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Memorandum

Residential HVAC Initiative NTG Research

To: Fernando Morales, Ameren Illinois; Jennifer Morris, Illinois Commerce Commission

From: Opinion Dynamics Evaluation Team

Date: September 21, 2020

Re: 2019 HVAC Initiative Net-to-Gross Research

Introduction and Key Findings

As part of the 2019 evaluation, the evaluation team conducted research with Residential HVAC (also referred to as the Residential Heating & Cooling Initiative) participants and trade allies to update the net-to gross ratios (NTGRs) for heat pumps (HP) and central air-conditioners (CAC) available through the initiative for application in 2021. We examined the results by those that installed their equipment upon burnout of existing equipment (replace-on-burnout or RB) and by those that installed new efficient equipment in place of inefficient, but operable, existing equipment (early retirement or ER). We developed the NTGRs using self-reported information from computer-assisted web interviewing (CAWI) surveys with program participants and active and non-active trade allies. We developed estimates of free-ridership (FR) and participant spillover (SO). Additionally, we researched whether active and non-active trade ally spillover occurred. This memo presents the results of the analysis NTGRs.

Summary of NTG Results

Table 1 presents the results of our NTGR analysis for prospective application.[1] Table 2 summarizes the results of our HVAC Initiative NTG analysis by providing the FR and SO values for participants (PSO) active trade allies (TASO), and SO values for non-active trade allies (NASO). Section 1.3 of this memo provides a detailed methodology for calculating each of these scores.

Table 1: Residential HVAC NTGRs from 2019 Research

Measure	Combined FR	Combined SO	NTGR (1-FR+SO)
CAC/HP SEER >16+ ER	0.35	0.092	0.74
CAC/HP SEER >16+ RB	0.27	0.092	0.82
BPM	0.42	0.008	0.59

[1] While included here, the evaluation team does not plan to recommend use of the BPM value for future application given the limited number of respondents for this measure.

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Table 2. Component Scores for 2019 HVAC Initiative NTGRs

Measure	Free-Ridership			Spillover				NTGR (1-FR+SO)
	Participant FR	Trade Allies FR	Combined FR	Participants (PSO)	Active Trade Allies (TASO)	Non-Active Trade Allies (NASO)	Combined SO	
CAC/HP SEER >16+ ER	0.24	0.46	0.35	.008	--	0.084	0.092	0.74
CAC/HP SEER >16+ RB	0.07	0.46	0.27	.008	--	0.084	0.092	0.82
BPM	0.37	0.46	0.42	.008	--	--	0.008	0.59

Data Collection and Sampling Methodology

Participant Survey

We conducted an online survey during Q1 2020 with 2019 participating customers. The survey explored FR and SO as well as key aspects of the participation process, the key drivers of purchase decisions, the role of the Initiative in that decision, and overall satisfaction with the Initiative.

As in previous evaluations, we sampled by project contact, rather than by project, because customers could complete more than one project. To reduce respondent burden and to facilitate question wording, we asked each contact about only one project. We also dropped contacts for whom no valid email was available (since this was a web survey).

Our sample frame of 3,428 records included all customers installing at least one HVAC Initiative measure in 2019 and resulted in 460 completed surveys (Table 1). We recruited respondents with an initial email sent to the entire sample frame and sent two reminders to non-respondents spacing the emails three to four days apart from one another.

Table 3. Participant Survey Disposition Summary

Disposition	Count
Complete	460
Incomplete (started but did not finish survey)	72
Ineligible	41
Bad emails	193
Non-respondents	2,662
Total	**3,428**

We limited our analysis of FR and SO to the 202 respondents that installed a CAC, HP, or BPM and received FR influence questions using the IL-TRM approved 10-point scale. Other respondents installed a measure like a thermostat or received an experimental 5-point influence scale to assess FR. We provided an assessment

of the of the differences between using the 5-point and 10-point scales to assess FR on June 10th to the Illinois NTG Working Group.

