Building Simulation User News

Published for US DOE by the Building Simulation Research Group
Lawrence Berkeley National Laboratory

This is the first of a new series of Building Simulation User News. The new series will be primarily web-based, though a PDF version may be downloaded by clicking here.

After producing the newsletter continuously since 1980, Kathy Ellington has retired. We extend our sincere thanks to Kathy for all her work in support of building simulation and wish her well in her retirement.

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New Release of EnergyPlus

EnergyPlus Version 3.1, released on April 14 and may be downloaded by clicking [here](). New features included in Version 3.1 include:

A few of the key new features include:

- simplified rectangular geometry for walls, roofs, ceilings, floors, windows, and shading;

- thermochromic windows;

- upgraded UFAD model;

- Standard 62.1 demand control ventilation;

- cool beam HVAC model;

- new tabular reports to support LEED EA Credit 1 forms; and

- new post-processing utility to combine Standard 90.1 Appendix rotation results.

Modeling capabilities have been updated and extended throughout the existing building envelope, daylighting, and HVAC equipment and systems portions of the program, along with many other enhancements and speed improvements. See table below for a comprehensive list of new features.

EnergyPlus Version 3.1 New Features

	Version 3.1 — April 2009
Input	• Users can now define surfaces as simple rectangles (Simple Rectangular Surfaces) for walls, roofs, ceilings, floors, windows, doors, glazed doors, and shading. New detailed surfaces objects (Wall:Detailed, RoofCeiling:Detailed, FloorDetailed). InputProcessor can now output defaults, autosizing, and autocalculation statistics. New Constant Schedule allows simpler schedule definition.
Daylighting	• New variables for reporting visual discomfort: Time Exceeding Glare Index Setpoint at Ref Point 1 and Time Exceeding Glare Index Setpoint at Ref Point 2.

	Version 3.1 — April 2009
Zone Model	• Thermochromic windows can now be modeled. New Adiabatic Surface option for Outside Boundary Condition. New Sinusoidal option for Other Side Coefficient Boundary Conditions allows users to apply a sinusoidal schedule to the surface boundary conditions. Two new simplified infiltration models added: Sherman-Grimsrud and AIM-2. Ventilated slab has additional system configuration DeliverySlab option.
Natural and Mechanical Ventilation	• UFAD model upgraded. AirflowNetwork wind speed model for height-dependency improved. Air Distribution System Model includes more components: heating coil and three heat exchangers. Demand Control Ventilation model based on ventilation rate procedure of Standard 62.1-2007.
HVAC	• New Heat Pump and Packaged VAV HVAC Templates. Improved control of unitary equipment (Furnaces, Heat Pumps, PTAC, PTHP, and Window AC). Furnaces with cycling fan systems now allow humidity control. Cool Beam model added. Option to size system flow rate and terminal units based on minimum ventilation requirements added; other zone equipment will be sized on zone loads Fan:OnOff now models multi-speed fan performance. Minimum stops on VAV terminals with reheat can now be scheduled. SensibleAndLatent and Desiccant Heat Exchangers now have economizer lockout option. Refrigeration racks and systems now accept either the name of a case or caselist, and compressor or compressorlist. Improved condensation controls for Radiant Low Temperature systems. EvaporativeCooler:Direct:ResearchSpecial model added. Water consumption model for Indirect Evaporative Cooler extended.

	Version 3.1 — April 2009
Output	• New tabular reports to support LEED EA Credit 1 forms. Tabular reports now can be in Inch-Pound units. Improved diagnostics, warnings, and informative messages throughout. Output:Reports object converted to simpler Ouput:Surfaces:List, Output:Surfaces:Drawing objects.
Utilities	• New AppGPostProcess utility in combination with Building:Compliance object averages the results from four building rotation runs for Standard 90.1 Appendix G compliance. Datasets can now be directly opened from a menu in IDFEditor. Weather Converter updated to allow more custom date formats. Weather Converter now can include rainfall information (where available) in EnergyPlus weather data files.
Documentation and Guides	• Input/Output Reference and Engineering Reference updated and extended for all new features and updates. Total documentation is now approximately 4,000 pages.
Platforms	• Windows, Linux, Mac

EnergyPlus Workshops

Advanced DesignBuilder and EnergyPlus

June 17-18, 2009
Pacific Energy Center, 851 Howard Street, San Francisco, CA 94103 USA

This workshop will feature one day of DesignBuilder leading into day 2 focused on EnergyPlus HVAC systems.

For more information, and to register click here

Introduction to EnergyPlus

July 31 - August 1, 2009
University of Strathclyde, Glasgow, Scotland

In conjunction with IBPSA Building Simulation 2009 (July 27-30)

For more information, and to register click [here](#)

Building Simulation 2009 Conference

Building Simulation 2009, the 11th International Building Performance Simulation Association Conference and Exhibition will be held in Glasgow, UK from July 27 to July 30. For more information, click [here](#).

IBPSA-USA Meeting, Louisville, KY, June 20

The US affiliate of the International Building Performance Simulation Association will meet from 4pm to 9pm on June 20 in Louisville, KY in conjunction with the ASHRAE Annual Meeting. For more information, click [here](#).

GenOpt Generic Optimization Program

GenOpt 3.0.0 beta was released in February 2009, under a BSD- style license, with all the source code available at no cost. New in version 3.0.0 is an implementation of parallel computation that allows GenOpt to run multiple simulations simultaneously on multi-core processors or multi-processor computers, thereby reducing the time needed for optimization and parametric studies. The parallelization of the simulations are is done automatically by GenOpt and does not require a special setup by the user.

GenOpt is a freely available open-source optimization program for the minimization of a cost function (such as annual energy use, peak electrical demand, utility cost, etc.) that is evaluated by an external simulation program.

For example, you can compute a building's annual energy cost in EnergyPlus, TRNSYS, IDA, DOE-2, or any simulation program with text-based input and output, and let GenOpt automatically find the values of selected parameters that yield lowest cost.

