

# DESIGNING LOW-ENERGY BUILDINGS

with

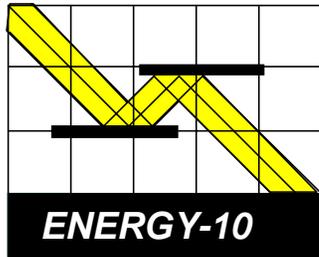
# ENERGY-10

The design tool  
you've been  
waiting for!



**Fast, Accurate, Easy to Use**

From NREL, LBNL, BSG, SBIC, and DOE



# ENERGY-10 MOTIVATION

**Mission** to provide a tool that a designer will use routinely to guide his or her decisions while developing the design of low-energy building.

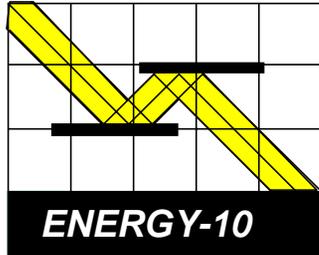
## Vision

Eventually all buildings will be designed to be delightful living, working, and learning environments, enhanced by natural light, requiring minimum resources to build and operate,



This library, built in 1980, has saved about 37 billion Btu (about \$700,000) over its 19 years operation, compared to a typical library. It cost no more to build and gets rave reviews from the librarians and users.

*—and that do not impair the environment for following generations.*



# ENERGY-10 TEAM

Buildings  
Research  
(provides  
strategies,  
algorithms)



## SBIC

(Sustainable  
Buildings  
Industries Council)  
English  
Schroeder

**Programming**  
Norm Weaver

## LBNL

Hitchcock  
Carroll

**NREL**  
*Balcomb*

## BSG

Wilcox

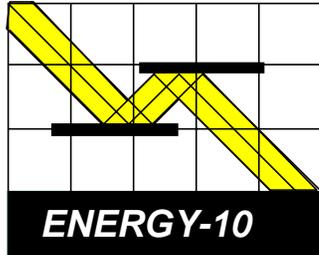


International Energy Agency (IEA) SH&C Tasks

Sustainable  
Solar  
Buildings  
(NREL)

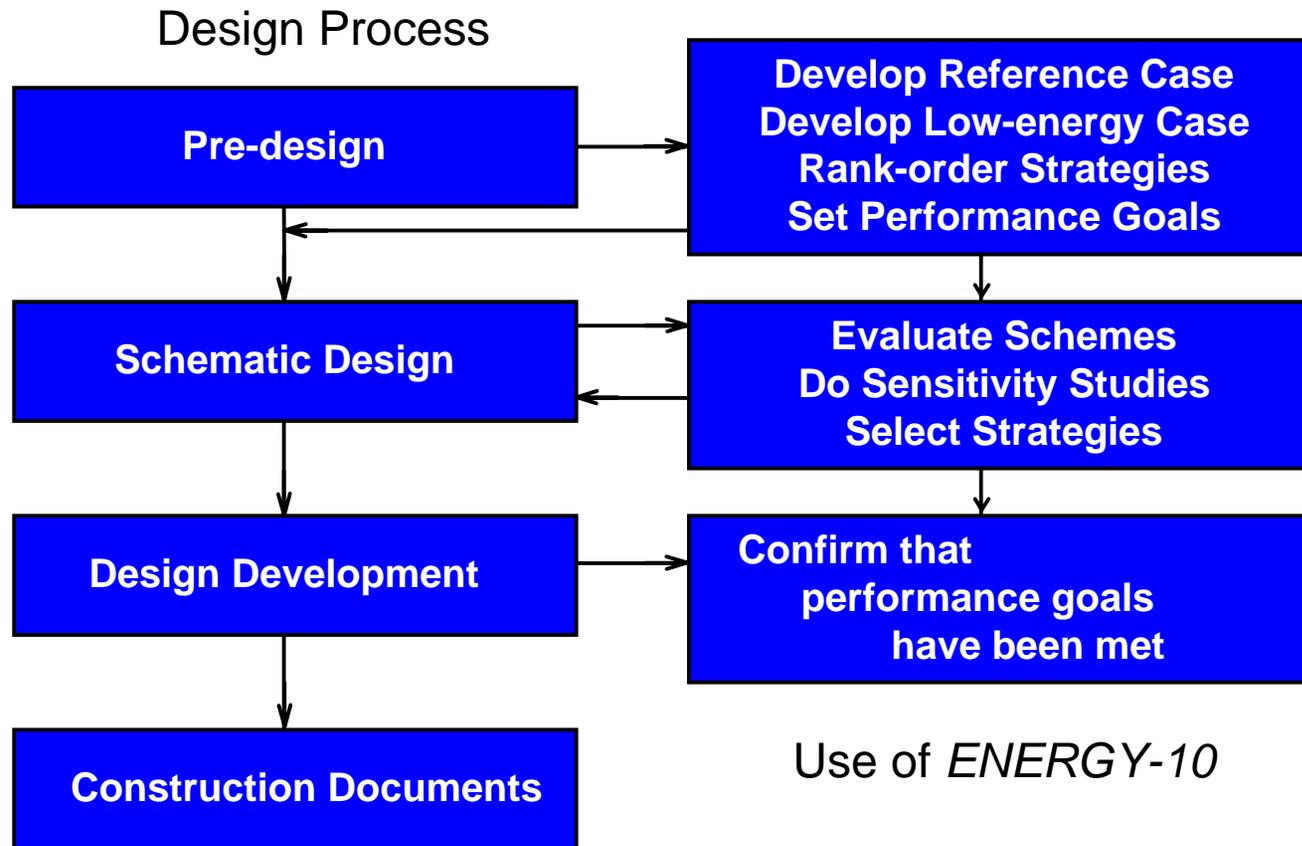
Daylighting  
(LBNL)

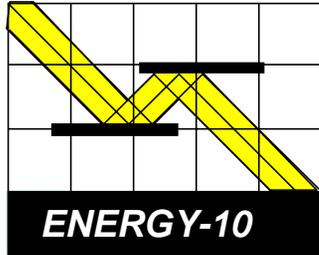
Tool Validation  
(HVAC BESTEST)



# WHOLE BUILDINGS FOCUS

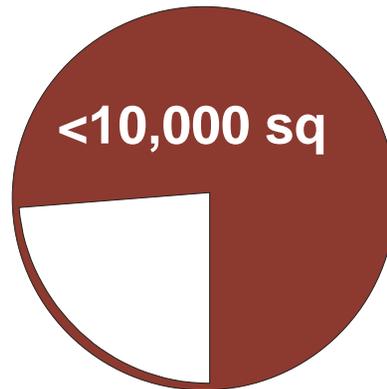
*ENERGY-10* works from the beginning of the design process





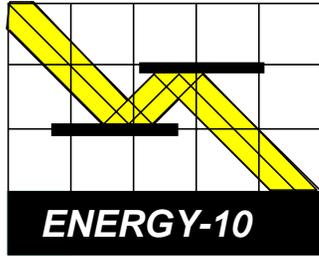
# ENERGY-10's NICHE

**ENERGY-10** is suitable for smaller buildings—commercial and institutional buildings under 10,000 sq. ft. — and also residential



76% of all non-residential buildings are under 10,000 sq. ft., representing 22 % of the total built floor area and 26% of the energy use.