Active and Non-Active Trade Ally Survey

We conducted a survey with active registered (AR) and non-active registered (NAR) trade allies in Q2 2020. We identified 218 AR contractors and 102 NAR contractors and completed surveys with 54 and 12 respectively (Table 2). We recruited respondents with an initial email sent to the entire sample frame and sent two reminders to non-respondents spacing the emails three to four days apart from one another.

Table 4: Trade Ally Survey Disposition Summary

Disposition	Active Trade Allies (AR)	Non-Active Trade Allies (NAR)
Complete	54	12
Incomplete (started but did not finish survey)	5	3
Ineligible	4	0
Bad emails	6	0
Non-respondents	149	87
Total	**218**	**102**

The active trade ally respondents (n=54) completed a total of 212 projects in 2019, representing 25% of all projects completed.

NTG Methods and Results

The NTG analysis for the HVAC Initiative includes the consideration FR, PSO, TASO, and NASO. FR is based on the participant survey and the trade ally survey; PSO is based on the participant survey; TASO and NASO are based on the trade ally survey. We calculate the NTG ratio as follows:

$$NTGR = 1 - FR + PSO + TASO + NASO$$

The Illinois evaluation teams have worked with the Illinois Commerce Commission (ICC) and the Illinois Stakeholder Advisory Group (SAG) to create a standard Illinois Statewide NTG approach for use in the Illinois energy efficiency evaluation, measurement, and verification work. Per the NTG methods attachment to the Illinois TRM (IL-TRM), all NTG data collection and analysis activities for program types covered by the attachment that began after January 1, 2020 must conform to the statewide NTG methods in IL-TRM V8.0. While data collection occurred in 2020, our survey covered all inputs required by IL-TRM Version 8.0. This evaluation therefore conforms with this requirement.

Free-Ridership

Participants

Free riders are program participants who would have purchased the same HVAC measure(s) at the same time without any HVAC Initiative influence. The participant survey collected information about the program's influence on (1) the timing of the installation, (2) the efficiency of the installed equipment, and (3) the quantity of installed equipment (where applicable).

Each participant receives a FR score based on answers to the FR questions in the participant survey. FR scores represent the percentage of savings that would have been achieved in the absence of the program. FR scores can range from 0% (not a free rider; the participant would not have completed the project without the program) to 100% (a full free rider; the participant would have completed the same project at the same time without the program). Respondent-level FR scores were aggregated to the program level using weights based on ex-post gross savings.

As prescribed by the Prescriptive Rebate (With No Audit) Protocol in IL-TRM V8.0, we applied the specified algorithm to residential HVAC projects. The algorithm consists of two scores: (1) the program influence (PI) score and (2) the no-program (NP) score (counterfactual). Each score ranged from 0 to 1, and the two scores were averaged to arrive at a final free-ridership score. We provide a description of each score below.

Program Influence Score

This score is based on a series of questions that asks respondents how influential the program rebate and the contractor recommendation were in making their decision to purchase high efficiency equipment over standard efficiency equipment. Each question was asked on a scale from 0 to 10, 0 being "not at all influential" and 10 being "extremely influential". Additionally, if a customer found out about the program prior to learning about the rebate their answer was automatically discounted by half. The max of the influence of the rebate and contractor recommendation were taken to arrive at the final program influence score.

Equation 1. Program Influence Score

$$PI\ Score = 10 - (PI_{max})$$

where:

- PI_{max} is the highest score given to a program factor.

The greater the importance of the program components such as the rebate and contractor recommendation, the lower the free-ridership score. Using this approach, if a respondent rated the program rebate a 10 out of 10 and the contractor recommendation a 7 out of 10, PI_{max} would be 10 and the PI score would be 0.

No-Program Score

This score is based on the likelihood that the exact same energy-efficient equipment would have been installed without the program. This section of the algorithm asks the respondent to rate the likelihood that they would have purchased the same equipment of any efficiency within 12 months, the likelihood that they would have purchased equipment with the same level of efficiency, and the likelihood they would have purchased the fewer high efficiency measures (if applicable) had the program not been available. Each of these questions were rated on a scale from 0 to 10, with 0 being "not at all likely" and 10 being "extremely likely".

