Agricultural Impact Evaluation 2017 - 2020

Final Report

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1 Introduction

1.1 Program Description

The Agricultural Energy Audit Program (AEAP) is a strategic initiative designed to support and promote energy efficiency within the agricultural sector in New York State. By providing targeted technical assistance to eligible farms, AEAP plays a crucial role in helping farm operators identify actionable energy efficiency measures that can lead to significant cost savings and sustainability improvements. Farms of various types, including dairies, orchards, greenhouses, vegetable growers, vineyards, grain dryers, and poultry or egg producers, can benefit from the program's offerings. By collaborating with NYSERDA, AEAP ensures that farms receive the expertise needed to navigate the complexities of energy management.

Upon enrollment in the program, farms are paired with consultants from NYSERDA's Flexible Technical Assistance (FlexTech) Program, who are tasked with conducting thorough energy audits. These audits culminate in detailed reports that pinpoint areas of potential energy savings and outline the expected payback periods for any recommended energy efficiency upgrades and clean energy investments. This comprehensive approach equips farm operators with the necessary information to make informed decisions that align with their operational goals and financial planning, fostering a more energy-conscious and economically viable agricultural industry in New York.

1.2 Summary of Evaluation Objectives and Methods

The objectives and methods of this impact evaluation are summarized in Table 1-1.

Table 1-1 Evaluation Objectives, Purpose, and Methods

Objective	Purpose	Method
Evaluate measure adoption rates (MARs) for AEAP audits	To assess the extent to which energy-efficient technologies are implemented.	Self-reported measure installation collected from participant survey. Verified measure installation from phone interviews and bottom-up calculation questioning.
Verify energy savings	Determine the extent to which adoptions of self-reported measures are correct. Benchmark program performance. Optimize future program efforts.	Utilize AEAP audits and utility billing data information to perform regression analysis and bottom-up calculations for individual installed measures.
Assess non-energy benefits	Determine the overall value, economically, environmentally, and socially, of the effectiveness of energy efficiency measures.	Phone interviews with participants will identify potential cost savings, air quality improvement, or time saved.

2 Impact Assessment Results

This section presents the results of the Agricultural Energy Audit Program impact evaluation.

2.1 Evaluated Population

The evaluated population covers AEAP audit participants from January 1, 2017, through December 31, 2020. Agricultural sites are categorized by year according to the "Completed Audit Date" field in the data portal FEAT, managed by EnSave. The completed audit date is when the audit participant receives the final audit report.

From 2017 through 2020, the AEAP conducted 933 energy audits, as detailed in Table 2-1. Guidehouse and APPRISE (the Market Evaluation Team) fielded a survey of program participants as part of a separate market evaluation. This survey yielded 327 responses, equating to a 35% participation rate. The survey supplied critical data for this impact evaluation, including details on the type of energy-efficient measures installed, the time of implementation, and any changes in operations affecting production and energy use.

Table 2-1 Population of Audit Participants and Participant Survey Completes

Completed Audit Year	Population Count of Completed Audits	Count of Completed Participant Surveys	Share of Completed Surveys (%)	Count of Utility Data Authorization	Share of Utility Authorization (%)	Count of Usable Data	Share of Usable Data (%)
2017	404	148	37%	48	12%	18	4%
2018	290	96	33%	33	11%	11	4%
2019	154	54	35%	16	10%	10	6%
2020	85	29	34%	11	13%	4	5%
Total	**933**	**327**	**35%**	**108**	**12%**	**43**	**5%**

To analyze the energy savings using a billing analysis, the Evaluation Team requires monthly utility bills from one year before the audit up to the date of the data request. Out of the 327 surveys the Market Evaluation Team completed, 108 participants (33%) agreed to share their utility billing data for this purpose. The request for utility data covered January 2016 to April 2023. However, data from 45 New York State Electric and Gas (NYSEG) and Rochester Gas and Electric (RGE) customer sites (14%) only spanned from 2020 to April 2023. Moreover, 26 sites (8%) from all utilities provided invalid account numbers. Eventually, utility billing data from 45 agricultural sites was used for regression analysis to assess energy savings.

