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Impact and Process Evaluation of the 2016 Illinois Power Agency Demand Based Ventilation Fan Control Program

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CADMUS

NAVIGANT

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1. Executive Summary

This report presents results from the evaluation of the Illinois Power Agency (IPA) Demand Based Ventilation Fan Control (DBVFC) for Year 9 (PY9), which was implemented by Matrix Energy Services (Matrix) from June 1, 2016 to May 31, 2017. The program targets facilities with highly variable occupancy, defined by Matrix as "facilities for which HVAC ventilation was designed for maximum assembly-like occupancy in mind, such as restaurants where people assemble at specific times." As part of the program, customers receive a free energy audit, identification of recommended energy efficient measures, and direct installation of fan controls. In PY9, the IPA DBVFC Program had energy savings goals of 4,932 MWh in electric savings, approved by the Illinois Commerce Commission (ICC)[1].

Over the course of PY9, 250 eligible customers completed 250 projects through the program and achieved 2,359 MWh in ex post net energy savings, which represents 48% of its goal of 4,932 MWh.

The evaluation of the PY9 SBDI Program involved both process and impact assessments. However, given Illinois' passage of the Future Energy Jobs Bill (SB 2814), which brings an end to IPA funding of energy efficiency programs after PY 9, the evaluation team conducted a limited process evaluation, which included a review of program-tracking data and program materials, and interviews with program administrators and implementation staff. Ex post gross impact evaluation efforts involved applying ex post verified savings algorithms and assumptions from the fan cycling work paper provided by the program implementer[2]. Through a review of the work paper and discussions with the implementer, we determined that this work paper was a more accurate method for determining savings for the IPA DBVFC Program than the Demand Controlled Ventilation (DCV) measure in the Illinois TRM[3]. The evaluation team applied the Illinois Stakeholder Advisory Group (SAG)-approved net-to-gross ratio (NTGR) of 0.89 to all measures to calculate net impacts. Key findings from the PY9 evaluation are presented below.

Program Impacts

Table 1 summarizes the electric energy savings from the PY9 IPA DBVFC Program. The program achieved ex post and ex ante gross savings of 2,651 MWh[4]. The evaluation team then applied the SAG-approved NTGR of 0.89 to the ex post gross impacts to estimate ex post net impacts of 2,359 MWh for energy savings.

[1] 2015 IPA Electricity Procurement Docket 14-0588

[2] The fan cycling work paper is an Excel spreadsheet provided by the implementer ("Energy Savings Calculations for Work Paper - Fan Cycling - Ameren Rev. 08112016") documenting the occupancy, temperature, enthalpy, reduced time profiles month by month across each hour of the month. The implementer also provided a qualitative measure description and energy savings descriptions via email. See attached files in Appendix Appendix B.

[3] The DCV methodology in the IL-TRM V5.0 operates under the assumption that the savings come through a reduction in conditioned air through reducing the operating hours of systems. The DBVFC unit reduces fan operating hours through cycling of the unit based on occupancy.

[4] The implementer did not provide gross savings at the individual participant level, therefore we estimated total ex ante gross savings using the deemed gross kWh savings per ton provided by Matrix and then multiplying by the project tonnage for each participant in the database. We use this same methodology for ex post calculations as documented in the Appendix.

Table 1. PY9 Small Business Demand Control Ventilation Savings Program Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	2,651	100%	2,651	0.89	2,359

Key Findings and Recommendations

The following findings and recommendations for the program are based on the results of our program evaluation:

- **Key Finding #1**: The program achieved 48% of its energy saving goals. Though the program met less than half of its energy savings goals, the program implementers were pleased with the limited participation in the program, given that the measure was unfamiliar to small business owners.
  - **Recommendation:** If ventilation fan controls are included as a measure in future programs, it may take more than one year for the measure to gain traction with small business owners. Energy saving goals with respect to this measure should be conservative and increase over time in accordance to increased consumer knowledge.
- **Key Finding #2**: The program was marketed primarily via the Matrix Small Business Linear LED program, and 80% of the participants in the IPA DBVFC Program had also participated in the Linear LED Program, showing that it was an effective marketing strategy.
  - **Recommendation:** Future programs should consider cross-marketing unfamiliar technologies with well-known energy efficiency upgrades to capture the attention of potential participants and build trust in the energy efficiency offerings.
- **Key Finding #3**: The evaluation team determined that discrepancies between ex ante and ex post savings values were minimal, and the ex ante savings methodology for the measure did not follow the IL-TRM V5.0, but rather a customized approach.
  - **Recommendation:** While the evaluation team agrees with ex ante deviation from the TRM, we recommend that project square footage data be collected for future projects in other programs to facilitate the application of IL-TRM algorithms as a method of comparison to the current method.

