Monday, October 01

10:45 AM-11:45 AM

Monday, October 01, 10:45 AM-11:45 AM

Modeling Track 1 – Daylighting's Effect on Building Energy Use Intensity (EUI)

Chair: Charles S. Barnaby, Member, Wrightsoft Corporation, Lexington, MA

This session compares the output of two daylighting simulation tools, one well known standalone tool dedicated to daylighting analysis only, the other a whole building simulation tool, to determine whether reasonable estimates of the effect of daylighting on high performance building energy use indices (EUI's) may reliably be predicted using a whole building simulation tool.

Capturing Daylighting Energy Savings: Is EnergyPlus Accurate Enough?

Rahul A. Athalye, Associate Member[1], *Bing Liu, P.E., Member*[1], *Yulong Xie*[1], *Mudit Saxena*[2] *and Tim Perry*[2], *(1)Pacific Northwest National Laboratory, Richland, WA, (2)Heschong Mahone Group, Sacramento, CA*

Daylighting is a key aspect of low-energy building design and energy codes and standards. In this presentation, we investigate the ability of EnergyPlus, a state-of-the-art whole building simulation program, to correctly capture daylighting savings using its built-in daylighting module. The energy use intensities predicted by EnergyPlus are compared with EnergyPlus models using Radiance for daylighting calculations. A Dynamic Radiance Model is used to evaluate the impact of blinds, interior furniture, and exterior obstructions on the ability of EnergyPlus to accurately predict energy use. Whole building EUIs, and individual end-uses are compared between the EnergyPlus-only and Radiance-supported EnergyPlus cases.

Differences in Energy Models and Existing Building Energy Use

Kristina Moores, P.E.*, Arup, New York, NY*

This project will build a database of actual energy use for buildings in several different sectors in the Americas region (office, cultural, educational, labs, residential) and provide a better understanding of the common sources of discrepancy between predicted energy use from energy models and the actual building energy. This is done by developing an energy benchmark for the building based on a year of actual energy bills after the building is completed and occupied, and comparing the actual monthly and annual energy use against the models.

Monday, October 01, 10:45 AM-11:45 AM

Modeling Track 2 - Existing Building Energy Modeling Processes for Energy Auditing and Operations and Maintenance Decision Making

Chair: Tom Butler, Southface, Atlanta, GA

This session considers the effectiveness of a range of simulation and modeling tools in the assessment of building energy performance. It provides an overview of the value of using simplified energy modeling tools during the energy auditing process and provides a demonstration of the process of evaluating a simplified tool's accuracy when compared to more robust energy modeling software.

Comparative Analysis of Audit Tools

***Shreya Agnihotri, Student Member**, Arizona State University, Tempe, AZ*

This study compared selected simulation tools to validate their accuracy and be used in the audit process of a building. The study was conducted by simulating prototype models and a case study building using the *Facility Energy Decision System* (FEDS) tool. The energy performance of the models from FEDS was compared to that from EnergyPlus and actual utility bills. The study established the validity of FEDS as an accurate tool to simulate a building for its energy performance using basic inputs and to accurately predict the energy savings achieved by the retrofits recommended on the basis of maximum LCC savings.

Using Energy Modeling to Make Better Design and Operational Decisions

***David C. Fishel, P.E., Member**, RLF Inc., Orlando, FL*

Energy modeling is a valuable tool for understanding the complex synergies between building design, operation, and energy use. From pre-design through post-occupancy, modeling is critical to informed, cost-effective decisions, for both new designs and existing facilities. This presentation will highlight two examples of effective energy model usage: a 25-year-old academic library in central Florida and a recent design of a carbon-neutral hospital in the Mojave Desert. Modeling software, its limitations and accuracy, and other useful tools will be discussed.

Monday, October 01, 1:00 PM-2:00 PM

Modeling Track 1.2 - Modeling Techniques for Evaluating Building Energy Use and Carbon Emissions

Chair: Oliver Baumann, Ebert and Baumann Consulting Engineers Inc., Washington, DC

Energy modeling is often used in the context of ASHRAE 90.1 for evaluating code compliance and percentage of energy cost savings. This session includes presentations that show modeling techniques that go beyond this and use alternative metrics, such as calibrating energy use against actual utility data, as well as evaluating source energy use and carbon emissions.

An Approach for Calibrating Existing Building Energy Models to Their Utility Consumption

***James V. Dirkes II, P.E., Member**, The Building Performance Team Inc., Grand Rapids, MI*

Existing buildings use the vast majority of facility-related energy, yet discussion of their energy modeling procedures is vastly under-represented in the industry and its literature. This presentation will develop a rationale (with examples) for a procedure to represent existing building energy use accurately and reliably. While sharing some common ground with new building models, there are numerous key differences for an existing building energy model. Not the least of these is that investors need high confidence that the predicted savings can be trusted to come true. Without this confidence, time is wasted and opportunity is squandered!