Table 2-2 provides a count of sampling outcomes. This evaluation sampled 49 agricultural sites, completing audits from 2017 through 2020. The Evaluation Team successfully analyzed 15 agricultural sites using regression methods. Additionally, 6 cases were completed using a bottom-up engineering approach. Two instances were documented where information was gathered exclusively through phone interviews. However, no billing data is available for these sites. The category "Failed Regression" includes 9 cases where regression analysis did not produce valid results. There are 13 instances where no measure has been installed for agricultural sites authorizing utility data access. Four cases have incomplete baseline data, which means the necessary foundational information for analysis is unavailable.

Table 2-2 Evaluation Sample Disposition

Sample Category	Count
Complete: Regression	15
Complete: Bottom-up	6
Phone Interview Only	2
Failed Regression	9
No Measure Installed	13
Incomplete Baseline Data	4
Total	**49**

2.2 Measure Adoption Rates

The evaluated estimate of the overall MAR for the program is 33%. This is the weighted share of adopted energy savings in kWh/year in relation to the total energy savings in kWh/year for all recommended energy-efficiency measures. This finding is based on self-reported measure installs, participant phone interviews, and bottom-up calculations. Measure Adoption Rates for individual audit completion years are provided in Table 2-3.

Table 2-3 Cumulative Weighted Measure Adoption Rate by Year Post-Audit (% kWh/year)

Audit Completion Year	Count of Agricultural Sites	Post Audit Year 1	Post Audit Year 2	Post Audit Year 3	Post Audit Year 4	Post Audit Year 5
2017	21	33%	51%	53%	54%	57%
2018	15	5%	7%	8%	8%	8%
2019	8	12%	24%	24%	24%	-
2020	5	5%	5%	5%	-	-
Total	**49**	**20%**	**30%**	**31%**	**32%**	**33%**

2.2.1 Agricultural Site Results

The Evaluation Team analyzed 287 individual audit measures for agricultural sites completing energy audits from 2017 through 2020. Table 2-4 provides the count and share of audit measures by category. The Evaluation Team estimates that 66% of identified audit measures included in participant reports are recommended for installation. According to self-reporting, the Evaluation Team estimates that 24% of audit measures are installed by sites. This self-reported share of installed measures includes measures not recommended in the participant audit reports. It is assumed that the audit reports influenced the participant's decision to install the measure.

Table 2-4 Measure Counts by Category

Measure Category	Sample Measure Count	Sample Share (%)
Audit Identified	287	100%
Audit Recommended	190	66%
Self-Reported Installed	69	24%

Figure 2-2 provides the distribution of agricultural sites by the number of recommended energy-efficiency measures per audit. On average, an audit provided 3.9 recommendations per site. Figure 2-3 shows the distribution of agricultural sites by the number of self-reported installed energy efficiency measures per site. On average, an audited agricultural site installed 2.2 recommended audit measures.