GenOpt has a library with local and global multi-dimensional and one-dimensional optimization algorithms, as well as algorithms for doing parametric studies.

For free download and more information, please visit

http://SimulationResearch.lbl.gov/GO or email [Michael Wetter](#)

DOE and NREL Release OpenStudio Plugin for SketchUp and EnergyPlus

Peter Ellis
National Renewable Energy Laboratory

The U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) recently released OpenStudio version 1.0.3, a free energy design plugin that works seamlessly within the Google SketchUp 3D drawing environment. The plugin simplifies use of DOE's award-winning EnergyPlus simulation software, which identifies potential energy savings by modeling lighting, heating, cooling, ventilating, water, and other building energy flows.

OpenStudio makes it easy to create and edit the building geometry in EnergyPlus input files using the Google SketchUp tools. With the native SketchUp 3D capabilities, users can view the geometry from any vantage point, apply different rendering styles and architectural finish details, and perform accurate shadowing studies. OpenStudio also allows users to launch EnergyPlus simulations and view the results without leaving SketchUp.

OpenStudio was created by NREL for DOE and is compatible with both the free and the Pro versions of Google SketchUp 6 or Google SketchUp 7.

OpenStudio integrates directly with NREL's EnergyPlus Example File Generator to help generate a code compliant building. The Example File Generator accepts the IDF file that is generated from OpenStudio and applies constructions and HVAC systems along with other energy-efficient options such as overhangs, daylighting, and photovoltaics. The resultant building is returned via email and can then be opened in OpenStudio.

OpenStudio is an open source project. Users and developers are invited to visit the collaborative project Web site hosted on SourceForge.net at: http://openstudio.sourceforge.net/

More information, along with a form to register for a free download of the OpenStudio plugin, is available on the EnergyPlus Web site at: http://www.energyplus.gov/openstudio.cfm

Modelica Library for Building Energy and Control Systems

Michael Wetter
Lawrence Berkeley National Laboratory, Building Technologies Department,, Berkeley, CA 94720
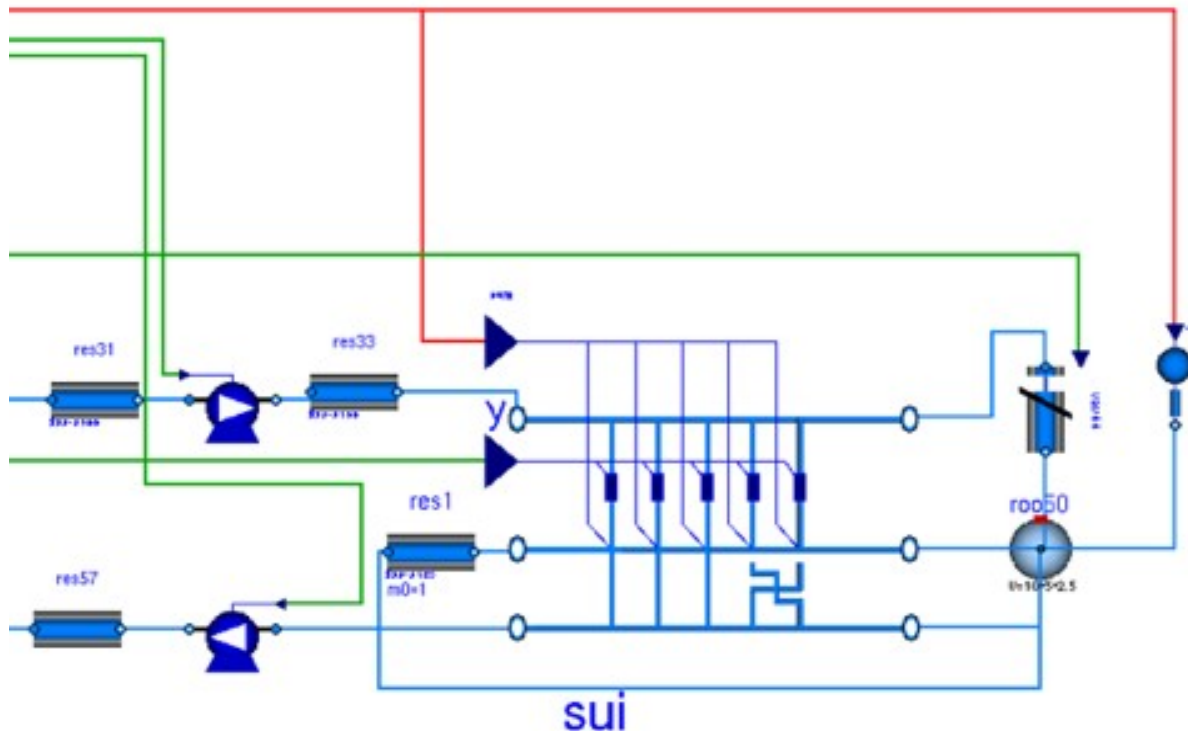
Implementation of a variable air volume flow system in Modelica

LBNL's Simulation Research Group has started an open-source development of an open-source component model library for building energy and control systems. The models are developed in the equation-based, object-oriented language Modelica language. The intent of this work is to make building system modeling flexible and fast enough so that it accelerates innovation towards leading to Zero Energy Buildings.

We are in particular interested in enabling:

- rapid prototyping of new building systems,

- development of advanced control systems,

- reuse of models during operation for energy-minimizing controls, fault detection and diagnostics, and

- active involvement of the simulation users in the development process.

Our intent is to collaboratively develop the library collaboratively, and mature it with early adopters whose needs are not met by existing building simulation programs. As early applications we envision that early applications will include the development of control algorithms, the development of integrated building energy systems and rapid prototyping.

The library development is open-source in order to allow others to participate in the development

process, and to provide better feedback that steers the further development. By sharing the development effort, participants will have tools that are of high quality due to constant peer-review, and they will be able to allocate more resources to do their actual research.

