

## **Phase I Ex Ante Review Findings**

**Table 1-1: Project Information**

<b>IOU</b>	PG&E
<b>Application ID</b>	NC0122746/47/48
<b>Application Date</b>	11/28/2012
<b>Program ID</b>	PGE21031
<b>Program Name</b>	Agricultural Calculated Incentives
<b>Program Year</b>	2012
<b>Itron Project ID</b>	X258
<b>IOU Ex Ante Savings Date</b>	TBD
<b>ED Measure Name</b>	Greenhouse Energy Efficiency Measures
<b>Project Description</b>	Implementation of energy efficiency measures in a new construction greenhouse
<b>Date of ED Review(s)</b>	7/9/2013
<b>Primary Reviewer / Firm</b>	Betsy Ricker/ERS
<b>Review Supervisor / Firm</b>	Joseph Ball/Itron
<b>ED Project Manager</b>	████████████████████ ████████████████████
<b>ED Policy Authorization (as needed)</b>	
<b>Type of Review (Desk, On-site, Full M&amp;V, Tool)</b>	Desk
<b>ED Recommendation</b>	Energy savings are not approved pending updates to the baseline heating system type and heat curtain energy savings calculations.

## Measure Description

This project proposes the implementation of six energy efficiency measures for three new construction greenhouses at a single location. The following are the proposed measures for the 2 x [REDACTED]. greenhouses and 1 x [REDACTED]. greenhouse:

- EEM1: Glazing, Roof, Double Polycarbonate – Install double-layer polycarbonate material on the greenhouse roof.
- EEM2: Glazing, Wall, Combination – Install double-layer polycarbonate on gable ends and on first 3 feet of greenhouse walls.
- EEM3: Heat Curtains, Single – Install a single-layer heat curtain for heat retention.
- EEM4: Under-bench Heating – Install a central boiler with an under-bench heat distribution system.
- EEM5: Movable Benches – Install movable benches to increase the production per sq.ft. in the greenhouse.
- EEM6: Boiler, High Efficiency – Install a high efficiency boiler.
- EEM7: All Measures Combined – Interactive savings of EEMs 1 through 6.

Energy savings have been calculated using a greenhouse modeling tool that calculates energy savings utilizing the eQuest energy simulation software. Model baselines have been developed using a 2006 greenhouse baseline study that was performed by Green Building Studio for PG&E.<sup>1</sup>

## Summary of Review

ED reviewed the following documents as part its review of this project:

- Response to EEGA request:
  - *EnergyEfficiencyOIR-Post-2008\_DR\_ED\_308\_EEGA\_2549.doc*
- Phase 3 & 4 greenhouse applications, reports, and analysis file:
  - *123111 XXXXXX Nursery Phase 3 Application.pdf*
  - *123112 XXXXXX Nursery Phase 4 Application.pdf*
  - *123111 XXXXXX Nursery Phase 3 OA Report (Final 12-03-12).pdf*
  - *123112 XXXXXX Nursery Phase 4 OA Report (Final 12-03-12).pdf*
  - *XXXXXX (CNC 111847) GH Tool Template (04-18-12).xls*
- Phase 5-12B greenhouse application and analysis file:
  - *123113 XXXXXX Nursery Phase 5-12B Application.pdf*
  - *123113 (XXXXXX Range 12B) GH Tool (version 02-27-13).xls*
- Responses to preliminary ED data request:
  - *RE X258 PGE NC0122746 47 48 New construction greenhouses.msg*

---

<sup>1</sup> “Greenhouse Baseline Study Final Report”, Green Building Studio, 2006 and Addendum to “Greenhouse Baseline Study Final Report”, 2008

- PGE greenhouse baseline study:
  - *PGEGreenhouseBaselineStudy.pdf*
  - *920 2-09 4 Addendum No 1 Greenhouse Baseline Study.pdf*
- PGE post-inspection report:
  - *118847 (XXXXXX Phase 1 Greenhouse ) Post-field Report.xls*
- Heat curtain specifications:
  - *Heat Curtain Spec.pdf*
- Responses to additional ED requests:
  - *PGE Response\_NC0122746\_47\_48.doc*

ED reviewed the above files, which included PDF reports detailing the proposed measures and energy savings. Following this initial review a preliminary data request was submitted to PG&E to initiate the parallel review process. PG&E responded to this data request with additional information and forwarded additional comments to ED. After some parallel review correspondence PG&E provided a formal data request response; ED reviewed PG&E's response and incorporated comments into this Phase I document.

