Final Ex Ante Review Findings

Table 1-1: Project Information

IOU	PG&E
Application ID	REEP-085
Application Date	10/29/2012
Program ID	REEP
Program Name	Refinery Energy Efficiency Program
Program Year	2013
CPUC Project ID	X329
IOU Ex Ante Savings Date	TBD
Measure Name	High Emissivity Coating on Furnace Refractory
Project Description	The measure proposes to increase the heat transfer efficiency by applying a proprietary water-based coating to refractory surfaces inside an industrial furnace
Date of CPUC Staff Review(s)	06/21/2013, 12/24/2014
Primary Reviewer / Firm	Kunal Desai / Itron, Keith Rothenberg/ Energy Metrics
Review Supervisor / Firm	Joseph Ball / Itron, Jeff Hirsch/ JJ Hirsch & Associates
CPUC Staff Project Manager	[redacted] / California Public Utilities Commission, Energy Division
ED Policy Authorization (as needed)	TBD
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
CPUC Staff Recommendation	The ex ante savings for this measure are approved at the CPUC Staff estimated value of 590,078 therms, 0 kW, 0 kWh. The project is an REA project type with project cost of $315,055. The EUL for this measure must be adjusted to match the expected shutdown date of the SMR furnace, and in no case be greater than 6 years.

With consideration for the possible inaccuracy and unreliability of savings estimates for this measure, CPUC Staff require a hold be placed on any applications with this measure until further review can be performed. The IOU must not execute any incentive agreements for projects with this measure until instructed by CPUC Staff. Additionally, the IOU must provide a complete list of all applications in its

pipeline and list of projects completed since 2008 with this measure. The status of each project should be provided-e.g. paid, signed, pending, sales lead, etc.

CPUC Staff will provide further instructions to the IOU after receipt and review of the list of other applications with this measure.

Measure Description

The project proposed to increase the heat transfer efficiency inside an industrial furnace used in the steam-methane reforming (SMR) process at an oil refinery to make hydrogen gas by applying a proprietary water-based coating to the furnace refractory surfaces. The coating was expected to increase the emissivity of the furnace refractory surfaces, thereby increasing heat absorption into the process fluid. Natural gas savings were expected to result from lowering the input fuel required by the furnace to complete the reforming process.

It was expected that heat recovered from the furnace's flue gas would be reduced due to the furnace's increased thermal efficiency and reduced firing rate. This was expected to result in a reduction in the amount of process steam generated in the furnace's flue gas stack. The reduction in thermal energy in the flue gas was expected to be caused by the lower flue gas temperature and flow rate. The steam generated in the hydrogen plant is primarily consumed by the steam methane reformer (SMR) process, with the excess exported to other refinery users. The decrease in steam production must be made up by the main plant boiler system. Therefore, increased boiler load caused by reduced steam generation from this furnace offsets some of the hydrogen reformer gas usage savings for this project.

Summary of Review

The Investor Owned Utility (IOU) submitted the following documents on 12/5/2014 for this Final review:

- PGE ED Technical Reviewers Check list REEP 085 12052014apf3.xlxs,
- REEP 085 MV [CUSTOMER NAME] Cetek Coating Data Analysis.xlxs,
- REEP 085 MV [CUSTOMER NAME] Cetek Coating.docx,
- REEP 085 MV Invoices.pdf; and

- REEP 085 MV Title Page.docx.

This is CPUC Staff's second and final disposition for this project. In the Phase I ex ante review, CPUC Staff noted that the IOU had confirmed that the SMR furnace did not have a high emissivity coating before the project was implemented. The IOU also confirmed that in 2010, this facility had installed a similar coating on a different furnace which received incentives from the IOU but that none of the other existing furnaces, which are similar to the SMR furnace in this application, had high emissivity coating on their refractory surfaces.

