## Final Phase II Ex Ante Review Findings - Addendum

**Table** Error! No text of specified style in document.**-1: Project Information**

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|---|---|
| **IOU** | PG&E |
| **Application ID** | NC0122166 |
| **Application Date** | March 2012 |
| **Program ID** | PGE21031 |
| **Program Name** | Customized Calculated Agricultural Incentives New Construction Program (Savings By Design) |
| **Program Year** | 2012 |
| **Itron Project ID** | X229 |
| **IOU Ex Ante Savings Date** | 8/19/2013 |
| **CPUC Staff Measure Name** | Greenhouse Energy Efficiency Measures |
| **Project Description** | Implementation of energy efficiency measures in a new construction greenhouse (phases 3 & 4) |
| **Date of CPUC Staff Review(s)** | 8/29/2013 & 12/23/2013 |
| **Primary Reviewer / Firm** | Shamus Cunningham/ERS |
| **Review Supervisor / Firm** | Betsy Ricker/ERS & Joseph Ball/Itron |
| **CPUC Staff Project Manager** | [redacted] |
| **CPUC Staff Policy Authorization (as needed)** | |
| **Type of Review (Desk, On-site, Full M&V, Tool)** | Desk |
| **CPUC Staff Recommendation** | CPUC staff approves PG&E's final savings values of 3.944 MWh and -13 kW~~, pending post-install IR, M&V, and IOU true-up~~. The post-install true-up was reported by the IOU to show an increase of energy savings greater than 20%, and PG&E chose to keep the original savings estimates without increasing the savings. CPUC accepts this decision. For this addendum, CPUC staff has reviewed and accepted the incremental costs (IMCs) for this project. |

## Measure Description

This project proposes the implementation of one energy efficiency measure in a new construction greenhouse. The proposed measure (high efficiency fans and pumps) includes the following energy efficiency actions for this 32.5 acre greenhouse:

- Transport Pumps (15 kW & 18.5 kW)
- Air Handling Unit (AHU) Fans
- Horizontal Air Flow (HAF) Fans
- Ventilation Fans
- $CO_2$ Fans

Energy savings have been calculated using Excel analyses of one full year of trended data from a nearly identical greenhouse that is already installed at the site.

## Summary of Review

ED reviewed the following documents as part its Phase I ex ante review of this project:

- Energy savings report
  *(Draft OA Report CNC 122611 (XXXXXXX Ranges Phase 3 and Phase 4).doc)*
- ED data request response
  *(EnergyEfficiencyOIR-Post-2008_DR_ED_281_EEGA_2474.doc)*
- Energy savings calculations spreadsheet
  *(Pre Calculations (111207 XXXXXXX Phase 3&4).xls)*
- Details on trended pump and fan energy use
  *(FW XXXXXXX energy consumption data.msg)*
  *(All Phase 1 Fan Data.xlsx)*
- Project application and additional analysis details
  *(CMT 24220 - XXXXXXX Farms - Greenhouse phase 3 4 – CNC.msg)*
- Trended weather data from site
  *(RE Climate Data Excel Spreadsheet.msg)*
- PG&E response to ED questions and requests for clarification
  *(XXXXX Farms PGE ERS Response 08-06-2013.pdf)*
  *(FW: NC0122166 X229 - NC greenhouse - PG&E Response.msg)*

ED reviewed the above files, which included a PDF report with detailed responses to ED's data requests and questions posed in the last EAR and excel files that included the energy savings calculations for the project and a full year's worth of trended fan speed data. ED noted that the information provided in response to their data request was extensive and very informative in understanding the CFD calculations which formed the basis for key analysis assumptions and energy savings calculations. The documents provided by PG&E provided further detail on the analysis assumptions.

