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Energy Efficiency
Nicor Gas Plan Year 3
(6/1/2013-5/31/2014)

Evaluation Report:
Emerging Technologies Program

Final

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1. Introduction to the Program

1.1 Program Description

The Nicor Gas Energy Efficiency Program's (EEP) Emerging Technology Program (ETP) is designed to identify energy efficient emerging technologies or practices (i.e., measures) that Nicor Gas can incorporate into their EEP to achieve greater program savings and provide better value to their customers.

The ETP measures therm savings through pilot assessment projects. Each pilot assessment project enables the ETP to conduct verification of manufacturer-claimed savings for each technology. In order to avoid double counting of savings among different programs, the savings from pilot assessments are attributable to the ETP only if they are not claimed by another program. The Gas Technology Institute (GTI) is Nicor Gas's implementation contractor for the ETP.

Gas Program Year 3 (GPY3) ran from June 1, 2013 to May 31, 2014. This program evaluation documents the GPY3 ex-ante savings and applies a historical realization rate. This evaluation will focus on: (1) changes made during GPY3 from prior years; and (2) the savings achieved through pilot assessment projects completed during GPY3.

Table 1-1 lists the five technologies for which the ETP completed field-based pilot assessment activities during GPY3.

Table 1-1. Pilot Assessments Completed in GPY3

Pilot Assessments in Nicor Gas Emerging Technology Program		
ID	**Short Title**	**Description and Status**
1009	Air Curtains	Technology produces a curtain of forced air over an open passageway to allow for an open barrier without excessive heat loss from the interior spaces to the outside. Monitoring completed 5/31/2014; report published 10/31/2014.
1008	Combo System	Combined systems provide both space heating and water heating for homes through a single piece of high efficiency gas fired equipment. Monitoring completed 5/31/2014; report published 10/1/2014.
1022	EcoFactor	Wi-Fi-enabled residential thermostat paired with third party proprietary software that makes thousands of micro-adjustments to the temperature setpoint over the course of a month to yield cumulative energy savings. Monitoring completed 5/31/2014; report published 5/4/2015.
1036	Non-Mod Dryer Retrofit	Post-factory retrofit to convert non-modulating commercial clothes dryers to two-stage modulation. Monitoring completed 5/31/2014; report published 9/16/2014.
1026	Thermal Equalizer	Also called de-stratification fans, thermal equalizers are a class of technology that reduces HVAC load by circulating the conditioned air within a space to prevent stratification. Monitoring completed 5/31/2014; report published 10/6/2014.

Sources: Email communications from B. Lutz of Nicor Gas on 5/4/15, published pilot assessment reports, and data extract from Nicor Gas EEP tracking system

1.2 Evaluation Questions

This evaluation sought to answer the following key researchable questions.

1. What is the ETP-attributable net therm savings for ETP pilot assessments in GPY3?
2. What processes have changed during GPY3? What drove the changes and how successful have they been?
3. Focusing on the five pilots completed in GPY3, where have challenges arisen? What are the key lessons learned and how might the ETP improve these processes in the future?
4. Did Nicor Gas transition specific technologies from ETP to EEP in GPY3? If so, what are the key lessons learned and how might the ETP improve the associated processes in the future?

2. Evaluation Methods

2.1 Primary Data Collection

The evaluation team conducted several in-depth telephone interviews to gather the data required for the evaluation. The interviews included prepared questions as well as time for free-flowing conversations between the evaluation team and participants. Table 2-1 provides a summary of the data sources contributing to the ETP evaluation.

Table 2-1. Principal Data Sources Contributing to the ETP Program Evaluation

Data Type	Targeted Population	Sample Frame	Sample Design	Sample Size	Timing
Tracking Data	TrakSmart database	Data submission template	-	All	March 2015
In-Depth Telephone Interviews	ETP Nicor Gas Program Manager	Contacts from Nicor Gas	Program Manager	1	April 2015
	ETP Implementation Contractor	Contacts from Gas Technology Institute (GTI)	Program Manager	1	April 2015

2.2 Impact Evaluation Methods

As planned for this GPY3 evaluation, Navigant did not perform a detailed project-specific impact evaluation of gross savings calculations. Instead, we reviewed the tracking data and verification approaches employed by the program and applied the 100% realization rate from GPY2 to the ETP's reported GPY3 savings, and applied the approved Net-to-Gross (NTG) ratio of 1.0. Our review covered the pilot assessment reports for each of the projects completed in GPY3, as well as a conference call with ETP to discuss the methodology. Particular attention was paid to the EcoFactor (ID#1022; see Table 1-1) pilot testing methodology to understand ETP's accounting for behavioral impacts. For emerging technologies it is customary to assume there is no measure free-ridership or spillover, since most customers are not familiar with the emerging technology, are reluctant to try something "new" or may have trouble finding an installer trained in the technology.