Please see https://gaia.lbl.gov/bir for further information or contact Michael Wetter.

Building Controls Virtual Test Bed

Michael Wetter
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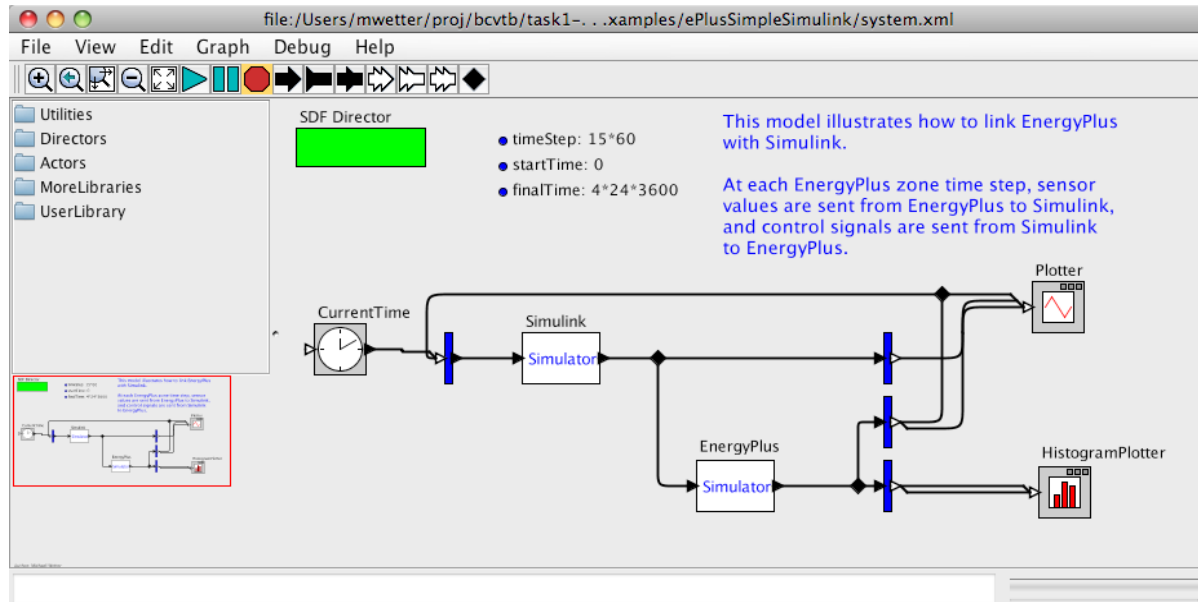
Building Controls Virtual Testbed, showing a model that links MATLAB/Simulink with EnergyPlus and plotters that plot time trajectories and histograms while the simulation progresses. In this example, control signals are computed by MATLAB/Simulink and sent to EnergyPlus. EnergyPlus computes the building thermal response and simulates the HVAC system. Measurement signals are then sent from EnergyPlus to MATLAB/Simulink.

LBNL is developing a Building Controls Virtual Test Bed (BCVTB), and a development version is currently available from https://gaia.lbl.gov/bcvtb The BCVTB allows expert users to couple different simulation programs for distributed simulation of building systems and their control algorithms. The software is still under development and aimed at expert users of simulation. Due to the different programs that may be involved in distributed simulation, familiarity with compiling and configuring programs is essential.

The current version of the BCVTB couples EnergyPlus and MATLAB/Simulink, ; and coupling of a Modelica simulation environment and a BACnet compliant Building Automation System (BAS) are part of the future development. The BCVTB is based on the Ptolemy II software from the University of California at Berkeley. Ptolemy II provides a graphical modeling environment that can also be used to define system models for physical devices, communication systems or for post processing and real-time visualization. The BCVTB allows the extension of the capabilities of EnergyPlus for controls simulation and for system simulation.

Typical applications include:

- performance assessment of integrated building energy and controls systems,

- development of new controls algorithms, and

- formal verification of controls algorithms prior to deployment in a building in order to reduce commissioning time.

Examples are provided with the BCVTB that show how to do distributed simulation. In the examples, we linked the following programs to the BCVTB:

- a development version of EnergyPlus 2.1

- MATLAB/Simulink

- a simulation program implemented in C

- a simulation program implemented in Fortran 90

The C and Fortran 90 simulation programs are provided to show developers how to couple a new program to the BCVTB. Such a coupling can be done by calling C functions that are provided as part of the BCVTB. The BCVTB also contains examples that show how control models can be implemented directly in Ptolemy II using Ptolemy II's graphical model editor. The control examples include a heterogeneous system consisting of a discrete time controller with a Finite State Machine.

In future versions, we plan to couple a Modelica simulation environment for which we are currently developing a model library for building energy systems (see https://gaia.lbl.gov/bir). This will allow advanced users to

- define on the fly - do rapid prototyping of new HVAC components and systems in a modular, hierarchical, object-oriented, equation-based graphical modeling environment and couple them to EnergyPlus,

- innovate new HVAC system and control architectures for which models do not yet exist in off-the-shelf whole building simulation programs, and

- analyze dynamic effects of HVAC systems, modeled in Modelica, and their local and supervisory control loops, modeled in MATLAB/Simulink, Modelica or Ptolemy.

Future work will also include coupling a BACnet compliant Building Automation System to the BCVTB. This will allow testing supervisory control sequences using an EnergyPlus model to assess the energy and comfort performance of different supervisory control algorithms. It will also allow formal verification of control sequences before deployment to a building.

Please see https://gaia.lbl.gov/bcvtb for further information or contact Michael Wetter or Philip Haves.

Recent Publications

Michael Wetter.
Modelica-based Modeling and Simulation to Support Research and Development in Building Energy and Control Systems.

Michael Wetter and Philip Haves.
A modular Building Controls Virtual Test Bed for the integration of heterogeneous systems.
Proc. of the 3rd SimBuild Conference, Berkeley, CA, USA, August 2008.

