Guidehouse

Memorandum

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From: Kevin Grabner, Carly Olig, Anusha Jagannathan, Eric Stern, Guidehouse

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Re: Home Energy Report Interim Impact Evaluation Savings Memo

INTRODUCTION

This memo presents the results of the interim impact evaluation of the Nicor Gas Home Energy Report (HER) Program. This program launched on October 18, 2019 and this memo covers savings from launch to April 30, 2020. It is Guidehouse's understanding that Nicor Gas will not be claiming savings based on this memo but will use it to inform programmatic decisions going into the 2020-2021 heating season. Nicor Gas intends to claim savings for a little under 15 months in CY2020, for the period covering program launch to the end of December 2020. This memo presents a summary of the energy impacts for the program and the appendix presents the impact analysis methodology and results detail.

PROGRAM DESCRIPTION

The HER Program is designed to generate energy savings by providing residential customers with information about natural gas use and conservation strategies. Program participants receive information in the form of regularly mailed and emailed home energy reports that give customers information, including:

- Information on how their natural gas use compares to that of neighbors with similar homes
- Assessment of how their natural gas usage breaks down between home heating and other gas appliances
- Tips on how to reduce natural gas consumption, some of which are tailored to the customer's circumstances

The program launched in October 2019 and includes 154,999 participants and 45,000 controls. An important feature of the Nicor Gas HER Program is that it is designed as a randomized controlled trial (RCT). Customers in the target group of residential customers were randomly assigned to either the recipient group or the control (non-recipient) group to estimate changes in energy use due to the

program.[1] Customers may opt *out* of the program at any time but cannot opt *in* due to the RCT design. An implication of the RCT design is that the savings estimates are intrinsically net of free-ridership and most spillover bias. Unless otherwise noted, reported "savings" in this memo refer to *net savings*.[2]

SAVINGS SUMMARY

Table 1 summarizes the energy savings the HER Program achieved between October 18, 2019 and April 30, 2020.

Table 1. Energy Savings Summary

Statistic†	Therms
Ex Ante Net Savings	781,021
Verified Net Realization Rate (RR)‡	113%
Verified Net Savings	880,734

† Since the RCT design inherently estimates net savings, neither the evaluation team nor the implementer estimated gross savings and there is no gross realization rate and no net-to-gross (NTG) ratio.
‡ Realization Rate (RR) is the ratio of verified net savings to ex ante net savings, based on evaluation research findings.
Source: Nicor Gas data and Guidehouse team analysis.

This savings estimate does not include the impact of uplift[3], which we anticipate will be a net reduction of savings in the range of 1% to 4%.

Table 2 presents participation details and savings for the HER Program based on two regression models Guidehouse used for estimation: a lagged dependent variable (LDV) model (LDV) and a linear fixed effect regression (LFER) model. As expected, the two models generated very similar savings estimates. For CY2020, Guidehouse will report savings based on the LDV model.[4]

[1] Guidehouse conducted this randomization and results were delivered to Nicor Gas in a memo, *Nicor Gas Ecotagious HER Randomization Memo*, on September 18, 2019.
[2] In some instances, the word "net" appears in column headings and summary sentences for added clarity.
[3] Uplift refers to the impact of the HER program on enrollment in *other* Nicor Gas energy efficiency programs. To avoid double-counting the savings from this indirect effect, Guidehouse subtracts the estimated uplift savings from the total HER program savings, including legacy uplift from prior years for multi-year HER programs. The fact that uplift savings is subtracted from the HER programs' total energy savings does not indicate that the uplift savings was not *caused by* the HER programs, or that the HER programs shouldn't be credited for its occurrence. It is an accounting adjustment to avoid double-counting when aggregating savings over multiple energy efficiency programs. Indeed, the existence of uplift is an indicator of successful cross-marketing by the HER programs, and thus should be seen as an added program benefit.
[4] More information about these models and the differences between them are provided in Appendix A. Detailed parameter estimates from each model are provided in Table 3 and Source: Nicor Gas data and Guidehouse team analysis.

Table 4 in Appendix B.

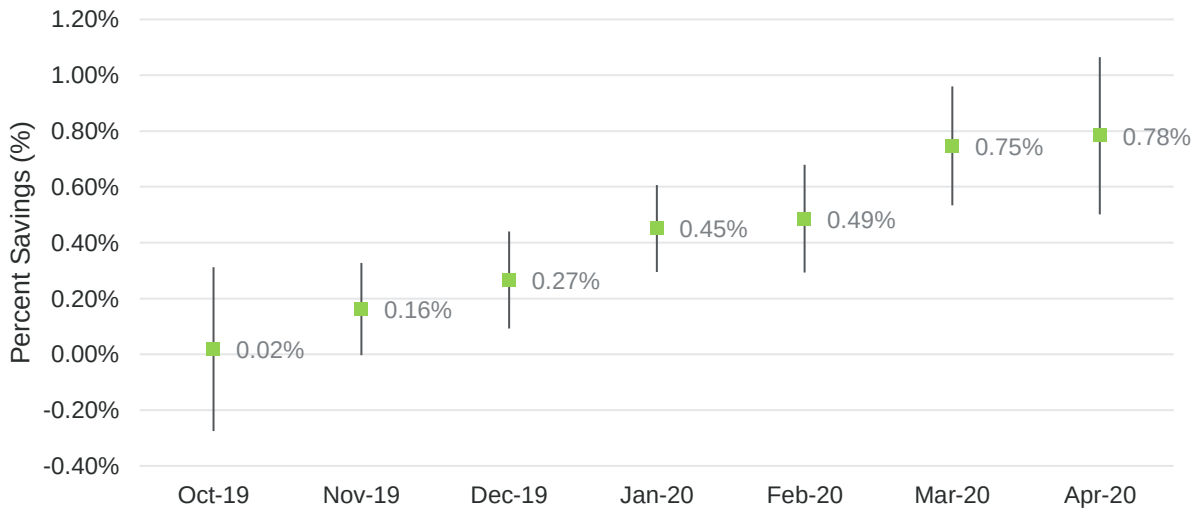
Table 2. Nicor Gas HER Program Participation Detail

