

Matter Number 16-00681, In the Matter of the Clean Energy Fund  
Investment Plan

# Clean Energy Fund Investment Plan: Agriculture

Portfolio: Market Development

**Submitted by:**

**The New York State Energy Research and Development Authority**

Revised November 1, 2017

| Clean Energy Fund Investment Plan:<br>Agriculture Chapter |   |                            |
|---|---|----------------------------|
| <b>Revision Date</b>                                      | <b>Description of Changes</b>                               | <b>Revision on Page(s)</b> |
| August 18, 2016   | Original Issue  | Original Issue             |
| November 1, 2017  | Filed Advancing Agricultural Energy Technologies initiative | Multiple                   |

## 14 Agriculture

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NYSERDA seeks to address energy efficiency opportunities in the agricultural sector that focus on providing trusted information and build on strengthening relationships with farm partners. To overcome barriers that are impeding progress, the initiatives will seek to address the risk aversion experienced by the owners and operators that energy efficiency could interrupt their agricultural business and processes, lack of trust in the energy efficiency technology to deliver the intended benefits, lack of in-house expertise or time to dedicate to energy improvements, and cost and finance sensitivity.

The first initiative described in this Chapter is Greenhouse Lighting and Systems Engineering, which aims to target energy-related improvements in greenhouse system operations by optimizing energy efficiency, crop yield and quality. The goal will be to establish a Consortium that will become financially self-sufficient by bringing together academia and marketplace knowledge and experience to develop new control systems, lighting products and technical services to increase the adoption of the new technologies in the greenhouse industry.

The second initiative described in this Chapter is Advancing Agriculture Energy Technologies. The goal will be to demonstrate advanced, underused, or emerging technologies or processes to illustrate and document the value proposition of technologies for targeted energy use on farms.

Program investments and activities will be informed via engagement with stakeholders and subject matter experts.

# 14.1 2030 Greenhouse Lighting and Systems Engineering

## 14.1.1 Overview

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| <p><b>Present Situation</b></p>     | <ul style="list-style-type: none"> <li>• Overall interest from consumers in locally-grown food is increasing, and to support this demand in New York, with its relatively short growing season, greenhouses are growing rapidly. The United States Department of Agriculture (USDA) census data<sup>1</sup> shows lettuce and tomato, two profitable crops that are well-suited for greenhouse production, growing in New York 10.6% per year from 2007 to 2012. Since 2012, continued rapid growth in greenhouse product value, acreage, year-round usage and control techniques has been observed, leading to newer greenhouses producing more than twice the yields per acre of low-tech greenhouses.</li> <li>• Greenhouses are more electricity-intensive (electricity use per square foot) overall than other buildings, including food service buildings and hospitals. Much of this is due to lighting. A typical lighting power density for commercial buildings is 1 watt per square foot, but a lettuce greenhouse in the New York climate uses more than ten times that number. A conservative estimate of the electricity used just for lighting in existing New York State greenhouses producing lettuce and tomatoes in 2015 is 313 GWH per year, which equates to 164,662 metric tons of CO<sub>2</sub> annually based on New York’s power generation mix.</li> <li>• Light-emitting diodes (LEDs), unlike traditional high-pressure sodium lighting, could be manufactured to emit a variety of light spectra to meet the needs of specific crops. With the right control systems, even current LEDs marketed to greenhouses can be dimmed, pulsed, and controlled, allowing an unprecedented level of optimization and integration of greenhouse management systems, leading to large energy savings.</li> <li>• More advanced control systems for greenhouses also regulate ventilation, lighting, and CO<sub>2</sub> supplementation. Electricity savings of 70 to 86% (depending on New York State climate zone) are possible through synergistic control of these parameters.</li> <li>• Though potential energy savings are very high, a market gap exists because the market players do not understand the potential opportunity. Growers do not have the expertise to design specialized control systems, nor can the lighting industry do it alone because they do not have the deep and specialized understanding in plant physiology and overall greenhouse systems that is needed to optimize crop production and energy usage. This is why packaged solutions for greenhouse production and energy-use optimization do not exist, system-wide demonstrations have not yet occurred at scale, and teams with cross-cutting expertise have not formed on their own.</li> <li>• The Consortium will develop progressively more advanced control systems that treat greenhouse operations as systems, make market players aware of these systems, develop cross-cutting expertise, and provide training for teams of service providers so that market adoption can occur.</li> </ul> |
| <p><b>Intervention Strategy</b></p> | <ul style="list-style-type: none"> <li>• To facilitate realization of the energy savings potential and address market barriers, NYSERDA will support formation of a Greenhouse Lighting and Systems Engineering (GLASE) Consortium that will synergistically target energy-related improvements to greenhouse system operations (e.g. integrated control of ventilation, lighting, humidity and CO<sub>2</sub> supplementation).</li> <li>• Funding will be provided to Cornell University and Rensselaer Polytechnic Institute (RPI) as core members to advance the Consortium, which will include further membership with the full range of required expertise, including plant biologists,</li> </ul>   |

<sup>1</sup> Based on New York State-specific data from USDA NAFF Census data 2007-2012, published in 2014

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|   | <p>agricultural engineers, computer software control engineers, and lighting engineers, who together represent world-class expertise on greenhouse operation. Past work performed by core members in this area (including a portfolio of existing patents and proprietary data) forms an in-depth body of knowledge and experience.</p> <ul style="list-style-type: none"> <li>• The Consortium will develop new control systems, lighting products, and technical services, and conduct iterative field testing to demonstrate and refine the systems and products in real-world settings.</li> <li>• Deployment of new lighting products will be pursued through manufacturers in the Consortium, working closely with plant biologists in the Consortium. Manufacturers will also work closely with other Consortium members versed in systems integration and greenhouse-specific engineering, who will deploy control systems and provide ongoing technical services to greenhouses.</li> <li>• The Consortium will achieve the best possible uptake and deployment of solutions by using the core members’ strong industry connections across the LED lighting and greenhouse supply chain with manufacturers, technical service providers, researchers, and through collaboration with specific adoption-ready growers.</li> <li>• NYSERDA will also coordinate with the Consortium to provide NYSERDA-based technical service assistance to growers, and work with NYSERDA outreach contractors to assist in information dissemination.</li> <li>• Successful integration of synergistic greenhouse operations will decrease operating expenses and optimize production, and in so doing increase revenues for New York growers.</li> <li>• For a visual representation of this strategy, please reference the flow chart entitled “Logic Model: Agriculture - GLASE,” which can be found in Appendix A.</li> </ul> |
| <b>Goals</b>  | <ul style="list-style-type: none"> <li>• The goal of this initiative is to establish a financially self-sufficient GLASE Consortium to develop new control systems and lighting technologies for greenhouses, and through an aggressive and targeted outreach campaign involving Consortium and industry partners, facilitate the uptake of the new technologies so the benefits may be realized. The GLASE Consortium aims to transform lighting and systems management in the rapidly-growing greenhouse industry by optimizing energy efficiency, crop yield and quality.</li> </ul>   |
| <b>State Energy Plan/Clean Energy Standard Link</b> | <p>This strategy contributes to the goals of the New York State Energy Plan and Clean Energy Standard (CES), including greenhouse gas emission reductions, statewide energy efficiency improvements and growth in the clean energy economy.</p> <p>By making greenhouses more efficient, the initiative will mitigate the increase in electricity demand resulting from New York’s growing greenhouse industry. Through use of better control systems, seasonal greenhouses may also extend their growing season in the spring and fall, or even extend their operations to year-round, which contributes positively to local load factors. These attributes of the program support Renewable Energy Vision (REV) concepts regarding electricity demand and load factors.</p>   |

14.1.2 Target Market Characterization

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| <b>Target Market Segment(s)</b> | The target market for this initiative is greenhouses and vertical farms <sup>2</sup> , with an initial focus on the fastest growing vegetable and other food crop markets in New York State.                                    |
| <b>Market Participants</b>      | <p>Market participants include:</p> <ul style="list-style-type: none"> <li>• Botanists with demonstrated expertise in greenhouse and vertical farm crop production, particularly hydroponic production of vegetables</li> </ul> |

<sup>2</sup> A vertical farm is a greenhouse system where trays of crops are stacked vertically to maximize production per square foot. Unlike greenhouses, all lighting is artificial; there is no sunlight.