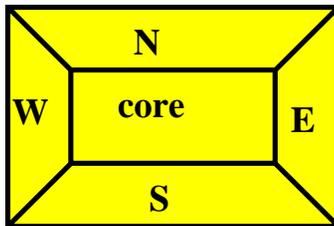




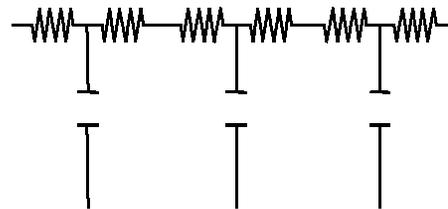
# ANALYSIS

Completely  
integrated  
hourly  
calculations

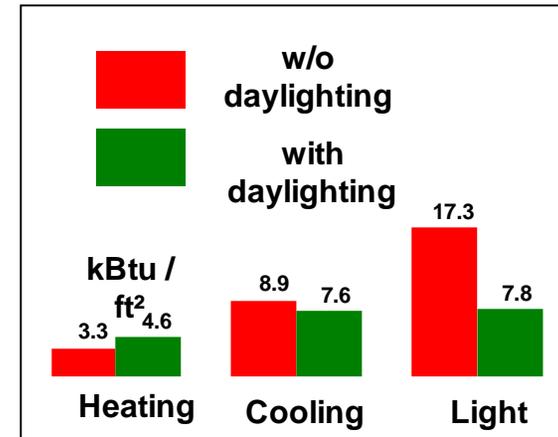
## Daylighting + Thermal



Split-flux method  
(from DOE-2)

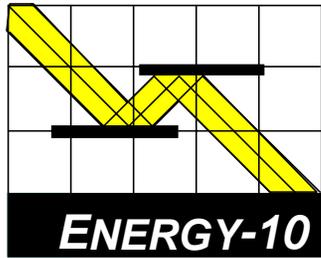


Thermal network method  
(exact energy balance)  
12 equipment options



*ENERGY-10* accounts for complex interactive effects, such as those shown here (dimming lights in response to daylight reduces cooling but increases heating).

**Passed IEA / DOE BESTEST  
validation procedure**

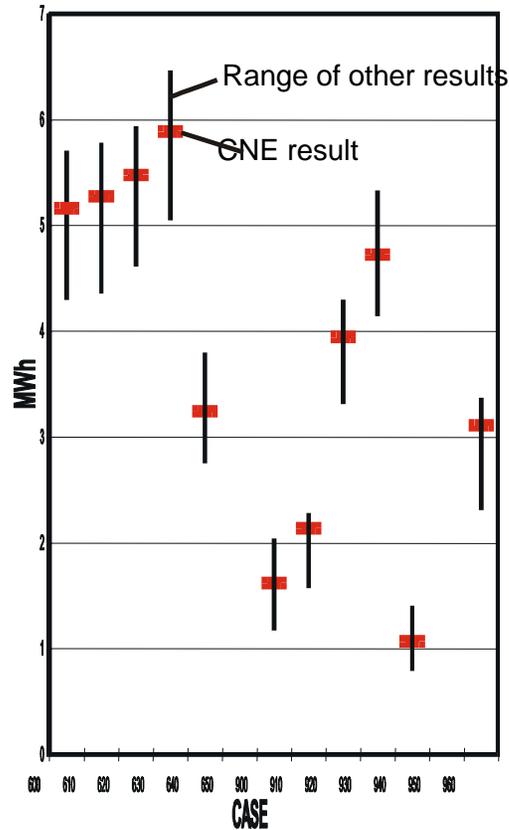


# BESTEST

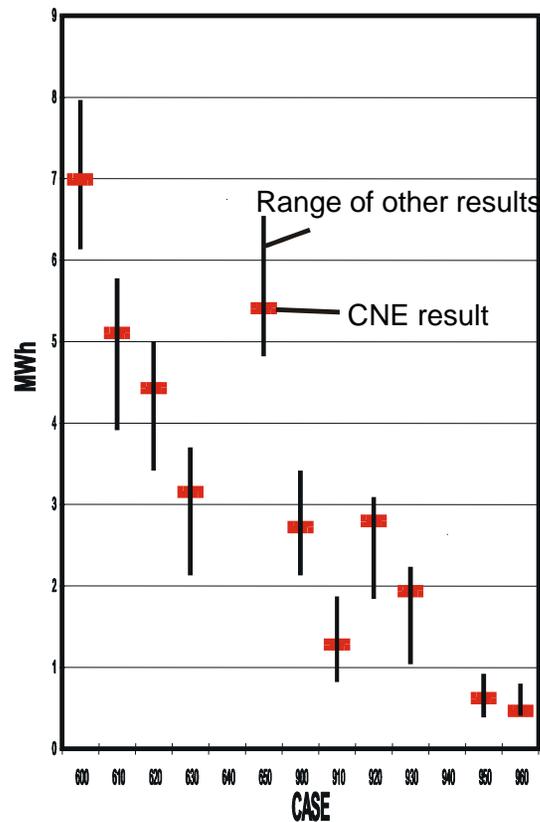
Compare CNE results with other simulation programs, DOE-2, BLAST, TRNSYS, ESP, SERI-RES, etc.