Model	Number of Participants	Number of Controls	Average Ex Ante Season Savings Per Participant (Therms)†	Average Verified Season Savings Per Participant (Therms)†	Average Savings Rate	Average Savings Rate Standard Error
LDV	154,999	45,000	5.21	5.68	0.41%	0.07%
LFER	154,999	45,000	5.21	5.78	0.42%	0.07%

† The season savings values represent the total savings for each customer for the entire period of evaluation.
Source: Nicor Gas data and Guidehouse team analysis.

Guidehouse also reviewed savings by month from October 2019 through April 2020. Monthly savings are shown in Figure 1 along with their 90% confidence interval. Savings in each month are consistently increasing from the previous month as is expected during the ramp up period of the program.[5] Savings were not statistically significant in October and November 2019, but were for the rest of the evaluation period. This aligns with Guidehouse's expectations of savings in the first couple months after program launch.

Figure 1. Monthly Savings Estimate with 90% Confidence Interval



Source: Nicor Gas data and Guidehouse team analysis.

IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

For Nicor Gas' HER program, Guidehouse verified 880,734 therms for the time period of October 18, 2019 through April 30, 2020. This savings estimate does not include the impact of uplift, which we anticipate will be a net reduction of savings in the range of 1% to 4%.

[5] HER programs often require 6-18 months to mature and generate maximum savings. It takes time for customers to understand the reports they receive and then develop conservation actions based on the information presented in the reports. Hence, Guidehouse expects to see ramp up for this initial program wave continuing throughout 2020.

Finding 1. Average daily savings from the HER Program are within the expected range for a gas program after eight months and compare favorably to the implementer's projections.

Finding 2. As expected, the program saw ramp up in savings throughout the evaluation period which is expected to continue through CY2020.[6]

Finding 3. Guidehouse found a RR of 113% for this evaluation. Guidehouse believes the high RR is driven by differences in the savings estimation methodology between Guidehouse and the implementer. The implementer used a difference in difference (DID) calculation while Guidehouse used a regression approach that controls for external variables to estimate savings.

Recommendation 1. If RR results closer to 100% are desired, Guidehouse recommends the implementer use a regression approach to estimate savings for CY2020 instead of using a DID calculation. A regression approach controls for external variables while estimating program impacts.

Finding 4. Guidehouse anticipates that adjustment for uplift will reduce savings approximately 1% to 4%. We will include the uplift adjustment in the end of year impact evaluation for CY2020.

[6] We note that gas savings are seasonal and may stagnate or fall during the warmer months of the year before climbing again in the next heating season.

APPENDIX A. IMPACT METHODOLOGY DETAIL

Detailed Data Cleaning

The evaluation team removed customers and data points from the analysis in several steps:

- Observations outside October 2019 to April 2020 and relevant pre-program period (October 2018 to April 2019)
- Observations with a bill duration of zero days
- Observations missing usage
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage

After selecting program and pre-program year data for each wave, these cleaning steps removed no customers and 11.83% of observations, evenly distributed across participants and controls. This suggests that non-random biases were not introduced into the data by the evaluation team's cleaning steps.

Detailed Regression Modelling

Guidehouse estimated program impacts using two approaches: an LDV regression model with lagged individual controls and an LFER model with a customer fixed effect. Both approaches were applied to monthly billing data. The two approaches should, in principal, produce unbiased estimates of program savings under a wide range of conditions, but Guidehouse prefers the LDV results. This is primarily because savings estimates produced by the LDV model tend to be more accurate and more precisely estimated than those from the LFER model[7] based on past experience analyzing similar HER programs' impacts and findings from the academic literature.[8]

Although the LDV and LFER models are structurally very different, they should generate similar program savings estimates, assuming the RCT is well balanced with respect to the drivers of energy use. Guidehouse uses the LDV results for reporting total program savings, while the LFER results are provided as a robustness check.