Equation 2. No-Program Score

$$NP\ Score = 1 - \left(\frac{NP_{min}}{10}\right)$$

where:

- NP_{min} is the lowest score given to a factor outside of the program.

If a program participant installed more than one of the same high efficiency unit then they are asked on a scale from 0 to 10 how likely they were to purchase the same number of units had the program not been available. This score is then subtracted from 10 and the subsequent score is then factored into the NP_{min} score.

A greater likelihood of participating without the program means a higher level of FR. For example, if the participant provides a minimum score of 7 to install the same equipment in absence of the program, their NP FR score would be a 0.30.

Combining the NP and PI Scores to Create a FR Value

We averaged the NP and PI scores to come up with a FR value for all cases (Equation 3). For example, if a respondent reported an NP score of 3, suggesting they were somewhat unlikely to install the efficient item without the program, and a PI score of 0, suggesting the program heavily influenced them to install the efficient item, they would receive a FR score of 1.5. Converting that value to a percentage makes the participant FR value 0.15.

Equation 3. Participant FR Score

$$Participant\ FR\ Score = Average\ (NP\ Score, PI\ Score)$$

Addressing Triggered Consistency Checks

To address the possibility of conflicting responses (i.e., a high program influence score and a high likelihood to have done the project without the program), the survey includes a consistency check that asks participants open-ended questions to address the influence of the program on their decisions, specifically asking about the influence of the rebate and the influence of the contractor recommendation.

Consistent with the IL-TRM guidelines, we assessed the response to these open-ended questions and their consistency with the other questions, and, if warranted—based on clear additional information—adjusted the score based on expert judgement. If the open-end comments for a respondent providing inconsistent answers noted the program was very influential, we deferred to the PI score instead of using the average of the PI and NP score. If any of the open-end comments noted the program was not very influential, we would have deferred to the NP score. Per IL-TRM guidelines, we removed cases from our analysis when we could not rectify the inconsistent responses. For this study, that meant we removed a total of 50 cases leaving us with 152 FR scores.

Participant Free-Ridership Results

Using the methods described above, we determined FR values for those that replaced an operable but inefficient CAC or HP – early replacement (ER) – and those that replaced a non-functioning piece of equipment – replace on burnout (RB). Seventy-two respondents installed a piece of equipment early (ER) and 68 respondents replaced their equipment upon burnout (RB). Free-ridership was higher among ER respondents (.24) compared to RB respondents (.07). Theoretically, it makes sense for the FR rate to be higher among ER respondents because those inclined to replace equipment early may have a greater interest in energy savings and thus be less inclined to be influenced by the program compared to those that replace equipment upon burnout. Conversely, RB respondents reported relatively low FR rates suggesting this group is more influenced by the program.

Trade Allies

The trade ally survey collected information about (1) the influence of the AIC program on the customers decisions, (2) the percent of high efficiency equipment installations that did receive a rebate, (3) the percent of high efficiency equipment installations that did not receive a rebate, and (4) the percent of high efficiency units that would have still been sold had the program not been available.

Based on answers to the FR questions in the trade ally survey, each active trade ally is assigned a FR score. FR scores represent the percentage of savings that would have been achieved in the absence of the program. FR scores can range from 0% (not a free rider; the trade ally would not have installed the incented units without the program) to 100% (a full free rider; the trade ally would have installed the same units without the program). Respondent-level FR scores were aggregated to the program level, using unit-based weights.

As noted in the Trade Ally Free-Ridership Calculation section of IL-TRM V8.0, there is not a standardized approach for assessing free-ridership from the trade ally perspective. The evaluation team chose to implement an algorithm consisting of two scores: (1) the program score and (2) the no program score (counterfactual). Both scores ranged from 0 to 1 and were averaged to arrive at a final free-ridership score. Each score is described in more detail below:

Program Influence Score

This score is based on how much influence trade allies believe the AIC program had on customer's decision to install high efficiency HVAC equipment over standard efficiency equipment. Trade allies rated the influence of the program on a scale from 0 to 10, 0 being "not at all influential" and 10 being "extremely influential".

