Designing Low Energy Buildings

ENERGY-10

exclusive distribution by the

SUSTAINABLE BUILDINGS INDUSTRY COUNCIL

The ***ENERGY-10***™ software was developed by NREL under funding from the U.S. Department of Energy

using

ENERGY-10

in

design

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 39 billion Btu (about $740,000) over its 20 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's NICHE

ENERGY-10 is suitable for smaller buildings–commercial and institutional buildings around 10,000 sq. ft. in size, and characterized by two thermal zones. It is an excellent tool for modeling homes

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.

ENERGY-10 Team

ENERGY-10

Sustainable Buildings Industry Council

distribution, user support
training

Lawrence Berkeley National Lab

daylighting

National Renewable Energy Lab

& InterWeaver Consulting

project lead, passive solar buildings expertise, PV

U.S. Department of Energy

funding and oversight

Berkeley Solar Group

CNE thermal simulation engine

Highlights

ENERGY-10

- First ***user-friendly*** program based on hour-by-hour building simulation targeting early conceptual design decisions
- Automates many routine tasks, reducing time to produce results needed to make design decisions from days to hours
- Graphic input and output
- Technically solid
- Becoming widely used, both in practice and for teaching
- Major enhancements are in the pipeline
    - *Graphic input*, Improved Daylighting, PV…

Ease of Use

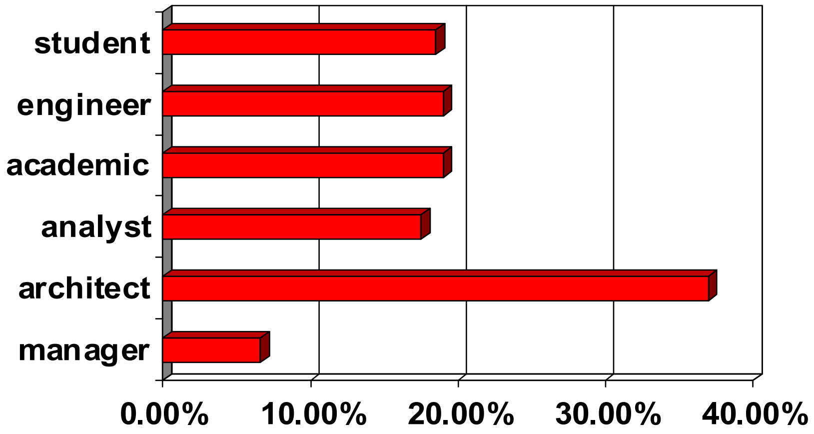
Automatic features make it easy and fast

- *AutoBuild* - defines a complete building based on five inputs and many defaults
- *APPLY* - creates a second building applying upgrades to implement any or all of 12 energy-efficient strategies
- *RANK* - determines relative effectiveness of strategies

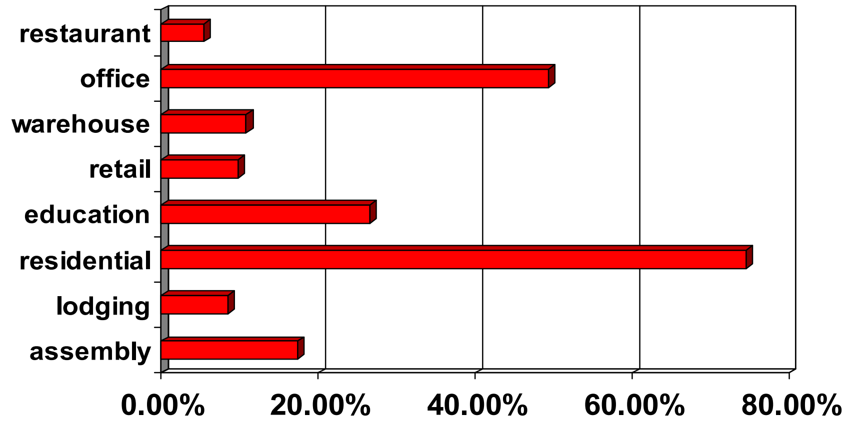
There are over 2000 registered users

Over 80 site licensees including 60 of these at colleges and universities where *ENERGY-10* is being used as a teaching tool.