Hourly Carbon and Source Energy Calculations

***Michael Deru, Ph.D., Member**[1] and Daniel Studer, Associate Member[1], (1)National Renewable Energy Laboratory, Golden, CO*

Carbon and source energy values from building energy consumption are calculated for a variety of reasons. Typically, these calculations involve average annual multiplication factors, which provide rough estimates of the actual emissions and source energy consumption. This presentation illustrates how hourly emission and source energy factors were developed for each of the eGRID subregions and how these hourly factors allow users to explore the impact of shifting loads with energy storage or using on-site generation. Examples will be presented that show where and when shifting peak energy use can reduce emissions and where it may lead to increased emissions.

Monday, October 01, 1:00 PM-2:00 PM

Modeling Track 2.2 - Lessons Learned from Energy Modeling for LEED Projects

Chair: George (Billy) Austin, Shultz Engineering Group, Charlotte, NC

This track focuses on lessons learned from the energy modeling of actual LEED projects.

Energy Modeling for LEED Projects - Top 10 Lessons Learned

***James S. Chidester, P.E., Member**, Chidester Engineering, PLLC, Cabot, AR*

Warning! What you ***don't*** know about Energy Modeling can kill you – or, at least, kill your LEED project. Actual LEED projects will serve as the basis for this discussion. "The Top 10 Lessons Learned," or, more-appropriately named, "The Top 10 Mistakes Made by the Presenter," will be discussed, as will the ways that these mistakes were overcome. This is everything you needed to know about Energy Modeling but were afraid to ask. This is the stuff you didn't know that you didn't know.

Monday, October 01, 2:15 PM-3:45 PM

Modeling Track 1.3 - Large and Complex Building Energy Modeling and Data Validation

Chair: Drury Crawley, Ph.D., Member, Bentley Systems, Inc, Washington, DC

Large building projects require a significant investment in data input and manipulation. This session shows how an extensive model was developed and includes techniques for editing the resultantly large data sets. Methods to improve the reliability of the model through sensitivity analysis are also explained.

A Case Study on Editing a Large Building Energy Model

***Molly Curtz, P.E., Member**, Arup, Seattle, WA*

Manually editing large building energy model files is tedious and error-prone. This case study presents several advanced editing techniques used to manage a large building energy model for a 900,000 sq.ft. office campus. The presentation focuses on techniques, rather than on the project specifics; covers global parameters, Building Description Language (BDL) expressions, regular expressions, and more; and discusses how and when to best use different editing techniques. Examples are based on eQUEST, but some of the techniques are applicable to any software with a text-based input file.

Building Energy Model Assimilation with Real World Sensor Data

***Zheng O'Neill, Ph.D., P.E., Member**[1], Bryan Eisenhower, Ph.D., Member[2], Satish Narayanan[1] and Trevor E. Bailey, Ph.D.[1], (1)United Technologies Research Center, East Hartford, CT, (2)UCSB-Center for Energy Efficient Design, Santa Barbara, CA*

This study presents a holistic approach to calibrating and validating building energy models through an extensive sensitivity study. Two case studies for EnergyPlus models of calibration and validation will be included. Compared with real time measured data, less than 5% CV (RMSE) is achieved for monthly whole building electricity usage. The calibrated models are being used for real time performance monitoring and energy diagnostics in buildings at the Naval Station Great Lakes (IL).

Energy Modeling of Complex Building and Advanced Building Systems

*Wayne King, P.Eng., Associate Member[1] and **Ivan Ivanov, Associate Member**[1], (1)AECOM, Calgary, AB, Canada*

This case study presents the creating of an energy model of a very large and difficult to model building. Calgary International Airport is a complex building featuring advanced building systems and envelope with LEED Gold as target: 1.8 million square feet, corridors penetrating multiple levels, sloped walls and roofs (some with airplane wing profile), skylights and light wells, double facade, radiant slab and ceiling panels, chilled beams, displacement ventilation, CO_2 control, geo-exchange system, cogeneration, condensing boilers, low and high temperature cooling and heating, daylight harvesting, and active and passive shading

Monday, October 01, 2:15 PM-3:45 PM

Modeling Track 2.3 - Modeling Contemporary HVAC Systems Using Off-The-Shelf Whole Building Simulation Tools

Chair: Daniel H. Nall, P.E., Member, WSP Flack + Kurtz, New York, NY

Off-The-Shelf whole building simulation tools often do not have "canned" libraries of contemporary HVAC system components such as ground source heat pump heat exchangers, variable refrigerant flow systems and dedicated outdoor air treatment systems. This session provides tools and techniques for the practicing modeler to help develop system components,

performance curves and operating characteristic libraries for these contemporary systems for use in the more common whole building simulation tools being used in the industry today.