According to the PG&E documentation the following system descriptions apply:

- The baseline heating system is a central boiler that supplies hot water to an under-bench heating system using constant speed pumps and horizontal airflow fans to circulate air throughout the greenhouse. Cooling is provided via ventilation fans that introduce outdoor air into the greenhouse and is circulated by the horizontal air fans. $CO_2$ injection via the greenhouse boilers is not included in the baseline calculations.
- The proposed greenhouse utilizes a central boiler plant that supplies hot water to heating coils in air handling units (AHUs) and hot water radiant heating rails via pumps with variable frequency drives (VFDs) and secondary constant speed pumps. Individual greenhouse growers determine if heat is delivered to the plants via the AHUs or hot water rails. Each of the air handler fans is equipped with a VFD. The AHUs also supply the greenhouse with cooling via an evaporative cooling system. In addition, an electric penalty is applied for the fans needed to operate the greenhouse's $CO_2$ injection system. There are no horizontal airflow or ventilation fans assumed in the proposed case.

Table 1-2 (below) summarizes the key analysis assumptions from the PG&E savings calculations. ED's notes on the PG&E assumptions, baseline selections, and calculations are also included in the table below. In total, fan savings account for 90% of the claimed annual kWh savings for the project and pump savings contribute 10% of the claimed annual kWh savings.

**Table 1-2: Baseline & Proposed Measure Assumptions & Review Notes**

| Equipment Description | Baseline Description | Proposed Greenhouse Description | ED Notes |
|---|---|---|---|
| Transport Pumps (15 kW & 18.5 kW) | **Equipment type & qty:** 4 x 20 hp pump<br>**Equipment schedule of operation:** 0% flow for 30% of the year, running at 100% speed for the remaining 70% of the year.<br>**Equipment operating setpoint:** Each pump operating at between 12 and 14 kW at 0% speed and 14 and 18 kW at 100% speed. | **Equipment type & qty:** 4 x 20 hp pump<br>**Equipment schedule of operation:** Flow varies based on load. Percent flow of pump calculated from trended Phase I system data.<br>**Equipment operating setpoint:** Based on 8,000 data points, typical pump operation between 16% and 36% speed (1.4 and 3.3 kW, average of ~ 1.4 kW). | |
| Air Handling Unit (AHU) Fans | N/A | **Equipment type & qty:** 1,055 fans per range operating at a peak of 1.55 kW/fan, 2 ranges (16 total fans)<br>**Equipment schedule of operation:** Flow varies based on load. Percent flow of pump calculated from trended Phase I system data.<br>**Equipment operating setpoint:** Based on one year of trended data, typical fan operates between 30% and 80% speed (0.4 and 0.8 kW, average of ~0.2 kW). | |
| Horizontal Air Flow (HAF) Fans | **Equipment type & qty:** 60 bays per range, 31.5 ft x 856 ft per range = 1,612,598 sq ft. per range; 2 cfm/ft2 of range floor area = 3,225,000 cfm of ventilation. Fan Efficiency = 8.5 cfm/watt; For two | N/A | The baseline greenhouse floor area was increased by 15% in PG&E calculations to account for the additional floor area |

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| | ranges, total wattage = 756 kW.<br>**Equipment schedule of operation:** 8,760 hrs/yr<br>**Equipment operating setpoint:** 100% kW at all times | | needed to meet the increased production possible at the higher production/sq.ft with the proposed system. The number of baseline HAF fans was also increased accordingly. CFD analysis was used to show that all HAF fans need to be in operation 8760 in order to maintain minimum air speed around plants to promote growth and prevent disease |
| Ventilation Fans | **Equipment type & qty:** Baseline range sq.ft. as per HAF fan calculations (1,612,598 sq ft./range); 1 cfm/ft2 = 1,612,598 cfm of ventilation. Fan efficiency = 13.9 cfm/watt; For two ranges, total wattage = 231.9 kW<br>**Equipment schedule of operation:** 6578 hrs/yr<br>**Equipment operating setpoint**: 100% kW at all times | N/A | The baseline greenhouse floor area was increased by 15% in PG&E calculations to account for the additional floor area needed to meet the increased production possible at the higher production/sq.ft with the proposed system. The number of baseline ventilation fans was also increased accordingly. Annual hours of operation were passed on a scaled calculation of the full load hours required to provide the same ventilation as the existing VFD controlled system. |