Multiple answers possible



Who is using the program

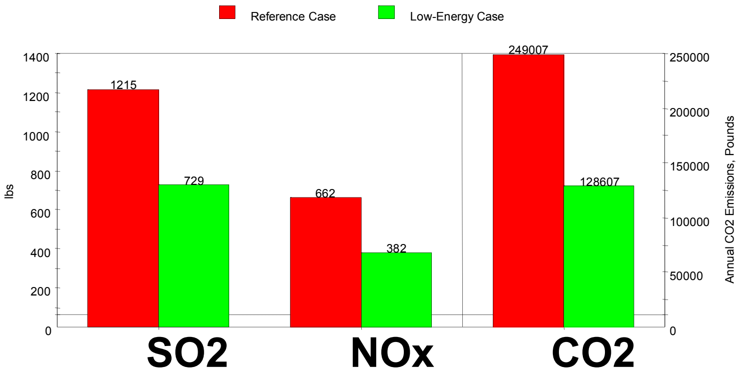


Building Types Analyzed

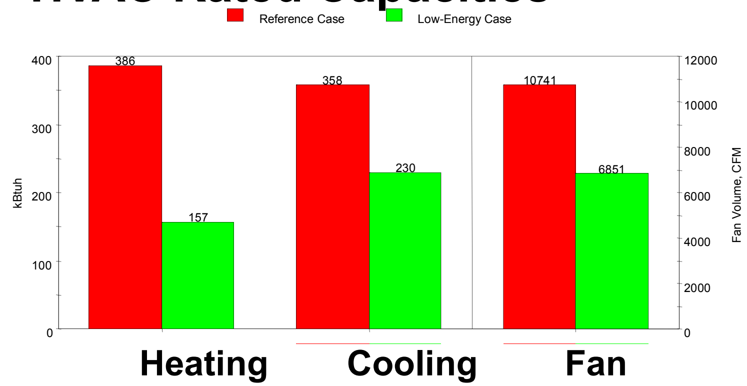
Non-residential adds to 128%

Many graphics options

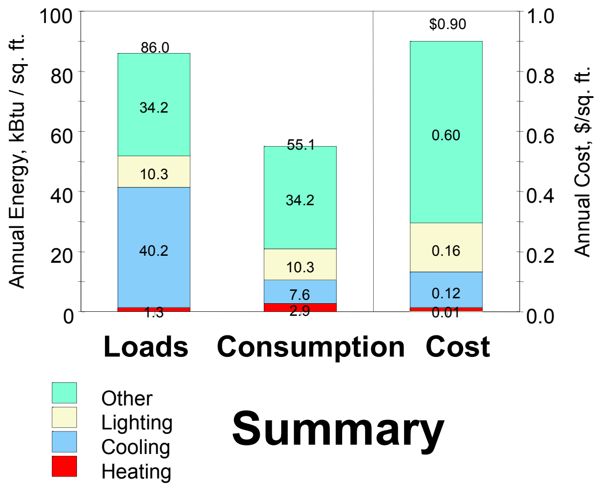
Annual Emissions Results



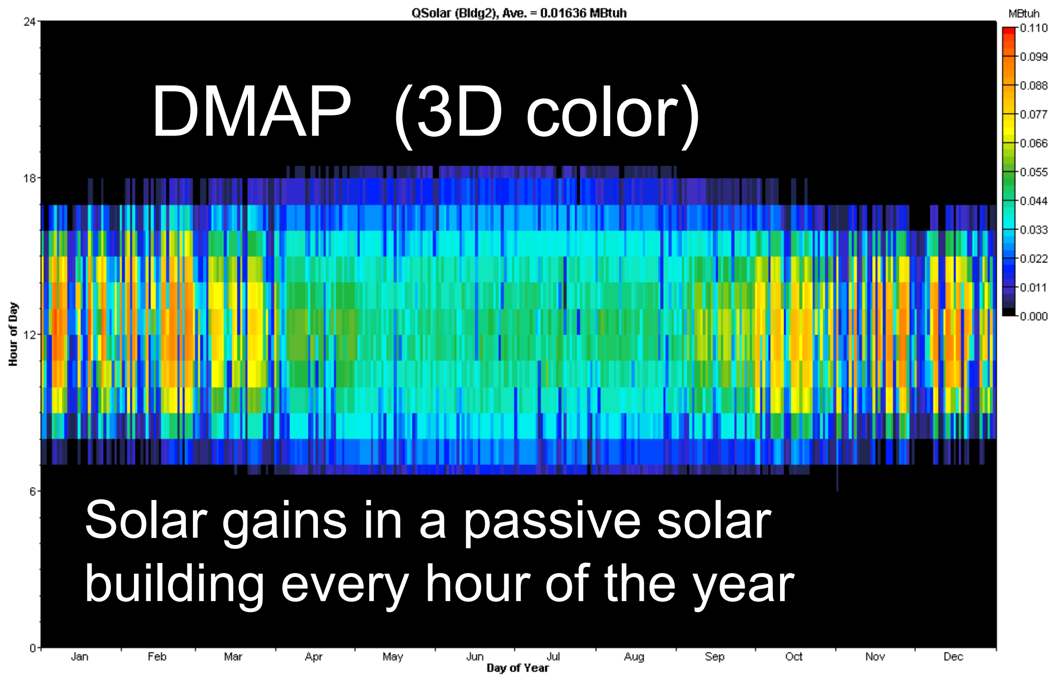
HVAC Rated Capacities



Low-Energy Case - Performance Summary

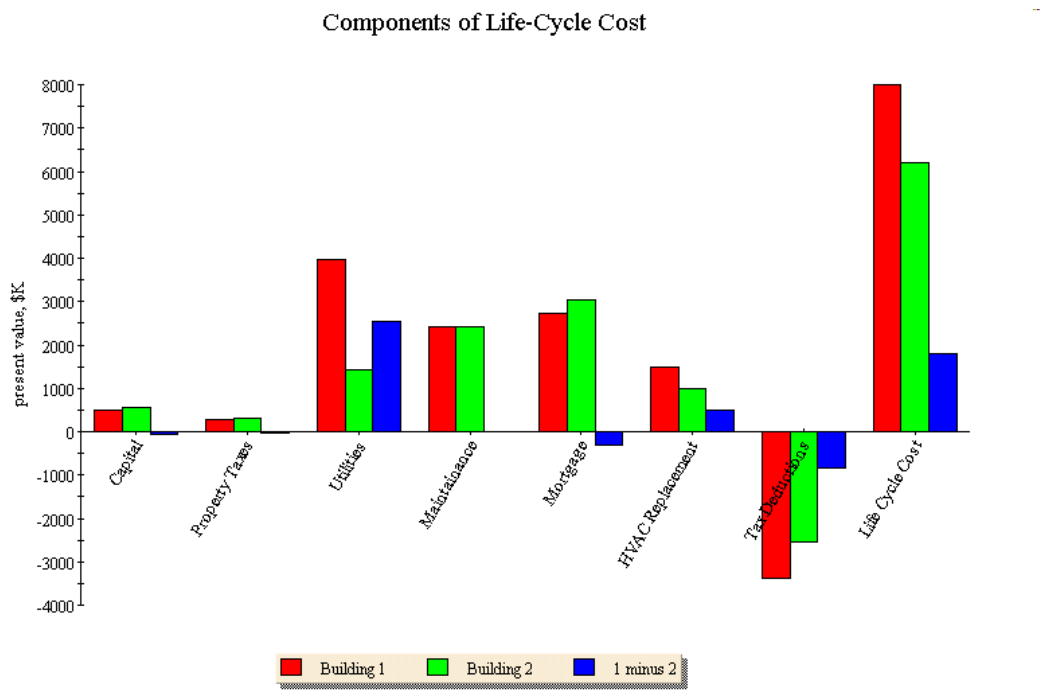


Summary



Life-Cycle Costs

- Full discounted cash flow analysis, accounting for all relevant factors to support cost/tradeoff decisions during conceptual design



- Ranks based on LCC, IRR, benefit/cost, or simple payback

Whole Building Focus

Evaluate a wide range of energy-efficient strategies, *working together*

Passive solar heating
Daylighting
High Efficiency HVAC
Insulation
Reduced duct leakage
Better windows
Energy efficient lights and ballasts
Lighting controls
Thermal mass
Better HVAC Controls
Economizer cycle
Reduced infiltration
Shading