Modeling Development of Centralized Ground Source Heat Pump Systems In EnergyPlus

Heejin Cho, Ph.D., Associate Member[1] *and Yunzhi (Lucy) Huang, Ph.D., Member*[2]*, (1)Pacific Northwest National Laboratory, Richland, WA, (2)Pacific Northwest National Laboratory, Atlanta, GA*

This paper presents development of centralized ground source heat pump (CGSHP) systems in EnergyPlus. Two system models are developed for CGSHP applications: (1) vapor-compression chillers with heat recovery and (2) water-to-water heat pumps. Each system type has its unique control strategy to provide heating, cooling, or simultaneous heating and cooling based on their operating characteristics (i.e., irreversibility and heat recovery feature for chillers and reversibility for heat pumps) according to the zone demand. The performance results of the CGSHP model evaluated in EnergyPlus will be discussed.

Modeling Energy Usage of Variable Refrigerant Flow Systems

Pam Androff, Associate Member[1]*, Matt Rash, P.E.*[1] *and* ***Nick Conklin, P.E.***[1]*, (1)Mitsubishi Electric, Atlanta, GA*

Variable Refrigerant Flow (VRF) Systems have continued to increase in popularity in the HVAC industry. As such, the demand for accurate energy modeling of these systems is at an all-time high. However, most energy modeling programs do not provide VRF as a system choice, forcing modelers into complex workarounds. This presentation will demonstrate methodology of modeling VRF systems in Energy Pro, Trane TRACE, and eQUEST. An example building will be used to highlight any variations in results between the three programs.

Modeling a Unique DOAS System

Keith Swartz, P.E., Member*, Energy Center of Wisconsin, Madison, WI*

Can't model a building component in your common energy modeling programs? Don't give up! Dust off your reference books and get back to basics using an ordinary spreadsheet. Follow this case study that used basic energy concepts and psychrometric principles to model a dedicated outside air system (DOAS) with tight humidity control. The DOAS included a total energy wheel, a chilled water cooling coil, an evaporative cooler, and a heat pipe for reheat. A direct-fired heater in the exhaust air stream provided system heat. Learn how the spreadsheet information was used with a common building energy modeling program.

Monday, October 01, 4:00 PM-5:00 PM

Case Studies-1 Optimizing Energy Performance in Higher Education

Chair: Dennis Knight, P.E., Member, Whole Building Systems, LLC, Charleston, SC

This session will provide real world examples of how to optimize energy performance at higher education facilities and campuses while providing practical ways to model complex and sometimes challenging large scale energy using and energy producing systems.

50% Better Than 90.1-2004: Harbor College Science Complex

Nathan Kegel, Member*, IES, Minnetonka, MN*

This case study will describe in detail how a 67,000 sq. ft. science classroom building with 22,000 sq. ft. of laboratory space was designed to achieve a 49.1% reduction in energy cost from the ASHRAE 90.1-2004 baseline on a tight project schedule with a design-build project delivery. Natural ventilation, photovoltaic panels, sub-meters, daylight dimming with light shelves, complex solar shading, and energy recovery devices are some of the strategies which were modeled in detail and implemented into the final design. Analysis models include renewable energy, thermal loads, daylight optimization, solar shading, computational fluid dynamics (CFD), occupant behavior, and energy end-uses.

Choosing the Most Energy Efficient System for a College Building and the Challenges Faced When Modeling Optimizations Involving Non-Traditional Technologies

Annie Marston, Ph.D.*, Ebert and Baumann Consulting Engineers Inc., Washington, DC*

A college building in Washington, DC is aiming for an energy use intensity of 36-48 kBtu/ft². A detailed analysis of two HVAC systems: an AHU-based VAV system and a DOAS with chilled ceilings. The DOAS system with chilled ceilings led to a vastly improved energy performance. This presentation further analyzes the addition of enthalpy wheels, efficient chillers, and water-side economizers to the system. These measures achieved around a 30% reduction in energy use compared with the AHU VAV system. The challenges with modeling these innovative systems in EnergyPlus will be presented in this paper.

Monday, October 01, 4:00 PM-5:00 PM

Modeling Track 1.4 - Modeling of Computational Fluid Dynamics and Calibration of Unique Systems

Chair: Seth Spangler, RMF, Charleston, SC

The first half of this session will discuss and demonstrate the advantages of modeling Computational Fluid Dynamics early in the design so that the most efficient relationship between occupant comfort and energy efficiency can be determined. The second half of the session will discuss various workflows and techniques that can be used to calibrate unique system types in existing buildings using HAP and Trane Trace modeling software.