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|---|---|---|---|
| $CO_2$ Fans | N/A | **Equipment type & qty:** 4 x 50 hp fans<br>**Equipment schedule of operation:** 93% efficient motor. 4,660 hrs/yr of CO2 dosing.<br>**Equipment operating setpoint:** Motor estimated to be 80% loaded. | |

PG&E utilized trended data from the site's existing greenhouses to calculate the energy use of the proposed pump and fan systems. The baseline system operation and energy use was projected based on industry practice assumptions and verified using CFD analysis. ED reviewed the industry standard practice assumptions applied by PG&E and noted the following concerns:

- The energy savings calculations are based on the greenhouse that is currently located at the site. The proposed greenhouse is expected to have a construction and intended operation that is very similar to the existing greenhouse. The proposed greenhouse technology is relatively new and the existing greenhouse, which employs the newer technology, has required some tuning as it has been brought up to speed over the last 12+ months. This has led to AHU operations and plant conditions that may not reflect how the greenhouse will be operated long-term or necessarily be indicative of the way that the proposed greenhouse will be operated after construction and commissioning. Given the challenges associated with optimizing the operation of the greenhouse systems, it is hard to say how closely the proposed greenhouse will mirror the existing one. ED recommends that PG&E inspect the proposed greenhouse operation after construction to determine ensure the existing greenhouses remain an appropriate basis for energy savings calculations or if adjustments are necessary due to significant differences in greenhouse operation and design.

Based on ex ante interviews conducted by ED for the natural gas measures associated with this same greenhouse construction project, the NTGR for high efficiency fans & pumps will be assigned an NTGR of 0.41.

CPUC staff reviewed the PDF of the incremental measure cost calculations (IMCs) submitted by PG&E. This file was provided by the customer and dated July 30, 2013, and provides a one page summary of the labor and material costs for the high efficiency AHU system, high efficiency boiler system, and thermal curtains. CPUC staff considers this information to be a reasonable of the cost for the high efficiency AHU equipment, however the high efficiency pumping measure costs could not be evaluated.

According to this PDF, the high efficiency AHU system cost is 5,066,162 euro (approximately $6,900,000 with a 1.36 conversion factor). PG&E's original calculations had this at 8,072,116 euro (approximately $10,980,000). We were unable to verify the costs for the high efficiency pumping system, which accounted for <1% of PG&E's calculated incremental cost for this project. Based on the verified high efficiency AHU costs and PG&E's estimated high efficiency pumping costs, the incremental cost is expected to exceed $3.6 million. PG&E's original estimate included an incremental cost of $7.8 million. The incentive is capped based on performance at the original incentive level $407,216.

The PDF provided breaks the labor and material costs out by measure. There is no line-by-line equipment and labor cost and is unrealistic to expect one. **Even with additional information it is unlikely that the incentive is going to change.**

It is noted that PG&E did not update the increment costs in their post-install savings calculations to be consistent with the PDF provided.

### Review Conclusion

~~Gross project energy savings are approved following our extensive discussion of baseline fan equipment annual hours of operation. A post installation inspection and savings true up may be required if the constructed greenhouse contains any systems which are materially different than the phase 1&2 greenhouses which formed the basis of these calculations. ED conditionally approves PG&E latest savings values of 3.944 MWh and -13 kW, pending post install IR, M&V, and IOU true up.~~ CPUC staff approves PG&E's final savings values of 3.944 MWh and -13 kW. The post-install true-up was reported by the IOU to show an increase of energy savings greater than 20%, and PG&E chose to keep the original savings estimates without increasing the savings. CPUS accepts this decision. For this addendum, CPUC staff has reviewed and accepted the incremental costs (IMCs) for this project.