2. Evaluation Approach

The PY9 evaluation of the IPA DBVFC Program involved both process and impact assessments. However, given Illinois' passage of the Future Energy Jobs Bill (SB 2814), which brings an end to IPA funding of energy efficiency programs after PY9, the evaluation team conducted a limited process evaluation, which included in-depth interviews with program administrators and implementation staff and a comprehensive review of program materials and program-tracking data. To evaluate gross impacts, the evaluation team reviewed the PY9 program-tracking data and applied the fan cycling algorithms and assumptions. To assess net impacts, the evaluation team applied the SAG-approved NTGR of 0.89 to ex post gross impacts.

2.1 Research Objectives

The overall objective of the PY9 evaluation is to assess program performance, a central component of which is providing estimates of gross and net electric savings associated with the program. As such, the PY9 impact evaluation answers the following questions:

1. What were the estimated gross electric and demand impacts from this program?
2. What were the estimated net electric and demand impacts from this program?

Given that this was the only year of the IPA DBVFC Program, the evaluation team conducted a limited process assessment to answer the following questions:

3. Program Participation
    a. What were the characteristics of participating customers? How many projects were completed? By how many different customers? What types of projects?
    b. Did customer participation meet expectations? If not, how different was it and why?
4. Program Design and Implementation
    c. Was the program implemented as planned? If not, what changes were made, and why?
    d. What, if any, implementation challenges occurred in PY9, and how were they overcome?

2.2 Evaluation Tasks

Table 2 summarizes the PY9 evaluation activities conducted for the IPA DBVFC Program.

Table 2. PY9 Evaluation Activities

Activity	Impact	Process	Forward Looking	Details
Program Staff Interviews		✓		Gather information about program marketing and implementation.
Program Materials Review	✓	✓		Review program data to assess program operations in PY9.
Impact Analysis	✓			Calculate gross and net impacts using the IL-TRM V5.0 and SAG-approved NTGR values for PY9.

2.2.1 Program Staff Interviews

The evaluation team completed in-depth interviews with AIC program administrators, Leidos (IPA Oversight), and Matrix (implementation staff) in June and July, 2017. The interviews explored implementation changes, program performance, program participation, and marketing and outreach throughout the IPA DBVFC Program.

2.2.2 Program Materials Review

The evaluation team conducted a comprehensive review of all tracking data and program materials, including the program implementation plan, program marketing materials, and the PY9 program-tracking database.

2.2.3 Impact Analysis

The evaluation team used ex post verified savings algorithms and assumptions from the fan cycling work paper provided by the program implementer. For net impacts, ex post analysis applied the SAG-approved NTGR of 0.89 to gross savings. Through a review of the work paper and discussions with the implementer, we determined that this work paper was a more accurate method for determining savings for the DBVFC Program than the Demand Controlled Ventilation (DCV) measure in the Illinois TRM[5].

2.3 Sources and Mitigation of Error

Table 3 provides a summary of possible sources of error associated with research tasks conducted for the IPA DBVFC Program. We discuss the sources of error below.

[5] The Demand Controlled Ventilation methodology in the IL-TRM V5.0 operates under the assumption that the savings come through a reduction in conditioned air through reducing the operating hours of systems. The DBVFC unit reduces fan operating hours through cycling of the unit based on occupancy.

Table 3. Possible Sources of Error

Research Task	Survey Errors		Non-Survey Errors
	Sampling Errors	Non-Sampling Errors	
Impact Analysis	N/A	N/A	Analysis Errors

Non-Survey Errors

This section reports on errors that could affect the results included in this report.

- **Analysis Errors**
  - **Impact Analysis:** To minimize analysis error, the evaluation team had all calculations reviewed by a separate team member to verify that calculations were performed accurately.

3. Detailed Evaluation Findings

This section of the report provides detailed findings related to program processes and impacts.