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|                         | <ul style="list-style-type: none"> <li>• Engineers with demonstrated success in technologies that integrate greenhouse operating systems, sensors and software, including design and modulation</li> <li>• Lighting designing and manufacturing companies</li> <li>• Potential manufacturers of improved greenhouse control and lighting products</li> <li>• Greenhouse growers</li> <li>• Supermarket produce buyers</li> <li>• Agriculture and lighting engineers</li> <li>• Controlled Environment Agriculture researchers</li> <li>• New York State Department of Agriculture and Markets</li> <li>• Cooperative Extension agents</li> <li>• Small lighting sales companies</li> <li>• Horticulture suppliers</li> <li>• Energy Auditors</li> <li>• Academic and research organizations</li> <li>• Trade associations</li> </ul>  |
| <b>Market Readiness</b> | <ul style="list-style-type: none"> <li>• The Consortium concept was an outgrowth of prior work sponsored by NYSERDA. In one prior project using commercially-available lighting in an operational greenhouse, the traditional LED luminaires performed below the industry standard: high-pressure sodium luminaires. The LEDs did not meet general manufacturer claims for light intensities or energy efficiencies, nor were their spectra optimized for plant growth. Other NYSERDA work led to development of a lighting software management system and a “virtual grower” greenhouse simulator. In still other work, significant energy savings were achieved by sensing the physiological state of the plant and controlling light delivery. This led to the concept of the need for a consortium that could be used to help specify, develop, demonstrate, and tailor systems to individual plant species, which vary widely in their specific needs.</li> <li>• This would allow LEDs to provide added value to the grower by not only meeting basic grower expectations for energy efficiency and light intensity, but also by providing improved plant responses, including yield and morphology.</li> <li>• The type and level of control of greenhouse operations has only recently been made possible by the unique attributes of LED lighting. However, to fully take advantage of the opportunity for energy savings, improved LEDs must be paired with improved control systems. Advanced greenhouse controls have the potential to lead to vast savings in greenhouse electricity usage. The potential for electricity reduction is conservatively estimated at 70-86% per greenhouse, (depending on the New York climate zone) leading to an estimated 1,915,000 metric tons of greenhouse gas savings by 2030.</li> <li>• If New York’s greenhouse acreage for lettuce and tomatoes grew by a conservative 10.6% per year, it would reach an estimated \$567 million by 2030 (in 2015 dollars). This would represent a 56.7% penetration of the \$1 billion+ New York market for lettuce and tomatoes alone. There is realistic potential for expansion beyond 2030 as these wholesale market values do not include other vegetables and crops.</li> <li>• NYSERDA has spent multiple years investigating the technologies and opportunities unique to the greenhouse market sector, and has fostered relationships with key players to bring a consortium of plant scientists and lighting technology and control specialists together. NYSERDA will use its deep understanding of the issues to help market players understand the large potential benefits that greenhouse systems can provide, and to help develop improved systems that synergistically control electricity use. NYSERDA will also use its existing relationships with market players to bring disparate parties together to form teams of cross-cutting expertise.</li> </ul> |
| <b>Customer Value</b>   | <ul style="list-style-type: none"> <li>• A successful effort would lead to an overall reduction of 10-16% in total greenhouse operating costs, including electricity and other energy costs (heating) as well as costs for labor, supplies, packaging, delivery, insurance, etc. Greenhouses operate in</li> </ul>  |

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|  | <p>a highly competitive environment with tight profit margins, and they use more electricity per square foot than other applications (e.g., food service, hospitals, offices, hotels, or schools). One type of greenhouse, a plant factory, uses nearly as much electricity on a watt per square foot basis as data centers, which are among the highest users of electricity. Effective management of electricity expenditures is crucial to remaining profitable and competitive, particularly for this energy-intensive sector. Payback for improved systems ranges from one to three years.</p> <ul style="list-style-type: none"> <li>• It is anticipated benefits to growers will begin to accrue in the first year of the seven-year program with commercial sales of the first generation of control system products. Electricity reductions from lighting alone are targeted at 50% of a greenhouse's current electricity usage. Electricity reductions for overall systems that control not only lighting but also humidity, ventilation and CO<sub>2</sub> levels, are targeted at 70-86% less electricity usage per greenhouse by year seven.</li> <li>• The energy efficiency and crop productivity improvements (shorter growth cycles) resulting from advances in greenhouse systems management will be quantified as avoided production of greenhouse gases (metric tons of CO<sub>2</sub>) and electricity consumption per unit of crop growth.</li> <li>• An additional benefit is expected through growth of new business opportunities in New York State for manufacturing the luminaires to a global greenhouse industry.</li> <li>• Benefits to the consumer that result from production system improvements include fresher, more local products with longer shelf life and improved nutritional value.</li> <li>• If the 10.6% annual growth in lettuce and tomato greenhouse space were to continue, lettuce and tomato crops produced in New York greenhouses would reach a wholesale market value of \$567 million (in 2015 dollars) by 2030. The wholesale value of all lettuce and tomatoes consumed in New York is currently more than \$1 billion. In addition to lettuce and tomatoes, there are many other crops (vegetables, flowers, herbs, berries, etc.) that could be grown in greenhouses, resulting in a total wholesale value for all crops much greater than \$1 billion.</li> </ul> |
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14.1.3 Stakeholder/Market Engagement

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| <p><b>Stakeholder/Market Engagement and Customer Discovery</b></p> | <ul style="list-style-type: none"> <li>• For more than three years, NYSERDA has been collaborating with Cornell and RPI to develop and refine this Consortium concept. NYSERDA has vetted the approach, market assumptions, technology readiness levels, estimates of energy and GHG savings, financial model, and business plan to self-sufficiency. The analysis concluded that there is a high level of technical readiness for the concept. The product development is maturing; the time to market for each individual product has been estimated, and plans are developed so that different products roll out during the seven years that NYSERDA will support the Consortium.</li> <li>• Marketing to potential GLASE Consortium participants will begin with the more than 30 stakeholders, including many important major market players, who have already signed letters of intent expressing interest in joining the GLASE Consortium.</li> <li>• The market for greenhouse system control products manufactured in New York is international and includes many well-known traditional lighting companies. Expansion of the GLASE Consortium to future members will be part of Consortium activities.</li> <li>• Existing greenhouse suppliers have a large network of online and print trade publications which will also be used for marketing. The Consortium will coordinate with the Controlled Environment Agriculture (CEA) Advisory Board, New York's newly-formed greenhouse stakeholder group.</li> <li>• Manufacturing partners will hold an advisory capacity in the Consortium.</li> <li>• Greenhouse growers will also be fully engaged as advisors and as demonstration sites.</li> </ul> |
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|  | <ul style="list-style-type: none"> <li>• NYSERDA staff will also work with New York State Department of Agriculture &amp; Markets and Cornell Cooperative Extension to connect to the in-state market.</li> <li>• NYSERDA will also utilize the Clean Energy Advisory Council (CEAC) as a way to engage with stakeholders, as appropriate.<sup>3</sup></li> </ul> |
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#### 14.1.4 Theory of Change