Implementing Computational Fluid Dynamics Early In the Design of HVAC Systems

Jon den Hartog, P.E., Member[1]*, Parker Wright, Member*[1] *and Rita Schnipke, Ph.D., Member*[1]*, (1)Autodesk, Charlottesville, VA*

As demand for high performance buildings increases, more sophisticated techniques are needed to ensure a balance between energy efficiency and occupant comfort. CFD, which enables detailed modeling of flow and thermal phenomena, is one such technique. This presentation will address the use of a CFD method that can be readily used early in the concept stage. Several examples of the application of CFD to HVAC design will be shown. For each, the details of the setup will be discussed along with the CFD results. In addition, the design change decisions resulting from the CFD analyses will be presented and illustrated.

Energy Simulations for Existing Buildings – Workarounds for Calibration of Unique Systems

Stuart J. Heisey, P.E., Member*, Entech Engineering, Inc., Reading, PA*

The presentation focuses on the workflow and techniques utilized to develop calibrated simulations for existing buildings in line with ASHRAE Level III Energy Audits. Techniques include workarounds for unique system types or component failures and analysis of simulation outputs with varying amounts of metered usage data. Examples from both Trace 700 and Hourly Analysis Program (HAP) include: multi-system spaces, classroom laboratory systems, dual duct VAV, constant volume air blender units, active desiccant dehumidification systems, optimized GSHP with DOAS, and others. Case studies include examples from Lafayette College, the Library of Congress, the Architect of the Capitol, and others.

Tuesday, October 02

1:15 PM-2:15 PM

Tuesday, October 02, 1:15 PM-2:15 PM

Case Studies-2 - Modeling Complex, High Performance Buildings and Systems – A Case Study

Chair: Charles S. Barnaby, Member, Wrightsoft Corporation, Lexington, MA

Most real life building HVACR engineering is not a ‘standard’ system: due to scale or complexity, it requires bespoke ‘workarounds’ to facilitate high performance designs. This session will illustrate techniques to successfully exploit modeling to produce effective solutions through examples of novel heat recovery techniques and a large scale project .

Lessons Learned In Modeling Underfloor Air Distribution with Air Handling Unit Heat Recovery In eQUEST

Kyle M. Adams, Member*, Arup, San Francisco, CA*

The presentation covers the energy modeling efforts completed for the Mary Idema Pew Library at Grand Valley State University in Allendale, Michigan. The presentation will be focused on the challenges of modeling complex mechanical systems, including air handling units with wrap-around heat pipes and an enthalpy recovery wheel used to serve an underfloor air distribution system. Many of these non-standard HVAC systems are not predefined in the whole-

building energy simulation software eQuest®; some can be incorporated into the model using workarounds and others must be modeled separately using exceptional calculations. Modeling strategies and key lessons learned are presented.

Energy Modeling a Six Million Square Foot Development In the Desert
***Liam Buckley, Associate Member**, IES Ltd., Boston, MA*
This case study presentation will focus on the energy modeling of a 6,100,000 sq. ft. development in Abu Dhabi, UAE. The Abu Dhabi Financial Center consists of eight buildings in total: four office towers above 30 stories, a retail podium, two parking garages, and a central stock exchange. This energy model is compared against ASHRAE 90.1-2004 (LEED Gold) and has a slew of innovative features. Energy conservation measures include ventilated double skin façades, external shading devices, automatic blind control, dynamic daylight dimming, occupancy sensing lighting, desiccant dehumidification, high-efficiency elevators, PV panels, and various HVAC systems including demand-controlled displacement ventilation.

Tuesday, October 02, 1:15 PM-2:15 PM

Codes and Standards-1 - Challenges in Using Models to Evaluate and Uphold the Standards

Chair: Oliver Baumann, Ebert and Baumann Consulting Engineers Inc., Washington, DC

Energy modeling in its different applications is the common way to evaluate and verify compliance with codes and standards. This session includes results of a parametric study that analyzes the modeled energy use of buildings that comply with ASHRAE 90.1 and ASHRAE 189.1 and also highlights the challenges that modelers encounter when applying energy efficiency standards to their models.

Does High Performance Standard 189.1 Have More Stringent Energy Efficiency Requirements Than Minimum Standard 90.1?
***Jian Zhang, Ph.D., Member**[1] and Bing Liu, P.E., Member[1], (1)Pacific Northwest National Laboratory, Richland, WA*
Comparative energy modeling analysis for ANSI/ASHRAE/IES Standard 90.1-2010 and ANSI/ASHRAE/USGBC/IES Standard 189.1-2009 was conducted using EnergyPlus program on 16 building prototype models in 17 climate locations. The modeled whole-building energy use intensities (EUIs) were reported for each prototype and for all 16 as a whole in order to compare the stringency of the two standards from national weighted average perspective. The presentation will provide an overview of the research methodology and analysis results. It will also use the standalone retail prototype as an example to demonstrate the key requirement differences between the two Standards and their modeling assumptions.