3.1 Program Design and Implementation

The IPA DBVFC Program was adopted through the IPA procurement plan process for the first time in PY9. This single year program targeted facilities with highly variable occupancy, defined by Matrix as "facilities for which HVAC ventilation was designed for maximum assembly-like occupancy in mind, such as restaurants where people assemble at specific times." Because American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Code dictates that HVAC units must operate to meet standards at peak occupancy, energy is wasted when a facility of highly-variable occupancy is empty. To address this issue, the program deployed demand-based ventilation fan controls, which automatically turn the fan motor off at times of low occupancy and reduce the volume of air to be heated or cooled during off hours.

As part of the program, customers received a free energy audit, identification of recommended energy efficient measures, and direct installation of fan controls. In PY9, the IPA DBVFC Program had energy savings goals approved by the ICC in the 2015 IPA Electricity Procurement Docket 14-0588 of 4,932 MWh in electric savings.

Matrix staff marketed the program, scheduled audits, enrolled customers, and scheduled installations. Matrix did not utilize program allies to market or deliver the program.

Marketing and Outreach

The IPA DBVFC Program targeted DS-2 customers with highly-variable occupancies, such as restaurants, bars, and fitness centers. Because the program measure was less commonly known compared to other energy efficiency upgrades, marketing for the program piggybacked on Matrix's other program—the Small Business Linear LED Program. When participants completed LED lighting upgrades at their facilities, program implementation staff recruited small business owners to also participate in the DBVFC. As such, program implementers did not employ canvassing or marketing efforts exclusively for the DBVFC program, and all marketing was conducted in tandem with the Small Business Linear Lighting Program.

3.2 Program Performance and Participation

3.2.1 Program Performance

The program achieved approximately 48% percent of its energy saving goals in its one year of operation. Table 4 outlines the program's performance against its energy goals.

Table 4. PY9 Program Performance against Energy Savings Goal

Metric	MWh
Goal	4,932
Ex Post Net Savings	2,359
% of Goal	48%

The program installed 3,375 measures across the 250 facilities. Table 5 presents key program performance and participation statistics.

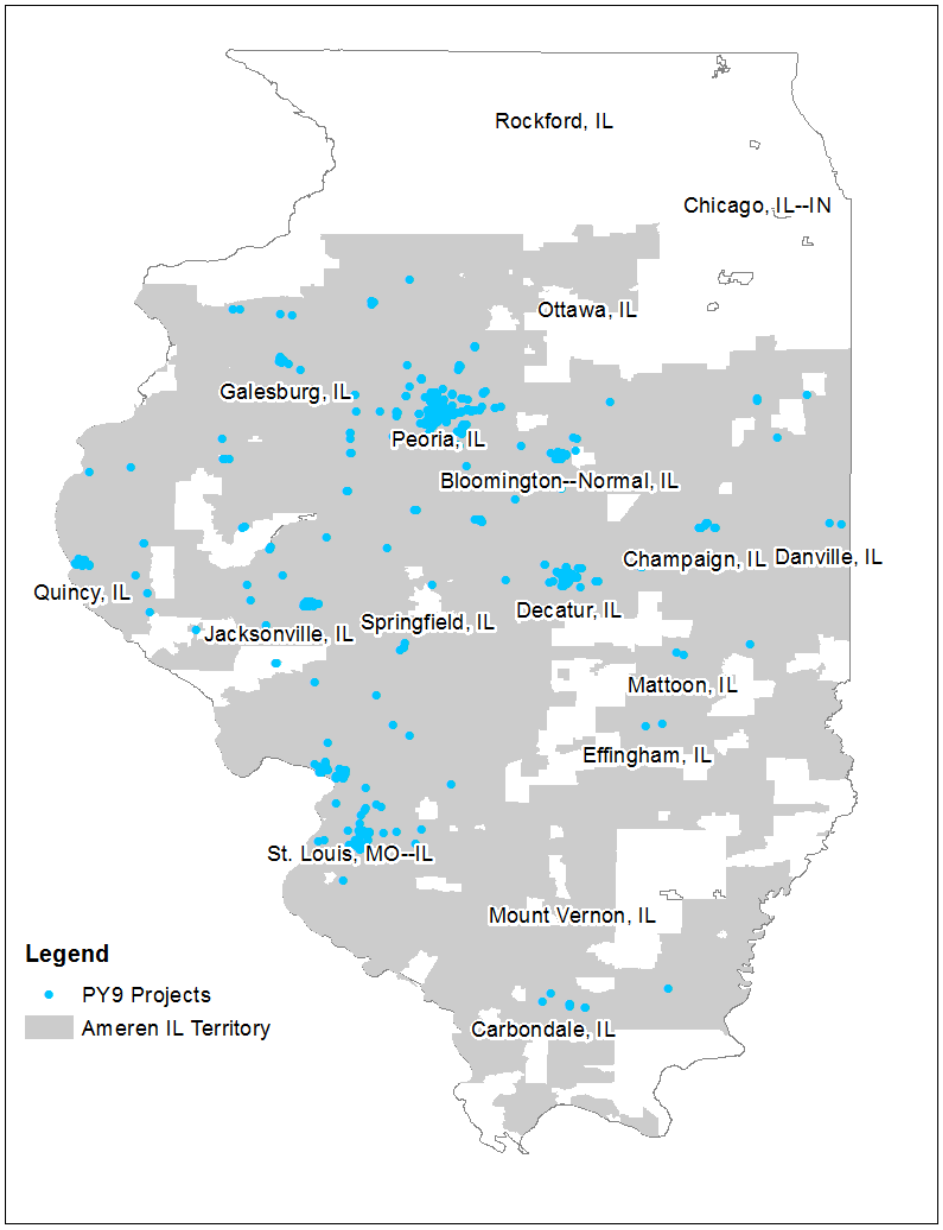
Table 5. Small Business DBVFC Program Performance and Participation

