2021-2024 CDM Framework Retrofit Greenhouse Enhancements PY2023 Evaluation Results

Submitted to IESO

in partnership with NMR Group

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Additionally, the evaluation team would like to thank the participants that supported the evaluation team's impact telephone and web-based surveys, and site visits. Their cooperation with the evaluation team's efforts has produced high-quality data that will serve Ontario conservation efforts for years to come.

Acronyms and Abbreviations

EM&V	Evaluation, measurement, and verification
EUL	Effective useful life
FR	Free-ridership
GW or GWh	Gigawatt or Gigawatt-hour
IDI	In-depth interview
IESO	Independent Electricity System Operator
kW or kWh	Kilowatt or Kilowatt-hour
LED	Light emitting diode
MW or MWh	Megawatt or Megawatt-hour
NTG	Net-to-gross
PY	Program year
SO	Spillover
TGP	Targeted Greenhouse Program

1 Executive Summary

The Independent Electricity System Operator (IESO) retained Resource Innovations, and their sub-contractor NMR Group, Inc., to conduct an evaluation of the Greenhouses project stream as part of the 2021-2024 Conservation and Demand Management (CDM) Framework business program. This memo presents the evaluation results for all Greenhouse projects reported between January 1st and December 31st, 2023 (PY2023) including the Targeted Greenhouse Program (TGP).

1.1 Program Description

The Retrofit program offers incentives to industrial, commercial, institutional, and multifamily residential facility customers that express interest in upgrading existing equipment with energy-efficient alternatives. The Targeted Greenhouse Program was introduced on May 17, 2023. Under this program, prescriptive incentives for common horticultural measures, as well as new incentives for advanced lighting controls were made available for greenhouses in the South-West region of Ontario. This program was introduced to address local supply need in this region driven by the growing greenhouse sector.[1] A Standard Greenhouse project is defined as an individual or company who installed greenhouse measures through the Retrofit Program. Whereas Targeted Greenhouse projects were those participants that installed greenhouse measures and were specifically targeted in Southwest Ontario. Standard Greenhouse projects installed measures such as LED Grow Lights - Vegetable Greenhouses, LED Grow Lights - Cannabis Warehouses, and Horticultural Inter-Lighting LED Grow Lights. Targeted Greenhouse projects installed LED Grow Lights - Vegetable Greenhouses and Greenhouse Advanced Lighting Controls measures.

1.2 Summary of Results

An impact evaluation was performed to analyze the impact of the program's improvements and quantify the savings realized from implementing energy efficiency projects in the Greenhouses stream during PY2023. During the evaluation period, 54 projects were completed in the overall Greenhouses stream, out of which 12 projects were reported as Targeted Greenhouse projects[2]. The first-year net verified energy and summer peak demand savings for the Greenhouse stream was 133,434 MWh and 1,611 kW, respectively. The net persisting energy and demand savings in 2026 is equal to the first-year net verified energy

[1] See West of London Bulk Transmission Report, 23/09/2021

[2] Participation data received by the evaluation team consisted of 12 Targeted Greenhouse projects but five of these projects consisted of space lighting measures only.

and demand savings. The results of the PY2023 2021-2024 CDM Framework Retrofit Program's greenhouse stream is presented in Table 1-1.

Table 1-1: PY2023 Greenhouses Stream Impact Results

Greenhouse Stream Savings	Gross Reported Savings	Realization Rate	Gross Verified Savings	Net-to-Gross Ratio	Net Verified Savings	Net Verified Energy Savings in 2026
Energy (MWh)	197,377	69.2%	136,576	97.8%	133,545	133,545
Summer Peak Demand (kW)	773	216.6%	1,673	97.5%	1,631	1,631

Figure 1-1 and Figure 1-2 display PY2023 net verified first year energy and summer peak demand savings percentages for the Standard Greenhouse and Targeted Greenhouse projects under the Greenhouse stream. The Standard Greenhouse projects represent 66% of total net verified first year energy savings achieved by the Greenhouse stream with the Targeted Greenhouse projects accounting for the remaining 34%.

Figure 1-1: Greenhouse Stream Net Verified Energy Savings Percentages

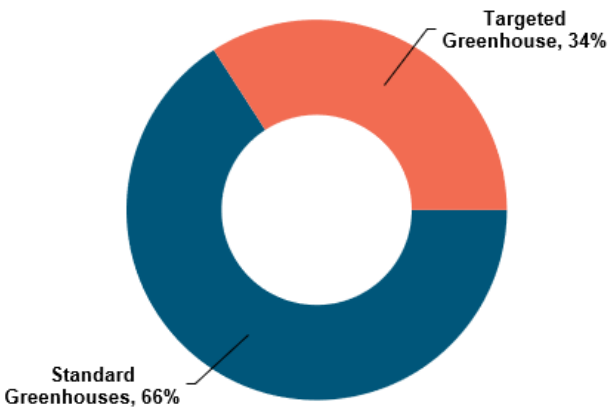
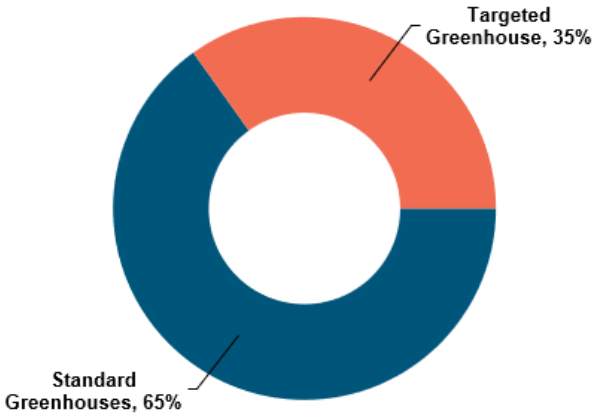


Figure 1-2: Greenhouse Stream Net Verified Summer Peak Demand Savings Percentages



Similarly for summer peak demand savings, Standard Greenhouse projects represent 65% of total net verified first year summer peak demand savings achieved by the Greenhouse stream, and Targeted Greenhouse projects accounts for the remaining 35% of summer peak demand savings.

The PY2023 overall Greenhouse stream achieved a Program Administrator Cost (PAC) ratio of 2.60, exceeding the 1.00 target threshold. The PY2023 CDM Retrofit Program Evaluation Report provides additional insight into the cost-effectiveness of the entire Greenhouse

stream. The PY2023 Standard Greenhouse projects achieved a PAC ratio of 2.68 while the Targeted Greenhouse projects achieved a PAC ratio of 2.48. First-year avoided GHG emissions from electricity savings resulted in 17,739 and 9,180 Tonnes of CO2 from Standard Greenhouse and Targeted Greenhouse projects respectively. These two tracks are expected to achieve a total of 267,338 and161,529 Tonnes of avoided GHG throughout the effective useful life of the installed measures.