Michael Wetter, Philip Haves, Michael A. Moshier and Edward F. Sowell.
Using SPARK as a solver for Modelica.
Proc. of the 3rd SimBuild Conference, Berkeley, CA, USA, August 2008.

EnergyPlus for the Development and Code Compliance of the California Building Energy Efficiency Standards

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California has been using DOE-2.1E as the reference calculation engine for developing Title 24 and code compliance. However, DOE-2.1E is no longer supported by DOE. EnergyPlus is a new generation program that incorporates most of the useful features from DOE-2 and BLAST, together with new modeling capabilities. With California's net zero energy goals for new residential buildings in 2020 and for new commercial buildings in 2030, California needs to evaluate and promote currently available best practice and emerging technologies to significantly reduce energy use of buildings. The California Energy Commission (CEC) needs to adopt a new building energy simulation program for developing and maintaining future versions of Title 24. In 2004, PG&E funded a project to evaluate the ability of EnergyPlus to model those energy efficiency measures specified in both the residential and nonresidential Alternative Calculation Method (ACM) of the Title-24 Standard. The project identified gaps between the modeling capabilities of EnergyPlus (version 1.2.1 released in October 2004) and the requirements of Title 24-2005 and the ACMs. The project report recommended that CEC adopt EnergyPlus for use with Title 24. The report also raised issues and concerns in the following areas:

- Modeling Capabilities

  EnergyPlus 1.2.1 lacked some modeling capabilities included in the Title 24 ACMs, and modeled some features differently than specified in the Title 24 ACMs.

- Computer Run Time

  EnergyPlus 1.2.1 much longer than DOE-2.1E to run typical building simulations.

- User Interface

  It is much more complex to prepare input files manually for EnergyPlus than for DOE-2.1E, and there was no available user interface for EnergyPlus that could cover most of its modeling features, especially the user-customizable loop-based HVAC systems. CEC recently funded two new PIER projects to develop a ruleset-based EnergyPlus compliance shell and a comprehensive HVAC interface to EnergyPlus.

- Accuracy Tests

The ACM accuracy tests were developed based on DOE-2. Running these accuracy tests with EnergyPlus raised a number of issues, the most important of which was how to address the discrepancies in model inputs and simulation results between EnergyPlus 1.2.1 and DOE-2.1E. This issues was partially addressed in a 2005 CEC-funded LBNL project.

In 2008, CEC funded LBNL to review the previously identified gaps in EnergyPlus for use in Title 24, and then close these gaps to help pave the way for EnergyPlus to be adopted as a Title 24 compliance ACM. The project has three technical tasks:

- Extend the modeling capabilities of EnergyPlus so that it can be used in the development of Title-24 standards and code compliance calculations,

- Reduce the computer run time of EnergyPlus to promote increased adoption in the standards and design communities, and

- Provide training and technical assistance for CEC staff in their use of EnergyPlus for analyses related to Title-24.

EnergyPlus 2.2 meets most of the modeling requirements for Title 24; the remaining gaps between Title 24-2008 and EnergyPlus version 2.2 were identified and scheduled to be addressed.

EnergyPlus does sub-hourly whole building integrated heat balance calculations in order to simulate new building technologies and provide more accurate results. As a result, EnergyPlus runs significantly slower than DOE-2, which does not generate a simultaneous solution of loads, systems and plant. The EnergyPlus development team has been making continuous progress in reducing computer run time since the first release of EnergyPlus by fine tuning the FORTRAN compiler settings and performing code profiling to identify run time bottlenecks. Even so, the longer computer run time remains a barrier to the effective use of EnergyPlus. EnergyPlus run time depends on many factors, including:

- The simulation settings users specified in the EnergyPlus model,

- The computer platform used to run the model, including computer hardware and operating system,

- The energy features defined in the EnergyPlus model,

- The version of EnergyPlus source code, and

- The FORTRAN compiler and its settings.

EnergyPlus run time can be analyzed from various perspectives. Two closely related approaches are employed to analyze the EnergyPlus run time on typical personal computers (PCs) with Intel 32-bit CPUs and Microsoft Windows operating systems, which are dominant PC platforms used today for building performance simulations. The first is to study the run time using EnergyPlus as a black box by performing parametric runs to identify key variables that have significant impact on run time. The second is to study the run time using EnergyPlus as a white box by profiling EnergyPlus code with a few typical simulation runs.

The following areas are being studied in the first approach:

- From the historical perspective, what is the trend of EnergyPlus run time? What to expect in future if the historical trend continues?

- From the peer perspective, how does EnergyPlus run time compare with that of DOE-2?

- From the user perspective, what simulation settings should be specified and how they impact the run time? What is the best practice to reduce run time without sacrificing simulation accuracy?

- From the model perspective, what model features are computationally intensive? How to deal with large models?

- From the computer platform perspective, what hardware and software is required to run EnergyPlus and how do they impact the run time? What is the recommended computer platform?

- From the EnergyPlus compiler perspective, which FORTRAN compiler should be used? What are compiler settings and how do they impact the run time?

The following areas are being studied in the second approach:

- Which FORTRAN subroutines use the greatest amount of time?

- Which FORTRAN subroutines get called most frequently?

- What is the critical path of the run time?

Further details are given in:

Hong, T., F. Buhl, P. Haves, 2008. EnergyPlus Analysis Capabilities for Use in California Building Energy Efficiency Standards Development and Compliance Calculations. Lawrence Berkeley National Laboratory, Berkeley, CA. LBNL-822E.

Hong, T., F. Buhl, P. Haves, 2008. EnergyPlus Run Time Analysis. Lawrence Berkeley National Laboratory, Berkeley, CA; California Energy Commission, Sacramento, CA. CEC–500–2008–xxx.