ASHRAE/IES Standard 90.1: Challenges with Evaluating Compliance of Energy Modeling
***John Hogan, P.E., Member**, Seattle Department of Planning and Development, Seattle, WA*
ASHRAE/IES Standard 90.1 is the basis for Energy Codes in the U.S, and is also used as the energy baseline for the USGBC's LEED green building program. Despite this, there are many challenges for evaluating compliance of hourly energy analysis modeling: baseline specifications are incomplete, modelers use the same software in different ways, software does not calculate criteria in Standard 90.1, input fields are missing for common uses, some algorithms are viewed as inadequate, and others are added by manufacturers without third-party vetting. The presentation will summarize challenges and make recommendations.

Tuesday, October 02, 2:30 PM-4:00 PM

Modeling Track 1.5 - Modeling Unique and Non-Traditional Energy Using Systems Using Both Complex and Simplified Energy Simulation Tools

Chair: Tom Butler, Southface, Atlanta, GA

Thermal bridging, daylighting and labyrinth ventilation systems create unique challenges to the energy modeler and their modeling tools. This session provides three case studies of how these types of systems can be better modeled whether the modeler is using a simplified tool for early stage energy use estimates or more complex modeling tools for final design decisions, equipment and material selections. These presentations will also consider how both minor and major building elements may be integrated into the assessment of the needs and the performance of the engineering systems.

Energy Model Assessment of Thermal Bridging and Fin Radiation Effect of Balconies

Susan Hayes, P.Eng.[1], *Graham Finch, P.Eng., Associate Member*[1], *Michael Aoki-Kramer*[2] *and Brittany Hanam, Associate Member*[1], *(1)RDH Building Engineering Ltd., Vancouver, BC, Canada, (2)RDH Building Sciences, Seattle, WA*

Slab edges, eyebrows and balconies on multi-story buildings are known to bridge the insulation provided by window and wall assemblies. Though solutions to reduce their impact exist, they are rarely employed in North America. This study examines the impact of concrete slab balconies on annual energy consumption in the 8 ASHRAE North American climate zones. The impacts of various boundary and internal conditions are considered, including: adjacent window and wall framing, insulation strategies, internal floor coverings, mechanical conditioning type, balcony size, and occupancy type. Several potential solutions are examined, comparing cost implications to the anticipated energy savings.

Incorporating HVAC Equipment Algorithms into SUNREL

David A. Hodgson, Ph.D., Member*, Union College, Schenectady, NY*

SUNREL is a free building energy simulation package developed by NREL. It is appropriate for simulating small, envelope-dominated buildings. HVAC equipment models have been added to the simulation package. The goals of the presentation are to introduce SUNREL and its new capabilities, and to provide an under-the-hood look at the building simulation package. Highlights of the new modeling capabilities include: part load effects, multistage equipment, losses and leaks in ducts, tank/tank-less and single-loop/multi-loop hydronic systems, flexible user defined output files. Feedback received at this session will help steer further development of this free software package.

Innovative Passive Daylight & Labyrinth Ventilation Design for a Healthcare Facility In BC, Canada

Liam Buckley, Associate Member*, IES Ltd., Boston, MA*

This case study presentation will focus on a healthcare facility in British Columbia, Canada. The main innovative feature of this healthcare facility is a below ground thermal labyrinth, which is used to pre-treat ventilation air by recovering heat and coolth from the adjacent ground during the year. The below ground labyrinth is modeled as an ECM against ASHRAE Standard 90.1. CFD analysis of the labyrinth assisted in the optimization of its shape, location of internal baffles, and night-flushing control strategy. Other innovative features that were modeled include natural ventilation, dynamic daylight harvesting, dynamic solar shading, and demand-controlled displacement ventilation.

Tuesday, October 02, 2:30 PM-4:00 PM

Modeling Track 2.4 - Carrying Forward Modeling on a Cloud

Chair: Drury Crawley, Ph.D., Member, Bentley Systems, Inc, Washington, DC

The use of cloud computing is providing access to greater computing power than was previously readily affordable. This session provides examples of how this is allowing more extensive modeling to improve project sustainability and looks forward to the potential benefits of more complex simulation tools. An example is given of coincident IAQ and energy modeling that could, in future, benefit from a more extendible modeling environment.

The Impact of Infinite Computing On Decision Making

Robert Middlebrooks*, Autodesk, Inc., Chesapeake, VA, USA, Chesapeake, VA*

Cloud-based technologies have the potential of completely changing how and where we make decisions. The real value of the Internet today comes from accessing an infinite amount of computing power that can assist you in making quality decisions. Being able to do iterative designs and refine them in near real time changes the environment of decision-making. It allows for collaboration with consultants and clients in ways that took days or weeks before. Ultimately the ability to analyze projects, simulate performance, and realistically visualize results increases predictability and reduces risk while increasing your value as a design professional.

