

# BUILDING ENERGY SIMULATION

*For Users of EnergyPlus, SPARK, DOE-2, BLAST, Genopt, Building Design Advisor, ENERGY-10 and their Derivatives*

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## EnergyPlus Wins R&D 100 Award

*R&D Magazine recently announced that EnergyPlus is one of the winners of the 41st annual R&D 100 Awards, which honor the 100 most technologically significant new products of the year.*



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## Release of EnergyPlus 1.2



The newest version of EnergyPlus (1.2) was released in mid-April. Many updates and extensions have been made to the building envelope, daylighting, and HVAC equipment and systems portions of the program. EnergyPlus may be downloaded free of charge from the EnergyPlus web site: [www.energyplus.gov](http://www.energyplus.gov).

### New Features of EnergyPlus Version 1.2

#### Input

- Dataset of measured input parameters from Sandia National Laboratory for 128 different photovoltaic modules
- Dataset of measured input parameters from the Solar Rating Coordinating Council for 96 different solar thermal (hot water) collectors
- Datasets of environmental emissions factors for electricity (US national-average and state-average) and combustion—natural gas, diesel, gasoline, LPG, propane, coal and fuel oils #1, #2, #4, #6

#### Geometry/Windows/Walls/Shading

- User-selectable outside convection algorithm (BLAST/TARP, DOE-2, MoWiTT, or ASHRAE simple)
- Radiation-to-air component separated from detailed exterior convection models
- User-schedulable temperature for the other-side-coefficient object
- Solar gain and daylighting calculations can now account for beam and sky diffuse solar reflected from building sections, fins, overhangs and neighboring buildings, including specular reflection from highly-glazed neighboring building facades
- Improved ground-reflected solar calculations now account for shadowing on the ground by the target building and by other shadowing surfaces
- Generalized multipliers for organizing identical groups of zones, e.g., floors in a multi-story building
- Dirt correction factor for glass solar and visible transmittance
- Interior solar report variables, including beam and diffuse solar incident on the inside face of surfaces
- Movable storm windows
- Solar gain through blinds now accounts for different transmittances for sky and ground diffuse solar
- Photovoltaic systems can be integrated with heat transfer surfaces (building integrated photovoltaic systems) to account for energy removed as electricity

#### Daylighting

- DELight, an alternative daylighting analysis method, has been added. DELight is similar to the existing EnergyPlus detailed method with two key differences:
  - DELight can analyze geometrically- and optically-complex fenestration systems that have been characterized using bi-directional light transmittance data
  - DELight uses a radiosity method for the calculation of interior interreflection of light
- More daylighting reporting variables have been added, including daylight illuminance from individual windows

#### Zone Model

- Added the Mundt room air model
- Added a displacement ventilation model developed by the University of California at San Diego
- Example files have been added to illustrate approximate modeling of an Underfloor Air Distribution (UFAD) system

## New Features of EnergyPlus Version 1.2 (continued)

### HVAC

- New latent capacity degradation model for DX cooling coil, constant supply air flow with cycling coil/compressor to meet zone load
- Cooling coils (DX or chilled water) can now be modeled in combination with an air-to-air heat exchanger to improve dehumidification performance
- New crankcase heater power modeling for DX cooling coil
- Auto-sizing of gas-turbine-driven chiller
- Outside air economizer implemented for cycling systems
- Economizer lockout for packaged systems
- Added a condensation cut-off to the radiant cooling systems to avoid cases when the radiant cooling surface temperature is so low that it results in condensation
- New evaporative condenser options for DX cooling coils
  - Based on simple effectiveness model
  - Water usage and water pump power can be calculated and metered
- New air distribution system model for calculating energy losses due to duct conduction and air leakage for constant-volume systems
- Water-to-air heat pumps
- Extended the wet bulb and saturation pressure functions to cover temperatures from -100C to 200C (up from -60 to 100C)
- Auto-sizing of multiple hot-water, cold-water and condenser-water loops
- Added new algorithms for the electric chillers to calculate heat recovery and to simulate a double-bundled condenser
- Improved the water heater to operate by itself (does not require plant loop)
- Added a plant loop component to allow the scheduling of domestic hot water demand and cold water supply from mains
- Added a load profile object for simulating plant loops without having to define a building
- Added stratified hot water tank model
- Allow multiyear simulation for ground source heat pump simulation startup
- Allow "Design Week" and "Design Month" simulation
- Delta-temperature plant loop operating controls allow loop control based on environmental and loop temperature differences
- Added ability to have multiple supply plenums
- Upgraded the simplified demand-controlled ventilation model
  - Ventilation now composed of rate-per-occupant and rate-per-unit floor area
  - Added availability schedule to allow ventilation air flow to be stopped while the remainder of the HVAC system can continue to operate
- Plant system availability managers added:
  - Differential thermostat
  - High temperature cutoff
  - Low temperature cutoff
- Changed the temperature schedule to a setpoint manager for the plant and condenser loop; this allows either the use of scheduled temperature setpoint manager on the loop setpoint, or the use of the outside air temperature reset temperature setpoint manager
- Modified the evaporative condenser option for DX coils as follows:
  - Changed "approach temperature" to effectiveness
  - Added field for evaporative condenser air flow to allow water usage to be calculated and metered
  - Added field for evaporative condenser water pump power

## New Features of EnergyPlus Version 1.2 (continued)

### COMIS Air Flow Calculation

- Venting through interior windows and doors now has the same control options as does venting through exterior windows and doors

### On-Site Energy Supply

- Added new flat-plate solar thermal collectors for domestic hot water; these can also be connected to HVAC plant loops for space heating systems
- Added two new options for photovoltaic power calculations—simple and Sandia
- Allow solar panels to be used and also to be modeled as shading surfaces
- Electric power generators now determine electric utility purchases and surplus
- Net site and source energy use intensities calculated to account for on-site production

### Environmental Impacts

- Extended the pollution calculations to include all major greenhouse gases, precursors and criteria pollutants, as well as water and nuclear waste. Environmental emissions calculated include: CO<sub>2</sub>, CO, CH<sub>4</sub>, NO<sub>x</sub>, N<sub>2</sub>O, SO<sub>2</sub>, PM, NH<sub>3</sub>, NMVOC, Hg, and Pb as well as water consumed by electricity generation and high- and low-level nuclear waste from nuclear electricity generation

### Output

- Added new Annual Building Utility Performance report (similar to DOE-2 BEPS) with reporting of energy use, water use and on-site electricity generation.
- Meters can now be reported to eplusout.mtr to reduce file size
- Added reporting of schedule values
- Added reporting of specific enthalpy, volumetric flow rate and wet-bulb temperature for all HVAC nodes

### Utilities

- New HVAC diagramming tool that shows user-specified HVAC components and connections
- Upgrades to IDFEditor that allow the opening of more than one file at a time so that objects can be copied between files

### Operating Systems Supported

- Mac OSX version (planned for release soon after the Windows and Linux versions)

### Documentation and Guides

- *Input/Output Reference* and *Engineering Reference* updated and extended for all new features and updates
- Revised *Module Developers Guide*
- Revised *Programming Guide*

More information on these and other new features in this version is available on the EnergyPlus web site:  
[www.energyplus.gov](http://www.energyplus.gov)



## EnergyPlus Introductory Workshop for Experienced Modelers



The objective of this workshop is to introduce EnergyPlus to experienced modelers who are familiar with the basic concepts of energy simulation. The course will cover the mechanics of using EnergyPlus with an emphasis on aspects of EnergyPlus that differ substantially from other common modeling tools (DOE-2, BLAST, etc.), such as the use of a multiple time-step approach, the integrated simulation of loads, systems and plant, and defining fluid and air loops. Time will be set aside to allow students to model basic building envelopes and systems using the latest version of EnergyPlus on their own laptop computers. Time for questions and answers will be provided for each topic. Class size will be limited to no more than 40.

### Locations and Dates

- San Francisco, CA (Pacific Energy Center), May 17 – 18, 2004
- Boulder, CO, August 2 – 3, 2004

### Course Fees and Deadlines

- Pacific Energy Center (San Francisco, CA) –  
The fee is \$250. Registration will be closed after April 30, 2004
- Boulder, CO - Through June 30, 2004 registration fees are \$200 per person for all four days.  
After June 30, fees will be \$250. Early registration ends June 30, 2004.  
Registration will be closed after July 16, 2004

### Instructors

Richard L. Liesen, Ph.D., University of Illinois at Urbana-Champaign (EnergyPlus Development)  
Michael J. Witte, Ph.D., GARD Analytics, Inc. (EnergyPlus Support and Testing)

From *WinterGreen*, the Steven Winter Associates newsletter ...

## GREEN SCHOOLS ONLINE

Interested in designing and building better-performing school facilities? Well, now there's an information and training resource just a few mouse-clicks away. *Online Training for High Performance School Design* is offered as a series of internet-based courses for anyone interested in sustainable design as it pertains to K-12 school buildings. Sponsored by the U.S. Department of Energy (DOE) and the National Association of State Energy Officials, these courses are based on the *National Best Practices Manual for Building High Performance Schools*. Curriculum topics include: site design; daylighting; energy efficient building shell; resource-efficient building products; commissioning; and a comparison of the CHPS and LEED™ rating systems.

This program was developed by the New York State Energy Research and Development Authority and five organizations at the forefront of high performance school design and internet training: the Sustainable Buildings Industry Council; the Collaborative for High Performance Schools; Building Media, Inc.; the New Jersey Institute of Technology; and Architectural Energy Corporation (formerly Eley Associates).

Take the program and you'll receive continuing education credit for the completion of each course. Complete all 25 courses and you're eligible to attend a NYSERDA workshop for A/Es and be listed on various referral lists for school districts. For more information or to sign up, visit

<http://www.hpschooldesigntraining.com/>





## Ask An EnergyPlus Expert



### ROOFTOP UNIT

I need to model a rooftop unit. The air of the system passes through an evaporator. However, I also need to model the compressor and the two condenser fans in order to know the real consumption of the system. I reviewed the IndEvapCoolerRTUOffice.idf, but don't understand why COIL:DX:CoolingBypassFactorEmpirical is used? Any suggestions? Is there an IDF example?

#### **Answer**

The Coil:DX:CoolingBypassFactorEmpirical is used to cool system air; it represents the evaporator, condenser and condenser fan. DX stands for direct expansion, meaning the coil is directly served by refrigerant rather than chilled water. If you know the performance of the unit then you'll have to convert this knowledge into five performance curves -- see the [Input/Output Reference](#) entry for Coil:DX:CoolingBypassFactorEmpirical (look in the Coils group). Also, look at FurnaceWithDXSystem.idf for another example of using a unitary system (e.g., rooftop package) to meet the cooling and heating loads for several zones. In IndEvapCoolerRTUOffice.idf, the HVAC system uses indirect evaporative coolers in combination with rooftop packaged units. This example file uses the object DXSystem:AirLoop to model the rooftop packaged units. The packaged units are comprised of DX cooling coils and gas heaters (see the top of the idf file for a description of the system).

As described in the documentation, COIL:DX:CoolingBypassFactorEmpirical models the direct expansion cooling coil (sensible and latent capacity delivered to the supply air stream) and the compressor plus condenser fan energy use (DX Cooling Coil Electric Consumption). The energy use of COIL:DX:CoolingBypassFactorEmpirical plus the energy use for the supply air fan describe the total electrical energy use for the rooftop packaged units.