The evaluation's recommendations with respect to Greenhouse measures including Targeted Greenhouse projects are highlighted in the PY2023 Retrofit Evaluation Report.

2 Impact Evaluation

An impact evaluation was performed to assess energy and summer peak demand savings attributable to the Greenhouse stream and to quantify savings generated by implementing Greenhouse projects during PY2023. Impact and net-to-gross evaluation methodologies are consistent with the province-wide Retrofit program evaluation as highlighted in the PY2023 Retrofit Program Evaluation Report.

2.1 Project Participation and Sampling

A Greenhouse stream participant is defined as an individual or company who completed a greenhouse project through the Retrofit Program during the evaluation period (January 1st and December 31st, 2023). All projects under the Greenhouse stream were prescriptive applications only.

The impact evaluation reviewed a total of 54 evaluation projects as part of the PY2023 Greenhouses stream, out of which 12 projects were defined as Targeted Greenhouse projects[3]. The project count exceeds the total number of unique greenhouse applications approved through the program during this evaluation period due to the evaluator's choice to stratify projects by measure type installed to increase the accuracy of the evaluation results.

A total of 31 random sample projects were targeted in the Greenhouse stratum, as shown in (Table 2-1). The number of projects selected in the Greenhouse stream target a 90% confidence level at 10% precision, assuming a coefficient of variation of 0.5. The evaluation team exceeded the intended sample size to achieve a 90% confidence level at a 10% precision level.

Table 2-1: PY2023 Greenhouse Project and Sample Count

Track/Type	PY2023 Target Sample	PY2023 Achieved Sample	Project Count
Greenhouse Stream	31	37	54

[3] Participation data received by the evaluation team consisted of 12 Targeted Greenhouse projects but five of these projects consisted of space lighting measures only.

2.2 Energy and Demand Savings

As mentioned in Section 1.2 the Greenhouse stream consists of Standard and Targeted Greenhouse projects. Overall, the Greenhouse stream contributed to 49% (133,434 MWh) of the net verified first-year energy and 6% (1,611 kW) of the net verified first-year summer peak demand savings to the PY2023 CDM Retrofit Program. Table 2-2 presents the energy contributions[4] of the Standard and Targeted Greenhouse projects to the Greenhouse stream. The Standard greenhouse projects contributed to 66% (87,932 MWh) and the Targeted Greenhouse projects contributed to 34% (45,613 MWh) of the Greenhouse stream's net verified first-year energy savings.

Table 2-2: PY2023 Greenhouse Stream Energy Savings

Greenhouse Stream Category	Gross Reported Savings (MWh)	Gross Verified Savings (MWh)	Net Verified Savings (MWh)	Net Verified Energy Savings % Program Contribution	Net Verified Energy Savings at 2026 (MWh)
Standard Greenhouses	129,964	89,909	87,932	66%	87,932
Targeted Greenhouses	67,413	46,667	45,613	34%	45,613
Total	**197,377**	**136,576**	**133,545**	**100%**	**133,545**

Table 2-3 presents the summer peak demand contributions[4] of the Standard and Targeted Greenhouse projects to the Greenhouse stream. The Standard greenhouse projects contributed to 64% (1,049 kW) and the Targeted Greenhouse projects contributed to 36% (582 kW) of the Greenhouse stream's net verified first-year summer peak demand savings.

Table 2-3: PY2023 Greenhouse Stream Summer Peak Demand Savings

Greenhouse Stream Category	Gross Reported Summer Peak Demand Savings (kW)	Gross Verified Summer Peak Demand Savings (kW)	Net Verified Summer Peak Demand Savings (kW)	Net Verified Summer Peak Demand Savings % Contribution	Net Verified Summer Peak Demand Savings at 2026 (kW)
Standard Greenhouses	484	1,073	1,049	64%	1,049

[4] Energy and Summer Peak Demand savings of the Targeted Greenhouse projects include savings from the projects that consisted of space lighting measures only.

Targeted Greenhouses	288	600	582	36%	582
Total	**773**	**1,673**	**1,631**	**100%**	**1,631**

2.3 Impact Evaluation Results

Table 2-4 presents the energy and summer peak demand realization rates for the sampled greenhouses stream projects. The greenhouses stream achieved an energy realization rate of 69.2% at 9.0% precision at the 90% confidence level and a summer peak demand realization rate of 221.5% at 46.4% precision at the 90% confidence level. Details regarding the main factors driving these realization rates can be found in the PY2023 Evaluation Report for the 2021-2024 CDM Framework Retrofit Program. The low energy realization rate was primarily due to lower verified hours of use (HOU) and higher conservation case wattages verified greenhouse facilities through visual inspections and data collected during the evaluation site visits. The high demand realization rate is due to the evaluation team validating greenhouse light fixtures being used for extended times during the IESO summer peak demand period[5]. The energy and summer peak demand realization rates were applied to all Greenhouse stream projects including Targeted Greenhouse projects.

Table 2-4: PY2023 Greenhouse Stream Sample Realization Rates and Precision

Measure Type	Energy Realization Rate	Energy RR Relative Precision	Summer Peak Demand Realization Rate	Demand RR Relative Precision
Greenhouse Stream	69.2%	9.0%	216.6%	46.4%

Overall, the Greenhouse stream projects consisted of measures such as LED Grow Lights - Vegetable Greenhouses, LED Grow Lights - Cannabis Warehouses, Horticultural Inter-Lighting LED Grow Light Fixtures and Greenhouse Advanced Lighting Controls. These measures combined contributed to 49% of the net verified first year energy and 6% of the net verified first-year summer peak demand savings to the CDM Retrofit Program.

Figure 2-1 and Figure 2-2 display PY2023 net verified first-year energy and summer peak demand savings percentages for the Standard Greenhouse and Targeted Greenhouse projects of the Greenhouse stream. The Standard Greenhouse projects represent 66% of total net verified first-year energy savings achieved by the Greenhouse stream with the Targeted Greenhouse projects accounting for the remaining 34%.