During the parallel review ED also received an energy simulation package that included the tools necessary to replicate the PG&E savings models. However, an error arose when ED attempted to run this tool, and consequently ED only reviewed the input values to these tools.

#### *Summary of Energy Savings Calculation Review*

ED's review of the measures proposed for this project is detailed below.

- **Thermal Curtains** - ED's previous experience with thermal curtain measures suggests that these technologies are typically installed in greenhouses for two purposes: shading and heat retention. If not required for shading, installing curtains to serve primarily as heat retention devices is a viable energy efficiency action. However, if the curtains are installed primarily for shading to ensure crop production, the installation of curtains may not represent an energy efficiency action. PG&E provided information to indicate that the facility utilizes shade cloths in some of their other greenhouses, and could have installed similar systems in the greenhouses covered under these three applications. In addition, ED's interview with the customer revealed that they did not require heat curtains for their greenhouses and could have built the greenhouses without them, but at the expense of higher heating costs. Based on the information provided by PG&E and collected in ED's interview with the site, thermal curtains are a viable energy efficiency measure for this site.
- **Underbench heating** - ED reviewed the findings of the 06-08 CPUC Ag-Food program evaluation and found that, in greenhouses that install heat curtains as an add-on measure, radiant heating via hot water distribution pipes was found in more greenhouses than unit heaters. The prevalence of hot water heating in the projects sampled in the 06-08 evaluation appears to be consistent with the findings in PG&E's

2006 Greenhouse Baseline Study, which included feedback from vendors and greenhouse owners that indicated a trend toward the installation of under-bench heating in greenhouses (10 of the 22 greenhouses included in the study utilized under-bench heating). Six years have elapsed since the 2006 Greenhouse Baseline Study, and given the data gathered in the 06-08 CPUC Ag-Food program evaluation, it appears that radiant heating with a standard efficiency central boiler may have advanced toward standard practice in new construction greenhouses. This is reflected in the DEER baseline models, which have been updated to permit either unit heaters or radiant heating as the baseline heating system type in greenhouses. In order to determine which of these two baseline heating system types is more appropriate for a given application, standard practice for a given crop or greenhouse location is considered. In the case of this project, discussions with the site contact indicated that for their crop type, under-bench heating is most appropriate because the focus is on heating the roots of the plants. The site contact indicated that, because of this, all of their existing greenhouses have under-bench heating. In reviewing the customer's standard practice, and considering the two baseline heating system options permitted in the DEER models, this measure should either be removed from consideration, or the radiant heating system should be specified as the baseline for this measure and the temperature stratification in the baseline greenhouse should be set to 0°F. This impacts the energy savings of both the under-bench and heat curtain energy efficiency measures and PG&E's calculations should be re-run to account for this adjusted baseline..

- **Remaining measures** - ED's review of the remaining measures suggests that all are viable energy efficiency measures except the EEM 1: Glazing, Roof, Double Polycarbonate, which actually results in an energy penalty compared to the baseline roof glazing system; however, the analysis assumptions may need some adjustment and more detailed review after post-installation savings true-up based on actual greenhouse operations.
- **Differences in greenhouse EUI** - The gas use of the proposed greenhouses is 0.60 therms/sq.ft./yr (greenhouse #3 and #4) and 1.06 therms/sq.ft./yr (greenhouse #12B); the baseline gas use of these greenhouses is estimated to be 1.45 therms/sq.ft./yr (greenhouse #3 and #4) and 2.78 therms/sq.ft./yr (greenhouse #12B). ED's review indicated that the baseline and proposed gas use of greenhouses #3 and #4 were in-line with the gas use intensities found in the 06-08 CPUC Ag-Food program evaluation and in the 2006 Greenhouse Baseline Study. However, the gas use intensity of greenhouse #12B appears high (even for its smaller size) compared to greenhouses #3 and #4, and the baseline gas use intensity of greenhouse #12B is high compared to the 2006 Greenhouse Baseline Study and the 06-08 CPUC Ag-Food evaluation findings. ED's interview with the customer indicated that greenhouse

#12B includes a laboratory where plantlets are grown in a sanitary operation. This requires a much more controlled environment and higher temperatures as this laboratory essentially acts as an incubator. This operation differs from that of greenhouses #3 and #4, which house more mature plants.