Equation 4. Program Influence Score

$$PI\ Score = 1 - (\frac{n}{10})$$

The greater the trade ally rated the importance of the program influence on the customer's decision, the lower the free-ridership score. Using this approach, if a respondent rated the program a 10 out of 10, the PI score would be 0.

No-Program Score

This score is based on the likelihood that the same number of high efficiency units would have been sold by the trade ally had the program not been available. This score is calculated using the percent of high efficiency units that the trade ally would have sold had the program not been available (FR3), the percent of total equipment installations that received a rebate (TA1b), and the percent of total equipment installations that did not receive a rebate (TA1c).

Equation 5. No-Program Score

$$NP\ Score = \frac{FR3\ x\ (TA1b + TA1c) - TA1c}{TA1b}$$

In this equation, the term *FR3 x (TA1b + TA1c)* refers to the share of the trade ally's total 2019 units that would still have been high efficiency without the program. From this value, we subtract TA1c to derive the share of all incented high efficiency units that would still have been installed without the program. We then

compare this counterfactual value to the share of the trade ally's actual share of incented units. If the numerator is the same as the denominator, the trade ally would have still installed all incented units without the program, and the NP Score is 1 (i.e., all incented units were free rider units). If, on the other hand, the numerator is half of the denominator, the trade ally would not have installed half of the incented units without the program, i.e., a NP Score of 0.5.

This calculation recognizes the fact that even with the program, some high efficiency units (TA1c) were installed without an incentive. This calculation thus develops a counterfactual that nets out units that even with the program do not receive an incentive, thus crystallizing the hypothetical effect of program removal on incented units only.

Trade Ally Free-Ridership Results

Using the methods outlined above, we were able to assess FR among 43 active trade ally respondents and determined a FR rate of .46, suggesting that almost half of all program measures they installed would have been installed without the program.

Triangulation of Participant and Trade Ally Free-Ridership

Evaluators who develop estimates of free-ridership from both participants and trade allies need to triangulate their results to come to a single free-ridership value for the program. According to Section 5.1.2 of IL-TRM V8.0, evaluators need to weight the participant and trade ally free-ridership values based on likely biases, accuracy, and representativeness of the results of the two methods. One example method shown in the IL-TRM asks evaluators to rate, on a scale of 0 to 10, the accuracy, validity, and representativeness of the two approaches and then weight the two approaches to determine how much to emphasize each approach.

In the case of the residential HVAC Initiative, we decided to weight the two methods equally and take an average of the two FR scores. We could not determine a justification to weight one approach more than the other as there are accuracy, validity, and representativeness strengths and challenges with both approaches.

For ER CACs and HPs, we took the FR value of .31 and averaged it with the .46 trade ally FR score to arrive at a FR value of .39. For RB CACs and HPs, we took the FR value of .11 and averaged it with the .46 trade ally FR score to arrive at a FR value of .28.

Spillover Methods and Results

Participants

PSO refers to additional energy efficiency upgrades participants made after their participation in the HVAC Initiative that were influenced by the program but for which they did not receive a program incentive. An example of PSO is a customer who installed incented equipment and, as a result of the positive experience, installs additional equipment but does not request an incentive. PSO is estimated at the program level and is expressed as a percentage of program savings.

The participant survey collected information about additional energy efficiency installations that participants made without receiving an incentive and the degree to which the program influenced their decision to install the efficient equipment. If a participant reports additional installations influenced by the program, they were asked follow-up questions about the quantity and type of those additional installations. We developed an estimate of savings for each additional measure that qualifies as PSO.

Our survey identified 16 participant respondents that indicated they may have conducted spillover activity. Seven of the 16 respondents agreed to an interview by our staff to discuss the specifics of their projects that may have qualified for spillover. These seven respondents told our team about their non-incented lighting, building shell, and appliance purchases. In total, we were able to claim 5,506 kWh, 1.1 kW demand savings, and 422.83 therms of savings (Table 4).