### EPMACRO – DOE-2 to EnergyPlus

I am trying to convert my DOE-2 file to an EnergyPlus file. I used the DOE2Translator and got an .imf file. As I read from the readme file of DOE2Translator, EPMacro is needed for an .imf file. But I can't find EPMacro. Can anyone help me?

#### **Answer**

EPMacro is automatically installed when you install EnergyPlus. The program is located in the "root" directory (C:\energyplus) by default but you don't need to run it separately. Use the EP-Launch program or the RunEnergyPlus batch file -- they both already call EPMacro when an .imf file is used.

### EPMACRO -- PARAMETRIC RUNS

Is there a fast and efficient way of doing parametric runs in EnergyPlus?

#### **Answer**

Please refer to the list of EnergyPlus Support Tools at [http://simulationresearch.lbl.gov/ep\\_tools.html](http://simulationresearch.lbl.gov/ep_tools.html). The Deringer Group offers EzPlus-Parm, a stand-alone Windows tool intended primarily for EnergyPlus parametric analysis. It was designed to simplify the running of multiple parametric EnergyPlus simulations and helps a user organize and edit files.

Another option is to use EpMacro. EpMacro is distributed with EnergyPlus to generate the input files. This is the same macro processing "language" contained in DOE-2 and it works by substituting variables or blocks of code. You can use a single \*.imf file to produce a number of variations in the \*.idf.





## Ask An EnergyPlus Expert



### IFCtoIDF ERRORS

When I use IFCtoIDF software, I get an error message of "Type Doesn't Match" from the EnergyPlus BSClient. I cannot convert any IFC file to an IDF file within WIN98 or XP for use in EnergyPlus. I have installed the BSpro server correctly.

#### Answer

You may have a mismatched IFCtoIDF client and BSPro COM Server. If you have previous versions of EnergyPlus installed on your computer, you should uninstall BSPro (using Windows Add/Remove Programs) and then install the version of BSPro that came with the version of EnergyPlus that you are currently running. The installation program for BSPro for EnergyPlus is named BSPro\_e+.EXE and is located in the PreProcess/IFCtoIDF subdirectory where you installed EnergyPlus.

### FLOOR TILT

I got this message even though the view factor to the ground is 1:

```
Program Version,EnergyPlus 1.1.1.012, 26.02.2004 10:51
** Warning **
Floor Tilt=0.0, much less than expected tilt of 180,
for Surface=ZN001:FLOOR001, in Zone=ZONE ONE
```

#### Answer

This means that your floor is upside down, because your coordinates have been entered in reverse order. To fix this, reverse the order of your four sets of vertices. To check surface tilt, azimuth, area and other specifications for all of your surfaces, add "Report, Surfaces, Details;" to your idf file. The report appears in the eio output file, and is comma-separated for easy viewing in a spreadsheet program.

### WALL TILT

I want to consider different wall tilt angles. Is it enough to modify the ViewFactorToGround or do I have to alter the Surfaces and SubSurfaces of the relevant walls?

#### Answer

Surface tilt and azimuth are controlled by the surface coordinates. ViewFactorToGround is only used to specify the amount of diffuse solar reflected from the ground that is incident on the surface.

### WATER TANK as an ENERGY STORAGE DEVICE

I am modeling a school and want to use a 200-liter water tank as an energy storage device. Can you give me some guidance as to how I should input it into EnergyPlus? Should I enter it as an internal mass? And if so, what would the "construction" be?

#### Answer

If this is a passive tank that has no flow in or out, then yes, internal mass would be a good way to model it. For a construction, you can use the same materials that the tank is made of, and then use water as the last layer. The area of the internal mass should equal the surface area of the tank. The thickness of the water layer should be calculated to provide the correct total volume of water when multiplied by the surface area. So, in your case → → → → → → → →

$$H_2O \text{ thickness} = \frac{\text{tank volume (m}^3\text{)}}{\text{tank surface area (m}^2\text{)}}$$



## Ask An EnergyPlus Expert



### COMIS QUESTIONS and ANSWERS

Which EnergyPlus report shows if the sum of inflows is equal to the sum of outflows in a naturally ventilated building section? Also if the section has vents at different levels how do I know if these are experiencing inflow or outflow?

#### Answer

Look at the report variables "Air Flow from FromZone to ToZone through COMIS Link [ $\text{m}^3/\text{s}$ ]" and "Air Flow from ToZone to FromZone through COMIS Link [ $\text{m}^3/\text{s}$ ]."

If you look at the InputOutput Reference section on EnergyPlus/COMIS Output Variables you will see that the first variable is defined as: *The air flow through a COMIS link (a crack or window/door opening) from the link's FromZone to the link's ToZone. The following input will cause reporting of the FromZone to ToZone air flow through heat transfer surface Window1, which is an openable exterior window in 3zvent.idf:*

*Report Variable, Window1, Air Flow from FromZone to ToZone through COMIS Link, timestep.*

The second variable is the flow from the ToZone to the FromZone.

The definition of FromZone and ToZone is: *In COMIS, air flows through a link between two zones, one of which is the "FromZone" and the other is the "ToZone." The FromZone and the ToZone may both be thermal zones or one of them may be an exterior air node and the other a thermal zone. The FromZone and ToZone for a link can be determined by looking at the eplusout.eio file in the <COMIS Air-Flow Link Data> section.*

The following shows an excerpt from the eplusout.eio file that gives the FromZone's and ToZone's for the links in the 3zvent.idf example input. (This input has three thermal zones, WEST\_ZONE, EAST\_ZONE and NORTH\_ZONE.) For example, the FromZone for SURFACE\_4 is EAST\_ZONE and the ToZone is WEST\_ZONE. Note that a FromZoneName or ToZoneName of the form "-EXN" means that the "zone" is actually exterior air node number N. For example, the FromZone for WINDOW1 is exterior air node number 3 and the ToZone is WEST\_ZONE.

```
! <COMIS Air-Flow Link Data>, Surface Name, Surface Class, Air-Flow Data Name, FromZone
Name, ToZone Name
COMIS Air-Flow Link, SURFACE_1, WALL, CR_0000001, -EX3, WEST_ZONE
COMIS Air-Flow Link, WINDOW1, WINDOW, WI_0003_1, -EX3, WEST_ZONE
COMIS Air-Flow Link, SURFACE_2, WALL, CR_0000001, -EX4, WEST_ZONE
COMIS Air-Flow Link, SURFACE_3, WALL, CR_0000002, NORTH_ZONE, WEST_ZONE
COMIS Air-Flow Link, DOORINSURFACE_3, DOOR, WI_0004_1, NORTH_ZONE, WEST_ZONE
COMIS Air-Flow Link, SURFACE_4, WALL, CR_0000002, EAST_ZONE, WEST_ZONE
COMIS Air-Flow Link, SURFACE_8, WALL, CR_0000001, -EX3, EAST_ZONE
COMIS Air-Flow Link, SURFACE_9, WALL, CR_0000001, -EX2, EAST_ZONE
COMIS Air-Flow Link, SURFACE_11, WALL, CR_0000002, NORTH_ZONE, EAST_ZONE
COMIS Air-Flow Link, SURFACE_14, WALL, CR_0000001, -EX4, NORTH_ZONE
COMIS Air-Flow Link, SURFACE_15, WALL, CR_0000001, -EX1, NORTH_ZONE
COMIS Air-Flow Link, WINDOW2, WINDOW, WI_0003_2, -EX1, NORTH_ZONE
COMIS Air-Flow Link, SURFACE_16, WALL, CR_0000001, -EX2, NORTH_ZONE
```

The sum of the "FromZone to ToZone" and "To Zone to FromZone" flows should be zero if you are careful to take into account the flow direction; this means you have to know what the FromZone and ToZone is for each crack or opening, as explained above.

Note that, depending on wind conditions, stack effect, etc., an opening can simultaneously have a non-zero value for both the "FromZone to ToZone" and "ToZone to FromZone" flow. This is because openings (like open windows) can have bi-directional flows.

(continued on the next page)





## Ask An EnergyPlus Expert



### COMIS QUESTIONS and ANSWERS (continued)

#### Question

How does EnergyPlus calculate and display the neutral pressure level for a tall stack?

#### Answer

The neutral pressure level is not displayed. The calculation is described on pp. 12-13 of H.E. Feustel, "COMIS -- An International Multizone Air-Flow and Contaminant Transport Model," [LBNL-42182 \(pdf file\)](#). COMIS download, user manual and more reports are at <http://epb1.lbl.gov/comis/users.html>.

#### Question

EnergyPlus does an "automatic calculation of COMIS wind pressure coefficients for rectangular buildings" but the user is asked to input COMIS CP ARRAY and CP VALUES by wind direction. Is this redundant or does the program use the user-defined values over calculated ones? Is it better if I enter zero for all CP values?

#### Answer

If you specify automatic calculation of wind pressure coefficients, then COMIS CP ARRAY, COMIS CP VALUES and COMIS EXTERNAL NODE are not used and do not have to be entered. See description of "Wind Pressure Coefficients" in the COMIS Simulation object.



### RADIATION DATA in the EPW WEATHER FORMAT

I need to know how the radiation data is handled on an hourly basis for the EPW format weather file; i.e., does the data for hour 11:00 am to 12:00 noon get integrated from 11:00 am to noon; or from 11:30 am to 12:00 pm and then get assigned to 12:00 noon.

#### Answer

In an EPW file, hour 12 represents 11:00 am to 12:00 noon. The solar radiation values for a given hour are the integrated total radiation over the hour in  $\text{Wh/m}^2$ . For hour 12, the value in the EPW file should be the total from 11:00 am to 12:00 noon. For hourly weather files, EnergyPlus uses this value as the average radiation rate for the hour in  $\text{W/m}^2$ . The average rate is assumed to occur on the half-hour, at 11:30 am in this example. Rates for the other time steps in the hour are determined by interpolation between the half-hour values of the previous and next time step.

### Positions Available at Steven Winter Associates, Inc.'s Connecticut Office

 Energy Analyst	Energy Analysis of outstanding projects, from 5,000 to 2 million sq. ft., with LEED ratings from Certified to Platinum. <u>Requirements:</u> Engineer. 3-5 yrs experience in HVAC design and/or energy use modeling. If your background is primarily in HVAC design, you must have U.S. experience supplemented by some modeling work (e.g., DOE-2, TRACE). If your background is primarily in modeling, it must include larger buildings. Will train in using DOE-2 as a modeling tool, understanding architectural aspects as they affect energy use. Excellent opportunities for advancement.
 Junior "Green" Architect	Sustainability / green consulting on high visibility projects, ranging from 5,000 to 2 million sq. ft., LEED Certified to Platinum. Fast-paced environment, potential to quickly assume responsibility. <u>Requirements:</u> Architect. Minimum 1 year work experience with LEED projects, or experience with U.S. construction documents and specifications. Must have a desire to continuously improve knowledge. Writing skills a plus.

Send resume in confidence to: Human Resources Department, Steven Winter Associates, Inc.,  
50 Washington Street, Norwalk, CT 06854 -- Fax: 203-852-0741 or e-mail: [mstarnes@swinter.com](mailto:mstarnes@swinter.com)

## New interface for EnergyPlus

# EplusInterface

**EplusInterface**, which will open and view an 'idf' file, is an open source initiative to develop a comprehensive interface for EnergyPlus. The code is freely available for anyone; the license is GNU General Public License.

Some of the modules under development are listed below; some of them are ready to use.