Design Process Focus

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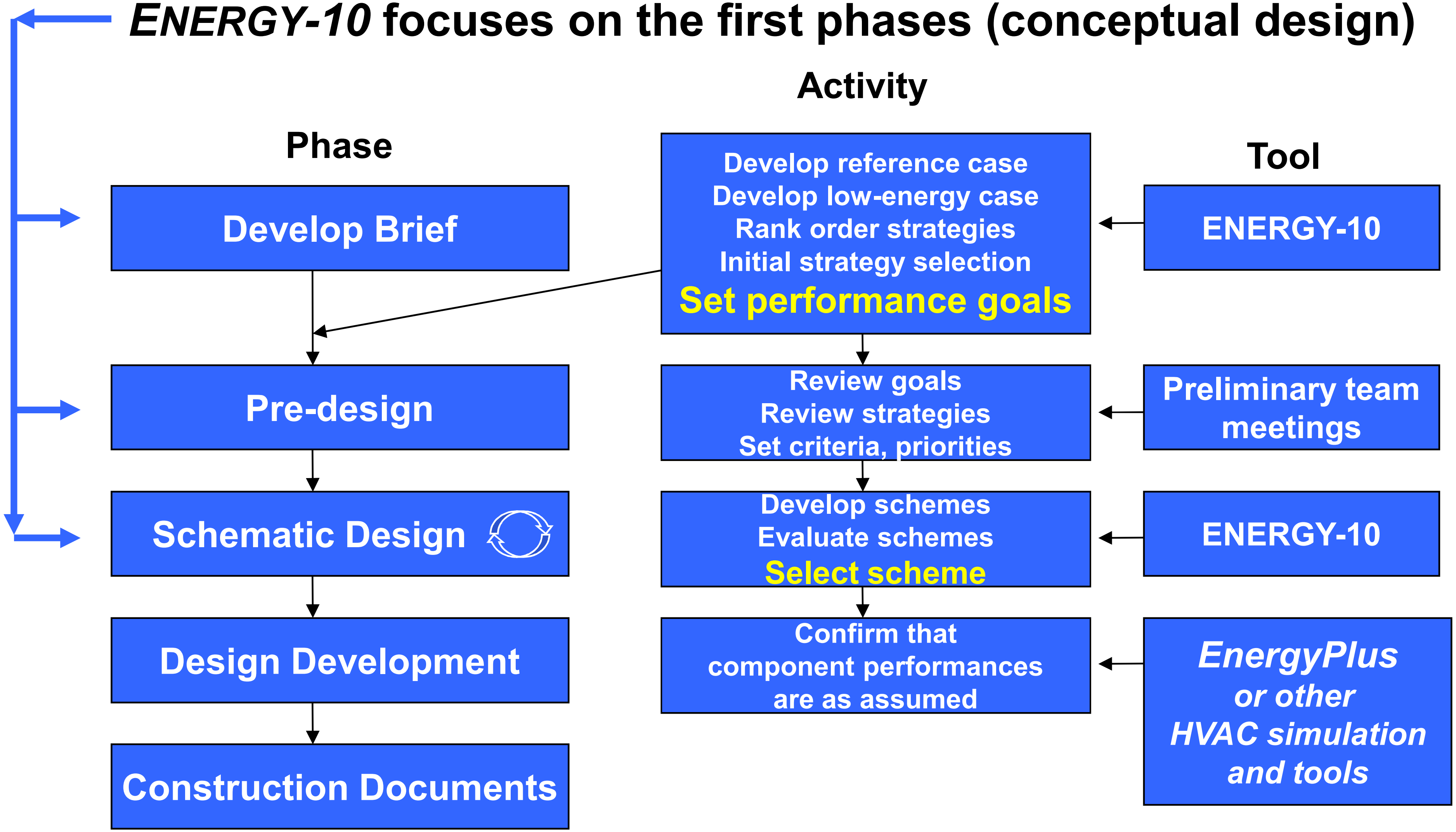
ENERGY-10 focuses on the first phases (conceptual design)



Before design starts

- Use *ENERGY-10* to develop performance goals

Develop Brief

Develop reference case
Develop low-energy case
Rank order strategies
Initial strategy selection
Set performance goals

- Then enforce the performance goals during the design process

Getting Started

- Use *AutoBuild* to develop a rectangular building with the desired attributes. This may require making changes in the *Provisional Data* dialog box.
- Adjust the Reference Case building as needed.
- Set the characteristics of the various EES Apply operations to reasonable choices.
- Apply a broad range of EESs to create a Low-Energy Case.

Example

ENERGY-10

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

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

Gets you started quickly.