[5] June 1st to Aug 31st from 1:00 PM to 7:00 PM

Figure 2-1: Greenhouse Stream Net Verified Energy Savings Percentages

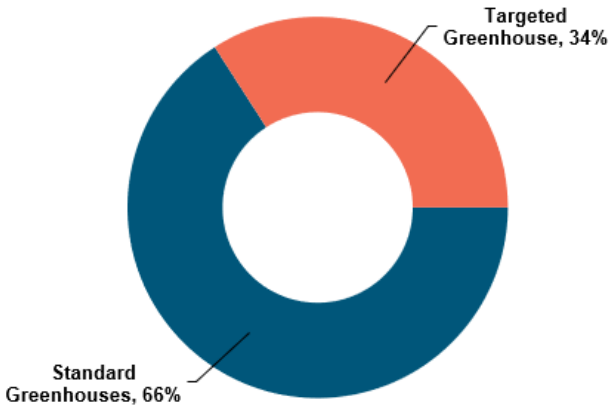
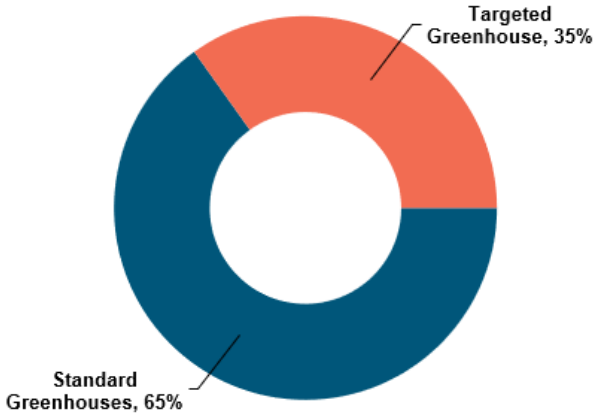


Figure 2-2: Greenhouse Stream Net Verified Summer Peak Demand Savings Percentages



Similarly for summer peak demand savings, the Standard Greenhouse projects represent 65% of total net verified first year summer peak demand savings achieved by the Greenhouse stream, and Targeted Greenhouse projects accounts for the remaining 35% of summer peak demand savings.

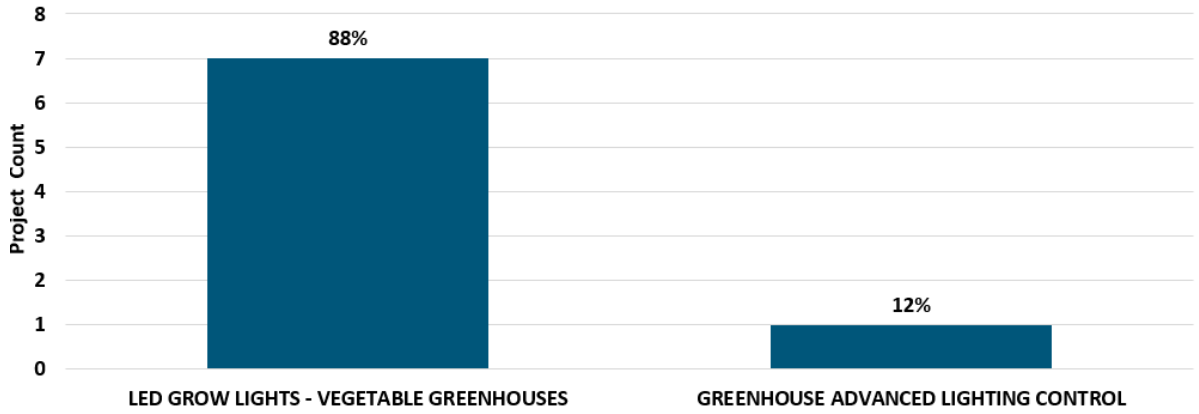
Standard Greenhouses were the most common type of Greenhouse projects, accounting for 87% (47) and the Targeted Greenhouses accounted for the remaining 13% (7) projects. Though Targeted Greenhouse projects accounted for only 13% of the Greenhouse stream projects, these projects had an average net verified energy savings per project (6,497 MWh) three times higher than the average net verified energy savings per project of Standard Greenhouse projects (1,965 MWh).

2.3.1 Targeted Greenhouse Projects

As mentioned in Section 1.2, participation data received by the evaluation team initially consisted of 12 Targeted Greenhouse projects but five of these projects consisted of space lighting measures only. As such, Figure 2-3 displays the project count percentage of the seven TGP projects by measure category. All seven projects were evaluated during the PY2023 evaluation cycle. Six of these projects were completed by one participant.

The Targeted Greenhouse projects consisted of only two measures - LED Grow Lights - Vegetable Greenhouses and Greenhouse Advanced Lighting Controls. LED grow lights in vegetable greenhouses provided the most common Targeted Greenhouse measure, accounting for 88%, followed by greenhouse advanced lighting controls at 12%.

Figure 2-3: TGP Project Count Percentages



LED grow lights in vegetable greenhouses measures achieved net energy savings of 45,480 MWh (99.95%), with greenhouse advanced lighting controls making up the remaining 22 MWh (0.05%) of net energy savings. LED grow lights in vegetable greenhouses accounted for all of the 562 kW (100%) net summer peak demand savings with greenhouse advanced lighting controls having no reported or net verified summer peak demand savings. The additional 133 MWh and 20 kW net verified energy and demand savings resulted from space lighting projects.

2.4 Net-to-Gross

The NTG evaluation assessed free-ridership and spillover through surveys with program participants. A customized survey instrument was developed to ensure the responses produced comparable data and allowed for the inference of meaningful conclusions. Table 2-5 presents the survey methodology, the total population of Greenhouse Stream participants invited to participate in the surveys, the total number of completed surveys, the response rate (RR), and the sampling error at the 90% confidence level. Additional details regarding the NTG evaluation methodology can be found in the PY2023 CDM Retrofit Evaluation Report.

Table 2-5: NTG Evaluation Primary Data Sources

Respondent Type	Methodology	Population	Total Completes	RR	90% CI Error Margin
Participants – Greenhouse Stream	Web and Phone Survey	33	15	45%	N/A*

*Error margin not displayed if the respondent count is below 30 unless census is achieved.

When conducting the participant survey, a census-based approach was used, which involved e-mailing all 33 companies who participated in the Greenhouse Stream to request their participation in the survey. A total of 15 participants responded to this request and completed the survey. The evaluation team developed the contact list of participants from program records provided by the IESO EM&V staff. The survey topics included Free-ridership and Spillover.

Table 2-6 presents the results of the PY2023 Greenhouse Stream NTG evaluation. The evaluation team targeted and achieved 90% confidence and 10% precision levels in the savings results. The PY2023 CDM Retrofit Program Evaluation Report provides additional analyses performed to assist in interpreting these values.

