only if encouraged. Compliers participate only after receiving the encouragement.

Because eligible subjects are randomly assigned to groups depending on whether they receive encouragement, the treatment and control groups should have equal frequencies of always takers, never takers, and compliers in expectation. After treatment, the only difference between the treatment and control groups is that compliers in the treatment group accept the treatment and compliers in the control group do not. In both groups, always takers accept the treatment and never takers always refuse the treatment. Therefore, the difference in energy use between the groups reflects the treatment effect of encouragement on compliers.

To estimate the effect of the intervention on compliers (known as the local average treatment effect [LATE]), it is necessary to scale the treatment effect of the encouragement by the difference between treatment and control groups in the percentage of customers who receive the intervention:[19]

1/(% of encouraged customers who accepted –
% of not encouraged customers who did not accept)

The LATE does not capture the program effect on always takers because always takers in the control group are permitted to participate.

For BB programs with REDs that do not permit control group customers to participate, evaluators can estimate the treatment effect on the treated (TOT). The TOT is the effect of the program intervention on all customers who accept the intervention. In this case, the difference in energy use between the treatment and control groups reflects the impact of the encouragement on the always takers and compliers in the treatment group. Scaling the difference by the inverse of the percentage of customers who accepted the intervention yields an estimate of the TOT impact.[20]

Successful application of an RED requires that compliers constitute a sufficiently large percentage of the encouraged population.[21] If the RED generates too few compliers, the effects of the encouragement and receiving the intervention cannot be precisely estimated. Therefore, before employing an RED, evaluators should ensure that the sample size is sufficiently large and

[19] This approach of estimating savings from the intervention because of encouragement assumes zero savings for customers who received encouragement but did not accept the intervention. If encouraged customers who did not accept the intervention reduced their energy use in response to the encouragement, the savings estimate for compliers will be biased upward.

[20] If the effect of program participation is the same for compliers as for others, those who would have participated without encouragement (always-takers) and those who do not participate (never takers), the RED will yield an unbiased estimate of the population average treatment effect.

[21] For an example of the successful application of an RED, see SMUD (2013).

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that the encouragement will result in the required number of compliers. If the risk of an RED generating too few compliers is significant, evaluators may want to consider alternative approaches, including quasi-experimental methods.

3.4.4 Persistence Design

Studies of home energy reports programs show that program savings persist while homes continue to receive reports.[22] However, utilities and regulators may want to know what happens to BB program savings after the behavioral intervention ends. They may wish to measure whether their savings persist after the utility stops sending reports and for how long, as well as the rate of the savings "decay." As Allcott and Rodgers (forthcoming) demonstrate, the rate of savings decay after treatment ends has significant implications for the performance of efficiency program portfolios and measuring cost effectiveness of BB programs. Initial studies of home energy reports programs indicate that some portion of savings may persist after the treatment stops, although further research is needed.[23]

This protocol recommends that evaluators employ RCTs to estimate the persistence of BB program savings after participants stop receiving the intervention. The application of an RCT to a savings persistence study proceeds similarly to the application of RCTs previously discussed.

The utility is assumed to implement the BB program as an RCT with opt-out design; that is, customers from the study population were randomly assigned to a treatment group that received an intervention or to a control group that did not. Customers are able to opt out of the program (see Figure 1).

The persistence study starts with identifying the study population, in this case, the population of treated customers who received the intervention. The utility may choose to screen this population and study persistence by energy use or by socio-demographic characteristics. The persistence study population must include customers who opted out, because evaluators will need to make energy use comparisons between the persistence study population and the original control group, which includes customers who would have opted out.

The next step is to randomly assign customers in the persistence study population to one of two groups. Customers in the "discontinued treatment" group will stop receiving the intervention; customers in the "continued treatment" group will continue receiving intervention. The utility then administers the study and collects energy use data after sufficient time has passed to observe the persistence effects.

To estimate savings persistence after the end of treatment, the evaluator compares the energy use of customers in the discontinued treatment group with the energy use of customers in the original control group. This represents the post-treatment savings for customers who no longer received the intervention.

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[23] Allcott and Rodgers (forthcoming), Brattle (2012), SMUD (2012), PSE (2012) estimate BB program savings after the treatment is discontinued. Allcott and Rodgers estimate a savings decay rate of about 19%/year.

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To estimate the decay of savings after the end of treatment, the evaluator compares the energy use of the discontinued treatment group before and after treatment was discontinued. This represents the change in savings after the end of treatment for customers in the discontinued treatment group.

To estimate savings that were foregone because treatment was discontinued, the evaluator compares the savings of the continued and discontinued treatment groups after the end of treatment.

3.5 Evaluation Benefits and Implementation Requirements of Randomized Experiments

This protocol strongly recommends the use of randomized field experiments (RCTs or REDs) for evaluating residential BB programs. Sections 3.1–3.4 described the benefits—and some requirements—of evaluating BB programs using randomized experiments; this section summarizes these benefits and requirements.

Table 1 summarizes the benefits and implementation requirements.

Table 1. Benefits and Implementation Requirements of Randomized Experiments

Evaluation Benefits	Implementation Requirements
• Yield unbiased, valid estimates of causal program impacts, resulting in a high degree of confidence in the savings • Yield savings estimates that are robust to changes in model specification • Are versatile, and can be applied to opt-out and opt-in BB programs • Are widely accepted as the "gold standard" of good program evaluations • Result in transparent and straightforward analysis and evaluation • Can be designed to test specific research questions such as persistence of savings after treatment ends	• An appropriately sized analysis sample • Accurate energy use measurements for sampled units • Advance planning and early evaluator involvement in program design • Restricted participation or program marketing to randomly selected customers

The principal benefit of randomized experiments is that they yield unbiased and robust estimates of program savings. They are also versatile, widely accepted, and straightforward to analyze. The principal requirements for implementing randomized experiments include the availability of accurate energy use measurements and a sufficiently large analysis study population.[24]

[24] A frequent objection to the use of randomized experiments is that some utility customers may not have the opportunity to participate in a program. However, programs are often limited to a certain subset of customers; for example, a program may start out as limited to customers in a certain county or other geographic location. REDs allow any customers who would like to participate the opportunity to do so, even if they are in the control group. In our view, limiting the availability of the program to certain customers in RCTs is done with the worthy objective of advancing the utility's knowledge of program savings effects and making future allocation of scarce efficiency resources more optimal.

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Also, this protocol specifically recommends REDs or RCTs for estimating BB program savings. Both designs yield unbiased savings estimates. The choice of RED or RCT will depend primarily on program design and implementation considerations, in particular, whether the program has an opt-in or opt-out design. RCTs work well with opt-out programs such as residential energy reports programs. Customers who do not want to receive reports can opt out at any time without adversely affecting the evaluation. RCTs also work well with opt-in programs for which customer participation can be delayed (e.g., customers are put on a "waiting list") or denied. For situations in which delaying or denying a certain subset of customers is impossible, REDs may be more appropriate. REDs can accommodate all interested customers, but have the disadvantages of requiring larger analysis samples and requiring two analysis steps to yield a direct estimate of the behavioral intervention's effect on energy use.

Table 2 lists some issues to consider in choosing an RCT or RED.

Table 2. Considerations in Selecting an Experimental Design

Experimental Design	Evaluation Benefits	Implementation and Evaluation Requirements
RCT	• Yields unbiased, robust, and valid estimates of causal program impacts, resulting in a high degree of confidence in the savings • Simple to understand • Works well with opt-out programs • Works well with opt-in programs if customers can be delayed or denied	• May require delaying or denying participation of some customers if program requires customers to opt in
RED	• Yields unbiased, robust, and valid estimates of causal program impacts, resulting in a high degree of confidence in the savings • Can accommodate all customers interested in participating • Works well with opt-in and opt-out programs	• More complex design and harder to understand • Requires a more complex analysis • Requires larger analysis sample

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4 Savings Estimation

Evaluators should estimate BB program savings as the difference in energy use between treatment and control group subjects in the analysis sample. Energy savings for a household in the BB program is the difference between the energy the household used and the energy the household would have used if it had not participated. However, the energy use of a household cannot be observed under two different states. Instead, to estimate savings, evaluators should compare the energy use of households in the treatment group to that of a group of households that are statistically the same but did not receive the treatment (the homes randomly assigned to the control group). In a randomized experiment, assignment to the treatment is random; thus, evaluators can expect control group subjects to use the same amount of energy that the treatment group would have used without the treatment. The difference in their energy use will therefore be an unbiased estimate of energy savings.

Savings can be estimated using energy use data from the treatment period only or from before and during the treatment. If energy use data from only the treatment period are used, evaluators estimate the savings as a simple difference (D). If the analysis also controls for energy use before the treatment, evaluators will estimate the savings as a D-in-D. The availability of energy use data for the period before the treatment will determine the approach, but D-in-D estimation is strongly advised when pretreatment energy use data are available.

Both approaches result in unbiased estimates of savings (i.e., in expectation, the two methods are expected to yield an estimate equal to the true savings), but D-in-D estimation generally results in more precise savings estimates (i.e., the D-in-D estimate will have a smaller standard error) because it accounts for time-invariant energy use that contribute significantly to the variance of energy use between subjects.[25]

When conducting D-in-D estimation, evaluators should collect at least 1 full year of historical energy use data (the 12 months immediately before the program start date) to ensure that baseline data fully reflect seasonal energy use effects.

How frequently should BB programs be evaluated? Regulators usually determine the frequency of program evaluation. Although requirements vary between jurisdictions, most BB programs are evaluated once per year. Annual evaluation seems appropriate for many BB programs such as home energy reports programs because savings tend to increase over time, or at least for the first several years of the program.

4.1 Sample Design

Utilities should integrate the design of the analysis sample with program planning, because numerous considerations, including the size of the analysis sample, the method of recruiting

[25] D-in-D estimation also accounts for differences in the mean energy use between treatment and control group subjects that are introduced when subjects are randomly assigned to the treatment or control group. Evaluators may not expect such differences with random assignment; however, these differences may nevertheless arise.

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customers to the program, and the type of randomized experiment, must be addressed before the program begins.

4.1.1 Sample Size

The analysis sample should be large enough to detect the minimum hypothesized program effect with desired probability.[26] To determine the minimum number of subjects required, researchers should employ a statistical power analysis. The inputs for this calculation are:

- The hypothesized program effect
- The coefficient of variation of energy use
- The specific analysis approach to be used (e.g., simple differences of means or a repeated measure analysis), tolerances for Type I and Type II statistical errors (as discussed in Section 3.2)
- The correlation of a subject's energy use observations. Most statistical software, including SAS, STATA, and R, include packages for performing statistical power analyses.[27]

If the BB program will operate for more than several months or allow subjects to opt out, program planners should account for attrition, the loss of some subjects from the analysis sample because of account closures.

4.1.2 Random Assignment to Treatment and Control Groups by Independent Third Party

After determining the appropriate sizes of the treatment and control group samples, an independent and experienced third-party evaluator should randomly assign subjects to the treatment and control groups. If there is a significant risk that the random assignment will result in unbalanced treatment and control groups, this protocol recommends that evaluators first stratify the study population by pretreatment energy use and then randomly assign subjects in each stratum to treatment and control groups. Stratifying the sample will increase the likelihood that treatment and control group subjects have similar pretreatment means and variances.[28]

Although this protocol strongly recommends that independent and experienced third-party perform the random assignment, circumstances sometimes make this impossible. In such cases, a third-party evaluator should certify that the assignment of treatment and control group subjects was done correctly and did not introduce bias into the selection process.

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[26] The utility may also base the number of subjects in the treatment group on the amount of savings it desires to achieve.

[27] If statistical software is not available and one wishes to manually calculate the sample sizes, Brattle (2011) provides formulas for calculating sample sizes using statistical power calculations. The formulas also appear in Hilbe (1993) and Seed (1997).

[28] Shadish et al. (2002) discuss the benefits of stratified random assignment.

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4.1.3 Equivalency Check

The third party performing the random assignment must verify that the characteristics of subjects in the treatment group, including pretreatment energy use, are balanced with those in the control group. If subjects in the groups are not equivalent overall, the energy savings estimates may be biased.

To verify the equivalence of energy use, this protocol recommends that the third party test for differences between treatment and control group subjects in both the mean pretreatment period energy use and in the distribution of pretreatment energy use. Evaluators should also test for differences in other available covariates, such as home floor area and heating fuel type.

If significant differences are found, the third party should consider performing the random assignment again. Ideally, random assignment should not result in any differences; however, differences occasionally appear, and it is better to redo the random assignment than to proceed with unbalanced treatment and control groups, which may lead to biased savings estimates. As noted in Section 4.1.2, stratifying the study population by pretreatment energy use will increase the probability that the groups are balanced.

If the evaluator is not the third party who performed the random assignment, the evaluator should also perform an equivalency check. The evaluator may be able to use statistical methods to control for differences in pretreatment energy use that are found after the program is underway.[29]

4.2 Data Requirements and Collection

4.2.1 Energy Use Data

Estimating BB program impacts using a field experiment requires collecting energy use data from subjects in the analysis sample. This protocol recommends that evaluators collect multiple energy use measurements for each sampled unit for the periods before and during the treatment.[30]

These data are known as a panel. Panels can consist of multiple hourly, daily, or monthly energy use observations for each sampled unit. In this protocol, a panel refers to a dataset that includes energy measurements for each sampled unit either for the pretreatment and treatment periods or for the treatment period only. The time period for panel data collection will depend on the program timeline, the frequency of the energy use data, and the amount of data collected.

Panel data have several advantages for use in measuring BB program savings:

- **Relative ease of collection.** Collecting multiple energy use measurements for each sampled unit from utility billing systems is usually easy and inexpensive.

[29] If energy use data are available for the periods before and during the treatment, it is possible to control for time-invariant differences between sampled treatment and control group subjects using subject fixed effects.
[30] A single measurement of energy use for each sampled unit during the treatment period also results in an unbiased estimate of program savings. The statistical significance of the savings estimate depends on the variation of the true but unknown savings and the number of sampled units.

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- **Can estimate savings during specific times.** If the panel collects enough energy use observations per sampled unit, estimating savings at specific times during the treatment period may be possible. For example, hourly energy use data may enable the estimation of precise savings during utility system peak hours. Monthly energy use data may enable the development of precise savings estimates for each month of the year.
- **Savings estimates are more precise.** Evaluators can more precisely estimate energy savings with a panel, because they may be able to control for the time-invariant differences in energy use between subjects that contribute to the variance of energy use.
- **Allows for smaller analysis samples.** All else being equal, fewer units are required to detect a minimum level of savings in a panel study than in a cross-section analysis. Thus, collecting panel data may enable studies with smaller analysis samples and data collection costs.

Using panel data has some disadvantages relative to a single measurement per household: (1) evaluators must correctly cluster the standard errors within each household or unit (as described in the following section); and (2) panel data require statistical software to analyze, whereas estimating savings using single measurements in a basic spreadsheet software program may be possible.

This protocol also recommends that evaluators collect energy use data for the duration of the treatment to ensure they can observe the treatment effect for the entire study period. Ideally, an energy efficiency BB program lasts for a year or more because the energy end uses affected by BB programs vary seasonally. For example, these programs may influence weather-sensitive energy uses, such as space heating or cooling, so collecting less than 1 year of data to reflect every season may yield incomplete results.

Collecting data for an entire year may be impossible because some BB programs do not last that long. For these programs, only an unbiased estimate of savings for the time period of analysis may be obtained. Evaluators should exercise caution s in extrapolating those estimates to seasons or months outside the analysis period, especially if the BB program affected weather-sensitive or seasonally varying end uses of energy.

4.2.2 Makeup of Analysis Sample

Evaluators must collect energy use measurements for every household or unit that is initially assigned to a control or treatment group, whether or not the household or unit later opts out. Not collecting energy use data for households initially placed in a treatment group but that then opts out results in imbalanced treatment and control groups and a biased savings estimate.

4.2.3 Other Data Requirements

Program information about each program participant must also be collected. These data must include whether the subject is assigned to the treatment or control group, when the treatments are administered, and if and when the subject opt out.

Temperature and other weather data may also be useful but are not necessary. Weather data should be collected for each household from the nearest weather station.

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4.2.4 Data Collection Method

Energy use measurements used in the savings estimation should be collected directly from the utility, not from the program implementer, at the end of the program evaluation period. Depending on the program type, utility billing system, and evaluation objectives, the data frequency can be at 15-minute, 1-hour, daily, or monthly intervals.

4.3 Analysis Methods

This protocol recommends using panel regression analysis to estimate savings from BB field experiments where subjects were randomly assigned to either treatment or control groups. Evaluators typically prefer regression analysis to simply calculating differences in unconditional mean energy use, because it generally results in more precise savings estimates. A significant benefit of randomized field experiments is that regression-based savings estimates are usually quite insensitive to the type of model specification.

Section 4.3.1 addresses issues in panel regression estimation of BB program savings, including model specification and estimation, standard errors estimation, robustness checks, and savings estimation. It illustrates some specifications as well as the application of energy-savings estimation.

4.3.1 Panel Regression Analysis

In panel regressions, the dependent variable is usually the energy use of a subject (a home, apartment, or dormitory) per unit of time such a month, day, or hour. The right side of the equation includes an independent variable to indicate whether the subject was assigned to the treatment or control group. This variable can enter the model singularly or be interacted with another independent variable, depending on the analysis goals and the availability of energy use data from before treatment. The coefficient on the term with the treatment indicator is the energy savings per subject per unit of time. D-in-D models of energy savings must also include an indicator for whether the period occurred before or during the treatment period.

Many panel regressions also include fixed effects. Subject fixed effects capture unobservable energy use specific to a subject that does not vary over time. For example, home fixed effects may capture variation in energy use that is due to differences such as home sizes or makeup of a home's appliance stock. Time-period fixed effects capture unobservable energy use specific to a time period that does not vary between subjects. Including time or subject fixed effects in a regression of energy use of subjects randomly assigned to the treatment or control group will increase the precision but not the unbiasedness of the savings estimates.

Fixed effects can be incorporated into panel regression in several ways.

- Include a separate dummy variable or intercept for each subject in the model. The estimated coefficient on a subject's dummy variable represents the subject's time-invariant energy use. This approach, known as Least Squares Dummy Variables, may, however, not be practical for evaluations with a large number of subjects, because the model requires thousands of dummy variables that may overwhelm available computing resources.

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- Apply the fixed-effect estimator, which requires transforming the dependent variable and all the independent variables by subtracting subject-specific means and then running Ordinary Least Squares (OLS) on the transformed data.[31] This approach is equivalent to Least Squares Dummy Variables.
- Estimate a first difference or annual difference of the model. Differencing removes the subject fixed effect and is equivalent to the dummy variable approach if the fixed-effects model is correctly specified.[32]

4.3.2 Panel Regression Model Specifications

This section outlines common regression approaches for estimating treatment effects from residential BB programs. Unless otherwise stated, assume that the BB program was implemented as a field experiment with a randomized control trial or randomized encouragement design.

4.3.3 Simple Differences Regression Model of Energy Use

Consider a BB program in which the evaluator has energy use data for the treatment period only, and wishes to estimate the average energy savings per period from the treatment. Let t = 1, 2, …, T, where t denotes the time periods during the treatment for which data are available[33], and let I = 1, 2, …, N, where i denotes the treatment and control group subjects. For simplicity, assume that all treated subjects started the treatment at the same time.

A basic specification to estimate the average energy savings per period from the treatment is:

Equation 1

$$y_{it} = \beta_0 + \beta_1 * Tr_i + \varepsilon_{it}$$

Where,

y_{it} = The metered energy use of subject i in period t.

[31] Greene (2011) Chapter 11 provides more details.

[32] Standard econometric formulations assume that fixed effects account for unobservable factors that are correlated with one or more independent variables in the model. This correlation assumption distinguishes fixed-effects panel model estimation from other types of panel models. Fixed effects eliminate bias that would result from omitting unobserved time-invariant characteristics from the model. In general, fixed effects must be included to avoid omitted variable bias. In an RCT, however, fixed effects are unnecessary to the claim that the estimate of the treatment effect is unbiased because fixed effects are uncorrelated with the treatment by design. Although fixed effects regression is unnecessary, it will increase precision by reducing model variance.
Some evaluators may be tempted to choose to use random-effects estimation, which assumes time- or subject-invariant factors are uncorrelated with other variables in the model. However, fixed-effects estimation has important advantages over random-effects estimation: (1) it is robust to the omission of any time-invariant regressors. If the evaluator has doubts about whether the assumptions of the random-effects model are satisfied, the fixed-effects estimator is better; and (2) it yields consistent savings estimates when the assumptions of the random-effects model holds. The converse is not true, making the fixed-effects approach more robust.
Because weaker assumptions are required for the fixed-effects model to yield unbiased estimates, this protocol generally recommends the fixed-effects estimation approach. The remainder of this protocol presents panel regression models that satisfy the fixed-effects assumptions.

[33] For a treatment that is continuous, an example might be t = 1 on the first day that the treatment starts, t = 2 on the second day, etc.; for a treatment that occurs during certain days only (e.g., a day when the utility's system peaks), an example might be t = 1 during the first critical event day, t = 2 during the second, etc.

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β_0 = The average energy use per unit of time for subjects in the control group.

β_1 = The average treatment effect of the program. The energy savings per subject per period equals $-\beta_1$.

Tr_i = An indicator for whether subject i received the treatment. The variable equals 1 for subjects in the treatment group and equals 0 for subjects in the control group.

ε_{it} = The model error term, representing random influences on the energy use of customer i in period t.

In this simple model, the error term ε_{it} is uncorrelated with Tr_i because subjects were randomly assigned to the treatment or control group. OLS estimation of this model will result in an unbiased estimate of β_1. The standard errors should be clustered on the subject. [34]

This specification does not include subject fixed effects. Because the available energy use data apply to the treatment period only, the program treatment effect cannot be identified and subject fixed effects cannot be account for. However, as previously noted, because of the random assignment of subjects to the treatment group, any time-invariant characteristics affecting energy use will be uncorrelated with the treatment, so omitting that type of fixed effects will not bias the savings estimates.

Using Equation 1, however, more precise estimates of savings could be obtained by replacing the coefficient β_0 with time-period fixed effects. The model thus captures more of the variation in energy use over time, resulting in greater precision in the estimate of savings. The interpretation of β_1, the average treatment effect per home per time period, is unchanged.

4.3.4 Simple Differences Regression Estimate of Heterogeneous Savings Impacts

Suppose that the evaluator still has energy use data that apply to the treatment period only, but wishes to obtain an estimate of savings from the treatment as a function of some exogenous variable such as preprogram energy use, temperature, home floor space, or pretreatment efficiency program participation (to determine, for example, whether high energy users save more or less energy than low energy users). If data for treatment and control group subjects on the exogenous variable of interest are available, the evaluator may be able to estimate the treatment effect as a function of this variable.

Let m_{ij} be an indicator that subject i belongs to a group j, j = 1, 2, …, J, where membership in group j is exogenous to receiving the treatment. Then the average treatment effect for subjects in group j can be estimated using the following regression equation:

[34] Although the methods recommended in this protocol minimize the potential for violations of the assumptions of the classical linear regression model, evaluators should be aware of–and take steps to minimize—potential violations.

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Equation 2

$$y_{it} = \beta_0 + \Sigma^{J}_{j=1} \beta_{1j} * Tr_i * m_{ij} + \Sigma^{J-1}_{j=1} \gamma_j m_{ij} + \varepsilon_{it}$$

Where,

m_{ij} = An indicator for membership of subject i in group j. It equals 1 if customer i belongs to group j and equals 0, otherwise.

β_{1j} = The average treatment effect for subjects in group j. Energy savings per subject per period j equals $-\beta_{1j}$.

γ_j = The average energy use per period for subjects in group j, j = 1, 2,…J-1.

All of the other variables are defined as in Equation 1.

This specification includes a separate intercept for each group indicated by γ_j and the treatment indicator Tr_i interacted with each of the m_{ij} indicators. The coefficients on the interaction variables β_{1j} show average savings for group j relative to baseline average energy use for group j.

4.3.5 Simple Differences Regression Estimate of Savings During Each Time Period

To estimate the average energy savings from the treatment during each period, the evaluator can interact the treatment indicator with indicator variables for the time periods as in the following equation[35]:

Equation 3

$$y_{it} = \Sigma^{T}_{j=1} \beta_t Tr_i * d_{jt} + \Sigma^{T}_{j=1} \theta_t d_{jt} + \varepsilon_{it}$$

Where,

β_t = The average savings per subject specific to period t (e.g., the average savings per subject during month 4 or during hour 6).

d_{jt} = An indicator variable for period j, j = 1, 2, …,T. d_{jt} equals 1 if j = t (i.e., the period is the t^{th}) and equals 0 if $j \neq t$ (i.e., the period is not the t^{th}).

θ_t = The average effect on consumption per subject specific to period t.

Equation 3 can be estimated by including a separate dummy variable and an interaction between that dummy variable and Tr_i for each time period t, where t = 1, 2, ..., T. When the time period is in months, the time-period variables are referred to as month-by-year fixed effects. The coefficient on the interaction variable for period t, β_t, is the average savings per subject for period t. Again, because ε_{it} is uncorrelated with the treatment after accounting for the average

[35] If the number of time periods is very large, the number of time period indicator variables in the regression may overwhelm the capabilities of the available statistical software. Another option for estimation is to transform the dependent variable and all of the independent variables by subtracting time period-specific means and then running OLS on the transformed data.

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energy use in period t, OLS estimation of Equation 3 (with standard errors clustered at the subject level) results in an unbiased estimate of the average treatment effect for each period.

Evaluators with smart meter data can use this specification to estimate BB program demand savings during specific hours of the analysis period. The coefficient β_t would indicate the demand savings from the treatment during hour *t*. Examples of research that estimates savings during hours of peak usage include Stewart (2013) and Todd (2014).

4.3.6 Difference-in-Differences Regression Model of Energy Use

This section outlines a D-in-D approach to estimating savings from BB field experiments. This protocol recommends D-in-D estimation to the simple differences approach, but it requires information about the energy use of treatment and control group subjects during the pretreatment and treatment periods. These energy use data enable the evaluator to:

- Include subject fixed effects to account for differences between subjects in time-invariant energy use.
- Obtain more precise savings estimates.
- Test identifying assumptions of the model.

Assume there are N subjects and T +1 periods, T > 0, in the pretreatment period denoted by t = -T, -T+1, …, -1, 0, and T periods in the treatment period, denoted by t = 1, 2, …, T. A basic D-in-D panel regression with subject fixed effects could be specified as:

Equation 4

$$y_{it} = \alpha_i + \beta_1 P_t + \beta_2 P_t * Tr_i + \varepsilon_{it}$$

Where,

α_i = Unobservable, time-invariant energy use for subject i. These effects are controlled for with subject fixed effects.

β_1 = The average energy savings per subject during the treatment period that was not caused by the treatment.

P_t = An indicator variable for whether time period t occurs during the treatment. It equals 1 if treatment group subjects received the treatment during period t, and equals 0 otherwise.

β_2 = The average energy savings due to the treatment per subject per unit of time.

The model includes fixed effects to account for differences in average energy use between subjects. Including subject fixed effects would likely explain a significant amount of the variation in energy use between subjects and result in more precise savings estimates. The interaction of P_t and Tr_i equals one for subjects in the treatment group during periods when the treatment is in effect, and 0 for other periods and all control subjects.

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Equation 4 is a D-in-D specification. For control group subject i, the expected energy use is α_i during the pretreatment period and $\alpha_i + \beta_1$ during the treatment period. The difference in expected energy use between pretreatment and treatment periods, also known as *naturally occurring savings*, is β_1. If that same subject i had been in the treatment group, the expected energy use would have been α_i during the pretreatment period and $\alpha_i + \beta_1 + \beta_2$ during the treatment period. The expected savings would have been $\beta_1 + \beta_2$, which is the sum of naturally occurring savings and savings from the BB program. Taking the difference yields β_2, a D-in-D estimate of program savings. OLS estimation results in an unbiased estimate of β_2.

4.3.7 D-in-D Estimate of Savings for Each Time Period

By respecifying Equation 4 with time-period fixed effects, savings can be estimated during each period and the identifying assumption tested to determine that assignment to the treatment was random. Consider the following D-in-D regression specification:

Equation 5

$$y_{it} = \alpha_i + \Sigma^{T}_{j=-T}\, \theta_j d_{jt} + \Sigma^{-1}_{j=-T}\, \beta_j\, Tr_i^* \, d_{jt} + \Sigma^{T}_{j=1}\, \beta_j\, Tr_i^* \, d_{jt} + \varepsilon_{it}$$

Savings in each period are estimated by including a separate dummy variable and an interaction between the dummy variable and Tr_i for each time period t, where t = -T, -T+1, …, -1, 0, 1, 2, ..., T. The coefficient on the interaction variable for period t, β_t^T, is the D-in-D savings for period t.

Unlike the simple differences regression model, this model yields an estimate of BB program savings during all periods except one, i.e., t = 0, for a total of 2T-1 period savings estimates. Figure 4 shows an example of savings estimates obtained from such a model. The dotted lines show the 95% confidence interval for the savings estimates.

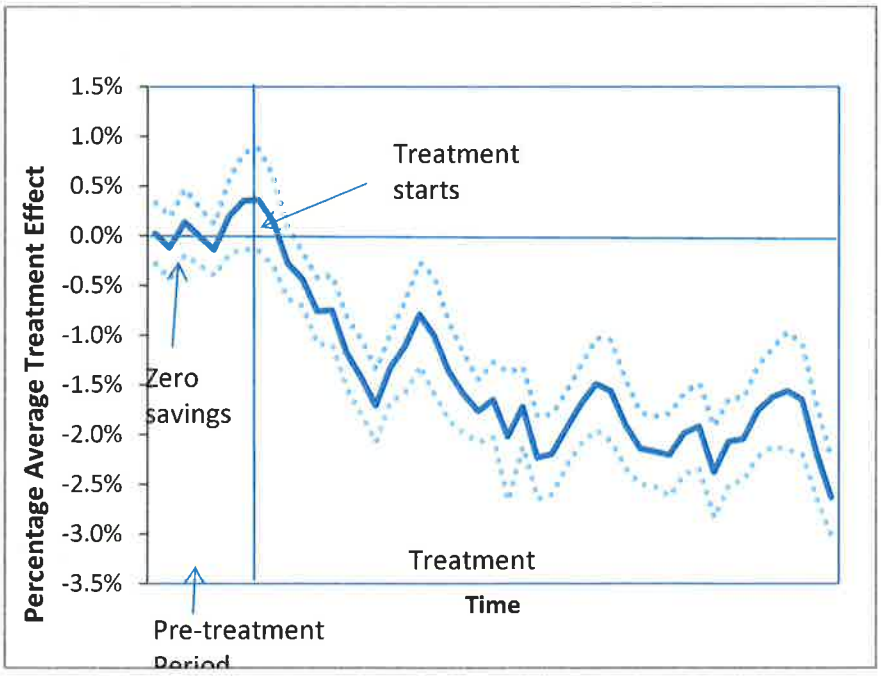

Figure 4. Example of D-in-D regression savings estimates

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Estimates of pretreatment savings can be used to test the assumption of random assignment to the treatment. Before utilities administer the treatment, statistically significant differences in energy use between treatment and control group subjects should not be evident. BB program pretreatment saving estimates that were statistically different from zero would suggest a flaw in the experiment design. For example, an error in the randomization process may result in assignments of subjects to the treatment and control groups that were correlated with their energy use.

As with equation 3, this specification can be used to estimate demand savings during specific hours. Energy use data for hours before the treatment are required, however.

4.3.8 Randomized Encouragement Design

Some field experiments involve an RED in which subjects are only encouraged to accept a BB measure, in contrast to RCTs in which a program administers a BB intervention. This section outlines the types of regression models that are appropriate for REDs, how to interpret the coefficients, and how to estimate savings from RED programs.

Evaluators can apply the model specifications previously described for RCTs to REDs. The model coefficients and savings are interpreted differently, however, and an additional step is required to estimate average savings for subjects who accept the behavioral intervention. Treatment in an RED is defined as receiving encouragement to adopt the BB intervention, rather than actually receiving the intervention as with RCTs.

Consider a field experiment with an RED that has energy use data for treatment and control group subjects available for the pretreatment and treatment periods. Equations 1 through 4 can be used to estimate the treatment effect, or the average energy use effect on those receiving encouragement. The estimate captures savings from compliers only, because never takers never accept the intervention, and always takers would accept the intervention with or without encouragement.

To recover the LATE, the savings from subjects who accept the treatment because of the encouragement, scale the estimate of β_2 must by the inverse of the difference between the percentage of subjects in the treatment group who accept the intervention and the percentage of subjects in the control group who accept the intervention (which is zero if control group subjects are prohibited from accepting the intervention). Estimate this as:

Equation 6

$$\beta_2 / (\pi_T - \pi_C)$$

Where,

π_T = The percentage of treatment group subjects who accept the intervention.

π_C = The percentage of control group subjects who accept the intervention.

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4.3.9 Models for Estimating Savings Persistence

A utility offering a residential BB program may want to know what happens to savings during the second or third year of the program or after the treatment stops. There are two kinds of savings effects to measure: (1) the effect of continuing the intervention on consumption called *savings during treatment*; and (2) the effect on consumption after discontinuing the intervention called *post-treatment savings.*

Suppose a utility implemented a BB program as an RCT and wants to measure the persistence of savings after the BB intervention stops. The utility started the treatment in period t = 1 and administered it for t* periods. Beginning in period t = t*+1, the utility stopped administering the intervention for a random sample of treated subjects. Evaluators can estimate the average savings c for subjects who continue to receive the treatment (continuing treatment group) and for those who stopped receiving the treatment after period t* (discontinued treatment group).