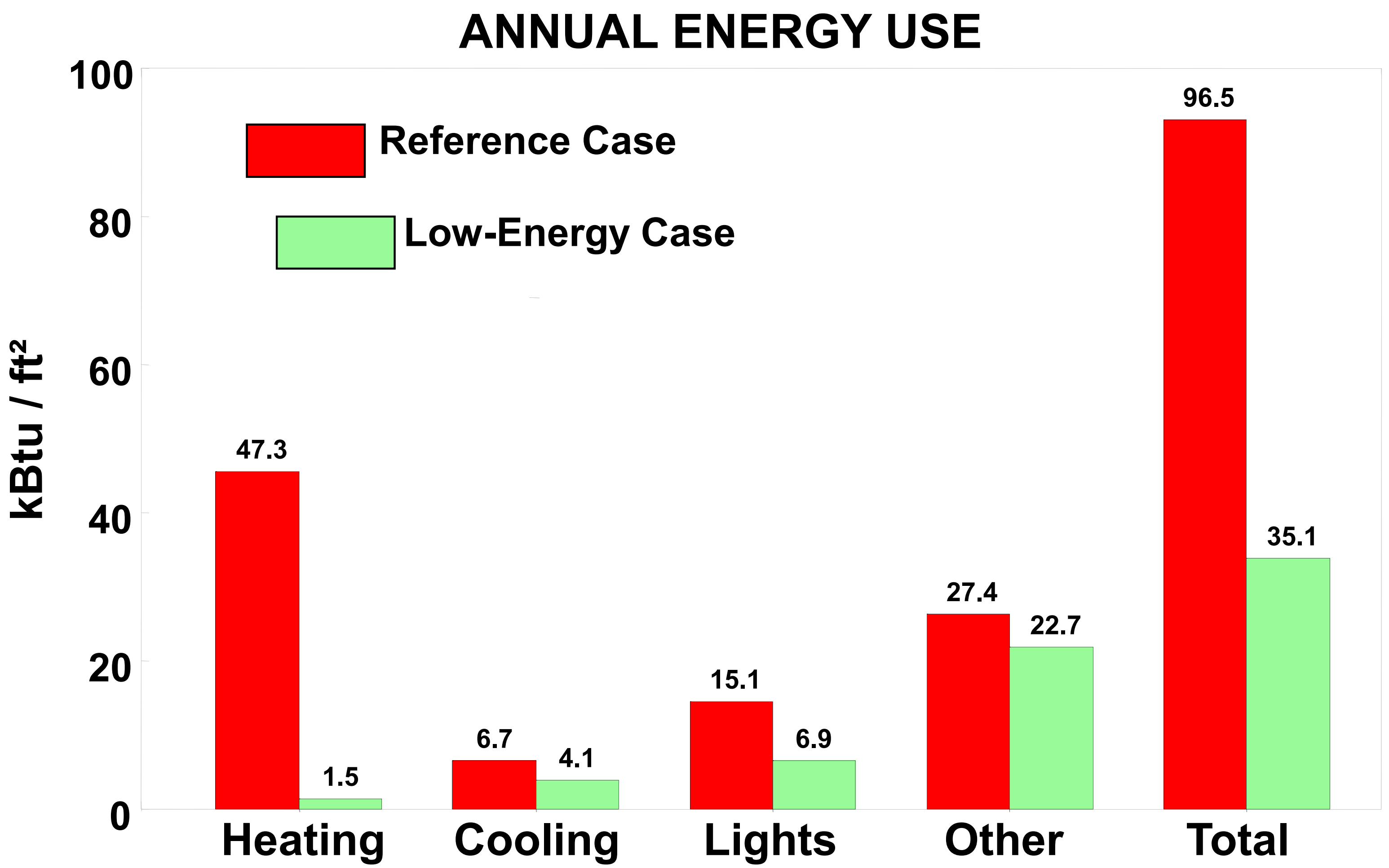
For example:

apply

Reference Case	Low Energy Case
R-8.9 walls (4" steel stud)	R-19.6 Walls (6" steel stud with 2" foam)
R-19 roof	R-38 roof
No perimeter insulation	R-10 perimeter insulation
Conventional double windows	Best low-e double windows
Conventional lighting	Efficient lights with daylight dimming
Conventional HVAC	High efficiency HVAC
Conventional air-tightness	Leakage reduced 75%
Uniform window orientation	Passive solar orientation
Conventional HVAC controls	Improved HVAC controls
Conventional duct placement	Ducts located inside, tightened

Colorado Springs School

20,000 ft^2 elementary school



Cost of EESs

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Costs for applying the Energy Efficient Strategies (using simple scaling laws)

The costs for Reference Case vs the costs for Low-Energy Case

EES Strategy	Reference	Low-Energy
Daylighting	0	13900
Glazing	0	13199
Shading	0	6432
Energy Efficient Lights	0	0
Insulation	0	21440
Air Leakage Control	0	2735
Thermal Mass	0	0
Passive solar heating	0	0
Economizer	0	5000
High efficiency HVAC	0	27935
HVAC Controls	0	2000
Duct leakage	0	3506
Total	0	96147