Figure 2-1 Recommended Audit Measures per Sample Site

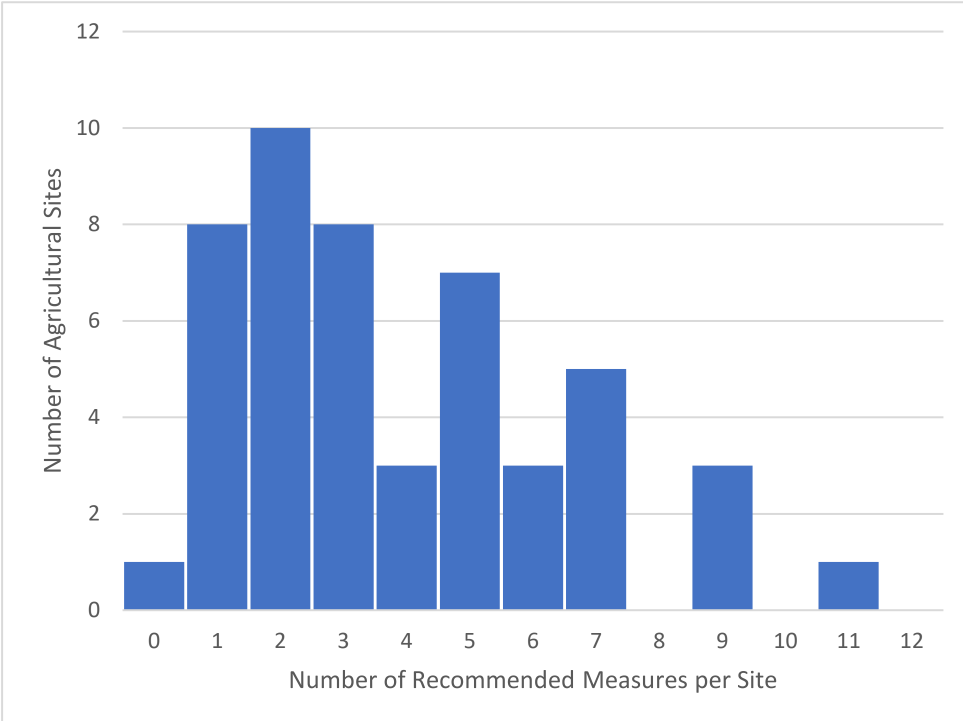
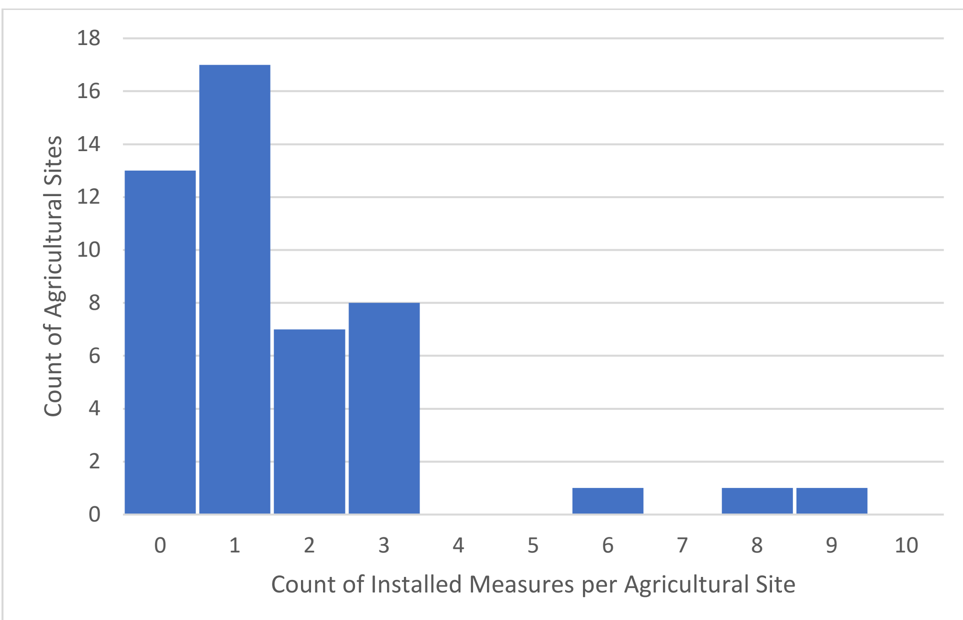


Figure 2-2 Count of Sites by Installed Audit Measures



2.2.2 Measure Adoption Rates by Count

This section of the evaluation report provides individual measures of adoption rates. These MARs are based on the count of installed measures as opposed to the percentage of kWh/year provided for program MAR earlier in this report.

