

# **Agriculture Market Evaluation**

**Advancing Agriculture Energy Technologies (AAET), Agriculture Technical Services, and Greenhouse Lighting and Systems Engineering (GLASE) Consortium**

Baseline Period (2018-2019)

## *Executive Summary*

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# Executive Summary

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The Clean Energy for Agriculture Task Force (CEATF)<sup>1</sup>, created by Governor Andrew Cuomo and comprised of leading agricultural organizations, farms, universities, individuals, and state agencies active in the State’s agriculture sector, developed a Strategic Plan that identified numerous strategies to address barriers and assist farms. Based on the strategic initiatives in the Strategic Plan, New York State Energy Research and Development Authority (NYSERDA) developed three major initiatives under the Clean Energy Fund<sup>2</sup> to aid the agriculture sector:

- **Advancing Agriculture Energy Technologies:**<sup>3</sup> The goal of the AAET initiative is to “demonstrate advanced, underused, or emerging technologies or processes to illustrate and document the value proposition of technologies for targeted energy use on farms.” The initiative is issuing competitive solicitations for technology vendor and farm teams to demonstrate technologies in the market. The initiative is also developing case studies to share with the market.
- **Agriculture Technical Services:**<sup>4</sup> This initiative includes two components: Agriculture Energy Audits, which provide comprehensive audits to farmers, and Best Practices, which provide information, tools, and resources to agriculture market.
- **Greenhouse Lighting and Systems Engineering Consortium:**<sup>5</sup> The GLASE Consortium aims to “target energy-related improvements in greenhouse system operations by optimizing energy efficiency, crop yield and quality.” The initiative involves establishing a consortium and recruiting market actors in the controlled environment agriculture market to become consortium members.

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<sup>1</sup> More information about the Clean Energy for Agriculture Task Force is available at <https://www.nyserda.ny.gov/About/Publications/Clean-Energy-for-Agriculture-Task-Force-Strategic-Plan>.

<sup>2</sup> More information about the Clean Energy Fund is available at <https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund>.

<sup>3</sup> Additional details on AAET are located in the *Clean Energy Fund Investment Plan: Agriculture. Portfolio: Market Development*. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised November 1, 2017. <https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund>

<sup>4</sup> Additional details on Agriculture Technical Services are located in the *Clean Energy Fund Investment Plan: Multi-Sector Solutions Chapter. Portfolio: Market Development*. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised November 1, 2017. <https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund>

<sup>5</sup> Additional details on GLASE are located in the *Clean Energy Fund Investment Plan: Agriculture. Portfolio: Market Development*. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised November 1, 2017. <https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund>

The evaluation had two objectives: assess the testable hypotheses<sup>6</sup>, goals prior to exit<sup>7</sup>, and indicators<sup>8</sup> for each of NYSERDA’s Agriculture Initiatives; and to estimate the indirect impacts<sup>9</sup> from the initiatives. The team surveyed six market actor groups (see Figure 1), completed secondary research, and developed an Indirect Impacts Tool to meet these objectives.

**Figure 1. Surveys by Market Actor Group**

Source: Market Evaluation Team

Initiative	Market Actor Group	Market Actor Respondent
AAET	Non-Participant Farms	A grower or farmer that has not participated in a NYSERDA agriculture program or demonstration site
Agriculture Technical Services	Agriculture Energy Audit Participants	A grower or farmer that has participated in the NYSERDA Agriculture Energy Audit Program under the Clean Energy Fund and transition funding period and it has been over a year since their participation
GLASE Consortium	Non-Participant Lighting Manufacturers	Works for a company that manufactures LED chips, fixtures or lighting controls to controlled environment agriculture facilities
	Non-Participant Controlled Environment Agriculture (CEA) Auxiliary Service Providers	Individual who works at a company that provides services or products designed to improve energy efficiency in controlled environment agriculture facilities
	Non-Participant CEA Facilities	Controlled environment agriculture facility operating in NYS that is not currently a member of the GLASE Consortium
	Non-Participant Grocery Retailers <sup>a</sup>	Grocery retailers that sell produce

<sup>a</sup> The Market Evaluation Team started the non-participant grocery retailers survey, drafted the survey instrument, identified a sample frame, and completed seven pre-tests. However, the team closed the survey after achieving seven completes due to the GLASE Consortium deciding to no longer include this market actor as a focus. The decision from the GLASE Consortium came after attending a Produce Marketing Association (PMA) conference and realizing that the current benefits of the GLASE Consortium were greater to other groups than to grocery retailers. The Market Evaluation Team did not analyze the data from these responses.

<sup>6</sup> A testable hypothesis is part of the theory of change. It is an if-then statement that states if there is an action, then a result will occur. An example is “If underutilized/emerging energy efficient technologies and processes are identified and proven effective, with guidance on financing, farmers will adopt technologies.”