## Annual Loads

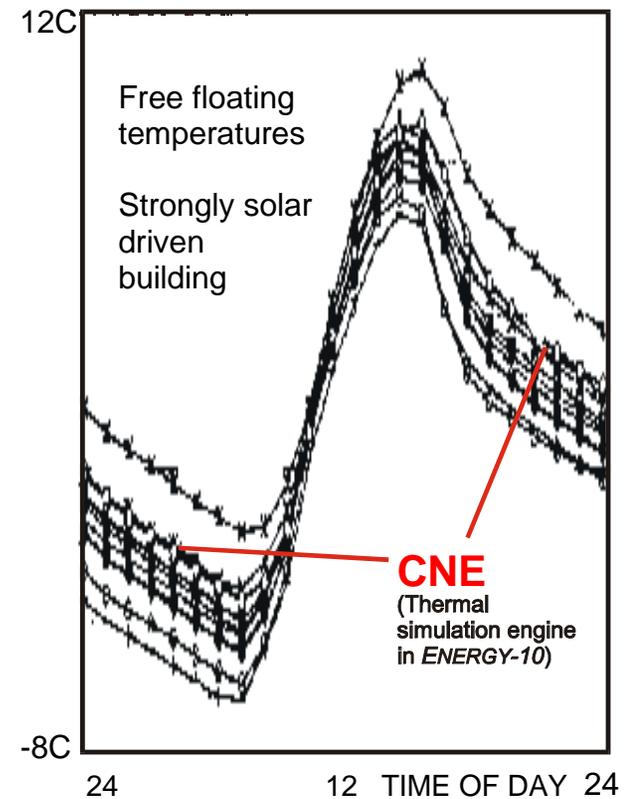
### Heating BESTEST

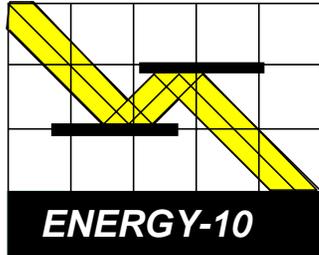


### Cooling BESTEST



### Transient BESTEST





# AutoBuild Feature

Creates two building descriptions based on five inputs and user-defined defaults.

- Location
- Building Use
- Floor area
- Number of stories
- HVAC system

**For example:**



Reference Case

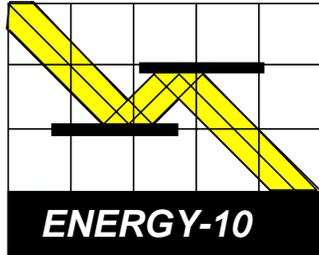
R-8.9 walls (4" steel stud)  
R-19 roof  
No perimeter insulation  
Conventional double windows  
Conventional lighting  
Conventional HVAC  
Conventional air-tightness  
Uniform window orientation  
Conventional HVAC controls  
Conventional duct placement



Low Energy Case

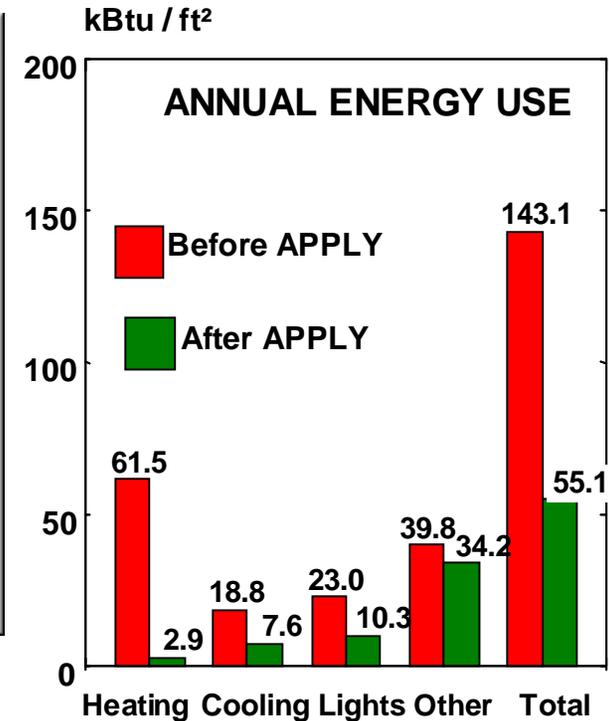
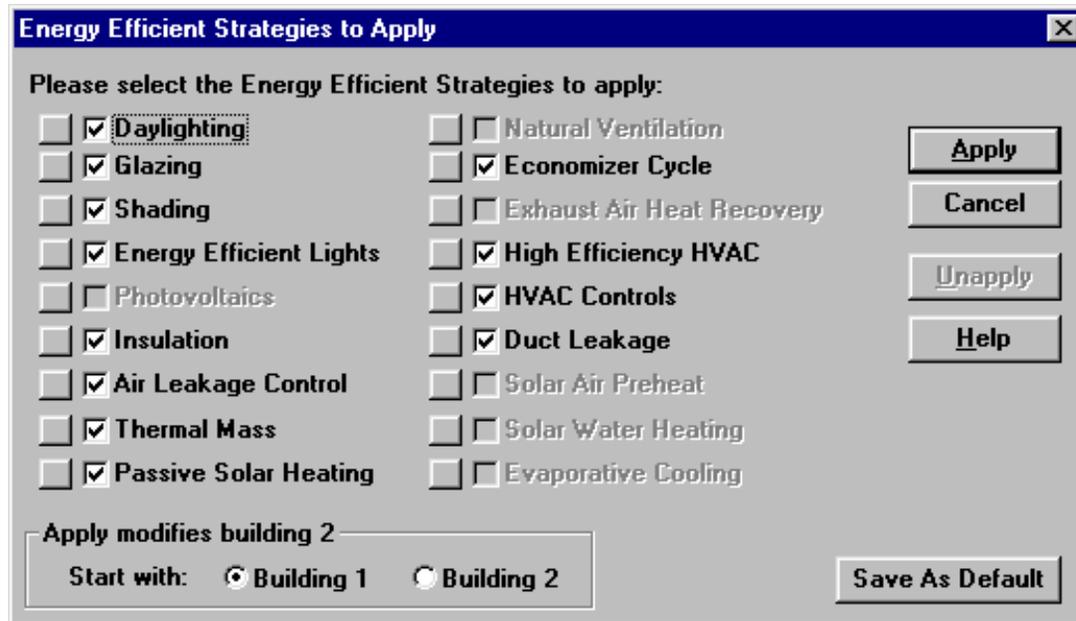
R-19.6 Walls (6" steel stud with 2" foam)  
R-38 roof  
R-10 perimeter insulation  
Best low-e double windows  
Efficient lights with daylight dimming  
High efficiency HVAC  
Leakage reduced 75%  
Passive solar orientation  
Improved HVAC controls  
Ducts located inside, tightened