Table 5. HVAC Initiative Participant Spillover Measures and Savings

Participant ID	Spillover Measures	kWh
1	Lighting, building shell, air purifier	3,503
2	Faucet aerator, showerheads, refrigerator/freezer, dishwasher	97
3	Lighting, building shell	880
4	Lighting, refrigerator/freezer	476
5	Refrigerator/freezer, dishwasher	68
6	Lighting, advanced power strips	432
7	Windows	49
Total		**5,506**

We calculated the program-level spillover rate as the sum of the savings for all PSO measures divided by the incented ex post gross savings of all survey respondents. Dividing the estimated total SO in our sample (5,506 kWh) by total program ex post gross savings of the overall participant sample (700,322 kWh) yields a SO rate of .008 as shown in Equation 1.

Equation 6. HVAC Initiative Participant Spillover Rate

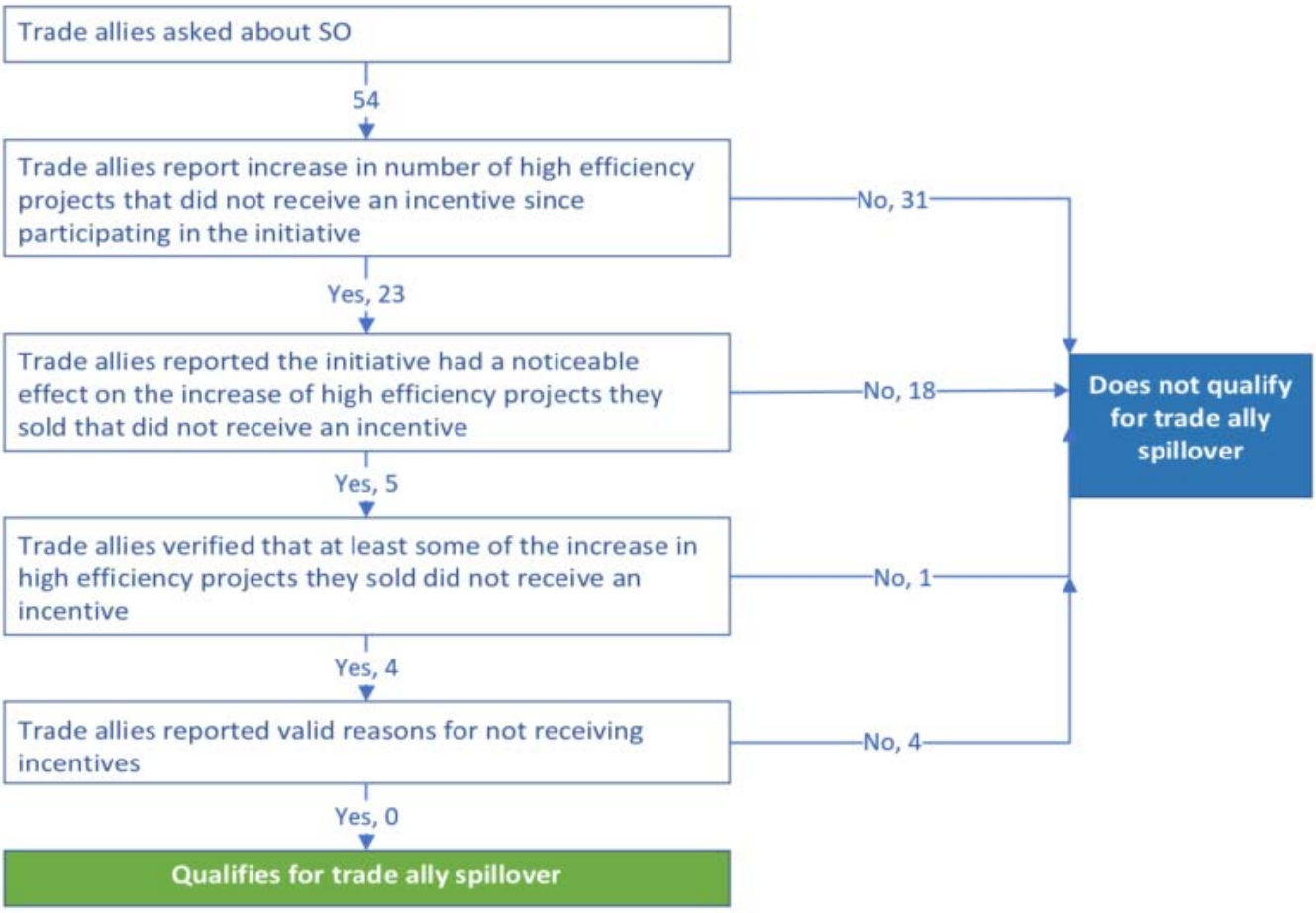
$$PSO\ \%_{Energy} = \frac{Total\ participant\ sample\ SO\ (kWh)}{Total\ participant\ sample\ savings\ (\mathrm{kWh})} = \frac{5{,}506\ \mathrm{kWh}}{700{,}322\ \mathrm{kWh}} = .008$$