<sup>7</sup> A goal prior to exit is a goal that the initiative is trying to reach before the initiative can stop intervening in the market.

<sup>8</sup> An indicator can encompass near-term through longer-term changes in market conditions expected to result from the activities/outputs of an intervention. Outcome indicators will have a baseline value and progress will be measured periodically through Market Evaluation.

<sup>9</sup> Indirect impacts are energy savings and other benefits resulting from measure adoption associated with indirect program influence. (Source: NYSERDA, “Appendix C. Indirect Benefits Evaluation Framework”). Refer to the Indirect Benefits Evaluation Framework for more information available at <https://portal.nyserra.ny.gov/servlet/servlet.FileDownload?file=00Pt000000HlyBmEAL>.

## Findings and Recommendations

**FINDING 1<sup>10</sup>:** Thirty-five percent of non-participant farms have heard of NYSERDA’s Agriculture Energy Audits Initiative.

### **RECOMMENDATION 1 for the Agriculture Technical Services – Agriculture Energy**

**Audits Initiative:** Based on this finding, there is an opportunity to increase awareness of NYSERDA’s Agriculture Energy Audits Initiative among farms. Initial ideas of ways to increase awareness include:

- NYSERDA could host farm dinners in regions with low participation in the Agriculture Energy Audits Initiative but a high concentration of farms. These farm dinners could be held at one farm in a region and invite other farms in that same region. They could include a meal and discussion of NYSERDA’s energy audits program. These dinners could be held at a farm that has participated in the Agriculture Energy Audits Initiative and has made energy efficiency upgrades to the farm. In this situation, the dinner would also include a tour of the farm and the energy efficient equipment. Alternatively, the farm dinner could be held at a farm that has not participated in the Agriculture Energy Audits Initiative, and the farm dinner could include a mini-audit to show attendees what an audit would entail. These hands-on demonstrations would be valuable to farms’ awareness and interest in the audit.
- If not already doing so or not recently done, NYSERDA could advertise the energy audits program by partnering with local and state farm organization such as New York State Agricultural Society, New York Farm Bureau, and Northeast Organic Farming Association of New York (NOFA-NY). These organizations posted the Non-Participant Farms survey link on their social media and newsletters for the market evaluation and thus may be open to a partnership with NYSERDA.

**FINDING 2<sup>11</sup>:** Nearly 50% of non-participant farms gave a 3 on a scale of 1 to 5 with 1 being not confident at all and 5 being very confident that energy efficiency technologies provide improved performance, operational and maintenance savings, and increased reliability.

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<sup>10</sup> Source of Finding: Non-Participant Farms survey shown in Section 2.2.1 in the Final Report under heading “TH1-GPE1-I4: Number of farmers requesting information on training on implementing energy efficiency and GHG reducing projects”

<sup>11</sup> Source of Finding: Non-Participant Farms survey shown in Figure 3 in the Final Report.

**RECOMMENDATION 2 for the Agriculture Technical Services – Best Practices Initiative:**

NYSERDA should ensure that the already planned best practices guides include detailed and easy to understand information about how energy efficiency technologies lead to improved performance, operational and maintenance savings, and increased reliability, in addition to energy bill savings. NYSERDA could also consider developing case studies on specific farms and energy efficient technologies on those farms, specifically a case study on how particular technologies on a specific farm lead to improved performance, operational and maintenance savings, and increased reliability.

**FINDING 3<sup>12</sup>:** Lighting manufacturers and CEA auxiliary service providers perceive access to CEA facilities as the main benefit of joining the GLASE Consortium. However, CEA facilities<sup>13</sup> are the least aware of and the least interested in the GLASE Consortium. These findings suggest that if the GLASE Consortium can get more CEA facilities to become members, they would attract more lighting manufacturers and CEA auxiliary service providers. Details below.

- Lighting manufacturers and CEA auxiliary service providers perceive access to CEA facilities as the main benefit of joining the GLASE Consortium.
  - 81% of lighting manufacturers noted access to agricultural producers through trade shows and the GLASE Consortium newsletter as a benefit.
  - 20% of CEA auxiliary service providers noted access to GLASE Consortium members, including agricultural producers as a benefit.
- CEA facilities are the least aware of and the least interested in the GLASE Consortium.
  - 19% of non-participant CEA facilities had heard of the GLASE Consortium compared to 26% of non-participant CEA auxiliary service providers and 57% of non-participant lighting manufacturers.
  - 42% of non-participant CEA facilities were interested in participating in free GLASE Consortium initiatives, such as webinars or short courses compared to 64% of non-participant CEA auxiliary service providers and 86% of non-participant lighting manufacturers.