*Summary of NTG Interview:*

ED implemented a net-to-gross interview with this customer, the summary of which is provided below. HISTORY: The nursery has been in operation for 30 years and has worked with PG&E rebate programs in the past. The customer grows trees and vines for orchard and vineyard farmers. The project includes three applications that concern a laboratory greenhouse (12b) and two standard greenhouses (greenhouses 3 and 4). The selected equipment is used in all of the customer's greenhouses.

FINANCIAL: The customer does not perform payback estimates in selecting equipment, as the payback period is largely dependent on unknown factors such as the price of gas in the future and the crop demand that derives from the orchard and vineyard industry. The customer guesses that the payback might be 4-5 years for these measures. The customer stated that they would not build a greenhouse without these measures. However, the utility rebate was critical in that the customer could not have financed the project on such a large scale without it, because, in maintaining a required ratio of upfront capital to borrowed capital, the rebate counts as upfront capital. Without the rebate, the customer might have built 50% of the same amount of greenhouse square footage.

NTG: The customer stated that he would have installed these measures without the program incentive, but that the rebate was 50% of the decision in that he would have constructed less square footage (50%) of greenhouse if the rebate was not available due to limited capital. The customer stated that all of these measures are integral to their greenhouse design and are necessary to ensure high quality product. Heat curtains serve not only to save energy, and perform shading functions, but also reduce disease and stress by minimizing fluctuations in greenhouse conditions. Plant quality would suffer without heat curtains. Under bench heating is necessary for the crop type which requires stable conditions at the roots rather than in the foliage, whereas in other applications unit/jet heating might be appropriate for hanging plants.

The NTG ratio for each measure is:

- Roof/wall glazing 0.29
- Heat Curtains 0.30
- Underbench heating: 0.33
- Moveable benches: 0.32
- Boiler: 0.32

All of the measures included in this project had NTG scores equal to or less than 0.33, indicating a high level of free ridership. Although ED cannot deem a project ineligible based on these NTG findings, it is recommended that PG&E strongly consider the prudence of providing incentives for this project - and similar projects moving forward - given the likelihood that these measures would have been implemented regardless of utility involvement.

A more detailed explanation of the NTG scoring appears in the following paragraphs.

The NTG ratio for each measure is calculated as (one-tenth) of the average of three scores: (1) the program influence score (score varies according to measure type); (2) the relative importance score (5.0 for all measures); and (3) the no program-score (0 for all measures).

Score 1 results were: 3.7 (glazing); 4.14 (heat curtains); 4.87 (underbench); 4.52 (moveable benches); and 4.71 (boiler). The customer prioritizes plant quality (9.5/10) among non-program factors and has a great deal of experience with these types of measures (8.5). Standard practice also played a role in underbench heating (10), the boiler (9), moveable benches (8), glazing (7.5) and heat curtains (7.5). The only significant program-factor was the availability of the program rebate: 5 (glazing); 6 (heat curtains); 9.5 (underbench); 7 (moveable benches); 8 (boiler).

Score 2 was calculated as 5.0 across all measure categories as the customer attributed 5 points to the program factors and 5 points to the non-program factors. Customer justified his statement by saying, “you remove the rebate, and want to call it standard practice, then you’re missing the point that the rebate is very important to us in purchasing each of these things because it helps us grow better plants and provide a better product. I can’t decide which is more important by separating the two.”

Score 3 was calculated as 0. Without the rebate, the customer would have been extremely likely (10/10) to install the same measures. Customer indicated that all of these measures are essential in building a new greenhouse.

## **Review Conclusion**

Energy savings are not approved pending updates to the baseline heating system type and heat curtain energy savings calculations. In addition, based on the NTG results for this site and the customer’s statements regarding their typical practice in greenhouse construction, ED considers providing incentives for this project as imprudent use of ratepayer funds and recommends that PG&E implement a process to better screen potential freeriders.