More information and downloads may be found at <http://www.coolshadow.com/EPlusInterface/>

Contact santosh\_philip@yahoo.com. [28 April 2004]

### EPlusTUI

Text based interface (*tui* = text user interface)

```
hit a button for:DESIGNDAY:
=====
[1] Chicago ILLINOIS SUMMER
[2] Chicago ILLINOIS WINTER
[3] -- Go up in menu --

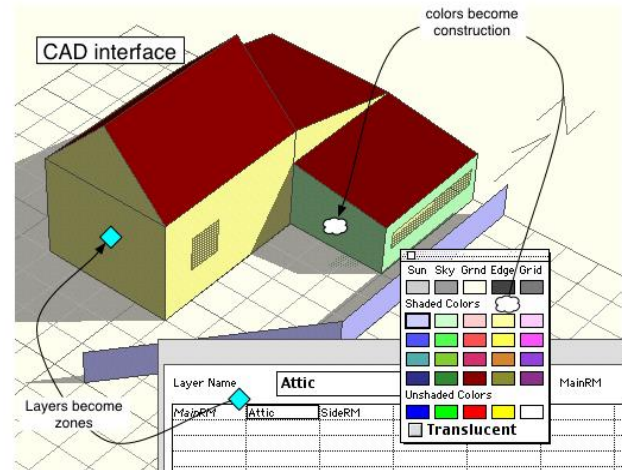
Enter the # of your choice: 2

finding DESIGNDAY
hit a button ::
=====
[1] DesignDay => min-fields 15
[2] Chicago ILLINOIS WINTER => field Desi
[3] -21.11111 => field Maximum Dry-Bulb T
[4] 0.0000000E+00 => field Daily Temperat
[5] -21.11111 => field Maximum Humiditatin
[6] 997.0 => field Maximum Pressure
[7] 11.6 => field Wind Speed
[8] 326.0000 => field Wind Direction
[9] 0.0000000E+00 => field Sky Clearness
[10] 0.0000000E+00 => field Sky Radiation
```

*Move thru file and edit*

### CAD Interface

Protocol for building 3D models in CAD for EnergyPlus - with conversion routines to generate EnergyPlus files



### EPlusGUI

Graphical interface for Linux, Mac and Windows

### Import/Export

Protocol for transferring elements between files

```
[11] GROUNDTEMPERATURES
[12] MATERIAL:REGULAR
[13] MATERIAL:REGULAR-R
[14] MATERIAL:AIR
[15] MATERIAL:WINDOWGLASS
[16] MATERIAL:WINDOWG[14] MATERIAL:AIR
[17] CONSTRUCTION* [15] MATERIAL:WINDOWGLASS
[18] ZONE [16] MATERIAL:WINDOWGAS
[19] SURFACEGEOMETRY [17] CONSTRUCTION*
[20] SURFACE:HEATTRAN[18] ZONE
[21] SURFACEGEOMETRY
[22] SURFACE:HEATTRANSFER
[23] SCHEDULETYPE [21] SURFACE:HEATTRANSFER:SUB
[24] DAYSCHEDULE [22] SURFACE:HEATTRANSFER:ATTACHED
[25] OfficeTower.idf [23] LA_Hotel.idf
[26] SCHEDULE
[27] SCHEDULE
```

*Import*

*Import & Export*

### Material Library

Develop standard libraries for materials, construction, windows, systems, plants etc.

### API

A set of well documented API that can be used to develop specialized interfaces

**EPlusEXE.zip** (executable for windows)

### Download

You can download the files in the following formats (Version 0.002)

**EPlusInterface0\_002.zip** (source code)

**EPlusInterface0\_002.tgz** (source code)

**EPlusInterface0\_002.sit** (source code)

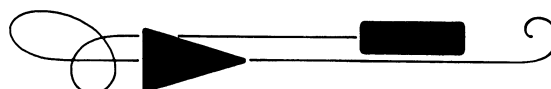
**EPlusEXE0\_002.zip** (executable for windows)

You can download the files in the following formats (Version 0.001)

**EPlusInterface.zip** (source code)

**EPlusInterface.tgz** (source code)

**EPlusInterface.sit** (source code)



## EnergyPlus Version 1.2

To download a free copy of the program go to  
**[www.energyplus.gov](http://www.energyplus.gov)**



### EnergyPlus Support Tools

Support software is listed on our website ([http://SimulationResearch.lbl.gov/EP/ep\\_tools.html](http://SimulationResearch.lbl.gov/EP/ep_tools.html)) and in Section 2 of this newsletter.

### EnergyPlus Weather Data from [www.energyplus.gov/](http://www.energyplus.gov/)

There are 275 locations in the United States, 16 California thermal zones, 55 Canadian locations, and 233 international locations in more than 80 countries.

### Ask an EnergyPlus Expert

Questions from EnergyPlus users are answered promptly via email by program developers. To submit questions, join the EnergyPlus User Group at [http://groups.yahoo.com/group/EnergyPlus\\_Support/](http://groups.yahoo.com/group/EnergyPlus_Support/). A selection of questions/answers are compiled (yearly) into a downloadable PDF document: Q and A for 2002, Q and A for 2003.

### Are you an EnergyPlus Consultant ?

If you are engaged in EnergyPlus consulting, and would like to be listed in the *Building Energy Simulation User News* and on our website (<http://SimulationResearch.lbl.gov>), please send details to [klellington@lbl.gov](mailto:klellington@lbl.gov).

### Join the EnergyPlus User Group

The developers of EnergyPlus have formed a support group to foster discussion and maintain an archive of information for program Users. We invite questions about program usage and suggestions for improvement to the code. Go to [http://groups.yahoo.com/group/EnergyPlus\\_Support/](http://groups.yahoo.com/group/EnergyPlus_Support/)

### Translate EnergyPlus Web Pages

A new link on the main EnergyPlus web page ([www.energyplus.gov/](http://www.energyplus.gov/)) allows you to view the pages in any of eight languages. Unfortunately, the translator doesn't work with PDF files. Look for the fish at the bottom of the web page. Pages may be translated into Chinese, French, German, Italian, Japanese, Korean, Portuguese and Spanish.

*EnergyPlus is being developed by University of Illinois and Lawrence Berkeley National Laboratory, with the assistance of DHL Consulting, C. O. Pedersen Associates, Florida Solar Energy Center, GARD Analytics, the National Renewable Energy Laboratory, Oklahoma State University and others. Development of EnergyPlus is supported by the U. S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technologies Program (Program Manager, Dru Crawley).*



*SPARK is an equation-based simulation environment that allows you to build customized models of complex physical processes by connecting calculation objects that represent system components like walls, fans, heat exchangers, chillers, ducts, mixing boxes, controls, etc. It is aimed at the simulation of innovative and/or complex building systems that are beyond the scope of whole-building programs like DOE-2 and EnergyPlus. VisualSPARK adds a graphical user interface to SPARK to simplify its use.*

## FREQUENTLY ASKED QUESTIONS – PART II

This is a list of frequently asked questions (FAQ) for VisualSPARK users. If you need help for something that is not covered by the SPARK Reference Manual, the SPARK Atomic Class API, the SPARK Problem Driver API, or this FAQ, please email us at [sparksupport@SimulationResearch.lbl.gov](mailto:sparksupport@SimulationResearch.lbl.gov). This FAQ is intended to supplement, not replace, the SPARK documentation. Before emailing us a question, you should first check to see if the topic is covered in the various manuals. Free documentation is downloadable from <http://SimulationResearch.lbl.gov/>.

### Contents

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  - What are internal and external requests?
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  - How to request a stopping time?
  - How to request a meeting point?

---

### SPARK Runtime Controls

Runtime control parameters are specified in the \*.run file using the so-called preference settings syntax, also used in the \*.prf file. In this section we discuss issues pertaining to the runtime control parameters only, independent of the file format.

#### How to perform a simulation with adaptive time stepping?

In order to perform a simulation with adaptive time stepping you should set the key `VariableTimeStep` to 1 in the \*.run file. By default, it is set to 0, which will perform a simulation with constant time step.

```
(  
  ...  
  VariableTimeStep    ( 1    )  
  MinTimeStep         ( 1.0e-6 )  
  MaxTimeStep         ( 10.0 )  
  ...  
)
```

When performing a simulation with variable time stepping it is recommended to also set the minimum allowed time step and the maximum allowed time step using the keys `MinTimeStep` and `MaxTimeStep`.

Setting the key `VariableTimeStep` to 1 in the \*.run file tells the solver that it should adapt the time step to respond to various time-related requests. For example, the solver will try to synchronize the global time with the user-requested meeting points or the various report and input events. However, the most important application of the adaptive time stepping operation is in conjunction with the new integrator classes that provide automatic integration error control. These new integrator atomic classes adapt the simulation time step so that the estimated integration error in the dynamic variables satisfies the prescribed relative tolerance specified in the global settings section of the preference settings file.

The new integrator atomic classes can be found in the globalclass directory of your VisualSPARK installation. They are named after the template filename "integrator\_\*.cc". Since they define the same port interface as the other integrator classes they can be readily used simply by changing the name of the integrator class in the DECLARE statements.

### How to specify an "infinite" final time?

When using the '\*' meta-character for the `FinalTime` entry, you essentially tell the SPARK solver to run the simulation until "infinity". However, because of the fixed-length representation of numbers on computers, infinity really means some large number. Therefore, the simulation will run until the value for the global time variable reaches the biggest possible floating point number in double precision. On a 64-bit architecture with an 8-byte representation of a `double` type this corresponds approximately to 1.7E+308.

```
(  
  ...  
  FinalTime           ( *    )  
  ...  
)
```

### How to generate reports for all computed steps?

Specifying a `ReportCycle` of zero essentially forces the simulator to report the solution values at each computed step. However, a negative report cycle value does not make sense.

```
(  
  ...  
  FirstReport         ( 0.0   )  
  ReportCycle         ( 0.0   )  
  ...  
)
```

## SPARK Preference Settings

The preference settings are specified in the \*.prf file using the so-called preference settings syntax that relies on set of parenthesis "(" ")" to identify the various tokens. See the SPARK Reference Manual for more information on the syntax. In this section we discuss issues pertaining to the preference settings only, independent of the file format.

## How to deal with bad numerics?

When SPARK detects bad numerics (i.e., Not a Number or an infinite number) in a strongly-connected component, you can try to set the `CheckBadNumericsFlag` in the component section of the preference settings file to 1 in order to activate a more robust numerical treatment that is likely to cure the problem. Essentially SPARK will check for bad numerics in the residual function at each iteration and halve the relaxation coefficient until the bad numerics situation is no longer detected in the resulting residuals. This mode of operation is very costly because it happens at the inner most level of the nonlinear solver. Therefore, it is not selected by default and you should only select it for the components that require it.

```
(  
  ComponentSettings (  
    0 ( ...  
      CheckBadNumericsFlag ( 1 )  
      ...  
    )  
  )  
)
```

For example, the previous code snippet sets the robust bad numerics checking mode on for the component 0. This setting might be required to solve highly nonlinear equation systems that are likely to produce bad numerics in the residuals if the full Newton step is applied.

## How to deal with no convergence?

For each strongly-connected component SPARK solves a system of nonlinear equations for the set of break variables identified by the setup program during the graph-algorithmic analysis. By default the nonlinear solver uses the Newton method with a fixed relaxation coefficient, typically set to 1. The Newton method is locally q-quadratically convergent, which means that if the initial approximation is good enough then it will be improved rapidly until the desired precision is achieved.