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<sup>12</sup> Source of Finding: Appendix A: Additional Findings, Section A.3 GLASE Additional Findings. This finding and recommendation were noted by the GLASE Consortium following the presentation of evaluation findings and modified slightly by the Market Evaluation Team.

<sup>13</sup> The GLASE Consortium is targeting CEA facilities that use supplemental lighting systems for more than 1 hour per day, are energy intensive, or require an advanced lighting control system. The CEA facilities that responded to the survey were broader than this target (i.e., used various types of lighting for various hours per day).

**RECOMMENDATION 3 for the GLASE Consortium:** This finding leads to a few suggested recommendations:

- The GLASE Consortium should develop a new outreach strategy to connect with more CEA facilities. Having more CEA facilities as part of the Consortium could lead to more interest from lighting manufacturers and CEA auxiliary service providers. The CEA facilities noted the following benefits of the GLASE Consortium were attractive. Therefore, the GLASE Consortium could use these ways to attract them:
  - Access to the GLASE Consortium’s case studies, technical reports, and proof-of-concept trials before they decide on upgrades. The GLASE Consortium could consider strategies such as access to one free resource before being a member to show this group the value.
  - Talk directly to the GLASE Consortium’s horticultural researchers.
  - Leverage the GLASE Consortium’s leading-edge innovations in integrated CO<sub>2</sub>, lighting, and shade control systems to save operational costs.
- The GLASE Consortium could also create different tiers of membership fees with different benefits for the CEA facilities. At the time of this study, the membership cost for CEA facilities was one flat fee. With a large range of membership prices and benefits, the GLASE Consortium may be able to attract small, medium and large CEA facilities. The different tiers could be tied to the benefits listed above (i.e., access to resources is one fee while talking to the GLASE Consortium is another fee).

## Testable Hypotheses, Goals Prior to Exit, and Indicators

The Market Evaluation Team summarized the findings on the indicators by initiative in Table 1. Note that the team only assessed a subset of all indicators this evaluation year because of the timing of the rollout of the initiatives.

**Table 1. Testable Hypotheses, Goals Prior to Exit, Indicators, and Findings from the 2018-2019 Market Evaluation**

*Source: Market Evaluation Team analysis of Non-Participant Farms survey data, Non-Participant Controlled Environment Agriculture Facilities survey data, Non-Participant Lighting Manufacturers survey data, and Non-Participant Controlled Environment Agriculture Auxiliary Service Providers survey data*

<b>Initiative</b>	<b>Testable Hypothesis (TH)</b> <i>If there is an action, then a result will occur.</i>	<b>Goal Prior to Exit (GPE)</b> <i>The initiative can end once the goal is met.</i>	<b>Indicator</b> <i>A value that can be tracked over time to assess market changes.</i>	<b>Market Evaluation Finding (2018-2019)</b>
<b>AAET</b>	TH 1: If underutilized/emerging energy efficient technologies and processes are identified and proven effective, with guidance on financing, farmers will adopt technologies.	GPE 1: Reliable market sources compile, develop, and maintain current information on advanced clean energy technologies for use by local information exchange networks.	List of underutilized or emerging technologies identified	Non-participant farms are aware of a range of technologies (e.g., LEDs, water heating, refrigeration) and listed other energy efficient technologies outside of a provided list.
			Number of farmers confident energy efficiency measures shall produce promised benefits	Non-participant farms felt very confident or confident that energy efficient technologies would produce promised energy bill savings (55%), improved performance (35%), operational and maintenance savings (37%), and increased reliability (29%).
			List of perceived barriers and benefits identified by farmers	Ninety-two percent of non-participant farms noted lower energy bills as a benefit to adopting energy efficient technologies. The barriers identified by most non-participant farms were financial. Ninety percent of non-participant farms selected upfront costs as a barrier, and 68% of non-participant farms selected length of payback period.
			Number of farmers requesting information or training on implementing energy efficiency and greenhouse gas (GHG) reducing projects	Thirty-seven percent of non-participant farms have sought out information or training on implementing energy efficient technologies, and a little over one-third (35%) of non-participant farms have heard of NYSERDA's energy audits program.
		GPE 2: Advanced technologies are installed by farms outside of demonstration projects.	Number of farms outside of demonstration projects installing advanced technologies	Non-participant farms are primarily installing LED lighting and/or LED lighting controls (71%). Other technologies had a less than 40% installation rate (e.g., water heating technologies (38%) and refrigeration equipment (22%)).
			Number of farms outside of demonstration sites knowledgeable of energy efficiency opportunities	Non-participant farms are most aware of LED lighting and/or LED lighting controls (94%), water heating technologies (73%), and refrigeration equipment (59%).