COMFEN

A commercial fenestration/façade design tool

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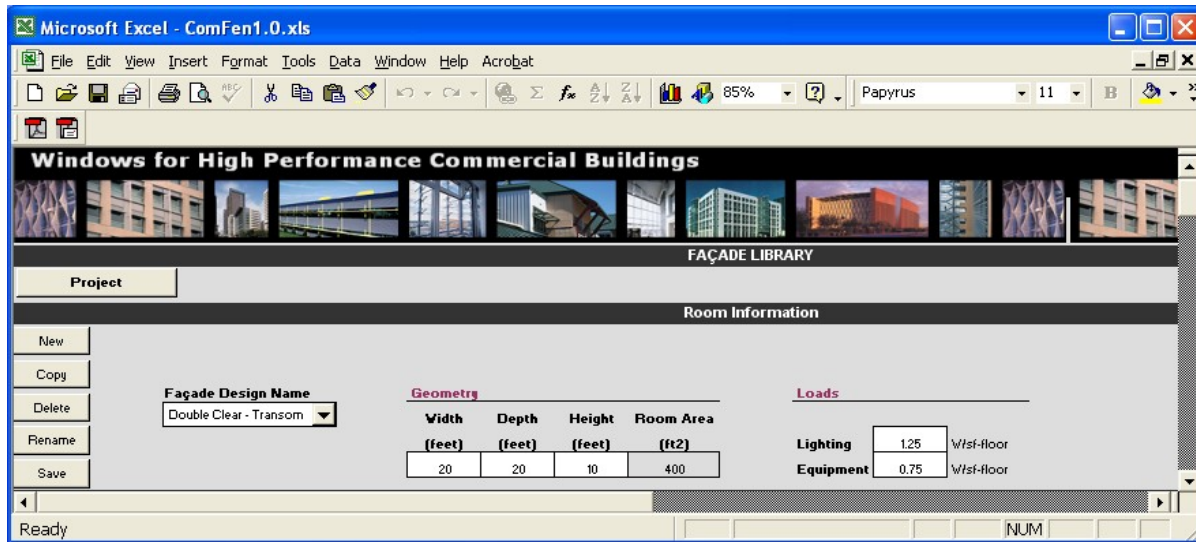
COMFEN is a new tool intended to promote the design and deployment of high performance fenestration systems by making detailed simulation comparisons of alternative fenestration design choices accessible to a wide audience of users. COMFEN provides a simple user interface that focuses attention on key variables in fenestration design. EnergyPlus simulates the effects of these variables on energy consumption, peak energy demand, and thermal and visual comfort. Results are presented in graphical and tabular format to help users move toward optimal fenestration design choices for their project. This article discusses the objectives in developing COMFEN, the implementation methods used, and plans for future development.

COMFEN OBJECTIVES AND AUDIENCE

COMFEN has been designed to meet the objective of clearly focusing user attention on a limited set of variables specific to façade fenestration design. One primary audience of COMFEN is architects during early design. This audience is key to realizing high performance fenestration systems. Many early design decisions focus on the exterior façade of the building. Aesthetic considerations may be foremost in this decision-making, so it is critical to introduce easy, yet sophisticated, evaluation of design choices with respect to their energy and occupant comfort impacts.

A second primary audience of COMFEN consists of fenestration manufacturers' representatives. This audience is key to promoting the deployment of high performance fenestration components and systems. The high-level features of COMFEN that are needed to address this audience are similar to those for designers. However, the tool must additionally provide access to emerging fenestration products, and have the ability to analyze these products. The main objective of COMFEN in this respect is the accurate analysis of new complex fenestration products in an

unbiased manner so that those products that enhance the overall performance of fenestration systems can be promoted to consumers.

Additional potential audiences for COMFEN include façade design specialists and commercial builders. An important additional feature of COMFEN for these audiences is the ability to access and modify the more detailed types of building information than was available in early design, such as those mentioned above.

COMFEN VERSION 1.0

COMFEN v1.0 targeted the two primary audience applications of early design and product promotion. To focus user attention on fenestration performance while minimizing attention to other building details, COMFEN provides a comparative analysis of individual room (thermal zone) modules with different fenestration. Each module consists of a single exterior façade wall attached to an interior rectangular thermal zone served by a packaged single zone HVAC system that is properly sized for each façade module. Up to four such modules can be included in an analysis project to compare variations in their façade walls.

COMFEN VERSION 2.0

COMFEN v2.0, released in December 2008, has a number of enhanced features. There is a richer and more flexible set of glazing systems, and shading options. A link to the International Glazing Database (IGDB 2007) has been implemented to support user-defined glazing systems built from the over 2700 glazing products currently in the IGDB. These glazing systems are input to EnergyPlus as material layer objects using full spectral data sets to maximize analysis accuracy. A more flexible method of adding new locations (i.e., weather and design data) has been implemented. The ability to select a variety of shading options, such as venetian blinds or translucent shades, located inside, outside, or between layers of each window, has been added. This will include the ability to select from a variety of shading control options (e.g., based on exterior incident solar or interior daylight illuminance levels).

The COMFEN v2.0 user interface consists of a number of screens:

• Façade Library Screen

Façade Library screen, shown in Figure 1, presents two-dimensional elevation, plan, and section views of a façade wall. Up to four separate windows can be located and sized on each wall using the edit boxes at the bottom of this screen, which are then displayed in the two-dimensional views. A different glazing system, frame type, and shading control option can be selected for each window. Rectangular overhangs and fins can be located and sized using the edit boxes on the right of the screen and will also be displayed in the 2-D views.

• Project Screen

The main Project screen is shown in Figure 2. Multiple projects can be created and stored. Each project is defined by a user name, location, building type, vintage, project orientation, and analysis run period. The building type is limited to small office in COMFEN v1.0 and v2.0, but will be extended in future versions. The design standard used is currently limited to ASHRAE 90.1-2004 but may be extended in the future. Each project consists of up to four comparative module cases that are selected using the Façade Design Comparison portion of the Project screen. The building orientation input data field allows the user to rotate the complete set of comparative module cases. Each case can be individually oriented and daylighting controls can be set to none, continuously

varying or stepped.