Assuming that pretreatment energy use data are available, the following regression equation can be used to estimate *savings during treatment* and *post-treatment savings*:

Equation 7

$$kWh_{it} = \alpha_i + \tau_t + \beta_1 P_{1,t}*Tc_i + \beta_2 P_{1,t}*Td_i + \beta_3 P_{2,t}*Tc_i + \beta_4 P_{2,t}*Td_i + \varepsilon_{it}$$

Where,

τ_t = The time-period fixed effect (an unobservable that affects the consumption of all subjects during time period t). The time period effect can be estimated by including a separate dummy variable for each time period t, where t = -T, -T+1, …, -1, 0, 1, 2, ..., T.

β_1 = The average energy savings per continuing subject caused by the treatment during periods t = 1 to t = t*.

$P_{1,t}$ = An indicator variable for whether subjects in the continued and discontinued treatment groups received the treatment during period t. It equals 1 if period t occurs between periods t = 1 and t = t* and equals 0 otherwise.

Tc_i = An indicator for whether subject i is in the continuing treatment group. The variable equals 1 for subjects in the continuing treatment group and equals 0 for subjects not in the continuing treatment group.

β_2 = The average energy savings per discontinuing subject caused by the treatment during periods t = 1 to t = t*.

Td_i = An indicator for whether subject i is in the discontinuing treatment group. The variable equals 1 for subjects in the discontinuing treatment group and equals 0 for subjects not in the discontinuing treatment group.

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β_3 = The average energy savings from the treatment for subjects in the continuing treatment group when t>t*.

$P_{2,t}$ = An indicator variable for whether continuing treatment group subjects received the treatment and discontinued treatment group subjects did not receive the treatment during period t. It equals 1 if period t occurs after t = t* and equals 0 otherwise.

β_4 = The average energy savings for subjects in the discontinued treatment group when t>t*.

OLS estimation of equation 7 yields unbiased estimates of *savings during treatment* (β_3) and *post-treatment savings* (β_4) because original treatment group subjects were assigned randomly to the continuing and discontinued treatment groups. Evaluators can expect that $\beta_4 \geq \beta_3$, that is, the average savings of the continuing treatment group will be greater than that of the discontinued treatment group. To estimate savings decay after treatment stops, evaluators can take the difference between savings during treatment (β_2) and post-treatment savings (β_4) for subjects in the discontinued treatment group.

Evaluators can test the identifying assumption of random assignment to the discontinued treatment group by comparing the savings of continuing and discontinuing treatment group subject between period t = 1 and t*. If assignment was random, their savings during this period are expected to be equal.

4.3.10 Standard Errors

Panel data have multiple energy use observations for each subject; thus, the energy use data are very likely to exhibit within-subject correlations. Many factors affecting energy use persist over time, and the strength of within-subject correlations usually increases with the frequency of the data. When standard errors for panel regression model coefficients are calculated, these correlations must be accounted for. Failing to do so will lead to savings estimates with standard errors that are biased downward.

This protocol strongly recommends that evaluators estimate robust standard errors clustered on subjects (the randomized unit in field trials) to account for within-subject correlation. Most statistical software programs, including STATA, SAS, and R, have regression packages that output regression-clustered standard errors.

Clustered standard errors account for having less information about energy use in a panel with N subjects and T observations per subject than in a dataset with N*T independent observations. Because clustered standard errors account for these within-subject energy-use correlations, they are typically larger than OLS standard errors. When there is within-subject correlation, OLS

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standard errors are biased downward and overstate the statistical significance of the estimated regression coefficients.[36]

4.3.11 Opt-Out Subjects and Account Closures

Many BB programs allow subjects to opt out and stop receiving the treatment. This section addresses how evaluators should treat opt-out subjects in the analysis, as well as subjects whose billing accounts close during the analysis period.

As a general rule, evaluators should include all subjects initially assigned to the treatment and control groups in the savings analysis.[37] For example, evaluators should keep opt-out subjects in the analysis sample. Opt-out subjects may have different energy use characteristics than subjects who remain in the program, and dropping them from the analysis would result in nonequivalent treatment and control groups. To ensure the internal validity of the savings, opt-out subjects should be kept in the analysis sample.

Sometimes treatment or control group subjects close their billing accounts after the program starts. Account closures are usually unrelated to the BB program or savings; most are due to households changing residences. Subjects in the treatment group should experience account closures for the same reasons and at the same rates as subjects in the control group; evaluators can thus safely drop treatment and control group subjects who close their accounts from the analysis sample.

However, if savings are correlated with the probability of an account closure, it may be best to keep subjects with account closures in the analysis sample. For example, if young households, which are the most mobile and likely to close their accounts, are also most responsive to BB programs, dropping these households from the analysis would bias the savings estimates downward,[38] and evaluators should keep these households in the analysis.

If evaluators drop customers who close their accounts during the treatment from the regression estimation, they should still count the savings from these subjects for periods during the treatment before customers closed their accounts. To illustrate, when estimating savings for a 1-year BB program, evaluators can estimate the savings from subjects who closed their accounts and from those who did not as the weighted sum of the conditional average program treatment effects in each month:

Equation 8

$$\text{Savings} = \sum_{m=1}^{12} -\beta_m * \text{Days}_m * N_m$$

[36] Bertrand et al. (2004) show when D-in-D studies ignore serially correlated errors, the probability of finding significant effects when there are none (Type I error) increases significantly.

[37] This protocol urges evaluators not to arbitrarily drop outlier energy use observations from the analysis unless energy use was measured incorrectly. If an outlier is dropped from the analysis, the reasons for dropping the outlier and the effects of dropping it from the analysis on the savings estimates should be clearly documented. Evaluators should test the sensitivity of the results to dropping observations.

[38] See State and Local Efficiency Action Network (2012), p. 30.

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Where,

m = Indexes the months of the year

$-\beta_m$ = The conditional average daily savings in month m (obtained from a regression equation that estimates the program treatment effect on energy use in each month)

$Days_m$ = The number of days in month m

N_m = The number of subjects with active accounts receiving the treatment in month m or in a previous month

This approach assumes that savings in a given month for subjects who close their accounts are equal to savings of subjects whose accounts remain open.

4.4 Energy Efficiency Program Uplift and Double Counting of Savings

BB programs may increase participation in other utility energy efficiency programs; this additional participation is known as *efficiency program uplift*. For example, many energy reports programs encourage report recipients to adopt efficiency measures, such as furnaces, air conditioners, wall insulation, windows, and compact fluorescent lamps, in exchange for cash rebates. A utility may want to quantify savings from efficiency program uplift. Also, when a household participates in an efficiency program because of this encouragement, the utility might count their savings twice: once in the regression-based estimate of BB program savings and again in the estimate of savings for the rebate program. To avoid double counting savings, evaluators must estimate savings from program uplift and subtract them from the efficiency program portfolio savings.[39]

Estimating the savings from BB program uplift with the experimental research designs recommended in this protocol is conceptually straightforward. To illustrate, suppose that a utility markets energy efficiency Measure A to treatment and control group subjects identically through a separate rebate program. Subjects in the treatment group also receive behavioral messaging encouraging them to adopt efficiency measures, including Measure A. Because customers were randomly assigned to the treatment and control groups, and the groups are equivalent except for whether they received the behavior treatment, evaluators can attribute any differences between the groups to the uptake of Measure A because of the BB program.

Figure 5 illustrates this logic for calculating behavior program savings from efficiency program uplift. Behavior program savings from adoption of Measure A is the difference between the treatment group and the control group in savings from Measure A. Savings can be estimated as the difference in rate of adoption of measure A between treatment and control group subjects

[39] BB program savings from efficiency program uplift were caused by the BB program: the savings would not have occurred in the program's absence. The level of participation in other utility efficiency programs caused by the BB program will depend on the efficiency program incentive amount, however. Although the BB program is necessary to cause the uplift, it may or may not be sufficient on its own. Because the incentive amount is typically not randomized, it is unclear whether the incentive program is necessary to cause the uplift; however, it alone is certainly not sufficient. Program uplift may be greater with larger rebates.

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multiplied by the number of treatment group subjects multiplied by Measure A's per-unit savings.

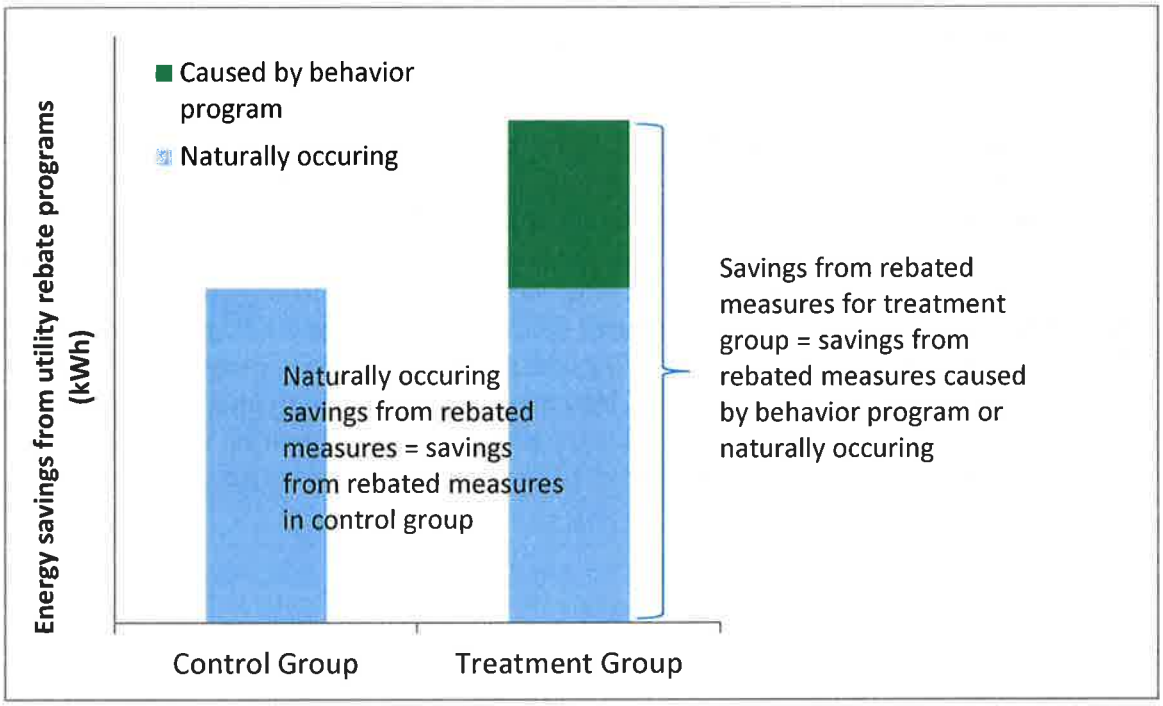

Figure 5. Calculation of double-counted savings

Evaluators can estimate BB program savings from efficiency program uplift for efficiency measures that the utility tracks at the customer level. Most measures that utilities rebate—such as high-efficiency furnaces, windows, insulation, and air conditioners—fit this description.

To estimate BB program savings from efficiency program uplift, evaluators should:

1. Match the BB program treatment and control group subjects to the utility energy efficiency program tracking data.
2. Calculate the savings per treatment group subject from efficiency uplift as the difference between treatment and control groups in average efficiency program savings per subject, where the savings are obtained from the utility tracking database. (The average should be calculated over all treatment group subjects, not just those that participated in efficiency programs.)
3. Multiply that difference by the number of subjects who are in the treatment group to see the savings from efficiency program uplift.

Evaluators should be mindful of specific reporting conventions for efficiency program measures in utility tracking databases. For example, many jurisdictions require utilities to report weather-normalized and annualized measure savings, which ignore both when measures were installed during the year and the actual weather conditions that affect savings. In contrast, the regression-based estimate of energy savings will reflect installation dates of measures and actual weather. Also, many utility tracking databases report gross savings instead of net savings.

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To achieve accurate estimates of program uplift, evaluators may therefore need to adjust the measure savings in the database before taking differences between treatment and control groups. Otherwise, the measure savings in the tracking database and the regression-based estimate of savings will be inconsistently measured and the estimate of savings from program uplift may be biased.

Estimating savings from program uplift for measures that the utility does not track at the customer level is more difficult. The most important such measures are high-efficiency lights such as compact fluorescent lamps and light-emitting diodes that are rebated through utility upstream programs. Most utilities provide incentives directly to retailers for purchasing these measures, and the retailers then pass on these price savings to utility customers in the form of retail discounts. Data on the purchases of rebated measures by treatment and control group subjects must be collected to estimate BB savings in upstream efficiency programs. Evaluators can use household surveys for this purpose.[40] However, because the individual difference in the number of upstream measure purchases between treatment and control group subjects may be small, a large number of subjects must be surveyed to detect the BB program effect.

[40] For an example of the approach required to estimate BB program savings from adoption of compact fluorescent lamps, see PG&E (2013).

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5 Reporting

BB program evaluators should carefully document the research design, data collection and processing steps, analysis methods, and plan for calculating savings estimates. Specifically, evaluators should describe:

- The program implementation and the hypothesized effects of the behavioral intervention
- The experimental design, including the procedures for randomly assigning subjects to the treatment or control group
- The sample design and sampling process
- Processes for data collection and preparation for analysis, including all data cleaning steps
- Analysis methods, including the application of statistical or econometric models and key assumptions used to identify savings, including tests of those key identification assumptions
- Results of savings estimate, including point estimates of savings and standard errors and full results of regressions used to estimate savings.

A good rule-of-thumb is that evaluators should report enough detail such that a different evaluator could replicate the results with the study data. Every detail does not have to be provided in the body of the report; many of the data collection and savings estimation details can be provided in a technical appendix.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

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UNDERTAKING J8.4

UNDERTAKING

TR, page 22

Enbridge to provide results from the two-15 pilot with OPower.

RESPONSE

Please find attached the power point presentation, as prepared by OPower on July 14, 2015 for Enbridge, providing an overview of the results of the 2015 My Home Health Record pilot.

Key conclusions from the pilot include:

- 550,000 m^3 of gas saved from October 2014 to May 2015;
- More than 14,000 web logins over the same period;
- Customers highly engaged in the program;
- Majority of customers report positive experience with the program;
- Majority of customers consider efficiency tips to be useful, and feel like they are able to make better decisions about their energy use, and;
- Recipients like getting information about their usage and how to reduce it.

Witnesses: S. Bertuzzi
S. Hicks
M. Lister

EGD Quarterly Meeting

July 14, 2015

OPOWER

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Pilot Program Review - Agenda

1.	Pilot Results and Program Review	1:00 – 2:45
	Break	2:45 – 3:00
2.	Program Expansion and Project Planning	3:00 – 3:45

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Pilot Results & Program Review

1. Program Overview
2. Savings Overview
3. Engagement Overview
4. Customer Engagement Tracker (CET)

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The Opower Enbridge Team

Lyle Morton

Engagement Manger
Client Services and Operations
Arlington, VA

Irene Scher

Director
Sales
Arlington, VA

Karim Al-Khafaji

Associate Director
Engagement Management
Arlington, VA

Dan Hake

Technical Project Manager
Technical Project Management
Arlington, VA

Marisa Uchin

Director
Regulatory Affairs and Market Development
Arlington, VA

Stacey Sivak

Vice President
Sales
Arlington, VA

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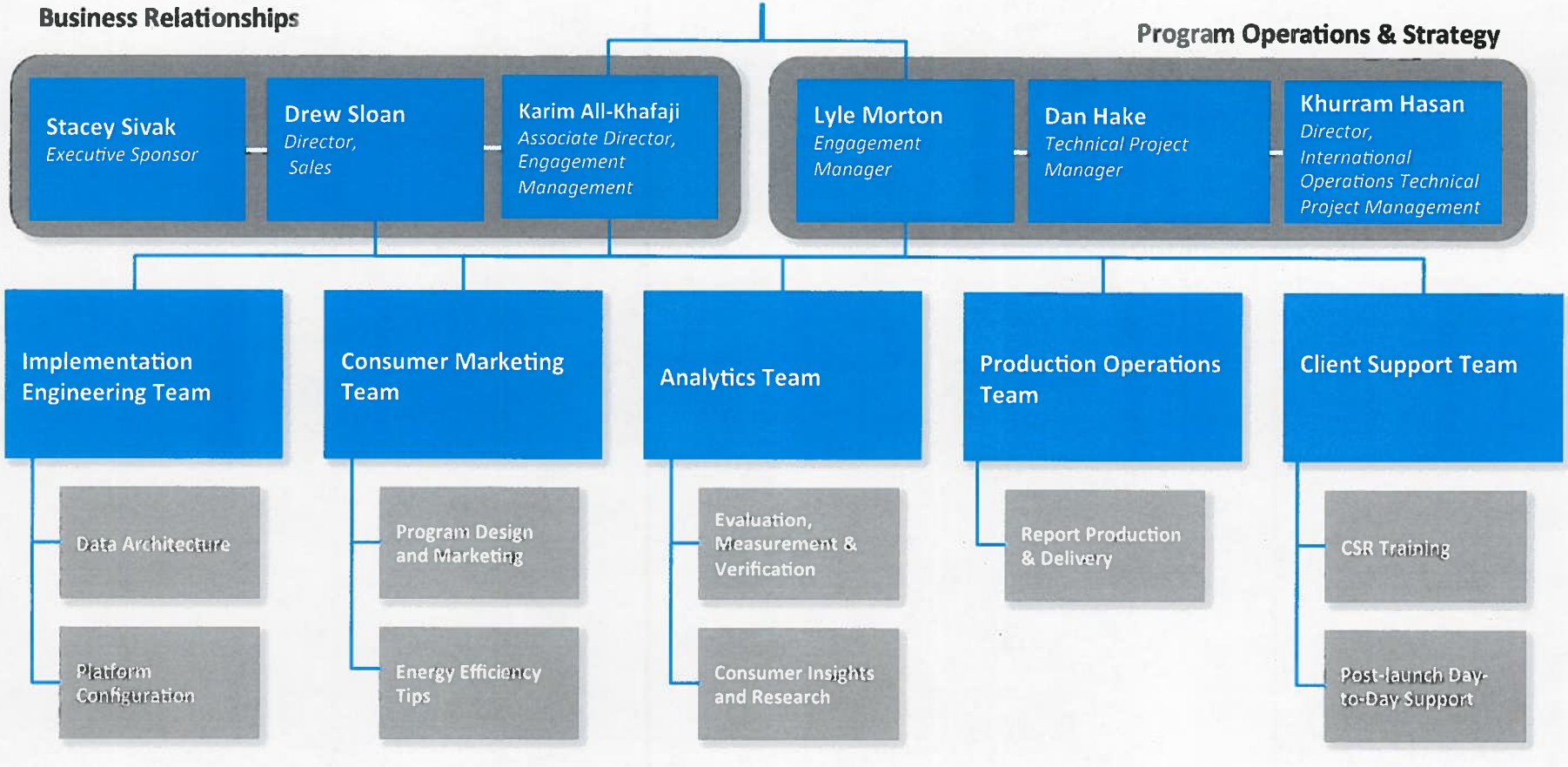
The team is supported by an extensive organization

ENBRIDGE



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It was a long winter…

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…TIAL. DO NOT DISTRIBUTE

...so let's recap what we've done since October

Launched a pilot behavioral energy efficiency program to **over 25,000 customers**

Delivered ~**3 Home Health Records per customer** with customized Enbridge content

Achieved a **savings rate of 0.8%** in April

Created over 550,000 cubes of savings in eight months in market

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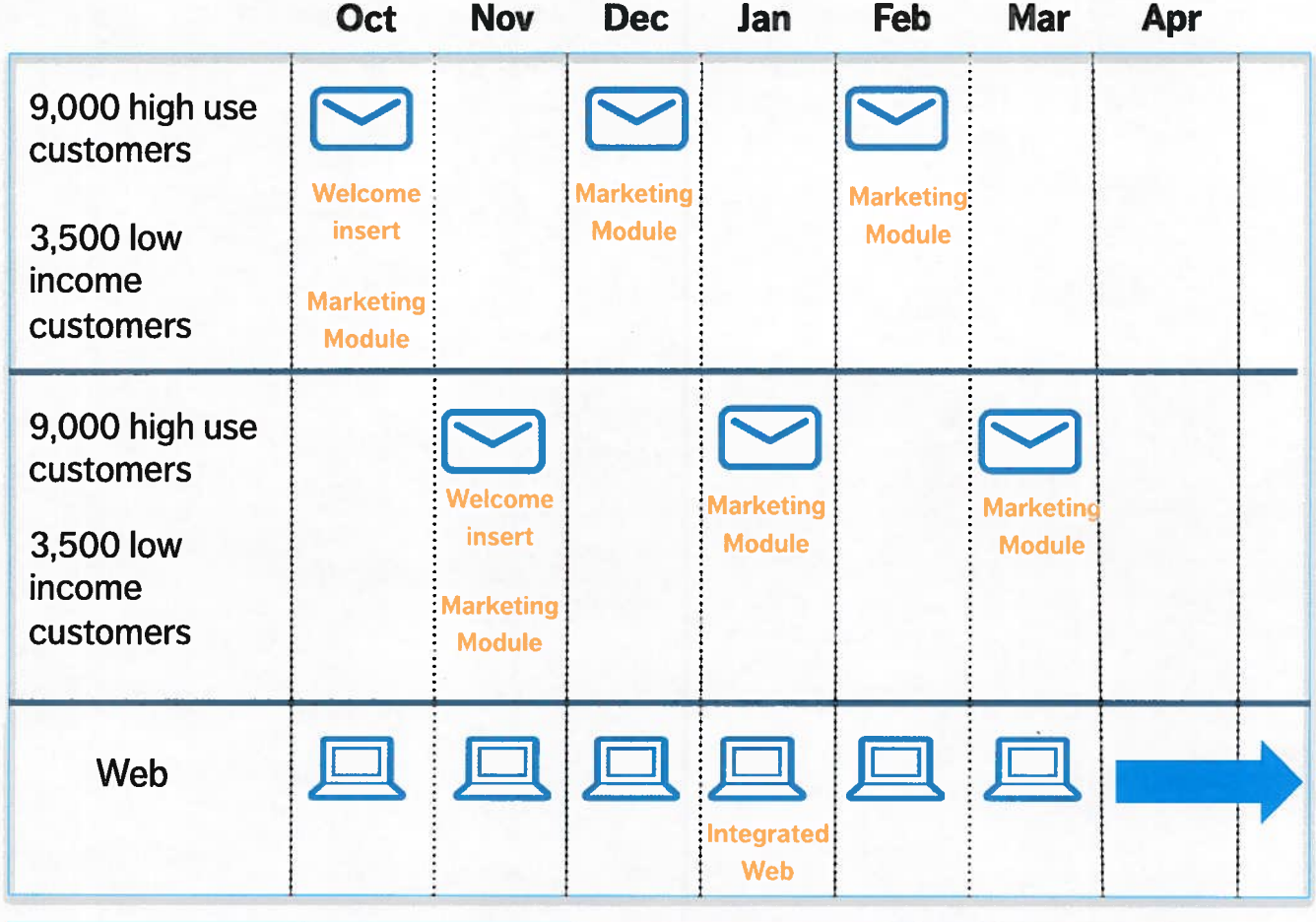
Our program design



Customers with odd read cycles

Customers with even read cycles

- ***Low Income Customers*** *– Identified by postal code*
- ***Exclusions included*** *– Social Housing Accounts; Weatherization Program; Community Energy Retrofit program*

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Welcome Insert

Introducing your Home Health Record

Enbridge Gas Distribution has been offering energy conservation programs and incentives since 1995, as mandated by the Ontario Energy Board. This report and others to come are part of a program designed to help you save energy and money. Millions of households are already enrolled in similar report programs worldwide. Combined, these programs have saved hundreds of millions of dollars. If you're ready to start saving on your natural gas bill, this program is for you.

About the Program

Household Comparison

In your reports, you can see your current natural gas use compared to approximately 100 nearby, occupied homes with similar characteristics, such as type of heating system. These homes represent homes similar to yours, but do not necessarily include the homes on your block or in your immediate neighbourhood. These comparisons, along with personalized natural gas saving tips, can help you better understand how you use natural gas.

Your Home Information

The comparisons and tips in your reports are personalized for you. To make your custom analysis and advice even better, you can go online to myhomehealthrecord.ca and update your home information under "My Account."

Your Online Tools

Get More Insights Online

Visit myhomehealthrecord.ca to find out what people in your area are doing to save, create a personal savings plan, and more. Here are three simple steps to get started:

1. Locate your account number at the upper right corner of your report.
2. Log in to the website using your account number as it appears on your report.
3. Explore the site for ways to save energy and money.

Visit myhomehealthrecord.ca

Key Notes

- ✓ Designed to introduce and explain the program
- ✓ Included in the first report
- ✓ Directs customers online for more information

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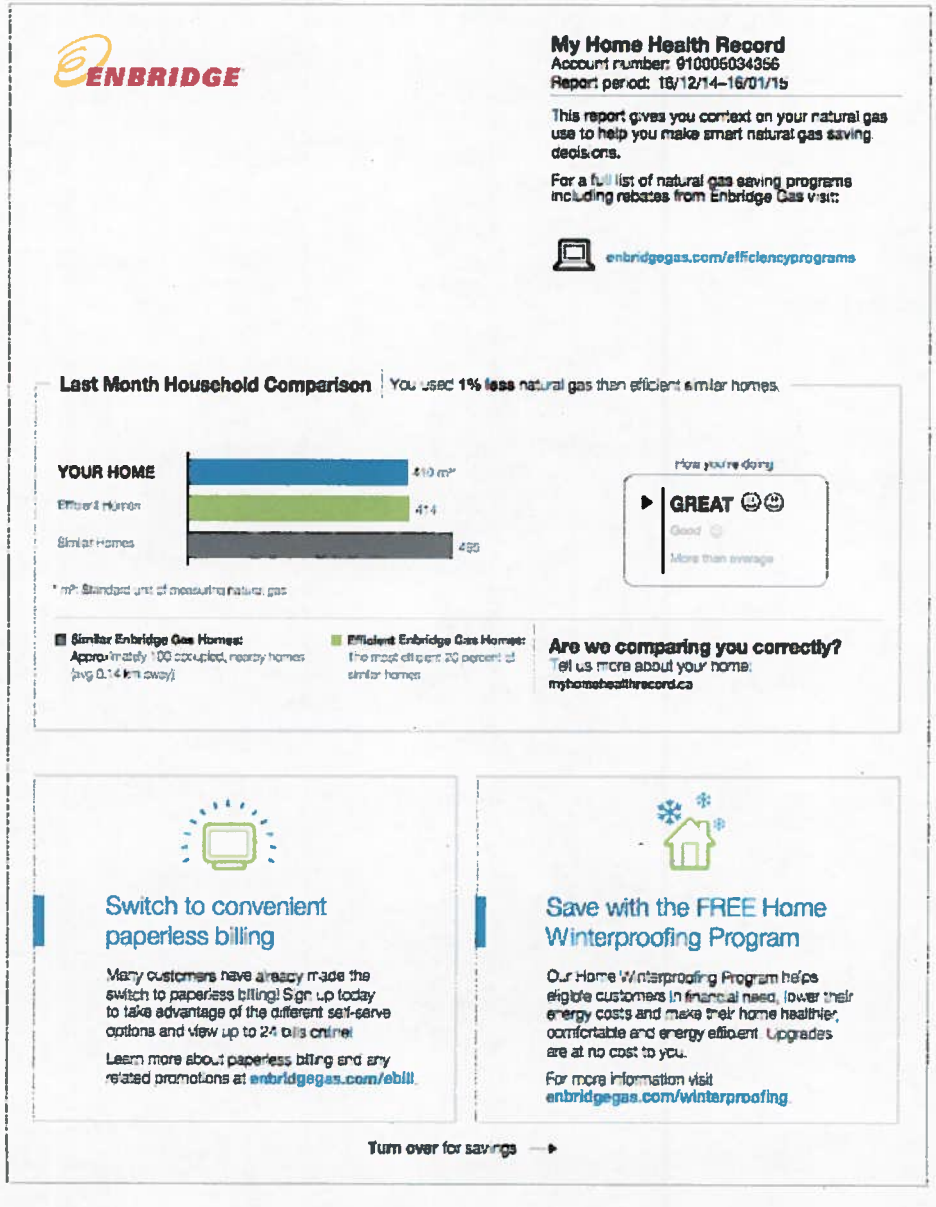
Home Health Record



ENBRIDGE

My Home Health Record
Account number: 910006034356
Report period: 18/12/14–16/01/15

This report gives you context on your natural gas use to help you make smart natural gas saving decisions.

For a full list of natural gas saving programs including rebates from Enbridge Gas visit:

enbridgegas.com/efficiencyprograms

Last Month Household Comparison | You used **1% less** natural gas than efficient similar homes

YOUR HOME
Efficient Homes
Similar Homes

How you're doing
GREAT
Good
More than average

Similar Enbridge Gas Homes: Approximately 100 occupied, nearby homes (avg 0.14 km away)

Efficient Enbridge Gas Homes: The most efficient 20 percent of similar homes

Are we comparing you correctly?
Tell us more about your home.
myhomehealthrecord.ca

Switch to convenient paperless billing

Many customers have already made the switch to paperless billing! Sign up today to take advantage of the different self-serve options and view up to 24 bills online!

Learn more about paperless billing and any related promotions at enbridgegas.com/ebill.

Save with the FREE Home Winterproofing Program

Our Home Winterproofing Program helps eligible customers in financial need, lower their energy costs and make their home healthier, comfortable and energy efficient. Upgrades are at no cost to you.

For more information visit enbridgegas.com/winterproofing.