<b>Initiative</b>	<b>Testable Hypothesis (TH)</b> <i>If there is an action, then a result will occur.</i>	<b>Goal Prior to Exit (GPE)</b> <i>The initiative can end once the goal is met.</i>	<b>Indicator</b> <i>A value that can be tracked over time to assess market changes.</i>	<b>Market Evaluation Finding (2018-2019)</b>
			for underutilized and emerging technologies	
		GEP 3: Agriculture vendors and suppliers use energy efficiency as a tool to sell their products.	Number of farms aware of federal incentives and assistance programs	Non-participant farms are aware of state incentives and assistance programs (54%), utility programs (48%), and federal incentives and assistance programs (31%). Twenty-eight percent of non-participant farms are not aware of any financial assistance programs.
			Number of farms utilizing external financial resources, including utility programs, to implement energy efficiency measures or process improvements or advanced technology measures	Of those aware of financial resources, non-participant farms are using external financial resources to implement energy efficiency via state incentives and assistance programs (22%), utility programs (31%), and federal incentives and assistance programs (16%).
<b>Agriculture Technical Services</b>	None evaluated in 2018-2019			
<b>GLASE Consortium</b>	TH 1: If greenhouse operators implement technologies to control lighting, ventilation, and carbon dioxide (CO <sub>2</sub> ) systems, they will save 70% to 86% on electricity.	GEP 1 Availability of products in the market that can reduce electricity costs and result in savings in greenhouses between 70% to 86%.	Number of products available in the market that can reduce electricity costs and result in savings in greenhouses between 70% and 86%	Lighting manufacturers identified LED lighting and controls as the most important technology to increase the energy efficiency of greenhouses. Non-participant controlled environment agriculture auxiliary service providers gave a range of technologies including LED lighting, controls of temperature, humidity, and shades and variable frequency drives (VFDs).
	TH 2: If the consortium successfully forms teams with cross-cutting expertise in greenhouse controls then those teams will help growers implement packaged energy solutions.	GPE 2: Up to 25% indirect savings from market penetration of control systems and lighting technologies in NY tomato & lettuce greenhouse acreage.	Average market penetration of improved technologies in New York greenhouse acreage in the lettuce and tomato sectors	In the lettuce sector, 16% of respondents had installed efficient ventilation, 12% had installed an energy curtain, and 10% had installed LED lighting and/or LED lighting controls. In the tomato sector, 20% of respondents had installed efficient ventilation, 16% had installed an energy curtain, and 10% had installed high efficiency motors.

## Indirect Impacts

The Market Evaluation Team estimated indirect impacts for the Agriculture Energy Audits component of the Agriculture Technical Services initiative based on findings from the 2019 market evaluation (Table 2). The market evaluation estimate for indirect impacts (cumulative annual) by 2020 is 4,476 MWh, 2,219 MMBtu, and 2,473 CO<sub>2</sub>e emissions reductions (metric tons). The market evaluation estimate for 2020 represents indirect impact savings measured in 2019 and forecast for 2020. In 2021 and beyond, the market evaluation estimates also represent forecast values.

**Table 2. Indirect Impacts Summary**

Sources: NYSERDA Estimates: NYSERDA Solicitation: “Advancing Agriculture Energy Technologies (AAET) & Greenhouse Lighting and Systems Engineering (GLASE),” AAET\_GLASE\_Technical Services Combined Evaluation Plan.docx, sent on December 13, 2017; Market Evaluation Estimates: Market Evaluation Team Indirect Impacts Tool and analysis of FlexTech Agriculture Energy Audit Participant survey data.

Initiative	Indirect Impact		2020	2025	2030	2020	2025	2030
			NYSERDA Estimates			Market Evaluation Estimates		
Agriculture Technical Services (Agriculture Energy Audits) <sup>a</sup>	Energy Efficiency	MWh Cumulative Annual	NYSERDA did not estimate indirect impacts for the Agriculture Energy Audits Initiative			4,476	8,953	8,953
		MMBtu Cumulative Annual				2,219	4,438	4,438
	Renewable Energy <sup>b</sup>	MWh Cumulative Annual				-	-	-
		MW				-	-	-
	CO <sub>2</sub> e Emission Reduction (metric tons) Cumulative Annual					2,473	4,946	4,946

<sup>a</sup> The Market Evaluation Team worked closely with NYSERDA to define the indirect impacts for this component. Once an audit is conducted through the Agriculture Energy Audits component, EnSave assists with the installation of measures and application of utility incentives (if applicable). This activity is counted as direct savings. Any additional measures installed outside of this touch point, or after EnSave, are counted towards indirect savings. This activity typically occurs within the second year after the audit has been completed.

<sup>b</sup> Renewable energy savings were not calculated in this evaluation.