**Gets you  
started  
quickly.**

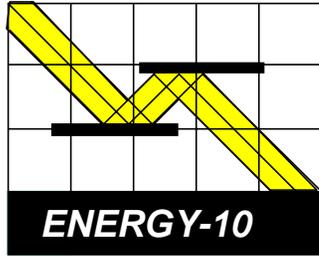


# APPLY Feature

Automatically modifies the building description to implement any or all of 12 strategies

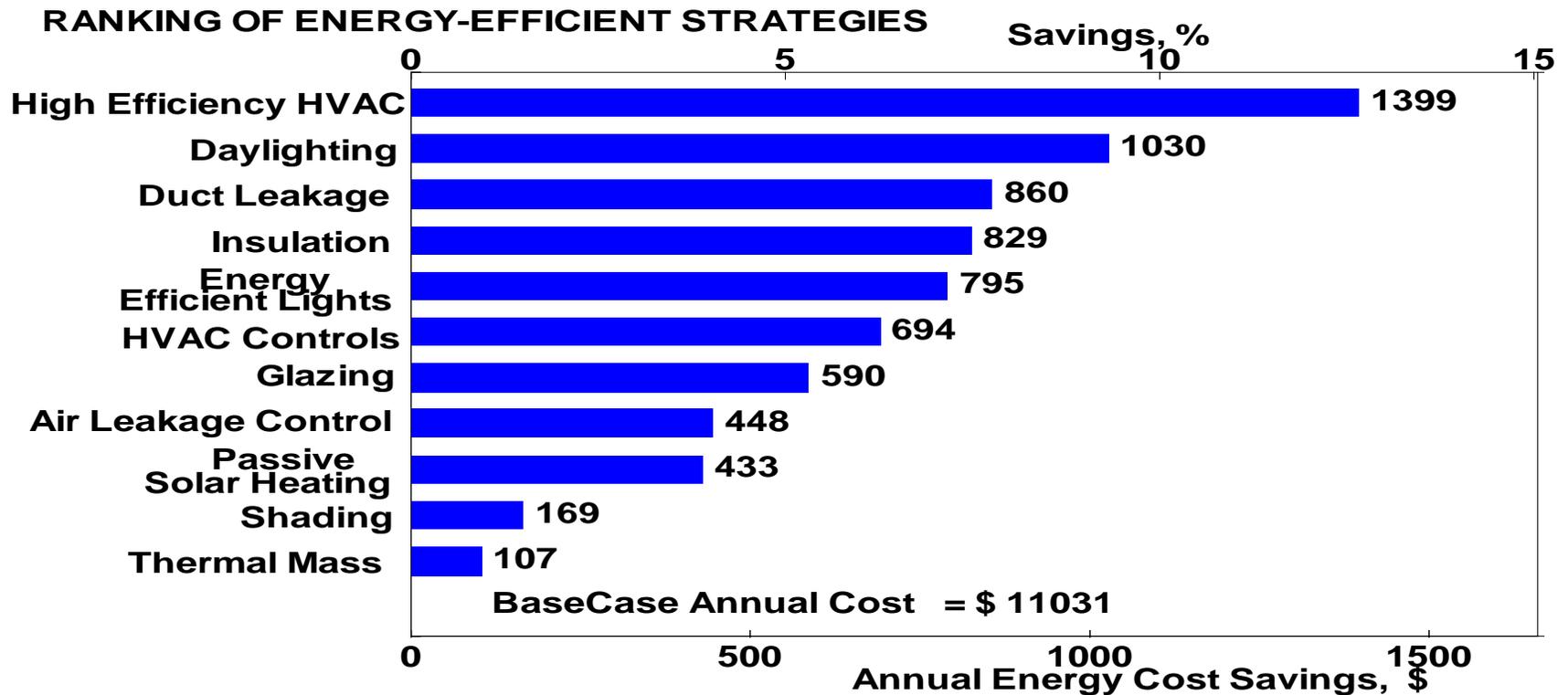


A few mouse clicks does it—saving time  
Yet the user has total control

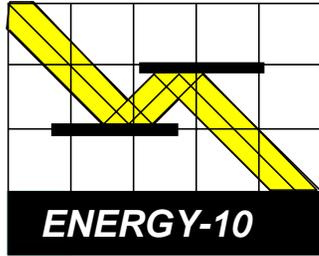


# RANK Feature

The same strategies in APPLY can be automatically ranked

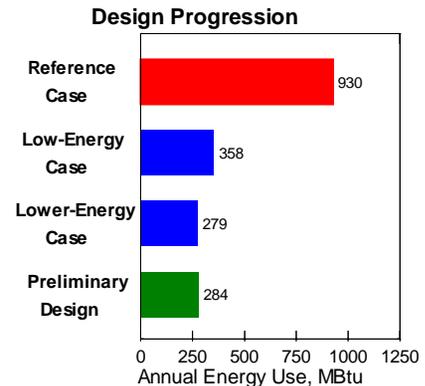
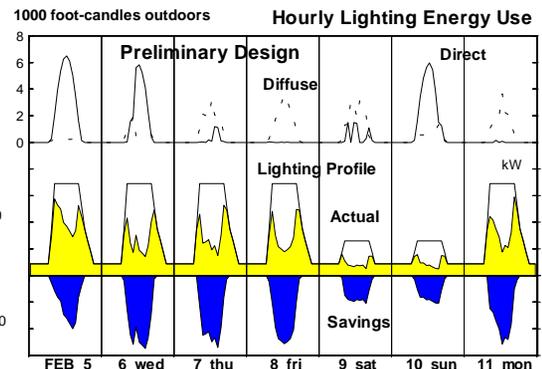
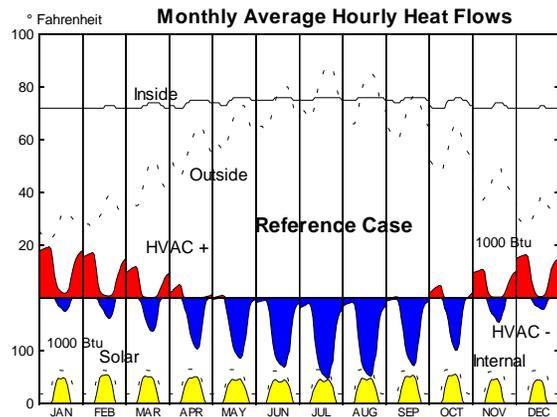
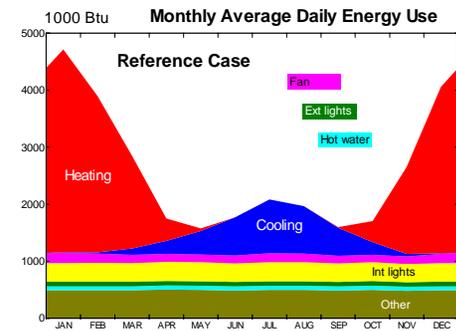
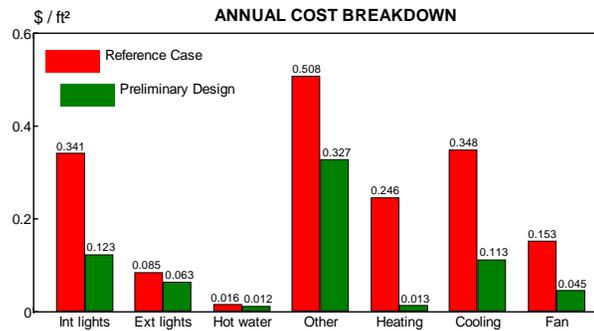
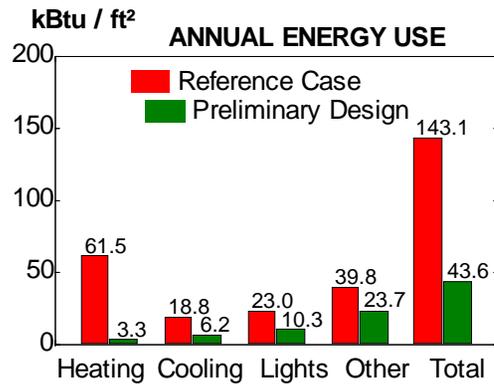


Procedures, such as sequencing simulations and rank ordering, are automated, greatly reducing the time required. This entire set of calculations, including making the plot, took about 10 minutes.