Table 2-6: Greenhouse Stream NTG Results

Unique Participants	NTG Responses	Savings Weighted Free-ridership	Spillover – Energy	Spillover – Summer Demand	Weighted NTG – Energy	Weighted NTG – Summer Demand	Energy NTG Precision at 90% Confidence
33	15	2.2%	0.0%	0.0%	97.8%	97.8%	± 2.2%

3 Cost Effectiveness

Cost-effectiveness results for the overall Greenhouse stream are presented in the PY2023 CDM Retrofit Program Evaluation Report submitted to the IESO. The sections below detail the cost-effectiveness results for the Standard Greenhouse projects and Targeted Greenhouse projects. Cost-effectiveness for these two types of projects was conducted using IESO's CE Tool V9.1.

3.1 Standard Greenhouse Projects

The PY2023 Standard Greenhouse projects achieved a Program Administrator Cost (PAC) ratio of 2.68, exceeding the 1.00 target threshold (designed to determine if a program proves cost-effective). Table 3-1 presents the results.

Table 3-1: PY2023 Standard Greenhouse Projects Cost-Effectiveness Results

PAC Test	PY2023
PAC Costs ($)	$18,022,556
PAC Benefits ($)	$48,287,879
PAC Net Benefits ($)	$30,265,323
PAC Net Benefit (Ratio)	2.68
Levelized Unit Energy Cost (LUEC)	**PY2023**
$/kWh	$0.02
$/kW	$1,569.91[6]

Measure-level cost-effectiveness analysis showed LED Grow Lights at vegetable greenhouses from Standard Greenhouses contributed the greatest PAC net benefits to the Greenhouse stream, at $26,908,202. Horticultural Inter-Lighting contributed PAC net benefits of $5,088,187 to the Greenhouse stream. These two measures produced higher than average PAC ratios of 3.10[7] and 5.14[6] respectively; combined, they contributed nearly

[6] The $/kW LUEC for Standard Greenhouse projects is based on province wide-peak demand definition (June 1st to Aug 31st from 1:00 PM to 7:00 PM) and does not reflect the local South-West region peak demand benefits.

[7] Measure benefit to cost ratios do not include program admin costs. Admin costs are included in the tables showing overall program and track level CE results. Track-level CE results are directional in nature and to be used for comparison purposes.

99% of the total Standard Greenhouse project's net verified energy and summer peak demand savings. Conversely, Greenhouse Advanced Lighting Controls and LED Grow Lights at cannabis warehouses in Standard Greenhouse projects contributed only $85,793 and $65,201 PAC net benefits, with lower-than-average PAC ratios of 1.61[6] and 1.58[6], respectively.

3.2 Targeted Greenhouse Projects

The PY2023 Targeted Greenhouse projects achieved a Program Administrator Cost ratio of 2.48, exceeding the 1.00 target threshold (designed to determine if a program proves cost-effective). Table 3-2 presents the results.

Table 3-2: PY2023 Targeted Greenhouse Projects Cost-Effectiveness Results

PAC Test	PY2023
PAC Costs ($)	$12,030,295
PAC Benefits ($)	$29,881,191
PAC Net Benefits ($)	$17,850,896
PAC Net Benefit (Ratio)	2.48
Levelized Unit Energy Cost (LUEC)	**PY2023**
$/kWh	$0.02
$/kW	$1,743.67[8]

LED Grow Lights at vegetable greenhouses and Greenhouse Advanced Lighting Controls being the only measures installed at Targeted Greenhouse projects, contributed PAC net benefits to the Greenhouse stream. LED Grow Lights at vegetable greenhouses in Targeted Greenhouse projects contributed the second highest PAC net benefits to Greenhouse stream at $18,735,801. Greenhouse Advanced Lighting Controls contributed PAC net benefits of $3,948. These two measures produced PAC ratios of 2.88[9] and 1.74[8]. As mentioned in Section 4.3.1, LED grow lights in vegetable greenhouses contributed nearly

[8] The $/kW LUEC for Targeted Greenhouse projects is based on province wide-peak demand definition (June 1st to Aug 31st from 1:00 PM to 7:00 PM) and does not reflect the local South-West region peak demand benefits.
[9] Measure benefit to cost ratios do not include program admin costs. Admin costs are included in the tables showing overall program and track level CE results. Track-level CE results are directional in nature and to be used for comparison purposes.

99% of the total Targeted Greenhouse project's net verified energy and 100% of the net verified summer peak demand savings.

4 Process Evaluation

The process evaluation for the Greenhouse Stream was conducted as part of the broader process evaluation of the PY2023 CDM Retrofit Program. The evaluation team assessed program processes through interviews and surveys with relevant program actors, including IESO staff, program delivery vendor staff, applicant representatives, contractors, and participants. The team developed customized interview guides or survey instruments for each respondent type to ensure responses produced comparable data and allowed for the inference of meaningful conclusions. Specific questions and topics related to the Greenhouse Stream were identified for each respondent. Table 4-1 presents the survey methodology, the total population invited to participate in the surveys or interviews, the total number of completed surveys, the response rate (RR), and the sampling error at the 90% confidence level for each respondent type. Additional details regarding the process evaluation methodology can be found in the PY2023 CDM Retrofit Evaluation Report.

Table 4-1: Process Evaluation Primary Data Sources

Respondent Type	Methodology	Population	Completed	Response Rate	90% CI Error Margin
IESO Staff	Phone In-depth Interviews (IDIs)	7	7	100%	0%
Program Delivery Vendor Staff	Phone IDIs	3	3	100%	0%
Applicant Representatives and Contractors – Greenhouse Stream	Web Survey	6	2	33%	N/A[10]

[10] Error margin not displayed if the respondent count is below 30 unless census is achieved.

Respondent Type	Methodology	Population	Completed	Response Rate	90% CI Error Margin
Participants – Greenhouse Stream	Web and Phone Survey	33	13[11]	39%	N/A[12]

4.1 IESO Staff and Program Delivery Vendor Staff Perspectives

The following subsections highlight feedback received from IESO staff and program delivery vendor staff IDIs.