Airflow Models of DOE Reference Commercial Buildings

Lisa C. Ng, Ph.D., Associate Member[1], *Amy Musser, Ph.D., P.E., Member*[2], *Andrew K. Persily, Ph.D., Member*[1] *and Steven Emmerich, Member*[1], *(1)National Institute of Standards and Technology, Gaithersburg, MD, (2)Vandemusser Design, PLLC, Asheville, NC*

Infiltration rates in the EnergyPlus models of the DOE reference buildings were input as constant airflow rates and not calculated based on established building airflow theory. In order to support more physically-based airflow calculations, models of the 16 reference buildings were created in CONTAM. This presentation discusses the differences between the CONTAM and EnergyPlus building models, outdoor air change rates calculated using CONTAM and EnergyPlus results, and calculated sensible load of the predicted outdoor air change rates. Opportunities will be discussed for using the building models to investigate technologies intended to simultaneously reduce building energy consumption while improving IAQ.

Integration of Sustainable Design Intelligence into the Early-Stage Building Design Process

***Varun Singh**, Sefaira, Inc., New York, NY*

This session will discuss how incorporating early-stage rapid sustainability modeling into the conceptual building design process mitigates the risk of not reaching project energy and sustainability objectives, and why traditional approaches to address this problem have failed to gain traction. We will highlight two case studies that have effectively leveraged cloud-based sustainable design tools, one of which produced a zero-energy building. We will look at how various sustainable strategies were evaluated, how key design decisions were made, and outcomes. Finally, the energy performance of the final designs will be discussed.

Tuesday, October 02, 4:15 PM-5:30 PM

Case Studies-3 - Applying Models to Predict Long Term Impacts of Building Modifications and Alternative Systems Operation

Chair: Daniel H. Nall, P.E., Member, WSP Flack + Kurtz, New York, NY

This group of case studies looks at long term implications of building fabric modifications, air distribution strategies and performance standards on the extended use, cost and energy use of environmental systems.

Energy Modeling of Existing Mid and High Rise Multi-Unit Residential Buildings to Predict Energy Savings of Building Enclosure Retrofits

***Brittany Hanam, Associate Member**[1] and Graham Finch, P.Eng., Associate Member[1], (1)RDH Building Engineering Ltd., Vancouver, BC, Canada*

Building energy modeling is a useful tool to evaluate potential energy retrofit projects for existing buildings. When modeling an existing building where actual energy consumption is known, the model can be calibrated to match the actual energy consumption to improve predicted energy savings. A study was undertaken to analyze energy consumption in mid and high rise multi-unit residential buildings in British Columbia. Gas and electrical energy consumption data was compared to computer energy simulations of buildings that had undergone full building enclosure rehabilitation projects. This presentation will provide results and lessons learned from the energy modeling performed for this study.

Impacts of Different Air Distribution Design Options On the Long Term Cost of Operating a School

***Stillman Jordan III, Associate Member**, University of Texas at San Antonio and HDR Engineering, San Antonio, TX*

An adequate amount of outside air and thermal comfort in schools are often correlated with improved performance in students. This presentation covers an analysis of the pertinent factors for the optimal air distribution system for schools in San Antonio, Texas. In addition, the presentation explains the long-term monetary benefits of energy efficient buildings to building owners using energy models and cost estimation calculations for multiple air distribution design options. It is intended to provide an analysis for school owners and operators, encouraging investment in efficient designs which have lower overall costs despite having higher initial costs.

Modeling Thermal Energy Storage On a College Campus with Wind Generated Energy

*Peter Potvin, P.E., Life Member[1] and **Judith Peters, Associate Member**[1], (1)LKPB Engineers, Inc., St. Paul, MN*

Building energy modeling is a useful tool to evaluate potential energy retrofit projects for existing buildings. When modeling an existing building where actual energy consumption is known, the model can be calibrated to match the actual energy consumption to improve predicted energy savings. A study was undertaken to analyze energy consumption in mid and high rise multi-unit residential buildings in British Columbia. Gas and electrical energy consumption data was compared to computer energy simulations of buildings that had undergone full building enclosure rehabilitation projects. This presentation will provide results and lessons learned from the energy modeling performed for this study.

Modeling of Data Center Energy Consumption with New ASHRAE IT Equipment Classes

***Zhiheng (Jay) Lei, Ph.D., Member**[1] and Nick Gmitter, Associate Member[1], (1)DLB Associates, Eatontown, NJ*

The design conditions for data centers have changed significantly in the past decade. The recommended temperature of 72.0^{o}F, +/- 2.0^{o}F in 2003 increased to 72.5^{o}F +/- 8^{o}F in 2008. New ASHRAE IT Equipment Classes (2011) offer the potential for server inlet temperatures of 113^{o}F. This presentation will compare the performance of several existing programs for modeling energy consumption, and compares the results to a custom program that also predicts server reliability. Cooling system models were examined for several climatic zones and include those with integrated air-side and water-side economizers, and those with no mechanical cooling at all.