3. Evaluation Results

This section presents the evaluation team's findings for the Nicor Gas ETP. These findings address the evaluation questions presented in Section 1.2, above.

3.1 Impact Evaluation Results

3.1.1 Gross Program Impact Results

The ETP reported a total Gross Savings of 10,027 therms. Table 3-1 details the savings from each individual project. These data represent annualized savings from each of the metered pilot assessment projects. For example, a Combo System, whose savings is impacted by the severity of the heating season, would be expected to have a different savings each year. The ETP reports a typical expected savings based on the 30-year average heating degree days for the location, which they document in pilot assessment reports for each technology.

Table 3-1. Gross Therm Savings Summary for GPY3 ETP Projects

	Gross Therm Savings		
	Ex Ante Gross Savings (ETP Finding)	Verified Realization Rate	Verified Gross Savings
Air Curtains (1 unit)	427	100%	427
Combo System (5 units)	521	100%	521
EcoFactor Smart Thermostat (92 units)	2,160	100%	2,160
Non-Mod Dryer Retrofit (8 units)	2,664	100%	2,664
Thermal Equalizer (2 units)	4,255	100%	4,255
	Total: 10,027	**100%**	**Total: 10,027**

Sources: GPY3 tracking system data, email exchange with B. Lutz (Nicor Gas), and telephone interview with B. Lutz (Nicor Gas) and D. Kosar (GTI)

3.1.2 Net Program Impact Results

Navigant applied the program-planned Net-to-Gross (NTG) ratio of 1.0 to the sum of the Gross Savings in Table 3-1, resulting in a Net Savings of 10,027 therms.

3.1.3 Analysis Methodology

Table 3-2 summarizes the analysis methodology for pilot assessment projects completed during GPY3. Detailed discussion is available in the completed pilot assessment reports.[1]

[1] Reports available at: http://nicorgasrebates.com/resources/Emerging-technology

Table 3-2: Analysis Methodology Summary for Pilot Assessments Completed in GPY3

Air Curtains (1009)	
Data Collection	• 30 second interval data (3 second intervals when door is open) for gas valve (current switch) status, door open status, air curtain runtime (current switch) and temperatures in vicinity of door • Gas-use based on valve open/closed status, multiplied by nameplate input rating • Data only used from a single site; data from two other sites discarded due to undersized heating systems that did not cycle (regardless of air curtain operation) • Duration: 59 days of baseline operation and 100 days of air curtain operation; staggered periods to ensure a range of ambient conditions
Process	• Developed daily (average) gas-use factor for both baseline operation and air curtain operation periods, as ratio of daily gas-use to HDD65 times door-open time (Btu/HDD-sec); used to normalize for climate conditions and door-open time • Annualized by multiplying daily gas-use factor by total annual HDD and average daily door open time; repeated for both gas use and electricity use. • Extrapolated savings to estimate savings for site with longer door open times (monitored sites had relatively short open times)
Combo System (1008)	
Data Collection	• 30 second interval data (5 second intervals during water draws) for gas and water consumption and energy delivered to each end use. Direct measure of natural gas and power use • 4 to 12 months of data, depending on site; annualized by HDD extrapolation for sites with less than 12 months of data • 4 units in residences and 1 in a commercial building
Process	• Calculation approach based on comparison with baseline nameplate efficiency: calculate baseline by dividing space heating and water heating energy delivered by nameplate efficiencies of baseline equipment (developed both non-condensing and condensing baselines) • No existing rating system for these systems; this methodology used in other activities and is feeding into ASHRAE standard development process
EcoFactor Smart Thermostat (1022)	
Data Collection	• Hourly data, including average outdoor temp, average indoor temp, average smart adjusted heating setpoint and cooling setpoint, consumer-programmed setpoint, % time in heating mode, % time in cooling mode, off time, heating/cooling runtime, % time connected to internet • EcoFactor submitted monthly reports to GTI for each thermostat with all data • 12 months of monitoring - May 2013 to May 2014 • 104 thermostats total, but utilized 54 thermostats in 49 homes for final calculations due to many with connectivity issues, unusual billing data, or modulating furnaces that confounded results
Process	• Goal to identify additional savings from smart thermostat relative to programmable thermostat baseline • Calculated each home's daily heat transfer factor (in Btu/hr-°F) based on the hourly monitored furnace/AC runtimes and equipment capacities and the hourly temperature differences between indoors and outdoors • Baseline developed using seasonally averaged heat transfer factors, which could then be used to develop heating and cooling baseline consumption (using homeowner's programmed setpoints) • Baseline consumption subtracted from monitored consumption provided savings data • Compared results to EnergyPlus model for verification • Flagged times when homeowner was intervening in smart setback operation (and hours of total 'smart' operation) but did not try to characterize or understand behavioral factors that would be expected in a 'typical' installation. Noted in report that fewer interventions showed greater savings.