4.1.1 Key Findings

Key findings from IESO staff and program delivery vendor staff IDIs include the following:

- Additional greenhouse measures to consider adding to the program in the future included a solar-only offering, expanding the rooftop solar panel with battery storage offering to more areas of the province, offering broader types of DER measures, offering programmable light fixtures, and considering opportunities to include lighting not on the DesignLights Consortium's (DLC) greenhouse qualified products list.
- IESO and delivery vendor staff explained that a main barrier to more growers participating in the program is that the project cost beyond the incentive can be prohibitively high given the scale of the projects in this sector. They noted that this was particularly true for the battery component of the rooftop solar panel with battery storage offering but was often mentioned as relevant to other greenhouse projects as well.
- Interviewees mentioned other barriers to participation, including short program cycles, customer hesitancy to try out new equipment when they have concerns about safety or when they are not sure how it will affect their product, and rising interest rates.

[11] The NTG evaluation included more respondents (n=15) than the process evaluation (n=13) as two respondents did not fully answer the process evaluation survey questions.
[12] Error margin not displayed if the respondent count is below 30 unless census is achieved.

- Recommendations for increasing program participation included extending the program life cycle, considering the inclusion of recommended measures, and further outreach to growers to minimize concerns about safety and trying new products.
- Delivery vendors did not think that seasonality was a significant barrier for participants as they have not typically seen participation rates in the greenhouse sector vary by season.

4.1.2 Background

IESO added greenhouse advanced lighting controls as prescriptive measure to the Greenhouse Stream. In limited areas of the province, it also added distributed energy resources (DER) measures, including a rooftop solar panel with battery storage offering. IESO staff members noted that this offering was introduced to support grid constrained areas where the agricultural business infrastructure is growing rapidly, and the electric infrastructure supply is a bottleneck. IESO staff members indicated that the Greenhouse Stream offerings were promoted by the relevant program delivery vendors and that webinars have been and continue to be provided to inform and engage growers. IESO staff members noted that participation for the rooftop solar panel with battery storage offering has been low following its introduction to the program in early 2023.

4.1.3 Equipment Offerings

When asked which, if any, additional greenhouse equipment or services could be added to the program in the future, one delivery vendor said that the current offerings generally meet customer needs, noting that the program still captures many new lighting upgrades and lighting controls installations. They also noted that the program offers other equipment of interest to greenhouse customers, such as variable frequency drives (VFDs) and fans. This same respondent reiterated that there has been difficulty with uptake of the DER equipment mainly because of the cost of the battery. They noted that offering a solar-only offering may be beneficial from the customer perspective.

Two delivery vendors reported that they have only had a small number of greenhouse lighting projects completed to date and said that they did not have any feedback on additional greenhouse equipment to consider at this time. One of these delivery vendors said that the projects that have come through were large indoor growers, and that they expect they may see more projects like these in the future. This same delivery vendor said that the rooftop solar panel with battery storage offering that is currently being piloted in other areas of the province would be welcome in their region as well, especially in capacity constrained areas.

One IESO staff member suggested considering what opportunities may exist to offer broader types of DERs through the program. Another IESO staff member recommended adding programmable light fixtures that offer the user the ability to program the desired color rendering.

Another IESO staff member said that education and awareness building around the current greenhouse offerings is also important as greenhouse growers are normally very sensitive about the equipment used given the critical role equipment plays in their production. They noted that the growers are often also risk averse as they work on lean profit margins.

Similarly, another IESO staff member agreed that growers can be hesitant to adopt new equipment even if they know it will save them energy because of concerns around how their produce might be affected in terms of color, taste, or texture. This same respondent noted that the related manufacturers have done a lot of their own testing to prove that different lighting offerings would not have a negative impact on a variety of produce.

Another IESO staff member said that the current lighting equipment follows the DLC's greenhouse qualified products list. They noted that they sometimes encounter custom greenhouse lighting projects that do not qualify for the program because they may not be on the DLC list. They recommended that the program consider what opportunities may exist to allow for such projects in the future.

Two IESO staff members said that greenhouse growers often show interest in co-generation but that the program cannot incentivize this equipment given the natural gas element.

4.1.4 Incentive Offerings

Delivery vendors and IESO staff were asked what incentive levels they thought would be appropriate for greenhouse equipment to drive customer participation and demand savings while remaining cost-effective for the IESO.

One delivery vendor said that the current solar-related incentives are set to appropriate levels, but that there is a prohibitive cost associated with the battery. They noted that the payback period is too slow for commercial companies that are typically looking for a payback of approximately 2-to-3-years. They also noted that it is hard to say how this incentive could be changed while remaining cost effective. This same delivery vendor said that other Greenhouse Stream incentives are generally set appropriately, noting that controls may even be a little high, but they noted that this may become more appropriate given rising equipment costs. They recommended looking into the solar-only offering in Ottawa as a good weathervane of how a solar-only offering could work as there has been good uptake there.

One IESO staff member said that they believe the growers find the greenhouse incentives to be relatively generous but that project cost beyond the incentive can still be prohibitively high given the scale of the projects. They noted other barriers, such as short program cycles and rising interest rates. They said that extending the program life cycle may lead to higher program participation.

Another IESO staff member said controllable fixtures are far more expensive as they can change colors or dim depending on the growers' needs. Deciding how to offer higher incentives for these types of fixtures is complicated—they may provide better outcomes for the growers, but from a strict energy savings perspective, the related prescriptive offering does not account for any differences in energy savings compared to other less expensive but less advanced controls. However, there can be incremental savings at different light spectrums as there are differences in the wattages. Given this, there may be opportunities to further explore how these types of controls are incentivized.

4.1.5 Rooftop Solar Panel with Battery Storage Offering

Interviewees were asked to gauge the level of awareness of the rooftop solar panel with battery storage offering among customers and contractors. They were also asked to comment on what the most significant barriers to installation were and potential ways to overcome them.

One delivery vendor said that they believe there is high awareness among customers and that some contractors are trying to become more involved with this offering. However, they noted that safety and cost concerns around the battery component of the offering, as well as space limitations, are barriers. Another delivery vendor could not comment directly on the offering as it is not currently offered in the region where they operate, but they noted that some customers do ask why they do not offer the battery component along with the existing solar offering. Another delivery vendor said that having a solar-only option would be beneficial to some customers who cannot afford or do not want to install the battery in combination with solar.

IESO staff members agreed with delivery vendors that greenhouse customers generally seem to know about the rooftop solar panel with battery storage offering, though noted that contractor awareness may be lower. Some customers have expressed concerns about the batteries not being safe given historical reports of fires and explosions, while others are concerned about the out-of-pocket cost. To address the safety concerns, IESO staff said that proactive outreach by the program (e.g., though continuing webinars and case study development) as well as from other industry leaders and stakeholders (e.g., the Electrical Safety Authority, Energy Storage Canada, CSA Group) will be necessary to educate customers and inform contractors about best practices. One IESO staff member thought

that DER offerings like these will be in higher demand in the future, particularly as electrification continues.