- Glazing System Library Screen

The Glazing System screen is shown in Figure 3. Glass layers are imported from the Intenational Glazing Database (IGDB) and used to create glazing systems in the Glazing System Library. Gas layers for the glazing system are also imported from the COMFEN database (COMFEN.mdb). When the glazing system has been defined, the center-of-glass U-value, solar heat gain coefficient (SHGC), and visible transmission are calculated using the algorithms used in the WINDOW 6 program. COMFEN can also import glazing systems from a WINDOW 6 database. COMFEN then creates EnergyPlus input objects for these glazing systems, again using full spectral data sets to maximize analysis accuracy.

- Shading Control Library Screen

The ability to select a variety of shading options, such as venetian blinds or translucent shades, located inside, outside, or between the layers of each window, has been added to COMFEN v2.0. On a given façade, each window glazing system can optionally include a shading layer such as Venetian blind, woven shade, or bug screen. COMFEN v2.0 allows users to define a library of shading layers and shading controls for those shading layers and also allows selection from a variety of shading control options, e.g. based on exterior incident solar or interior daylight illuminance levels.

- Project Analysis and Output

Having selected a set of comparative cases in the Project screen, the user clicks on the *Calculate* button to perform an analysis. An EnergyPlus input data file is automatically generated and simulated and the results retrieved for graphical and tabular display. The top section of the Results portion of the Project screen displays bar charts comparing the annual energy consumption (heating, cooling, fans, and lighting), peak energy, CO_2 emissions, daylight illuminance, visual glare, and thermal comfort (Figure 5-a) of the selected cases. The lower portions of this screen display bar charts of monthly energy use, peak electricity consumption and thermal comfort (Figure 5-b). There are also detailed charts of hourly daylight illuminance, discomfort glare and thermal comfort distributions.

IMPLEMENTATION METHODS

- User Interface

As discussed above, COMFEN has been developed within the Microsoft Excel™ environment, to provide a simplified user interface for input and graphical display of output. The Visual Basic macro programming facilities within Excel have been used to customize input and output display features described in the previous section.

- Links to EnergyPlus

Links to EnergyPlus as the analysis engine make use of both Excel and EnergyPlus macro capabilities. A number of hidden worksheets within the Excel spreadsheet are used for calculating and storing parameter values required for the EnergyPlus input models. An Excel macro script is then used to set up and execute a batch file that manages an EnergyPlus simulation run for the current COMFEN project. Following successful completion of the simulation run, the EnergyPlus output results are processed using another batch file. These results are then automatically

imported into the spreadsheet to populate other hidden worksheets, and displayed on the user-viewable worksheets in graphs and tables. To avoid exceeding the Excel file size limits, only the most recently simulated COMFEN project results are stored in the spreadsheet.

FUTURE DEVELOPMENT PLANS

Development plans for COMFEN include changing the development and user interface environment, adding more complex fenestration system options, and addressing more detailed design requirements. The Excel spreadsheet-based prototype versions of COMFEN (V1 and V2) have proven in use case workshops to be of great interest to architects, environmental performance analysts, and fenestration manufacturers who are all looking for a fast but physically accurate modeler for 'sketching' building performance. In response to user feedback, COMFEN V3 is focusing on providing the functionality of V2 in an improved 'drag and drop' interface.

V3.0:

- V2 implemented as a standalone package

- Runs EnergyPlus V3

- Share scenarios between projects

- Separate project files

- Link to UC Berkeley Comfort model

- Economizer cycle in the HVAC system definition

- Tighter integration with Commercial Windows database/website

V3.1

- Custom versions for industry partners

- Add EnergyPlus functionality:

    - Natural ventilation

    - Double facades

    - Run each scenario in non-HVAC mode to establish how well the building design itself functions

- Utilize multi-core processors to run EnergyPlus in parallel

- Add at least three more building type templates

    - School

    - Hospital

- Big box retail

- Improve all building templates

  - E.g. simple office has a ceiling that can be made higher near the window wall

  - Cross flow venting for natural ventilation with atrium and double sided and single sided variants

- Link more explicitly to web interfaces

- Provide realistic benchmarks that relate the single room /zone energy and other results to LEED points and other whole building benchmarks- codes and standards

- Link to SketchUp and the su2rad Radiance exporter via a COMFEN button that automates the Ruby interface – use this to build seamless workflow for the SU2COMFEN relationship

  - At a minimum, provide numerical glare analyses at the two daylight metering points in the EnergyPlus file

  - At a minimum, provide Radiance files that can be run in semi-automated fashion in Radiance and that represent the shading systems accurately

V3.2

- Enhance multi-core processor operation

  - Run EnergyPlus in the background on specified design variants to determine and report which parameters have most influence on performance

  - Run COMFEN design scenarios on the compute cloud provided by Amazon or Microsoft

- Ensure compatibility with Radiance

  - Build a series of standard output reports from Radiance

  - Link to DAYSIM

- Link to Lightsolve

- Add ability to examine more than one facade –

  - Top lighting

  - Corner offices

- Explore with Autodesk:

  - the relationship between Ecotect and COMFEN – and develop a plan that is consistent with the Ecotect / Revit future

- the relationship between their computational design product and COMFEN

- Explore with Bentley how COMFEN might work with their sustainability tools

- Explore with Graphisoft how COMFEN might work with their sustainability tools

V3.3

- Add ability to share building design templates and scenarios via a wiki-supported web interface

- Link to CFD

- Provide more reliable building description libraries –

    - Explicitly allow linking of HVAC, fenestration and building fabric to capture thermal storage effects

    - Explicitly link to Autodesk SEEK or other databases – making Quality Assured building properties visible, as the IGDB does already for glazing properties

- Complete development of seamless workflow for the Autodesk Revit / Ecotect to COMFEN information exchange