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| <b>Technology Opportunities and Barriers Addressed</b> | <ul style="list-style-type: none"> <li>• <b>Packaged solutions for greenhouse production and energy-use optimization do not exist.</b> While there are LED technologies that have the potential to improve the energy efficiency and therefore energy costs of greenhouses, they are not tailored to the necessary conditions for enhanced crop production. For example, lighting manufacturers do not specialize in plant physiology, but growers need to synergistically optimize not only lighting but also CO<sub>2</sub>, humidity, and ventilation needs. The Consortium will address this by documenting potential and trending market size, disseminating information, and working with key players to implement solutions.</li> <li>• <b>The full potential of a system-wide approach to greenhouse control has not been fully demonstrated at scale,</b> and market players are not yet aware of the large potential for benefits that greenhouse systems can provide. A major goal of the Consortium is to promote a system-wide approach to greenhouse operation.</li> <li>• <b>The industry currently lacks cross-cutting expertise in greenhouse system solutions.</b> More service provider teams will be needed in the greenhouse industry who can integrate lighting with the other parameters to optimize plant health and energy use. The Consortium can help bring these partners together and train them in specialized applications.</li> </ul> |
| <b>Testable Hypotheses</b>                             | <ul style="list-style-type: none"> <li>• If greenhouse operators implement innovations that improve and customize their ability to control lighting, ventilation and CO<sub>2</sub> systems for their specific crops, then they will save 70 to 86% of their electricity costs, depending on their New York climate zone.</li> <li>• If influential manufacturers and end-users are involved in the Consortium, then they will participate as commercialization partners and demonstration sites that accelerate adoption of new innovations beyond the 18 acres of greenhouses targeted for 2019.</li> <li>• If the GLASE Consortium is successful in disseminating information, then paid memberships will occur, resulting in a financially self-sustaining Consortium that continues after the NYSERDA-funded milestones end.</li> <li>• If the GLASE Consortium is successful in forming and training teams with cross-cutting expertise in specialized applications of greenhouse control systems, then those teams will be able to assist growers in implementation of packaged solutions that optimize energy usage.</li> </ul>   |
| <b>Activities</b>                                      | <p>NYSERDA will contract with Cornell University and RPI to form and advance the GLASE Consortium. In doing so, NYSERDA will:</p> <ul style="list-style-type: none"> <li>• <b>Form and Grow Consortium.</b> Assist Consortium with the design and organizational structure, and draft documents. Monitor Consortium activities, including: formalizing relationships with those who have expressed interest in joining the Consortium and delineating specific activities and roles for each; recruiting new members; targeting influential large manufacturers of luminaires; in order to achieve financial sustainability, finalizing the business model and growing Consortium membership to balance costs and income to achieve financial self-</li> </ul>  |

<sup>3</sup> The Clean Energy Advisory Council was established by the Public Service Commission through an Order in the Clean Energy Fund Proceeding (Case 14-M-0094. et al, Proceeding on Motion of the Commission to Consider a Clean Energy Fund, Order Authorizing the Clean Energy Fund Framework, filed January 21, 2016).



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|                              | <p>sustainability after year seven; including mechanisms to support partnerships, membership fees, fee-based trainings and services, and royalties and licenses of patentable products.</p> <ul style="list-style-type: none"> <li>• <b>Establish Scientific Advisory Panel.</b> Establish a panel within the Consortium. Also work with existing advisory panels in New York’s newly-formed Controlled Environment Agriculture trade group<sup>4</sup>, as appropriate, to identify areas of need/opportunity, vet potential solutions, offer guidance on optimal path to market, provide a source of technical and market intelligence, and serve as a pool of potential demonstration partners.</li> <li>• <b>Technical Activities.</b> Monitor work of the Consortium as it develops new lighting products as well as new control strategies and services for light, CO<sub>2</sub> and humidity. Work is anticipated to include: optimizing lighting by automating dimming, pulse-width modulation, and integrating combinations of appropriate wavelengths for optimal crop growth; use of CO<sub>2</sub> enhancement in greenhouses; investigation of LED use to alter plant physiology and morphology as appropriate to increase yield or the production of chemical compounds that increase crop value; design of novel prototype luminaires for greenhouses; and development of software that includes whole greenhouse systems management integrated with light and CO<sub>2</sub> regulation. New products will be tested in small and large pilot settings, and provisional patents will be filed.</li> <li>• <b>Deployment Support Activities.</b> Assist the Consortium with the continual education and outreach to growers and the lighting industry, specifically targeting companies within New York State to assemble and market novel luminaires. Fact sheets, case studies and social media products will publicize the results of the program to growers, lighting manufacturers and others, and highlight participation by various stakeholders. This information will help Consortium members and others better understand best practices and the economics of improved control systems, as well as assist with new member recruitment. Trade association meetings and industry conferences targeting the greenhouse industry will be used to network with key market constituents. Training will be provided to help service providers target the specialized needs of growers. NYSERDA will utilize its Environmental Research Program’s Science Advisors for agriculture to provide guidance on market uptake. NYSERDA and the Consortium will work closely with Cornell Cooperative Extension, an experienced provider of assistance to farmers, to disseminate information. NYSERDA will also coordinate this effort with the existing NYSERDA Agricultural Energy Audit program, which performs energy audits for farms. The Consortium will develop and maintain a data warehouse to assist in data dissemination, as well as survey members and non-members to track market adoption rates, associated savings, and product lifespans.</li> </ul> |
| <p><b>Key Milestones</b></p> | <p><u>Milestone 1 (2016)</u></p> <ul style="list-style-type: none"> <li>• Contract with core Consortium members.</li> </ul> <p><u>Milestone 2 (2016)</u></p> <ul style="list-style-type: none"> <li>• Review and approve Scientific Advisory Panel structure.</li> </ul> <p><u>Milestone 3 (2017)</u></p> <ul style="list-style-type: none"> <li>• Review and approve Consortium business plan to attain financial self-sustainability in 2023.</li> </ul>   |

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<sup>4</sup> The Controlled Environment Agriculture trade group is a voluntary information exchange organization with a broad mission of promoting opportunities in controlled environment agriculture.

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|                            | <p><u>Milestone 4 (2018)</u></p> <ul style="list-style-type: none"> <li>• Monitor small (6,000 square feet) pilot demonstration of a basic light and shade control system.</li> </ul> <p><u>Milestone 5 (2018)</u></p> <ul style="list-style-type: none"> <li>• Publish case study of demonstration.</li> </ul> <p><u>Milestone 6 (2019)</u></p> <ul style="list-style-type: none"> <li>• Monitor small (6,000 square feet) pilot demonstration of CO<sub>2</sub> supplementation integrated with the light and shade control system.</li> </ul> <p><u>Milestone 7 (2019)</u></p> <ul style="list-style-type: none"> <li>• Monitor large (20,000 square feet) pilot demonstration of a basic light and shade control system.</li> </ul> <p><u>Milestone 8 (2019)</u></p> <ul style="list-style-type: none"> <li>• Publish case study of demonstrations.</li> </ul> <p><u>Milestone 9 (2020)</u></p> <ul style="list-style-type: none"> <li>• Monitor small (6,000 square feet) pilot demonstration of efficient LED lights integrated with the CO<sub>2</sub> supplementation and light and shade control system.</li> </ul> <p><u>Milestone 10 (2020)</u></p> <ul style="list-style-type: none"> <li>• Monitor large (20,000 square feet) pilot demonstration of CO<sub>2</sub> supplementation integrated with the light and shade control system.</li> </ul> <p><u>Milestone 11 (2020)</u></p> <ul style="list-style-type: none"> <li>• Publish case study of demonstrations.</li> </ul> <p><u>Milestone 12 (2021)</u></p> <ul style="list-style-type: none"> <li>• Monitor large (20,000 square feet) pilot demonstration of efficient LED lights integrated with the CO<sub>2</sub> supplementation and light and shade control system.</li> </ul> <p><u>Milestone 13 (2021)</u></p> <ul style="list-style-type: none"> <li>• Publish case study of demonstration.</li> </ul> <p><u>Milestone 14 (2021)</u></p> <ul style="list-style-type: none"> <li>• Formal training offered to service providers.</li> </ul> |
| <b>Goals Prior to Exit</b> | <ul style="list-style-type: none"> <li>• Availability of products in the marketplace that can reduce electricity costs (and concomitant carbon emissions). Savings in an individual greenhouse up to 70 to 86% (depending on New York climate zone) are targeted.</li> <li>• The Consortium is self-funding through partnerships, membership fees, fee-based trainings and services, and royalties and licenses of patentable products.</li> <li>• Demonstrated electricity savings are achieved through synergistic solutions for greenhouse systems. Up to four hardware and software products and up to three services will be commercialized at program’s end. There are approximately eight provisional patents filed by the Consortium.</li> <li>• In addition to the direct savings from the pilots, there are indirect savings resulting from market penetration of improved control systems and lighting technologies in New York tomato and lettuce greenhouse acreage of at least 25%.</li> </ul>   |