Non-Mod Dryer Retrofit (1036)	
Data Collection	• Monitored gas use, electric use, number of dryer cycles, intake air temp (often semi-conditioned air from behind unit) • Gas used based on valve open/closed status, multiplied by nameplate input for baseline operation • Similar for retrofit operation, but with specific monitoring for high and low firing durations (determined low-fire rate using manifold pressure of the valve) • Monitored 3 months of baseline (non-modulating) operation, 3 months total modulating dryer operation; alternating periods to account for differing make-up air temps
Process	• Averaged results across 8 monitored units (3 units excluded due to "baseline equipment issues") • Annualized by scaling 3 month data to 12 month period assuming consistent usage • Additionally conducted one standardized test each (for each dryer) in non-modulating and modulating operation using an identical laundry load to verify savings; normalized by measuring Btus consumed per pound of moisture removed (clothes weighed before and after drying).
Thermal Equalizer (1026)	

Data Collection	• Monitored gas valve open/closed status (current switch), fan runtimes (no modulation) and space temperatures to monitor stratification
	• Gas used based on valve open/closed status, multiplied by nameplate input
	• Monitoring period – collected in extended blocks of days:
	  ○ Site 1: 39 baseline operation days; 66 fan operation days
	  ○ Site 2: 42 baseline operation days; 53 fan operation days

Process	• Summed gas use (heating units) and electric use (fans) from all units in the space • Annualized using linear regression to calculate daily therm usage using observed 12 month HDD65

3.2 Process Evaluation Results

ETP personnel at both Nicor Gas and the implementation contractor, GTI, commented that GPY3 was characterized by steady-state operation with few big changes. As a result, programmatic changes were more incremental in nature. The following subsections discuss challenges encountered and changes made in GPY3.

3.2.1 Monitoring Equipment Inventory

Beginning in GPY3, the ETP began a process of maintaining inventory for field demonstration equipment such as data acquisition systems, metering hardware, and cellular communication modules among other things. This inventory does not include the customer-owned equipment (i.e., the emerging technology) under investigation. Over the course of 3 years of field demonstrations, the ETP had accumulated a substantial inventory of this equipment, and felt that such an asset should be carefully managed. Now, having documentation of this equipment, the ETP should be able to more easily manage these assets. Over time, the re-use of this equipment should enable some gradual reduction in costs as less new equipment will be required for each new pilot assessment.

3.2.2 Qualifying Criteria for Technologies

The ETP has broadened the qualifying criteria relating to market readiness for candidate technologies to allow evaluation of earlier-stage technologies. Typically, the ETP requires that products must be in commercial production and the manufacturer must have distribution channels established before ETP

consideration. However, the ETP is increasingly seeing candidate technologies that are worth evaluating that are still in late-stage development and/or do not have distribution channels established. By loosening this criterion, the ETP can initiate the screening processes (e.g., cost and energy research) in parallel with the manufacturer's late-stage product development.

ETP targets completion of screening processes at the same time the manufacturer completes fabrication and assembly of field-ready prototypes for testing. For example, the ETP may initiate cost and energy savings research on a heating technology that is not yet in production in order to be ready for a field demonstration at the start of the heating season (assuming a prototype will be available for testing at that time).

For less-well-established manufacturers (e.g., a startup), the ETP wants the loosening of the qualifying criteria to help show early support of a technology. They hope this may build confidence among the manufacturer's investors, which in turn can help accelerate the manufacturer's time to market and assist in overcoming remaining barriers. With these manufacturers, ETP is also more willing to bear costs for the equipment than they typically do for other manufacturers (typically free or at minimal cost to the program). These changes reflect maturation in the program and acknowledgement that ETP support can be an important factor in helping commercialize a product.

4. Findings and Recommendations

This section summarizes the evaluation team's findings and presents recommendations from the GPY3 evaluation of the Nicor Gas ETP.

4.1 Impact Findings

Table 4-1 documents the net therm savings attributable to the ETP in GPY3. The ETP assumes a net-to-gross ratio (NTG) of 1.0 for emerging technologies, thus *ex post* net savings equals *ex post* gross savings.

