

## Readme Text

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ReadMe File for the EnergyPlus Version 2.1 Release  
To assist in installing and using EnergyPlus  
To include any last minute changes  
Release Version 2.1.0.023  
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The Web address (<http://www.energyplus.gov/>) will contain periodic (as needed) updates. If you have any problems with the software, please fill out the BUGREPRT.TXT in the directory where you installed the software. Instructions for sending in the report form are included in the file. The form can be mailed to [EnergyPlus-Support@gard.com](mailto:EnergyPlus-Support@gard.com) who will post change requests appropriately.

### EnergyPlus – What it is, What it is not

EnergyPlus is a simulation program designed for modeling buildings with all their associated heating, cooling, lighting, ventilating, and other energy flows. EnergyPlus is a stand-alone simulation engine without a ‘user friendly’ graphical interface . . . EnergyPlus reads input and writes output as text files. Because public funds (U.S. Department of Energy, primarily) were used to develop EnergyPlus, we chose to develop the engine and not try “to be all things to all users”. Developing good user interfaces takes many resources, specific attention to problem domains, and backing from specific user communities. The team feels that those interests are better served through private considerations where domain specific funding may help quantify the requirements.

Utilities and tools for creating, editing, and running input files that come with EnergyPlus include IDF Editor and EP-Launch. Third party tools for creating, editing, and displaying EnergyPlus input files are also available, including DrawBDL, DrawEzPlus, EzPlus-Parm, TSe+Mat and TSE+Glz, and xEsoView. Information about building software interoperability standards and tools for translating building geometry from CAD into EnergyPlus IDF input is also available. More than six user interfaces that create and run EnergyPlus input files and display results graphically are available (DesignBuilder, E2AC, Hevacomp, EFEN) and under development (E+IEQ and EPlusInterface). Software tools that were specifically designed or are able to create EnergyPlus input files include ECOTECT, EP Geo, EP Sys, EP-Quick, IFCtoIDF, ESP-r, Green Building Studio, and IHIT. See [http://www.energyplus.gov/interfaces\\_tools.html](http://www.energyplus.gov/interfaces_tools.html) for more information.

### What’s going on in V2.1?

***Will there be any considerable difference between version 2.0 and 2.1?***

Yes.... and no. The basic structure of EnergyPlus is still as it has been but there are some significant changes that you will want to be aware of:

As always, there are a number of new features and bug fixes.

***How about IDF and IDD? Do they remain unchanged?***

There will be some changes in the IDD and reflected in IDFs. Particularly for any new features, there will be new objects.

### ***Is version 2.1 backward compatible? Can I run v2.0 file in v2.1?***

For many options, the answer is yes. However, there are **several changes** that require you to use the transition program for V2.0. EP-Launch can check the selected file (if there is a version object) and you can launch the Transition program from the EP-Launch “File” menu. You can also view the ObjectStatus spreadsheet in the root folder of the installed version. This file has detailed explanations of changes to the objects. There is also a new option for the transition program that allows you to supply a list of files and it will convert them for you. The transition program is described more fully in the Auxiliary Programs document. In addition, we can make available a zip file of all transitions programs and batch files such that files can be taken from much earlier versions to current version.

## **Documentation**

The documentation package included with EnergyPlus addresses all aspects of using EnergyPlus from user input to output examples to outside developer (module and interface) to internal programming standards. If it were printed, there would be over 3,500 pages included in the printing. Though documentation is identified as an optional component of the EnergyPlus install, it is a very important part of EnergyPlus.

Documents open with bookmarks and pages (PDF option) and open at the first page of text (rather than table of contents).

EnergyPlus documentation may be accessed several ways:

From the Start Menu, select Programs, EnergyPlus Programs, EnergyPlus Document Main Menu (Note – if you selected a different name for the program group, the items will be in that group.)

Or locate the EnergyPlus installation directory, go to the Documentation folder, and open the file "EPlusMainMenu.pdf". (You must have Acrobat Reader™ Version 6/7/8 installed on your system to access the EnergyPlus documentation). We recommend version 7 at minimum. Due to a bug in Adobe’s PDFMaker, the headers on files have some extra characters – as far as we can tell it does not affect the rest of the content.

The documentation is also accessible from the **Help** menu in EP-Launch and IDF-Editor.