Compared to a construction cost of 2,276,237

Prioritizing Strategies

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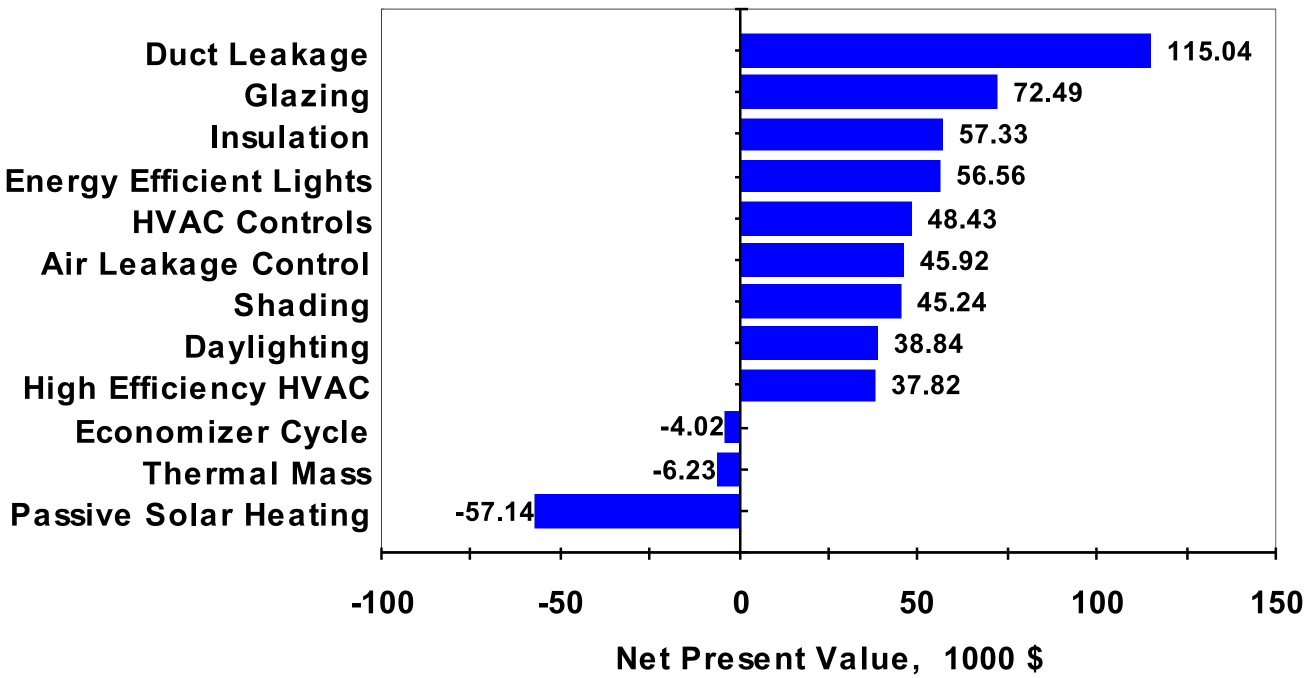
RANKING OF ENERGY-EFFICIENT STRATEGIES



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.

Parametric analysis helps guide decisions regarding best strategies to meet design team goals

Apply Cost Effective Strategies

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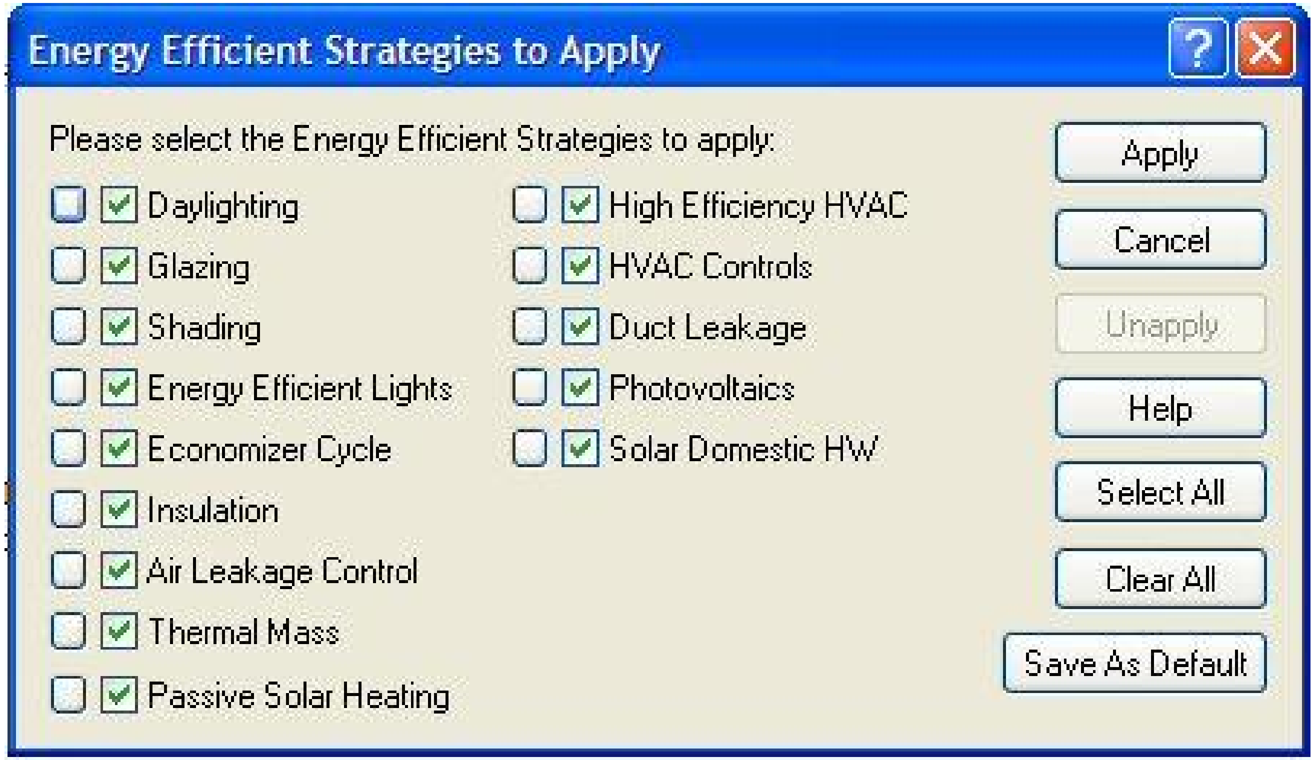
Automatically modifies the building description to implement any or all of 14 strategies