Metric	PY9 Outcome
Ex Post Net Savings (MWh)	2,359
Program Participants	250
Projects Completed	250
Measures Installed	3,375

3.2.2 Program Participation Analysis

The program recruited 250 participants, which were spread across the AIC service territory (Figure 1). Eighty percent of the IPA DBVFC Program participants were also participants in the Matrix Small Business Linear LED Program, verifying that the Linear LED Program was an effective way to reach small businesses and recruit them for participation in the IPA DBVFC Program.

Figure 1. IPA DBVFC Program Participant Map



3.2.3 Barriers to Program Implementation

The IPA DBVFC Program achieved 2,359 MWh in ex post net energy savings, which accounted for 40% of its goal (4,932 MWh). These shortfalls are attributed to the following factors:

- **Lack of understanding of the measure's benefits:** Program implementers anticipated that small business owners would not have prior knowledge of, or experience with, ventilation controls and thus would not appreciate the energy bill savings associated with the measure. However, the relatively high program goal suggests that implementers believed they could overcome this barrier and meet an

ambitious goal. This lack of understanding of the measure likely did influence participation in the program, as the program had relatively low participation and met only a fraction of its goal.

- **Matrix programs were suspended for six weeks in early 2017:** Due to customer complaints related to the Small Business Linear LED Program (another IPA program that Matrix was implementing), all Matrix programming was suspended for six weeks. This may have affected the IPA DBVFC Program, as participation in the IPA DBVFC Program was driven by participation in the Linear LED Program.

3.3 Impact Results

The following sections outline the results of the gross and net impact analysis for the PY9 IPA DBVFC Program. Overall, the program fell short of its goal, but achieved 100% realization rate for net energy savings.

3.3.1 Gross Impacts

Overall, total gross energy ex post impacts for the IPA DBVFC Program was 2,651 MWh. The evaluation team applied savings algorithms from the fan cycling work paper, provided by the implementation team, using program-tracking database inputs to estimate PY9 ex post gross savings for the IPA DBVFC Program. The evaluation team also applied an in-service rate (ISR) of 100% based on the IL-TRM V5.0. We provide detailed results in the following sub-sections.

Measure Verification and In-Service Rates

For PY9 the evaluation team referenced the IL-TRM V5.0 to develop a verified measure quantity from the DCV ISR of 100% as seen below in Table 6.

Table 6. PY9 DBVFC Measure Quantities and ISRs

Measure Category	Ex Ante Measure Quantity[a] (a)	Ex Post ISR[b] (b)	Verified Measure Quantity (a*b)
12-Hr Business	102	100%	102
13-Hr Business	22	100%	22
14-Hr Business	88	100%	88
15-Hr Business	94	100%	94
16-Hr Business	318	100%	318
17-Hr Business	130	100%	130
18-Hr Business	317	100%	317
19-Hr Business	259	100%	259
20-Hr Business	344	100%	344
21-Hr Business	46	100%	46
22-Hr Business	306	100%	306
23-Hr Business	667	100%	667
24-Hr Business	685	100%	685
Total	**3,375**	**100%**	**3,375**

[a] Source: Matrix Energy –DBVFC IPA Program Results PY9 - (Final Program Tracking Database)
[b] Ex post ISRs are from the IL-TRM V5.0.