CPUC Staff had requested a recent boiler test and NOx compliance certificate from the IOU for this facility. The IOU's response was that the facility has not conducted boiler tests in the past two years. The proposed boiler efficiency value was taken from a study conducted by the IOU on facility's steam boilers. They also stated that there are no regulatory requirements for NOx compliance certification specifically for this furnace, however the furnace complies with facility's Title V permit condition 23872 and federal regulation CFR 60.44(a)(1) in terms of NOx emission rates. Additionally, this furnace is also among a group of furnaces that are regulated under BAAQMD Reg. 9-10 in terms of the NOx emission rate. The EUL of the proposed measure is expected to be more than 6 years. The IOU stated that the high emissivity coating can withstand temperatures to a maximum of 2,800 ºF and the operating temperature of the furnace was approximately 1,750 ºF. This alleviated CPUC Staff's concerns about the furnace temperature affecting the proposed EUL. The project was conditionally approved pending post-implementation verification and savings true-up.

The preliminary energy savings estimate for this project was 1,119, 054 therms annually. The estimated incentive for this project was $122,125. The estimated project cost was $244,250.

CPUC Staff have reviewed the IOU's recent submission for this project. The IOU's analysis adjusted the baseline of the project to account for another project which had been implemented on the SMR furnace after the original baseline was established. The revised baseline data are from a period after the other SMR furnace project was installed and before the high emissivity coating was applied to the SMR furnace's refractory surfaces. The IOU's analysis also adjusts for furnace upset conditions caused by a power outage and shutdown of another related process which occurred during the post data collection period. Data from these periods were removed from the analysis. The IOU's final ex ante savings analysis estimates the impacts of this project to be 819,928 therms annually. The project cost was $315,055. The proposed incentive is $157,527.50, 50% of the project cost. The project was accepted by CPUC Staff as an REA measure with an EUL of 6 years in the Phase I ex ante review disposition.

The M&V data and final calculations provided by the IOU on 12/5/2014 were analyzed by CPUC staff. CPUC Staff's review revealed that the IOU's analysis had adjusted the steam/methane fluid flow through the furnace used to normalize the analysis based on the percent of pure hydrogen produced in the pre and post project measurement periods. The

average baseline period hydrogen purity was 94.31% and the post implementation period average hydrogen purity was 95.75 % (a 1.5% increase in purity between the baseline and post project periods). CPUC Staff could not identify any justification for using the pure hydrogen flow to normalize the analysis since changing the purity of the product produced was not described as an effect of the project. The critical parameter for the analysis normalization is the mass flow rate of the fluid through the furnace, not the purity of the product being produced. CPUC Staff also identified that the IOU's adjustment of the post implementation data to remove the upset periods required slight modification to include only flow rates that were equal or

greater to the minimum observed in the baseline data, not 50% of the maximum flow as was done in the IOU's analysis.

CPUC Staff modified the data to account for total fluid flow through the furnace and adjusted the upset data removed from the post implementation data as described above. The data were analyzed using two different approaches. The first approach is a normalized "specific energy" approach comparing the pre and post project (furnace input therms)/(MMSCFH H2) and (furnace output steam mlb./hr)/(MMSCFH H2). This analysis method yielded an estimated annual savings impact of 635,025 therms annually. The second approach is a linear regression approach using the same data set. The linear regression approach yielded an estimated annual savings impact of 590,078 therms annually. The linear regression approach has a smaller standard error than the specific energy approach and is therefore considered the favored approach. This analysis yields a savings impact 28% less than the IOU's estimated impact of 819,928 therms annually. Exhibit 1 summarizes the analysis results.

Exhibit 1- Comparison of Analysis Results

		Baseline		Post	
Analysis Approach	Net Impacts Therms	Std Error therms	Std Error steam mlbs	Std Error therms	Std Error steam mlbs
Specific Energy	635,025	145.40	5.55	171.10	9.23
Regression model	590,078	143.78	5.50	171.09	9.11
IOU Analysis	819,928				

The regression model estimates that the furnace input therms have been reduced by approximately 2% while the furnace steam output had been reduced by approximately 1%. While the saving impacts of 590,078 therms annually may seem significant with respect to the impacts of other natural gas savings projects in the IOU's portfolio, the impacts are in fact small with respect for the process involved. The SMR furnace has an input fuel rate of approximately 500 MMBtuh or 5,000 therms/hour. The estimated savings impacts associated with this project are less than 1.5% of the input fuel rate for the furnace and in reality too small to be considered reliable or accurate. CPUC Staff's analysis is shown on the blue colored tabs of the MS Excel

spreadsheet with a file name of "X329 PGE REEP 085 Cetek Coating CS Data Analysis 2014_1224.xlxs"