However, applying the full Newton step at each iteration might be unsatisfactory when the initial approximation is not good enough. Such situations might lead to poor convergence or even divergence of the solution process. In order to ensure finding a solution of the system of nonlinear equations, *from almost any starting point*, SPARK implements globally convergent strategies derived from the Newton method. Such methods are usually referred to as **quasi-Newton** methods. They behave like the Newton method close to the solution, thus retaining its local convergence rate, whereas away from the solution they rely on a step dictated by a global method to ensure taking a *reasonable* step.

In SPARK these strategies are called the **step control methods**. They are responsible for determining the direction and the length of the step that the nonlinear solver makes at each iteration. In particular, they adapt the relaxation coefficient to ensure global convergence. SPARK implements the following step control methods, specified from the less robust and "cheapest" strategy to the most robust and most computationally expensive one:

- [0] Fixed relaxation coefficient strategy (default)
- [1] Basic halving strategy
- [2] Linesearch backtracking strategy
- [3] Affine invariant backtracking strategy

When the default step control method does not converge, you should try to use one of the more robust methods by specifying the corresponding value using the key `StepControlMethod` in the



component section of the preference settings file. For each strategy listed above we have included in square brackets the corresponding value used to identify it in the preference settings file.

```
(  
  ComponentSettings (  
    0 ( ...  
      StepControlMethod ( 2 ())  
      RelaxationCoefficient ( 1.0 ())  
      MinRelaxationCoefficient ( 1e-10 ())  
      ...  
    )  
  )  
)
```

For example, setting the step control method to 2 in the previous code snippet will select the linesearch backtracking strategy for the component 0. Furthermore, this strategy will attempt to use a relaxation coefficient of 1.0 close to the solution, and otherwise will be allowed to adapt the relaxation coefficient up to a minimum value of 1.0e-10. Such settings are typical of highly nonlinear system of equations.

Finally, it is fundamental that the model equations are **continuously differentiable** otherwise the convergence assumptions underlying the Newton method will break down and SPARK will not be able to compute the solution of the nonlinear equations. The way the equations are formulated in the atomic classes is critical to guarantee the differentiability of the system. Also, the model writer should always be aware of the possibility that the Jacobian matrix derived from the set of equations may be intrinsically or become singular or ill-conditioned. Most numerical problems can be avoided by paying enough attention to the formulation of the equations during the design phase. Typically it is good practice to avoid:

- possible divisions by zero,
- discontinuities in the return values,
- expressions that will generate partial derivatives likely to become infinite, and
- expressions that have a limited validity domain likely to generate a NaN.

The remaining pathological numerical problems arising at runtime are then dealt with algorithmically using a different solution method and the various recovery strategies implemented in SPARK.

### How to prevent early convergence after the prediction step?

The nonlinear solver always checks for the convergence after the prediction phase, i.e. firing of the predict callbacks assigned to the break variables. This is accomplished by checking the residual functions associated with the break variables against the specified tolerance multiplied by the prediction safety factor. By default the prediction safety factor is set to 0.01 so that this prediction convergence test will only succeed when the residuals are significantly smaller than the prescribed tolerance.

However, this test does not ensure that the desired precision is achieved in all the unknown variables for the component in question since "small" residual functions do not imply a certain number of significant digits in the solution. Such an assumption is entirely dependent on the scaling of the residual functions. This is especially an issue with highly nonlinear equations. In order to prevent such early and unsatisfactory convergence from being detected, it is possible to set the value of the prediction safety factor in the global settings section of the preference settings file using the key `PredictionSafetyFactor`.

```
(  
  GlobalSettings ( ...  
    PredictionSafetyFactor ( 0.0  )  
    ...  
  )  
)
```

For example, setting the prediction safety factor to 0.0 will ensure that the nonlinear solver never detects convergence after the prediction phase unless all residuals are exactly equal to zero. When the "convergence" diagnostic level is set in the runtime controls file, the result of the prediction phase is indicated with the iteration count 0 in the run log file.

### How to relax the convergence test on the non-break variables?

After each iteration the nonlinear solver checks for convergence by comparing the solution increments since the last iteration against the specified tolerance. The iterative process stops only when the increments of both the break variables and the non-break variables are smaller than the prescribed tolerance multiplied by some safety factor.

In some cases it is impossible to obtain the desired precision for some of the non-break variables because the error is amplified from the break variables in such way that the smallest change in the solution of a break variable causes the increments of a dependent non-break variable in the same component to be larger than the requested tolerance. Such unfortunate numerical situations are likely to occur with SPARK when solving highly nonlinear problems because of its solution methodology whereby only the break variables forming the cut set are solved iteratively as opposed to the entire set of unknowns in each strongly-connected component.

To deal with such situations we recommend that:

- either you make the cut set bigger by forcing some of the offending variables to become break variables using the BREAK\_LEVEL language construct,
- or that you relax the convergence test on the non-break variables by specifying a safety factor larger than 1, the default value.

The latter is achieved using the key `NormalUnknownSafetyFactor` in the global settings section of the preference settings file.

```
(  
  GlobalSettings ( ...  
    NormalUnknownSafetyFactor ( 100.0  )  
    ...  
  )  
)
```

For example, setting the safety factor for the non-break variables (also referred to as the normal unknowns) to 100 relaxes the convergence test by 2 orders of magnitude. If the requested tolerance is 1.0e-6, you should expect 6 significant digits in the solution of the break variables but only 4 significant digits in the solution of the non-break variables.

Such precision is of course only achieved for the variables whose values lie far away from their respective absolute tolerance. Consult the SPARK Reference Manual for more information on the convergence tests and the meaning of the various safety factors and tolerances involved.

## SPARK Requests

Requests are processed at runtime during the simulation of a problem, i.e. within the `TProblem::Simulate()` method. Requests can be sent from the callbacks in the various atomic classes or from the driver function or internally from within the SPARK solver.

### What are internal and external requests?

A request is referred to as an **internal** request if the "to" and "from" `SPARK::TProblem` addresses in the `SPARK::THeader` constructor are the same. In all other cases the requests are considered to be **external**. In general internal requests have to comply with further restrictions than external requests in order to prevent unwanted behavior at runtime. Consult the SPARK Atomic Class API for more information.

### How to request a time step?

A `set_time_step` can be sent to request the time step to use for the next dynamic step. The desired time step must be strictly larger than zero. The time step effectively used for the next dynamic step might be smaller than the requested one in case a request for a smaller time step was sent (e.g. to synchronize with the next meeting point internally), but it will never be larger.

### How to request a stopping time?

A `set_stop_time` request can be sent to request a stopping time ahead of the current time and earlier than the final time specified in the runtime control parameters. The stopping time is cleared when it is hit by the simulation. So if you restore the simulation to an earlier state the stopping time will no longer be active.

### How to request a meeting point?

A `set_meeting_point` request can be sent to request a meeting point ahead of the current time. The meeting points are stored internally in the solver. They are used to synchronize the global time with the next event when the solver is operating in variable time stepping mode. Only the meeting points before the **final time** as specified in the \*.run file will be tracked. If the requested meeting point is after the final time, it will be discarded. In order to clear all the meeting points you should send a `clear_meeting_points` request.



*SPARK is an equation-based simulation environment that allows you to build customized models of complex physical processes by connecting calculation objects that represent system components like walls, fans, heat exchangers, chillers, ducts, mixing boxes, controls, etc. It is aimed at the simulation of innovative and/or complex building systems that are beyond the scope of whole-building programs like DOE-2 and EnergyPlus. VisualSPARK adds a graphical user interface to SPARK to simplify its use.*

**Download VisualSPARK free of charge from**

**<http://SimulationResearch.lbl.gov> > [visualspark/](#)**

**Please go to our website to download this new VisualSPARK documentation:**

- **New Features, Bug Fixes, and Changes**
- **Frequently Asked Questions**
- **How To Port Atomic Classes To SPARK 2.x**
- **Theoretical Speed-Up Using SPARK**

*SPARK was developed by the Simulation Research Group at Lawrence Berkeley National Laboratory and by Ayres Sowell Associates, with Support from the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technologies Program of the U.S. Department of Energy, Program Manager Dru Crawley.*

# GenOpt 2.0

## Generic Optimization Program

**GenOpt** is an optimization program for the minimization of a cost function, such as annual energy use, that is evaluated by an external simulation program.

**GenOpt** can be used with any simulation program -- such as EnergyPlus, SPARK or DOE-2 -- that has text-based input and output. It also offers an interface for adding custom optimization algorithms to its library.

## GenOpt Technical Reports

- [Generalized Pattern Search Algorithms with Adaptive Precision Function Evaluations](#) by Elijah Polak and Michael Wetter (click on the title to download the document)
- [Comparison of a Generalized Pattern Search and a Genetic Algorithm Optimization Method](#), by Michael Wetter and Jonathan Wright (click on the title to download the document)
- [A Convergent Optimization Method Using Pattern Search Algorithms with Adaptive Precision Simulation](#), by Michael Wetter and Elijah Polak (click on the title to download the document)

All reports and GenOpt documentation are available free of charge from <http://SimulationResearch.lbl.gov/>

## Features of Version 2.0

### Capability to Process Discrete Independent Variables

**GenOpt** can now process discrete independent variables, such as different window constructions, either for optimization problems with mixed discrete and continuous independent variables or for doing parametric studies.

### New Optimization Algorithms

The following optimization algorithms are new in **GenOpt 2.0**:

- **GPSCoordinateSearch** and **GPSHookeJeeves**: These algorithms are members of the family of Generalized Pattern Search (GPS) algorithms. They can be used to solve optimization problems with continuous independent variables. Both algorithms can be run using multiple starting points to increase the chance of finding the global minimum if the cost function has several local minima.
- **DiscreteArmijoGradient**: An algorithm that approximates gradients by finite differences and uses the Armijo line search algorithm.
- **PSOCC**, **PSOCCMesh**, and **PSOIW**: These algorithms are members of the family of Particle Swarm Optimization algorithms (which are global heuristic optimization algorithms). They can be used to solve optimization problems with continuous and/or discrete independent variables.
- **GPSPSOCCHJ**: This is a hybrid global optimization algorithm that starts by performing a Particle Swarm Optimization for continuous and discrete independent variables and then switches to the Hooke-Jeeves Generalized Pattern Search algorithm to refine the continuous independent variables.

### Pre- and Post-Processing

Some simulation programs, such as EnergyPlus, cannot pre-process the independent variables or post-process values that are computed during the simulation. For such situations, *input function objects* and *output function objects* can now be used without having to modify **GenOpt's** source code.

**GenOpt 2.0** (with documentation) may be downloaded free of charge from

<http://SimulationResearch.lbl.gov> > **GenOpt**

# Recent Reports

This report is available from the Simulation Research Group at  
Lawrence Berkeley National Laboratory.

**LBNL-54657** ([download document](#))

## **BuildOpt: A New Building Energy Simulation Program Built on Smooth Models**

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Berkeley, CA 94720, USA

### **ABSTRACT**

Building energy simulation programs compute numerical approximations to physical phenomena that can be modeled by a system of differential algebraic equations (DAE). For a large class of building energy analysis problems, one can prove that the DAE system has a unique once continuously differentiable solution. Consequently, if building simulation programs are built on models that satisfy the smoothness assumptions required to prove existence of a unique smooth solution, and if their numerical solvers allow controlling the approximation error, one can use such programs with Generalized Pattern Search optimization algorithms that adaptively control the precision of the solutions of the DAE system. Those optimization algorithms construct sequences of iterates with stationary accumulation points and have been shown to yield a significant reduction in computation time compared to algorithms that use fixed precision cost function evaluations.