### 14.1.5 Relationship to Utility/REV

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| <b>Utility Role/Coordination Points</b>       | <ul style="list-style-type: none"> <li>Utilities may be able to identify specific greenhouses with high energy bills or specific geographic areas with large loads and work collaboratively with the Consortium to address those needs.</li> <li>NYSERDA will also take advantage of the CEAC Clean Energy Implementation and Coordination Working Group to coordinate planning and implementation with the New York State utilities.</li> </ul> |
| <b>Utility Interventions in Target Market</b> | <ul style="list-style-type: none"> <li>Utilities currently do not have similar interventions specifically targeted at this market segment, however customers may be able to take advantage of utility incentive programs for energy efficiency improvements at commercial and industrial facilities.</li> </ul>  |

### 14.1.6 Budgets & Expenditures

An annual commitment budget for all activities included in this chapter is shown in Table 1. The annual expenditure projection is included in Table 2. Budgets and expenditures do not include Administration, Evaluation, or Cost Recovery Fee; these elements are addressed in the Budget Accounting and Benefits chapter filing. The budget as presented in the Budget Accounting and Benefits Chapter will serve as the basis for any subsequent reallocation request. The additional level of detail presented within the table below is intended for informational purposes only.

NYSERDA’s commitment of funds in this case is to a Consortium who will distribute assistance and information to current and potential participants on NYSERDA’s behalf. These activities will occur over a longer period of time than is evident from the committed budget and benefits shown here. NYSERDA will continually monitor performance and report actual progress.

**Table 1: Annual Innovation & Research Budget Allocation – Commitment Basis**

| <b>Commitment Budget</b>                          | <b>2016</b> | <b>2017</b> | <b>2018</b> | <b>Total</b> |
|---|-------------|-------------|-------------|--------------|
| Research and Technology Studies/Development/Demos | \$4,250,000 | -           | -           | \$4,250,000  |
| Implementation Support                            | \$450,000   | -           | -           | \$450,000    |
| Tools, Training, and Replication                  | \$300,000   | -           | -           | \$300,000    |
| Total   | \$5,000,000 | -           | -           | \$5,000,000  |

**Table 2: Annual Expenditures Projection**

| <b>Expenditures</b> | <b>2016</b> | <b>2017</b> | <b>2018</b> | <b>2019</b> | <b>2020</b> | <b>2021</b> | <b>2022</b> | <b>2023</b> | <b>Total</b> |
|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| Total               | 5%          | 20%         | 20%         | 19%         | 17%         | 11%         | 6%          | 3%          | 100%         |

### 14.1.7 Progress and Performance Metrics

Table 3 provides program Activity/Output indicators representing measurable, quantifiable direct results of activities undertaken in the initiative. Outputs are a key way of regularly tracking progress, especially in the early stages of an initiative, before broader market changes are measurable. Outcome indicators 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.

**Table 3. Initiative Specific Metrics**

|                              | <b>Indicators<sup>5</sup></b>  | <b>Baseline<br/>(Before/Current)</b> | <b>2019<br/>(Cumulative)</b>  | <b>2022 (Cumulative)</b>  |
|------------------------------|--|--------------------------------------|---|---|
| <b>Activity/<br/>Outputs</b> | Greenhouse area used for pilot testing   | 0                                    | 26,000 square feet  | 26,000 square feet  |
|                              | Number of paid Consortium memberships  | 0                                    | 20  | 25  |
|                              | Number of products developed   | 0                                    | 2   | 4   |
|                              | Number of services developed   | 0                                    | 2   | 3   |
|                              | Number of product variations tested in pilot systems   | 0                                    | 5   | 8   |
|                              | Number of case studies developed   | 0                                    | 2   | 4   |
| <b>Outcomes</b>              | Average market penetration of improved technologies in New York greenhouse acreage in the lettuce and tomato sectors | 0%                                   | 22%   | 25%   |
|                              | Number of provisional patents filed  | 0                                    | 2   | 8   |
|                              | Reduction in greenhouse electricity use in New York  | 0                                    | Up to 50% reduced electricity usage per greenhouse, depending on NYS climate zone | Up to 70-86% reduced electricity usage per greenhouse, depending on NYS climate zone            |
|                              | Number of acres of greenhouses in New York (beyond pilot participants) adopting the improved technologies            | 0                                    | 18  | 23  |
|                              | Consortium remains viable after NYSERDA milestones are completed   | n/a                                  |   | Projections for Year 8 financials show positive cash flow. Consortium has 25-30 paying members. |

<sup>5</sup> A 0 (zero) denotes that the actual value is currently believed to be zero for baseline/market metrics.

Benefits shown in Table 4 and Table 5 are direct, near term benefits associated with this initiative's projects. These benefits will be quantified and reported on a quarterly basis and will be validated through later evaluation.

**Table 4. Direct Impacts<sup>6</sup>**

| Primary Metrics <sup>7</sup>                   |                | 2016   | 2017 | 2018 | TOTAL  |
|--|----------------|--------|------|------|--------|
| Energy Efficiency                              | MWh Annual     | 3,470  | -    | -    | 3,470  |
|  | MWh Lifetime   | 34,700 | -    | -    | 34,700 |
|  | MMBTu Annual   | -      | -    | -    | -      |
|  | MMBTU Lifetime | -      | -    | -    | -      |
|  | MW             | -      | -    | -    | -      |
| Renewable Energy                               | MWh Annual     | -      | -    | -    | -      |
|  | MWh Lifetime   | -      | -    | -    | -      |
|  | MW             | -      | -    | -    | -      |
| CO2e Emission Reduction (metric tons) Annual   |                | 1,830  | -    | -    | 1,830  |
| CO2e Emission Reduction (metric tons) Lifetime |                | 18,300 | -    | -    | 18,300 |
| Customer Bill Savings Annual (\$ million)      |                | \$0.29 | -    | -    | \$0.29 |
| Customer Bill Savings Lifetime (\$ million)    |                | \$2.92 | -    | -    | \$2.92 |
| Private Investment (\$ million)                |                | \$9.46 | -    | -    | \$9.46 |

**Table 5. Annual Projected Initiative Participation**

|  | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|--|------|------|------|------|------|-------|
| Participants (Paid Consortium members) | 0    | 5    | 10   | 5    | 5    | 25    |

Benefits shown in Table 6 represent the estimated indirect market effects expected to accrue over the longer term as a result of this investment and follow on market activity. Many interrelated factors impacting indirect benefits (e.g., potential electricity reduction, growth in greenhouse acreage in NY, or market penetration of improved technologies) may vary from projected values. Thus, rather than claim the full and very significant amount of indirect benefits that NYSERDA believes may accrue from this investment, as discussed on other sections of this investment plan, NYSERDA has applied some additional conservatism to the indirect benefit targets in Table 6. Actual indirect benefits may exceed targets shown in Table 6. The indirect benefits that accrue from this investment will be quantified and reported based on periodic Market Evaluation studies to validate these forecasted values. Market Evaluation may occur within one year (-/+ ) of the years noted in the table and projected future indirect benefits and/or budgets necessary to achieve them may be updated based on the results of market evaluation. Indirect impact across NYSERDA initiatives may not be additive due to multiple initiatives operating within market sectors. The

<sup>6</sup> NYSERDA's commitment of funds in this case is to an implementor who will put the funds to use on NYSERDA's behalf over a longer period of time (seven years) than is evident from the committed budget and benefits shown in this plan (benefits will be acquired over a period of 10 years). NYSERDA will monitor performance and report actual progress.