When asked if they believe that including ground solar panels with battery storage as an offering would drive additional interest, one IESO staff member said that the opportunity cost is high for greenhouse customers when it comes to ground solar given that it is often more profitable to them to use their land for growing their products. Another IESO staff member thought that the lack of an incentive for ground solar may be a barrier to participation for some customers who may prefer that option due to lack of roof space. This same respondent noted, however, that there may be challenges to ground solar installation at greenhouse sites if the location where it is installed is zoned as agricultural land.

4.1.6 Seasonality Impacts

Delivery vendors were asked if participation rates varied by season and if seasonality is a barrier for participants. One delivery vendor said that it is hard to say as the greenhouse participants all operate in their own way and projects can come up any time of year. The respondent noted that spring is generally where they see pre-projects initiated and then installations occur in the second half of the year, but that depends on various factors, such as budget availability or what market conditions are like. For example, they noted that in 2023, there was a customer who decided to make a large investment to upgrade their facility quickly because they saw an entry point into the market for a certain type of produce as California wasn't doing well with that product at that time. One delivery vendor said they did not think participation rates depend on seasonality and that it was unlikely to be a barrier for participants.

4.2 Applicant Representative and Contractor Perspectives

The following subsections highlight feedback received from the applicant representative and contractor survey.

4.2.1 Key Findings

- Neither respondent was aware of the incentives for rooftop solar panels with battery storage.
- Both respondents were unsure if customers would be interested in aground solar panel with battery storage offering if it were to be offered through the Greenhouse Stream in the future.

- One respondent was unsure if there are any barriers preventing horticultural businesses from participating in the Greenhouse Stream and the other had not observed any barriers.
- One respondent suggested that the Greenhouse Stream consider offering higher incentives for LED lights that are 1,000W or above.

4.2.2 Equipment and Incentive Offerings

Both respondents assisted customers in participating in the Save on Energy Retrofit Program Greenhouse Stream and indicated that they were not aware of the rooftop solar panel with battery storage offering.

Both respondents also indicated that their companies have neither expertise around rooftop solar panels with battery storage nor experience connecting customers with companies with expertise around rooftop solar panels with battery storage.

Both respondents were unsure if customers would have an interest in ground solar panels with battery storage if they were offered through the Greenhouse Stream.

4.2.3 Barriers and Recommendations

Respondents were also asked if they were aware of any barriers preventing horticultural businesses from participating in the Greenhouse Stream; one respondent was unsure and the other indicated they had not observed any barriers.

Finally, respondents were asked to recommend additional energy-efficient equipment or services for inclusion in the Greenhouse Stream in future years. One respondent suggested offering higher incentives for LED lights that are 1,000W or above.

4.3 Participant Perspectives

The following subsections highlight the feedback received from the participant survey.

4.3.1 Key Findings

Key findings from the participant survey include the following:

- A substantial number of respondents (6 out of 13) were not willing to share additional data from their energy management systems with the program.

- Most respondents (10 out of 13) do not obtain power from on-site generators or co-generation.
- Awareness of the Greenhouse Stream's incentives for rooftop solar panels with battery storage was moderate, with 7 out of 13 respondents aware.
- There is notable interest in installing rooftop solar panels with battery storage (7 out of 13), with slightly less interest in ground solar panels with battery storage (5 out of 13).
- Insufficient roof space was a common barrier to installing rooftop solar panels with battery storage, mentioned by two respondents.
- Financial risk, high costs, low incentives, and land space requirements were barriers to installing ground solar panels with battery storage, each cited by two respondents.
- The scale of horticulture projects and the timing of budgeting decisions are key barriers to participating in the Greenhouse Stream more generally, mentioned by four respondents each.
- Over one-half of respondents (7 out of 13) indicated that they would not have been willing to accept a lower incentive if it had been offered immediately upon purchasing the eligible equipment.
- Budgeting decisions among horticultural businesses do not follow a consistent annual schedule, with four respondents indicating varied timing.
- Suggestions for equipment to consider adding to the program include expanding provincial coverage and incorporating new technologies like sand batteries and co-generation, with one respondent each recommending these additions.

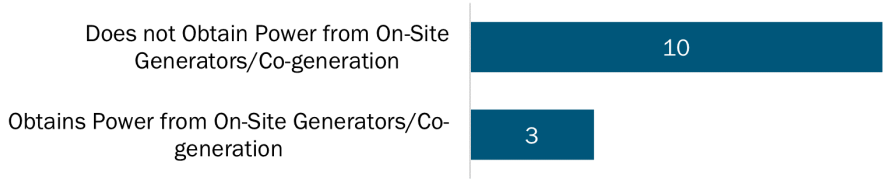
4.3.2 Background

Respondents were asked if their company would be willing to share additional data from their energy management systems with IESO to help better evaluate the program's impact on energy and cost savings. As shown in Figure 4-1, slightly less than one-half of respondents (5 out of 13) indicated they were willing to share additional data.

Figure 4-1: Participant Willingness to Share Additional Energy Management System Data (n=13)

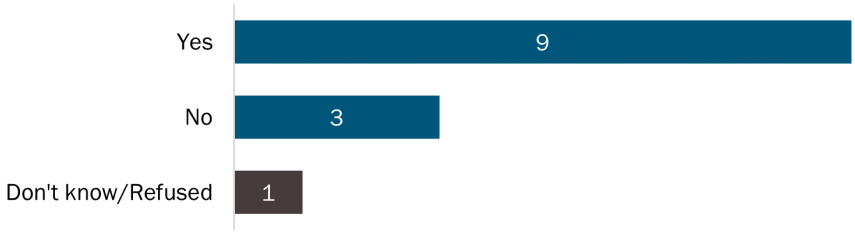
Respondents were asked if their company obtains power from on-site generators or co-generation. As shown in Figure 4-2, most respondents (10 out of 13) indicated that their company does not obtain power from on-site generators or co-generation. Only three respondents reported that their company does obtain power from these sources.

Figure 4-2: Use of On-Site Generators or Co-Generation (n=13)



Respondents were asked about their company's intentions regarding adding new connections due to increased load (Figure 4-3). Out of the 13 responses received, the majority (nine respondents) indicated affirmatively, with plans to add new connections. Conversely, a smaller portion (three respondents) reported no plans for new connections.