In this paper, we state the required smoothness assumptions and present the theorems that state existence of a unique smooth solution of the DAE system. We present BuildOpt, a detailed thermal and daylighting building energy simulation program. We discuss examples that explain the smoothing techniques used in BuildOpt. We present numerical experiments that compare the computation time for an annual simulation with the smoothing techniques applied to different parts of the models. The experiments show that high precision approximate solutions can only be computed if smooth models are used. This is significant because today's building simulation programs do not use such smoothing techniques and their solvers frequently fail to obtain a numerical solution if the solver tolerances are tight. We also present how BuildOpt's approximate solutions converge to a smooth function as the precision parameter of the numerical solver is tightened.

**LBNL-54658** ([download document](#))

## **BuildOpt 1.0.1 Validation**

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Building Technologies Department  
Environmental Energy Technologies Division  
Lawrence Berkeley National Laboratory  
Berkeley, CA 94720, USA

### **ABSTRACT**

To validate BuildOpt's thermal models, we used the ANSI/ASHRAE Standard 140-2001. This standard has been developed to identify and to diagnose differences in predictions for whole building energy simulation software that may possibly be caused by software errors. The test consists of a series of specified test cases that progress systematically from the simple to the relatively realistic case. Output values, such as annual energy consumptions, peak loads, annual minimum, average and maximum room air temperatures, and some hourly data are compared to the results of other building energy simulation programs, namely to ESP, BLAST, DOE-2.1D, SUNCODE, SERIRES, S3PAS, TRNSYS and TASE. We used the so-called "basic test cases" to validate BuildOpt. The basic test cases test the ability to model such combined effects as thermal mass, solar gains, window-shading devices, internally generated heat, outside air infiltration, sunspaces and thermostat control.



# VisualDOE 4.0



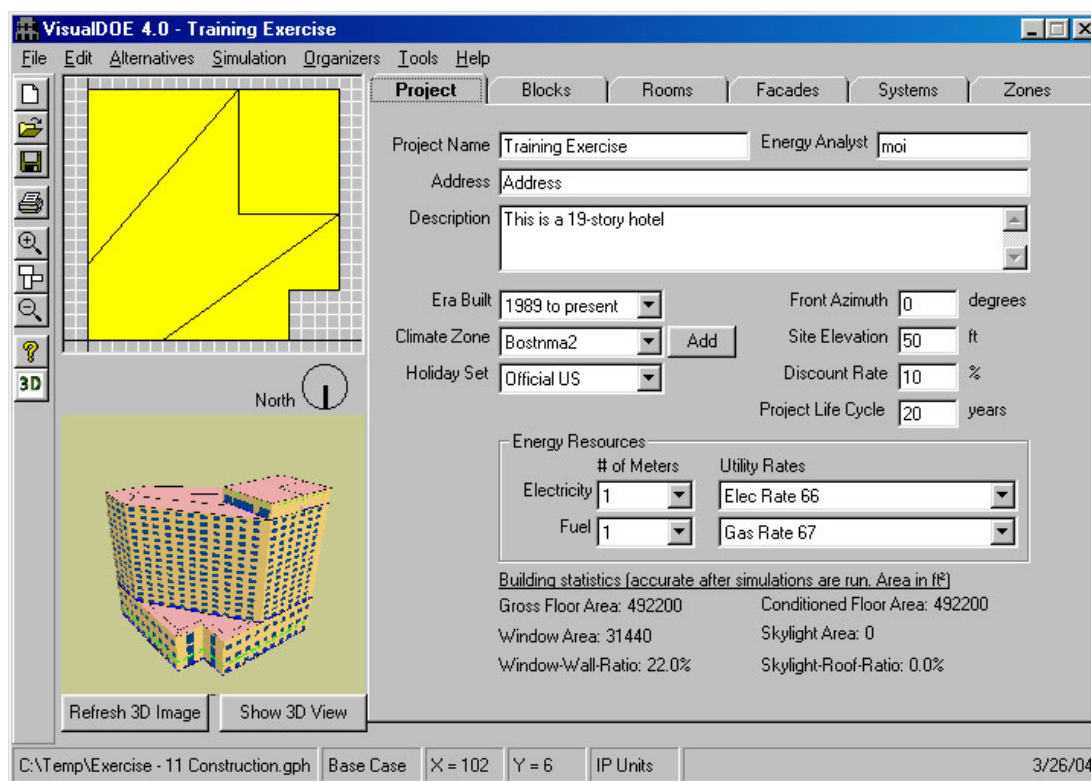
## A Sustainable Building Design Tool

Architectural Energy Corporation is proud to announce the release of VisualDOE 4.0, the 10th Anniversary Edition of its popular energy simulation program. All details may be found at [www.archenergy.com/products/visualdoe/](http://www.archenergy.com/products/visualdoe/).

VisualDOE 4.0 is a powerful, yet easy-to-use "front end" to DOE-2.1E, the industry-standard, building energy simulation program. VisualDOE is developed and supported by architects and engineers as a tool for designers and building scientists to accurately model the performance of building design alternatives. VisualDOE is also commonly used to perform energy calculations for LEED certification.

VisualDOE covers all major building systems including lighting, daylighting, HVAC, water heating, and building envelope. Among the wide range of simulation results are electricity and gas consumption, electric demand, and utility cost. Hourly results are available for detailed analysis.

VisualDOE is packaged with the latest version of DOE-2.1E from Lawrence Berkeley National Laboratory. VisualDOE saves time and energy by automating the process of writing the input file, running the simulation and extracting the results from the output file. No experience with DOE-2.1E is necessary, but advanced users have the option to modify the input files directly and still run the simulations from within VisualDOE. VisualDOE supports both SI and IP units and has thousands of licensed users in more than 40 countries.



**Start the Simulation**



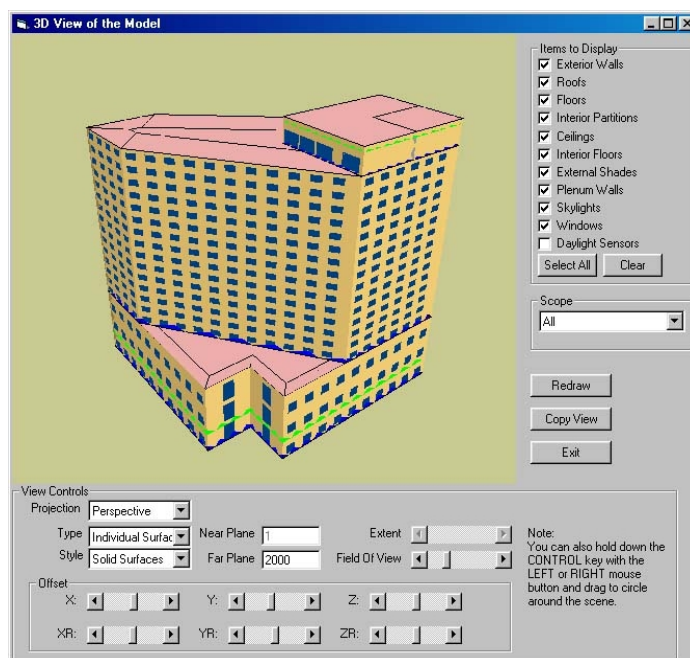
## VisualDOE 4.0 Continued ...

### New Features of VisualDOE 4.0

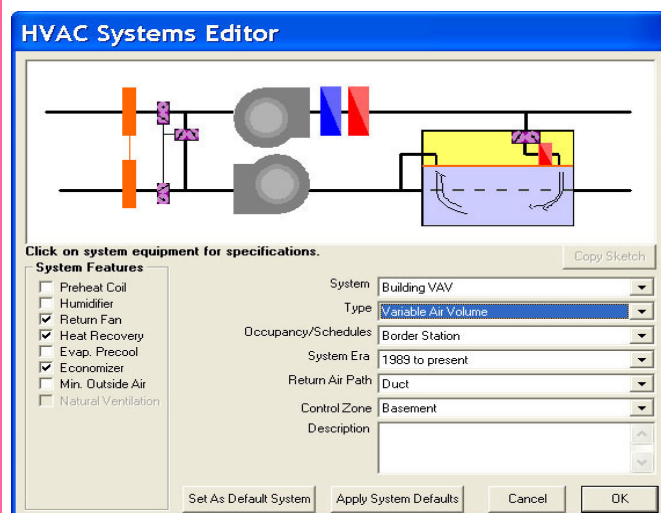
- Check Model Definitions
- Advanced Edit of Alternatives
- Polygon Clipping Module
- Water-side Economizer
- Import Schedules from DOE-2 and EnergyPlus Files
- Import CoolTools Chillers
- Diagnostics of Systems
- Water-cooled Condenser for Packaged Systems of PSZ, PVAVS and PVVT
- Ground Source Heat Pump Systems
- Re-order Design Alternatives
- LEED Style End-Use Report
- Run Multiple Copies on the Same PC
- DOE-2 Manuals with Bookmarks
- New VisualDOE 4.0 User Manual
- Updated Online Help System
- Plus more!

### Major Enhancements of VisualDOE 4.0

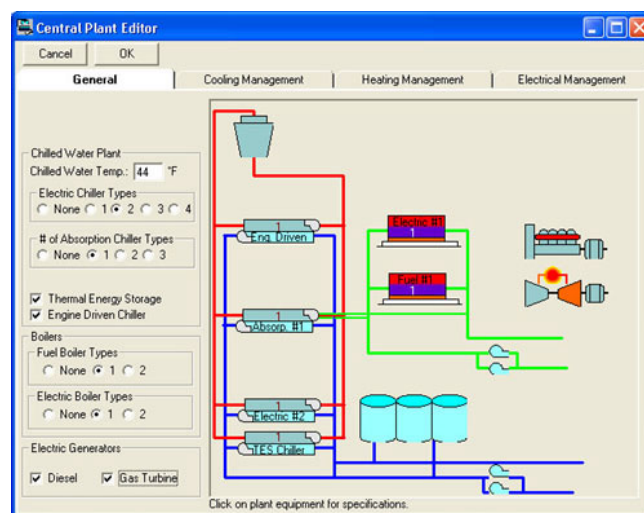
- Custom Block Editor
- Use Smart HVAC Defaults
- Create Plenum Zones
- Water Loop Heat Pump
- VisualDOE Reports
- Move Blocks
- Description of Property for Organizer Items
- Launch Schedules Organizer from the Occupancy Editor
- Updated Library and Templates