Tuesday, October 02, 4:15 PM-5:30 PM

Modeling Track 1.6 - Life Cycle Cost Analysis and Verification

Chair: George (Billy) Austin, Shultz Engineering Group, Charlotte, NC

This track focuses on using energy modeling to determine life cycle cost analysis of energy conservation measures and comparison of modeled to actual performance.

Utilization of Energy Modeling In Whole Building Life Cycle Assessment

***Jerry Phelan, Associate Member**, Bayer MaterialScience, Pittsburgh, PA*

This research provides insight into evaluating the environmental life cycle performance of buildings using recognized and ISO standardized LCA techniques along with energy performance simulation. Special attention is given to alignment of boundary systems between the cradle-to-grave analyses of the building materials and consumed site utilities. It examines the WBLCA performance of designs with varying roof and wall thermal performance for buildings of differing use type located in various climate zones. EnergyPlus and the designs of the DOE/PNNL Prototypes are utilized. The results of the PIMA LCA Project along with the Athena Eco-Calculator provide the LCA data for the assemblies.

Energy Modeling Calibration for Existing Buildings

***Bridgette Baugher, Associate Member**, Southland Industries, Dulles, VA*

As building rating systems evolve, there is an increasing need to compare as-designed building energy performance to as-operated building energy use. LEED 2012 and ASHRAE 189.1 will require whole building energy monitoring and comparison to as-designed energy models. It is becoming more important than ever to be able to calibrate an energy model to utility data. We have used building calibration modeling on both new construction and existing buildings to verify peak energy savings, identify opportunities for energy savings, and to compare predicted and operational energy use. Case studies are presented that demonstrate methods of improving building calibration modeling accuracy.

Whole Building Energy Modeling and Life Cycle Cost Analysis for Hybrid HVAC Systems

***Garold Hamilton, P.E., Associate Member**[1] and Ionel Petrus, Associate Member[1], (1)SmithGroupJJR, Washington, DC*

This presentation will provide an in-depth analysis on how to model the energy consumption of a university-type building that will have the HVAC systems connected to ground wells. The ground wells will be used for thermal energy storage. The intent of this analysis is to determine the cost effectiveness of an innovative HVAC system and to verify that the methods used to calculate the building energy consumption give accurate results. The outputs from the calculations will be compared with historical data from similar buildings that use conventional and nonconventional HVAC systems.

Wednesday, October 03

8:45 AM-10:15 AM

Wednesday, October 03, 8:45 AM-10:15 AM

Case Studies-4 - Modeling to Optimize Retrofits

Chair: Dennis Knight, P.E., Member, Whole Building Systems, LLC, Charleston, SC

Improving the performance of existing buildings is the major challenge of today. This session will show how models may be used to drive the retrofit process and ensure that there are realistic expectations of saving energy and reducing carbon emissions.

Simplified Data Center Modeling

*Brian D. Peasley, P.E., Associate Member[1] and **Dana Etherington**[2], (1)CRB, Plymouth Meeting, PA, (2)CRB, Cambridge, MA*

Learn how to analyze a planned or existing data and identify financially-viable energy saving opportunities through the use of readily available tools and data and inexpensive computational fluid dynamics (CFD) software. The presentation will include a step-by-step review of select case studies and actual design

tools with samples provided for experimentation by audience members real-time. The primary objective of the presentation is to provide the audience with the education necessary to save energy within planned or existing data centers through the simplified use of inexpensive CFD modeling and free weather data paired with Microsoft Excel.

Retrofit Analysis Using eQUEST and VE-Ware: A University Dormitory Case Study

Seyed Nariman Mostafavi[1] *and Simi T. Hoque, Ph.D., Associate Member*[1]*, (1)University of Massachusetts-Amherst, Amherst, MA*

DOE-2 eQUEST and IES VE-Ware are used to quantify the predicted energy savings of a scheduled retrofit of a university dormitory (removal and replacement of original windows and exterior non-structural infill brick panels coupled with installation of supplementary insulation materials). Reports generated from baseline design simulations are compared to real energy consumption data in order to ascertain the accuracy of the two modeling programs. Retrofit analysis is carried out by comparing results of each retrofit design alternative against the baseline and assessing carbon dioxide emissions reduction resulting from the proposed retrofit process. Advantages and disadvantages of the programs are discussed.

Wednesday, October 03, 8:45 AM-10:15 AM

Modeling Track 2.5 - Early Stage Analysis and Model Based Commissioning

Chair: Seth Spangler, RMF, Charleston, SC

This session will examine several case studies that will review pre- and post construction energy model analysis. The pre-construction case study will review three interoperable platforms utilized to analyze multiple components of the early building design. The post construction case study will review how energy models can be utilized along with actual building operation to enhance the commissioning process and determine faults and potential performance enhancing changes.