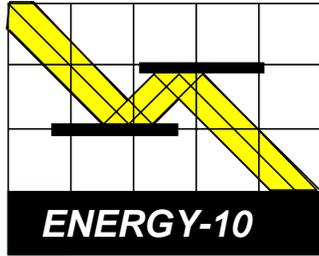


# Graphic Output

A few of the many options



Different views of the same pair of buildings



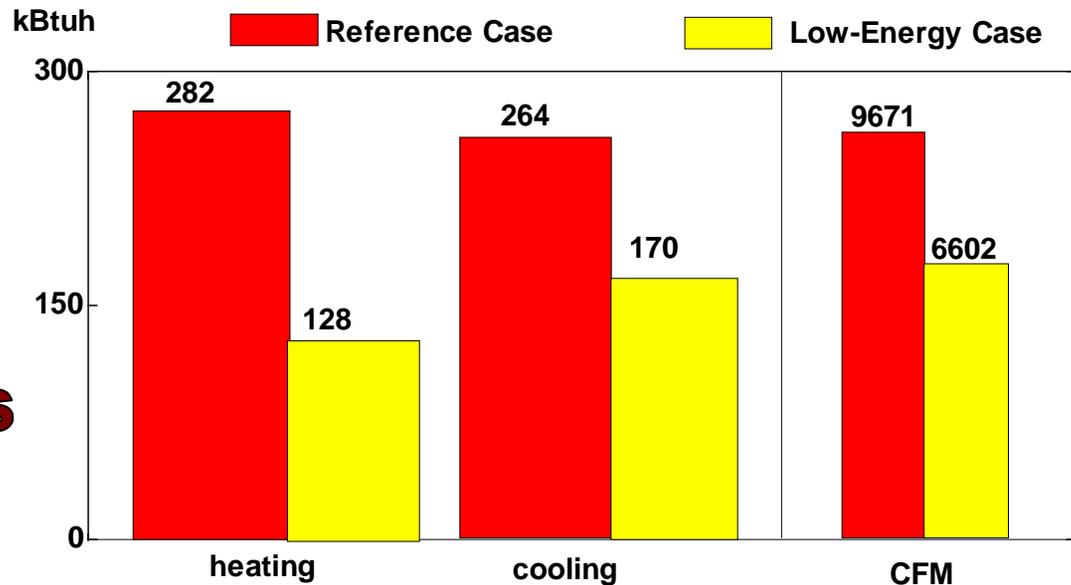
# AutoSize Feature

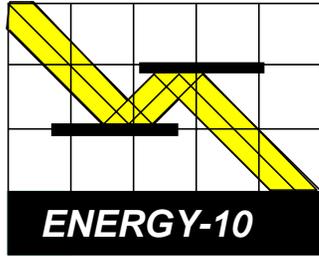
**ENERGY-10** uses the stimulation engine to size HVAC equipment.  
The process is automatic and takes only 1 or 2 seconds.

**HVAC cost reductions can pay the added cost of all the other upgrades!**

**AutoSize tells the story**

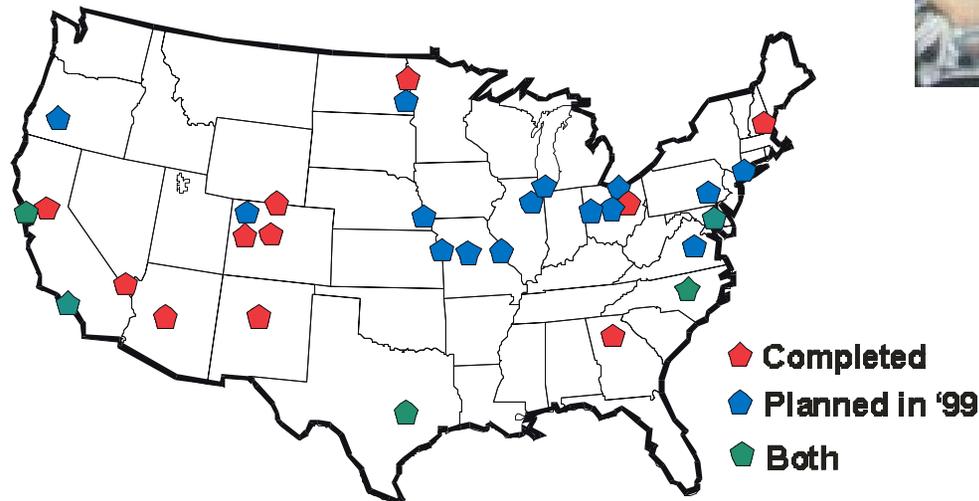
**HVAC RATED CAPACITIES**





# WORKSHOPS

Two-day workshops are a primary means of dissemination, providing critical instruction in the principles of energy efficient design and hands-on training in the use of *ENERGY-10*.