EnergyPlus Documentation is searchable! Using the indexing capabilities of Acrobat along with the search button on the main menu document, you can literally enter in a word (Windows OS) and find all the occurrences of that word within the 3500+ pages of EnergyPlus documents. **(The search file capability was built in version 8. There may be some issues with using either version 6 or version 8 – we have tested in both versions and searches seem to be okay. For version 6, you may have to open the index.pdx file manually.)**

## **Highlights of this release (V2.1.0.023)**

The highlights – improved and new features – are displayed by category.

## **Data Sets**

- Color schemes for DXF. (original and default).
- Additional options in StandardReports data set.

## **Design Day**

- User now can choose between ASHRAE Clear Sky and Zhang-Huang solar radiation models for use in design day calculations.

## **Input**

- Example input files created for all new features (More than 225 example input files now available).

## **Geometry/Window/Walls/Shading**

- Surface Surround Subsurface error detection more robust (less false errors)
- Autocalculate now allowed for shading surfaces (number of vertices)

## **Daylighting**

### **Zone Model**

- Zone sizing calculations now include heat gains from domestic/service hot water uses and water heaters.

### **Natural and Mechanical Ventilation**

- Added new system availability manager to allow system-level control of hybrid ventilation systems.

### **HVAC**

- Added water-cooled condenser capability to refrigeration compressor racks for useful heat recovery.
- Chilled and hot-water coils can now be used in the outside air system to preheat or precool outside air.
- New desiccant dehumidifier with additional capabilities and flexibility compared to the existing solid desiccant dehumidifier model.
- Water side economizer (including simulation of integrated and non-integrated water side economizers).
- Water heater improved for indirect heating (e.g. with remote boiler) and autosizable design flow rates for plant connections.
- Packaged terminal air conditioner (PTAC) added to model a fan, DX cooling coil, and a gas, electric, hydronic or steam heating coil serving a single zone.
- Multispeed heat pump with up to four discrete speeds for both cooling and heating.
- Heat losses (and gains) from plant piping.
- New and updated Compact HVAC objects:
  - Compact HVAC chilled water coils now use the COIL:WATER:COOLING model by default, COIL:Water:DetailedFlatCooling can be selected as an option.

- Compact HVAC unitary system now supports the draw-thru fan placement option, and allows a schedule for the supply fan operating mode (continuous or cycling).
- New Compact HVAC options for dehumidification and humidification controls for unitary and VAV system types.
- New primary-secondary loop options for Compact HVAC chilled water loops.
- Compact HVAC expanded to support specification of outside air as a combination of flow/person, flow/area and flow/zone.
- Compact HVAC baseboard heat option added for unitary and VAV zones.
- New Compact HVAC objects for unitary heat pump, unitary VAV, packaged terminal air conditioner, and packaged terminal heat pump.

### **Water Manager**

### **Electrical Power**

### **On-Site Energy Supply**

### **Environmental Impacts**

### **Economics**

### **Output**

- New tabular reports for surface shadowing, shading, lighting, HVAC sizing, system and component sizing, and outside air.
- New Report:SurfaceColorScheme allow users to select their own colors for building elements in the DXF output.

### **Utilities**

- WeatherConverter now produces KML output (for Google Earth) of latitude, longitude, elevation, and a few climate statistics for locations in a list processing run.
- Add comma delimited form of CLM (ESP-r Ascii files) conversion to WeatherConverter.
- WinEPDraw produces in new default colors.

### **Documentation and Guides**

- Completely rewritten Getting Started manual provides more hands-on example exercises and other information for getting up to speed on EnergyPlus.
- Input/Output Reference and Engineering Reference updated and extended for all new features and updates. Total documentation now exceeds 3500 pages.

And many other enhancements and speed improvements throughout. *Suggestion: get as much memory as possible in your computer for running EnergyPlus.* A recent team upgrade from 1.8GHZ machine with 768MB memory to a 2.1GHZ machine with 2G memory caused one file to go from a full annual simulation (5 zones) at about 8 minutes to a 2 ¼ minute run on the newer machine.

## Installation contents

The installation creates a program folder with icons/shortcuts for the programs/files in EnergyPlus that can be accessed from Windows menus, including removing EnergyPlus from your system. In Windows OS, these will be available from the "Programs" area in the Start Menu. Note that only a few of the programs will store anything in your Windows\System directory (IDFEditor, EPLaunch, WeatherConverter).