3-D view of the model

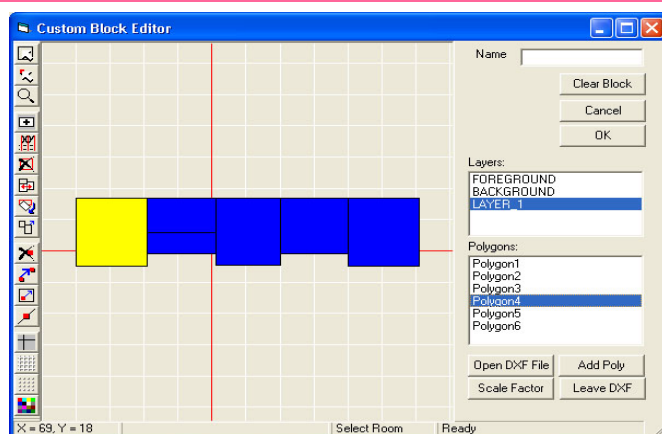


HVAC Systems Editor

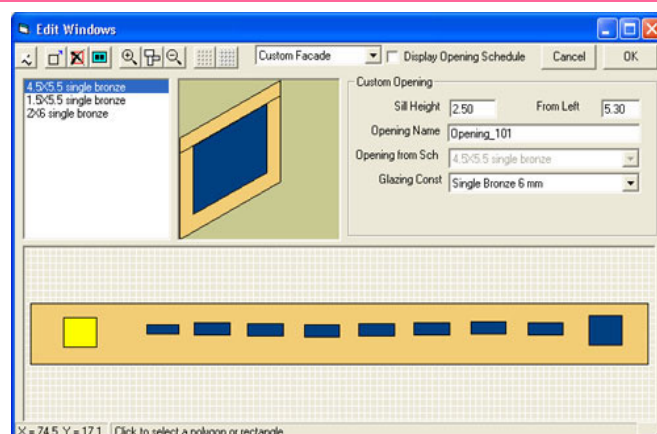


Central Plant Editor

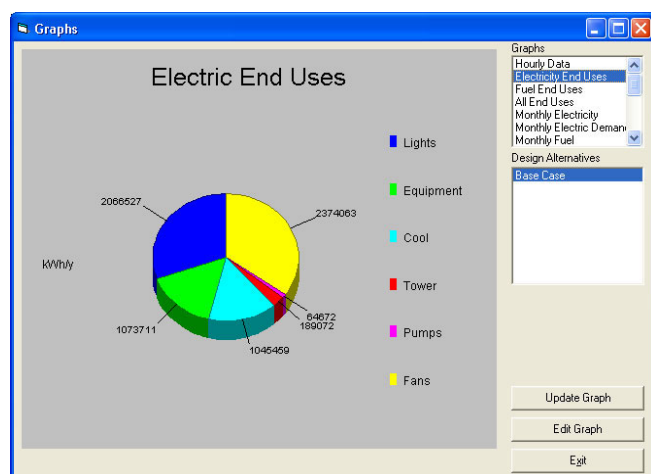
## VisualDOE 4.0 Continued ...



Custom Block Editor



Custom Façade Editor

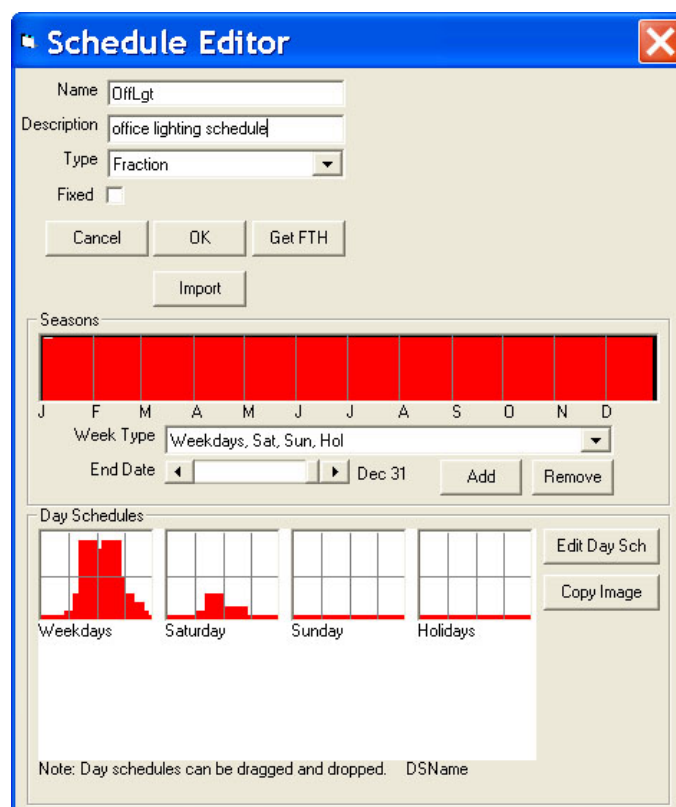


Graphical output of Electric End Uses

VisualDOE 4.0 - Results					
April 7, 2004					
Energy Cost Summary (\$/y)					
Alternative	Total Electric	Total Fuel	Total Utility	Incremental First Cost	PV Life Cycle Cost*
<b>Total Energy Costs (\$/y)</b>					
Base Case	\$43,872	\$13,677	\$57,649	\$0	\$490,798
Efficient Lighting Systems	\$39,150	\$14,236	\$53,386	\$12,000	\$466,505
<b>Incremental Energy Savings (\$/y)</b> (compared with previous alternative, negative savings represent increase)					
Efficient Lighting Systems	\$4,822	\$-559	\$4,263	\$-12,000	\$24,293

\* 20 year life cycle w/ 10% discount rate.

Life Cycle Costs Report



Schedule Editor

## VisualDOE 4.0 Continued ...

VisualDOE 4.0 - Systems Summary

March 26, 2004

Project Information

Name: Training Exercise

Address: Address

Description: This is a 19-story hotel

Analysis done by: mol @ AEC

Project File: c:\dev\visualdoe\training\materials\vd cd\training files\exercise\exercise - 11 construction.gph

Case Name: Base Case

Case Description: Base Case

Number of Systems: 3

Systems Summary

Name	Type	Cond. Area (ft²)	Supply (CFM)	Min. OA	Cooling Cap (kBtu/h)	Heating Cap (kBtu/h)	Cooling Peak (kBtu/h)	Heating Peak (kBtu/h)	Cooling Energy (MBtu)	Heating Energy (MBtu)
Base System	VAV S	115200	120000	0.288	5563.9	0	3085.9	3946.6	3408	3382
Hotel System	FPFC	369000	184500	0.12	0	0	3479.8	2854	7274	1791
Restaurant System	RHFS	8000	15000	0.393	660	0	682.4	442.8	901	1496

Systems Summary per Conditioned Area

Name	Type	Cond. Area (ft²)	Supply (CFM/ft²)	Min. OA	Cooling Cap (Btu/h/ft²)	Heating Cap (Btu/h/ft²)	Cooling Peak (Btu/h/ft²)	Heating Peak (Btu/h/ft²)	Cooling Energy (kBtu/ft²)	Heating Energy (kBtu/ft²)
Base System	VAV S	115200	1.042	0.288	48	0	27	34	30	29
Hotel System	FPFC	369000	0.5	0.12	0	0	9	8	20	5
Restaurant System	RHFS	8000	1.875	0.393	83	0	85	55	113	187

### Systems Summary Reports

End Use Report for Base Case				
Component	Type	kBtu - Annual Energy Use	kBtu/h - Peak Demand	kBtu/ft <sup>2</sup> - Annual Energy Use
<b>Energy Summary By End Use</b>				
Lighting	Electricity	420,232	124.2	13.5
Space Heating	Electricity	48,311	10.9	1.6
Space Cooling	Electricity	334,849	178.5	10.8
Pumps	Electricity	10,580	4.1	0.3
Fans	Electricity	202,217	78.2	6.5
Office Equipment	Unregulated	183,671	54.3	5.9
Total Electricity	Electricity	1,199,861		38.6
Space Heating	Fuel	4,127,962	1372	132.8
Service Water Heating	Fuel	441,738	180.9	14.2
Total Fuel	Fuel	4,569,700		147
Building Total	All End-Use	5,769,561		185.6
<b>Energy and Cost Summary B...</b>				
Regulated Energy Use (kBtu)				
Electricity		1,016,190		
Fuel		4,569,700		
<b>Regulated Energy Cost (\$)</b>				
Electricity		32,753		
Fuel		39,956		
Building Total		72,709		

Note: End-use peak demands are non-coincident values taken from DOE-2 PS-E report

### LEED-style reports

## Professional VisualDOE Training Seminars

Architectural Energy Corporation is pleased to announce two upcoming VisualDOE 4.0 professional training seminars. These courses provide hands-on DOE-2 simulation experience and cover the full range of VisualDOE 4.0 features. An optional third day training focuses on how to use VisualDOE 4.0 for LEED energy saving calculations. Seminars are scheduled on June 16-18, 2004 and October 20-22, 2004 in San Francisco.

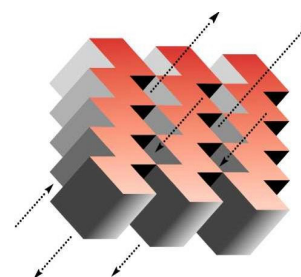
For further details including seminar fees, please go to <http://www.archenergy.com/products/visualdoe/training/> or email [vdoetraining@archenergy.com](mailto:vdoetraining@archenergy.com)

## More Information and Ordering

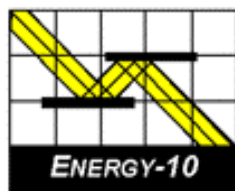
To order a copy of VisualDOE 4.0, please go to <http://www.archenergy.com/products/visualdoe/ordering/>. For details of new features, free demo download, and others, please visit us on the web at <http://www.archenergy.com/products/visualdoe/>

Architectural Energy Corporation provides free technical supports for one year via email, phone, web resources, and user newsletters with the purchase of any new license or upgrade.

**Architectural Energy Corporation**  
142 Minna Street, Second Floor  
San Francisco, CA 94105  
Phone: (415) 957-1977  
Fax: (415) 957-1381  
Email: [vdoesupport@archenergy.com](mailto:vdoesupport@archenergy.com)  
Web: <http://www.archenergy.com/>



**ARCHITECTURAL ENERGY**  
C O R P O R A T I O N



## ENERGY-10, VERSION 1.6

**ENERGY-10** is a design tool for smaller residential or commercial buildings that are less than 10,000 ft<sup>2</sup> or buildings that can be treated as 1- or 2-zone increments. It performs whole-building energy analysis for 8760 hours/year, including dynamic thermal and daylighting calculations. **ENERGY-10** was specifically designed to facilitate the evaluation of energy-efficient building features in the very early stages of the design process.

### Version 1.6 Upgrades

#### Synchronize Libraries

Libraries may now be associated with more than one building.

#### Free Run Mode

Automated process of monitoring how a building operates without any HVAC system.

#### Clear All Internal Gains

The name is self-explanatory.

#### New Buttons on Provisional Data Dialog Box

Users may specify whether they want autobuild HVAC sizing to be computed with or without daylighting.

#### Performance Summary Reports

Three performance summary reports have been added. One is a simple performance summary, which breaks down the standard summary into more readable chunks and adds a column that reflects the percentage change of going from Building 1 to Building 2. The other two are daylighting reports that show the standard daylighting factor calculated for each lighting zone.

#### New Defaults Library

A new set of libraries contains all the standard libraries such as floorlib, rooflib, etc. with updated values.

#### Registry Path for ENERGY-10 Data

New registry path allows users to maintain separate copies of the three most recent versions of **ENERGY-10**. In addition, the installation script allows installation for either "all users" or the "current user only."

#### Additional Tutorials on Installation CD

Three new tutorials are included in the slide show section of the installation CD, including Economics, Daylighting, and Using **ENERGY-10** in the Design Process.