<sup>7</sup> Impacts are expressed on a commitment-year basis, and are incremental additions in each year. Assumes a 10-year measure life. Benefits are rounded to three significant figures. Totals may not sum due to rounding. Customer bill savings are calculated as direct energy bill savings realized by customers participating in NYSERDA's programs.

values presented below are not discounted, however NYSERDA has applied a discount of 50% to the overall portfolio values in the Budget Accounting and Benefits chapter.

**Table 6. Estimated Indirect Market Impact**

| Indirect Impact   |                         | 2020    | 2025    | 2030    |
|---|-------------------------|---------|---------|---------|
| Energy Efficiency                                       | MWh Cumulative Annual   | 112,000 | 278,000 | 364,000 |
|   | MMBtu Cumulative Annual | -       | -       | -       |
| Renewable Energy  | MWh Cumulative Annual   | -       | -       | -       |
|   | MW                      | -       | -       | -       |
| CO2e Emission Reduction (metric tons) Cumulative Annual |                         | 59,000  | 146,000 | 191,000 |

#### 14.1.8 Fuel Neutrality

|                        |   |
|------------------------|---|
| <b>Fuel Neutrality</b> | <ul style="list-style-type: none"> <li>This initiative is not being delivered on a fuel neutral basis. The focus is electric lighting, ventilation and controls.</li> </ul> |
|------------------------|---|

#### 14.1.9 Performance Monitoring and Evaluation Plans

|   |  |
|---|--|
| <b>Performance Monitoring &amp; Evaluation Plan</b> | <p>NYSERDA’s approach to monitoring and assessing the effectiveness of the initiative and overall market development is described below.</p> <p><b><u>Test-Measure-Adjust Strategy</u></b></p> <ul style="list-style-type: none"> <li>Routine reporting on energy savings to date, and progress against identified annual energy savings goals will be collected and reviewed. Private sector and federal funding leverage will be evaluated.</li> <li>The Consortium operations and success, including its ongoing research, will be evaluated annually together with input from the advisory panel with regard to set goals, metrics, outputs and outcomes. Redirecting (as needed) will ensure continued progress against goals.</li> <li>Annually assess mix of market participants in the Consortium and determine if outreach strategies have to be updated to attract more members from specific market sectors.</li> <li>Survey growers and manufacturers on barriers, perceived benefits and their willingness to participate in the Consortium and/or adopt new products or technologies.</li> <li>Annually gather market characterization data from Controlled Environment Agriculture trade association and USDA, as available.</li> <li>Track over time the number of non-Consortium members participating in outreach activities.</li> </ul> <p><b><u>Agriculture – GLASE Strategy Measurement &amp; Verification</u></b></p> <ul style="list-style-type: none"> <li>As part of the implementation strategy, all pilot sites will undergo intense measurement and verification of electricity savings, which will be used to calculate CO<sub>2</sub> savings. Data will be analyzed to increase the understanding of product performance and iteratively improve greenhouse control systems.</li> </ul> |
|---|--|

**Market Evaluation**

- Market Evaluation will draw on the logic model and will include baseline and longitudinal measurement of key indicators of market success.
- Baseline measurements of key performance indicators will occur within one year of strategy approval, including current market penetration of control systems in greenhouses, current product lifespans and current crop production yields.
- Regular (e.g., annual) updates to key performance indicators and measurement of market change, including level of market adoption (replication into non-pilot facilities), and the associated benefits.
- Sources of data will include pilot data, public and commercially available data, data from New York's Controlled Environment Agriculture trade association, and primary data collection through surveys of key market actors.

**Impact Evaluation/Field Verification**

- As noted above, the implementation of pilots will include intense measurement and verification of electricity savings, which will be used to calculate CO<sub>2</sub> savings. Independent impact evaluation/field verification will rely on measurement and verification conducted as part of the pilot activities and will verify the results of this analysis as needed.
- Replication of improved technologies into other greenhouses in New York State, beyond pilot participants, and the resultant energy benefits will also be subject to independent impact evaluation review. Methodology will be determined, as appropriate, based on the level of adoption and technologies involved.
- Data from Field Verification/Impact Evaluation can be used to help lend confidence in the market, especially among other end users.

## 14.2 Advancing Agricultural Energy Technologies

### 14.2.1 Overview

|                                 |   |
|---------------------------------|---|
| <p><b>Present Situation</b></p> | <ul style="list-style-type: none"> <li>• The agriculture sector (comprised of animal farms and on-farm crop production – herein referred to as “farms”), with its over 35,000 farms, contributes \$5.4 billion annually to the State’s economy. These facilities also account for approximately 7.2 million acres of farmland, roughly one-quarter of the State’s land area.<sup>8</sup></li> <li>• Total energy use on farms accounts for approximately 9% of farm expenses, or approximately \$450 million in annual expenses. Total energy costs vary from farm to farm. Approximately 45% of dairy farms spend between \$5,000 and \$25,000 annually on utilities, which includes electricity, phone, internet and water, while roughly 10% spend greater than \$25,000.<sup>9</sup></li> <li>• The agriculture sector operates under tight margins and farms try to reduce operating expenses to maintain profitability and long-term farm viability. While energy efficiency projects represent a strong cost saving opportunity, identifying what improvements could lower utility expenses, as well as how and where to obtain the appropriate level of technical and financial assistance, can be onerous for farms to navigate.</li> <li>• The Clean Energy for Agriculture Task Force (CEATF), 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.<sup>10</sup> This initiative will address the Technology Advancement and Research and Development Opportunities for Clean Energy and Managing Greenhouse Gas Impacts strategy by implementing a process to identify, highlight, and evaluate barriers and opportunities for technology advancement for clean energy and GHG reduction in agricultural applications.</li> <li>• NYSERDA currently offers assistance to the agriculture sector through the following initiatives: the Agriculture Energy Audit Program and Anaerobic Digester Gas to Electricity Program in the Resource Acquisition chapter, the Greenhouse Lighting and Systems Engineering (GLASE) Consortium approved in the Agriculture Chapter, and a revised Agriculture Energy Audit component of FlexTech, that will be issued in 2019 via the Multi-Sector Solutions Chapter, as well as the development and distribution of an agriculture best practice guide.</li> </ul> |
|---------------------------------|---|

<sup>8</sup> United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) census data for 2012.