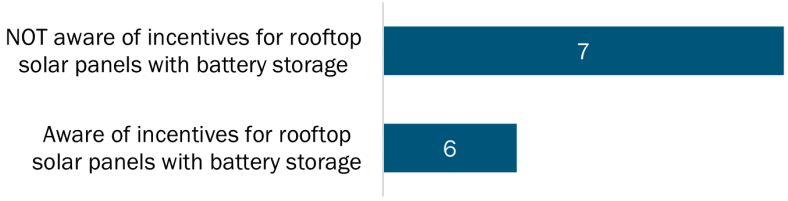
Figure 4-3: Participant Anticipation of Adding New Connections Due to Increased Load (n=13)



4.3.3 Equipment and Incentive Offerings

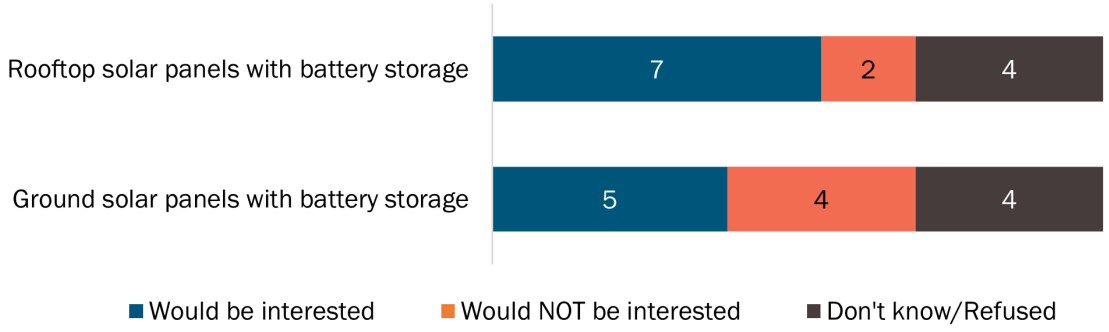
Respondents were asked about their awareness of the Greenhouse Stream's incentives for rooftop solar panels with battery storage (Figure 4-4). More than one-half of respondents (7 out of 13) were aware of such incentives, while slightly fewer (6 out of 13) were not aware.

Figure 4-4: Awareness of Solar Panel with Battery Storage Offering (n=13)



Respondents were asked to indicate how interested their company is in the Greenhouse Stream's incentive for rooftop solar panels with battery storage as well as how interested they would be in a potential future incentive for ground solar panels with battery storage. As shown in Figure 4-5, more than one-half of respondents (7 out of 13) expressed interest in rooftop solar panels with battery storage, while a smaller number expressed interest ground solar panels with battery storage (5 out of 13 respondents).

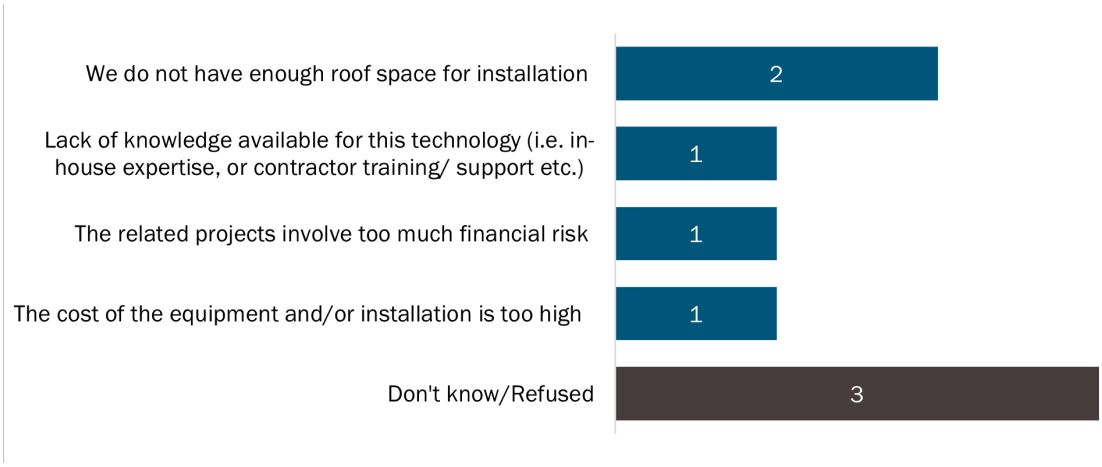
Figure 4-5: Interest in Rooftop or Ground Solar Panels with Battery Storage (n=13)



Respondents who indicated their company was not interested in the *rooftop* solar panel with battery storage offering or did not know if their company was interested were asked why they were not interested. As shown in Figure 4-6, responses were mixed, with the most cited reason being insufficient roof space for the installation (two respondents).

Figure 4-6: Reasons for Low Interest in Rooftop Solar Panels with Battery Storage