**Douglas K. Schroeder**  
1331 H Street N.W., #1000  
Washington, DC 20004

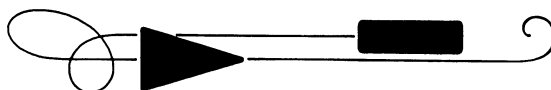


**Tel: 202.628.7400 ext 210**  
**Fax: 202.383.5043**  
**[www.sbicouncil.org](http://www.sbicouncil.org)**

### ***Sustainable Buildings Industry Council (SBIC)***

ENERGY-10 User Group [www.sbicouncil.org/forum](http://www.sbicouncil.org/forum)

SBIC Bookstore [www.sbicouncil.org/store/resources.php](http://www.sbicouncil.org/store/resources.php) - pubs



# BLASTnews

[www.bso.uiuc.edu](http://www.bso.uiuc.edu)

**Building Systems Laboratory**  
University of Illinois, 30 Mechanical Engineering Building,  
1206 West Green Street, Urbana, IL 61801  
Tel: (217) 333-3977 - Fax: (217) 244-6534  
[support@blast.bso.uiuc.edu](mailto:support@blast.bso.uiuc.edu)

The **Building Loads Analysis and System Thermodynamics (BLAST)** program predicts energy consumption, energy system performance and cost for new or existing (pre-retrofit) buildings.

BLAST contains three major sub-programs:

- **Space Load Prediction** computes hourly space loads in a building based on weather data and user inputs detailing the building construction and operation.
- **Air Distribution System Simulation** uses the computed space loads, weather data, and user inputs.
- **Central Plant Simulation** computes monthly and annual fuel and electrical power consumption.

## Heat Balance Loads Calculator (HBLC)

The BLAST graphical interface (HBLC) is a Windows-based interactive program for producing

BLAST input files. You can download a demo version of HBLC (for MS Windows) from the BLAST web site (User manual included).

## HBLC/BLAST Training Courses

Experience with the HBLC and the BLAST family of programs has shown that new users can benefit from a session of structured training with the software. The Building Systems Laboratory offers such training courses on an as needed basis typically at our offices in Urbana, Illinois.

## WINLCCID 98

LCCID (Life Cycle Cost in Design) was developed to perform Life Cycle Cost Analyses (LCCA) for the Department of Defense and their contractors.

**To order BLAST-related products, contact the Building Systems Laboratory at the address above.**

Program Name	Order Number	Price
<b>PC BLAST</b> Includes: BLAST, HBLC, BTEXT, WIFE, CHILLER, Report Writer, Report Writer File Generator, Comfort Report program, Weather File Reporting Program, Control Profile Macros for Lotus or Symphony, and the Design Week Program. The package is on a single CD-ROM and includes soft copies of the BLAST Manual, 65 technical articles and theses related to BLAST, nearly 400 processed weather files with a browsing engine, and complete source code for BLAST, HBLC, etc. Requires an IBM PC 486/Pentium II or compatible running MS Windows 95/98/NT.	3B486E3-0898	\$1500
<b>PC BLAST Package</b> Upgrade from level 295+	4B486E3-0898	\$450
<b>WINLCCID 98:</b> executable version for 386/486/Pentium	3LCC3-0898	\$295
<b>WINLCCID 98:</b> update from WINLCCID 97	4LCC3-0898	\$195

*The last four digits of the catalog number indicate the month and year the item was released or published. This will enable you to see if you have the most recent version. All software will be shipped on 3.5" high density floppy disks unless noted otherwise.*

## Left Brain + Right Brain = No Brainer?

*While seated, lift your right foot off the floor and make clockwise circles. Now, while doing this, draw the number "6" in the air with your right hand. Your foot will change direction and there's nothing you can do about it!!*





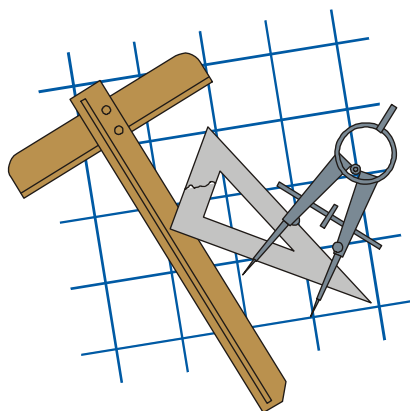
## Building Energy Software

from the Environmental Energy Technologies Division of Lawrence Berkeley Laboratory

Free Downloads	
<b>BDA 3.0 (Building Design Advisor)</b> (building decision-making from design through completion)	<a href="http://gaia.lbl.gov/BDA">gaia.lbl.gov/BDA</a>
<b>COMIS</b> (multi-zone air flow and contaminant transport model)	<a href="http://www-epb.lbl.gov/comis">www-epb.lbl.gov/comis</a>
<b>EnergyPlus 1.1.1</b> (new-generation whole-building energy analysis program, based on BLAST and DOE-2)	<a href="http://www.energyplus.gov/">http://www.energyplus.gov/</a> --or-- <a href="http://SimulationResearch.lbl.gov">SimulationResearch.lbl.gov</a> > EnergyPlus
<b>GenOpt<sup>®</sup> 2.0<math>\beta</math></b> (generic optimization program)	<a href="http://SimulationResearch.lbl.gov">SimulationResearch.lbl.gov</a> > GenOpt
<b>Optics 5.1.02</b> (for analyzing optical properties of glazing systems)	<a href="http://windows.lbl.gov/materials/optics5/">windows.lbl.gov/materials/optics5/</a>
<b>RADIANCE 3.5</b> (analysis and visualization of lighting in design) <b>Desktop Radiance 2.0<math>\beta</math></b> (integrates the Radiance Synthetic Imaging System with AutoCAD Release 14) <b>Radiance Control Panel</b> (automates some Radiance tasks once the model has been created)	<a href="http://radsite.lbl.gov/radiance/">radsite.lbl.gov/radiance/</a> <a href="http://radsite.lbl.gov/deskrad/">radsite.lbl.gov/deskrad/</a> <a href="http://www.squ1.com/site.html">www.squ1.com/site.html</a>
<b>RESEM (Retrofit Energy Savings Estimation Model)</b> (calculates long-term energy savings directly from actual utility data)	<a href="http://eetd.lbl.gov/btp/resem.htm">eetd.lbl.gov/btp/resem.htm</a>
<b>SUPERLITE</b> (calculates illuminance distribution for room geometries)	<a href="http://eetd.lbl.gov/btp/superlite2.html">eetd.lbl.gov/btp/superlite2.html</a>
<b>THERM 5.2</b> (models two-dimensional heat-transfer effects in building components where thermal bridges are of concern)	<a href="http://windows.lbl.gov/software/therm/therm.html">windows.lbl.gov/software/therm/therm.html</a>
<b>VisualSPARK 2.0 (Simulation Problem Analysis and Research Kernel)</b> (connect component models to simulate innovative building envelope and HVAC systems)	<a href="http://SimulationResearch.lbl.gov">SimulationResearch.lbl.gov</a> > VisualSPARK
<b>WINDOW 5.2</b> (thermal analysis of window products)	<a href="http://windows.lbl.gov/software/window/window.html">windows.lbl.gov/software/window/window.html</a>
Free Software / Request by Fax from 510.486.4089	
<b>RESFEN 3.1</b> (choose energy-efficient, cost-effective windows for a given residential application)	<a href="http://windows.lbl.gov/software/resfen/resfen.html">windows.lbl.gov/software/resfen/resfen.html</a>
Web Based (free)	
<b>Home Energy Saver</b> (quickly computes home energy use) and <b>Home Improvement Tool</b> (simplified Home Energy Saver)	<a href="http://hes.lbl.gov">hes.lbl.gov</a> and <a href="http://hit.lbl.gov">hit.lbl.gov</a>







## Building Energy Tools Directory

The web-based Building Energy Tools Directory contains information on more than 270 building-related software tools from around the world.

For each tool in the directory, a short description is provided, along with information about technical expertise required, users, audience, input, output, validation, computer platforms, programming language, strengths, weaknesses, technical contact, availability and cost. A link is also provided for directly translating the web pages into more than eight languages.

Know of a tool (yours?) that isn't in the directory? Visit [http://www.eere.energy.gov/buildings/tools\\_directory/your\\_software\\_here.html](http://www.eere.energy.gov/buildings/tools_directory/your_software_here.html) or contact Dru Crawley at [Drury.Crawley@ee.doe.gov](mailto:Drury.Crawley@ee.doe.gov).

*The Forecast Looks Favorable for ...*

## (Free!) Weather Data on Demand

You can access archived weather data from around the world through this U.S. DOE web interface:



[www.eere.energy.gov/buildings/energyplus/cfm/weatherdata/weather\\_request.cfm](http://www.eere.energy.gov/buildings/energyplus/cfm/weatherdata/weather_request.cfm)

Hourly weather data is continuously collected and stored into a local database, available through this web interface. Most stations have information for dry bulb temperature, wet bulb temperature, wind speed/direction, atmospheric pressure, visibility, cloud conditions, and precipitation type.

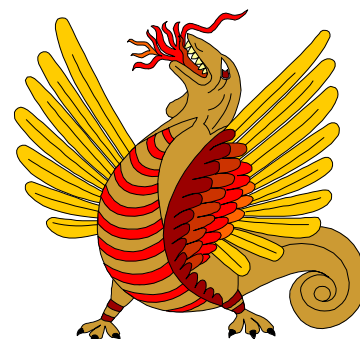
### JOIN THE BLDG-SIM MAILING LIST

BLDG-SIM is a mailing list for users of building energy simulation programs like EnergyPlus, DOE-2, Trace-600, HAP, BLAST, ESP, SERIRES, TRNSYS, TASE, ENERGY-10 and others.

Because building simulation professionals are located worldwide, the BLDG-SIM list is an attempt to foster the development of a community of those users. Users of all levels of expertise are welcome and are encouraged to share their questions and insights about these programs. To subscribe, send a blank email message to [BLDG-SIM-SUBSCRIBE@GARD.COM](mailto:BLDG-SIM-SUBSCRIBE@GARD.COM)

The web page for BLDG-SIM is [www.gard.com/bldg-sim.htm](http://www.gard.com/bldg-sim.htm)

Jason Glazer, P.E., of GARD Analytics, Inc., is the list administrator ([jglazer@gard.com](mailto:jglazer@gard.com)).



*Run for safety, foolish pedestrians!*



*Newsletters are a great way to keep up to date  
on news within the building energy  
efficiency community.  
Here is our "short list" of the best.*

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**Advanced Buildings**

<http://greenbuilding.ca/GBIC.htm>

Newsletter of the Royal Architectural Institute of Canada. Building simulation activities in Canada..

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**The Blueprint**

<http://www.energy.ca.gov/efficiency/blueprint/index.html>

Newsletter of the California Energy Commission's Efficiency Standards Office.

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**CADDET**

<http://www.caddet.co.uk/>

The International Energy Agency's newsletter on energy efficiency. Practical and innovative articles by international energy researchers and practitioners.

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**CARB-News**

<http://www.carb-swa.com/carbfax.html>

CARB, the Consortium for Advanced Residential Buildings, presents updates on the Building America program

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**EETD News**

<http://eetd.lbl.gov/EETDtoc.html>

Reports on research conducted by Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division.

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**e-EFFICIENCY NEWS**

<http://www.ase.org/about/about.htm>

The bi-monthly electronic newsletter from the Alliance to Save Energy.

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**Energy User News**

<http://www.energyusernews.com/>

Trade publication covers energy efficiency in new and existing non-residential buildings.

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**EREN News**

<http://www.eren.doe.gov/news/>

Energy Efficiency and Renewable Energy Network of the U.S. Department of Energy. EREN Network News is a weekly electronic newsletter covering energy efficiency and renewable energy news.

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**Green Energy News**

<http://www.nrglink.com/index.html>

Weekly online publication offers news about energy efficiency and related "green" energy issues for non-residential facilities, etc.