Turn over for savings →

Key Notes

- ✓ **Three report sequence**
- ✓ **Rotating dynamic content**
- ✓ **Three customized program modules**

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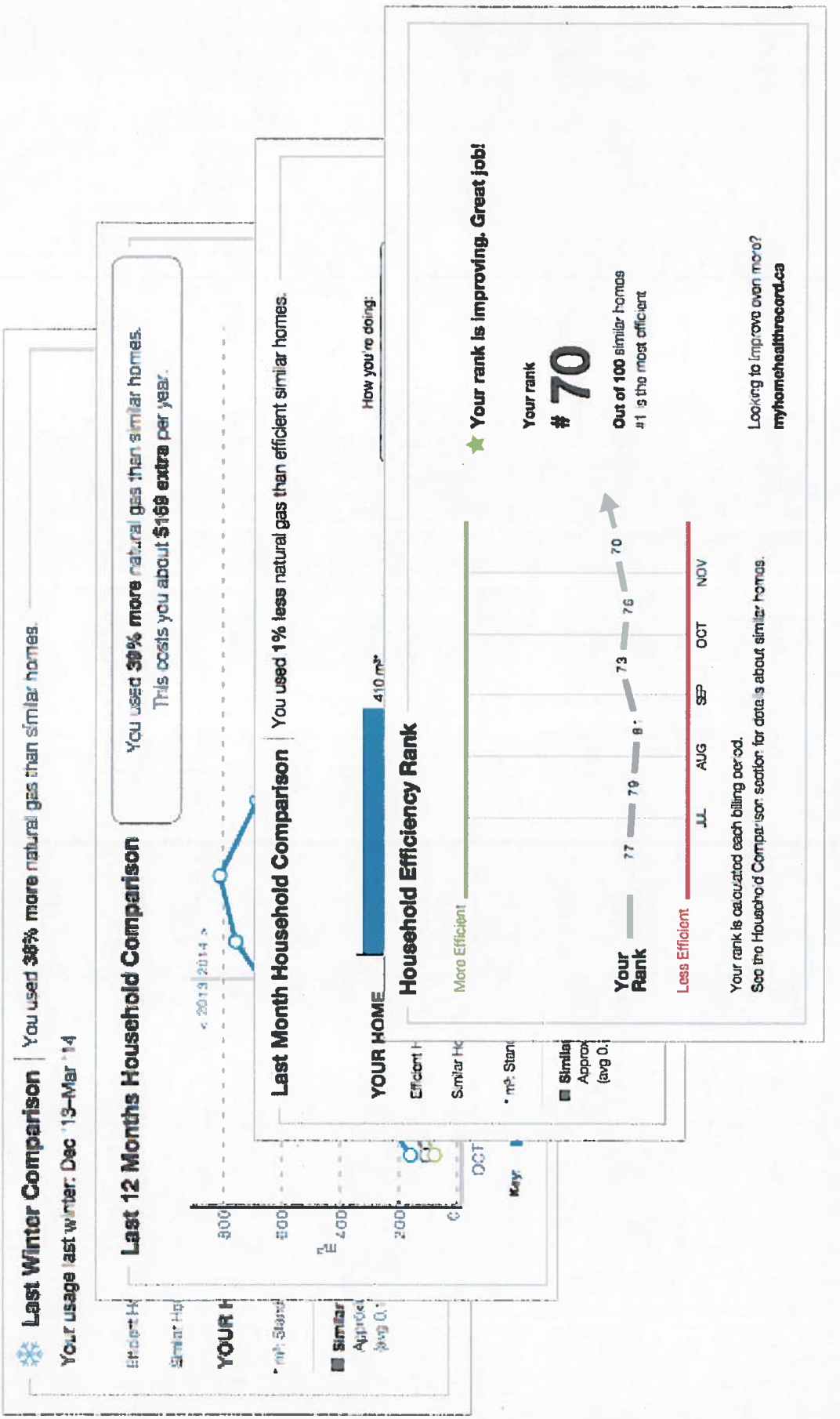
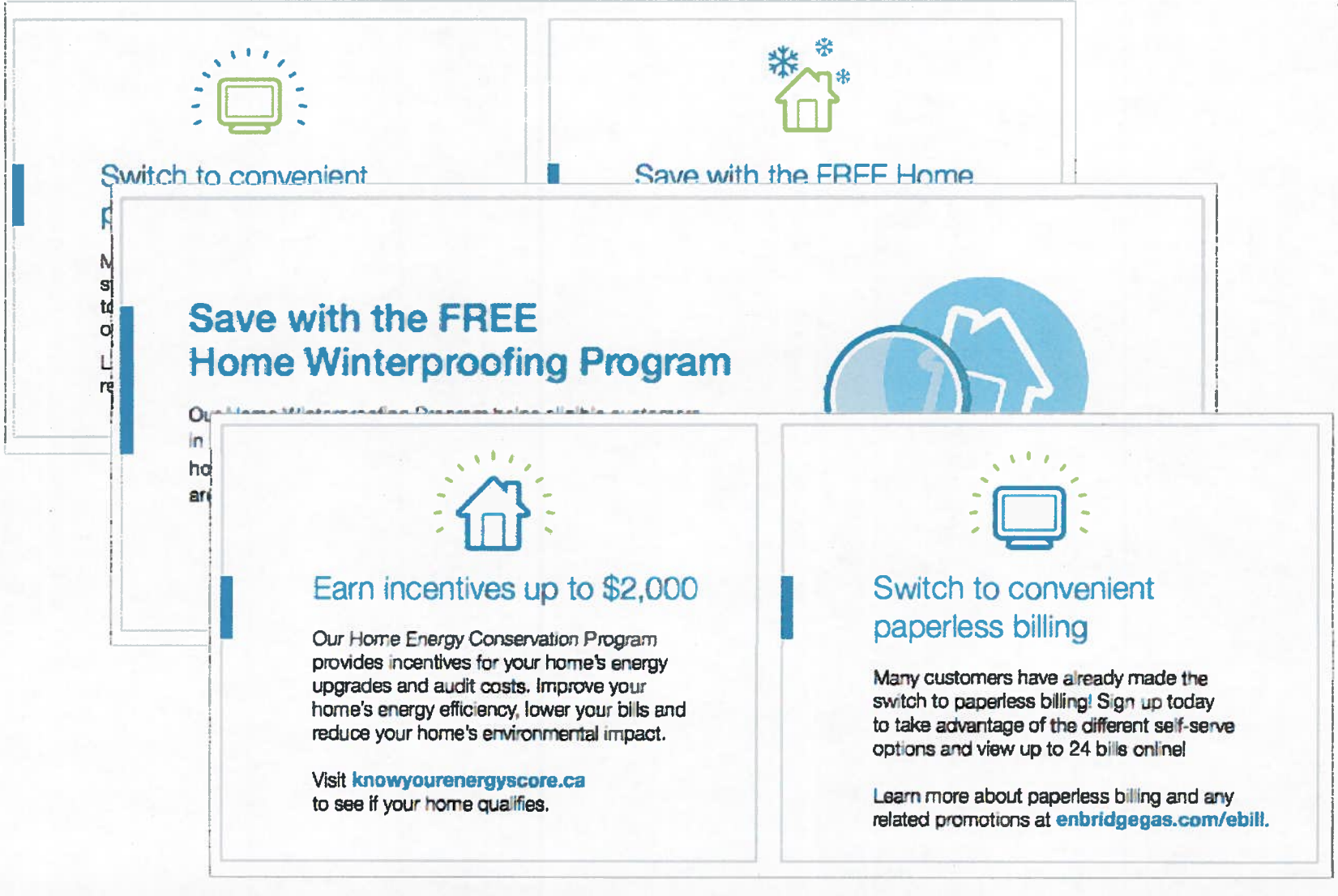
Dynamic Modules



Custom HER content and promotions



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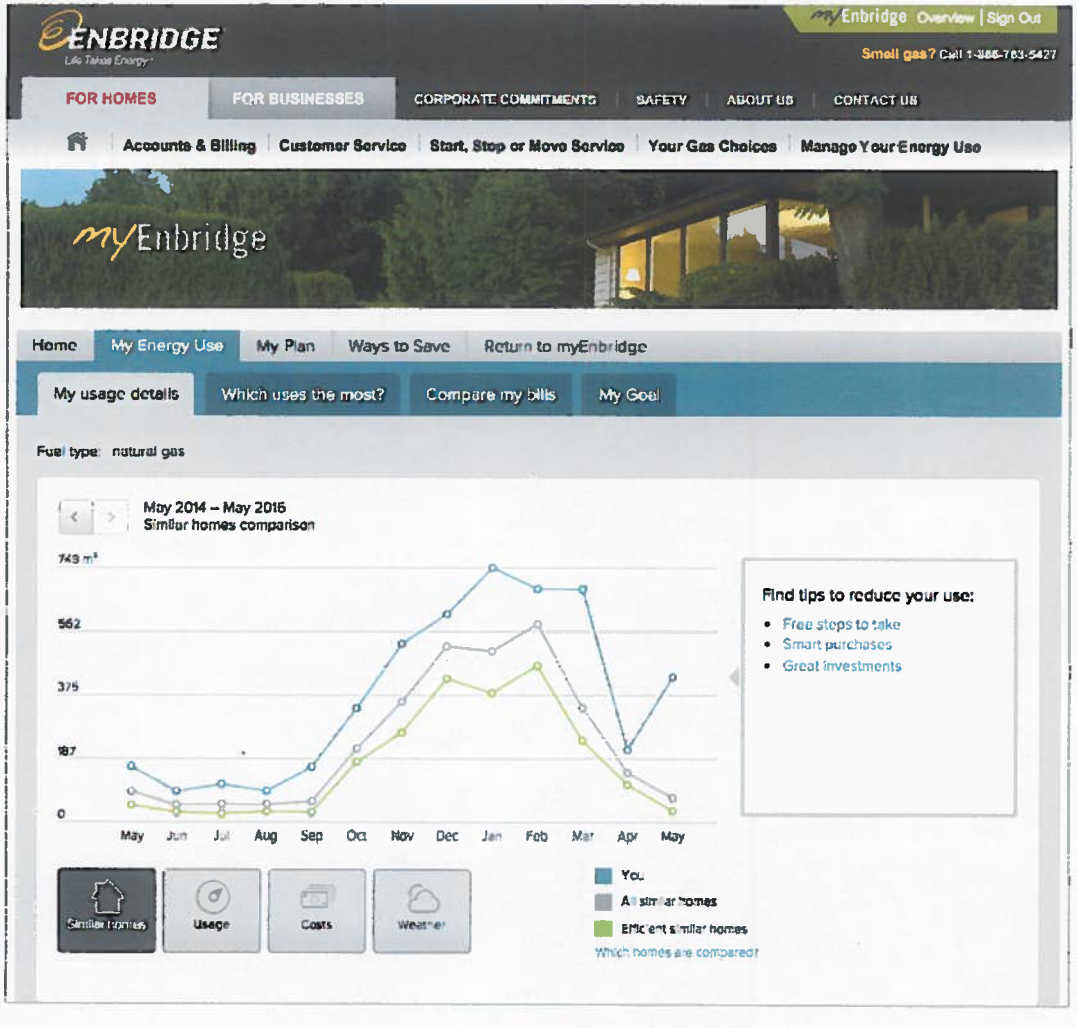
Web Portal



Key Notes

- ✓ **Launched as stand-alone web site**
- ✓ **Moved to integrated web in January, 2015**

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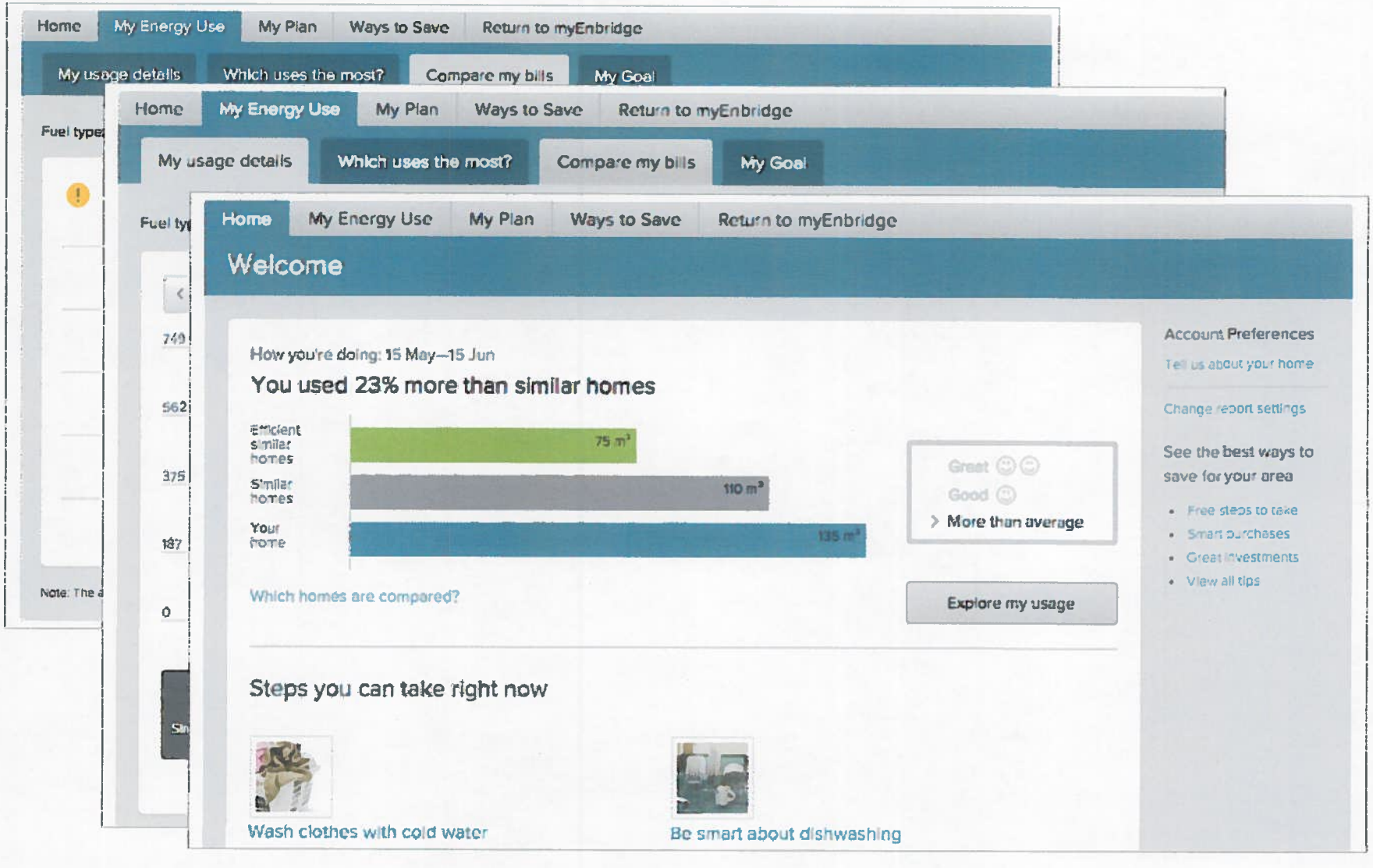
Web content



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Pilot Results & Program Review

1. Program Overview
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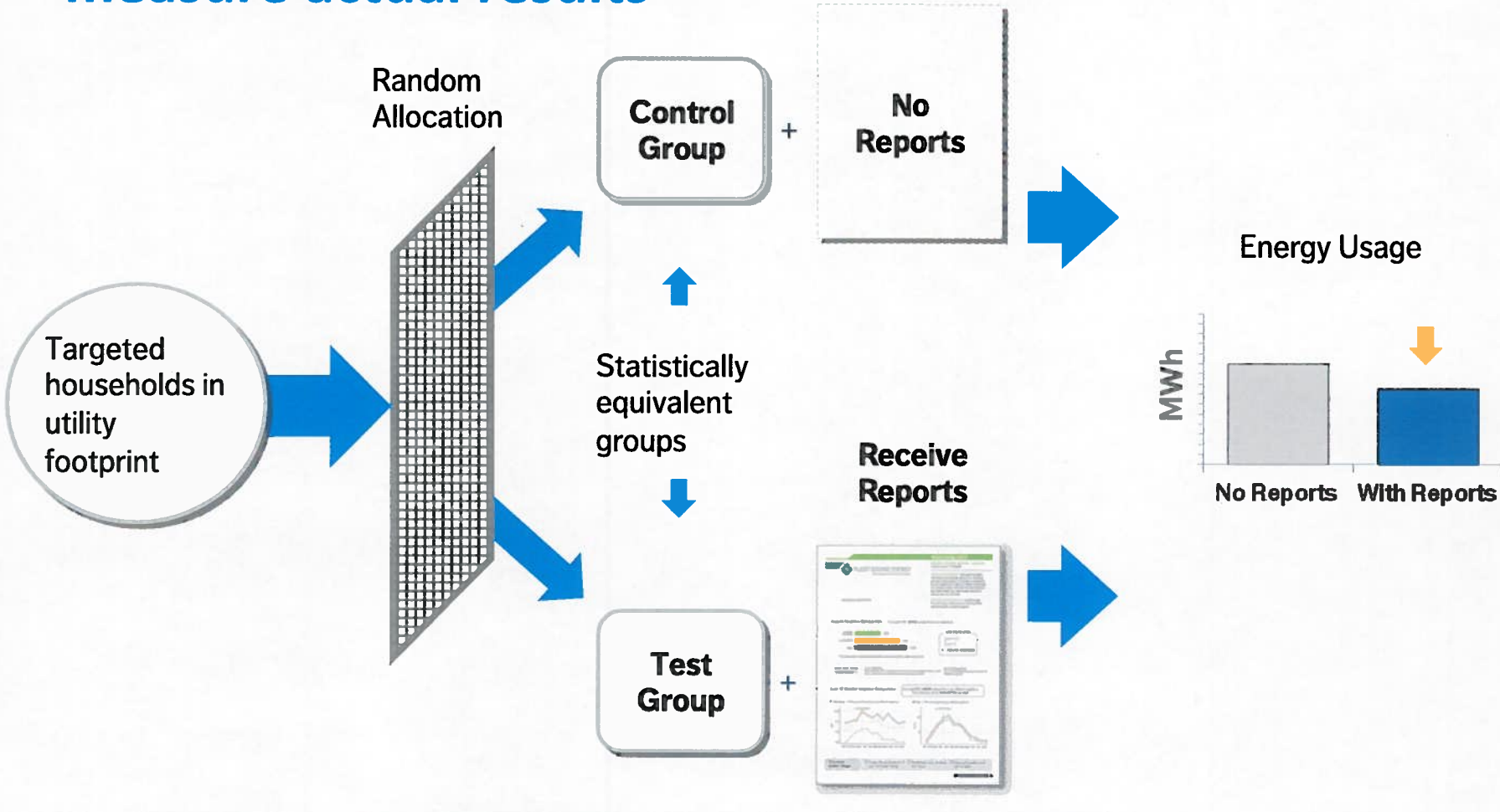
One more refresher: How our M&V allows us to measure actual results



KEMA THE CADMUS GROUP, INC. EDF ENVIRONMENTAL DEFENSE FUND Finding the ways that work NAVIGANT CONSULTING U.S. DEPARTMENT OF ENERGY

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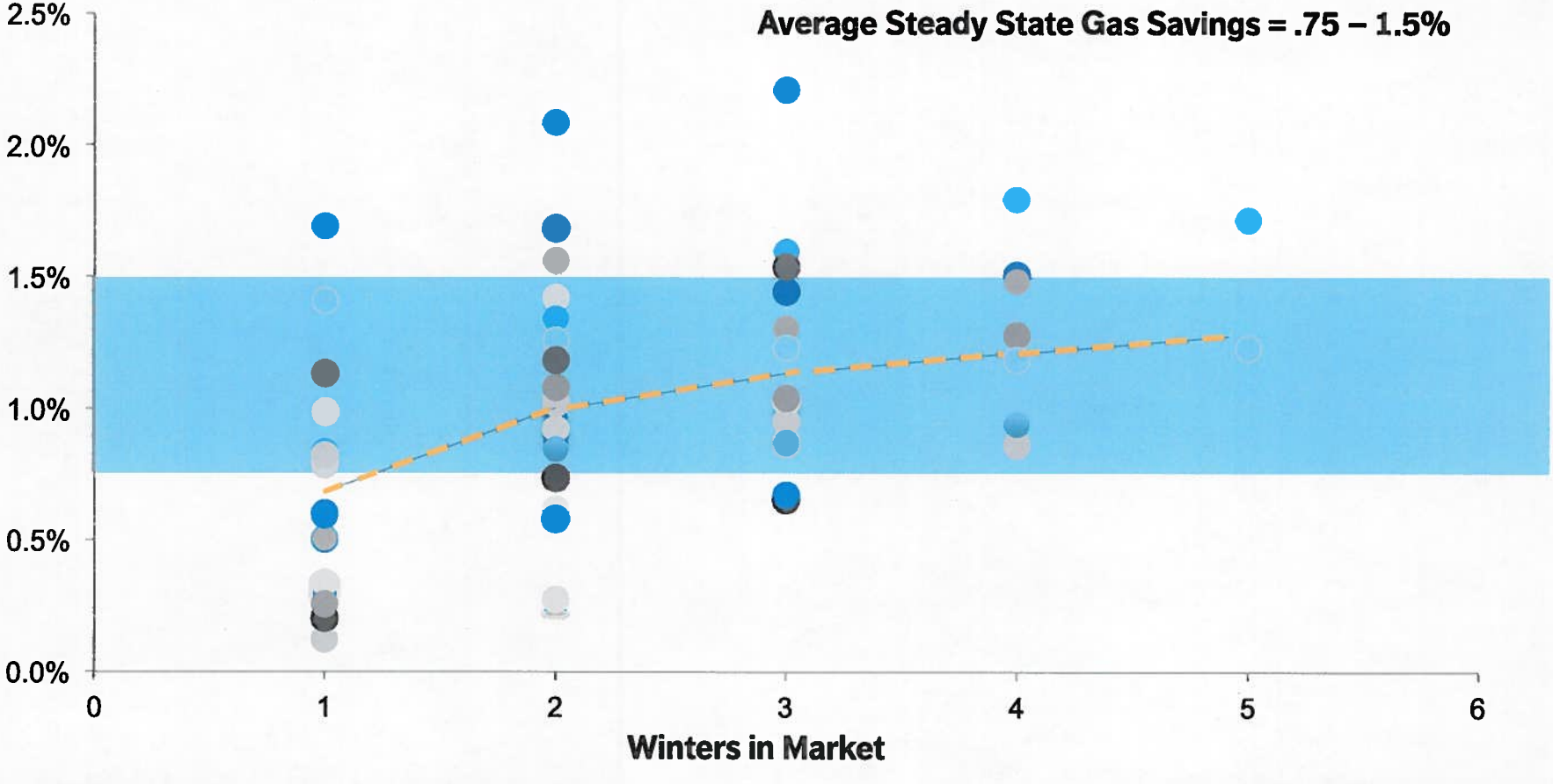
Predictable and Verified Gas savings



CADMUS

ODC OPINION DYNAMICS CORPORATION

NAVIGANT

KEMA DNV

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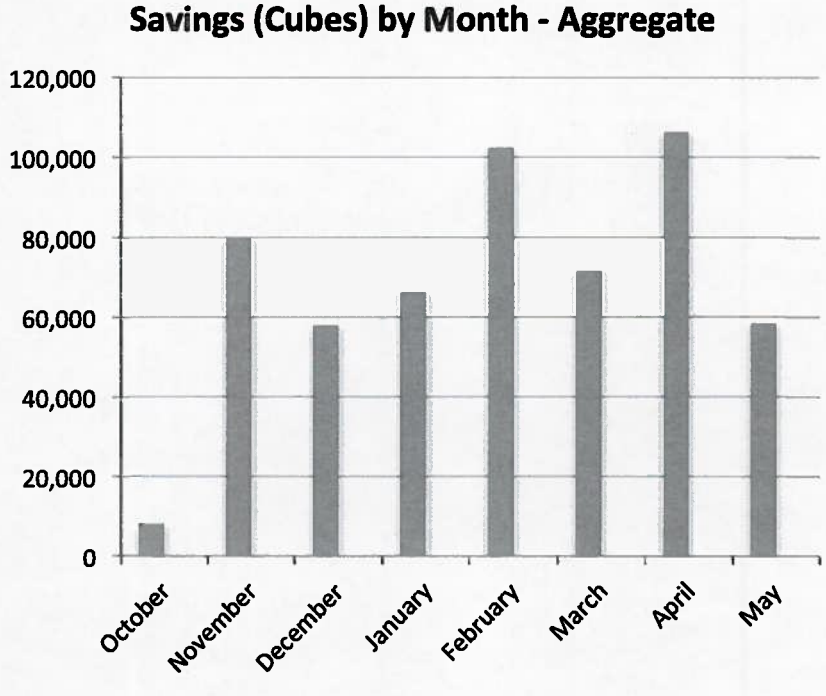
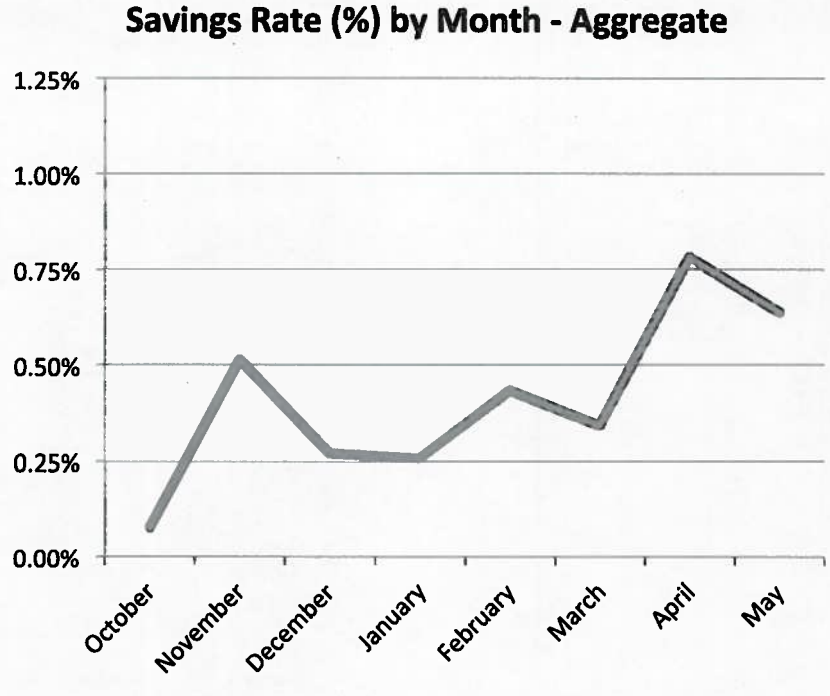
Savings Overview





Fuel	Cumulative Savings to date	Savings Rate (%) in April
Gas	550,923 cubes	0.8%

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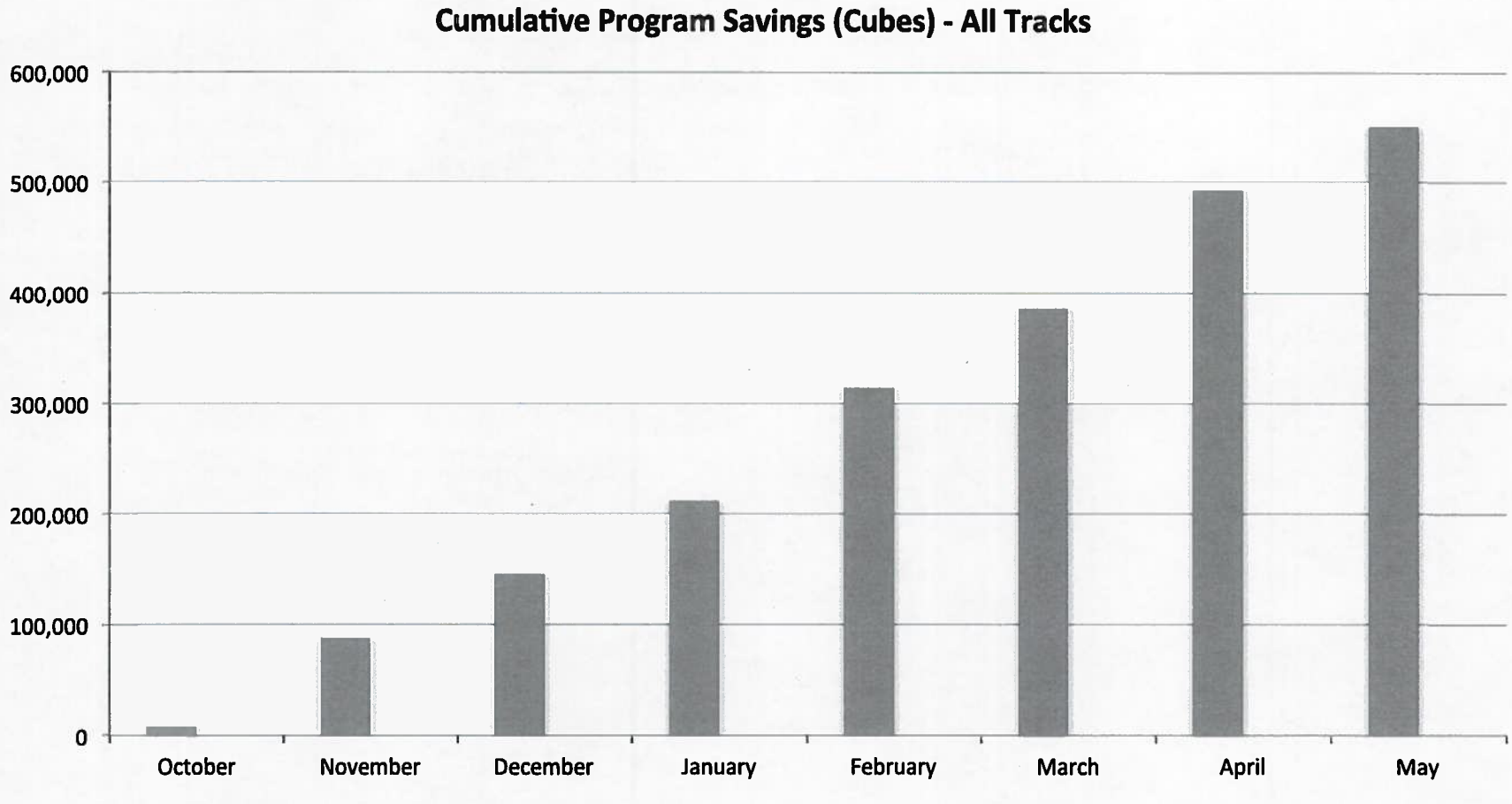
Savings by Month – Cumulative



Key note: ***

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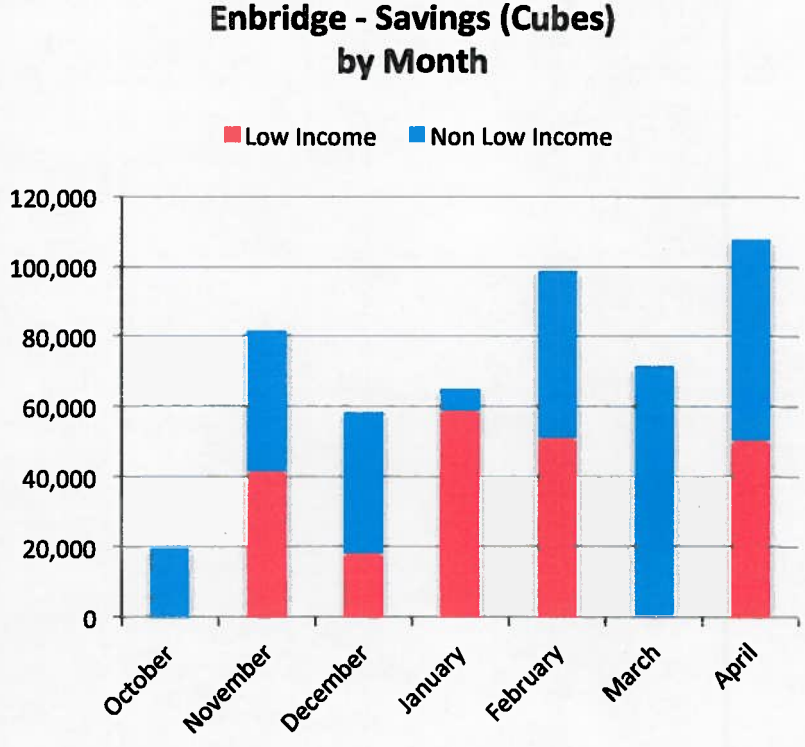
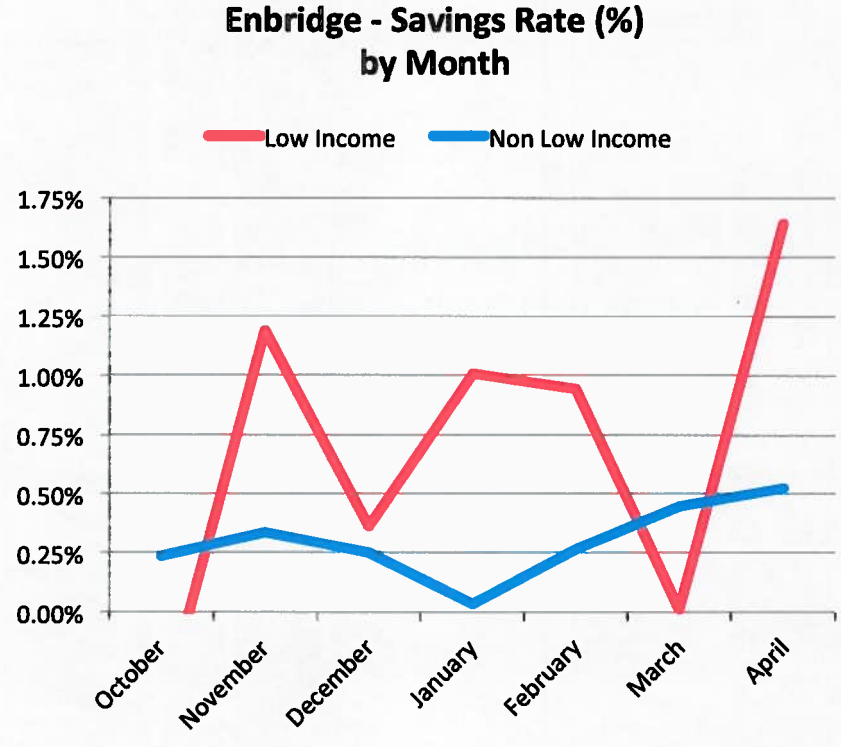
Low Income and High Use Waves





Key note: Savings were driven by both waves, though the low income wave showed stronger, if more volatile, savings rates. Volatility likely derives from sample size.