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

~~No further IOU actions are required, unless during the post-install verification parameters used in this analysis have changed significantly, causing a greater than 20% change in savings.~~

**Table 1-3: Review Findings**

| Reviewed Parameter | Analysis |
|---|---|
| **Project Baseline Type** (Early Replacement, Normal Replacement, Capacity Expansion, New Construction, System Optimization, Add-on Measures, Major Renovation) Note: For early retirement projects only, include RUL through EUL baseline) | IOU Proposal: New Construction |
| | CPUC Staff Assessment: New Construction |
| | CPUC Staff Recommendation: None |
| **Project Baseline Technology** (in situ equipment, Title 24 (specify year), other code or other efficiency level (specify), industry standard practice - ISP) | IOU Proposal: ISP – standard efficiency fans and pumps |
| | CPUC Staff Assessment: Agree |
| | CPUC Staff Recommendation: None |
| **Project Cost Basis** (Full Incremental, or Both. Note: For early retirement projects, include RUL through EUL cost basis treatment) | IOU Proposal: Incremental Costs |
| | CPUC Staff Assessment: Incremental Costs |
| | CPUC Staff recommendation: None |
| **RUL** (required for early retirement projects only, otherwise N/A) | IOU Proposal: N/A |
| | CPUC Staff Assessment: N/A |
| | CPUC Staff recommendation: N/A |
| **EUL** (for each measure) | IOU Proposal: 15 years |
| | CPUC Staff Assessment: 15 years |
| | CPUC Staff Recommendation: None |
| **Savings Assumptions** | IOU Proposal: See Table 1-2 above |
| | CPUC Staff Assessment: See Table 1-2 above |
| | CPUC Staff Recommendation: None |
| **Calculation Methods/Tool review** | IOU Proposal: Excel spreadsheet model calculations |
| | CPUC Staff Assessment: Method appropriate |
| | CPUC Staff Recommendation: None |

| Reviewed Parameter | Analysis |
|---|---|
| **Pre- or Post-Installation M&V Plan** | IOU Proposal: Not required for NC projects |
| | CPUC Staff Assessment: Equipment and parameters should be checked post-installation to see if changes affect savings for a true-up. |
| | CPUC Staff Recommendation: Conduct a post-install inspection report and true-up savings if parametric changes are greater than 20% different than the original proposal. |
| **Net-to-Gross Review** | IOU Proposal: Not provided |
| | CPUC Staff Assessment: Based on interviews for NC natural gas measures for the same greenhouse project, NTGR is 0.41. This customer is a partial free-rider. |
| | CPUC Staff Recommendation: NTGR = 0.41; for an early adopter in the greenhouse industry of innovation, ED encourages the IOU for future greenhouse projects to move this customer into the Emerging Technologies Program to showcase their forward-thinking concepts. |

**Table 1-4: Energy Savings Summary, Project Costs and Incentive**

| Description | IOU Ex Ante Claim | CPUC Staff Recommendations |
|---|---|---|
| **First Year kWh Savings** | 3,944,000 kWh | Accept |
| **First Year Peak kW Savings** | -13 kW | Accept |
| **First Year Therms Savings** | N/A | N/A |
| **kWh Savings** (RUL Period) | N/A | N/A |
| **Peak kW Savings** (RUL Period) | N/A | N/A |
| **Therms Impact** (RUL Period) | N/A | N/A |
| **kWh Savings** (RUL thru EUL Period) | 3,944,000 kWh | Accept |
| **Peak kW Savings** (RUL thru EUL Period) | -13 kW | Accept |
| **Therms Savings** (RUL thru EUL Period) | N/A | N/A |
| **Annual Non-IOU Fuel Impact** (RUL Period) | N/A | N/A |
| **Annual Non-IOU Fuel Impact** (RUL thru EUL Period) | N/A | N/A |
| **Project Costs for Baseline #1** (RUL or EUL) | $7,816,003 (initial); costs may be adjusted by IOU but were not. | CPUC staff estimates (using a 1.36 euro to dollar conversion factor) that full project costs of the AHU was approximately $6,900,000, and that the incremental costs would be around $3,600,000. The costs do not include the pumping measure costs, which represent < 1% of the other measures combined. |
| **Project Costs for Baseline #2** (EUL minus RUL period) | N/A | N/A |
| **Project Incentive Amount** | $407,216 (estimated); adjusted incentive value not yet provided to ED | The incentive value was not adjusted since the incentive is capped by performance; therefore, the $407,216 incentive is accepted. |