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**Home Energy Magazine**

<http://homeenergy.org/hewebsite/>

Not a newsletter, but the best resource for home energy.

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**IBPSA News**

<http://www.mae.okstate.edu/ibpsa/newslett.htm>

Newsletter of the International Building Performance Simulation Association (IBPSA). Technical articles about building simulation techniques, conference news.

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**Setting the Standard**

<http://www.energycodes.gov/news/>

Newsletter of the U.S. Department of Energy's Building Standards and Guidelines Program.

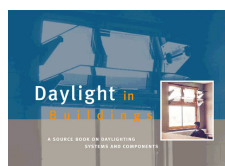
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**WinterGreen**

<http://www.swinter.com/company/WinterGREEN.html>

WinterGREEN is an update on the work of Steven Winter Associates, Inc. Each issue presents reports from the field and presentations on sustainable building systems and concepts

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## Daylight in Buildings

### A Source Book on Daylighting Systems and Components

Free!!

This source book gives a comprehensive overview of innovative daylighting systems, the performance parameters by which they are judged, and an evaluation of their energy savings potential and user acceptance. The book has been written to overcome a lack of evidence of the advantages of daylighting in buildings and a lack of knowledge regarding the performance of innovative daylighting systems in buildings. The information presented here is intended to be used in the earliest stages of the building design process.

Innovative daylighting systems are designed to redirect sunlight or skylight to areas where it is required, without glare. These systems use optical devices that initiate reflection, refraction, and/or use the total internal reflection of sunlight and skylight. Advanced daylighting systems can be designed to actively track the sun or passively control the direction of sunlight and skylight. The systems included in this book have been generally limited to passive devices.

*Daylight in Buildings is available **FREE OF CHARGE** from the Building Technologies Department at Lawrence Berkeley National Laboratory. Send your request to JeShana Dawson ([jldawson@lbl.gov](mailto:jldawson@lbl.gov)).*



Pacific Gas and  
Electric Company™

WE DELIVER ENERGY.™

## PG&E Spring 2004 Programs

To register call 415.973.7268 or go to [www.pge.com/pec](http://www.pge.com/pec)

### HVAC

- |        |   |
|--------|---|
| May 12 | New Title 24 2005 Non-Residential Mechanical Requirements |
| June 3 | All About Variable Speed Drives: A Brown Bag Seminar      |

### WHOLE-BUILDING PERFORMANCE

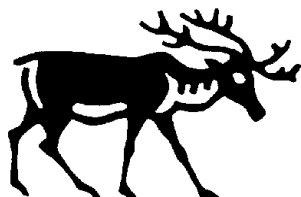
- |         |   |
|---------|---|
| May 06  | Data Collection for Lighting Controls   |
| June 15 | Practical Introduction to Commissioning |

### ARCHITECTURE AND INTEGRATED DESIGN

- |        |   |
|--------|---|
| May 04 | Designing Green Buildings: A Panel Discussion |
| May 19 | The Glass Class                               |
| May 27 | Green Materials and Systems                   |
| June 9 | Daylighting Fundamentals                      |

### LIGHTING

- |         |  |
|---------|--|
| May 11  | Integrating Daylighting and Electric Lighting Design |
| May 18  | Lighting Fundamentals                                |
| June 02 | Discharge and Solid State Light Sources              |



# DOE-2



DOE-2.1E (v. 121) 1,000-Zone version for Windows from ESTSC; other vendors of DOE-2 based programs are listed on our website: <http://SimulationResearch.lbl.gov/>.

Cost is as follows:

- \$ 300 U.S. Government/Non-Profits/Education
- \$ 575 U.S. Public, Mexico, Canada
- \$1129 to \$1268 Other Foreign

## DOE-2 Documentation on a CD from ESTSC - Cost US\$100

### *What is included on the CD?*

- DOE-2 Reference Manual (Part 1)
- DOE-2 Reference Manual (Part 2)
- DOE-2 Supplement to the Reference Manual (2.1E)
- DOE-2 BDL Summary (2.1E)
- DOE-2 Engineers Manual (2.1A)

## Order Software and ESTSC Documentation

Ed Kidd or Kim Buckner  
NCI Information Systems, Inc.  
Energy Science and Technology Software Center (ESTSC)  
P.O. Box 1020  
Oak Ridge, TN 37831

Phone: 865/576-1037  
Fax: 865/576-6436  
Email: [estsc@adonis.osti.gov](mailto:estsc@adonis.osti.gov)

## Purchase DOE-2 Documentation

DOE-2 Sample Run Book (2.1E) -- The Sample Run book is the only remaining DOE-2 manual not available electronically. It must be purchased separately from NTIS; ordering information may be found at <http://SimulationResearch.lbl.gov> > DOE-2 > Documentation

## Free DOE-2 Documentation (<http://simulationresearch.lbl.gov/> > DOE-2 > Documentation)

### DOE-2 Basics Manual (2.1E)

**Update Packages:** Update Packages are **not** cumulative; each one contains different information. Download all four packages then print and insert the pages into your existing DOE-2 manuals.

- Update Package #1: DOE-2.1E Basics, the Supplement and BDL Summary
- Update Package #2: BDL Summary and Supplement.
- Update Package #3: Appendix A of the Supplement.
- Update Package #4: (1000-zone DOE-2.1E) BDL Summary.

### DOE-2 Modeling Tips (pdf files) for 2003 for 2002

A compilation of all the "how to" and "DOE-2 Puzzler" articles from the *Building Energy Simulation User News*.

### Changes and Bug Fixes to DOE-2.1E (txt file)

Description of all changes and bug fixes in a text document.

**DOE-2 listings are continued on the next page**



## DOE-2 (continued)



### DOE-2 Training

Private or group DOE-2 courses for beginning and advanced users.  
Contact Marlin Addison at (602) 968-2040, [marlin.addison@doe2.com](mailto:marlin.addison@doe2.com)

### DOE-2 Help Desk

Email ([klelligenton@lbl.gov](mailto:klelligenton@lbl.gov)) or fax the Simulation Research Group with your questions. Fax: (510) 486-4089

**E-nnouncements is a free, monthly electronic news service for the energy and environmental community; it covers CADDET Annexes (energy efficiency and renewable energy) and GREENTIE (greenhouse gas mitigation technologies).**



**Visit [www.greentie.org](http://www.greentie.org) to sign up for the newsletter.**

### **Interactive Web-Based Calculators for Building Envelope Calculations**

*These interactive calculators, from the Building Envelopes Program at Oak Ridge National Laboratory, allow you to enter values specific to your construction type and location to determine the energy efficiency of a new or existing building.*



#### **Modified Zone Method**

Calculate thermal resistance (R-values) for metal stud walls with insulated cavities.



#### **Moisture Control in Low-Slope Roofing**

Determine if a roof design needs a vapor retarder or if the roofing system can be modified to enhance its tolerance for small leaks.



#### **Simplified R-Value Recommendation**

Recommendations for buying and installing insulation to help conserve energy and reduce utility costs.



#### **Whole-Wall Thermal Performance**

Determine thermal resistance (R-values) for whole walls by selecting the components that make up the walls in your home.



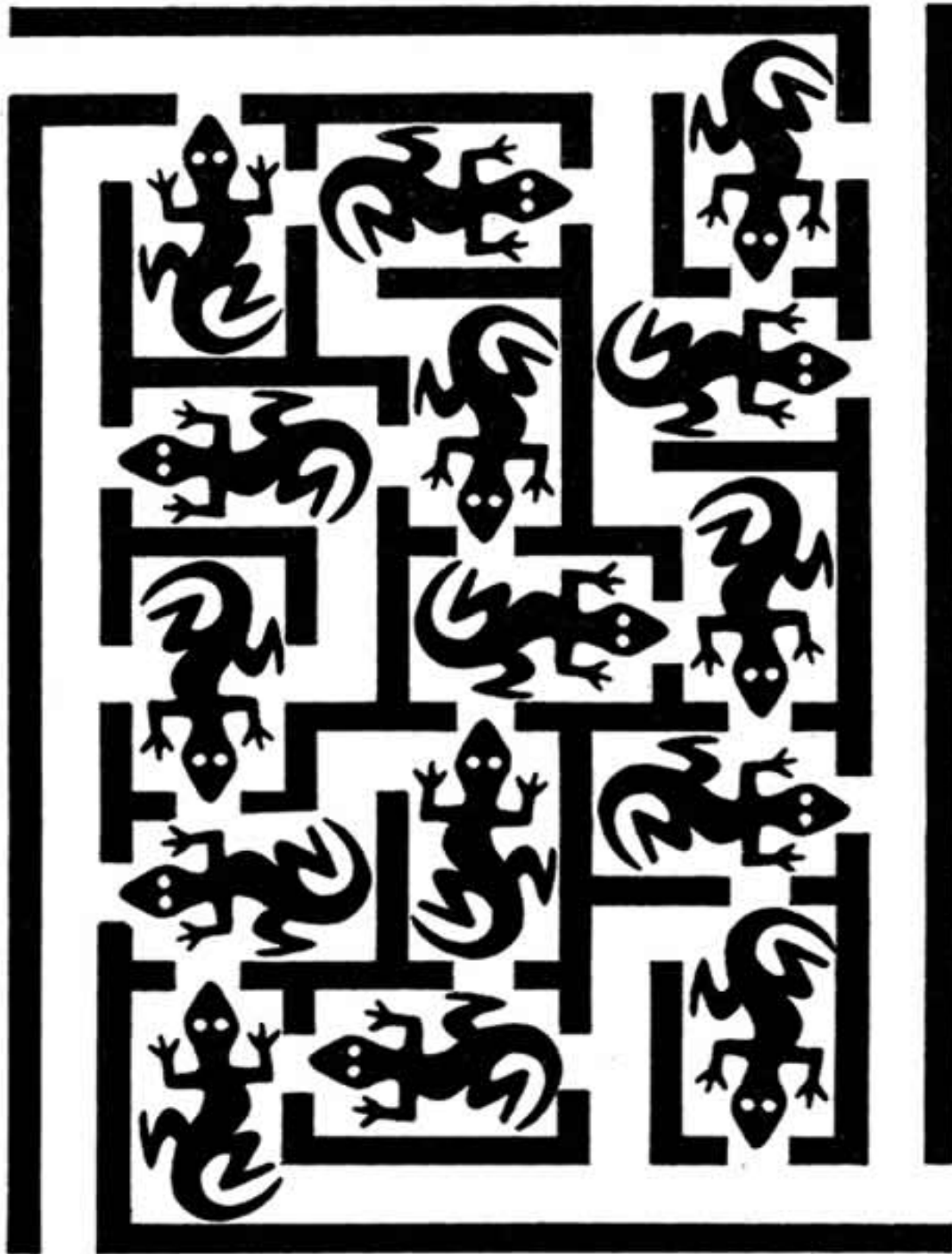
#### **ZIP-Code R-Value Recommendation** (Requires Java-enabled browser)

Find the most economic insulation level and cost value for new or existing construction based on the climate in your area.



#### **Radiation Control Calculator** (Requires Java-enabled browser)

Estimate annual energy cost savings from the use of solar radiation control on low-slope roofs for commercial buildings. First-time users are encouraged to visit the Solar Radiation Control Fact Sheet first for essential background on use of the estimating tool.



### LIZARDS

Find a path that enters the maze, passes through all lizards and exits the maze without using any part of a path more than once. You may not collect a lizard head on.

(Solution is on p.49 in [Section 2](#) of the Building Energy Simulation User News )