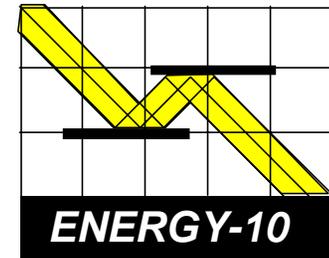
22 two-day workshops have been conducted and many more are scheduled.

Average attendance is about 22 persons.

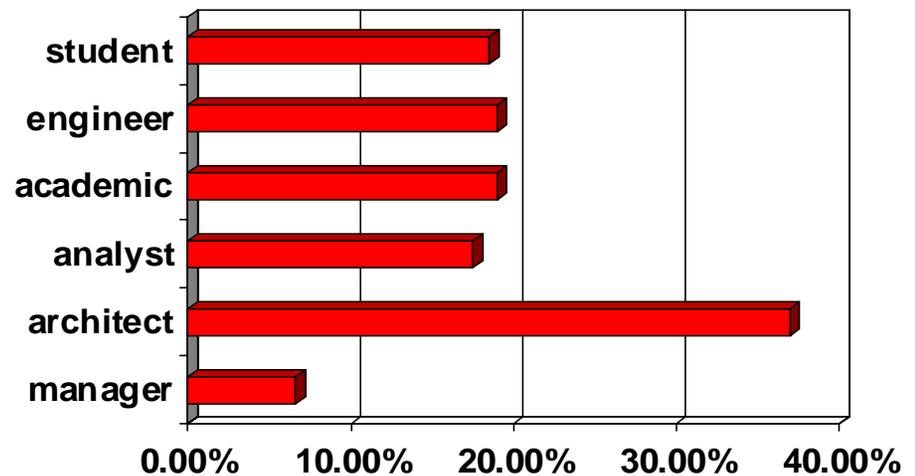
There are over 1290 registered users in just three years since Version 1.0 release.

40 site licensees are established at colleges and universities where *ENERGY-10* is being used as a teaching tool.

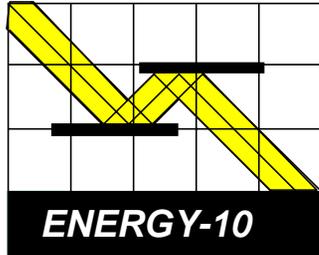
**Who is using ENERGY-10?**



Multiple answers possible



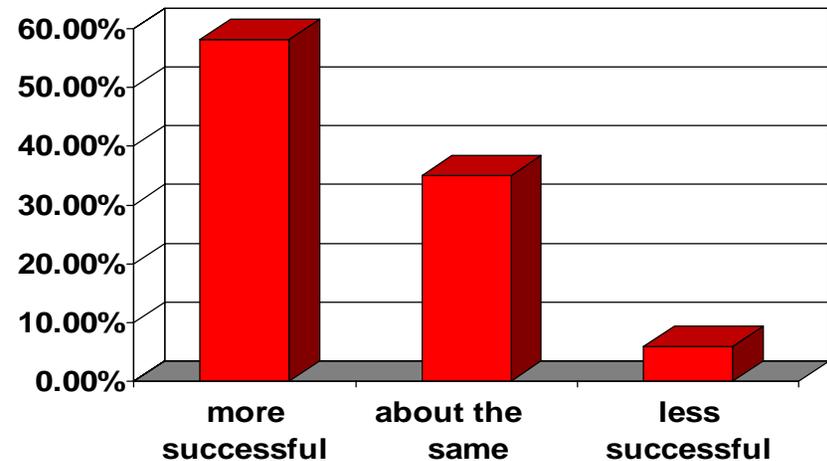
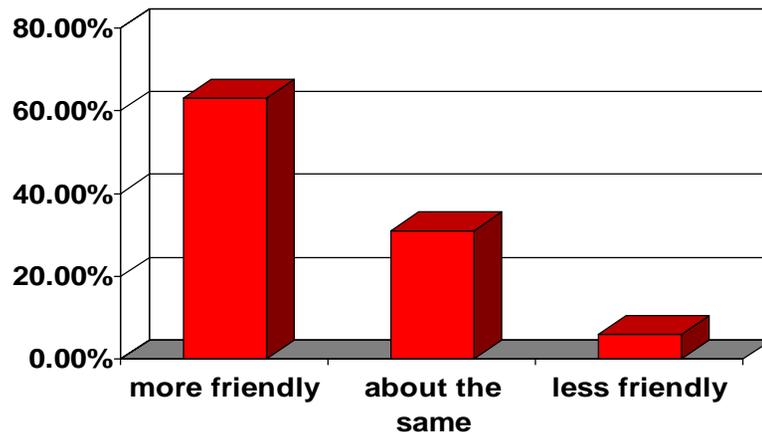
SBIC user survey, October 1998



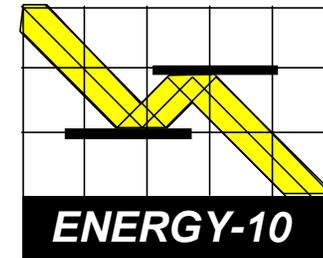
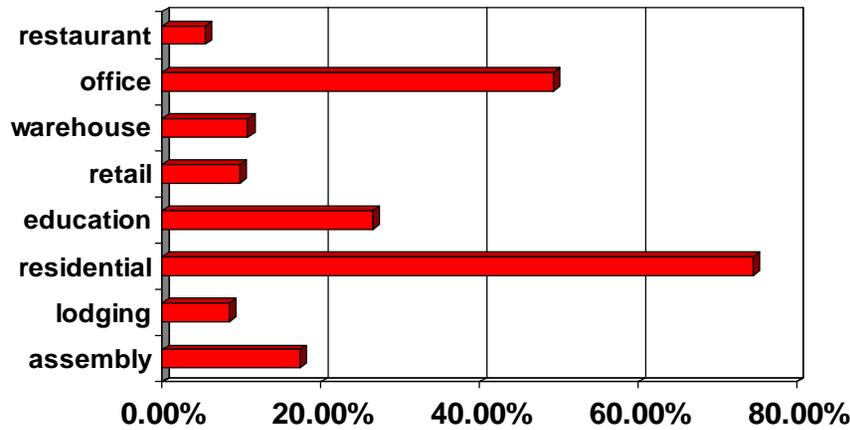
# SBIC User Survey