The SMR process is highly complex, likely with numerous parameters affecting the firing rate and steam output of the furnace. It is very likely that this project was implemented during a turnaround on this unit where maintenance and other activities occurred. Other activities may have included furnace burner maintenance or adjustments, and cleaning of heat exchangers, etc. that would also affect the furnace efficiency

CPUC staff had also selected PG&E application number REEP 081 for ex ante review. That project was the same measure in an SMR furnace at another refinery. CPUC Staff waived that project from further review, however it was selected for ex post evaluation in the 2013 sample. The IOU's analysis for that project estimates the impacts to be 4%, more than three times the impacts estimated for this project.

CPUC Staff note that the customer plans to retire the SMR furnace after a new hydrogen plant is constructed. The local government approved the construction of the new hydrogen plant in July 2014, and construction of the new plant is expected to begin in early 2015. The IOU must adjust the EUL for this measure to match the expected shutdown date of the existing SMR furnace as determined from the customer's project schedule.

Review Conclusion

The ex ante savings for this measure are approved at the CPUC Staff estimated value of 590,078 therms, 0 kW, 0 kWh. The project is an REA project type with project cost of $315,055. The EUL for this measure must be adjusted to match the expected shutdown date of the SMR furnace, and in no case be greater than 6 years.

With consideration for the possible inaccuracy and unreliability of savings estimates for this measure, CPUC Staff require a hold be placed on any applications with this measure until further review can be performed. The IOU must not execute any incentive agreements for projects with this measure until instructed by CPUC Staff. Additionally, the IOU must provide a complete list of all applications in its pipeline and list of projects completed since 2008 with this measure. The status of each project should be provided-e.g. paid, signed, pending, sales lead, etc.

CPUC Staff will provide further instructions to the IOU after receipt and review of the list of other applications with this measure.

Summary of CPUC Staff Required Action by the IOU

Immediately upon receipt of this disposition or not later than December 31, 2014:

1. CPUC Staff require a hold be placed on any applications with this measure (high emissivity coating) until further review can be performed. The IOU must not execute any incentive agreements for projects with this measure until instructed by CPUC Staff.

For this project due January 12, 2015 or 14 days after receipt of this disposition:

1. Revise the final documentation for this project to reflect the CPUC Staff approved savings estimates for this project.
2. Revise the EUL for the project to match the expected shutdown date of the existing SMR furnace based on the customer's schedule for the construction of the new hydrogen plant. Provide documentation to support the EUL assigned for this measure.

3. Provide a complete list of all applications in the IOU pipeline and list of projects completed since 2008 with this measure (high emissivity coating). The status of each project should be provided-e.g. paid, signed, pending, sales lead, etc.
4. For the final savings claim for this project, the IOU is required to upload to this project's folder in the CMPA the final claim ID number(s), the quarter claimed, and any further IOU revisions to the documentation not previously provided.

For all future projects (submitted after receipt of this review):

1. The IOU must make a diligent effort to ensure that custom project savings calculation methodologies and M&V plans are carefully designed to provide reliable savings estimates in accordance with good engineering practice, CPUC policies and PA program rules.

   For this project, Commission Staff identified that the savings impacts for this measure are likely to small to be accurately measured and are probably unreliable. The IOU must be diligent in reviewing custom measures to ensure accurate and reliable savings estimates can be provided for implemented measures. CPUC Staff's review also revealed that the IOU's analysis had adjusted the steam/methane fluid flow through the furnace used to normalize the analysis based on the percent of pure hydrogen produced in the pre and post project measurement periods. The average baseline period hydrogen purity was 94.31% and the post implementation hydrogen purity was 95.75 % (a 1.5% increase in purity between the baseline and post project periods). CPUC Staff could not identify any justification for using the pure hydrogen flow to normalize the analysis since changing the purity of the product produced was not described as an effect of the project. The critical parameter is the mass flow rate of the fluid through the furnace, not the purity of the product being produced. The Commission has authorized the ex ante savings review process to increase savings estimate reliability.