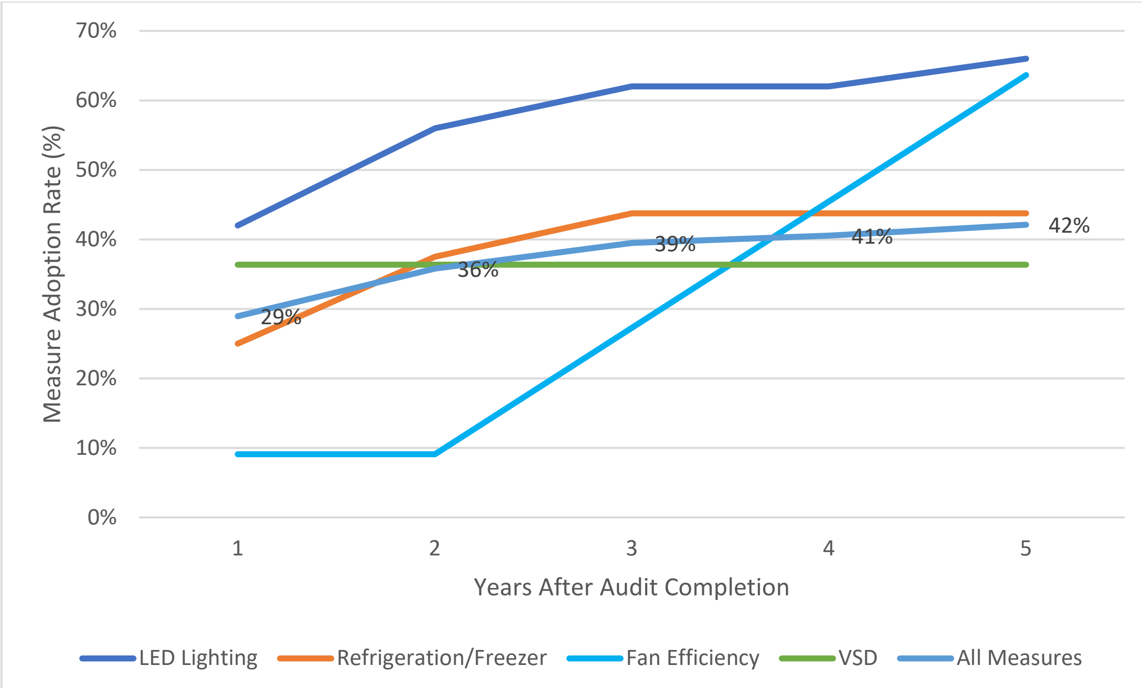
In this evaluation, 80 of the 190 recommended audit measures, or 42%, have been implemented across the sampled sites. The 2023 Market Evaluation Report for this program indicated that 36% of audit recommended measures were installed.[1] The difference in the installed measure share is due to the tendency of participants to under-report the installation of measures. Table 2-5 provides measure counts and shares of audit measures by individual audit categories. LED lighting is the most frequently recommended measure (93%) and has the highest installation share of any individual measure (66%). Solar PV systems, Motor upgrades, and Variable Frequency Drive (VFD) recommended audit measures all have a 0% installation rate. Figure 2-4 compares notable individual audit measures to all measures installed within five years of a completed audit.

Table 2-5 Individual Measure Adoption Rates

Audit Measure	Audit Count	Recommended Count	Recommended Share (%)	Installed Count	Installed Share (%)
LED Lighting	54	50	93%	33	66%
Refrigeration/ Freezers	25	16	64%	7	44%
Solar PV	24	6	25%	0	0%
Motors	20	5	25%	0	0%
Fan Efficiency	19	11	58%	4	36%
VFD	14	6	43%	0	0%
VSD	14	11	79%	4	36%
Heating Efficiency	12	6	50%	1	17%
Heat Recovery	12	9	75%	3	33%
Other	93	70	75%	29	41%
Total	**287**	**190**	**66%**	**80**	**42%**

[1] New York State Energy Research and Development Authority. (2023, September). *Agriculture Market Evaluation: Market Update 1.* Retrieved from https://www.nyserda.ny.gov/About/Publications/Evaluation-Reports/Commercial-Industrial-Agriculture

Figure 2-3 Measure Adoption Rate (%) by Measure Count Years After Audit Completion



2.3 Direct and Indirect Impacts

Direct savings result from measures implemented in the first year after an audit. Indirect savings occur between the second and fifth years post-audit. For this study, which examines audits from 2017 through 2020, it is acknowledged that the evaluation's timeline does not entirely cover the indirect savings for audits performed in 2019 and 2020.

All evaluation periods show negative savings attributable to an increase in overall energy use and a high frequency of linear regression analyses that cannot precisely model agricultural business practices and changes in behavior. Due to the lack of available data and subsequent poor relative precision of findings, this evaluation does not provide total savings estimates. More robust data collection is planned for the next phase of this evaluation, allowing for more accurate savings reporting calculations.

Energy savings by key parameter measurement more accurately represent the actual energy savings attributable to this program than those estimated through linear regression models. Table 2-6 provides each savings category's electric energy savings, realization rates, and precision values for sites evaluated by key parameter measurement. The five key sites analyzed under key parameter measurement achieved total annualized savings of 13,478 kWh/year. The full evaluation period realization rate of 113% for measures evaluated using key parameter measurement is attributed to agricultural sites installing additional energy-efficient measures outside the scope of their audit report.