- Explore with Autodesk

    - the complementary roles of COMFEN and GBS

    - the relationship between their computational design product and COMFEN

- Complete development of workflows with Bentley

    - For the relationship between Microstation and COMFEN

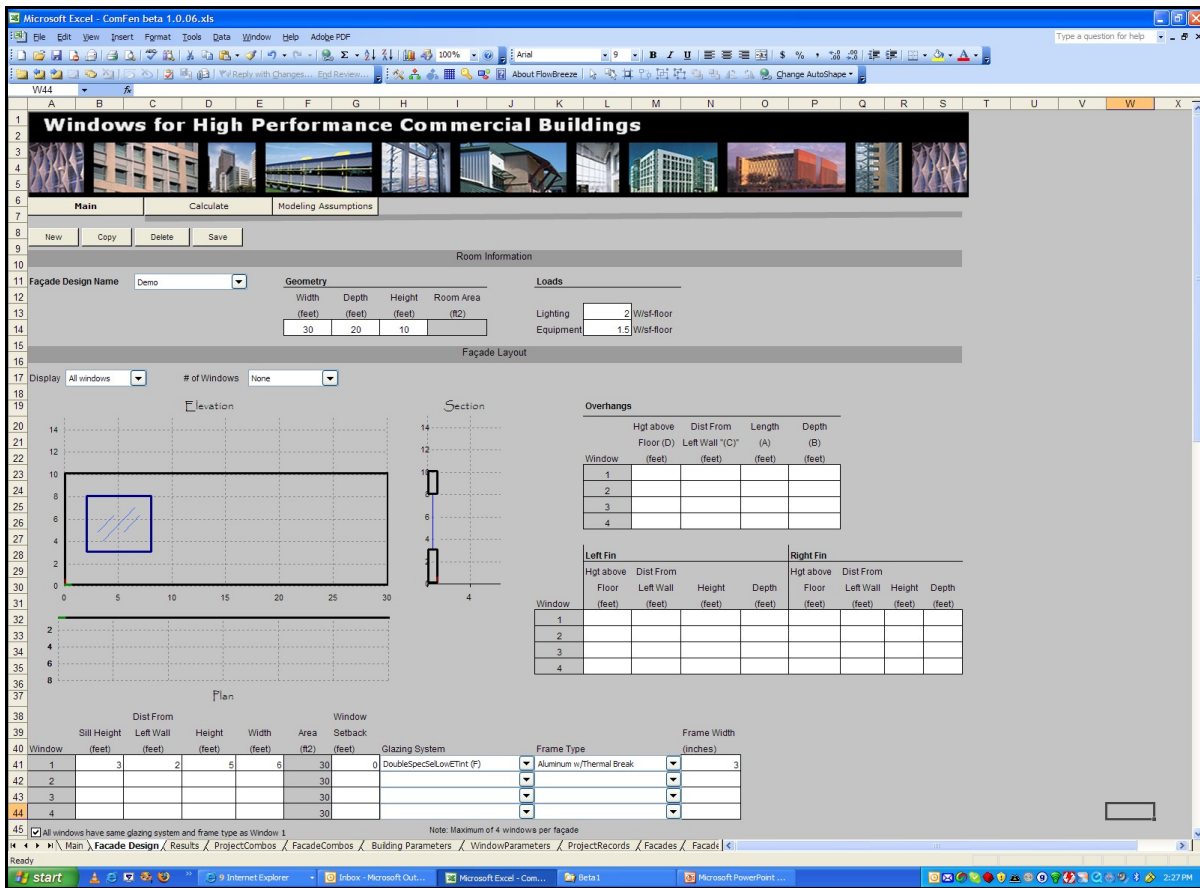   - For the relationship between Generative Components and COMFEN

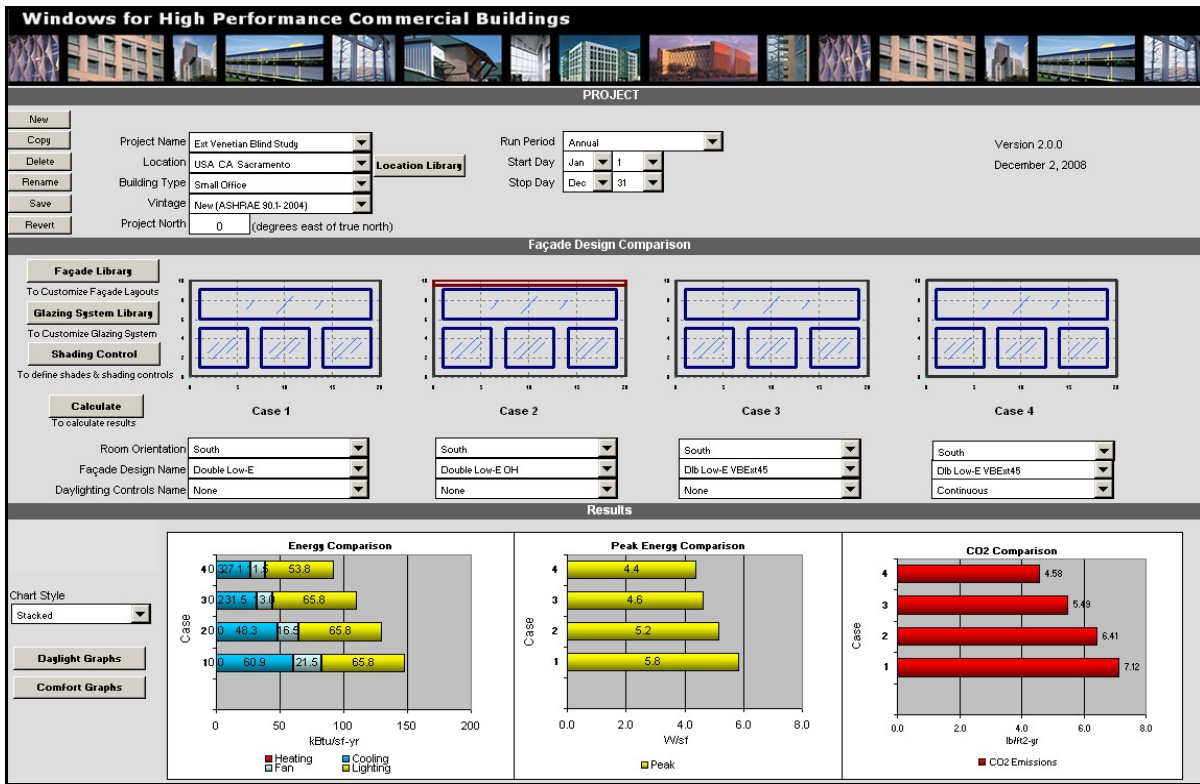*Figure 1 The COMFEN Façade Library screen allows definition of custom façade designs*