Model-Based Continuous Commissioning

C. Birk Jones, Student Member[1]*, Hans Barsun, P.E.*[1]*, Rick Burnett*[1] *and Andrea Mammoli, Ph.D.*[1]*, (1)University of New Mexico, Albuquerque, NM*

Energy models, running in parallel with actual building operations, can be used to evaluate performance, identify faults, and aid in the determination of upgrade opportunities. The research team in the Mechanical Engineering Department at the University of New Mexico is developing the Building Energy Retrofit Testbed (B.E.R.T.) to run experiments that identify key sensors, data collection and storage procedures, IT infrastructure, and the overall platform necessary for model-based continuous commissioning. This development is essential so that buildings will continue to perform as designed throughout their lifetime.

Comparison of Predicted Energy Performance of Advanced HVAC Systems

Tom Webster, P.E., Member[1]*, Fred S. Bauman, P.E., Member*[1]*, Clark C. Bisel*[2]*, Glenn Friedman, P.E., Member*[3]*,* ***Jason Kirkpatrick, Associate Member***[4] *and Tyler Bradshaw, P.E., Member*[5]*, (1)Center for the Built Environment (CBE), University of California, Berkeley, CA, (2)WSP Flack+Kurtz, San Francisco, CA, (3)Taylor Engineering, Alameda, CA, (4)Skidmore Owings & Merrill LLP, San Francisco, CA, (5)Integral Group Inc., Oakland, CA*

This unique case study presentation will focus on early analysis of a Nature Center in Oklahoma. This model was passed through three different analysis platforms including a plugin embedded in Google SketchUp for climatic and rainwater harvesting analysis, a dynamic loads analysis with ECMs including various solar shading and natural ventilation strategies, and then a geothermal heat-exchanger analysis platform for geothermal well field analysis and optimization – all of which can be completed within a few hours from start to finish. The early-stage analysis produced incredible visual and quantitative results and informative guidance to assist progression of the design.

Early Stage Analysis Through Three Interoperable Analysis Platforms of An Oklahoma Nature Center

Liam Buckley, Associate Member*, IES Ltd, Boston, MA*

This unique case study presentation will focus on early analysis of a Nature Center in Oklahoma. This model was passed through three different analysis platforms including a plugin embedded in Google SketchUp for climatic and rainwater harvesting analysis, a dynamic loads analysis with ECMs including various solar shading and natural ventilation strategies, and then a geothermal heat-exchanger analysis platform for geothermal well field analysis and optimization – all of which can be completed within a few hours from start to finish. The early-stage analysis produced incredible visual and quantitative results and informative guidance to assist progression of the design.

Wednesday, October 03, 10:30 AM-12:00 PM

Modeling Track 1.7 - Effective Use of BIM in Energy Modeling

Chair: George (Billy) Austin, Shultz Engineering Group, Charlotte, NC

This track focuses on the effective and efficient use of BIM in energy modeling.

Rapid Building Modeling and Interval Consumption Data and for Estimating Potential Energy Savings

***Hugh Gaasch**, Retroficiency, Boston, MA*

With more than 5 million buildings and 80 billion square feet to cover, there aren't enough auditors, consultants, and engineers to put a real dent in the commercial building energy efficiency problem. Current processes do not address the issue in a systematic and scalable way. Rapid simulation modeling and energy analytics to assess utility interval consumption data offers a new approach to prioritizing building potential and identifying savings opportunities without ever visiting a building. This presentation will describe this approach and present case study results while discussing the benefits and limitations involved in the future of interval analytics.

To Geometry and Beyond – How Far Can BIM Really Go In the Energy Modeling Process?

***Nicole Dubowski, Associate Member**[1] and Holly Stevenson, Associate Member[1], (1)Arup, New York, NY*

This presentation will discuss the realities of integrating BIM with the load and energy modeling process. Topics covered include the benefits of BIM and energy modeling software integration, current limitations and workarounds, workflow, data management and automation, and model checking. The presentation will discuss storing geometry and other zone parameters within Revit spaces, exporting to Trace 700 and IES-VE software, and bringing load modeling results back into Revit. The presentation will include case studies showing how this process has been used on two projects.

Performance Based Energy Analysis: The BIM Approach

***Leo Salce**, Microdesk, Boston, MA*

This session will explain the core concepts of performance-based design and integrating building information modeling into an energy analysis workflow. We will go over how to evaluate the BIM model for LEED and Title 24 compliance through the use of gbXML compatible and validated analytical tools, to help understand the level of effort, purpose, and benefits of BIM for analytical modeling. Learn about the required steps needed to transform a physical model into an analytical one with a direct connection to decision making through comparative analysis throughout the various design phases.