Table 2-6 Energy Savings and Realization Rates for Measures Evaluated Using Key Parameter Measurement

Savings Category	Savings (kWh/year)	Realization Rate (%)	Precision
Direct	11,730	121%	0.22
Year 2	1,748	88%	0.11
Indirect	1,748	88%	0.11
Total	13,478	113%	0.19

Natural Gas and Fossil-Fuel Sourced Measures

Due to a lack of available natural gas billing data, the evaluation team did not perform linear regression analyses for agricultural sites that installed natural gas energy efficiency measures. Examples of energy-efficient natural gas measures include installing more efficient boilers or unit heaters.

Additionally, the agricultural sites in communication with the evaluation team for key parameter measurement did not install natural gas or fossil-fuel-sourced energy efficiency measures.

2.4 Non-Energy Benefits

Non-energy benefits (NEBs) are additional impacts from the AEAP beyond the energy savings from implementing energy efficiency measures. Table 2-7 summarizes the NEBs of cost savings and avoided GHGs over different periods for agricultural sites analyzed by key parameter measurement.[2] To calculate avoided GHG emissions, the evaluation team utilizes an emissions factor of 0.31 short tons of CO_2/MWh, a system-average emissions factor for New York State form 2017-2020.[3] In the first year, direct energy savings amounted to 11,730 kWh, leading to cost

[2] Additional areas of cost savings fall beyond this evaluation's capacity to address. These include potential savings in areas that are not easily quantifiable, such as operational and maintenance expenses or changes to labor.

[3] New York State Energy Research and Development Authority (NYSERDA). 2022 "Projected Emission Factors for New York State Grid Electricity," NYSERDA Report Number 22-18. Albany, NY. Table 1 nyserda.ny.gov/publications

savings of $1,014 and a reduction of 5,853 kg in CO2 emissions. By the second year, energy and cost savings decreased to 1,748 kWh and $120, respectively, with avoided GHG emissions also lowering to 872 kg. Indirect savings and avoided GHG emissions mirror the Year 2 values. In total, the installed audit measures result in energy savings of 13,478 kWh, cost savings of $1,134, and a reduction of 6,725 kg in CO2 emissions.

Table 2-7 Non-Energy Benefits for Measures Evaluated Using Key Parameter Measurement

Category	Energy Savings (kWh/year)	Cost Savings ($/year)	Avoided GHG Emissions (kg CO_2/year)
Direct	11,730	1,014	5,853
Year 2	1,748	120	872
Indirect	1,748	120	872
Total	13,478	1,134	6,725

This evaluation estimates the total cost savings for agricultural sites with estimated energy savings performed through key parameter measurement to be $13,538. The evaluation team applies a discount rate of 3% to all cost savings associated with reductions in energy consumption over the Effective Useful Life (EUL) of installed measures.[4]

2.5 Disadvantaged Communities

The evaluation team attempted to stratify savings estimates for agricultural sites in Disadvantaged Communities. However, the sample for this evaluation includes two sites located in DACs, a sample size that does not meet the minimum threshold for extrapolation of findings to this population of participants.

2.6 Findings and Recommendations

The evaluation team presents four findings and recommendations for the Agricultural Energy Audit Program in this section.

[4] New York State Department of Public Service. (2023, October). New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 11. https://dps.ny.gov/technical-resource-manual-trm

2.6.1 Finding 1

The five-year measure adoption rate (MAR) for the Agriculture Energy Audit Program - defined as the ratio of kWh/year installed to kWh/year recommended - was estimated to be 33% using data self-reported by audit participants, but the evaluation team expects to report a stronger, verified estimate of the MAR for this program in the next report from of this evaluation in 2025. Lighting upgrades are the most prevalent, with 66% of sites installing the recommended measure. While the lost cost of most LED lighting makes this energy-efficient measure an enticing option for agricultural sites, the cost for liner LEDs present with indoor growing operations is still cost-prohibitive for farms.

The evaluation found the realization rate to be strong: 121% for electricity. While the realization rate for agricultural sites with verified savings under the key parameter measurement method provides a strong indication of success, it's important to note that these sites represent only 5 out of the 21 evaluated sites (Table 21). As with the MAR, the methodology for assessing the realization rate will be reviewed and potentially modified in the next evaluation.