Figure 2 The COMFEN Project screen allows comparison of four different façade designs

Ask an EnergyPlus Expert

Run EnergyPlus on Microsoft Windows Vista Computers

I had problems running EnergyPlus on Windows Vista computers. What can I do?

Answer

EnergyPlus has no problems running on Vista computers if it is run directly by executing the EnergyPlus.exe file assuming you have prepared the in.idf and in.epw files at the same folder. There were some issues running earlier versions of EP-Launch, but most have been fixed for the latest version of EP-Launch. If EnergyPlus was installed at a user folder like C:\ EnergyPlusV3-0-0, there should be no problems running EP-Launch. If EnergyPlus was installed at a windows system folder like 'C:\Program files\ EnergyPlusV3-0-0', you have to run EP-Launch every time with administrator rights by right clicking the EP-Launch.exe file and choose 'Run as Administrator'. Another way is to create a shortcut to EP-Launch and change settings appropriately.

Run EnergyPlus in Parallel

I have to perform lots of parametric runs with EnergyPlus. Is there a way to run EnergyPlus in parallel?

Answer

EnergyPlus is a single thread application. A simulation run with EnergyPlus only utilizes a CPU. However, multiple parametric runs can be launched in parallel if these runs are independent. The way to do it is to create multiple folders and copy files EnergyPlus.exe, Energy+.idd, DElight2.dll, EPMacro.exe (if macros are used), ExpandObjects.exe (if HVACTemplate or Compact HVAC objects are used) from the original EnergyPlus installed folder. Inside each folder, copy IDF file as in.idf and EPW file as in.epw, then run EnergyPlus.exe from each folder. This is better handled with a batch file. If the Energy+.ini file

exists in one of the created folders, make sure it is empty or points to the current EnergyPlus folder.

The benefit of run time savings depends on computer configurations including number of CPUs, CPU clock speed, amount of RAM and cache, and hard drive speed. To be time efficient, the number of parallel EnergyPlus runs should not be more than the number of CPUs on a computer.

The EnergyPlus utility program EP-Launch is being modified to add the parallel capability for group simulations. The long term goal is to run EnergyPlus in parallel on multi-core computers even for a single EnergyPlus run.

Reduce EnergyPlus Run Time

I have EnergyPlus models that took long to run. What are ways to reduce EnergyPlus run time?

Answer

Compared with creating energy models either by hand coding the IDF file or by using GUI tools or a combination of both, EnergyPlus run time is normally a small fraction of the total time needed to complete an energy modeling job. Therefore it is very important to build a clean and concise EnergyPlus model up front. Techniques of simplifying large and complex building and systems should be used during the creation of energy models, especially during the early design process when detailed zoning and other information is not available. Producing lots of hourly or sub-hourly reports from EnergyPlus runs can take significant amount of time. Modelers should only request time step reports when necessary. On the other hand, producing summary reports and typical monthly reports take relatively small amount of run time. These reports are valuable references for troubleshooting and model fine tuning.

With powerful personal computers get more and more affordable, EnergyPlus modelers should choose to use current available PCs with 3 or more GHZ and 3 or more GB of RAM. For a large volume of EnergyPlus parametric runs, modelers can launch multiple runs in parallel.

For modelers, most time is spent on troubleshooting and fine tuning energy models. During the early modeling process, it is recommended to keep the model as simple as possible and make quick runs to identify problems. Then modify the IDF file to fix problems and re-run the model. This is an iterative process until satisfactory solutions are found. The simulation process can be split into three phases: the diagnostic runs, the preliminary runs, and the final runs. The three phases would use different simulation settings. The diagnostic runs would use a set of simulation settings to speed up the runs with simulation accuracy being set as the second priority. The diagnostic runs will help catch most model problems by running simulations on summer and winter design days. The preliminary runs use a tighter set of simulation settings in order to catch problems missed in the diagnostic runs, and provide better results for quality assurance purpose. The final runs use the EnergyPlus recommended set of simulation settings in order to achieve better accuracy for simulation results ready for review and reporting. The following table gives samples of simulation settings for the three phases of runs.

Sample Simulation Settings for EnergyPlus Runs

PARAMETER	VALUE		
	Diagnostic Runs	Preliminary Runs	Final Runs
Run Period	Design Days	Typical Months or Annual	Annual
Loads Time Step	4 (15 minutes)	4 (15 minutes)	6 (10 minutes)
Maximum Number of	5	20	50

PARAMETER	VALUE		
HVAC Iterations			
Minimum HVAC Time Step	15 minutes	10 minutes	5 minutes
Solar Distribution Algorithm	MinimalShadowing	MinimalShadowing	FullInteriorAndExterior if daylighting
Heat Balance Solution Algorithm	CTF	CTF	CTF or CondFD/EMPD if needed
Warmup Loads Convergence Limit	0.04 (4%)	0.04 (4%)	0.02 (2%)
Warmup Temperature Convergence Limit	0.2°C	0.2°C	0.1°C
Number of Warmup Days	7	14	21
Inside Convection Algorithm	Simple	Simple	Detailed
Outside Convection Algorithm	DOE-2	DOE-2	DOE-2
Reports	HVAC sizing reports, Envelope summary reports	All Predefined Summary Reports	All Predefined Summary and Monthly reports, and other reports as needed

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