<sup>9</sup> Ibid

<sup>10</sup> Clean Energy for Agriculture Task Force (CEATF) Strategic Plan, prepared by Energy & Resource Solutions, March 2017 ([nyserdera.ny.gov/CEATF-Plan](http://nyserdera.ny.gov/CEATF-Plan))



|   |   |
|---|---|
| <b>Intervention Strategy</b>                        | <ul style="list-style-type: none"> <li>• NYSERDA will identify and demonstrate advanced, underused, or emerging technologies and processes to determine those that provide cost-effective energy and process efficiency.<sup>11</sup> Underused or emerging technologies are defined as commercially available technologies that are not currently standard practices at farms in NYS.</li> <li>• NYSERDA will collect, analyze, and verify demonstration site data to support the business case for the technologies and share the information with the market. NYSERDA will use existing resources that are trusted in the agricultural community (e.g., Cornell Cooperative Extension), as well as webinars, workshops, and events, to disseminate the information.</li> <li>• For a visual representation of this strategy, please refer to the flow chart entitled “Logic Model: Advancing Agricultural Energy Technologies,” which can be found in Appendix A.</li> </ul> |
| <b>Goals</b>  | <ul style="list-style-type: none"> <li>• Increase the number of farms adopting underused or emerging energy efficiency technologies.</li> <li>• Increasing communication and market awareness of clean energy technologies.</li> </ul>  |
| <b>State Energy Plan/Clean Energy Standard Link</b> | <p>This strategy contributes to the goals of the New York State Energy Plan and Clean Energy Standard (CES), including 40% statewide greenhouse gas emission reductions and 600 TBTU of statewide energy efficiency improvements. The 2015 New York State Energy Plan highlights the importance of energy efficiency and calls on NYSERDA to “seek to address the diverse set of remaining barriers with new programs and strategies that unlock the potential of energy efficiency to reduce operating costs, spur investment, and create jobs throughout the State”.</p>  |

14.2.2 Target Market Characterization

|                                 |   |
|---------------------------------|---|
| <b>Target Market Segment(s)</b> | The target market for this initiative is all New York State farms, with an initial focus on higher energy consuming sub-sectors such as dairy farms.  |
| <b>Market Participants</b>      | <p>Market participants include:</p> <ul style="list-style-type: none"> <li>• Farm equipment vendors and suppliers</li> <li>• Farm owners</li> <li>• Agricultural industry consultants and partners</li> <li>• Soil and Water Districts</li> <li>• County Agricultural Business Centers</li> <li>• New York State Department of Agriculture and Markets</li> <li>• New York Farm Bureau</li> <li>• United States Department of Agriculture</li> <li>• Cornell Cooperative Extension</li> <li>• Clean Energy for Agricultural Task Force</li> <li>• New York State investor-owned utilities</li> <li>• Energy Auditors</li> <li>• Trade Associations</li> </ul> |
| <b>Market Readiness</b>         | <ul style="list-style-type: none"> <li>• In the past, NYSERDA has demonstrated what were, at the time, advanced, underused, or emerging energy-efficiency technologies for dairy farms, which went on to become best practices. The agriculture sector has been more willing</li> </ul>   |

<sup>11</sup> Some potential technologies, such as non-conventional cow cooling technologies and ozone laundry, are identified in “Energy Efficiency in New York State Agriculture: Summary of Energy Efficiency Programs and Research Opportunities”, NYSERDA Report June 2015. (<https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Other-Technical-Reports/energy-efficiency-in-new-york-state-agriculture.pdf>) Technologies will not be limited to those identified in the study, it is anticipated that other technologies will be identified through market participant outreach.

|                       |  |
|-----------------------|--|
|                       | <p>to install new technologies when their peers and neighbor have had successful demonstrations, making peer-to-peer sharing a valuable tool for farm uptake of energy efficiency technologies.</p> <ul style="list-style-type: none"> <li>Farms and farm supply vendors have indicated, through interviews and feedback on past NYSERDA programs, that providing unbiased information, case studies and illustrating energy efficiency opportunities to the farm sector through a variety of trusted entities and approaches would provide assurance to pursue energy improvements. Farms suggest that case studies highlighting effective best practices and technologies are a successful way to encourage implementation.</li> </ul> |
| <b>Customer Value</b> | <ul style="list-style-type: none"> <li>Provision of straightforward technical and financial information about advanced, underused, or emerging energy-efficiency technologies, including the cost to implement, potential savings, payback, and other cost benefits, assist farms in making investment decisions which can provide energy bill savings.</li> <li>Reduced customer acquisition time and costs for service providers and equipment suppliers make it easier to sell new technologies, facilitating market adoption.</li> </ul>   |

14.2.3 Stakeholder/Market Engagement

|                                      |  |
|--------------------------------------|--|
| <b>Stakeholder/Market Engagement</b> | <ul style="list-style-type: none"> <li>Through the CEATF's working groups, NYSERDA has investigated and obtained marketplace feedback confirming the value of and need for assisting farms in improving energy efficiency, making clean energy decisions and advancing technologies.<sup>12</sup></li> </ul> |
|--------------------------------------|--|

14.2.4 Theory of Change

|                                  |  |
|----------------------------------|--|
| <b>Market Barriers Addressed</b> | <ul style="list-style-type: none"> <li><b>Seasonality.</b> The timeframe to provide information to farms to make energy efficiency improvements often competes with other priorities. Working with the agricultural community and leveraging the opportune times to deliver workshops, webinars and other outreach will improve the chance of obtaining the businesses' attention, increasing the likelihood that an energy efficiency project will move forward.</li> <li><b>Lack of understanding of the benefits of energy and process efficiency.</b> The benefits of energy and process efficiency, particularly for emerging or underused technologies, are often not made clear to the broader farm community. Delivering reliable information on the technology and benefits will enable businesses to understand all the potential benefits various energy efficiency improvements can deliver, making them more apt to adopt energy improvements.</li> <li><b>Limited capital for investment.</b> Given the tight margins that farms operate under, farms are constantly making decisions on where to use their limited financial resources. Providing necessary technical information that includes financial criteria such as payback can assist farms in their decision-making process to invest in energy efficient technologies.</li> </ul> |
|----------------------------------|--|

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<sup>12</sup> The working groups consists of NYSERDA, several NYS farms, Cornell University, Cornell Cooperative Extension, New York State Department of Agriculture & Markets, New York State Department of Environmental Conservation, New York Gas & Electric, National Grid, Northeast Dairy Producers, New York Cow Power Group and NYS Pollution Prevention Institute.

|                            |  |
|----------------------------|--|
|                            | <ul style="list-style-type: none"> <li>• <b>Risk aversion.</b> Farms tend to be risk averse in implementing new technologies. Assurance that energy efficiency technologies will not disrupt operations or affect product quality will enable farms to more readily accept and implement the improvements.</li> </ul>  |
| <b>Testable Hypotheses</b> | <ul style="list-style-type: none"> <li>• If underused or emerging farm energy-efficient technologies and processes are identified, demonstrated, and proven effective, and coupled with guidance on how to obtain financial assistance, then farms will adopt the technology to reduce their energy costs.</li> </ul>  |
| <b>Activities</b>          | <ul style="list-style-type: none"> <li>• Identify and demonstrate advanced, underused, or emerging technologies and processes to determine those that provide cost-effective energy and process efficiency opportunities <ul style="list-style-type: none"> <li>○ Issue a competitive solicitation to select approximately 20 teams of a technology vendor and farm establishment willing to be the site of a demonstration and for whom the technology fits a need.</li> <li>○ Provide technical assistance through contractors to collect and verify data from demonstration projects. Host sites, with the assistance of technical service providers, will collect information to compare energy use data in base case and post installation scenarios to determine the effectiveness and efficiency of the technology.</li> </ul> </li> <li>• Collect, analyze, and verify demonstration site data to support the business case for the technologies and share the information with the market <ul style="list-style-type: none"> <li>○ Identify and implement appropriate channels and strategy for dissemination of business case scenarios for successful underused or emerging technology and process efficiency improvements. Target the most active and trusted sources within each sub-sector to disseminate the information to the market.</li> <li>○ Develop case study materials to illustrate successful underused and emerging energy efficiency technologies vetted through demonstration projects that were ultimately installed at a farm.</li> <li>○ Disseminate case studies to the relevant farms. Host open house events on a farm to showcase their successful demonstration and invite farms suitable for replication.</li> <li>○ Guide the agriculture sector to available financial resources by assisting farms in finding possible financial implementation assistance and other incentives available from the utilities, federal agencies (such as USDA) and other available sources.</li> </ul> </li> </ul> |
| <b>Key Milestones</b>      | <p><u>Milestone 1 (2018)</u></p> <ul style="list-style-type: none"> <li>• Identify technologies to demonstrate.</li> </ul> <p><u>Milestone 2 (2018)</u></p> <ul style="list-style-type: none"> <li>• Issue solicitation to select teams of technology vendor and farms to demonstrate technologies.</li> </ul> <p><u>Milestone 3 (2019)</u></p> <ul style="list-style-type: none"> <li>• Contract with teams to demonstrate underused and emerging technologies.</li> </ul> <p><u>Milestone 4 (2020)</u></p> <ul style="list-style-type: none"> <li>• Publish and disseminate business case scenarios that support underused and emerging technology implementation.</li> </ul> <p><u>Milestone 5 (2021)</u></p> <ul style="list-style-type: none"> <li>• Perform targeted outreach of successful business case scenarios to farms suitable for implementing the demonstrated technology.</li> </ul>   |