### Installation Directory Structure

Since you were allowed to select components, some of the items in the default directory structure may not be on your system:

**\EnergyPlusV2-1-0** (or main directory selected)

#### Core files for the application

\DataSets - "library" files

\MacroDataSets - "library" files

\Documentation - documentation pdf files

#### \PreProcess

\IDFEditor - simple editor to create/modify IDF files

\BLASTTranslator – (this is available separately)

\DOE2Translator – (this is available separately)

\GrndTempCalc – pre-processor for Ground Temperature Calculations

\CalcSoilSurfTemp – pre-processor for EarthTube related calculations

\ParametricSpreadsheets – (this is available separately)

\ViewFactorCalculation – a stand alone app for calculating view factors

\CoeffConv – small utility programs for converting DOE-2 temperature based curves

\WeatherConverter – WeatherConverter program and files

#### \PostProcess

##### core post processing programs

\convertESOMTRpgm – simple converter program for output files

#### \ExampleFiles

\sparklink (to use the spark model features)

#### \WeatherData

## Known problems

While every effort has been made to clean up all the “defects” that have occurred during our testing, quite a few known (and even more unknown) probably remain. Specifics on the remaining known problems can be found in [Known\\_Issues-V2-1-0.htm](#). If you are super interested in what has been addressed, the issues resolved in this release are installed in the main EnergyPlus folder – html file [Addressed\\_Issues-V2-1-0.htm](#).

## Thanks

Thanks for downloading and registering EnergyPlus. If you did not download the previous version, we welcome you. If you are a returning customer, we hope you find the latest release exceeding your expectations.

We look forward to serving you!

*EnergyPlus Development, Testing, and Support Team*

## Acknowledgments

Copyright © 1996-2007 The Board of Trustees of the University of Illinois and The Regents of the University of California through Ernest Orlando Lawrence Berkeley National Laboratory. All rights reserved.

Portions of the EnergyPlus™ software package have been developed and copyrighted by other individuals, companies and institutions. These portions have been incorporated into the EnergyPlus software package under license.

**In addition to the primary authorship of the LBNL Simulation Research Group (<http://simulationresearch.lbl.gov/>) and the UIUC Building Systems Laboratory, the following have contributed to EnergyPlus Version 1 (includes all minor revisions):**

Portions of the EnergyPlus weather processor were developed by US Department of Energy, Office of Building Technologies, [www.energyplus.gov](http://www.energyplus.gov)

Portions of the input processing, output processing, weather processor, BLAST Translator were developed by US Army Corps of Engineers, Construction Engineering Research Laboratories, 2902 Newmark Drive, Champaign IL 61821. [www.cecer.army.mil](http://www.cecer.army.mil)

Portions of this software package were developed for Ernest Orlando Lawrence Berkeley National Laboratory by Linda Lawrie of DHL Consulting.

Portions of this software package were developed for Ernest Orlando Lawrence Berkeley National Laboratory by C.O. Pedersen Associates.

Portions of the EnergyPlus utility software (EP-Launch, IDFEditor, DOE2Translator, HVAC-Diagram, ExpandObjects, CSVProc, System Templates, and convertESOMTR) were developed by GARD Analytics, Inc. 1028 Busse Highway, Park Ridge, Illinois 60068-1802, USA (847) 698-5690, [www.gard.com](http://www.gard.com). GARD Analytics performed independent verification and validation testing of the software after developing the testing strategy and plan. GARD Analytics was also responsible for gas absorption chiller, desiccant dehumidifier, ice storage (simple), table reports and economics.

Portions of flow resolver, chiller models (absorption, electric, const cop, engine-driven, gas-turbine), generator models (diesel electric, gas turbine), furnace models, heat recovery loop, plant loop, plant condenser loop, air-change dependent inside film coefficients were developed by Oklahoma State University, 110 Engineering North, Stillwater, OK 74078.

Portions of EnergyPlus related to the models for EMPD moisture calculations, DX coils, furnace/unitary systems, air-to-air heat pumps, changeover-bypass VAV systems, packaged terminal heat pumps, cooling towers, AirflowNetwork, refrigerated cases, reformulated and electric EIR chillers, desuperheater air and water heating coils, heat pump water heaters, desiccant and generic air-to-air heat exchangers, window screens, and thermal comfort controls were developed by University of Central Florida, Florida Solar Energy Center (FSEC), 1679 Clearlake Road, Cocoa, FL 32922, [www.fsec.ucf.edu/](http://www.fsec.ucf.edu/).

Portions of the refrigeration model were developed by Oak Ridge National Laboratory, Bethel Valley Road, Oak Ridge, Tennessee 37831.