250 responding to 600 questionnaires, October 1998

**How does *ENERGY-10* compare with other energy analysis software you have used?**



**How do you judge the technical success of *ENERGY-10* compared with other software?**

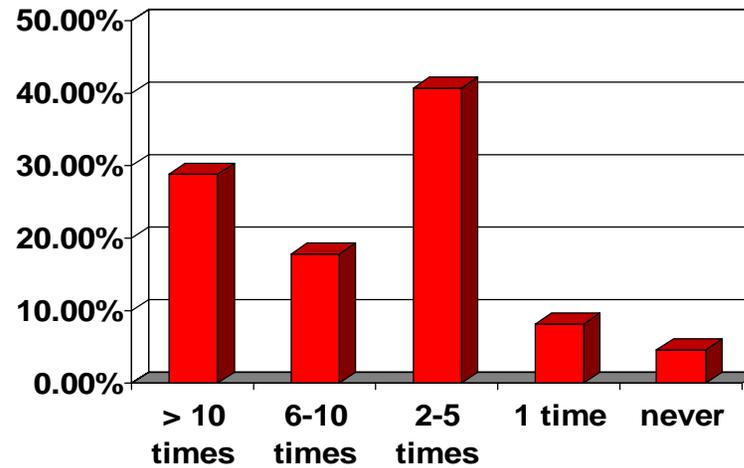


**HOW IS ENERGY-10 BEING USED?**

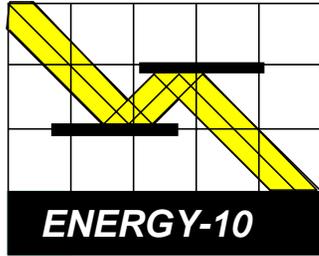
### Building Types Analyzed

Multiple answers possible  
 Non-residential adds to 128%

### Frequency of Use



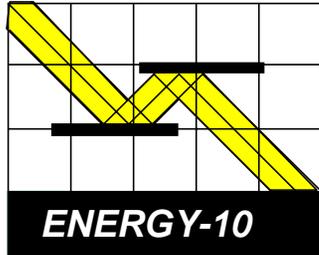
SBIC user survey, October 1998



# Architectural Award

**The *Progressive Architecture Research Award* was given to NREL and SBIC for the *Designing Low-Energy Buildings with ENERGY-10* package.**





# WeatherMaker

A weather-file utility for use with *ENERGY-10*

## Features:

### CONVERT

TMY2 format files to *ENERGY-10* format  
*ENERGY-10* format files to TMY2 format  
*ENERGY-10* (binary) to ASCII

### EVALUATE

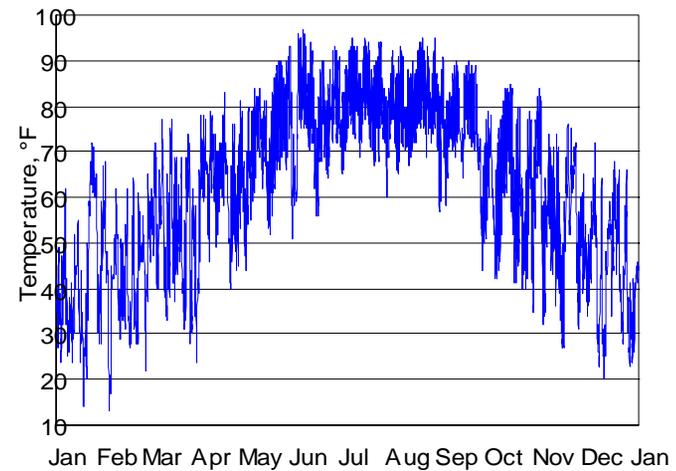
12 powerful graphical views of the data.

### ADJUST

Create new weather files for *ENERGY-10*.  
Expands the available 239 sites to  
3958 locations

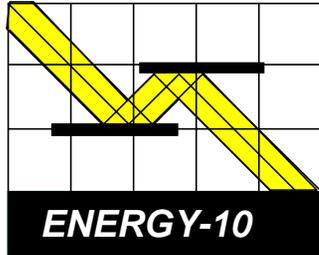


Temperatures  
Memphis, Tennessee



— Dry Bulb

January 01 - 12 AM to January 01 - 12 AM



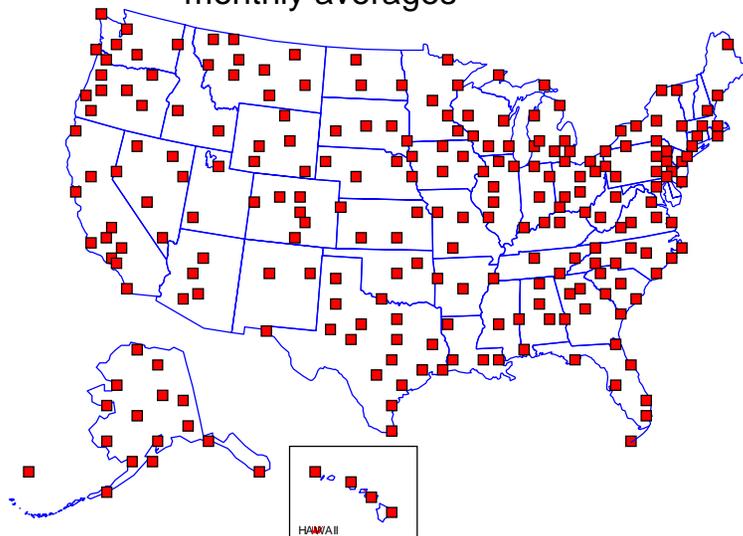
# WeatherMaker

## ADJUST

Create new weather files for *ENERGY-10*

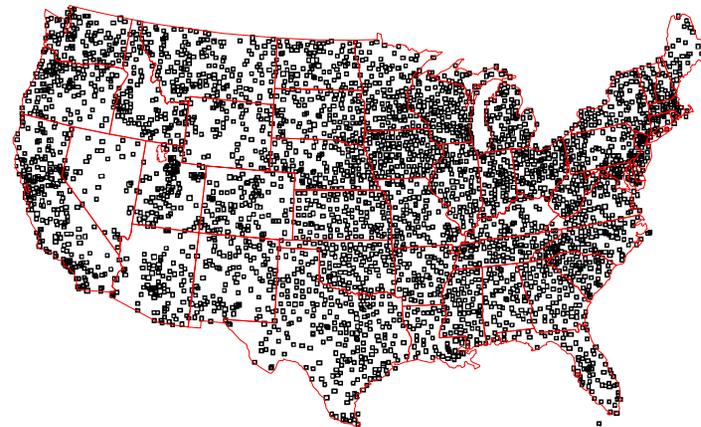
### 239 potential 'parent' sites (TMY2 data)