## **Summary of ED Requested Action by the IOU**

In order to complete an ex ante review, the ED requests that the IOU perform the following activities after project implementation, IR report submitted, and IOU savings true-up:

- Provide information that documents the date of construction of each of the three greenhouses.

- Submit data detailing and substantiating project incremental costs, including itemized invoices showing equipment and labor costs, and estimates of baseline equipment and labor estimates.
- Provide photos or accurate elevation drawings of the installation & locations of the movable benches.
- Present photos detailing the make and model of the installed boiler.
- Verify and document the heating and cooling setpoint temperatures and schedules for each of the three greenhouses (greenhouse #3, #4, and #12B) and the heat curtain control type and schedule of operation for each greenhouse (including shading schedules if the heat curtains are used for shading as well as heat retention). Update the energy analyses with this information and submit revised savings calculations for ED review prior to freezing the ex ante savings.

**Table 1-2 Review Findings**

Reviewed Parameter	Analysis
<p><b>Project Baseline Type</b> (Early Replacement, Normal Replacement, Capacity Expansion, New Construction, System Optimization, Add-on Measures) Note: For early retirement projects only, include RUL through EUL baseline)</p>	IOU Proposal: New Construction
	ED Assessment: All three applications (and greenhouses) are being constructed from the ground up. A new construction baseline is appropriate.
	ED Recommendation: New Construction
<p><b>Project Baseline Technology</b> (in situ equipment, Title 24 (specify year), other code or other efficiency level (specify), industry standard practice - ISP)</p>	IOU Proposal: Industry standard practice (ISP) based on the 2006 Greenhouse Baseline Study
	ED Assessment: Industry standard practice baselines are appropriate for these greenhouses, although updates need to be made to the baseline heating system type to ensure consistency with DEER models and to establish that a regressive baseline is not applied to this application.
	ED Recommendation: Update the baseline heating system type to a radiant system or remove the under-bench heating system measure from the project completely.
<p><b>Project Cost Basis</b> (Full Incremental, or Both. Note: For early retirement projects, include RUL through EUL cost basis treatment)</p>	IOU Proposal: Incremental costs based on typical glazing and equipment costs from PG&E tools.
	ED Assessment: The typical costs shown in PG&E’s tools appear to be appropriate for the baseline equipment, but additional information (invoices) is needed to substantiate the itemized cost of the proposed equipment.
	ED recommendation: Incremental costs are appropriate. Itemized invoices or other documentation are needed to verify the material and labor costs of both the baseline and installed equipment.
<p><b>RUL</b> (required for early retirement projects only, otherwise N/A)</p>	IOU Proposal: N/A
	ED Assessment: N/A
	ED recommendation: N/A
<p><b>EUL</b> (for each measure)</p>	IOU Proposal: Not provided
	ED Assessment: The CPUC Energy Efficiency Policy Manual recommends an Effective Useful Life (EUL) of five (5) years for heat curtains and twenty (20) years for high efficiency boilers. The document does not specify an EUL for the underbench heating system or movable benches, therefore, an EUL of fifteen (15) years is recommended based on the ‘SPC - Custom Other’ measure category in the CPUC Energy Efficiency Policy Manual.
	ED Recommendation: The EUL for the project is equal to the EUL of the shortest measure. The recommended EUL is 5 years.