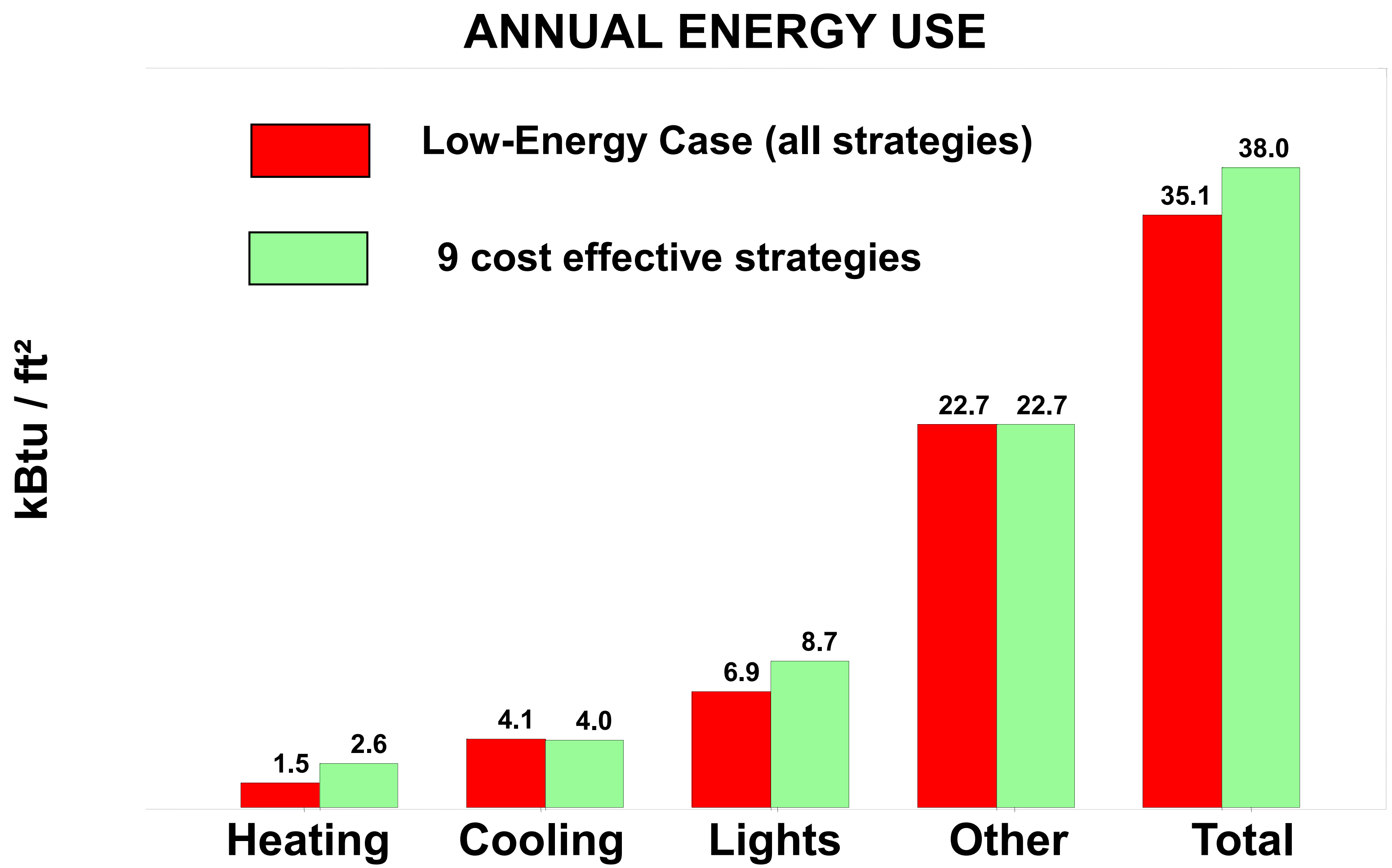
A few mouse clicks does it—saving time
Yet the user has total control

