Ex Ante Phase I Review Findings

Table 1-1: Project Information

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	TBD
ED Measure Name	Greenhouse Energy Efficiency Measures
Project Description	Implementation of energy efficiency measures in a new construction greenhouse (phases 3 & 4)
Date of ED Review(s)	2/7/2013
Primary Reviewer and Firm	Shamus Cunningham/ERS
Review Supervisor and Firm	Betsy Ricker/ERS
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
ED Recommendation	Gross project energy savings are conditionally approved pending discussion of baseline fan equipment annual hours of operation and post-installation inspection and savings true-up.

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 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)
- 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)

ED reviewed the above files, which included a PDF report with detailed responses to ED's data requests and an excel file that included the energy savings calculations for the project. ED noted that the information provided in response to their data request was extensive and very informative in understanding 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. 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 electricity 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:

Equipment Description	Baseline Description	Proposed Greenhouse Description	ED Notes
Transport Pumps (15 kW & 18.5 kW)	**Equipment type & qty:** 4 x 20 hp pump **Equipment schedule of operation:** 0% flow for 30% of the year, running at 100% speed for 70% of the year. **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 **Equipment schedule of operation:** Flow varies based on load. Percent flow of pump calculated from trended Phase I system data. **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) **Equipment schedule of operation:** Flow varies based on load. Percent flow of pump calculated from trended Phase I system data. **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

	ranges, total wattage = 756 kW. **Equipment schedule of operation:** 8,760 hrs/yr **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.
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 **Equipment schedule of operation:** 8,760 hrs/yr **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.
CO_2 Fans	N/A	**Equipment type & qty:** 4 x 50 hp fans **Equipment schedule of operation:** 93% efficient motor. 4,660 hrs/yr of CO2 dosing. **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. ED reviewed the industry standard practice assumptions applied by PG&E and noted the following concerns:

- The baseline that is proposed does not include any differences in equipment sizing that would be required with baseline glazing constructions or total heat loads due to the absence of heat curtains or other energy efficiency features in the greenhouse. The savings for this project may actually increase if the potentially higher baseline heating load is considered for this project.
- The baseline HAF and ventilation fans are both assumed to operate 8,760 hours per year. ED's understanding is that the HAF fans run to circulate air throughout the greenhouse, especially when the greenhouse is being heated, while the ventilation fans run to circulate ventilation air throughout the greenhouse. ED expects that, in the baseline, the ventilation fans would run most often during the daytime hours when ventilation is used to provide fresh air to the plants and to cool the greenhouse. The HAF fans would be expected to run more often at night. ED requests additional information to substantiate the operation and runtime of the baseline HAF and ventilation fans.
- The baseline assumes that greenhouse footprint would need to increase by 15% to allow for the same amount of tomato production with the baseline design as is achieved with the proposed greenhouse design and layout. It is not clear how this adjustment was derived. ED's interview with the greenhouse owner indicated that he believed the proposed greenhouse could be 5%-10% more productive than a conventional greenhouse, but that it is difficult to predict this value given the limited experience with the proposed greenhouse design.
- 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 if the existing greenhouses are an appropriate basis for energy savings calculations or if adjustments are necessary due to significant differences in greenhouse operation and design.

ED noted the following assumptions in the pump savings calculations and requests that PG&E provide information to substantiate the assumptions applied or update the savings calculations as appropriate.

- The total load (GPM delivered) is drastically different between the baseline and the installed cases. The baseline primary pumps deliver 3.5 times more water than the installed cases. Baseline calculation should include a throttling valve or some other flow control to reduce total flow down to the maximum total observed in the metered data (800 GPM for pumps 1.1,1.2 & 2.1 and 860 GPM for pump 2.2).
- The pump speed curve used for calculating VFD pump savings is returning negative kWh for low speed values. Either, the minimum pump speed should be set at 10% or the pump speed curve needs to be adjusted for the lowest speeds in the calculation.

ED implemented a net to gross (NTG) interview with this customer, the results of which are currently under analysis and pending finalization. ED also interviewed the decision maker to gather information on how the greenhouse design and operation influences productivity and how CO_2 injection is utilized in the greenhouse.

Review Conclusion

Gross project energy savings are conditionally approved pending discussion of baseline fan equipment annual hours of operation and post-installation inspection and savings true-up.

Summary of ED Requested Action by the IOU

In order to complete an ex ante review the ED recommends that the IOU submit the following documentation:

- Provide information to substantiate the similarities between the existing and proposed greenhouse constructions and operations and, if the two differ, details on what kind of action will be taken to true-up the kWh savings of the proposed greenhouse after construction.
- Provide information to substantiate the 15% floor area increase assumed in baseline energy savings calculations. ED recommends that a 10% floor area be applied since this is more consistent with information provided by the greenhouse owner.
- Provide information detailing how differences between baseline and proposed greenhouse heating and cooling loads have been accounted for in the energy savings calculations provided.
- Provide information to substantiate the baseline pump and fan controls and associated runtime.