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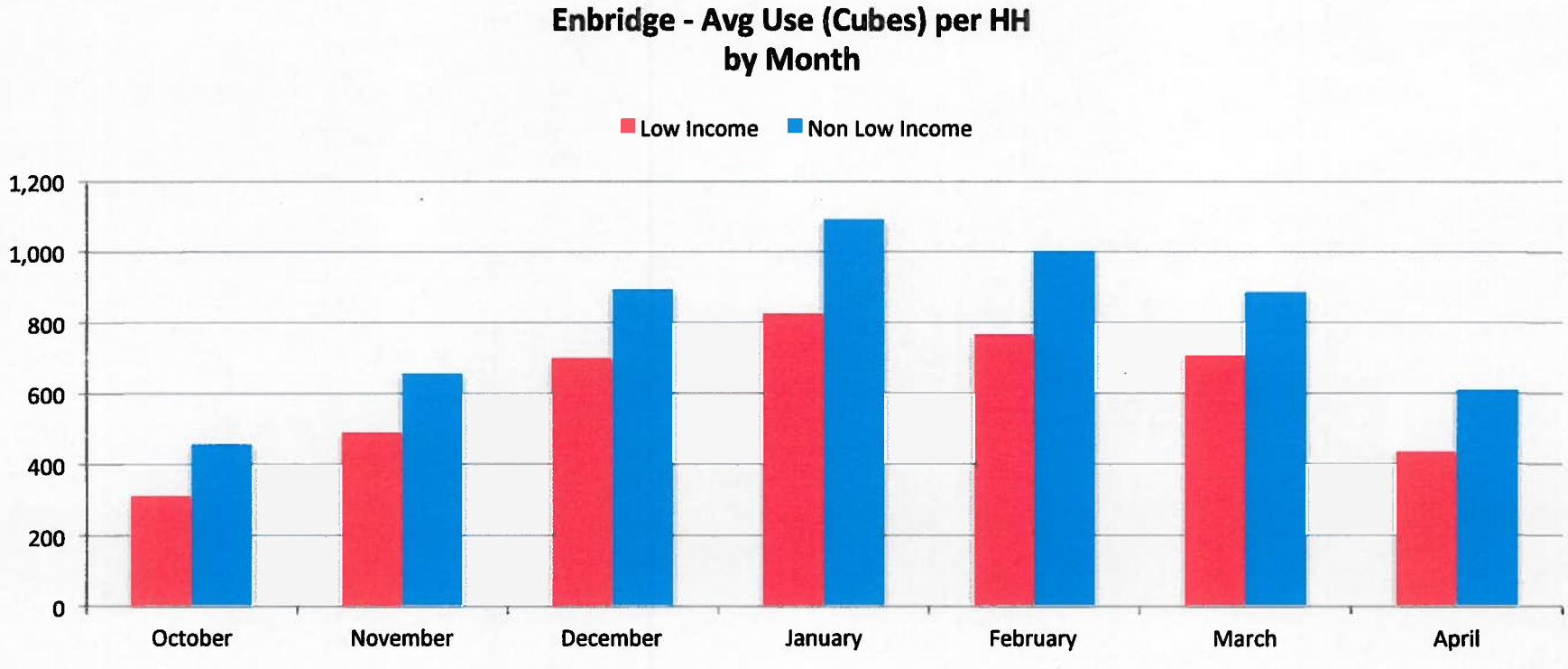
Household gas use per month



Key note: Households in the "low income" track used approximately 25% less gas than the "non low income" track

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Savings Takeaways & Next Steps

Savings were strong, despite one of the coldest winters on record

Savings = engagement. Savings is ultimately one of the best indicators of customer value

Enbridge customers have saved a **cumulative 550,923 cubes** through the end of May

Strong low income savings points to opportunities for messaging and other segmentation options

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Pilot Results & Program Review

1. Program Overview
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Communications & Engagement Overview

Sent ~3 **Home Health Records to over 25,000 customers**

Over 11,066 Enbridge customers have **created their accounts** on the web portal

Nearly 3,500 Enbridge customers have **completed the online audit**

Opt outs and move out rates are well below benchmarks for similar programs

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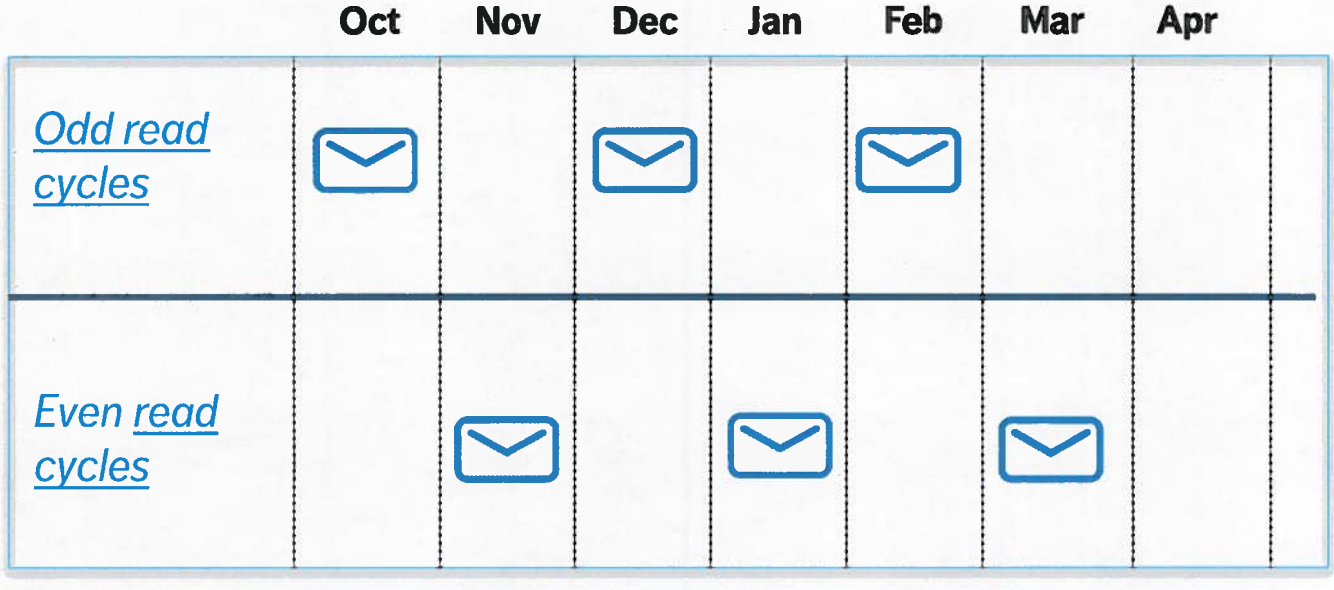
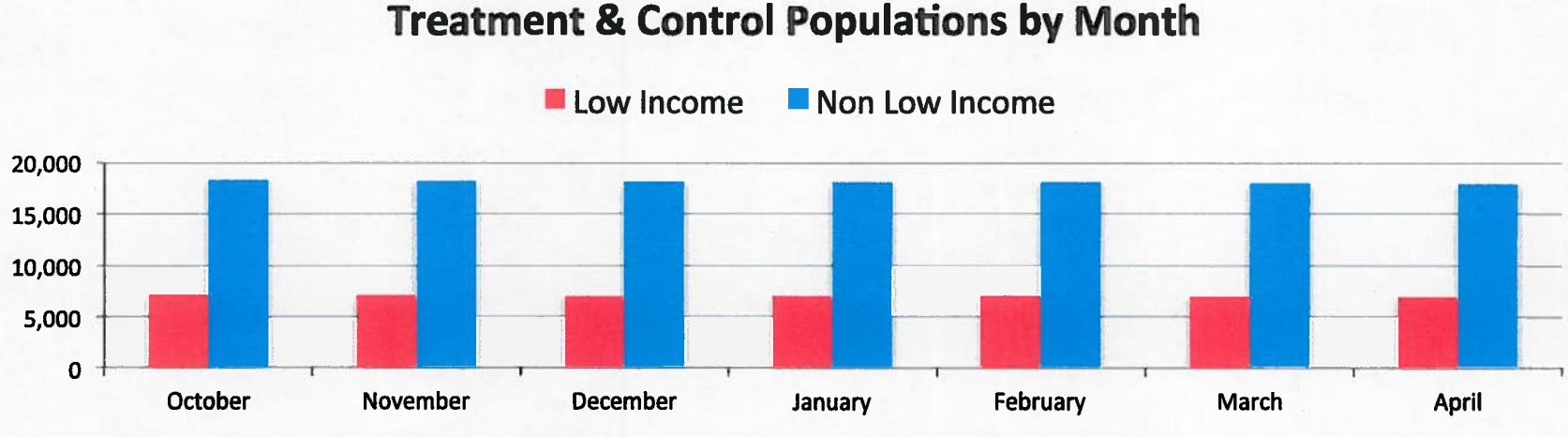
Communication & Engagement Key Metrics





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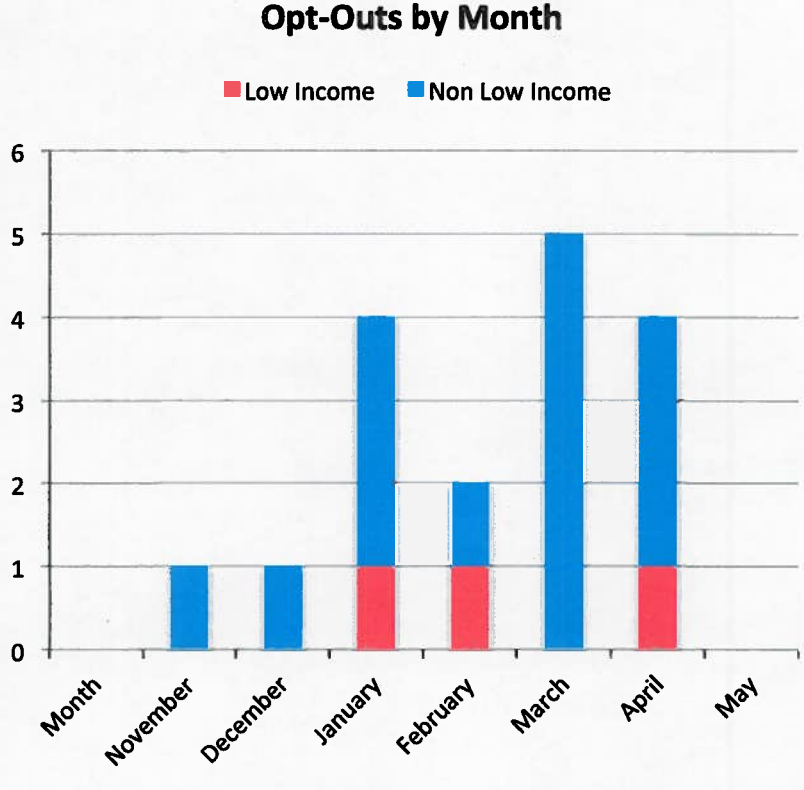
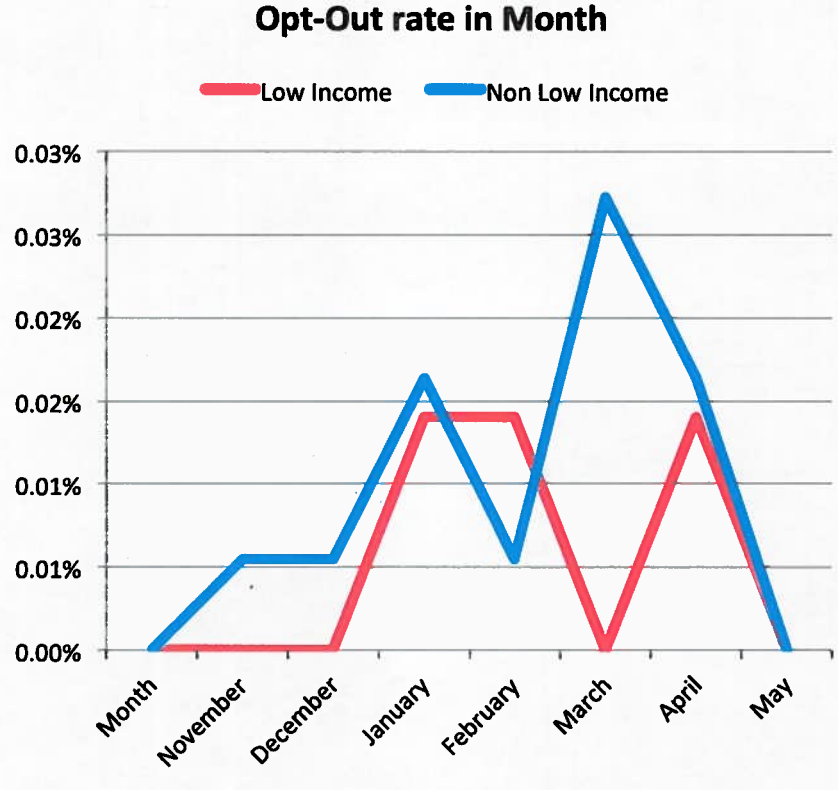
Opt-outs figures are among our lowest to date





Key notes: Opt outs typically correspond to the days and month following the receipt of a report; opt-outs rates typically decline over the course of a program

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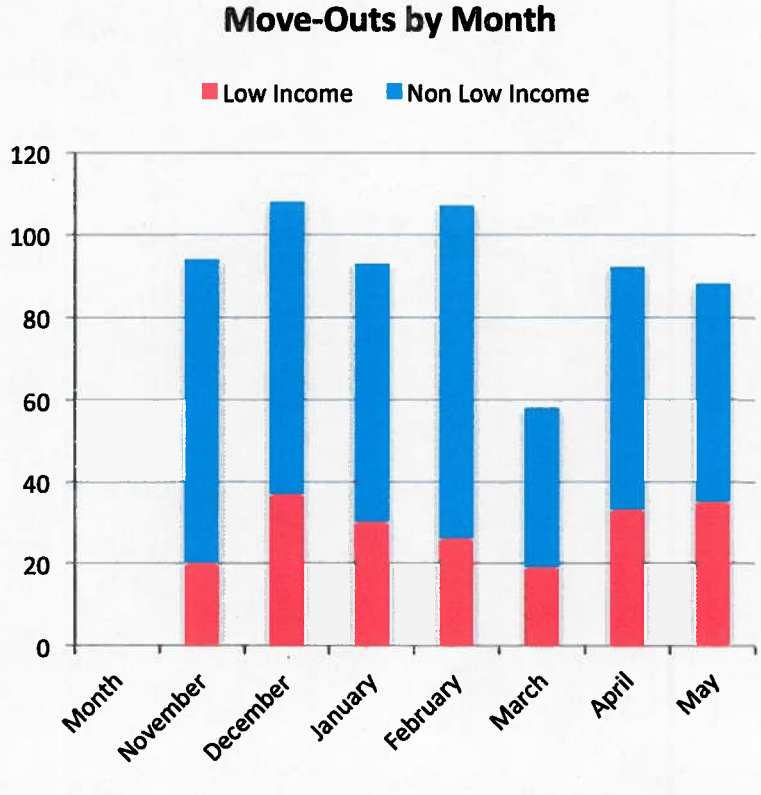
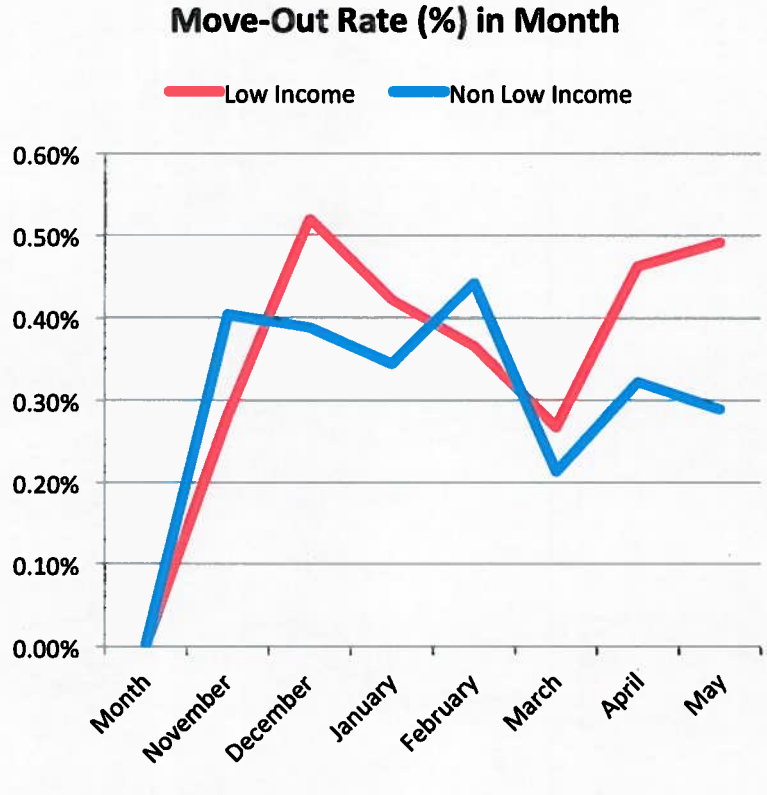
Move Outs relatively low, stable

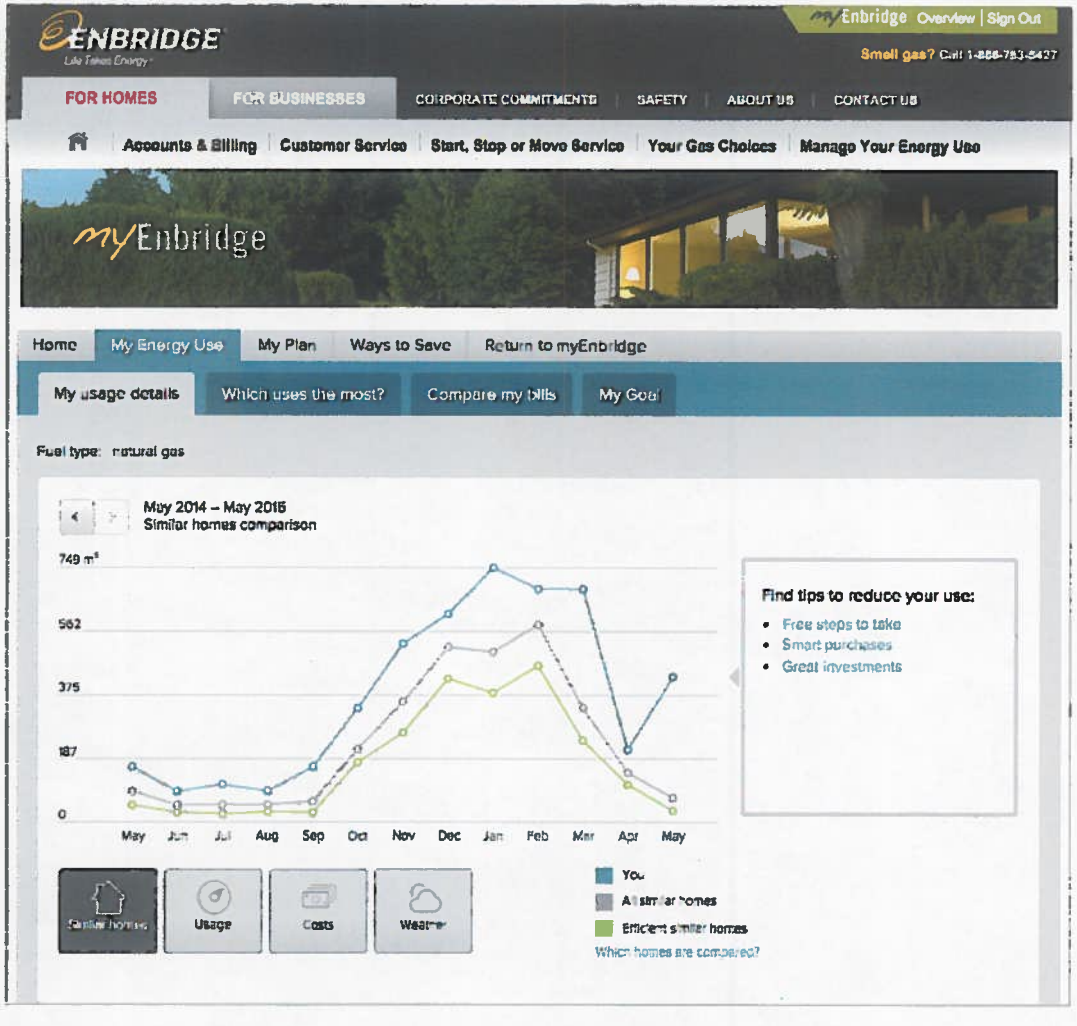
Key note: Cumulative move out rate of just 2.5%; move out rates tend to be higher during summer months





Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 27 of 76

Web statistics

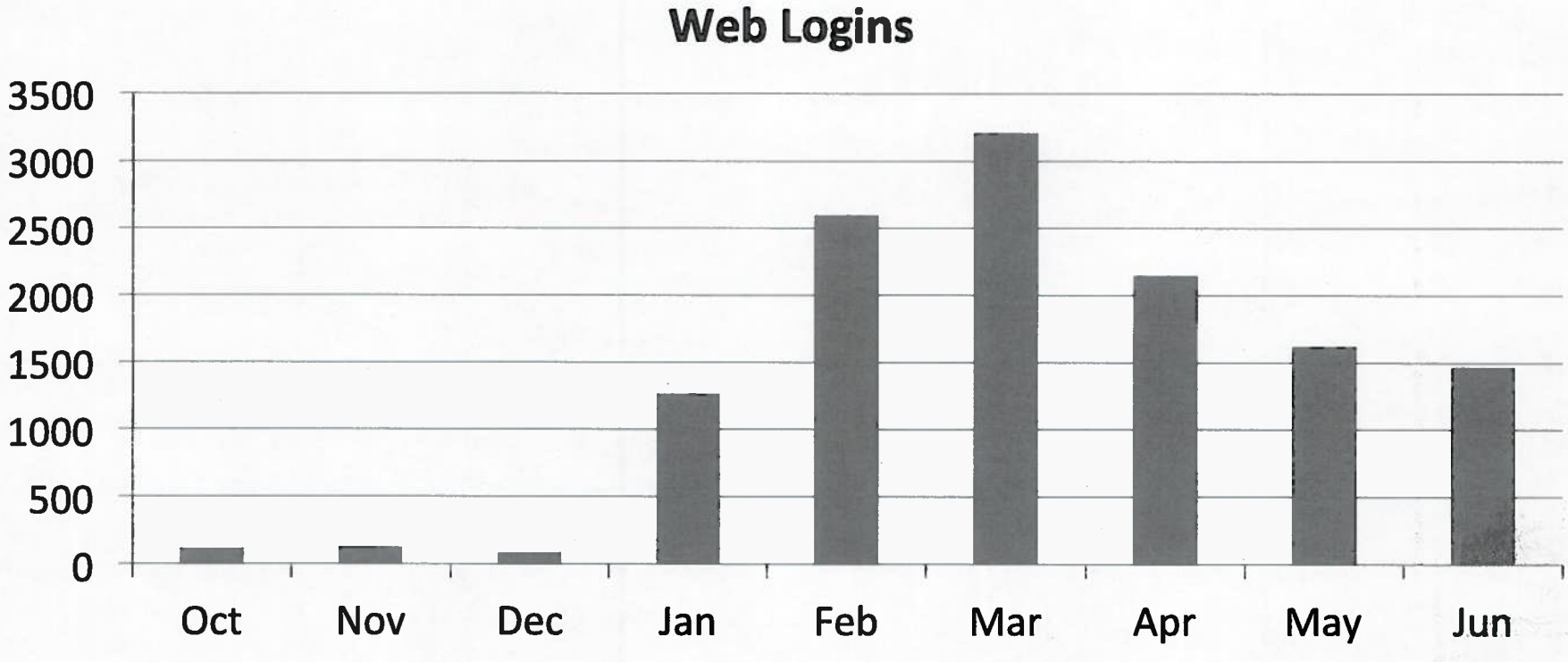


Web Metrics

Accounts created	11,066
Checked off tip	2,425
Completed audit	3,406
Made commitment	326
Avg. pages/visit	6.4
Time on site	4:08

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 28 of 76

Web logins – Oct-Jun



Key notes: 11,066 Accounts from Oct-Jun

Account creation skyrocketed when we moved to integrated web; accounts creation was highest in months with Home Health Records, and tapered in May and June

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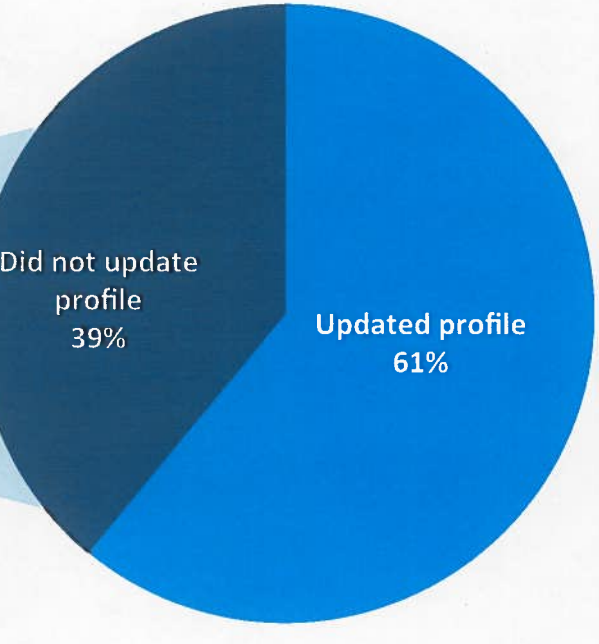
Web visitors tend to update profile

Although the level of web engagement due to the reports could be higher, customers who do visit often update their profiles.

Home Health Record Reactions

372 interviews with customers that read the reports

Other Actions	
Took a specific energy-saving action	20%
Visit the Enbridge web portal	9%
Call Enbridge for more information	5%



After reviewing your reports, did you...

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Engagement Takeaways & Next Steps

Engaged customers: Enbridge customers are actively engaged online

Customers want energy tools: Customers are using the online energy management tools

Opt out rates are as low as we have seen, indicating engagement and satisfaction

Segmentation drives smart engagement: As we move forward, we can identify ways to deliver optimized content

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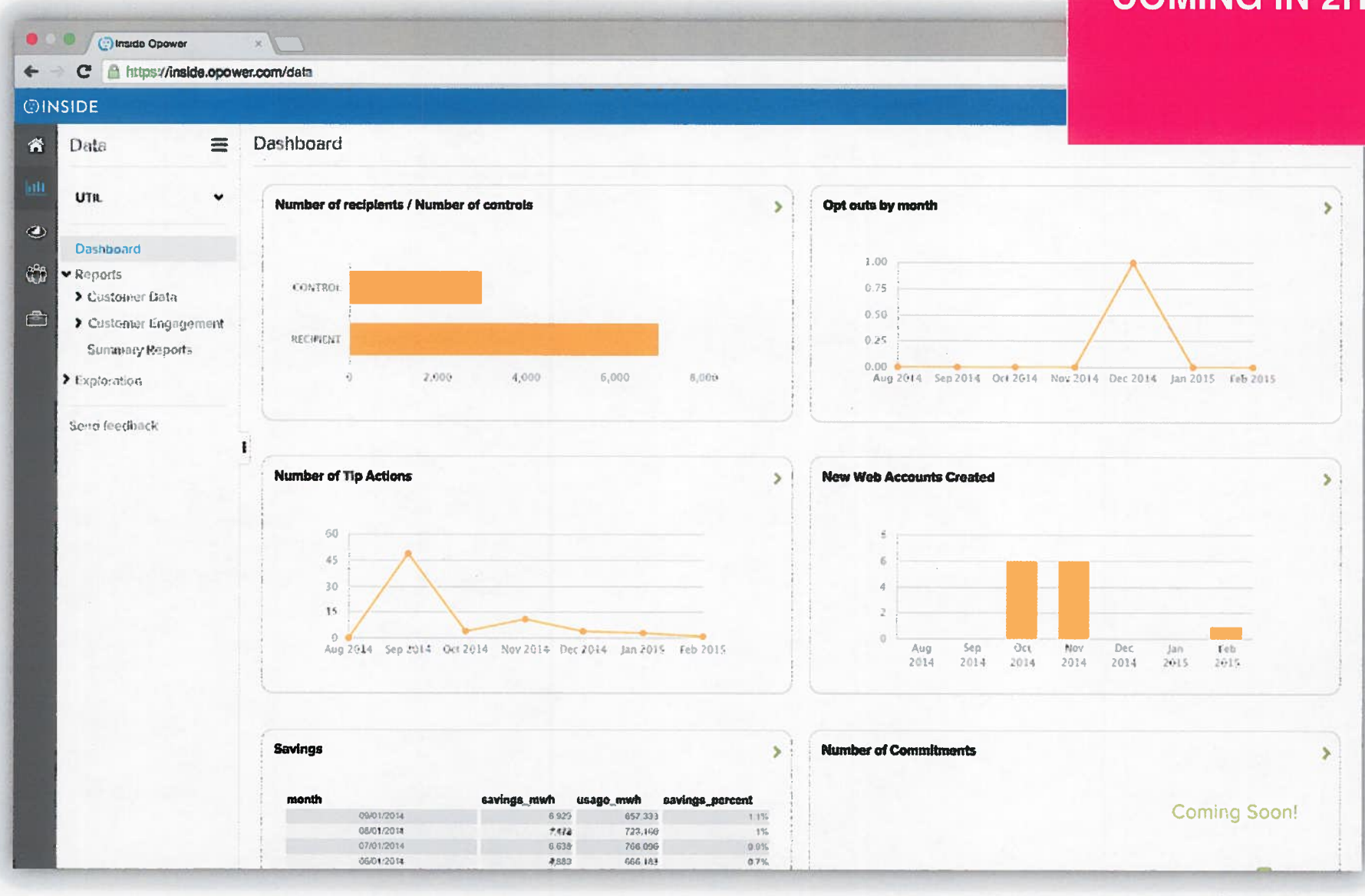
Pilot Results & Program Review

1. Program Overview
2. Savings Overview
3. Engagement Overview
4. Customer Engagement Tracker (CET)

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 32 of 76

Inside Opower: Real-time metrics

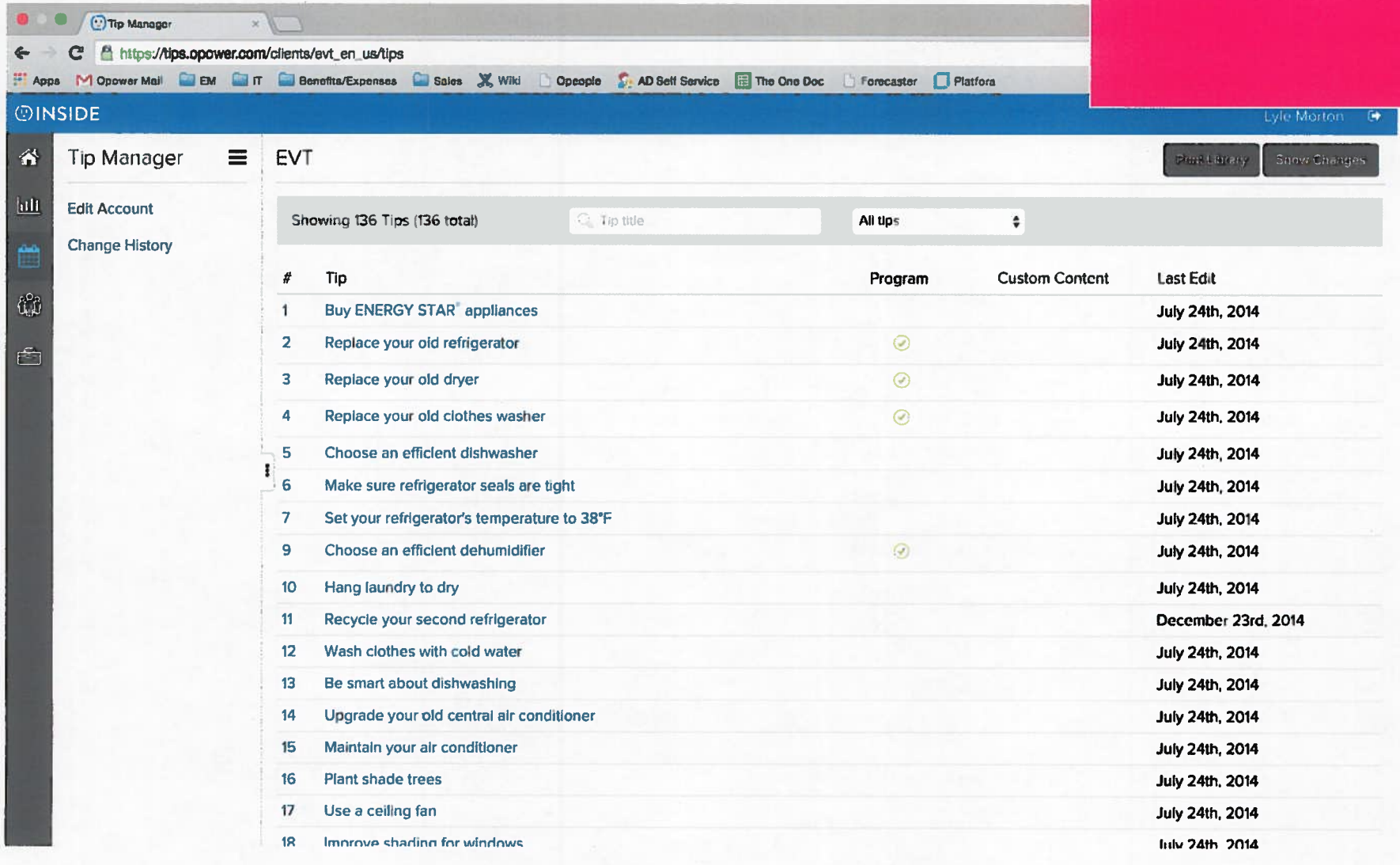
COMING IN 2H



Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 33 of 76

Tip Manager: Real-time program managem

COMING IN 2H



#	Tip	Program	Custom Content	Last Edit
1	Buy ENERGY STAR® appliances			July 24th, 2014
2	Replace your old refrigerator	✓		July 24th, 2014
3	Replace your old dryer	✓		July 24th, 2014
4	Replace your old clothes washer	✓		July 24th, 2014
5	Choose an efficient dishwasher			July 24th, 2014
6	Make sure refrigerator seals are tight			July 24th, 2014
7	Set your refrigerator's temperature to 38°F			July 24th, 2014
9	Choose an efficient dehumidifier	✓		July 24th, 2014
10	Hang laundry to dry			July 24th, 2014
11	Recycle your second refrigerator			December 23rd, 2014
12	Wash clothes with cold water			July 24th, 2014
13	Be smart about dishwashing			July 24th, 2014
14	Upgrade your old central air conditioner			July 24th, 2014
15	Maintain your air conditioner			July 24th, 2014
16	Plant shade trees			July 24th, 2014
17	Use a ceiling fan			July 24th, 2014
18	Improve shading for windows			July 24th, 2014

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Pilot Results & Program Review

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Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 35 of 76

Customer Engagement Tracker (CET)

