# PREDICTING BUILDING ENERGY PERFORMANCE – WE STILL HAVE A LONG WAY TO GO

*Moderator: Rafael Friedmann, Pacific Gas and Electric Company*

PAPERS *(in order of appearance)*:

**Energy Trust of Oregon 2009-2011 New Homes Billing Analysis: Comparison of Modeled vs. Actual Energy Usage**

Dan Rubado, Energy Trust of Oregon

**Sources of Error in Home Energy Use Calculations: Evaluation in Real-World Laboratory Homes**

Abram Conant, Proctor Engineering Group, Ltd.
John Proctor, Proctor Engineering Group, Ltd.
Henry Liu, Proctor Engineering Group, Ltd.
Bruce Wilcox

**Results of Validation Tests Applied to Seven ENERGY STAR Building Models**

John Scofield, Oberlin College
Gabriel Richman, Oberlin College

SESSION SUMMARY:

This session will focus on recent research on how well various residential and commercial energy efficiency rating systems and compliance software work. The session includes two papers on residential and one on commercial buildings. Home and commercial building energy performance scores and analyses supporting these were reviewed and found to have high levels of uncertainty and/or questionable accuracy. Results point to the need for further refinement of the currently available tools, especially if specific building energy savings performance is of interest. For program-level energy savings results, the tools perform more adequately. Ideas on how to improve current practice are offered so that the energy performance scores align better with actual performance.

Rubado and Degens paper describes a Pacific Northwest program that provides incentives to encourage builders to incorporate more energy efficient building practices and products in new homes. Incentives are based on performance measurement and home energy modelling software. A customer facing efficiency score rating is established to help builders market these homes. This study analyzed and compared monthly billing data for program rated homes and non-program, code built homes. The actual billing data was compared with the modeled energy usage and that of similar homes built to code in the same year. The analysis covered gas heated homes built between 2008 and 2011 using 2009 to 2012 billing data. Though program rated homes used significantly less gas than code compliant homes, the savings were less than expected. Inaccurate modeled energy use and increased energy efficiency of the entire new homes market were the main causes of the reduction in observed savings.

Energy simulation modeling and Home Energy Ratings (HERs) are increasingly used in the design and implementation of energy efficiency programs. It is important to verify that these ratings be both repeatable and accurate. Conant and Proctor's paper highlights the results of their study designed to provide a precise evaluation of error sources and magnitude by eliminating the usage variability associated with occupancy. The study used four houses of various vintage, square footage, geometry, and shell characteristics that were unoccupied, fully instrumented, with equipment schedules and internal loads controlled by computer. Each house was rated by six HERS raters and the resulting estimates were compared to each other, to energy simulation model estimates with inputs verified by the study team, and to the monitored heating and cooling consumption of the homes. Estimated annual

heating consumption varied between raters by as much as 97%, and annual cooling consumption estimates varied by as much as 125%. A comparison of HERs raters' annual heating use estimates with EnergyPro model results averaged 115% of the estimate with verified modeling inputs, with a range of 73% to 217%. The raters' estimates of annual cooling energy use averaged 150% of the estimate with verified inputs, with a range of 88% to 263%. Finally, the modeled estimates were compared to the measured annual heating and cooling energy consumption at each house. The models with verified inputs produced annual heating use estimates that averaged 147% of the measured value with a range of 84% to 182%. Cooling energy use estimates averaged 216% of the measured value, with a range of 137% to 329%. The systematic modeling errors combined with the variability and overestimation bias in HERS raters' inputs resulted in annual cooling use estimates that exceeded the measured use by a factor of 3X on average, and over 6X in the most extreme case. Clearly there is room for significant improvement in the home energy rating process and within the simulations models.

The final paper by Scofield is an in-depth review of the methodology and accuracy of the EPA's ENERGY STAR building score. Until recently benchmarking efforts were entirely voluntary and ENERGY STAR scores issued remained mostly confidential. In recent years the US Green Building Council (USGBC) and Green Globes have adopted the ENERGY STAR score for judging energy efficiency in connection with their green-building certification programs. Moreover, 10 or more major cities have passed laws requiring building owners to use the EPA's Portfolio Manager to receive ENERGY STAR scores. As a result ENERGY STAR benchmarking has greatly expanded, is no longer voluntary, scores are being made public and used to estimate building energy savings. The research identified and describes serious methodological issues behind the ENERGY STAR scores across various building types. These limit the accuracy and value of the ENERGY STAR building score as a predictor of commercial building performance.

This session will be of use to analysts, policymakers, and program managers who rely on building performance scores to promote energy efficiency in buildings. Attendees will come away with a deeper appreciation of the applicability of these building score methods and how to best apply these going forth, as well as ways to improve their accuracy.