Ranking results

- NPV results depend on all costs, EES costs, HVAC costs, and energy costs
- The HVAC costs sometimes are a critical factor in the cost changes
- Peak cooling loads are often the deciding factor

Applying 9 strategies

20,000 ft^2 elementary school



<u>Construction Costs</u>

Reference

$2,805,025

9 strategies

$2,839,608

Difference

$31,583

<u>Life-Cycle Costs</u>

Reference

$3,284,769

9 strategies

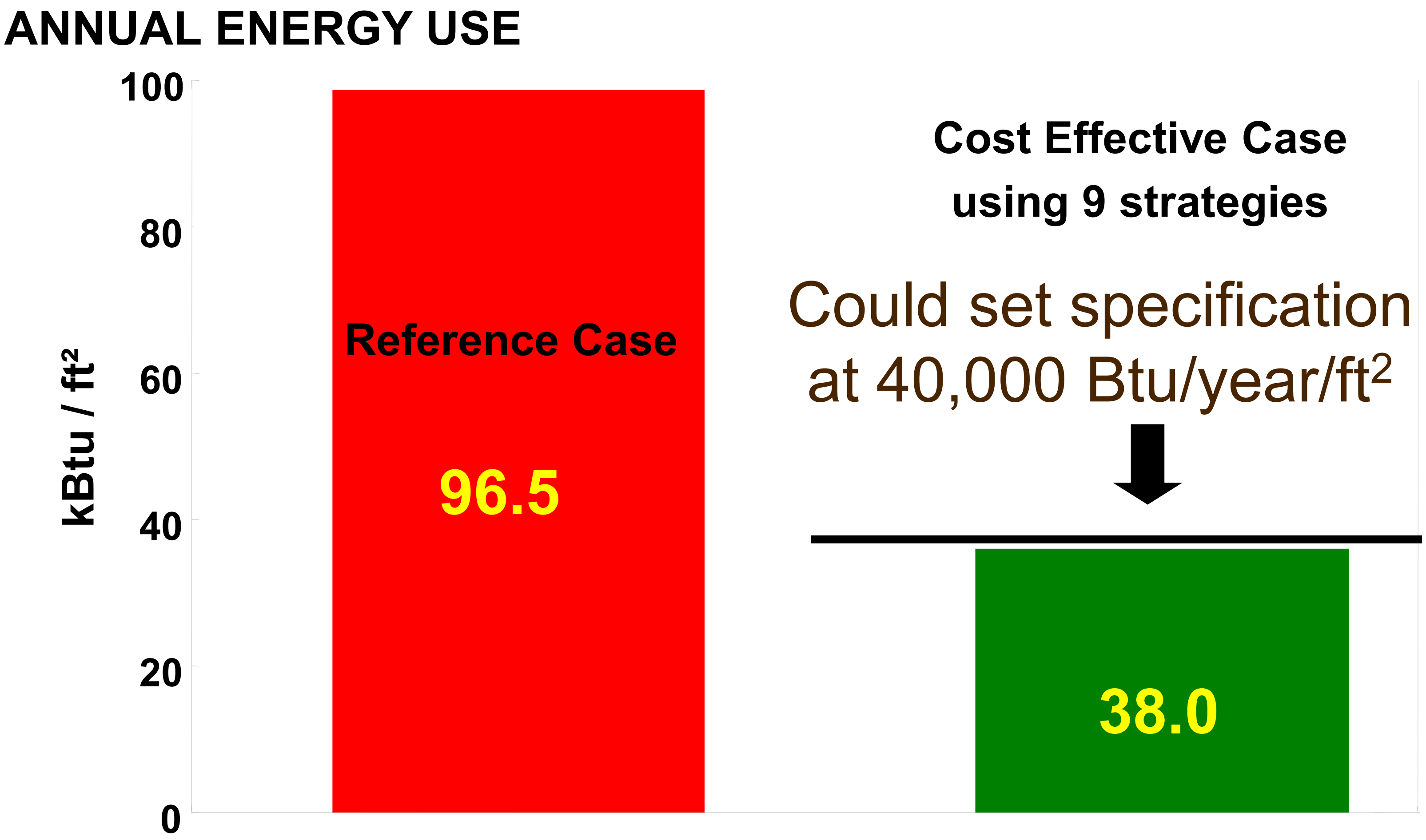
$2,904,048

Difference

$ -380,721

Example

20,000 ft^2 elementary school in Colorado Springs



Design Process

- The design team reviews the pre-design evaluations and conclusions – these form a basis for preliminary screening
- As the design evolves, the building is re-simulated periodically to see if the performance is on track
- At the end preliminary design a more detailed simulation should be made
- *These simulations require doing area takeoffs from the plans*