|                            |   |
|----------------------------|---|
| <b>Goals Prior to Exit</b> | <ul style="list-style-type: none"> <li>Reliable market sources compile, develop and maintain current information on advanced clean energy technologies for use by local information-exchange networks.</li> <li>Advanced technologies are installed by farms outside of demonstration projects.</li> <li>Agriculture vendors and suppliers use energy efficiency as a tool to sell their products.</li> </ul> |
|----------------------------|---|

#### 14.2.5 Relationship to Utility/REV

|   |   |
|---|---|
| <b>Utility Role/Coordination Points</b>       | <ul style="list-style-type: none"> <li>Utilities will be invited to be participants in the selection committee to ensure on-going collaboration efforts and technologies meet their needs. NYSERDA will share data from underused and emerging technology demonstrations and information on the value proposition of implementing the underused and emerging technology with utilities. This data can be used by utilities to expand their incentive offerings.</li> </ul>  |
| <b>Utility Interventions in Target Market</b> | <ul style="list-style-type: none"> <li>Utility prescriptive and custom incentive programs for farms currently exist in the market through investor owned utilities. With this initiative, NYSERDA can provide the information on technologies once successfully demonstrated. This information will help the utilities expand their incentive program's prescriptive measure lists to reflect the more advanced technologies as they are proven, or can be used as the basis for new customer incentives to support new technologies and approaches.</li> </ul> |

#### 14.2.6 Budgets & Expenditures

An annual commitment budget for all activities included in this chapter is shown in Table 1. The annual expenditure projection is included in Table 2. Budgets and expenditures do not include Administration, Evaluation, or Cost Recovery Fee; these elements are addressed in the Budget Accounting and Benefits chapter filing. The budget as presented in the Budget Accounting and Benefits Chapter will serve as the basis for any subsequent reallocation request. The additional level of detail presented within the table below is intended for informational purposes only.

**Table 7: Annual Market Development Budget Allocation – Commitment Basis**

| <b>Budget</b>                                     | <b>2018</b>      | <b>2019</b>      | <b>2020</b>      | <b>2021</b>      | <b>2022</b>      | <b>2023</b>     | <b>Total</b>       |
|---|------------------|------------------|------------------|------------------|------------------|-----------------|--------------------|
| Research and Technology Studies/Development/Demos | \$0              | \$750,000        | \$750,000        | \$750,000        | \$750,000        | \$0             | \$3,000,000        |
| Tools, Training, and Replication                  | \$20,000         | \$0              | \$65,000         | \$45,000         | \$45,000         | \$45,000        | \$220,000          |
| Implementation Support                            | \$0              | \$145,000        | \$125,000        | \$145,000        | \$125,000        | \$0             | \$540,000          |
| <b>Total</b>                                      | <b>\$ 20,000</b> | <b>\$895,000</b> | <b>\$940,000</b> | <b>\$940,000</b> | <b>\$920,000</b> | <b>\$45,000</b> | <b>\$3,760,000</b> |

**Table 8: Annual Expenditures Projection**

| <b>Expenditures</b> | <b>2018</b> | <b>2019</b> | <b>2020</b> | <b>2021</b> | <b>2022</b> | <b>2023</b> | <b>2024</b> | <b>2025</b> |
|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <b>Total</b>        | 1%          | 1%          | 7%          | 18%         | 25%         | 23%         | 18%         | 7%          |

## 14.2.7 Progress and Performance Metrics

Table 3 provides program Activity/Output indicators representing measurable, quantifiable direct results of activities undertaken in the initiative. Outputs are a key way of regularly tracking progress, especially in the early stages of an initiative, before broader market changes are measurable. Outcome indicators 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.

**Table 9. Initiative Specific Metrics**

| Indicators <sup>13</sup> |   | Baseline<br>(Before/Current) | 2022<br>(Cumulative) |
|--------------------------|---|------------------------------|----------------------|
| Activity/<br>Outputs     | Number of farm sites hosting demonstration projects   | 0                            | 50                   |
|                          | Number of case studies developed and disseminated   | 0                            | 10                   |
|                          | Number of open houses hosted  | 0                            | 2                    |
| Outcomes                 | Number of farms knowledgeable of energy efficiency opportunities for underused or emerging technologies | 0                            | 100                  |

Benefits shown in Table 4 and Table 5 are direct, near term benefits associated with this initiative's projects. These benefits will be quantified and reported on a quarterly basis and will be validated through later evaluation.

**Table 10. Direct Impacts**

| Primary Metrics                                |                | 2019   | 2020   | 2021   | 2022   | TOTAL   |
|--|----------------|--------|--------|--------|--------|---------|
| Energy Efficiency                              | MWh Annual     | 410    | 410    | 410    | 410    | 1,642   |
|  | MWh Lifetime   | 6,160  | 6,160  | 6,160  | 6,160  | 24,630  |
|  | MMBtu Annual   | -      | -      | -      | -      | -       |
|  | MMBTU Lifetime | -      | -      | -      | -      | -       |
|  | MW             | -      | -      | -      | -      | -       |
| Renewable Energy                               | MWh Annual     | -      | -      | -      | -      | -       |
|  | MWh Lifetime   | -      | -      | -      | -      | -       |
|  | MW             | -      | -      | -      | -      | -       |
| CO2e Emission Reduction (metric tons) Annual   |                | 216    | 216    | 216    | 216    | 864     |
| CO2e Emission Reduction (metric tons) Lifetime |                | 3,240  | 3,240  | 3,240  | 3,240  | 12,960  |
| Customer Bill Savings Annual (\$ million)      |                | \$0.06 | \$0.06 | \$0.06 | \$0.06 | \$0.239 |
| Customer Bill Savings Lifetime (\$ million)    |                | \$0.90 | \$0.90 | \$0.90 | \$0.90 | \$3.58  |
| Private Investment (\$ million)                |                | \$0.19 | \$0.19 | \$0.19 | \$0.19 | \$0.75  |

<sup>13</sup> A 0 (zero) denotes that the actual value is currently believed to be zero for baseline/market metrics. These values reflect metrics for this initiative only, and does not include any prior NYSERDA demonstration project efforts which focused on different technologies.

**Table 11. Annual Projected Initiative Participation**

|                            | 2019 | 2020 | 2021 | 2022 | Total |
|----------------------------|------|------|------|------|-------|
| Participants <sup>14</sup> | 5    | 5    | 5    | 5    | 20    |

Benefits shown in Table 6 represent the estimated indirect market effects expected to accrue over the longer term because of this investment and follow on market activity. The indirect benefits that accrue from this investment will be quantified and reported based on periodic Market Evaluation studies to validate these forecasted values. Market Evaluation may occur within one year (-/+ ) of the years noted in the table and projected future indirect benefits and/or budgets necessary to achieve them may be updated based on the results of market evaluation. Indirect impact across NYSERDA initiatives may not be additive due to multiple initiatives operating within market sectors. The values presented below are not discounted, however NYSERDA has applied a discount of 50% to the overall portfolio values in the Budget Accounting and Benefits chapter.