Ex Post Gross Impact Results

Table 7 summarizes the PY9 ex post gross impacts associated with the IPA DBVFC Program. The overall ex post gross impact savings for the PY9 DBVFC Program are 2,651 MWh, seen in Table 7. Ex ante program data did not provide claimed gross savings at the project level, therefore the evaluation team calculated ex ante gross savings using the implementer supplied deemed gross savings per measure. Similarly, the evaluation team calculated ex post savings using inputs and algorithms from the ex ante fan cycling calculations and applied the ISRs summarized above in Table 6.

Table 7. PY9 DBVFC Program Gross Impacts

Program	Ex Ante Gross MWh	Ex Post Gross MWh
DBVFC	2,651	2,651
	Realization Rate[a]	**100%**

[a] Gross realization rate = ex post gross value ÷ ex ante gross value

Table 8 summarizes the gross impact results by measure. As ex ante program data did not provide gross savings at the project level[6], the evaluation team was unable to document project specific discrepancies between ex post and ex ante savings estimations. Further discussion of discrepancies follows this section in the net impacts section. Specific inputs for all ex post savings estimates are in Appendix B.

Table 8. DBVFC PY9 Ex Post Gross Impacts

Measure Category	Verified Measure Quantity	Ex Ante Gross MWh	Ex Post Gross MWh	Gross MWh Realization Rate
12-Hr Business	102	62	62	100%
13-Hr Business	22	14	14	100%
14-Hr Business	88	59	59	100%
15-Hr Business	94	64	64	100%
16-Hr Business	318	222	222	100%
17-Hr Business	130	93	93	100%
18-Hr Business	317	234	234	100%
19-Hr Business	259	196	196	100%
20-Hr Business	344	267	267	100%
21-Hr Business	46	36	36	100%
22-Hr Business	306	251	251	100%
23-Hr Business	667	561	561	100%
24-Hr Business	685	592	592	100%
Total	**3,375**	**2,651**	**2,651**	**100%**

[6] The implementer did not provide gross savings at the individual participant level, therefore we estimated total ex ante gross savings using the deemed gross kWh savings per ton provided by Matrix and then multiplying by the project tonnage for each participant in the database. We use this same methodology for ex post calculations as documented in the Appendix.

3.3.2 Ex Post Net Impact Results

In determining the overall net savings associated with the IPA DBVFC Program, the team applied the SAG-approved NTGR of 0.89 to ex post gross savings.

Although the savings calculation method used for ex post was nearly identical to that of the implementation team, there were a handful of project specific irregularities. For 11 out of the 250 total projects, the implementer calculated net energy savings differently, as the values for these projects do not align with the stated assumptions. Overall, these discrepancies resulted in less than 1% difference between ex ante and ex post total net energy savings. As a combined result, the program achieved net realization rates of 100% for energy savings (Table 9).

Table 9. DBVFC Program Net Impacts

Program	Ex Ante Net MWh	Ex Ante NTGR	Ex Post NTGR	Ex Post Net MWh
DBVFC	2,351	0.89	0.89	2,359
			Net Realization Rate	**100%**

[a] Net realization rate = ex post net value ÷ ex ante net value.

4. Conclusions and Recommendations

Based on the results of the PY9 IPA DBVFC evaluation, the evaluation team offers the following key findings and recommendations for the program moving forward:

- **Key Finding #1**: The program achieved 40% of its energy saving goals. Though the program met less than half of its energy savings goals, the program implementers were pleased with the limited participation in the program, given that the measure was unfamiliar to business owners.
  - **Recommendation:** Future programming for ventilation and HVAC measures may take more than one year to gain traction and reach full participation. Energy saving goals should be conservative for unfamiliar measures and increase over time in accordance to increased consumer knowledge.
- **Key Finding #2**: The program was marketed primarily via the Matrix Small Business Linear LED Program, and 80% of the participants in the IPA DBVFC Program had also participated in the Linear LED Program, showing that it was an effective marketing strategy.
  - **Recommendation:** Marketing for unfamiliar measures should occur in conjunction with well-known energy efficiency upgrades in order to capture the attention of potential participants and build trust in the energy efficiency offerings.
- **Key Finding #3**: The evaluation team determined that discrepancies between ex ante and ex post savings values were minimal, and the ex ante savings methodology for the measure did not follow the IL-TRM V5.0, but rather a customized approach.
  - **Recommendation:** While the evaluation team agrees with ex ante deviation from the TRM, we recommend that project square footage data be collected for any future projects to facilitate the application of IL-TRM algorithms as a method of comparison to the current method.