Table 2-8 Realization Rates

Savings Period	All Sites (n = 21)	Key Parameter Measurement (n = 5)
Direct	(0.19)	1.21

:

The infrequent recommendation of PV solar in audit reports is attributed to its unfavorable cost-to-benefit ratio and lengthy ROI periods. For example, one AEAP recommendation involves a 9 kW PV system with an upfront cost of over $31,000 and a payback period of 23 years is not feasible for a small farming operation with profit margins estimated at less than 10%. Additionally, choices in the level of energy audits (comprehensive and targeted) affect installations and energy savings; some participants chose a targeted audit that looked only at PV systems when other, most financially viable options would have benefited their operations. During phone interviews, a lack of awareness about energy-efficient alternatives was apparent, suggesting that participants might benefit from more economically feasible solutions such as lighting and refrigeration upgrades.

For motors, the absence of installations is linked to generic advice provided in audits. In contrast, specific suggestions, such as installing a Variable Frequency Drive (VFD) on milk transfer pumps, have increased implementation rates. Furthermore, within the agricultural sector, particularly in dairy production, there is a hesitancy in installing VFDs due to their adverse effects on livestock. The electrical noise generated by VFDs are believed to negatively impact dairy cows, prompting producers to forgo installing these drives near the animals to protect their well-being and maintain productivity.

Recommendation 1

NYSERDA should report a stronger estimate of the audit program's measure adoption rates, as well as realization rates, in the next report-out from this evaluation in 2025.

Initial NYSERDA Response to Recommendation: Rejected. While NYSERDA will work with the evaluator to reassess and potentially modify its MAR and realization rate approach for the next round of evaluation, MAR and realization rate findings estimated through this study will be applied to reporting to reflect the current analysis conducted.

2.6.2 Finding 2

Feedback from participants indicates that agricultural audits are most effective at driving the adoption of energy efficiency measures if they provide recommendations that meet the specialized needs of agricultural operations.

Recommendation 2a

NYSERDA should consider advertising solutions to common concerns raised by agricultural sites in the audit program evaluations (for example, cattle disliking the sound of electrical motors) in its Energy-Related Agricultural Best Practices guides.

Initial NYSERDA Response to Recommendation: Pending. This recommendation is under consideration for implementation.

Recommendation 2b

Impact evaluators should ask participants' reasoning as to why recommended equipment is not installed.

Initial NYSERDA Response to Recommendation: NYSERDA will report measure adoption rates based on kWh/year of energy savings and gross realization rates now and roll results into the final report of this evaluation (2017-2022) which is planned for completion in 2025.

2.6.3 Finding 3

Self-reported measures in the 2023 market evaluation of the Agriculture Energy Audit Program participant survey under-represent the actual installation of equipment. Participants are more likely to forget about installing an energy-efficient measure than to falsely claim installation. This information is represented in Table 2-8.

The positive predictive value, the probability that a self-reported measure is installed, is 93%. The sensitivity, also known as the True Positive Rate (TPR), reflects the likelihood that an installed measure is self-reported through the participant survey. The calculated sensitivity for this study is 29%.

The purpose of this finding is not to increase the positive predictive value through improved survey design. The participant survey successfully presented a simple approach to answering the complicated data collection process of measure installations. Instead, this finding highlights the importance of installation validation in capturing accurate energy savings that are contributable to this program.

Table 2-9 Survey Performance Metrics

	Actual Positive	Actual Negative
Survey Positive	26 (True +)	2 (False +)
Survey Negative	10 (False -)	63 (True -)

Recommendation 3

To strengthen evaluation results, NYSERDA should attempt outreach to conduct impact evaluation as soon as possible following the performance period after audit completion, to ensure respondents have recent memory of the measures installed and other details following their audits.

Initial NYSERDA Response to Recommendation: Implemented. The impact evaluation team will conduct outreach to collect primary data as an input for this evaluation one year after audit completion where possible, instead of following the previous plan of waiting a full 2 years after audit completion to follow up.

2.6.4 Finding 4

The variety of conditions of agricultural sites pose challenges to conducting billing analysis to evaluate energy impacts, whereas key parameter measurement using data obtained from phone interviews and on-site visits has been found to be more effective in many cases.

Bottom-up calculations, following the guidelines of IPMVP Option A – Retrofit Isolation: Key Parameter Measurement, determine savings through engineering calculations of data points collected via email, phone interviews, or site visits. These calculations do not require participants to provide authorization for the use of utility energy consumption data. Additionally, energy savings deemed from engineering calculations are not influenced by external factors such as the use of on-site fossil fuels, changes in production levels, and energy use due to behavior changes, new construction, or other unpredictable events.