Active Trade Allies

TASO refers to non-incented energy efficiency upgrades made by customers who were influenced by a participating trade ally who was in turn influenced by AIC's HVAC Initiative. We attempted to identify spillover candidates through questions asked in the TA survey and, if we had found instances of spillover, we would have determined savings for qualifying TAs to develop a quantitative estimate of spillover relative to total program savings associated with survey respondents.

Figure 1 shows how trade allies were deemed potentially eligible for spillover and shows how many trade allies were removed from consideration for spillover at each phase of questioning.

Figure 1. Active Trade Ally Eligibility for Spillover – Methodology



If we had found instances of Active Trade Ally spillover, we would have applied the following equation:

Equation 7. Trade Ally Spillover

$$Overall\ Active\ TA\ Spillover\ Ratio = \frac{Trade\ Ally\ Spillover\ Estimate}{Total\ Respondent\ Program\ Savings}$$

Non-Active Trade Allies

Non-Active TA SO (NASO) refers to non-incented energy efficiency upgrades made by customers who were influenced by non-active trade allies who were in turn influenced by previous participation in AIC's HVAC Initiative. Non-active trade allies are trade allies who did not complete any projects through the program during 2019. The evaluation team interviewed 102 non-active trade allies to determine if the program influenced their sales of high-efficiency equipment and if so, to quantify the program's impact on their high-efficiency sales. We asked non-active trade allies how many of each measure type they had sold in AIC's service territory in 2019 and how many of them were high efficiency. We then asked them to estimate how many they would have sold in the absence of the program.

We computed the non-active trade ally spillover according to the following steps:

1. We calculated the difference between the total reported number of high-efficiency units sold and the total that would have been sold in the absence of the program to obtain the total number of spillover units for that contractor.
2. We then multiplied the total net number of spillover units of each measure type sold by each non-active trade ally by the average gross savings for each measure type. [2]
3. We summed the result for each contractor and weighted the results by the ratio of the population of non-active trade allies to the sample to compute the total spillover energy.[3]
4. To obtain the spillover percentage we divided the spillover energy by the 2019 HVAC Initiative gross savings.

Table 6. Non-Active Trade Ally Spillover Results

Calculation Components	Values
Total Respondent SO Savings (kWh)	67,903
Extrapolation Factor (All NA TAs/Respondents)	8.5
NA Trade Ally Population SO Savings	577,177
HVAC Initiative Ex Post Gross Savings (kWh)*	6,892,455
Program SO Percentage	.084

[2] The 2019 Residential Program Impact Evaluation served as the source of average gross savings. Note that savings for CAC, HPs and advanced thermostats are included in this figure.

[3] Since we segmented the non-active contractor population of 424 into AIC's lists of two groups who were registered for the program: those never participating, and those who had previously participated (but had not since April, 2012) we weighted the responses by the ratio of the population to the sample for that particular group.