Appendix A. DBVFC Program Assumptions and Algorithms

In PY9, the impact evaluation efforts estimated gross impact savings for the IPA DBVFC Program by applying savings algorithms from the Energy Savings Calculations for Work Paper, provided by the implementer, to the information provided in the program-tracking database.

We present the algorithms used to calculate all evaluation program savings below, along with all input variables.

A.1 DBVFC

The evaluation team determined ex post savings for demand based ventilation fan control using the algorithms below.

Equation 1. DBVFC Algorithms

$$Energy\ Savings\ (\Delta kWh) = Energy\ Savings * Quantity$$

$$Gas\ Savings\ (\Delta Therms) = Therm\ Savings * Quantity$$

Where:

Energy savings = Deemed energy savings per ton (varies by measure type, see Table 10)

Therm savings = Deemed therm savings per ton (varies by measure type, see Table 10)

Quantity = HVAC tonnage specific to project location

Table 10. Deemed Savings Values for DCV

Measure Type	Deemed Energy per Measure (kWh/ton) [a]	Deemed Therms per Measure (Therms/ton) [a]
12-Hr Business	609.43	75.56
13-Hr Business	657.23	73.78
14-Hr Business	665.47	73.56
15-Hr Business	682.11	73.05
16-Hr Business	699.44	72.90
17-Hr Business	718.56	72.67
18-Hr Business	737.96	72.67
19-Hr Business	757.06	72.67
20-Hr Business	777.57	72.67
21-Hr Business	798.67	72.67
22-Hr Business	819.62	72.60
23-Hr Business	841.40	72.60
24-Hr Business	864.16	72.60

[a] Calculated and provided by Matrix Energy Service, in Energy Savings Calculations for Work Paper. The calculations are based upon temperature and occupancy profiles through an entire year at an hour by hour resolution.

Appendix B. DBVFC Program Calculation Input File

Fan Cycling Work Paper description fr

In support of this report, we also provide a calculation file detailing the implementer's ex ante savings calculation methods. Due to the large size of this file, we have chosen not to embed it in this document. It is available on Opinion Dynamics' ShareFile website at the below web address:

https://opiniondynamics.sharefile.com/d-sd092759e62344de8

Appendix C. DBVFC Program Therm Savings

In addition to the energy savings detailed above (Section 3.3), the evaluation team also calculated gas savings associated with the IPA DBVFC Program. Although the program data does not include heating equipment type, following the IL-TRM V5.0, the evaluation team estimated net gas savings of 218,624 therms via the assumption that all buildings have gas heat. We recommend providing heating fuel type for future programs to allow for a more accurate determination of therm savings.

Table 11. PY9 Small Business DCV Net Therm Savings

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Gas Savings (Therms)					
Total Therms	0	N/A	245,645	0.89	218,624

We present the further breakdown of gross, and measure level gas savings in the tables below. Ex post gross gas savings, seen in Table 12, was 245,645 therms. Measure specific therm savings are reported in Table 12.

Table 12. DBVFC PY9 Ex Post Gross Therms Impacts

Measure Category	Verified Measure Quantity	Ex Ante Gross Therms[a]	Ex Post Gross Therms	Gross Therms Realization Rate
12-Hr Business	102	N/A	7,669	N/A
13-Hr Business	22	N/A	1,586	N/A
14-Hr Business	88	N/A	6,473	N/A
15-Hr Business	94	N/A	6,866	N/A
16-Hr Business	318	N/A	23,184	N/A
17-Hr Business	130	N/A	9,447	N/A
18-Hr Business	317	N/A	23,035	N/A
19-Hr Business	259	N/A	18,784	N/A
20-Hr Business	344	N/A	24,997	N/A
21-Hr Business	46	N/A	3,306	N/A
22-Hr Business	306	N/A	22,215	N/A
23-Hr Business	667	N/A	48,387	N/A
24-Hr Business	685	N/A	49,694	N/A
Total	**3,375**	**N/A**	**245,645**	**N/A**

[a] Ex ante claimed no gas savings

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