1. Research Overview

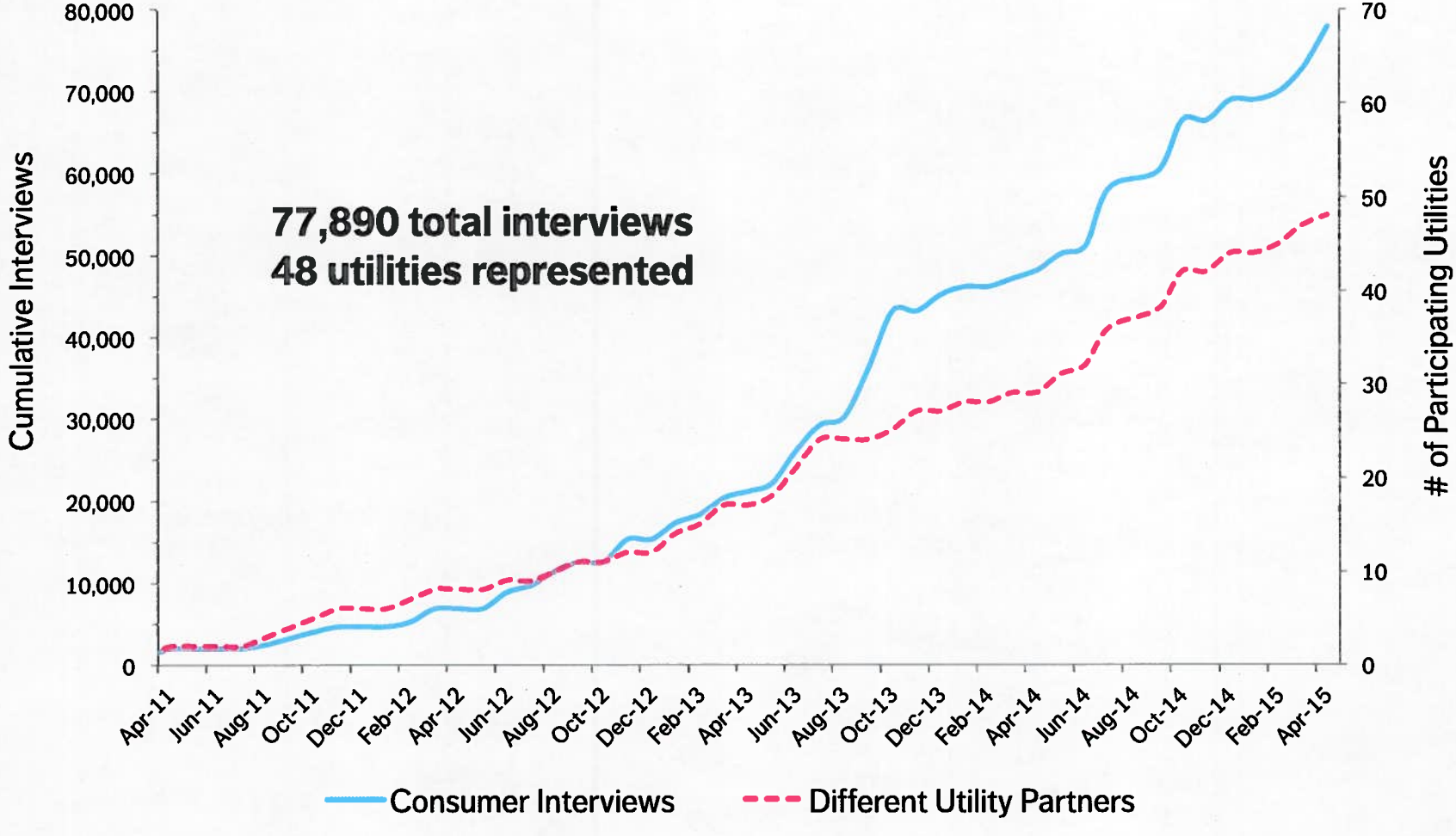
2. Home Health Record Interaction

3. Impact on Enbridge Customer Relationship

4. Home Health Record Reception

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 36 of 76

Survey data increasing over time, creating relevant benchmarks to evaluate & improve programs



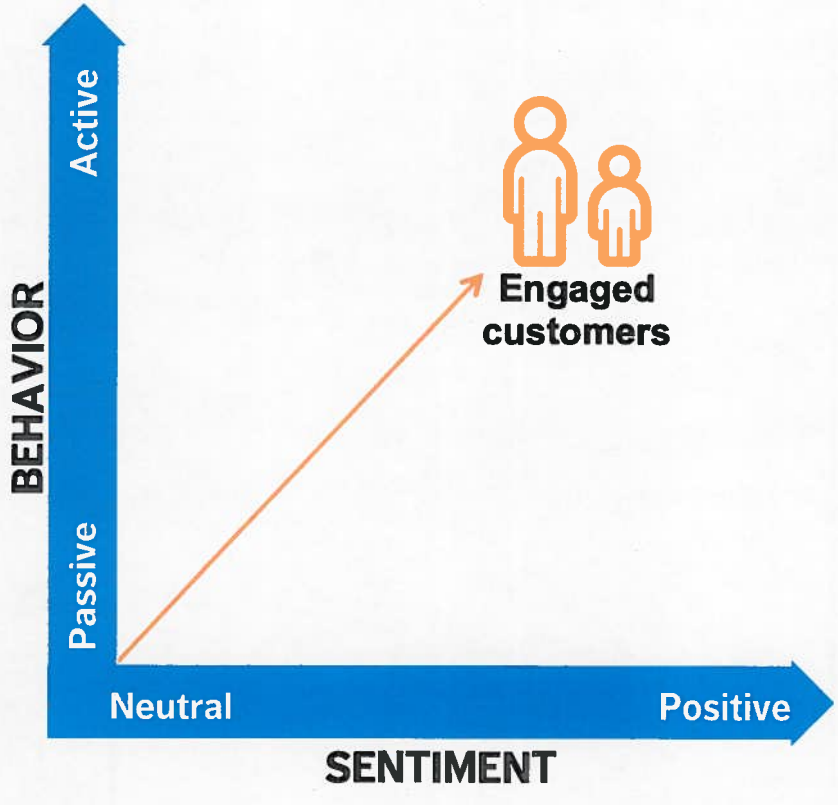
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 37 of 76

Customer engagement overview

Customer engagement is the interaction of positive sentiment and behavior. The CET survey explores the impact of Home Energy Report program on Enbridge's relationship with its customers.

Action

- Report engagement
- Digital engagement
- Program participation
- Energy efficiency actions



Satisfaction

- Utility satisfaction & loyalty
- Program reception and evaluation

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 38 of 76

Survey Methodology

Telephone survey of 1,000 randomly selected Enbridge customers

- 700 total Home Energy Report recipient interviews
- 300 total non-recipient (control) interviews that are used a a baseline to isolate report effects
- Margin of error approximately 3% to 4%

Survey targeted customers from Enbridge's 2014 pilot deployment wave

- Third-party vendor matched customer records to contact data and conducted interviewing from a Toronto-based call center

Interviews conducted between June 5th and June 18th

- Average interview length: 10.08 minutes
- 17,640 customers dialed, 4,839 successfully contacted, for a response rate of 21%

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Summary

Customers are engaging with the program at high rates.
Although overall awareness is still on the lower end, almost all customers who recall the reports are reading them in some fashion.

The majority of recipients feel positive about their experience.
Around 70% of recipients are satisfied with the program and over 80% appreciate the energy efficiency advice given in the reports.

Program is improving customer sentiment
Recipients are significantly more likely to think that Enbridge offers efficiency programs and 40% say they feel better about Enbridge due to the reports.

More work needed to explain neighbor comparison
Although the neighbor comparison is a very popular aspect of the report, many recipients are unclear about how it is calculated.

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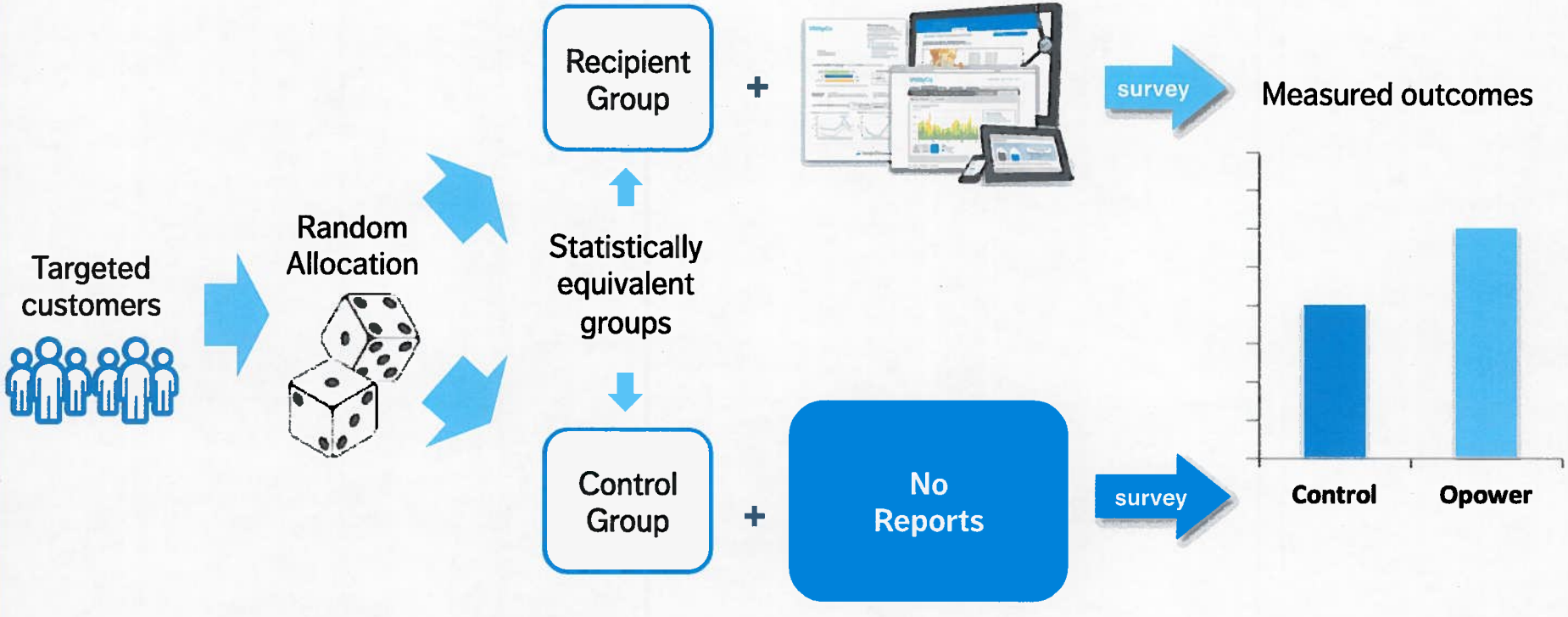
Impact measured using experimental design

By surveying a randomly selected control group, we can have confidence that observed differences between the control and recipient (Opower-enabled) groups are attributable to the program, and not to external factors.



Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 41 of 76

Customer Engagement Tracker (CET)

1. Research Overview

2. Home Health Record Interaction

3. Impact on Enbridge Customer Relationship

4. Home Health Record Reception

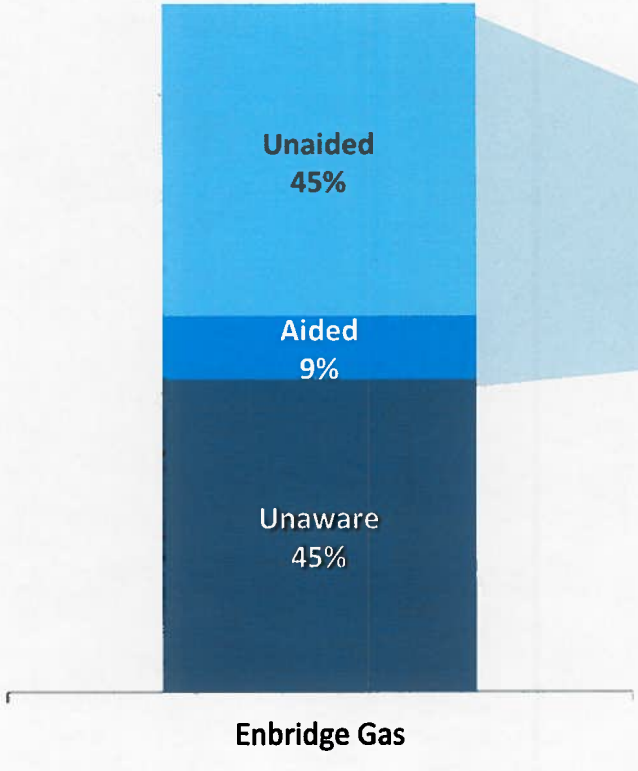
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 42 of 76

Majority of recalling recipients interact with report

About 54% customers remember receiving the Home Health Record, with 98% of those respondents typically reading the reports in some way.

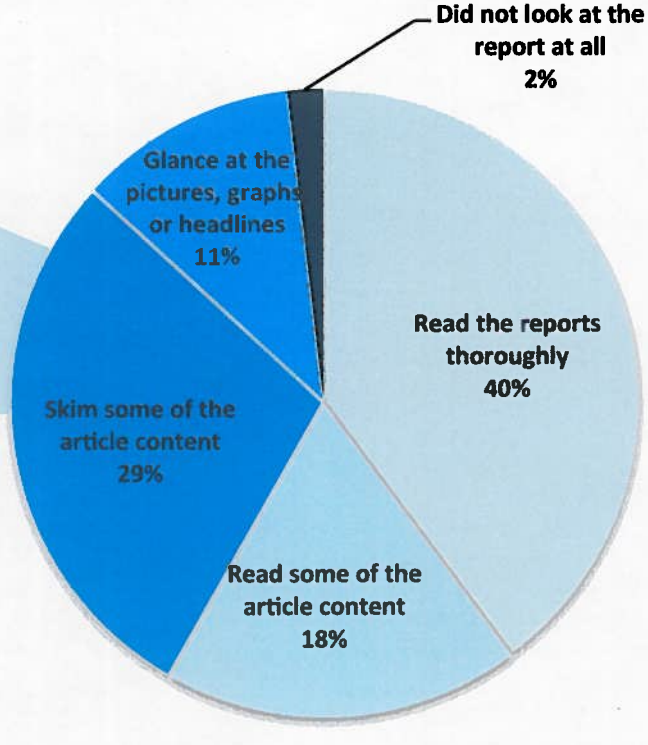
Home Health Record Recall

700 report recipient interviews



Home Health Record Reading

382 recalling recipient interviews



In the six months, do you remember receiving a My Home Health Record from Enbridge about your in-home energy use?

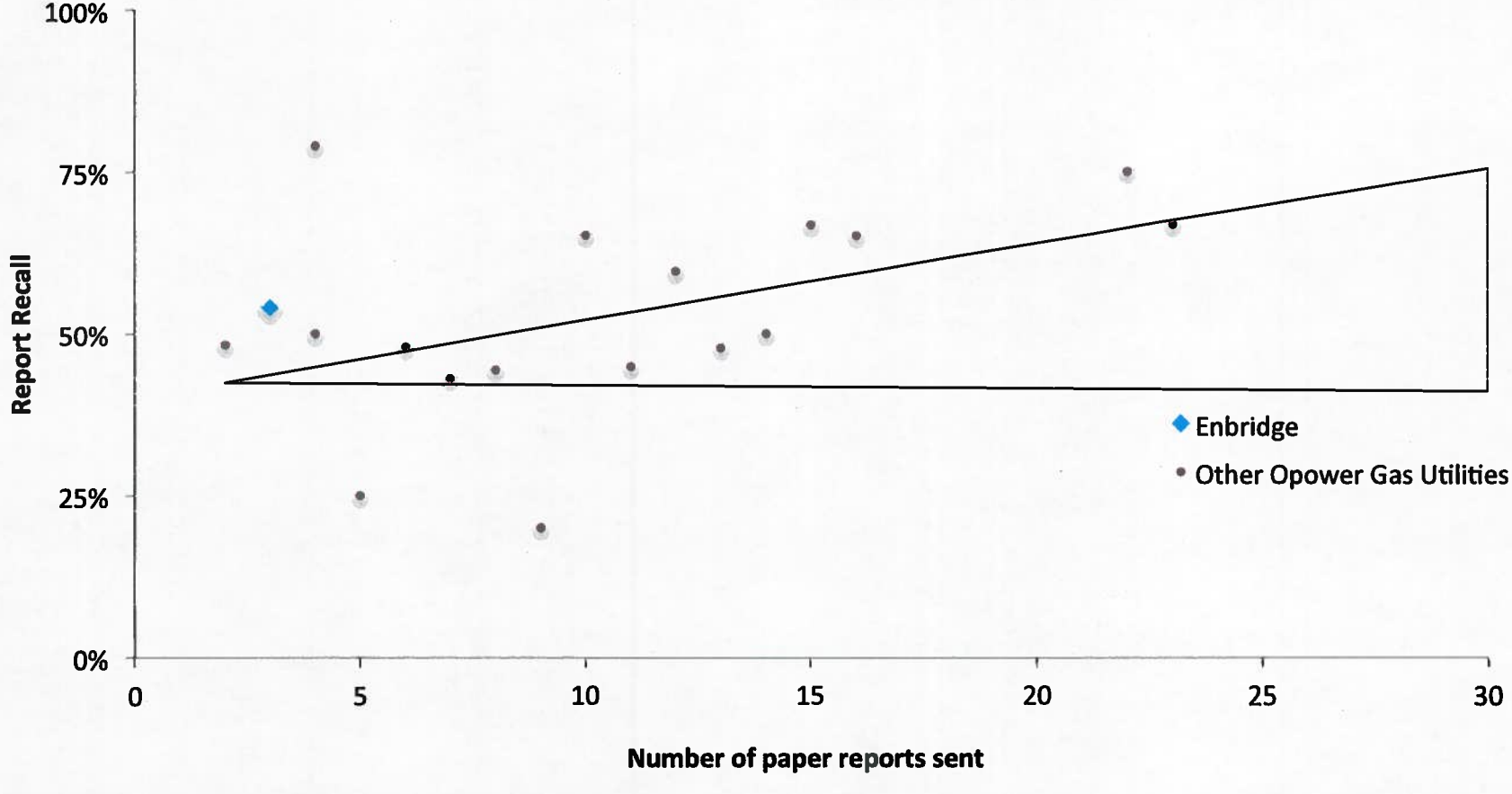
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 43 of 76

Recall rate is in line with expectations

With 54% of all report recipients reading it in some fashion, engagement is on par with what Opower expects of a young program.

Home Health Record Recall

700 interviews with Enbridge recipients
~3k interviews with report recipients across 10 gas utility deployments



In the six months, do you remember receiving a My Home Health Record from Enbridge about your in-home energy use?

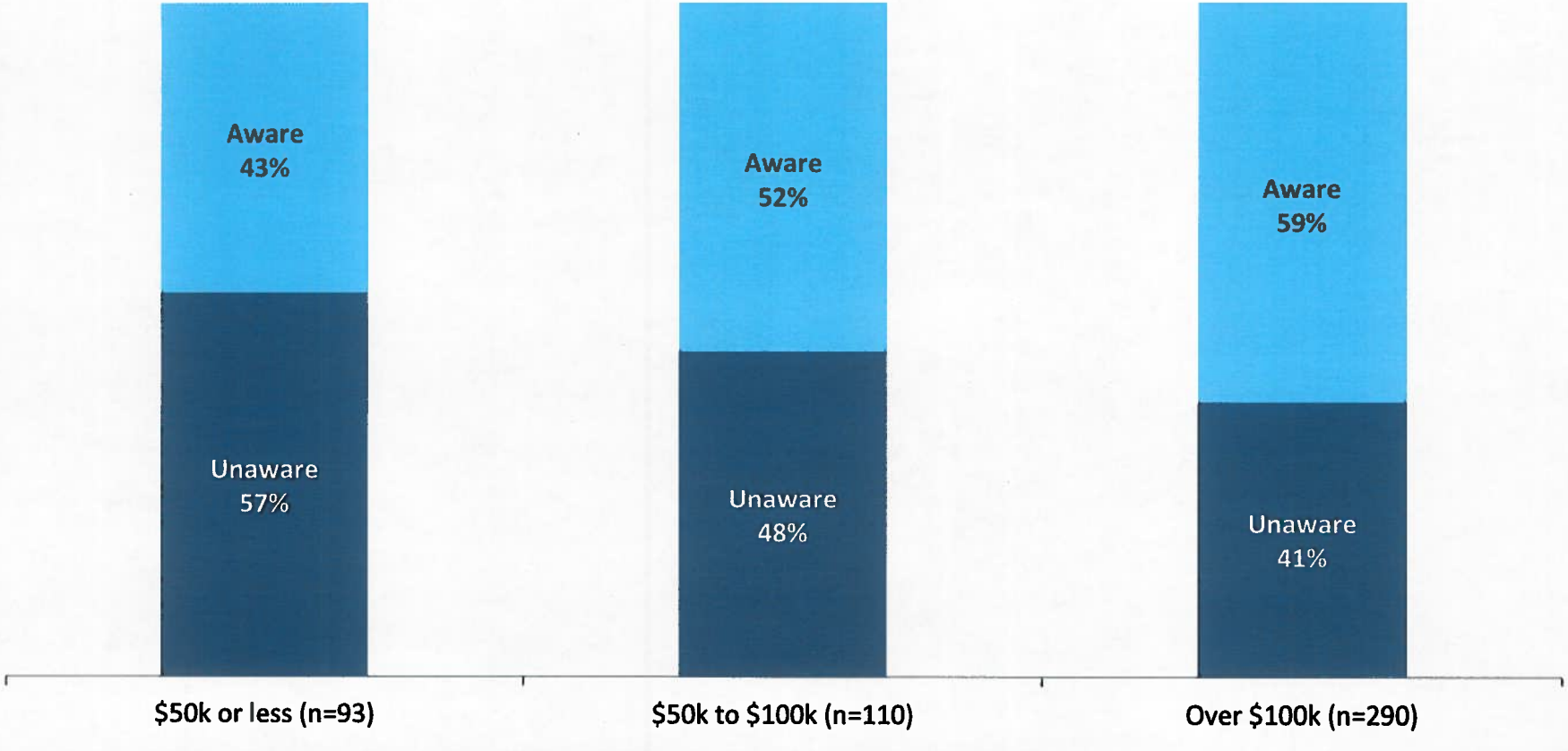
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 44 of 76

Lower income customers less likely to recall reports

As household income increases, customers are more likely to by familiar with the Home Health Record.

Report Recall by Income

493 interviews with Enbridge recipients

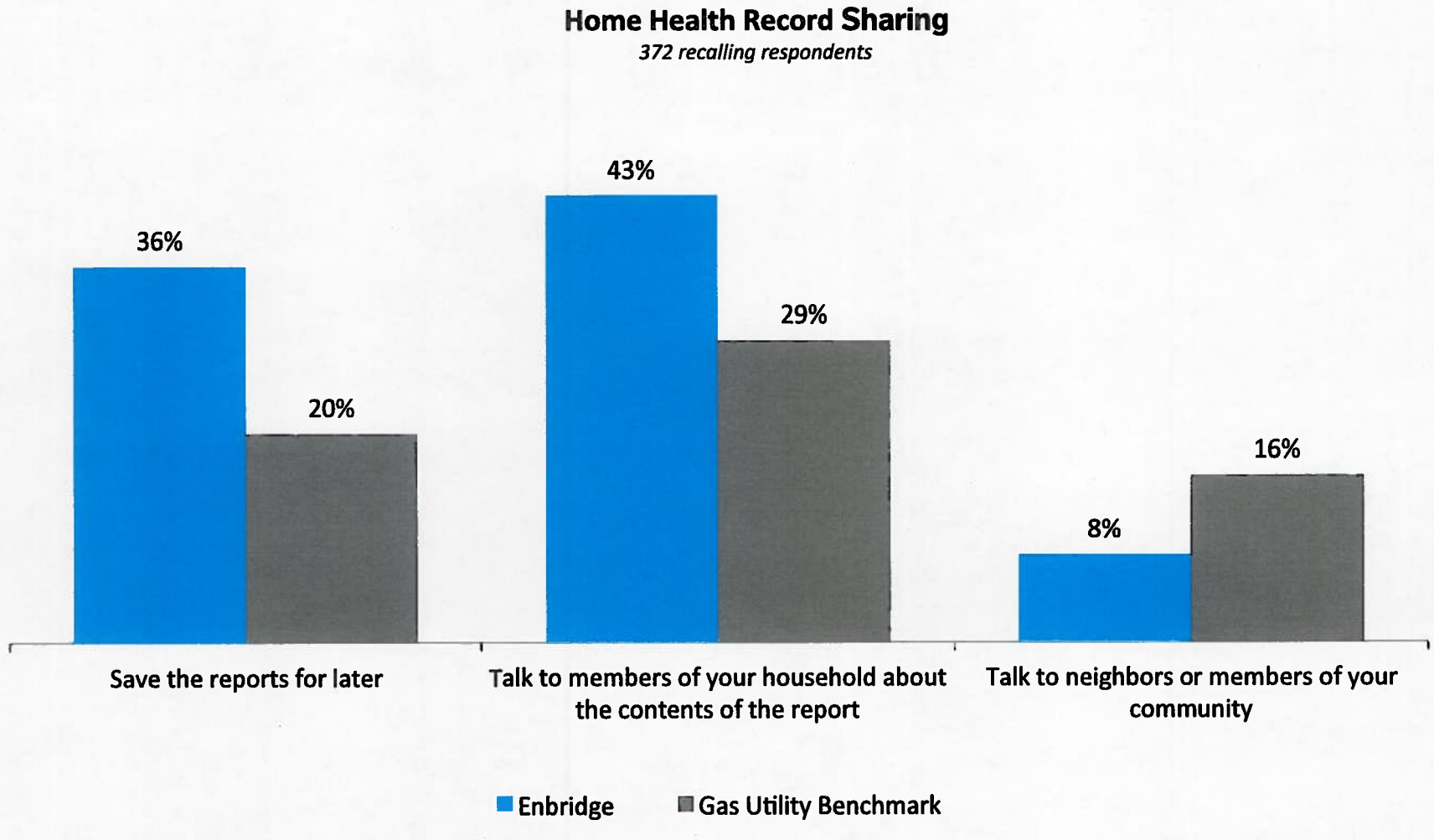


In the six months, do you remember receiving a My Home Health Record from Enbridge about your in-home energy use?

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 45 of 76

Reports are highly social

Many report recipients talk about the content with their family members or others. Enbridge customers are much more likely to talk to family members about the reports.



After reviewing your reports, did you...

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 46 of 76

Customer Engagement Tracker (CET)

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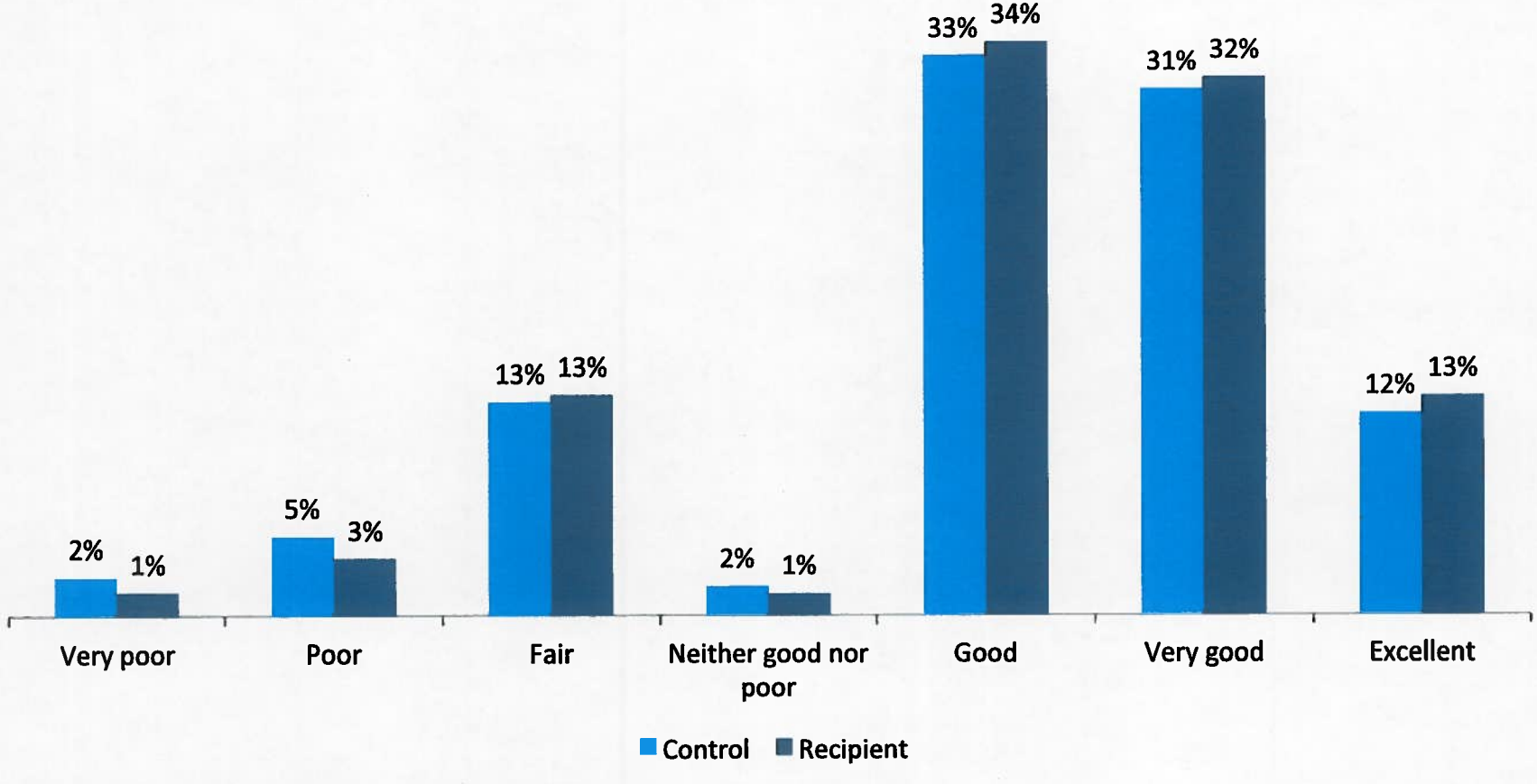
At first glance, no change in overall satisfaction...

There is no significant change on overall satisfaction with Enbridge's services. Movement on these measures is generally uncommon.

Satisfaction with Services

700 recipient and 300 control interviews



How would you rate the overall quality of Enbridge Gas Distribution and the services it provides? Are the services...

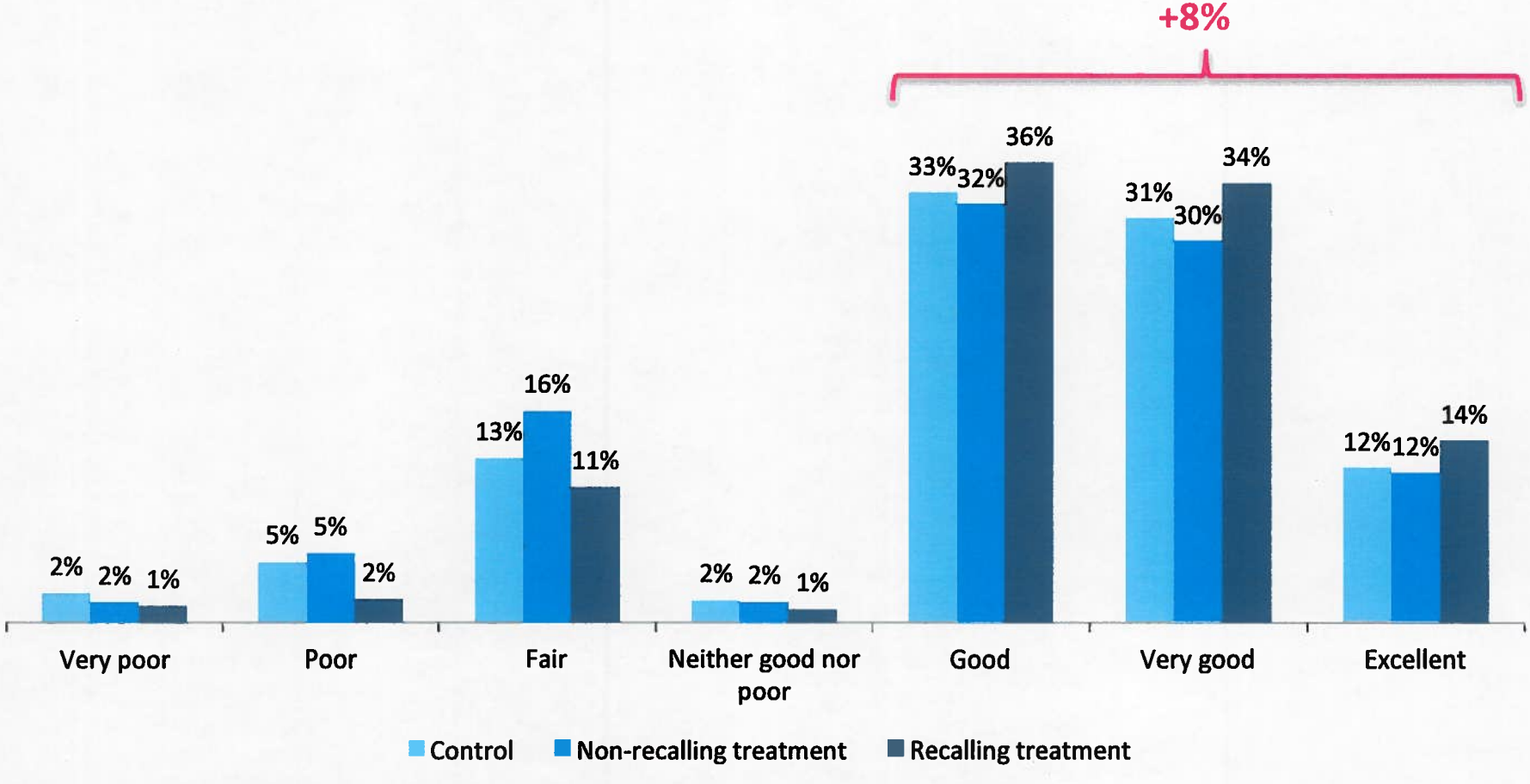
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 48 of 76

Customers who remember reports more satisfied

If we isolate out the portion of treatment customers who recall receiving the reports, satisfaction with services is 8% higher than control. However, they may just be more engaged to begin with.