Temperatures and (later) solar radiation are adjusted hourly to match child site monthly averages

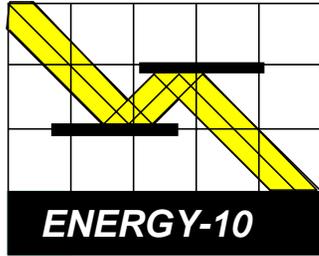


### 3958 'child' sites options:

locations on this map plus many in Alaska and Hawaii:



monthly data are stored on the *ENERGY-10* CD-ROM and are automatically loaded by the ADJUST wizard



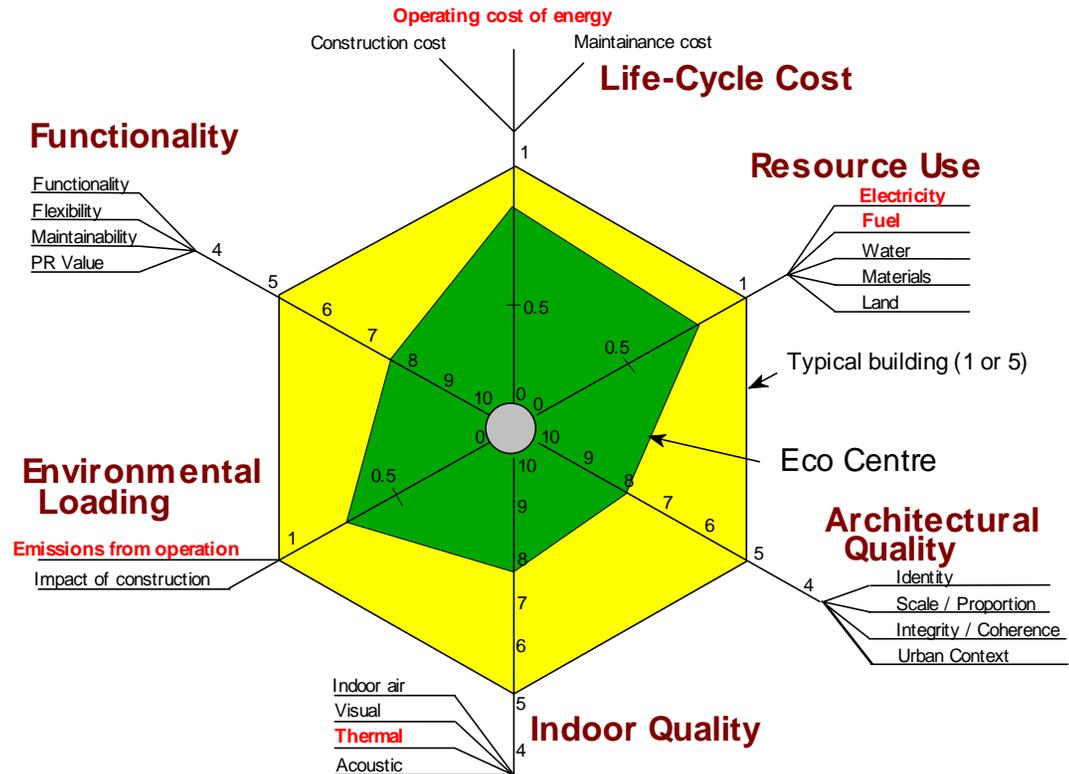
# Whole-Building Design

Consider all relevant criteria.

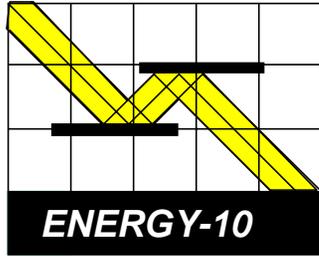
Use *ENERGY-10* to calculate some of the key values (shown in red)

Display results on a star diagram.

Multi-Criteria Building Performance Chart

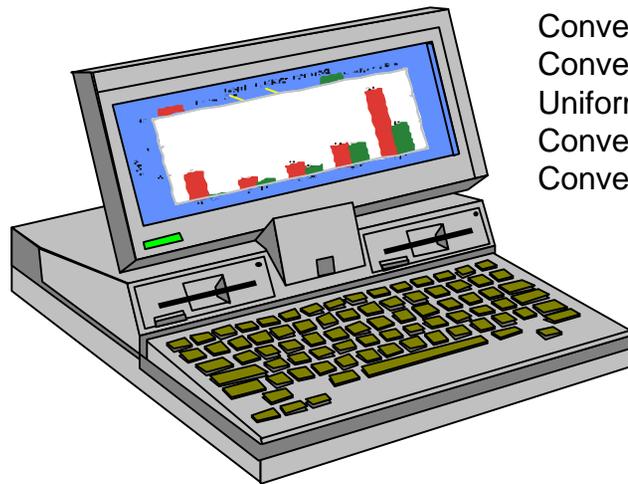


(This diagram developed by IEA SH&C Task 23, "Sustainable Solar Low-Energy Buildings")



# Demonstration

**Evaluate  
a 6500 sq.ft.  
single-story  
bank  
in Columbia,  
Missouri**



## Reference Case

R-8.9 walls (4" steel stud)  
R-19 roof  
No perimeter insulation  
Conventional double windows  
Conventional lighting  
Conventional HVAC  
Conventional air-tightness  
Uniform window orientation  
Conventional HVAC controls  
Conventional duct placement



## Low Energy Case

R-19.6 Walls (6" steel stud with 2" foam)  
R-38 roof  
R-10 perimeter insulation  
Best low-e double windows  
Efficient lights with daylight dimming  
High efficiency HVAC  
Leakage reduced 75%  
Passive solar orientation  
Improved HVAC controls  
Ducts located inside, tightened