**Table 12. Estimated Indirect Market Impact**

| Indirect Impact   |                         | 2020 | 2025  | 2030  |
|---|-------------------------|------|-------|-------|
| Energy Efficiency                                       | MWh Cumulative Annual   | -    | 1,810 | 4,020 |
|   | MMBtu Cumulative Annual | -    | -     | -     |
| Renewable Energy  | MWh Cumulative Annual   | -    | -     | -     |
|   | MW                      | -    | -     | -     |
| CO2e Emission Reduction (metric tons) Cumulative Annual |                         | -    | 951   | 2,110 |

#### 14.2.8 Fuel Neutrality

|                        |   |
|------------------------|---|
| <b>Fuel Neutrality</b> | <ul style="list-style-type: none"> <li>This initiative is not being delivered on a fuel neutral basis. The focus is on potential electric saving through the installation of advanced, underused, or emerging efficiency technologies.</li> </ul> |
|------------------------|---|

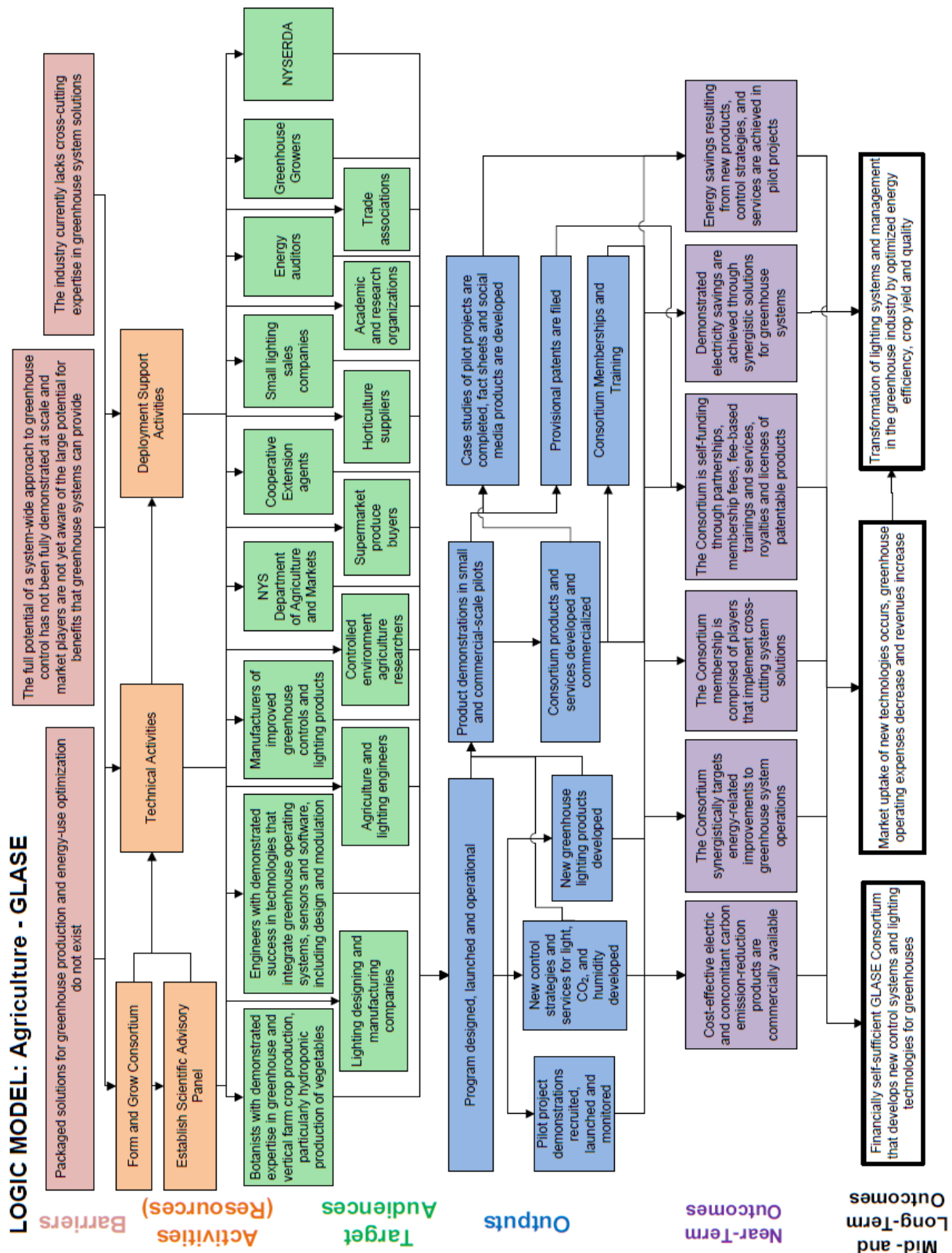
#### 14.2.9 Performance Monitoring and Evaluation Plans

|   |   |
|---|---|
| <b>Performance Monitoring &amp; Evaluation Plan</b> | <p>NYSERDA’s approach to monitoring and assessing the effectiveness of the initiative and overall market development is described below.</p> <p><u>Test-Measure-Adjust Strategy</u></p> <ul style="list-style-type: none"> <li>Collect, analyze and report on progress of the initiative by comparing progress against identified goals on a regular basis (i.e., quarterly, bi-annually).</li> </ul> |
|---|---|

<sup>14</sup> Participants are teams selected to demonstrate advanced or underused technologies.

|  |   |
|--|---|
|  | <ul style="list-style-type: none"> <li>• Annually assess the number of demonstration projects to determine if this outreach strategy is effective in attracting interest and confidence in energy and process efficiency improvements in the agriculture and farm sector.</li> <li>• Insights as to how the initiative can be optimized will be gathered and applied to future initiative design to ensure greatest market impacts within the identified market sectors.</li> <li>• Aggregate and analyze data from NYSERDA-supported projects to verify realized energy savings and persistence of savings. <ul style="list-style-type: none"> <li>○ Survey farms on barriers, perceived benefits and their willingness to implement underused and emerging technology.</li> </ul> </li> </ul> <p><u>Market Evaluation</u></p> <ul style="list-style-type: none"> <li>• Market evaluation will draw on the logic model and will include baseline measurements of key market indicators. Regular longitudinal measurements (e.g., annual or biennial) will include updates of the baseline metrics as well as additional measurements to assess market change resulting from the initiative.</li> <li>• Key market indicators will include, but not be limited to, the rate at which underused or emerging technologies are adopted and replicated by participants and non-participants and knowledge of and confidence in the benefits of underused or emerging approaches and technologies.</li> <li>• As appropriate, the market evaluation will leverage sector-level market studies as well as publicly and commercially available data to inform the tracking of key market indicators.</li> </ul> <p><u>Impact Evaluation/Field Verification</u></p> <ul style="list-style-type: none"> <li>• Evaluation M&amp;V will be conducted according to the International Performance Measurement and Verification Protocol (IPMVP) method(s) most appropriate given the measures promoted by this initiative. Data from the impact evaluation can be used to help lend confidence in the market, especially among other end users.</li> <li>• Evaluation M&amp;V of direct savings will focus on areas of greatest impact and will draw upon project-level data collected by the program.</li> <li>• Depending on the extent of replication identified in market evaluation activities, impact evaluation may be conducted on a sample of replication projects to assess outcomes.</li> </ul> |
|--|---|

# Appendix A – Logic Models





# LOGIC MODEL: Advancing Agricultural Energy Technologies