Satisfaction with Services

382 recalling recipient, 318 non-recalling recipient, and 300 control interviews



How would you rate the overall quality of Enbridge Gas Distribution and the services it provides? Are the services...

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 49 of 76

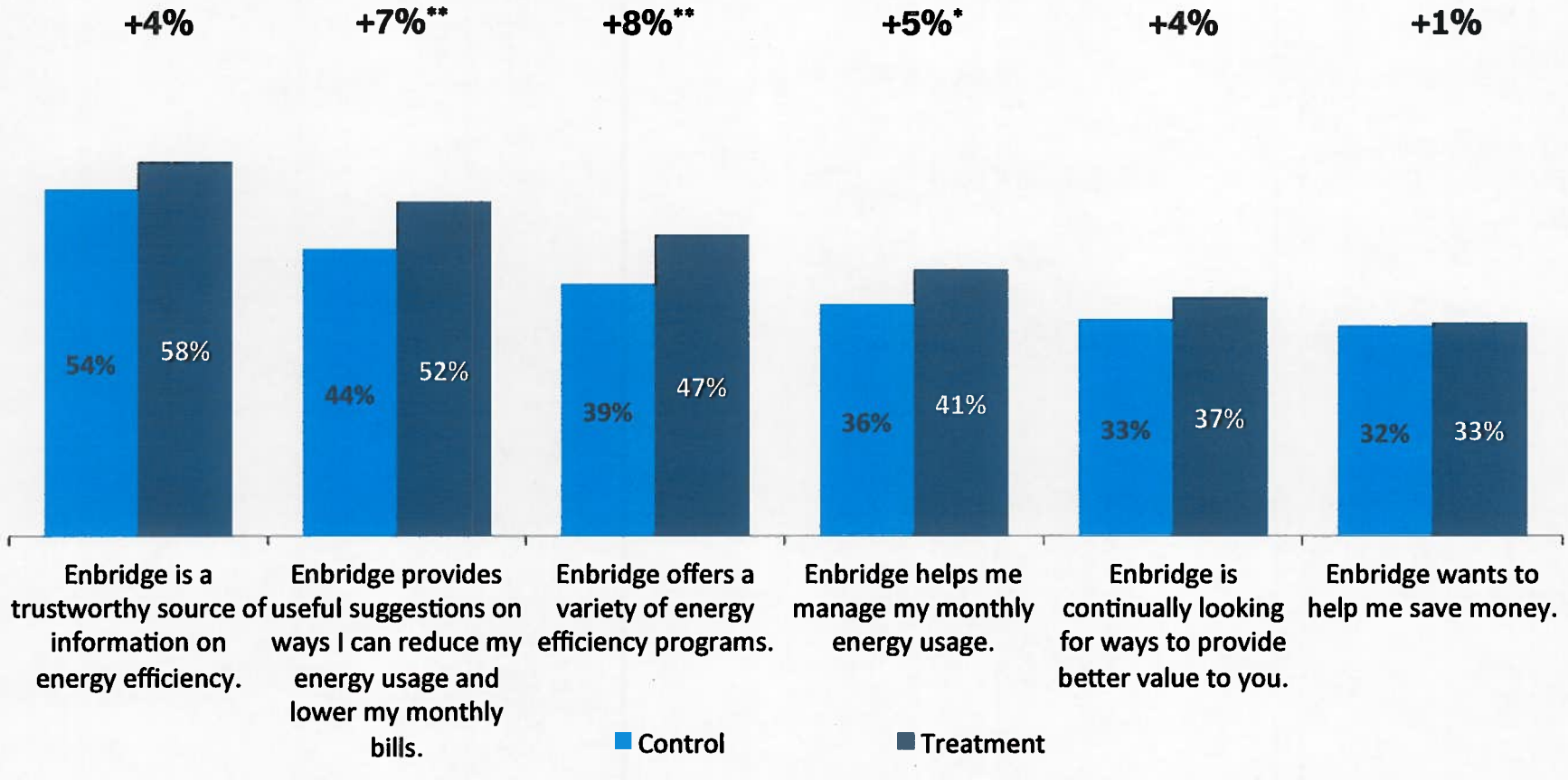
Significant positive impact on customer sentiment

Report recipients have generally higher sentiment towards Enbridge, particularly when it comes to having access to efficiency programs and receiving helpful advice.

Customer Relationship Metrics

672 recipient and 282 control interviews

Top 4 Box (10 point scale)



Rate Enbridge on a scale of one to ten for the following…

****95% significant difference**
*** 90% significant difference**

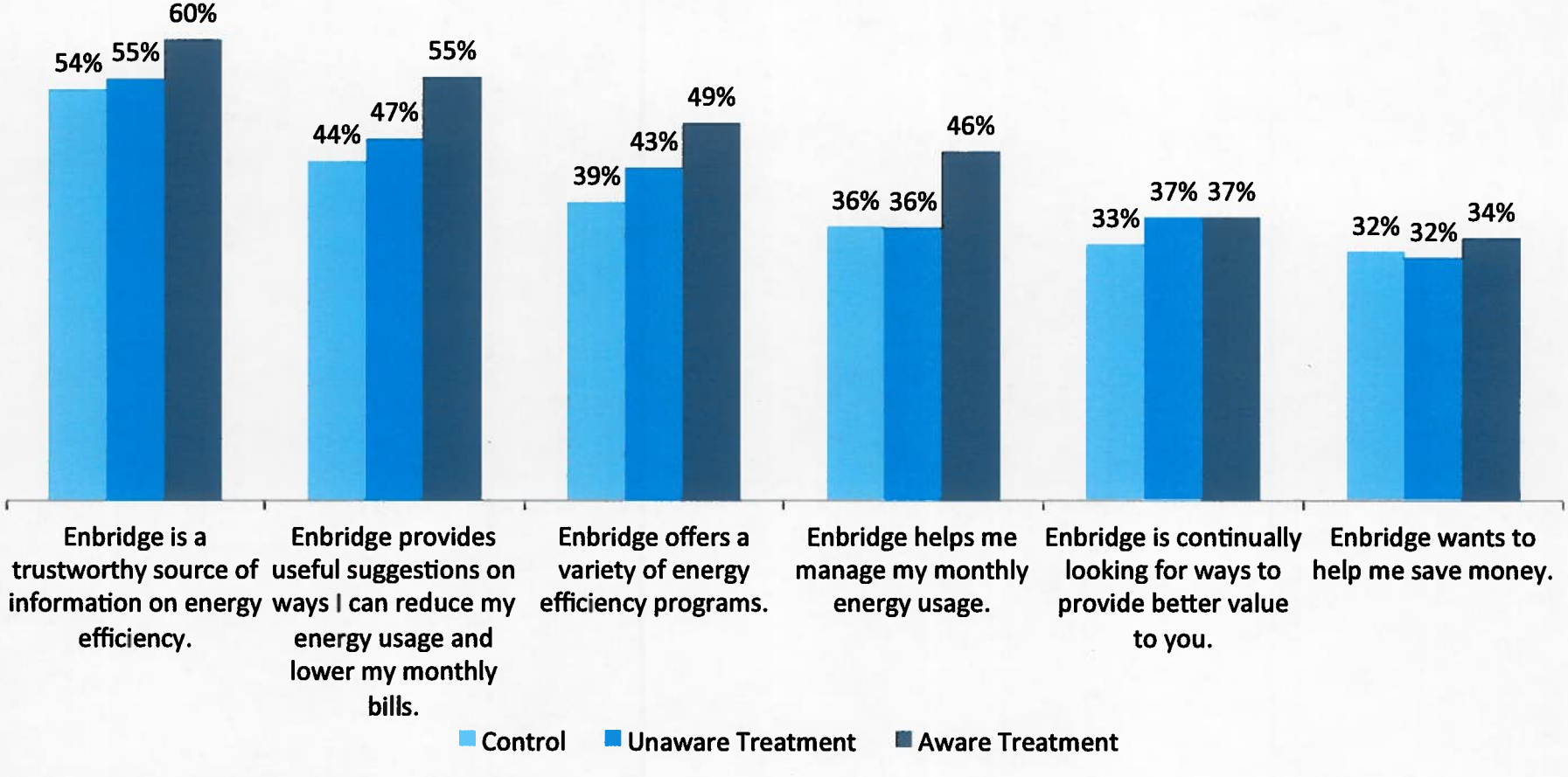
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 50 of 76

Significant positive impact on customer sentiment

Report recipients have generally higher sentiment towards Enbridge, particularly when it comes to having access to efficiency programs and receiving helpful advice.

Customer Relationship Metrics

372 recalling recipient, 298 non-recalling recipient, and 300 control interviews
Top 4 Box (10 point scale)



Rate Enbridge on a scale of one to ten for the following…

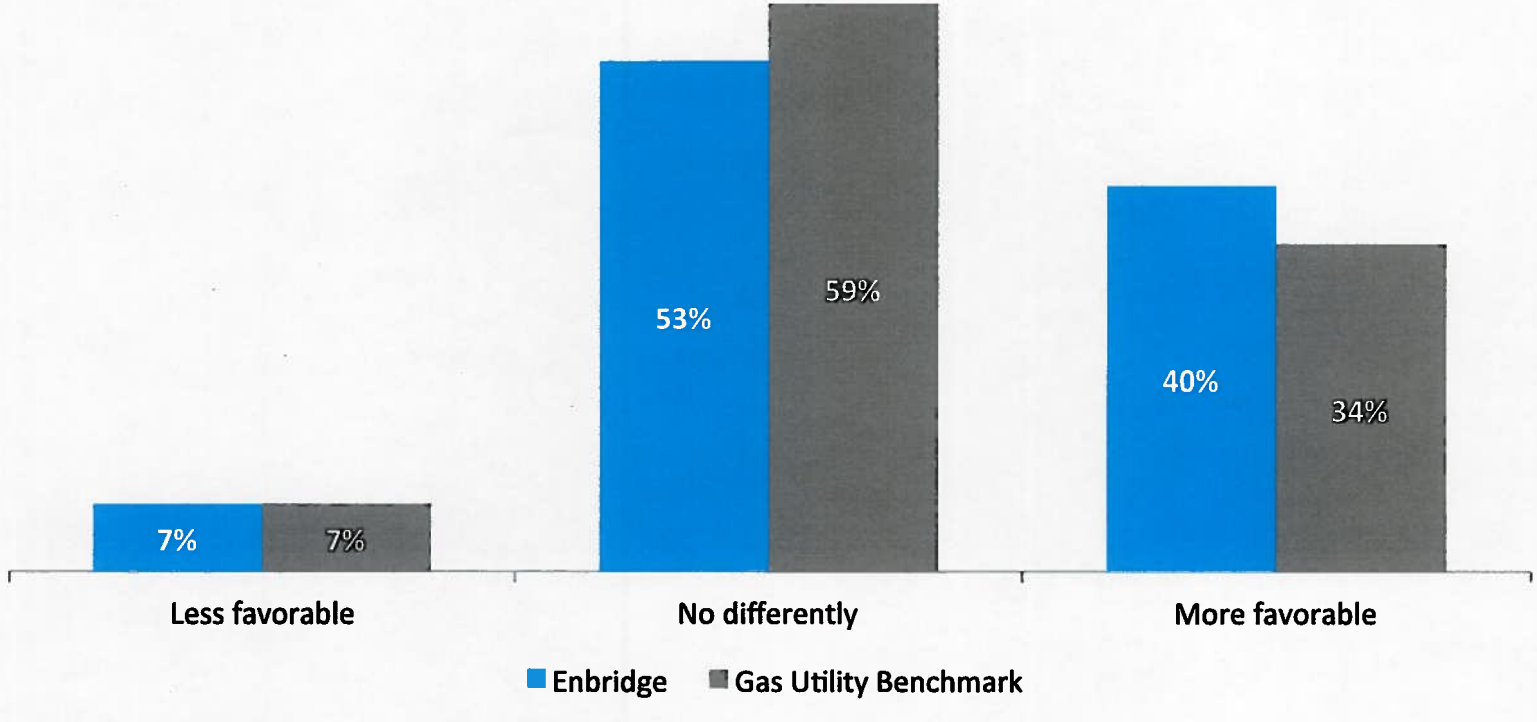
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 51 of 76

Reports make people feel more positive towards Enbridge

Among program participants, 93% have either improved their opinion of Enbridge or have not had it impacted.

Impact on Sentiment Towards Enbridge

368 recalling recipient interviews



Thinking about the My Home Health Record program, how does it make you feel about Enbridge? Would you say it make you feel?

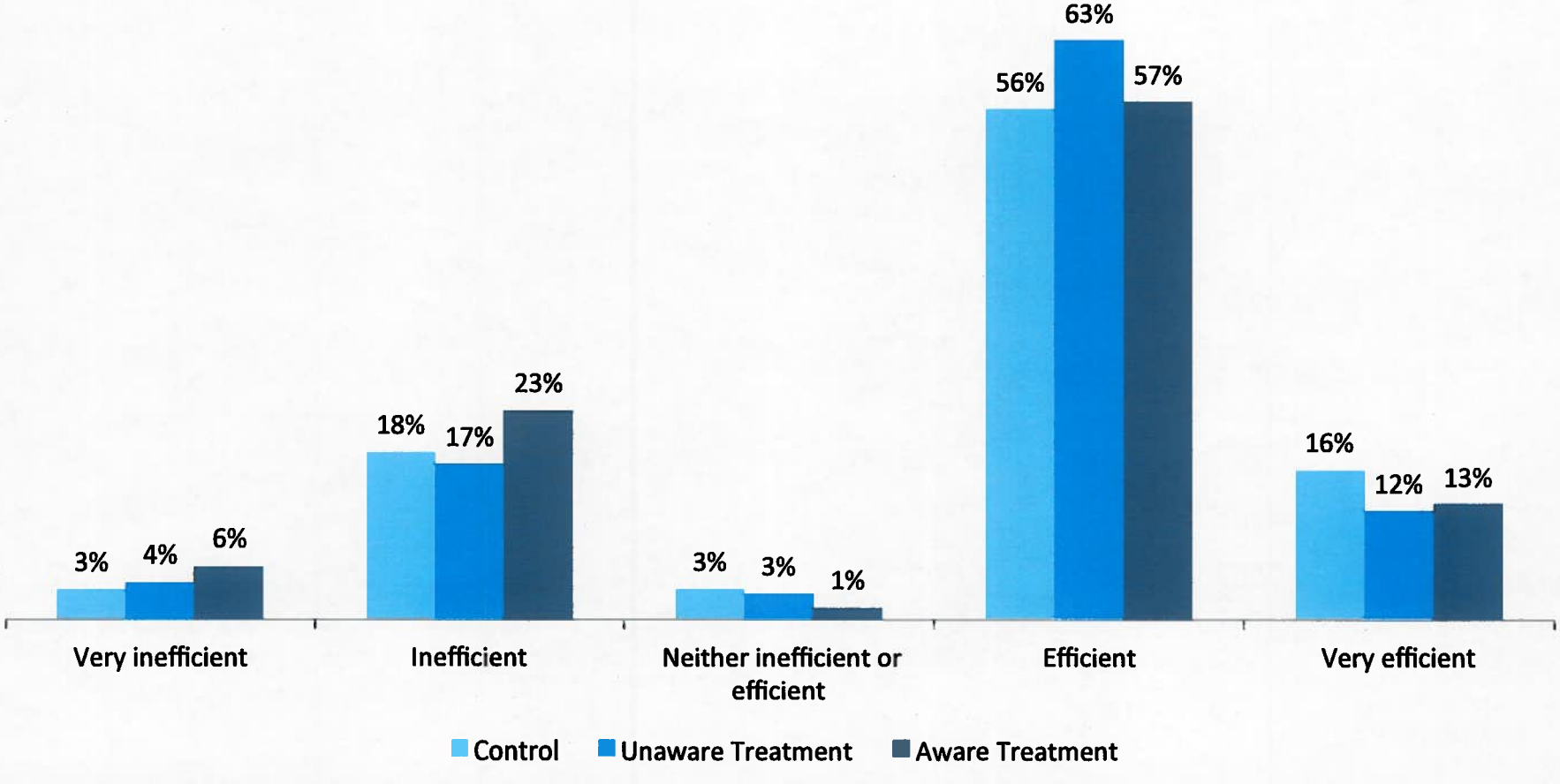
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 52 of 76

Report recipients slightly less likely to feel efficient

Control customers are more likely to think their homes are "very efficient" compared to report recipients – this makes sense given the content of the reports.

Efficiency Perception

382 recalling recipient, 318 non-recalling recipient, and 300 control interviews

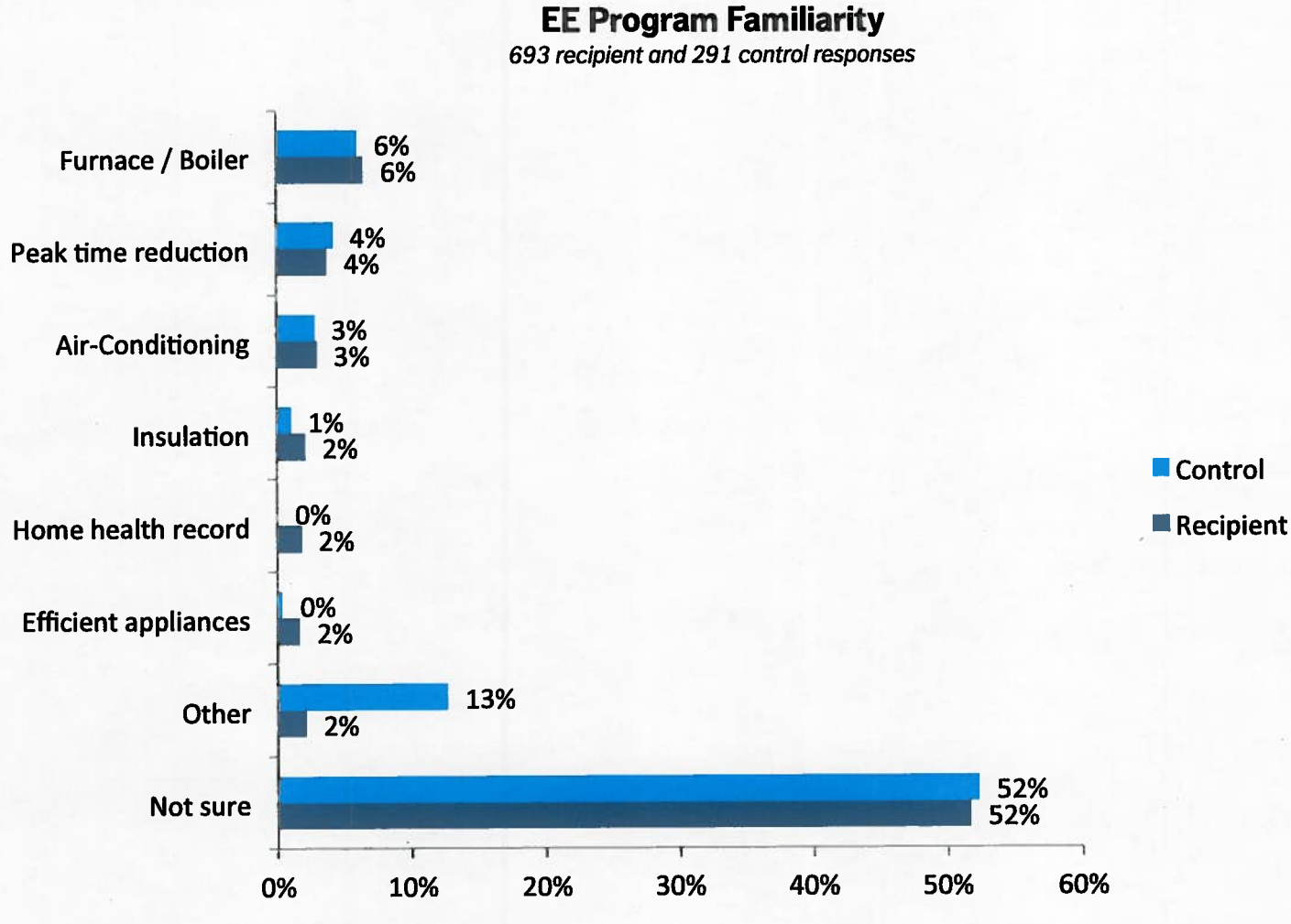


How energy efficient would you say your home currently is:?

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 53 of 76

No difference in specific program recall

Both control and treatment customers have similar familiarity with specific programs.

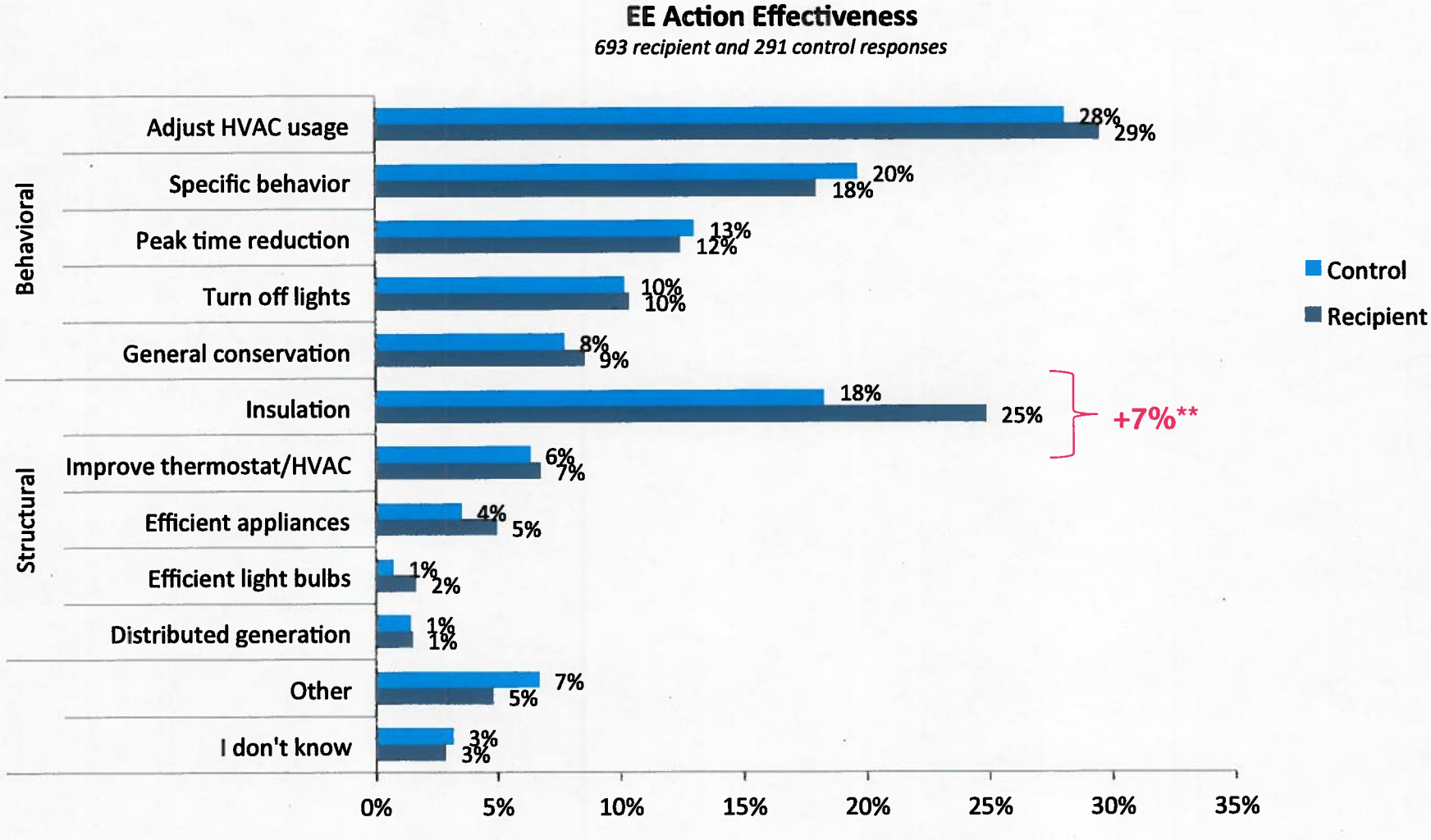


With which, if any, energy efficiency programs offered by Enbridge are you familiar?

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 54 of 76

Reports promote focus on insulation

Recipients are significantly more likely to identify improved insulation as the most effective action one can take to improve the home's efficiency.



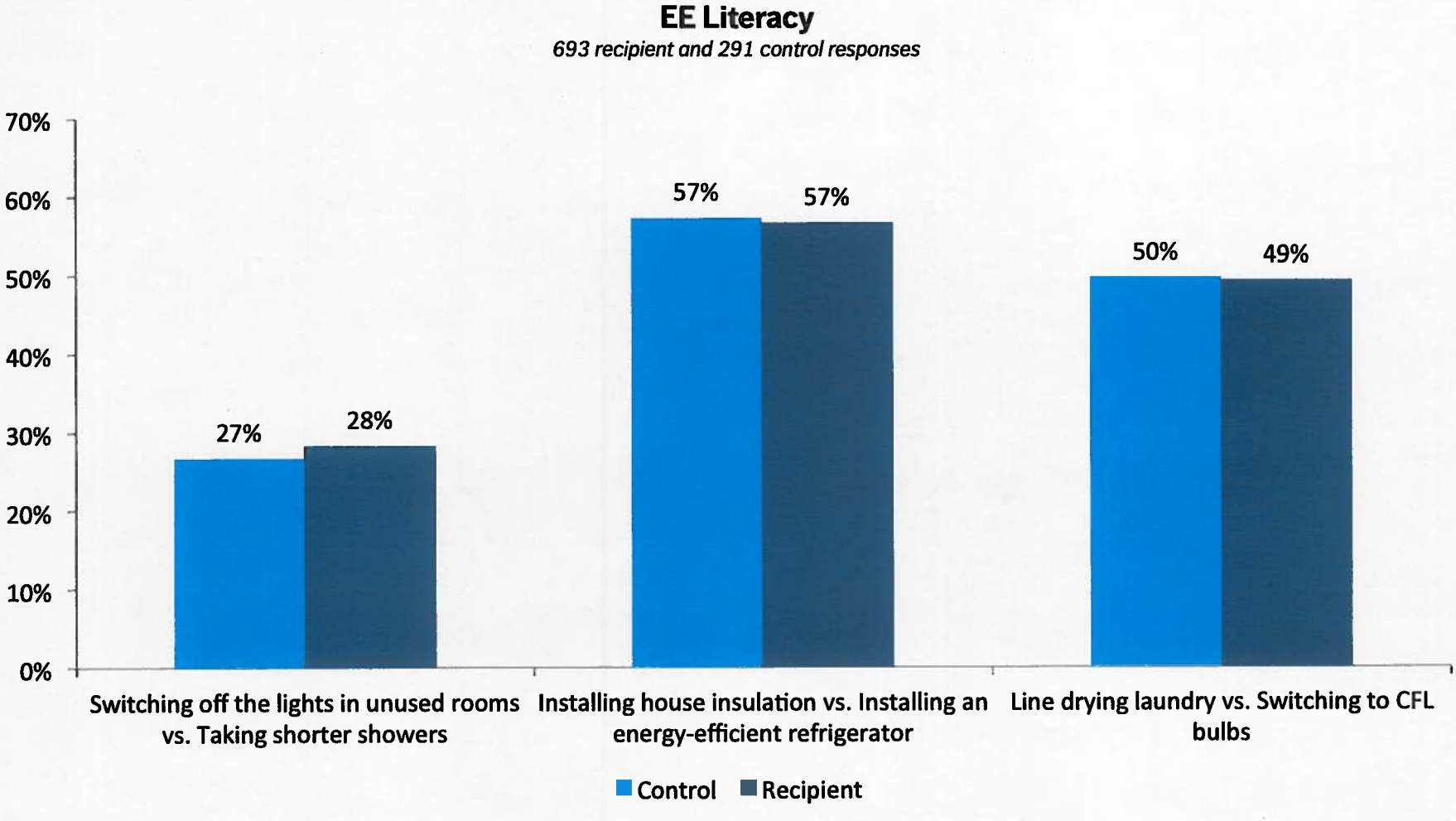
What is the single most effective thing the average person could do to reduce energy use in their home?

**95% significant difference
* 90% significant difference

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 55 of 76

Recipients and controls similarly informed on EE

When asked to select from between two efficiency actions (in terms of which one is likely to yield more savings), recipients and controls perform at about the same level.



Between these two options - please select that action that you would take in order to save the most energy.

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 56 of 76

Customer Engagement Tracker (CET)

1. Research Overview

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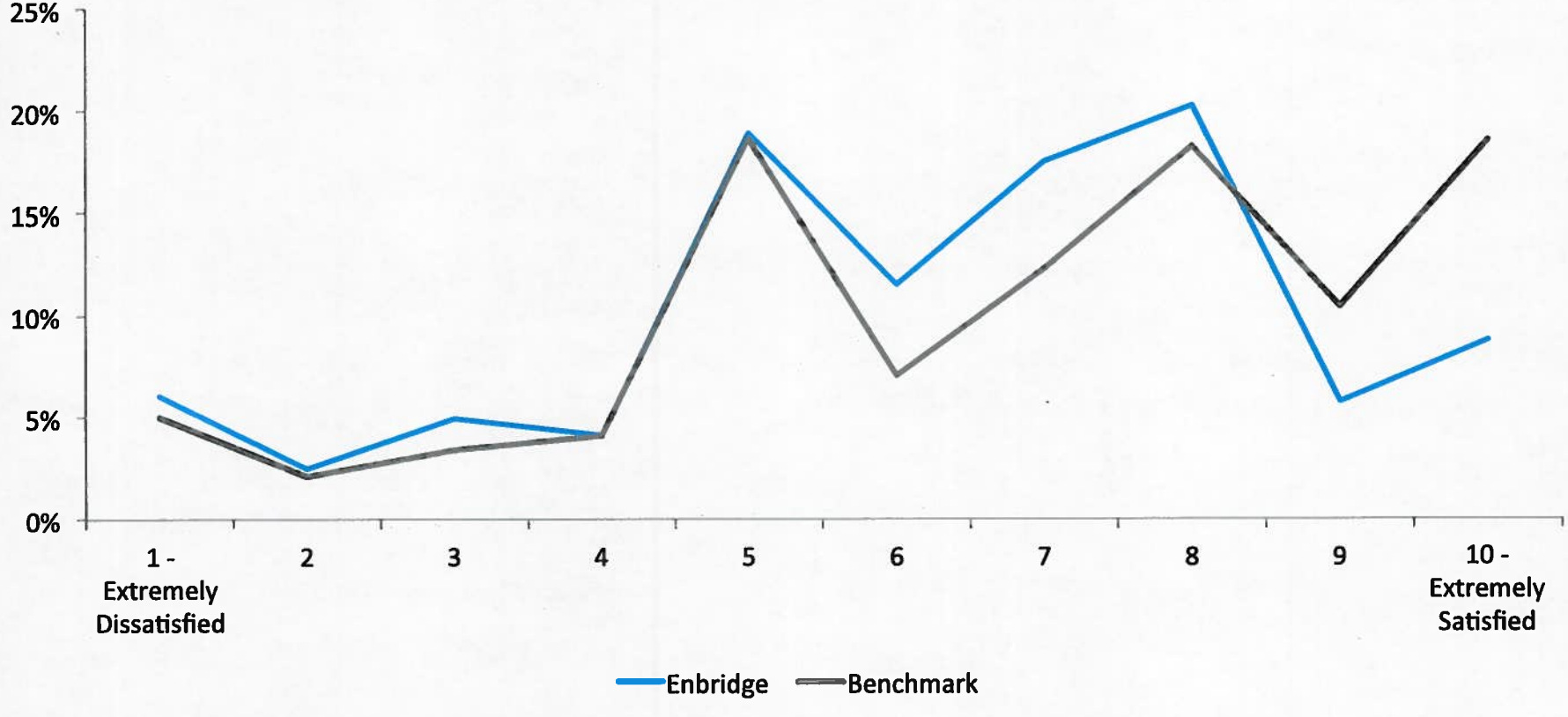
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 57 of 76

Majority of customers positive towards report

Most customers rate the program between 6 and 8. Relatively few customers are unsatisfied, but we would like to see more customers that are 'extremely' satisfied.

