

**Description:**

EnergyPlus is energy simulation software for the design of energy-efficient commercial and residential buildings, including both new and retrofit construction.

Why is it Innovative?

Buildings are complex entities. Their energy performance depends on non-intuitive, interdependent factors. One way to optimize performance is to use an energy simulation program that models the complex building heat transfer processes. These programs are proven energy and money savers and there are several that model energy use and perform certain aspects of this well. **However, EnergyPlus raises the state of the art to an entirely new level by significantly expanding what can be simulated, integrating these simulations, and providing real-time feedback to assist with building operations.**

Identify Each of Its Innovations

EnergyPlus' Critical advantages over other building simulation software include the following:

- **Models not only heating, cooling, and ventilating systems (HVAC), but also natural ventilation, windows, solar shading, passive solar heating, daylighting, photovoltaics, occupant thermal comfort, and atmospheric pollutant production.**
- Integrated Simultaneous Simulation of Building Processes
- Compatible with CAD (Computer-Aided Design) Programs
- User-Configurable HVAC Systems
- End-Use Meters
- Modeling of Natural Ventilation Flows
- Accessible, Easily Updated Modular Code

What it Changed or Replaced?

We know that energy simulation programs work. Building energy use accounts for one-third of the nation's total energy use and two-thirds of our electrical energy use. This means that even relatively small efficiency gains translate into large energy savings. For instance, through the use of building software called DOE-2 (the U.S. Department of Energy's original building software and one of EnergyPlus's predecessors) a **\$20 billion cumulative energy savings** was gained over the last 25+ years. With its expanded features, modularity, and ability to simulate so many interactions, the EnergyPlus development team expects **EnergyPlus will surpass this level of savings.**

Where and When did it Originate

EnergyPlus was developed jointly by Lawrence Berkeley National Laboratory, the University of Illinois, the U.S. Army Construction Engineering Research Laboratory, GARD Analytics, Inc., Oklahoma State University and others, with support from the U.S. Department of Energy, Office of Building Technology, State and Community Programs. Version 1 was released in April 2002

Where Has it Been Used (partial list)

- Freedom Tower, World Trade Center, NY
- New Federal Building, San Francisco
- Teterboro Airport building, Bergen County, NJ
- Evergreen College Arts Center, San Jose, CA
- University of California at San Diego Computer Center
- Schools in Kishinau, Republic of Moldavia
- Apartment building, Bucharest
- Hospital, Dublin, Ireland
- Harrison Street Station, Passaic, NJ
- Onehunga Library, Auckland, NZ

Where Will it be Used in the Future

In addition to EnergyPlus being used by engineers, building designers/owners, and architects, the program may be used for these additional applications:

- **New Software Development** -- New software products have been developed that extend the modeling capabilities of EnergyPlus.

Standards Development -- New building energy standards for the U.S. and other countries.

Analyze the impact(s) of New Technologies -- For example, EnergyPlus can analyze the performance of a fuel cell that provides heat and power to a building, and thereby determine if it is cost effective for that specific building.

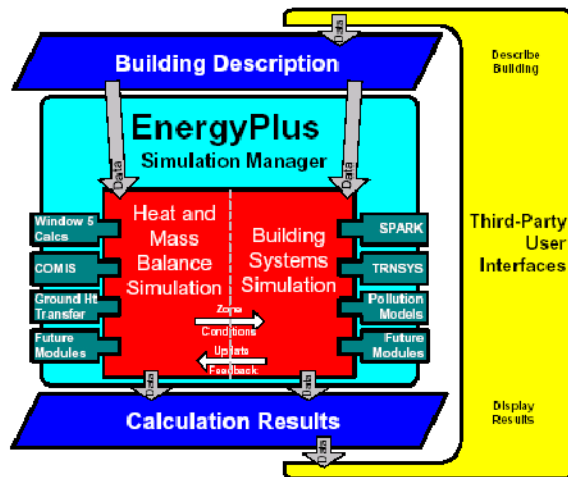
Guidelines to Reducing Building Electric Demand -- EnergyPlus is being used to make recommendations to California building operators on how to reduce electric demand when blackouts are threatened.

Diagnosis of Existing Building Systems and Building Control -- Detect faults in existing building systems by comparing the ideal operation of the system (as predicted by EnergyPlus running in real time) with the actual operation. This can function as an integral part of building control.

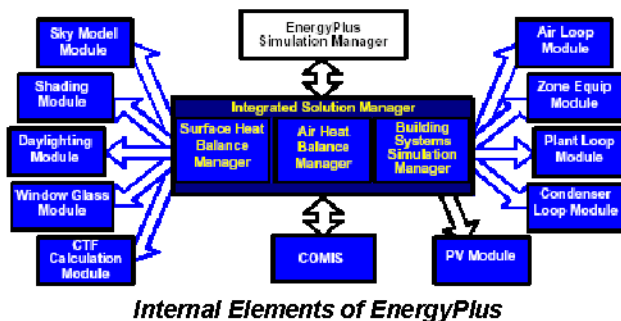
Educational Tool -- EnergyPlus is being used in college classrooms to train architectural students in building modeling.

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Internal Structure of EnergyPlus and Selected Buildings Designed Using EnergyPlus



Schematic of EnergyPlus. With third-party interfaces, users describe the building (Input Data) and display calculation results (Output Data). The Simulation Manager accepts input data and controls the Heat Balance Simulation (calculation of heating and cooling requirements) and the Building Systems Simulation (modeling the air conditioners, furnaces, etc. that provide heating and cooling). Plug-in modules run specialized simulations such as atmospheric pollutant production.



Federal Courthouse, Miami, FL



EnergyPlus is being used in the energy-efficient design of the Freedom Tower, to be built at the World Trade Center, New York



**FEDERAL BUILDING
SAN FRANCISCO, CA**

The new San Francisco federal building, cooled by natural ventilation, was designed with the aid of EnergyPlus. A unique feature of EnergyPlus is its ability to model natural ventilation flows through open windows.