Portions of EnergyPlus were developed by the National Renewable Energy Laboratory (NREL), 1617 Cole Blvd, Golden, CO 80401.

EnergyPlus v1.0.1, v1.0.2, v1.0.3, v1.1, v1.1.1 (Wintel platform) includes a link to TRNSYS (The Transient Energy System Simulation Tool) for photovoltaic calculations developed by Thermal Energy System Specialists, 2916 Marketplace Drive, Suite 104, Madison, WI 53719; Tel: (608) 274-2577. EnergyPlus v1.2 and later includes Photovoltaic calculations implemented in EnergyPlus by Thermal Energy System Specialists. This model was originally developed by Oystein Ulleberg, Institute for Energy Technology, Norway -- based on the Duffie and Beckman equivalent one-diode model.

Portions of this software package that convert certain stand-alone heat transfer models for slab-on-grade and basement foundations were developed by William Bahnfleth, Cynthia Cogil, and Edward Clements, Department of Architectural Engineering, Pennsylvania State University, 224 Engineering Unit A, University Park, Pennsylvania 16802-1416, (814) 863-2076.

The concept and initial implementation for the EnergyPlus COM/DLL version (Wintel platform) was made possible through cooperation with DesignBuilder Software, Ltd, Andy Tindale – an EnergyPlus collaborative developer.

The thickness, conductivity, density and specific heat values of the material layers for the constructions in the Composite Wall Construction reference data set have been taken from the ASHRAE report “Modeling Two- and Three-Dimensional Heat Transfer through Composite Wall and Roof Assemblies in Hourly Energy Simulation Programs (1145-TRP),” by Enermodal Engineering Limited, Oak Ridge National Laboratory, and the Polish Academy of Sciences, January 2001.

EnergyPlus v1.2 and later versions contains DELight2, a simulation engine for daylighting and electric lighting system analysis developed at Ernest Orlando Lawrence Berkeley National Laboratory.

Portions of the EnergyPlus AirflowNetwork model were written by George Walton of the National Institute for Standards and Technology (NIST), 100 Bureau Drive, Gaithersburg, MD 20899. The EnergyPlus AirflowNetwork model also includes portions of an early version of COMIS (Conjunction Of

Multizone Infiltration Specialists) developed by a multinational, multi-institutional effort under the auspices of the International Energy Agency's Buildings and Community Systems Agreement working group focusing on multizone air flow modeling (Annex 23) and now administered by the Swiss Federal Laboratories for Materials Testing and Research (EMPA), Division 175, Überlandstrasse 129, CH-8600 Dübendorf, Switzerland.

The EnergyPlus v1.2 model for displacement ventilation and cross-ventilation was developed by Guilherme Carrilho da Graça (Department of Mechanical and Aerospace Engineering, University of California, San Diego and NaturalWorks) and Paul Linden (Department of Mechanical and Aerospace Engineering, University of California, San Diego).

The EnergyPlus models for UFAD served zones were developed by Anna Liu and Paul Linden at the Department of Mechanical and Aerospace Engineering, University of California, San Diego.

ASHRAE research project 1254-RP supported the development of the following features first added in EnergyPlus v1.2.2: DXSystem:AirLoop enhancements (valid as OA system equipment, new humidity control options); New set point managers: SET POINT MANAGER:SINGLE ZONE HEATING, SET POINT MANAGER:SINGLE ZONE COOLING, and SET POINT MANAGER:OUTSIDE AIR PRETREAT; New 2-stage DX coil with enhanced dehumidification option (COIL:DX:MultiMode:CoolingEmpirical); Additional DESICCANT DEHUMIDIFIER:SOLID setpoint control option; American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329. [www.ashrae.org/](http://www.ashrae.org/). Work performed by GARD Analytics, Inc., 1028 Busse Highway, Park Ridge, Illinois 60068-1802, USA. [www.gard.com/](http://www.gard.com/), November 2004.

EnergyPlus v1.2.2 and later versions contains links to SPARK, a simulation engine for detailed system modeling developed at Ernest Orlando Lawrence Berkeley National Laboratory in conjunction with Ayres Sowell Associates, Inc.

The Ecoroof (Green Roof) model, first introduced in EnergyPlus v2.0, was developed at Portland State University, by David Sailor and his students. It is based on the FASST vegetation models developed by Frankenstein and Koenig for the US Army Corps of Engineers.

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**TRADEMARKS:** EnergyPlus is a trademark of the US Department of Energy.

### **Other Acknowledgments**

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