Recommendation 4

NYSERDA evaluation staff should prioritize bottom-up calculations over regression analyses. Bottom-up calculations require additional data collection from program participants, but this effort is worth the benefit of increased precision of energy savings attributable to the program. Regression analyses' reliance on utility data authorization and the profound impact of non-routine events and external variables on statistical models make this approach imprecise. It is not a viable option for evaluating savings from the agricultural sector.

Initial NYSERDA Response to Recommendation: Implemented. The next phase of this evaluation will employ Key Parameter Measurement as central to the study's methodology.

2.6.5 Finding 5

Survey fatigue from multiple touchpoints with evaluators and the absence of an incentive for responding to outreach inhibit response rates. Responses could be increased through stronger coordination between the market and impact evaluation teams and through use of incentives for respondents.

Recommendation 5

NYSERDA should facilitate closer coordination between the market and impact evaluation teams evaluating the audit program to streamline and expedite outreach and should implement incentives for interview and on-site visit participation in the next updated to this evaluation.

Initial NYSERDA Response to Recommendation: Implemented. The impact evaluation team will coordinate more closely with the evaluation team on the related market evaluation of the NYSERDA Agriculture programs to better advertise the impact evaluation team's outreach requests and to incentivize responses from agricultural sites with monetary incentives, in the next update of this impact evaluation.

3 Methods

This section summarizes a three-phased methodological approach to calculate the energy savings for individual agricultural sites. The first phase involves Data Collection, where the Impact Evaluation Team gathers baseline energy consumption data and relevant weather variables and measures installation information. The second phase, Billing Analysis, utilizes linear regression models to understand the relationship between energy consumption, non-routine events, and weather variables, such as Heating Degree Days (HDD), Cooling Degree Days (CDD), and dry bulb temperatures. The final phase, Key Parameter Measurement, entails a desk review or bottom-up analysis comparing pre- and post-audit energy consumption for individual measures.

3.1 Data Collection

Following the completion of the participant survey, administered by the Market Evaluation team of Guidehouse and APPRISE, the Impact Evaluation Team request billing data from the appropriate utilities for agricultural site participants who authorized use of their data. The Impact Evaluation Team requested billing data from 2016 to the time of the request, April 2023.

The Impact Evaluation Team conducted phone interviews with AEAP participants who completed the Market Evaluation Survey to verify the installation of equipment measures. During the phone interviews, the Impact Evaluation Team also collected information on changes to production levels or energy use resulting from non-routine events.

Weather data utilized in this analysis is obtained from Iowa Environmental Mesonet provided by Iowa State University.[5] This source uses actual weather data from the Automated Surface Observing System (ASOS), an automated observing network providing data for the National Weather Service (NWS).

3.2 Billing Analysis

The primary approach the Impact Evaluation Team took to estimate energy savings used the IPMVP Option C (Whole Building) methodology. The process involves first identifying independent variables that drive energy use (e.g., production, weather, and schedule variables). Using these independent variables, the Impact Evaluation Team creates a statistical model of the baseline energy use to represent the counterfactual energy use for individual agricultural sites. In

[5] Iowa State University. (2023) *Iowa Environmental Mesonet* [Dataset]. Retrieved from IEM :: ASOS/AWOS Network (iastate.edu)

other words, the model represents how the agricultural site would have used energy in the absence of some intervention. Savings are then calculated by taking the difference between this counterfactual model and the facility's actual energy use.

Initially, the Impact Evaluation Team aligned the baseline consumption data with the modeled dataset to ensure consistency and pattern continuity. The model emphasizes explicitly the influence of independent variables, such as weather, by analyzing their coefficients, which indicate their impact on energy consumption.

A critical aspect of this approach is modeling energy consumption for the year before the audit, which serves as the baseline. This baseline is then used to forecast energy consumption for the subsequent five years, creating a counterfactual scenario that depicts what energy consumption would have been without implementing audit-recommended changes.

3.2.1 Regression Variables

The billing analysis regressions incorporate a variety of variables to enhance the accuracy of the modeled energy usage. Weather-related variables include actual Heating Degree Days (HDD), actual Cooling Degree Days (CDD), relative humidity, dry bulb, and enthalpy. Moreover, the regression models integrate non-weather-related variables, like milk production data and the number of days in billing periods. Including the days in the billing periods variable accounts for the variability in aligning participants' billing period start dates with the beginning of the calendar month.