Overall Satisfaction with Report

372 recalling Enbridge recipients; 3.5k recalling recipients from other utilities

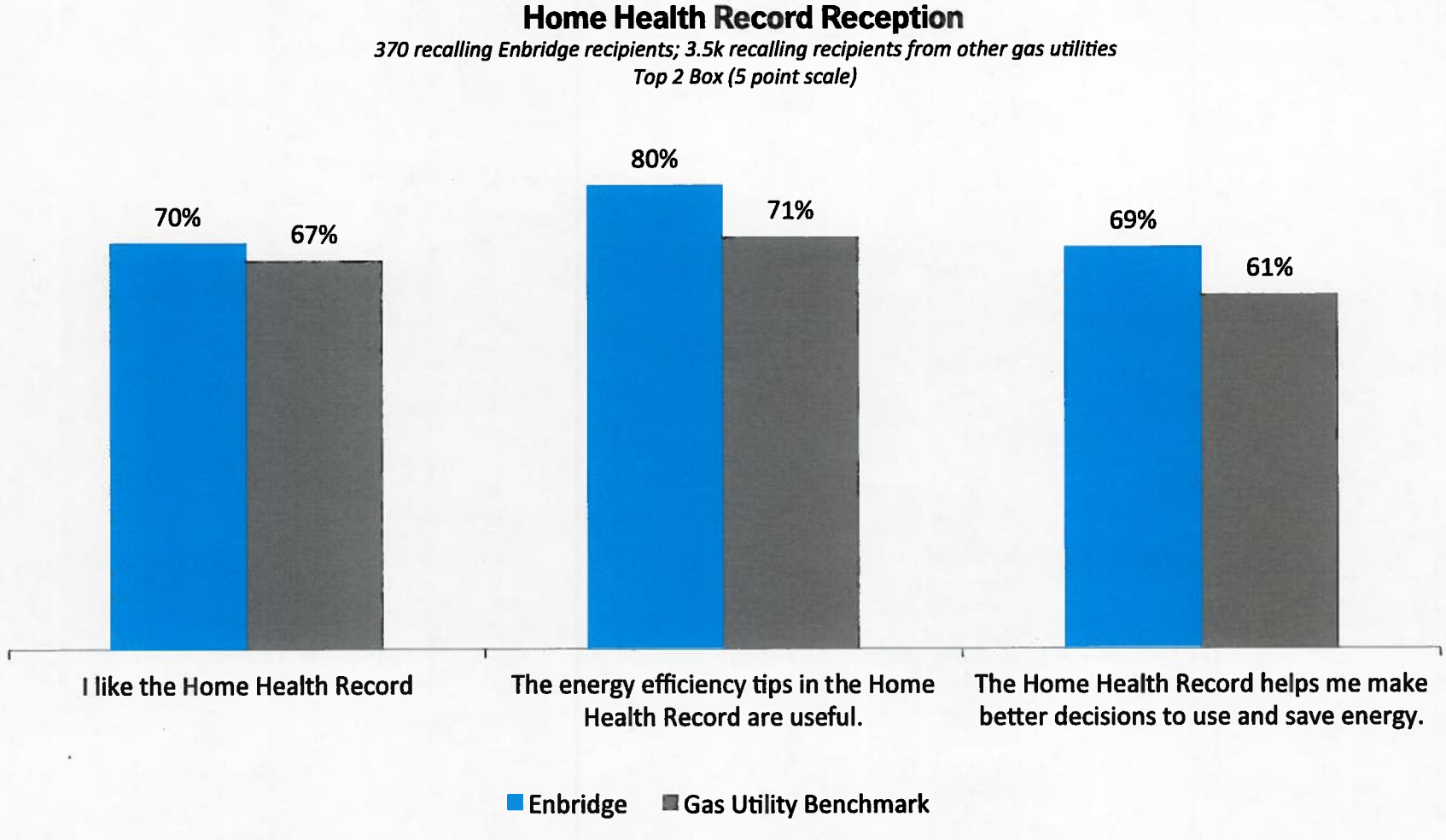


Overall, how satisfied are you with the My Home Health Record program?

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 58 of 76

Most customers like the reports and find tips useful

A majority of customers consider the efficiency tips to be useful and feel like they are able to make better decisions about their energy use as a result of the reports.

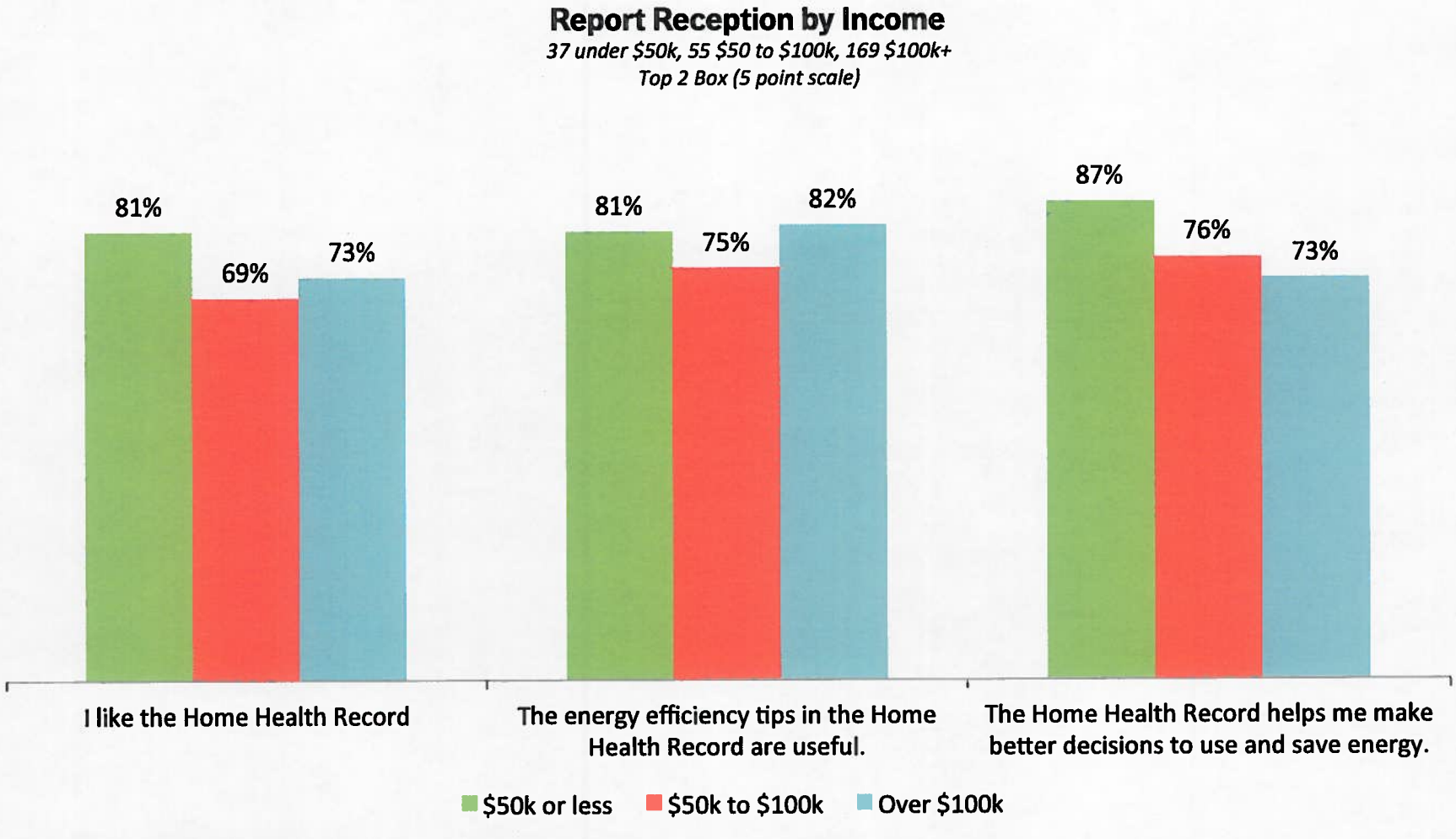


Using a scale of 1 to 5, where 1 is "Strongly Disagree" and 5 is "Strongly Agree", how much do you agree with the following statements?

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 59 of 76

Most customers like the reports and find tips useful

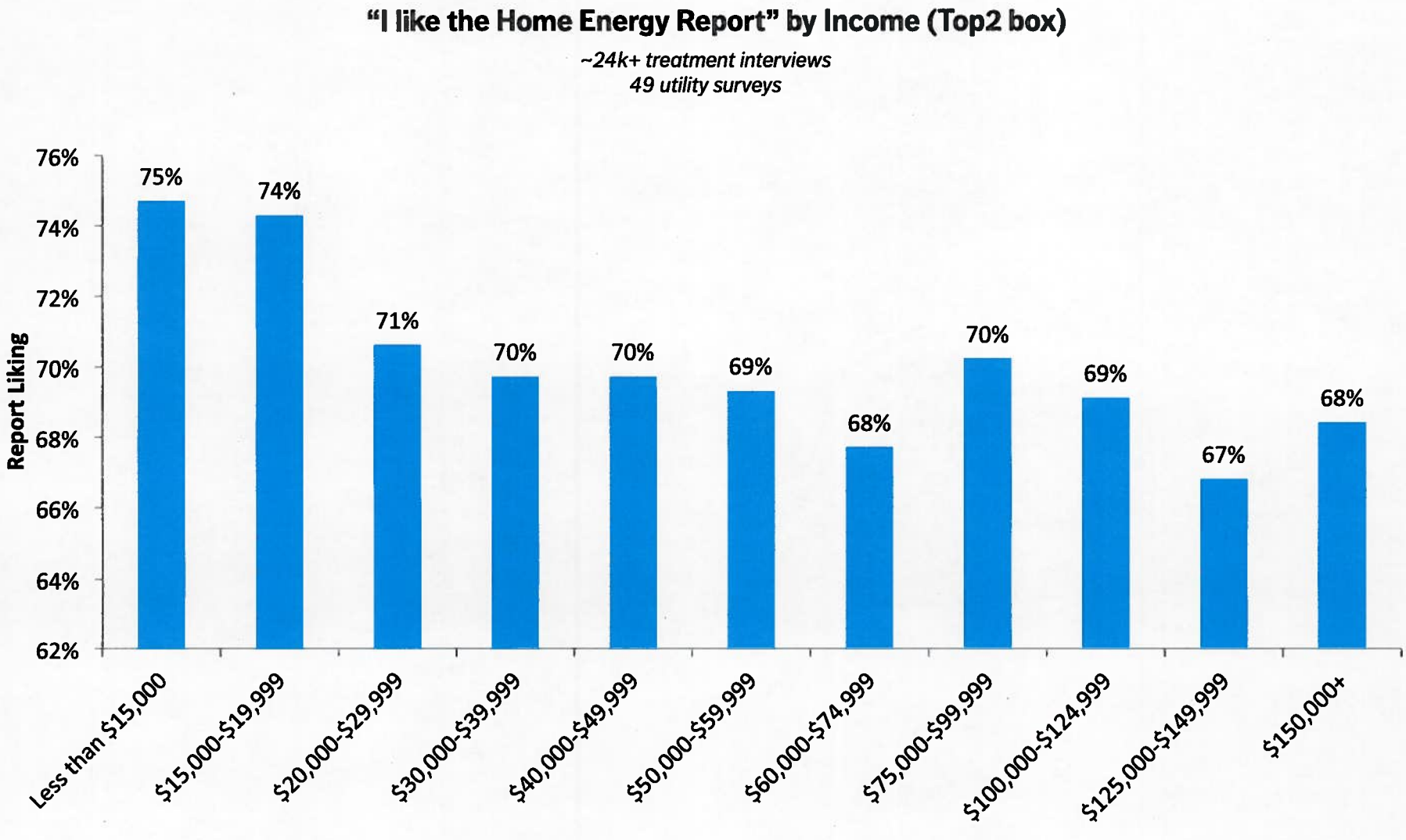
A majority of customers consider the efficiency tips to be useful and feel like they are able to make better decisions about their energy use as a result of the reports.



Using a scale of 1 to 5, where 1 is "Strongly Disagree" and 5 is "Strongly Agree", how much do you agree with the following statements?

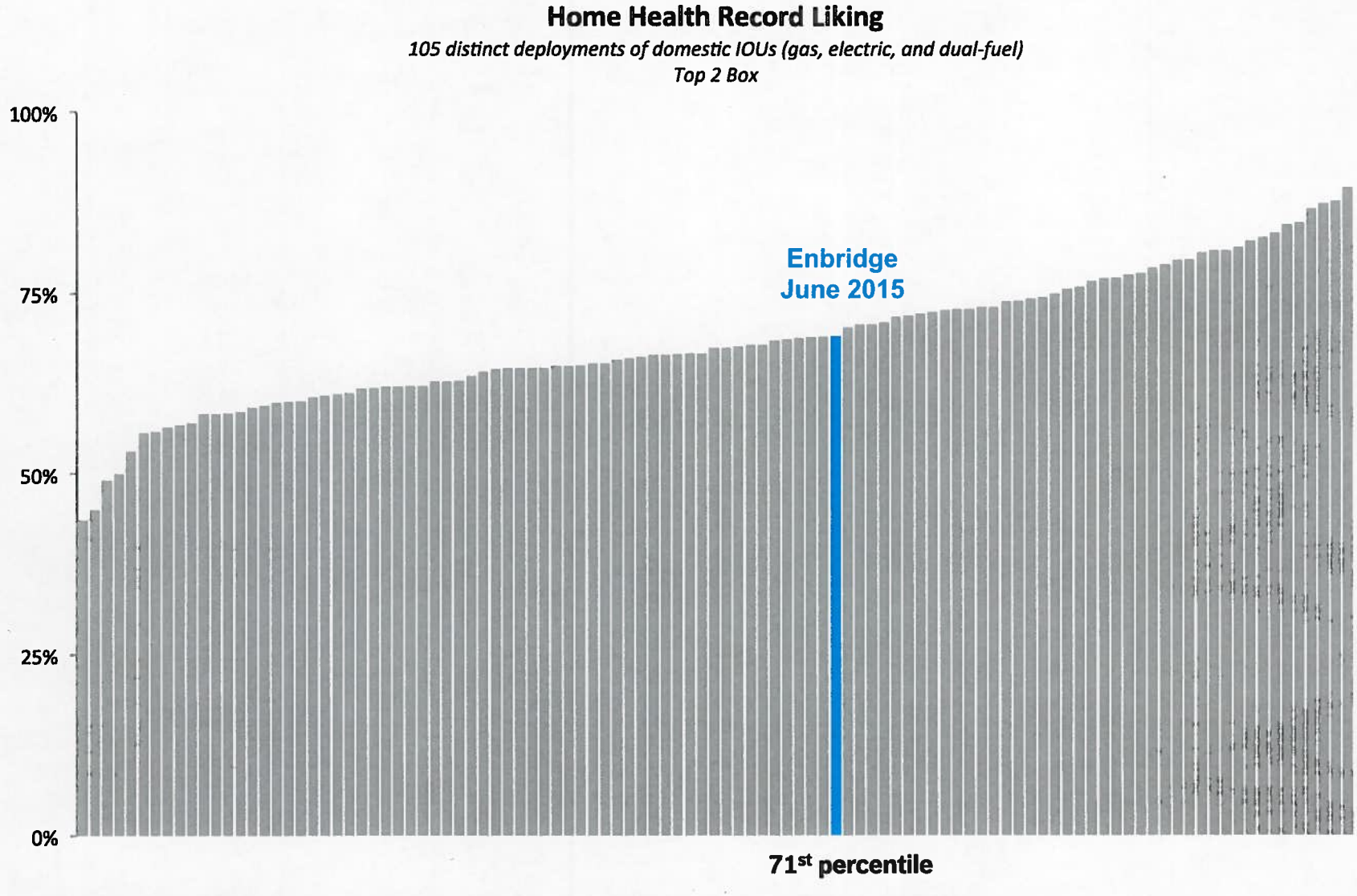
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 60 of 76

Lower income customers tend to like reports more



Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 61 of 76

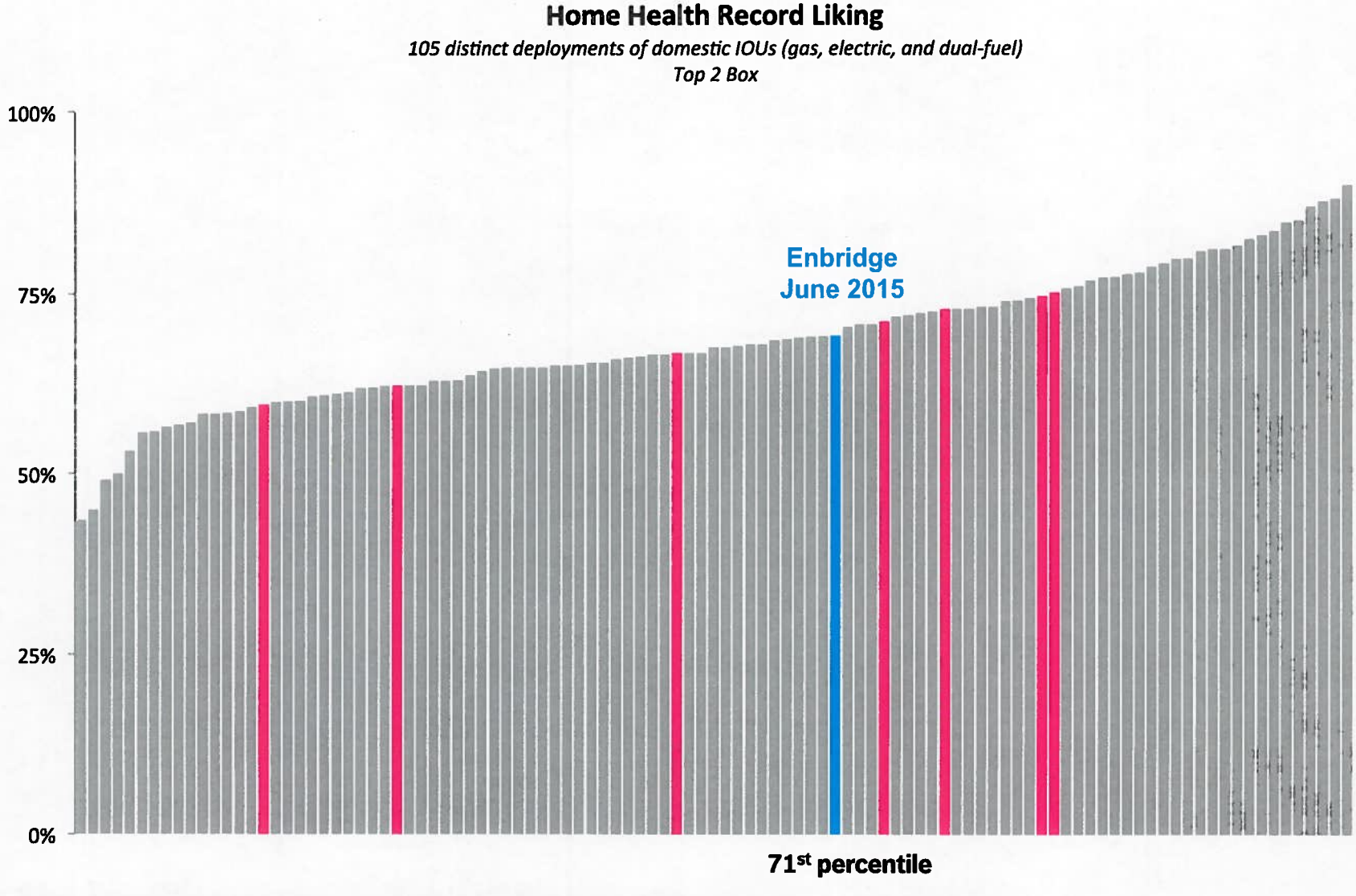
Report reception compares well to other programs



Tell me whether you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree with each of the following statements

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 62 of 76

Report reception compares well to other programs



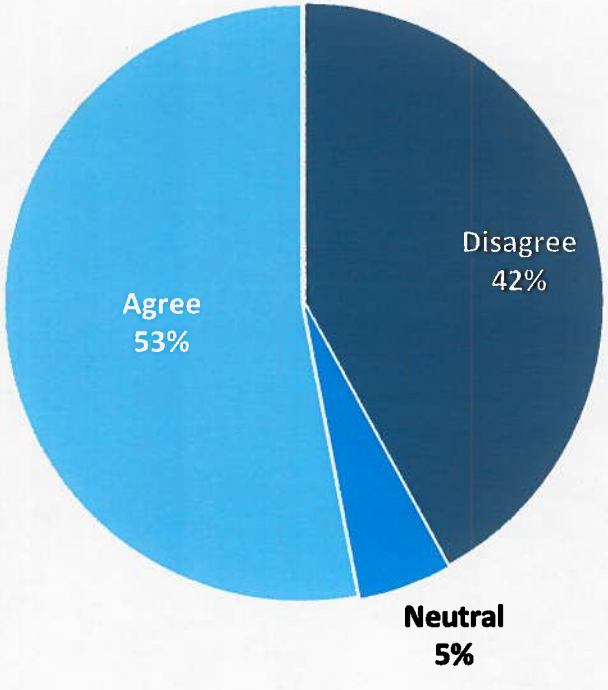
Tell me whether you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree with each of the following statements

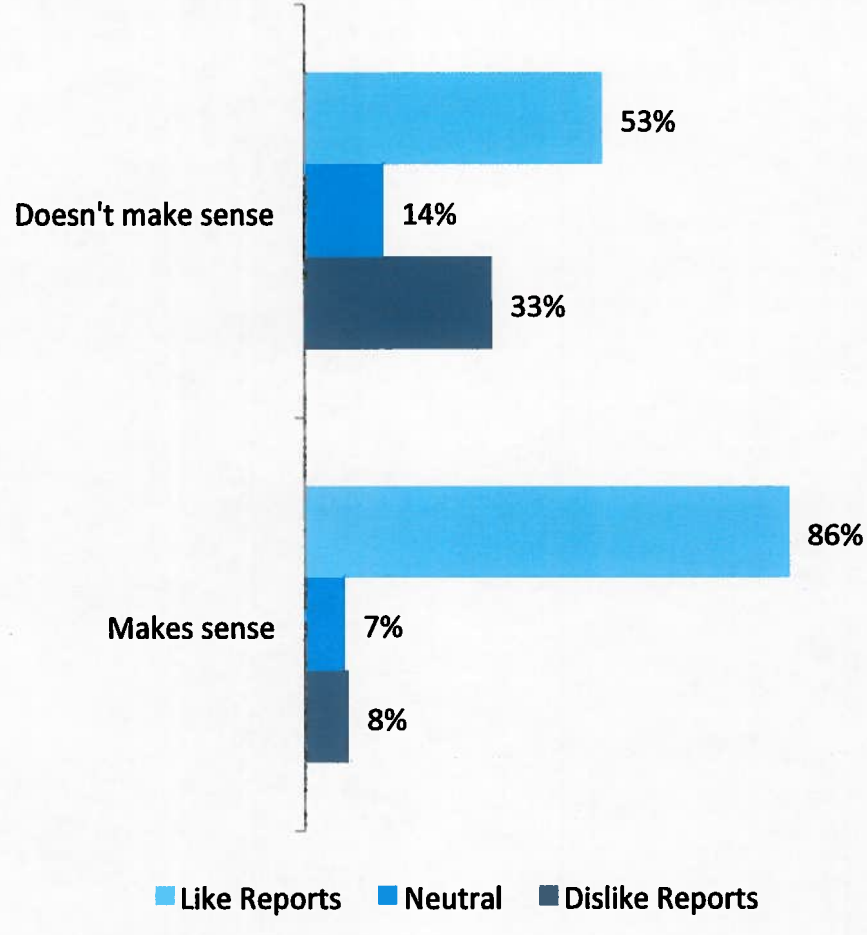
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 63 of 76

Some customers have doubts about comparison

Many recipients question the applicability of the neighbor comparison – however, even among those with doubts, over half still are happy with the report experience.

It makes sense to compare people's energy use to that of their neighbors





Using a scale of 1 to 5, where 1 is "Strongly Disagree" and 5 is "Strongly Agree", how much do you agree with the following statements?

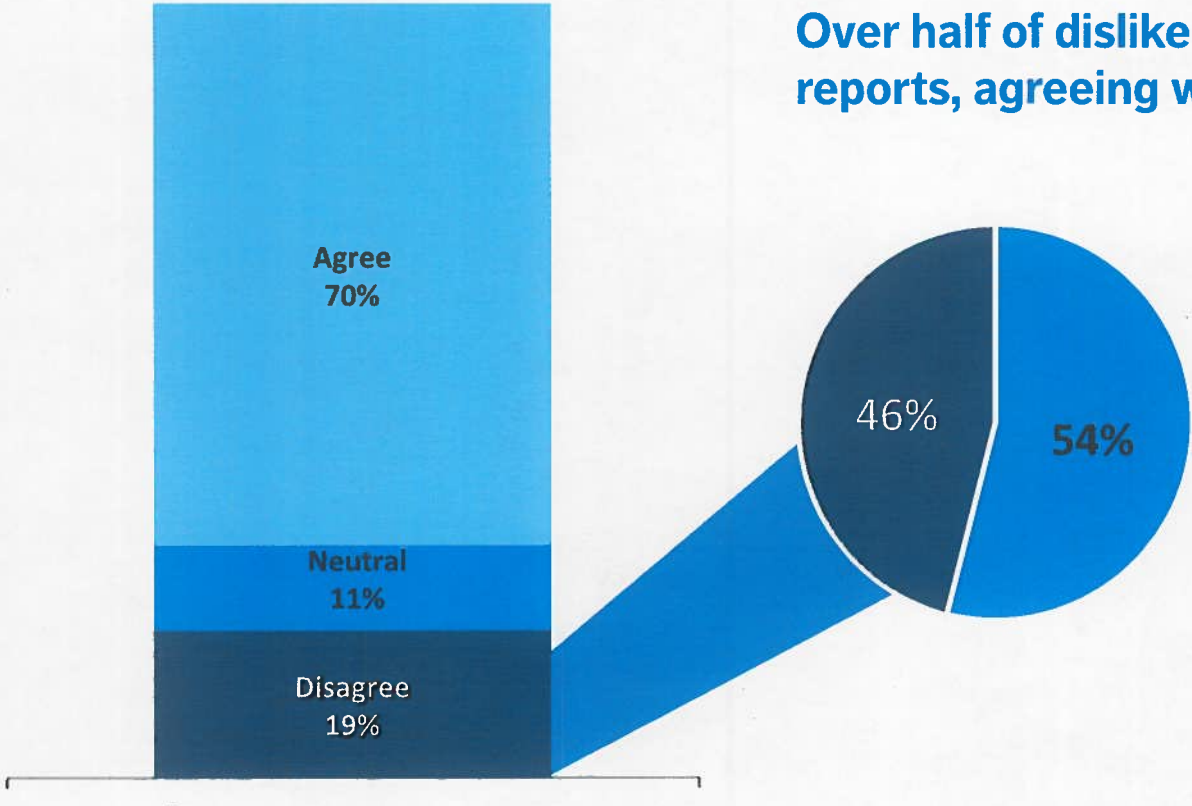
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 64 of 76

Many "dislikers" see value in reports

Over half of the customers at Enbridge who claim not to like the Home Health Record still see some value in receiving it.

Home Energy Report Liking

370 recalling recipient interviews



Over half of dislikers (54%) still see value in reports, agreeing with at least one statement:

- The energy efficiency tips in the Home Health Record are useful.
- The Home Health Record helps me make better decisions to use and save energy.
- It makes sense to compare people's energy use to that of their neighbors

Using a scale of 1 to 5, where 5 is "Strongly agree" and 1 is "Strongly disagree", how much do you agree with the following statements?

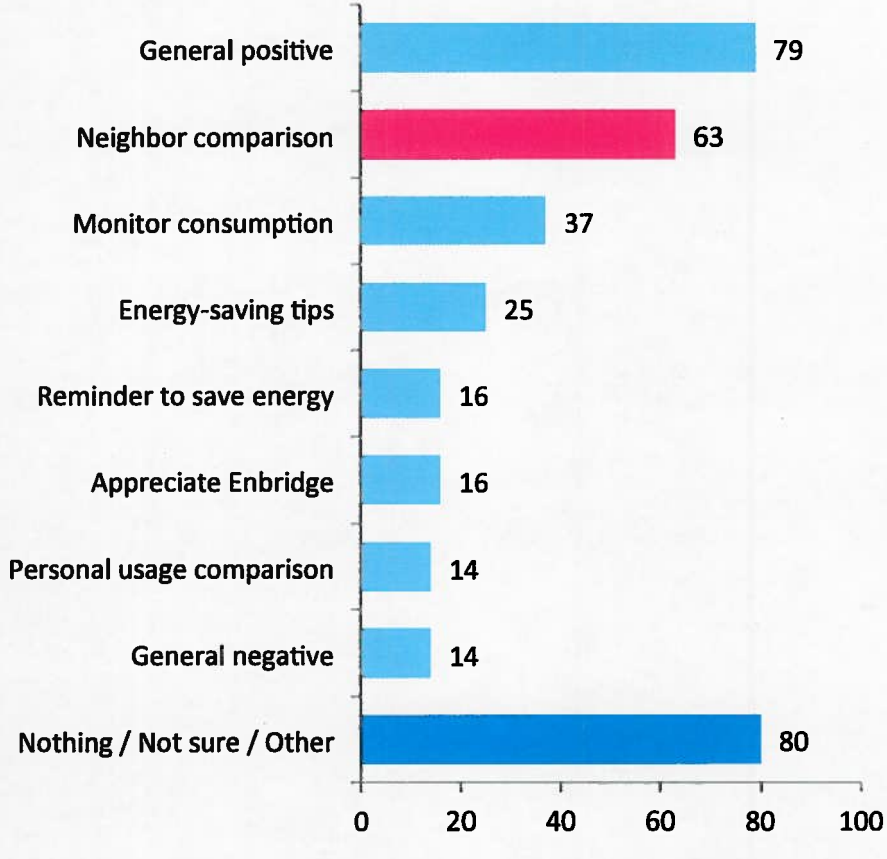
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 65 of 76

Comparison is most compelling feature

The neighbor comparison is most frequently cited as the favorite aspect of the Home Energy Reports, but many people are just generally positive about receiving this type of information.

What aspect of the report do you like the most?

338 recalling recipient interviews



What, if anything do you like the most about the My Home Health Record?
What, if anything, would you do to improve the My Home Health Record?

What aspect of the report should we improve?

304 recalling recipient interviews

"Get a lot more data on occupancy and equipment, and age of homes, demographics, and then work up a proper statistical analysis and work on that."

"It is a mixed neighbourhood where a lot of homes are new, old, single homes or not. I find it is kind of hard to compare my home with other homes..."

"Needs to be more accurate per house. The report did not take into consideration the amount of people in the house."

"To know the impact of various actions that a homeowner could take, the specific impacts of various actions."

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 66 of 76

Customers appreciate the reports

Recipients like getting information about their usage and how to reduce it. Many of the recipients are willing to provide a testimonial about the reports.

What aspect of the report do you like the most?

"In our case we're very efficient, so it makes you feel like you do a good job in your own home. It makes me feel like we should continue doing what we do and even look at other options."

"I like that you get hard copy information and that it's easy to understand, and that it's tailored specifically to my house as opposed to something general."

"It shows a level of care from Enbridge to inform consumers about the importance of energy saving and showing me that I am a proud Enbridge customer."

"It was helpful to see how we could improve and the comparison of our house with the other houses in the neighborhood."

46 Recipients willing to provide a testimonial about their experience with the program

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 67 of 76

Opportunities

Accuracy → Parcel

With parcel coverage, we have the opportunity to directly address customer concerns about accuracy, and improve the quality of their print and web experience.

Recall → Program design

With an expanded Home Health Report program, using 4 reports a year, program recall will increase year over year. HER 2.0 brings additional flexibility to program design.

Program participation → Focus messaging

By focusing our messaging on specific outcomes, we can drive program participation and concentrate marketing value.