Reviewed Parameter	Analysis		
<b>Savings Assumptions</b>	IOU Proposal: The IOU proposal includes the following assumptions in their analysis:		
		<b>IOU Base Case</b>	<b>IOU Proposed Case</b>
	EEM1: Glazing, Roof, Double Polycarbonate – Install double-layer polycarbonate material on the greenhouse roof.	Double polyethylene	Double polycarbonate
	EEM2: Glazing, Wall, Combination – Install double-layer polycarbonate on gable ends and on first 3 ft of greenhouse walls.	Single polycarbonate	Double polycarbonate
	EEM3: Heat Curtains, Single – Install a single-layer heat curtain for heat retention.	No heat curtains; 6°F temperature offset to simulate temperature stratification	With heat curtains; 23% reduction in roof glazing conductance with heat curtains deployed and 4°F temperature offset to simulate temperature stratification
	EEM4: Under-bench Heating – Install a central boiler with an under-bench heat distribution system.	6°F temperature offset to simulate temperature stratification in greenhouse due to unit heater system type	0°F temperature offset to simulate direct heating of plants via underbench system
	EEM5: Movable Benches – Install movable benches to increase the production per sq ft. in the greenhouse.	Fixed benches w/25% floor area	Movable benches requiring less floor area to grow the same amount of product
	EEM6: Boiler, High Efficiency – Install a high efficiency boiler.	80% efficient boiler	90% efficient boiler
	ED Assessment: ED agrees with the IOU’s assumptions, but recommends that the following inputs be adjusted and that key inputs be verified and savings tried-up after the greenhouses have been constructed and their operation has stabilized.		
		<b>IOU Base Case</b>	<b>IOU Proposed Case</b>
EEM3: Heat Curtains, Single – Install a single-layer heat curtain for heat retention.	No heat curtains; 0°F temperature offset to simulate temperature stratification	With heat curtains; 23% reduction in roof glazing conductance with heat curtains deployed and 0°F temperature offset to simulate temperature stratification	
EEM4: Under-bench Heating – Install a central boiler with	0°F temperature offset to simulate temperature	0°F temperature offset to simulate direct	

Reviewed Parameter	Analysis		
	an under-bench heat distribution system.	stratification in greenhouse due to radiant heating system	heating of plants via underbench system
	ED Recommendation: IOU assumptions are reasonable; verification of key inputs recommended.		
<b>Calculation Methods/Tool review</b>	IOU Proposal: eQuest energy simulation with Excel front end		
	ED Assessment: Despite multiple efforts from PG&E, ED was unable to run the greenhouse simulation tool provided. However, given the information provided, ED was able to review the key inputs and simulation assumptions and is comfortable with the tool that was used to calculate savings.		
	ED Recommendation: Simulation tool is appropriate for calculating savings.		
<b>Pre- or Post-Installation M&amp;V Plan</b>	IOU Proposal: No information provided.		
	ED Assessment: The magnitude of claimed savings across the three projects included in this review warrants some level of post-installation true-up to verify the accuracy of savings claims.		
	ED Recommendation: ED recommends that post-installation greenhouse temperature data and boiler energy use information be collected to calibrate energy models and true-up energy savings.		
<b>Net-to-Gross Review</b>	IOU Proposal: Not provided		
	ED Assessment: The overall NTG scores are as follows: <ul style="list-style-type: none"> <li>- Roof/wall glazing 0.29</li> <li>- Heat Curtains 0.30</li> <li>- Underbench heating: 0.33</li> <li>- Moveable benches: 0.32</li> <li>- Boiler: 0.32</li> </ul>		
	ED Recommendation: All of the measures included in this project had NTG scores equal to or less than 0.33, indicating a high level of free ridership. ED considers providing incentives for this project as imprudent use of ratepayer funds and recommends that PG&E implement a process to better screen potential freeriders.		

**Table 1-3 Energy Savings Summary**

Description	IOU Ex Ante Claim	ED Recommendations
First Year kWh Savings	-97,436	TBD

<b>Description</b>	<b>IOU Ex Ante Claim</b>	<b>ED Recommendations</b>
<b>First Year Peak kW Savings</b>	-32.8	TBD
<b>First Year Therms Savings</b>	365,619	TBD
<b>kWh Savings (RUL Period)</b>	N/A	N/A
<b>Peak kW Savings (RUL Period)</b>	N/A	N/A
<b>Therms Impact (RUL Period)</b>	N/A	N/A
<b>kWh Savings (RUL thru EUL Period)</b>	Not provided	TBD
<b>Peak kW Savings (RUL thru EUL Period)</b>	Not provided	TBD
<b>Therms Savings (RUL thru EUL Period)</b>	Not provided	TBD
<b>Annual Non-IOU Fuel Impact (RUL Period)</b>	N/A	N/A
<b>Annual Non-IOU Fuel Impact (RUL thru EUL Period)</b>	N/A	N/A