Table 4-1. ETP Net Therm Savings Summary

Technologies Installed	Individual Measures Installed	Ex Ante Gross Savings (Therms)	Realization Rate	Verified Gross Savings (Therms)	Net-to-Gross Ratio	Verified Net Savings (Therms)
5	108	10,027	100%	10,027	1.0	10,027

4.2 Process Findings and Recommendations

4.2.1 Actionable Recommendations

- ***ETP project and savings tracking***
  Finding: ETP projects in the tracking database contain out-of-date and missing information, which suggests that ETP performance tracking is inaccurate. Such data, when accurate, provides an important view into the value that the ETP provides to Nicor Gas and to the EEP.
  Recommendation: Since ETP tracking is distinct from typical EEP tracking in its objectives and metrics, the resolution is not necessarily just to update the specific pieces of information that are missing or out-of-date. ETP and EEP should review and clarify ETP's tracking objectives and tracking processes to determine what is required and what will provide the most benefit to the ETP (and EEP more broadly). Based on this review, ETP should implement changes that reflect these objectives and that minimize the maintenance burden and improve value to the program.

- ***Engineering rigor and ETP outputs***
  Finding: ETP outputs are often difficult to articulate clearly at the start of a technology evaluation. As the evaluation proceeds and a vision starts to emerge for how the utility can benefit from the technology, the ETP may be able to articulate better what the outputs must be. However, without direct input from the team that will be implementing the technology or process, there is risk that the ETP outputs will not exactly match the implementer's needs. During GPY3 PM/IC interview, ETP expressed good awareness of this challenge and acknowledged opportunity for improvements.
  Recommendation: Pursue two avenues to improve the value of ETP outputs by ensuring that they always match EEP needs:
    1. At the start of each new technology evaluation, develop a comprehensive understanding of the specific ETP outputs required for the evaluation. Leverage stakeholder expertise in developing engineering goals for each project through discussions with other EEP staff.

2. Expand the ETP's detailed understanding of the level of engineering rigor and necessary outputs required for various categories of projects. For example, the requirements are very different for a custom measure vs. a deemed measure or for a climate-varying measure vs. a non-climate varying measure. Consider convening a group of relevant ETP stakeholders for one or more meetings to collectively articulate output requirements, including engineering guidelines and parameters for common end-uses or technology categories. The guidelines could cover expectations for TRM documentation, technical workpapers, or transitioning of custom measures to deemed measures. Stakeholders may include (but are not limited to) EEP IC representatives, TRM experts, and engineering staff. Additionally, leverage this group of stakeholders later during action plan development to help provide specific engineering goals for each pilot assessment.

4.2.2 Additional Process Findings

- ***Idea generation***

  Finding: There is an increasing need for outreach and research to identify new technologies; the ETP has covered many of the well-known emerging technology opportunities in the first three years of the program and has exhausted much of the backlog of technologies that were queued up for evaluation. New technology evaluations come increasingly from internal research and focused outreach, all of which requires greater effort. ETP has expressed comfort in their balance between identifying technologies via internal research and accepting applications (or otherwise being contacted by outside parties with measure ideas). We see this as good awareness of market changes and appropriate process refinements to maintain their pipeline. The evaluation team has no related recommendations at this time.

- ***Technology landscape and ETP portfolio***

  Finding: ETP observes that new technologies that they identify (either from internal research or via contact from a vendor or distributor) are increasingly more complex solutions that address system integration and incorporate "smart" technologies, internet connectivity, and behavioral components. This is a distinct transition away from more traditional emerging technologies that improve performance by, for example, increasing natural gas burner efficiency. The ETP's apparent recognition of this transition is warranted. At this time, no changes are needed to adapt the ETP processes. In GPY4, we will revisit the topic to determine if broader changes would be beneficial to adapt the ETP. The evaluation team has no related recommendations at this time.

- ***Re-evaluation of promising technologies***

  Finding: ETP has implemented an annual review of previously evaluated, but shelved, emerging technology ideas, per a GPY1 evaluation recommendation. We believe that this has achieved the intended result of staying abreast of technology developments that may warrant re-introduction for more detailed evaluation (e.g., a pilot assessment). ETP has achieved a good balance in the level of effort spent reviewing past technologies while avoiding the common pitfall of using excessive resources on repeated review of non-viable technologies. The evaluation team has no related recommendations at this time.

- ***Non-technical barriers***
  Finding: Based on interviews with the program manager and implementation contractor, we found that ETP has an increased awareness, relative to prior years, of non-technical barriers that impact success of new measures. ETP's increased awareness is indicative of the maturing of the program and reflects a healthy understanding of the many technical and market forces that impact emerging technology viability. The evaluation team has no related recommendations at this time.