[7] One likely reason for this is that the LDV model embodies more flexibility than the LFER model, in that the former allows the individual customer control variable to vary seasonally while the latter does not – a particularly attractive feature given the highly seasonal nature of natural gas usage. The LFER model treats all unobserved inter-household heterogeneity affecting households' energy usage as time-invariant, while the LDV model uses lagged individual controls that can vary over time.
[8] Allcott, Hunt and Todd Rogers, 2014. "The Short-Run and Long-Run Effects of Behavioral Intervention: Experimental Evidence from Energy Conservation." *American Economic Review*, 104(10): 3003-37.

LDV Model

The LDV model controls for non-program differences in energy use between the treatment and control groups using each customer's lagged energy usage as an explanatory variable. In particular, the model frames energy use in calendar month *t* of the post-program period as a function of both the treatment variable and energy use in the same calendar month of the pre-program period. The underlying logic is that systematic differences between control and treatment customers will be reflected in differences in their past energy use, which is highly correlated with their current energy use. Formally, the model is shown in Equation 1.

Equation 1. Lagged Dependent Variable Regression Model

$$ADU_{kt} = \beta_1 Treatment_k + \sum_J \beta_{2j} Month_{jt} + \sum_J \beta_{3j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

where:

ADU_{kt}	is average daily consumption of therms by household *k* in bill period *t*
$Treatment_k$	is a binary variable taking a value of 0 if household *k* is assigned to the control group, and 1 if assigned to the treatment group
$ADUlag_{kt}$	is household *k*'s energy use in the same calendar month of the pre-program year as the calendar month of month *t*
$Month_{jt}$	is a binary variable taking a value of 1 when *j* = *t* and 0 otherwise[9]
ε_{kt}	is the cluster-robust error term for household *k* during billing cycle *t;* cluster-robust errors account for heteroscedasticity and autocorrelation at the household level.[10]

The coefficient β_1 is the estimate of the average daily therms energy savings due to the program.

LFER Model

The LFER model used by Guidehouse is one in which average daily consumption of therms by household *k* in bill period *t*, denoted by ADU_{kt}, is a function of the following three terms:

1. The binary variable $Treatment_k$
2. The binary variable $Post_t$, taking a value of 0 if month *t* is in the pre-treatment period, and 1 if in the post-treatment period.
3. The interaction between these variables, $Treatment_k \cdot Post_t$

Formally, the LFER model is shown in Equation 2.

Equation 2. Linear Fixed Effects Regression Model

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t + \varepsilon_{kt}$$

In this model, the coefficient α_{0k} captures all household-specific effects on energy use that do not change over time, including those that are unobservable, the coefficient α_2 captures the average effect *across all households* of being in the post-treatment period, and the effect of being both in the

[9] In other words, if there are *T* post-program months, there are *T* monthly dummy variables in the model, with the dummy variable $Month_t$ the only one to take a value of 1 at time t. These are, in other words, monthly fixed effects.
[10] Ordinary Least Squares (OLS) regression models assume that the data are homoskedastic and not autocorrelated. If either of these assumptions is violated, the resulting standard errors of the parameter estimates are incorrect (usually underestimated). A random variable is heteroskedastic when the variance is not constant. A random variable is autocorrelated when the error term in one period is correlated with the error terms in at least some of the previous periods.

treatment group and in the post period (i.e., the effect directly attributable to the program) is captured by the coefficient α_2. In other words, while the coefficient α_1 captures the change in average daily therms use across the pre- and post-treatment for the *control* group, the sum α_1 + α_2 captures this change for the treatment group, and so α_2 is the estimate of average daily therms energy savings due to the program.

Monthly Model

Guidehouse also used a variation on the LDV model to estimate savings individually for each month of the evaluation period. The treatment term is interacted with monthly binary variables to allow energy savings to vary by month. This model is shown in Equation 3.

Equation 3. Monthly Model

$$ADU_{kt} = \sum_{J} \beta_{1j} Treatment_k \cdot Month_{jt} + \sum_{J} \beta_{2j} Month_{jt} + \sum_{J} \beta_{3j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

Where all variables are as previously defined.

APPENDIX B. IMPACT RESULTS DETAIL

Table 3 and Table 4 show the parameter estimates from the LDV and LFER models.

Table 3. LDV Model Parameter Estimates

variable	coefficient	t_statistic
treatment	-0.0299565	-5.6478134
yrmo201910	2.5514348	60.3207211
yrmo201911	2.42113289	83.114461
yrmo201912	2.98843065	115.325108
yrmo202001	2.84395183	98.2997043
yrmo202002	3.13692692	127.572949
yrmo202003	3.15809	173.236695
yrmo202004	2.20502373	112.448864
yrmo201910:pre_use	0.69096541	109.917308
yrmo201911:pre_use	0.65794354	192.431075
yrmo201912:pre_use	0.60799147	208.676977
yrmo202001:pre_use	0.55442369	229.588413
yrmo202002:pre_use	0.49509934	200.981902
yrmo202003:pre_use	0.42143877	134.390631
yrmo202004:pre_use	0.4850384	88.7957437

Source: Nicor Gas data and Guidehouse team analysis.

Table 4. LFER Model Parameter Estimates

variable	coefficient	t_statistic
post_trt	-0.0304622	-5.9017877
post	2.27194953	497.878096

Source: Nicor Gas data and Guidehouse team analysis.