(Open-ended and multiple responses allowed; n=6)*

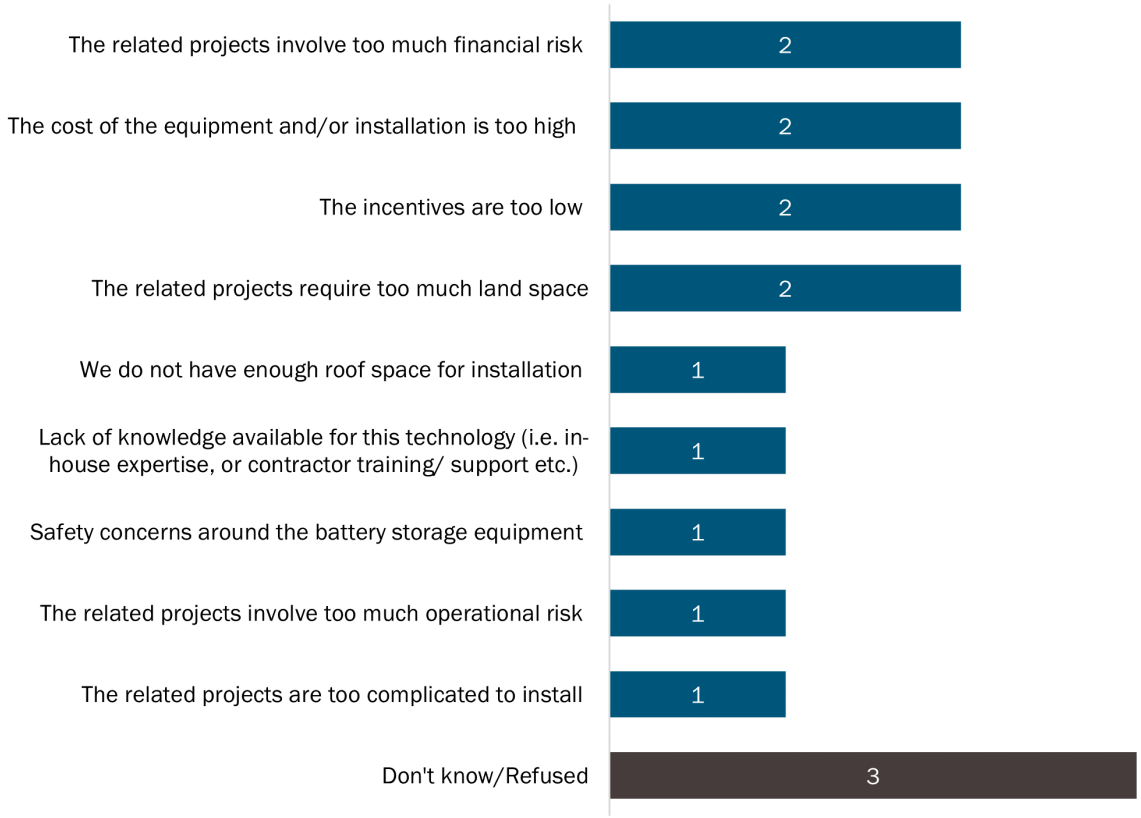


*Does not sum to 6 due to multiple responses.

Respondents who indicated their company was not interested in *ground* solar panels with battery storage or did not know if their company was interested were asked why they are not interested. As shown in Figure 4-7, the most frequently mentioned reasons included too much financial risk, high equipment and installation costs, low incentives, and the requirement for too much land space (two respondents each).

Figure 4-7: Reasons for Low Interest in Ground Solar Panels with Battery Storage

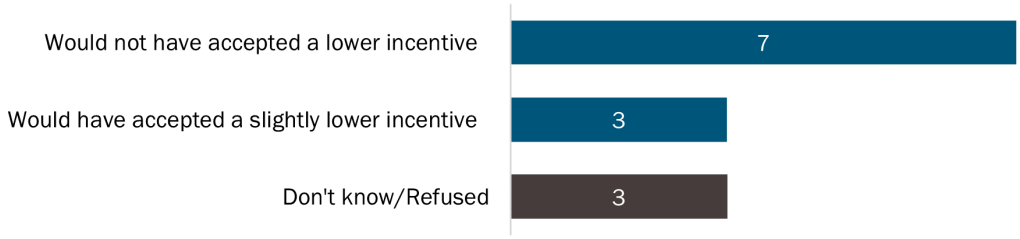
(Open-ended and multiple responses allowed; n=8)*



*Does not sum to 8 due to multiple responses.

Surveyed participants were asked whether they would have been willing to accept a slightly lower incentive or a significantly lower incentive if the Greenhouse Stream had offered them an incentive immediately upon purchasing the eligible equipment, as opposed to waiting for the incentive after the work was complete (which aligns with the current approach) (Figure 4-8). The majority (seven respondents) indicated that they would not have accepted a lower incentive if it were offered immediately upon purchasing the eligible equipment. A smaller portion (three respondents) expressed willingness to accept a slightly lower incentive under these circumstances.

Figure 4-8: Receptivity to Lower Incentive if Incentive Offered Immediately Upon Purchase (n=13)

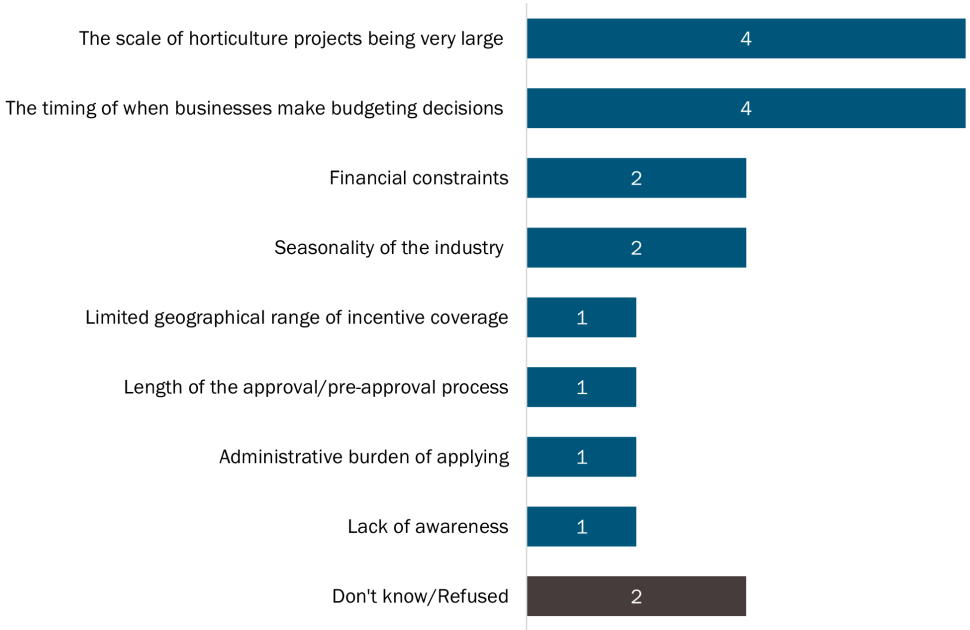


4.3.4 Barriers and Recommendations

Respondents identified several barriers that may be preventing horticultural businesses like theres from participating in the Greenhouse Stream (Figure 4-9). Responses were again mixed, with the most commonly cited barriers including the scale of horticulture projects being very large and the timing of when businesses make budgeting decisions (mentioned by four respondents each).

Figure 4-9: Barriers to Participation in the Save on Energy Retrofit Program

(Open-ended and multiple responses allowed; n=13)*



*Does not sum to 13 due to multiple responses.

The four respondents who indicated that the timing of when horticultural businesses make budgeting decisions may be a barrier to participation were asked a follow-question of

whether their *own company* makes budgeting decisions at the same time every year. All four respondents specified that budgeting decisions do not necessarily occur for them at the same time each year.

Respondents were asked to suggest additional energy-efficient equipment or services for inclusion in the Greenhouse Stream in future years. A mix of recommendations is shown in Figure 4-10, including offering incentives to growers throughout the province, continuing to offer lighting, co-generation, and sand battery technology (mentioned by one respondent each).

Figure 4-10: Greenhouse Stream Equipment /Service Recommendations

(Open-ended and multiple responses allowed; n=4)