Non-routine events are included in this evaluation's regression models as binary variables. Examples of non-routine events include behavioral changes to energy consumption, construction of new structures, and increases in production, such as the number of dairy cows present at the agricultural site. The Impact Evaluation Team followed the *IPMVP Application Guide on Non-Routine Events and Adjustments* when non-routine events were identified.

3.2.2 Passing Regressions

Regression models aim to estimate the counterfactual energy use that would have occurred without installing energy efficiency measures. The inclusion and combination of variables will affect model performance differently from site to site. Therefore, the selection of variables included in the regression model for each site is up to the modeler's discretion. The Impact Evaluation Team created several iterations of regression models for each agricultural site to determine which variables provide the best fit.

A regression model is deemed passing if four statistical metrics are met. A detailed table of regression variables and statistical outputs can be found in Appendix C.

1. R-squared for the model must be 0.8 or greater. R-squared indicates how well the model's prediction fits the actual data.

2. Fractional Savings Uncertainty (FSU) of less than 0.5 at 68% confidence. The FSU represents savings uncertainty as a percentage of savings, with lower values having lower uncertainty.

3. Independent Variable T-Statistics - Variables are removed if the absolute value t-statistic is below 2.The independent variable t-statistic identifies statistically significant differences between the means of values.

4. CV(RMSE) – A root-mean-square-error cross validation of less than 0.2. The CV(RMSE) measures the differences in predicted versus observed values.

3.3 Key Parameter Measurement

Agricultural sites with poorly performing regression models were identified for verification through IPMVP Option A (Key Parameter Measurement), also called a bottom-up analysis. Pre-installation equipment information is provided in an agricultural site's audit report for these sites. The evaluation team contacted participants with detailed questions regarding the installed equipment (*i.e.,* make, model, year, capacity, etc.), conditions of the building in which the equipment is installed, and hours of use. The annual energy consumption for pre- and post-installation is then calculated independently, with the difference being the energy savings deemed.

3.3.3 Baseline Assumptions

A typical energy-efficient measure recommendation on a participant's audit report will reflect a 1-to-1 replacement of an existing measure with a more energy-efficient option. For example, four existing incandescent light bulbs illuminating a barn will be associated with the recommendation to install four LED bulbs illuminating the same space. In this example, the pre-installation usage is provided in the participant's audit report. The usage for the energy efficiency measure is calculated based on the specifications of the installed equipment; an example can be found in Appendix B.

An atypical energy-efficient measure recommendation on a participant's audit report does not reflect a 1-to-1 replacement of an existing measure with a more energy-efficient one. Atypical measure recommendations stem from conversations between energy auditors and agricultural site owners or operators about their needs and wants. For example, an existing 16 cubic foot freezer exists at an agricultural site, and the owner requires more freezer space to accommodate growing needs or an expected increase in production. The audit recommendation is for a 72 cubic-foot ENERGY STAR-rated commercial freezer. In this example, the recommended measure will likely consume more energy than the existing equipment even though the participant installed a measure recommended by the program. To calculate energy savings, the annual usage of the energy-efficient measure is compared to a non-efficient baseline provided in the New York Technical Resource Manual.[6] In cases where the baseline measure does not exist with the NY TRM, the Evaluation Team references other regional TRMs or implements sound engineering principles to estimate comparable measures.

3.4 Sampling and Weighting

The Evaluation Team sampled 49 agricultural sites, completing energy audits from 2017 through 2020. Table 3-1 provides counts and weighting of individual audit years compared to the audit participants' population. Sites completing audits in 2020 are slightly over-sampled in this evaluation, with a weight of 0.89.

Table 3-1 Sample Counts and Weighting to the Population

Completed Audit Year	Count of Sample	Count of Population	Weight
2017	21	404	1.01
2018	15	290	1.02
2019	8	154	1.01
2020	5	85	0.89
Total	**49**	**933**	

[6] New York State Joint Utilities (2023, October 6). *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*. Department of Public Service: Technical Resource Manual (TRM). Retrieved February 19, 2024, from https://dps.ny.gov/technical-resource-manual-trm