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 68 of 76

Pilot Program Review - Agenda

1.	Pilot Results and Program Review	1:00 – 2:45
	Break	2:45 – 3:00
2.	Program Expansion and Project Planning	3:00 – 3:45

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 69 of 76

Gas Program Design

Enbridge Gas

OPOWER

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 70 of 76

2015-16 Heating Season Plan

450,000

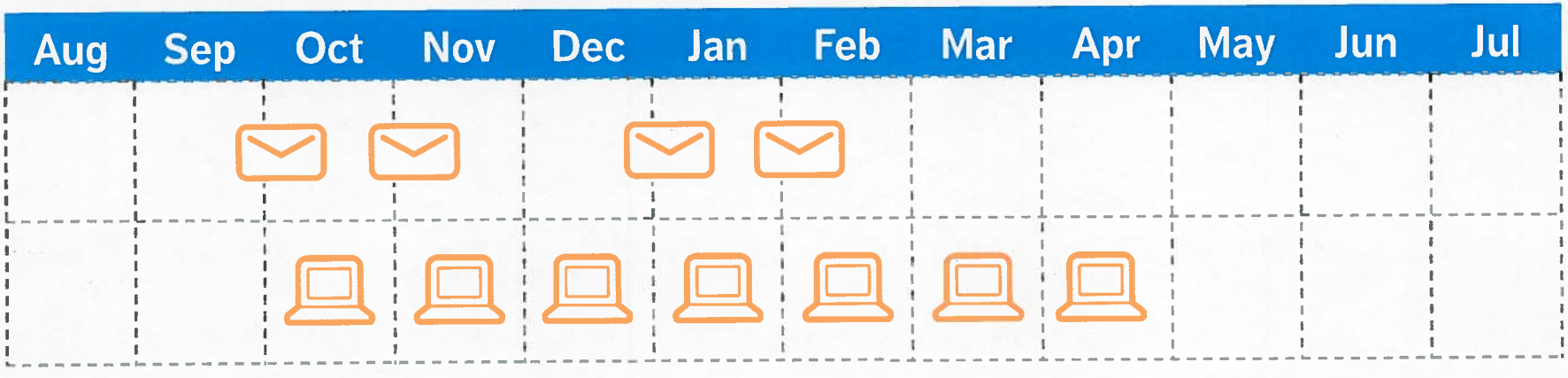
- Paper + Layered email
- Includes pilot customers
- Web access for all
- Monthly marketing modules in HER and eHER
- 50K email only (selected from customers with e-bill)
- Web for all report recipients
- Monthly marketing modules in paper and eHER

50,000

- Email only
- Selected from customers who have opted for ebilling
- Web for all report recipients
- Monthly marketing modules in eHER

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 71 of 76

Gas Season Program Design



Paper HERs	1st Report	2nd Report	3rd Report	4th Report
Front Middle	Seasonal comparison last winter	Neighbor comparison	Neighbor comparison	Neighbor comparison
Front Bottom	Prep for winter marking module	Marketing module TBD	12 month graph	Marketing module TBD
Back Top	Line graph last winter	Personal comparison	Marketing module TBD	12 month graph
Back Bottom	Tips	Tips	Tips	Tips

eHER marketing modules TBD

OPOWER CONFIDENTIAL: DO NOT DISTRIBUTE

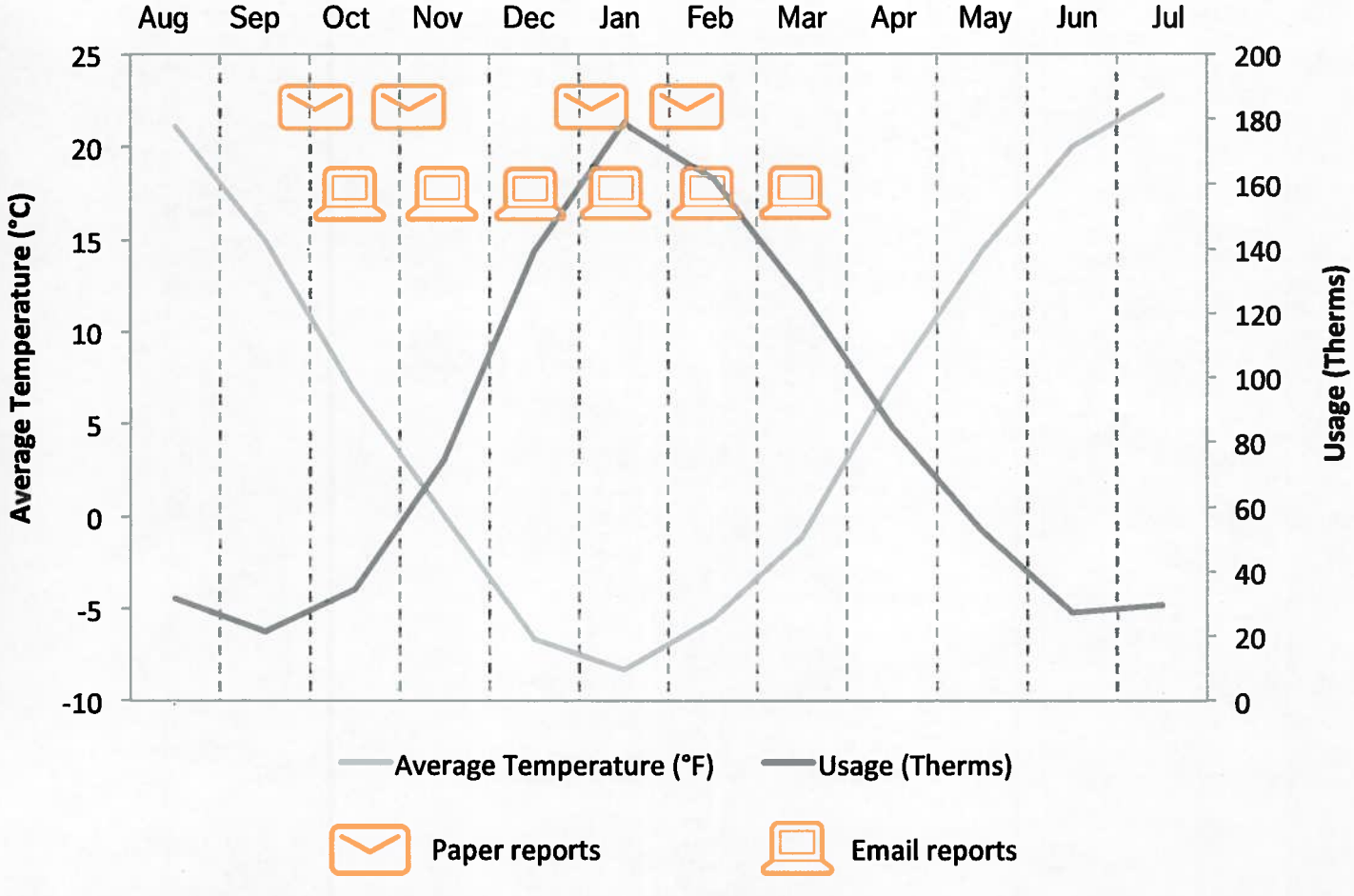
Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 72 of 76

Report timing coincides with cold weather & high usage months

1) We see savings 6 to 8 weeks after RIH

2) To ramp up, we front load

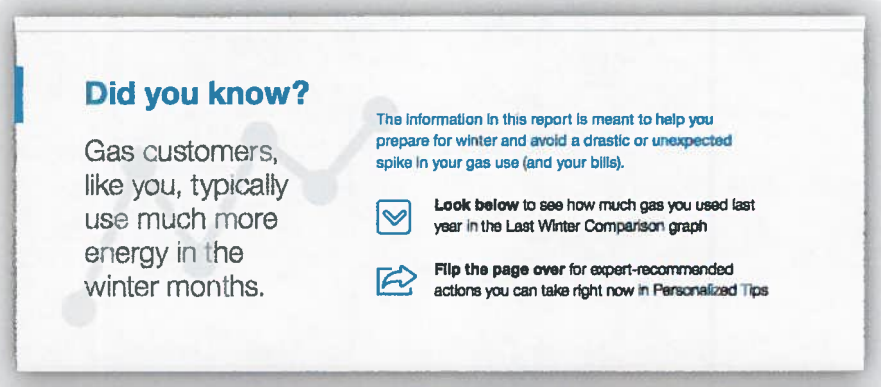
3) Most potential savings in winter shoulder months

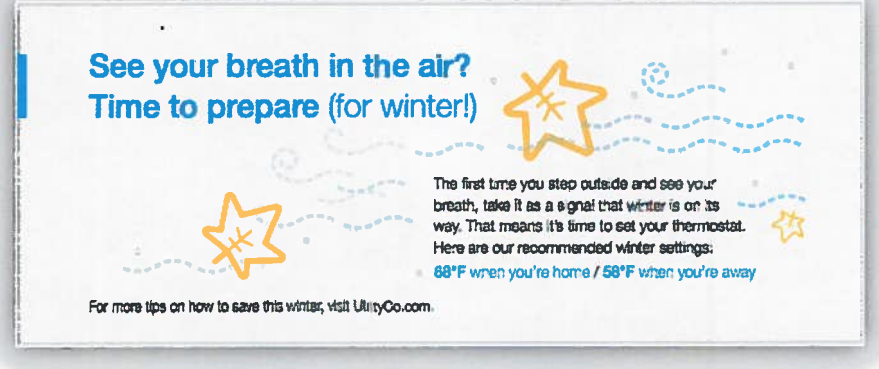


OPOWER CONFIDENTIAL: DO NOT DISTRIBUTE

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 73 of 76

Introductory modules prepare customers for winter





Prep for Winter module A

Prep for Winter module B

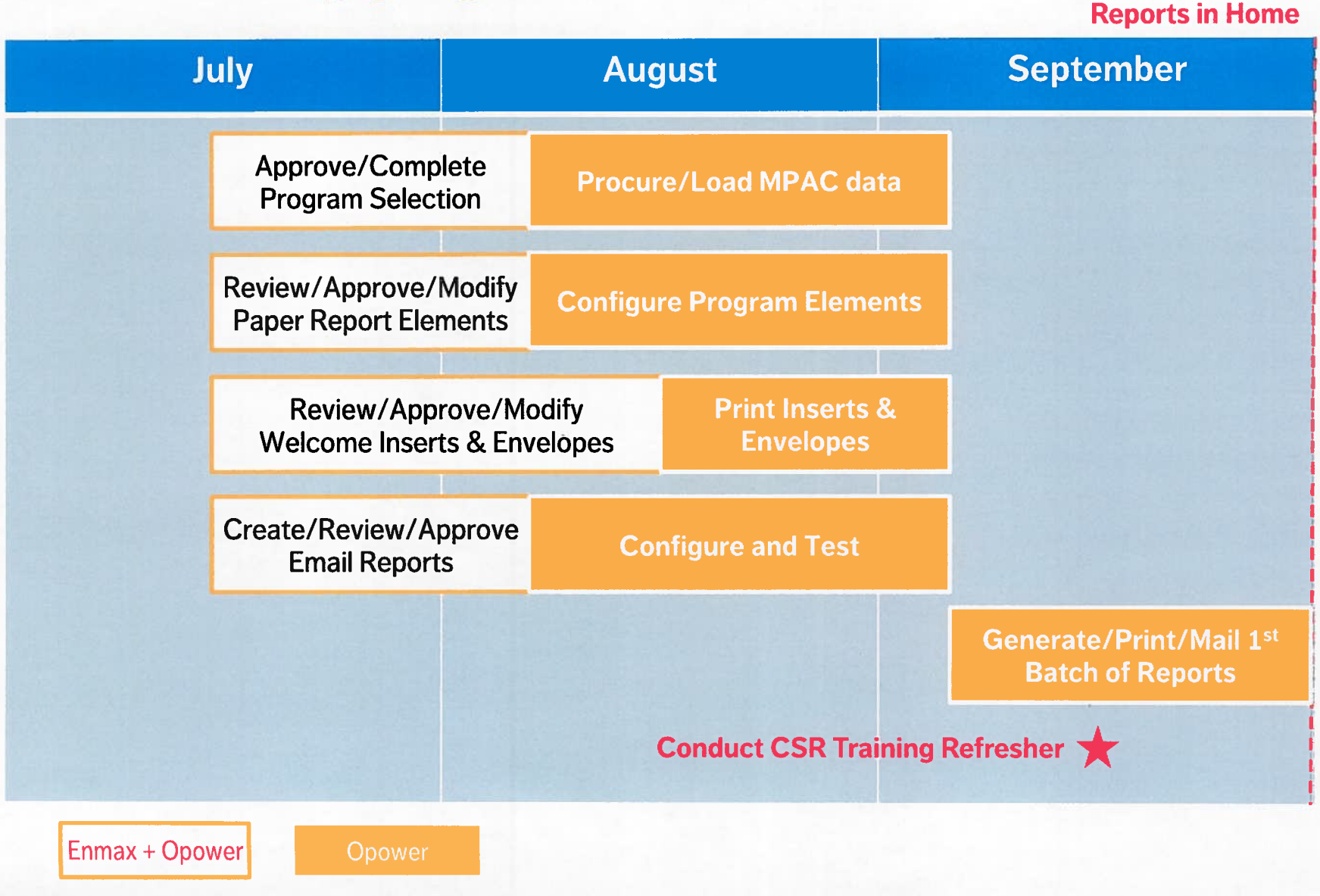
Prep for Winter module C

Choose one

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 74 of 76

OPOWER CONFIDENTIAL: DO NOT DISTRIBUTE

We will be working throughout the summer to ensure a timely program launch



Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 75 of 76

This season's program will be leveraging old and new components

» **Old components:**

- Paper report template
- Welcome Insert
- Branded envelope design
- Dynamic data modules

» **New components:**

- Prepare for winter module for first paper report
- Email report template
- Promotional modules for reports 2-4

Filed: 2015-09-03, EB-2015-0049, Exhibit J8.4, Attachment, Page 76 of 76

UNDERTAKING J8.11

UNDERTAKING

TR, page 104

Enbridge to file the budget proposed to management.

RESPONSE

The Company has determined that the only alternative budgets and targets that were contemplated and presented to management were in the context of possible Settlement discussions in the early months of 2015. Enbridge believes it would be inappropriate to include such contemplated alternatives in the context of what it believed were confidential discussions and which included and incorporated the various positions of parties and involved multiple concessions by parties across a number of offerings for 2015.

Witnesses: M. Lister
F. Oliver-Glasford
B. Ott

UNDERTAKING J8.12

UNDERTAKING

TR, page 113

With reference to Exhibit K8.1, page 31 of 36, Enbridge to ask its consultant to add two more columns to that, the first column being "marginal acquisition cost per CCM", and the second additional column being "marginal TRC ratio."

RESPONSE

Reference: EB-2015-0049, Exhibit C, Tab 1, Schedule 1, page 133

Please see below the table referenced with the additional columns requested.

Modified Table 5-20: Cumulative (10-Year) Budget* and Achievable Potential for Residential Sector

	Residential			
Scenario	Budget ($ million)	Savings (million m3/yr)	Marginal[1] Acquisition Cost ($/CCM)	Marginal[2] TRC Ratio
A	32	118	NA	NA
Base Case	40	130	0.060	2.64
C	48	141	0.061	2.59
D	55	152	0.061	2.55
E	63	163	0.059	2.51
F	71	174	0.061	2.47
G	80	184	0.064	2.43
H	90	195	0.068	2.40
I	100	206	0.071	2.37
J	144	222	0.138	2.11
K	317	264	0.175	1.76
L	542	319	0.161	1.46

1. Incremental budget divided by incremental CCM, where incremental is relative to the next lower budget scenario.
2. Incremental NPV of benefits divided by incremental NPV of costs, where incremental is relative to the next lower budget scenario.

Witnesses: J. DeVenz
C. Welch

UNDERTAKING J8.14

UNDERTAKING

TR, page 133

Enbridge to advise whether the table at page 36 of the VECC compendium includes overheads

RESPONSE

Enbridge confirms the values in the table in question do not include overheads.

	Cost Effectiveness				
Resource Acquisition	**2016 $/CCM or $/Participant**	**2017 $/CCM or $/Participant**	**2018 $/CCM or $/Participant**	**2019 $/CCM or $/Participant**	**2020 $/CCM or $/Participant**
Large C&I Customers (Sum)	$0.0123	$0.0126	$0.0128	$0.0130	$0.0132
Large Custom	$0.0114	$0.0117	$0.0119	$0.0121	$0.0123
Large Prescriptive	$0.0195	$0.0200	$0.0203	$0.0207	$0.0210
Small C&I Customers (Sum)	$0.0414	$0.0417	$0.0417	$0.0417	$0.0417
Small Custom	$0.0257	$0.0259	$0.0259	$0.0259	$0.0259
Small Prescriptive	$0.0138	$0.0139	$0.0139	$0.0139	$0.0139
Small DI	$0.0821	$0.0827	$0.0827	$0.0827	$0.0827
Small Commercial New Construction	N/A	$0.0893	$0.1335	$0.1251	$0.1073
Residential Thermostats	$0.0367	$0.0320	$0.0304	$0.0296	$0.0294
Residential HEC (CCM)	$0.1184	$0.1111	$0.1067	$0.1037	$0.1017
TOTAL	**$0.0330**	**$0.0362**	**$0.0385**	**$0.0386**	**$0.0387**

Witnesses: M. Lister
K. Mark
J. Paris

UNDERTAKING J8.16

UNDERTAKING

TR, page 137

Enbridge to provide a copy of the program literature

RESPONSE

Enbridge's 2015 Affordable Housing Multi-residential offering brochure has been provided as an attachment to this undertaking.

Witnesses: M. Lister
E. Lontoc
J. Paris

ENBRIDGE
Life Takes Energy™

Energy Efficiency Incentives for Affordable Housing Providers

Save money on improvements that reduce energy and improve comfort

Incentives for Affordable Housing Providers

Do an energy audit or make capital improvements that reduce gas consumption and get cash back through Enbridge Gas Distribution's Affordable Housing Program!

Fixed Incentives

Condensing Boilers

Up to 299 MBH, AFUE of 90% or greater	$ 600

High-Efficiency Seasonal Boiler [A]

300 – 599 MBH	$1,000
600 – 999 MBH	$1,500
1000 – 1500 MBH	$3,000
1501 – 2000 MBH	$4,000

High-Efficiency Non Seasonal Boiler [A]

300 – 599 MBH	$1,000
600 – 999 MBH	$1,500
1000 – 1500 MBH	$2,500

Energy Recovery Ventilation [B]

Minimum Heat Recovery Effectiveness 67%	$1.00/CFM

Heat Recovery Ventilation [B]

Minimum Heat Recovery Effectiveness 61%	$1.00/CFM

Custom Incentives

Capital Improvements. [C]

Receive one-time energy saving retrofit incentives of up to $100,000

Free In-suite Incentives

Showerhead Incentive. [D]

With the Enbridge Direct Install Program, replace standard showerheads with energy-efficient ones[D], supplied and installed at no cost to you.

Novitherm™ Heat Reflector Panels.

The radiators and baseboard convectors in your apartments work hard to keep your residents warm and comfortable. Novitherm™ Heat Reflector Panels are an easy and effective way to improve your residents comfort. It will reflect heat being lost behind the unit, back into the suite. Enbridge Gas is working to reduce energy use in our city by providing heat reflectors to everyone in your apartment building. The reflectors are professionally installed and require zero maintenance. If your building qualifies, heat reflectors will be provided to every apartment in your building at no charge. It's a win-win – improve the net operating income in your building while improving your residents home.*

*Subject to eligibility requirements

Enbridge incentives reward your efficiency gains

Operational Improvements

Implement recommended no cost/low cost operational improvements and we'll monitor your associated natural gas savings for 12 months.*

* Available where eligible natural gas meters are installed. Please contact Enbridge to confirm meter requirements.

Energy Audits

Do an energy audit and receive either half the cost back, up to $5,000 per building, or $0.01/m³ of gas consumed in the last calendar year, (whichever is less).

Look at the incentives others have received:

Hot water and heating boilers
Cost: $22,035
Incentive: $8,378
Operational Savings: over $7,000/yr*

Hot water and heating boilers
Cost: $119,000
Incentive: $28,883
Operational Savings: nearly $25,000/yr*

Make-Up Air replacement
Cost: $63,490
Incentive: $3,619
Operational Savings: over $3,000/yr*

* Operational savings are reductions in gas consumption based on natural gas costs of $0.17/m3 and the projected consumption resulting from equipment upgrades.

Offset the costs of retrofits and enjoy ongoing energy efficiency savings that reduce the payback time.

- ***Is any of your old equipment coming to the end of its lifecycle?***
  Consider replacing it to avoid the emergency costs of equipment failure.
- ***Is your gas-fired equipment 10+ years old?***
  Older equipment may operate at 60% efficiency, compared to 85% or better for new equipment, and cost more to operate.
- ***Looking to maximize your savings?***
  Upgrading to high-efficiency boilers, domestic hot water tanks, and make-up air units means larger incentives.

Contact an Enbridge Energy Solutions Consultant at 1-888-427-8888 to learn more.

Enbridge is here to help

Program Support and Project Facilitation Services
Get knowledgeable, personal support through the entire process, starting with your application.

Informing You About Financial Incentives
Enbridge offers incentives to maximize your financial returns. We'll keep you informed about incentives and special time limited offers.

We can determine your eligibility, help you to apply, and submit the required documents.

Call Enbridge today to discuss your projects

1-888-427-8888

www.enbridgegas.com/affordablehousing

ENBRIDGE®
Life Takes Energy™

General Terms and Conditions. Offers available to qualified participants only. Contact Enbridge to confirm your eligibility. Additional terms and conditions may apply to specific offers. Enbridge Gas account must be in good standing. Must provide proof of purchase matched to installation address. Valid in Enbridge Gas Distribution franchise area (Ontario) only, between January 1, 2015 and December 31, 2015.

All forms and proof of purchase must be received by Enbridge no later than January 15, 2016. Enbridge is not responsible for lost mail or mail disruptions. Allow 10 to 12 weeks for delivery of payment. Enbridge Gas Distribution does not guarantee the performance of installed equipment nor guarantee energy savings. We reserve the right to independently verify the information in all applications and to randomly select a number of locations to confirm installation. Offers are subject to cancellation without notice at any time.

[A] **High-Efficiency Boilers.** Must be a new non-atmospheric hydronic boiler with thermal efficiency from 85% to 88% and must replace an atmospheric boiler operating in a continuous loop. Rental boilers are eligible. Boilers under 300 MBH must have an AFUE of 85% or greater, limit one per address. Boilers up to 1,500 MBH can be used for water heating as well. Custom incentives are calculated on projected first year's natural gas savings at $0.40/m^3 saved, up to a $100,000 limit.

[B] **Ventilation.** To be used for space conditioning (not process heating) applications only. Product must have a minimum air flow capacity of 300 CFM per unit. Not to be used to recover energy from airstreams containing noxious or toxic fumes. Not to be used as part of a restaurant exhaust system. Frost control must be used for an ERV where winter design temperature is below 0° F. Offers are valid only if technology is used for common areas. Each unit must have a minimum Heat Recovery Effectiveness of 61% for an HRV and 67% for an ERV. For installations that have an electric humidification, the HRV rather than ERV incentive applies. Custom incentives are calculated on projected first year's natural gas savings at $0.40/m^3 saved, up to a $100,000 limit.

[C] **Capital Improvement Guidelines.** Incentives should not exceed 50% of the project's capital cost. To be eligible, projects must have a Total Resource Cost (TRC) ratio of .70 or greater, unless otherwise approved. Projects with a simple payback of up to 5 years typically meet the TRC ratio requirement. If greater than 5 years, Enbridge can run a TRC calculation to determine incentive eligibility. For details on how simple payback and total project costs are calculated, contact Enbridge.

[D] **Showerheads.** Incentive available to existing customers only. New construction not eligible. Customer must use natural gas for water heating and replace an existing standard showerhead (with a flow rate of 2.5 GPM or greater) with an energy-efficient showerhead with a manufacturer-specified flow rate of 1.5 GPM or less. Cannot be combined with any other showerhead offer. Additional terms, conditions and restrictions apply. Please contact Enbridge for further details.

UNDERTAKING J8.17

UNDERTAKING

TR, page 141

To confirm that the dollars per CCM for its "home health record" program is calculated on the same basis as shown in the Union response to SEC Interrogatory 31.

RESPONSE

The chart below represents My Home Health Record on the same basis as shown in Union's response to SEC Interrogatory 31, found at Exhibit B.T3.Union.SEC.31.

My Home Health Record Program Budget 2016 – 2020	
Direct Budget	$ 31,248,059.00
Development, Start up, Evaluation	$ -
Administration	$ -
Total Program	$ 31,248,059.00
Share of Portfolio Costs	$ 902,441.00
Shareholder Incentive	$ 242,440.00
Total Cost of Savings	$ 32,392,940.00
Forecast CCM	$ 70,487,616.00
Cost per CCM	$ 0.46

Witnesses: S. Bertuzzi
S. Hicks
M. Lister

UNDERTAKING J9.1

UNDERTAKING

TR, page 5

To advise whether low-income participants were surveyed in order to get an apples-to-apples comparison with Union.

RESPONSE

Enbridge conducted an on-site verification inspection using a random sampling method of its low income multi-residential participants that participated in its 2012 direct install showerhead offer. The inspection showed an 87.7% retention rate, (i.e. 87.7% of showerheads remained installed).

Witnesses: R. Idenouye
E. Lontoc

UNDERTAKING J9.2

UNDERTAKING

TR, page 8

Enbridge to provide further information, further to the last undertaking about 2012 participant results, about aerators in the low-income context.

RESPONSE

The on-site verification inspection in 2012 referenced in Undertaking J9.1 was for a sample size of 524 apartment units. There were a total of 12,154 apartment units that participated in the 2012 showerhead program.

Due to the small number of aerators distributed in the low income program, and more specifically under the Part 9 – Single Family Homes offer, the showerhead retention rate of 87.7% was used as a proxy value for the aerators in 2013.

In 2014, a retention rate of 22.5% and 33.1% for the bathroom and kitchen aerators respectively were used. These rates were based on a 2011 survey of the residential self-install ESK-TAPS program.

The average annual number of participants who received aerators over the three year period was 187.

Witness: E. Lontoc

UNDERTAKING J9.3

UNDERTAKING

TR, page 9

Enbridge to make best efforts to ask its delivery agents or agent, the ones who would be doing the installation of these, leaving behind or actually installation if they were to do direct install, whether their current liability insurance would cover direct installs of aerators.

RESPONSE

The insurance requirements in the Home Winterproofing Program service contracts of third party delivery agents, including coverage amounts, are prescribed by Enbridge's risk management group.

Enbridge confirms that it does not anticipate any increase in insurance coverage requirements should aerators be included as a direct install measure, subject to installation guidelines, under the Home Winterproofing Program.

Witnesses: M. Lister
E. Lontoc
J. Paris

UNDERTAKING J9.4

UNDERTAKING

TR, page 13

Enbridge to calculate incremental costs and advise whether the direct install of the aerators still makes the single family offering cost effective.

RESPONSE

Using the installation costs of Enbridge's current delivery agents as indicators for the costs associated with the direct installation of kitchen and bathroom aerators, Enbridge confirms that direct installation of this measure is likely cost effective in consideration of the Low Income TRC Plus ratio threshold of .7. The Company's calculations are predicated on a persistence rate (i.e. non-removal rate) of no less than 30%.

Witnesses: M. Lister
E. Lontoc
J. Paris

UNDERTAKING J9.6

UNDERTAKING

TR, page 34

Enbridge to provide a sample of these individualized reports.

RESPONSE

Please find attached a sample of an individualized report that illustrates the type of information that will be distributed to participants of the My Home Health Record offer.

Witnesses: S. Bertuzzi
S. Hicks
M. Lister

ENBRIDGE
Life Takes Energy™

500 Consumers Road
North York, Ontario M2J 1P8

My Home Health Record

Account number:
Report period: 16/06/15–20/07/15

This report gives you context on your natural gas use to help you make smart natural gas saving decisions.

For a full list of natural gas saving programs including rebates from Enbridge Gas visit:

enbridgegas.com/efficiencyprograms

Last Winter Comparison

You used **1% more** natural gas than similar homes.

Your usage last winter: Dec '14–Mar '15

* m³: Standard unit of measuring natural gas

How you did last winter:

You used more than average

Turn over for ways to save →

Similar Enbridge Gas Homes: Approximately 100 occupied apartments or condos that are either in the same building or nearby (avg 0.11 km away)

Efficient Enbridge Gas Homes: The most efficient 20 percent of similar homes

Are we comparing you correctly?

Tell us more about your home:
enbridgegas.com/homehealth

See your breath in the air? Time to prepare (for winter!)

The first time you step outside and see your breath, take it as a signal that winter is on its way. That means it's time to set your thermostat. Here are our recommended winter settings:

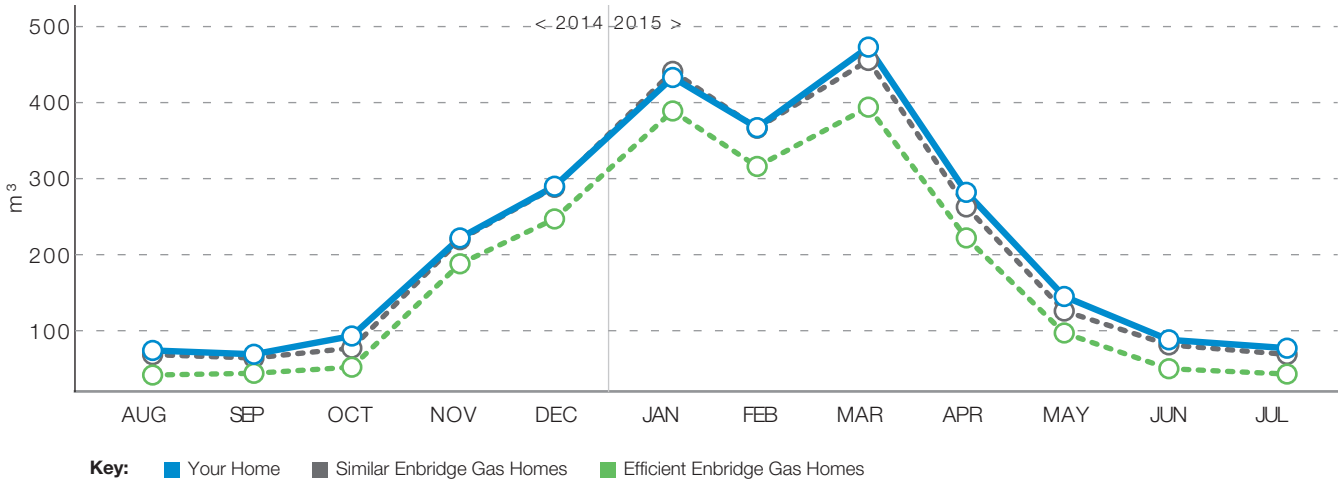
20°C when you're home / **17°C** when you're away

For more tips on how to save this winter, visit enbridgegas.com/homehealth.

Turn over for savings →

Last 12 Months Household Comparison

You used **25% more** natural gas than efficient similar homes.
This costs you about **$76 extra** per year.



Visit **enbridgegas.com/efficiencyprograms** for Enbridge's energy efficiency programs and their terms and conditions

Quick Fix
Something you can do right now

☐ **Hang laundry to dry**

Your dryer uses about 20% of the total power your major appliances consume. Over time, high heat cycles may damage your clothes, too.

To save energy and keep your clothes feeling like new, use clotheslines, drying racks, or plastic hangers to air-dry clothes. Even partially drying your clothes before using the dryer can help.

For softer clothes, you can throw your dry laundry in the machine for about five minutes.

SAVE UP TO
$40 PER YEAR

Smart Purchase
An affordable way to save more

☐ **Install efficient showerheads**

Showering accounts for about 40% of your hot water use, but you can cut costs without sacrificing comfort.

If your shower fills a 4-litre bucket in less than 20 seconds, you could save with an efficient showerhead. These showerheads, with flow rates no greater than 10 litres per minute, help reduce hot water use while maintaining water pressure.

You can realize significant savings with efficient showerheads, especially if you have a large household.

SAVE UP TO
$85 PER YEAR

Great Investment
A big idea for long-term savings

☐ **Replace your old clothes washer**

ENERGY STAR® certified clothes washers use about 30% less energy and 35-50% less water than non-certified models.

New, efficient washers spin more water out of clothes, so your dryer won't have to work as hard. They can handle larger loads and are gentler on your clothes, too.

Conventional washers manufactured before 2001 are especially inefficient. If you have one, consider an upgrade soon.

SAVE UP TO
$10 PER YEAR

ENBRIDGE
Life Takes Energy™

runs on OPOWER®

Enbridge Gas Distribution Inc. ("EGD") does not represent or warrant the accuracy of any information in this report. In the event of any discrepancy between the information in this report and the information on your EGD bill, the EGD bill will govern. Dollar savings are estimated using EGD's commodity and distribution rates for typical households in the EGD franchise area. Tip savings are not guaranteed. Actual savings may vary household to household. This report is prepared and distributed by a third party as a service to EGD's customers.
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Enbridge to provide the number of customers in each of rates 110, 115, and 170 that would be in the 10 million cubic metres per year, 25 cubic metres per year, and 50 million cubic metres per year and up categories.

RESPONSE

Please see below the requested table showing a breakdown of accounts within rates 110, 115 and 170 based on volumetric ranges.

Volume Range [million m^3 per year]	Number of Accounts		
	Rate 110	Rate 115	Rate 170
10 to 24.99	6	5	8
25 to 49.99	5	5	2
50 plus	0	2	1

Witnesses: P. Goldman
K. Mark

UNDERTAKING J9.10

UNDERTAKING

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Enbridge to provide information on the incremental cost of the project that relates to the energy-efficiency measure.

RESPONSE

Please see below a comparison of the incremental cost of energy efficiency to customers with the incentive amounts provided by Enbridge in 2013 and 2014. These figures have been limited to projects for customers whose gas consumption is 10 million m^3 per year or greater.

Year	*Number of Projects*	*Incremental Cost*	*Incentive Amount*	*Incentive as Percentage of Incremental Cost*
2014	21	$ 2,156,194	$ 351,072	16%
2013	15	$ 3,286,181	$ 574,804	17%

Witnesses: P. Goldman
K. Mark